

COSEWIC Assessment and Status Report

on the

Dense Blazing Star *Liatris spicata*

in Canada



**THREATENED
2010**

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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COSEWIC Assessment Summary

Assessment Summary – April 2010

Common name

Dense Blazing Star

Scientific name

Liatris spicata

Status

Threatened

Reason for designation

This showy perennial herb is restricted in Canada to a few remnant tallgrass prairie habitats in southwestern Ontario. A variety of threats, including lack of consistent application of fire to control the spread of woody species, spread of invasive plants, loss of habitat to agriculture and development and various management practices, including mowing, have placed the species at continued risk.

Occurrence

Ontario

Status history

Designated Special Concern in April 1988. Status re-examined and designated Threatened in May 2001. Status re-examined and confirmed in April 2010.



COSEWIC
Executive Summary

Dense Blazing Star
Liatrix spicata

Species information

Dense Blazing Star (*Liatrix spicata*) is a perennial herb of the aster family. It has numerous, narrow, grass-like leaves becoming smaller up the stem. The flowering stem is a robust and striking spike of densely packed, purple, compound flowering heads. The inflorescence is commonly 40-70 cm, but can reach over 1 m long, with the plant up to 2 m tall.

Distribution

Dense Blazing Star is widespread over much of the eastern United States. In Canada, it is restricted to southwestern Ontario. Over 90% of all native Dense Blazing Star plants in Canada grow at Walpole Island First Nation (WIFN), with another large population in Windsor. There are ten extant populations in Ontario. The actual area of habitat occupied is probably only about 2.5 km².

Habitat

Dense Blazing Star is a plant of open tallgrass prairies. It can grow in a range of moisture regimes from dry to very moist.

Biology

Dense Blazing Star is an outcrossing, insect-pollinated perennial that reproduces by seed. The overwintering organ is a globular corm. Based on horticultural information, plants live for about 3-5 years.

Population sizes and trends

Ten native populations of Dense Blazing Star were confirmed as extant in 2008 ranging in size from a single flowering stem at one location to about 120,000 stems. Two additional populations of unknown status but likely extirpated were not checked. All populations appear to be declining. Several populations and sub-populations have been extirpated in the last 15 years. Habitat loss through development and conversion to agriculture has caused extirpations in the 10 years since the previous status report. Decline in habitat quality is resulting in losses at most remaining populations. Total population is estimated at 120,000-140,000 stems representing 60,000-70,000 plants.

Limiting factors and threats

The major threat is loss of habitat through land use change, mainly to development, but also to agriculture. Encroachment by woody species is causing habitat decline in all populations and has extirpated some. Lack of frequent fires is the main reason for the growth of woody species. Management practices (mowing, site alteration, vegetation control) are also a threat. Trampling is a concern at some sites. Invasive species, particularly the non-native form of Common Reed, have degraded portions of the species habitat. Erosion from the wake of passing ships has caused local loss of plants at WIFN. Herbicide use may have caused one extirpation. The construction of a proposed expressway and bridge close to Ojibway Prairie could result in the loss of a large number of individuals. Cross-contamination from non-native hybrids and cultivated varieties is a potential threat, but one that has not been demonstrated yet.

Special significance of the species

The species is commonly sold as a cut flower in the florist trade and is a popular garden plant, with several varieties commercially available. The leaves and root have been used for a number of medicinal purposes in herbal remedies and are sometimes added to pot-pourri and herbal insect repellents.

Existing protection

Dense Blazing Star is considered by NatureServe as apparently secure in the U.S. In Canada, it is ranked as vulnerable and imperiled in Ontario. COSEWIC assessed this species as Threatened in May 2001, and this species is listed on Schedule 1 of the Canadian federal *Species at Risk Act*. In Ontario, it is listed as Threatened under the *Endangered Species Act, 2007* and populations in provincial parks are protected under the *Provincial Parks Act*.

TECHNICAL SUMMARY

Liatris spicata

Dense Blazing Star

liatris à épi

Range of occurrence in Canada: Ontario (adventive in Quebec)

Demographic Information

Generation time Based on observation of plants in cultivation (Armitage, 1987)	Unknown but determined as about 3-5 yrs in cultivation
Is there an observed and projected continuing decline in number of mature individuals?	Probably
Estimated percent of continuing decline in total number of mature individuals within 2 generations. >90% of plants are on WIFN where habitat is still declining, by 1+ ha per year; 1.2 ha represents about 1% of the occupied habitat x 2 generations (each is 3-5 years) = 6-10% (based on habitat decline in Crow <i>et al.</i> 2003 extrapolated to decline in plant numbers)	Perhaps 6-10% decline
Estimated and suspected percent reduction in total number of mature individuals over the last 3 generations.	Perhaps 9-15% based on above rationalization
Projected percent reduction in total number of mature individuals over the next 3 generations.	Perhaps 9-15%
Observed percent reduction in total number of mature individuals over any 3 generation period, over a time period including both the past and the future. Based on proposed destruction of plants and habitat due to IDRC and continuing habitat losses and habitat decline in Windsor and at WIFN.	Possibly 9-15%
Are the causes of the decline clearly reversible and understood and ceased? Declines due to change in land use and loss of habitat are understood, but not reversible.	Likely understood but not ceased and likely not completely reversible
Are there extreme fluctuations in number of mature individuals? There may be fluctuations in the number of flowering stems related to fire regimes.	Probably not

Extent and Occupancy Information

Estimated extent of occurrence Without the outlying population at Bronte creek the EO would be 7,100 km ² .	8,800 km ²
Index of area of occupancy (IAO) Index of AO based on 1 x 1 km grid is 81 km ² , but actual area occupied is probably <3 km ²	172 km ² using a 2x2 grid
Is the total population severely fragmented?	No
Number of "locations".	10
Is there an observed continuing decline in extent of occurrence?	No
Is there an observed continuing decline in index of area of occupancy?	Yes
Is there an observed and projected continuing decline in number of populations?	Yes
Is there an observed and projected continuing decline in number of locations?	Yes
Is there an observed and projected continuing decline in area, extent and quality of habitat?	Yes
Are there extreme fluctuations in number of populations?	No

Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	Number of Mature Individuals
The following numbers represent flowering stems. The number of mature individuals is unknown, but is probably in the order of 60,000-70,000 mature plants based on an estimated average about 2 stems per plant.	
Walpole Island First Nation	~120000 stems
Ojibway Prairie and surrounding area	~5000
Pinery Provincial Park	~2100
Dutton Prairie	400
Cedar Creek	70
Port Franks	55
Highgate	6
Lucan	6
Murkirk	3
Tupperville	1
Total	120,000-140,000 flowering stems or 60,000-70,000 plants

Quantitative Analysis

Not applicable	
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Threats (actual or imminent, to populations or habitats)

Loss of habitat through development and conversion to agriculture. Encroachment by woody species, lack of frequent fires, invasive species, (particularly <i>Phragmites australis</i>), management practices (mowing, site alteration, vegetation control), trampling, wildflower picking, erosion from ship wakes, herbicides, genetic contamination from adventive hybrids. The construction of a proposed expressway and bridge close to Ojibway Prairie could result in the loss of a large number of individuals.

