Environment and Natural Resources Trust Fund
2014 Request for Proposals (RFP)

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Project Title:

New Data Directions for Understanding Our Natural Systems

Category: A. Foundational Natural Resource Data and Information

Total Project Budget: $ 253,000

Proposed Project Time Period for the Funding Requested: 1 Year, July 2014-June 2015

Other Non-State Funds: $ 0

Summary:

We will develop new levels for natural resource data through very-low-altitude self-guided model aircraft equipped for sensing and imaging. We have acquired these aircraft and are ready to apply them.

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Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

MP: 0613-2-258-proposa
Budget: 0613-2-258-bud
Qual: 0613-2-258-qualifi
Map: 0613-2-258-map-L
Resolution:
List:

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

PROJECT TITLE: New data directions for understanding our natural systems

I. PROJECT STATEMENT

Why. Understanding our biological resources and planning for their conservation and use has always been hampered by the cost and difficulty of obtaining high-resolution biological data. On-the-ground surveys provide high-resolution data but are labor intensive; satellite images capture large landscapes but at a coarser scale.. Recent advances in extremely lightweight, electrically powered, self-guided model aircraft equipped with multispectral cameras and other sensors promise the potential of spanning those scales. In the past year, the University's College of Biological Sciences has acquired two such aircraft and is seeking funds and locales to perfect their use. As state agencies, environmental organizations, and academic institutions expand their efforts at collecting data to understand our world, advancing to the most modern methods and keeping up with growing developments is crucial for data collection efforts now.

Goals and outcomes. Our goal is to pilot new applications in natural resource data collection using very-low-altitude images and sensors to provide high-resolution eyes for our natural systems. Outcomes will be the (1) development of techniques to identify individual plants and animals of various species, natural and invasive, using existing software and novel machine-learning algorithms to analyze the data collected, (2) demonstration sessions for natural resource professionals relevant to their data collection needs, and listening sessions to generate new application ideas, (3) a permanent project website and reports available to site managers and the public, showing results and accepting new ideas. The ultimate goal is to develop capabilities for collecting detailed, high-resolution information integrated over spatial scales never before possible, providing Minnesota with the most up-to-date tools for monitoring its natural resources, and serving as a template for other state, local, and federal efforts.

How. We would develop these capabilities across the broad spectrum of Minnesota's ecosystem types, with areas selected from Minnesota's Wildlife Management Areas, Scientific and Natural Areas, University field stations, and other representative sites. Our emphasis is on protected natural areas which need supplemental environmental data. The diversity of sensors now available makes the biological applications numerous, and we will select from more than a dozen possibilities: (1) Tracking leaf-out and leaf-drop times for individual trees and whole forests, to understand population responses in changing conditions, (2) providing early warning of disease outbreaks such as oak wilt, (3) observing flower resources in grasslands and woodland edges to monitor continuity for pollinators, (4) detecting and monitoring invasive plant species, (5) censusing populations of recovering species such as swans, (6) night thermal imaging for deer and fawn surveys in fields, (7) developing fine-scale temperature and humidity profiles with elevation to understand insect population dynamics, (8) examining biome boundary changes that may signify local climate changes, (9) documenting variations in peatlands where CO2 emissions may affect climate, (10) thermal imaging of lakes and rivers to calculate hydraulic residence times, (11) monitoring ephemeral wetlands as part of wildlife habitat, (12) examining ecological effects of storms, snowpacks, and so forth, (13) calibrating satellite images, (14) angle-viewing through forest canopy gaps for understory development, (15) discovering landscape geometry from overlapping images, and finally (16) potential very close information for running forest fires, closer than manned aircraft can attempt.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: *Spectral testing and calibration* **Budget:** $126,000

Description: The first field season and subsequent winter season will be for laboratory and field testing, calibration, and initial analysis.

