

MN NWAC Risk Assessment Worksheet (04-2011)	Common Name	Latin Name
	Dalmatian Toadflax	<i>Linaria dalmatica</i> (L.) P. Mill with synonyms <i>Linaria genistifolia</i> , <i>L. genistifolia</i> ssp. <i>dalmatica</i>
Reviewer	Affiliation/Organization	Date (mm/dd/yyyy)
Original Reviewer: Roger Becker	University of Minnesota	05/25/2011
Update Reviewer: Monika Chandler	Minnesota Department of Agriculture	07/19/2019

**Species Description:**

Dalmatian toadflax is short-lived perennial forb that escaped cultivation as an ornamental, fabric dye component and as a medicinal plant (Jacobs and Sing 2006). It thrives in open, sunny areas and can overtake grasslands. It does well in very dry, sandy soils and has infested gravel pits in Minnesota. There are recorded comments about Dalmatian toadflax grown as an ornamental in Massachusetts in 1894 (Alex 1962).

Dalmatian toadflax is in the Plantaginaceae (formerly Scrophulariaceae) family and looks like a large, yellow snapdragon. It can grow to approximately 4 feet tall and has heart-shaped, clasping leaves. Multiple flowers are arranged in spikes. Flowers are bright yellow and sometimes have an orange center. Seedpods are ½ inch long and contain black seeds with wings. Dalmatian toadflax has a robust root system and underground stems that can send up new shoots. Yellow toadflax, *Linaria vulgaris*, is a similar, also non-native species that is common in Minnesota.

**Current Regulation:** Minnesota Prohibited Noxious Weed on the Eradicate List

Box	Question	Answer	Outcome
1	Is the plant species or genotype non-native?	Yes, it is native to the Dalmatian coast of Croatia, northeastward to Romania and Moldavia, southward and eastward around the Black Sea to northern Syria, northern Iraq and northern Iran (Alex 1962).	Go to 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. It is regulated in AZ, CO, ID, MT, ND, NM, NV, OR, SD, WA, WI and WY (National Plant Board 2019).	Go to Box 6
4	Are the plant species life history and growth requirements understood?	<b>Yes</b>	<b>This text is provided as additional information not directed through the decision tree process for this particular risk assessment.</b>
5	Gather and evaluate further information:	(Comments/Notes)	
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. There are small, isolated infestations in Halma, Lutsen and Schroder. Ongoing management has reduced populations to very low levels.	Go to Box 7
	B. Has the plant become established in areas having a climate and growing conditions similar to those found in Minnesota?		
7	Does the plant species have the potential to reproduce and spread in Minnesota?		
	A. Does the plant reproduce by asexual/vegetative means?	Yes. Spread is by lateral underground stems with adventitious buds (Vujnovic and Weil 1997).	Go to Question 7B
	B. Are the asexual propagules effectively dispersed to new areas?	Dispersal of root fragments on equipment is possible (Jacobs and Sing 2006) but dispersal is unlikely without human involvement. Therefore, the answer to this question was no.	Go to Question 7C
	C. Does the plant produce large amounts of viable, cold-hardy seeds?	Robocker 1970 reported that Dalmatian toadflax produced up to 500,000 seeds per plant and that seeds remain viable under field conditions for up to 10 years. Although some seedlings emerge in the fall, most seedlings emerge in the spring (Robocker 1970).	Go to Question 7F

