The Effects of Southern Pine Beetle (*Dendroctonus frontalis*) on Coarse Woody Debris in the Long Island Central Pine Barrens

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Abstract

Brookhaven National Lab is located on globally rare pitch pine (*Pinus rigida*) barrens, in the Atlantic Coastal Plain of the United States. The pine barrens ecosystem is shaped by fire. Frequent fire within pine barrens create open canopy savannah like stands with dominant pitch pine and sapling scrub oaks, and understory containing various flowering plants including species of low and high bush blueberry (*Vaccinium* spp.), huckleberry (*Gaylussacia* spp.), and sweet fern (*Comptonia peregrina*), among others. As a result of the extensive history of fire suppression not only on Long Island but the northeast in general, pine barrens community composition has changed from predominantly xeric species to more mesic species. This change in fire regime, along with globally warming temperatures, resulting in warmer winters, allowed for the invasion of southern pine beetle (SPB; *Dendroctonus frontalis*), which creates tunnels within the cambium of pitch pines, cutting off nutrient flow and kills the tree within months and changes fuel dynamics by adding more downed woody debris. The extra deadwood within a fire dependent ecosystem may affect fire behavior, how the execution of prescribed fires take place, and changes wildfire suppression tactics. An analysis of the coarse woody debris (CWD) within an area in relation to time will help determine the effects of the beetle on the fuel dynamics of the pine barrens. The downed woody debris analysis was done

using Browns's transects to determine that as time since infestation of SPB there is also an increase of CWD. By varying the time since attack, it can be determined how quickly, and in what way SPB is affecting the fuel dynamics of the pine barrens. This will teach me how to do fuel analysis of CWD and build on my knowledge of fuel dynamics in relation to prescribed fires. An understanding of fuel dynamics may be important for the safe and effective implementation of BNL's prescribed fire program.

Introduction

Fuel dynamics is an integral aspect of prescribed fire, influencing flame length, intensity, and fire behavior (NPS, 2024). Within the Central Pine Barrens of Long Island and the northeastern US broadly there has been a long history of fire suppression. Drastically changing the community composition within the area, as fire is necessary to maintain these ecosystems (USFS, 2000). To maintain a pitch pine (*Pinus rigida*) barren and prevent a closing of the canopy leading to a cooler mesic understory a high intensity top-killing fire must occur more frequently, greater than 30-40 years (Jordan et al, 2003) to prevent a tree oak canopy from forming. The lack of disturbance, whether it be thinning, or fire has allowed for increased density and for succession to take place shifting what was once pine-oak forests to coastal oak forests, not only closing the canopy but reducing flammability (Jordan et al, 2003). This in combination with climate change has allowed for the expansion of the southern pine beetles' (SPB) range into the northeast causing extreme tree mortality (NYSDEC). SPB has been able to spread and decimate the Central Pine Barrens so quickly because of how dense the pitch pine stands are, as these denser stands allow for easier pheromone communication, therefore attracting more SPB to already stressed trees (NYSDEC). As with other pine beetle infestations like that of mountain pine beetle (*Dendroctonus ponderosae*) in the western United States (Klustch et al, 2009) it can be assumed that there will be a positive correlation between time since attack and Downed Woody Debris (DWD). Although Klustch found no difference between infested plots vs

healthy ones, there has been no comprehensive analysis on the effects of the southern pine beetle on the Downed Woody Debris within the Central Pine Barrens on Long Island due to the recency of infestation. This is critical to determine the effects of SPB on the future of fire within the Central Pine Barrens, along with the future of the health of the ecosystem and can be applied to other pitch pine oak forests along the North Atlantic Coastal Plain. A hypothesis that as time since infestation of beetles increases there will be a subsequent increase of downed woody debris within a given area. The goal of this study is to complete a comprehensive analysis of DWD within the Central Pine Barrens on Brookhaven National Laboratory land in relation to prescribed fire fuels and determine how the infestation of SPB changes the DWD within stands over time since attack.

Methods

Brookhaven National Laboratory is a 2,131-ha federally owned facility located within the greater 22,275 ha Central Pine Barrens on Long Island (Environmental Protection Division, 2021). An ecosystem with well-drained, nutrient-poor, coarse soil, a dominant pine-oak forest, with associated heath shrubs, and grasses. (Jordan et al, 2003). It is managed through the use of mechanical treatments and prescribed fire, Aerial imagery from Nearmap® was used to compare specific areas during the growing season to examine change in overstory mortality, to determine areas experiencing different times since infestation of SPB.

