



# Environment and Natural Resources Trust Fund (ENRTF)

## M.L. 2018 ENRTF Work Plan (Main Document)

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**Today's Date:** December 15, 2017

**Date of Next Status Update Report:** January 31, 2019

**Date of Work Plan Approval:**

**Project Completion Date:** June 30, 2021

**Does this submission include an amendment request?** no

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

**Project Manager:** Daniel Stanton

**Organization:** University of Minnesota-Twin Cities

**College/Department/Division:** College of Biological Sciences/Ecology, Evolution and Behavior

**Mailing Address:** 140 Gortner Laboratory, 1479 Gortner Avenue

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**Email Address:** stan0477@umn.edu

**Web Address:** www.dstantonlab.com

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**Location:** Statewide

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

**Amount Spent:** \$0

**Balance:** \$213,000

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**Legal Citation:** M.L. 2018, Chp. xx, Sec. xx, Subd. xx

**Appropriation Language:**

**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. 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. 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 Minnesota Department of Natural Resources, world-class historical collections at the University of Minnesota and skilled experts.

**II. OVERALL PROJECT STATUS UPDATES:**

**First Update January 31, 2019**

**Second Update June 30, 2019**

**Third Update January 31, 2020**

**Fourth Update June 30, 2020**

**Fifth Update January 31, 2021**

**Final Update June 30, 2021**

**III. PROJECT ACTIVITIES AND OUTCOMES:**

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

**Description:** 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. The scale of this potential effect is unknown, and likely varies 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. The results of the analysis will be combined with state vegetation maps to create maps of potential environmental filter effects of lichens and mosses, since the effects are likely to vary with climate and forest type. This data will be made publicly available through the Bell Museum of Natural History Online Atlas and contributed to national databases using lichens and bryophytes as low-cost indicators of air-quality.

**ENRTF BUDGET: \$99,000**

| Outcome   | Completion Date |
|---|-----------------|
| 1. Survey of lichen and moss cover at representative sites across state | October 2020    |

|   |            |
|---|------------|
| 2. Analysis of lichen and moss samples for pollutant and nutrient content | April 2021 |
| 3. Mapping of environmental filter effects of lichens and mosses          | June 2021  |

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

**Description:** 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 I to measure the water-holding capacity of lichens and moss and calculate their potential tree-scale impact. The project will determine predictors of water-holding capacity and drying rates of common lichens and mosses of Minnesota. This information will be combined with the aforementioned abundance data to generate maps of potential hydrological effects of lichens and bryophytes in forests.

**ENRTF BUDGET: \$55,000**

| <b>Outcome</b>   | <b>Completion Date</b> |
|--|------------------------|
| 1. Measurements of water holding capacity of common lichens and mosses of MN | April 2021             |
| 2. Mapping of hydrological impacts of lichens and mosses                     | June 2021              |
| 3.   |                        |

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

**Description:** 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, Cloquet and Anoka) 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. Direct tests of the impacts of forest lichen and bryophytes will be conducted at four sites representing different forest types. The measured effects of lichens and bryophytes on microclimate and stem-flow chemistry will be written up and published in scientific journals, as well as communicated to the general public in signage at the experimental sites.

**ENRTF BUDGET: \$59,000**

| Outcome   | Completion Date |
|---|-----------------|
| 1. Set up of lichen and moss removal experiments      | April 2019      |
| 2. Measurement of effects on tree water and chemistry | June 2021       |
| 3.  |                 |

**First Update January 31, 2019**

**Second Update June 30, 2019**

**Third Update January 31, 2020**

**Fourth Update June 30, 2020**

**Fifth Update January 31, 2021**

**Final Update June 30, 2021**

**IV. DISSEMINATION:**

**Description:** Research findings will be disseminated to both general and academic audiences using a variety of platforms:

Scientific Publications: The proposed research is expected to generate several scientific research publications

Data Availability: The majority of the data generated by this project will be made freely available. Voucher specimens for all lichen and bryophyte samples will be deposited at the Bell Museum of Natural History Herbarium (MIN), which will include adding the records to the publicly accessible Bell Atlas (<http://bellatlas.umn.edu>). The maps of lichen and bryophyte impacts on forests will also be made freely available through the Bell Museum webpage. The FIA protocol survey data and the measurements of chemical composition of common lichens and bryophytes will be added to the National Lichens and Air Quality database (<http://gis.nacse.org/lichenair/>).

