2016 Project Abstract
For the Period Ending June 30, 2021

PROJECT TITLE: Evaluate Prescribed Burning Techniques to Improve Habitat Management for Brushland Species
PROJECT MANAGER: Rebecca Montgomery
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2016, Chp. 186, Sec. 2, Subd. 08d as extended by M.L. 2020, First Special Session, Chp. 4, Sec. 2

APPROPRIATION AMOUNT: $267,000
AMOUNT SPENT: $267,000
AMOUNT REMAINING: $0

Sound bite of Project Outcomes and Results

Lowland brush ecosystems provide critical habitat for a variety of wildlife. Lack of fire degrades habitat value. Our project suggests that prescribed burning in different seasons (e.g., spring, summer, fall) can be a tool to support a variety of outcomes, maintaining a diverse habitat that supports a diverse bird community.

Overall Project Outcome and Results

Lowland brush ecosystems provide critical habitat for a variety of wildlife including over 80 Species of Greatest Conservation Need. These ecosystems depend on fire. Without fire, shrubs become dominant, reduce herbs, and reduce the quality of habitat for wildlife. Managers use prescribed burning as a tool in these ecosystems, conducting most burns in spring. We know that in other systems, summer and fall fires increase habitat value by creating patchiness in the vegetation. This patchiness supports greater plant and animal diversity. The objective of our project was to evaluate the effects of burn season on fire severity, woody and herbaceous plant communities, and breeding bird communities. Our goal was to understand whether burning in different seasons might improve brushland habitat to meet the needs of diverse wildlife and plants.

Four study sites were each broken into four 100-acre burn units including spring, summer, fall, and a control. At eight points per unit, we collected pre- and post-burn plant and breeding bird data. We found similar levels of loss of aboveground shrub stems in all seasons in patches that burned. However, we found that spring burns burned more area in fall or summer. Overall, spring burns were the most successful at reducing woody stem density one year after burn. However, spring burns created a uniform layer of resprouting shrubs. This could reduce habitat quality. We found that the when there was a greater variety of stem heights, we found more bird species. Thus, burning in just one season could homogenize brushlands reducing their value to wildlife. Overall, our project suggest that managers should view fire season as a tool to support a variety of outcomes and maintain a diverse habitat that supports a diverse bird community. Our data will be used to develop best management practices for brushland habitats.

Project Results Use and Dissemination

Our project results were presented at numerous regional meetings of natural resource managers, including several workshops focused specifically on the use of fire in management. In addition, two M.S. theses were completed ([Lori Knosalla](#) and [Annie Hawkinson](#)) with peer-reviewed publications in progress.

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2016 Work Plan

Date of Report: December 7, 2021

Final Report

Date of Work Plan Approval: June 7, 2016

Project Completion Date: June 30, 2021

PROJECT TITLE: Evaluate Prescribed Burning Techniques to Improve Habitat Management for Brushland Species

Project Manager: Dr. Rebecca Montgomery

Organization: University of Minnesota

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Location: Aitkin, Carlton, St. Louis, and Pine Counties

	Total ENRTF Project Budget:	**ENRTF Appropriation:**	**$267,000**
		Amount Spent:	**$267,000**
		Balance:	**$0**

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 08d as extended by M.L. 2020, First Special Session, Chp. 4, Sec. 2

Appropriation Language:

$267,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to compare the effects on brushland habitat of conducting prescribed burning in spring, summer, and fall to provide improved management guidelines for wildlife habitat. This appropriation is available until June 30, 2020, by which time the project must be completed and final products delivered.

M.L. 2020 - Sec. 2. ENVIRONMENT AND NATURAL RESOURCES TRUST FUND; EXTENSIONS. [to June 30, 2021]

I. PROJECT TITLE: Evaluate Prescribed Burning Techniques to Improve Habitat Management for Brushland Species

II. PROJECT STATEMENT:

We propose to compare the response of brushland vegetation to prescribed burns conducted in the spring, summer, and fall to understand how the season of burning influences the ability to effectively maintain open, brushland conditions. Brushlands cover approximately 8.5 million acres (20% land surface) in Minnesota and provide critical habitat for over 250 wildlife species, including >80 species on the Minnesota Department of Natural Resources (DNR) list of Species of Greatest Conservation Need (SGCN) including 38 birds, 17 mammals, 12 reptiles, 2 amphibians, and 12 insects. Numerous game species also use brushland habitats including Sharp-tailed grouse, American Woodcock, white-tailed deer, and furbearers. The brushland habitats that these wildlife use are intermediate between grasslands and forests, and require periodic disturbance to maintain them as brushlands.

Prior to European settlement, Minnesota's brushlands were maintained by frequent wildfires. These burns happened most frequently in summer and fall when vegetation was dry enough to carry fire. We know very little about the effects of burning in different seasons on brushland vegetation. We know that in forest and grasslands, summer and fall fires increase habitat value by creating patchiness in the vegetation due to variation in where the fire burned hotter and cooler. This patchiness supports greater plant and animal species diversity.

Prescribed burning has become an important wildlife management tool to incorporate fire disturbance in a controlled way on the modern landscape. Currently, most brushland prescribed burns executed by the Department of Natural Resources are conducted in the spring. However, historically, wildfires occurred throughout the year, including both the summer growing season and spring and fall dormant seasons. Because springs tend to be moist, fires are less hot and are easy to control. However, cooler fires may be less effective in achieving habitat goals of maintaining open conditions by preventing the conversion of brushland to forest. The scientific literature indicates that summer burns are more effective at maintaining fire-dependent grassland and oak forest habitats than dormant-season spring burns. However, no such studies exist for brushlands.

Why don't managers burn in summer and fall? Lack of science-based guidelines hinders change in practice. Managers require data showing benefits before changing existing management, especially when so many significant wildlife species are involved. Data on benefits to achieving habitat goals using summer and fall burns will motivate adoption of more diverse prescribed fire regimes on brushlands, ultimately benefiting wildlife.

We will compare the effects of spring, summer and fall prescribed burns on brushland vegetation in 900 acres of brushland in the northeast region of Minnesota. Our project will:

- provide data on the habitat benefits of spring, summer and fall burns
- develop best management practices for maintaining healthy brushland habitat
- improve brushland habitat to meet the needs of diverse wildlife and native plant species

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of *January 25, 2016*:

We hired two graduate students, Anna (Annie) Hawkinson and Lori Knosalla to support fieldwork and a crew of field staff. Initial bird surveys were conducted in June 2016 in all sites in all burn units with vegetation surveys in July and August in all sites and most burn units. We conducted pre-burn fuel assessments in September in all fall burn units. Due to very wet conditions in summer and fall only a single site was burned. Over the winter we've been entering data and beginning analysis of our baseline dataset on birds and vegetation.

