Minnesota Noxious Weed Risk Assessment

Developed by the Minnesota Noxious Weed Advisory Committee

Assessment information

Common name: Creeping meadow foxtail, creeping foxtail

Scientific name: *Alopecurus arundinaceus* Poir.

Family name: Poaceae (Grass Family; true grasses)

Current reviewer name and organizational affiliation: Laura Van Riper, Minnesota Department of Natural Resources
Date of current review: August 9, 2023

Species description

Photos

Photo caption: Creeping meadow foxtail at Salt Lake Wildlife Management Area in Lac Qui Parle County, Minnesota. Photo credit: Rhett Johnson, Minnesota Department of Natural Resources.

Photo caption: Creeping meadow foxtail ligule. Photo credit: Rhett Johnson, Minnesota Department of Natural Resources.

Photo caption: Creeping meadow foxtail seedhead beginning to lose seeds. Photo credit: Rhett Johnson, Minnesota Department of Natural Resources.

Why the plant is being assessed

- Creeping meadow foxtail has been planted for stabilization projects and in some pasture mixes. Minnesota Department of Natural Resources land managers are finding it to be much more widely distributed in Minnesota than maps show. Where they have seen it, it appears to crowd out other species including reed canary grass (*Phalaris arundinacea*). Creeping meadow foxtails forms a dense monotype that excludes other plants. It appears to be a concern to prairies and wetlands.

Identification, biology, and life cycle

- Perennial, rhizomatous, cool-season grass well adapted to wet areas (Freeman 2000, Robins and Jensen 2011).
- Spreads by rhizomes and windborne and waterborne seeds (USDA NRCS 2006).
- Anthers are more than 1.5 mm long and awns are 0.3-2.0 mm long (Freeman 2000).
- Stems are 50-120 cm tall and 8 mm wide (USDA NRCS 2006).
- Leaves are 6 to 8 mm wide and the top side is glabrous (smooth) above and the bottom side is scabrous (rough) (USDA NRCS 2006).
- The ligule is 1 to 5 mm long and is rounded to acute (USDA NRCS 2006).
- The inflorescence is a 4 to 10 cm long spike that turns purplish or black with maturity (USDA NRCS 2006).
- Similar species (USDA NRCS 2006):
    - Seedhead is similar in appearance to the seedheads of timothy (*Phleum pratense*), but creeping foxtail heads turn purplish or black while timothy seedheads turn a brownish – buff color.
    - Creeping meadow foxtail is a close relative of meadow foxtail (*Alopecurus pratensis*) and can be distinguished by having broader leaves (8-12 mm vs. 4-8 mm) and a dark purplish inflorescence.
    - Species such as foxtail barley (*Hordeum jubatum*) and green foxtail (*Setaria viridis*) have similar common names and can occupy similar habitats but have very different seedheads and are unlikely to be confused for creeping meadow foxtail.
- Distinguishing among *Alopecurus* species (Minnesota Wildflowers 2023): “There are 4 *Alopecurus* species known to be in Minnesota, 2 of which are native. At a glance they may all look similar—narrowly cylindric spikes usually blooming (and completely shedding seed) from the top down, single-flowered spikelets usually blackish when mature, hairy glumes equal in size and shape, and

lemma awns arising from the lower half of the lemma—but the size of the spikelet combined with length of the awn can help determine a correct ID. Creeping Foxtail has relatively large spikelets (3.5 to 6+ mm long) and short awns that barely extend beyond the tip of the spikelet, if at all. The glume tips are also more widely separated than the other species. Of the other species in Minnesota, meadow foxtail (*A. pratensis*) is the only other with spikelets that large, but it has conspicuously longer awns. Of the other species with short awns, spikelets are rarely more than 3.5 mm long."

Current distribution

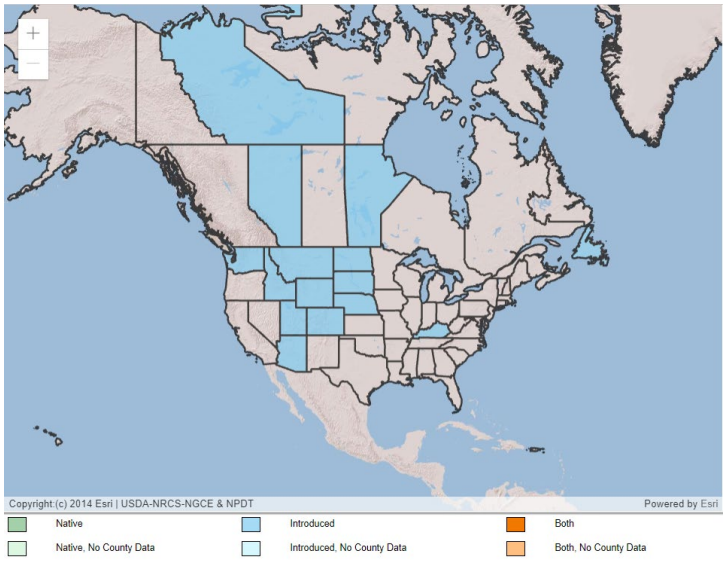

Photo caption: National level map of creeping meadow foxtail from USDA Plants accessed January 20, 2023 (USDA Plants 2023).
Description of where the plant is found in the United States: Creeping meadow foxtail is reported in the neighboring states and provinces of South Dakota, North Dakota, and Manitoba.

