

A Common Species at the Edge of Its Range: Conservation of Bear Oak (*Quercus ilicifolia*) and Its Low Elevation Rocky Summit Community in North Carolina (USA)

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ABSTRACT: Bear oak (*Quercus ilicifolia* Wang), an abundant shrub species in the mid-Atlantic states, reaches its southern limit in North Carolina (USA), where it occurs in five small populations in an uncommon Piedmont natural community type called low elevation rocky summit. Although the species is rare in North Carolina, it receives no legal protection or special management, even though all five populations are located in state parks. The two southernmost populations declined by 24% between 1984 and 1997 because of loss of habitat resulting from forest succession. Historically, bear oak habitat was maintained by both lightning-ignited and anthropogenic fires, which for the last 50 years have been suppressed in state parks in the Piedmont. Bear oak exemplifies a dilemma that conservation biologists face in managing a locally rare but globally common species.

Index terms: bear oak, *Quercus ilicifolia*, Piedmont prairies, fire, local extinction

INTRODUCTION

Every common species becomes rare at the edge of its range. This truism creates a dilemma for conservation biologists: How should we allocate scarce resources to manage populations of species that are locally rare but globally common? Outlying populations may have higher than average risks of extinction because they are living at the margin of their ecological niches. Yet outlying populations may possess adaptations unique to the species for survival in an otherwise unsuitable environment (Lesica and Allendorf 1995). The purpose of this study was to document the history of the decline of a locally rare species and its community type and illustrate this conservation biology dilemma. The species, bear oak (*Quercus ilicifolia* Wang.), grows in a natural community type known as "low elevation rocky summit," an uncommon type found in the Piedmont region of North Carolina (Schafale and Weakley 1990).

Bear oak, a shrub, is abundant in the mid-Atlantic states but rare at its southern range limit in North Carolina, where there are only five small populations. Fortunately, all five of these populations are in state parks; yet the populations as well as the community type in which they occur are declining as a consequence of fire suppression and ensuing forest succession (Barden 1985). This study focuses on the two southernmost populations of bear oak, which grow on Kings Pinnacle and Crowders Mountain in Crowders Mountain State Park (CMSP), North Carolina. Although

the low elevation rocky summit community, with bear oak as a member, occurs both inside and outside of state parks, it is best represented in state parks (Schafale and Weakley 1990).

HISTORY OF FIRE AND VEGETATION CHANGE IN THE NORTH CAROLINA PIEDMONT

When European explorers first visited the Piedmont in 1540, 1567, and 1670, they found numerous large grasslands (Barden 1997). Maps published in 1676 and 1718 show large "Savannae" or "Grande Savane" ("Savanna" meant "grassland" at that time) covering much of the Piedmont (Figure 1; Cumming 1958, 1998). Explorers attributed these Piedmont prairies to Native American burning and agriculture, but lightning fires regularly occur in the area and may have shared responsibility for the existence of the open vegetation, particularly on extremely xeric ridges like Kings Pinnacle and Crowders Mountain in CMSP.

By 1740 word of this open land, where "a man may more easily clear 10 acres than one elsewhere" (Lawson 1709), had spread to seaboard colonies. Between 1740 and 1760 European-American settlers by the thousands left crowded farms in Pennsylvania, New York, and other northeastern colonies and poured into the Piedmont region. They appropriated the land from the Catawba Indians, whose populations were decimated by disease, and converted these prairies into agricultural fields and pastures, including the prairies of Gaston County near CMSP (Pruett 1939: 39-40).

