Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)

Project Title: **ENRTF ID:**   020-A

Maintaining Minnesota's Natural Heritage by Monitoring Landscape Dynamics

Category: A. Foundational Natural Resource Data and Information

Total Project Budget: $ 272,000

Proposed Project Time Period for the Funding Requested: 2 years, July 2018 to June 2020

Summary:

This project will create necessary knowledge infrastructure for Minnesota's natural resource professionals and policy-makers by providing ongoing information about landscape dynamics throughout the state at frequent intervals.

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Examples of change in MN from 2000 to 2014

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

PROJECT TITLE: MAINTAINING MINNESOTA'S NATURAL HERITAGE BY MONITORING LANDSCAPE DYNAMICS

I. PROJECT STATEMENT
Goal: This project will create necessary knowledge infrastructure for Minnesota's natural resource professionals and policy-makers. This will improve the information on which they base management decisions. Better-informed decisions will result in better management and protection of Minnesota's natural heritage.

- This project will build on the previously LCCMR-funded statewide land cover update. That project created a *new baseline land cover map* for Minnesota. This project will show *how Minnesota changes into the future*.
- This project will create a system that uses satellite and aerial imagery to provide frequent, ongoing, statewide identification of landscape changes in Minnesota.
- Such a system is needed because current survey methods, while valuable and necessary, do not capture the **rapid, extensive, and frequent changes** occurring in many parts of the state. Among these changes are urban and rural development, habitat alteration, forest fragmentation, evolving agricultural practices, and impacts on wetlands.
- Knowledge of these landscape dynamics is vital for natural resource professionals and policy-makers to make informed decisions to maintain Minnesota's natural heritage.
- After development, this will be a self-supporting system that will require no additional LCCMR funding.
- Creation of this landscape dynamics monitoring system would position Minnesota as a **national leader** in providing the best possible information to its natural resource professionals and policy-makers.
- No existing natural resource monitoring system can provide the **statewide, high frequency** landscape change updates that this project would create.

Background/Justification: Minnesota has a wealth of natural resources that provide substantial benefits to its citizens. These benefits include outdoor recreation, wildlife habitat, clean water, good foods, natural resource-focused careers, and many more. Minnesotans of varied backgrounds in all parts of the state appreciate this natural heritage. To protect our valuable landscapes, we need to know how they are changing in response to natural and human-caused factors. Government agencies at multiple levels, non-profit organizations, and citizen groups monitor landscape dynamics using a variety of programs and methods. Examples of these methods include the Minnesota Wetland Status and Trends Monitoring Program (WSTMP), the U.S. Forest Service's Forest Inventory and Analysis (FIA) program, and citizen-science programs by non-profits such as Ducks Unlimited. However, these programs, while valuable and needed, are not designed to monitor "wall-to-wall" change at frequent intervals across the state. *No existing monitoring program allows for such high spatial and temporal detail*. This proposed project will create a comprehensive image-based monitoring system that will provide *statewide* landscape change descriptions at *annual or better* time intervals. Such a system would be highly complementary to existing monitoring programs, and would provide unprecedented information to Minnesota's natural resource professionals and policy-makers.

This project will benefit substantially from, and augment, previously-funded LCCMR and state activities, such as the Minnesota lidar dataset, LCCMR's National Wetlands Inventory update, the ongoing LCCMR DNR lidar forest inventory project, the recently completed LCCMR statewide land cover update, and DNR/PCA's Wetland Status and Trends Monitoring Program.

Methods: Significant recent advances in satellite/aerial imaging and cloud-based computing resources now allow for rapid, comprehensive, and frequent monitoring of large areas like Minnesota. This project would use imagery from the Landsat and Sentinel satellite systems, imagery collected through the ongoing National

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Agricultural Imagery Program, and other suitable sources, in a cloud-based computing system such as Google Earth Engine. Imagery would be acquired as often as every three days, and would be processed in the cloud-based system to create annual or better depictions of landscape change statewide, at spatial resolutions from 10 meters to 30 meters, depending on timing and imagery source.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Create Landscape Dynamics Monitoring System and make results available to*   **Budget: $272,000**
stakeholders
We will create a cloud-based monitoring system that will ingest Landsat and Sentinel satellite imagery as it is acquired. These images will be aggregated into monthly composite image datasets for all of Minnesota. The cloud system will use advanced algorithms to compare the image composites through time and identify and characterize areas that are changing. The accuracy of the results will be rigorously evaluated using robust statistical validation procedures. The validated landscape change information will be made available on a publicly accessible website to allow for wide usage. Partnerships with state agencies will be created to sustain operations after LCCMR funding ends (please see section III.B. below). The system will be publicized using methods such as website announcements, emails, newsletters, social media, in-person presentations at meetings and conferences, and scientific and mass-media publications.