Public Outreach Activities: The findings from this project will be communicated to the general public through several venues in addition to simply making the data available. D. Stanton is a coordinator for “Market Science” outreach program at the University of Minnesota College of Biological Sciences, which helps scientists at the UMN bring their research to the public at farmer’s markets and

county fairs. We will develop a module for the Market Science format, and present it at multiple venues in years 2 and 3 of the project. Additionally, we will develop outreach activities with Bell Museum of Natural History.

**First Update January 31, 2019**

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**Final Update June 30, 2012**

**V. PROJECT BUDGET SUMMARY:**

**A. Preliminary ENRTF Budget Overview:** See attached budget spreadsheet

**Explanation of Capital Expenditures Greater Than \$5,000:** NA

**Explanation of Use of Classified Staff:** NA

**Total Number of Full-time Equivalent (FTE) Directly Funded with this ENRTF Appropriation:**

|  |                              |
|--|------------------------------|
| Enter Total Estimated Personnel Hours:                 | Divide by 2,080 = TOTAL FTE: |
| 6240 (junior scientist) + 1248 (undergraduates) = 7488 | 3.6                          |

**Total Number of Full-time Equivalent (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:**

|  |                              |
|--|------------------------------|
| Enter Total Estimated Personnel Hours: | Divide by 2,080 = TOTAL FTE: |
|--|------------------------------|

**B. Other Funds:**

| SOURCE OF AND USE OF OTHER FUNDS  | Amount Proposed | Amount Spent | Status and Timeframe |
|---|-----------------|--------------|----------------------|
| <b>Other Non-State \$ To Be Applied To Project During Project Period:</b> |                 |              |                      |
|   | \$              | \$           | N/A                  |
| <b>Other State \$ To Be Applied To Project During Project Period:</b>     |                 |              |                      |
|   | \$              | \$           | N/A                  |
| <b>Past and Current ENRTF Appropriation:</b>                              |                 |              |                      |
|   | \$              | \$           | N/A                  |
| <b>Other Funding History:</b>   |                 |              |                      |

|  |            |            |                                     |
|--|------------|------------|-------------------------------------|
|  |            |            |                                     |
| Indirect costs associated with this proposal | \$ 115,000 | \$ 115,000 | Secured July 1 2018 to June 30 2021 |

**VI. PROJECT PARTNERS:**

**A. Partners receiving ENRTF funding**

| Name | Title | Affiliation | Role |
|------|-------|-------------|------|
|      |       |             |      |

**B. Partners NOT receiving ENRTF funding**

| Name           | Title | Affiliation               | Role  |
|----------------|-------|---------------------------|---|
| Otto Gockman   |       | Midwest Natural Resources | Assistance on specimen identification and mapping   |
| Courtner Kerns |       | Itasca Community College  | Advice on fieldwork planning, student recruitment and assistance on specimen identification |
| John Thayer    |       | Minnesota Wildflowers     | Assistance on specimen identification and mapping   |

**VII. LONG-TERM- IMPLEMENTATION AND FUNDING:**

The majority of the data generated by this project will be made freely available. Voucher specimens for all lichen and bryophyte samples will be deposited at the Bell Museum of Natural History Herbarium (MIN), which will include adding the records to the publicly accessible Bell Atlas (<http://bellatlas.umn.edu>). The maps of lichen and bryophyte impacts on forests will also be made freely available through the Bell Museum webpage. The FIA protocol survey data and the measurements of chemical composition of common lichens and bryophytes will be added to the National Lichens and Air Quality database (<http://gis.nacse.org/lichenair/>), which will enable re-sampling in the future to track changes through time.

**VIII. REPORTING REQUIREMENTS:**

- The project is for 3 years, will begin on 07/01/2018, and end on 06/30/2021.
- Periodic project status update reports will be submitted 01/31 and 06/30 of each year.
- A final report and associated products will be submitted between June 30 and August 15, 2021.

