

**Environment and Natural Resources Trust Fund
2017 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 154-F

Restoring and Preserving Savanna Using Bison

Category: F. Methods to Protect, Restore, and Enhance Land, Water, and Habitat

Total Project Budget: \$ 388,000

Proposed Project Time Period for the Funding Requested: 3 years, July 2017 to July 2020

Summary:

Restoration of Minnesota's oak savanna, of which < 1% remains, has been problematic. Our research would determine if some combination of bison grazing and fire can restore this threatened ecosystem.

Name: David Tilman

Sponsoring Organization: Cedar Creek Ecosystem Science Reserve, U of MN

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Location

Region: Central

County Name: Anoka, Isanti

City / Township: East Bethel

Alternate Text for Visual:

Aerial view of restoration site and details of the experimental design that shows the 6 treatment, 5 replicates of each treatment per site, and 2 sites.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____ %



PROJECT TITLE: Restoring and Preserving Savanna Using Bison

I. PROJECT STATEMENT

Oak savanna is Minnesota’s most threatened ecosystem, and fire, alone, is not restoring and preserving it. At the time of settlement, a broad swath of savanna stretched from the south to north across the middle of Minnesota, but by the early 1900’s most had become cropland and pasture. And now, after a century without fire and bison, less than 0.1% remains as savanna, and most remnants have lost their prairie grasses and wildflowers as they became dominated by trees that invaded when fire stopped.

Efforts to restore savanna have been insufficient. Our savanna restoration research started in 1965 in what had once been native savanna at Cedar Creek Ecosystem Science Reserve (henceforth “Cedar Creek”). It has shown that burning about 2 of every 3 years eliminates shrubs and non-savanna tree species and restores prairie grassland species. However, our 50 years of research is also showing that these frequent fires are preventing oaks from regenerating. Although our efforts to date have “restored” the second largest stand of oak savanna in Minnesota, it is now clear that **fire, by itself, is leading to the slow demise of this savanna because oaks are not replacing themselves before they die.** It remains unclear how oak savanna can be both restored and preserved.

We propose that bison are essential for savanna restoration and preservation because bison preferentially graze the most abundant native prairie grasses. When not grazed, these grasses can outcompete oak seedlings for soil nutrients and, when these ungrazed grasses burn, their high abundance causes intense fires that kill oak seedlings. **Fire is also likely essential** since frequent fires eliminate shrubs and most trees except oaks, thus allowing prairie species and oaks to persist.

Our **GOALS are to experimentally test whether and how bison grazing and fire can jointly restore and preserve oak savanna.** Because neither cattle nor deer nor elk preferentially eat the most abundant native grasses, we believe that bison grazing, in particular, may be of central importance to maintaining oaks in savanna ecosystems. This research on bison is essential since the role and usefulness of bison in savanna restoration and maintenance remain completely unknown.

The **OUTCOMES** we plan to achieve are to:

- (1) Discover better restoration and preservation practices for savanna remnants;**
- (2) Determine how these practices impact the full range of savanna biodiversity; and**
- (3) Educate Minnesotans about the ecological heritage of their state, including the roles that bison, fire and biodiversity play in the functioning of savannas and other Minnesota ecosystems.**

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Restore bison grazing to 200 acres of oak savanna **Budget: \$99,300.**

We propose to restore bison grazing to a 200-acre-site on the southwest edge of Cedar Creek (bordered by yellow line in graphic) that is a mosaic of restored oak savanna (that lacks oak regeneration) and remnant oak savanna (that is now low-diversity forest). In 2017 we will install 2 miles of bison fencing around this parcel, watering facilities, and a bison corral. Then, starting in late spring of 2018 and each subsequent year, a project partner, Northstar Bison, will deliver and release bison, periodically visit throughout the growing season to provide any needed veterinary services, collect any bison that might escape, mend fences, and round-up bison each year in October. We will control the intensity and timing of bison grazing to achieve restoration goals. A similar seasonal bison grazing partnership between Northstar Bison and Belwin Conservancy has successfully restored prairie grassland with minimal ongoing costs for Belwin. We cannot afford to purchase, or to maintain all year for many years, a herd of 100% genetically pure bison for this research and, fortunately, do not need to do so since **Northstar’s bison preferentially graze abundant native grasses just as do genetically pure bison.**

Outcome	Completion Date
<i>1. Perimeter fences and bison corrals constructed and watering facilities established</i>	<i>Nov. 2017</i>
<i>2. About 40 bison grazing in 200 acres of current and remnant savanna each year</i>	<i>June 2018-2020</i>



Activity 2: *Experimental tests of savanna restoration using bison.* Budget: \$268,300.

