RESEARCH ARTICLE

Do Prescribed Fires in South Florida Reduce Habitat Quality for Native Carnivores?

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"Essentially all natural fires here are caused by lightning."
R.H. Hofstetter, 1984

ABSTRACT: Prescribed fire, as a management tool, is unquestionably vital to the maintenance of natural areas in the southeastern United States. However, centuries of tradition and one-size-fits-all prescriptions may ultimately reduce the ability for key preserves to support the Florida panther (*Puma concolor coryi* Bangs) and black bear (*Ursus americanus floridanus* Pallas) in the only area that supports both species in the eastern U.S. Overly frequent fires and out-of-season fires, especially in south Florida saw palmetto (*Serenoa repens* Bartr.) habitat, have the potential to change landscape patterns as well as the evolutionary relations between large carnivores and their prey. Whereas frequent winter fires may reduce potentially dangerous fuel loads and provide temporary forage for panther prey, subsequent changes in upland plant communities may reduce important bear foods and the structures used as natal dens. Large carnivore management in south Florida has the potential to maintain historical levels of biodiversity, but only if fire is an ingredient that fits the evolutionary history of this subtropical landscape and the organisms that evolved there. We provide a blueprint for fire management in south Florida forests that is based on the autecology of large carnivores and saw palmetto, a key vegetative component of this flat, subtropical landscape.

Index terms: black bear, fire management, Florida panther, saw palmetto

INTRODUCTION

The responsible use of fire – in all of its many forms – is one of the greatest challenges facing human society (Mumford 1959, Landsberg et al. 1963). Though wildland fires are generally recognized as benign or beneficial to wildlife (Arno 2002), the extinction of at least one endangered species, the dusky seaside sparrow (*Ammodramus maritimus nigrescens* Ridgway), was likely hastened due to improper fire management (Walter 1992), and human-caused fires or their exclusion have been implicated in the loss of global biodiversity (Robertson 1953, Hansen et al. 1991, Bunting 1996, Harris et al. 1996, Quintana-Ascensio and Menges 1996, Myers 1997, Laurance and Williamson 2001, Newmark 2002). Terborgh (2002: 34) advised that "reforms are urgently needed to prevent the further degradation of public lands" and that one of these includes the "restoration of semi-natural fire regimes."

It has long been recognized that an increasing understanding of fire ecology has not always resulted in better land stewardship (Thompson et al. 1974). Our intent in this paper is to encourage managers of conservation lands in Florida and elsewhere to appreciate that there is more to prescribed burning than setting fires when it is climatologically feasible, politically acceptable, and economically desirable – especially in areas that are large enough to accommodate the occurrence of naturally started fires and where the promotion of natural processes is an important management objective. As Hendee et al. (1978: 265) suggested, "The goal of a prescribed fire policy is the restoration of the natural fire regime through the substitution of deliberate ignitions for lightning-caused fires. It is based on the assumption that the ecological effects of fire will be the same, whether man or lightning caused." Whereas it is important to protect human lives and structures from the damaging effects of wildfires, it is equally important to recognize the ecological significance of natural fires in the evolution of species and their biotic communities. We take a close look at the potential consequences of frequent prescribed fire on the Florida panther (*Puma concolor coryi* Bangs) and the Florida black bear (*Ursus americanus floridanus* Pallas), two listed species that are often featured as management targets on public land. We also review the literature and use a geographic information system (GIS) to develop a simple model of natural fire occurrence on the Florida Panther National Wildlife Refuge (FPNWR), a federal reserve that supports a large population of black bear (Maehr 1997a) and where the Florida panther is the primary target of management (Durrwachter 2000).

Background

Land use changes and human attitudes have created "severe conflicts" for managers of fire in south Florida (Wade et al. 1980: 1) where human numbers increased by nearly 80% between 1980 and 1990 in and around population centers of the endangered Florida panther and threatened Florida black bear (Winsberg 1996). Public resistance to wildland fire was spawned by anthropomorphized cartoon portrayals of nature (i.e., Smoky the Bear; Marrison 1976), whereas managers developed a zeal for frequent fires that began with European and regional traditions (Stoddard 1935, Stewart 1956, Pyne 1997). Frequent and extensive burning is now commonplace on many public conservation lands.