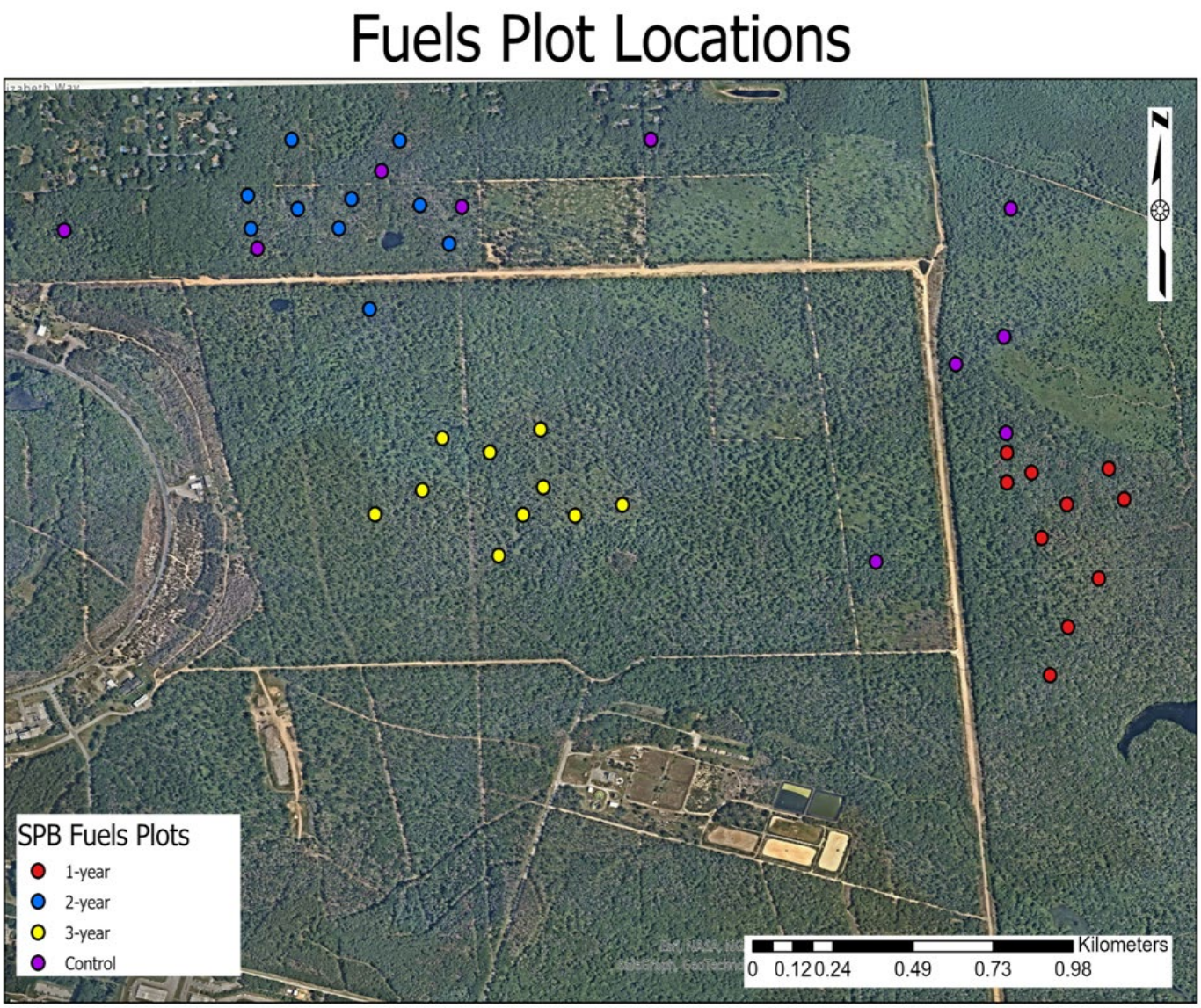

Figure 1: Different areas of SPB infection type. Color coded into 4 groups: control- orange, 1 year since attack- light blue, 2 years since attack- dark blue, 3 years since attack-pink