Outcome	Completion Date
1. Obtain sensor equipment and training	*August 2014*
2. Assemble and test under controlled conditions	*August 2014*

3. Select initial survey sites, with ground-truth of specific exotic and native plants	*August 2014*
4. Identification and development as necessary of image processing software	*February 2015*
5. Calibrated field tests	*October 2014*

Activity 2: *Application, surveys, and report* **Budget:** $127,000

Description: The second field season will be for surveys of selected sites, based on the calibration and testing of the first season, and for demonstrations. The second winter season will be for analysis, reporting, and publication, which will continue beyond the two years of the project.

Outcome	Completion Date
1. Actual surveys of selected sites	*September 2015*
2. Public demonstration sessions: ideas, methods, and results	*September 2015*
3. Publicly accessible website with close-fly images for download	*December 2015*
4. Field guide to spectral characteristics of invasive species	*August 2016*
5. Occurrence lists of invasive species in selected sites	*August 2016*
6. Final reports and publications	*August 2016*

III. PROJECT STRATEGY

A. Project Team/Partners

All team members are affiliated with the University of Minnesota. Clarence Lehman is Project Manager and contributes expertise in computer methods and ecology. John Rotenberry will lead partnership efforts with field stations and research sites and contribute expertise in remote sensing. James Cotner will guide wetland components of the project and contribute expertise in human impacts on ecosystems. Rebecca Montgomery will lead phenological monitoring and contribute expertise on hyperspectral remote sensing of vegetation. James Forester will guide wildlife applications of the project, such as movement paths of radio-collared animals, and will contribute expertise on animal movement ecology and statistics. These faculty will receive up to 1% FTE from these funds while the remainder of their support comes from University funds. Craig Bantz will oversee computer technology. He will also receive up to 1% FTE from these funds, the remainder of his support coming from University funds. Michael Nelson will contribute knowledge and experience with aerial camera technology and invasive species in Minnesota. He and other research scientists will receive larger proportions, up to a majority of their support from this project.

B. Timeline Requirements

This project requires two field seasons, one for testing and calibrations, the other for actual field surveys. We will primarily fly surveys during the growing season, but will also test operations during winter. The growing season will be dedicated to gathering data, testing, and demonstrating, while the off season will be used for activities related to organizing and analyzing results.

C. Long-Term Strategy and Future Funding Needs

This is a stand-alone project that will support other groups. The efficacy of the techniques will be established and results communicated to state and federal agencies and environmental organizations. For example, flowering times and extents of pollinator resources will be communicated to groups interested in pollinator survival, and occurrence lists of invasive species detected in selected state natural areas, state parks, and wildlife areas will be communicated to Minnesota DNR, TNC, and others for use in planning. It could generate much interest and consequences could be far-reaching. Lessons learned and techniques developed should help many agencies—state, federal, and local—save funds and expand the information returned on dollars invested. Commercial interests can also be expected to develop in environmental businesses.

2014 Detailed Project Budget

Project Title: New data directions for understanding our natural systems

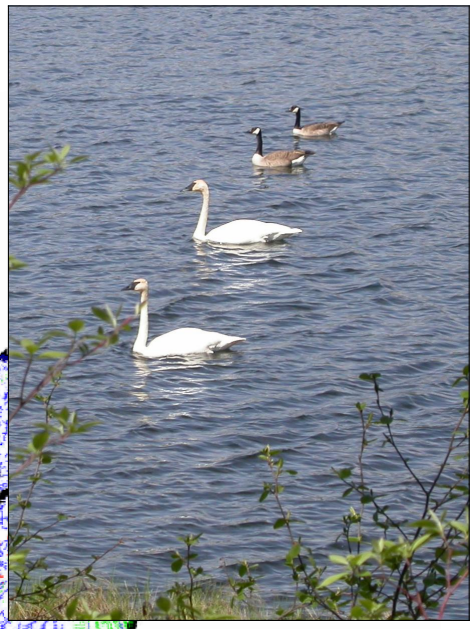
IV. TOTAL ENRTF REQUEST BUDGET - 2 years

