Toronto and Region Conservation Authority

The Meadoway: Vegetation, Bird and Butterfly Monitoring 2016, 2018-2020

Prepared by Watershed Planning and Ecosystem Science

December, 2020

Table of Contents

INTRODUCTION

The Meadoway project involves the revitalization of a 16-km linear hydro corridor, formerly known as the Gatineau Hydro Corridor (Figures 1 and 2). The goals of the revitalization are to create and maintain meadow habitat and to create an active east-west link between downtown Toronto and the Rouge National Urban Park becoming one of the largest greenspaces in Canada (Sharma 2018).

Restoration and maintenance activities have included seeding portions of the corridor with flora species native to meadows, mowing and invasive species management. Restoration began in 2012 with the section between McCowan Road and Lawrence Avenue East being prepared and seeded. Several other sections were seeded between 2013 and 2016; however, some sections remained un-restored as highly manicured turfgrass. Several of these turfgrass areas started undergoing restoration (spraying, tilling, seeding cover crops) in the summer of 2019 while other sections began in 2020. Mowing and herbicide application has occurred intermittently in different sections although became a more prominent focus in 2018.

Monitoring activities occurred in 2016, 2018, 2019 and 2020 to document changes in species composition related to the vegetation, breeding birds and butterfly presence. This report is an update to the 2019 monitoring report with a shift in focus to determining seeding success, the establishment of seeded species and the effectiveness of invasive species management in each section. We have also included a special section that presents preliminary results of several experimental seeding plots focusing on germination success based on the seasonality of planting, method of planting and glyphosate application. We also summarized the results of bird and butterfly surveys throughout The Meadoway.

Figure 1. The Meadoway

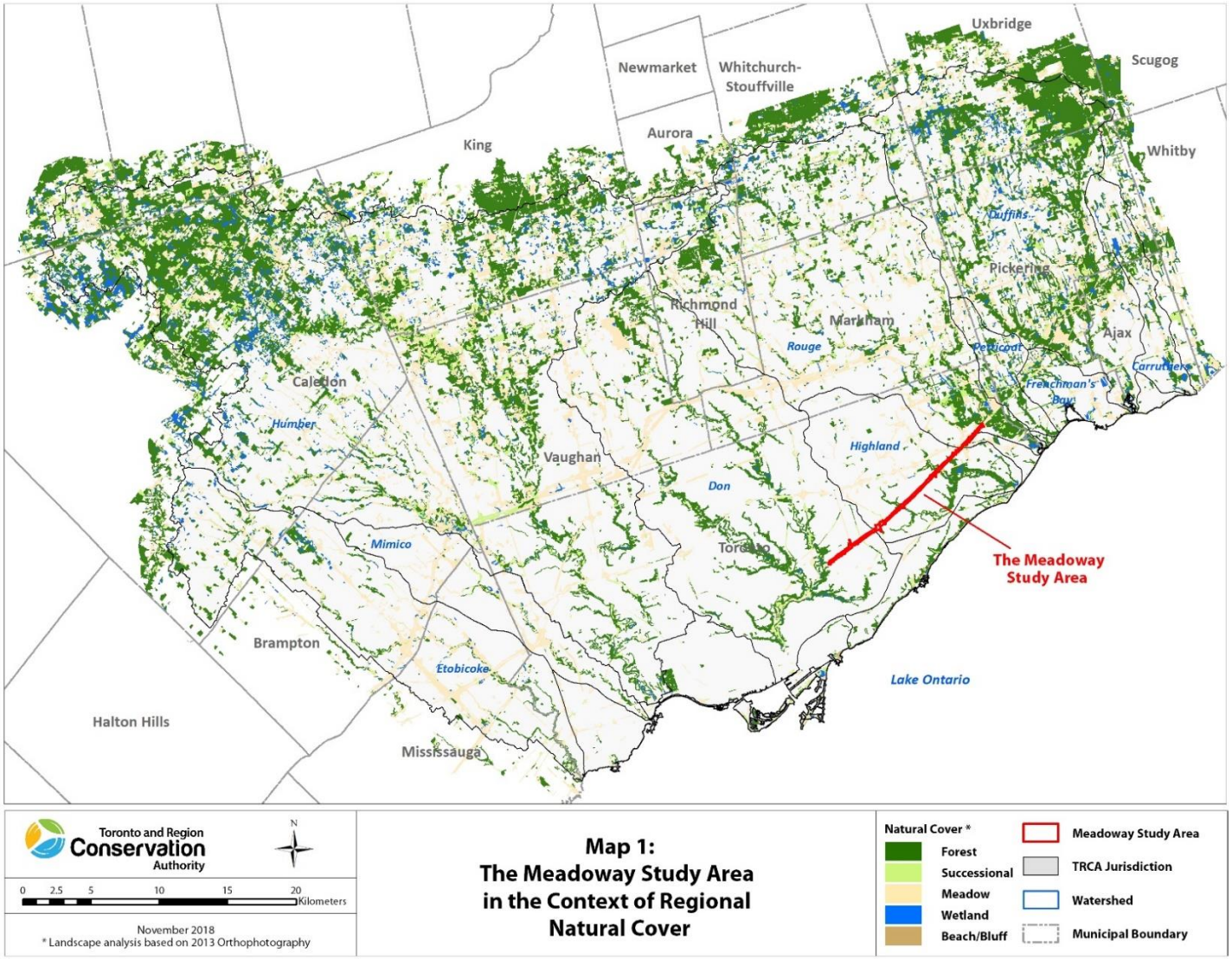

Figure 2. Geographic location of The Meadoway related to the Toronto and Region Conservation Authority (TRCA) jurisdiction

METHODOLOGY

Vegetation plots

The methodology for monitoring meadow ecosystems used by the Toronto and Region Conservation Authority (TRCA) is based on the Ecological Monitoring and Assessment Network (EMAN) endorsed terrestrial vegetation biodiversity monitoring protocols identified by Roberts-Pichette and Gillespie (1999). As the EMAN protocol was originally intended for forest communities, adaptations to the protocol were made making it specific to meadow ecosystems (Figure 3).

Figure 3. Vegetation plot set-up at The Meadoway

Each meadow plot consisted of one 20 x 20 m (400 m^2) main plot, five 2 x 2 m (4 m^2) shrub and sapling regeneration sub-plots and five 1 x 1 m (1 m^2) ground cover vegetation sub-plots (nested within the larger regeneration sub-plots). Shrub and sapling regeneration sub-plots were monitored once during the growing season (September). Sites were visited approximately the same time each year coinciding with the second ground vegetation visit. All shrubs and seedlings that were <10 cm diameter-at-breast-height and ≥16 cm in height were considered in regeneration sub-plots. Only live plants were recorded in regeneration sub-plots. The boundaries of the 2 x 2 m sub-plots were identified and delineated. All qualifying plant species originating within the sub-plot were identified. Individuals within each species were then measured with a metre stick and recorded into the appropriate height class located on the data sheet. Height measurements were taken from the ground to the upper most living portion of the plant. For plants that leaned, the vertical distance from the ground to the highest part of the plant was recorded as the height. The percent cover that each species provides was estimated.

All herbaceous plants, regardless of size, as well as shrub, tree and woody vines <16 cm in height were considered in ground vegetation sub-plots. Ground vegetation sub-plot monitoring was conducted twice during the growing season to capture early and late growing meadow/prairie species. The first visit was in early June and the second in late summer (September). Sites were visited approximately the same time each year. Each plant species originating within or hanging over into the 1 x 1 m sub-plot was identified. A 1 x 1 m grid square consisting of smaller 10 x 10 cm grids was positioned over corner "A" of the sub-plot and shifted to the other three corners. The number of 10 x 10 cm squares that each species occupies was summed to determine their total percentage of cover within the sub-plot. It was also noted if a species was solitary. The cover of dead vegetation (thatch) was also measured in the ground vegetation plots.

Species lists were created for the plot as a whole using data combined from the 20 x 20, all 2 x 2s and all 1 x 1s. For the examination of establishment of seeded species (e.g. cover), we only considered species from ground vegetation plots that occurred in each year. For a detailed description of vegetation monitoring methodology please see the Bob Hunter Meadow Management Monitoring Protocol (TRCA 2016).

Vegetation data were interpreted using TRCA's local rank (L-rank) system for flora (TRCA 2017). The L-rank system is a species scoring and ranking system developed at TRCA to provide guidance for natural heritage protection and management within the jurisdiction. The L-rank system uses simple ranks to convey individual species' ecological needs and sensitivities rather than just "rarity" in order to portray such complexities on a simple ordinal scale. Flora are scored using four criteria: local occurrence, population trend, habitat dependence and sensitivity to development impacts. For example, species ranked L1 would have: a limited local occurrence, declining population trends, habitat specialist preferences and a sensitivity to development. Species ranked L5 would have: a widespread local occurrence, increasing population trends, habitat generalist preferences and a tolerance to development. These are extreme examples and species can be ranked L1, L2, L3, L4 or L5 based on the scores associated with this combination of ecological needs and population status assessments. In addition, flora species can be categorized as follows: L1-L3 species are of regional conservation concern, L4 species are of conservation concern in urban areas, L5 species are not of conservation concern at this time, L* species are native to southern Ontario but with no known natural records in TRCA jurisdiction, LX species have been extirpated from the TRCA jurisdiction (but have been planted since extirpation), L+ species are introduced species not native to the TRCA jurisdiction, L+? species are probably introduced.

Bird stations

Meadow bird monitoring followed an adapted Ontario Forest Bird Monitoring Protocol (Figure 4). This protocol is also used for meadow bird surveys conducted through TRCA's Terrestrial Long-term Monitoring Program (TRCA 2011). Meadow birds were monitored twice during the field season with the first visit occurring between May 15th and May 30th, and the second visit between May 30th and June 15th, with at least 10 days between visits. Counts were conducted between 05:00 and 10:00 hours and at approximately the same time of day on subsequent visits from year to year. Counts were only conducted in good weather conditions (no rain, light winds). All birds seen or heard within a 100 m radius circle and during a 10-minute time period were recorded. This report only contains species assumed to be breeding at the site.

Figure 4. Biologist conducting bird monitoring

Butterfly transects

Butterflies were surveyed in 2016, 2018, 2019 and 2020 by slowly walking a specified path through the meadow and identifying/counting butterfly species observed (Figure 5). Butterflies were identified to species where possible or to genus if species-level identification was not possible. Four visits were made each year to capture variation in adult emergence dates among species and migratory species. Surveys were conducted between 09:00 and 16:00 and only in good weather conditions (>20^{o}C, no rain, light winds). Start and end times were recorded and were generally consistent among years.

Figure 5. Eastern tailed blue (Cupido comyntas)

RESULTS

Thirty-three vegetation plots were set-up between 2016 and 2020 (Table 1, Appendix 1, Figure 6). Plots were set-up in different years corresponding to the occurrence of management activities. Bird monitoring was completed in 2016, 2018, 2019 and 2020 with 3 new survey stations added in 2020 in sections 1.2, 5.2 and 5.3. Butterfly monitoring was completed in 2016, 2018, 2019 and 2020. In 2016 and 2018, five sections were surveyed with transects situated on the paved trail that runs the length of the corridor. In 2019 there were several changes to butterfly transects. First, transects were added to sections 1 and 2 (Figure 6). Second, transects were moved slightly in each section to run beneath the northmost hydro wires for the entire length of the corridor (instead of along the trail). Third, Hydro One established a works yard in a portion of section 7 making comparisons across the three years difficult. In 2020, four new transects were added in the east end of section 5 (Figure 6).

Table 1. Vegetation plots, bird surveys and butterfly survey locations and years surveyed

Section	Veg plot name	Vegetation plot monitoring years	Bird survey station #	Bird survey years	Butterfly survey years
1.1	MV-24_1.1X	2019, 2020			
	MV-24_1.1Y	2020			
1.2	MV-24_1.2P	2018, 2019, 2020	8	2020	2020
1.3	MV-24_1.3Q	2018, 2020			
	MV-24_1.3V	2019 (abandonned post-2019)			
1.4	MV-24_1.4W	2019 (abandonned post-2019)	6	2018, 2019	2019
	MV-24_1.4R	2019 (abandonned post-2019)			
2.2	MV-24_2.2S	2018, 2019			
2.3	MV-24_2.3T	2018, 2019			
2.4	MV-24_2.4U	2018, 2019	7	2018, 2019	2019
3.2	MV-24_3.2AA	2020			
3.3	MV-24_3.3AB	2020			
4.1	MV-24_4.1G	2016, 2018, 2019, (2020 summer only)	1	2016, 2018-2020	2016, 2018-2020
	MV-24_4.1H	2016, 2018, 2019, (2020 summer only)			
	MV-24_4.1I	2019 (abandonned post-2019)			
4.2	MV-24_4.2A	2016, 2018-2020	2	2016, 2018-2020	2016, 2018-2020
	MV-24_4.2B	2016, 2018-2020			
	MV-24_4.2C	2016, 2018-2020			
4.3	MV-24_4.3D	2016, 2018-2020	3	2016, 2018-2020	2016, 2018-2020
	MV-24_4.3E	2016, 2018, 2019, (2020 summer only)			
	MV-24_4.3F	2016, 2018, 2019, (2020 summer only)			
4.4	MV-24_4.4J	2016, 2018, 2019, (2020 summer only)	4	2016, 2018-2020	2016, 2018-2020
	MV-24_4.4K	2016, 2018, 2019, (2020 summer only)			
	MV-24_4.4L	2016, 2018, 2019, (2020 summer only)			
5.1	MV-24_5.1AC	2020			
5.2	N/A	N/A	9	2020	2020
5.3	MV-24_5.3AD	2020	10	2020	
5.4	MV-24_5.4AE	2020			
6.1	MV-24_6.1AF	2020			
6.2	MV-24_6.2AG	2020			
6.4	MV-24_6.4AH	2020			
7.1	MV-24_7.1M	2016, 2018-2020	5	2016, 2018-2020	2016, 2018-2020
	MV-24_7.1N	2016, 2018-2020			
	MV-24_7.1O	2016, 2018-2020			

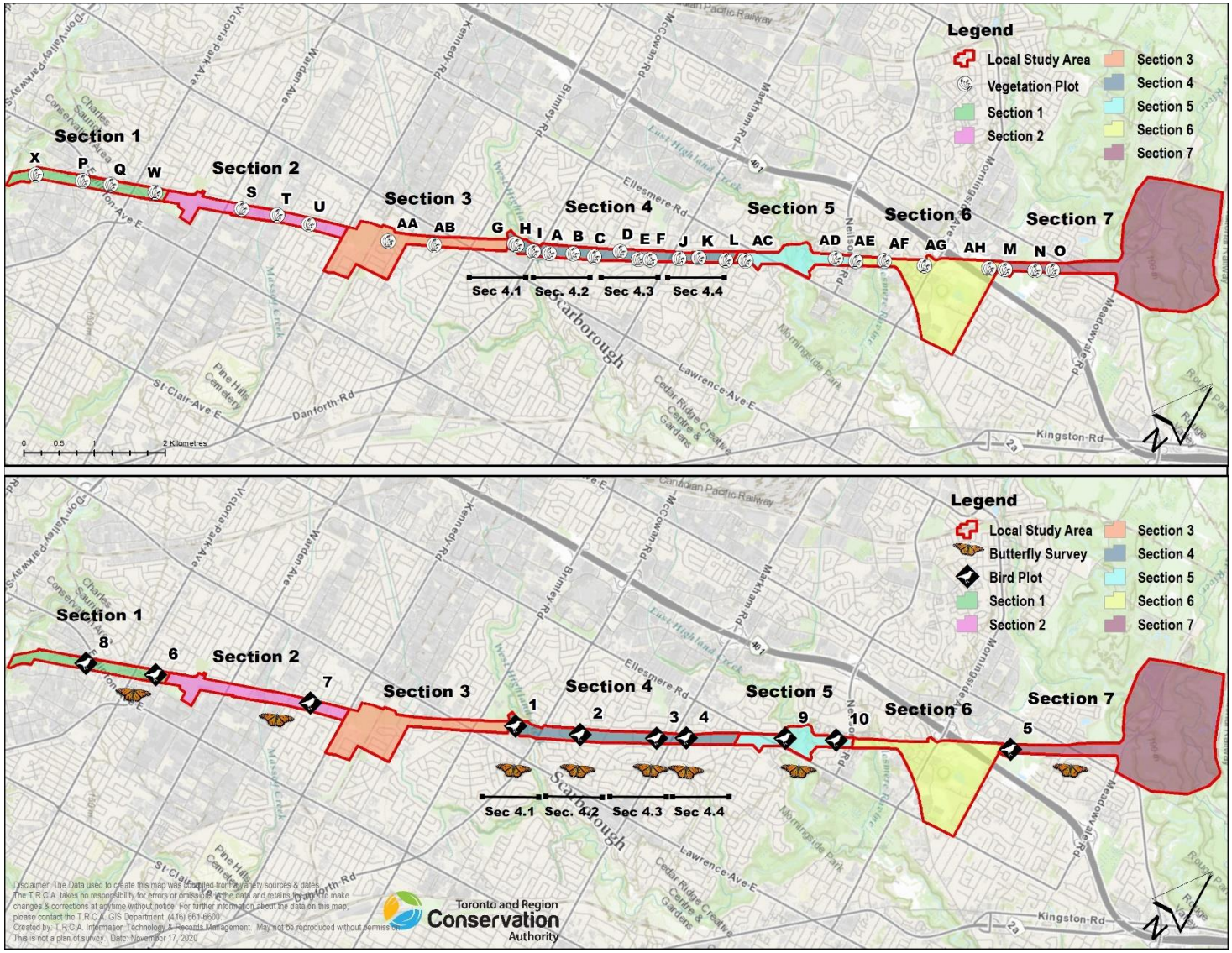

Figure 6. Vegetation plot, bird and butterfly survey locations at The Meadoway in 2016, 2018, 2019 and 2020. NOTE: Not all survey types were completed at all sections each year (described in Table 1 above).

