# Environment and Natural Resources Trust Fund
# 2015 Request for Proposals (RFP)

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

A Foundational Dataset Characterizing Historic Forest Disturbance Impacts

**Category:**    A. Foundational Natural Resource Data and Information

**Total Project Budget: $**   323,161

**Proposed Project Time Period for the Funding Requested:**    3 years, July 2015 - June 2018

**Summary:**

Quantify forest disturbance impacts over the past 40 years for applications in natural resource management, and demonstrate dataset utility by relating patterns with water quality, wildlife demographics, and woodfiber supply

**Name:**    Michael           Falkowski

**Sponsoring Organization:**  U of MN

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**Web Address**

## Location

**Region:**   NW, NE

**County Name:**   Aitkin, Becker, Beltrami, Carlton, Cass, Clearwater, Cook, Crow Wing, Hubbard, Itasca, Koochiching, Lake, Lake of the Woods, Pine, St. Louis

**City / Township:**

**Alternate Text for Visual:**

Utilize historic satellite imagery to quantify the timing, type, and magnitude of disturbance

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

**PROJECT TITLE: A foundational dataset characterizing historic forest disturbance impacts**

# I. PROJECT STATEMENT

Forest disturbance dynamics (arising from harvesting, fire, land conversion, etc.) have a fundamental control on the health and resilience of multiple forest resources including water quality, wildlife habitat, and wood resources, among others. Disturbance impacts on forest resources can persist across a landscape for decades. Understanding disturbance dynamics and associated impacts is readily recognized as being critically important to developing forest management responses that that *improve and sustain* forest resources. Despite this recognition, until recently it has been nearly impossible to quantify and interpret disturbance configurations (type, timing, and pattern) that have persistent impacts on forest resources. Recently the United States Geological Survey made a revolutionary decision by allowing open access to a 40-year historic archive of Landsat satellite data, providing a *new opportunity* to assess historic forest disturbance dynamics. These satellite-derived disturbance observations can be used to (i) determine the fundamental drivers of past disturbance and (ii) assess the impacts of disturbances on current forest resources. *A foundational dataset characterizing historic forest disturbance dynamics -and related resource impacts- would be a powerful tool for identifying threshold disturbance patterns that negatively impact multiple forest resources across Minnesota.* This foundational dataset will allow us to evaluate how disturbance and landuse configuration over the past 40 years have influenced the current status of forest resources, and ultimately help to identify management responses that *improve and sustain* forest resources into the future.

The *overarching goals* of this project are to:
1. Develop a foundational dataset characterizing historic forest disturbance dynamics across MN,
2. Employ this dataset to quantify the impact of historic disturbances on the resilience of three key forest resources: water quality, wildlife habitat, and wood fiber, and
3. Demonstrate the utility of this dataset for informing forest management responses to disturbance across forested watersheds and landscapes of MN.

*This foundational dataset will ultimately guide forest management response aimed at avoiding or mitigating persistent detrimental impacts of forest disturbance on forest resources.* For example, forest managers will *be better equipped* to strategically plan disturbance *mitigation practices where risks to forest resources are high, or manipulate disturbed areas to enhance forest response in a manner beneficial to multiple resources. **This study is critical now because**:*

- Our forests are facing multiple disturbance threats including insect outbreaks, fire, conversion to agriculture, and climate related stress, which will only increase under project climate change.
- Understanding how past disturbances have influenced current forest resources is essential to improving and sustaining future resource conditions under existing and eminent threats.
- The dataset will serve as a basis for continued assessment of forest resource threats including ongoing forest conversion to agriculture and development, as well as natural disturbacne.

# II. PROJECT ACTIVITIES AND OUTCOMES

**Activity 1: Process Landsat satellite imagery into a useable format**　　　**Budget: $ 67,122**
Although Landsat data are now available free of charge from the USGS, processing is required to transform them into a useable format. We will acquire and process archived Landsat imagery that encompasses the forested region of Minnesota (~16 million acres). Specifically, this imagery will be obtained on a bi-monthly basis during all growing seasons over the last 40 years (1974-Present). In total we will acquire and process approximately 2,800 images depending on availability of suitable, cloud-free imagery. This represents approximately *$1.2 million in cost savings*, based on historic image prices.

