



Restoring the Pine Barrens of Northwest Wisconsin

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Introduction

The pine barrens of Northwest Wisconsin were a major landscape feature before European settlement (Vora 1993). Once covering an estimated 930,000 hectares, today only 1% remains, and pine barrens regions are imperiled in Wisconsin and rare globally (Forest Service 2001). The decline in pine barrens areas caused concern for the species that rely on this habitat. This led to the development of seven restoration areas between 1948 and 1978 in Northwest Wisconsin. Long term restoration efforts have been continuing in order to protect this rare ecosystem and the organisms that occupy it.

Ecological History of Restoration Area

The Wisconsin Pine Barrens region is an area of sandy rolling hills historically comprised of a mosaic of pine forests, open prairies, and oak savanna (Figure 1). The region is located on a sandy outwash plain with nutrient poor, sandy soils (Radeloff et al. 2000). These sandy, well-drained soils were prone to drought conditions and recurrent forest fires were frequent (Radeloff et al. 2000). Fire was the major factor forming the pine barrens (Curtis 1959).

The dominant vegetation found in the pine barrens were grasses, shrubs, and forbs, with an occasional scattered stand of trees (Curtis 1959). *Pinus banksiana* (jack pine) was the most often encountered tree and the understory was comprised largely of *Vaccinium angustifolium* (blueberry) and *Myrica asplenifolia* (sweet fern) (Curtis 1959). This understory was also comprised of a high percentage of shrubs, 42%, higher than any other community in Wisconsin (Curtis 1959). Seven tree species were found throughout the barrens overstory (*Pinus banksiana*, *P. resinosa*, *Quercus ellipsoidalis*, *Q. macrocarpa*, *Q. borealis*, *Populus grandidentata*, *P. tremuloides*) (Curtis 1959). These trees were broadly spaced in some areas and dense elsewhere. Initial observations describe an area in which "the trees are at considerable distances from each other" (Sweet 1880). In 1877, Strong described some areas as "covered with scrub pine to the exclusion of all else save underbrush...Other areas are covered with burr, black, and even white oak bushes, with occasional trees of these species". The overall description is an area of forests comprised of pine and oak in low density, but in differing amounts throughout the region (Radeloff et al. 1998).

The varying degree of dominance and density of different tree species throughout the region most likely caused different fire regimes. Fires promoted the growth of *Pinus resinosa* (red pine), *Quercus ellipsoidalis* (pin oak), *Q. macrocarpa* (bur oak), *Pinus banksiana* (jack pine), *P. strobus* (white pine), and many understory plants, such as blueberry and other berry species. In the northern area of the pine barrens, red pine, jack pine, and white pine were common (Radeloff et al. 2000). In this area fires were most likely less common and the forests were more dense. The central area was dominated almost entirely by jack pine and most likely visited by recurrent crown fires (Radeloff et al. 2000). The presence of serotinous cones in the crown of jack pine gives it an adaptive advantage in crown fires that favors its regeneration over other species in this type of fire regime. Red pine, pin oak, and bur oak dominated the southern area (Radeloff et al. 2000). Low intensity ground fires were most likely common in this area and these species are adapted to this fire regime. Red pine and bur oak are thick bark species that are not damaged during low intensity fires, pin oak has great re-sprouting abilities after the canopy is killed (Radeloff 2000). Yet, over the entire landscape areas were constantly changing. The pine barrens were a dynamic landscape.

Franklin D. Roosevelt established the Civilian Conservation Corps (CCC). Developed during the Depression years in order to employ young men around the country, the main goal of the CCC was to fight soil erosion and declining timber resources. By the end of the CCC in 1942, an estimated 3 billion trees had been planted (www.cccalumni.org). The Civilian Conservation Corps (CCC) reforested the pine barrens area with jack pine during this period and open habitat greatly diminished (Radeloff et al. 2000). A forester once remarked that the greatest accomplishment of the CCC was turning the great sand barrens, the Moquah Barrens in the Chequamegon National Forest, into flourishing pine plantations (Gibson 1963).

Today, most of the historic pine barrens area is pine plantation and open expanses are rarely seen. The largest industry in the area is timber production (Niemuth et al. 1998).

Restoration Areas

While pine plantations were created in the Northwestern Wisconsin barrens, ideas about habitat management and prescribed burning were being developed at the University of Wisconsin. Herbert Stodard, Wallace Grange, and Aldo Leopold were conducting experiments using prescribed burns to restore prairie and savanna areas. This experimentation led them to conclude that they could not restore these areas without active management (Radeloff et al. 2000). A concern by wildlife managers in the pine barrens about the decrease in *Tympanuchus phasianellus* (sharp-tailed grouse) along with this new experimentation led to the decision to develop restoration areas in Northwest Wisconsin.