After determining canopy death due to SPB, a total of forty points were selected throughout the Lab site—ten controls (little or no canopy mortality), and ten each based on time since initial attack—one year, two years, three years since the start of SPB infestation. One randomly established 15-meter transect was run at each GPS location, to analyze the Downed

Woody Debris. A transect tape was laid so that it was below any vegetation, and downed woody material, so that it was as close to the ground as possible. Brown's Downed Woody Fuels Inventory (Brown 1974) was the basis for the data collection method. The transect was then walked in 2-meter sections initially. Any downed woody fuel (unrooted and dead) under 3 meters high that intersected with the transect was counted and divided into fuel size classes: 0-0-0.635 (1-hr) cm, 0.635- 2.54 cm (10-hr), 2.54 -7.62 cm (100-hr), and >7.62 cm(1000-hr). 1000-hour fuels were measured perpendicular to the central axis of the tree, and it was also noted if the downed wood was sound or rotten. Within the sections 0-30 cm, 3-3.5 meters, 6-6.5 meters, 9-9.5 meters, and 12-12.5 meters a measurement of the greatest litter depth, highest unrooted woody fuel (slash), rooted shrub, and live rooted shrub or tree shorter than 3 meters were measured. All data was then entered into a spreadsheet to calculate tons per acre of each fuel size class. The accepted alpha value for significance was <.05. The average for each fuel size class was calculated for SPB plots vs Control Plots and was graphed. P-value was calculated doing a t-test.

Results

Shown below are the graphs visualizing the intersections with DWD along each of the ten transects within each treatment type in the chrono-sequence along with the control plot (Figures 2-5). As shown in Figure 2, There is little to no DWD in the majority of transects within the control areas, aside from transects a and j in which large 1000-hour fuels were noted, however these were not as recently downed as those within the SPB infested areas (determined by level of decomposition). These graphs show that there is an increase in intersections with DWD the longer it has been since attack of SPB in a plot. As moving through the chrono-sequence it can

be seen that there is an increase in DWD as time since infestation increases. The 1 year since attack plots have more DWD than the controls, but rarely does it pass 1 ton/acre for any size class (Figure 3). At 2 years since infestation the tons/acre of DWD quadruple from that of the 1-year transects (Figure 4). There is also an increase of about 50 tons/acre between the 2-year and 3-year mark (Figure 5).

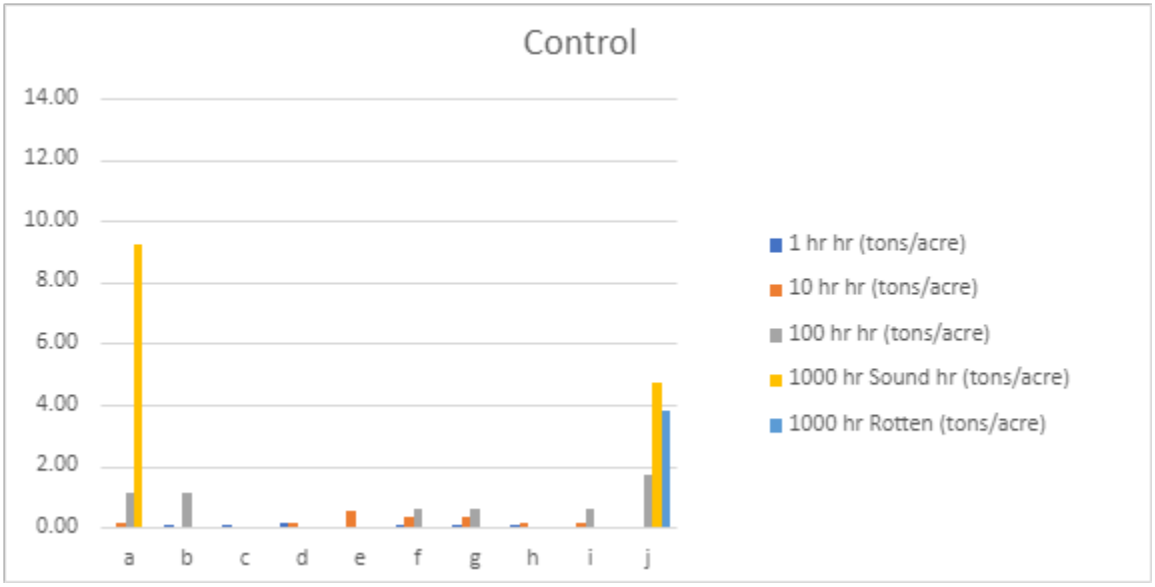

Figure 2: Control transects with no beetle infestation in growing season of 2024.

