The impact of forest management on avian communities in the central pine barrens of Long Island, New York

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The Atlantic coastal pine barrens are a globally rare ecosystem that requires regular fire to persist. Fire suppression has caused large portions of these fire-dependent systems to be lost or degraded alongside the accumulation of excess fuel in the canopy and understory. These factors can significantly increase the risk of greater damage should a wildfire occur. Without fire, the barrens become more like a dense forest, which will be less suitable for shrubland birds, a suite of species that is facing decline in the northeast. It is hypothesized that fuels management regimes (prescribed fire and/or mechanical treatments) for these overgrown barrens will promote shrubland birds and thus increase diversity. Fuel reduction can help to maintain the heterogeneity of the landscape, allowing different niches of birds to occupy the area. By analyzing bird survey data from the Brookhaven National Laboratory's Environmental Protection Division, as well as new point counts conducted specifically for this study, bird communities in areas with or without management were compared. All of the transects surveyed had a relatively similar evenness of species. Despite the transect with regular management exhibiting a greater species richness, and thus a wider diversity, there was no statistically significant difference in the species observed between transects, likely due to the close proximity of management plots to those that do not receive management. This study aligns with the US Department of Energy's mission of progressing environmental solutions for the advancement of life on Earth. The Science Undergraduate Laboratory Internship has given me a more realistic experience in the world of ecological research. Skills such as setting up and carrying out a standardized procedure, bird, tick, vegetation, and turtle surveying, soil coring, camera trap installation, and statistical analysis were honed during my time at the lab.

Introduction

"Pine barrens" is a general term used to describe a mosaic of related woodlands, grasslands, and barrens communities (Kurczewski and Boyle 2000). Pine barrens, including the Atlantic coastal pine barrens, contain some of the highest quality shrubland habitat and require regular fire, management, or other disturbance to maintain their early-successional characteristics (Bried et al. 2014). Characterized by sandy, acidic, nutrient-poor soil, this system maintains an open canopy dominated by mixed, yet sparse, pitch pine (*Pinus rigida*) and tree oaks (*Quercus spp.*) (Jordan et al. 2003). This barrens' low, shrubby understory contains scrub oak (*Q. ilicifolia*), with huckleberry (*Gaylussacia spp.*) and blueberry (*Vaccinium spp.*) mixed in (Kurczewski and Boyle 2000, Schwager 2021).

With European settlement and modern development, fire began to be excluded from these systems, increasing the severity and frequency of wildfires (Nowacki and Abrams 2008). The suppression of fire leads to the accumulation of excess fuel in the canopy and understory, increasing the risk of human injury and property damage should a wildfire occur (King et al. 2011). To combat this risk, prescribed fire and mechanical treatments can be done to rearrange and/or remove the excess fuel, keeping it at safe levels for adjacent communities and infrastructure (Ryan et al. 2013).

Brookhaven National Laboratory (BNL), located in Suffolk County, NY, contains 3,500 acres of the 105,000 acres of Long Island's Central Pine Barrens (CPB) (Schwager 2021) with much of this land having its historical fire regime suppressed during the 20th century. In April of 2012, the Crescent Bow Wildfire started in the northeastern portion of the site and burned 432 hectares (Meng et al. 2017). This event sparked the lab's Environmental Protection Division

(EPD) to expand on their previous prescribed burn plan, originally created to ensure the safety of BNL and adjacent communities by reducing excess fuel. Such burn treatments have been done for almost 20 years. Many pitch pine stands on site have been lost to southern pine beetle (SPB; *Dendroctonus frontalis*), which was first detected on Long Island in 2014, likely making its way northward due to higher winter temperatures. Pitch pine is one of the preferred eastern hosts of SPB, making the beetle a significant potential threat to the CPB. Without fire, overgrown pitch pine forests become very stressed, producing less of their chemical defenses against insects. This leaves stands of pitch pines particularly vulnerable to SPB fatality, further adding to the accumulating fuel load following fire removal and increasing wildfire danger (Schwager 2021, Thomason et al. 2025).

From an ecological perspective, the removal of fire in the CPB can allow tree oaks to outcompete the more fire-adapted pitch pines, leading the habitat to homogenize and transition towards a denser, more mesic forest (a process known as "mesophication") as other non-fire-adapted species, such as red maple (*Acer rubrum*), make their way in (Jamison et al. 2023). When fire is returned to this system, even for primarily wildfire risk-management purposes, the ecosystem can experience a restoration effect that helps fire-adapted species become dominant again and open up the canopy for shrublands to return (Bried et al. 2014).

Under the CPB's historical fire regime, the mix of habitats within this ecoregion fosters a diverse avian community, but when fire is excluded and the habitat homogenizes, forest birds become more prevalent as shrubland birds lose more of their habitat and are thus outcompeted (King et al. 2011). It can be predicted that forest management methods are not only helping to restore historical vegetation characteristics, but also the avian assemblages that would have occupied these areas prior to fire exclusion. If this is the case, areas receiving active management will have a greater diversity of birds overall, compared to areas that lack such management.