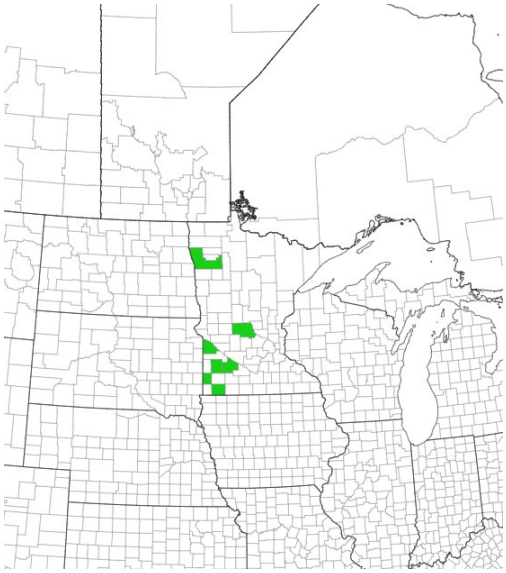

Photo caption: State level map of creeping meadow foxtail from EDDMapS accessed January 20, 2023 (EDDMapS 2023).

Description of where the plant is found in Minnesota: There are EDDMapS reports from seven counties in Minnesota: Polk, Stearns, Lac Qui Parle, Lyon, Redwood, Pipestone, and Nobles. There are two reports in Lac Qui Parle County and one report in each of the other counties. The University of Minnesota Bell Museum Herbarium also has a record from Pennington County in 2017 (Catalog Accession #: 966035).

Current regulation

Creeping meadow foxtail is not regulated in Minnesota and is not known to be regulated by any states or the federal government.

Risk assessment

Box 1:

Is the plant species or genotype non-native?

Answer: Yes.
Outcome: Go to Box 3.
Creeping meadow foxtail is native to Eurasia (Freeman 2000), including Russia (Mirkin et al. 1985) and Turkey (Günaydın and Aykurt 2023). Stroh (1978) reports that the first specimen received by North Dakota State University was in 1934, but that residents report the plant being introduced in 1902. The first record in Colorado was from 1998 along a sandy roadside in short grass prairie (Freeman 2000). Creeping meadow foxtail has been planted in the US for pasture forage and hay (USDA NRCS 2006). There is a variety called 'Garrison' that is promoted for use for forage production in saline soils (Darambazar et al. 2022). There is also a cultivar called 'Retain', but 'Garrison' is the only commonly available cultivar on the commercial seed market in the United States (Robins and Jensen 2011).

Box 2:

Does the species pose significant human or livestock concerns or have the potential to significantly harm agricultural production?

Question 2A: Does the plant have toxic qualities that pose a significant risk to livestock, wildlife, or people?

Outcome: Decision tree does not direct to this question.

Question 2B: Does the plant cause significant financial losses associated with decreased yields, reduced quality, or increased production costs?

Outcome: Decision tree does not direct to this question.

Box 3:

Is the species, or a related species, documented as being a problem elsewhere?

Answer: Yes.
Outcome: Go to Box 6.
The Nebraska Invasive Species Program has a webpage for creeping meadow foxtail as part of its list of invasive plants (Nebraska Invasive Species Program 2023). The Nebraska webpage notes that creeping meadow foxtail is widespread in Nebraska.

Box 4:

Are the species' life history and growth requirements understood?

Outcome: Decision tree does not direct to this question.

Box 5:

Gather and evaluate further information.

Outcome: Decision tree does not direct to this question.

Box 6:

Does the species have the capacity to establish and survive in Minnesota?

Question 6A: Is the plant, or a close relative, currently established in Minnesota?

Answer: Yes.

Outcome: Go to Box 7.

There are EDDMapS reports of creeping meadow foxtail from seven counties in Minnesota: Polk, Stearns, Lac Qui Parle, Lyon, Redwood, Pipestone, and Nobles (EDDMapS 2023). The University of Minnesota Bell Museum Herbarium also has a record from Pennington County in 2017 (Catalog Accession #: 966035). A cold tolerance study of the Garrison cultivar of creeping meadow foxtail found that 100% of plants survived 14 days of ice encasement and 75% of plants survived freezing at 10.4 degrees Fahrenheit (Gudleifsson et al. 1985).