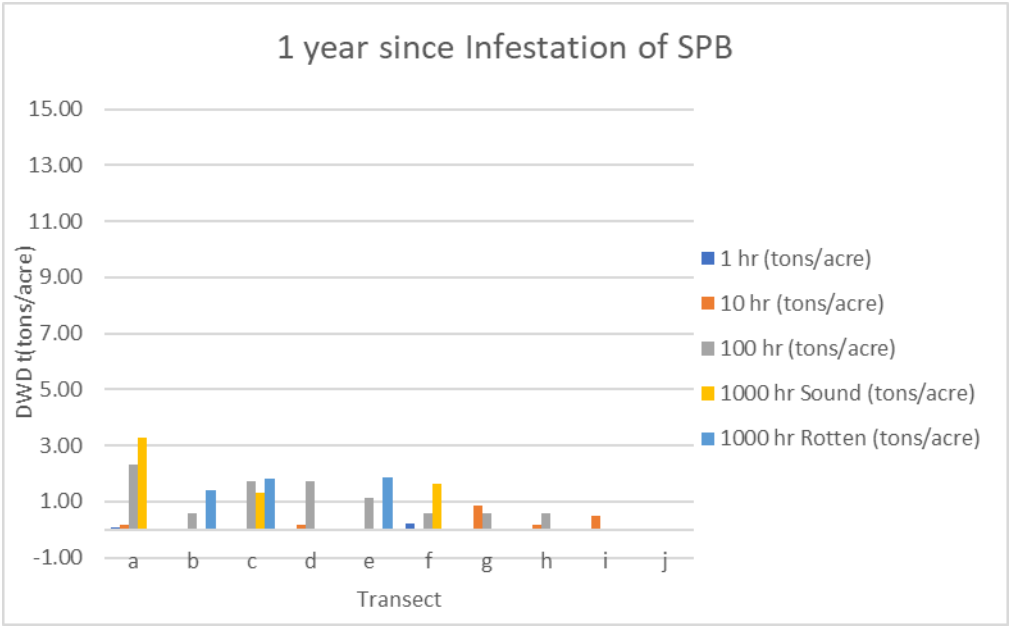

Figure 3: Transects with 1 year since beetle infestation in growing season of 2024.

