Fungal Diversity in Successional Burn Plots

Lauren Bradshaw

University of Michigan Biological Station
EEB 381- General Ecology
08-16-2010
Professor Bob Pillsbury

(';j c ;I-~ p~J J~
II£.I./"t,. ,,-vr

ABSTRACT

Fungi are a diverse group of organisms that can be found in many cosystems and serve many ecological purposes, but can not thrive in all conditions. Re arch has shown that fungi are more abundant and diverse with higher humidity levels d plenty of organic substrates, like leaf litter, on the forest floor (Svrcek, 1977; rchard, 1996). The University of Michigan Biological Station has several plots ofland on it's property that have been purposefully burned in the recent past. Fungal diversity was examined in 4 plots that were burned in 1936, 1954, 1980, and 1998, respectively, by recording observed fungal fruiting bodies. Although data was not statistically significant (p=O.2), species richness and number of fruiting bodies was higher in older burn plots. A spike in observed fruiting bodies was seen in the 1954 plot, potentially as a result of the more diverse plant composition than the other plots.

INTRODUCTION

Fungi are a diverse group of organisms with an estimated 1.5 million species and can be found in many different ecosystems across the planet and serve many purposes (Hawksworth, 2005). Many fungi are a great food source for animals such as voles and mice (Kurta 1995), mycorrhizal fungi improve plant growth by providing additional nutrients, and fungi are often involved in nutrient cycling (Morris, 2005). In short, fungi are an integral part of forest function but they can not grow in all environmental conditions.

Fungi are more abundant and diverse with higher humidity levels that come from greater canopy cover (Svrcek, 1977). Dead leaves, rotting wood, and other organic substrates on the forest floor are also vital to fungal diversity, as they provide vital nutrients (Orchard, 1996). These conditions can be found in forests all over the world, which is why fungi are a thriving taxon. However, forests are rarely left undisturbed. Secondary succession is continually driven by humans, animals, fires or floods (Blatt 2005). Fire is a common and major disturbance of forest ecosystems which greatly affects soil-inhabiting fungi (Zak, 1991).

Forests around the world may have varying climates but all have a history of fire, but with different severities (Abbas et. aI, 2010). While forest fires are an important disturbance agent that can benefit diversity, one study found that, after a forest fire, percentage of canopy cover and density of trees is significantly decreased (Abbas et. aI, 2010). Since fungi thrive in humid environments, and humidity is a direct consequence of dense canopy cover, it could be assumed that forest fires would not create an optimal environment for fungal diversity. This study addresses the forest age required to regenerate enough canopy cover for high fungal diversity.

In this experiment we examined the differences in fungal diversity between several burn plots on the University of Michigan Biological Station property in Cheboygan county, Michigan. We hypothesized that older successional forests would have higher fungal diversity because of increased canopy cover and organic material on the forest floor.

METHODS

In this experiment, four plots were examined. The burn plots chosen for study were as follows: 1936, 1954, 1980, and 1998 (Figure 1). Both the 1980 and 1998 burn plots were composed of young Aspen trees with little to no ground cover. The 1954 plot was a mixed coniferous/ deciduous forest and the 1936 plot was more of a climax population of the same composition; both had a great deal of leaf litter and down logs.