Vegetation plots

Vegetation monitoring plots were subject to different, and often multiple, management techniques over the past four years of monitoring. Due to this variation, we assessed seeding success and the effectiveness of invasive species management by section. We compared the seed mix list to species present in the monitoring plots post-seeding to determine the success of the seed mix. Seed mixes included primarily one of two mixes prior to 2020 (mix 1 or mix 2) and various other mixes including butterfly mix, Ontario wet meadow mix, and dry mix in 2020 (Appendix 2). If more than one mix was used over multiple years at a specific vegetation plot, seed mix lists were combined to evaluate success. We examined the effectiveness of invasive species management, particularly the targeted treatment/removal of creeping thistle (*Cirsium arvense*) and dog-strangling vine (*Cynanchum rossicum*; DSV), by comparing the absolute maximum cover in each sub-plot over the years monitored. Other species were targeted for invasive species management including common reed (*Phragmites australis*), spotted knapweed (*Centaurea stoebe* ssp. *micranthos*) and tansy (*Tanacetum vulgare*), and were only included in the analysis if applicable to a specific section and vegetation monitoring plot.

Section 1

Four vegetation plots were monitored in section 1 (X, Y, P, and Q). Plot P (in section 1.2) could not be assessed because the experimental seeding plots were placed on top of the vegetation plot and subsequently treated with a range of seeding/management techniques confounding the effectiveness of the original seeding in the area. Plots X and Y in section 1.1 were seeded with Ontario wet mix in May 2020 and were also managed for invasive species in 2020 using a blanket spray and spot spraying for DSV. Plot Q in section 1.3 was seeded with butterfly mix in May 2020 and was also managed for invasive species in 2020 using a blanket spray and spot spraying for DSV. The effectiveness of the seed mix or invasive species management may not be fully seen for several years but nonetheless, we have included the results of the first year of management.

Section 1.1

Section 1.1 represented pre-management conditions in 2019 consisting of a large amount of DSV and was seeded with Ontario wet meadow mix in the spring of 2020. We compared the species found to the seed mix using data from both plots X and Y in 2020 (spring and summer visits) and only plot X in 2019 (only spring visit). In 2019, heath aster (*Symphyotrichum eriocoides* var. *ericoides*), path rush (*Juncus tenuis*) and New England aster (*Symphyotrichum novae-angliae*) were the only targeted species occurring from the seed mix (which had yet to be applied). In 2020, 14 (40%) of the 35 species seeded were observed including several species of regional concern such as cardinal flower (*Lobelia cardinalis*), spike blazing-star (*Liatris spicata*), Indian grass (*Sorghastrum nutans*), switch grass (*Panicum virgatum*) and foxglove beard-tongue (*Penstemon digitalis*) (Table 2).

A blanket spray and spot spraying for DSV occurred in 2020. Plot X was not monitored in the summer of 2019 so we compared the cover of DSV between spring 2019 and spring 2020. There were large declines in the absolute percent cover of DSV in all five sub-plots between 2019 and 2020. Declines ranged from 8 to 90% resulting in percent covers of <1% in all sub-plots by 2020.

Table 2. Seeded species and those occurring in vegetation monitoring plot X (2019) and plot X and Y (2020) (section 1.1). Plot seeded in the spring of 2020 with Ontario wet meadow mix.

Species name	Species code	Common name	L-rank	Ontario wet meadow mix	2019	2020
Lobelia cardinalis	LOBCARD	cardinal flower	L1	x		x
Liatris spicata	LIASPIC	spike blazing-star	L2	x		x
Sorghastrum nutans	SORNUTA	Indian grass	L2	x		x
Bromus ciliatus	BROCILI	fringed brome grass	L3	x		
Doellingeria umbellata var. umbellata	ASTUMBE	flat-topped aster	L3	x		
Lobelia siphilitica	LOBSIPH	great blue lobelia	L3	x		
Panicum virgatum	PANVIRG	switch grass	L3	x		x
Penstemon digitalis	PENDIGI	foxglove beard-tongue	L3	x		x
Physostegia virginiana ssp. virginiana	PHYVIRG	false dragonhead	L3	x		
Symphyotrichum pilosum var. pilosum	ASTPIPI	hairy aster	L3	x		
Asclepias incarnata ssp. incarnata	ASCINCA	swamp milkweed	L4	x		x
Juncus balticus ssp. littoralis	JUNBALT	Baltic rush	L4	x		
Mimulus ringens	MIMRING	square-stemmed monkey-flower	L4	x		
Rudbeckia hirta	RUDHIRT	black-eyed Susan	L4	x		x
Rudbeckia laciniata	RUDLACI	cut-leaved coneflower	L4	x		x
Scirpus cyperinus	SCICYPE	woolly bulrush	L4	x		
Carex bebbii	CARBEBB	Bebb's sedge	L5	x		
Carex stipata	CARSTIP	awl-fruited sedge	L5	x		
Carex vulpinoidea	CARVULP	fox sedge	L5	x		
Elymus virginicus var. virginicus	ELYVIRG	Virginia wild rye	L5	x		
Eupatorium perfoliatum	EUPPERF	boneset	L5	x		x
Euthamia graminifolia	EUTGRAM	grass-leaved goldenrod	L5	x		x
Eutrochium maculatum var. maculatum	EUPMACU	spotted Joe-Pye weed	L5	x		
Glyceria striata	GLYSTRI	fowl manna grass	L5	x		
Juncus articulatus	JUNARTI	jointed rush	L5	x		
Juncus effusus	JUNEFFU	soft rush	L5	x		
Juncus tenuis	JUNTENU	path rush	L5	x	x	
Juncus torreyi	JUNTORR	Torrey's rush	L5	x		
Monarda fistulosa	MONFIST	wild bergamot	L5	x		x
Oenothera biennis	OENBIEN	common evening-primrose	L5	x		x
Scirpus atrovirens	SCIATRO	black-fruited bulrush	L5	x		
Symphyotrichum ericoides var. ericoides	ASTERIC	heath aster	L5	x	x	x
Symphyotrichum novae-angliae	ASTNOVA	New England aster	L5	x	x	x
Symphyotrichum puniceum var. puniceum	ASTPUNI	swamp aster	L5	x		
Verbena hastata	VERHAST	blue vervain	L5	x		

Section 1.3

Section 1.3 was turfgrass in 2018 and was seeded with butterfly mix in the spring of 2020. In 2018, only one of the targeted species from the seed mix (which had yet to be applied) occurred, heath aster. In 2020, 12 (40%) of the 30 species seeded were observed including several species of regional concern such as ox-eye (*Heliopsis helianthoides*), Indian grass, big bluestem (*Andropogon gerardii*), switch grass and sand dropseed (*Sporobolus cryptandrus*) (Table 3).

Table 3. Seeded species and those occurring in vegetation monitoring plot Q (section 1.3). Plot seeded in the spring of 2020 with butterfly seed mix.

Species name	Species code	Common name	L-rank	Butterfly mix	2018	2020
Liatris cylindracea	LIACYLI	cylindric blazing-star	L1	x		
Heliopsis helianthoides	HELHELI	ox-eye	L2	x		x
Schizachyrium scoparium	SCHSCOP	little bluestem	L2	x		
Sorghastrum nutans	SORNUTA	Indian grass	L2	x		x
Andropogon gerardii	ANDGERA	big bluestem	L3	x		x
Drymocallis arguta	POTARGU	tall cinquefoil	L3	x		
Lespedeza capitata	LESCAPI	round-headed bush-clover	L3	x		
Panicum virgatum	PANVIRG	switch grass	L3	x		x
Penstemon digitalis	PENDIGI	foxglove beard-tongue	L3	x		
Penstemon hirsutus	PENHIRS	hairy beard-tongue	L3	x		
Pycnanthemum virginianum	PYCVIRG	Virginia mountain-mint	L3	x		
Sporobolus cryptandrus	SPOCRYP	sand dropseed	L3	x		x
Verbena stricta	VERSTRI	hoary vervain	L3	x		
Elymus canadensis	ELYCANA	Canada wild rye	L4	x		x
Rudbeckia hirta	RUDHIRT	black-eyed Susan	L4	x		x
Sisyrinchium montanum	SISMONT	blue-eyed grass	L4	x		
Symphyotrichum oolentangiense	ASTOOLE	sky-blue aster	L4	x		
Apocynum cannabinum	APOCANN	hemp dogbane (sensu lato)	L5	x		
Asclepias syriaca	ASCSYRI	common milkweed	L5	x		x
Desmodium canadense	DESCANA	showy tick-trefoil	L5	x		x
Euthamia graminifolia	EUTGRAM	grass-leaved goldenrod	L5	x		
Monarda fistulosa	MONFIST	wild bergamot	L5	x		x
Oenothera biennis	OENBIEN	common evening-primrose	L5	x		x
Silphium perfoliatum	SILPERF	cup-plant	L5	x		
Solidago nemoralis ssp. nemoralis	SOLNEMO	grey goldenrod	L5	x		
Symphyotrichum ericoides var. ericoides	ASTERIC	heath aster	L5	x	x	x
Symphyotrichum novae-angliae	ASTNOVA	New England aster	L5	x		
Verbena hastata	VERHAST	blue vervain	L5	x		
Asclepias tuberosa	ASCTUBE	butterfly milkweed	LX	x		
Helenium autumnale	HELAUTU	sneezeweed	L*	x		

A blanket spray and spot spraying for DSV occurred in 2020. The cover of DSV was low in 2018 ranging from <1% to 3% in each of the five sub-plots. In 2020, DSV was only found in one sub-plot with a cover of <1%.

Section 2

Vegetation plots S, T and U in section 2 were not monitored in 2020 due to site preparation activities (e.g. tilling). These plots were monitored in 2018 and 2019 and represented pre-management, turfgrass communities consisting of primarily meadow fescue (*Schedonorus pratensis*), red fescue (*Festuca rubra* ssp. *rubra*) and Kentucky blue grass (*Poa pratensis* ssp. *pratensis*), all of which are non-native species. The results of the 2020 management activities will be apparent when the plot data are collected in 2021.

Section 3

Sections 3.2 and 3.3 were monitored for the first time in 2020 and represented pre-management, turfgrass communities. Similar to the results for section 2, the plots (AA and AB) primarily contained meadow fescue and Kentucky bluegrass and results of the 2020 management activities will be apparent when the plot data are collected in 2021. Section 3.2 was unique for pre-restoration areas with several, naturally occurring native

species including golden-fruited sedge (*Carex aurea*), blue-eyed grass (*Sisyrinchium montanum*), plantain-leaved pussytoes (*Antennaria parlenii* ssp. *fallax*) and Howell's pussytoes (*Antennaria howellii* ssp. *howellii*).

Section 4

Twelve vegetation plots have been monitored in section 4 since 2016 (plots A-L). The plots in this section provide the longest record of data collection within The Meadoway similar to section 7 allowing us to evaluate success over a longer time period compared to more recently restored sections. In this section, we also examined changes in percent cover of seeded species within sub-plots to examine establishment instead of just germination success. We compared the cover of seeded species found in plots only if they were found in all years in the sub-plots. If both spring and summer surveys were included, we used the maximum absolute cover.

Section 4.1

Vegetation plots G and H were set up in 2016 in section 4.1. In 2020, only summer surveys were conducted so we compared species occurrence only using data from summer visits for 2016 and 2018-2020. This section was seeded with mix 2 and invasive species management targeted DSV and thistle.

Between 2016 and 2020, 12 (48%) of the 25 species seeded were observed including several species of regional concern such as ox-eye, little bluestem (*Schizachyrium scoparium*), Indian grass, big bluestem and switch grass (Table 4). Of the seeded species that established populations in all years, Indian grass, ox-eye, switch grass, tall sunflower (*Helianthus giganteus*) and wild bergamot (*Monarda fistulosa*) appeared to be increasing in cover since 2016 (Figure 7). Black-eyed Susan (*Rudbeckia hirta*) and common evening-primrose (*Oenothera biennis*) had lower covers in 2020 compared to other years although this may be expected since these species typically occur in areas with recent soil disturbance.

The cover of DSV was very low (0-3%) in all years in plots G and H and no increasing or decreasing patterns were evident. The cover of thistle was also low (0-3%) in most sub-plots of G and H; however, covered 9-13% of the area in sub-plot 2 in plot G between 2018 and 2020.

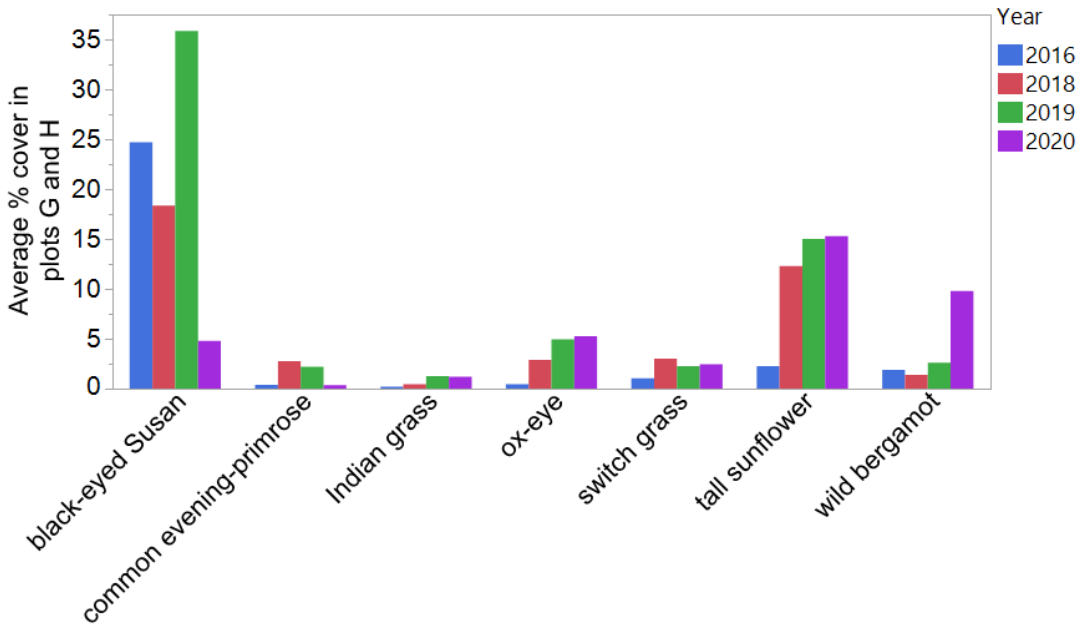

Figure 7. Average percent cover of seeded species occurring annually in vegetation plots G and H (section 4.1)

Table 4. Seeded species and those occurring in vegetation monitoring plots G and H (section 4.1)

Species name	Species code	Common name	L-rank	Seed mix 2	2016	2018	2019	2020
Lobelia cardinalis	LOBCARD	cardinal flower	L1	x				
Heliopsis helianthoides	HELHELI	ox-eye	L2	x	x	x	x	x
Schizachyrium scoparium	SCHSCOP	little bluestem	L2	x		x	x	x
Sorghastrum nutans	SORNUTA	Indian grass	L2	x	x	x	x	x
Andropogon gerardii	ANDGERA	big bluestem	L3	x	x	x	x	x
Gentiana andrewsii	GENANDR	bottle gentian	L3	x				
Lespedeza capitata	LESCAPI	round-headed bush-clover	L3	x				
Lobelia siphilitica	LOBSIPH	great blue lobelia	L3	x				
Panicum virgatum	PANVIRG	switch grass	L3	x	x	x	x	x
Penstemon digitalis	PENDIGI	foxglove beard-tongue	L3	x				
Penstemon hirsutus	PENHIRS	hairy beard-tongue	L3	x				
Elymus canadensis	ELYCANA	Canada wild rye	L4	x				
Rudbeckia hirta	RUDHIRT	black-eyed Susan	L4	x	x	x	x	x
Desmodium canadense	DESCANA	showy tick-trefoil	L5	x	x	x	x	x
Monarda fistulosa	MONFIST	wild bergamot	L5	x	x	x	x	x
Oenothera biennis	OENBIEN	common evening-primrose	L5	x	x	x	x	x
Silphium perfoliatum	SILPERF	cup-plant	L5	x				
Asclepias sullivantii	ASCSULL	smooth milkweed	LX	x				
Asclepias tuberosa	ASCTUBE	butterfly milkweed	LX	x				
Helianthus giganteus	HELGIGA	tall sunflower	LX	x	x	x	x	x
Allium cernuum	ALLCERN	nodding wild onion	L*	x				
Coreopsis lanceolata	CORLANC	lance-leaved coreopsis	L*	x	x			
Coreopsis tripteris	CORTRIP	tall tickseed	L*	x				
Echinacea pallida	ECHPALL	pale purple coneflower	L*	x				
Ratibida pinnata	RATPINN	grey-headed coneflower	L*	x				x

Section 4.2

Vegetation plots A, B and C were set up in 2016 in section 4.2. In 2016, only summer surveys were conducted so we compared species occurrence over both visits between 2018 and 2020. This section was seeded with mix 1 and invasive species management targeted DSV and thistle.