A seed company (Great Basin Seed 2023) website lists the Garrison cultivar as hardy in Plant Hardiness Zones 3-10. In their description of habitat requirements, they say "Well adapted to wetland pastures, 'Garrison' Creeping Foxtail will withstand up to 60 to 70 days of inundation once established. Adapted to a wide range of poorly drained soils. Can tolerate strongly acidic to slightly alkaline environments. Garrison is exceptionally frost tolerant where frost-free periods are less than 30 days. It is moderately drought tolerant, but best performs best in areas receiving 18 inches or more annual precipitation."

USDA NRCS (2006) states, "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 (500-9000 ft), but grows best on middle to high elevation wet to semi-wet sites."

Rhett Johnson, private lands specialist with the Minnesota Department of Natural Resources (personal communication 2023), shared his experience with creeping meadow foxtail in Minnesota. He first encountered it in Minnesota in 2001-2003 when he was working in the Bluestem Prairie area in Clay County. At the time it was pretty common along Interstate 29 in North Dakota. It was in a Native Prairie Bank photo from May 2010 in Lyon County just south of Marshall. At one site in Pipestone County, he collected it in 2019 and at that time the population was about 50 feet down a wet road ditch and about 20 feet up an adjacent drainageway. When he looked at it two years later it was covering a large area probably about an acre in extent. At Pembina Trail (near Crookston, Polk County) he first noticed it in 2019 and at that time it had become established and dense in a drainage ditch and had spread into the preserve in numerous locations. He knows that at Pembina Trail creeping meadow foxtail was not planted in any nearby areas and he thinks it spread from a drainage ditch. Many of the roadside populations he has seen were not planted in the location but may have been planted in other ditches and spread to the location, probably through water and mowing/haying.

Question 6B: Has the plant become established in areas having a climate and growing conditions similar to those found in Minnesota?

Outcome: Decision tree does not direct to this question.

Question 6C: Has the plant become established in areas having a climate and growing conditions similar to those projected to be present in Minnesota under future climate projections?

Outcome: Decision tree does not direct to this question.

Box 7:

Does the species have the potential to reproduce and spread in Minnesota?

Question 7A: Are there cultivars of the plant that are known to differ in reproductive properties from the species?

Answer: No.

Outcome: Go to Question 7B

There are two cultivars ('Garrison' and 'Retain') but there is no evidence they differ in reproductive properties from the species. 'Garrison' is the only commonly available cultivar on the commercial seed market in the United States (Robins and Jensen 2011).

USDA NRCS (2006) description of 'Garrison': " 'Garrison' creeping foxtail (*Alopecurus arundinaceus*) 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." Stroh (1978) includes that the plants collected in 1950 were plants that had escaped from plantings in the area of seed from Ukraine.

USDA NRCS (2006) description of 'Retain': " 'Retain' creeping foxtail (*Alopecurus arundinaceus*) 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."

Robins and Jensen (2011) note that "While creeping foxtail (Alopecurus arundinaceus Poir.) is widely grown in wet meadows and pastures throughout temperate regions of the United States and world, only the cultivars 'Garrison' and 'Retain' have been developed in the United States. These cultivars represent a narrow genetic base and substantial improvement of creeping foxtail may be realized by incorporating additional germplasm resources into a cultivar development program." They "compared the agronomic and nutritive value of 47 creeping foxtail accessions to that of 'Garrison' and 'Retain' in a field study conducted over two production years at a site near Richmond, Utah." They found that "The U.S. cultivars had the numerically highest dry matter yield (116 g plot−1) and the Mongolian accessions (945 g kg−1) had higher in vitro true digestibility than the other regions. Differences among the individual accessions occurred for all traits except rhizome spread. A group of

seven accessions from Afghanistan, Iran, Russia, and Turkey exhibited high dry matter yield and neutral detergent fiber digestibility. These accessions could be combined with the cultivar Garrison to develop a broad base population for further creeping foxtail improvement and cultivar development." The focus on breeding has been to make creeping meadow foxtail a better forage grass, not to reduce reproduction. None of the traits compared in the study related to reproduction.

A cold tolerance study of creeping meadow foxtail 'Garrison' cultivar found that 100% of plants survived 14 days of ice encasement and 75% of plants survived freezing at 10.4 degrees Fahrenheit (Gudleifsson et al. 1985). It did not compare 'Garrison' to the non-cultivar of creeping meadow foxtail.

A seed company (Great Basin Seed 2023) website lists the 'Garrison' cultivar as hardy in Plant Hardiness Zones 3-10. In their description of habitat requirements, they say, "Well adapted to wetland pastures, 'Garrison' Creeping Foxtail will withstand up to 60 to 70 days of inundation once established. Adapted to a wide range of poorly drained soils. Can tolerate strongly acidic to slightly alkaline environments. 'Garrison' is exceptionally frost tolerant where frost-free periods are less than 30 days. It is moderately drought tolerant, but best performs best in areas receiving 18 inches or more annual precipitation." It does not compare the cultivar 'Garrison' to the parent species.

Question 7B: Does the plant reproduce by asexual/vegetative means?