Fire in the southeastern U.S. is a natural part of the landscape and has helped shape its biotic communities (Komarek 1964, Craighead 1971, Martin et al. 1993). The evolution of wildland fire policy in the U.S. has followed a contentious pathway from complete suppression to prescriptions that are intended to mimic natural cycles and protect human property (Pyne 1997). The role of humans in setting fires appears to coincide with their millennia-old colonization of the region (Pyne 1997). Fires were frequently set in central Florida from at least 500 B.C. until European contact (Kalisz et al. 1986), but their effects on succession and landscape patterns are equivocal (Stewart 1956, Croker 1968, Komarek 1973, Duever et al. 1979, Wade et al. 1980, Pyne 1997). Regardless, detailed archaeological investigations are clear in demonstrating that the native Calusa and Tequesta cultures in south Florida did not use fire for agriculture – indeed, farming was disdained (Hann 1991, Marquart 1992). Instead, abundant marine life that included shellfish, manatee (*Trichechus manatus* Linnaeus) and Atlantic right whale (*Eubalaena glacialis* Müller) was supplemented with uncultivated terrestrial foods, including fruits from saw palmetto (*Serenoa repens* Bartr.) and cocoplum (*Chrysobalanus icaco* L.) (Larson 1980). Such bounty obviated the need for slash and burn agriculture – a practice that was widespread in the rest of the southeastern Coastal Plain (Hann 1991, Milanich 1994, 1995). Pre-Columbian settlements in south Florida tended to be coastal and relatively permanent (Larson 1980); their inhabitants were "fisher-hunter-gatherers" (Hann 1981: 329). Thus, if interior forests and marshes burned primarily as the result of summer lightning, the evolutionary relations between non-human-induced fire and many plant and animal species was uninterrupted by pre-Columbian south Florida humans and their relatively short history in North America.

Fire in the U.S. through much of the 20th century was viewed as a destructive force that required suppression (Martin et al. 1993, Pyne 1997). However, the proliferation of huge fires in the middle of the 20th century – caused in part by the accumulation of high fuel loads – alerted managers to the use of prescribed burns in reducing fuels, enhancing timber production, and promoting game populations (Brown and Davis 1973, Sanderson 1974, Pyne 1997). Managers in the southeastern U.S. were quick to adopt burning prescriptions that reduced the likelihood that fires might rage out of control or threaten human life and property. Prescribed fire in much of the Southeast soon became pine-centric, game-centric, and production-oriented (Croker 1968, Stoddard 1963). By comparison, the study of fire lagged behind its utilitarian application. Traditional burning occurred during winter when fires were more easily controlled, when valuable timber species were less vulnerable to heat damage, and when new crops of wildlife were believed to be less susceptible to fire-related mortality. Some researchers even defended "frequent winter fires" as essential to maintaining natural communities (Garren 1943: 646), even though it was known that lightning-producing convectional storms in summer were the primary cause of naturally occurring fires (Komarek 1964), a force with which many species in pine-dominated ecosystems evolved (Robertson 1953, Hofstetter 1984).

Important components of southeastern pine forests, such as gallberry (*Ilex glabra* L.) and saw palmetto, have been viewed as problem species that reduce range quality for cattle and require reduction or eradication (Nation 1951, Hilmon and Hughes 1965, Croker 1968). Because winter fires tended to reduce these "problem" species, cool season burns gained additional favor among land managers, even though the net overall effects included reductions in hard and soft mast availability (Johnson and Landers 1978). Game managers also extolled the virtues of two to three year spring fire rotations to enhance habitat for early successional game species such as white-tailed deer (*Odocoileus virginianus* Zimmerman) (Beckwith 1965) and northern bobwhite (*Colinus virginianus* Linnaeus) (Stoddard 1935). It was not long before it was an accepted practice for game managers, foresters, and cattle ranchers to burn southeastern pine-dominated forests at rotations of three years and less (Wade et al. 1980). Today, management plans for many conservation lands in south Florida call for short prescribed fire intervals (Schortemeyer et al. 1991, Barnwell and Richards 1999, Durrwachter 2000, Bozzo et al. 2001, National Park Service 2002) in upland habitats that are preferred by large terrestrial mammals (Maehr 1997a), or proposed intervals are vague (Kelly et al. 1997). Intervals of six years are considered long (Snyder 1997).

