

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

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**Project Title:**

**ENRTF ID: 013-A**

Assessing Ecosystem Services Provided by Lichens and Mosses

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

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**Total Project Budget:** \$ 213,000

**Proposed Project Time Period for the Funding Requested:** 3 years, July 2018 to June 2021

**Summary:**

The proposed project aims to better understand the impacts that moss and lichens may have on water and pollution.

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**Name:** Daniel Stanton

**Sponsoring Organization:** U of MN

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Saint Paul MN 55108

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**Location**

**Region:** Statewide

**County Name:** Statewide

**City / Township:**

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**Alternate Text for Visual:**

Visual contains a line drawing of a tree with moss and lichens of various types growing on the trunk and branches.

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



**Environment and Natural Resources Trust Fund (ENRTF)**

**2018 Main Proposal**

**Project Title: Assessing ecosystem services provided by lichens and mosses**

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**I. PROJECT STATEMENT**

Although usually small and unassuming, lichens and mosses are among some of the most impressive organisms in our landscape: they easily withstand freezing and drying; in fact, one of the common orange lichens of the North Shore has been shown to be able to withstand outer-space! This tolerance comes primarily from two characteristics: (1) the ability to take up water rapidly, sometimes even from moist air and (2) the ability to derive most or all of their nutrition from dust, rain and air. These characteristics also illustrate how lichens and moss are likely to affect their surroundings: by holding moisture in the canopy of trees and by retaining minerals and pollutants (see Visual). This project will combine surveys and experiments to provide an accurate assessment of what the effects of mosses and lichens are on pollutant and water retention in Minnesota, and how these effects are distributed across the state. For this we will draw on resources that make Minnesota one of the best states in the country for this work, including extensive background knowledge established by the DNR, world-class historical collections at the University of Minnesota and skilled experts.

**II. PROJECT ACTIVITIES AND OUTCOMES**

**Activity 1:** Pollution and nutrient retention by lichens and moss

**Budget: \$145,000**

One of the notable characteristics of both lichens and mosses is their ability to derive most of their nutrition from the air and dust. This makes them particularly susceptible to accumulating pollutants, and the abundance and identities of lichens and mosses on trees have been used as low-cost indicators of airborne pollutants. But this property has a different relevance if the lichens and moss survive: they effectively become a filter selectively retaining airborne pollutants when dosages are moderate. The scale of this potential effect is unknown, and most likely varies with lichen/moss cover across the state. This part of the project would fund a technician and 2 undergraduate students to collect common species of lichen and moss across the state, including estimates of their local abundance. Each summer at least 8 sites will be visited, with the aim of sampling representatives of all of the state’s common forest types by the end of the project, as well as urban trees and apple orchards. During the fall and spring, these samples will be analyzed for common nutrients (e.g. nitrate and ammonia) and pollutants (e.g. sulfur, heavy metals) at the University of Minnesota. Additional specimens collected at the same time will be used for Activity 2. The results of the analysis will be combined with state vegetation maps to create maps of potential environmental filter effects of lichens and mosses for the state, since the effects are likely to vary with climate and forest type.

<b>Outcome</b>	<b>Completion Date</b>
<i>1. Survey of lichen and moss cover at representative sites across state</i>	<i>Sept. 2020</i>
<i>2. Analysis of lichen and moss samples for pollutant and nutrient content</i>	<i>June 2021</i>
<i>3. Mapping of environmental filter effects of lichens and mosses</i>	<i>June 2021</i>

**Activity 2:** Water retention by lichens and moss in tree canopies

**Budget: \$55,000**

The water content of lichens and mosses varies frequently and dramatically, and many species are able to hold many times their weight in water (up to 20 times for some mosses!). This water can be taken up from rain, but also often dew, fog and even moist air. All this water in the canopy can make the canopies of trees considerably cooler and moister, but the existing studies of the scale of this impact have so far been conducted in the Pacific Northwest and the tropics, and may be limited direct applicability to the Minnesota landscape. This part of the project would make use of the specimens and survey information collected in Activity 1 to measure the water-holding capacity of lichens and moss and calculate their potential tree-scale impact. Protocols are already in place for measuring lichen water-holding capacity on the Saint Paul campus of the University of Minnesota, and



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funds are sought to hire 2 student technicians during the school year to process samples. As in Activity 1, the lab analyses and the survey data will be combined with vegetation maps to create state-wide maps of potential hydrological impacts of lichens and mosses on trees.