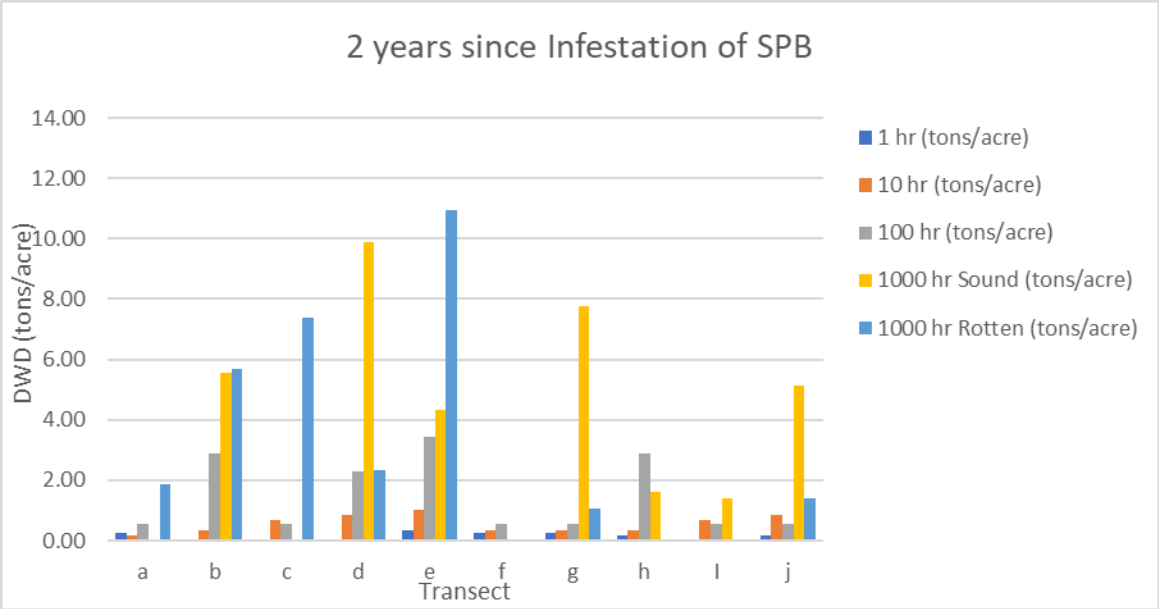

Figure 4: Transects with 2 years since beetle infestation in growing season of 2024.

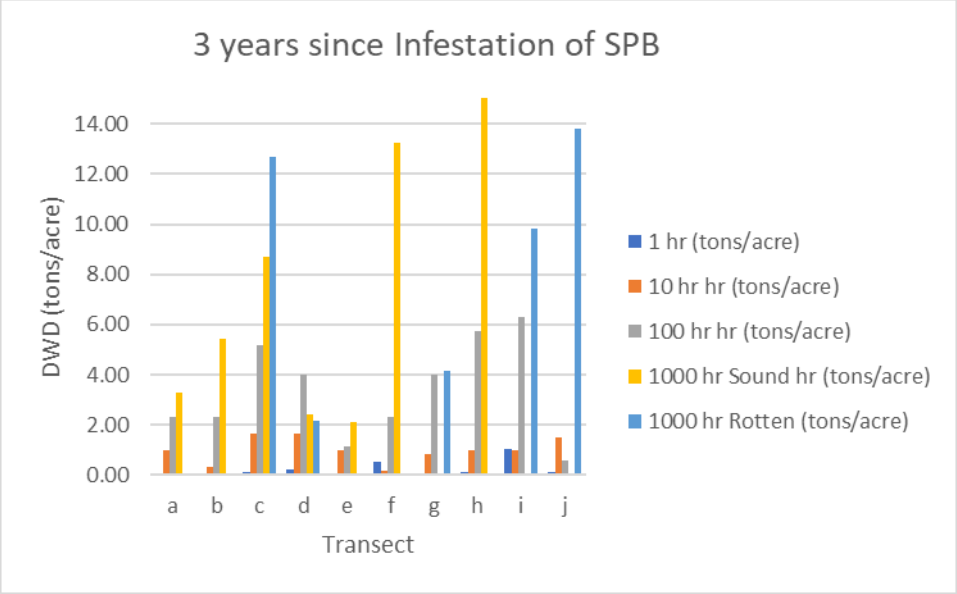

Figure 5: Transects with 3 years since beetle infestation in growing season of 2024.