While it is true that lightning-caused fires occur frequently each summer, especially in south Florida (Henry et al. 1994), there is no evidence to suggest that a particular patch of pine forest burned about once every three years in the absence of human intervention. There is ample evidence, however, that before human settlement of the region, most fires occurred during the summer rainy season, from May to October (Wade et al. 1980, Duever et al. 1979, Hoffstetter 1984). Further, fire does not have an equal probability of occurring on all sites (Harris 1984). The traditions of frequent prescribed winter fire in the southeastern U.S. likely lead to Frost's (1998) conclusion (in the absence of autecological and historical data) that uplands in the southeastern coastal plain burned on a one to three year pre-settlement cycle. Today, most prescribed fires are set during winter and may disrupt the life cycles of native plants and animals (Duever et al. 1979), especially those needing habitat features that require > 3 years to recover after burning. The Florida panther and

black bear prefer dense stands of saw palmetto for natal dens in winter, daytime cover throughout the year (Maehr 1997a, Maehr et al. 1990), and food during fall (Maehr et al. 2001) – attributes that may decline with frequent out-of-season fires. We are aware of at least one instance in which a litter of cubs was destroyed by a winter prescribed fire in south Florida (Maehr et al. 2001) and another instance where a prescribed fire came within 50 m of an occupied Florida panther natal den in highly flammable vegetation (Maehr 1997b). Thus, fire effects on these species can be both direct and indirect.

Carnivore-Saw Palmetto Relations

The highly flammable saw palmetto is abundant (Hilmon 1968) and widespread (Little 1978) in the southeastern coastal plain. It is the most characteristic shrub in south Florida pinelands (Tomlinson 1980), it is a very important fuel for fires (Davison and Bratton 1988), and its fruit and apical meristem are important foods throughout the year in Florida (Maehr 1997a) (Table 1). Frequent fires reduce carbohydrate stores in its prostrate stems (Hough 1968), reduce the incidence of fruiting and flowering (Hilmon 1969), and may eliminate it from a given community (Langdon 1981). Several studies of saw palmetto indicate that frequent fires change the species' fruiting phenology and structural characteristics that are important to black bear and panther. Although saw palmetto may flower profusely the year following

Figure 1. A Florida panther natal den site with one 14-day-old kitten in a typical setting of dense saw palmetto growth (photo by David S. Maehr).

Table 1. Either saw palmetto fruit or apical meristem is a key part of the diet in all Florida black bear populations. Food items are listed in descending order of importance based on frequency of occurrence within each study area (across rows).

Location	Reference	Food 1	Food 2	Food 3
Osceola National Forest	Maehr & Brady 1982	***Saw palmetto***	Swamp tupelo	Yellow jacket
Apalachicola National Forest	Maehr & Brady 1984b	Swamp tupelo	Odorless bayberry	***Saw palmetto***
Florida	Maehr & Brady 1984a	***Saw palmetto***	Sabal palm	Fire flag
Central Florida	Roof 1997	Acorns	***Saw palmetto***	Sabal palm
Okefenokee National Wildlife Refuge	Scheick 1999	***Saw palmetto***	Acorns	Swamp tupelo
South Florida	Maehr 1997a	***Saw palmetto***	Sabal palm	Brazilian pepper
Eglin Air Force Base	Stratman 1998	Acorns	***Saw palmetto***	Beetles

fires (Abrahamson 1999), fruit production becomes irregular with repeated burning (Gholz et al. 1999). Whereas palmetto responds with new growth immediately after a fire (Davison and Bratton 1988), substantial fruit crops are not produced for up to 10 years following the last burn (Hilmon 1969, Carrington and Mullahey 1997). Further, while it may regain 80% of its crown coverage in the year following a fire, its relatively slow stem growth (Abrahamson 1995, Kennard et al. 2003) means that the dense horizontal cover (Figure 1) that is preferred by the Florida panther for natal dens (Maehr et al. 1990) may not return for many years (Sackett 1975). Similarly, regular production of saw palmetto fruit as bear food cannot be expected with frequent burning.

