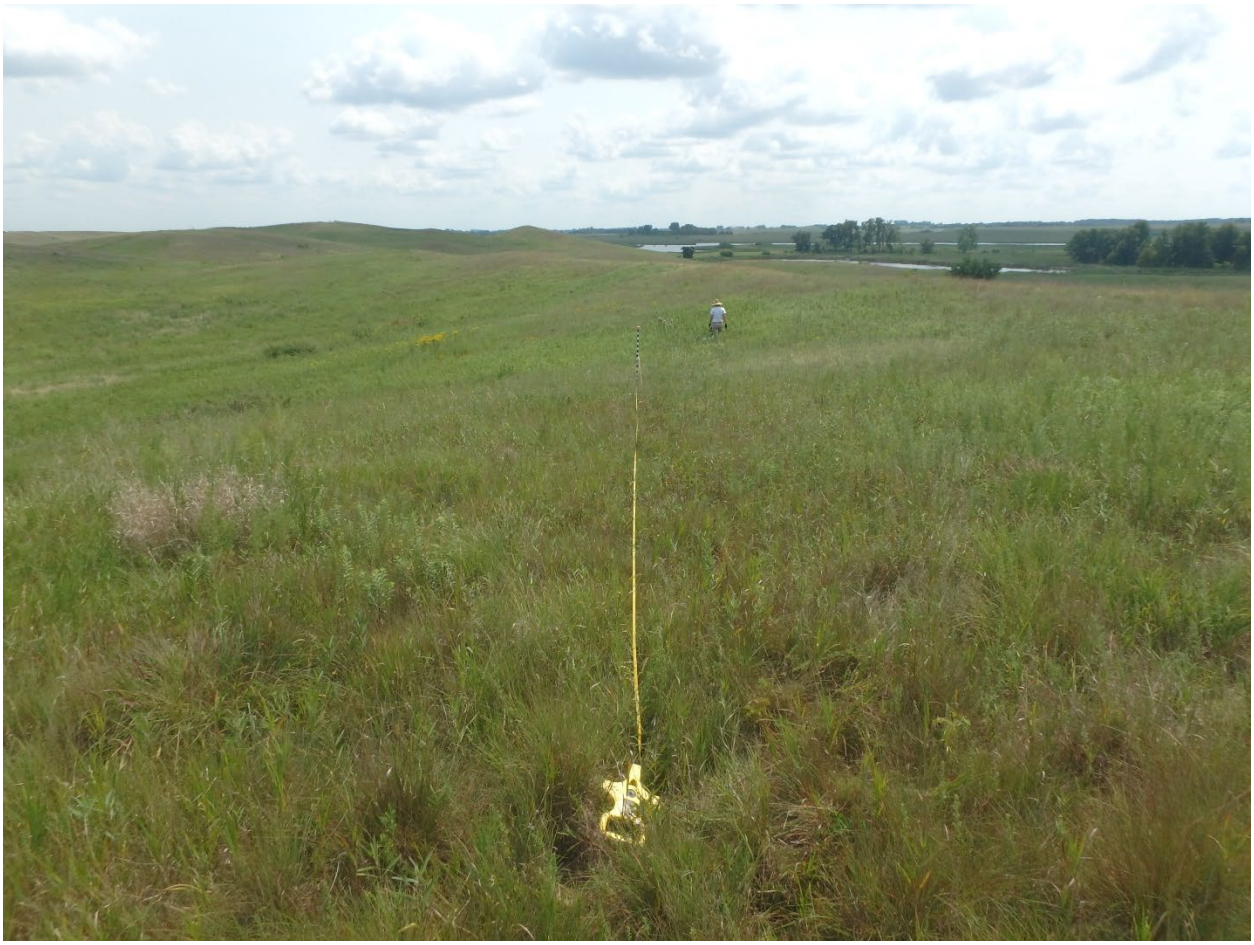
Monitoring for Minnesota's State Wildlife Action Plan

MN T-15-R-3/ F17AF00233

Final Report

Mar 01, 2017 to June 30, 2019

State of Minnesota
Department of Natural Resources
Division of Ecological and Water Resources



Minnesota Department of Natural Resources

Federal Grant Number: F17AF00233

Grant Title: Monitoring for Minnesota's Wildlife Action Plan, T-15-R-3

Final Report for time period: 3/1/2017 to 6/30/19

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Need:

MN Wildlife Action Plan 2015-25 (MNWAP) establishes three goals and two primary approaches for addressing the goals (MNDNR 2016).

1. Ensure the long-term health and viability of Minnesota's wildlife, with a focus on species that are rare, declining, or vulnerable to decline;
2. Enhance opportunities to enjoy Species of Greatest Conservation Need (SGCN) and other wildlife and to participate in conservation; and
3. Acquire the resources necessary to successfully implement MNWAP, (Objective 2 includes providing leadership and coordination of the establishment or implementation of monitoring initiatives or projects focused on biological diversity and ecosystem resilience)

Approaches:

- A habitat approach with a focus on sustaining and enhancing terrestrial and aquatic habitats in the context of the larger landscape/watershed and a changing climate. Conservation actions focus on improving habitat quality and enhancing landscape-scale biological diversity by addressing stressors such as fragmentation, invasive species, and climate change within a mapped Wildlife Action Network (WAN).
- A species approach with a focus on SGCN or groups (e.g. pollinators) for which a habitat approach alone in not sufficient.

This proposal addresses goals 1 and 3, within the context of the habitat approach.

Prairies are amongst the most altered habitats in Minnesota and are important for a large number of species in greatest conservation need (SGCN). Goal 1 Objective 1.1 of

MNWAP identifies high-diversity native prairie complexes as one of eight ecological communities that are thought to be most vulnerable to a changing climate. Climate change and habitat fragmentation are two significant impacts on remaining native prairie that, in combination, exacerbate the effects of each other as well as other stressors. Several animal species that require native prairie are negatively impacted by this suite of drivers. Grassland birds, more than any other group of birds, have experienced significant declines in the last several decades, both in Minnesota and across North America. It has long been recognized that management is needed to maintain the structural and native biological diversity in prairies, but questions remain about which type(s) and frequency of management are most effective at maintaining native prairie quality.

