The bark is worse because they bite: a case study on the frequency, density, and effects of black turpentine beetles (*Dendroctonus terebrans*) on pitch pine restoration at BNL

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Abstract

Pine barrens have evolved over millennia in the presence of frequent fires. In the absence of disturbance, the ecosystem's structure and stability changes to favor hardwoods, stress pitch pines *(Pinus rigida)*, and overstock the under and overstory. Management, such as mechanical treatments and prescribed burns, are necessary to restore destabilized pine barrens. Black turpentine beetles (BTB; *Dendroctonus terebrans*) thrive on weakened pines and while not obligate tree killers, their presence has the potential to attract more bark infesting species and cause serious pitch pine destruction. This case study aims to expand literature and research on BTB in the mid-Atlantic by investigating the frequency and density of BTB in a variety of restoration stands along with the characteristics of attacked trees. It was found that BTB were of highest density and mean count in areas with no/low management like low intensity burns and lowest in areas mechanically thinned and with histories of at least one wildfire. This furthers literature on both BTB and their presence in mid-Atlantic pine barrens.

Introduction

Pine barrens are globally rare communities, only occurring in extensive stands on the Atlantic Coastal Plain[2]. Pine barrens are comprised of an open canopy of primarily pitch pine and understory of scrub oak (*Quercus ilicifolia*), heath shrubs, and grasses[5]. Disturbance, whether biotic or abiotic, is necessary in these communities to sustain this structure and composition[4].

Brookhaven National Laboratory (BNL) manages approx. 2,130 ha (5,265 ac) in the central region of the Long Island Pine Barrens, which has a long history of fire suppression and low/no management[3]. This has resulted in overgrown understory, overstocked canopy, and the slow transition towards oak dominance[9,5]. Large portions of the region have also been damaged by the southern pine beetle (SPB; *Dendroctonus frontalis*) since 2014[1,8].

BTB can colonize all species of pine (*Pinus* spp.) within their range targeting freshly cut stumps and weakened trees[7]. They're often found colonizing trees attacked by SPB, and/or *Ips* spp.[9]. BTB have the potential to attract more bark infesters along with being indicative of an area's overall health[6]. Preventative management like thinning stands and reducing competition among vegetation are effective methods of management for BTB[7].

Restoration is necessary to reduce tree density, especially hardwoods, and allow for greater pitch pine regeneration. Despite aiming to reduce overall stress within the ecosystem, restoration treatments are also sources of immediate stress as they're still events of disturbance.

This study aims to provide ample description of stand history, BTB density, and the characteristics of colonized pitch pines. The results of this study aim to allow for a more thorough understanding of the effects of different restoration treatments on pine barrens communities in relation to BTB and other bark beetle presence and influence.