Rescue Effect (immigration from an outside source)

Status of outside population(s) N4 in USA, SNR in most states where it occurs including adjacent states of Michigan and Ohio. USA:	
Is immigration known or possible?	Adventive populations have established
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Limited, yes
Is rescue from outside populations likely?	Possible

Current Status

COSEWIC: Threatened (April 2010)

Status and Reasons for Designation

Status: Threatened	Alpha-numeric code: B1ab(ii,iii,iv,v)+2ab(ii,iii,iv,v)
Reasons for designation: This showy perennial herb is restricted in Canada to a few remnant tallgrass prairie habitats in southwestern Ontario. A variety of threats, including lack of consistent application of fire to control the spread of woody species, spread of invasive plants, loss of habitat to agriculture and development and various management practices, including mowing, have placed the species at continued risk.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Percentage declines lower than minima under this criterion.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Threatened B1ab(ii,iii,iv,v)+2ab(ii,iii,iv,v). EO and IAO are within criterion limits, there are likely only 10 locations (with no severe fragmentation), and declines in IAO, area and quality of habitat, number of populations and mature individuals have occurred.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Estimated number of mature individuals is above criterion limits.
Criterion D (Very Small Population or Restricted Distribution): Not applicable. Population size and IAO above criterion limits.
Criterion E (Quantitative Analysis): None available.



COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2010)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.



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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Dense Blazing Star

Liatris spicata

in Canada

2010

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SPECIES INFORMATION

Name and classification

Scientific Name: *Liatris spicata* (L.) Willd. Species Plantarum 3: 1636. (1803).
Synonyms: *Serratula spicata* Linnaeus, Species Plantarum 2: 819. (1753).
Lacinaria spicata (L.) Kuntze Revisio Generum Plantarum (1891).
Common Names: Dense Blazing Star, Marsh Blazing Star, Gayfeather, Marsh Gayfeather, Florist Gayfeather, Spiked Blazing Star, Dense Gayfeather, Dense Button-snakeroot, Prairie-pine.
Family: Asteraceae
Major plant group: Eudicot flowering plants

Morphological description

Liatris spicata is a perennial herb with numerous, narrow, grass-like leaves becoming smaller up the stem. Often stems are clustered because of budding and division of the globular corm. The flowering stem is a robust and striking spike of densely packed compound flowering heads. The inflorescence is commonly 40-70 cm, but can reach over 1 m long, with the plant up to 2 m tall (Figure 1). Flower heads are cylindric to bell-shaped and contain 4-14 flowers with purple rays (Figure 2). A detailed description of the plant is given by Gaiser (1946).

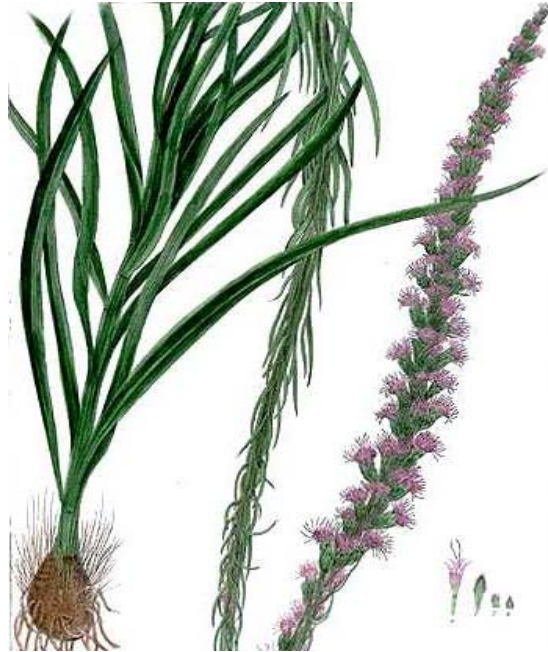


Figure 1. Colour illustration of *Liatris spicata* from John Torrey (1843), A Flora of New York. Courtesy of Robert W. Freckmann Herbarium, University of Wisconsin - Stevens Point.



Figure 2. Photograph of *Liatris spicata* and habitat at Walpole Island First Nation. Photo: Jane M. Bowles, 2008.

Liatris spicata and *L. pycnostachya* can be told from other species of *Liatris* by their long, slender, dense spikes of flower heads. In *L. spicata*, the main axis of the flowering spike is more or less hairless and the phyllaries (scales at the base of the flower heads) have rounded tips. In *L. pycnostachya*, the axis is more or less covered with crinkled hairs and the phyllaries have pointed, outturned tips (Voss, 1996).

There are two recognized varieties of *Liatris spicata*, a coastal element (var. *resinosa*) that can occur in the montane regions of North Carolina and Tennessee, and an inland element (var. *spicata*) (Nesom, 2006). Apparent intergrades are found in Tennessee and Alabama (E.O.L. 2008). Plants in Ontario are var. *spicata*.

Spatial population structure

The chromosome number of *Liatris spicata* is $n=10$. Counts of nearly rounded meiotic chromosomes in the pollen mother cells showed no differences in plants from across the entire range of the species (Southern U.S. to Ontario) and no differences were found with plants of various horticultural varieties (Gaiser, 1949).

Both varieties of *Liatris spicata* show two forms in the size of the flowering head, with large-headed plants apparently occurring in scattered locations. Nesom (2006) suggests that the variation might be caused by independent polyploidy events.

The only other native species of *Liatris* in Ontario (Cruise, 1964; Roberts *et al.*, 1977) are Rough Blazing Star (*L. aspera*) and Slender Blazing Star (*L. cylindracea*). Hadley and Levin (1967) found that the three species are separated by habitat even where they occurred together in the same area. They suggested that hybrids between the three species were rare and only persisted where intermediate habitats existed. Hybrids between *L. spicata* and *L. aspera* have been collected at Walpole Island First Nation (WIFN) where the two species occur together (Allen, 2001), and are suspected at Pinery Provincial Park (MacKenzie, pers. comm., 2008).

