Vine Cutting as an Effective Forest Management Technique on the South County Trail: A DNA Barcoding Study

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Abstract

The cutting & removal of invasive vines is a common forest management technique; however, the effectiveness and long-term effects of the method has not been evaluated. Quadrats along the South county trail MC, 3C, and 5C were cleared of the invasive vine, Porcelain Berry, 16 months, 36 months and 60 months ago, respectively. Quadrat NC was the control group which was never cut. Biodiversity and quality of soil quality were used as methods of quantifying the overall health of the ecosystem. The initial Simpson Indices from year 1 do not provide clear differences in biodiversity. In year two of the study, we used DNA Barcoding to identify the species within the quadrat and assess what species were able to flourish in each of the quadrats. Interestingly, the control quadrat that was untouched had the most new invasive species. Therefore, our hypothesis that the quadrant most recently cut will have the least new species is incorrect.

Introduction

Invasive Vines

- A plant that is alien to a certain ecosystem and shows a tendency to spread out of control (Beaulieu, 2019)
- Destroys habitat, economy, and property
- Costs the US $2.6 million annually (Pfennigwerth, 2012)

Figure 1: Invasive Vine Evolution

Forest Management

Ways for vine removal:

Fire

Vine Cutting

Chemical Removal

Biological Control

Vine Cutting

- Method least detrimental to the environment
- Community Volunteers
- Forces roots to regenerate new growth

Investigating Effects of Invasive Species on Plant Community Structure

Franklin, W. (2008). Investigating Effects of Invasive Species on Plant Community Structure. *The American Biology Teacher, 70*(8), 479-482. Retrieved from http://www.jstor.org/stable/30163329)

Goal: Create a study to understand the effects of an increased invasive species population on ecosystem services

Results: Competitive exclusion by invasive species hinders services such as topsoil stabilization

PROBLEM	GOAL	HYPOTHESIS
Invasive vines cause numerous environmental and economic impacts as they overgrow and outcompete ecosystems.	The removal of the invasive vines will increase forest biodiversity and soil quality.	The removal of the invasive vines will increase forest biodiversity and soil quality.
	There will be more native species within the ecosystem rather than native species post-cutting.	There will be more native species within the ecosystem rather than non-native species post-cutting.

Methods

Phase 1

Specify Four Individual Quadrants on South County Trail in Westchester, New York

- **MC: Vines Cut (May 19th, 2018) [Q1]**
- **3C: Vines Cut (2016)[Q2]**
- **5C: Vines Cut (2014)[Q3]**
- **NC: Vines Never Cut[Q4]**

Assess the health of each Quadrant

Rutgers Soil Suitability Test

Soil test that assesses the different qualities of the soil

Simpson's Diversity Index

$$1-\sum_{i=1}^{k}\frac{n_i(n_i-1)}{n(n-1)}$$

https://codegolf.stackexchange.com/questions/53455/simpson-diversity-index

Fig 1: Simpson's Diversity Index

Summation that estimates average biodiversity

Phase 2

Preparation

- 4 locations in Westchester, NY
- Same quadrats as phase 1 of the study

Collection

- Collected 30 plant samples
- September 29, 2019
- Handpicked samples
- Identified using "Picture This" plant identification application
- Recorded in master spreadsheet

Identification

- 27 of 30 Samples were barcoded
- DNA extracted through PCR
- Barcoding through blue line of DNA Subway via BLASTN Results
- Identification of Invasive or Native Species
- Established versus Invasive Species

https://www.researchgate.net/figure/The-DNA-barcoding-workflow-Biochemical-protocols-at-the-website-DNA-Barcoding-101_fig1_326486258