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Amendment Request *September 22, 2017*:

We request to move $2,000 dollars from salary to equipment to cover costs of equipment for fire severity monitoring, for waders for access to field sites, for large field packs for transporting biomass. The difficulty of the terrain has required more equipment than expected including replacing waders each year (~$100/pair). We request to move $9,000 from salary to travel. Due to difficulty in burning sites we have continued to survey 5 sites into our second year. These sites range from Aitken to Hibbing to Cromwell meaning considerable driving mileage to conduct fieldwork (~140 miles/day). In addition, our bird surveys take ~4 weeks and due to field conditions that make moving difficult our vegetation surveys average 1.5 months to complete. This has added considerable travel expense to the project. Overall, these represent an almost doubling of our original cost estimate. We request to move funds from salary as one of our graduate students received a fellowship to support her this year and our graduate student salary costs are therefore lessened.

Amendment Approved by LCCMR 9/25/2017

Project Status as of *January 19, 2018*:

Bird surveys were conducted in June 2017 in the four sites that remain in the study with vegetation surveys in July and August of those same sites. We conducted post-burn surveys at the single site that burned in fall 2017. We conducted pre-burn fuel surveys in all spring and summer burn units and post-burn fuel surveys in the two sites that burned in spring and summer 2017. We conducted pre-burn surveys in the one site that burned in fall 2017. Over the winter we've been entering data from 2017, continuing analysis of our baseline dataset on birds and vegetation and beginning analysis of our dataset on fire severity and on burn impacts on bird and vegetation. Overall we completed all fieldwork for Activity 1. Several presentations were given on the work at local and national professional meetings.

Project Status as of *August 26, 2018*:

Bird surveys were conducted in June 2018 in burn units and control sections in all sites that received burns prior to the survey. Vegetation surveys were conducted in July of those same sites. We conducted post-burn surveys at the two sites that burned in spring 2018. We've completed data entry from 2017, continuing analysis of our baseline dataset on birds and vegetation and fire severity and on burn impacts on bird and vegetation. Several presentations were given on the work at local professional meetings.

Project Status as of *November 15, 2018*: Two prescribed burns were completed by DNR partners. This concludes that part of the project. We've completed data entry from 2018, continuing analysis of our baseline dataset on birds and vegetation and fire severity and on burn impacts on bird and vegetation.

Project Status as of *May 7, 2019*: We continue analysis of our baseline dataset on birds and vegetation and fire severity and burn impacts on bird and vegetation. Annie Hawkinson defended her M.S. thesis and is preparing two manuscripts for publication in peer reviewed journals. Several presentations were given on the work at local professional meetings and a webinar was given to local stakeholders and practicioners.

Amendment Request *May 1 2019*:

We request to move the remaining subcontract funds ($24,019.07) from DNR subaward to personnel to support summer field staff ($19,019.07) and travel ($5000). The DNR completed all burns well under budget. However, our ecological field work has cost significantly more than originally budgeted. Moving these funds back into the UMN budget will allow us to conduct bird and vegetation summers this summer. We note that our original proposal didn't include bird survey or a control. These were added in our final workplan after peer review of our research addendem. Bird surveys take ~4 weeks to complete. In addition, due to field conditions that make

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moving difficult our vegetation surveys average 1.5 months to complete. This has added considerable travel and personnel expenses to the project. Overall, these represent an almost doubling of our original cost estimate. We have done what we can to stretch the budget – one graduate student received a one year fellowship and we have received supplemental summer funding for field staff from the Lake States Fire Science Consortium. Reallocating unused funds would support continued research critical to our outcomes and deliverables.

Amendment Approved LCCMR 6/10/2019.

Project Status as of *January 22, 2020***:**

Summer fieldwork on birds and vegetation was completed. This is be the final set of vegetation data from this project. Depending on funds left we would like to collect another round of bird data in June to support Phase II. We continue analysis of our dataset on birds and vegetation and fire severity and burn impacts on bird and vegetation. Lori Knosalla defended her M.S. thesis. Several presentations were given on the work at local professional meetings.

Project extended to June 30, 2021 by LCCMR 6/18/20 as a result of M.L. 2020, First Special Session, Chp. 4, Sec. 2, legislative extension criteria being met.

Project Status as of November 15, 2020:
Summer fieldwork on birds was completed. Using supplemental funding we were also able to get another year of vegetation data from this project. We continue analysis of our dataset on birds and vegetation and fire severity and burn impacts on bird and vegetation. Research publications are in progress. We held an online meeting with managers that were involved in the burns to share results and learn from their experiences. The outcomes of that meeting will inform final recommendations of the project.

Project Status as of Jun 16, 2021:
Nothing to report

Overall Project Outcomes and Results:
Lowland brush ecosystems provide critical habitat for a variety of wildlife including over 80 Species of Greatest Conservation Need. These ecosystems depend on fire. Without fire, shrubs become dominant, reduce herbs, and reduce the quality of habitat for wildlife. Managers use prescribed burning as a tool in these ecosystems, conducting most burns in spring. We know that in other systems, summer and fall fires increase habitat value by creating patchiness in the vegetation. This patchiness supports greater plant and animal diversity. The objective of our project was to evaluate the effects of burn season on fire severity, woody and herbaceous plant communities, and breeding bird communities. Our goal was to understand whether burning in different seasons might improve brushland habitat to meet the needs of diverse wildlife and plants.

   Four study sites were each broken into four 100-acre burn units including spring, summer, fall, and a control. At eight points per unit, we collected pre- and post-burn plant and breeding bird data. We found similar levels of loss of aboveground shrub stems in all seasons in patches that burned. However, we found that spring burns burned more area in fall or summer. Overall, spring burns were the most successful at reducing woody stem density one year after burn. However, spring burns created a uniform layer of resprouting shrubs. This could reduce habitat quality. We found that the when there was a greater variety of stem heights, we found more bird species. Thus, burning in just one season could homogenize brushlands reducing their value to wildlife. Overall, our project suggest that managers should view fire season as a tool to support a variety of outcomes and maintain a diverse habitat that supports a diverse bird community. Our data will be used to develop best management practices for brushland habitats.

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Document current conditions on 2000 acres of brushland habitat in NE Minnesota

Description: In summer 2016, MN DNR partners will identify potential study sites in NE Minnesota, with the intention of treating three sites with prescribed fire. Since burns are dependent on weather and site-specific fuel conditions we will do site preparations on five sites with the goal of burning three of them. Each site will be at least 400 acres and divided into four equally sized sections with similar vegetative composition. DNR staff will create firebreaks to separate the four sections for prescribed fire treatment. To document initial conditions of brushland habitats, we will measure vegetation metrics such as duff layer depth, grass biomass, shrub density, invasive species presence, and plant species composition in the summer prior to burning in 80 plots per site that will also be permanently marked for post-fire sampling. In addition, wildlife surveys (e.g. bird point counts) will be conducted across study sites. These baseline conditions are important to fully evaluate the impacts of prescribed fire.

