Lichen Abundance in the Burned Versus Unburned Forest

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Abstract

Lichens can be used as a bioindicator in forest ecosystems. Although lichen have slow growth rates, their adaptive capabilities enable them to respond rapidly to environmental fluctuations. We took samples of lichen from Mount Rose, a boreal forest in western Washington in both burned and unburned areas following a recent wildfire. We used the samples to compare the overall abundance and diversity of lichen growth in burned and unburned areas.

KEY WORDS

Lichen, fire, diversity, abundance, moss, bioindicator

Introduction

Lichens are found in large numbers in many ecosystems. They have slow growth rates and various tolerances and adaptive capabilities, which enable different species to respond rapidly to environmental fluctuations (Hale 1983). This is why they have been employed as bioindicators of environmental changes, ranging from air pollution to forest disturbance (Richardson 1988).

Lichen require light, like most green plants. However, lichen differ significantly from vascular plants. Lichen is a symbiotic relationship between photosynthetic algae and fungus. Fungal tissues make up most of the lichen thallus, or body. Fungi do not have chlorophyll; to create energy they associate with photosynthetic symbionts: green algae, cyanobacteria, or sometimes both (Brook et al. 2001) The photobionts in lichens make enough carbohydrates to supply themselves and the fungi. Carbohydrates pass into the fungal tissue as glucose or sugar alcohols, which are stored in the fungus as mannitol. If the algae are isolated from the fungus the flow of carbohydrates stops.

For most lichen photosynthesis functions are best when the thallus is fifty to seventy percent saturated in water and respiration is highest when the thallus is entirely or almost entirely saturated. Photobiont cells are not permanently damaged when dry lichen is in a dormant state because it is neither using nor generating energy. Respiration will exceed photosynthesis when dry lichen absorbs enough water and the thallus is close to saturation.

Lichens grow slowly; the symbiosis of the lichen is well balanced: the fungus and the algae to grow at the right speeds in order to maintain the partnership.

Our study examined abundance and diversity of lichen in burned and unburned areas in and adjacent to a one-year-old wildfire. We predicated overall abundance and diversity of lichen to be greater within unburned area that we surveyed. We made this prediction because generally in an unburned ecosystem species maintain a stable habitat and there

Methods

Our study took place on Mount Rose located on the edge of the Olympic National Forest in Western Washington. We chose two sites to study lichen. The first site was one that had been burned within the last year. The second site was adjacent to the burn site but was unaffected by the fire, and with similar terrain and pre-burn vegetation.

We collected samples of lichen from 30 rocks in each site. We limited our samples to lichen growing on rocks larger than 20cm either in length, width or height. We used a random number table and the randomly generated walk method to find the closest rock that met our size specifications. We measured the length, width and height of each rock with a meter tape and recorded our observations. We used a sharp knife to scrape a sample of each species we found and place it in a labeled plastic bag. These samples were used to identify the individual species in the lab using McCune and Geiser (2003) and Brodo et al.(2001). We also collected smaller samples to create a reference chart to simplify our data collection in the field. Each specimen was morph typed and photographed. Total percentage of lichen coverage and the percentage of each individual species coverage on the rock were estimated visually. We also made note of any patterns that were taking place on the rock.

Results

Out of 30 samples in the unburned section, five rocks had lichen on them. The most prevalent lichen was green crustose, found covering 10% of two rocks and 5% of one rock. Gray foliose covered 5% of one rock. White squamulose, white foliose, white fruiticose and orange fruiticose each covered 1% of separate samples. The majority of non-burn samples were at least 50% covered with moss (Fig.1).

From 30 samples in the burned section, we found lichen on fifteen rocks. Twelve of these fifteen had gray crustose; of those twelve we had rocks categorized as 50%, 40%, 35%, 30%, 10%, 5%, 3%, 2%, and four rocks had 1% lichen coverage. Three had orange fruiticose: one rock with 2% and two rocks with 1% lichen coverage. Two samples had 1% coverage of white crustose. We did not observe any moss growing on the burned samples; however there was evidence to suggest moss had been growing prior to the burn (Fig.1).

Lichen was more abundant in the burned area, and greater lichen diversity overall was found in the unburned area (Fig.2).

Discussion

Our hypothesis was that the lichen abundance and diversity would be higher in the unburned zone than in the burned zone. We came to this theory because lichen grow slowly and that led us to believe that they would be more abundant in the unburned area. However, we discovered that that the overall abundance of lichen was higher in the burned zone and the diversity of lichen was higher in the unburned area.