Seven restoration areas were established in the pine barrens (Table 1). Six southern areas managed by the Wisconsin Department of Natural Resources (WI DNR) and one northern area by the Chequamegon National Forest (U.S. Forest Service). Most sites were created with the goal of restoring sharp-tailed grouse habitat. This goal has changed over the years to include habitat for upland nesting waterfowl, *Lycaeides melissa samuelis* (Karner Blue Butterfly), and other species that rely on barrens habitat (P. Engman, personal communication).

Table 1. Pine Barrens Restoration Sites in Northwestern Wisconsin (modified from Radeloff et al. 2000)

Site	Year of Establishment	Barrens Habitat		Management Agency	Treatments			
		Current (ha)	% of Goal		Burning	Mowing	Spraying	Tilling
Amsterdam Slough Wildlife Area	1968	240	30%	WI Department of Natural Resources	X			
Crex Meadows Wildlife Area	1948	7,065	97%	WI Department of Natural Resources	X	X	X	X
Douglas County Wildlife Area	1948	1,615	91%	WI Department of Natural Resources	X	X	X	X
Fish Lake Wildlife Area	1960	970	60%	WI Department of Natural Resources	X			
Kohler-Peet Barrens	1978	260	71%	WI Department of Natural Resources	X			
Moquah Barrens Wildlife Management Area	1953	1735	72%	U.S. Forest Service	X	X		X
Namekagon Barrens Wildlife Area	1956	1900	51%	WI Department of Natural Resources	X			

Restoration Practices

Restoration efforts throughout the pine barrens region have focused on the creation of open habitat or open brush prairie. While management practices vary throughout the pine barrens region, common methods include 5-10 year cycles of prescribed burns, timber removal, mowing, and/or herbicide spraying (Radeloff et al. 2000). Historically, fire was the major natural disturbance in the area (Curtis 1959); the techniques used today try to mimic the effect of fire across the landscape.

The U.S. Forest Service and the Wisconsin Department of Natural Resources have used prescribed burning as a main restoration tool beginning in 1947. High-intensity burns of 200 ha are the most common barrens restoration practice used by the Forest Service (Vora 1993). Crex Meadows, managed by the Wisconsin Department of Natural Resources, performed its first burn in 1948 and is highly regarded for its management through prescribed burning. Burning is done mostly in the spring, fall burns are complicated because of requirements for the endangered Karner Blue Butterfly (P. Engman, personal communication).

Timber clearcuts have been used as a substitute for prescribed burning. Timber harvest is a large industry in Northwestern Wisconsin and offers many economic and ecological opportunities. For instance, timber sales are offered in barrens areas on the Chequamegon National Forest in order to meet vegetation management objectives (Forest Service 2001). This allows timber companies to clearcut the timber in a way that can restore the openness of an area. This practice can reproduce certain aspects of a burned landscape: size, shape, and removal of overstory vegetation.

Restoration tools such as mowing, tilling, and spraying are used to remove encroaching woody plants in open areas. These practices are common when oak becomes too dense on a site (Radeloff et al. 2000).

Monitoring is becoming an important part of restoration practices. The Chequamegon National Forest is partnering with Northland College in Ashland, Wisconsin to monitor and inventory some birds, small mammals, vegetation, amphibians, and reptiles (M. Sheehan, personal communication). They have also established long-term monitoring areas on the Moquah Barrens (Vora 1993). The Wisconsin Department of Natural Resources has been monitoring small mammals, birds, amphibians, and reptiles since the mid-1990s (Evrard 1998, 2000, 2000). Sharp-tailed grouse have been monitored since 1950 on the Namekagon Barrens (Wisconsin Department of Natural Resources) and on the Moquah Barrens (U.S. Forest Service). In recent years, 55 males have been found on the dancing grounds in the Namekagon Barrens, the highest number since monitoring began (Radeloff et al. 2000).

Evaluation of Vegetation Management Strategies

Restoration practices typically involve prescribed burning or clearcutting to mimic natural fire throughout the barrens landscape. To evaluate whether these practices are restoring the different woody vegetation components of the early successional pine barrens ecosystem, research has looked at differences in vegetation structure and composition that result from crown fires, clearcutting, or prescribed burning procedures throughout the barrens.

