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OPINION ARTICLE

Why Pine Barrens Restoration Should Favor Barrens Over Pine

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Abstract

Pine barrens include an assortment of pyrogenic plant communities occurring on glacial outwash or rocky outcrops scattered along the Atlantic coastal plain from New Jersey to Maine, and inward across New England, New York, Pennsylvania, and the northern Great Lakes region. At least historically, pine barrens provided some of the highest quality terrestrial shrublands and young forests in the eastern North American sub-boreal and northern temperate region. However, the mosaic open-canopy, sparse-shrub, and grassland early successional state is generally lacking in contemporary pine barrens. Many sites in the northeastern United States have converted to overgrown scrub oak (*Quercus ilicifolia*, *Quercus prinoides*) thickets and closed canopied pitch pine (*Pinus rigida*)-dominated forests. Thinning pitch pine is a contentious issue for the imperiled pitch pine-scrub oak barrens community type (G2 Global Rarity Rank, 6–20 occurrences). Here we provide a historical, ecological, and resource management rationale for thinning pitch pine forest to restore savanna-like open barrens with a mosaic of scrub oaks, heath shrubs, and prairie-like vegetation. We postulate that the contemporary dominance of pitch pine forest is largely of recent anthropogenic origin, limits habitat opportunities for at-risk shrubland fauna, and poses a serious wildfire hazard. We suggest maintaining pitch pine-scrub oak barrens at 10–30% average pitch pine cover to simultaneously promote shrubland biodiversity and minimize fire danger.

Key words: crown fire, forest history, pitch pine, scrub oak, shrubland animals, young forest animals.

Introduction

Over-protection of forests can threaten the early seral stages of vegetation development, and few may notice when open-canopy structure transitions to mature forest over several decades. In the United States, natural communities experiencing the most areal decline and ecological degradation include terrestrial grasslands (e.g. Midwest prairies), savannas (e.g. *Pinus palustris* in the southeast), and shrublands (e.g. Intermountain sagebrush) (Noss et al. 1995). Many of these communities transition to closed-canopy forest in the absence or alteration of periodic disturbance. It is important to document where these changes are occurring and provide a clear rationale for canopy thinning to restore early successional ecosystems where appropriate.

According to the recently launched Young Forest Project (www.youngforest.org), the northcentral and northeastern United States is dominated by mature forest. Historic cycles of stand-replacing natural disturbances (beaver activity, insect outbreaks, severe weather, and wildland fire) have ceased, slowed, or changed dramatically, commensurate with the attenuation of traditional hunting and farming activities by Native Americans and early settlers (Foster & Aber 2004). Net forest area across the region is increasing as abandoned farming, logging, and other open-canopy lands revert back to closed-canopy forest. Additionally, large areas of pine plantations were established to revegetate former agricultural lands and bolster timber production. Recognizing this trend, the journals *Forest Ecology and Management* and the *Wildlife Society Bulletin* each published special issues over a decade ago highlighting the ecological importance and restoration of shrub and sapling dominated landscapes. Now the Young Forest Project is promoting popular awareness of these systems and their critical link to the conservation of diverse and declining wildlife populations in the eastern North American sub-boreal and northern temperate region.

At least historically, much of the region's highest quality terrestrial shrublands and young forests and woodlands could be found in what are regionally referred to as "pine barrens." The term includes an assortment of pyrogenic plant communities occurring on glacial outwash and rocky outcrops scattered along the Atlantic coastal plain from New

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Table 1. Estimated acreage of total forest, pitch pine-scrub oak forest (PPSOF), and pitch pine-scrub oak barrens (PPSOB) at historic (1925–1947) and more recent (1985–1992) time intervals.

	Total Forest		*PPSOF*		*PPSOB*	
Site	*Historic*	*Recent*	*Historic*	*Recent*	*Historic*	*Recent*
Albany	1,202	2,014	450	1,017	28	1
Concord	386	420	166	165	10	2
Montague	139	862	2	745	534	—
Ossipee	6,561	6,319	3,874	3,722	12	11
Waterboro	403	1,050	9.5	83	995	48

—, data not available.
"Total forest" is the sum of hardwood, softwood, mixed woods, and PPSOF acreages from the earliest and latest years when data from two or more of these cover types were available. "PPSOB" refers to open barrens with relatively sparse scrub oak; we excluded the estimate of scrub oak thicket during these time periods.
Derived from Table 4 in Finton 1998.