Between 2018 and 2020, 18 (58%) of the 31 species seeded were observed including several species of regional concern such as ox-eye, little bluestem, Indian grass, big bluestem, round-headed bush-clover (*Lespedeza capitate*), switch grass and Virginia mountain-mint (*Pycnanthemum virginianum*) (Table 5). Several species were only found in one or two years including little bluestem, round-headed bush-clover and Canada wild rye (*Elymus canadensis*).

Of the seeded species that established populations in all years, Indian grass, ox-eye, stiff goldenrod (*Solidago rigida* ssp. *rigida*), tall sunflower and wild bergamot appeared to be increasing in cover between 2018 and 2020 (Figure 8). All other species varied only slightly in percent cover since 2018 with no species showing a clear decline between 2018 and 2020.

The cover of thistle decreased in 8 of 15 sub-plots in this section, remained similar at 2 of 15 sub-plots, increased slightly at 4 sub-plots and was absent from only 1 sub-plot. Evidence of herbicide or mechanical removal of thistle was noted at 6 sub-plots between 2018 and 2020. Overall, the average cover of thistle decreased between 2018 and 2020 in this section. The cover of DSV increased by doubling or tripling between 2018 and 2020 at 2 sub-plots of plot A (in the west end) while in other sub-plots of plots B and C, DSV cover has remained low (<8%) between 2018 and 2020. In 2020, DSV plants were described as spreading seeds or fruiting in some sub-plots. Overall, the average cover of DSV increased from 2.3% in 2018 to 4.9% in 2020.

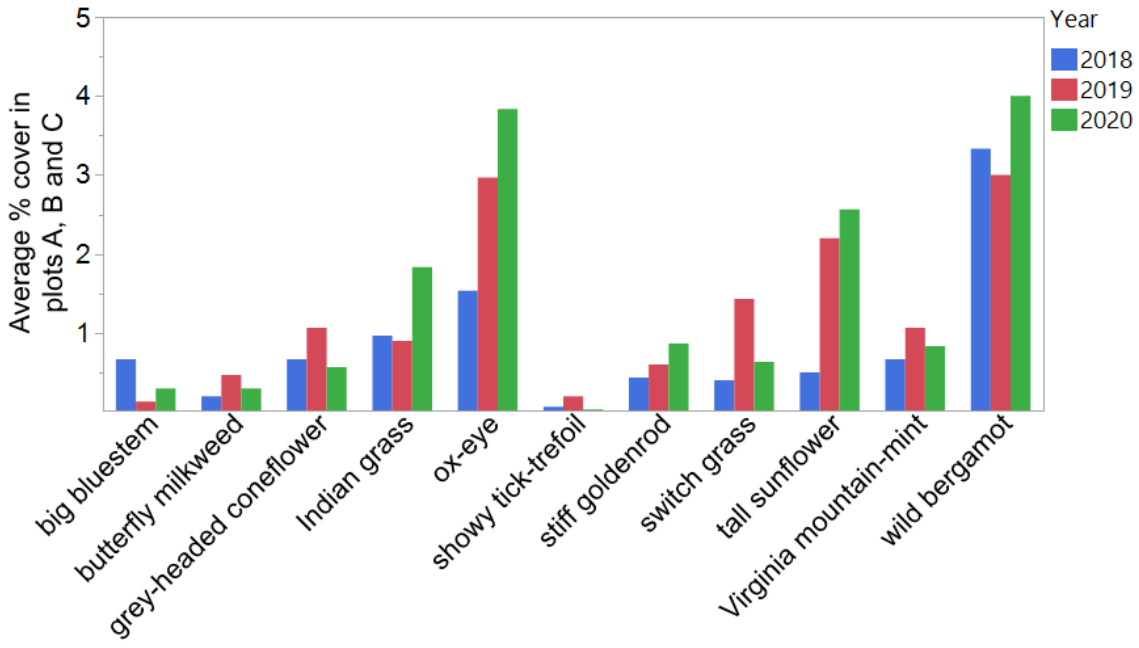

Figure 8. Average percent cover of seeded species occurring annually in vegetation plots A, B and C (section 4.2)

Table 5. Seeded species and those occurring in vegetation monitoring plots A, B and C (section 4.2)

Species name	Species code	Common name	L-rank	Seed mix 1	2018	2019	2020
Lobelia cardinalis	LOBCARD	cardinal flower	L1	x			
Heliopsis helianthoides	HELHELI	ox-eye	L2	x	x	x	x
Schizachyrium scoparium	SCHSCOP	little bluestem	L2	x	x		
Sorghastrum nutans	SORNUTA	Indian grass	L2	x	x	x	x
Andropogon gerardii	ANDGERA	big bluestem	L3	x	x	x	x
Gentiana andrewsii	GENANDR	bottle gentian	L3	x			
Lespedeza capitata	LESCAPI	round-headed bush-clover	L3	x	x		x
Lobelia siphilitica	LOBSIPH	great blue lobelia	L3	x			
Panicum virgatum	PANVIRG	switch grass	L3	x	x	x	x
Penstemon digitalis	PENDIGI	foxglove beard-tongue	L3	x			
Penstemon hirsutus	PENHIRS	hairy beard-tongue	L3	x			
Pycnanthemum virginianum	PYCVIRG	Virginia mountain-mint	L3	x	x	x	x
Elymus canadensis	ELYCANA	Canada wild rye	L4	x		x	
Rudbeckia hirta	RUDHIRT	black-eyed Susan	L4	x	x	x	x
Desmodium canadense	DESCANA	showy tick-trefoil	L5	x	x	x	x
Elymus virginicus var. virginicus	ELYVIRG	Virginia wild rye	L5	x			
Monarda fistulosa	MONFIST	wild bergamot	L5	x	x	x	x
Oenothera biennis	OENBIEN	common evening-primrose	L5	x	x	x	x
Silphium perfoliatum	SILPERF	cup-plant	L5	x	x	x	x
Verbena hastata	VERHAST	blue vervain	L5	x			
Asclepias sullivantii	ASCSULL	smooth milkweed	LX	x	x	x	x
Asclepias tuberosa	ASCTUBE	butterfly milkweed	LX	x			
Helianthus giganteus	HELGIGA	tall sunflower	LX	x	x	x	x
Solidago rigida ssp. rigida	SOLRIGI	stiff goldenrod	LX	x	x	x	x
Allium cernuum	ALLCERN	nodding wild onion	L*	x			
Coreopsis lanceolata	CORLANC	lance-leaved coreopsis	L*	x			
Coreopsis tripteris	CORTRIP	tall tickseed	L*	x	x	x	x
Echinacea pallida	ECHPALL	pale purple coneflower	L*	x			
Ratibida pinnata	RATPINN	grey-headed coneflower	L*	x	x	x	x
Vernonia missurica	VERMISS	Missouri ironweed	L*	x			
Veronicastrum virginicum	VERVIRG	Culver's root	L*	x			

Section 4.3

Vegetation plots D, E and F were set up in 2016 in section 4.3. In 2020, only summer surveys were conducted for plots E and F so we compared species occurrence only using data from summer visits for 2016 and 2018-2020. This section was seeded with mix 1 and invasive species management targeted DSV and thistle.

Between 2016 and 2020, 26 (84%) of the 31 species seeded were observed including several species of regional concern such as ox-eye, little bluestem, Indian grass, big bluestem, round-headed bush-clover, great blue lobelia (*Lobelia siphilitica*), switch grass, foxglove beard-tongue (*Penstemon digitalis*) and Virginia mountain-mint (Table 6). Of the 26 seeded species found, 17 occurred in every year while 5 species occurred in only one year including Canada wild rye in 2016, little bluestem and blue vervain (*Verbena hastata*) in 2018, and Culver's root (*Veronicastrum virginicum*) and Virginia wild rye (*Elymus virginicus* var. *virginicus*) in 2020.

Of the seeded species that established populations in all years in plots D, E and F, big bluestem, ox-eye and butterfly milkweed (*Asclepias tuberosa*) appear to have increased in cover since 2016 (Figure 9). All other species had lower percent covers in 2020 compared to 2016. This could be due to the higher cover of grasses (compared to forbs) in this section and the subsequent thatch produced.

The cover of thistle decreased in 5 of 15 sub-plots in this section, remained similar at 5 of 15 sub-plots, increased at 1 sub-plot and was absent from 4 sub-plots. Overall, the average cover of thistle decreased between 2016 and 2020 in this section. The cover of DSV decreased in 2 of 15 sub-plots between 2016 and 2020, remained similar at 9 sub-plots and was absent from 4 sub-plots. Overall, the average cover of DSV did not change between 2016 and 2020.

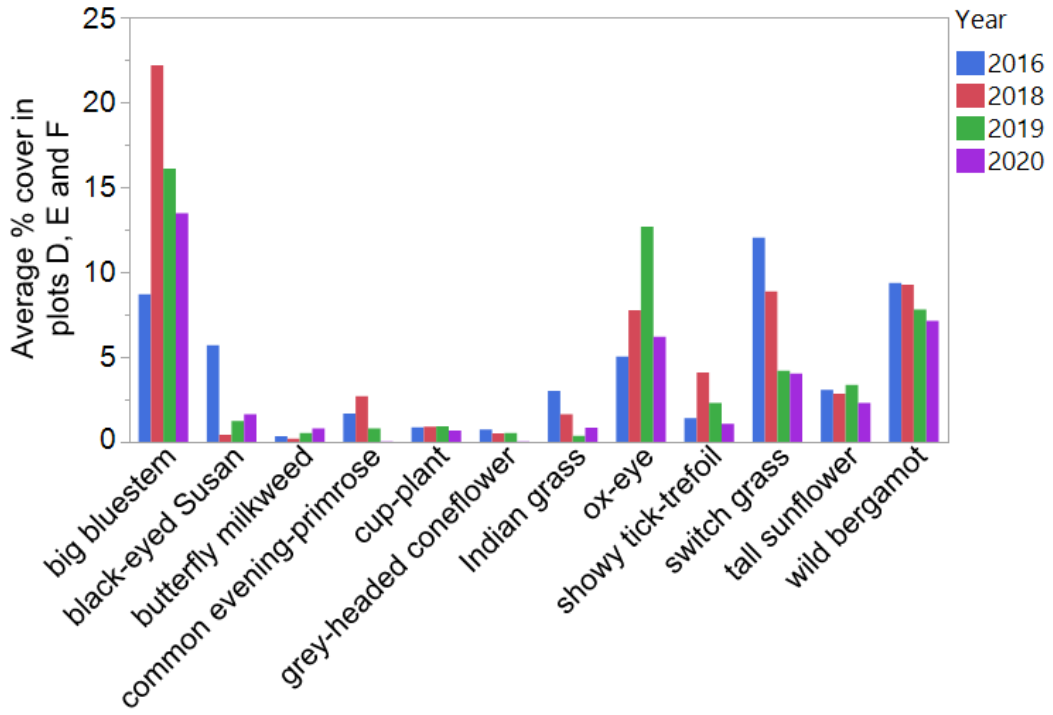

Figure 9. Average percent cover of seeded species occurring annually in vegetation plots D, E and F (section 4.3)

Table 6. Seeded species and those occurring in vegetation monitoring plots D, E and F (section 4.3)

Species name	Species code	Common name	L-rank	Seed mix 1	2016	2018	2019	2020
Lobelia cardinalis	LOBCARD	cardinal flower	L1	x				
Heliopsis helianthoides	HELHELI	ox-eye	L2	x	x	x	x	x
Schizachyrium scoparium	SCHSCOP	little bluestem	L2	x		x		
Sorghastrum nutans	SORNUTA	Indian grass	L2	x	x	x	x	x
Andropogon gerardii	ANDGERA	big bluestem	L3	x	x	x	x	x
Gentiana andrewsii	GENANDR	bottle gentian	L3	x				
Lespedeza capitata	LESCAPI	round-headed bush-clover	L3	x	x	x	x	x
Lobelia siphilitica	LOBSIPH	great blue lobelia	L3	x		x	x	x
Panicum virgatum	PANVIRG	switch grass	L3	x	x	x	x	x
Penstemon digitalis	PENDIGI	foxglove beard-tongue	L3	x			x	x
Penstemon hirsutus	PENHIRS	hairy beard-tongue	L3	x				
Pycnanthemum virginianum	PYCVIRG	Virginia mountain-mint	L3	x	x	x	x	x
Elymus canadensis	ELYCANA	Canada wild rye	L4	x	x			
Rudbeckia hirta	RUDHIRT	black-eyed Susan	L4	x	x	x	x	x
Desmodium canadense	DESCANA	showy tick-trefoil	L5	x	x	x	x	x
Elymus virginicus var. virginicus	ELYVIRG	Virginia wild rye	L5	x				x
Monarda fistulosa	MONFIST	wild bergamot	L5	x	x	x	x	x
Oenothera biennis	OENBIEN	common evening-primrose	L5	x	x	x	x	x
Silphium perfoliatum	SILPERF	cup-plant	L5	x	x	x	x	x
Verbena hastata	VERHAST	blue vervain	L5	x		x		
Asclepias sullivantii	ASCSULL	smooth milkweed	LX	x	x	x	x	x
Asclepias tuberosa	ASCTUBE	butterfly milkweed	LX	x	x	x	x	x
Helianthus giganteus	HELGIGA	tall sunflower	LX	x	x	x	x	x
Solidago rigida ssp. rigida	SOLRIGI	stiff goldenrod	LX	x	x	x	x	x
Allium cernuum	ALLCERN	nodding wild onion	L*	x				
Coreopsis lanceolata	CORLANC	lance-leaved coreopsis	L*	x	x		x	
Coreopsis tripteris	CORTRIP	tall tickseed	L*	x	x	x	x	x
Echinacea pallida	ECHPALL	pale purple coneflower	L*	x				
Ratibida pinnata	RATPINN	grey-headed coneflower	L*	x	x	x	x	x
Vernonia missurica	VERMISS	Missouri ironweed	L*	x		x	x	x
Veronicastrum virginicum	VERVIRG	Culver's root	L*	x				x

Section 4.4

Vegetation plots J, K and L were set up in 2016 in section 4.4. Unlike sections 4.1-4.3, this section was undergoing seeding and tilling in both June and August 2020 so while a summer visit was conducted, data were not presented here in order to avoid mis-representing flora communities. Seeding success in plots J, K and L will be reported in subsequent monitoring reports. Invasive species management targeted DSV and thistle although again, active seeding and tilling may mis-represent actual species cover.

Sections 5 and 6

Sections 5 and 6 were monitored for the first time in 2020 and represented pre-management, turfgrass communities. There were six vegetation plots set-up in these sections in 2020 (AC, AD AE, AF, AG, and AH). Similar to the results for other pre-management sections, the plots primarily contained meadow fescue, Kentucky bluegrass, red fescue, and orchard grass (*Dactylis glomerata*).

Section 7

There were three vegetation plots set up in section 7.1 in 2016 (M, N and O). Plots M and N (west end) were seeded prior to 2020 using mix 1 while plot O (east end) was seeded with mix 1 and dry mix prior to 2020 and butterfly mix in July 2020. Due to the recent management activities in plot O in 2020, results were not

presented. In 2016, only summer surveys were conducted so we compared species occurrence over both visits between 2018 and 2020 for plots M and N. In this section, we also examined changes in cover of seeded species within the sub-plots of M and N to examine establishment instead of only germination success.