Answer: Yes.
Outcome: Go to Question 7C.
The species is rhizomatous and produces colonies vegetatively via rhizomes (Robins and Jensen 2011). Pieces of rhizomes can spread the plant (USDA NRCS 2006).

Question 7C: Are the asexual propagules - vegetative parts having the capacity to develop into new plants - effectively dispersed to new areas?

Answer: No (No evidence found).
Outcome: Go to Question 7D.
No information was found on how effectively the rhizomes are spread to new areas. Due to the lack of data indicating that they are effectively disbursed, this question was answered as "no".

Question 7D: Does the plant produce large amounts of viable, cold hardy seeds? For woody species, document the average age the species produces viable seed.

Answer: Yes.
Outcome: Go to Question 7G.
USDA NRCS (2006) says "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."

No information was found with detailed seed production numbers per plant. Stroh (1978) noted "in favorable environments, established stands are long lived and improve with age because of prolific rhizomes and the abundance of shattering seed." In one 13-year study, under agronomic conditions with irrigation and nitrogen application, seed yield ranged from 32 pounds of seed per acre in the lowest production year to 412 pounds of seed per acre in the highest production year (Stroh 1978). There are 750,000 seeds per pound (Stroh 1978).

Hoffman et al. (1980) studied the germination of 14 plant species commonly found along reservoirs in the Northern Great Plains, including creeping meadow foxtail. Plants were collected from Lake Oahe, South Dakota.

Half the seeds were tested in the autumn and the remaining half overwintered outside in Vermillion, South Dakota in these treatments: (1) dry, (2) on moist filter paper in light and in darkness, and (3) in light in water. Germination was tested in light on moist filter paper, in darkness on moist filter paper, and in water in light. Creeping meadow foxtail germinated best in water. Creeping meadow foxtail germinability was enhanced by overwintering, in either the dry or moist treatments. Stratification also increased germinability. The highest germination for creeping meadow foxtail was 81% germination for the treatment where it was overwintered dry and then germinated on filter paper in the light.

USDA NRCS (2006) states, "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 (500-9000 ft), but grows best on middle to high elevation wet to semi-wet sites."

Question 7E: For species that produce low numbers of viable seeds, do they have a high level of seed/seedling vigor or remain viable for an extended period (seed bank)?

Outcome: Decision tree does not direct to this question.

Question 7F: Is the plant self-fertile?

Answer: ***This information is supplemental and is not part of the flow chart pathway for this risk assessment.***
Stroh (1978) states: "The species, including the variety Garrison, is open pollinated, possibly self sterile, strongly heterozygous, and susceptible to interspecific breeding with *A. pratensis*".

Question 7G: Are sexual propagules – viable seeds – effectively dispersed to new areas? List and consider all vectors.

Answer: Yes.
Outcome: Go to Question 7I.
USDA NRCS (2006) says "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."

Question 7H: Can the species hybridize with native species (or other introduced species) and produce viable seed and fertile offspring in the absence of human intervention?

Answer: ***This information is supplemental and is not part of the flow chart pathway for this risk assessment.***
Stroh (1978) states: "The species, including the variety Garrison, is open pollinated, possibly self sterile, strongly heterozygous, and susceptible to interspecific breeding with *A. pratensis*". *Alopecurus pratensis* is not native to Minnesota (CABI 2015).

Question 7I: Are there natural controls (species native to Minnesota) which have been documented to effectively prevent the spread of the species in question?

Answer: No.
Outcome: Go to Box 8.
No evidence was found for natural, population-level controls in Minnesota. USDA NRCS (2006) states, "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."

Perilla López et al. (2015) found that non-native *Stenodiplosis geniculati* (Diptera: Cecidomyiidae) gall midges were present in South Dakota and were restricted to *Alopecurus arundinaceus* (creeping meadow foxtail) and *A. pratensis*. The *Stenodiplosis geniculati* were observed ovipositing into creeping meadow foxtail inflorescences. The *Stenodiplosis geniculate* were found to have an undetermined Aphelinidae hyperparasitoid that emerged from them. They found that the gall midge infestation rates on creeping meadow foxtail ranged from 20-80%. They noted that those are signification rates that could impact "seed production and impact the commercial production of these grasses used as forage crops" but that further evaluation would be needed to see if they act as a biological control.

Creeping meadow foxtail has been documented as a host of ergot (*Claviceps purpurea*) in Turkey (Eken et al. 2006).

Question 7J: Was the answer to Question 7A (Are there cultivars that differ in reproductive properties from the original species) "Yes"?

Outcome: Decision tree does not direct to this question.

Box 8:

Does the species pose significant human or livestock concerns or have the potential to significantly harm agricultural production, native ecosystems, or managed landscapes?

Question 8A: Does the plant have toxic qualities, or other detrimental qualities, that pose a significant risk to livestock, wildlife, or people?

Answer: No.

Outcome: Go to Question 8B.