This project will continue to implement prairie monitoring on high-quality native prairie begun in 2008 under SWG grant MN T-15-R-1, and continued under SWG grant T-15-R-2 (F11AF00094) to detect long-term changes in plant and bird communities in relation to climate change and habitat fragmentation and to inform adaptive management. This project partners with the multi-agency Grassland Monitoring Team (GMT) as part of an adaptive management effort to evaluate the effects of fire and grazing. As part of this effort, almost 24,000 acres of native prairie has been monitored using a consistent set of hierarchical protocols across several ownerships and organizations. The data is pooled into a centralized database and utilized in a state and transition model to provide management recommendations.

Objectives:

1. Monitor high-quality remnant prairie habitat characteristics on 23 sites (11 sites in 2017 and 12 sites in 2018).

2. Monitor prairie avian use on 20 sites (10 sites in 2017 and 10 sites in 2018).

3. Manage, summarize, and distribute data annually

Objectives 1 and 2. Expected Results and Benefits:

Effectively managing prairie habitat benefits many species in greatest conservation need. The efforts of the MNWAP Prairie monitoring project combine long-term status and trend monitoring focused on climate change and habitat fragmentation with a collaborative adaptive management project, thereby addressing both site and landscape-level issues.

Applying monitoring to assess important indicators of vulnerable habitats and species at multiple scales as implemented in this proposal helps assess the efficacy of conservation efforts and to identify management and policy needs. Information on status and trends can alert managers to changes that might require action and highlight policy and planning needs, such as protection strategies.

The adaptive management component of this project is designed to address questions about which types and frequencies of management (fire and grazing) are most effective at maintaining native prairie quality.

Monitoring avian communities combined with information on management as collected for the habitat adaptive management component can help identify which management actions and frequencies of those actions are effective for grassland bird species. In addition, this information augments other avian status/trend monitoring efforts such as the Breeding Bird Survey as the monitoring sites are generally well away from roadsides.

Objectives 1 and 2. Methods:

Overall design:

Objectives 1 and 2 are based on a design first implemented in 2010, following the 2008-2009 pilot years, and will continue monitoring on 40 high-quality native prairie sites stratified by geography (Figure 1) and landscape context (Table 1) using a serially alternating sampling design (Table 2). Thirty-three of the 40 sites were chosen during the 2008-2009 pilot years, while the remaining seven sites were added in to the monitoring pool between the years 2010 and 2012 as the project evolved. This included replacing some originally chosen sites that were found to be of poor quality during initial monitoring site visits. For initial site selection, MNDNR botanists were solicited for a list of sites meeting the geography and landscape context parameters defined above, and the 40 sites were randomly selected from the initial list. Sites are on permanently protected parcels (publically owned or private easements), with one exception of a privately owned site that is significant for its size and outstanding plant and avian communities.

Objective 1 - Prairie habitat monitoring:

Prairie habitat monitoring will be conducted by contractors and / or DNR staff from mid-July through mid-September using two methods: 1) the hierarchical belt-transect protocols developed by the Grassland Monitoring Team (Appendix 1), and 2) prairie releves. Prairie relevés consist of recording the cover of all plant species in 10m x 10 m plots (MNDNR 2007).

The Grassland Monitoring Team (GMT) protocols provide options for collecting vegetation information at three hierarchical levels of detail with all levels collecting the same core data. This monitoring project utilizes both the least and most detailed levels of the protocol in order to detect plant community changes important for prairie SGCN and to inform partners collecting less detailed information. Vegetation information is collected on 50 half-meter plots along 25 m long transects to measure structure, percent cover of native vegetation relative to non-native vegetation, presence of non-native plant species (species-level), and the frequency and percent cover (in 11 categories) of all prairie plant species. All transect data is recorded electronically in ruggedized tablets, while relevé data is recorded on paper datasheets.

Transects were assigned randomly with spatial balance at 1 per 10 acres with a minimum of five and a maximum of 15 transects per management unit. Transects are designed to allow for sampling of a relatively homogenous prairie system (upland prairie, wet prairie, brush prairie or wet meadow as defined MNDNR 2005), and the protocols specify procedures for moving transects if they are found to cross into a different system type. This sampling scheme was formalized following results from a statistical power analysis in 2013. As a result, as sites come up for monitoring some adjustments are made to either increase or decrease the sampling density for each management unit. The number of management units in some sites are reduced to maintain a number of transects that it is feasible to monitor each year.

While most sites are monitored every six years using the most-detailed level of the protocols (Protocol C), MNDNR Native Prairie Banks and Scientific and Natural Areas are also monitored using the least detailed protocols (Protocol A) in the intervening three years as needed for the GMT adaptive management model (Table 3). This is for habitat monitoring only, and is the reason why there are more sites in a given year for habitat monitoring than for bird monitoring.

In addition to the GMT transects, one relevé per management unit on a site is conducted. When available, sampling occurs at locations of historic relevés (first collected between 15 and 40 years ago depending on the site) to provide a longer-term perspective of vegetation changes, to continue building this large and valuable dataset, and to provide a comparison of results to the GMT transect protocols.

Objective 2 - Avian use monitoring:

Bird monitoring consists of standard, ten minute point counts repeated three times per breeding season (generally June 1 through the first week of July) in order to calculate species detectability using occupancy and removal models (MacKenzie et al. 2006, Royle & Nichols 2003). At each point, surveyors record all bird species seen or heard during a ten-minute interval, and also record estimated distance, sex, and breeding evidence. Data are recorded in Trimble mobile handheld units and downloaded into a Microsoft Access database. The use of the mobile data recorders allows for an exact timestamp of when the bird was recorded facilitating species removal analyses (Farnsworth et al. 2002). Sites are not monitored for birds in the intervening three year monitoring described in Objective 1 (Table 3).

