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Effect of Decreased Snowpack on a Rare Butterfly's Host Plant

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EFFECT OF DECREASED SNOWPACK ON A RARE BUTTERFLY'S HOST PLANT

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Background

Earth's increased global temperature as a response to climate change has caused less snowfall and earlier snowmelt in spring (Figure 1). These changes can alter the phenology of organisms such as through plant leafing and flower blooming (e.g., Gezon et al. 2016). This can be harmful to species reliant on plants that are more sensitive to temperature changes. The frosted elfin (*Callophrys irus*) (Figure 2a-c) is a species of concern in 11 states—including RI, MA, and CT. These host plant specialists only lay eggs on small yellow wild indigo (*Baptisia tinctoria*) and wild lupine (*Lupinus perennis*). If neither plant emerges and develops leaves by the time butterflies are laying eggs, this would be catastrophic for the downstream population. These phenological changes can also affect host plant nutritional content, impacting the caterpillars' (Figure 2d) only source of food and consequent health. We predict that growth of wild indigo plants will be greater in plots with decreased snowpack and that nutritional content will vary between treatments. For this study, we focused on the wild indigo plant, investigating patches found at Gavins Pond (GP) in Foxborough, MA.

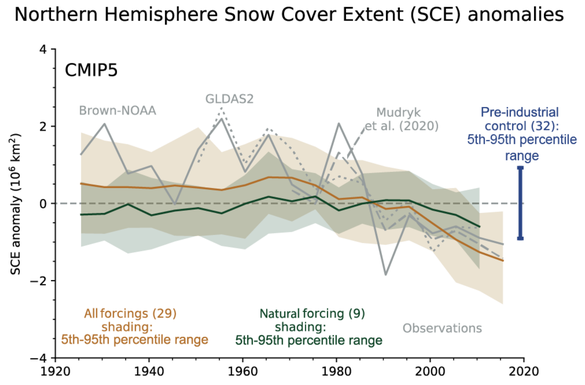


Figure 1. Anomalies in snow cover in spring (March-April) from 1950, compared to pre-industrial levels (IPCC 2021)

Methods

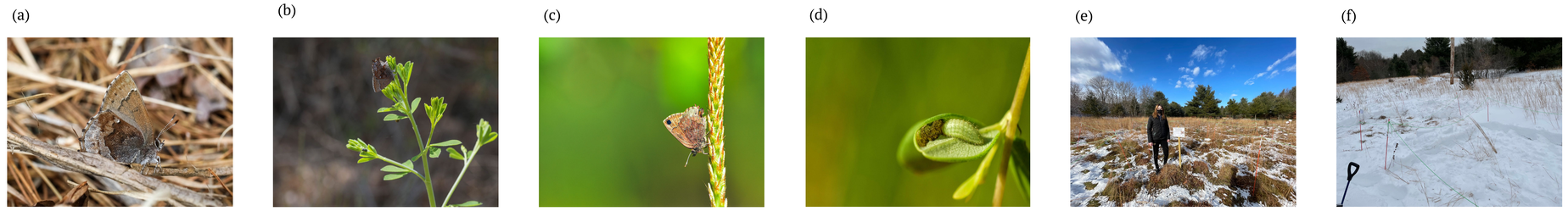
At GP, 2 patches were selected in which the elfin host plant, wild indigo, was in abundance.

Winter 2021-22: 15 plots were set up (Figure 2e-f):
- 5 control plots
- 5 shoveled plots, snow shoveled to one inch
- 5 trampled plots, snow trampled once with snowshoes

Spring-Summer 2022: Indigo samples from each of the plots were collected using fine forceps to pluck off a tip of the leaf. The five plants selected within the plots were chosen with the intention of best representing the quality of the indigo in the whole patch.

Fall 2022: Samples were combusted in an elemental analyzer (Elementar UNICUBE for CHNS) to determine the percent carbon and nitrogen present.

(a) (b) (c) (d) (e) (f)



Figures 2. (a-c) Frosted elfin adult butterfly (d) Frosted elfin caterpillar on wild indigo leaf (e) Plots in winter at Gavins Pond (f) Shoveled plot on left and trampled plot on right

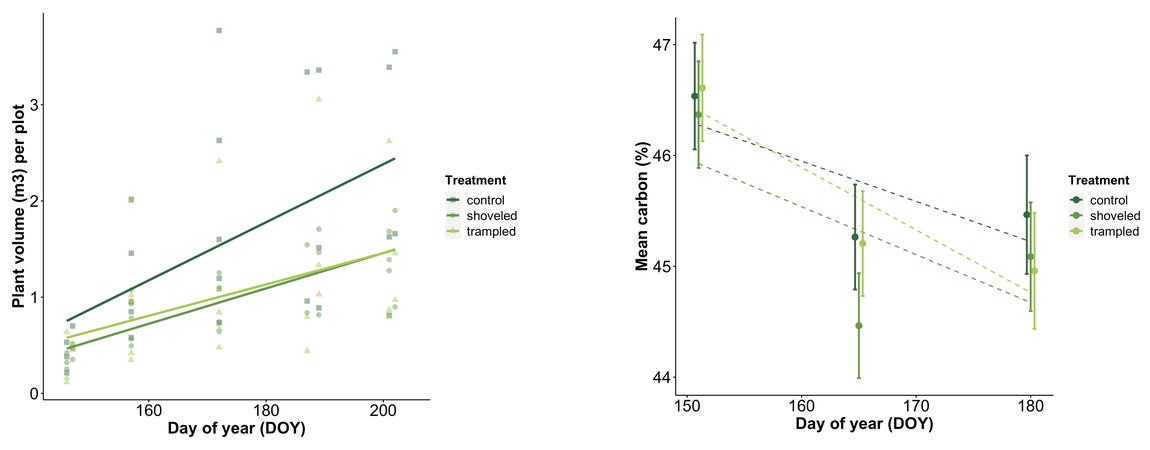
Results

Growth: Wild indigo growth was greater in the control plots than the trampled and shoveled plots (Figure 3a). There was a significant difference in plant size over time (chi-square = 31.601, p-value < 0.001) and plant size varied among treatments (chi-square = 12.686, p-value = 0.002). No matter the treatment, plants did grow larger over time.

Nitrogen: Wild indigo percent nitrogen content decreased over time (Figure 3b). There was a significant difference in N content over time (chi-square = 52.967, p-value < 0.001) and N content varied among treatments (chi-square = 7.528, p-value = 0.023). Treatment had a significant effect on how much N was present over time (chi-square = 14.595 p-value = 0.006)

Carbon: Similar to nitrogen, percent carbon content found in the wild indigo decreased over time (Figure 3c). There was a significant difference in C content over time (chi-square = 78.880, p-value < 0.001). However, C content did not appear to vary among treatments, though the result was marginally significant (chi-square = 5.957, p-value = 0.051), so more data should be analyzed to confirm this pattern. No matter the treatment, C content did change over time.

(a) (b) (c)



Figures 3. (a) Growth of wild indigo over time (b) Percent nitrogen content over time (c) Percent carbon content over time

Conclusion

These data do not support our hypothesis that growth for shoveled and trampled plots will be higher than the control. They also do not support the hypothesis that snowpack will affect carbon content. However, nitrogen content was affected by decreased snowpack.

Future research could involve continued analysis of indigo nutrition, additional data collection with another year of snow removal, temperature investigation through temperature loggers, or use of another site with more frosted elfin butterflies.

Acknowledgement

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References

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Figure AR6 WG1. (n.d.). IPCC. https://www.ipcc.ch/report/ar6/wg1/figures/chapter-3/figure-3-22/

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