Cultivated stock sold as Dense Blazing Star is often a hybrid between *L. spicata* and the non-native *L. pycnostachya* (Gaiser, 1946, 1949). First generation hybrids and backcrosses generally have good seed set. Voss (1996) notes that *L. pycnostachya* is widely cultivated in Michigan and has escaped into the wild. There is no information on how much cross-contamination may have occurred in native populations of *L. spicata*.

Designatable units

The species comprises a single designatable unit because only one infraspecific taxon is recognized in Canada and the species occurs within a very restricted geographical area within a single COSEWIC Ecological Area (Great Lakes Plains).

DISTRIBUTION

Global range

Liatris spicata is widely distributed over eastern North America from Maryland, Massachusetts, and New Jersey in the northeast through Pennsylvania, Ohio, Ontario, and Michigan, to Wisconsin in the northwest, south to Alabama and Arkansas, Mississippi, Georgia, and Florida (Figure 3). It is listed as extirpated in the District of Columbia, and considered adventive in New York (where the native population is extirpated).



Figure 3. Approximate native distribution of *Liatris spicata* in North America, adapted from Allen (2001).

Canadian range

In Canada, *L. spicata* is native only in Ontario where it is restricted to Essex, Lambton, Middlesex and Elgin Counties and the Municipality of Chatham-Kent. In Halton Region there is a small population that may be adventive (there are no historic records for the area and it is a long way from the next nearest location), however this population is considered native by the Natural Heritage Information Centre (Oldham,

pers. comm. 2007) because it occurs with other prairie species and there is no evidence of planting. This population is included for assessment purposes. Adventive populations occur in York Region and the Niagara Peninsula, Ontario, and in Quebec. These are excluded for assessment. Most plants (over 90% of the native Canadian population) are found on WIFN (Table 1, Figure 4).

Table 1. Status of *Liatrix spicata* populations in Ontario.

Element Occurrence (EO) numbers from the Natural Heritage Information Centre database and status in 1986 at the time of the first COSEWIC report (Allen 1986) and in 2001 at the time of the update report (Allen, 2001) as well as estimates for this report (2008).

Location/Population	EO #	Status and Date			Extant
		1986	2001	2008	
Port Franks, Lambton County	1858	About 100	No plants seen	54 stems	yes
Walpole Island First Nation	5161	Hundreds of thousands	No abundance given	140,000 stems (2003)	yes
Pinery Provincial Park, Lambton County	5162	Several thousand	661 + 1110 (new population)	>120,000 stems About 2100	yes
Murkirk, NE of Highgate, Chatham-Kent	5163	Not known	Not listed	3 stems	yes
West Lorne, Elgin County	5164	Not known	Unknown	No plants seen	no
Dutton Prairie, Elgin County	5165	Several thousand	Thriving	About 400 stems	yes
Lucan, Middlesex County (possibly adventive)	5166	Site not known	New, 20 plants in 1990	6 stems	yes
Ipperwash, Lambton County	13268	Site not known	Not checked. Sutherland <i>et al.</i> (1994) reported 2 stands, one with 1 plant	Not checked by Bowles but not seen by DND contractors in 2007 or 2008.	unknown but likely extirpated
Point Edwards, Sarnia	13270	Extirpated (Last obs. by Teidje 1980)	Extirpated	Checked by Teidje	no
Ojibway Prairie and surrounding areas, Essex County	13275	Numerous thousands	12 of 27 sites extirpated 5 severely reduced 2 new sites	Over 5000 in about 13 sites	yes
Cedar Creek, Essex County	13276	About 500	About 100	67	yes
Chanel-Ecarte Prairie and Woods, Chatham-Kent	13277	Unknown	Presumed extirpated	Not checked	no
Tupperville, Chatham-Kent	13279	Verified extant	1 plant	1 stem	yes
Patrick's Cove, Chatham-Kent	13280	10 stems	5 stems Single plant	Probably extirpated	no
Rumble Prairie, Chatham-Kent	13281	About 1000	Extirpated	Not checked	no
Bronte Creek PP, Halton Region	32061	Site not known	1 stem, 1 plant	Not checked	unknown but
Highgate, Chatham-Kent	32062	Site not known	No abundance information	6 stems	yes
Coffelline Prairie, Chatham-Kent	32068	Site not known	1 plant	No plants seen	no
Westhill, York Regional Municipality	None	1700 stems	Continues to thrive	Not checked	introduced outside of natural range