Outcome	Completion Date
1. Landscape Dynamics Monitoring System developed	January 31, 2020
2. Landscape Dynamics Monitoring System deployed to public website	March 31, 2020
4. Results publicized using a wide variety of communications methods	June 30, 2020

III. PROJECT STRATEGY
A. Project Team/Partners
Joseph Knight, University of Minnesota, Project lead.
Keith Pelletier, University of Minnesota, Image analyst.
Trent Erickson, University of Minnesota, Information technologist.

Unfunded Partners
Steve Kloiber, MNIT, MNDNR
Jennifer Corcoran, Division of Forestry, MNDNR
Project stakeholders: Metropolitan Council, MPCA, MNDNR, MnGeo, SWCD, BWSR, USFWS

B. Project Impact and Long-Term Strategy
This project would provide unprecedented information to Minnesota's natural resource professionals and policy-makers. Rather than having to wait for expensive field surveys to be completed or data to be gathered from monitoring programs that provide infrequent coverage of limited areas, professionals and policy-makers would quickly know of landscape changes happening in any part of the state. Existing monitoring programs would be improved by having this broader knowledge, and management and policy efforts could be focused on areas that are changing, saving time and taxpayer funds. After development using LCCMR funds, this program would require no further LCCMR support. Ongoing operation would be supported by partnerships already in development with state agencies.

C. Timeline Requirements
The project will be completed in two years, as described in the activity completion dates above.

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2018 Detailed Project Budget

Project Title: MAINTAINING MINNESOTA'S NATURAL HERITAGE BY MONITORING LANDSCAPE DYNAMICS

IV. TOTAL ENRTF REQUEST BUDGET *2* years

| BUDGET ITEM	AMOUNT
Personnel:	
Joseph Knight, Project Manager (75% salary, 25% benefits), 12% FTE for 2 years	$ 25,589.00
Keith Pelletier, Image Analyst (75% salary, 25% benefits), 100% FTE for 2 years	$ 133,000.00
Trent Erickson, IT Specialist (75% salary, 25% benefits), 25% FTE for 2 years	$ 24,636.00
Graduate Assistant (TBD), Image Analyst (70%, 30% benefits), 50% FTE for 2 years	$ 84,575.00
Professional/Technical/Service Contracts:	N/A
Equipment/Tools/Supplies:	
General operating supplies and services (research consumables, publication costs)	$ 200
Acquisition (Fee Title or Permanent Easements):	N/A
Travel:	N/A
Additional Budget Items:	$ -
Laboratory fees for project personnel (image analysts), $1000 each per year	$ 4,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 272,000

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period: N/A	N/A	N/A
Other State $ To Be Applied To Project During Project Period: N/A	N/A	N/A
In-kind Services To Be Applied To Project During Project Period: N/A	N/A	N/A
Past and Current ENRTF Appropriation: N/A	N/A	N/A
Other Funding History: N/A	N/A	N/A

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Minnesota's Changing Landscape

