OpenRiver

Student Research and Creative Projects 2020-2021

Grants & Sponsored Projects

9-1-2020

The Role of Soil Health and Fertility in Reclaiming Mined Peatland Areas

Logan Swenson
Winona State University

Candance Kairies-Beatty
Winona State University

Follow this and additional works at: https://openriver.winona.edu/studentgrants2021

Recommended Citation

Swenson, Logan and Kairies-Beatty, Candance, "The Role of Soil Health and Fertility in Reclaiming Mined Peatland Areas" (2020). *Student Research and Creative Projects 2020-2021*. 4.
https://openriver.winona.edu/studentgrants2021/4

This Grant is brought to you for free and open access by the Grants & Sponsored Projects at OpenRiver. It has been accepted for inclusion in Student Research and Creative Projects 2020-2021 by an authorized administrator of OpenRiver. For more information, please contact klarson@winona.edu.

WINONA STATE UNIVERSITY
UNDERGRADUATE STUDENT RESEARCH & CREATIVE PROJECTS
FINAL REPORT

Submit this complete form and a copy of the project end product(s) no later than ten (10) days after the completion of the project. Submit items as email attachments to Grants & Sponsored Projects (grants@winona.edu).

For more information, go to the Student Grants webpage.

Final Report Checklist

The final report **MUST** include this form and the end product (*check to verify inclusion of each component*):

☒ This final report fully completed

☒ A copy of the project end product. Indicate the format of your final product (*select all that apply*):

- ☐ Research Report
- ☐ Presentation
- ☒ Poster
- ☐ Other – Please describe: Click or tap here to enter text.

Note: A copy of the project end product will be forwarded to Krueger Library for archival purposes.

Project Information	
Title of Project: The Role of Soil Health and Fertility in Reclaiming Mined Peatland Areas	
Student Name (PI): Logan Swenson	Student Email: lswenson15@winona.edu
Co-Investigators Names: Click or tap here to enter text.	
Faculty Sponsor: Dr. Kairies-Beatty	Faculty Department: Department of Geosciences
Was this a capstone, senior thesis, or other degree culminating project? No	

Project Abstract

What was the purpose of this research? What were the planned outcomes? What did you do to achieve them? What were the actual outcomes?

Abstract: The Role of Soil Health and Fertility in Reclaiming Mined Peatland Areas

L.J. Swenson*, C.L. Kairies-Beatty, P. Eger, and P. Jones

In Minnesota, American Peat Technology® (APT) harvests and manufactures reed-sedge peat products to be used in the agricultural and water remediation industries. Peat harvesting operations need a permit to mine from the MN Department of Natural Resources, which requires all disturbed areas be reclaimed. In 2016, APT began testing various reclamation techniques, including the use of live stakes, seed mixtures and donor soil to revegetate a final slope at their harvest area. Abnormal rainfall caused flooding of the site and the seed mix was washed off the slope. Live stake survival was estimated to be less than 5% after two growing seasons. No other treatments have been applied to the area and very little has grown on the site. Potential causes for the low stake survival and lack of vegetative growth include poor soil fertility, insufficient moisture or some form of chemical imbalance. The purpose of this work is to evaluate soil health and fertility in disturbed and undisturbed peatlands to determine potential causes for the lack of regrowth. Peat soils were collected along three transects within a grid on the previously harvested unvegetated slope. Grab samples were also collected from a vegetated and non-vegetated area that was previously disturbed about 15 years ago, and an area of undisturbed peatland. All samples were analyzed for pH, % organic matter, moisture content, cation exchange capacity, trace and major elemental concentrations, and nutrient availability to plants. Organic matter and pH in all samples ranged from 71.9% to 90.8% and 5.0 to 6.5, respectively. Plant-available nitrogen concentrations were highest in the near-surface samples collected in the vegetated disturbed area (23.5 to 27.8 ppm) compared to the non-vegetated disturbed area

(7.3 to 14.9 ppm) and ranged from 8.1 to 37.2 ppm for the slope (highest concentration on the upper slope transect) and 0.3 to 1.2 ppm for the natural peatland. For plant-available concentrations of phosphorous and potassium, the range across all samples was 2 to 6 ppm and 6 to 30 ppm, respectively, with no discernable trends. Cation exchange capacity ranged 8.4 to 21.8 meq/100g across all samples.