Within the 200-acre bison enclosure we will create a well-replicated experiment to determine how bison grazing and fire frequency impact the restoration and preservation of oak savanna ecosystems. Using 60 plots, each 40' x 40' in size, we will determine the impacts of all combinations of 3 fire frequencies crossed with either bison grazing or no bison grazing. Thirty plots would be in a stand of restored oak savanna, and the other 30 plots in a stand of remnant oak savanna (see graphic). In total across these two areas, half of the plots would be fenced to exclude bison, which would require about 1 mile of fencing. Abundances of oak seedlings, saplings and trees and of prairie species, soil chemistry, and soil mycorrhizal fungi would be measured each summer to determine the impacts of bison and fire frequency. This experiment will have the power to test our hypotheses and determine the roles of bison and fire in savanna restoration and preservation.

Outcome	Completion Date
<i>1. Oak and grass seedling competition experiment established both inside and outside bison grazing exclosures</i>	<i>May 2018</i>
<i>2. Plant and soil sampling completed each year</i>	<i>Aug. 2018, 2019</i>
<i>3. Plant and soil data analyzed and results published</i>	<i>May 2020</i>

Activity 3: *Disseminate results to K-12 students and visitors*

Budget: \$20,400.

We propose to inform and educate Minnesotans about the ecological heritage of their state, including the roles that bison, fires and biodiversity play in the functioning of savannas and other Minnesota ecosystems, by providing educational programming for the thousands of K-12 students and other visitors who come to Cedar Creek each year and by creating an accessible viewing area (slightly-elevated wooden deck with insect screening) with educational signs and handouts that is open to the public whenever bison are on-site.

Outcome	Completion Date
<i>1. Viewing platform constructed and educational signs displayed</i>	<i>October 2017</i>
<i>2. At least 10,000 K-12 students and visitors benefit from educational programming</i>	<i>May 2020</i>

III. PROJECT STRATEGY

A. Project Team/Partners: Cedar Creek Ecosystem Science Reserve of the University of Minnesota. David Tilman (Director, Cedar Creek ESR and Regents Professor, UMN) will oversee the project. Forest Isbell (Associate Director, Cedar Creek ESR, UMN) will supervise work on-site at Cedar Creek. The CCSR Education Coordinator will lead the education programming. Project partners include Northstar Bison (Lee Graese), who at no cost to Cedar Creek will annually provide bison and associated veterinary services, the Red Headed Woodpecker Recovery Project (Chet Myers and citizen scientists who monitor red headed woodpeckers in our savannas at no cost to Cedar Creek). This project would complement efforts to reintroduce bison for restoration of grassland habitat by the DNR, US Fish and Wildlife Service, the Forest Service, and The Nature Conservancy.

B. Project Impact and Long-Term Strategy: Our results would guide efforts by state and federal agencies and conservation organizations to restore oak savanna across the state. To maximize what is learned from reintroducing bison to Cedar Creek, we aim to maintain bison grazing as long as possible. The partnership with Northstar Bison makes this financially feasible since they provide and care for the bison each year at no cost to Cedar Creek, thus allowing the project to continue potentially indefinitely. Moreover, we have successfully attracted major federal research funding to Cedar Creek for more than three decades and will seek such funding to continue sampling the bison experiment at the end of the proposed 3 years of LCCMR support.

C. Timeline Requirements: The proposed project will require three years to rigorously test effects of bison on oak seedling recruitment, herbaceous plant diversity, plant productivity, oak-grass competition and fire intensity, and to attract K-12 students and visitors for educational opportunities.