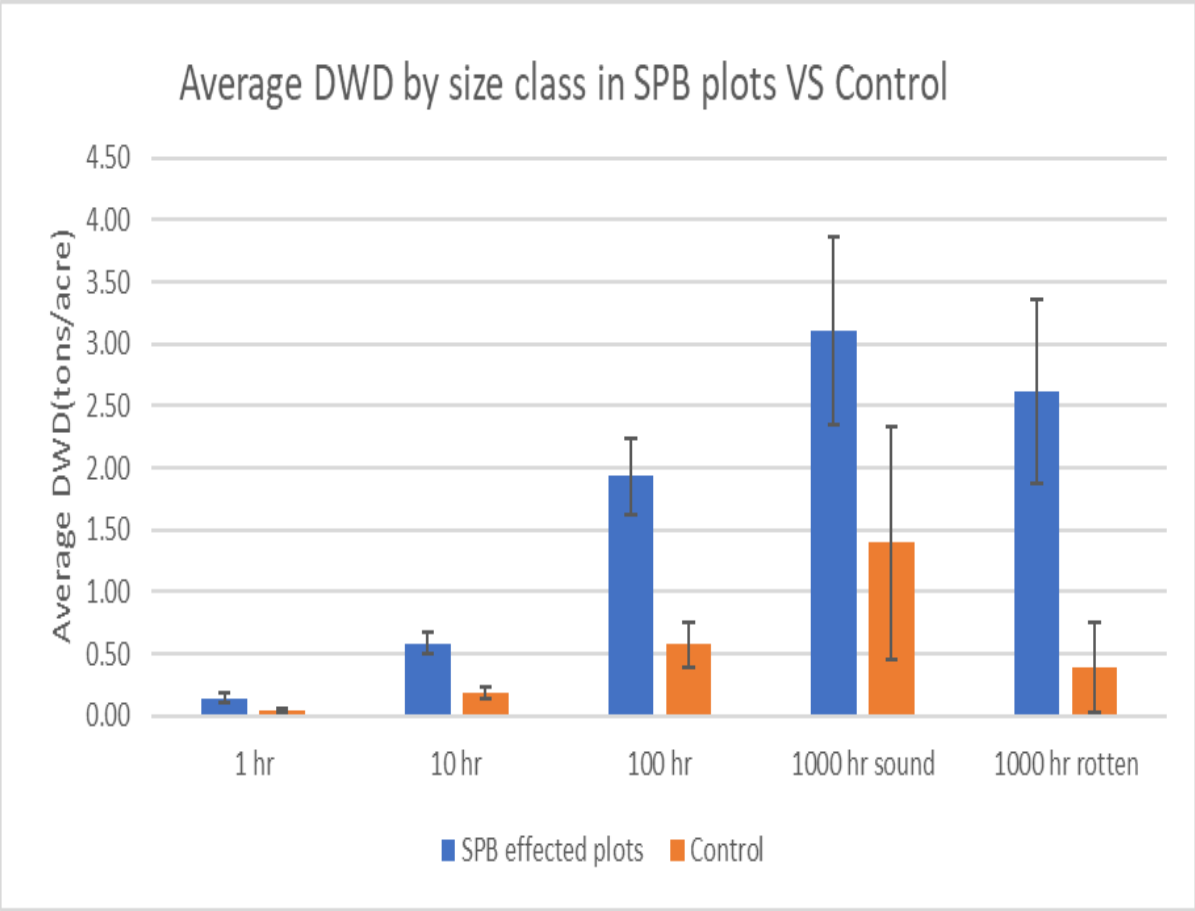

Figure 6: Average DWD by size class in plots with SPB vs Control of all fuels size classes p=0.027239, 0.000153, 0.001155, 0.164359, 0.012832. As shown every fuel size class has a greater average tons/acre in SPB infested plots vs. control plots. P value=<.001.

Size class	P value	Standard error
1-hr	0.027239	0.037846
10-hr	0.000153	0.089768
100-hr	0.001155	0.310187
1000-hr sound	0.164359	0.759007
1000-hr rotten	0.012832	0.740348

Figure 7: P-values and standard errors of bar graphs in Figure 6, accepted p value=<.001