Key Words: live-stake revegetation, peat soil fertility

1. Logan J. Swenson (* presenter), Undergraduate Student and Candace L. Kairies-Beatty, Professor, Department of Geoscience, Winona State University, Winona, MN, 55987; Paul Eger, Environmental Engineer, Global Minerals Engineering LLC, Hibbing, MN 55746; Peggy Jones, Vice President Sales and Research, American Peat Technology, Aitkin, MN 56431.

The Role of Soil Health and Fertility in Reclaiming Mined Peatland Areas

Logan J. Swenson[1], Candace L. Kairies-Beatty[1], Paul Eger[2], and Peggy Jones[3]
[1]Department of Geoscience, Winona State University; [2]Global Minerals Engineering; [3]American Peat Technology

Introduction

American Peat Technology® (APT; Aitkin, MN) harvests and manufactures reed-sedge peat products for use in the agricultural and water remediation industries. All peat harvesting operations need a permit to mine from the Minnesota Department of Natural Resources, which requires all disturbed areas to be reclaimed.

In 2016, APT began testing various reclamation techniques including the use of live stakes, seed mixtures and donor soil to revegetate a final slope at their harvest area. Abnormal rainfall caused flooding of the site and the seed mix was washed off the slope. Live stake survival was estimated to be less than 5% after two growing seasons. No other treatments were applied to the area and very little has grown on the site. Potential causes for the low stake survival and lack of vegetative growth include poor soil fertility, insufficient moisture or some chemical imbalance. Another previously mined site, which has been undisturbed for 15 years, also exhibits a spotty lack of vegetation growth.

PURPOSE: to evaluate soil health and fertility in the disturbed and undisturbed peatlands, determine potential causes for the lack of regrowth, and provide recommendations for future revegetation efforts.

Methods

Peat soil were collected from multiple locations:

- The previously harvested unvegetated slope using bucket augers to a depth of 24" within a 20' x 200' grid along three transects– lower, middle, and upper at 20, 60, 100, 140, and 180 ft intervals (Figure 1). Homogenized composite samples were complied on site;
- The non-vegetated and sparsely vegetated areas which were previously disturbed about 15 years ago using shovels and trowels to collect grab samples at various depths (Figure 2); and
- An area of undisturbed peatland.

Figure 1. Harvested slope area.

Figure 2. Previously disturbed area.

Sample analysis included:

- Moisture content (Winona State University)
- pH, plant nutrient availability (N, P, K, S, Ca, Mg, Zn, Fe, Mn, Cu, B; Minnesota Valley Testing Laboratories (MVTL), Inc.)

Figure 3. Peat soil sample collected from the harvested slope area.

Results

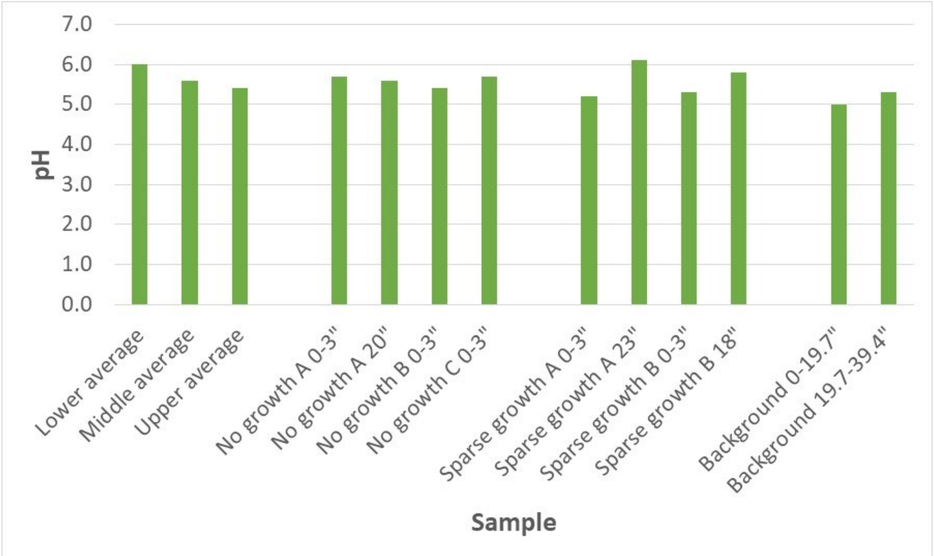

Figure 4. pH of the harvested slope, previously disturbed, and background areas.