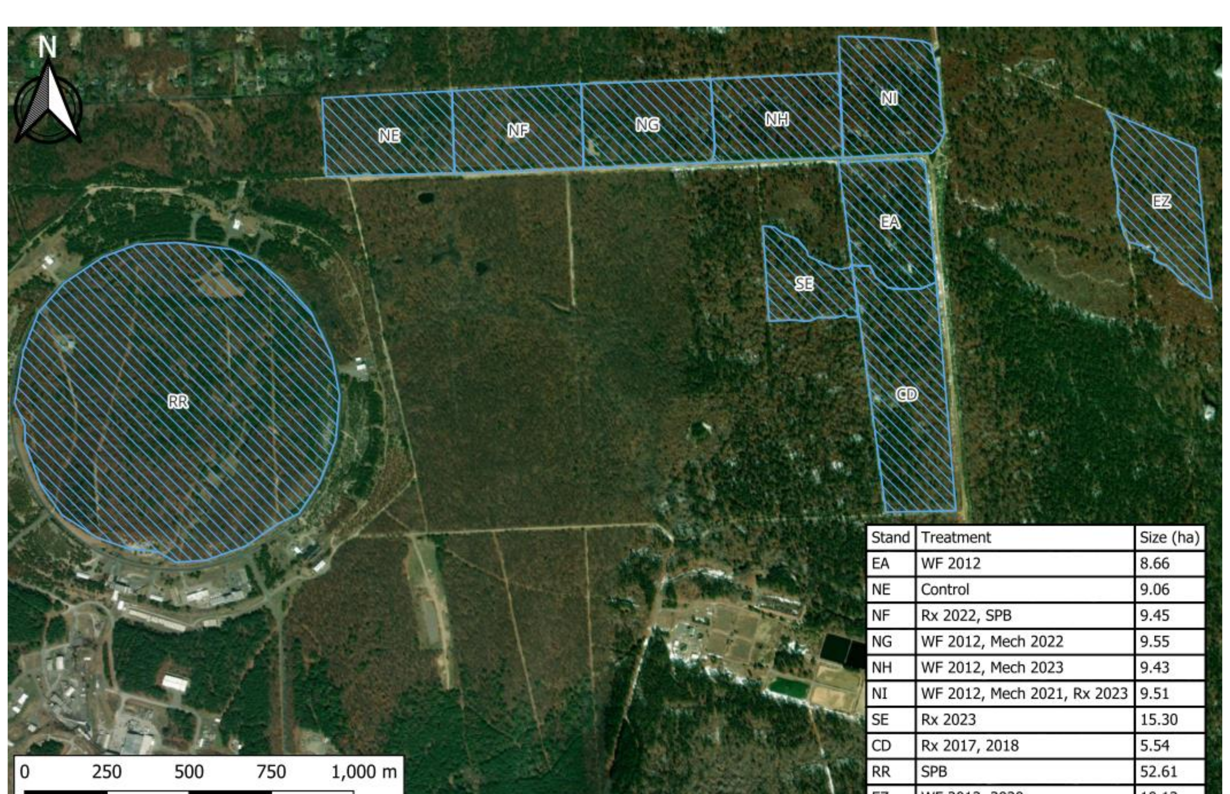

Figure 1. BNL restoration stand map, treatment history, and stand size

Methods

Field Surveys

- 10 stands w/ varying treatments, structure, disturbance types, size, and stand history (Figure 1)
- 6 plots w/ a fixed radius of 11.3 m were randomly established w/ at least 20 m separating each and a 10 m edge buffer for each stand (Figure 1)
- Tree characteristics collected: DBH (min of 10 cm), canopy class, living/decay stage, and BTB presence
  - If BTB were present: height of highest and lowest attack in cm, BTB count by resin tubes (Figure 2), and *Ips* spp. or SPB presence

Data Analysis

- **Overstory composition**: average DBH, number of trees per ha, live/dead basal area (m^2/ha) (BA), percent composition of crown class and living/decay stage
- **BTB presence**: number BTB per ha, number BTB infested trees per ha, BTB BA, BTB mean per stand, and other bark beetle presence

Overall Composition	Stand									
Variable	EA	CD	NE	NF	NG	NH	NI	RR	SE	EZ
No. of trees per ha	1.62	1.24	1.99	4.34	0.94	1.8	3.05	1.44	1.44	1.19
Avg. DBH (cm)	40.98	37.05	35.79	27.48	33.64	33.03	29.84	25.42	33.47	34.02
Live tree basal area (m^2/ha)	6.82	4.28	4.11	0.98	3.97	6.97	6.98	1.29	3.1	3.92
Dead tree basal area (m^2/ha)	1.46	4.31	3.77	10.49	0	0.93	2.05	17.65	0	0.85

Table 1. Overall stand conditions & composition

BTB Present	Stand									
Variable	EA	CD	NE	NF	NG	NH	NI	RR	SE	EZ
No. of trees w/ BTB	2	6	7	20	0	5	10	7	1	0
No. of BTB	16	156	251	509	0	143	129	265	12	0
No. of trees per ha w/ BTB	0.23	0.39	0.77	2.12	0	0.53	1.05	0.13	0.18	0
Mean BTB per tree	1.14	8.21	13.94	12.41	0	8.4	4.45	3.5	1.5	0
Total BTB Basal area (m^2/ha)	1.35	3.59	3.88	7.17	0	0.44	3.65	3.14	0.05	0
Standard error	0.88	4.3	6.39	2.77	0	5.09	1.7	1.63	1.5	0

