Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2015 Work Plan

Date of Report: October 15, 2014

Date of Next Status Update Report: January 1, 2016

Date of Work Plan Approval:

Project Completion Date: June 30, 2018

Does this submission include an amendment request? __

PROJECT TITLE: Effects of Grazing Versus Fire for Prairie Management

Project Manager: Karen Oberhauser

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Location: Statewide

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$414,000**
	Amount Spent:	**$0**
	Balance:	**$414,000**

Legal Citation: M.L. 2015, Chp. 76, Sec. 2, Subd. 03o

Appropriation Language:
$414,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to compare the effects of conservation grazing and prescribed fire on tallgrass prairie plants and pollinators in Minnesota in order to inform and improve land management practices. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Effects of Grazing Versus Fire for Prairie Management

II. PROJECT STATEMENT:

Minnesota's tallgrass prairies depend on disturbance (e.g., fire, grazing, drought), without which they would rapidly transition to woodland and forest. Drought alone will not maintain prairies in Minnesota, so land managers use prescribed fire and "conservation grazing" (the use of grazing by domestic animals to achieve conservation goals) to preserve prairie plant communities and the many pollinators, birds, and mammals that depend on them. Although effects of fire on northern tallgrass prairies are well documented, there are *no* studies of the effects of conservation grazing on Minnesota prairies in the published literature, and gradients in temperature and precipitation make extrapolation from studies to the west and south of Minnesota risky. Yet, because prescribed fires are expensive, require significant personnel numbers and time, can only be completed during specific windows of time, and may have negative effects on some pollinators, managers have turned to conservation grazing, *despite its unknown consequences.* The study proposed here aims to address this knowledge gap, taking advantage of existing prairies with known management histories.

Our primary goal is to conserve and enhance Minnesota's tallgrass prairies by providing the tools necessary for federal, state, local, and private land managers to be effective stewards of prairie plant communities and the pollinators and other animals that depend on them. We will accomplish this goal by through biological monitoring (of both plants and pollinators), and dissemination of our findings.

First, we will identify Minnesota prairies that meet our criteria for having known management histories, and including both burning and grazing management strategies. Fortunately, Minnesota is home to thousands of acres of prairies with a wide variety of known management histories. We will work with the land management community to identify prairie tracts that have been managed predominantly with fire or predominantly with grazing throughout the tallgrass prairies of Minnesota.

We will then assess the effects of grazing intensity and prescribed fire on native plant species richness and diversity and the prevalence of invasive grasses in at least 75 prairies. Because of their potential effects on vegetation, we will also measure rates of nitrogen cycling, soil characteristics, and surrounding land use. All prairies will be assessed for vegetation cover in year one, and a subset resampled in year two. We will also assess the direct and indirect effects of grazing and fire on pollinator species richness (native bees and butterflies), because pollinating insects are sensitive to both management (direct effects) and plant species composition (indirect effects). We will use field surveys and observation transects designed to provide detailed information on the diversity and abundance of solitary bees, bumble bees, and butterflies. These surveys will be conducted during both summers at a random sample of the 75 prairies, using sampling intervals that will account for differences in insect flight times. The attached figure illustrates potential pathways of direct and indirect effects of management on key prairie characteristics; our research will allow us to evaluate the relative importance of these pathways.

Finally, we will compile our findings and disseminate them to land managers using a variety formats, with the goal of providing unbiased information on the implications of fire and grazing for Minnesota's tallgrass prairies. The ultimate outcome of this work will be a well-informed management community that will understand the relative and varying effects of fire and conservation grazing on Minnesota's prairie resources.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of *January 2016***:**

Project Status as of *July 2016***:**

Project Status as of *January 2017***:**

Project Status as of *July 2017***:**

Project Status as of *January 2018***:**

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES: Overview. Site and graduate student selection will begin in July 2015, or when funds are secured. Research will be conducted over two field seasons. Field teams will be hired in March 2016, and field work will occur during the 2016 and 2017 growing seasons (May – September), with insect identification and statistical analysis during the subsequent fall, winter, and spring seasons. All dissemination vehicles (reports, manuscripts, website and workshops) will be completed by June 2018.

ACTIVITY 1: Identify prairie tracts, collect management histories, assemble GIS layers in preparation for field work.