Between 2018 and 2020, 15 (48%) of the 31 species seeded were observed including several species of regional concern such as ox-eye, little bluestem, Indian grass, big bluestem and switch grass (Table 7). Of the 11 seeded species found, 8 occurred in every year. Little bluestem was only found in 2018, big bluestem only in 2018 and 2020 and Virginia wild rye in 2018 and 2019.

Of the seeded species that established populations in all years, grey-headed coneflower, Indian grass and switch grass appeared to be increasing in cover between 2018 and 2020 (Figure 10). Black-eyed Susan and wild bergamot appeared to have increased slightly between 2018 and 2020. All other species varied only slightly in percent cover since 2018; however, common evening-primrose was absent from many quadrats in 2020 where it was present in prior years. Common evening-primrose colonizes sites aggressively but can all but disappear following the establishment of more conservative perennials only to increase again with soil disturbance.

The cover of thistle in plots M and N was relatively low (<4%) and was absent from 4 of 10 sub-plots over all years. By 2020, thistle was absent from 6 of sub-plots. Thistle cover remained relatively constant between 2018 and 2020. The cover of DSV was generally similar between 2018 and 2020 within the sub-plots, although increased from 9 to 15% in sub-plot 1 of plot M between 2018 and 2020. Both spotted knapweed and tansy had a low occurrence in the plots between 2018 and 2020 with tansy absent from all plots and spotted knapweed only occurring in three sub-plots over all years. Based on this low occurrence, we could not examine the effectiveness of removal efforts for these species. Even though these species had a low occurrence within monitoring plots, biologists noted evidence of management of these species within section 7.

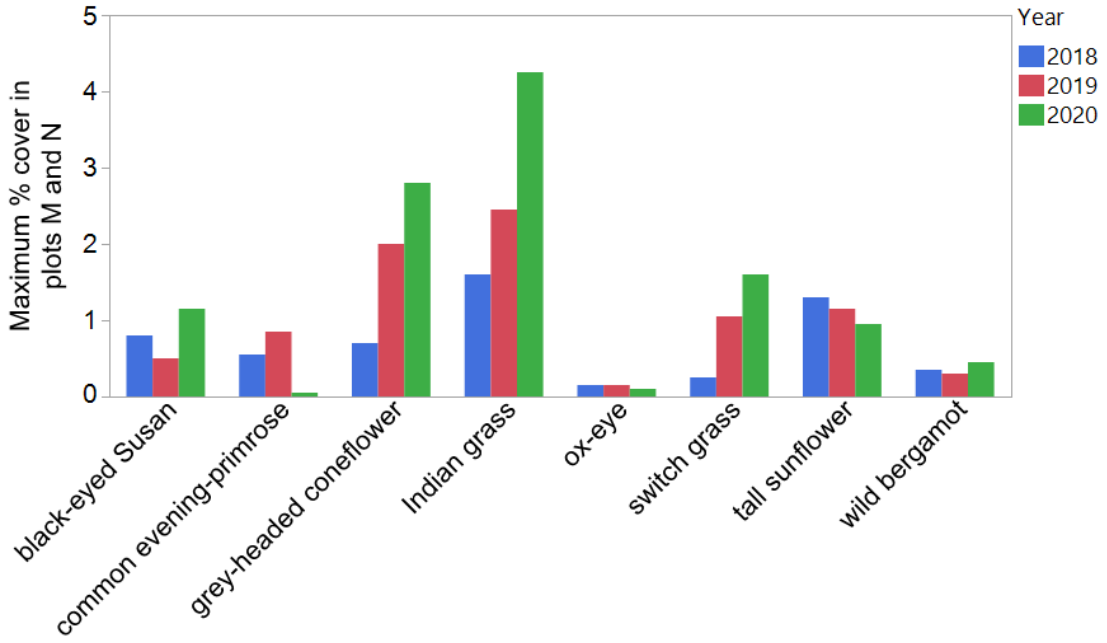

Figure 10. Average percent cover of seeded species occurring annually in vegetation plots M and N (section 7.1)

Table 7. Seeded species and those occurring in vegetation monitoring plots M and N (section 7.1)

Species name	Species code	Common name	L-rank	Seed mix 1	2018	2019	2020
Lobelia cardinalis	LOBCARD	cardinal flower	L1	x			
Heliopsis helianthoides	HELHELI	ox-eye	L2	x	x	x	x
Schizachyrium scoparium	SCHSCOP	little bluestem	L2	x	x	x	x
Sorghastrum nutans	SORNUTA	Indian grass	L2	x	x	x	x
Andropogon gerardii	ANDGERA	big bluestem	L3	x	x	x	x
Gentiana andrewsii	GENANDR	bottle gentian	L3	x			
Lespedeza capitata	LESCAPI	round-headed bush-clover	L3	x			
Lobelia siphilitica	LOBSIPH	great blue lobelia	L3	x			
Panicum virgatum	PANVIRG	switch grass	L3	x	x	x	x
Penstemon digitalis	PENDIGI	foxglove beard-tongue	L3	x			
Penstemon hirsutus	PENHIRS	hairy beard-tongue	L3	x		x	x
Pycnanthemum virginianum	PYCVIRG	Virginia mountain-mint	L3	x			
Elymus canadensis	ELYCANA	Canada wild rye	L4	x			
Rudbeckia hirta	RUDHIRT	black-eyed Susan	L4	x	x	x	x
Desmodium canadense	DESCANA	showy tick-trefoil	L5	x			
Elymus virginicus var. virginicus	ELYVIRG	Virginia wild rye	L5	x	x	x	x
Monarda fistulosa	MONFIST	wild bergamot	L5	x	x	x	x
Oenothera biennis	OENBIEN	common evening-primrose	L5	x	x	x	x
Silphium perfoliatum	SILPERF	cup-plant	L5	x			
Verbena hastata	VERHAST	blue vervain	L5	x			
Asclepias sullivantii	ASCSULL	smooth milkweed	LX	x			
Asclepias tuberosa	ASCTUBE	butterfly milkweed	LX	x			
Helianthus giganteus	HELGIGA	tall sunflower	LX	x	x	x	x
Solidago rigida ssp. rigida	SOLRIGI	stiff goldenrod	LX	x			
Allium cernuum	ALLCERN	nodding wild onion	L*	x			
Coreopsis lanceolata	CORLANC	lance-leaved coreopsis	L*	x		x	x
Coreopsis tripteris	CORTRIP	tall tickseed	L*	x			x
Echinacea pallida	ECHPALL	pale purple coneflower	L*	x			
Ratibida pinnata	RATPINN	grey-headed coneflower	L*	x	x	x	x
Vernonia missurica	VERMISS	Missouri ironweed	L*	x		x	
Veronicastrum virginicum	VERVIRG	Culver's root	L*	x			

Experimental seeding trial plots

In 2019, two sets of experimental seeding trial plots were set-up in section 1.2 (Figure 11). The broad goal of the study was to determine factors affecting seeding success in The Meadoway by answering the following questions:

- Is hand seeding or seeding using a seed drill more effective?
- Is seeding in the fall, winter or spring most effective?
- Is spraying or not spraying (with glyphosate) more effective?

For the purpose of this assessment, the most effective method was defined as the one that maximized both the number of species and total stem count of species that occurred from the seed mix.

In order to answer these questions, each treatment combination was replicated in the design of the experimental plots including the timing of seeding (fall, winter, spring), the effectiveness of spraying or not spraying and seeding method (hand seeding vs. seed drill). Vegetation plot monitoring occurred in September 2020 to assess seeding success. We set-up 36 1m x 1m quadrats, one in the centre of each treatment replicate (9 x 2 m section) or just outside the hand seeded areas. We counted the number of stems and estimated the percent cover of all native species within each quadrat. We also counted the number of stems of a select list of invasive species that would be targeted for management within each quadrat including creeping thistle, bull thistle (*Cirsium vulgare*), DSV, *Centaurea* spp., tansy (*Tanacetum vulgare*), common reed, Manitoba maple (*Acer negundo)*, black locust (*Robinia pseudoacacia*), Japanese knotweed (*Reynoutria japonica* var. *japonica* (Poljapo)), garlic mustard (*Alliaria petiolata*) and common burdock (*Arctium minus*). Within the larger, 9 x 2m sections, a species list was created but only included species suspected to have been in the seed mix along with specific asters and goldenrods and targeted invasive species listed above. This analysis only included a comparison of species seeded in the seed mix to species occurring within the 1 x 1m quadrats along with stem counts of seeded species.

One set of plots, called the butterfly mix plots, were located in the west end of section 1.2 (Figure 11). These plots had butterfly mix seeded in various combinations of treatments including hand seeding in either winter 2019-2020 or spring 2020, seed drilling in spring 2020, and areas that were sprayed or not sprayed.

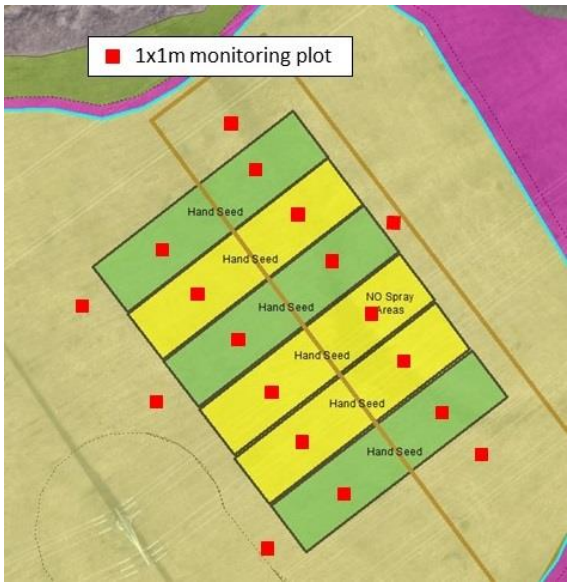

Figure 11. Butterfly seed mix trial plot area showing areas with various treatment combinations. Green = hand seeded in spring, yellow = hand seeded in winter, large gold box indicates no spray areas while all other areas were sprayed, light beige area outside of yellow and green boxes indicates areas seeded with the seed drill in the spring.

The other set of plots, dry mix plots, were located in the east end of section 1.2 (Figure 12). These plots had dry mix seeded in various combinations of treatments including hand seeding in either fall 2019, winter 2019-2020 or spring 2020 and areas that were sprayed or not sprayed.

Figure 12. Dry seed mix trial plot area showing areas with various treatment combinations. Green = hand seeded in spring, blue = hand seeded in winter, pink = hand seeded in fall, large teal box indicates the no spray area while all other areas were sprayed.

Butterfly mix test plots

We used a two-factor analysis of variance (ANOVA) to examine the effect of seeding season (winter or spring) and spraying (sprayed or not sprayed) on seeding success. We used a separate two-factor ANOVA to examine the effect of seeding method (hand or seed drill) and spraying on seeding success. Seed drilling only occurred during the spring, so hand seeding and seed drilling were only compared in the spring.

Significantly more species from the butterfly seed mix occurred when seeds were sown in winter compared to spring ($F=7.23$, $p=0.028$; Figure 13). There was no significant effect of spraying on the number of species observed from the seed mix ($F=1.33$, $p=0.283$; Figure 13). Significantly higher stem counts occurred from seeded species when seeds were sown in winter compared to spring ($F=12.8$, $p<0.01$). There was no significant effect of spraying on the number of stems of seeded species that occurred ($F=0.303$, $p=0.597$).

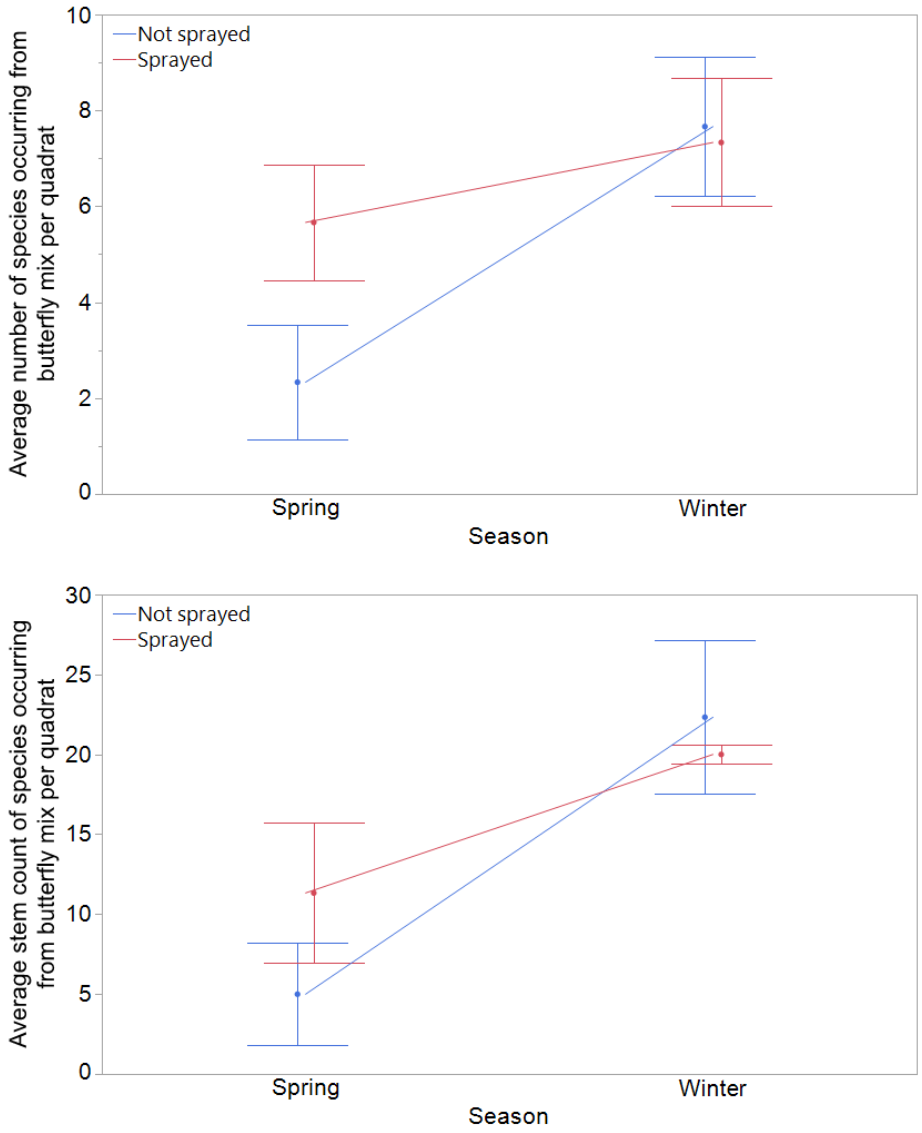

Figure 13. Effect of seeding season and spraying on seeding success in butterfly mix plots. Shown are averages ± 1 standard error for each treatment combination

There was no significant effect of seeding method (hand or seed drill) on the number of species observed from the seed mix if sown in the spring ($F=0.628$, $p=0.451$; Figure 14). While not significant ($p<0.05$), spraying may be an effective treatment to increase the number of species observed from the seed mix if sown in the spring but the results were only approaching significance ($F=3.71$, $p=0.090$). Stem count of species from the seed mix was not significantly affected by seeding method or spraying if sown in the spring (all $p>0.163$; Figure 14).