Box	Question	Answer	Outcome
	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?	<b><i>Dalmatian toadflax is self-incompatible (Docherty 1982).</i></b>	<b>This text is provided as additional information not directed through the decision tree process for this particular risk assessment.</b>
	F. Are sexual propagules – viable seeds – effectively dispersed to new areas?	Yes. Most seeds fall within 5 feet of the parent (Jacobs and Sing 2006) then seed can be moved by water, wind, wildlife, equipment and with soil.	Go to Question 7I
	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?		
	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?	No.	Go to Box 8
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?	No, although not a significant risk, Dalmatian toadflax leaves contains alkaloid peganin and iridoid glycosides, such as antirrinocide (Vujnovic and Wein 2006). Cattle avoid Dalmatian toadflax but sheep and goats can be trained to eat it (Jacobs and Sing 2006). The Canadian Poisonous Plants Information System (2019) suggested that hay should not contain high levels of Dalmatian toadflax. No cases of animal poisoning have been reported (Wilson et al 2005)	Go to Question 8B
	B. Does, or could, the plant cause significant financial losses associated with decreased yields, reduced crop quality, or increased production costs?	Yes, grass production 2.5 times lower in dense infestations compared to similar areas without Dalmatian toadflax (Jacobs and Sing 2006).	Go to Box 9
	C. Can the plant aggressively displace native species through competition (including allelopathic effects)?	<b><i>Yes, but displacement is limited. Dalmatian toadflax thrives in disturbed areas where it can displace native species but it is not a good competitor in undisturbed areas with closed canopies (Sing and Peterson 2011).</i></b>	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?	<b><i>No, but Ward et al. 2009 documented hybrids of yellow and Dalmatian toadflax. These hybrids could be cryptic with morphology of one species but contain hybrid genetic material (Boswell et al. 2016). The native ranges of yellow and Dalmatian toadflax do not overlap and hybrids have not been reported in Eurasia (McCartney et al. 2019). Turner 2012 documented that hybrids emerged earlier, accumulated more biomass in a season, had a longer flowering time, produced more flowering shoots and seed than either species. Hybrids present management challenges for both herbicide and biological controls (Sing et al. 2016). Concern about potential hybrids is a rational for eliminating Dalmatian toadflax populations.</i></b>	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.)?		
	F. Does the plant have the potential to introduce or harbor another pest or serve as an alternate host?	<i>Yes. Dalmatian toadflax is a host of cucumber mosaic virus (Pariera Dinkins et al. 2007).</i>	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.	Go to 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?	<i>Yes.</i>	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?	<i>No.</i>	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?		
10	Should the plant species be enforced as a noxious weed to prevent introduction &/or dispersal; designate as prohibited or restricted?		

Box	Question	Answer	Outcome
	A. Is the plant currently established in Minnesota?	Yes.	Go to Question 10B
	B. Does the plant pose a serious human health threat?	No.	Go to Question 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?	<p>Yes, but careful management and persistence are needed.</p> <p><b>Ineffective methods:</b> Mowing and tillage are not effective control methods and could spread Dalmatian toadflax (Kyser and DiTomaso 2013). Burning can result in increased density, cover, seed production and spread (Dodge and Fulé 2008).</p> <p><b>Effective methods:</b> Torching seedlings, hand-pulling small plants, grazing with sheep and goats, herbicide treatment and classical biological control can be effective (USDA FS 2014). USDA FS 2014 recommends application of picloram, dicamba, chlorsulfuron, aminocyclopyrachlor + chlorsulfuron, or imazapic for control. Kyser and DiTomaso 2013 reported the most consistent long-term control with aminocyclopyrachlor applied to dormant plants in the fall. This reduced Dalmatian toadflax cover by over 90%. They also had success with applications of aminocyclopyrachlor or aminocyclopyrachlor + chlorsulfuron to both dormant and rosette stages, chlorsulfuron at the dormant stage and aminopyralid at the rosette stage.</p> <p>Biological control development began in the 1960s. The following agents are approved for field release <i>Brachypterolus pulicarius</i>, <i>Calophasia lunula</i>, <i>Eteobalea intermediella</i>, <i>E. serratella</i>, <i>Mecinus janthinus</i>, <i>Rhinusa antirrhini</i>, <i>R. neta</i> and <i>R. linariae</i>, Genetic studies determined that a stem-mining weevil</p>	List as a Prohibited Noxious Weed on the Eradicate List

Box	Question	Answer	Outcome
		thought to be one species was actually two species <i>Mecinus janthinus</i> associated with yellow toadflax and <i>M. janthiniformis</i> associated with Dalmatian toadflax (Toševski et al. 2018). These weevils were the first effective biocontrol agents and were released as <i>M. janthinus</i> in the 1990s (Toševski et al. 2018). Although outcomes for Dalmatian toadflax biocontrol are improving, biocontrol would not be an approved practice for an eradicate list species because all plants must be controlled.	
11	Should the plant species be allowed in Minnesota via a species-specific management plan; designate as specially regulated?		

