Effects of Prescribed Fire Intervals on Bryophyte Diversity and Cover

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Abstract

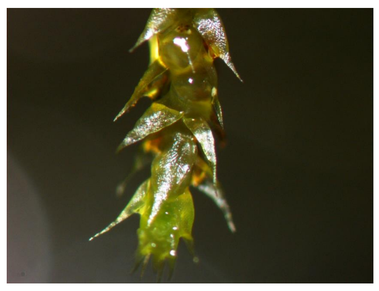
The Long Island Central Pine Barrens are a globally rare fire-adapted ecosystem. Fire return intervals of 10-40 years are typical for Atlantic coastal pine barrens. This study aims to understand the impact of various fire frequencies on bryophyte communities and determine an optimal fire interval to promote bryophyte cover and diversity. Some species of bryophytes serve as early-successional pioneer species and stabilize recently burned soils. Percent bryophyte cover was estimated along 25 meter transects in each location, and species present were recorded. Bryophyte cover was found to be very low in all plots, with unburned control plots having on average higher percent cover. Control plots had an average bryophyte cover of 0.85%, whereas infrequently and frequently burned plots had 0.1% and 0.08% cover respectively. This study might provide evidence that the Long Island Central pine barrens would benefit from a more frequent fire return interval, as our data might illuminate an intermediate fire regime that is detrimental to bryophyte cover and diversity within plots categorized as frequent, or that environmental conditions prevent bryophyte growth.

Introduction

In disturbance-dependent ecosystems like Long Island's Central Pine Barrens, the presence, frequency, and intensity of fire is a crucial factor in shaping vegetation composition. Fire return intervals of 10-40 years are typical for Atlantic coastal pine barrens [1]. However, intervals may be as low as 3-5 years in more open barrens systems [2]. In areas with relatively frequent or intense fires, a dominant overstory of pitch pine (Pinus rigida) with co-dominant oak species (*Quercus* spp.) are observed. In the absence of fire, open-canopy pine barrens may be displaced by shadier dense-canopy mixed forest, with the eventual inclusion of species like red maple (*Acer rubrum*) and Eastern white pine (*Pinus strobus*) [2]. This process is known as mesophication. Mesophication creates a positive feedback loop resulting in increased moisture, soil organic matter, and fire sensitivity [3]. A history of fire suppression has led to increasingly fire-sensitive forests in the northeast, and ongoing fire management may be one of the only ways to combat this trend [4].

The species composition of epiphytic and terrestrial bryophytes in pine barrens ecosystems remain relatively unknown. No work has been published on them to date at Brookhaven National Lab (BNL), where this study was conducted. Although mosses are generally killed in wildfires and prescribed fires, their response to the changed characteristics of frequently or recently burned areas is not well understood. Some bryophytes may spread more easily after a fire due to reduced understory vegetation, while others might do better in the wet, shady understory more characteristic of infrequently burned areas [5] [6]. Prior research in the New Jersey Pine Barrens indicate that bryophyte cover is highest in annually burned stands [7] [8], or potentially in areas burned every three years [9]. Severely burned areas of the New Jersey Pinelands may also develop lichen and moss mats, whose composition may in turn influence the germination of different vascular plants [10].

- The goal of this study is to examine the effect of fire return interval on the percent cover and diversity of bryophytes in the Long Island Central Pine Barrens.
- We hypothesized that bryophyte cover would be higher in areas burned more frequently because of increased proliferation of early-successional bryophyte species.
- Additionally, we hypothesized that diversity would be greater with a more frequent fire return interval due to improved efficacy of wind dispersal of spores in more open stands.



Methods

BNL is a Department of Energy laboratory located within Long Island, NY's Central Pine Barrens. Of the lab's 5,265-acre property, approximately 3,445 acres are undeveloped woodlands. These woodlands are managed primarily through the use of mechanical treatments and prescribed fire towards the goal of maintaining forest health and wildlife habitat. BNL has not historically used active fire management. However, efforts in the past two decades have returned prescribed fire to a portion of BNL's woodland areas [11].

