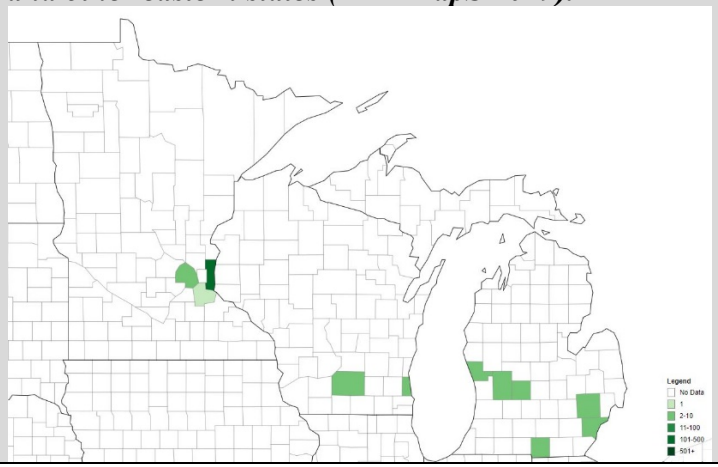
MN NWAC Risk Assessment Worksheet (04-2017)	Common Name	*Latin Name* (Full USDA Nomenclature)
	Grecian foxglove	***Digitalis lanata* Ehrh.**
Original Reviewer: Emilie Justen	**Affiliation/Organization: MN Dept. Of Ag.**	**Original Review: 08/13/2019**

Species Description:

- Grecian foxglove is a perennial plant that forms a rosette its first year, then bolts and sends up a single flowering stem its second and subsequent years.
- The flowering stems are unbranched and grow 2- 5 feet tall with many tubular flowers arranged in an elongated cluster. Flowers are creamy white to pale yellow with brownish-purple venation inside.
- Leaves are simple, alternate, and oblong-shaped with a pointed tip. Flowering stems and calyxes are covered with woolly hairs.
- Flowering occurs in the summer. The flowers are pollinated primarily by bees, after which seed-containing oval pods are produced.
- Seed production is prolific and is the only means of reproduction for this species.
- The common garden foxglove, *D. purpurea*, can be distinguished by the lack of woolly hairs on the stem and calyx. The leaf shape of garden foxglove is more rounded and the flowers exhibit a wide range of colors. Garden foxglove has not been reported as invasive in Minnesota. Multiple species of *Digitalis* can hybridize, but no hybrids have been reported in Minnesota.

Current Regulation: Prohibited – Eradicate. All above and below ground parts of the plant must be destroyed. Additionally, no transportation, propagation, or sale of this plant is allowed. Failure to comply may result in an enforcement action by the county or local municipality.

Box	Question	Answer	Outcome
1	Is the plant species or genotype non-native?	Yes	Box 3
2	Does the plant species pose significant human or livestock concerns or has the potential to significantly harm agricultural production?		
	A. Does the plant have toxic qualities that pose a significant risk to livestock, wildlife, or people?		

Box	Question	Answer	Outcome
	B. Does the plant cause significant financial losses associated with decreased yields, reduced quality, or increased production costs?		
3	Is the plant species, or a related species, documented as being a problem elsewhere?	Yes. Wisconsin lists it on the NR-40 as Prohibited; Kansas has a quarantine to prohibit it from sale (National Plant Board).	Box 6A
4	Is the plant species' life history & Growth requirements understood?		
5	Gather and evaluate further information:		
6	Does the plant species have the capacity to establish and survive in Minnesota?		
	A. Is the plant, or a close relative, currently established in Minnesota?	Yes. Herbarium records dating back to 1956 exist for populations in Washington County (Bell Herbarium). Currently established in Washington and Hennepin Counties.	Box 7
	B. Has the plant become established in areas having a climate and growing conditions similar to those found in Minnesota?	***Yes. Populations reported in Wisconsin, Michigan, and other eastern states (EDDMapS 2019).*** 	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
7	Does the plant species have the potential to reproduce and spread in Minnesota?		
	A. Does the plant reproduce by asexual/vegetative means?	No.	Box 7C