Jersey to Maine, and inward across New England, New York, Pennsylvania, and the northern Great Lakes region. One well recognized barrens community is confined to the northeast and characterized by pitch pine (*Pinus rigida*) and scrub oaks (*Quercus ilicifolia*, *Quercus prinoides*) with grasses, forbs, and heath shrubs in the understory. Few inland pitch pine-scrub oak sites remain, at least sites that are not small or highly degraded, with the best examples found at the Albany Pine Bush in New York, Concord and Ossipee barrens in New Hampshire, Montague Plain in Massachusetts, and Waterboro barrens in Maine (Finton 1998). A detailed map of these and other northeastern barrens is given in Kirchman et al. (2011) and at the *Managing Fuels in Northeastern Barrens* website (http://www.umass.edu/nebarrensfuels/index.html). A standardized analysis of vegetation change spanning a roughly 50-year interval showed large increases in forest area and large decreases in shrub barrens at several of these sites (Table 1), with most of the shrubland dominated by overgrown thicket instead of open barrens. Forest and woodland dominance still persists at these sites despite intensive, ongoing management over the past couple decades (e.g. APBPC 2010). The shift from shrubland to closed-canopy forest in pine barrens mirrors a general successional trend in vegetated landscapes across the region (Trani et al. 2001; Buffum et al. 2011).

The pitch pine-scrub oak barrens community is an open-canopy, sparse-shrub early successional state that requires active management. Specific goals for managing pine barrens vary across their range, but in general land managers desire restoring forest and thicket vegetation to open barrens to promote early successional wildlife and mitigate hazardous fuel loads (http://www.umass.edu/nebarrensfuels/index.html). Intensive canopy thinning is generally considered the best approach for restoring shrublands and early successional habitats, but even highly selective thinning can become controversial due to concerns about visual impacts and loss of habitat for mature-forest species (Gobster 2001). For pitch pine-scrub oak barrens, a G2-ranked community type (6–20 occurrences globally), the prospect of thinning pitch pine stands may raise public concern and require justification.

We provide a historical, ecological, and resource management rationale for thinning pitch pine forest to restore savanna-like open barrens characterized by scrub oaks, heath shrubs, and prairie-like vegetation. We postulate that the contemporary dominance of pitch pine forest is an artifact of recent land use activities, limits habitat opportunities for many rare and declining faunal species, and may create a serious health and safety hazard in the form of catastrophic wildfire. Principles suggested here apply mainly to pitch pine-scrub oak communities and may not extend to other pitch pine-containing barrens (e.g. coastal dwarf pine plains and pine-oak-heath rocky summits), or to the jack pine (*Pinus banksiana*) barrens of northern New York, the Great Lakes region, and sub-boreal Canada.

Biodiversity Argument

A large number of at-risk species in the eastern North American cold-temperate and sub-boreal region depend on early successional shrubland and young forest habitats. Scrub-shrub conditions in pine barrens can persist for long periods due to harsh microclimates (e.g. frost pockets) and edaphic factors (Lorimer & White 2003), offering stable opportunities for shrub-dependent wildlife. Most of the at-risk faunal species in pine barrens associate or specialize with shrubland or savanna-type habitat (e.g. Wagner et al. 2003; Gifford et al. 2010), and with shrublands and young forests rapidly disappearing, pine barrens may contribute disproportionately to early successional habitat availability and regional biodiversity conservation (Bried et al. 2011). As such, habitat management in pine barrens (e.g. Patterson et al. 2005; Malcolm et al. 2008) should favor the restoration and maintenance of early seral communities dominated by scrub oaks, heath shrubs, and prairie-like vegetation.

Thinning of pine canopy cover will undoubtedly increase the distribution, abundance, and reproductive success of shrubland birds, a group with proportionately more threatened species than forest-interior bird communities (King et al. 2011). Point count surveys and nest searches at both the Albany Pine Bush and Montague Plains suggest that maintaining high-quality barrens will improve habitat for the prairie warbler (*Dendroica discolor*) and other obligate shrubland birds (Gifford et al. 2010; Bried et al. 2011; King et al. 2011; Akresh 2012). Additionally, mist netting and feather isotope analyses reveal that open-canopy barrens can serve as resting sites for migratory forest bird species (Kirchman et al. 2011), and a sharply declining open forest woodpecker (*Melanerpes erythrocephalus*) was recently discovered in the Albany Pine Bush shortly after a restoration thinning. Shrublands and early successional pine barrens are also important to many rare reptiles and amphibians (e.g. Stewart & Rossi 1981) and to about one-third of the native terrestrial mammal species in the northeastern United States (Litvaitis 2001; Fuller & DeStefano 2003).