14 pre-established 25 by 16-meter plots were selected and categorized as frequently or infrequently burned, or as unburned controls. Frequently burned plots were defined as having one fire in the past 15 years and one fire in the 15 years preceding that. Infrequently burned plots were defined as having one fire in the past 15 years and none in the 15 years preceding that. Control plots did not have any fires within 30 years. At each plot, a 25 meter transect was established along one side of the plot. A 1-meter square PVC quadrat was placed every 5 meters along the transect, inside the plot. Inside the quadrat, the percentage of soil and tree trunks and woody debris covered by bryophytes was estimated and recorded. A timed meander was conducted inside the plot; two investigators walked through the plot for ten minutes, flagging each bryophyte found. At the end of the ten-minute period, the number and identity of unique bryophyte species observed were recorded. Samples of unknown bryophytes were collected and keyed out or sent out for identification by a bryologist.

Results

- Bryophyte cover is very low in all plots
- Cover was found to be highest in Control(unburned) plots at 0.85%
- Infrequent plots had an average cover of 0.1%
- Frequent plots had an average cover of 0.08%
- These values are lower than those found in other studies in the ecologically similar New Jersey pinelands
- A greater number of species were found in control plots than in infrequent or frequent treatment types.

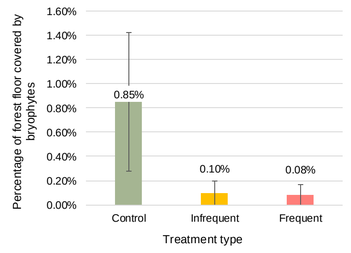


Figure 1. Average percentage of forest floor covered by bryophytes across treatment types, ± 1 standard error

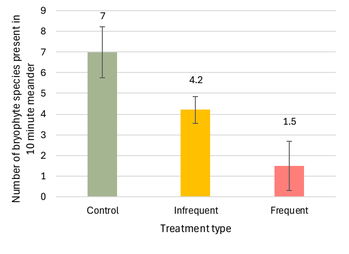


Figure 2. Average number of bryophyte species present in 10 minute timed meander across treatment types ± 1 standard error

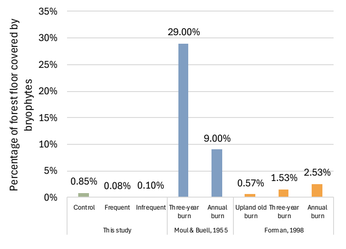


Figure 3. Average percentage of forest floor covered by bryophytes across treatment types, compared with ± 1 standard error

Discussion

Our data do not support our hypotheses that more frequent fire return intervals lead to greater moss cover, as other research [7] [9] suggests. Further investigation is required to determine whether this trend continues in areas with more frequent fire return intervals than the plots we labeled as "frequent". As discussed above, recent research on similar inland communities suggests an optimal fire return interval of 3-5 years [2]. Our data may indicate the existence of a median range in which the fire interval is too infrequent for fire adapted species to succeed, and simultaneously too frequent for species preferring wetter, less frequently burned areas. Alternatively, the low overall cover may indicate ecological conditions that are unfavorable for moss growth across treatment types. The low sample size used in this investigation makes drawing conclusions from the data difficult.

Our data also do not support our hypothesis that bryophyte diversity increases with burn frequency, as described in previous literature [6]. Additionally, this investigation did not find many species characteristic of frequently burned areas, such as Bryum argenteum, Ceratodon purpureu, Funaria hygrometrica, Marchantia polymorpha, and Polytrichum juniperinum [5] [6]. This trend could be attributed to relatively low overall burn frequency, as above. The relatively high volume of leaf litter – accumulated as a result of long-term fire suppression – may present unfavorable habitat for non-epiphytic mosses. Many of the species observed were found growing on trees and might suffer even from infrequent burning. This could explain the decrease in diversity in plots categorized as "frequent".

Further investigation in areas burned more frequently over extended periods of time is necessary to determine whether the data reflect a negative correlation between fire frequency and cover/diversity or a median range, after which diversity and cover increase. These areas may not exist yet within the Long Island Central Pine barrens, highlighting the need to return fire management to the ecosystem. Due to the low sample size of this study, no conclusions can be definitively drawn from it, however, we lay out a foundation upon which other studies may build in the future.

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