Table 2. Stand data in sampled trees where BTB was present

Figure 2. Fresh BTB resin tubes

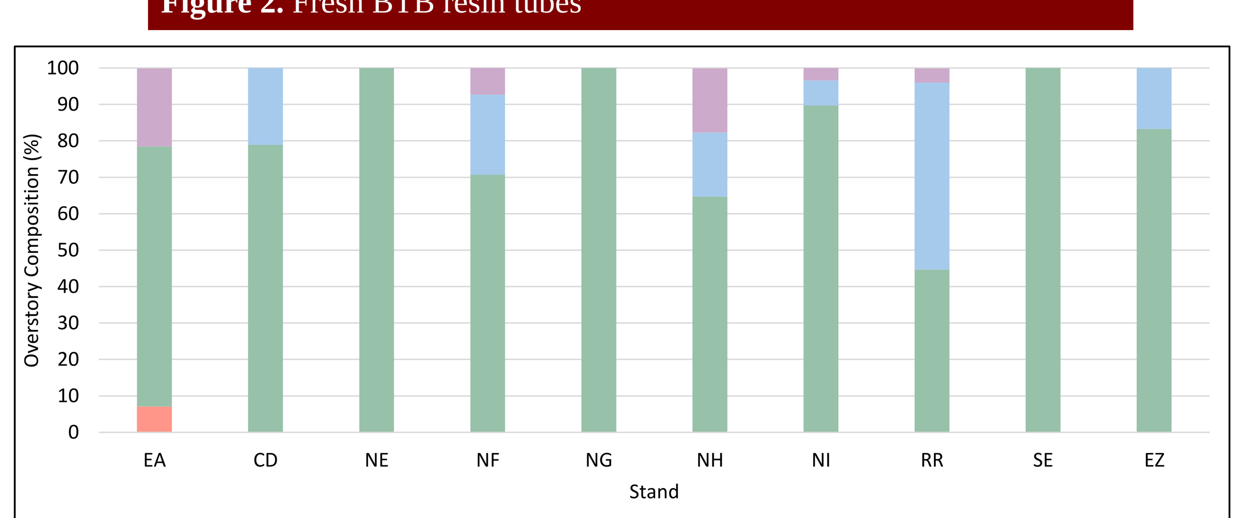

Figure 3. Overstory stand structure in sampled stands

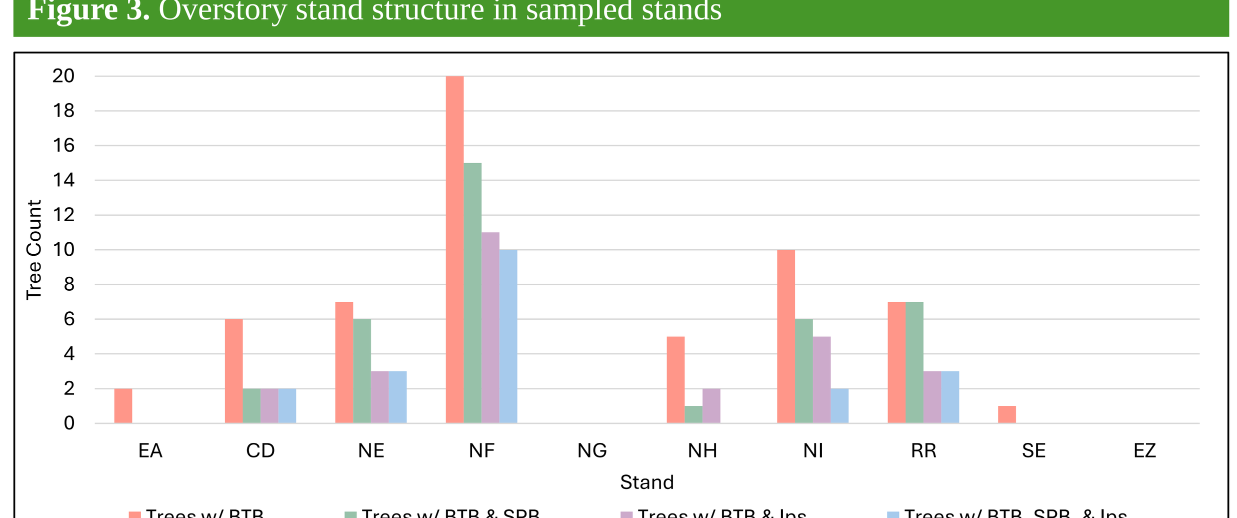

Figure 4. SPB and *Ips* spp. presence when BTB present

Results

Stand Condition

- Highest live BA found in stands with **a history of fire** and **mechanical thinning**
- Highest dead BA found in stands with significant SPB damage and **little/no history of fire**

BTB Frequency & Density

- Highest BTB count and BTB tree count found in **North F** and **North E -** histories of no management and low intensity burns
- Lowest BTB count and tree count found in the **North G** and **East Z -** histories of mechanical thinning and at least one wildfire
- BTB **consistently found with** *Ips* spp. and/or SPB, however, not vice versa