Creeping meadow foxtail has been purposely planted for livestock forage and is palatable to all classes of livestock (USDA NRCS 2006). USDA NRCS (2006) states, "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 palatable forage season long. Plants break winter dormancy early in spring, and leaves remain green and palatable even during the hottest months."

Research in Minnesota (Allen et. 2012) compared 'Garrison' creeping meadow foxtail and 10 other cool-season grasses to evaluate forage yield and persistence of cool-season grasses under horse grazing. Creeping meadow foxtail was one of the three species with the lowest yield and was not one of the four species that the authors recommended for maximizing forage yield and persistence. In Allen et al. (2013) they evaluated horse preference and forage nutritive value of the same cool-season grasses. Creeping meadow foxtail was one of the least preferred grasses and had a lower concentration of crude protein than other species. They stated that overall creeping meadow foxtail was the "was the lowest quality cool-season grass, with low CP [crude protein] and NDFD [neutral detergent fiber digestibility] amounts and high NDF [neutral detergent fiber] values."

Darambazar et al. (2022) studied forage mixtures for saline soils in Saskatchewan. They found that "binary mixtures of 'Halo' alfalfa with 'Revenue' slender wheatgrass or 'Garrison' creeping meadow foxtail could be reasonable alternatives for adequate forage production and quality, high N-use efficiency, and ultimately livestock gain per hectare, as well as for controlling soil salinity and improving soil fertility in this saline area in the dark brown soil zone."

Creeping meadow foxtail has been documented as a host of ergot (*Claviceps purpurea*) in Turkey (Eken et al. 2006). The author could not find articles documenting negative impacts from livestock eating ergot-infested creeping meadow foxtail.

Question 8B: Does, or could, the plant cause significant financial losses associated with decreased yields, reduced crop quality, or increased production costs?

Answer: No.
Outcome: Go to Question 8C.
While no information was found on financial loss related to crops, USDA NRCS (2006) does state, "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."

Question 8C: Can the plant aggressively displace native species through competition (including allelopathic effects)?

Answer: Yes.
Outcome: Go to Box 9.
USDA NRCS (2006) states, "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."

USDA NRCS (2006) notes that creeping meadow foxtail is adapted to many habitats and conditions, stating "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 (500-9000 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 60 to 90 cm 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)."

Stroh (1978) noted "in favorable environments, established stands are long lived and improve with age because of prolific rhizomes and the abundance of shattering seed. This aggressiveness provides vigorous competition to other plants, including Canada thistle (*Cirsium arvense*) which was suppressed in a seed production field at Bridger, Montana, to the extent that it did not bloom. Seedings of Garrison in legume mixtures must be managed with care to maintain legumes in the mixture." Stoh (1978) also noted "The closest competitor to Garrison on wetland sites is reed canarygrass (*Phalaris arundinaceus* L.). Both species have similar moisture and flooding tolerance, and both are aggressive competitors on these sites."

Rhett Johnson, Minnesota Department of Natural Resources private land specialist, nominated creeping meadow foxtail for a noxious weed risk assessment. He noted that it has been planted for stabilization projects

and in some pasture mixes. He is finding it to be much more widely distributed in Minnesota than the maps show. He has worked to send specimens to the Bell Museum and report locations in EDDMapS. Where he has seen it, he notes it is extremely aggressive and even appears to crowd out reed canarygrass. He shared the photo on page 1 of this assessment that shows a large stand at Salt Lake Wildlife Management Area. He notes it forms a dense monotype that excludes other plants and has seen the same results at other places he has encountered it (Johnson 2022 personal communication). In terms of habitat, he finds that tends to be in the same habitats as reed canarygrass. He has seen it growing in ankle-deep water (about 4 inches). Usually when he has encountered it, it is growing in areas that have standing water in the spring but were in saturated soil or moist soil at the time he encountered them (Johnson 2023 personal communication). He notes that the places he has seen it have mostly been around shallow waterways (streams, road ditches and drainage ditches) and in places where it most likely spread to from a ditch. He thinks the most likely means of arrival to the sites he manages are through waterways by floating seeds, on people and animals through clingy hairs on the seeds, and through mowing and haying ditches. He notes that it flowers very early and can take advantage of spring high water levels to spread the seed, but some seed hangs on long enough to be transported by haying.

Isleib (2016) noted that creeping meadow foxtail planted in a beef farm in the Upper Peninsula of Michigan produced a significant amount of viable seed and spread fairly aggressively. He stated it "is very competitive with other forage species and often crowds them out, including reed canary grass in wet areas. Seed is small and fluffy and seedling vigor is low for the first six weeks or so after emergence."

Question 8D: Can the plant hybridize with native species resulting in a modified gene pool and potentially negative impacts on native populations?

Answer: ***This information is supplemental and is not part of the flow chart pathway for this risk assessment.*** There are four *Alopecurus* species in Minnesota (Minnesota Wildflowers 2023). Two are non-native: *A. arundinaceus* and *A. pratensis*. Two are native: *A. aequalis* and *A. carolinianus*. No information was found regarding hybridization with native *Alopecurus* species.

