Food Preference of Invertebrates at Different Stages of Forest Succession

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Abstract

Humans depend on the resources and services from forest ecosystems. Due to human overconsumption of resources, our forests are diminishing. We must develop a better understanding of forests in order to use forest resources more efficiently. In order to better understand forest ecosystems we investigated whether a forest's stage of succession affects the food preference within each forest. To test this we arranged several sites of rice, coated in different substances, in forests at different stages of succession. We found a significant difference in amount of food consumed in each plot, but not a significant difference in type of food consumed in each plot. The 1954 Burn Plot had significantly less consumption than the other plots. Overall the consumption of rice decreased as forest age increased. With a better understanding of forest succession, we can preserve Michigan forests.

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Introduction

Succession occurs as a biological community forms in an ecosystem after a disturbance. Secondary succession, after a fire or field clearing, removes all the plants and animals, but leaves the soil layers intact. Species composition differs greatly between forests of different ages. The richness of animal species is closely related to plants' successional patterns (Perry et al. 2008). Many studies show biomass increases to a late-successional maximum (Barnes et al. 1980). Vegetation that inhabits early successional environments creates a more habitable environment for later successional species (Rehkopf 2011). Invertebrate diversity also develops as the vegetation proceeds through successional stages (Altizer et al. 2004). In many forest ecosystems arthropods, especially carabid beetles, are used as indicators of forests recovering from a disturbance (Paquin, 2008; Butterfield, 1997; Heliola et al., 2001; all in Farner et al., 2009). Successful ecosystem management requires the ability to predict future forest composition which requires an understanding of succession (Taylor 2009).

We want to find the food preferred by arthropods in forests at different stages of succession after prescribed burns. Using this information, we can determine if the amount of time since a forest's most recent fire changes the resources of the forest. To explore these ideas we set 100 bait sites of rice covered in sugar, salt, or butter, and recorded the amount consumed from each site.

We predicted arthropod diversity to be highest in the forests at later stages of succession, leading to more consumption in the forests at later stages of succession. We hypothesized food removal will increase with the increase in the age of the forests and that sugar rice and butter rice would be preferred over the control rice. We also hypothesized that choice of food consumed will depend on the stage of forest succession.

Methods

For our experiment we arranged two separate 24 hour trials, with 100 replicates each, to test the most desired resource by arthropods at different stages of forest succession. We performed our test at the University of Michigan Biostation Burn Plots located in Pellston Michigan. These forest plots were last burned at different times and therefore are at different stages of succession. We tested the 5 forest plots that were last burned in 1911, 1936, 1954, 1980, and 1998.

We distributed 5 sites randomly in a 50 meter quadrant in each forest plot. Each site was separated by at least 2 meters. At each site we arranged a quadrant of 4 petri dishes all in contact of each other. Each petri dish held 10 pieces of partially cooked rice. Our control rice was left plain. We coated one set of rice in powdered sugar, another in salt and another in partially melted unsalted butter. In order to prevent access to macrofauna, we placed a wire mesh cage over each petri dish quadrant. We cut each cage with the dimensions of 6in x 5in x 1in.

For our two trials we picked different times to set out and check on the rice sites. For trial one, we arranged the sites at 8:00 AM and checked on each site at 10:00 AM, 4:00 PM, 9:00 PM, 11:00 PM, and 8:00 AM the next day. On day two, set out the rice sites at 12:00 PM, we checked them at 2:00 PM, 5:00 PM, 10:00 PM, and 7:00 AM and 1:00 PM the next day. We checked the sites in the same order each time to keep the intervals of time between checks consistent. We recorded the rice pieces missing at each check. We used a two-way ANOVA to compare the total amount of rice removed across the plots.

Results

Using a 2-way ANOVA analysis we found a significant difference in rice consumption depending on stage of forest succession ($F_{4, 180}$= 9.403; P= 0.00) (Figure 1). The rice removed from the 1911 plot was significantly different from the 1936, 1980, and 1998 plots (p-value= 0.018, 0.002, and 0.000 respectively). The average rice removed from the 1954 plot was significantly different from the 1936, 1980, and 1998 plots (P= 0.001, 0.000, and 0.000 respectively). The 1911 and 1954 plots were not significantly different, and the 1936, 1980, and 1998 plots were not significantly different. Significantly less rice was removed on average from the 1954 plot and the 1911 plots compared to the 1936, 1980, and 1998 plots (Figure 1). Overall, the amount of rice consumed decreased with forest age (r^2 = 0.078) (Figure 2).