Summary Budget Information for Activity 1:	ENRTF Budget:	$ 54, 117
	Amount Spent:	$ 54, 117
	Balance:	$ 0

Outcome	Completion Date
1. *Up to 2000 acres (400 acres/site * 5 sites) surveyed for baseline conditions*	*October 2016*
2. *Up to 400 permanent monitoring plots established*	*October 2016*
3. *Dataset of plant communities at up to five sites compiled and analyzed*	*April 2017*

Activity 1 Status as of *January 25, 2017***:**

Five sites of approximately 400 acres in size were identified for inclusion in the study including Deer Run Wildlife Management Area (WMA), Aitkin WMA, Gerzin, Hasty Brook, and Highway 29 sites. Each site was divided into 100 acre parcels to be burned as treatments during Fall, Spring, and Summer, along with a control. In summer 2016, we surveyed most of the sites and burn units for woody and herbaceous vegetation and songbirds. In total, 569 point counts were conducted by four observers (185, 136, 144, and 104) at 160 points. Out of the 79 bird species detected, 20 were Species in Greatest Conservation Need including Le Conte's Sparrow, Swamp Sparrow, Sedge Wren, as well as large numbers of Warblers and Flycatchers. Vegetation sampling was conducted in two plots per sample point for a total of 320 vegetation plots. Eleven species of willow were identified, along with alder, birch, *Rubus* and *Ribes* species, and a highly diverse forbs, grass, sedge, and bryophyte community. We are finishing plant data entry and beginning initial analysis.

Activity 1 Status as of *January 18, 2018***:**

Field work is complete for this Activity. In 2017, we resurveyed all sites except Aiken for birds and all sites for vegetation. Data from 2016 have been entered checked for quality assurance/quality control (QA/QC) and have undergone preliminary analysis. Data from summer 2017 are entered and are undergoing QA/QC.

Activity 1 Status as of *August 26, 2018***:**

Data from summer 2017 are entered have been checked for QA/QC and are being analyzed. Data from summer 2018 are being entered and will undergo QA/QC in the fall.

Activity 1 Status as of *November 15, 2018***:**
We completed all baseline data collection in summer 2019 and all QA/QC.

Activity 1 Status as of *May 7, 2019***:**

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Results of baseline bird surveys are part of Chapter 1 of Annie Hawkinson's M.S. thesis (defense date March 28, 2019) and will be submitted soon for publication. Baseline vegetation data are part of Chapter 2 of Lori Knosalla's M.S. thesis (defense data June 9, 2019).

Activity 1 Status as of *January 22, 2020*:
Nothing to report.

Activity 1 Status as of *November 15, 2020*:
Nothing to report.

Activity 1 Status as of June 18, 2021:
Nothing to report.

Final Report Summary:

Outcomes. All three outcomes have been met. We surveyed 1600 acres across four sites for woody and herbaceous vegetation and songbirds. Each site was divided into four 100 acre parcels that were later burned (see Activity 2). In each 100 acre parcel, 8 permanent plots were established. Data were analyzed as part of two M.S. theses:

- Lori Knosalla (M.S. 2019, NRSM) Seasonal prescribed burning impacts to northern Minnesota lowland bursh ecosystem plant communities
- Annie Hawkinson (M.S. 2019, NRSM) The effect of season of prescribed fire on richness and abundance of breeding bird species and vegetation structure in Minnesota lowland brush ecosystems

Major findings. The most frequently detected woody species included *Cornus sericea*, *Alnus incana ssp. rugosa*, *Betula pumila*, and *Spiraea alba*. In addition, two species groups were common: (a) ericaceous shrubs, including *Rhododendron groenlandicum*, *Chamaedaphne calyculata*, *Kalmia polifolia*, *Andromeda polifolia*, *Vaccinium angustifolium* and *V. myrtilloides* and (b) willows, including *Salix petiolaris*, *S. discolor*, *S. pyrifolia*, *S. planifolia*, *S. serissima*, *S. bebbiana*, *S. pedicellaris*, *S. lucida*, *S. candida*, *S. humilis*, and *S. eriocephala*. Average total woody stem density across all burn and control units was 17.9 stems/m^2 ($\pm$ 0.611). Average stem density was greatest in the 0-0.5m height category (6.72 $\pm$ 0.507 stems/m2) and decreased with each increase in height category (Fig. 2-3). Across all units, average grass percent cover was 37.8 ($\pm$ 2.3), average forb percent cover was 43.6 ($\pm$ 3.3), and average sedge percent cover was 32.6 ($\pm$ 2.1).

We found that bird species richness was positively related to stem height diversity. Four of 10 most frequently detected bird species were positively associated with tall woody vegetation, including alder flycatchers (*Empidonax alnorum*), chestnut-sided warblers (*Setophaga pensylvanica*), veeries (*Catharus fuscescens*), and yellow warblers (*Setophaga petechia*). Chestnut-sided warblers were also positively associated with number of woody plant species. Only clay-colored sparrows (*Spizella pallida*) were positively associated with woody plant density. Sedge wrens (*Cistothorus platensis*), the most frequently detected species, were negatively associated with woody stem height, density, and the number of woody plant species, and positively associated with patchiness of woody stem density.

Significance and relevance to management. Our results are significant for several reasons. First, they set a baseline for our longitudinal study of prescribed burning impacts funded by a Phase II LCCMR grant. Second, they provide critical ecological information about a poorly studied ecosystem. We suggest that managing lowland brushlands to promote diverse woody plant structure, including tall shrubs and areas with open, herbaceous cover, by implementing temporally and spatially variable disturbance regimes will likely increase species richness and support lowland brushland specialists with a range of breeding habitat requirements.

ACTIVITY 2: Conduct prescribed burning and monitor vegetation response on 900 acres of brushland habitat in NE Minnesota

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Description: MN DNR partners will develop and seek approval for burn plans and conduct prescribed burns at three sites in each of three seasons: spring, summer and fall (nine burns total). Fires will be led and executed by MN DNR staff with fire training. To determine the initial impacts of the burns, we will measure duff layer depth, grass biomass, and shrub top-kill in assess fire intensity and coverage using permanent monitoring plots set up in Activity 1. This sampling will occur immediately following each burn. To determine the vegetation response to the burns, we will examine plant species composition including invasive species, and vegetation density and cover for the initial two years following treatment using ENTRF funds. In addition, wildlife surveys (e.g. bird point counts) will be conducted several times during the growing season in the study sites. Permanent plots will be censused after the period of this request by university partners and MNDNR.

Summary Budget Information for Activity 2:   ENRTF Budget: $ 196,140
                                                       Amount Spent: $ 196,140
                                                       Balance: $ 0

Outcome	Completion Date
1. Three hundred acres burned in spring, 300 in summer and 300 in fall	*November 2017*
2. Nine hundred acres surveyed for post-burn conditions	*November 2017*
3. Nine hundred acres surveyed for vegetation response to burning	*December 2019*
4. Dataset of fire effects and vegetation response compiled and analyzed	*December 2019*

Activity 2 Status as of *January 25, 2016***:**

Activity this period included developing burn plans and installing firebreaks in preparation for prescribed fires to be conducted as part of the collaborative study between the University of Minnesota and MNDNR Research. All Burn Plans for Fall Burn Treatments at the 5 study sites (Table 1) have been completed. Firebreaks for Fall Burn Treatments have been installed and firebreak installation has begun at 2 sites for Spring and Summer Treatments. At Gerzin, conditions were too wet to mow firebreaks in advance, so firebreaks were going to be wet tramped prior to the burn if conditions were conducive to burning. Conditions were not very favorable for burning this fall because of excessive moisture. One burn was conducted at Hasty Brook. Firebreak installation will continue during winter 2016-2017 in anticipation of upcoming treatments.