1

| Outcome | Completion Date |
|---|---|
| 1. Complete Acquisition and Local Storage of Landsat Imagery | October 2015 |
| 2. Complete Pre-processing of Landsat Imagery | March 2016 |

**Activity 2: Disturbance database development and classification**      **Budget: $ 121,302**
We will employ a Landsat time series image analysis algorithm to detect forest disturbances from 1974-Present. Image processing algorithms will be subsequently employed to classify the timing, type (i.e., cause), and impact duration of each disturbance identified. Following disturbance identification and classification, historical information (e.g., FIA data, aerial photography, forest health surveys) and field data will be used to validate the disturbance products. Furthermore, these satellite-based disturbance detections combined with other long-term monitoring datasets (e.g., FIA data, county forest inventories, aerial surveys of forest insects, wildlife habitat and population surveys) to assess disturbance impacts on resources.

| Outcome | Completion Date |
|---|---|
| 1. Disturbance patterns from 1974-2015 Identified | June 2016 |
| 2. Disturbances classified into primary categories | October 2016 |
| 3. Database with validated disturbance patterns over time completed | March 2017 |

**Activity 3: Development of spatial descriptors and application of findings**      **Budget: $ 134,737**
Statistical descriptors of the disturbance patterns will be derived from the disturbance database. These statistical descriptors will be integrated into models assessing the impacts on the current status of three critical resources: water quality, wildlife habitat (e.g., deer, ruffed grouse), and wood resources (specifically timber volume, biomass, mortality, and carbon storage). Through this process we will identify management responses that will sustain and or improve forest resources under future disturbances. Results quantifying the impacts of disturbance dynamics on the health and resilience of forest resources will be summarized in public project reports and conveyed to forest managers through outreach activities.

| Outcome | Completion Date |
|---|---|
| 1. Develop statistical descriptors of disturbance patterns | August 2017 |
| 2. Model impacts of disturbance dynamics on forest resources | January 2018 |
| 3. Publish project summaries and conduct outreach activities | June 2018 |

## III. PROJECT STRATEGY
### A. Project Team/Partners
The Project team includes scientists at the University of Minnesota, Department of Forest Resources, namely Dr. Michael Falkowski, Dr. Alan Ek, Dr. Tony D'Amato, Dr. Joe Knight, Dr. Matthew Russell and Dr. Linda Nagel, as well as Dr. Robert Slesak, a scientist with the Minnesota Forest Resources Council. We will be collaborating closely with DNR's Forest Wildlife Habitat and Resources Assessment sections for work outlined in Activity 3, and partner with the Superior National Forest, University of Minnesota Extension, and several counties in northern Minnesota for application of findings.

### B. Project Impact and Long-Term Strategy
Given the fundamental importance of disturbance dynamics to the management of natural resources (e.g., water, wildlife, wood resources, etc.), the information generated from this historic assessment will be a powerful tool for ongoing and future strategic planning to sustain Minnesota's forest resources. This project complements another project being conducted by MN DNR to evaluate current and future disturbance patterns to assess potential risks to water quality in forested watersheds of MN.

### C. Timeline Requirements
The project duration is 3 years. The requested time is necessary to acquire and process suitable Landsat imagery, develop and validate the disturbance database, and demonstrate the utility of the dataset with application to forest wildlife habitat, water quality, and forest productivity.