Assignment of point count locations were established in previous monitoring years based on the following: a minimum of seven point counts, spaced a minimum of 200 meters apart, were assigned to sites in the office prior to field surveys. Fewer than seven points were assigned for exceptionally small or irregularly shaped sites where seven points could not be assigned 200 m apart. Point count locations were first assigned to points previously established by Minnesota Biological Survey (MBS) bird surveyors. Where feasible, remaining points were arranged 200 meters apart in a hexagonal grid to match the Iowa MSIM protocols (Manley et al. 2006, Kinkead 2006). This was often not possible either because of the arrangement of the pre-existing MBS points or because sites were too small or irregularly-shaped to fit a grid of that size. In

those cases, points were located to cover as much of the area as possible while still being 200 meters apart. In all cases, bird points correspond to the starting transect locations described in the habitat section above, although there are usually more vegetation transects than there are bird points in a given management unit. Coordinates for these pre-determined point count locations are downloaded and located in the field using Trimble Nomad GPS data units.

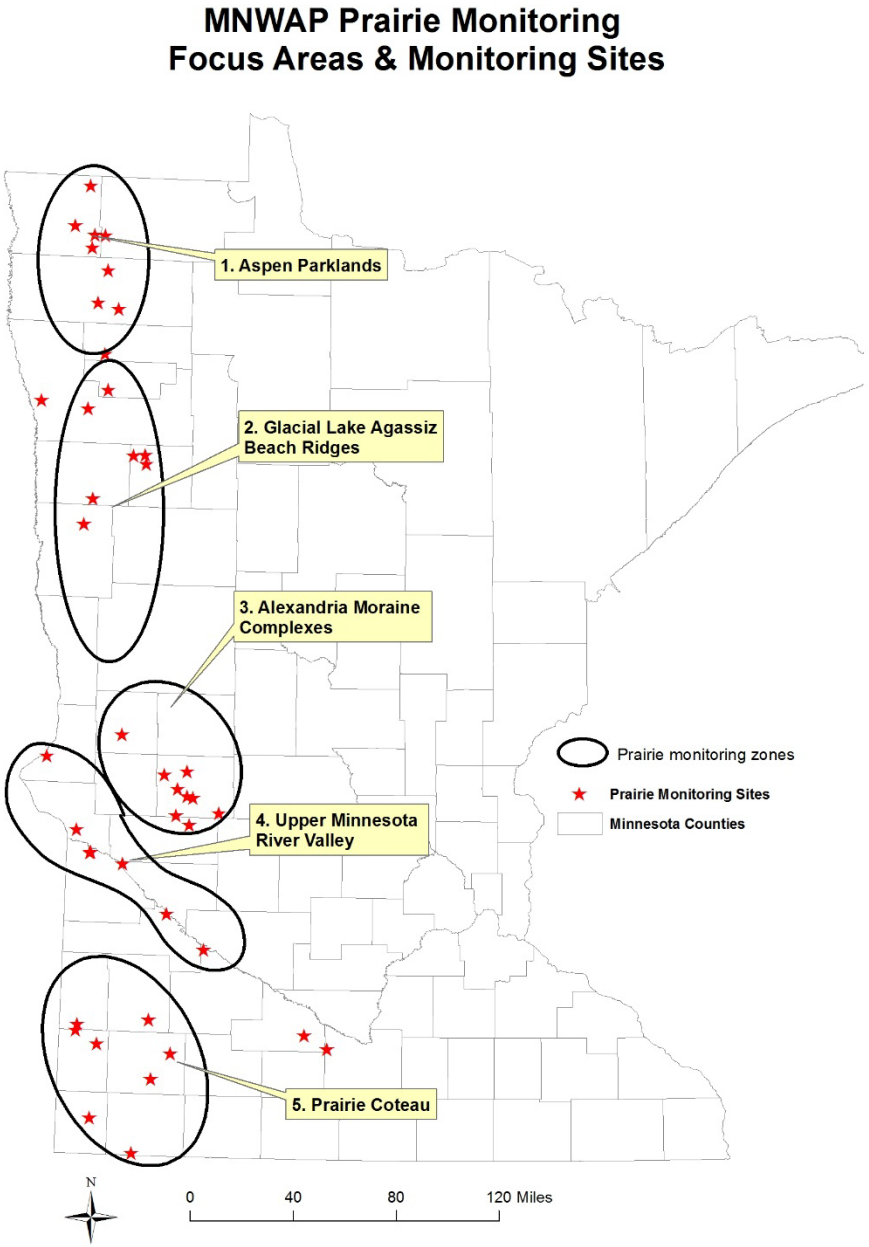

Figure 1 Prairie monitoring site in relation to the five geographic focus areas.

Table 1 Stratification by landscape context.

		% grassland in a 1 km buffer around the prairie site		
		<20%	**20-50%**	**>50%**
Size (aces)	**5-30**	**SI**		
	30-50			
	>50			**LE**

SI = Small, isolated sites; LE = Large, embedded (within grassland matrix) sites, and indicate the levels chosen for this project.

Table 2. Serially alternating design for prairie monitoring project. 2010 -2019 were completed.

Year	S_0	S_1	S_2	S_3	S_4	S_5	S_6	# sites/yr[1, 2,3]
2010	5 sites	7 sites						12
2011	4 sites		6 sites					10
2012	4 sites			5 sites				9
2013	4 sites				5 sites			9
2014	4 sites					6 sites		10
2015	4 sites						6 sites	10
2016	4 sites	7 sites						11
2017	4 sites		6 sites					10
2018	4 sites			6 sites				10
2019	4 sites				6 sites			10
2020	4 sites					6 sites		10
2021	4 sites						6 sites	10
2022	4 sites	6 sites						10
2023	4 sites		6 sites					10
2024	4 sites			6 sites				10
2025	4 sites				6 sites			10
2026	4 sites					6 sites		10
2027	4 sites						6 sites	10

40 sites total

S_0 – sites sampled every year, n = 4 (one from each focus area)

S_1 – sites sampled every 6 years starting in year 1 and repeated every 6 years, n=6

S_2 – sites sampled every 6 years starting in year 2 and repeated every 6 years, n=6.