Description: Because the effects of land management on perennial vegetation can take years to become evident and are in part dependent on variation in abiotic factors, we are using a retrospective approach to assess the relative effects of management by grazing versus fire on tallgrass prairies, prairie dependent pollinators and butterflies, and invasive grasses. The Minnesota DNR, The Nature Conservancy, and the US Fish and Wildlife Service all include conservation grazing and fire in their prairie management strategies and all have expressed a willingness to allow us to study these prairies. During the first 6 months of the project, we will compile a list of prairies from these sources and determine which have complete management histories for at least the past 10 years, with the goal of identifying 75 prairies (see spatial range of our potential study sites in figure 1), approximately half of which have been predominantly managed via grazing and half via fire. Both fire and grazing may be applied in various ways, and these must be taken into account in evaluating their effects. We will gather the following management information about these sites: the years and seasons in which the management was applied, the fire conditions (wind and humidity) on the day of a fire, and the number of animals and length of time they grazed in a given area (animal-unit month, or aum, defined as one 1000-lb cow grazing for 1 month). Additionally, precipitation prior to, during, and following the management action will help us evaluate the fuel load available for a fire or forage available for grazers and the potential for vegetation to recover following a management action.

For each prairie, we will compile landscape information including size; distance and connectivity to nearest remnant; soil types within the prairie boundaries; proportion of prairie, cropland, pasture, Conservation Reserve Program, wetland, riparian, or other land uses in a 10-km wide buffer around the prairie; and mean temperature and total precipitation during each growing season over the past 10 years.

Summary Budget Information for Activity 1:

ENRTF Budget: $ 50,000
Amount Spent: $ 0
Balance: $ 50,000

Outcome	Completion Date
1. GIS map layers for each prairie tract	May 2016
2. Spreadsheet of management actions and dates for each prairie tract	May 2016

Activity Status as of *January 2016***:**

Activity Status as of *July 2016***:**

Activity Status as of *January 2017***:**

Activity Status as of *July 2017***:**

Activity Status as of *January 2018***:**

Final Report Summary:

ACTIVITY 2: Compare effects of grazing and fire on native plant species richness and composition and abundance of invasive grasses (Kentucky bluegrass (*Poa pratensis*), reed canary (*Phalaris arundinacea)*, smooth brome (*Bromus inermis*).

Description: Using the prairies identified in Activity 1, we will conduct surveys to assess native plant species richness (both forbs and grasses), and exotic grass cover. The prairies we sample will vary in size, perhaps substantially. Because we want to compare species richness, which increases with area sampled, yet we do not want to miss rarer species, we will use a two-tiered approach. First, we will conduct prairie surveys during June - September to estimate vegetative cover by species and total species richness of vegetation. We will stratify our sampling so that all potential vegetation types (wet, mesic, and dry) are sampled. In addition to the random transects, a time-constrained botanist-directed walk will be done at each polygon to search for plant species not found in the transect plots. This will yield a more complete species list than the random design for assessing presence of uncommon or rare species. Within each polygon we will collect and combine three soil samples collected at random points to assess soil nitrogen dynamics. We will conduct vegetation surveys at least once at all of the prairies over the two field seasons, with surveys repeated on a random subset of 25% in both years to assess variation due to sample year; dramatic changes in species composition are not expected, but there may be differences in detection of some rarer species. These data will allow us to relate native plant species richness and abundance of invasive grasses to management history and grazing intensity, while taking into account nitrogen dynamics, and soil and landscape characteristics. We hypothesize that there will be a strong relationship between management strategies and the plant composition of the prairie tracts.

Summary Budget Information for Activity 2:

ENRTF Budget:	**$ 182,000**
Amount Spent:	**$ 0**
Balance:	**$ 182,000**

Outcome	Completion Date
1. Preliminary analysis of first field season completed; status report sent to cooperators.	May 2017
2. Data analysis from both field seasons completed	December 2017
3. Information dissemination via web site, workshops, and fact sheet	June 2018

Activity Status as of *January 2016***:**

Activity Status as of *July 2016***:**

Activity Status as of *January 2017***:**

Activity Status as of *July 2017***:**

Activity Status as of *January 2018***:**

Final Report Summary:

ACTIVITY 3: Compare effects of grazing and fire on pollinator species richness.