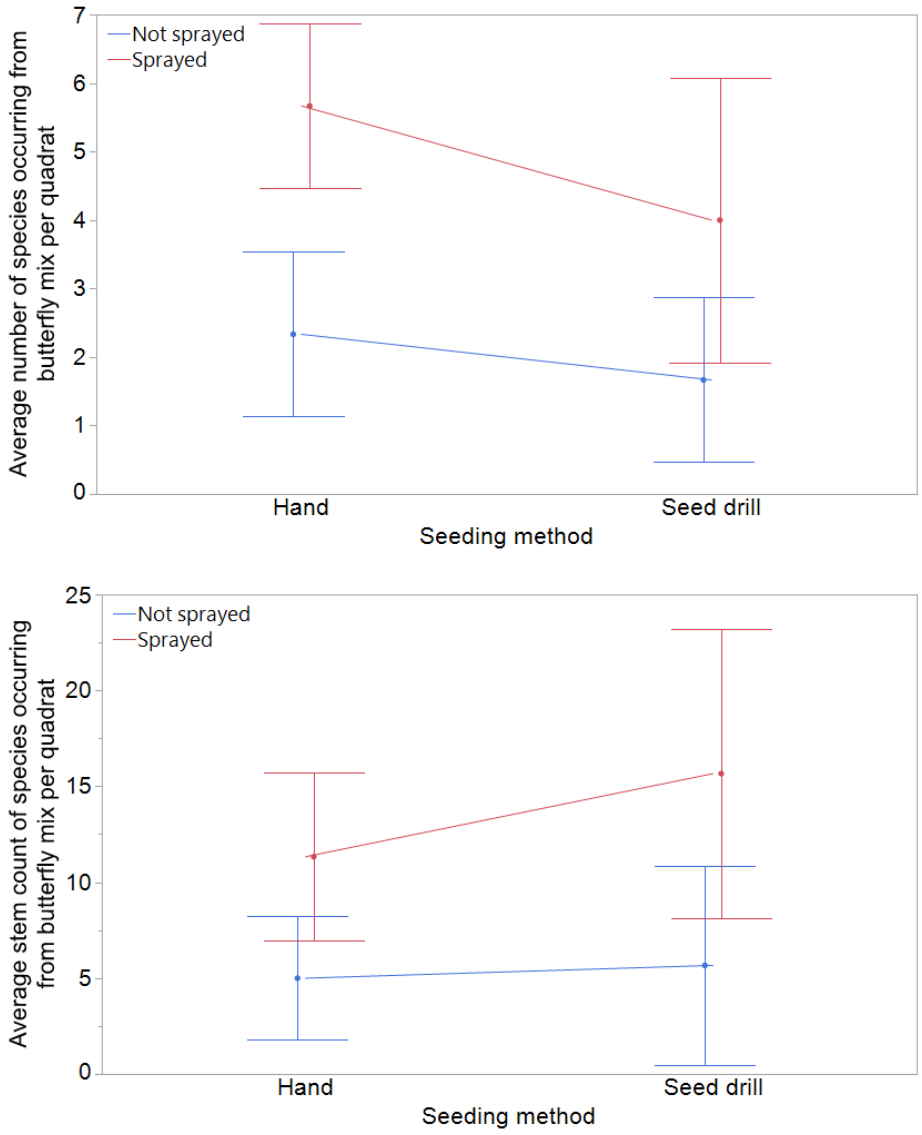

Figure 14. Effect of seeding method and spraying on seeding success in butterfly mix plots if seeded in the spring. Shown are averages ± 1 standard error for each treatment combination

In summary, within the plots seeded with butterfly mix, winter seeding without spraying was most effective; however, if seeding occurs in the spring, there was no difference in the effectiveness of hand seeding or using the seed drill but spraying may be more effective (Table 8).

Table 8. Occurrence of seeded species and stem counts in the butterfly mix experimental plots under various combinations of treatments

Common name	Hand seeding				Seed drill	
	Spring		Winter		Spring	
	No spray	Spray	No spray	Spray	No spray	Spray
big bluestem	2	10		6	7	3
black-eyed Susan		1	7	1		19
blue vervain			11	1		
Canada wild rye				6		3
common evening-primrose	5	5	20	10		4
common milkweed	1	5	1	9		
foxglove beard-tongue			2			
grey goldenrod	1		4			
heath aster			4			
hoary vervain		1	5	1		
Indian grass		5	1	9	5	4
little bluestem				2		
New England aster			2		1	
ox-eye	2		2	4	1	5
round-headed bush-clover		1				3
sand dropseed						1
switch grass	1	4	2	11	3	2
wild bergamot	3	2	6			3
Total number of species	**7**	**9**	**13**	**11**	**5**	**10**
Total stem count	**15**	**34**	**67**	**60**	**17**	**47**

Dry mix test plots

We used a two-factor analysis of variance (ANOVA) to examine the effect of seeding season (fall, winter, spring) and spraying (sprayed or not sprayed) on seeding success. A different seed mix was used for seed drilling outside of test plots so a comparison between hand seeding and seed drilling was not possible.

Significantly more species from the seed mix occurred when plots were sprayed compared to not sprayed ($F=26.3$, $p<0.001$; Figure 15). There was no significant effect of seeding season on the number of species observed from the seed mix ($F=1.33$, $p=0.300$; Figure 15). Significantly higher stem counts occurred when plots were sprayed compared to not sprayed ($F=18.1$, $p<0.01$; Figure 15). There was no significant effect of seeding season on the number of stems of seeded species that occurred ($F=1.21$, $p=0.333$).

In summary, within the plots seeded with dry mix, spraying significantly increased seeding success and stem count in all seasons (Table 9). There was a small amount of variation in seeding success among seasons although it depended greatly on whether or not the plot was sprayed. For example, if seeds were sown in the winter, spraying didn't provide considerable benefits. If seeds were sown in either the fall or spring, spraying provided clear benefits.

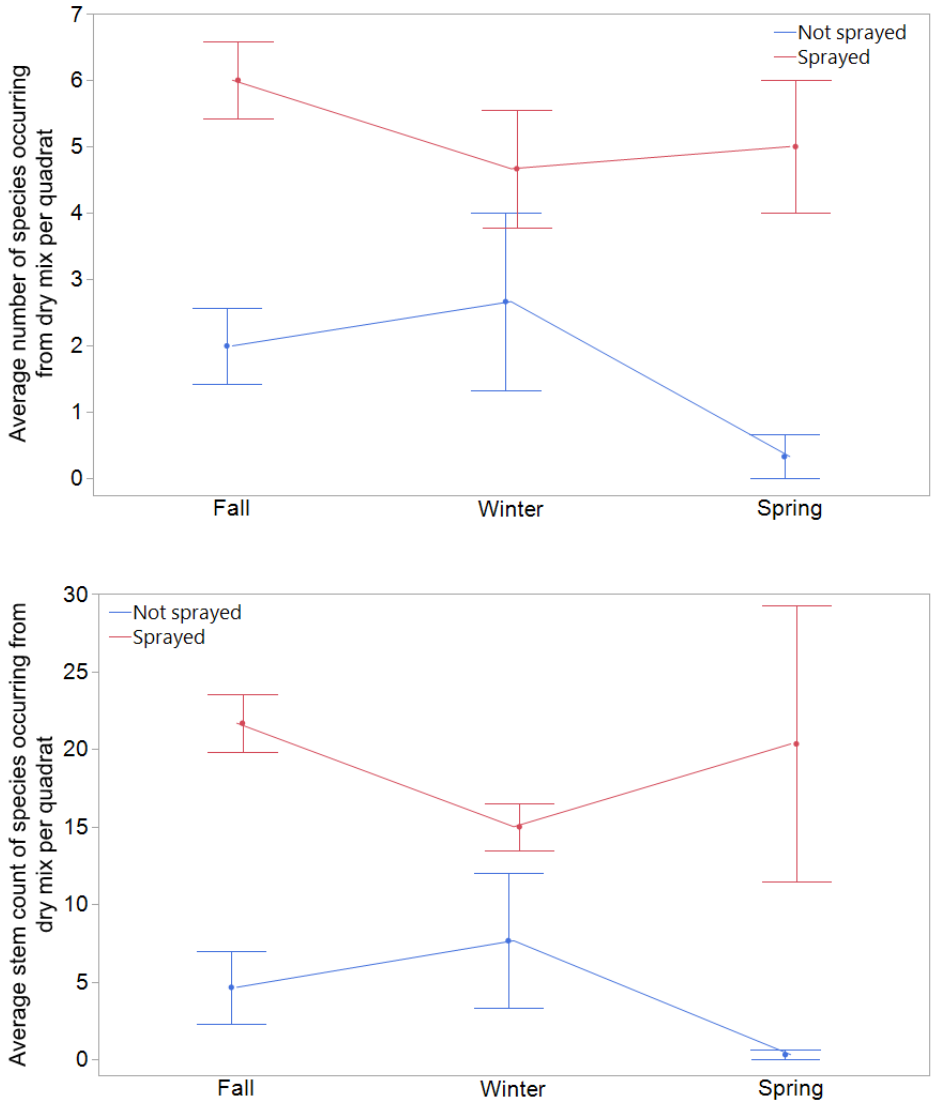

Figure 15. Effect of seeding season and spraying on seeding success in dry mix plots. Shown are averages ± 1 standard error for each treatment combination

Table 9. Occurrence of seeded species and stem counts in the dry mix experimental plots under various combinations of treatments

Common name	Fall		Spring		Winter	
	Not sprayed	Sprayed	Not sprayed	Sprayed	Not sprayed	Sprayed
big bluestem		4		11	4	6
black-eyed Susan	5	4		13	5	5
common milkweed				2		
foxglove beard-tongue		1				
Indian grass	2	14	1	12	6	9
little bluestem	6	3		4		1
New England aster					1	
showy tick-trefoil		4		2		3
switch grass	1	35		17	7	21
Total number of species	**4**	**7**	**1**	**7**	**5**	**6**
Total stem count	**14**	**65**	**1**	**61**	**23**	**45**

Bird surveys

Twenty-nine bird species were detected during 2016, 2018, 2019 and 2020 surveys (Appendix 3, Figures 16-19). These included one species of conservation concern in the Toronto Region (ranked L3): eastern meadowlark (*Sturnella magna*). Eastern meadowlark is a meadow-dependent species that nests on the ground in grassland habitats and is a species of conservation concern due to declining population trends and sensitivity to disturbance. Eastern meadowlark is also listed as threatened in the province of Ontario under the Endangered Species Act (Endangered Species Act 2007). Even though this species was recorded during the breeding season, it is unlikely to be successful because they are ground-nesters and are subject to high nest predation rates from urban-related predators (e.g. domestic cats, off-leash dogs, and subsidized predators such as raccoons, opossums and skunks). There were three other meadow-dependent species detected during surveys including savannah sparrow (*Passerculus sandwichensis*; Figure 16), willow flycatcher (*Empidonax traillii*) and eastern kingbird (*Tyrannus tyrannus*). Red-winged blackbirds (*Agelaius phoeniceus*; Figure 16), song sparrows (*Melospiza melodia*) and American robins (*Turdus migratorius*) were the most frequently occurring and most abundant species detected during surveys.

Three new stations (8, 9, 10) were added in turfgrass/early restoration sites in 2020 and contained species not seen elsewhere in The Meadoway or only rarely including American kestrel (*Falco sparverius*), killdeer (*Charadrius vociferus*) and northern mockingbird (*Mimus polyglottos*). Both American kestrel and northern mockingbird were likely using The Meadoway for foraging; however, killdeer did nest in section 1. In 2020, savannah sparrow nested and were observed carrying food (confirming the presence of nestlings) at all three of the new bird monitoring stations (in sections 1 and 5). Each of these three stations are in turfgrass habitat and as the planting and meadow creation progresses, it is likely that this species will no longer find suitable habitat. Unfortunately, sections 1.4 and 2.4 were not monitored in 2020; these two stations had previously provided habitat for savannah sparrows in both 2018 and 2019.

We recorded the presence of two other meadow bird species in 2020: eastern kingbird and willow flycatcher. Both of these species are aerial insectivores meaning they forage for flying insects. Eastern kingbird had

previously been recorded in section 4 and in 2020 the meadow at section 4.1 hosted a territorial pair. Willow flycatcher was observed during the second visits in sections 4.2 and 7.1. As local insect populations expand in the improving meadow habitat, these aerial insectivores should become more established and continue to benefit from foraging opportunities. Both of these species have the potential to succeed in The Meadoway since they nest higher in shrubs and small trees at the edge of open habitat and are not subject to disturbance/predation from ground-borne predators.

Figure 16. Savannah sparrow (Passerculus sandwichensis) carrying food (left); and the most common species observed at The Meadoway, the red-winged blackbird (Agelaius phoeniceus) (right)

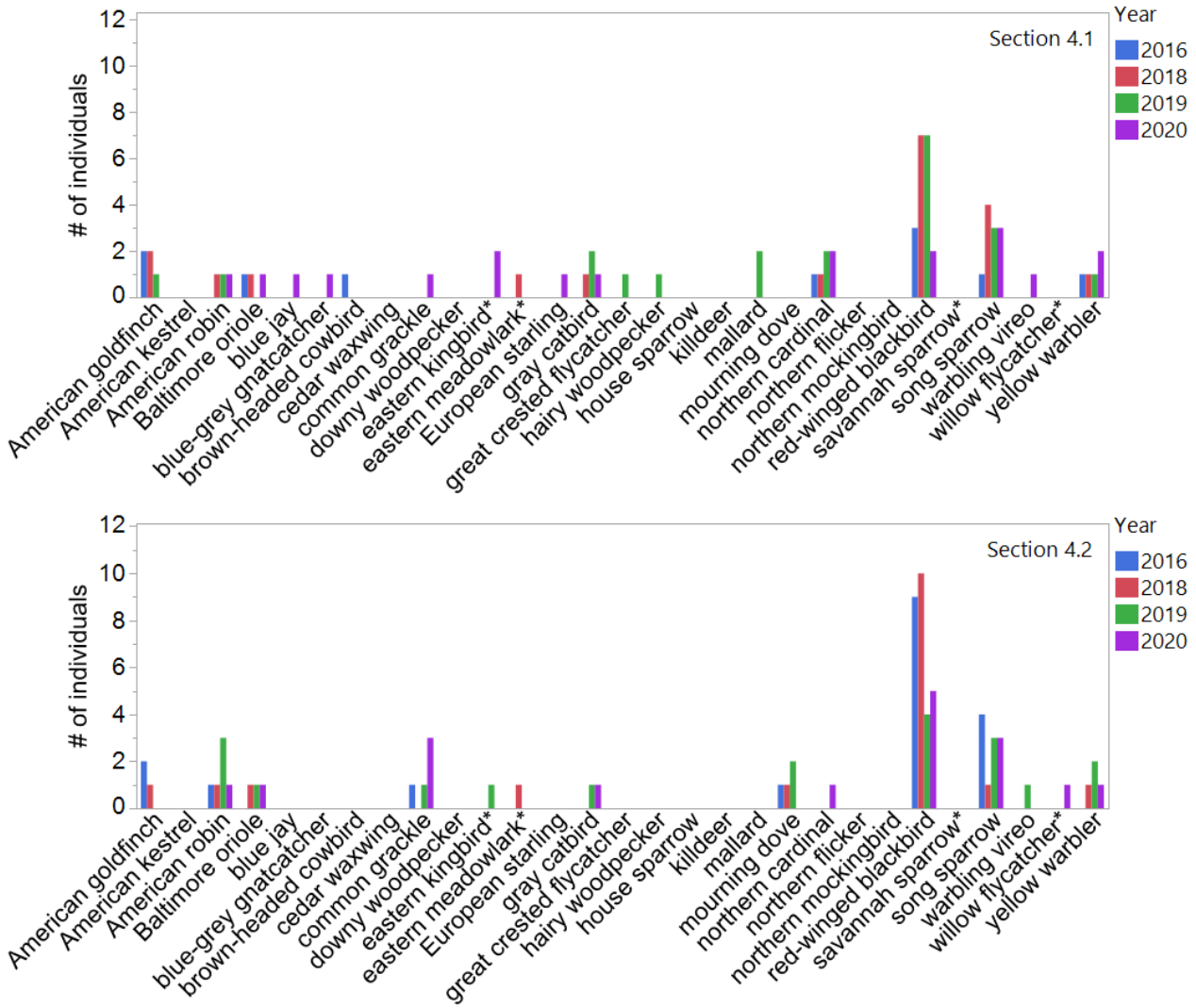

Figure 17. Total bird abundance by species and year at The Meadoway in section 4.1 (top) and section 4.2 (bottom). An asterisk indicates meadow-dependent species