We conducted a partial post-burn vegetation survey of Hasty Brook but due to persistent snow cover after the burn, we complete post-burn vegetation surveys prior to green-up in spring.

Table 1. Summary of Activities to Date for the Season of Burning Study

Site Name	Burn Plans Completed to Date	Plans Still Needed by May 2017	Miles of Firebreaks Installed to Date	Firebreaks Completed for Fall Treatments	Firebreaks Started for Spring and Summer Treatments	Acres Burned
Deer Run WMA	2	1	7.5	Yes	Complete	0
Aitkin WMA	1	2	2.5	Yes	No	0
Gerzin	3	0	0	Yes	No	0
Hasty Brook	1	2	3.4	Yes	Yes	100
Highway 29	1	2	1.5	Yes	No	0
Totals	8	7	14.9	5 sites	2 sites	0

Activity 2 Status as of *January 19, 2017***:**

MNDNR Subcontract Burn Status Report. Since the study began, MNDNR has completed burns in all 3 seasons at 2 sites for a total of 6 burns. These burns occurred at the Highway 29 site and Hasty Brook site. At the Highway 29 site, 149 acres were burned in Spring 2017 (100%), 60 acres of 102 acres planned (59%) were burned in Summer 2017, and 60 acres of 126 acres planned (48%) were burned in Fall 2017. At the Hasty Brook site, 139 acres (~90%) were burned in Spring 2017, 40 acres of 91 acres (44%) planned were burned in Summer 2017, and 91 acres (100%) were burned in Fall 2016. Managers have reported that more open areas of brush and thatch burned successfully in all seasons, but that the fire doesn't carry as well through muskegs and dense brush when the vegetation is green. They attempted backing fires but they did not last long. We still hope to complete burns at Deer Run WMA and at the Gerzin site, but in conjunction with the PIs, have decided to drop Aitkin WMA from the study. The site poses numerous logistical challenges to completing surveys and data collection has been incomplete to date. Faced with larger than expected costs for seasonal help, removing Aitkin WMA from the study seemed a prudent call. Burns attempted at Deer Run WMA and Gerzin sites will be included in future reports. At Gerzin, ~0.4 mile of firebreak may need to be reinstalled along the north unit prior to a burn.

Table 2. Summary of Activities to Date for the Season of Burning Study

Site Name	Burn Plans Completed	Miles of Firebreaks Installed	Firebreaks Completed	Seasons Burns Completed	Acres Burned
Deer Run WMA	3 in 1 plan	7.5	Yes	0	0
Aitkin WMA	3 in 1 plan	3.4	Dropped	0	0
Gerzin	3 in 1 plan	5.0	Yes	0	0
Hasty Brook	3	5.0	Yes	3	270
Highway 29	3	4.3	Yes	3	269
Total (% complete)	9 (100%)	25.2 (98%)	5 sites (100%)	6 at 2 sites (67%)	539

Bird and Vegetation Sampling. All sites were resurveyed for birds and vegetation regardless of burn status. This included post-burn assessment of one fall burn and two spring burns.

Burn assessments. We conducted a series of burn assessments to determine the severity of each prescribed burn. These assessments include a survey of the number of aboveground woody stems that are killed by the fire, patchiness transects, and fuel consumption surveys using biomass collections and wooden dowels. The survey of killed stems is conducted at each permanent vegetation plot and includes stem counts in fixed height categories. Patchiness transects are established in a grid pattern throughout an entire burn section to assist in the determination of the burn extent and severity. Fuel consumption is measured via pre- and post-burn biomass collections and/or by pre-weighed wooden dowel arrays.

Activity 2 Status as of *August 26, 2018***:**

MNDNR Subcontract Burn Status Report. As part of the collaborative study between the University of Minnesota and MNDNR Research, 5 sites of approximately 400 acres were originally identified for the study. These sites included Deer Run Wildlife Management Area (WMA), Aitkin WMA, Gerzin, Hasty Brook, and Highway 29 sites. Each site was divided into ~100 acre parcels to be burned as treatments during Fall, Spring, and Summer, along with a control. The goal was to treat 3 of the 5 sites with prescribed fire in each of the 3 seasons. Since the study began, MNDNR has completed burns in all 3 seasons at 2 sites and burns in one season at two other for a total of 8 burns. These burns occurred at all sites except Aiken which has been dropped from the study. At the Highway 29 site, 149 acres were burned in Spring 2017 (100%), 60 acres of 102 acres planned (59%) were burned in Summer 2017, and 60 acres of 126 acres planned (48%) were burned in Fall 2017. At the Hasty Brook site, 139 acres (~90%) were burned in Spring 2017, 40 acres of 91 acres (44%) planned were burned in Summer 2017, and 91 acres (100%) were burned in Fall 2016. Gerzin was burned in spring 2018 and Deer Run WMA in both spring and summer 2018. Acreages TBD and will appear in our November report.

Table 1. Summary of Activities to Date for the Season of Burning Study

Site Name	Burn Plans Completed	Miles of Firebreaks Installed	Firebreaks Completed	Seasons Burns Completed	Acres Burned
Deer Run WMA	3 in 1 plan	7.5	Yes	2	TBD
Gerzin	3 in 1 plan	5.0 (2x)	Yes	1	TBD
Hasty Brook	3	5.0	Yes	3	270
Highway 29	3	4.3	Yes	3	269
Total (% complete)	9 (100%)	25.2 (98%)	5 sites (100%)	9 at 4 sites (75%)	539+

Bird and Vegetation Sampling. We resurveyed only sites burned prior to June 2018 for birds. We sampled vegetation at all four sites in all burn units.

Burn assessments. We conducted a survey of the number of aboveground woody stems that are killed by the fire for the spring burns. We were unable to complete patchiness transect at Deer Run due to excessively high water levels that made it too dangerous to work until late July. We discontinued fuel consumption surveys using biomass collections and wooden dowels. Analysis data from prior burns showed that results had very high variance such that no inferences could be gained from the data and the surveys were costly in terms of staff time.

Activity 2 Status as of *November 15, 2018***:**

To date, MNDNR has completed 10 burns at 4 sites. Since the last report, MNDNR completed 2 burns; 1 each at both Deer Run WMA and the Gerzin site. In addition, we have acreages for spring 2018 fires. At Deer Run WMA, approximately 72 acres of a 90 acre unit (80%) was burned in Spring 2018 and approximately 66.5 acres of a 95 acre unit (70%) was burned in Summer 2018. At the Gerzin site, approximately 95 of 100 acres (95%) were burned in Spring 2018 and 30 of 100 acres (30%) were burned in Fall 2018. Managers reported that rank standing grass burned well in the fall, but that grass under brush, brush, and ericaceous vegetation did not burn well. Notably, the fall burn site was quite wet from recent rain and snowfall in 2018.