2017 Detailed Project Budget

Project Title: Restoring and Preserving Savanna Using Bison

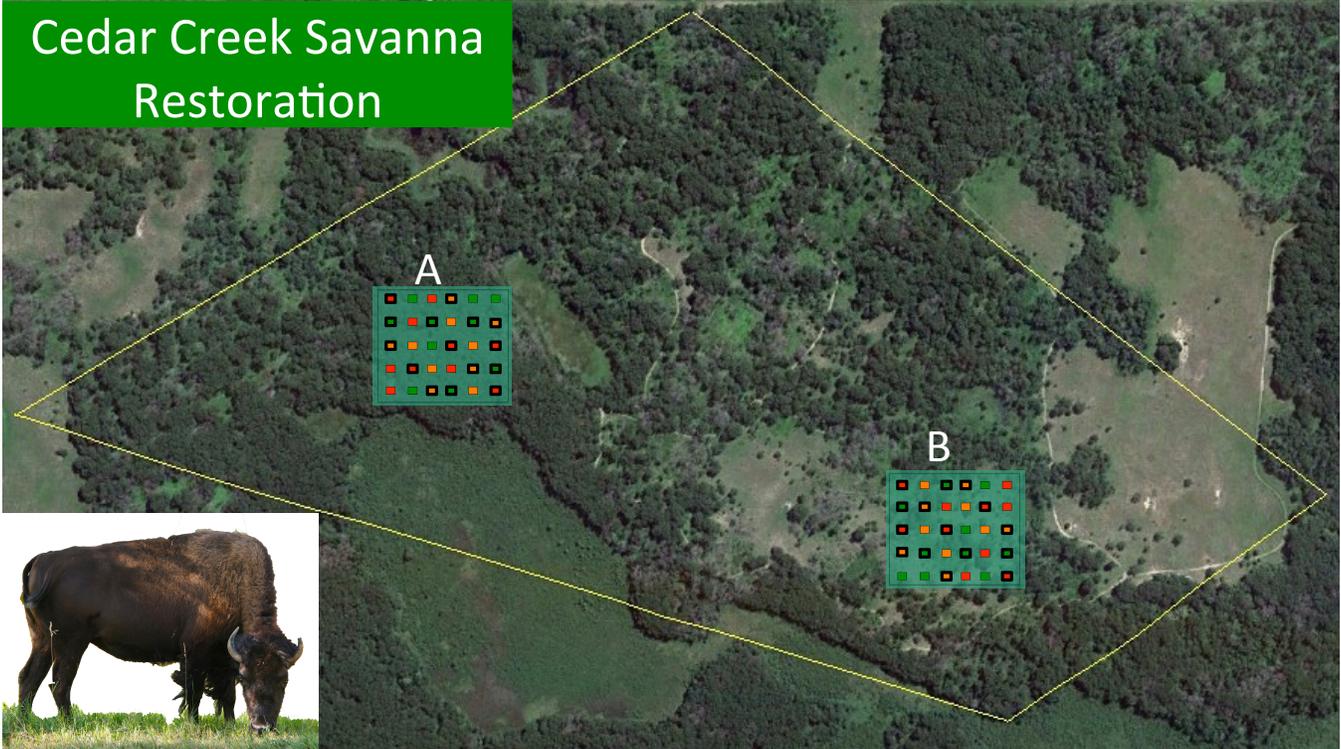
IV. TOTAL ENRTF REQUEST BUDGET 3 years

<u>BUDGET ITEM</u>	<u>AMOUNT</u>
Personnel: Post-doctoral researcher (82% salary, 18% benefits) 100% FTE for 2 years	\$109,000
Personnel: 3 undergraduate research assistants/temps. for year 1 + 5 undergraduate research assistants/temps. for years 2 and 3 (93% salary, 7% benefits) 25% FTE	\$99,000
Personnel: 4 temporary employees to install fence during year 1 (79% salary, 21% benefits) 41% FTE	\$57,000
Equipment/Tools/Supplies: 2 miles of perimeter fencing, including wire mesh fence, posts and gates.	\$58,000
Equipment/Tools/Supplies: 1 mile of interior fencing for experimental enclosures, including wire mesh fence and posts.	\$28,000
Equipment/Tools/Supplies: materials to construct screened bison viewing area for use by K-12 students and other visitors participating in our education program (\$16,000).	\$16,000
Equipment/Tools/Supplies: <i>Experiment</i> : 540 plot and subplot aluminum tags - \$500; 3,840 pieces of 3' re-bar plus re-bar caps to mark subplots - \$3,100; <i>Education</i> : 8 weatherproof photographic aluminum signs - \$2,400; 10,000 educational handouts - \$2,000.	\$8,000
Additional Budget Items: Rental of equipment for digging holes for the fence posts	\$5,000
Additional Budget Items: Chemical analyses of soils at UMN Soils Lab (ammonium, nitrate, total soil nitrogen and total soil carbon @\$16/sample x 60 plots x 4 samples per plot x 2 years + 20 standards x\$16/standard = \$8,000.	\$8,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 388,000