# 2015 Detailed Project Budget

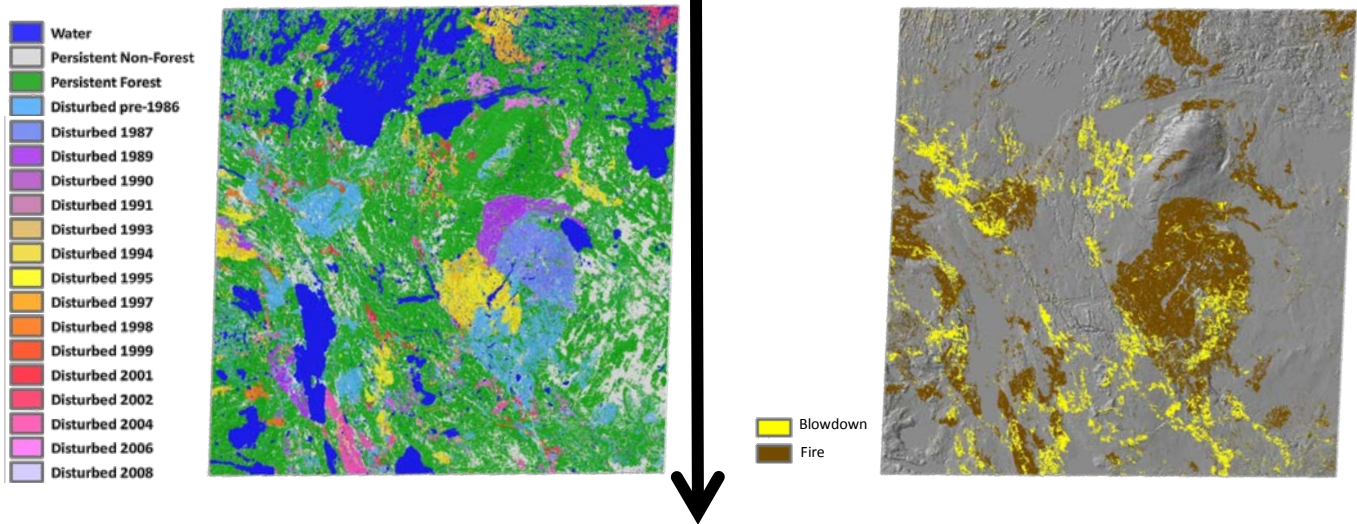**Project Title:** A foundational dataset characterizing historic forest disturbance impacts

## IV. TOTAL ENRTF REQUEST BUDGET 3 years

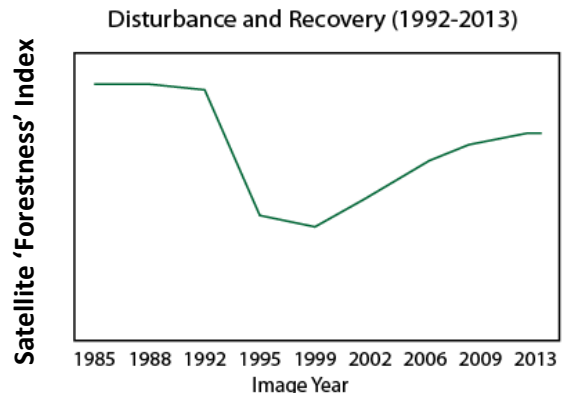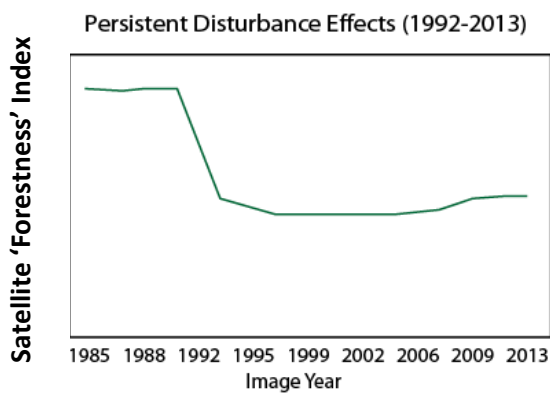| BUDGET ITEM | AMOUNT |
|---|---|
| **Personnel:** Salary and fringe (0.336) for Falkowski (0.27 FTE), Research Associate (0.9 FTE), and technician (0.2 FTE; 0.743 fringe) for 3 years. | $ 311,661 |
| **Equipment/Tools/Supplies:** Supplies including data storage hardware for Landsat data (e.g., external hardrives) | $ 1,500 |
| **Travel:** Travel within Minnesota. This money will be used to pay for mileage (75%) and lodging (25%) for reseachers and field technician for data collection and validation of the disturbance products, as well as outreach activities. | $ 10,000 |
| **TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =** | $ 323,161 |

## V. OTHER FUNDS

| SOURCE OF FUNDS | AMOUNT | Status |
|---|---|---|
| **Other Non-State $ To Be Applied To Project During Project Period:** *Indicate any additional non-state cash dollars secured or applied for to be spent on the project during the funding period. For* | NA | NA |
| **Other State $ To Be Applied To Project During Project Period:** *Indicate any additional state cash dollars (e.g., bonding, other grants) secured or applied for to be spent on the project during the* | NA | NA |
| **In-kind Services To Be Applied To Project During Project Period:** Satellite Imagery from the USGS Landsat Archive (approximately 2,800 images) | NA | NA |
| **Funding History:** *Indicate funding secured but to be expended prior to July 1, 2015, for activities directly relevant to this specific funding request, including past and current ENRTF funds. State specific source(s) of fund and dollar amount.* | NA | NA |
| **Remaining $ From Current ENRTF Appropriation:** *Specify dollar amount and year of appropriation from any current ENRTF appropriation for any directly related project of the project manager or organization that remains unspent or not yet legally obligated at the time of proposal submission. Be as specific as possible. Indicate the status of the funds.* | NA | NA |