Thinning dense pine barrens forest and preventing canopy closure (>90% cover) also benefits many insect taxa which depend on open-canopy habitats, exposed sandy areas, and

specific floral resources. Many rare butterflies and moths associate with pine barrens and require non-forested areas with sparse-shrub cover and abundant food plants (Wagner et al. 2003; Grand & Mello 2004). For example, the federally endangered Karner blue (*Lycaeides melissa samuelis*) and regionally rare frosted elfin (*Callophrys irus*, listed for protection in 11 states) feed on wild blue lupine (*Lupinus perennis*) and a variety of nectar-providing species. Sustaining these butterflies in barrens and related systems (oak savanna, sand plains) requires both forest thinning to create prairie openings and maintenance treatments to control heavy shrub and ground layer woody encroachment (Albanese et al. 2007; Pavlovic & Grundel 2009; Pfitsch & Williams 2009). Other insect groups will also benefit from reduced densities of scrub oak and limited pitch pine cover (e.g. Schlesinger & Novak 2011; Bried & Dillon 2012). However, the inland barrens buckmoth (*Hemileuca maia*) and 15 other rare Lepidoptera may require high scrub oak densities for larval feeding and protection from natural enemies (Wagner et al. 2003; Haggerty 2006).

Pine barrens offer habitat islands for shrubland animals in landscapes dominated by closed-canopy forest and human development. With extensive mature forest and limited young forest throughout the region, pine barrens may contribute little to the maintenance of regional forest biodiversity but significantly to regional shrubland and prairie biodiversity. Pitch pine forests appear to provide limited habitat opportunities for rare and declining shrub-dependent and prairie-specialist fauna.

Wildfire Argument

Matlack (2013) suggests that the eastern deciduous forest experienced very low historical fire frequency except in the immediate vicinity of Native American villages and in geologically defined barrens microsites. Lorimer and White (2003) similarly viewed fire as a minor source of disturbance in the region, but of local importance in areas of glacial outwash sands and on shallow soils at higher elevations. Northeastern pine barrens contain some of the most volatile fuels in North America and are found near some of the most heavily populated areas on the continent. Prolonged fire suppression has led to a reduction in open pine barrens while increasing fuel loads of highly flammable trees and shrub thickets. Although fire is a crucial process determining pine barrens ecological structure and function, managers of pine barrens have long been concerned with reducing fuel loads to mitigate disastrous wildfires (http://www.umass.edu/nebarrensfuels/index.html).

Dense conifer forests are often crown fire-dominated ecosystems that can threaten human life and property (Alexander & Cruz 2011). Actively spreading crown fires are dangerous and difficult to control, exhibiting tall and deep flame fronts, high rates of spread, intense radiant heating, and frequent long distance spotting (Duveneck 2005 and references therein). The combined effect of flammability and fine fuel loading creates the possibility for intense crown fires in pitch pine stands. Duveneck and Patterson (2007) destructively sampled well-stocked pure stands of pitch pine at the Montague Plains and on Martha's Vineyard and found high crown fire potential. Skowronski et al. (2011) reported pitch pine stem densities and canopy fuel loads conducive to actively spreading crown fire in the New Jersey Pinelands. Bried and Gifford (unpublished data) demonstrated a high likelihood for at least passive crown fire development under moderate to severe burning conditions in diffuse pitch pine stands of the Albany Pine Bush. Managers at this site, the Concord site in New Hampshire, and other urbanizing pine barrens must be especially wary of crown fire potential and the commensurate risks to human safety and property. In addition to direct combustion and ignitions caused by embers, thick clouds of smoke can travel far from the actual flame front causing reduced visibility on roadways and a variety of health problems (Knowlton 2013).

Scrub oaks, heath shrubs, and other understory vegetation may provide both surface and ladder fuels needed to ignite and support running crown fires in pitch pine forest. Some argue that thinning understories would mitigate the threat without having to thin pitch pine. However, it is generally very difficult and expensive to mechanically treat understory fuels, and prescribed burning under closed canopies may inadvertently lead to crown fire. Indeed, torching of individual pitch pine trees has been observed during prescribed fires in pine barrens (authors' personal observations). Furthermore, fully stocked stands are subject to storm damage and blowdown that can create even worse fire hazard conditions, and the potential for extreme fire behavior may increase with rising temperatures and worsening droughts mediated by climate change (Pechony & Shindell 2010). As a consequence of milder winters, the southern pine beetle (*Dendroctonus frontalis*) is moving north and creating large fire-prone swaths of standing dead pitch pines (M. Jordan 2013, The Nature Conservancy, Cold Spring Harbor, NY, personal communication). Mechanical thinning of pitch pine stands, which might be done at no net cost or even for profit, offers the best hope of averting disastrous fires in pitch pine-scrub oak systems (Patterson et al. 2005).