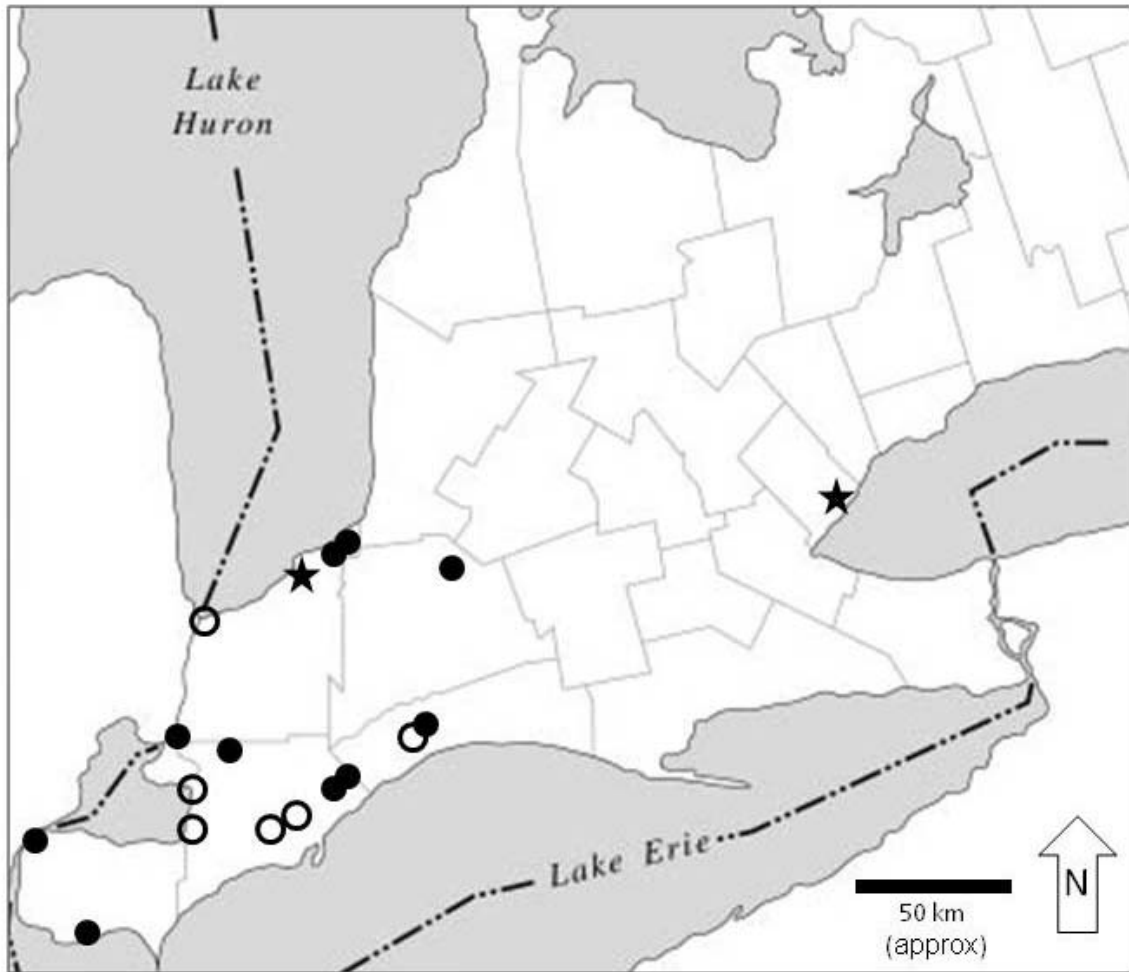


Figure 4. Location of native populations of *Liatris spicata* in Canada. Closed circles represent 10 extant populations, open circles are extirpated populations; stars represent sites of unknown status that are likely extirpated. Basemap modified from: St. Catharines sontbase. St. Catharines, Ontario: Brock University Map Library. Available: Brock University Map Library Controlled Access <http://www.brocku.ca/maplibrary/images/stcathv8.jpg>. (Accessed November 2, 2008.)

The total Extent of Occurrence (EO) of the 12 native populations (including the outlying Bronte Creek, Halton Region, populations is about 8,800 km² calculated by drawing a convex polygon around all known locations and subtracting the area of the portion of Lake St. Clair that falls within the polygon. The EO of the 10 known extant populations is 7,100 km². The Index of Area of Occupancy (IAO) based on 1x1 km UTM grid squares is 81 km² and 172 km² for 2 x 2 km squares. The actual area occupied is probably about 2.5 km² (Table 3).

Table 2. S-rank status for *Liatris spicata* in the United States.

S-rank	State
SX	District of Columbia, New York, Missouri
S1	Delaware, Maryland
S3	North Carolina West, Virginia, Wisconsin
S4	Kentucky, Virginia
SNR	Alabama, Arkansas, Connecticut, Florida, Georgia, Illinois, Indiana, Louisiana, Iowa, Massachusetts, Tennessee, Michigan, Mississippi, Ohio, Pennsylvania, South Carolina

Table 3. Index of Area of Occupancy (AO) based on 1 x 1 km UTM grid squares and 2 x 2 km squares for each extant natural site of *Liatris spicata* in Canada.

Location/Population	Index of AO based on 1 x 1 km squares occupied	Index of AO based on 2 x 2 km squares occupied	Estimated area Occupied
Port Franks, Lambton County	1	4	<0.014 km ²
Walpole Island First Nation	47	80	1.2 km ²
Pinery Provincial Park, Lambton County	3	8	<0.2 km ²
Murkirk, NE of Highgate, Chatham-Kent	1	4	<0.001 km ²
Dutton Prairie, Elgin County	7	16	0.7 km ²
Lucan, Middlesex County (possibly adventive)	1	4	<0.001 km ²
Ojibway Prairie and surrounding areas, Essex County	16	32	~0.5 km ²
Cedar Creek, Essex County	1	4	0.015 km ²
Tupperville, Chatham-Kent	1	4	<0.0001 km ²
Highgate, Chatham-Kent	1	4	<0.001 km ²
TOTAL	81	172	

The populations are not severely fragmented. Even though tallgrass prairie habitat has been highly fragmented since European settlement, the seeds of *Liatris spicata* are wind-dispersed and therefore disperse readily and far. The majority of the plants occur in one large population at WIFN, with other sizable numbers at the Ojibway Prairie Complex and Pinery Provincial Park. These three populations and Dutton Prairie comprise almost 99% of the habitat area occupied by the species. The area occupied by *L. spicata* at WIFN is estimated at about 1.2 km² based on a GIS area measurement of prairie polygons in which it occurs (WIFN unpublished data). The area occupied at the Ojibway Prairie Complex was not measured, but the distribution of remnant habitat patches is similar to that at WIFN, where they make up about 2.5% of the IAO. The area occupied has been estimated at 0.4 km² (Table 3). The three largest populations thus occupy over 70% of the area for the species in Canada and over 80% of the IAO. Four of the 10 populations confirmed as extant in 2008 had fewer than 10 plants and populations are probably not viable (Table 1).

HABITAT

Habitat requirements

Most plants in Canada are found in tallgrass prairie habitats ranging in moisture regime from dry-mesic to very moist, though most often in fresh to moist sites. Some plants are found in openings in oak savannahs or dune woodlands and in interdune meadows, along roadside ditches and road allowances, and along railways and hydro corridors. Frequent fire is important for maintaining tallgrass prairie habitat and Medve (1987) found that plant biomass of *Liatris spicata* was increased after two successive spring burns, even though density was decreased.

Habitat trends

Tallgrass prairie is one of the most imperiled ecosystems in Ontario, with a rank of S1 (critically imperiled) (Natural Heritage Information Centre, 1997). Prior to European settlement there were about 1000 km² of tallgrass prairie in Ontario, but by 1992 this had been reduced to about 21,000 ha (less than 3% of the original). Most of the remaining habitat is highly fragmented, with most patches smaller than 2 ha (Bakowsky and Riley, 1994).