Description: We will conduct bee and butterfly surveys on a subset of 20 randomly-selected prairies (10 with primarily fire and 10 with primarily grazing management histories) which will be sampled in both years, due to known year-to-year variation in insect abundance and species composition.

Bees will be surveyed in two ways, passively via bowl and glycol traps, and actively, via netting. We will conduct these surveys three times per summer (June 1-August 31) at each of the 20 sites. We will use standard 3.25 oz plastic bowls in three colors (white, yellow, and blue) placed at 5-m intervals along the same transects as used for the vegetation surveys (above). The bowls will be filled with soapy water, placed on the ground, and left in place for 24 hours. All insects captured on a transect will be placed in a single whirlpack bag and kept in a cooler until they can be dried and pinned. Glycol traps, which can be left out for a week or more at a time, will be deployed in concert with the butterfly "citizen science" surveys described below and will allow us to expand our number of sampled sites. Pollinators also will be netted during time-constrained walks through each polygon (described above). These insects will be placed individually into glassine envelopes and the flower species upon which they were captured, the site, and the date will be recorded on the envelope. Envelopes will be placed in kill

jars charged with ethyl acetate, except for bumblebees, which can be identified in the field and released. Insects will be pinned and the information on the envelope will be transcribed and linked to the specimen by an ID number.

Butterflies can usually be identified non-destructively, so we will assess their presence and abundance in specific survey locations, using the transects identified for the vegetation surveys and conducting the surveys during the same visits that we survey the solitary bees (confining our surveys whenever possible to days that are at least 70 °F and with low wind). We use protocols adapted from those proposed by Pollard (1977), and used by several North American Butterfly Monitoring Networks (see www.nab-net.org). Briefly, observers walk the transect and record all butterflies seen within 6 meters of the census route. When necessary, butterflies will be netted for identification, and released. When feasible, we will work with existing or new citizen science programs (e.g., those organized by the North American Butterfly Association, Bumble Bee Watch, and the Minnesota Bee Atlas currently being considered by the LCCMR for 2015 funding) to engage the public in our butterfly and bee surveys, after training them in survey protocols and identification. This engagement will both increase our capacity to conduct these time-consuming surveys (and perhaps allow us to add more survey sites in the second year), and will result in more dissemination. Our analyses will allow us to assess both the indirect effects of management on pollinator communities (through effects on the plant communities) and direct effects (e.g., killing some insects during burns, disturbance by grazing or mowing). We hypothesize the indirect effects will be greatest, but that high fire frequency or grazing intensity could have direct effects on pollinator diversity and abundance.

Summary Budget Information for Activity 3:

ENRTF Budget: $ 182,000
Amount Spent: $ 0
Balance: $ 182,000

Outcome	Completion Date
1. Preliminary analysis of first field season completed; status report sent to cooperators.	May 2017
2. Data analysis from both field seasons completed; list of pollinator species sent to cooperators	December 2017
3. Information dissemination via web site, workshops, and fact sheet	June 2018

Activity Status as of *January 2016***:**

Activity Status as of *July 2016***:**

Activity Status as of *January 2017***:**

Activity Status as of *July 2017***:**

Activity Status as of *January 2018***:**

Final Report Summary:

V. DISSEMINATION:

Description: Our deliverables will include 1) written materials, 2) a website, and 3) workshops. Written materials will be targeted to both managers and the general public in the form of manuscripts in the published literature and a management-oriented fact sheet that will be disseminated at workshops, through partners, and via a project website. The website will be hosted on the University of Minnesota Extension website, and linked to the Northern Prairie Wildlife Research Center, as well as to relevant butterfly and bee citizen science projects. We will highlight the engagement of the citizen scientists when relevant.