Box	Question	Answer	Outcome
	B. Are the asexual propagules effectively dispersed to new areas?		
	C. Does the plant produce large amounts of viable, cold-hardy seeds?	Yes. Grime et al. (1988) states that *D. purpurea* (closely related non-native species) may produce more than 70,000 seeds/plant and forms a persistent seed bank; no known studies of *D. lanata* seed bank longevity. The *Digitalis* genus is generally known to have seeds that remain viable for longer than a year and less than 10 years (Van Baalen 1982).	Box 7E
	D. If this species produces low numbers of viable seeds, does it have a high level of seed/seedling vigor or do the seeds remain viable for an extended period?		
	E. Is this species self-fertile?	Yes. (Bebeau 2014, Mastenbroek 1985)	Box 7F
	F. Are sexual propagules – viable seeds – effectively dispersed to new areas?	Yes. Cultivated as an ornamental and medicinal purposes; dispersed mainly by humans (Bell Museum, Bucay 1999, Crooks 1948, Mastenbroek 1985). Possible adhesion to animals (Grime et al 1988; Tackenberg et al. 2006; de Pablos and Peco 2007).	Box 8
	G. Can the species hybridize with native species (or other introduced species) and produce viable seed and fertile offspring in the absence of human intervention?	***No. There are no known endemic* Digitalis *species in North America.***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	H. If the species is a woody (trees, shrubs, and woody vines) is the juvenile period less than or equal to 5 years for tree species or 3 years for shrubs and vines?		
	I. Do natural controls exist, species native to Minnesota, that are documented to effectively prevent the spread of the plant in question?		
8	Does the plant species pose significant human or livestock concerns or has the potential to significantly harm agricultural production, native ecosystems, or managed landscapes?		

Box	Question	Answer	Outcome
	A. Does the plant have toxic qualities, or other detrimental qualities, that pose a significant risk to livestock, wildlife, or people?	Yes. Contains cardiac glycosides that are very toxic to humans and livestock if ingested. A case study of a family who mistakenly consumed leaves of *Digitalis purpurea* (closely related to *D. lanata*) in Italy revealed that the basal leaves of *Borago officinalis* look similar to the basal leaves of *Digialis* (Maffe et al 2009). Case studies of *Digitalis* poisoning from dietary supplements have also been documented in the New England Journal of Medicine (Slifman et al 1998). Symptoms of poisoning in humans include nausea, vomiting, diarrhea, weakness, fatigue, atrial fibrillation which can lead to death (Hermann et al 1944, Roberts et al 2016, Serrano 2018). There are both anecdotal and peer reviewed research that dried leaves in hay have sickened and killed calves (El Mahdy et al 2017, Jordan et al. 2008). Digoxin is similar to the toxins contained in milkweed species and symptoms in livestock are sudden death, labored respiration, pulmonary edema, muscular tremors, and a weak rapid pulse (Stegelmeier and Panter 2012).	Box 9
	B. Does, or could, the plant cause significant financial losses associated with decreased yields, reduced crop quality, or increased production costs?	***No***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	C. Can the plant aggressively displace native species through competition (including allelopathic effects)?	***Yes. I have observed numerous populations in Washington County, MN outcompeting native grassland and woodland species (Justen 2019).***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	D. Can the plant hybridize with native species resulting in a modified gene pool and potentially negative impacts on native populations?	***No. There are no species in the Digitalis genus native to North America (USDA 2019).***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**

Box	Question	Answer	Outcome
	E. Does the plant have the potential to change native ecosystems (adds a vegetative layer, affects ground or surface water levels, etc.)?	***Yes, displaces native vegetation (Justen 2019).***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	F. Does the plant have the potential to introduce or harbor another pest or serve as an alternate host?	***In the Netherlands where it was grown in commercial production for digoxin extraction, one fungus Septoria digitalis produces damage sufficient to require chemical control (Mastenbroek 1985).*** ***It is also a natural host of broad bean wilt virus and turnip mosaic virus, two aphid-born viruses in Italy (Bellardi et al 2007). Bellardi et al (2007) confirmed infections of a phytoplasma related to aster yellows in D. lanata.***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
9	Does the plant species have clearly defined benefits that outweigh associated negative impacts?		
	A. Is the plant currently being used or produced and/or sold in Minnesota or native to Minnesota?	No	Box 10
	B. 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?	***Yes it is introduced, with persistent outreach and herbicide treatments populations have decreased. Minnesota Dept of Transportation conducted herbicide trials and found that active ingredient metsulfuron methyl was the most effective (Walvatne et al. 2001).***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	C. Is the plant native to Minnesota?	***No***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	D. Is a non-invasive, alternative plant material commercially available that could serve the same purpose as the plant of concern?		
	E. Does the plant benefit Minnesota to a greater extent than the negative impacts identified at Box #8?	***No. It is not sold in the nursery trade.***	***This text is provided as additional information not directed through the decision tree process for this particular risk assessment.***

Box	Question	Answer	Outcome
10	Should the plant species be enforced as a noxious weed to prevent introduction &/or dispersal; designate as prohibited or restricted?		
	A. Is the plant currently established in Minnesota?	Yes	Box 10B
	B. Does the plant pose a serious human health threat?	Yes	Box 10C
	C. Can the plant be reliably eradicated (entire plant) or controlled (top growth only to prevent pollen dispersal and seed production as appropriate) on a statewide basis using existing practices and available resources?	Yes. With persistent herbicide treatments (at least twice per year), eradication may be feasible. Infestations in Minnesota total less than 300 acres in three counties.	Enforce as Prohibited - Eradicate
11	Should the plant species be allowed in Minnesota via a species-specific management plan; designate as specially regulated?		