Conservation and management of Minnesota's natural resources require significant investments of time and money by many state/local agencies and stakeholder groups. Success in such efforts necessarily begins with accurate monitoring of the state's changing landscapes. The following is an example of a significant change in Minnesota's land cover from 2000 to 2014.
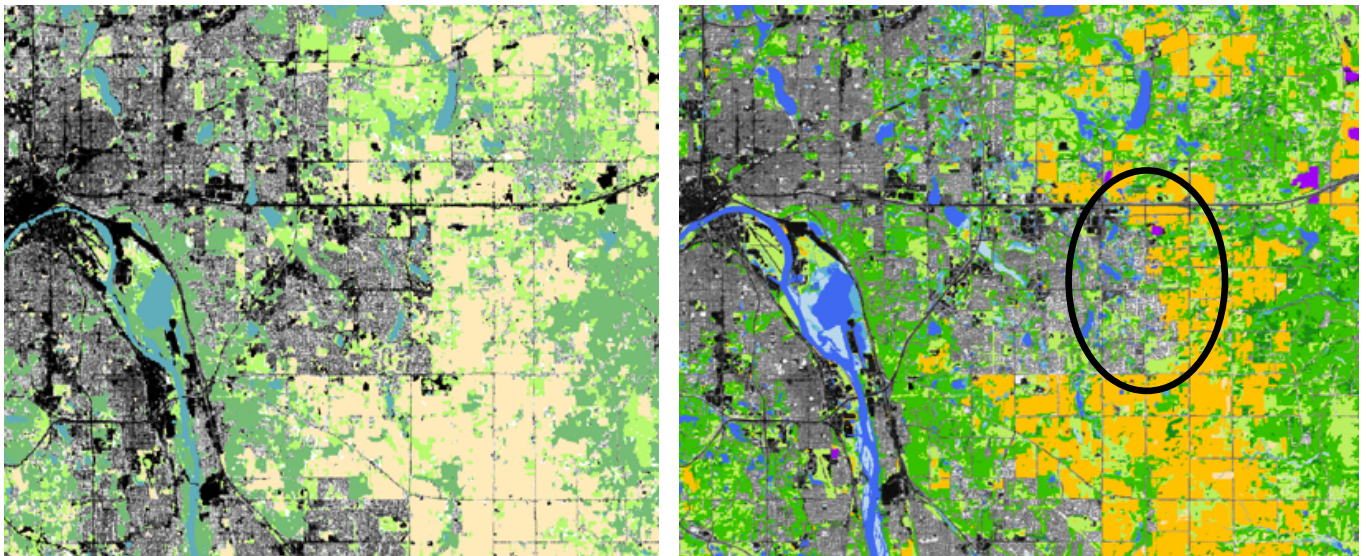
Urbanization in Woodbury, MN (center frame, circled) from 2000 (left image) to 2014 (right image) is an example of the significant development occurring in the Twin Cities Metropolitan Area and other cities in Minnesota. Urban areas appear as gray and black.

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Institution Description

The flagship University of Minnesota Twin Cities is the state's land-grant university and one of the most prestigious public research universities in the nation.

- Our 3,800 faculty include members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine, plus the American Academy of Arts and Sciences, among other bodies.
- Current and former faculty have won Guggenheim Fellowships, MacArthur Fellowships ("genius grants"), Nobel Prizes, and other significant honors.
- While nationwide the average time spent with an employer is four years, employees stay at the U of M for an average of eight years. They stay because they know their work matters.

Research: We seek new knowledge that can change how we all work and live. At the University of Minnesota, students do research alongside top professors in all majors.

Education: We prepare students to meet the great challenges facing our state, our nation, and our world. U of M students engage with your professors and fellow students from the very beginning, and develop strengths with beyond-the-classroom experiences.

Outreach: We apply our expertise to meet the needs of Minnesota, our nation, and the world. We partner with communities across Minnesota to engage our students, faculty, and staff in addressing society's most pressing issues.

Remote Sensing and Geospatial Analysis Laboratory
The facilities of the Remote Sensing and Geospatial Analysis Lab (RSGAL) include up to date hardware and the relevant software for image processing and geospatial analysis, as well as a wide array of ancillary and supporting equipment. Lab hardware includes: Twelve workstation class computers, servers, GPS receivers, spectroradiometers, and a SenseFly eBee UAV. A suite of applications software provides state-of-the-art capabilities for image processing, mapping, modeling, statistical analysis, and visualization.

Project Leader Qualifications

Joseph Knight is an Associate Professor of Remote Sensing in the Department of Forest Resources at the University of Minnesota, Twin Cities. Dr. Knight studies how changing land use affects both natural resources and humans. He uses geospatial science methods such as remote sensing, image processing, and geographic information systems (GIS) in applications such as: identifying and characterizing natural and anthropogenic landscape change to assess impacts on natural resources, wetlands mapping and characterization, describing landscape-human interactions that lead to exposure to infectious diseases, and thematic accuracy assessment methods development.