Many organizations in Minnesota work on prairie conservation, and we will use our connections with these organizations (including Minnesota chapters of The Wildlife Society and The Prairie Enthusiasts, the Nature

Conservancy, the Minnesota DNR, and the US Fish and Wildlife Service) to plan and conduct at least 3 workshops for interested land managers throughout the state in late 2017 and early 2018). At these workshops, we will provide managers with a framework for designing a disturbance regime that will achieve their management goals for prairie plant and pollinator diversity. While our research will focus on remnant prairies, our findings will also be relevant to management of restored prairies, and we will thus not limit dissemination to managers of remnant prairies. By soliciting managers' input during site selection, we can capitalize on their continued interest and involvement in the study to ensure that the results are put to use. The continued involvement of USGS and University of Minnesota personnel with Minnesota land managers, along with audience-appropriate dissemination vehicles, will ensure access to these results in the long-term. All dissemination products and activities (reports, manuscripts, website and workshops) will be completed by June 2018.

Status as of *January 2016***:**

Status as of *July 2016***:**

Status as of *January 2017***:**

Status as of *July 2017***:**

Status as of *January 2018***:**

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	$ Amount	Overview Explanation
Personnel	$40,845 $234,582 $72,842 $12,656	• Karen Oberhauser (Co-PI); 8.3% FTE for 3 years. Supervision of and participation in all project activities, direct supervision of graduate student focusing on pollinators. • U of M Master's Students (2 @ $21,767 salary and $17,330 fringe [tuition and insurance], year-round for 3 years). Help with site selection, aggregating data on sites, and research assistance hiring. Help set up research protocols; collect data on plants, pollinators, and soil; sort and identify insects; analyze project findings. • Student research assistants, 2 at 50% FTE/year for 2 years. Help with field data collection, sort and identify insects, enter data, and (ideally) conduct related independent projects. • Jennifer Larson (temp/casual at U of M), Quality Assurance and Project coordination, 10% FTE for 2 years. Oversee biological monitoring.
Equipment/Tools/Supplies	$2,800 $1820	• Field Supplies: pan traps, sweep nets, soil sample vials, binoculars, field notebooks, measuring tape, insect vials • Lab Supplies: insect pinning materials, chemicals
Other Research Expenses	$12,000	• U of M soil lab costs for nitrogen determinations ($12,000)
Printing:	$1000	Fact sheets
Travel Expenses in MN:	$32,520	Field crew travel: sampling plants, soil and insects at study sites, $83 motel + $46/person/day meals, 3 people x 60 days/season x 2 seasons; 2 people/room Larson and Oberhauser travel for training and supervision of field crew , $129/day, 2 people x 5 days/season x 2 seasons Field vehicle (UM-owned) mileage, gas and maintenance
Other:	$2935	Workshop costs (room costs, miscellaneous supplies)

TOTAL ENRTF BUDGET:	$414,000	

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: Grad students = 3 (2 @ half time for 3 years), Oberhauser = 0.25, Undergrads = 2 (2 @ half time for 2 years), Larson = 0.20 (10% time for 2 years): **total = 5.45**

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

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
In-kind services			
Salary for Sam Droege, U.S.G.S., 3.8% FTE for 3 years	$8,976.00	$	
Salary for Diane Larson, U.S.G.S., 20% FTE for 3 years	$86,923.20	$	
State			
In-kind services			
Salary for Karen Oberhauser, University of Minnesota; 1% FTE for 3 years	$4921	$	
TOTAL OTHER FUNDS:	**$**	**$**	

VII. PROJECT STRATEGY:

A. Project Partners: **Karen Oberhauser**, Professor in Fisheries, Wildlife and Conservation Biology at the University of Minnesota (focus is conservation of Lepidoptera), will oversee funds within the University, provide butterfly identification expertise, and co-advise graduate students. **Diane Larson**, Research Scientist, U.S. Geological Survey (research foci are invasive species and pollination mutualisms), will oversee vegetation research and co-advise graduate students. **Sam Droege**, U.S. Geological Survey (foci are survey methods and taxonomy of hymenoptera) will oversee insect identification. The University of Minnesota will receive all of the funds. Both the USGS and the University of Minnesota will contribute space and time to the project. The time contributions of Larson (20% FTE for 3 years) and Droege (3.8% FTE for 3 years) are in-kind support from the USGS. 1% of Oberhauser's time will be in-kind support from the University of Minnesota.