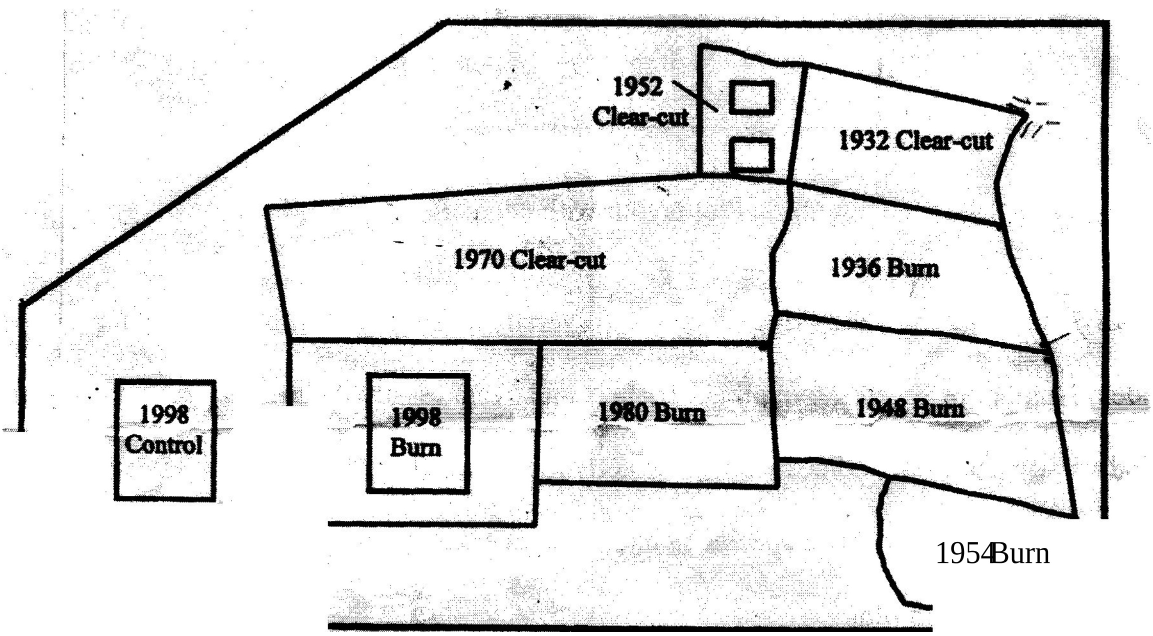

Figure 1. The layout of clearcut and burn chronosequence, Section 32, Township 37 North, Range 3 West, University of Michigan Biological Station, Cheboygan Co., northern Lower Michigan.

In each burn plot, five transects were studied and any fungi that fell within two meters on either side of the transect were recorded.-Forest edges differ from the forest interior in many environmental features such as light intensity, air, litter and soil humidity and temperature minima and maxima (Dierschke, 1974; Stoutjesdijk & Barkman, 1992; and Matlack, 1993). As a result of this, the immediate edge (20 meters from all sides) of the plots was excluded from transects to keep environmental conditions consistent (Figure 2).

20 meters

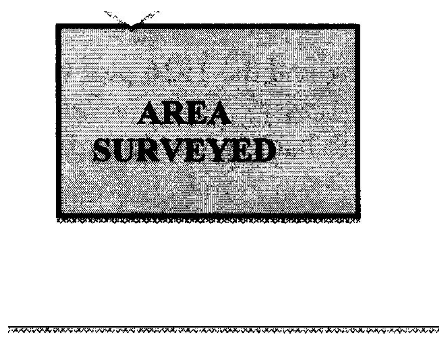

Figure 2. Plot layout with edge effect

Biodiversity was analyzed using Shannon's diversity index and Simpson's diversity index. Number of species, overall abundance, and evenness are the primary aspects of biodiversity and these indices measure exactly that (Buckland, 2005). Qualitative analysis was also done using average species richness and average number of fruiting bodies in the transects in each plot.

RESULTS

According to both Shannon's diversity index and Simpson's diversity index, 1998 was the most diverse plot and 1954 was the least diverse (Table 1).

Year Burned	Shannon Diversity Index	Simpson Diversity Index
1936	1.642	0.703
1954	0.612	0.250
1980	1.560	0.763
1998	1.846	0.909

Table 1. Shannon's and Simpson's diversity indexes for burn plots

Although the data proved to not be statistically significant (p=0.2), older growth forests had a tendency to have a higher species richness than recently burned plots (Figure 3). In general, older growth forests also had a higher average number of individuals (Figure 4). Due to the large abundance of *Omphalotus olearius* found in the plots, there were concerns that this species was scewing our data, but these trends were still apparent when all numbers for *Omphalotus olearius* were discredited (Figure 5).