Table 1. Summary of Activities to Date for the Season of Burning Study

Site Name	Burn Plans Completed	Miles of Firebreaks Installed	Firebreaks Completed	Seasons Burns Completed	Acres Burned
Deer Run WMA	3 in 1 plan	8.5	Yes	2	138
Aitkin WMA	3 in 1 plan	3.4	Dropped	0	0
Gerzin	3 in 1 plan	5.0 (2x)	Yes	2	125
Hasty Brook	3	5.0	Yes	3	270
Highway 29	3	4.3	Yes	3	269
Total (% complete)	9 (100%)	25.2 (98%)	5 sites (100%)	10 at 4 sites	802

Activity 2 Status as of *May 7, 2019***:**

Since the last report, the team has focused on analyzing data collected to date and planning for Summer 2019. One graduate student thesis (bird results) was completed March 28, 2019. Two papers are in preparation for submission to research journals. Another graduate student (vegetation and fire) will complete in June 2019.

Activity 2 Status as of *January 22, 2020***:**

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One graduate student (vegetation and fire) completed M.S. thesis June 9, 2019. We conducted a survey of the number of aboveground woody stems that were killed by fire at Deer Run WMA and Gerzin sites. We surveyed birds in June 2019 at Deer Run and Gerzin. We sampled vegetation response at all four sites in Summer 2019. We are currently added 2019 data to our analyses.

Activity 2 Status as of *November 15, 2020***:**
We surveyed birds in June 2020 at Hasty Brook and Highway 20. We sampled vegetation response at Hasty Brook and Highway 29 in Summer 2020. We are currently added 2020 data to our analyses.

Activity 2 Status as of June 16, 2021:
Nothing to report

Final Report Summary:

Outcomes. In general, all three outcomes have been met. We burned 802 total acres across four sites (Table 1). This is slightly less than our target (900 acres) due in part to peatland patches embedded within our burn units. Due to risk associated with peat fires, these areas were excluded from burning. We conducted four spring, three summer and three fall burns across the four sites. Due to logistics and lack of appropriate fire conditions, two sites have only two seasons represented (Table 1).

Table 1. Summary of Burn Activities the Season of Burning Study

Site Name	Burn Plans Completed	Miles of Firebreaks Installed	Firebreaks Completed	Seasons Burns Completed	Acres Burned
Deer Run WMA	3 in 1 plan	8.5	Yes	2	138
Gerzin	3 in 1 plan	5.0 (2x)	Yes	2	125
Hasty Brook	3	5.0	Yes	3	270
Highway 29	3	4.3	Yes	3	269
Total (% complete)	9 (100%)	29.8 (100%)	5 sites (100%)	10 at 4 sites	802

Data were analyzed as part of two M.S. theses:
- Lori Knosalla (M.S. 2019, NRSM) Seasonal prescribed burning impacts to northern Minnesota lowland bursh ecosystem plant communities
- Annie Hawkinson (M.S. 2019, NRSM) The effect of season of prescribed fire on richness and abundance of breeding bird species and vegetation structure in Minnesota lowland brush ecosystems

Major findings for the plant community. We focused on the impacts of burn season on burn severity and the plant community in the first growing season after the burns were conducted, and include the results of four spring burns, two fall burns, and two summer burns. Although another fall and summer were conducted under the grant they were in the final year so there is no vegetation or bird data for those two burn units. Those data will be collected in Phase II.

While found that burn severity and plant community response differed among burn season treatments, our findings varied by spatial scale. Burns conducted in the spring burned more area those in fall or summer. Given that more area burned in spring compared to fall or summer, we examined the impacts of burn season at different scales to consider broad landscape scale impacts (burn unit scale) and direct fire impacts (plot scale). Burn unit scale included analysis of all permanent sample plots within each burn unit regardless of whether there was evidence of fire at the plot, and at the plot scale we included only on sample plots where evidence of fire was present. Additionally, we broke down the direct fire impacts at the plot scale to look at impacts on common woody plant species and species groups.

At the burn unit scale, spring burns were the most severe, resulted in the highest amounts of topkilled woody stems, and the overall greatest reduction in woody plant density even though vigorous resprouting was

likely occurring (Figure 1) . At the plot scale, burn severity did not differ among burn seasons, but spring burns still resulted in an overall reduction in woody stems while fall and summer burns did not (Figure 2). Furthermore, woody species varied in their response to burn season with some species appearing to resprout prolifically and others not as much, while herbaceous cover did not change as a result of fire compared to the control units.