#### 2011 Original Risk Assessment

Review Entity	Comments	Outcome
NWAC Listing Subcommittee		Prohibited Eradicate
NWAC Full Committee		Prohibited Eradicate
MDA Commissioner		Prohibited Eradicate

#### 2019 Risk Assessment Update

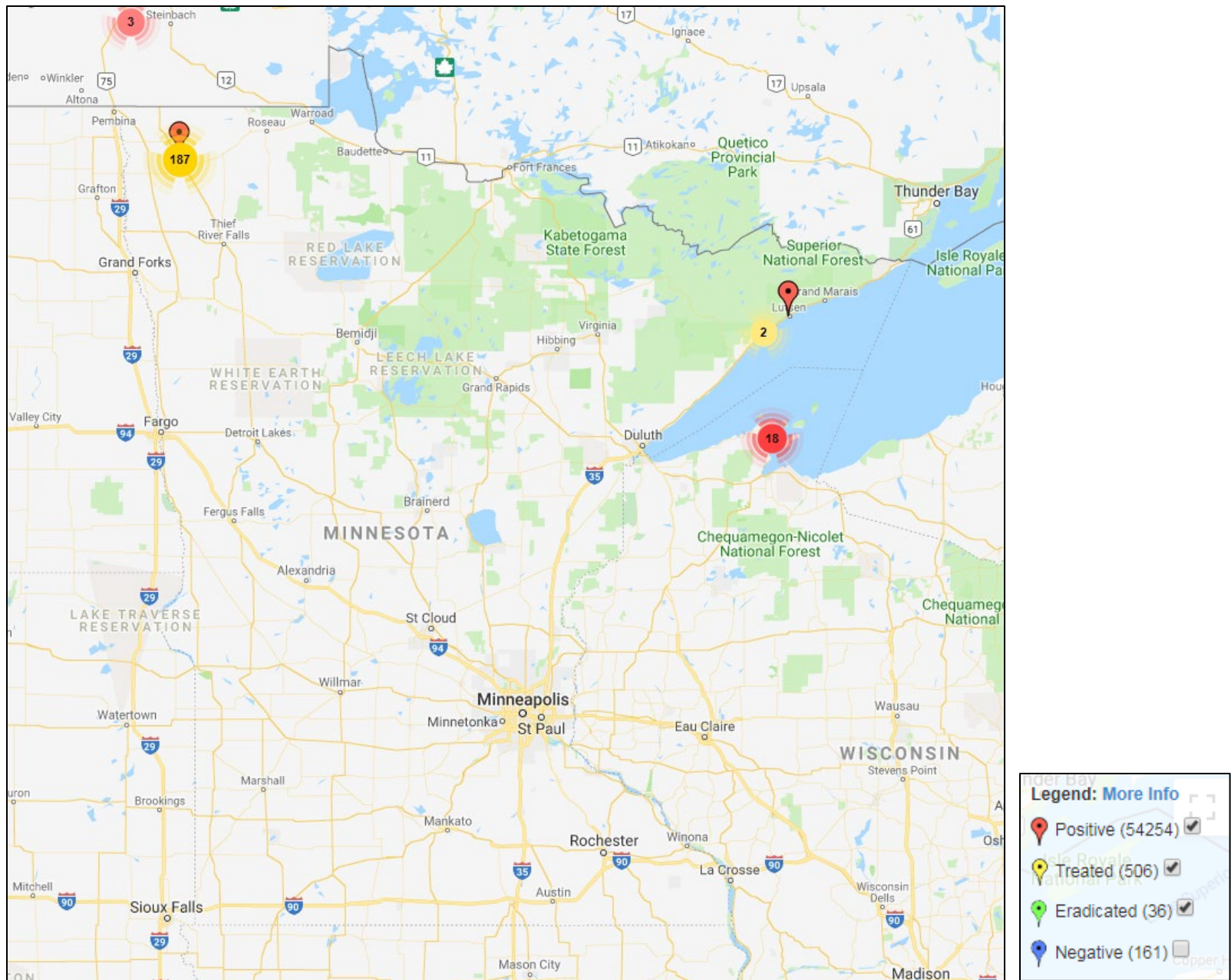
Review Entity	Comments	Outcome
NWAC Listing Subcommittee	Distribution remains limited and there is good progress on controlling infestations, 07/1/19.	Prohibited Eradicate
NWAC Full Committee	Vote on 12/03/19 was 15:0 to remain Prohibited Eradicate.	Prohibited Eradicate
MDA Commissioner	Commissioner agreed	Prohibited Eradicate

#### References

- Alex, J.F. 1962. The taxonomy, history and distribution of *Linaria dalmatica*. *Canadian Journal of Botany* 40:295-307.
- Boswell, A., S.E. Sing and S.M. Ward. 2016. Plastid DNA analysis reveals cryptic hybridization in invasive Dalmatian toadflax (*Linaria dalmatica*) populations. *Invasive Plant Science and Management* 9:112-120.
- Canadian Poisonous Plants Information System. 2019. <https://www.cbif.gc.ca/eng/species-bank/canadian-poisonous-plants-information-system/all-plants-scientific-name/linaria-vulgaris/?id=1370403266920> accessed 07/16/19.
- Docherty, Z. 1982. Self-incompatibility in *Linaria*. *Heredity* 49:349-352.