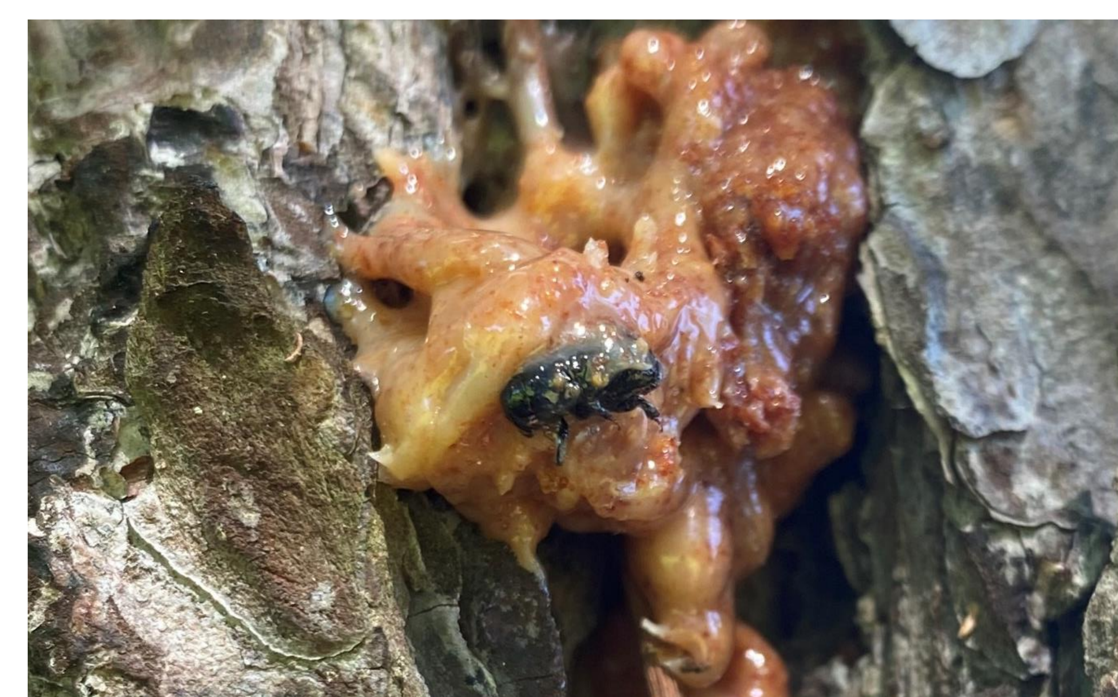

Figure 5. BTB caught in pitch resin

Discussion & Conclusion

BTB were found in almost every stand regardless of treatment type, history, and size. Stands with no/low management (NE, NF) saw the highest mean BTB (Table 2). They were observed to have high hardwood and SPB presence. Stands with histories of mechanical treatment and multiple wildfires (NG, EZ) saw the lowest mean BTB (Table 2). They also had the lowest BAs (Table 1) meaning lots of open canopy and space, along with lowest observed quantity of overstory oaks.

These findings support previous literature on BTB behavior and the importance of open canopies and a pitch pine dominant overstory in pine barrens. They stress the importance of thinning and disturbance as a means of management. There is a trend within this study where areas with solely mechanical thinning and at least one wildfire had lowest BTB count, BTB mean, other beetle presence, and dead basal area in comparison to those also treated with prescribed fire. An area with histories of wildfire, mechanical treatment, and prescribed burn (North I) is an example of this trend. This stand had a higher percentage of dead/declining trees, higher number of trees with BTB, and a higher dead basal area than other mechanically treated stands.

These trends could suggest that thinning without fire should be considered first when aiming to decrease oak density and increase open canopy over prescribed burns. However, more research with a larger sample size is needed for this conclusion to be more definitive.

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Acknowledgments

I would like to thank my mentor at Brookhaven, Kathy Schwager, and from the US Forestry Service, Kevin Dodds, for their invaluable guidance, support, and knowledge throughout this project. I'd also like to thank the DOE and BNL for the opportunity to conduct research with them. This project was supported by the US Department of Energy, Office of Science, Office of Workforce Development for Teachers and Scientists (WDTS) under the Science Undergraduate Laboratory Internships Program (SULI).

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