In Ontario, where rainfall is abundant, and without fire to suppress tree growth, prairies can quickly change to savannah and savannah to woodland. This is particularly true on WIFN where the water table is relatively high (Woodliffe and Allen, 1996; Woodliffe, 2002). In the 25-year period between 1972 and 1998, air photos suggest that the prairie at WIFN was reduced from about 730 ha to about 470 ha, a loss of 36% (Crow *et al.*, 2003). Some of this was a result of conversion to agriculture and housing, but most was due to encroachment by woody species in the absence of regular fires and loss of grazing by herds of wild ponies. Development continues to destroy habitat for *Liatris spicata* on WIFN, where pressure for new housing is high. The frequency of prairie fires is decreasing as housing density increases so encroachment by woody species is accelerating. Conversion to agriculture has occurred at several sites within the last 10 years; this has destroyed habitat and extirpated *Liatris spicata* from some areas. In 2008, an area of about 9 ha was mowed to expand a dump. Several piles of construction material were deposited and trucks trampled a number of plants. No *Liatris spicata* flowered in this area in 2008 although rosettes were still present. The non-native and invasive subspecies of Common Reed (*Phragmites australis* ssp. *australis*) is invading all meadow marshes and moist prairies at WIFN and is also degrading *Liatris* habitat. On the other hand, falling lake levels and drainage programs at WIFN have allowed *Liatris spicata* to colonize or re-establish in areas that were under water during high lake levels in the 1980 and 1990s. Most of these sites are also now threatened by *Phragmites*, however.

Allen (2001) reported large losses of *Liatris spicata* habitat in the Windsor area as a result of development and encroachment by woody species. This trend in both development and growing-in of prairie habitat continues. Some sites are protected from development in the Ojibway Prairie complex but many plants are on private land, road allowances, and hydro rights of way outside the protected areas. Many of these are suffering encroachment by woody species. If a proposed expressway connecting to the Detroit River International Crossing is built, further habitat will be destroyed or affected. The Nature Reserve itself had not been burned for several years and populations of several prairie species appeared to be declining as a result (Pratt, pers. comm., 2008). A planned burn was scheduled for 2009, but a wildfire burned a significant portion of the area that would have been burned.

At Pinery Provincial Park, most plants are found in openings in dune woodlands and in wet meadows in dune slacks. Most of these are within an active campground and many plants are trampled or picked each year. Plants growing in fenced exclosures are declining as a result of encroachment by woody species protected from deer browse.

Most plants in other areas (not in the places mentioned above) are along railway lines. In most cases, for example at Dutton Prairie, the railway lines have been removed and encroachment by woody species is causing rapid habitat decline. At Dutton Prairie sections of the area under a hydro right-of way parallel to the tracks has been managed by removing all vegetation and scarifying the soil to a depth of about 10-15 cm. Many *Liatris spicata* plants have been affected by this treatment. At Port Franks, the meadow marsh occupied by a few *Liatris* stands is beginning to grow in with Tamarack (*Larix laricina*).

Habitat protection/ownership

Although *Liatris spicata* is protected under both the federal *Species at Risk Act* and the Ontario *Endangered Species Act, 2007*, its habitat is not currently protected under either legislation. At WIFN, *Liatris spicata* is widely dispersed in prairie patches over most of the terrestrial portions of the territory. Ownership includes private lands held under Certificates of Possession (under the *Indian Act*). Some areas are leased for conservation purposes. Several stands are on Band-owned land managed by the Walpole Island Heritage Centre and other plants are on Band-owned areas that may be subject to land use change such as housing or other development or conversion to agriculture. Several areas have been recognized by the Band Council as Significant Natural Heritage Sites. This status provides recognition, but no formal protection. One important site with thousands of plants has been purchased by the Walpole Island Land Trust that was registered in 2008, and is the first First Nations land trust registered in Canada. The Draft Walpole Island Ecosystem Recovery Strategy (Bowles, 2005) identifies general threats and actions to protect habitat on WIFN.

At Windsor, most of the areas with the largest populations of *Liatris spicata* are in the Ojibway Prairie Provincial Nature Reserve. This area is managed for conservation. Other populations however, such as those in private ownership, or owned by the city have little formal protection.

At Pinery Provincial Park, all stands are within the park and are Protected under the *Provincial Parks Act* and managed by Ontario Parks. There are continuing conflicts between providing revenue-generating opportunities (such as camping), educating the public (to prevent off-trail trampling and wildflower gathering) and protecting *Liatris spicata* and other species at risk (MacKenzie, pers. comm., 2008).

The site at Dutton Prairie is part of a natural area managed by West Elgin Nature Club, but part of the population lies in a hydro right-of-way and vegetation has been removed. Most other sites belong to railway companies or are privately owned portions of abandoned railways.

BIOLOGY

Surprising little information appears in the literature about the biology of this spectacular plant. It grows well in a garden setting and is popular in floriculture. Some of the information below is from horticultural sources.

Life cycle and reproduction

Liatris spicata is a perennial and an obligate out-crosser that reproduces by seed. Horticulturally, plants can be brought from seed to flowering in 12 months (Armitage and Laushman, 2003). The overwintering organ is a globular corm. The corm continues to grow each year of the plant's life. Larger corms will lead to taller stems and more and larger inflorescences each year. Up to 15 flowering stems can be expected from a three year old plant under cultivation, and plants will continue to flower for at least 5 years, but decline after the third year (Armitage, 1987). A cold temperature rest period (overwintering) for the corm is required for flowering (Espinosa *et al.* 1991). Corms will bud and divide, but this does not seem to be a mechanism for dispersal in the wild, since they do not separate and spread from the parent plant. It makes it difficult to determine longevity of single ramets since old corms may be replaced by new ones producing plants at the same location.

Seeds collected from wild plants germinate readily under greenhouse conditions after being stored at 5°C for several weeks (Bowles, pers. obs.).

Herbivory

Allen (2001) reported that *Liatris spicata* at Pinery Provincial Park is browsed by White-tailed Deer (*Odocoileus virginianus*). Deer populations at Pinery were high at the time and many species below browse level were affected. Deer populations have since been reduced and some browsing pressure removed. Browse may also have been contributing to the maintenance of *Liatris spicata* habitat by preventing shrub growth and reducing successional changes. No browse has been noted at WIFN where the deer populations are low.

A number of beetle (Coleoptera) species are found on the inflorescences of *Liatris spicata* and some undoubtedly feed on flowers.

Dispersal

The seeds of *Liatris spicata* are reasonably large (about 2-3 mm long) and have a pappus of minutely barbed hairs that aid wind dispersal at least for short distances. The tall spikes probably assist in dispersal by presenting seeds above the shelter of surrounding herbage. *Liatris spicata* is obviously a reasonably effective short-distance disperser because it appears fairly quickly in newly available habitat such as old fields adjacent to seed sources. Several Ontario populations are along railway lines and this suggests that the plants in some sites may be adventive, dispersed along the tracks.

Interspecific interactions

Insect visitors to the flowers include a wide range of bee, butterfly and beetle species and *Liatris spicata* is an obligate out-croser, relying on insect visitors for pollination (Hadley and Levin, 1967; Bowles, pers. obs.).