Final Results of Risk Assessment		
Review Entity	**Comments**	**Outcome**
NWAC Listing Subcommittee	07/18/19	Prohibited Eradicate
NWAC Full Committee	Vote was 15:0 in favor of Prohibited Eradicate on 12/03/19.	Prohibited Eradicate
MDA Commissioner	Commissioner agreed	Prohibited Eradicate

Risk Assessment Current Summary (*08/13/2019*):

- Grecian foxglove had not had a risk assessment completed prior to this year. Though information on its invasiveness was limited, due to its toxicity and invasiveness in Washington County, the listing subcommittee voted to keep it on the Prohibited-Eradicate list.

References:

Bebeau, G.D. 2014. Friends of the Wild Flower Garden, Inc. https://www.friendsofeloisebutler.org/pages/plants/foxglove.html Accessed 04/18/2019.

Bellardi, M. G., A. Benni, S. Paltrinieri, and A. Bertaccini. 2007. A severe disease induced by 'Candidatus Phytoplasma asteris' in Digitalis lanata. Bulletin of Insectology 60 (2): 275-276.

Bell Herbarium. 1956. Catalog (Accession) #: 531551. Collector: John De Q. Briggs.

De Pablos, I. and B. Peco. 2007. Diaspore morphology and the potential for attachment to animal coats in Mediterranean species: an experiment with sheep and cattle coats. Seed Science Research. 17: 109-114.

EDDMapS. 2019. Early Detection & Distribution Mapping System. The University of Georgia - Center for Invasive Species and Ecosystem Health. Available online at http://www.eddmaps.org/; last accessed June 14, 2019.

El Mahdy, C., S. Popescu, and C. Borda. 2017. Plants that can be poisonous for cows. Bulletin UASVM Animal Science and Biotechnologies 72(2): 69-83.

Grime, J. P., J. G. Hodgson & R. Hunt. 1988. Comparative plant ecology. a functional approach to common British species. Unwin Hyman, London, UK. 742 pp.

Hermann, G. R., G. M. Decherd Jr., and W. F. McKinley. 1944. Digitalis poisoning. J.A.M.A. 126(2): 760-762.

Jordan, M.J., G. Moore and T.W. Weldy. 2008. Invasiveness ranking system for non-native plants of New York. Unpublished. The Nature Conservancy, Cold Spring Harbor, NY; Brooklyn Botanic Garden, Brooklyn, NY; The Nature Conservancy, Albany, NY.

Justen, E. 2019. Personal observations.

Maffe, S., L. Cucchi, F. Zenone, C. Bertoncelli, F. Beldi, M. L. Colombo, M. Bielli, A. M. Paino, U. Parravicini, P. Paffoni, P. Dellavesa, A. Perucca, N. F. Pardo, F. Signorotti, C. Didino, M. Zanetta. 2009. Journal of Cardiovascular Medicine 10: 727-732.

Mastenbroek, C. 1985. Cultivation and breeding of Digitalis lanata in the Netherlands. Heart 1985;54:262-268.

National Plant Board. Kansas Summary of Plant Protection Regulations. https://nationalplantboard.org/wp-content/uploads/docs/summaries/kansas.pdf. Accessed 04/18/2019.

Roberts, D. M., G. Gallaptthy, A. Dunuwille, and B. S. Chan. 2016. Pharmacological treatment of cardiac glycoside poisoning. British Journal of Clinical Pharmacology. 81(3): 488-495.

Serrano, R. 2018 Toxic plants: knowledge, medicinal uses and potential human health risks. Environment and Ecology Research. 6(5): 487-492.

Slifman, N. R., W. R. Obermeyer, B. K. Aloi, S. M. Musser, W. A. Correll, S. M Cichowicz, J. M. Betz, and L. A. Love. 1998. Contamination of botanical dietary supplements by *Digitalis lanata*. The New England Journal of Medicine. 339: 806-811.

Stegelmeier, B. L., K. E. Panter. 2012. Poisonous plants and the plant toxins that are likely to contaminate hay and other prepared feeds in the western United States. Society for Range Management.

Tackenberg, O., C. Romermann, K. Thompson and P. Poschlod. 2006. What does diaspore morphology tell us about external animal dispersal? Evidence from standardized experiments measuring seed retention on animal-coats. Basic Applied Ecology. 7(1):45-48.
Van Baalen, J. 1982. Germination ecology and seed population dynamics of Digitalis purpurea. Oecologia. 53(1):61-67.
Walvatne, P., T. Klein, and D. Stenlund. 2001. Herbicide trials on Grecian foxglove (Digitalis lanata) along state highway 95 right-of-way in Minnesota. Presented at the 2001 National Roadside Vegetation Management Association Conference.
USDA. 2019. Plants Database. https://plants.usda.gov/java/nameSearch. Accessed 04/25/2019.