Using a two-way ANOVA we found no significant difference between rice consumed and treatment type ($F_{3, 180}$ =2.340; P = 0.075). The rice consumed in the butter and sugar treated rice were significantly different from the control treatment (p-value=0.036 and 0.017, respectively). The butter and sugar coated rice very preferred over the control group (Figure 1). However, the rice group was not found to be significantly different from the control treatment (p-value=0.084). We found no significant difference between the amount of rice removed per each treatment and forest succession stage ($F_{12, 180}$ = 1.605; P = 0.093).

Discussion

We predicted to see that food consumption increased in the forests at older stages of succession. However, food consumption slightly decreased as forest age increased. We thought we would see more food consumption in the older plots due to higher species diversity, but it appears consumption increased, possibly due to more abundant resources already present in the older burn plots.

Our results show that food consumption was significantly lower in the 1954 burn plot, a middle aged forest compared to the other plots. Because the 1954 burn plot had significantly less consumption, we suspect the invertebrate diversity could also be significantly less. One study, also focusing on UMBS burn plots, did found insect diversity to be significantly lower in the 1948 burn plot compared to the 1911 and 1980 burn plots (Kosek 1988). This study correlates with our interpretation of the 1954 burn plot having less insect diversity. Kosek also found

significantly less ant species in the 1948 burn plot (Kosek 1988). Because ants were our primary rice consumer, if the middle aged burn plots support significantly less ant species, that could explain why significantly less rice was consumed in the middle plots.

Although we did not find that invertebrate food presence depends on age of forest, we still gained a better understanding of forest succession and the invertebrate succession patterns. We can consider the idea that older forests, despite having more invertebrate diversity, may also have more resources available. Understanding forest succession is especially important for Michigan, due to excessive logging in the past. With a thorough understanding of succession with can bring back Michigan forest ecosystems.