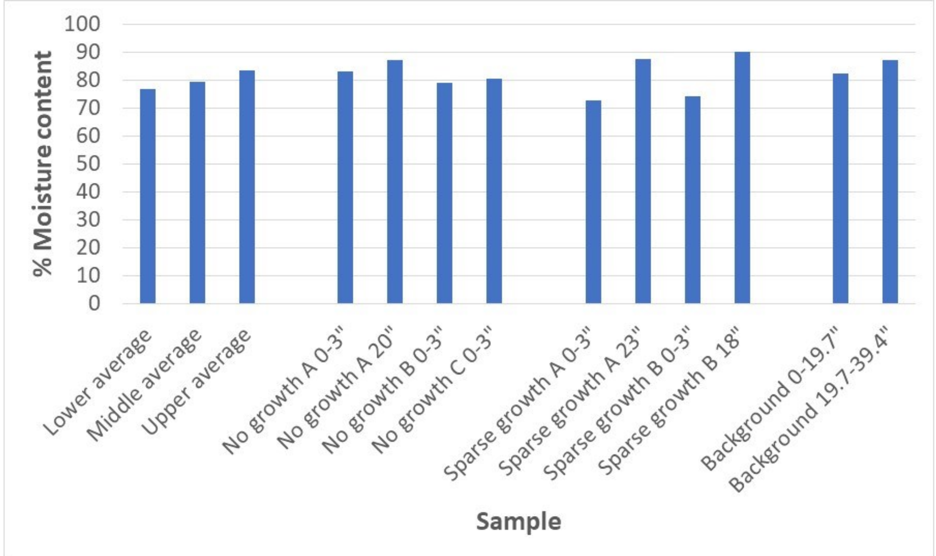

Figure 5. Moisture content calculated as a percent of the wet soil for the harvested slope, previously disturbed, and background areas.

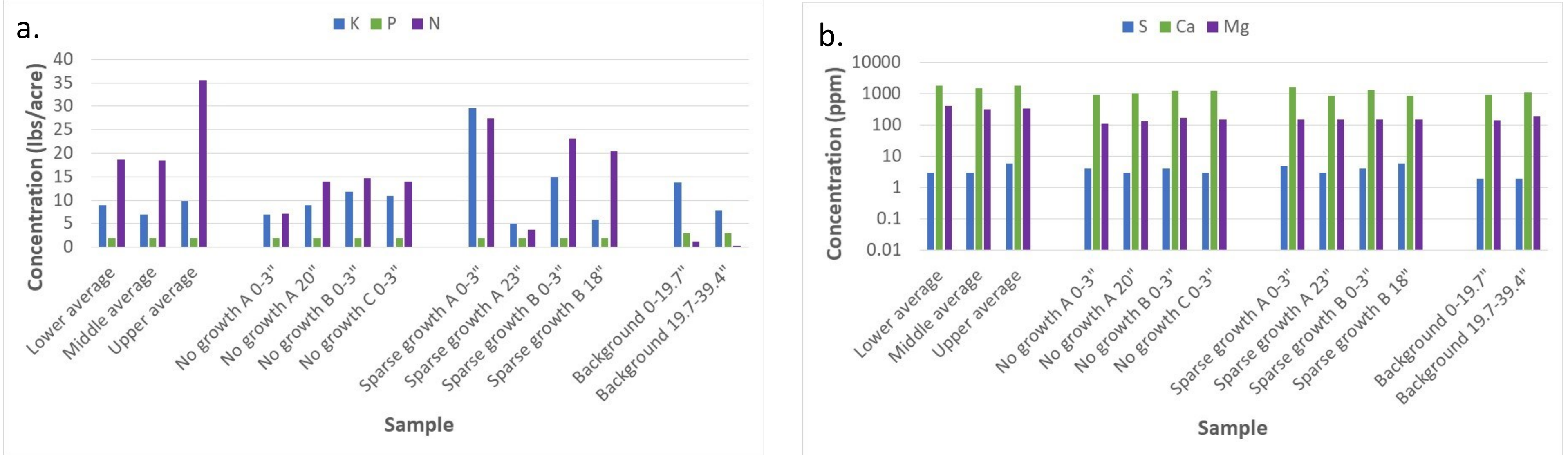

Figure 6. Concentrations of plant-available (a) primary (NO_3-N, P, and K) and (b) secondary (S, Ca, and Mg) nutrients for the harvested slope, previously disturbed, and background areas.