# Utilize historic satellite imagery to quantify the timing, type, and magnitude of disturbance



Legend:
- Water
- Persistent Non-Forest
- Persistent Forest
- Disturbed pre-1986
- Disturbed 1987
- Disturbed 1989
- Disturbed 1990
- Disturbed 1991
- Disturbed 1993
- Disturbed 1994
- Disturbed 1995
- Disturbed 1997
- Disturbed 1998
- Disturbed 1999
- Disturbed 2001
- Disturbed 2002
- Disturbed 2004
- Disturbed 2006
- Disturbed 2008



Legend:
- Blowdown
- Fire

# Develop disturbance metrics that describe disturbance dynamics and recovery over time



Persistent Disturbance Effects (1992-2013)

Satellite 'Forestness' Index vs Image Year



Disturbance and Recovery (1992-2013)

Satellite 'Forestness' Index vs Image Year

# Relate the metrics to water, wildlife, and wood fiber datasets to determine the influence of disturbance patterns on natural resources



Water quality parameter vs Disturbance index 1



Ruffed Grouse Habitat vs Disturbance index 1
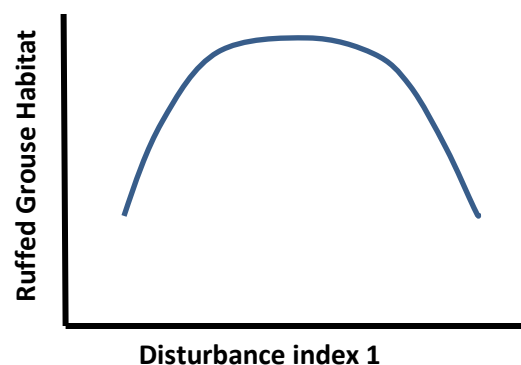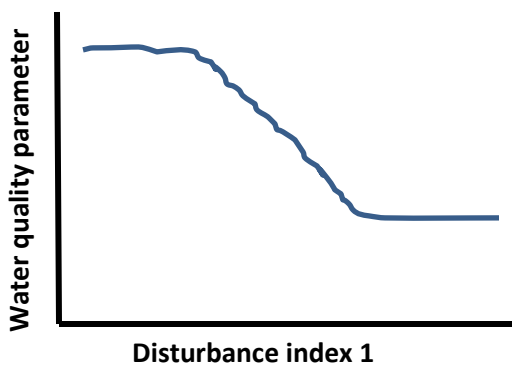
# Incorporate information into strategic planning efforts to achieve ideal disturbance configurations arising from natural events and management actions (e.g. timber harvest)

**Figure 1.** Example of the workflow we will employ in this project

**A foundational dataset characterizing historic forest disturbance impacts**

**Project Manager Qualifications**

**Michael J. Falkowski**

**Qualifications**
Michael is a Research Associate Professor of Remote Sensing and Applied Landscape Ecology in the Department of Forest Resources, University of Minnesota. He conducts teaching, research, and participates in outreach/Extension programs. His research primarily focuses on using remote sensing and geospatial information to support sustainable forest management. His primary outreach audiences are natural resource managers and forestry practitioners

Michael has been the principal investigator and project manager on several large-scale projects funded via a variety of federal and state agencies. He has published numerous peer-reviewed and non-technical articles which addressing novel applications of remote sensing and geospatial data in forest resource assessment and management.

**Responsibilities**
As Project Manager, Michael would coordinate and manage the overall project, coordinate the establishment of foundational disturbance dataset (Activity 1), provide oversight for the validation (Activity 2), and application (Activity 3) of the dataset. In the coordination and management role, he would convene meetings of project participants throughout the life of the project to facilitate collaborative efforts, share results, discuss future directions, and identify additional outreach opportunities that could be pursued. His research would focus on evaluating the management implications of disturbance dynamics (Activity 3).

**Organization Description**
The Department of Forest Resources is part of the University of Minnesota.