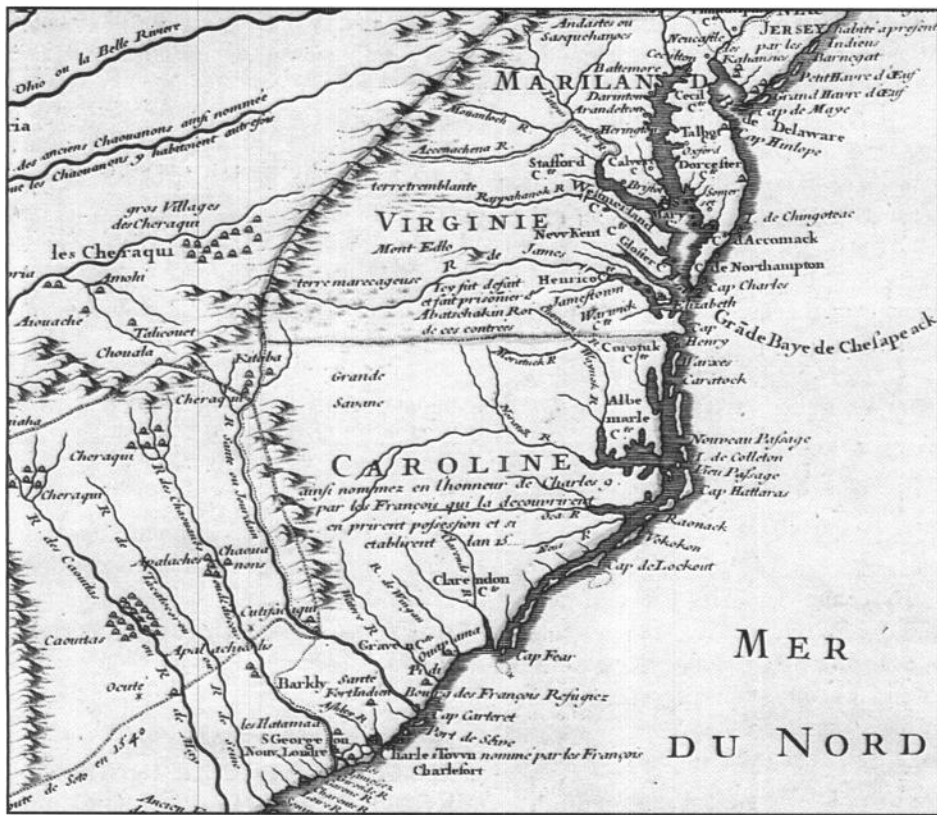


Figure 1. A portion of Delisle's 1718 Carte de la Louisiane showing Grande Savane in the Carolina Piedmont. The North Carolina study site is located near the "C" in Caroline. (Map courtesy of Davidson College Library.)

On Crowders Mountain and Kings Pinnacle, however, frequency of fires probably did not decline after settlement. Settlers annually burned areas that were unsuitable for plowing so that livestock would have green pasturage. In addition, during the late eighteenth and early nineteenth centuries, an iron processing operation less than a mile north of Kings Pinnacle made charcoal in large pits (M. Peters, Crowders Mountain State Park volunteer, pers. com.), an activity that probably depleted hard-wood forests and caused fires on both mountains. The impact of nineteenth-century fires on vegetation is apparent in a photograph of a "Picnic Party" of five women standing on the north side of Kings Pinnacle, dressed in fashions of the 1890s (Figure 2A). Exposed rock and low shrubs surrounded the women, on a site that in 1997 was virtually hidden by trees (Figure 2B).

During the 1890s, John K. Small, an eminent botanist and author of *Manual of the Southeastern Flora* (Small 1933), visited

Crowders Mountain and Kings Pinnacle several times (Small 1901). His 1901 description of the vegetation is remarkably detailed:

The vegetation of the summits is almost exclusively of woody plants, and shrubby. The shrubby condition of normally large forest trees presents an extraordinary and interesting aspect. The chestnut tree, *Castanea dentata*, ranges from three to six feet in height, nevertheless these plants produce an abundance of fruit. *Sassafras*, *Pinus Virginiana*, *Quercus Prinus*, *Diospyros* and *Oxydendrum*, all appear of the same form and stature. The common sour gum, *Nyssa sylvatica*, in like condition, exists on King's Mountain [Pinnacle], and a single shrub of *Ilex opaca* was found on the uppermost cliffs of Crowder's Mountain.