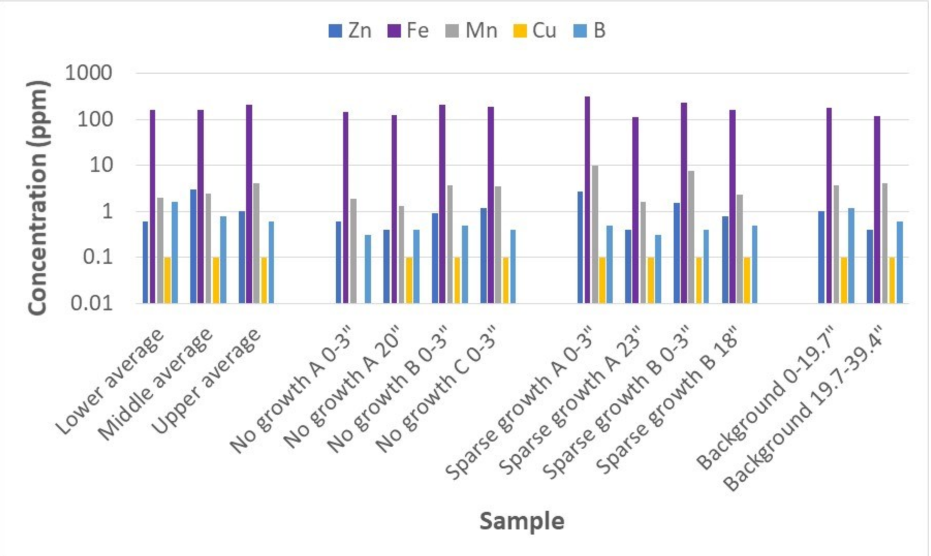

Figure 7. Concentrations of plant-available micronutrients (Zn, Fe, Mn, Cu, and B) for the harvested slope, previously disturbed, and background areas.

Nutrients	Our range (ppm, unless otherwise noted)	Medium sufficiency in agricultural soils (ppm)	Sufficiency compared to agricultural soils	Function/Importance
Nitrogen*	0.3 - 35.6 lbs/acre	30 - 60 (at depth of 24")	Very low	Major constituent of amino acids, enzymes; chlorophyll component; hastens crop maturity
Phosphorous*	2 - 3 lbs/acre	22 -30	Very low	Necessary for hardy growth; stimulates rapid cell development (inc. disease resistance)
Potassium*	5 - 30 lbs/acre	162 - 240	Very low	Amino acid and chlorophyll production; controls turgor pressure (prevent wilting)
Sulfur#	2- 6	7 - 11	Very low -low	Plant metabolism, chlorophyll formation
Calcium#	834 - 1795	501 - 2000	Medium	Stimulates root, leaf development, reduces soil acidity, toxicity of Mn, Zn, Al
Magnesium#	113 - 416	51 -100	High	Essential for photosynthesis
Zinc†	0.4 - 3	0.51 - 0.75	Low - very high	Catalyst in chlorophyll formation; required for forming carbohydrates
Iron†	111 - 319.5	5.1 - 7.5	Very high	Catalyst in chlorophyll formation, required in redox reactions in plants
Manganese†	1.3 - 9.9	2.1 - 3.0	Low - high	Catalyst in chlorophyll formation; important role in many metabolic processes
Copper†	0.0 - 0.1	0.5 - 0.6	Very low	Catalyst in chlorophyll formation
Boron†	0.3 - 1.6	0.9 - 1.2	Very low - high	Essential for seed germination; cell walls

Table 1. Agricultural sufficiency ranges for primary (*), secondary (#) and micro (†) nutrients in the harvested slope, previously disturbed, and background areas.

Conclusions

- All areas were deficient in plant-available N, P, and K, the primary nutrients required for plant function, growth.
  - Deficiency likely responsible for low live stake survival rates seen in the first reclamation attempt.
- Secondary and micronutrient sufficiency (which often determine quality of growth or yield, not necessarily whether growth occurs) varied and exhibited no discernable trends across sampling areas, except S, which was deficient at all sites.
- Future work: determine fertilizer application rates; compare the cost of seeding to donor soil restoration techniques.

Acknowledgements

The authors thank Brent Hansen (MVTL), Carl Rosen (U of MN), and Jeff Stedman (Northern Ecological Associates). This project was funded in part by a WSU Undergraduate Student Research & Creative Projects Grant and the WSU GALE Scholarship.