<b>Outcome</b>	<b>Completion Date</b>
1. <i>Measurements of water holding capacity of common lichens and mosses of MN</i>	<i>Jan. 2021</i>
2. <i>Mapping of hydrological impacts of lichens and mosses</i>	<i>June 2021</i>

**Activity 3:** Experimental removal of lichens and moss in trees

**Budget: \$13,000**

The final component of this project is the experimental removal of mosses and lichens to directly measure the resulting impact on trees. This is too time-consuming an effort to be carried out at all of the survey sites, but will provide more detailed measurements of the effects of lichens and mosses on trees, including the seasonal and year-to-year variation in their importance. This portion of the project would establish experiments at 4 sites across the state (Ely, Itasca, Anoka and the Minnesota Arboretum) representing a wide variety of Minnesota forested landscapes. We have conducted a pilot experiment in a black spruce bog at Marcell Experimental Forest near Grand Rapids in the spring of 2017, which will be maintained as well. The effects of removing lichens on tree microclimate (temperature, humidity, etc) will be measured with custom-made sensors developed at the U of MN and the effects on chemical composition measured with resin bags.

<b>Outcome</b>	<b>Completion Date</b>
1. <i>Set up of lichen and moss removal experiments</i>	<i>Sept. 2019</i>
2. <i>Measurement of effects on tree water and chemistry</i>	<i>June 2021</i>

**III. PROJECT STRATEGY**

**A. Project Team/Partners**

Project Team: PI (receives funding) Daniel Stanton (University of Minnesota). Project Partners: Courtney Kerns (Itasca Community College), Otto Gockman and John Thayer (Midwest Natural Resources)

**B. Project Impact and Long-Term Strategy**

The proposed project will provide previously unavailable estimates of the contributions of lichens and mosses to Minnesota ecosystem function, including their impact on water resources and airborne pollutants/nutrients. This will provide key information on the ecosystem services provided by lichens and mosses, and facilitate the inclusion of lichens and mosses in management strategies, including restoration and remediation efforts.

**C. Timeline Requirements**

We are requesting support for 36 months. Survey work and sample collection (Activities 1 and 2) will be conducted at at least 5 sites each summer of the project, with analyses conducted during the fall and spring. In the first 18 months, experiments (Activity 3) will be set up and monitored during the remainder of the project.

## 2018 Detailed Project Budget

Project Title: Assessing ecosystem services provided by lichens and mosses

### IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM	AMOUNT
<b>Personnel:</b> A junior scientist will lead the fieldwork teams of undergraduate students, as well as the sample processing and analyses. Salary is calculated as \$35,000 annually plus 27.2% benefits, with 3% inflation for subsequent years. (79% salary, 21% benefits) 100% FTE each year	\$ 138,000
<b>Personnel:</b> Undergraduate student workers, 2 for each summer and academic year, to assist with collection and processing of samples. Salaries are calculated as \$1,500 per academic semester and \$4,500 for summers. (100% salary, 0% benefits) 20% FTE each year	\$ 45,000
<b>Equipment/Tools/Supplies:</b> Custom-made sensors (~\$300 each) and resin bags will be installed at each experimental removal site to repeatedly record the effects of moss and lichen removal on plant microclimate and runoff chemistry	\$ 11,000
<b>Travel:</b> Mileage reimbursement (Univ. MN rate of \$ 0.535 / mile) for travel to research sites outside of Mpls - St. Paul.	\$ 4,000
<b>Additional Budget Items:</b> Sample analyses. Chemical analyses of moss and lichens from across the state. Analyses will measure carbon, nitrogen content and 27 ions including heavy metals at \$33/sample with 150 samples analyzed each year.	\$ 15,000
<b>TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =</b>	<b>\$ 213,000</b>