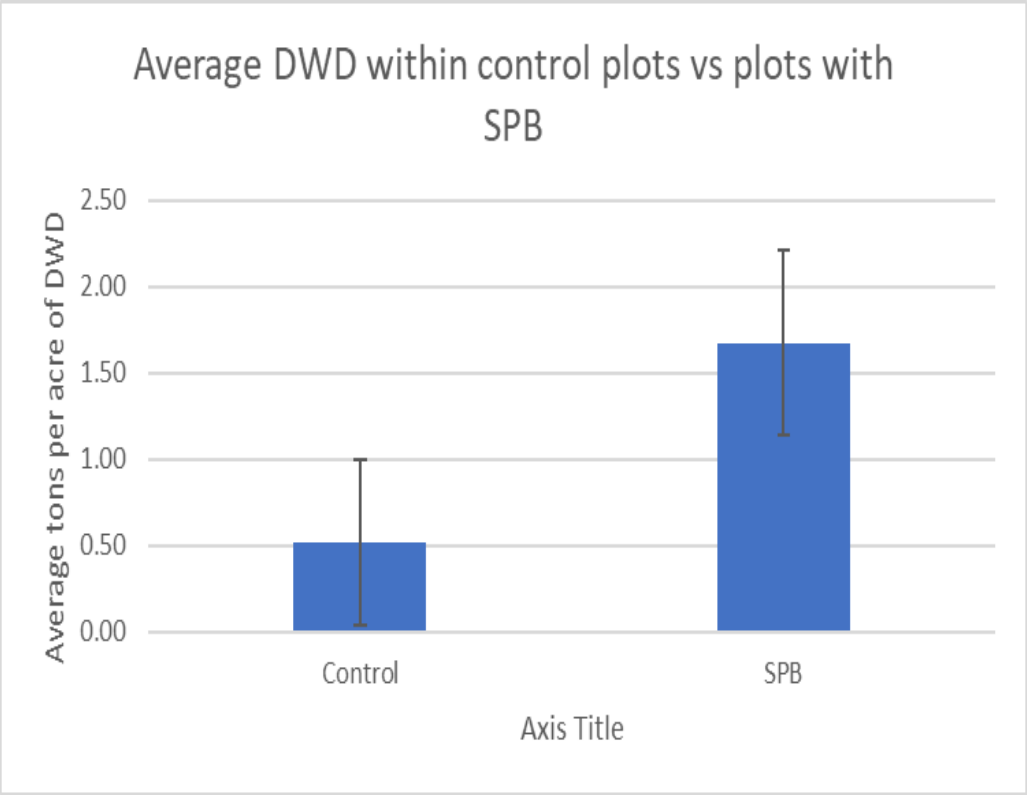

Figure 8: Combined Average of all DWD within SPB plots vs control plots regardless of size. As shown SPB plots have an average of 1.67 tons/acre, while control plots have an average of 0.52 tons/acre. p=<.001

As seen in the graphs above there is an increase of DWD as time since attack of SPB on pitch pine increases. There is an increase in not only the number of encounters per size class, but also the number of encounters overall. This is confirmed when examining the calculated averages of each size class as the average tons/acre of DWD is greater in plots with SPB is when considering every size class (Figure 6). Although a greater number in plots with SPB infestation, only the 10-hr, and 100 hr fuel size classes fall into the range of significance. While the 1-hr, 1000-hr sound, and 1000-hr rotten do not fall into the range of significance, as shown

in Figure 7. When averaging the entirety of the attacked plots and comparing that to the control plots (Figure 8). It can be seen that there are significantly fewer encounters of DWD among control plots vs plots infested with SPB. After running a t-test the p-value was 0.000495, with standard errors of 0.482672 for control plots, and 0.537997 for SPB plots.

Discussion

Within this study the effect of southern pine beetle on Downed Woody Debris was analyzed using Brown's Transects. Four different areas were sampled within a chrono-sequence, based on varying times since infestation of SPB. The hypothesis that as time since attack of SPB increases so will the amount of downed woody debris counted within the transects sampled. After sampling and analysis, it can be clearly determined that in terms of a count the hypothesis was supported. As time increases since the time of infestation there is a subsequent increase in DWD.

While this count is very helpful to start conversations about fuel loading and SPB's effects on fire regimes in its expanded range, it must be noted that due to the excessive fuel loading on Long Island prior to SPB infestation (Jordan 2003), data is important as increased DWD within an area can significantly change fire behavior. Due to the already high fuel loading as a result of long-term fire suppression the increased DWD may not significantly impact fire behavior in the pine barrens on Long Island (Jordan 2003). Due to the speed of SPB infestations and mortality rate of trees within stands infected there were some trees within control transects that had some visible signs of infestation on the stem of the tree, but had not yet caused overstory mortality, which was the determining factor in determine the plots as aerial imagery was used. It should also be stated that the total number of tons/acres of DWD is greater in the control plot than that of the 1 year since attack plot. This can be attributed to the large diameter 1000-hour fuels found within the transect. While limited, this study does open the doors for more interesting and in-depth studies on how SPB affects trees and wildland fuel

composition. These findings are contrary of a study done by Klustch in 2009 on mountain pine beetle in Colorado that found no change in DWD within the affected areas. The difference in finding from Klustch may have to do with the differing conditions these studies take place within. The results are interesting to compare as they are studying quite similar ecological phenomena but very different results. It should be noted that SPB-infested trees have been found to decay more quickly and come down sooner than those not infested by SPB. This is of extreme importance as it drastically affects surface fuels and therefore fire behavior. Overall, when examining the DWD within plots infested with SPB vs. those not infested there was no significant difference in tons/acre of DWD for the majority of size classes, the size classes in which there was a significant difference were the 10-hr and 100-hr fuel classes. But when the total averages of DWD were calculated regardless of fuel class a significant difference was seen as there was over three times the amount of tons/acre of DWD in the areas attacked by SPB.

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