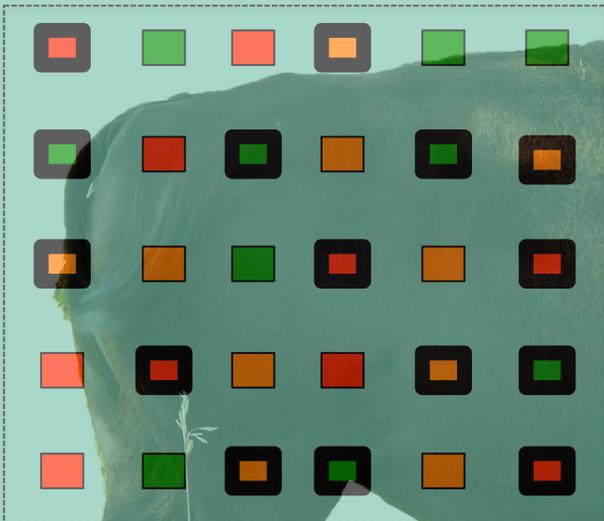
V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

<u>SOURCE OF FUNDS</u>	<u>AMOUNT</u>	<u>Status</u>
Other Non-State \$ To Be Applied To Project During Project Period: N/A		
Other State \$ To Be Applied To Project During Project Period: N/A	\$ -	
In-kind Services To Be Applied To Project During Project Period: <i>Indirect costs associated with this proposal</i>	\$ 207,000	<i>Secured</i>
Funding History: LCCMR has supported some of past efforts at savana restoration at Cedar Creek.	\$ -	
Remaining \$ From Current ENRTF Appropriation: N/A	\$ -	

Cedar Creek Savanna Restoration



Experimental Design:



Bison Grazing:



Not Burned



Burned 2 of 3



Annual Burns

Not Grazed:



Plots will be 2 times further apart than illustrated

Top: 200 Acre Site for Savanna Restoration and Preservation Experiment. Yellow line is approximate location of Bison fence. Fenced area burned 2 of 3 years, but plots differ.

A: The set of 30 plots located in remnant un-restored savanna

B: The set of 30 plots located in restored savanna that lacks oak regeneration

Lower: Six treatments and replication for each set of 30 plots. Thick black boxes are Fenced to be Bison Enclosures. The other 15 are grazed. Green plots are not Burned; Orange are Burned 2 of every 3 years; Red are Burned every year

PROJECT MANAGER QUALIFICATIONS: DAVID TILMAN

Professional Appointments at the University of Minnesota

2002-present	Regents Professor
2001-present	McKnight Presidential Chair in Ecology
1992-present	Director, Cedar Creek Ecosystem Science Reserve
1984-present	Professor
1980-1984	Associate Professor
1976-1980	Assistant Professor of Ecology

Professional Preparation

University of Michigan	Zoology	Ph.D., 1976
University of Michigan	Zoology	B.S., 1971

Qualifications and Responsibilities

David Tilman will oversee the project. His research focuses on the causes, consequences, and conservation of Earth's biodiversity, and on how managed and natural ecosystems can sustainably meet human needs for food, energy, and ecosystem services. He has written or edited 5 books and written more than 350 scientific papers. He has been awarded a Guggenheim Fellowship, is a Fellow of the American Association for the Advancement of Science and of the American Academy of Arts and Sciences, and is a member of the National Academy of Science. He has received many international prizes, including the Balzan Prize for Plant Ecology, the Frontiers of Knowledge Award from the BBVA Foundation, the Premi Ramon Margalef Award for Ecology by the Spanish State of Catalonia, the Alexander von Humboldt Medal, the A. H. Heineken Prize for Environmental Sciences and the International Prize for Biology from the Japanese Society for the Promotion of Science.

Forest Isbell (Associate Director, Cedar Creek ESR, UMN) will directly supervise work on-site at Cedar Creek. Much of Isbell's previous research has been conducted at Cedar Creek Ecosystem Science Reserve, the site of the proposed work, and has been published in the world's top scientific journals (more than 40 publications, including 8 in *Nature*, *Science*, or *PNAS*). Furthermore, Isbell is currently a Lead Author on both regional (Americas) and global assessment reports for the United Nations Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services. The CCESR Education and Outreach Coordinator (to be hired this month, supervised by Isbell) will co-lead the education programming, in collaboration with Forest Isbell.

Organization Description

Cedar Creek Ecosystem Science Reserve is a University of Minnesota biological research field station. Its 5,500 acres includes Minnesota's second largest stand of oak savanna as well as many other types of ecosystems and species found throughout the forests, grasslands, and wetlands of North America. Faculty, staff and students who work at Cedar Creek are dedicated to discovering sustainable solutions to environmental challenges. We do this by: (1) **investigating** the fundamental processes that govern the dynamics and functioning of ecological communities and ecosystems, and how human activities are changing ecosystems; (2) **sharing knowledge** gained at Cedar Creek with citizens of the state, the nation, and the world; and (3) **conserving natural ecosystems** as platforms for study and as examples of intact ecosystems.