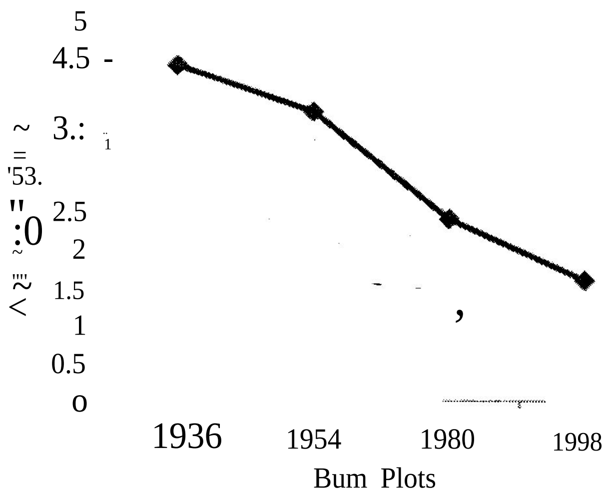

Figure 3. Number of observed species per transect-averaged for each burn plot

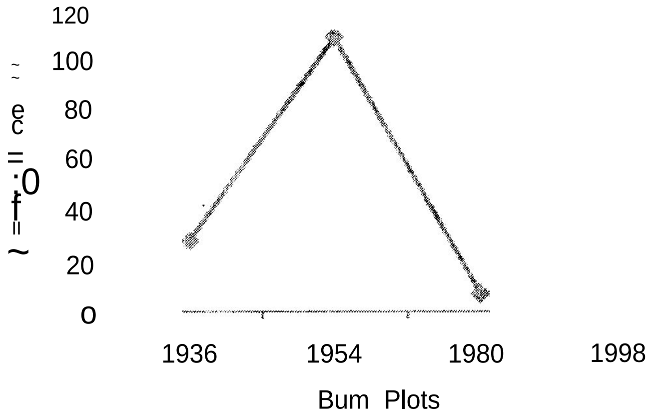

Figure 4. Total number of fruiting bodies per transect-averaged for each burn plot

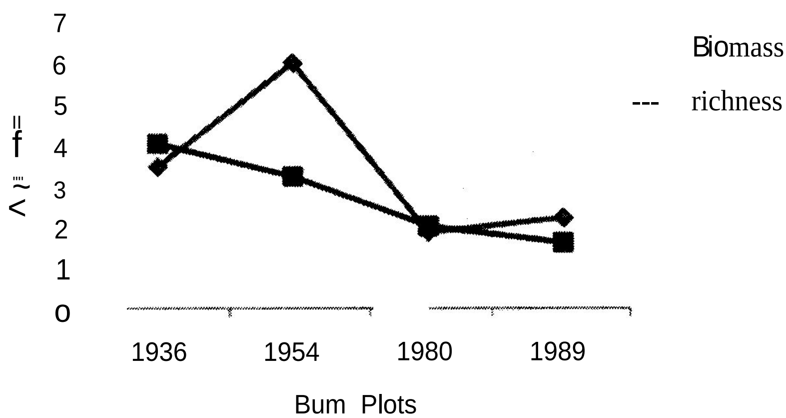

Figure 5. Number of observed species and total number of fruiting bodies per transect-average for each burn plot *(Omphalotus olearius* not included).

DISCUSSION

Diversity indexes are a useful tool for comparing biodiversity in an area, but they are not perfect. Many of the species observed in the burn plots were only seen once or twice and Simpson's diversity index gives relatively little weight to rare species (Krebs, 2009). Shannon's index is also difficult because, while it does account for evenness, it does not account for species abundance. This means that, although these indexes showed trends, they are not necessarily accurate for our data set. As a result of this, we chose to rely heavily on qualitative analysis of species richness.