Short fire rotations are certainly justified where human property and structures need protection, especially at the urban-wilderness interface. In southwest Florida, where black bear and Florida panther populations are the most abundant in the state (Maehr 1992, Maehr and Wooding 1992), this area begins about 15 km east of the Gulf of Mexico in Collier and Lee counties (Figure 2). Beyond this zone, public lands, including the Fakahatchee Strand State Preserve, Big Cypress National Preserve, Picayune Strand State Forest, and the

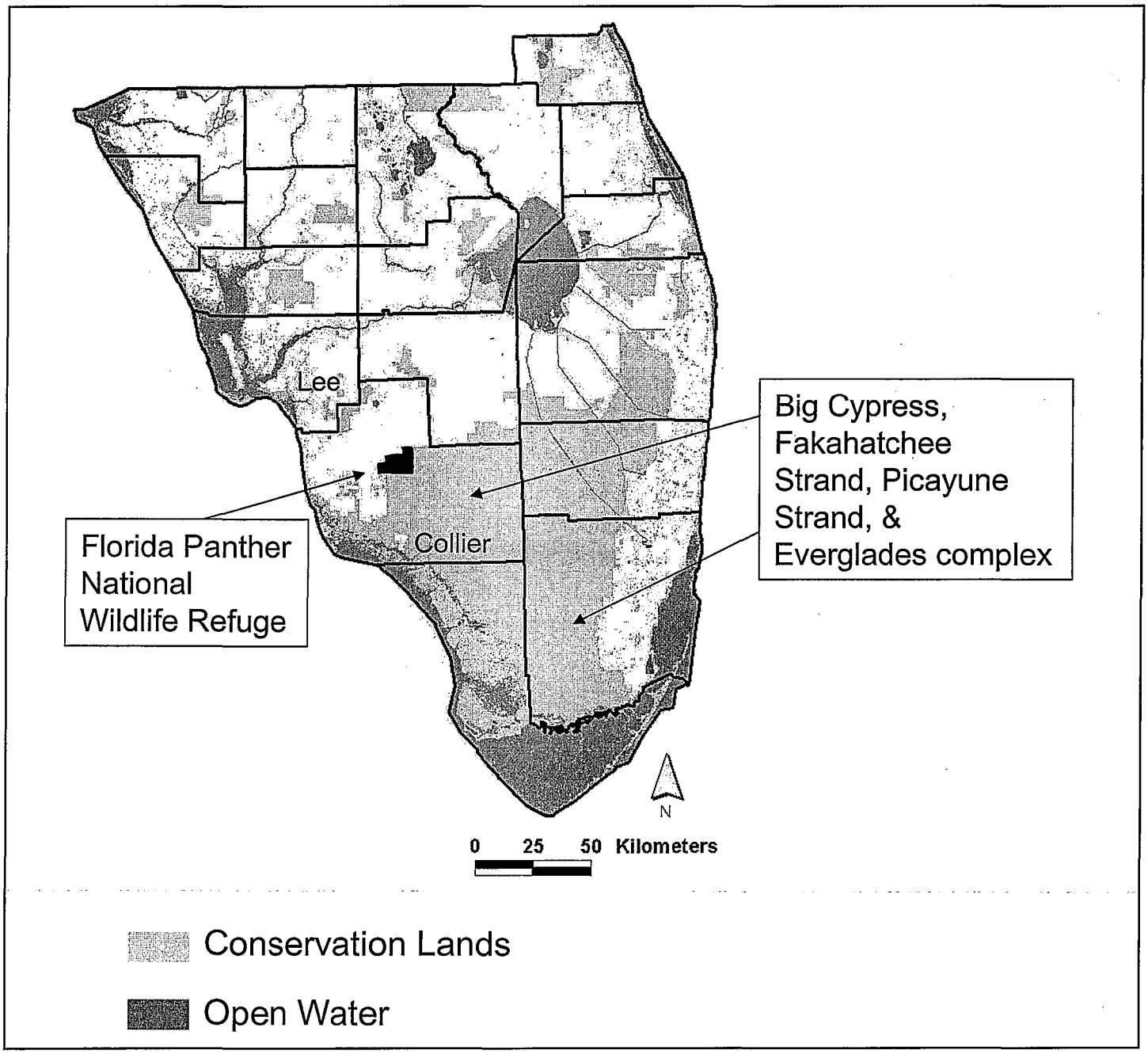

Figure 2. The Florida Panther National Wildlife Refuge is located at the western edge of the urban-wilderness interface in southwest Florida, and is part of a larger complex of public conservation lands.