Nutrients are brought back into the soil through burning. Fire burns plant matter and leaves the topsoil with a covering of fresh organic debris that creates an excellent fertilizer for future growth. The lower canopy of the forest burns away, and the additional sunlight is beneficial for lichen growth. The fire also kills many plants that compete with lichen. However, due to slow lichen growth it is unlikely that the lichen would have time to grow back. But because the fire did not show that there was a high enough intensity to kill off all the lichen present before the burn some were able to survive.

Heavy moss growth was prevalent on the unburned side. The majority of rocks had 50% or more moss coverage (Fig. 3). Over half of the rocks studied were 100% covered by moss. These rocks had no signs of lichen growth on them. The rocks that had 50% or less of moss growth had little to no lichen growth found on them.

In the burned site there was no moss on the rocks that we studied, although there was evidence that moss grew on the rocks prior to the burn. The moss cover could slow down the rate of fire spread and enhance fire intensity. (Johansson 2005) The lack of moss after the burn could suggest that the moss is out competing the lichen in the unburned zone, or that the moss was covering the lichen on the rocks in the unburned zone.

Our data suggests lichen abundance is reduced in areas with dense canopies and vascular plant growth (Cornelissen, 2001). The rise in vascular plant population correlates to a decline in lichen population. This is due to the warming of the climate, fertilization and vascular plant shade. Due to the vascular plant growth the lichens can be out-competed for nutrient availability.

More shade in temperate climates may be related to reduced lichen presence (Cornelissen, 2001). In our site, the ground cover was very dense with vascular plants ranging from sword fern (*Polystichum munitum)* to salal (*Gaultheria shallon)*.

Large amounts of under story plant growth at the burn site may have damaged most of the lichen that had been present. However, moss ”sheltering” may have protected some of the lichens on the rocks where high moisture content moss was overlain on lichen. This “protective shield” may have protected for some of the crustose and fruiticose lichens.

Over all, we found a smaller percentage of lichen in the unburned area; while in the burned area, an area of significantly less canopy cover, lichens were more abundant. This may be due to changes in environmental conditions (i.e., a change in canopy cover or local competitors) or a sampling artifact associated with the difficulty of measuring lichen abundance when concealed by other organisms in the unburned area. However, our data suggest that even in high intensity wildfires, lichen persistence on the landscape can occur on boulder habitats. Such persistence may support colonizing populations that could be important for recovery of lichen biodiversity following disturbance. These data suggest that major disturbances such as wildfire may not be major detriments to lichen biodiversity on rocks.

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Literature Cited

Binkley, Dan., Grahm, Robin L., 1981. Biomass, production and nutrient cycling of mosses in an old-growth Douglas-fir forest, Ecology **62**: 1387-1389.

Brodo, Irwin M., Sharnoff, S. D., Sharnoff, S., 2001. Lichens of North America. Yale University Press, New Haven, Connecticut

Cornelissen, J.H.C., Cllaghan, T.V., Alatalo, J.M., Michelsem, A., Graglia, E., Hartley, A.E., Hik, D.S., Hobbie, S.E., Press, M.C., Robinson, C.H., Henery, C.H.R., Shaver, G.R., Phoenix, G.K., Gwynn Jones, D., Jonasson, S., Chapin III, F.S., Molau, U., Neill, C., Lee, J.A., Melillo, J.M., Sveinbjornsson, B., Aerts, R..2001.Global change and artic ecosystems: is lichen decline a function of increases in vascular plants biomass? Journal of Ecology. **89**: 984-994.

Johnson, P., Reich, Peter B., 2005 Population size and fire intensity determine post fire abundance in grassland lichens, Applied Vegetation Science **8**: 193-198.

Mistry, J., 1998. A Preliminary Lichen Fire History (LFH) Key for the Cerrado of Distrito Federal, Central Brazil, Journal of Biogeography. **25**: 443-452.

McCune, B., Geiser, L., 2003. Macrolichens of the Pcific Northwest, Oregon State University Press, Corvallis, Oregon

Neiland, Bonita J., 1958. Forest and adjacent burn in the Tillamook burn area of northwest Oregon, Ecology **39**: 660-671.