S_3 – sites sampled every 6 years starting in year 3 and repeated every 6 years, n=6.

S_4 – sites sampled every 6 years starting in year 4 and repeated every 6 years, n=6.

S_5 – sites sampled every 6 years starting in year 5 and repeated every 6 years, n=6.

S_6 – sites sampled every 6 years starting in year 6 and repeated every 6 years, n=6.

[1]Year 1 (2010) of the sampling design was based on a five-year sampling rotation, resulting in 12 sites sampled.

[2] In each of years 3 and 4 (2012, 2013), nine sites were sampled, since 12 sites were sampled in 2010.

[3] In 2016, a correction in the sampling schedule required eleven sites to be sampled.

Table 3. List of sites and the information collected by year. Protocols described in Appendix 1, GMT Standardized Monitoring Protocols.

Site	2017	2018
Langhei Prairie SNA[1]	Bird, Veg. Protocol C	Bird, Veg. Protocol C
Plover Prairie TNC[1]	Bird, Veg. Protocol C	Bird, Veg. Protocol C
Prairie Coteau SNA[1]	Bird, Veg. Protocol C	Bird, Veg. Protocol C
Santee Prairie SNA[1]	Bird, Veg. Protocol C	Bird, Veg. Protocol C
Bejou WMA	Bird, Veg. Protocol C	
Blue Mounds SP	Bird, Veg. Protocol C	
Butternut Valley Prairie SNA	Bird, Veg. Protocol C	
Glacial Lakes SP	Bird, Veg. Protocol C	
Joseph A. Tauer SNA	Bird, Veg. Protocol C	
Strandness Prairie TNC	Bird, Veg. Protocol C	
Stony Run 11 NPB	Veg. Protocol A	
Chippewa Prairie Preserve		Bird, Veg. Protocol C
East Park WMA		Bird, Veg. Protocol C
Lake Bronson SP		Bird, Veg. Protocol C
Lundblad Prairie SNA		Bird, Veg. Protocol C
Malmberg Prairie SNA		Bird, Veg. Protocol C
Svor WPA		Bird, Veg. Protocol C
Twin Valley Prairie SNA		Veg. Protocol A
Two Rivers Aspen SNA		Veg. Protocol A

Veg. Protocol A = the least detailed protocol level; the core set of data collected at all protocol levels.
Veg. Protocol C = the most detailed protocol level. See Attachment A for more information.
1 Sites monitored every year.

Objective 3. Expected Results and Benefits:

Monitoring results and management recommendations from the Grassland Monitoring Team (GMT) adaptive management model are distributed annually to land managers for sites that have completed the three year management and monitoring cycle. The adaptive management model provides recommendations on the type (fire, grazing, or rest) and the frequency (number of times during the next three year management cycle) based on the “state” or condition the prairie management unit was in at the last monitoring time. Long-term status and trend data are provided after each six-year sampling cycle to land managers and decision makers at participating government agencies and organizations. This information on status and trends can alert managers to changes that might require action or a change in management approach and highlight policy and planning needs at a broader institutional level, such as protection strategies.

Objective 3. Methods

Data will be managed, summarized and distributed annually. The schedule is to analyze trend data after each six-year sampling interval, with the next interval scheduled for 2022. The first followed the 2016 field season and was covered under a previous grant. Based on these analyses, conservation recommendations will be developed and distributed to conservation managers. In addition, annual management recommendations for sites monitored in a given year are provided as part of the GMT adaptive management model.

Data collected through Objective 1 is shared with the Grassland Monitoring Team (GMT) on a sharepoint site accessible to all users, and for use in the adaptive management model. The full GMT meets in person at least once per year and participates in a field training day just prior to onset of the field season. A core team, currently comprised of the MNWAP monitoring coordinator and one staff person each from TNC and USFWS communicate regularly throughout the year on issues such as protocol modifications, model refinement, data management and analysis, and broader GMT communications and recruitment.

This grant will fund regular updates of mobile data units and databases for storage and management of monitoring data. Funding also includes a portion of a position (0.25 FTE) to assist with annual planning of field work, coordinating some staff and contract requirements, conducting fieldwork as needed, data analysis, and evaluation. This objective also covers grant administration as needed, such as budgeting, and preparing reports or amendments.

Location: Focal areas within the aspen parklands and prairie parkland provinces of Minnesota (see Figure 1).

Accomplishments: March 01, 2017 to March 31, 2018

Objective 1 Monitor high-quality remnant prairie habitat characteristics:

A total of eleven sites were monitored for vegetation during the reporting time period (Table 4). Ten of these sites follow the six-year serially alternating schedule (Table 2) using the most-detailed monitoring protocols (Protocol C). One additional site (Stony Run 11 Native Prairie Bank) was monitored using the least detailed monitoring protocols (Protocol A) as part of the intervening three year schedule needed for the Grassland Management Team (GMT) adaptive management model.

A total of 142 vegetation transects using the detailed protocols (Protocol C), 10 transects using the simple protocols (Protocol A), and 17 relevés were completed by one contracting firm in July through September 2017.

<u>2017 observers:</u>
Midwest Natural Resources - Scott Milburn (lead botanist), Otto Gockman (lead botanist), Andy Kranz (lead botanist), Mattie Anders (assistant), Alex Cahlander-Mooers (assistant), Rachel Funke (assistant), Dylan Leuth (assistant), Eric Liesse, (assistant), Jacob Thompson (assistant), Nic Tourville (assistant), and Anne Weeks (assistant).

Objective 2 Monitor prairie avian use:

A total of 10 sites were monitored for birds during the reporting time period. These sites were the same 10 sites monitored for vegetation following the six year schedule. The additional site monitored for vegetation using Protocol A was not monitored for birds as the bird data is not used in the adaptive management model.

Sites were visited 3 times each from late May through the end of June and a total of 219 point counts were completed by MNDNR staff.

2017 observers:
Mike Worland and Christine Herwig

Objective 3 Manage, summarize, and distribute data annually:

Both plant and bird data were collected electronically using mobile data collectors.