Question 8E: Does the plant have the potential to change native ecosystems (adds a vegetative layer, affects ground or surface water levels, etc.)?

Answer: ***This information is supplemental and is not part of the flow chart pathway for this risk assessment.*** In a study in Iran, creeping meadow foxtail was found to have high root colonization levels by arbuscular mycorrhizal fungi (Khakpour and Khara 2012). The authors note that "mycorrhizal plants frequently show resistance to environmental stresses. They also increase the activity of nitrogen-fixing organisms in the root zone."

Question 8F: Does the plant have the potential to introduce or harbor another pest or serve as an alternate host?

Answer: ***This information is supplemental and is not part of the flow chart pathway for this risk assessment.*** Creeping meadow foxtail has been documented as a host of ergot (*Claviceps purpurea*) in Turkey (Eken et al. 2006). The author could not find articles documenting negative impacts from livestock eating ergot-infested creeping meadow foxtail.

Box 9:

Does the species have clearly defined benefits that outweigh associated negative impacts?

Question 9A: Is the plant currently being used or produced and/or sold in Minnesota or native to Minnesota?

Answer: Yes.
Outcome: Go to Question 9B.
Creeping meadow foxtail is sold for forage and hay. It is not native to Minnesota. Minnesota studies, such as Allen et al. (2013), indicate it is planted in the state. Vendors such as Great Basin Seed (2023) offer creeping meadow foxtail for sale. Albert Lea Seed (2023) located in Albert Lea, Minnesota lists Garrison creeping foxtail for sale. It is unclear if they grow it themselves. The reviewer was unable to track down sales numbers for the state of Minnesota or determine if there are any producers of creeping meadow foxtail seed in the state.

Denise Thiede (Seed, Weed, Hemp and Biotechnology Section Manager at the Minnesota Department of Agriculture, personal communication 2023) reviewed seed inspection records for 2020, 2021, 2022, and as of March 8, 2023, did not inspect or sample any lots of this species in Minnesota. She noted that they inspect a small proportion of seed lots in the marketplace (typically 1600-1800 seed lots per year) so creeping meadow foxtail could be in the marketplace and just not inspected. Denise Thiede also noted that other sources of information, such as using the sales reports from permanent permit holders won't provide data on creeping meadow foxtail because they only report grasses in a category and do not report the sale of each species.

Dan Lofthus (State Statistician for the Upper Midwest Region – Minnesota at the USDA, National Agricultural Statistics Service) is the contact for state agricultural statistics (personal communication 2023). He did not have any data on the species and noted it is not something that they have ever picked up in the Census of Agriculture which he said was the most likely place where a crop like creeping meadow foxtail could be written in by a producer.

The Minnesota Department of Agriculture surveyed nursery certificate holders and Minnesota Nursery Landscape Association members regarding plant species being assessed by the Noxious Weed Advisory Committee. The survey was open during June and July 2023 and there were 30 responses. For creeping meadow foxtail, no respondents indicated that they sell creeping meadow foxtail or had concerns about potential regulation of the species.

Question 9B: Is the plant an introduced species and can its spread be effectively and easily prevented or controlled, or its negative impacts minimized, through carefully designed and executed management practices?

Answer: No.
Outcome: Go to Question 9C.
No easy and effective methods were found for reducing impacts.

Question 9C: Is the plant native to Minnesota?

Answer: No.
Outcome: Go to Question 9D.
Creeping meadow foxtail is native to Eurasia (Freeman 2000), including Russia (Mirkin et al. 1985) and Turkey (Günaydın and Aykurt 2023).

Question 9D: Is a non-invasive, alternative plant material or cultivar commercially available that could serve the same purpose as the plant of concern?

Answer: Yes.
Outcome: Go to Box 10.
While some of the alternative plants are non-native, there are many that are not regulated as noxious weeds.

The University of Minnesota Extension (2018a) webpage on identifying pasture grasses lists the following species as common cool-season pasture grasses in Minnesota: Kentucky bluegrass (*Poa pratensis*), orchardgrass (*Dactylis glomerata*), perennial ryegrass (*Lolium perenne*), reed canarygrass (*Phalaris arundinacea*), smooth bromegrass (*Bromus inermis*), tall fescue (*Schedonorus phoenix*), and timothy (*Phleum pratense*). The University of Minnesota Extension (2018b) webpage on cool-season grasses grown with alfalfa mixes for forage, recommends meadow fescue (*Festuca pratensis*) and orchardgrass.