Figure 2: Blue Line of DNA Subway

Results

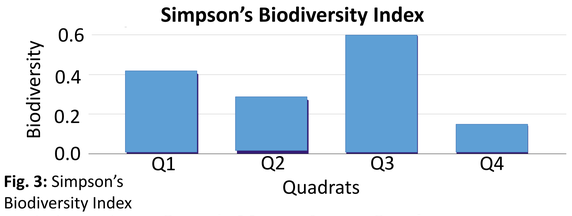


Fig. 3: Simpson's Biodiversity Index results by quadrat

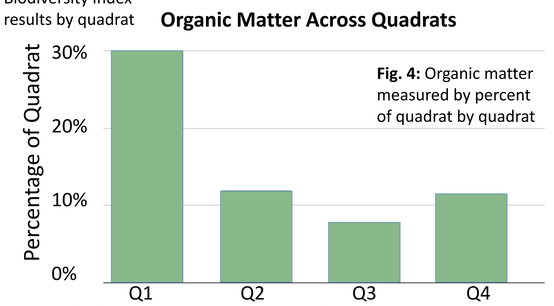


Fig. 4: Organic matter measured by percent of quadrat by quadrat

Fig. 5: Levels of various micronutrients measured in parts per million by Quadrat

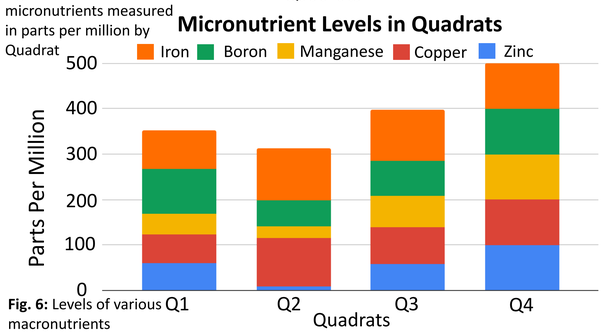


Fig. 6: Levels of various macronutrients measured in petapascal by Quadrat

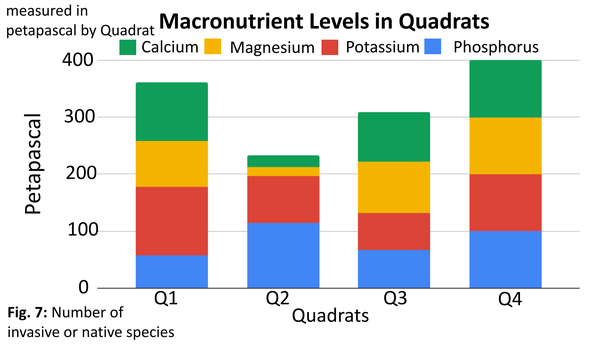
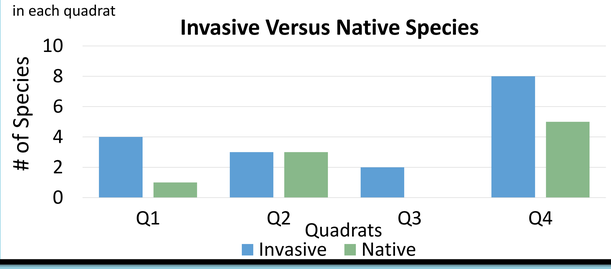


Fig. 7: Number of invasive or native species in each quadrat



Discussion

Soil

- Quadrant NC had the most macronutrients and micronutrients
  - These results do not support the hypothesis
- All of the quadrants had a healthy pH (5.5 - 7.0)
- Quadrant NC had more micronutrients and macronutrients than the other quadrants
- Quadrant 3C had the least amount of micronutrients and macronutrients
- Quadrant MC had the highest percent of organic matter

Biodiversity

Quadrant NC

- Lowest biodiversity
- Porcelain Berry vine had spread horizontally and outcompeted native plants

Quadrant 3C

- Had the lowest biodiversity
- Possible confounding factor = high foot traffic
- Not much diversity in the species

Quadrant 5C

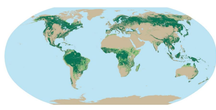
- Highest biodiversity
- This quadrant had been **maintained for the longest**

Quadrant MC

- Second-highest biodiversity
- Vines recently removed
- Benefited biodiversity

Limitations

1. Sunlight
   Differing levels of direct sunlight
2. Small sample in one region
   Widespread testing to be applicable
3. Foot Traffic
   People may step off of the trail and carry seeds on their shoes
4. Water Quality
   Different areas have different quality which may affect growth



http://www.fao.org/forest-resources-assessment/past-assessments/fra-2005/maps-and-figures/en/

Fig. 8: Forest Coverage Around the Globe

Acknowledgements

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