Plant data was error checked and follow-up correspondence with the contractor was necessary to confirm or correct any questionable records. Once corrections were completed, the data was uploaded to the Grassland Monitoring Team (GMT) sharepoint site which holds all data collected by GMT participants. This pooled dataset is utilized by the GMT adaptive management model to provide management recommendations to managers. The 2017 adaptive management model run was completed in February 2018. Monitoring summaries and management recommendations were provided to managers. A professional journal publication is in development and will describe the GMT adaptive management process, the adaptive management model, and results from analyzing the pooled GMT dataset.

Bird data was downloaded to a Microsoft Access database and error checked. The data was then combined with the main database containing data for all years. Bird trend analysis, as described in the final report for MNT15R2, was re-run with the 2017 data included. Results were similar to those in the T15R2 final report. Results were presented at several venues including webinars, conferences, and on local radio stations. A professional journal publication is in progress and will be completed following analysis of the 2018 data.

Accomplishments: April 01, 2018 to March 31, 2019

Objective 1 Monitor high-quality remnant prairie habitat characteristics:

A total of twelve sites were monitored for vegetation during the reporting time period (Table 4). Ten of these sites follow the six-year serially alternating schedule (Table 2) using the most-detailed monitoring protocols (Protocol C). Two additional sites (Two-Rivers Aspen Prairie Parkland SNA and Twin Valley Prairie SNA) were monitored using the least detailed monitoring protocols (Protocol A) as part of the intervening three year schedule needed for the Grassland Management Team (GMT) adaptive management model.

A total of 158 vegetation transects using the detailed protocols (Protocol C), 30 transects using the simple protocols (Protocol A), and 21 relevés were completed by one contracting firm in July through September 2018.

2018 observers:
Midwest Natural Resources – **Lead botanists:** Otto Gockman and Andy Kranz; **Assistant botanists:** Robert Cress, Bennett Grider, David Paynotta, Nic Tourville, Jake Walden, and Anne Weeks.

Objective 2 Monitor prairie avian use:

A total of 10 sites were monitored for birds during the reporting time period. These sites were the same 10 sites monitored for vegetation following the six year schedule. The additional site monitored for vegetation using Protocol A was not monitored for birds as the bird data is not used in the adaptive management model.

Sites were visited 3 times each from late May through the end of June and a total of 264 point counts were completed by MNDNR staff.

2018 observers:
Daren Carlson, Mike Worland, and Christine Herwig

Objective 3 Manage, summarize, and distribute data annually:

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Plant data was error checked and follow-up correspondence with the contractor was necessary to confirm or correct any questionable records. Once corrections were completed, the data was uploaded to the Grassland Monitoring Team (GMT) sharepoint site which holds all data collected by GMT participants. This pooled dataset is utilized by the GMT adaptive management model to provide management recommendations to managers. The 2018 adaptive management model run was completed in February 2019. Monitoring summaries and management recommendations were provided to managers. A professional journal publication was submitted to Ecosphere. This publication describes the GMT adaptive management process, the adaptive management model, and results from analyzing the pooled GMT dataset.

Bird data was downloaded to a Microsoft Access database and error checked. The data was then combined with the main database containing data for all years. Bird trend analysis will be re-run with 2018 and 2019 data in preparation for the final report. Previous results were presented at several venues including webinars and conferences.

Final Report March 01, 2017 to December 31, 2019

This is an ongoing, long-term status/trend monitoring project and this T15-R3 grant culminated midway during the 6-year monitoring cycle. The next cycle finishes in 2022. We present here preliminary summaries; a more complete analysis will be conducted following the 2022 monitoring season (to be covered under T15-R4).

Objective 1 Monitor high-quality remnant prairie habitat characteristics

2017
11 sites were monitored for vegetation in 2017. 10 of these sites were monitored for vegetation using the detailed GMT Protocol C version, following the six-year serially alternating schedule (Table 2). One additional site in 2017 (Stony Run 11 Native Prairie Bank) was monitored using the least detailed monitoring protocol (Protocol A) as part of the intervening three year schedule needed for the Grassland Management Team (GMT) adaptive management model.

A total of 142 vegetation transects using the detailed protocols (Protocol C), 10 transects using the simple protocols (Protocol A), and 17 relevés were completed by one contracting firm in July through September 2017.

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2018
12 sites were monitored for vegetation in 2018. 10 of these sites were monitored for vegetation using the detailed GMT Protocol C version, following the six-year serially alternating schedule (Table 2). Two additional sites in 2018 (Two-Rivers Aspen Prairie Parkland SNA and Twin Valley Prairie SNA) were monitored using the least detailed monitoring protocol (Protocol A) as part of the intervening three year schedule needed for the Grassland Management Team (GMT) adaptive management model.

A total of 158 vegetation transects using the detailed protocols (Protocol C), 30 transects using the simple protocols (Protocol A), and 21 relevés were completed by one contracting firm in July through September 2018.

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Midwest Natural Resources – Lead botanists: Otto Gockman and Andy Kranz; Assistant botanists: Robert Cress, Bennett Grider, David Paynotta, Nic Tourville, Jake Walden, and Anne Weeks.

Results
This final report provides a short summary of Objective 1 prairie vegetation trends from 2008 to 2018. Provided is an example of how the condition of remnant prairie vegetation changed over the 2008–2018 time period expressed as a condition score ranging from 0 (worst condition) to 100 (best condition) using three metrics (percent native cover, woody vs. herbaceous functional group – hereafter “shrub”, and proportion of native indicators) from the vegetation monitoring protocols.

The overall mean condition score did not significantly change between the start of the monitoring period in 2008 and the end of the monitoring period in 2018. Mean overall

scores went from 55.0 at the start to 52.9 at the end, but were not statistically different (Fig. 2a). Of the three individual components, only the shrub score indicated a change over time with a score of 24.4 at the end compared to 21.1 at the start.

A different picture emerges when looking at transects based on their starting condition. Transects that started in a lower quality, had a substantially higher overall score by the end of the monitoring period (28.8 at the start; 36.8 at the end, Fig. 2b). Scores of the individual metrics reveal that most of the increase in the overall score can be attributed to an increase in the percent native cover score. Transects that started out in low quality had less cover of invasive plants at the end.