B. Project Impact and Long-term Strategy: This research will begin to help us understand the impacts of conservation grazing, a commonly-used management technique in prairies, on plant communities and the bees and butterflies that depend on them. By comparing this practice to fire, a more thoroughly-studied practice in northern tallgrass prairies, we will be able to inform federal, state, local, and private land management practices. Thus, the ultimate goal of this project is better-informed management practices on Minnesota prairie remnants, including those owned by federal, state, and local government, as well as private landowners. The continued involvement of USGS and University of Minnesota personnel with Minnesota land managers, along with audience-appropriate dissemination vehicles, will ensure access to these results in the long-term. Because we are able to take advantage of existing variation in site management strategies, we anticipate that two field seasons will suffice, and do not foresee the need for ongoing funding

C. Funding History: N/A

Funding Source and Use of Funds	Funding Timeframe	$ Amount
None.		$

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 graphic.

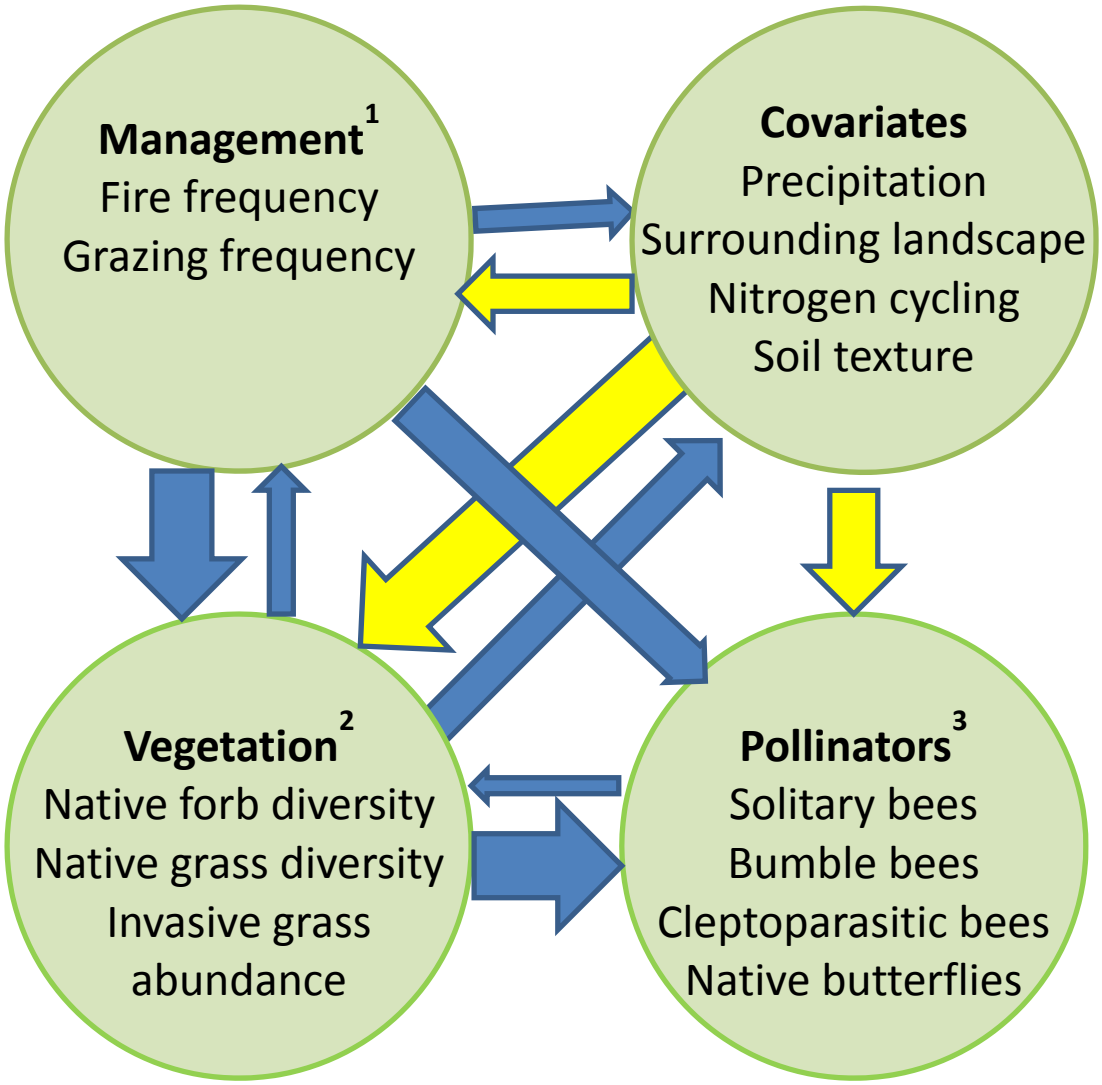
X. RESEARCH ADDENDUM: See attached Research Addendum.