BUDGET ITEM	AMOUNT
Personnel: Faculty salary, 0.05 FTE. (75% salary, 25% fringe) Faculty salary and fringe is for project coordination, analysis, publications, and other academic tasks.	$ 14,000
Personnel: Research Scientists, 1.33 FTE. (73% salary, 27% fringe) Research scientist salary and fringe is for planning, analysis, field coordination, and other tasks as required. These are staff scientists, postdoctoral researchers, and other academic positions.	$ 178,000
Personnel: Field Technician, 0.33 FTE. (91% salary, 9% fringe) Field assistant salary and fringe is for seasonal employees to assist researchers in field aspects of the project.	$ 15,000
Personnel: IT Personnel, 0.12 FTE. (73% salary, 27% fringe) IT personnel is for technological support.	$ 28,000
Equipment/Tools/Supplies: Supplies cover camera equipment, copies, handouts, posters, and other expenses throughout the project.	$ 5,000
Travel: Travel and lodging covers travel to field sampling sites and to public demonstrations and discussions supported by the project.	$ 10,000
Additional Budget Items: Publications: Publication costs cover fees for open-access publication of results of the project, two papers.	$ 3,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 253,000

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period:	$ -	
Other State $ Being Applied to Project During Project Period:	$ -	
In-kind Services During Project Period:	$ -	
Remaining $ from Current ENRTF Appropriation (if applicable):	$ -	
Funding History:	$ -	

Right: A Minnesota prairie lake. Self-guided model aircraft will, among many other things, help us census recovering species in hidden bays and small wetlands.



Left: Launching with imaging and sensors on board. The craft pilots itself along pre-established GPS flight paths only hundreds of feet off the ground, then lands automatically with its observations ready for downloading.

Above. Minnesota is the meeting point for the three great ecosystems of North America, providing a range of conditions ideal to test new data gathering methods. Three representative sites shown are (1) the heart of the old northern tallgrass prairie, (2) the rich agricultural areas, and (3) the northern peat forests.

Project Manager Qualifications
Clarence Lehman

Clarence Lehman has experience in engineering, science, and management, both in industry and academia. He serves as Associate Dean for Research and Graduate Education in the University's College of Biological Sciences, as Adjunct Faculty in the Department of Ecology, and as a Fellow of the University's Institute on the Environment. For six years he also served as Associate Director of Cedar Creek Ecosystem Science Reserve.

His academic degrees are all three from the University of Minnesota. Clarence Lehman's work covers theoretical, experimental, and computational ecology, including renewable energy, biodiversity and its ecosystem properties, the ecology of disease in plants, animals, and humans, connections between ecology and economics, and restoration of natural habitats. He has restored and maintains several areas of native prairies, savannas, and wetlands in northwestern Minnesota and maintains them through specialized experiments for adaptive management.

Clarence Lehman has experience designing and managing projects and experiments, including three LCCMR projects—one on grassland energy and water purification, another on grassland management and wildlife conservation. The latter is ongoing in its final phase. He handled the computerized aspects of the design and layout of Cedar Creek's long-term biodiversity experiment and its long-term carbon dioxide enrichment experiment. He also has designed and managed several practical long-term prairie experiments to determine best establishment practices, seeding times, and burning frequencies for restored native prairies.

Scientific papers authored and coauthored cover topics such as biodiversity and the functioning of ecosystems, habitat destruction and extinction, competition among species, environmental change, long-term carbon cycling, stability of ecological systems, conservation biofuels, disease in the environment, and ecological economics. Scientific software development covers new methods for computer simulation of natural systems, including those involving the spread of human and wildlife disease, a computer system to select native prairie plants suited to specified geographic locations in Minnesota under specified soil, moisture, and sunlight conditions, and web-based keys for plant species identification.

Organization Description

The University of Minnesota is the state's main research and graduate teaching institution. Our university has been repeatedly ranked number-one or number-two in the nation for ecology and environment, based on the citational influence of its scientific publications.