Figure 1. Number of topkilled stems (stems/m^2) for prescribed burns executed in three different seasons. Results are at the burn unit scale and reported in least square means and standard errors. Lowercase letters indicate significant pairwise differences between burn seasons among survived stems and among topkilled stems. Sample size (*n*) identifies the number of permanent sample plots included in model for fixed factor (Season). At burn unit scale, all plots were included regardless of the presence fire.
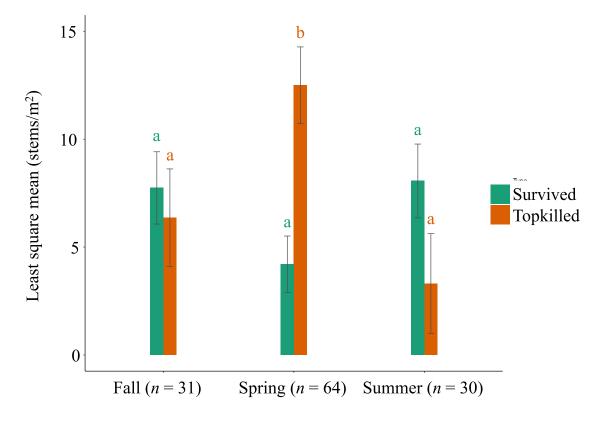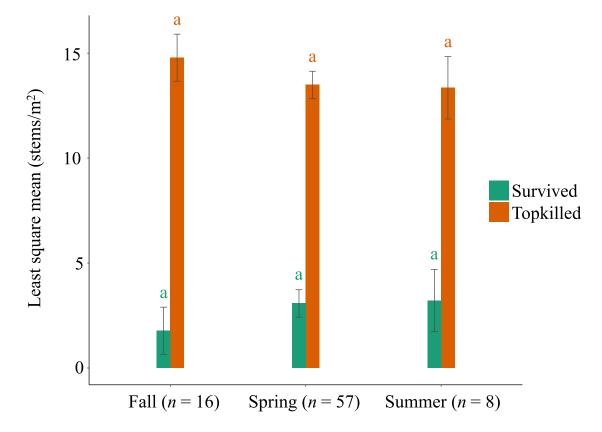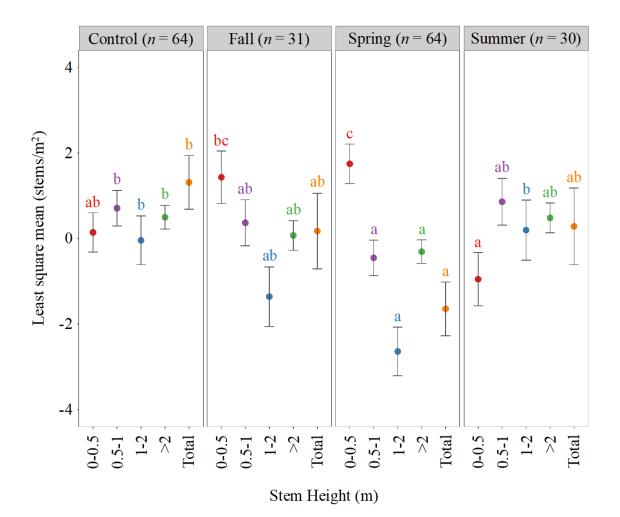
Figure 2. Number of topkilled stems (stems/m^2) for prescribed burns executed in three different seasons. Results are at the plot scale and reported in least square means and standard errors. Lowercase letters indicate significant pairwise differences between burn seasons among survived stems and among topkilled stems. Sample size (*n*) identifies the number of permanent sample plots included in model for fixed factor (Season). At plot scale, plots were only included where evidence of fire was detected post-burn.
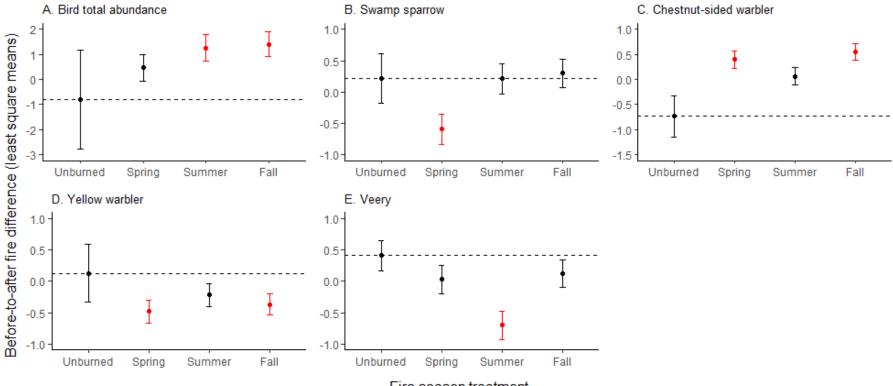

At the burn unit scale (all sample plots included in the models regardless of the presence of fire), we found significant changes in stem density across all height categories for spring burns compared to the control (Figure 3). Overall, total stem density (sum of stems/m^2 in all height categories) increased in the control units, decreased following spring burns, and did not change following fall or summer burns. Measures in total stem density masked changes within height categories that often went in opposing directions.

Figure 3. Change in woody stem density (stems/m^2) for prescribed burns executed in three different seasons and control unit where no burn occurred. Results are at the burn unit scale and reported in least square means and standard errors. Lowercase letters indicate significant pairwise differences among change in stem density in height categories between the control and burn seasons. Sample size (*n*) identifies the number of permanent sample plots included in model for fixed factor (Season). At burn unit scale, all plots were included regardless of the presence fire.

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Major findings for the bird community. We used a Before-After-Control-Impact experimental design to evaluate the magnitude in change in response to spring, summer, and fall fire treatments of the same bird and vegetation variables assessed in Activity 1. This allowed us to determine vegetation characteristics that are important to breeding birds and how the responses of birds and plants relate to season of fire. Stem height and stem height diversity, which was a measure of vertical structural diversity, were related to the most frequently detected bird species and bird species richness. Although these vegetation variables did not respond significantly to spring, summer, and fall fire treatments compared to controls, they exhibited decreasing trends after fires. Additionally, changes in stem height were nearly statistically significant. Veery and yellow warbler (*Setophaga petechia*) decreased in abundance after summer (veery) and spring and fall (yellow warbler) season treatments and were related to stem height in baseline explanatory models (Figure 4de). We posit that these species decreased in abundance due to decreases in stem height. In contrast, chestnut-sided warblers (*Setophaga pensylvanica*) increased in abundance after spring and fall fires (Figure 4c). This species was also related to stem height and the number of woody plant species. Therefore, chestnut-sided warblers may have been responding to additional changes in vegetation from fire and notably, chestnut-sided and yellow warblers exhibited opposite responses to the same fire seasons even though these species exhibit similar life history traits. Bird total abundance increased after summer and fall fires, the two seasons when prescribed fires are not typically conducted in the Upper Midwest. In our explanatory baseline models, the null model best explained bird total abundance and so although we were unable to relate this response to vegetation measurements, we suggest this response be considered in future management.

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Figure 4. Bird response variables (panels A–E) that changed significantly after fire. Dots and lines represent least square means of response variable data (post-fire – pre-fire means) ± SE. Dotted lines are placed at the unburned value, rather than 0, to better observe differences from unburned sections that changed due to yearly and study site patterns unrelated to treatment. Red indicates a significant difference between fire season treatment and unburned, controls at α = 0.05. Graphs show data from bird total abundance (A), and abundances of swamp sparrow (B), chestnut-sided warbler (C), yellow warbler (D), and veery (E) per point-count location.

Significance and relevance to management. Our results indicate that spring burns were the most successful at reducing woody stem density one year after burn. However, reduction in woody stem density may not be the only management objective. Our results also suggest that spring burns create a uniform understory of shrub regeneration, which may reduce heterogeneity on the landscape. Recent research suggests that high severity burns, which create a single cohort of regenerating woody shrubs, reduce habitat quality for the bird community (Zlonis et al., 2019). Thus, natural resource managers should view fire season as a tool for supporting a variety of outcomes in lowland brush ecosystems. Based on our results and the diversity of responses to spring, summer, and fall fire seasons, conducting prescribed fires during different seasons may support different breeding bird species. The overall breeding bird community may also benefit, especially if prescribed fire is implemented during the summer when plants are growing. Adding summer burns to disturbance management-regimes that are often restricted to the spring in lowland brush ecosystems may also provide managers with larger burn-windows.

ACTIVITY 3: Develop a manager's guide for brushland habitat

Description: To promote incorporation of findings of this study into management, we will present a webinar to brushland managers and landowners to describe the vegetation and wildlife response to prescribed fire in our study, following which we will host a workshop for DNR staff and other stakeholders to design a brushland prescribed fire best management practices (BMP) document and management guide. The goal of these efforts is to develop recommendations for restoring and maintaining diverse brushland habitat for non-game and game wildlife species.

Summary Budget Information for Activity 3: **ENRTF Budget:** $ 16,743
Amount Spent: $ 16,473
Balance: $ 0

Outcome	Completion Date
1. *Webinar for brushland managers and landowners on vegetation response to prescribed fire in different seasons (spring, summer and fall)*	*January 2020*
2. *Workshop with DNR staff and stakeholders to develop best management practices for using prescribed fire for brushland habitat management*	*March 2020*
3. *Management guide for using prescribed fire to maintain brushland habitat*	*June 2020*

Activity 3 Status as of *January 25, 2017***:**

Nothing to report.