Methods

To add to previous BNL point count data, new point count surveys were done five times for each of three transects of focus, with birds primarily identified by call as well as sight when possible. Each plot within a transect was approximately 300 meters apart, with each point count lasting five minutes.

The South Transect (ST-1 through ST-5) located near the southern end of the property has had no active management and thus served as the control for this study. This transect is primarily comprised of a pitch pine/mixed oak-heath forest, with some scattered patches of scarlet oak-heath forest (Schwager 2021).

The Forest Management Transect (FM-1 through FM-5) consists of five points around an approximately 100-acre area that has experienced management through mechanical treatments and/or prescribed fire giving the landscape a fire regime most similar to a historical pine barrens relative to the other transects. These plots are mostly pitch pine/mixed oak-heath forest, with relatively small patches of pitch pine/white oak forest (Schwager 2021).

The Z-Path Transect (ZP-1 through ZP-4) contains three points that were directly in the path of the 2012 Crescent Bow wildfire, with the fourth just outside the perimeter of the fire. This transect has not received further management since the wildfire. This area consists primarily of pitch pine with a dense oak coppice growing throughout as well as some scarlet oak-heath forest and pitch pine/mixed oak-heath forest (Schwager 2021).

The Shannon Diversity Index was used to determine the diversity, evenness, and the number of effective species (Jost 2006) for each transect, grouping point counts by year. These values were calculated for all 3 transects with data from 2025. They were also calculated for data from 2011, 2012, 2013, 2015, and 2017 for the ST and ZP transects. These are the years before, of, one year after, three years after, and five years after the Crescent Bow Wildfire, respectively.

Results

Even though the FM transect had values greater than those of the others, none of the transects differed too greatly in any category (Table 1). There were no statistically significant differences in the species observed between any of the transects (p=0.23 for FM vs. ST; p=0.27 for FM vs. ZP; p=0.99 for ZP vs. ST).

Table 1: The richness, evenness, Shannon diversity, and number of effective species for FM, ZP, and ST in 2025.

2025	FM	ZP	ST (Control)
Richness	53	43	36
Evenness	0.812	0.768	0.789
Diversity	3.223	2.890	2.829
Effective Species	25.108	17.997	16.925

For 2011, 2012, 2013, 2015, and 2017 there was no statistically significant difference in the species observed between the ZP and ST transects (p=0.76, p=0.52, p=0.51, p=0.51, and p=0.07 respectively). For all five years, both transects maintained high evenness and moderate diversity values. There was a slight trend of increasing diversity for ZP over the years (Table 2).

Table 2: The richness, evenness, Shannon diversity, and number of effective species for ZP and ST in 2011, 2012, 2013, 2015, and 2017.

2011	ZP	ST (Control)
Richness	31	26
Evenness	0.828	0.843
Diversity	2.843	2.747
Effective Species	17.164	15.602
2012		
Richness	30	21
Evenness	0.860	0.836
Diversity	2.925	2.545
Effective Species	18.628	12.749
2013		
Richness	32	29
Evenness	0.853	0.818
Diversity	2.956	2.754
Effective Species	19.225	15.702
2015		
Richness	38	32
Evenness	0.789	0.82
Diversity	2.87	2.841
Effective Species	17.641	17.126
2017		
Richness	37	25
Evenness	0.834	0.857
Diversity	3.011	2.758
Effective Species	20.313	15.764

Discussion

The lack of a significant difference between the species observed for all three transects in 2025 brings to light a few issues with this study. For one, the FM transect was just across the road from areas that were predominately non-managed scarlet oak-heath forest and the ZP transect was relatively close by (Schwager 2021). Birds must travel while searching for food to maximize their chances of finding a meal, especially during the breeding season. It is highly likely that a bird foraging in a non-managed area could simply fly across to continue foraging in a managed area, and vice versa, even if that area is less desirable (Yap et al. 2017). The managed area along the FM transect is only about 100 acres in size, a distance easily traveled by a foraging bird. Considering this and the Shannon Diversity Index calculations for the transects (Table 1), it would make sense that the differences in values wouldn't be very large since the birds are able to easily access managed and non-managed areas in a short distance.