The normally shrubby plants appear more natural. *Polycodium* [*Vaccinium*] *stamineum*, *Vaccinium vacillans* and *Quercus nana* [bear oak, *Q. ilic-*

ifolia] are common to both peaks, while *Kalmia latifolia*, *Rhododendron Catawbiense*, *Gaylussacia frondosa*, *Gaylussacia resinosa* and *Batodendron* [*Vaccinium*] *arboreum* are species apparently confined to the top of King's Mountain [Pinnacle]. Only two perennial or shrubby herbs, namely *Galax aphylla* and *Paronychia argyrocroma*, exist on the summit of King's Mountain [Pinnacle], while the summit of Crowder's Mountain is destitute of herbaceous vegetation with exception of a fern and a few sterile plants of some sedge.

During the twentieth century, fires continued to occur. Crowders Mountain burned several times during the 1940s, but no one tried to extinguish these fires (M. Wolf Sr., Retired Fire Chief, Chapel Grove Volunteer Fire Department, N.C., pers. com.). Indeed, the cultural shift in North Carolina from ignoring fires on uninhabited ridges and mountains to actively suppressing them did not occur until about 1950, when local fire departments and the North Carolina Forest Service began fighting wildland fires. Since 1957 at least 17 anthropogenic fires have been extinguished on Kings Pinnacle and Crowders Mountain. Although three of these fires burned more than 100 acres, most were controlled before they exceeded 10 acres in extent (Gaston County fire records, North Carolina Forest Service, Dallas 1997).

The frequency of lightning fires on Crowders and Kings Mountains before European settlement is, of course, unknown. However, since 1947 at least 84 lightning fires have occurred in the four counties surrounding Crowders Mountain (North Carolina and South Carolina State Forest Services, pers. com.). The reported frequency of 3.4 lightning fires per year per million hectares is inevitably conservative because of uncertainty in determining the cause of ignition and because most fire departments did not keep fire reports until the 1960s (K. Cabe, South Carolina State Forest Service, pers. com.). Thus, even in the absence of human influence, fire would likely have been a recurring event in the environment of bear oak on these mountains.

Aerial photographs taken in 1938 of Crowders Mountain and Kings Pinnacle (N.C. Forest Service, Dallas) corroborate historical records. In 1938 vegetation on the slopes below the summits consisted of widely scattered pines separated by open areas of low vegetation. In 1997 vegetation on the slopes and peaks of both mountains consisted of relatively dense stands of pines and hardwoods 10–20 m tall. The

consequence of a half-century of fire suppression has been a dramatic change in the vegetation on Crowders Mountain and Kings Pinnacle.

SIGNIFICANCE OF VEGETATION CHANGE

In 1997, after 50 years of fire suppression, populations of bear oak in CMSP were

declining. This shrubby oak, which rarely exceeds 4 m in height, requires a combination of droughty soil and periodic fires for its survival (Hallisey and Wood 1976). It cannot compete for light with taller forest species in undisturbed habitat. Evidence of the decline comes from two surveys conducted 13 years apart. In 1984 populations of bear oak in CMSP were censused and mapped on large-scale topographic maps as part of a statewide survey of the species (Barden 1985). Approximate diameter and height of crowns of shrubs or clumps of shrubs were noted to aid identification during a later recensus. In 1997 I recensused populations in CMSP using the 1984 maps to relocate populations. Since 1984 recensused populations on Kings Pinnacle and Crowders Mountain have declined from a total of 76 to 58 shrubs, a 24% decline (Table 1). In 1997 none of the shrub crowns were larger than in 1984, and many had declined in crown diameter or height.

In 1901 Small reported that blazing star (*Liatris regimontis* [Small] K. Schumann), a species of open habitat, was prevalent on the slopes below the summits of both Kings Pinnacle and Crowders Mountain. In 1997 it was present only in a few small populations. Small described woody vegetation on both peaks as "shrubby," and photographic evidence corroborates his description. But at the time of the 1997 census, trees 10–20 m tall dominated both peaks. In 1938 vegetation on the slopes of these mountains consisted of widely scattered pines; in 1997 closed forests covered the slopes.