Liatris spicata is a host for the Blazing Star Stem Borer Moth (*Papaipema beeriana*) listed as a species of conservation concern in the United States because of declining populations (USDA Forest Service, 2003). This moth has not been recorded in Canada, but it is listed as S1 (critically imperilled) in the adjacent states of Michigan and Ohio.

Medve (1985) found that all *Liatris* plants examined had vesicular-arbuscular mycorrhizae associations. Fungal leaf spots may be caused by *Phyllosticta liatridis* and *Septoria liatridis*, and rusts are known to infect the species. It is not known how prevalent these diseases are in the wild.

Adaptability

Liatrix spicata appears to require full sunlight, since it grows in open prairie habitats and declines in the presence of tree and shrub growth. It grows in a wide range of moisture regimes from very moist sites with standing water well into the growing season and 30-40 cm of organic matter to dry-mesic prairies on well drained soils. It grows well under cultivation, but in the wild is almost exclusively restricted to areas with tallgrass prairie associates.

POPULATION SIZES AND TRENDS

Search effort

Fieldwork for this report consisted of visiting all sites in southwestern Ontario that are thought to have native and extant plants and for which there are element occurrence records at the Natural Heritage Information Centre (Peterborough, Ontario), except for the Bronte Creek population. Sites at Ojibway Prairie and surrounding area are considered one element occurrence (one population) because all records are within 1 km of one another. Similarly, the plants at WIFN are considered one population even though they are scattered over an area of several square kilometres.

Fieldwork was undertaken by Bowles over 15 dates between August 11 and September 16, 2008, including partial days on 8 dates at WIFN, 2 days at Windsor (Ojibway Prairie and surrounding areas), 1 day at Pinery PP, 1 day at Port Franks and 3 days at other sites in Essex, Chatham-Kent, Middlesex and Lambton. In addition, counts at Pinery Provincial Park were made on 3 days (August 16, 17 and one date in September) by Margie Wilkes and Stacey Peel. Clint Jacobs and Leroy Altman made additional counts at WIFN on September 9 and 11. Dorothy and John Teidge checked the Point Edwards site in September 2008. An introduced population at Westhill in York Regional Municipality (Allen, 2001) and the site at Bronte Creek Provincial Park were not checked. In 2008, a detailed inventory of stems was done by consultants in the Area of Investigation north of Ojibway Prairie for the proposed Detroit River International Crossing (DRIC). Personal communications in 2008 (Oldham, Woodliffe, Pratt and other sources who wish to remain anonymous) suggest that there are several to many other small and large stands scattered in the area.

Most counts consisted of walking the areas where plants were known to occur and taking GPS readings and counting flowering stalks when a stand was encountered. At WIFN, many counts were made by driving along tracks adjacent to or through prairie patches. Only flowering spikes were counted at each location. In several locations at WIFN and Ojibway Prairie, a stepladder was used in order to see over the intervening vegetation. In most cases, counts probably underestimate the populations, since many plants were likely missed. At Ojibway Prairie and surrounding areas, only locations visited by Allen in his 2000 survey (Allen, 2001) and stands suggested by Pratt (pers. comm., 2008) were visited.

Abundance

Counts were made in 2008 (Table 1). Previously, little attempt has been made to quantify populations except in small stands and at WIFN where a census was done in 2003 using similar methods (Walpole Island Heritage Centre, 2008). Over 90% of plants in native populations in Canada are found on WIFN where estimates are in the range of 120,000-140,000 flowering stems. Estimates from Ojibway Prairie and surrounding areas are about 5000 stems (about 1000 counted in this survey and about 4000 reported from other sources including surveys for the DRIC). About 2000 flowering stems were censused at Pinery Provincial Park. Other sites have far fewer plants, with estimates ranging from 1, at Tupperville, to about 400 at Dutton Prairie. The number of flowering stems is only an estimate of relative abundance because of the difficulty of determining individual plants. Several stems may develop from one plant and the corms of one plant may divide into a number of ramets. Not all plants flower every year in the wild, and non-flowering individuals were not included in these estimates. At Pinery, 2017 stems were counted in 964 "groups", where groups may represent individuals, making an average of 2.1 stems per plant. Using this number a rough estimate of total abundance would be about 60,000-70,000 mature plants in Canada.

Fluctuations and trends

Accurate estimates of population trends are impossible to determine for this species since early estimates (Allen, 1987) are not quantitative, but given in terms of hundreds of thousands (WIFN) and numerous thousands (Ojibway). What is certain is that over the last approximately 10-12 years (about three generations) the plant has been extirpated from several former sites (particularly in Windsor, but also at WIFN). Allen (2001) found that in Windsor and La Salle (Ojibway Prairie and surrounding area), plants at 12 of 27 sites had been extirpated and at five others severely reduced. Most of this decline was due to change in land use (development and expansion of agriculture), but some loss was due to changes in habitat quality (encroachment of woody species).

An overall decline rate in the Canadian population of perhaps 3-5% per generation may have occurred taking into account that >90% of plants are on WIFN where habitat decline, over a 25 year period, was over 1ha per year (Crow *et al.* 2003). Habitat loss is likely continuing at the same rate. A loss of about 1.2 ha at WIFN per year represents about 1% of the occupied habitat of *Liatris spicata*. When this is extrapolated to reflect a similar potential loss of *Liatris spicata* over a period of one generation (about 3-5 years), a decline of 3-5% of plants may have occurred per generation.

Development and loss of plants continues at both Windsor and at WIFN. Encroachment by woody species, trampling and invasion by Common Reed as well as management practices such as mowing, ditch maintenance and soil perturbation have caused recent declines in some populations. Almost all the railway sites have declined since the last estimates in 2000. At WIFN, some plants have been washed from the edge of the St. Clair River by the wake of ships passing up the seaway (Bowles, pers. obs. and Jabobs, pers. comm. 2008). Other habitat declines have been caused by trampling (both pedestrians and vehicles).

Fire regime is important for maintaining populations of *Liatris spicata*. Woodliffe (pers. comm. 2008) reported a decline in flowering stems in areas that have not burned for a few years. Census of flowering stems following a burn would probably be higher than a census conducted several years after a burn. Weather conditions during spring and early summer may also affect the profusion of flowering stems and the size of spikes. The spring and early summer of 2008 were unusually cool and wet and the plants at least at one stand at WIFN appeared to be smaller and sparser than in previous years, even though the site burned in the spring of that year (Bowles, pers. obs.).