Crown fires create an early successional habitat that varies in structure and composition and this fire regime frequently occurred in the central area of the pine barrens. Niemuth and Boyce (1998) looked at areas where crown fires occurred naturally throughout the pine barrens region and measured the response of the vegetation. In comparison to prescribed burning and clearcutting, the greatest tree density, woody debris, and jack pine cover were found in crown fire sites (Niemuth et al. 1998). The greatest height variation and the highest Shannon-Wiener diversity were also found (Niemuth et al. 1998). Dominated

by dead and injured trees, crown fire sites have a greater number of trees with sloughing bark that provide cover for invertebrates and foraging sites for birds (Niemuth et al. 1998). The rotting wood makes excavation by cavity dwellers easier and is an important nutrient reservoir (Niemuth et al. 1998). The heat of crown fires also stimulates the opening of serotinous jack pine cones allowing for high regeneration rates (Niemuth et al. 1998).

Timber removal through clearcutting has been used as a substitute for fires in the pine barrens region (Niemuth et al. 1998, Radeloff et al. 2000). This allows for an economic gain while attempting to restore a site to more open habitat. While clearcutting can mimic some features of a burned area, such as size and shape, it does not reproduce all aspects (Radeloff et al. 2000). Using crown fire sites as examples of natural disturbance, comparisons can be made between clearcuts and crown fires. Clearcuts reproduce large woody debris, Shannon-Wiener diversity, and height variation to a lesser degree than crown fire sites. This practice also falls short on the number of remaining trees/hectare, degree of patchiness, and jack pine cover (Niemuth and Boyce 1998). Some jack pine regeneration occurs as high ground temperatures stimulate cones to open when they are on the ground, but not at high rates. Overall, spatial heterogeneity is lost in clearcuts compared to burned areas, jack pine is affected by loss of regeneration, and woody debris abundance is limited in clearcut areas (Radeloff et al. 2000).

Prescribed burning has been the major action performed on restoration sites to mimic natural fire regimes. Research by Niemuth and Boyce (1998) shows that because of the frequency of prescribed burning it does not successfully reproduce results similar to crown fire sites. Repeated fire intervals of 5-10 years removes jack pine of all ages before successful regeneration can occur (Niemuth et al. 1998). This burning frequency also removes most woody debris and does not allow for woody vegetation regeneration. Tree quality for nesting is diminished as most trees that survive frequent burns are large oaks and red pine that are not of high value to nesting or foraging animals. Dead or injured trees that are seen after crown fires provide better habitat (Niemuth et al. 1998). Although jack pine was once the most common tree found in the pine barrens (Curtis 1959), prescribed burn management eliminates most from the landscape (Niemuth et al. 1998). While prescribed burning keeps parcels open, Niemuth and Boyce (1998) have shown that using prescribed burning alone does not mimic the dynamic aspect of natural fire regimes.

Vegetation Composition Across the Landscape

Forest composition has changed throughout the pine barrens landscape since European settlement. While restoration efforts may successfully open habitat on specific parcels, the question remains whether these efforts are enough to retain the overall mosaic once seen in the pine barrens. Survey records from the U.S. General Land Office (GLO) completed during the 1850s exist for the pine barrens region. Using this data, a picture of the historic vegetation cover of the area can be constructed. Radeloff et al. (1998, 1999) compared vegetation components pre-settlement using GLO records to current conditions using 1987 Landsat satellite images.

To determine what affects human activity has had on the vegetation composition of the pine barrens, Radeloff et al. (1998, 1999) looked at the vegetation across the pine barrens landscape to determine differences between pre-settlement and present tree cover. The authors were able to detect differences in forest composition that may be attributable to a change in management practices. The historic GLO records depict an area that was not homogenous, but differed in tree dominance and open habitat throughout the area (Radeloff et al. 1998, 1999). The vegetation cover depicted by the 1987 Landsat satellite forest classification reveals an area that is now quite different. The forest density gradient seen throughout pre-settlement times has diminished, the composition of tree species has changed, and certain types of habitat, such as red pine savannas and oak savannas, have disappeared (Radeloff et al. 1999).

The composition of tree species in the pine barrens region has changed due to logging, planting, and fire suppression. Jack pine, once the most abundant tree species, has declined to limited portions of the central and southwestern barren area. Red and white pines, an important component in the 1850s, are no longer widespread. Jack pine has decreased by 30%, red pine by 80%, and white pine could not be detected in the cover data for 1987 (Radeloff et al. 1999). In place of these three species are now large areas of hardwoods, specifically oaks and aspens. Aspen increased in area by a factor of 5.7 and oak increased by a factor of 3.6 throughout the region (Radeloff et al. 1999). Areas of oak savanna during pre-settlement times are now oak forests. Fire suppression and pine removal have allowed oaks to mature in the region and become part of the canopy, increasing overall by 198% from 1850 to 1987 (Radeloff et al. 1998). The relative distribution of red, pin, and bur oak has not changed, but the overall abundance has increased. The change in composition has led the authors to believe that the change in fire regime, intensity and frequency, and the small size of the restoration areas limit the ability of the landscape to function as it once did resulting in the different forest composition that is now seen (Radeloff et al. 1998).