FPNWR dominate a landscape (approximately 336,180 ha) where prescribed fire rotations follow the regional tradition of one to four years in pine-dominated ecosystems, even though rotations of 10-23 years have been suggested as the more typical cycles in similar habitats (Thomas 1956, Komarek 1974, Christensen 1981, Turner and Bratton 1987).

Despite the fact that relatively frequent fires reduce important understory attributes (i.e., dense vegetative structure and fruit production) that are important to south Florida's large carnivores, recent studies on panther habitat use recommend the regional tradition of short fire cycles (Dees et al. 2001, Main and Richardson 2002) primarily because white-tailed deer appear to prefer recently burned pine forests. This should accrue nutritional benefits to panthers (although none were demonstrated). Whereas Dees et al. (2001) advise that further study is needed to understand the effect of reduced burn rotations on vegetation and landscape pattern, Main and Richardson (2002) unequivocally recommend rotations of ≤ 4 years.

Implications of Short-rotation, Out-of-season Fires

If managers of public lands in south Florida focus strictly on panther nutritional needs in their use of short-rotation fire, other, equally important, carnivore habitat attributes may be neglected. Whereas frequently burned pine ecosystems may benefit the panther through locally concentrated deer, an entire upland landscape of recently burned pine and saw palmetto habitat would reduce a very important food resource for the black bear (Maehr et al. 2001), eliminate the dense palmetto thickets that panthers prefer for natal dens and day beds (Maehr et al. 1990), and increase the probability of endangering neonates if set during winter (Land 1994, Maehr 1997b, Stratman 1998). An extensive history of saw palmetto autecology (Hilmon 1968, Davison and Bratton 1988, Abrahamson 1995, 1999, Gholz et al. 1999) and recent studies on large carnivore habitat relations (Maehr et al. 1990, Maehr 1997a, Maehr et al. 2001) make a compelling argument for considering longer rotation burns during the growing season.

METHODS

Modeling the pre-Columbian Fire Regime

Although the precise temporal and geographic distribution of fire in ancient south Florida will never be known, records of regional lightning occurrence, the sizes of naturally occurring fires, and suggestions by those familiar with fire ecology provide enough basic information to develop a simple landscape model of fire in south Florida. Most pre-Columbian fires in south Florida pine forests with saw palmetto-dominated understories were likely small. First, saw palmetto usually grows in distinct, restricted patches of a few ha or less. Second, because primarily summer lightning caused natural fires, most burns were restricted by standing surface waters, afternoon rains, and high humidity (Duever et al. 1979, Hofstetter 1984). Third, although the Big Cypress Swamp experienced many fires annually before its establishment, only 5% of all recorded fires were caused by lightning – the remainder were caused by humans (Duever et al. 1979).

There is a paucity of empirical studies on lightning and non-human-caused wildfire in south Florida, but several authors have offered some guidelines based on personal observation and historical anecdotes. Based on 1970-1977 records from the Big Cypress National Preserve, the average size of summer fires in "palmetto-gallberry" habitat was 2.6 ha (Duever et al. 1979). They also noted that nearby Ft. Myers (in southwest Florida) had 96 thunderstorms per year and that most lightning-caused fires went undetected because they were so small. At the very least, most lightning strikes do not start fires (Taylor 1971), and more than a decade of observations revealed only three fires that were not started by humans on the 10,688 ha of the FPNWR (J. Durrwachter, pers. comm.: 2000). Such subjective information leaves a lot of room for speculation, so we chose to compare two extremes in fire proneness – one that results in 49% of all lightning strikes starting fires in habitats containing saw palmetto and the other that results in a 5% rate of ignition (still, an estimate that exceeds the natural rate suggested by Durrwachter). Using Komarek's (1964) estimate of one to two strikes per storm, we then randomly distributed 1.5 lightning strikes per 2.6 ha across the entire refuge for each of 100 thunderstorms per year (rounding up from 96; resulting in 4100 lightning strikes per year over the entire refuge).