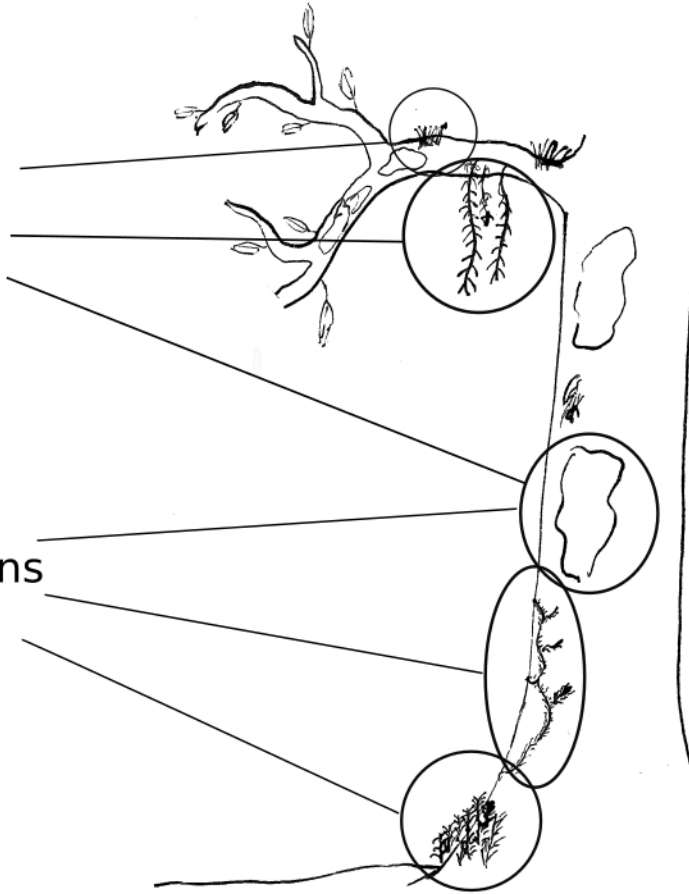
### V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

SOURCE OF FUNDS	AMOUNT	Status
<b>Other Non-State \$ To Be Applied To Project During Project Period:</b>	N/A	N/A
<b>Other State \$ To Be Applied To Project During Project Period:</b>	N/A	N/A
<b>In-kind Services To Be Applied To Project During Project Period:</b> Indirect costs associated with this proposal	\$ 115,000	Secured
<b>Past and Current ENRTF Appropriation:</b>	N/A	N/A
<b>Other Funding History:</b>	N/A	N/A

**Two important ways in which mosses and lichens may affect Minnesota forests:**

**Water holding:** Mosses and lichens hold water, keeping canopies moist and reducing what reaches the ground

**Pollutant/Nutrient retention:** Mosses and lichens capture chemicals from dust and rain, changing what enters soil and groundwater



**How can we study them?**

**Surveys:**

- How much moss and lichen is there on trees in different part of MN?
- What are the most common kinds?

**Analyses:**

- What is the average chemical content of the common species (e.g. nitrogen, heavy metals, etc)?
- How much water are the common species holding?

**Experiments:**

- If we remove most of the moss and lichens, how does the canopy microclimate change? What about the chemistry of run-off from the trunk?

**Synthesis:**

- What is the potential *ecosystem service* contribution of moss and lichens to different parts of MN?

**PROJECT TITLE: Assessing ecosystem services provided by lichens and mosses**

**Project Manager Qualifications and Organization Description:**

Daniel Stanton, Dept. of Ecology, Evolution and Behavior, University of Minnesota

My research focuses on how some plants cope with difficult environments, and what consequences those coping strategies have on their surroundings. In particular I have worked on lichens and mosses at sites around the world, from their effects on trees in South American deserts to understanding how the shape of mosses adapts them to Antarctica. I am currently running experiments on Minnesota lichens near Grand Rapids, and managing the Lichen and Moss collections at the University of Minnesota Bell Herbarium. As an instructor and educator I have taught courses on Minnesota Flora and Flowering Plant Diversity, as well as participated in outreach to the general public, invited lectures on lichens at the Minnesota Naturalists Association and various Nature Centers and training workshops with park rangers.

Dr. Stanton has a Ph.D. in Ecology and Evolutionary Biology from Princeton University (2011) and a double B.S. in Botany/Biochemistry from University of Wisconsin-Madison.

**Organization Description**

The Department of Ecology, Evolution and Behavior and the University of Minnesota are dedicated to supporting biological research that integrates knowledge across levels of biological complexity. This includes field research, the development of collections, and the management of ecosystems. The institution is dedicated to teaching and research, especially as it pertains to biological issues that affect society.