These striking contrasts between historic and modern plant communities in Crowders Mountain State Park are representa-

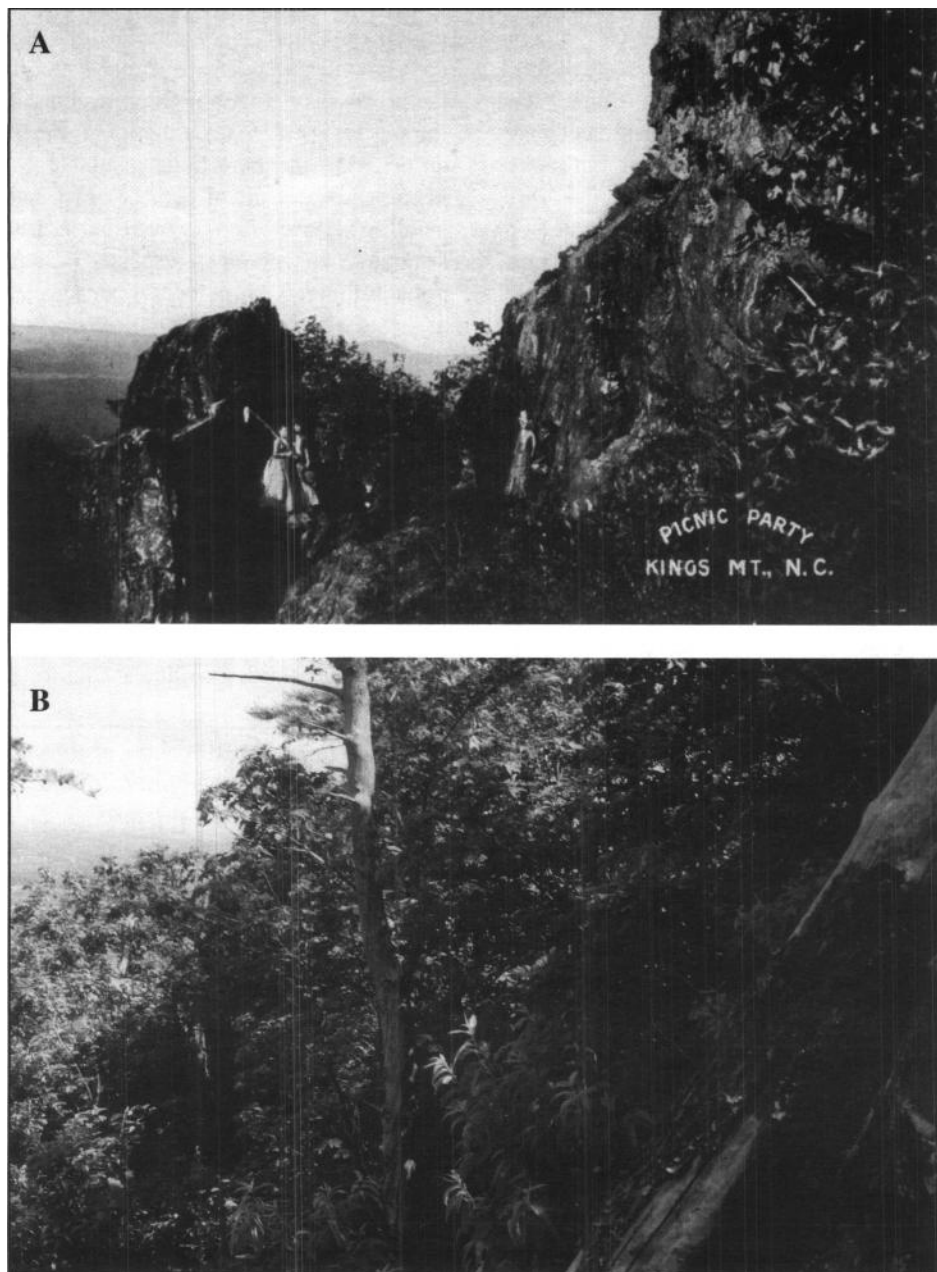


Figure 2. A. (Upper) "Picnic Party," ca. 1890, showing shrubby aspect of vegetation on northwest side of main peak of Kings Pinnacle. (Photo courtesy of Duke University Library) B. (Lower) "Picnic Party" site in 1997, showing dense vegetation. Photo taken from same point as Figure 2A.