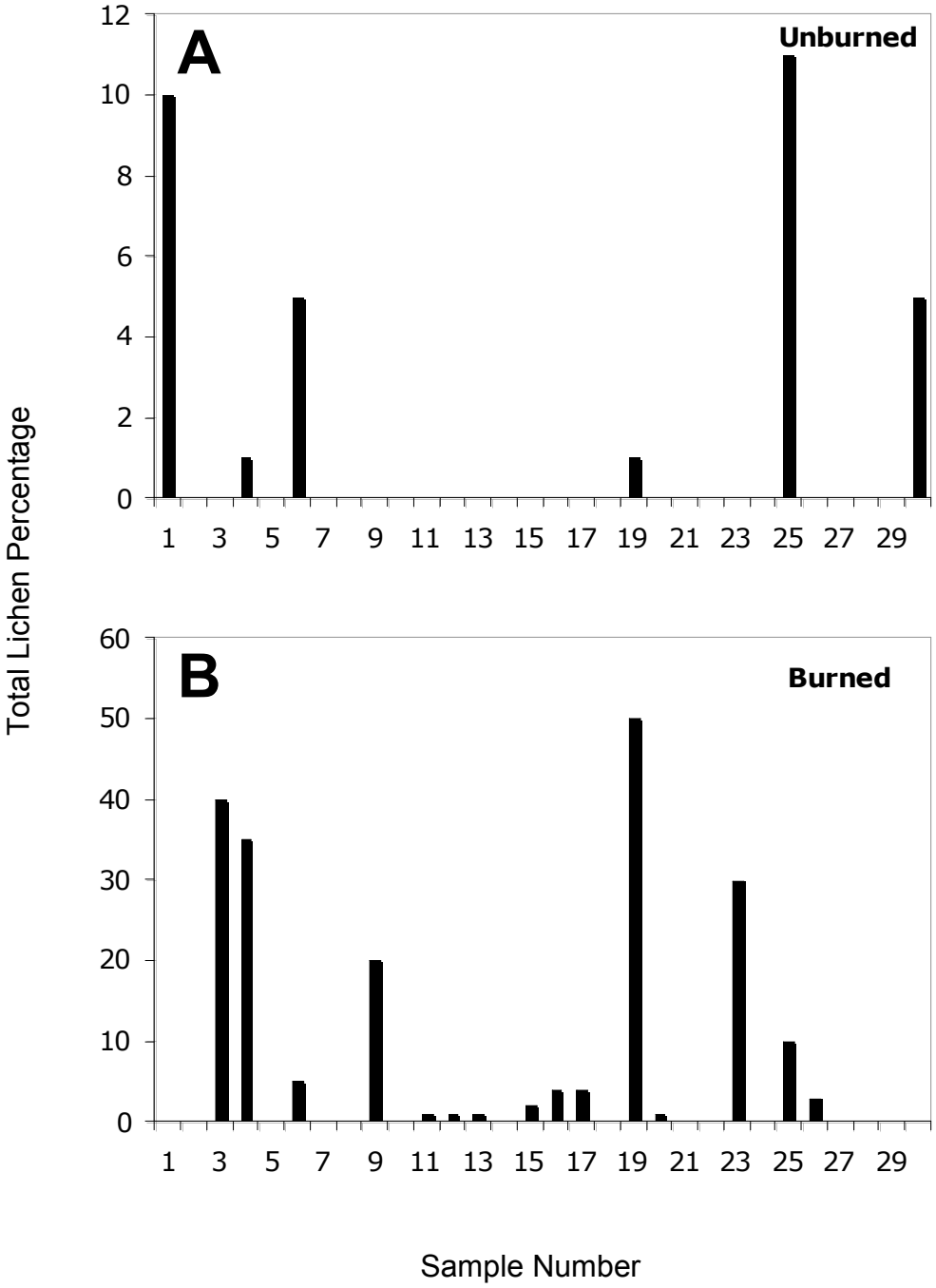
Nritlich, Peter., Rogers, P., Rosentreter, R., 2003. Lichen Communities Inclinator Results Fom Idaho: Baseline Sampling United States Department of Agriculture.