In accordance with our hypothesis, more species were found in the older burn plots and species abundance, or total number of fruiting bodies observed, also showed a general increase as plot age increased. In both the 1936 and 1954 plots, we observed more ground cover in the form of leaf litter and down logs, and larger trees that provided strong canopy cover. The 1980 and 1998 burn plots were composed almost entirely of young aspens and had little to no leaf litter or ground cover of any form. These observations are exactly what we would expect, given that fungi thrive with organic substrates on the forest floor and higher humidity levels that come from greater canopy cover (Svrcek, 1977; Orchard, 1996).

Species abundance spiked in the 1954 plot and it was suspected that this was a result of the multitude of small *Omphalotus olearius* found, but this trend was still observed when all values for *Omphalotus olearius* were removed. Fungi form strong mycorrhizal relationships with trees, and a single plant may associate with many species of mycorrhizal fungi (Bennett, 2010). The 1954 burn plot had a range of tree species present in contrast with the aspens in the 1980 and 1998 plot or the pines in the 1936 plot. This difference in tree species riclmess could be a possible explanation for the spike in fruiting body abundance. If a range of tree species are available to form mycorrhizal mutualisms with, then there may be less competition among the fungi for preferred trees.

This study was done over a span of 3 weeks in late July and early August but fungi produce fruiting bodies at varying times of year (Kauserud, 2007). If this study had been expanded over a longer period of time to provide a larger sample size, data may have proved to be statistically significant. It should also be noted that the summer of 2010 had record rainfall (http://www.noaa.gov) and this may have affected the number of fruiting bodies produced.

CITATIONS

Abbas BS, Moslem A, Gholamali J, Mohsen H. 2010. Forest fire effects in beech dominated mountain forests oflran. Forest Ecology and Management, 259 (11): 2191-2196.

Bennett, A.E. and J.D. Bever. 2010. Mycorrhizal species differentially alter plant growth and response to herbivory. Ecology, 88 (1):210-218

Blatt, S.E., Crowder, A. and Harmsen, R. 2005. Secondary Succession in Two South-Eastern Ontario Old-Fields. Plant Ecology, 177 (1):25-41.

Buckland ST, Magurran AE, Green RE, Fewster RM. 2005. Monitoring change in biodiversity through composite indices. Philosophical Transactions of The Royal Society, 360:243-254

Hawksworth DL, Mueller GM. 2005. Fungal communities: their diversity and distribution. In: Dighton J, White JF, Oudemans (eds) The fungal community: its organization and role In the ecosystem. CRC, Boca Raton, pp 27-37

Kauserud, H., Stige, L.C., Vik, J.O., Okland, R.H., Hoiland, K., Stenseth, N.C. 2007. Mushroom fruiting and climate change. Proceeding of the National Academy of Sciences of the United States of America, 105 (10): 3811-3814

Krebs, Charles. 2009. Ecology: The experimental analysis of distribution and abundance. San Francisco, CA: Pearson Education Inc.

Kurta, Allen. 1995. Mammals of the Great Lakes Region. The University of Michigan Press, Ann Arbor, Michigan.

Morris SJ, Robertson GP. 2005. Linking function between scales of resolution: The fungal community: its organization and role in the ecosystem. In: Dighton J, White JF, Oudemans P (eds) The fungal community: its organization and role in the ecosystem. CRC, Boca Raton, pp 13-26

Orchard AE. 1996. Fungi of Australia In: Simpson JA (ed) Wood decay fungi, vol lB. Introduction-fungi in the environment Australian biological resources study, Canberra, pp 95-136

Svrcek M. 1977. A colour guide to familiar mushrooms and fungi. pp 20-21

Zak, J.C.. 1991. Response of soil fungal communities to disturbance. In *The Fungal Community. Its Organization and Role in the Ecosystem.* G.C. Carroll and D.T. Wicklow (eds). Marcel Dekker, New York pp. 403 - 425