Fire-prone areas of the FPNWR were considered those that support slash pine (*Pinus elliottii* var. *densa* Little and Dorman) and saw palmetto. Our model did not allow fires to start in wetland habitats. Although this is certainly an oversimplification of modern fire pattern (especially because nearby agricultural drainage has lowered regional water tables and shortened the amount of time that standing water occurs in low-lying areas), our intent was simply to demonstrate a hypothetical range of pre-Columbian fire frequency. We also recognize that very large fires occasionally occurred on the pre-Columbian landscape. In part to account for this oversimplification, we used a 49% ignition rate (based on Taylor's [1971] statement that most lightning strikes do not start fires) as our upper limit of fire proneness in these habitats. The lower 5% ignition rate was based on observations by Duever et al. (1979) for the Big Cypress Swamp. We used ArcView GIS (ESRI, Redlands, CA) to identify upland areas and to randomly distribute the 4100 lightning strikes across the FPNWR. Land cover data based on Landsat Thematic Mapper imagery and aerial photography were obtained from the South Florida Water Management District. Fires were modeled as 3 ha circular areas. If the boundary of the circle included non-flammable habitat, this portion of the circle was excluded from the burn footprint. These steps were then repeated for each of four consecutive years with areas burned the first year excluded from potential fire in the second year (to simulate reduced fuel). These areas became eligible to burn again in year three. We then totaled the areas burned over four years and under each of our two fire regimes and compared these with the area of the FPNWR that is targeted for burning by managers over a similar time frame (i.e., all pine and palmetto habitat).

MODELING RESULTS

Total available pine and saw palmetto habitat in the FPNWR was 1363 ha in 126 patches ranging in area from 0.08 to 178.6 ha ($\bar{x}$ = 10.8, sd = 28.6) (Figure 3a). Of the 4100 lightning strikes in year one, 478 were in fire-prone habitats. The number of fires ranged from 23 at the 5% ignition rate to 234 at the 49% ignition rate, and burned 47 and 387 ha, respectively. In year two, lightning strikes started 25 (@ 5%) and 174 (@ 49%) fires, and burned 48 and 264 ha, respectively. In year three, 26 fires burned 53 ha at the 5% rate, whereas 220 fires burned 320 ha at the 49% rate. The total area burned in four years at the 5% rate was 195 ha, or 15% of fire prone habitat on the FPNWR. This became 990 ha (73%) at the 49% rate (Figure 3b) or nearly three-quarters of all fire-prone habitat.

DISCUSSION

Although our hypothetical fire regimes burned dramatically different amounts of fire-prone habitat, both affected less than the total coverage that is the management target for the FPNWR. We found no empirical evidence to support a natural lightning ignition rate of nearly 50%, and published estimates (Duever et al. 1979) and anecdotal observations (J. Durrwachter pers. comm.: 2002) suggest that lightning-caused fires are much less common than those started by people. Clearly, the lower rate of ignition would result in maintaining more older saw palmetto habitat in conditions that are conducive to bears and panthers than the 49% ignition rate would allow. High ignition rates, if maintained on a short rotation, would likely reduce important food and cover characteristics to the same degree as have current fire prescriptions. Burning 15% of fire prone habitat in a four-year period on the FPNWR may come close to simulating the pre-Columbian fire regime, and would leave unburned saw palmetto refugia that are preferred by panther and bear for cover and food.

The extensive fires in Yellowstone National Park during 1988 reduced grizzly bear (*Ursus arctos* Linnaeus) carrying capacity by eliminating important foods such as whitebark pine (*Pinus albicaulis* Engelm.), a species that may take > 40 years to recover (Craighead et al. 1995). This largely natural event is distinguished from south Florida where inhabited carnivore range is smaller and is isolated from other conservation lands in the region and where fires are largely human-started and are set on a short burn rotation. South Florida is further distinguished from Yellowstone inasmuch as decades of management and the effects of the most recent fires can be reversed relatively quickly simply by changing burn prescriptions to promote fruit production and dense cover. Saw palmetto, which serves as suitable carnivore natal den habitat and as food for the black bear, can return in a matter of years rather than decades. This is particularly important because the microhabitat features that seem to be important to black bear and panther in south Florida have more to do with understory conditions than species composition or height of the forest canopy. That is, a