Activity 3 Status as of *January 19, 2017***:**

Nothing to report.

Activity 3 Status as of *August 26, 2018***:**

Nothing to report.

Activity 3 Status as of *November 15, 2018***:**

Nothing to report.

Activity 3 Status as of *May 7, 2019***:**

We have begun developing presentations that will form part of the final part of the project webinars and workshops. We gave two presentations to regional forest and wildlife managers: webinar through the Lake States Fire Science Consortium (January 2019) and oral presentation at the MN Society of American Foresters and The Wildlife Society MN Chapter joint meeting (February 2019). We have been invited to present at the Sharp-tailed grouse conference.

Activity 3 Status as of *January 22, 2020***:**
We gave two presentations to regional forest and wildlife managers: presentation at the Sharp-tailed grouse conference (September 2019) and a presentation at the Sustainable Forests Education Cooperative Forestry and Wildlife Research Review (January 2020). We are currently planning a workshop with DNR staff involved in brushland management.

Activity 3 Status as of *November 15, 2020***:**
We held a workshop with DNR staff involved in brushland management. Discussion from that meeting is guiding completion of a final report and guide for brushland management practices.

Activity 3 Status as of June 16, 2021:
We continue to work on a the final report that includes guide for brushland management practices.

Final Report Summary:

Outcomes. Two of the three outcomes were met for this Activity. We gave ten presentations at a variety of venues including professional forest and wildlife meetings, a research review aimed at land managers and a workshop specifically focused on fire in local ecosystems. This addressed our first outcome for this activity: *Webinar for brushland managers and landowners on vegetation response to prescribed fire in different seasons (spring, summer and fall).* We held one workshop with management staff to address our section outcome: *Workshop with DNR staff and stakeholders to develop best management practices for using prescribed fire for brushland habitat management*. Emerging from that workshop were calls to compile information on the actual burn conditions, collect data on the outcomes beyond the first/second year and use those as well as anecdotal information from agencies managing brushlands to develop the management guide. COVID-19 curtailed efforts of further engagement with land managers and also led to higher costs for field work related to getting data on responses beyond years ½ that meant that we didn't have funds to support analysis of data beyond years 1 & 2 or creating a draft of a management guide. As such, our third outcome, *Management guide for using prescribed fire to maintain brushland habitat*, was not fully met. We have been granted Phase II. Phase II includes completion of the management guide based on more engagement with practitioners and extended four year results. Thus, we envision that our combined projects will meet this final outcome.

V. DISSEMINATION:
Description: Results of this study will be presented at local, regional, and national meetings (e.g. Sustainable Forests Education Cooperative Annual Research Round-up, The Wildlife Society). Findings will be published in peer-reviewed journals, in outreach newsletters (e.g., the Lake States Fire Science Consortium), and posted annually on the Minnesota Department of Natural Resources (MN DNR) website in the Summaries of Wildlife Research Findings section found at http://www.dnr.state.mn.us/publications/wildlife/index.html. Project description and results will also be available through websites of the University of Minnesota's Department of Forest Resources (http://www.forestry.umn.edu/)and Center for Forest Ecology (http://cffe.cfans.umn.edu/).

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Research will form the basis of an M.S. thesis that will be publically available through the University of Minnesota.

As described in Activity 3, webinars and workshops aimed at developing BMP and management guidelines also disseminate results. BMP and management guidelines will be made publically available on the MN DNR website (http://www.dnr.state.mn.us) and in paper form when requested.

Status as of *January 25, 2017*:

Nothing to report.

Status as of *January 19, 2018*:

Annie Hawkinson presented at the following meetings: The Wildlife Society MN Chapter, February 14-16 2017, Graduate Student Poster; The Wildlife Society Annual Conference, September 23-27 2017, Student Research in Progress Poster. Lori Knosalla presented at the following: UMN Natural Resources Association of Graduate Students Symposium, April 14, 2017; UMN Natural Resources Seminar, November 29, 2017

Status as of *August 26, 2018*:

Nothing to report.

Status as of **November 15, 2018**:

Nothing to report.

Status as of *May 7, 2019*:

We have given a number of presentations on the work at professional meetings and to regional stakeholders. Some are from earlier reporting periods that we forgot to report.

Hawkinson, A., R. Montgomery, L. Frelich, C. Roy and L. Shartell. Avian and plant communities in disturbance-dependent brushlands. The Wildlife Society MN Chapter, Brainerd, MN. February 2018

Montgomery, R.A. Prescribed burning to improve management for brushland dependent species. Lake States Fire Science Center Intern Project Webinar. January 25, 2018

R. A. Montgomery, A. Hawkinson, L. Knosalla, C. Roy, L. Frelich, and L. Shartell. The effect of season of prescribed fire on breeding bird and plant communities in Minnesota lowland brush ecosystems. MN Society of American Foresters and the Wildlife Society MN Chapter joint meeting, Duluth, MN. February 2019

Montgomery, R.A. Prescribed burning to improve management for brushland dependent species new updates. Lake States Fire Science Center Intern Project Webinar. March 25, 2019

Status as of *January 22, 2020*:

Montgomery, R. A., A. Hawkinson, L. Knosalla, C. Roy, L. Shartell and L. Frelich. The effect of season of prescribed fire on breeding bird and plant communities in Minnesota lowland brush ecosystems. Sustainable Forests Education Cooperative Forestry and Wildlife Research Review. January 9, 2020.

Status as of *November 15, 2020*:

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Montgomery, R. Prescribed burning (and seasonal effects) to improve management for brushland dependent species. Fire in Minnesota Ecosystems Workshop. January 29-30, 2020

We held a workshop with management staff but COVID-19 has curtailed other dissemination efforts.

Status as of June 19 2021:
Nothing to report

Final Report Summary:

We gave 10 presentations at a variety of venues including professional forest and wildlife meetings, a research review aimed at land managers and a workshop specifically focused on fire in local ecosystems. We held one workshop with management staff but COVID-19 curtailed more interactive efforts to disseminate our work to relevant stakeholders. We have been granted Phase II funding and will be able to complete more engagement with practitioners around our extended 4 year results. This Phase I project only covers first/second year results due to the timeline for implementation of burn treatments.