Conversely, transects with better condition at the start, had a substantially lower overall score by the end (67.9 at the start; 60.8 at the end, Fig. 2c). This decrease was explained by a decrease in the shrub score, indicating that high quality transects experienced woody encroachment over time.

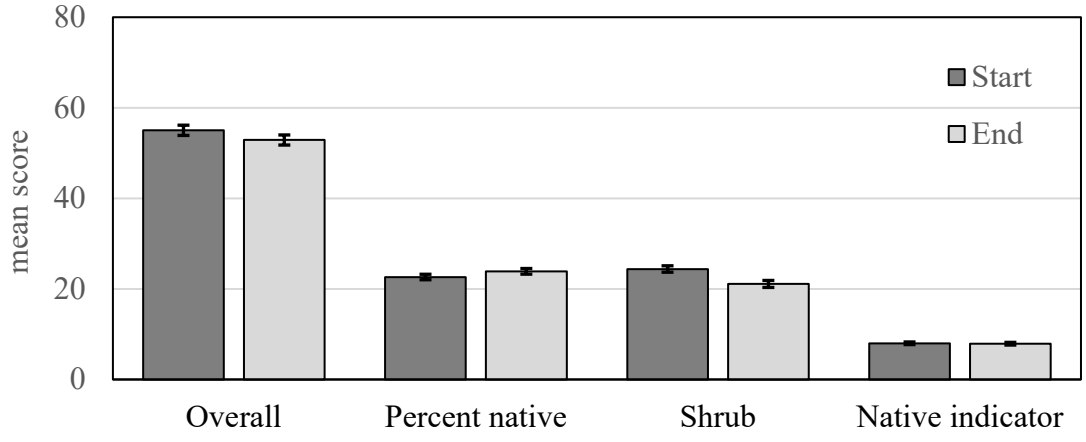

Figure 2a. Mean condition score from the start to the end of the monitoring period– all transects.

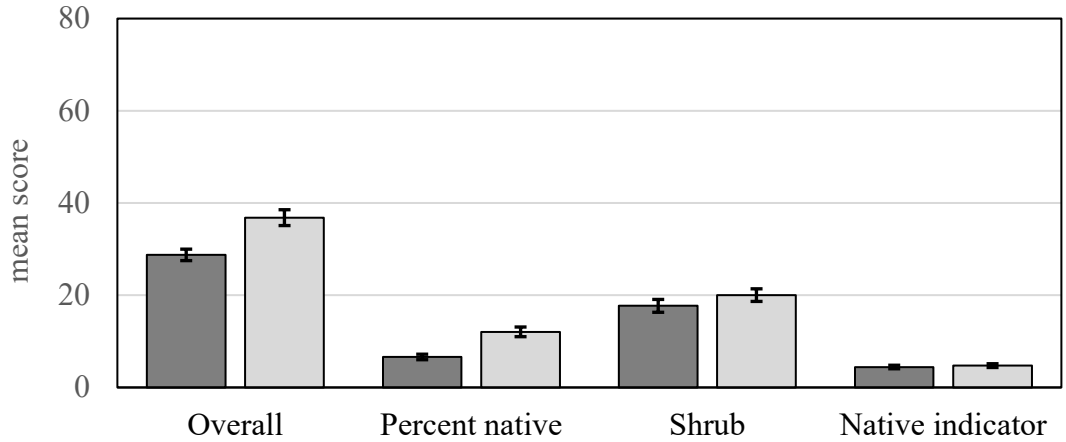

Figure 2b. Mean condition score from the start to the end of the monitoring period– low condition transects.

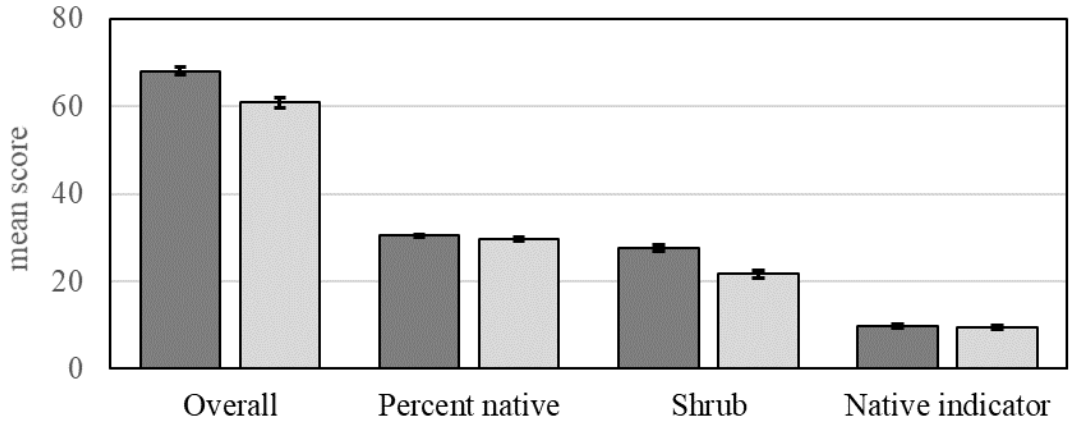

Figure 2c. Mean condition score from the start to the end of the monitoring period– high condition transects.

Objective 2 Monitor prairie avian use:

2017:
A total of 10 sites were monitored for birds in May-June 2017. These sites were the same 10 sites monitored for vegetation following the six year schedule. The additional site monitored for vegetation using Protocol A was not monitored for birds as the bird data is not used in the adaptive management model.

Sites were visited 3 times each from late May through the end of June and a total of 219 point counts were completed by MNDNR staff.

2017 observers:
Mike Worland and Christine Herwig

2018:
A total of 10 sites were monitored for birds in May-June 2018. These sites were the same 10 sites monitored for vegetation following the six year schedule. The additional site monitored for vegetation using Protocol A was not monitored for birds as the bird data is not used in the adaptive management model.