In the Allen et al. (2013) study of horse grazing, they found that out of 11 cool-season grasses studied (including creeping meadow foxtail), the horses preferred Kentucky bluegrass (*Poa pratensis* L.), timothy (*Phleum pratense* L.), and meadow fescue (*Schedonorus pratensis* (Huds.) P. Beauv.) and that perennial ryegrass (*Lolium perenne* L.), quackgrass (*Elymus repens* (L.) Gould), and smooth bromegrass (*Bromus inermis* Leyss.) had a higher concentration of crude protein than other grasses. In the Allen et al. (2013) study of horse grazing, they found that out of 11 cool-season grasses studied (including creeping meadow foxtail), they found that orchardgrass (*Dactylis glomerata* L.)., meadow fescue (*Schedonorus pratensis* Huds.), Kentucky bluegrass, and tall fescue (*Schedonorus phoenix* Scop.), were the most persistent grasses and that orchardgrass produced the highest yield while Garrison creeping foxtail (*Alopecurus arundinaceus* Pior.), smooth bromegrass, and timothy produced the lowest yield.

Roger Becker from University of Minnesota Extension (personal communication 2023a) shared that, in general, native cool season grasses do not support as high a level of animal performance per acre compared to improved, introduced forage selections. In Minnesota, for beef and nonlactating dairy cows, smooth bromegrass and low-alkaloid forage varieties of reed canarygrass are widely used and yield well in grazing and reduced cutting schedule harvest systems. Junegrass (*Koeleria macrantha*) is a native cool season grass that is sometimes used for forage, notably in northcentral and northeastern Minnesota. Additionally, slender wheatgrass (*Elymus trachycaulus*), western wheatgrass (*Pascopyrum smithii*), Canada wild rye (*Elymus canadensis*), and Virginia wild rye (*Elymus virginicus*) are productive native cool season alternatives to introduced species.

Roger Becker (2023a) also noted an underutilized niche for Minnesota's native warm-season grasses, e.g., side-oats grama (*Bouteloua curtipendula*), big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), switchgrass (*Panicum virgatum*), and Indiangrass (*Sorghastrum nutans*), which when properly managed are good forage. Compared to cool-season grasses, optimal use of native warm-season grasses involves fewer harvests for hay and the plants are grazed during the summer months. Like some cool season grasses, most warm season grasses are well suited for winter stockpile grazing.

Question 9E: Does the plant benefit Minnesota to a greater extent than the negative impacts identified at Box #8?

Outcome: Decision tree does not direct to this question.

Box 10:

Should the species be regulated as Prohibited/Eradicate, Prohibited/Control, or Restricted Noxious Weed?

Question 10A: Is the plant currently established in Minnesota?

Answer: Yes.
Outcome: Go to Question 10D.
There are EDDMapS reports from seven counties in Minnesota: Polk, Stearns, Lac Qui Parle, Lyon, Redwood, Pipestone, and Nobles. There are two reports in Lac Qui Parle County and one report in each of the other counties (EDDMapS 2023). The University of Minnesota Bell Museum Herbarium also has a record from Pennington County in 2017 (Catalog Accession #: 966035). Since it has been sold and disseminated as a forage grass, there are likely to be more plantings that are the size of pastures.

Question 10B: Would prohibiting this species in trade prevent the likelihood of introduction and/or establishment?

Outcome: Decision tree does not direct to this question.

Question 10C: Does this risk assessment support this species being a top priority for statewide eradication if found in the state?

Outcome: Decision tree does not direct to this question.

Question 10D: Does the plant pose a serious human health threat?

Answer: No.
Outcome: Go to Question 10F.
There was no information found indicating that it is a human health threat.

Question 10E: Is the health threat posed by the plant serious enough, and is the plant distribution sufficiently small enough to be manageable, and are management tools available and effective enough to justify listing as Prohibited / Eradicate species?

Outcome: Decision tree does not direct to this question.

Question 10F: Is the plant known to cause significant ecological or economic harm and can the plant be reliably <u>eradicated</u> (entire plant) on a statewide basis using existing practices and available resources considering the distribution, reproductive biology and potential for spread?

- *For distribution, note if the distribution is well documented, the number and acreage of known infestations and how widespread they are in the state. Note if there are infestations in border areas.*
- *For reproductive biology, note if there are reproductive biology factor that make the plant easier to control and eradication more likely (for example, long pre-reproductive period, self-incompatible pollination, short-lived seed bank).*
- *For potential for spread and re-invasion of controlled areas, note its potential to spread beyond places where it is being controlled such as deliberate planting by people, wildlife vectors, re-infestation from border states, or other factors that facilitate spread.*
- *For known management tools, note what management tools are available, potential non-target impacts, and the reasonableness of state management or mandating that landowners throughout the state use the management tools to eradicate or control existing plants.*

- *For available resources, consider the capacity of state and local personnel and availability of funding to respond to new and existing infestations.*

Answer: No.

Outcome: Go to Question 10G.

The plant is not known to cause significant ecological or economic harm. Its ecological impacts have not been studied.

Question 10G: Is the plant known to cause significant ecological or economic harm and can the plant be reliably controlled to limit spread on a statewide basis using existing practices and available resources? Would the economic impacts or other hardships incurred in implementing control measures be reasonable considering any ongoing or potential future increase of ecological or economic harm?

- *Also consider all bullet points listed under 10F when evaluating 10G*

Answer: No.