Restoration Target

Clearly, based on the biodiversity and wildfire arguments, pine barrens restoration should favor barrens over pine, but how much open barrens should exist across a particular landscape? We reviewed the previously referenced studies for the most relevant and concrete information that would help set specific targets for pitch pine thinning.

At the Montague Plains, significantly greater scrub-shrub bird abundance was recorded in thinned pitch pine forests (mean 30% cover) than in unmanaged forests (mean 51% cover), and thinning increased pairing and reproductive success of second-year prairie warblers (King et al. 2011; Akresh 2012). Simulation models based on detailed measurements of fuel loadings and fire behavior indicate that the treatment significantly reduced the amount of ladder fuels and the likelihood of crown fires (Duveneck 2005). For active crown fire to evolve, thinned stands would require much greater open

wind speeds (98 km/hour) than untreated stands (34 km/hour), making crown fire far less likely after thinning.

At the Albany Pine Bush, shrubland bird occupancy probabilities and abundance concentrations were generally higher across the pine barrens shrubland (10–30% pitch pine cover on average) than the pitch pine forest (Gifford et al. 2010; Bried et al. 2011). Simulated pitch pine removals and crown fire predictions recommended <20% residual canopy cover, or about 20–25 trees per acre, to effectively mitigate crown fires at this site (Bried & Gifford, unpublished data).

In a southeastern Massachusetts pine barrens, adult frosted elfin density was highest when tree cover (including pitch pine) was <29% (Albanese et al. 2007). On Martha's Vineyard, buckmoth larvae were found in seven vegetation types with limited canopy cover (27% mean), but not in closed-canopy pitch pine (over 80% mean cover) (Haggerty 2006). Also on Martha's Vineyard, fuel loading was high and observed fire behavior extreme in untreated pitch pine and scrub oak plots. Average flame lengths and rates of spread greatly reduced after pitch pine thinning (to <25% cover) and understory treatment (mowing, pile-burning, and grazing).

Pitch pine-scrub oak barrens are often characterized as having 20–60% pitch pine cover. On the basis of the biodiversity and wildfire arguments, we suggest maintaining an average of 10–30% pitch pine cover across the landscape, with 0–100% cover allowed for individual stands. The landscape as a whole should be viewed as a mosaic of varying fire frequency, stand ages, and plant community types.

Historical Perspective

Lorimer and White (2003) estimated that only 10–30% of the pre-European settlement pitch pine-scrub oak landscape occurred in a scrub-shrub condition, contradicting the restoration target suggested above. However, their estimate was extrapolated from scattered fire records, and the authors acknowledged that a lack of quantitative evidence on pre-settlement stand-replacing fires precluded an accurate history. They also cautioned that even if the estimate were reliable, restoring the historic forest dominance could have unfavorable consequences for many early successional species.

Contemporary pitch pine dominance in the region's pine barrens is largely an artifact of post-settlement human intrusion, including a rigid policy of fire suppression in the 20th century. Monotypic pitch pine stands often replaced young forest and shrubland areas due to clearing, burning of slash, and cultivation/grazing by European settlers (Patterson & Backman 1988). Plowing or logging history was found to be a primary determinant of contemporary vegetation types and distribution in the Albany Pine Bush (Milne 1985), Montague Plains (Motzkin et al. 1996), and Waterboro barrens (Coppenheaver et al. 2000). Other studies conclude that contemporary pitch pine forests of the region's pine barrens appear to be almost exclusively a product of post-settlement land use and fire suppression (Finton 1998; Motzkin et al. 1999). The historical perspective may therefore bolster the biodiversity and wildfire arguments for canopy thinning.

Implications for Practice

- Thinning pitch pine stands to restore savanna-like open barrens containing 10–30% pitch pine cover (average across the landscape) will simultaneously promote shrubland biodiversity and greatly reduce catastrophic fire danger.
- Prescriptive treatment of scrub oak after pitch pine thinning is needed to maintain open area habitat for prairie-specialist and shrubland species.
- Management should not be restricted to the creation and maintenance of open barrens by complete elimination of the pitch pine forest type.

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