Sites were visited 3 times each from late May through the end of June and a total of 264 point counts were completed by MNDNR staff.

2018 observers:
Daren Carlson, Mike Worland, and Christine Herwig

Summary of the avian long-term status/trend monitoring project 2008-2018:
Through 2018, twelve consecutive field seasons of grassland bird monitoring have been

completed in prairies of western Minnesota, as part of this and previous SWG grants. This effort includes 40 field sites monitored over this time period, with four of these sites surveyed annually and the remaining 36 surveyed on a six-year rotation schedule. To date, twelve different observers have participated in the monitoring since its first year in 2008, and just under 50,000 observations have been recorded.

Data analyzed from 2008 to 2018 mirrors other studies, such as the ongoing Breeding Bird Survey by the U.S. Geological Survey, indicating significant and dramatic declines of several obligate grassland species over the 2018-2018 time period (examples in Figures 3a-d). These include species considered more generalist in their habitat needs and more common across the landscape in Minnesota. A significant contribution of this project is that the monitored areas were from the interior of high-quality and permanently-protected remnant prairie, regardless of the size or landscape context of the grasslands. These results indicate that landscape-level factors may be driving declines rather than site-level factors. Publication of these results in a peer-reviewed professional journal are in preparation and expected for submittal in early 2020.

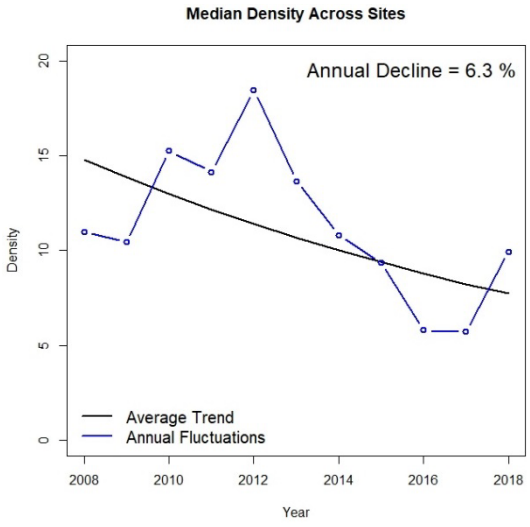

Figure 3a. Clay-colored sparrow (*Spizella pallida*) density (#indiv/10 ha) trend over time.

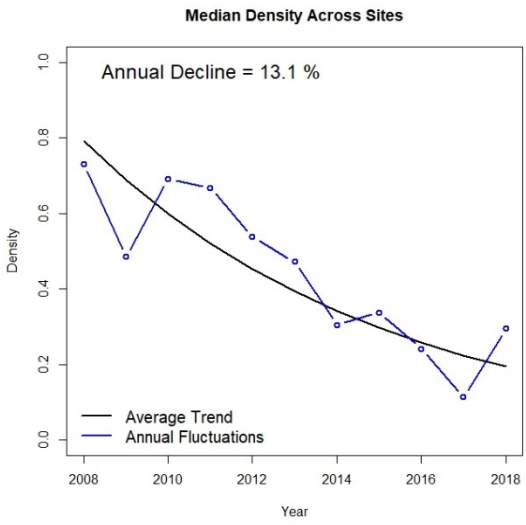

Figure 3b. Grasshopper sparrow (*Ammodramus savannarum*) density (#individuals/10 ha) trend over time.

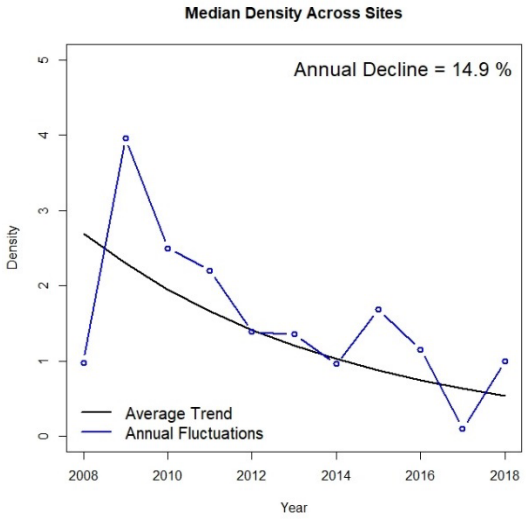

Figure 3c. Savannah sparrow (*Passerculus sandwichensis*) density (#individuals/10 ha) trend over time.

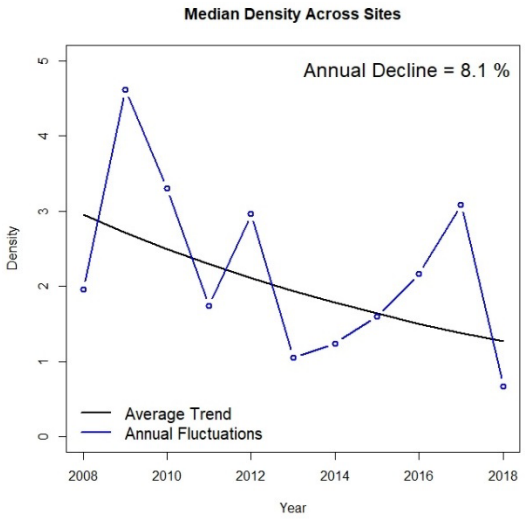

Figure 3d. Sedge wren (*Cistothorus stellaris*) density (#individuals/10 ha) trend over time.

Objective 3 Manage, summarize, and distribute data annually:

During this grant period, both plant and bird data were collected electronically using mobile data collectors.

2017 and 2018 Bird data was downloaded to a Microsoft Access database and error checked. Bird trend analyses for 2008-2019 are in progress with a publication expected in early 2020.

Vegetation data was error checked and corrected as needed. Following quality control steps, vegetation was uploaded into the Grassland Monitoring Team (GMT) sharepoint site which holds all data collected by GMT participants. 2017 and 2018 monitoring reports and management recommendations were provided to site managers following adaptive management model runs in each year.