Outcome: Question 10H.

The answer for this question was given as a "no" because there is not documented "significant" ecological or economic harm.

Distribution: Creeping meadow foxtail is known to be in eight counties in Minnesota and the EDDMapS reports add up to it covering 8 acres (EDDMapS 2023). Given its history as being promoted as a forage grass, it is likely more widespread than what is mapped in EDDMapS. USDA Plants (2023) shows creeping meadow foxtail as present in the neighboring states of North Dakota and South Dakota, but does not provide detailed maps of where it is found within those states.

Reproductive biology: There are no identified reproductive biology factors that make the plant easier to control and eradication more likely.

Potential for spread and reinvasion: Creeping meadow foxtail does have the potential to spread beyond places where it is being controlled such as through deliberate planting by people or its own spread of seeds. Wildlife vector or spread from neighboring states appears to be less of an issue.

Management tools: Management for creeping yellow foxtail (*A. arundinaceus*) is likely similar to meadow foxtail (*A. pratensis*) management. Cascadia Prairie-Oak Partnership (2019) provides the following information on Control Methods for *A. pratensis*:

- Large Scale:
    - Chemical: Glyphosate is very effective for non-sensitive habitats. Timing: Late summer to early fall, before tillering occurs.
    - Chemical: Some effect from dicamba application at 1.5 kg/ha.
    - Chemical: Grass-selective control around broadleaf plants- haloxyfop, sethoxydim or fluazifop may be effective.
    - Grazing/Mowing - Early spring grazing may decrease the percentage of *A. pratensis* within mixed species pasture but it may become less palatable as it matures but its use as a pasture grass makes it unlikely that grazing alone will be effective control. Early and frequent mowing can reduce biomass and prevent further seeding (can still spread through rhizomes).
    - Fire: May respond to fire, but does not appear to be significantly controlled with prescribed burns.
- Small Scale:

    - Hand-pulling/ digging is possible for small colonies because rhizomes are not extensive.
- Unsuccessful control methods:
    - Flooding is tolerated by meadow foxtail.
    - Herbicides chlorsulfuron or metsulfuron-methyl have no effect on biomass up to 0.14kg/ha.
    - Herbicide 2,4-D amine (at 3 kg/ha) and 2,4-D butyl ester (at 2 kg/ha) had little effect.

In a personal communication with Roger Becker of University of Minnesota Extension (2023b), he noted that glyphosate is generally most consistent and efficacious when applied in late September through to killing frost due to historically dry periods in August and September in upland areas causing stressed cool season grasses in late summer. He noted that the Cascadia Prairie-Oak Partnership (2019) rate of dicamba application is high and may cause a lot of collateral damage to dicots and have residual soil activity. He also shared that clethodim could also be an appropriate herbicide and has some non-crop labelling.

Available resources: The are no novel resources for managing creeping meadow foxtail. Management would need to be done from existing budgets.

Question 10H: Would prohibiting this species in trade have any significant or measurable impact to limit or reduce the existing populations or future spread of the species in Minnesota?

Answer: Yes.
Outcome: LIST THE PLANT AS A RESTRICTED NOXIOUS WEED
Prohibiting the species in trade would prevent additional areas from being planted with creeping meadow foxtail. It would not stop existing populations from spreading to new areas.

Question 10I: Are there any other measures that could be put in place as Special Regulations which could mitigate the impact of the species within Minnesota?

Answer: No. ***This information is supplemental and is not part of the flow chart pathway for this risk assessment.***
There were no measures identified that would be appropriate for Special Regulations.

Box 11:

The species is being proposed to be designated as a Specially Regulated Plant. What are the specific regulations proposed?

Answer: Decision tree does not direct to this question.

Final outcomes of risk assessment (2023)

NWAC Listing Subcommittee

Outcome: Restricted Noxious Weed
Comments: No comments

NWAC Full Committee

Outcome: List as a Restricted Noxious Weed
Comments: The vote was 15 to 2 in favor of the recommendation.

MDA Commissioner

Outcome: List as a Restricted Noxious Weed
Comments: No comments

Risk Assessment Current Summary (08-09-2023)

- Creeping meadow foxtail has been planted for forage, hay, and soil stabilization.
- Minnesota Department of Natural Resources land managers are finding it in prairies and wetlands where it appears to crowd out other species including reed canary grass (*Phalaris arundinacea*).
- Published descriptions of creeping meadow foxtail highlights its ability to grow in wet soils ands its ability to outcompete other species (USDA NRCS 2006, Stoh 1978).
- There is limited documentation on the impacts of creeping meadow foxtail.
- Due to the limited information on creeping meadow foxtail impacts, it is likely not a high enough priority to add to the Prohibited Eradicate or Prohibited Control lists.
- The main introduction pathway for creeping meadow foxtail is through agronomic plantings. Listing creeping meadow foxtail as a Restricted Noxious Weed would reduce additional introductions to the state.

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