Table 1. Bear oak (number of shrubs) and percent change in Crowders Mountain State Park, North Carolina, 1984 and 1997.

Site	%		
	1984	1997	Change
Kings Pinnacle	34	26	-24
Crowders Mountain	42	32	-24
Both Mountains	76	58	-24

tive of changes that have occurred through-out the Piedmont in low elevation rocky summit communities. For example, in Pilot Mountain and Hanging Rock State Parks in North Carolina, rocky summit ecosystems that harbor remnant populations of bear oak are changing to closed-canopy hardwood forests because of forest succession (Barden 1985). Bear oak is only one species in a changing community, but it serves as an indicator of what is happening to many other species of concern that are found on these peaks, such as Bradley's spleenwort (*Asplenium bradleyi* D.C. Eaton), ground juniper (*Juniperus communis* var. *depressa* Pursh), Biltmore carrion-flower (*Smilax biltmoriana* Small), and Piedmont indigo-bush (*Amorpha schwerinii* Schneider) (N.C. Department of Environment, Health, and Natural Resources 1993).

Another reason to be concerned about the decline of bear oak populations in North Carolina is the potential loss of unique genetic traits. North Carolina lies at the southernmost edge of the geographical range of bear oak, which has survived in relict populations at only five sites in North Carolina since the retreat of glaciers in North America 12,000 years ago. Populations at these sites are very small and may possess unique genetic adaptations to existence in a southern climate. Such ecotypic variation of plant populations from different provenances is usually taken into account by commercial foresters and restoration ecologists in their choice of planting stock (Millar and Libby 1989).

No studies of genetic variation of bear oak across its geographic range have been published. However, a study of genetic heterozygosity in swamp pink (*Helonias bullata* L.), an herbaceous species whose range is very similar to that of bear oak, has shown that small disjunct populations in the southern Appalachians possess greater genetic heterozygosity than large populations at the center of the species' range in Virginia and New Jersey (Godt et al. 1995, Hamrick and Godt 1996). This finding, which is contrary to general expectations for outlying populations, suggests that swamp pink populations survived in the South during the last glacial advance and

founded northern populations after glacial retreat (Hamrick and Godt 1996). A similar history and genetic structure is possible for bear oak, even though its mating system differs from that of swamp pink.

The problem of extinction of genetically unique populations is massive on a global scale, with potentially harmful economic and ecological consequences to humans (Hughes et al. 1997, Hobbs and Mooney 1998). Yet the legal language for plant protection in the federal Endangered Species Act, unlike that for animals, does not provide protection for genetically unique populations of a plant species. A few states, such as Massachusetts, have stronger state Endangered Species Acts that protect plants that are locally rare but common outside the state. Bear oak is listed in the North Carolina Natural Heritage Program List of Rare Plant Species as "significantly rare" (Amoroso 1997), but this designation provides no legal protection, despite the fact that the population of 26 plants on Kings Pinnacle is the southernmost population of the species. However, the North Carolina state parks service subscribes to a policy of preserving native plant communities, which qualifies the low elevation rocky summit community for protective management (S. Regier, Head of Resource Management Section, N.C. Division of Parks and Recreation, Raleigh, pers. com.).

Unless the developing canopy of overstory trees is controlled at the five state-owned sites, bear oak populations will not survive, and their low elevation rocky summit plant communities will succeed to hardwood forest. Fires that are hot enough to kill large trees will also top-kill bear oak shrubs, but this fire-adapted species quickly sprouts new stems and replaces its crown (Hallisey and Wood 1976). If intense fires are infeasible, canopy trees can be girdled or injected with herbicide and less intense fires used to control understory trees.