Appendix

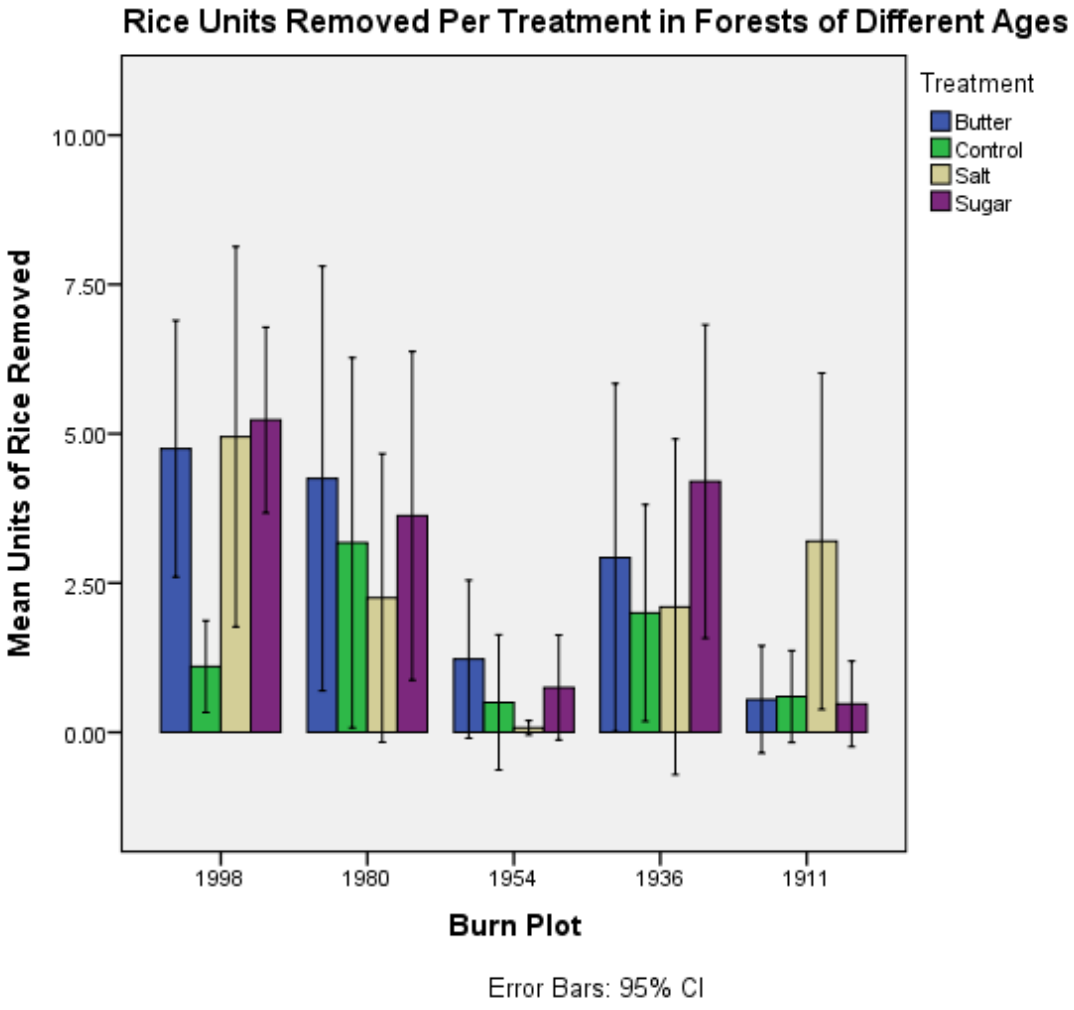

Figure 1: Number of rice units removed per treatment in each burn plot

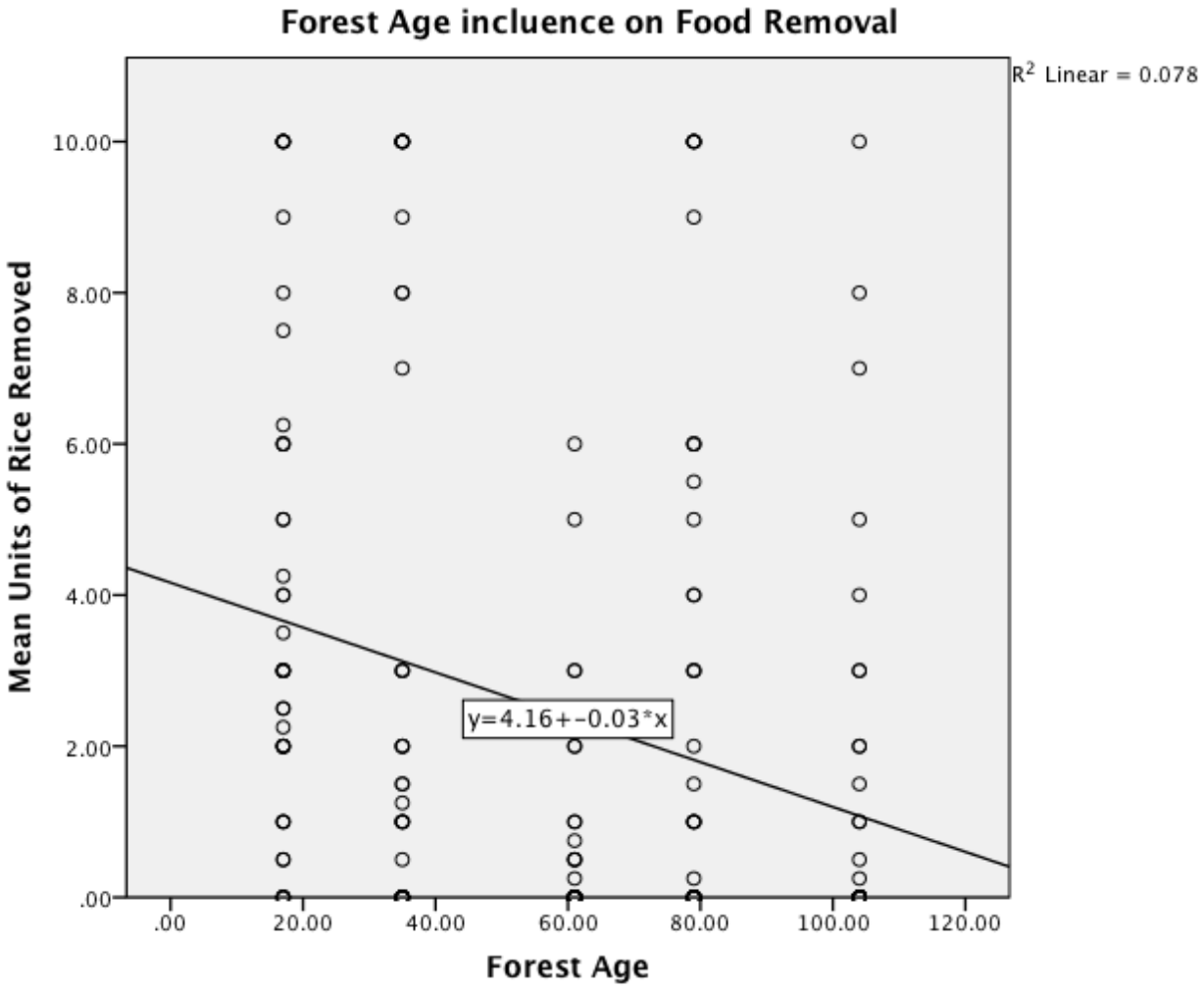

Figure 2: Food removal depending on stage of forest succession

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