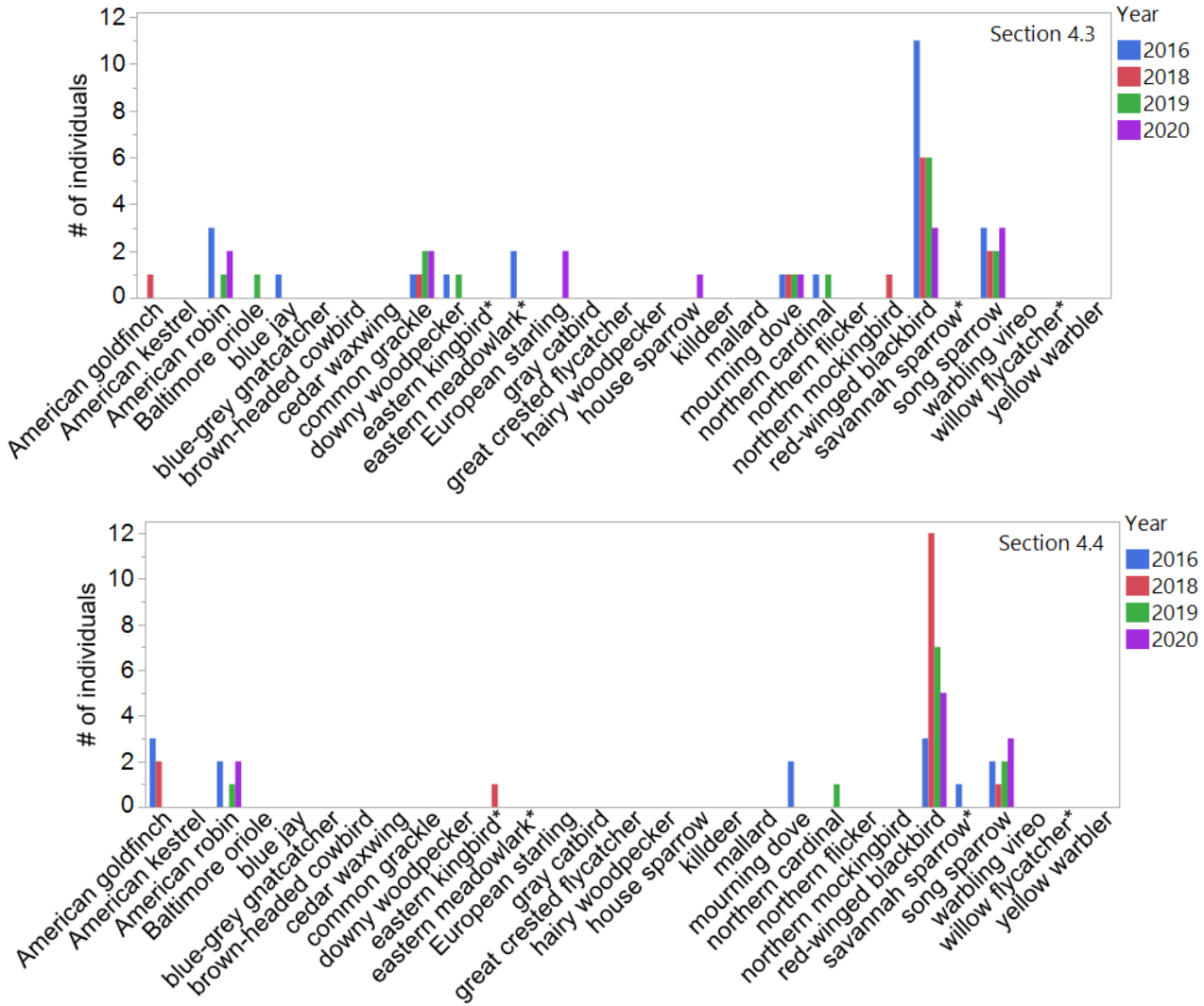

Figure 18. Total bird abundance by species and year at The Meadoway in section 4.3 (top) and section 4.4 (bottom). An asterisk indicates meadow-dependent species

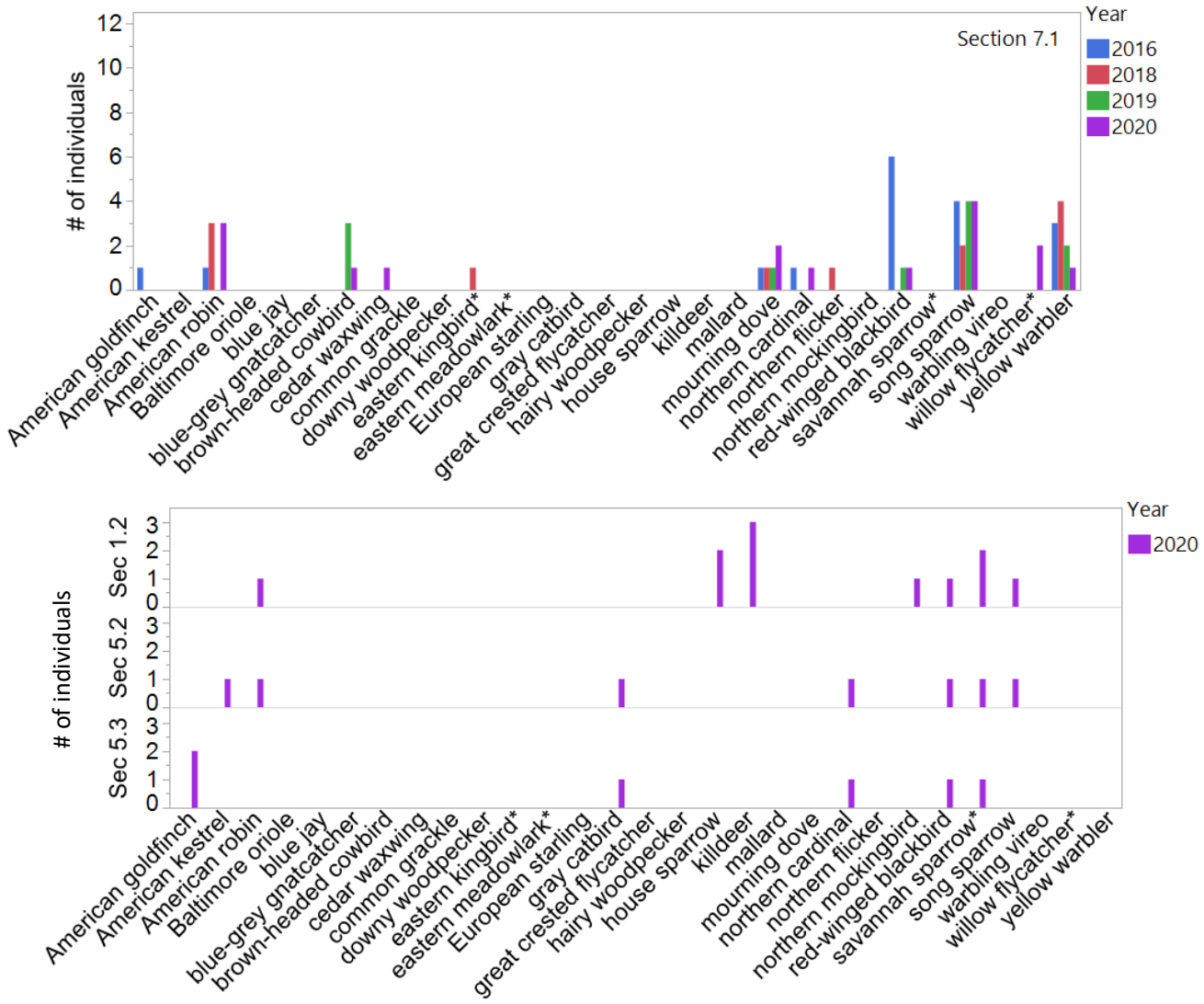

Figure 19. Total bird abundance by species and year at The Meadoway in section 7.1 (top) and turfgrass/pre-restoration sections 1.2, 5.2 and 5.3 (bottom). An asterisk indicates meadow-dependent species

Butterfly surveys

Thirty-eight butterfly species were observed during 2016, and 2018-2020 surveys (Figures 20-23, Appendix 4). Of these 38 species, the giant swallowtail (*Papilio cresphontes*), Delaware skipper (*Anatrytone logan*), silver-spotted skipper (*Epargyreus clarus*), pearl crescent (*Phyciodes tharos*) and wild indigo duskywing (*Erynnis baptisiae*) are ranked at the provincial level as S4 species. Species with an S4 rank are not rare species, but are uncommon, and there is some cause for long-term concern due to population declines or other factors (Nature Serve 2018). Monarch butterflies (*Danaus plexippus*) were also found using The Meadoway in very high numbers although numbers varied from year-to-year. For example, 280 monarchs were counted using section 4.3 (between Bellamy Road North and Markham Road) in 2019; however, only 49 were recorded in 2020.

Figure 20. Black swallowtail caterpillar (Papilio polyxenes) (left); and wild indigo duskywing (Erynnis baptisia) (right)

In 2020, section 5 (turfgrass/pre-management) was monitored and while fewer species were found, the section did support several local, resident breeding species such as common ringlet (*Coenonympha tullia*), black swallowtail (*Papilio polyxenes*) and several skipper species. In addition to these native species, we observed a European common blue (*Polymmatus icarus*) for the first time in 2020 (in section 5). This species was first identified in North America in 2005 at Mirabel Airport, Montreal. The first report for eastern Ontario was in 2017 and since then there have been a handful of records across the Toronto region. Several other interesting new species were found in 2020 including white admiral (*Limenitis arthemis*) and pearl crescent both in section 4.2. The occurrence of these species could be due to the creation of butterfly-friendly habitat and the linkage to the Rouge National Urban Park in the east end.

Several patterns may be emerging related to skippers, crescents, ringlets and blues when comparing changes over time in sections 4 and 7. Several species decreased in abundance between 2018 and 2019/2020 in section 7 including the crescents, tawny-edge skipper, silvery blue and eastern-tailed blue. Populations of common ringlet in this section decreased from 66 individuals in 2018 to just 4 in 2020. There have also been declines in eastern tailed blue and common ringlet in section 4.1. This could be due to the structure of the vegetation becoming too dense to continue to provide larval foodplants such as Kentucky bluegrass, clovers and legumes. Sections 4.2, 4.3 and 4.4 appear to be continuing to provide habitat for small populations of these species.

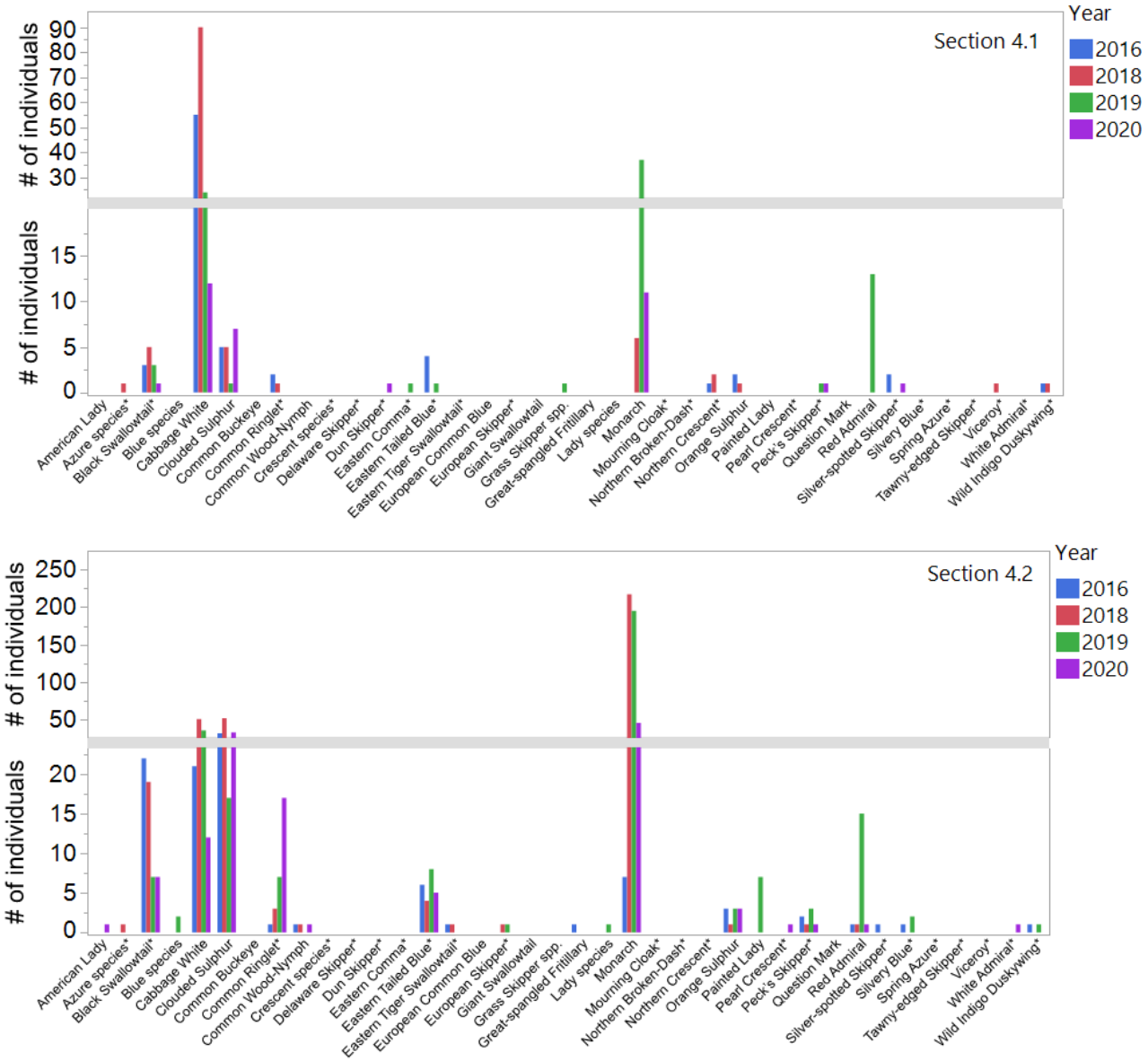

Figure 21. Total butterfly abundance per year at The Meadoway in section 4.1 (top) and section 4.2 (bottom). Note that there is a scale-break to facilitate viewing less abundant species at the same time as more abundant species

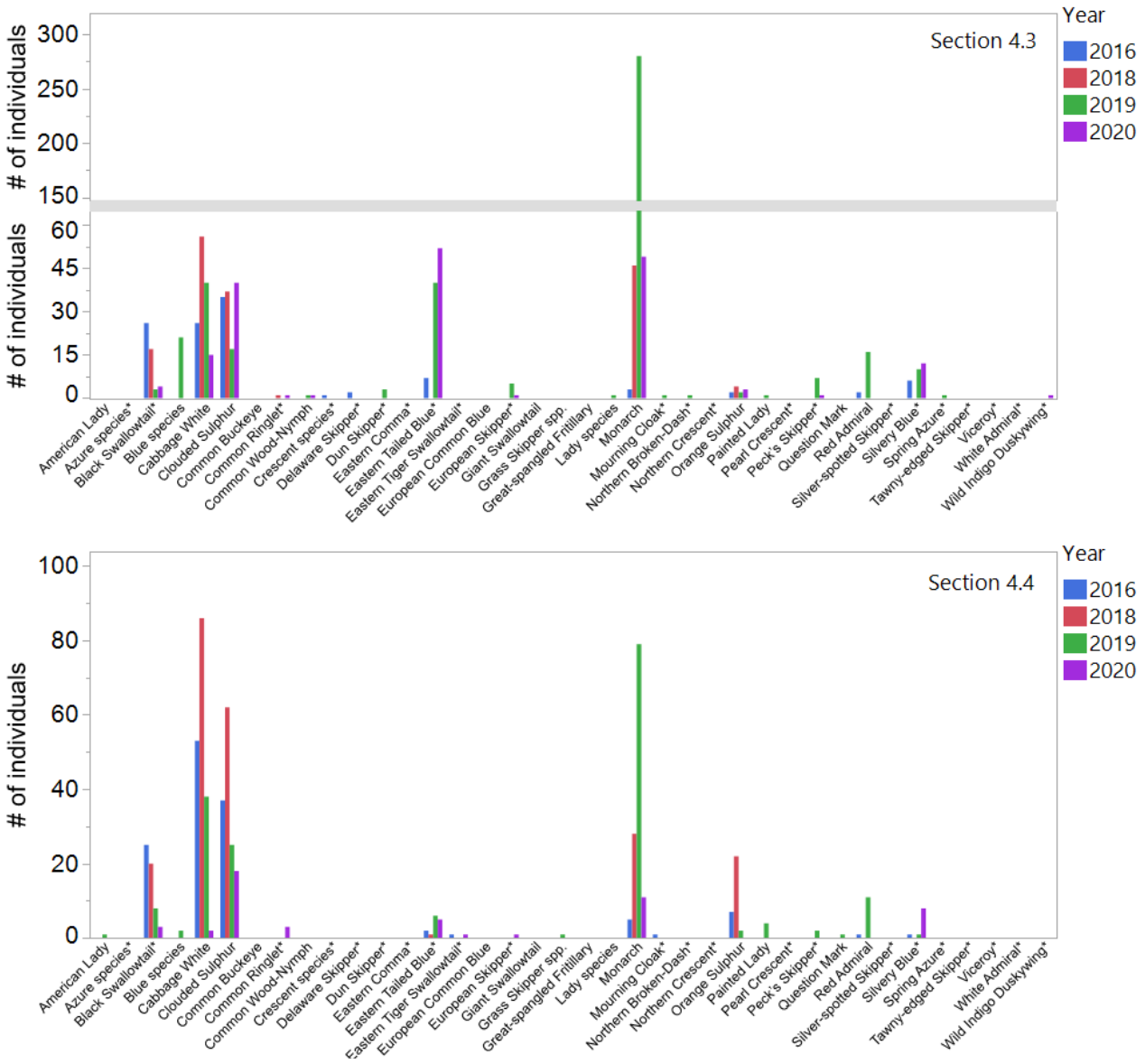

Figure 22. Total butterfly abundance per year at The Meadoway in section 4.3 (top) and section 4.4 (bottom). Note that there is a scale-break to facilitate viewing less abundant species at the same time as more abundant species