Overall, pine barrens restoration is working on a small scale to maintain open areas (Radeloff et al. 2000). This, however, only approximates a small portion of what the overall landscape was in the past.

New Approaches to Restoration

Goals of restoration efforts throughout the pine barrens region are beginning to change from open habitat to diverse habitat. While efforts have been successful in restoring small, open habitat parcels, research has shown that the mosaic of the pine barrens is no longer present. The U.S. Forest Service and Wisconsin Department of Natural Resources are changing management plans to include areas of greater structural variety along with open prairie areas (Vora 1993, Radeloff et al. 2000). The Chequamegon National Forest is attempting to use prescribed burning as a tool to manage vegetation in various stages of succession, with jack pine and red pine being the most common trees (Vora 1993). They are also using larger clearcut and prescribed burn parcels, instead of many small parcels. The structural variety of the pine barrens area is lost when areas are burned every 5-10 years without specific vegetation goals and practices. This has implications as to which species, especially birds, will prefer an area. For instance, *Sialia sialis* (Eastern bluebird) and *Tachycineta bicolor* (tree swallow) occur in pine barrens with high tree density, while *Eremophila alpestris* (horned lark) and *Pooecetes gramineus* (vesper sparrow) prefer areas of low vegetation (Niemuth et al. 1998).

In March 1991, an ice storm presented an opportunity for the Forest Service to experiment with restoration prescriptions that would lead to a more varied landscape (Vora 1993). Six restoration prescriptions were to be attempted on 50-year-old jack pine plantations where the storm caused extensive damage (Vora 1993). These prescriptions included leaving 5 percent of trees in clumps 0.05 to 1 ha in size, leaving red pines and removing jack pines; leaving clumps of mature jack pine with surrounding trees to protect from prevailing winds; removing most trees except the largest, healthy ones; removing all but 15-25 trees per ha, leaving the largest healthy jack pine or aspen and all oak; underplanting areas with white pine; and leaving areas uncleared and uncut for comparison. Prescribed burning would be used in half of these areas. These prescriptions, except for underplanting, were implemented in 1991 (Vora 1993). Long-term monitoring sites were established throughout the restoration and surrounding area.

The Wisconsin Department of Natural Resources is using management techniques to add diversity to pine barrens habitat on the Douglas County Wildlife Area and in the Douglas County forests. They are restoring pine savannas by leaving solitary trees and groups of pines in open areas. They ensure longer lived red pines by trimming lower branches before fires (Radeloff et al. 2000). The Douglas County Forest has a goal of 20% open habitat in 2-3 large patches at all times. As areas are clearcut, old barrens

areas are reforested. This begins to imitate dynamic changes in the forest while allowing timber harvest to still continue (Radeloff et al. 2000).

Conclusion

Evaluations of the success of pine barrens restoration has been difficult. The early accounts of the area beginning in the late 1800s and early 1900s give only a small picture in time and limited scope. For instance, it is known that Native American Indians frequented the area and most likely set fires to encourage berry crops and open areas for hunting. This makes it hard to determine if the fire regime that was thought to exist was natural or human initiated. Given the soil type, rolling topography, and early descriptions intuitive guesses can be made at what the landscape was like and what the goal of the restorations should be. However, this information cannot help determine how the area changed over time, how the vegetation changed across the landscape, or what plants or animals have been lost from the area.

The focus of pine barrens restoration will need to move to a landscape scale if there is any hope of creating what was historically located in that area. Small scale patches are not large enough to mimic a changing, dynamic landscape (Radeloff et al. 2000). The pine barrens region was not static but was constantly shifting from open prairie to brush prairie to forest. Reproducing these changes in small scale is very difficult. Managers need to continue to change restoration goals to include pine and oak savannas along with open prairies and brush prairies. Since the mid-1990s, the different management agencies have been cooperating to achieve the layout of the pine barrens and the different forest compositions that were historically seen, but this is just beginning. Restoration efforts are working on small scale open prairie and brush habitat, but the pine barrens were more diverse. The pine barrens in Northwest Wisconsin are no longer what they once were, but there are glimpses of what they used to be and with the right management the mosaic of different habitats will return.

Resources

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