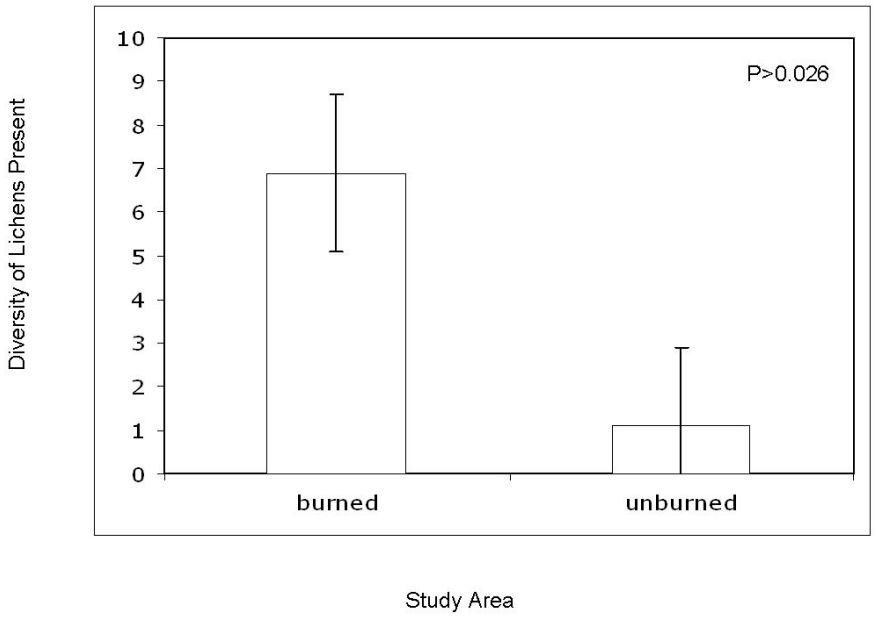
Figure Legend

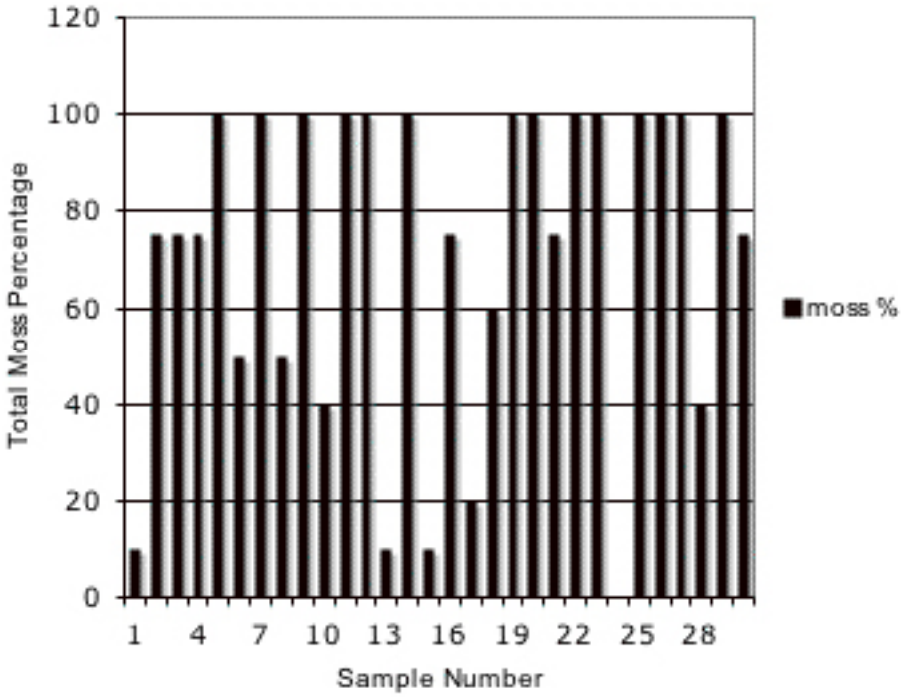
Fig. 1:
These two graphs (**A, B**) display the total percentage of lichen abundance in the unburned and burned areas of Mt. Rose, WA.

Fig. 2:
This figures displays overall diversity of lichens present in the unburned and burned areas of Mt. Rose, WA.

Fig. 3:
This figure displays the total percentage of moss present on each rock sample in the unburned area.


A
Unburned
B
Burned
Total Lichen Percentage
Sample Number
0
2
4
6
8
10
12
0
10
20
30
40
50
60
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29


Diversity of Lichens Present
10
9
8
7
6
5
4
3
2
1
0
P>0.026
burned
unburned
Study Area


120
100
80
60
40
20
0
Total Moss Percentage
1
4
7
10
13
16
19
22
25
28
Sample Number
moss %