In 1997 both bear oak and its low elevation rocky summit community were falling through the cracks in the language of the Endangered Species Act and the fire management policy of the North Carolina Division of Parks and Recreation. However, in 1998 the state agency began plan-

ning a policy of controlled burning in Piedmont parks (S. Regier, pers. com.). Controlled burns scheduled for Spring 2000, though only a few hectares in area, may help prevent further decline of the species and its community.

Somewhere, every species is at the edge of its range. If it is not protected at the edge of its range, its range shrinks and a new edge is created. If the species is not protected at the new edge, its distribution shrinks further. This process continues until the species' range contracts to a central region of abundance or the species becomes so rare that it is federally listed; if the process is not identified early enough, the species is driven to extinction. It can be argued that the best tools available for keeping species off of the U.S. Fish and Wildlife Service's Endangered Species List are state-level endangered species laws or policies that recognize locally rare species as "state listed" and actively protect them within their jurisdiction (R. Szafoni, Center for Wildlife Ecology, Illinois Natural History Survey, pers. com.).

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Lawrence Barden is Professor of Biology at the University of North Carolina at Charlotte. His current interests include restoration of two piedmont prairies and their populations of the federally listed endangered species Helianthus schweinitzii near Charlotte, North Carolina.

LITERATURE CITED

- Amoroso, J.L. 1997. Natural Heritage Program list of the rare plant species of North Carolina, North Carolina Department of Environment and Natural Resources, N.C. Natural Heritage Program, Raleigh.
- Barden, L.S. 1985. Bear oak (*Quercus ilicifolia*) in North Carolina. *Castanea* 50:121-123.
- Barden, L.S. 1997. Historic prairies in the Piedmont of North and South Carolina, USA. *Natural Areas Journal* 17:149-152.

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- Cumming, W.P. (ed.). 1958. The Discoveries of John Lederer. University of Virginia Press, Charlottesville. 148 pp.
- Cumming, W.P. 1998. The Southeast in Early Maps. 3rd Ed. University of North Carolina Press, Chapel Hill. 362 pp.
- Godt, M.J.W., J.L. Hamrick, and S. Bratton. 1995. Genetic diversity in a threatened wetland species, *Helonias bullata* (Liliaceae). *Conservation Biology* 9:596-604.
- Hallisey, D.M. and G.W. Wood. 1976. Pre-scribed fire in scrub oak habitat in central Pennsylvania. *Journal of Wildlife Management* 40:507-516.
- Hamrick, J.L. and M.W. Godt. 1996. Conservation genetics of endemic plant species. Pp. 281-304 in J.C. Avise and J.L. Hamrick, eds., *Conservation Genetics: Case Histories from Nature*. Chapman & Hall, New York.
- Hobbs, R.J. and H.A. Mooney. 1998. Broadening the extinction debate: population deletions and additions in California and western Australia. *Conservation Biology* 12:271-283.
- Hughes, J.B., G.C. Daily, and P.R. Ehrlich. 1997. Population diversity: its extent and extinction. *Science* 278:689-692.
- Lesica, P. and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation? *Conservation Biology* 9:753-760.
- Lawson, J. 1709. *A New Voyage to Carolina*. Reprint (1966), University Microfilms, Ann Arbor, Mich.
- Millar, C.I. and W.J. Libby. 1989. Disneyland or native ecosystem: genetics and the restorationist. *Restoration and Management Notes* 7:18-24.
- N.C. Department of Environment, Health, and Natural Resources. 1993. General management plan for Crowders Mountain State Park. N.C. Department of Environment, Health, and Natural Resources, Division of Parks and Recreation, Raleigh.
- Pruett, M.S. 1939. *History of Gaston County*. The Observer Printing House, Charlotte, N.C. 218 pp.
- Schafale, M.P. and A.S. Weakley. 1990. Classification of the natural communities of North Carolina: Third Approximation. N.C. Department of Environment, Health, and Natural Resources, Natural Heritage Program. 325 pp.
- Small, J.K. 1901. The summit flora of King's Mountain and Crowder's Mountain, North Carolina. *Torreyia* 1:7-8.
- Small, J.K. 1933. *Manual of the Southeastern Flora*. Science Press Printing, Lancaster, Penn. 1554 pp.