A new vegetation data collection application was developed through a contract with the US Fish & Wildlife Service using a Survey123 for ArcGIS platform. This application was used for 2019 vegetation data collection covered under the T15-R4 SWG grant. Migration of this data from sharepoint to an ArcGis geodatabase and connections to the AM model are in progress

A professional journal publication of the adaptive management process and vegetation results was re-submitted with edits to Ecosphere in October 2019. This publication describes the GMT adaptive management process, the adaptive management model, and results from analyzing the pooled GMT dataset.

Results of both birds and vegetation continue to be presented at many venues including webinars and conferences.

Vegetation data are also being utilized by a graduate student at the University of Minnesota examining climate change effects on plant communities and individual plant species. Results are forthcoming.

Table 4 Long-term prairie monitoring sites and completed monitoring schedule.

Zone	Context	Site_Id	Site_Name	County	Acres		Bird Points	Veg. Trans.	Relevés	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	LE	1-LE-4	Caribou WMA	Kittson	552.90	62.57	24	30	2		C				C					
		1-LE-6	Pelan WMA	Kittson	141.11	33.66	7	12	2		C						C			
		1-LI-1	Marsh Grove 36 NPB	Marshall	395.16	27.39	6	15	1		C	C						C		
		1-LI-3	Two-Rivers Aspen Prairie Parkland SNA	Roseau	96.43	24.09	7	10	1		C						C			A
	SI	1-SI-1	Higginbotham WMA	Pennington	130.65	19.20	11	16	3		C	C						C		
		1-SI-2	Lake Bronson SP	Kittson	31.94	19.23	5	10	2		C	C								C
		1-SI-3	Twin Lakes WMA (was 1-LE-2)	Kittson	31.79	31.86	5	6	1		C					C				
		1-SI-4	East Park WMA	Marshall	39.56	TBD	3	5	1					C						C
2	LE	2-LE-1b	B Bar B	Clay	658.11	70.84	12	30	2						C					
		2-LE-4	Santee Prairie SNA	Mahnomen	169.18	74.88	9	17	2	C						C		C	C	C
		2-LE-5	Tympanuchus WMA	Polk	Tbd	96.26	14	28	1	C		C	C	C	C	C	C			
		2-LE-6	Twin Valley Prairie SNA	Norman	226.75	60.90	9	20	1		C						C			A
	SI	2-SI-1	Bejou W WMA	Mahnomen	60.20	31.75	7	7	1	C			C						C	
		2-SI-2	Loncrace WMA	Mahnomen	34.15	8.93	5	6	1	C	C						C			
		2-SI-3	Malmberg Prairie SNA	Polk	50.96	5.35	6	10	2	C				C			A			C
		2-SI-4	Lake Pleasant 22 NPB	Red Lake	18.23	77.73	3	10	2	C	C	C						C		
3	LE	3-LE-1	Ordway Prairie TNC	Pope	379.51	32.98	14	29	2	C	C					C				

		3-LE-2	Glacial Lakes SP	Pope	494.57	67.16	13	28	3		C		C						C		
		3-LE-2b	Vegoe NPB	Pope	49.39	61.80	7	7	1		C	C							C		
		3-LE-3	Svor WPA	Swift	54.87	65.46	7	5	1	C	C			C							C
		3-SI-2	Langhei Prairie SNA	Pope	27.85	45.95	6	10	2				C	C	C	C	C	C	C	C
		3-SI-3	New Prairie WPA	Pope	15.24	42.66	4	5	1			C					C			
	SI	3-SI-4	Strandness Prairie TNC	Pope	33.14	TBD	5	10	2				C						C		
		3-SI-5	Selix NPB	Pope	18.2	TBD	5	10	2						C			A			
		4-LE-1	Agassiz 23 NPB	Lac Qui Parle	63.75	74.34	6	7	1	C					C			A			
		4-LE-1	Plover Prairie TNC	Lac Qui Parle	200.95	74.34	7	15	1	C		C	C	C	C	C	C	C	C	C	C
	LE	4-LE-2	Chippewa Prairie TNC/Lac Qui Parle WMA	Chippewa	1328.02	71.31	31	60	4	C	C			C							C
		4-LE-4	Schellberg NPB	Big Stone	176.55	46.03	8	13	1			C						C			
4		4-SI-2	Boiling Springs NPB	Redwood	27.09	50.65	7	7	1	C	C	C						C			
		4-SI-3	Stony Run 11 NPB	Yellow Medicine	9.43	23.03	4	5	1	C	C					C			A		
	SI	4-SI-4	Joseph A. Tauer Prairie SNA	Brown	80.02	0.00	7	10	2		C		C						C		
		4-SI-5	Butternut Valley Prairie SNA	Blue Earth	11.67	0.00	2	10	2		C		C						C		
		5-LE-1	Altona WMA	Pipestone	79.99	81.38	8	12	2	C	C					C					
		5-LE-2	Hole in the Mountain TNC/WMA	Lincoln	147.14	74.59	12	16	1	C	C	C						C			
	LE	5-LE-3	Prairie Coteau SNA	Pipestone	244.09	69.46	7	16	2	C	C		C	C	C	C	C	C	C	C	C
5		5-LE-4	Blue Mounds SP	Pipestone	130.76	73.73	11	21	3		C	C	C						C,A		
		5-SI-1	Dovray 7 NPB	Murray	6.02	50.61	4	5	1	C					C			A			
	SI	5-SI-2	Garvin County Park	Lyon	22.12	17.26	7	5	1	C	C						C				

5-SI-3	Lundblad Prairie SNA	Murray	17.38	17.38	7	10	2	C	C			C			A			C
5-SI-4	Sunrise Prairie County Park	Nobles	3.73	38.57	4	5	1							C				

LE = Large size, Embedded in grassland matrix; SI = Small size, Isolated from other grassland habitat. Acres refers to the size of the native prairie site in acres. “% Grass in buffer” refers to the percentage of grassland in a 500 m buffer surrounding the site. “Bird Points” refers to number of established bird point count locations, “Veg. Trans.” refers to the number of established vegetation transects, and “Relevés” refers to the number of established relevés. A = site sampled using Protocol A, C = site sampled using Protocol C.

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