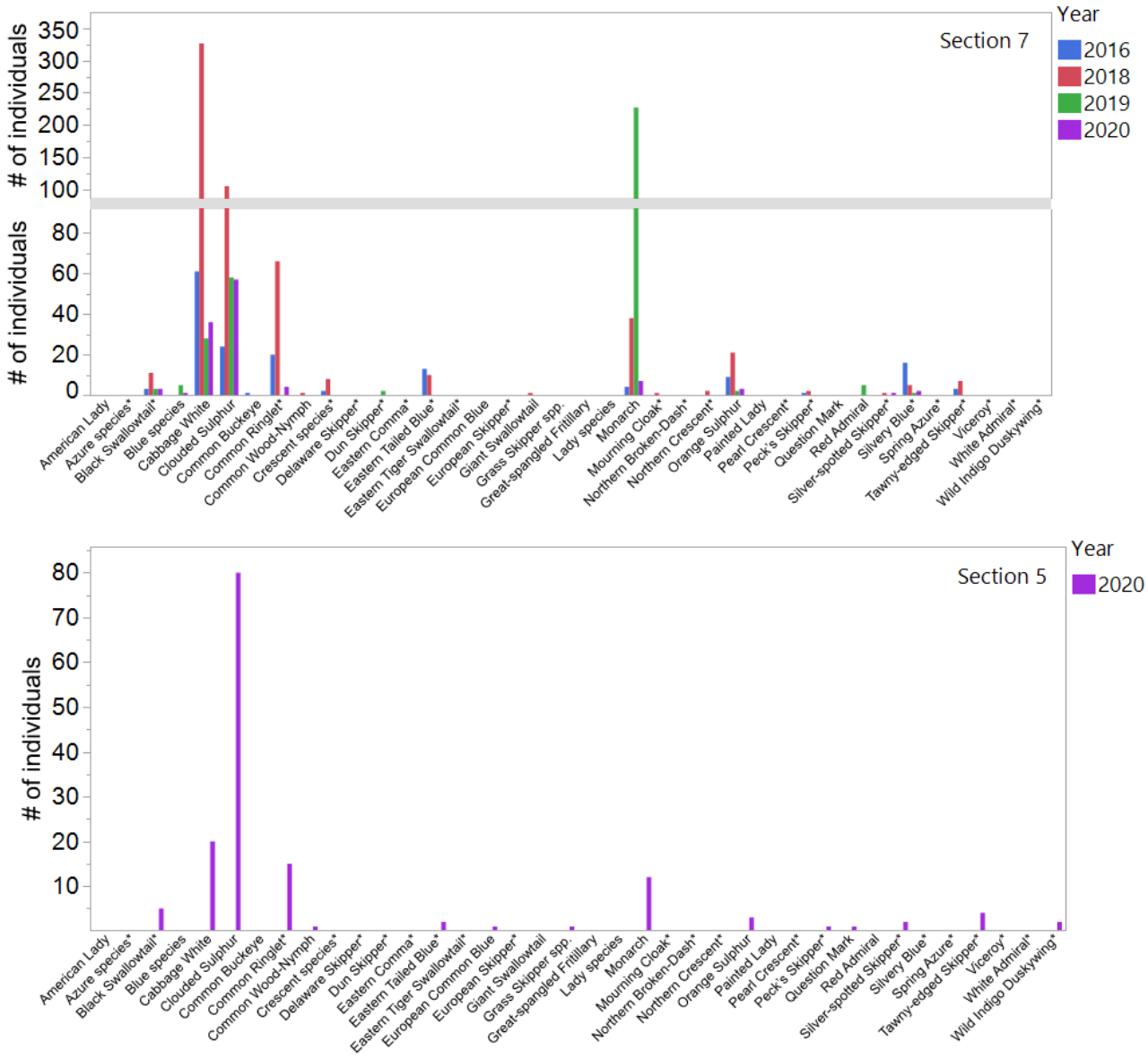

Figure 23. Total butterfly abundance per year at The Meadoway in section 7 (top) and in section 5 (turfgrass/pre-restoration; bottom). Note that there is a scale-break to facilitate viewing less abundant species at the same time as more abundant species

SUMMARY

Meadow monitoring during 2016, and 2018-2020 generally indicated that restoration work in The Meadoway has successfully introduced a variety of meadow flora through seeding, provides habitat used by meadow birds and foraging opportunities for butterflies. A wide range of species were found during monitoring including numerous rare and sensitive species and species of conservation concern. In addition to these sensitive species, invasive flora species are persisting in The Meadoway although recent management initiatives have been successful at reducing their extent.

After four years of monitoring, several patterns emerged related to the longer term success of restoration efforts. In general, seeding has been successful although the number of species occurring from the seed mix varied among sections (Figure 24). Sections with the longest record of restoration and monitoring (>4 years) had between 48 and 84% of the seeded species present while sections that were restored recently had 40% of seeded species present. In the sections with the longest record of restoration, many of the seeded species were establishing populations although again, there was variation among sections and species. There were increases in cover for Indian grass, ox-eye, tall sunflower, switch grass and wild bergamot in multiple restored sections while in other sections (e.g. section 4.3), several of these species, along with others, may be decreasing in cover.

Figure 24. Big bluestem (Andropogon gerardii) in flower (left); stiff goldenrod with bumblebee (right)

Invasive species management has been effective throughout The Meadoway with most sub-plots showing decreases in cover of thistle and DSV. In the recently restored section 1, the decrease in cover of DSV was extensive with declines of between 8 and 90% resulting in covers of <1% by 2020. Several other sections had a low cover of DSV consistently while several sub-plots in section 4.2 had increasing cover and fruiting plants noted. Overall, current methods appear to be mostly effective for controlling DSV and thistle. Without this management, it is likely that DSV would quickly spread and outcompete other species. Additional techniques are being trialed to help control DSV including over-seeding areas with milkweed.

The first year of monitoring the experimental seeding plots provided several insights into effective seeding techniques. Within the plots seeded with butterfly mix, winter seeding without spraying was most effective producing the highest stem counts and number of species. There was no difference in seeding success based on whether or not the seed drill was used or the seeds were hand sown. This comparison was only possible in the spring since that was when seeding with the drill occurred. Within the plots seeded with dry mix, spraying significantly increased seeding success and stem count in all seasons. There was a small amount of variation in seeding success among seasons although it depended greatly on whether or not the plot was sprayed. For example, if seeds were sown in the winter, spraying did not provide considerable benefits. If seeds were sown in either the fall or spring, spraying provided clear benefits. Additional years of monitoring are required to determine the long-term effectiveness of each technique.

The bird community at The Meadoway continues to consist of a mix of generalists, meadow and forest-edge species. Several meadow-dependent bird species were found at least once since 2016 including savannah sparrow, eastern meadowlark, willow flycatcher and eastern kingbird (Figure 25). A large proportion of meadow-dependent birds are ground-nesters and are often subject to higher levels of nest predation in urban meadows. Due to this pressure, it is unlikely that meadow species such as eastern meadowlark or bobolink (*Dolichonyx oryzivorus*) would select The Meadoway for nesting. However, it is likely that several other meadow-dependent species will continue to use The Meadoway for nesting and foraging including willow flycatcher and eastern kingbird since they nest in trees and shrubs next to open areas and restoration has provided foraging opportunities. The improved foraging opportunities should also continue to attract other aerial insectivorous bird species such as swallows and common nighthawk (*Chordeiles minor*). Several of these aerial insectivores are listed both federally and provincially as species at risk and research has suggested that one of the main reasons for populations declines over the past few decades is the decline in populations of flying insects (Nebel et al. 2010).

Figure 25. Eastern kingbird (Tyrannus tyrannus)

Butterfly monitoring continues to detect species characteristic of meadows in more urbanized areas of southern Ontario. Species that were especially abundant included cabbage white (*Pieris rapae*), clouded sulphur (*Colias philodice*) and monarch. The greatest number of monarchs (280) was observed in section 4.3 in 2019; however, far fewer were observed in 2020 in all sections. Changes in the number of monarchs are likely not due to changes in The Meadoway but due to changes affecting the entire monarch population such as conditions in their overwintering habitat in Mexico. Other migrant/transient species had slightly lower counts in 2020 including cabbage white and clouded sulphur although the reasons for this remain unknown. One locally breeding, resident species, Eastern tailed blue appears to be increasing in section 4.3. In 2020, this section had the highest number of Eastern tailed blue of all four monitoring seasons and the species was even found in section 1, a recently restored section. In addition to apparent improving conditions for some species, declines have also occurred since 2018 in section 7 and 4.1 for several species of crescents, skippers, blues and ringlets.

Both resident and migrant butterfly species continue to use The Meadoway in high numbers with several newly identified species in 2020 (e.g. European common blue; Figure 26). Although the number of migrating butterflies using The Meadoway for nectaring is impressive, perhaps more relevant to the restoration project is the change in occurrence of local resident species that are using the new availability of food-plant species. Going forward, this suite of species (e.g. eastern tailed blue, common ringlet, various skipper species) will provide an excellent indication of the quality of meadow habitat being provided. Nevertheless, the provision of a well-linked nectaring corridor for all species continues to be an exciting development in the Toronto urban landscape.

Figure 26. European common blue (Polymmatus icarus)

REFERENCES

Burghardt, F., P. Proksch, and K. Fiedler. 2001. Flavonoid sequestration by the common blue butterfly *Polyommatus icarus*: quantitative intraspecific variation in relation to larval hostplant, sex and body size. Biochemical Systematics and Ecology 29: 875-889.

Endangered Species Act. 2007. Ontario Regulation 242/08 and 230/08.

Nature Serve. 2018. Nature Serve Explorer. Retrieved from: http://explorer.natureserve.org/nsranks.htm on December 5, 2018

Nebel, S., A. Mills, J. McCracken, and P. Taylor. 2010. Declines of aerial insectivores in North America follow a geographic gradient. Avian Conservation and Ecology 5:1. http://www.ace-eco.org/vol5/iss2/art1/

Roberts-Pichette, P. and L. Gillespie. 1999. Terrestrial vegetation biodiversity monitoring protocols. EMAN Occasional Paper Series, Report No. 9. Ecological Monitoring Coordinating Office, Burlington, Ontario

Sharma, C. 2018. The Meadoway Project, Update and Authorization. Toronto and Region Conservation Authority Meeting #17/18, September 28, 2018

Toronto and Region Conservation Authority (TRCA). 2011. Meadow Bird Monitoring Protocol - Terrestrial Long-term Monitoring Program – Regional Watershed Monitoring and Reporting

Toronto and Region Conservation Authority (TRCA). 2016. Bob Hunter Memorial Park Meadow Management Monitoring Protocol.

Toronto and Region Conservation Authority (TRCA). 2017. Scoring and Ranking TRCA's Vegetation Communities, Flora, and Fauna Species.

APPENDIX

Appendix 1. Vegetation, bird and butterfly plot locations, years monitored and management techniques 2016, 2018-2020 in The Meadoway

Section	Current vegetation monitoring plot name	Years monitored	Seed mix pre-2020	Seed mix 2020	Invasives mgmt pre-2020	Invasives mgmt 2020	Bird survey station #	Bird survey years	Butterfly survey years
1.1	MV-24_1.1X	2019, 2020	Pre-mgmt	Ontario Wet Meadow Mix - May	None	DSV, blanket spray			
1.1	MV-24_1.1Y	2020	N/A	Ontario Wet Meadow Mix - May	None	DSV, blanket spray			
1.2	MV-24_1.2P	2018, 2019, 2020	Turfgrass (pre-mgmt)	Grasses Mix (*in Exp. Plots) - May	None	DSV, thistle hand pull, blanket spray	8	2020	2020
1.3	MV-24_1.3Q	2018, 2020	Turfgrass (pre-mgmt)	Butterfly Mix - May	None	DSV, blanket spray			
1.3	MV-24_1.3V	2019 (abandonned post-2019)	Turfgrass (pre-mgmt)	N/A	None	DSV, blanket spray			
1.4	MV-24_1.4W	2019 (abandonned post-2019)	Turfgrass (pre-mgmt)	N/A	None	DSV, blanket spray	6	2018, 2019	2019
1.4	MV-24_1.4R	2019 (abandonned post-2019)	Turfgrass (pre-mgmt)	N/A	None	DSV, blanket spray			
2.2	MV-24_2.2S	2018, 2019	Turfgrass (pre-mgmt)	Oats - May, Jul, Aug, Sep	None	None			
2.3	MV-24_2.3T	2018, 2019	Turfgrass (pre-mgmt)	Oats - Jun, Jul, Aug, Sep	None	None			
2.4	MV-24_2.4U	2018, 2019	Turfgrass (pre-mgmt)	Oats - Jun, Aug, Sep, Oct	None	None	7	2018, 2019	2019
3.2	MV-24_3.2AA	2020	N/A	Turfgrass (pre-mgmt)	None	None			
3.3	MV-24_3.3AB	2020	N/A	Turfgrass (pre-mgmt)	None	None			
4.1	MV-24_4.1G	2016, 2018, 2019, 2020- Summer only	Mix 2	None	Non-specific effort since 2018	DSV, thistle			
4.1	MV-24_4.1H	2016, 2018, 2019, 2020-Summer only	Mix 2	None	Non-specific effort since 2018	DSV, thistle	1	2016, 2018-2020	2016, 2018-2020
4.1	MV-24_4.1I	2019 (abandonned post-2019)	Mix 2	N/A	Non-specific effort since 2018	DSV, thistle			
4.2	MV-24_4.2A	2016, 2018, 2019, 2020	Mix 1	None	Non-specific effort since 2018	DSV, thistle, Garlon (woody)			
4.2	MV-24_4.2B	2016, 2018, 2019, 2020	Mix 1	None	Non-specific effort since 2018	DSV, thistle, Garlon (woody)	2	2016, 2018-2020	2016, 2018-2020
4.2	MV-24_4.2C	2016, 2018, 2019, 2020	Mix 1	None	Non-specific effort since 2018	DSV, thistle, Garlon (woody)			
4.3	MV-24_4.3D	2016, 2018, 2019, 2020	Mix 1	None	Non-specific effort since 2018	DSV, thistle			
4.3	MV-24_4.3E	2016, 2018, 2019, 2020-Summer only	Mix 1	None	Non-specific effort since 2018	DSV, thistle	3	2016, 2018-2020	2016, 2018-2020
4.3	MV-24_4.3F	2016, 2018, 2019, 2020-Summer only	Mix 1	None	Non-specific effort since 2018	DSV, thistle			
4.4	MV-24_4.4J	2016, 2018, 2019, 2020-Summer only	Mix 2	Active mgmt: Butterfly - Jun; Resilient - Aug	Non-specific effort since 2018	DSV, thistle, Garlon (woody)			
4.4	MV-24_4.4K	2016, 2018, 2019, 2020-Summer only	Mix 2	Active mgmt: Butterfly - Jun; Resilient - Aug	Non-specific effort since 2018	DSV, thistle, Garlon (woody)	4	2016, 2018-2020	2016, 2018-2020
4.4	MV-24_4.4L	2016, 2018, 2019, 2020-Summer only	Mix 2	Active mgmt: Resilient - Aug	Non-specific effort since 2018	DSV, thistle, Garlon (woody)			
5.1	MV-24_5.1AC	2020	N/A	Turfgrass (pre-mgmt)	None	None			
5.2	N/A	N/A	N/A	N/A	N/A	N/A	9	2020	2020
5.3	MV-24_5.3AD	2020	N/A	Turfgrass (pre-mgmt)	None	None	10	2020	2020
5.4	MV-24_5.4AE	2020	N/A	Turfgrass (pre-mgmt)	None	None			2020
6.1	MV-24_6.1AF	2020	N/A	Turfgrass (pre-mgmt)	None	None			
6.2	MV-24_6.2AG	2020	N/A	Turfgrass (pre-mgmt)	None	None			
6.4	MV-24_6.4AH	2020	N/A	Turfgrass (pre-mgmt)	None	None			
7.1	MV-24_7.1M	2016, 2018, 2019, 2020	Mix 1	None	Non-specific effort since 2018	DSV, thistle, knapweed, tansy			
7.1	MV-24_7.1N	2016, 2018, 2019, 2020	Mix 1	None	Non-specific effort since 2018	DSV, thistle, knapweed, tansy	5	2016, 2018-2020	2016, 2018-2020
7.1	MV-24_7.1O	2016, 2018, 2019, 2020	Mix 1, Dry	Active mgmt: Butterfly Mix - Jul	Non-specific effort since 2018	DSV, thistle, knapweed, tansy			

Appendix 2. Species included in each seed mix used in The Meadoway in sections with vegetation plots