Although the populations at Walpole Island and Ojibway Prairie and surrounding areas have declined, the number of plants is large and some areas are protected from future land use change. At Pinery Provincial Park, management is planned towards reducing trampling of *Liatris spicata* stands and opening the canopy in shaded exclosures. The population at Dutton Prairie has declined from “several thousand” in 1985 to about 400 in 2008. Although this site is managed as a nature preserve, the decline in plants appears to have been caused by management along a hydro corridor. Small stands at other locations along railway tracks in the region have been reduced or extirpated as a result of encroachment by woody species. Most small populations of *Liatris spicata* in Ontario appear to be in jeopardy.

Rescue effect

There is a possibility of natural rescue from the populations in the U.S. *Liatris spicata* is not at risk in the adjacent states of Michigan and Ohio. The plant can grow in a range of moisture regimes and suitable prairie habitat, though very fragmented and in limited supply, exists in several places. Seed dispersal by wind appears to be moderately successful over short distances and adventive populations have appeared in Ontario; however, some adventive populations may be hybrids derived from horticultural varieties. Introduced plants from the same climate zone would likely be able to survive.

LIMITING FACTORS AND THREATS

The major threats to the species have been and continue to be loss of habitat through land use change, mainly to development, but also to agriculture. Encroachment by woody species is causing habitat decline in all populations and several populations have been extirpated or reduced as a result. Lack of frequent fires is the main reason for the growth of woody species. Management practices (mowing, site alteration, vegetation control) are also a threat. Trampling is a concern at Pinery Provincial Park and to a lesser extent at WIFN. Invasive species, particularly Common Reed, continue to degrade moist habitats, especially at WIFN. The plant is often found associated with Purple Loosestrife (*Lythrum salicaria*), another invasive exotic, in wet meadows. Erosion from passing ships has caused local loss of plants at WIFN. The construction of a proposed expressway and bridge associated with the DRIC close to Ojibway Prairie is likely to result in the loss of a large number (over 1000) of individuals. Allen (2001) listed herbicide applications as a probable factor in the extirpation of the Patrick's Cove population.

Prairie restoration, recreation and creation are becoming increasingly popular in southern Ontario (Rodger, 1998). Groups such as Lambton Wildlife Inc. have restored and created prairies in a number of places in the Sarnia area. Some of these projects have included *Liatris spicata*. While restoration projects may be an important component of species at risk recovery, such projects need to be carefully planned and monitored. Establishing non-native stock, not of local provenance, may be counter-productive. There is no information on whether hybrid material of horticultural origin may have been established in prairie plantings, but the threat of cross-contamination exists if such plants become adventive.

Locations based on threats

Of the 19 populations listed in Table 1, six are known to be extirpated, one in Westhill is introduced (presumably beyond its normal range), and the status of two populations (Ipperwash and Bronte Creek) are unknown but possibly extirpated. The Ipperwash population, which was reported in 1994 to consist of two sites with one of these having a single plant, is likely extirpated. Detailed surveys between December 2007 and March 2008 by consultants involved with the decommissioning of the DND site did not see any *L. spicata*, although old flowering stalks of Slender Blazing Star (*L. cylindracea*) were visible (Sandilands, pers. comm. 2010). The impact on *L. spicata* habitat as a result of decommissioning the lands by DND prior to ceding the property to the local First Nation community is uncertain. The existence of the Bronte Creek population, previously consisting of a single plant with one stem in 2001, is doubtful.

The largest population of *Liatris spicata* occurs scattered over a wide area of WIFN in dozens of land parcels under various ownership. Most of these are potentially subject to the same suite of threats, but because of the difficulty in distinguishing the extent of the impacts in each parcel and the potentially different time scales for the impacts to occur, the various habitat fragments cannot readily be separated as different locations. For this reason the WIFN lands are best recognized as a single location subject, in particular, to habitat deterioration due to lack of fire and invasive species. Potential land use change (to development or agriculture) is a further potential threat on many land parcels. Considering that the habitats at WIFN are not severely fragmented by definition due to the dispersal ability of the species, attempting to recognize multiple locations at WIFN is likely unwarranted.

Similarly, the extensive number of remnant habitats in which *Liatris spicata* occurs in the Ojibway Prairie Complex and surrounding areas are difficult to differentiate into distinct locations based on threat. Land management activities and habitat deterioration are the main threats to all the remnants, which are best recognized as a single location under a suite of similar threats.

The remaining eight native populations are all subject to potential population decline through habitat degradation and unpredictable events. These populations are all well separated and should be recognized as distinct locations. In addition, four of the eight are doubtfully viable in the long-term because they have fewer than 10 plants each. The total number of locations for native occurrences has been rationalized to be on the order of 10, not all of which are likely viable.

SPECIAL SIGNIFICANCE OF THE SPECIES

Liatrix spicata is commonly sold as a cut flower in the florist trade and is a popular garden plant, with several varieties commercially available. Many of the cultivated varieties are genetic permutations of hybrids with other species. *Liatrix spicata* apparently escapes cultivation and Nesom (2006) suggests that reports from Arkansas, Connecticut, and Quebec are probably garden escapes.

The leaves and root have been used for a number of medicinal purposes in herbal remedies and are sometimes added to pot-pourri. They are also sometimes added to herbal mixtures used as insect repellents (Plants for a Future, 1997-2000).

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Liatrix spicata has a Global Status of G5 (secure) and a U.S. Status of N4 (NatureServe, 2009). It is not ranked (SNR) in most of the states where it occurs, but is ranked S1 (critically imperiled) in Delaware and Maryland, S3 or S3? (rare) in North Carolina, West Virginia and Wisconsin and extirpated from New York and the District of Columbia (see Table 2). In Canada, it has a rank of N2, and S2 in Ontario. COSEWIC assessed this species as Threatened in May 2001, and it is currently listed on Schedule 1 of the *Species at Risk Act*, which applies to populations on federal land, including Walpole Island First Nation. In Ontario, it is listed as Threatened under the *Endangered Species Act*, 2007. This Act has provided protection for the species since June 2008, but the habitat will not be legally protected until June 2013.

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Authorities consulted during the preparation of this report:

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Dorothy Teidge, Botanist in Sarnia. Author of the Flora of Lambton County.

INFORMATION SOURCES

Allen, G.M. 1988. COSEWIC status report on the dense blazing star *Liatris spicata* in Canada. Committee on the Status of Endangered Wildlife in Canada. 50 pp.

Allen, G.M. 2001. Update COSEWIC status report on the dense blazing star *Liatris spicata* in Canada, in COSEWIC assessment and status report of the dense blazing star in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Pp 1-21.