**IX. SEE ADDITIONAL WORK PLAN COMPONENTS:**

- A. Budget Spreadsheet - attached
- B. Visual Component or Map - attached
- C. Parcel List Spreadsheet - NA
- D. Acquisition, Easements, and Restoration Requirements - NA
- E. Research Addendum - Separate attachment

Attachment A:  
 Environment and Natural Resources Trust Fund  
 M.L. 2018 Budget Spreadsheet



Project Title: Assessing the Ecosystem Services Provided by Lichens and Mosses

Legal Citation:

Project Manager: Daniel Stanton

Organization: University of Minnesota

College/Department/Division: College of Biological Sciences/Ecology , Evolution and Behavior Department

M.L. 2018 ENRTF Appropriation: \$213,000

Project Length and Completion Date: 3 years, June 30 2021

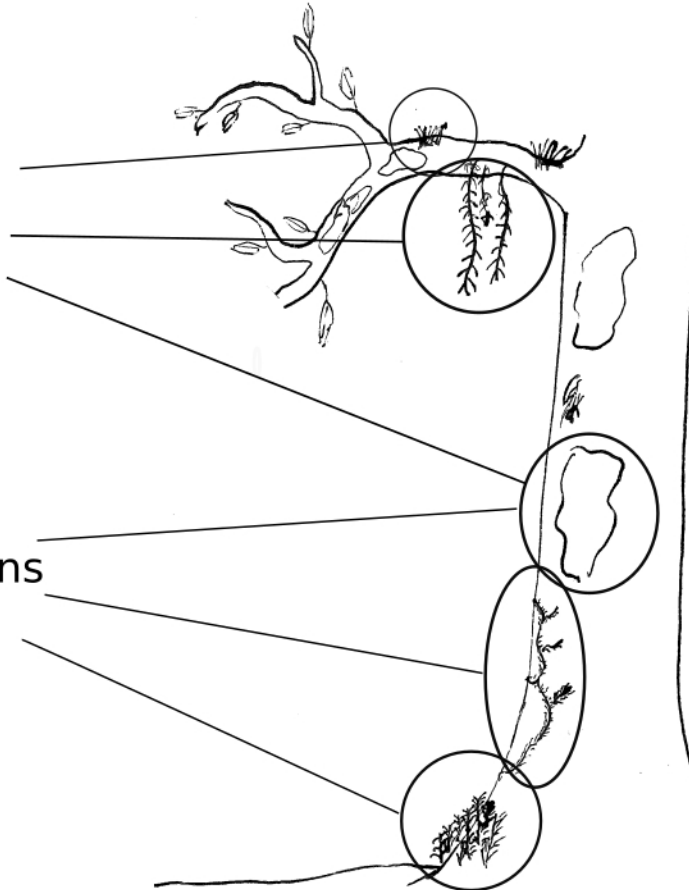
Date of Report: February 19, 2018

| ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET  | BUDGET    | AMOUNT SPENT | BALANCE   |
|--|-----------|--------------|-----------|
| <b>BUDGET ITEM</b>   |           |              |           |
| <b>Personnel (Wages and Benefits)</b>  |           |              |           |
| Undergraduate student workers, 2 for each summer and academic semester, 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 for 3 years                            | \$45,000  | \$0          | \$45,000  |
| A junior scientist will lead the fieldwork teams of undergraduate students, as well as the sample processing and analyses. <i>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 for 3 years</i> | \$138,000 | \$0          | \$138,000 |
| <b>Equipment/Tools/Supplies</b>  | \$11,000  | \$0          | \$11,000  |
| Custom-made sensors (~\$300 each) ~32 sensors  |           |              |           |
| Resin Bags \$1,400   |           |              |           |
| <b>Travel expenses in Minnesota</b>  |           |              |           |
| Mileage for travel to sampling sites   | \$4,000   | \$0          | \$4,000   |
| <b>Other</b>   |           |              |           |
| 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  | \$0          | \$15,000  |
| <b>COLUMN TOTAL</b>  | \$213,000 | \$0          | \$213,000 |

**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?