Species name	Species code	Common name	L-rank	Seed mix 1	Seed mix 2	Butterfly mix	Ontario wet meadow mix	Resilient mix
Liatris cylindracea	LIACYLI	cylindric blazing-star	L1			x		
Lobelia cardinalis	LOBCARD	cardinal flower	L1	x	x		x	
Heliopsis helianthoides	HELHELI	ox-eye	L2	x	x	x		x
Liatris spicata	LIASPIC	spike blazing-star	L2				x	
Schizachyrium scoparium	SCHSCOP	little bluestem	L2	x	x	x		x
Sorghastrum nutans	SORNUTA	Indian grass	L2	x	x	x	x	x
Andropogon gerardii	ANDGERA	big bluestem	L3	x	x	x		x
Bromus ciliatus	BROCILI	fringed brome grass	L3				x	
Doellingeria umbellata var. umbellata	ASTUMBE	flat-topped aster	L3				x	
Drymocallis arguta	POTARGU	tall cinquefoil	L3			x		
Gentiana andrewsii	GENANDR	bottle gentian	L3	x	x			
Lespedeza capitata	LESCAPI	round-headed bush-clover	L3	x	x	x		
Lobelia siphilitica	LOBSIPH	great blue lobelia	L3	x	x		x	
Panicum virgatum	PANVIRG	switch grass	L3	x	x	x	x	x
Penstemon digitalis	PENDIGI	foxglove beard-tongue	L3	x	x	x	x	
Penstemon hirsutus	PENHIRS	hairy beard-tongue	L3	x	x	x		
Physostegia virginiana ssp. virginiana	PHYVIRG	false dragonhead	L3				x	
Pycnanthemum virginianum	PYCVIRG	Virginia mountain-mint	L3	x		x		x
Sporobolus cryptandrus	SPOCRYP	sand dropseed	L3			x		
Symphyotrichum pilosum var. pilosum	ASTPIPI	hairy aster	L3				x	
Verbena stricta	VERSTRI	hoary vervain	L3			x		
Asclepias incarnata ssp. incarnata	ASCINCA	swamp milkweed	L4				x	
Elymus canadensis	ELYCANA	Canada wild rye	L4	x	x	x		x
Juncus balticus ssp. littoralis	JUNBALT	Baltic rush	L4				x	
Mimulus ringens	MIMRING	square-stemmed monkey-flower	L4				x	
Rudbeckia hirta	RUDHIRT	black-eyed Susan	L4	x	x	x	x	x
Rudbeckia laciniata	RUDLACI	cut-leaved coneflower	L4				x	
Scirpus cyperinus	SCICYPE	woolly bulrush	L4				x	
Sisyrinchium montanum	SISMONT	blue-eyed grass	L4			x		
Symphyotrichum oolentangiense	ASTOOLE	sky-blue aster	L4			x		
Apocynum cannabinum	APOCANN	hemp dogbane (sensu lato)	L5			x		
Asclepias syriaca	ASCSYRI	common milkweed	L5			x		x
Carex bebbii	CARBEBB	Bebb's sedge	L5				x	

Appendix 2. (cont'd)

Species name	Species code	Common name	L-rank	Seed mix 1	Seed mix 2	Butterfly mix	Ontario wet meadow mix	Resilient mix
Carex stipata	CARSTIP	awl-fruited sedge	L5				x	
Carex vulpinoidea	CARVULP	fox sedge	L5				x	
Desmodium canadense	DESCANA	showy tick-trefoil	L5	x	x	x		x
Elymus virginicus var. virginicus	ELYVIRG	Virginia wild rye	L5	x			x	
Eupatorium perfoliatum	EUPPERF	boneset	L5				x	
Euthamia graminifolia	EUTGRAM	grass-leaved goldenrod	L5			x	x	
Eutrochium maculatum var. maculatum	EUPMACU	spotted Joe-Pye weed	L5				x	
Glyceria striata	GLYSTRI	fowl manna grass	L5				x	
Juncus articulatus	JUNARTI	jointed rush	L5				x	
Juncus effusus	JUNEFFU	soft rush	L5				x	
Juncus tenuis	JUNTENU	path rush	L5				x	
Juncus torreyi	JUNTORR	Torrey's rush	L5				x	
Monarda fistulosa	MONFIST	wild bergamot	L5	x	x	x	x	x
Oenothera biennis	OENBIEN	common evening-primrose	L5	x	x	x	x	x
Scirpus atrovirens	SCIATRO	black-fruited bulrush	L5				x	
Silphium perfoliatum	SILPERF	cup-plant	L5	x	x	x		x
Solidago nemoralis ssp. nemoralis	SOLNEMO	grey goldenrod	L5			x		
Symphyotrichum ericoides var. ericoides	ASTERIC	heath aster	L5			x	x	
Symphyotrichum novae-angliae	ASTNOVA	New England aster	L5			x	x	
Symphyotrichum puniceum var. puniceum	ASTPUNI	swamp aster	L5				x	
Verbena hastata	VERHAST	blue vervain	L5	x		x	x	
Asclepias sullivantii	ASCSULL	smooth milkweed	LX	x	x			
Asclepias tuberosa	ASCTUBE	butterfly milkweed	LX	x	x	x		
Helianthus giganteus	HELGIGA	tall sunflower	LX	x	x			
Solidago rigida ssp. rigida	SOLRIGI	stiff goldenrod	LX	x				
Allium cernuum	ALLCERN	nodding wild onion	L*	x	x			
Coreopsis lanceolata	CORLANC	lance-leaved coreopsis	L*	x	x			
Coreopsis tripteris	CORTRIP	tall tickseed	L*	x	x			
Echinacea pallida	ECHPALL	pale purple coneflower	L*	x	x			
Helenium autumnale	HELAUTU	sneezeweed	L*			x		
Ratibida pinnata	RATPINN	grey-headed coneflower	L*	x	x			
Vernonia missurica	VERMISS	Missouri ironweed	L*	x				
Veronicastrum virginicum	VERVIRG	Culver's root	L*	x				

Appendix 3. Bird species detected and abundance during bird monitoring at The Meadoway in 2016, and 2018-2020.

Common name	Nesting guild	L-rank	Section 4.1 Station 1				Section 4.2 Station 2				Section 4.3 Station 3				Section 4.4 Station 4				Section 7 Station 5				Section 1 Station 6				Section 2 Station 7				Section 1 Station 8				Section 5 Station 9				Section 5 Station 10			
			2016	2018	2019	2020	2016	2018	2019	2020	2016	2018	2019	2020	2016	2018	2019	2020	2016	2018	2019	2020	2016	2018	2019	2020	2016	2018	2019	2020	2016	2018	2019	2020	2016	2018	2019	2020	2016	2018	2019	2020
eastern meadowlark	meadow low-level nester	L3		1				1			2												-			-	-	1		-	-	-	-		-	-	-		-	-	-	
American kestrel	generalist upper-level nester	L4																					-			-	-			-	-	-	-		-	-	1	-	-	-	
blue-grey gnatcatcher	forest upper-level nester	L4				1																	-			-	-			-	-	-	-		-	-	-		-	-	
eastern kingbird	meadow upper-level nester	L4				2			1							1				1			-			-	-			-	-	-	-		-	-	-		-	-	
gray catbird	generalist mid-level nester	L4		1	2	1			1	1													-			-	-			-	-	-	-		-	-	1	-	-	-	1
great crested flycatcher	forest upper-level nester	L4			1																		-			-	-			-	-	-	-		-	-	-		-	-	
hairy woodpecker	forest upper-level nester	L4			1																		-			-	-			-	-	-	-		-	-	-		-	-	
killdeer	generalist low-level nester	L4																					-			-	-			-	-	-	3		-	-	-		-	-	
northern flicker	generalist upper-level nester	L4																		1			-			-	-			-	-	-	-		-	-	-		-	-	
savannah sparrow	meadow low-level nester	L4													1								-	1	2	-	-	2	2	-	-	-	-	2	-	-	-	1	-	-	-	1
willow flycatcher	meadow mid-level nester	L4								1												2	-			-	-			-	-	-	-		-	-	-		-	-	
American goldfinch	generalist mid-level nester	L5	2	2	1		2	1				1			3	2			1				-			-	-			-	-	-	-		-	-	-		-	-	2
American robin	generalist mid-level nester	L5		1	1	1	1	1	3	1	3		1	2	2		1	2	1	3		3	-	1	1	-	-	1	1	-	-	-	-	1	-	-	-	1	-	-	-	
Baltimore oriole	generalist upper-level nester	L5	1	1		1		1	1	1			1										-			-	-			-	-	-	-		-	-	-		-	-	
blue jay	generalist upper-level nester	L5				1					1												-			-	-			-	-	-	-		-	-	-		-	-	
brown-headed cowbird	special case	L5	1																		3	1	-			-	-			-	-	-	-		-	-	-		-	-	
cedar waxwing	generalist mid-level nester	L5																				1				-	-			-	-	-	-		-	-	-		-	-	
common grackle	generalist mid-level nester	L5				1	1		1	3	1	1	2	2									-			-	-			-	-	-	-		-	-	-		-	-	
downy woodpecker	forest-edge mid-level nester	L5									1		1										-			-	-			-	-	-	-		-	-	-		-	-	
mallard	wetland low-level nester	L5			2																		-			-	-			-	-	-	-		-	-	-		-	-	
mourning dove	generalist mid-level nester	L5					1	1	2		1	1	1	1	2				1	1	1	2	-			-	-			-	-	-	-		-	-	-		-	-	
northern cardinal	generalist mid-level nester	L5	1	1	2	2				1	1		1				1		1			1	-		1	-	-			-	-	-	-		-	-	-	1	-	-	1
northern mockingbird	generalist mid-level nester	L5										1											-			-	-			-	-	-	-	1	-	-	-		-	-	
red-winged blackbird	generalist mid-level nester	L5	3	7	7	2	9	10	4	5	11	6	6	3	3	12	7	5	6		1	1	-			-	-		1	-	-	-	-	1	-	-	-	1	-	-	-	1
song sparrow	generalist low-level nester	L5	1	4	3	3	4	1	3	3	3	2	2	3	2	1	2	3	4	2	4	4	-			-	-			-	-	-	-	1	-	-	-	1	-	-	-	
warbling vireo	generalist upper-level nester	L5				1			1														-			-	-			-	-	-	-		-	-	-		-	-	
yellow warbler	generalist mid-level nester	L5	1	1	1	2		1	2	1									3	4	2	1	-			-	-			-	-	-	-		-	-	-		-	-	
European starling	generalist mid-level nester	L+				1								2									-			-	-			-	-	-	-		-	-	-		-	-	
house sparrow	generalist mid-level nester	L+												1									-			-	-			-	-	-	2		-	-	-		-	-	

Legend
L1-L3: species of regional conservation concern
L4: species of conservation concern in urban areas
L5: species not of conservation concern at this time

Appendix 4. Butterfly species detected during monitoring at The Meadoway in 2016, 2018-2020 (S-rank definitions from Nature Serve 2018).

Common name	Scientific name	S-rank	Section 1				Section 2				Section 4.1				Section 4.2				Section 4.3				Section 4.4				Section 5	Section 7				Host plant
			2016	2018	2019	2020	2016	2018	2019	2020	2016	2018	2019	2020	2016	2018	2019	2020	2016	2018	2019	2020	2016	2018	2019	2020	2020	2016	2018	2019	2020	
American Lady	*Vanessa virginiensis*	S5								x							1								1							Sunflower family, pearly everlasting, plantain-leaved pussy toes, wormwood, ironweed, burdock
Azure species*	*Celastrina* spp.	n/a								x		1				1																
Black Swallowtail*	*Papilio polyxenes*	S5			2	2			3	x	3	5	3	1	22	19	7	7	26	17	3	4	25	20	8	3	5	3	11	3	3	Carrot family… parsley, dill, celery and Queen Anne's lace
Blue species	Lycaenidae family	n/a								x							2				21				2					5	1	
Cabbage White	*Pieris rapae*	SNA			8	13			22	x	55	90	24	12	21	51	36	12	26	56	40	15	53	86	38	2	20	61	327	28	36	Mustards… cabbage, cauliflower and broccoli
Clouded Sulphur	*Colias philodice*	S5			2	16			12	x	5	5	1	7	32	52	17	33	35	37	17	40	37	62	25	18	80	24	105	58	57	Legumes… cultivated crops
Common Buckeye	*Junonia coenia*	SNR (G5)								x																		1				Uncommon breeding migrant
Common Ringlet*	*Coenonympha tullia*	S5			1					x	2	1			1	3	7	17		1		1				3	15	20	66		4	Kentucky bluegrass
Common Wood-Nymph	*Cercyonis pegala*	S5								x					1	1		1			1	1					1		1			Grasses (Poaceae)
Crescent species*	*Phyciodes* spp.	n/a								x									1									2	8			
Delaware Skipper*	*Anatrytone logan*	S4								x									2													Big bluestem and old switch panicgrass
Dun Skipper*	*Euphyes vestris*	S5								x				1							3									2		Sedges: chufa flatsedge, sun sedge
Eastern Comma*	*Polygonia comma*	S5								x			1																			Elm and nettle families: American elm, hops, nettle, false nettle, wood nettle
Eastern Tailed Blue*	*Cupido comyntas*	S5				2				x	4		1		6	4	8	5	7		40	52	2	1	6	5	2	13	10			Clovers and legumes
Eastern Tiger Swallowtail*	*Pterourus glaucus*	S5								x					1	1							1			1						Trees… hop tree, cherries and ashes
European Common Blue	*Polymmatus icarus*	SNA								x																	1					Alfalfa, clover, crown vetch (Burghardt et al. 2001)
European Skipper*	*Thymelicus lineola*	SNA								x						1	1				5	1				1						Grasses but prefers common timothy
Giant Swallowtail	*Papilio cresphontes*	S4								x																			1			Common prickly ash and common hop tree
Grass Skipper spp.	Hesperiinae family	n/a								x			1												1		1					
Great-spangled Fritillary	*Speyeria cybele*	S5								x					1																	Violets
Lady species	*Vanessa* spp.	n/a								x							1				1											
Monarch	*Danaus plexippus*	S2N,S4B			29	13			32	x		6	37	11	7	217	195	46	3	46	280	49	5	28	79	11	12	4	38	227	7	Milkweeds
Mourning Cloak*	*Nymphalis antiopa*	S5								x											1		1						1			Trees… willows, elms, cottonwoods and hackberries
Northern Broken-Dash*	*Wallengrenia egeremet*	S5								x											1											Panic grasses: deertongue
Northern Crescent*	*Phyciodes cocyta*	S5								x	1	2																	2			Asters
Orange Sulphur	*Colias eurytheme*	S5			1	4				x	2	1			3	1	3	3	2	4	2	3	7	22	2		3	9	21	2	3	Legumes… clovers and alfalfas
Painted Lady	*Vanessa cardui*	S5			2				3	x							7				1				4							Broad: most often thistles, hollyhock, mallow, various legumes
Pearl Crescent*	*Phyciodes tharos*	S4								x								1														Smooth-leaved true asters
Peck's Skipper*	*Polites peckius*	S5								x			1	1	2	1	3	1			7	1			2		1	1	2			Kentucky bluegrass and little bluestem
Question Mark	*Polygonia interrogationis*	S5								x															1		1					American elm, red elm, hackberry, Japanese hop, nettles, false nettle
Red Admiral	*Vanessa atalanta*	S5			2				1	x			13		1	1	15	1	2		16		1		11					5		Nettles
Silver-spotted Skipper*	*Epargyreus clarus*	S4								x	2			1	1												2		1		1	Legumes… showy tick-trefoil, Am. hog peanut and black locust
Silvery Blue*	*Glaucopsyche lygdamus*	S5								x					1		2		6		10	12	1		1	8		16	5	1	2	Legumes… tufted vetch, white sweet clover and alphlfa
Spring Azure*	*Celastrina lucia*	S5								x											1											Cherrys, blueberrys and early blooming viburnums
Tawny-edged Skipper*	*Polites themistocles*	S5								x																	4	3	7			Panicgrasses and bluegrasses
Viceroy*	*Limenitis archippus*	N5								x		1																				Willow and poplar
White Admiral*	*Limenitis arthemis*	S5								x							1															Trees and shrubs… wild cherry, aspen, poplar, cottonwood, oaks, hawthorn, birch, willows, basswood
Wild Indigo Duskywing*	*Erynnis baptisiae*	S4								x	1	1			1		1					1					2					Purple crown-vetch

Legend
S2N (non-breeding)-Imperiled-imperiled nationally because of rarity due to very restricted range, very few population (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation nationally
S3B (breeding)-Vulnerable-vulnerable in the provice due to a restructed range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation
S4-Apparently secure-uncommon but not rare; some cause for long-term concern due to declines or other factors
S5-Secure-common, widespread, and abundant in Ontario
N5-Secure-common, widespread, and abundant in the nation
SNR-Unranked-provincial conservation status not yet assessed (G5-globally secure)
SNA-Not applicable-a conservation status rank is not applicable because the species is not a suitable target for conservation activities
*resident species

www.trca.ca

Toronto and Region Conservation Authority