VI. PROJECT BUDGET SUMMARY:
A. ENRTF Budget Overview:

Budget Category	$ Amount	Overview Explanation
Personnel:	$204,472	1 project manager at 2% FTE ($12,286), 1 field coordinator at 8% FTE ($34,295) and one undergraduate at 25% FTE ($30,000) for 4 years; 1 project staff (graduate student, post-doctoral research associate or staff scientist) at 25% FTE years 1&2 and 50% FTE years 3&4 ($127,891).
Professional/Technical/Service Contracts:	$34,481	Contract with MN DNR to conduct burning.
Equipment/Tools/Supplies:	$ 2,958	Notebooks for field data collection, flags and rebar for plot marking, GPS for plot locations
Capital Expenditures over $5,000:	$ 0	
Fee Title Acquisition:	$ 0	
Easement Acquisition:	$ 0	
Professional Services for Acquisition:	$ 0	
Printing:	$ 0	
Travel Expenses in MN:	$25,089	Travel for natural resource manager workshops and fieldwork.
Other:	$ 0	
TOTAL ENRTF BUDGET:	**$ 267,623**	

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than $5,000: N/A

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 2.9 FTE

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: 1 FTE

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B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
State			
MNDNR: Dr. Charlotte Roy and Dr. Lindsey Shartell (5% time each, 4 years)	$34,159	$34,159	DNR staff time will be used as in-kind support
MNDNR: Additional staff time for burns	$13,500	$13,500	In-kind support
University of Minnesota, in-kind	$95,056	$95,056	Unrecovered indirect costs at 52% of modified direct cost base $182,800.
Lake States Fire Science Consortium Intern Grant	$0	$24,000	This supported a summer intern in 2017 and 2018 and 2020.
TOTAL OTHER FUNDS:	**$142,715**	**$166,715**	

VII. PROJECT STRATEGY:

A. Project Partners:

➢ Dr. Rebecca Montgomery (UMN-TC, Department of Forest Resources), overall management responsibility for project team and co-advise graduate student, staff scientist or technician

➢ Dr. Lee Frelich (UMN-TC, Department of Forest Resources), coordinate day-to-day activities and mentor research staff

➢ Charlotte Roy (MNDNR) and Lindsey Shartell (MNDNR), provide expertise on habitat characteristics for wildlife, coordinate prescribed burning with MNDNR field staff

All team members will collaborate on Activity 3, translating research to action.

B. Project Impact and Long-term Strategy:

Prescribed fire has become an important wildlife management tool to incorporate natural disturbance in a controlled way on the modern landscape. Yet, prescribed burns can be difficult to implement under many conditions (e.g., too wet, windy, dry) and require many people to execute safely. Currently, most prescribed burns executed by the MNDNR are conducted in the spring due to greater staff availability, larger burn windows, longer days, and more favorable fire and smoke conditions. Yet, managers indicate anecdotally that the woody response to burning is better during late summer and early fall, when vegetation is not dormant. Furthermore, spring fire top kills brush only, leaving energy in the roots resulting in suckering. Species resistant to or enhanced by spring fires are inadvertently favored by the current burning regime and species that benefit from fires at other times of year may be neglected. Our project will improve our understanding of how the season of burning influences brushland vegetation response and thus wildlife habitat. If vegetation responses differ among seasons in brushlands as they do in other ecosystem types, then wildlife managers may need to consider incorporating summer and fall burns into their management practices. This study will provide data to support a change in practices, if needed. Many wildlife species, both game and non-game species, rely on brushland habitats. Understanding how the season of management influences the vegetation response will help the DNR be more effective in maintaining these habitats.

The project will have practical utility by providing data and guidelines that will support management actions that keep brushland habitat healthy by mimicking historical patterns of fire. The management guidelines and BMPs developed from this study will guide future management of brushland habitats across Minnesota. By continuing

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to make these resources available to land managers the results of this study will have long-term impacts on management practices.

Permanent monitoring plots established at the study sites will allow university partners and MNDNR to conduct vegetation surveys to track responses to treatment into the future (e.g. 5-10 yr response). The treated sites will continue to be managed as open brushland habitat and future treatments could also be assessed and compared to the study results.

C. Funding History: N/A

VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS:

A. Parcel List: N/A

B. Acquisition/Restoration Information: N/A

IX. VISUAL COMPONENT or MAP(S): see attached

X. RESEARCH ADDENDUM: see attached (to be submitted December 11, 2015)

XI. REPORTING REQUIREMENTS:
Periodic work plan status update reports will be submitted no later than *November 30, 2016*; *April 15, 2017*; *November 30, 2017*; *April 15, 2018*; *November 15, 2018*; *April 15, 2019*; *November 15, 2019*; *April 15, 2020, November 15, 2020 and April 15, 2021*. A final report and associated products will be submitted between June 30 and August 15, 2021.

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Environment and Natural Resources Trust Fund
M.L. 2016 Final Project Budget

Project Title: Evaluate Prescribed Burning Techniques to Improve Habitat Managemen
Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 08d
Project Manager: Rebecca A. Montgomery
Organization: University of Minnesota
M.L. 2016 ENRTF Appropriation: $ 267,000
Project Length and Completion Date: 5 Years, June 30, 2021
Date of Report: December 7, 2021

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Revised Activity 1 Budget 9/22/2017
BUDGET ITEM	*Document curren brushland habita*
Personnel (Wages and Benefits)	$46,319
Rebecca Montgomery, Project manager, $12,286 (66% salary, 34% fringe), 2 % FTE all years	
Lee Frelich, Field coordinator, $34,295 (66% salary, 34% fringe), 8 % FTE all years	
1 Research staff member, $127,891 (57% salary, 43% benefits), 25% FTE Years 1 & 2, 50% FTE Years 3 & 4	
1 undergraduate student or field technician, $30,000 (100% salary), 25% FTE all years	
Professional/Technical/Service Contracts	
Contract with MN DNR to conduct burning. $65/acre * 900 acres in central and NE MN	
Equipment/Tools/Supplies	
Notebooks for field data collection, flags and rebar for plot marking, GPS for plot locations	$1,958
Travel expenses in Minnesota	
Travel for natural resource manager workshops: 1 year * 1 workshops * 5 persons * 1 d * (mileage [250 mi/workshop*0.575 cents/mile] + per diem [$82 lodging + $56 M&I])	
Travel for field work: up to 60 days/year (100 mi/d) of vehicle rental or personal mileage reimbursement, whichever is least costly $7100; ~50d/year housing at Cloquet Forestry Center at 17/d = $2500	$5,840
COLUMN TOTAL	**$54,117**

t for Brushland Species

Amount Spent	Activity 1 Balance	Revised Activity 2 Budget 6/10/2019	Amount Spent	Activity 2 Balance
nt conditions on 2000 acres of *t in NE Minnesota*		*Conduct prescribed burning and monitor* *vegetation response on 900 acres of brushland* *habitat in NE Minnesota*		
$46,319	$0	$142,819	$142,819	$0
		$34,481	$34,481	$0
$1,958	$0	$1,000	$1,000	$0
$5,840	$0	$17,840	$17,840	$0
$54,117	**$0**	**$196,140**	**$196,140**	**$0**

Activity 3 Budget	Amount Spent	Activity 3 Balance	Revised Total Budget 6/10/2019	TOTAL BALANCE
Develop a manager's guide for brushland habitat				
$15,334	$15,334	$0	$204,472	$0
			$34,481	$0
			$2,958	$0
$1,409	$1,409	$0	$1,409	$0
			$23,680	$0
$16,743	**$16,743**	**$0**	**$267,000**	**$0**

12/13/2021