- Dodge, R.S. and P.Z. Fulé. 2008. Dalmatian toadflax (*Linaria dalmatica*) response to wildfire in a southwestern USA forest. *Ecoscience* 15(2):213-222.
- Jacobs, J. and S. Sing. 2006. Ecology and management of Dalmatian toadflax. USDA NRSC Invasive Species Technical Note MT-3.
- Kyser, G.B., J.M. DiTomaso. 2013. Effect of timing on chemical control of Dalmatian toadflax (*Linaria dalmatica*) in California. *Invasive Plant Science and Management* 6:362-370.
- McCartney, K.R., S. Kumar, S. Sing and S. Ward. 2019. Using invaded-range species distribution modeling to estimate the potential distribution of *Linaria* species and their hybrids in the U.S. northern Rockies. *Invasive Plant Management and Science*. 12:97-111.
- National Plant Board Laws and Regulations. 2019. <https://nationalplantboard.org/laws-and-regulations/> accessed 06/15/19.
- Pariera Dinkins, C.L., S.K. Brumfield, R.K.D. Peterson, W.E. Grey and S.E. Sing. 2007. Dalmatian toadflax (*Linaria dalmatica*): New host for cucumber mosaic virus. *Weed Technology* 21:41-44.
- Robocker, W.C. 1970. Seed characteristics and seedling emergence of Dalmatian toadflax. *Weed Science* 18(6):720–725.
- Sing, S.E. and R.K.D. Peterson. 2011. Assessing environmental risks for established invasive weeds: Dalmatian (*Linaria dalmatica*) and yellow (*L. vulgaris*) toadflax in North America. *International Journal of Environmental Research and Public Health* 8:2828-2853.
- Sing, SE, De Clerck-Floate, RA, Hansen, RW, Pearce, H, Randall, CB, Toševski, I, Ward, SM. 2016. Biology and Biological Control of Dalmatian and Yellow Toadflax. Morgantown, WV: USDA Forest Service, Forest Health Technology Enterprise Team, FHTET-2016-01 [https://www.fs.fed.us/rm/pubs\\_journals/2016/rmrs\\_2016\\_sing\\_s001.pdf](https://www.fs.fed.us/rm/pubs_journals/2016/rmrs_2016_sing_s001.pdf) accessed 07/20/19.
- Toševski, I., S.E. Sing, R. De Clerck-Floate, A. McClay, D.K. Weaver, M. Schwarzländer. 2018. Twenty-five years after: post-introduction association of *Mecinus janthinus* s.l. with invasive host toadflaxes *Linaria vulgaris* and *Linaria dalmatica* in North America. *Annals of Applied Biology* 16-34.
- Turner, Marie F. S. 2012. Viability and invasive potential of hybrids between yellow toadflax (*Linaria vulgaris*) and Dalmatian toadflax (*Linaria dalmatica*). Fort Collins, CO: Colorado State University, Department of Soil and Crop Sciences. Dissertation. 142 p. <https://www.fs.usda.gov/treearch/pubs/44737> accessed 07/20/19.
- USDA Forest Service. 2014. Field guide for managing Dalmatian and yellow toadflaxes in the Southwest [https://www.fs.usda.gov/Internet/FSE\\_DOCUMENTS/stelprdb5410111.pdf](https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5410111.pdf) accessed 07/16/19.
- Vujnovic, K. and R.W. Wein. 1997. The biology of Canadian weeds. 106. *Linaria dalmatica* (L.) Mill.
- Ward, S.M., C.E. Fleischmann, M.F. Turner, and S.E. Sing. 2009. Hybridization between invasive populations of Dalmatian toadflax (*Linaria dalmatica*) and yellow toadflax (*Linaria vulgaris*). *Invasive Plant Science and Management* 2:369-378.
- Wilson, L.M., S.E. Sing, G.L. Piper, R.W. Hansen, R. De Clerck-Floate, D.K. MacKinnon and C.B. Randall. 2005. Biology and Biological Control of Dalmatian and Yellow Toadflax [https://www.fs.fed.us/rm/pubs\\_other/rmrs\\_2005\\_wilson\\_1001.pdf](https://www.fs.fed.us/rm/pubs_other/rmrs_2005_wilson_1001.pdf) accessed 07/16/19.





Distribution of Dalmatian toadflax in Minnesota. All known populations have been treated.