Another potential source of error comes from the fact that bird songs/calls are notoriously difficult to learn, taking a lot of time and experience to master their identification. Even expert birders can get lost in the many sound-a-likes and mimics in a given area. When counting and identifying birds by ear during a point count, there is almost always some amount of bias resulting from environmental factors, such as ambient noises (Simons et al. 2009). Censusing birds with point counts also has its limitations and makes some assumptions. When you compare point count data between transects, you are assuming that both transects have equal probabilities of detection, which is often not the case. Factors such as a bird's distance from the observer, where birds are in terms of their breeding cycle or life stage, as well as foliage density can impact how likely a bird is to be detected (Farnsworth et al. 2002). This is important to be aware if since the main purpose of this study was to compare birds occupying areas with and without management, which have different vegetative characteristics. A site like the ST transect had more foliage compared to the FM transect, which could have limited the detectability of birds at each point. If conducting a point count survey, especially if comparing birds in areas that differ in vegetation, one should account for the different detection probabilities of each transect. While point counts almost always have some degree of inaccuracy in estimating bird populations, you can mitigate some of it by establishing more points when possible (if they won't overlap with previously established points), increase the time each count lasts (especially if the area is large and the landscape is complex), and repeat counts at each point (Ralph et al. 1995). Point counts can still be a good way to estimate local and small-scale densities, especially when repeated (Ralph et al. 1993).

The calculated values for the FM transect (Table 1) still possibly reflect how management is helping the area become more diverse in its landscape. As the canopy is thinned out, birds adapted for shrubland conditions might be better able to take advantage of the area, increasing the observed diversity. In the field, this could be seen in how species associated with early successional or more open habitat (Dettmers 2003, Gifford et al. 2010, Koenig et al. 2017) occurred only or more often in areas of management. Species such as the American goldfinch (*Spinus tristis*), black-billed cuckoo (*Coccyzus erythropthalmus*), brown thrasher (*Toxostoma rufum*), chipping sparrow (*Spizella passerina*), eastern kingbird (*Tyrannus tyrannus*), field sparrow (*Spizella pusilla*), pine warbler (*Setophaga pinus*), prairie warbler (*Setophaga discolor*), and red-headed woodpecker (*Melanerpes erythrocephalus*) all were consistently observed either exclusively or more often on the FM transect. On the other hand, species such as the Baltimore oriole (*Icterus galbula*), downy woodpecker (*Dryobates pubescens*), eastern wood-pewee (*Contopus virens*), hairy woodpecker (*Dryobates villosus*), northern flicker (*Colaptes auratus*), ovenbird (*Seiurus aurocapilla*), red-bellied woodpecker (*Melanerpes carolinus*), scarlet tanager (*Piranga olivacea*), and tree swallow (*Tachycineta bicolor*), were observed either exclusively or more frequently on the more forested ST transect. This demonstrates that the bird communities are indeed changing as management alters the fire-suppressed landscape.

It is necessary to note that the point count data available for the FM transect only goes as far back as April of 2025, since this is when the transect was first established, and could only go as far as July due to time limitations. Several more years of data would be ideal to get a clearer picture of how the bird community may change over time after regular management. Areas of management are also fairly small at BNL, with approximately 100 total acres being treated (Schwager 2021). Birds can have large ranges due to their unique transportation abilities. A relatively small burn plot such as those within the FM transect could make up only a small portion of an individual bird's range. Ranges differ between species, so those with smaller ranges may be able to take better advantage of a smaller patch of shrubland than others. It has been suggested that shrubland birds may not be as particular about the size of a patch of habitat compared to other suites of birds, being able to utilize as little as 0.8 hectares (Dettmers 2003), which could explain how the FM transect still exhibited a greater diversity of species (Table 1).

From 2011 through 2017, ZP showed a subtle trend of increasing diversity that peaked in 2017 (Table 2). By 2025, this value went back down (Table 1). This can contribute to the idea that *regular* fire/management are necessary to maintain the heterogenous landscape of the CPB (Bried et al. 2014) that allows for a wider diversity of bird species. After the 2012 wildfire top-killed much of the tree oaks, basal sprouting soon began, fostering a more open-canopied and shrub-dominated habitat. This change in vegetation characteristics would have likely proven more suitable for shrubland birds compared to the conditions exhibited before, increasing the diversity observed in the years after the fire. However, fire didn't return to the area for over 13 years, which allowed the mesophication process to restart as the oak coppice continued to grow back into a dense forest. The habitat eventually became more homogenized again, explaining the reduction in diversity that was observed in 2025 (Table 1).

Conclusion

When fire-adapted ecosystems are managed with historical fire regimes in mind, not only can you ensure the safety of nearby communities, but you can also promote and conserve the biodiversity they foster. As previously mentioned, the removal of fire from fire-adapted landscapes can have significant consequences for adjacent infrastructure (Nowacki and Abrams 2008) and the ecological communities they are composed of (Jamison et al. 2023). With the return of regular fire or mechanical thinning to forest management efforts, a reverse-mesophication transition can be observed over time. It is important that historical fire regimes are considered when trying to conserve a pyrogenic ecosystem, since fire is deeply integral to their persistence (Ryan et al. 2013). When such a habitat recovers from fire suppression, so do the avian communities that live within them as shrubland, early successional, and open canopy birds make a comeback. This study suggests that management must be done on a long-term and large spatial scale in order to keep communities safe and restore the avian diversity of the CPB.

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