XI. REPORTING REQUIREMENTS:
Periodic work plan status update reports will be submitted no later than January 2016, July 2016, January 2017, July 2017, and January 2018. A final report and associated products will be submitted between June 30 and August 15, 2018.

Environment and Natural Resources Trust Fund
M.L. 2015 Project Budget

Project Title: Effects of Grazing Versus Fire for Prairie Management
Legal Citation: M.L. 2015, Chp. 76, Sec. 2, Subd. 03o
Project Manager: Karen Oberhauser
Organization: University of Minnesota
M.L. 2015 ENRTF Appropriation: $ 414,000
Project Length and Completion Date: 3 Years, June 30, 2018
Date of Report: October 15, 2014

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	Field work preparation: Identify prairie tracts, collect management histories, assemble GIS layers			Compare effects of grazing and fire on native plant species richness and composition and abundance of invasive grasses			Compare effects of grazing and fire on pollinator species richness				
Personnel (Wages and Benefits)	$91,809	$0	$91,809	$134,558	$0	$134,558	$134,558	$0	$134,558	$360,925	$360,925
Karen Oberhauser (Co-PI); $40,845, 75% salary, 25% benefits, 8.3% FTE for 3 years											
University of Minnesota Master's Students, $234,582, 56% salary, 44% benefits (including tuition), 50% FTE for 2 students each year for 3 years											
Jennifer Larson (temp/casual at U of M, Quality Assurance and Project coordination), $12,656, 75% salary, 25% benefits, 10% FTE each year for 2 years											
Student research assistants, $72,842, 2 at 50% FTE/year for 2 years											
Equipment/Tools/Supplies				$2,310	$0	$2,310	$2,310	$0	$2,310	$4,620	$4,620
Field Supplies (plot frames, markers, data sheets, nets, pan trap supplies, field guides, measuring tape, glassine envelopes, kill jars, soil sampling equipment): $2,800											
Lab Supplies (insect pinning/preserving equipment, materials for N extraction and soil texture): $1,820											
Other research expenses											
U of M soil lab costs for nitrogen determinations				$12,000	$0	$12,000			$0	$12,000	$12,000
Printing				$500	$0	$500	$500	$0	$500	$1,000	$1,000
Fact sheets for dissemination											
Travel expenses in Minnesota				$16,260	$0	$16,260	$16,260	$0	$16,260	$32,520	$32,520
Field crew travel (to ~37 sites once per summer, 20 sites plus 2 additional times for insect sampling and follow-up vegetation sampling, lodging and food costs for 2 grad students and 2 undergrad assistants [$83 motel + $46/person/day M&IE, 4 people x 60 days/season x 2 seasons; 2 people/room]): $17,940											
Larson and Oberhauser travel for training and supervision of field crew: $129/day, 2 people x 5 days/season x 2 seasons: $2,580											
field vehicle (2, U of M owned, 2 field seasons) : $2,580											
Other											
Workshop costs: Room costs, miscelaneous supplies				$1,467	$0	$1,468	$1,468	$0	$1,468	$2,938	$2,935
COLUMN TOTAL	**$91,809**	**$0**	**$91,809**	**$167,096**	**$0**	**$167,096**	**$155,096**	**$0**	**$155,096**	**$414,000**	**$414,000**



Hypothesized effects of management on response variables (vegetation and pollinators). Each arrow represents a potential causal pathway, with arrow width representing hypothesized relative importance of the pathway. Pathways shown by blue arrows are the focus of our study; yellow arrows represent other factors that could affect the focus variables and thus must be taken into account in the analysis.

[1]Frequency includes intervals between events, number of events in past 10 or 20 years (depending on management history data), time since last event

[2]Vegetation response variables: native species richness and diversity indices, total exotic cover, cover of individual invasive grasses

[3]Both species richness and diversity indices will be calculated for all pollinator groups