Armitage, A.M. 1987. The influence of spacing on field grown perennial crops. Horticultural Science 22: 904-907.

Armitage, A.M. and J.M. Laushman. 2003. Specialty Cut Flowers: The Production of Annuals, Perennials, Bulbs, and Woody Plants for Fresh and Dried Cut Flowers. 2nd Edition. Timber Press, 586 pp.

Bakowsky, W. and J. Riley. 1994. A survey of the prairies and savannas of southern Ontario. In R. Wickett, P. Dolan Lewis, A. Woodliffe and P. Pratt, eds. Proceedings of the Thirteenth North American Prairie Conference: Spirit of the Land, Our Prairie Legacy. August 6-9, 1992. Windsor, Ontario: Corporation of the City of Windsor. pp. 7-16.

Bowles, J.M., 2005. Draft Walpole Island Ecosystem Recovery Strategy. Prepared for Walpole Island Heritage Centre and Environment Canada. 50 pp.

Crow, C., J. Demelo, J. Hayes, J. Wells and T. Hundey, 2003. Walpole Island Land Use change 1972-1998. Unpublished class report, Department of Geography, University of Western Ontario.

Cruise, J.E. 1964. Biosystematic studies of three species of the genus *Liatris*. Canadian Journal of Botany 42: 1445-1455.

E.O.L. 2008. Encyclopedia of Life website: *Liatris spicata*.
<http://www.eol.org/pages/820265>

- Espinosa, I., W. Healy and M. Roth. 1991. The role of temperature and photoperiod on *Liatris spicata* shoot development. *Journal of the American Society of Horticultural Sciences* 116(1): 288-290.
- Gaiser, L.O. 1946. The genus *Liatris*. *Rhodora* 48: 165-183; 216-263; 273-326; 331-282; and 393-412.
- Gaiser, L. O. 1949. Chromosome studies in *Liatris*. I. *Spicatae* and *Pycnostachyae*. *American Journal of Botany* 36: 122–135.
- Hadley, E.B. and D.A. Levin. 1967. Habitat differences of three *Liatris* species and their hybrid derivatives in an interbreeding population. *American Journal of Botany* 54(5): 550-559. *Brittonia* 19: 248-260.
- Jacobs, C.R. pers. comm. 2007. Natural Heritage Coordinator, Walpole Island Heritage Centre. Various verbal communications.
- Mackenzie, A. pers. comm. 2008. Resource Management & Natural Heritage Education Supervisor Pinery Provincial Park. . Verbal communication. 5 September 2008.
- Medve, R.J. 1987. The Effects of Fire on Resource Allocation and Growth of *Liatris spicata*. *American Midland Naturalist* 117(1): 199-203.
- Natural Heritage Information Centre. 1997. Community listing website.
http://nhic.mnr.gov.on.ca/MNR/nhic/communities/comm_list_terrestrial.cfm
- NatureServe, 2006. A Online Encyclopedia of Life. *Liatris spicata*.
<http://www.natureserve.org/>
- Nesom, G.L. 2006. Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. New York and Oxford. Volume. 21: 512-513.
- Oldham, M.J, pers. comm. 2007. Botanist, Natural Heritage Information Centre, Ministry of Natural Resources, Peterborough Ontario. Verbal communication at Ojibway Prairie.
- Oldham, M,J, pers. comm. 2008. Botanist, Natural Heritage Information Centre, Ministry of Natural Resources, Peterborough Ontario.
- Plants for a Future (1997-2000). Plants for a Future database: edible, medicinal and useful plants for a healthier world: *Liatris spicata*. Web page:
http://www.ibiblio.org/pfaf/cgi-bin/arr_html?Liatris+spicata
- Pratt, P. pers. comm. 2008. Chief Naturalist, Ojibway Prairie Nature Centre, Windsor, Ontario. Verbal communication 2 September 2008.
- Roberts, T., T. Robson, P.M. Catling. 1977. Factors maintaining a disjunct community of *Liatris spicata* and other prairie species in Ontario, Canada. *Canadian Journal of Botany*. 55, 5: 593-605.
- Rodger, L. 1998. Tallgrass Communities of Southern Ontario: A Recovery Plan. Prepared for the World Wildlife Fund, Canada and the Ministry of Natural Resources.

- Sandilands, A. pers. comm. 2010. Senior ecologist, Gray Owl Environmental Inc., Branchton, ON. e-mail to Sarah Mainguy, senior ecologist, North-South Environmental, Campbellville, ON, 20 Jan. 2010.
- USDA Forest Service. 2003. Conservation Assessment for Blazing Star Stem Borer Moth (*Papaipema beeriana*). US Forest Service, Eastern Region. 10 pp.
- Voss, E.G., 1996. Michigan Flora. Part III, DICOTS (Pyrolaceae-Compositae). Cranbrook Institute of Science Bulletin 61 and University of Michigan Herbarium. Walpole Island Heritage Centre, 2008. Rare plant database. Internal database.
- Woodliffe, P.A. and G.M. Allen, 1996. Draft. A life Science Inventory of the prairie, savannah and woodlands of the Walpole Island First Nation. Ontario Ministry of Natural Resources, Chatham District.
- Woodliffe, P.A. 2002. A re-evaluation of the 17 Top Ranked Sites (primarily prairie, savannah and oak woods) of the Walpole island First Nation. Unpublished Report. 15 pp + tables and figures.
- Woodliffe, P.A. pers. comm. 2008. District Ecologist, Ontario Ministry of Natural Resources, Chatham, Ontario. Various discussions and verbal communications.

BIOGRAPHICAL SUMMARY OF REPORT WRITER

Jane M. Bowles received her Ph.D. from the University of Western Ontario in 1980. She has over 25 years of experience as a freelance ecologist in southern Ontario, doing life science inventories, pursuing research in conservation ecology and working with species at risk. She has worked with the Walpole Island Heritage Centre on their species at risk and habitat stewardship programs since 2003. She has been a member of the Vascular Plant Specialist Sub-Committee of COSEWIC since 2002 and a member of COSSARO since 2006. She sits on the recovery teams for Wood-poppy, Lake Huron Dune Grasslands/Pitcher's Thistle, Tallgrass, Carolinian Woodlands and Walpole Island First Nation. She is an Adjunct Professor at the University of Western Ontario where she has also been Curator of the Herbarium and Director of the Sherwood Fox Arboretum since 2005.

COLLECTIONS EXAMINED

No herbarium specimens were examined during the preparation of this report.