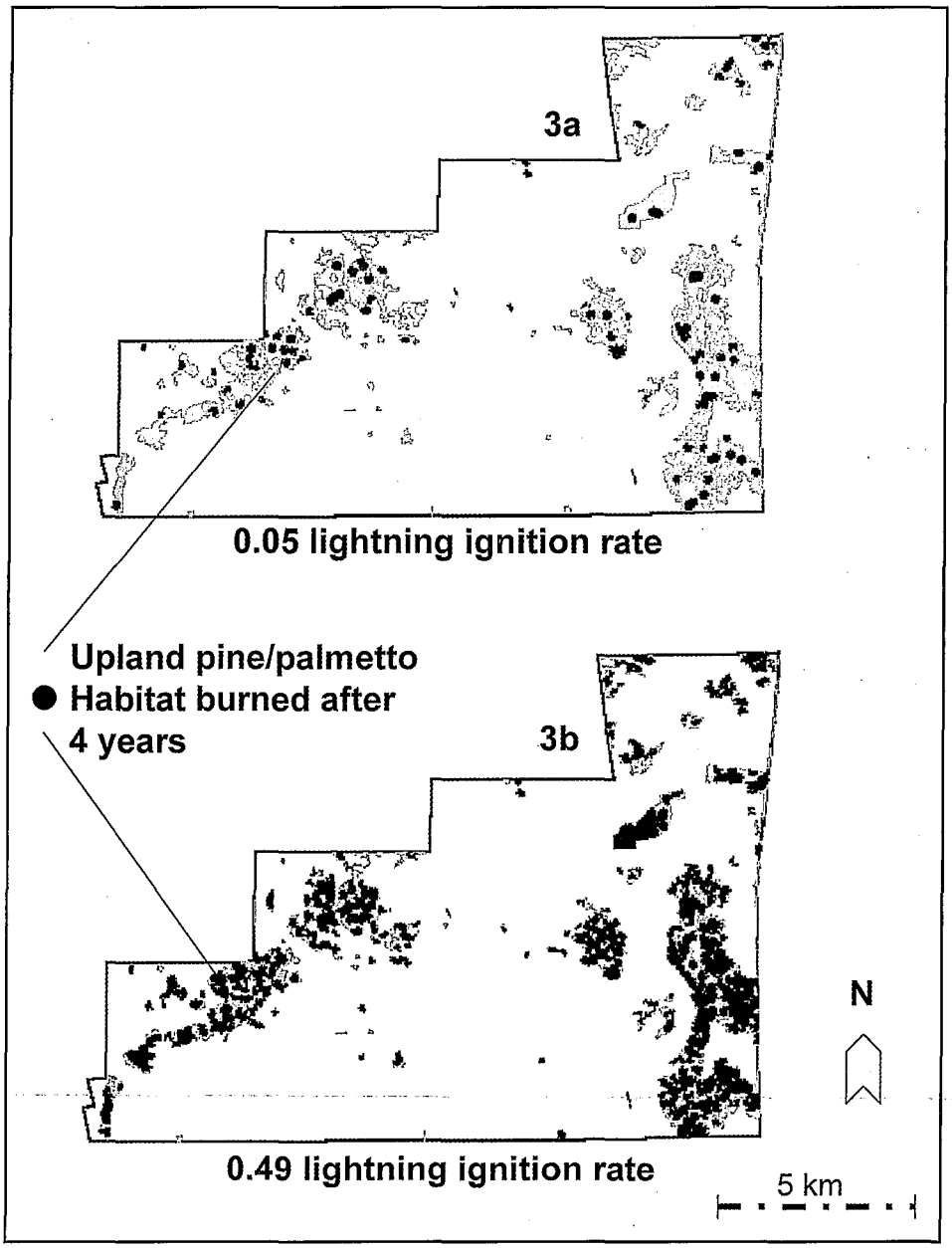

Figure 3. Upland habitats containing saw palmetto cover approximately 13% of the Florida Panther National Wildlife Refuge. A lightning ignition rate of 49% (3b) burns considerably more saw palmetto-dominated habitat after 4 years than a 5% ignition rate (3b). Gray and black areas represent pine/palmetto habitat, and burned areas, respectively.

mature pine overstory is not required for a palmetto patch to have value to large carnivores in south Florida.

Whereas a long-rotation, growing season approach to south Florida fire can be defended because it makes ecological sense in a wilderness landscape, it is clear that managers have more than just large carnivores to consider in their planning. Further, we recognize that even the best planned fires, conducted under optimal conditions, often burn much less (or much more) than is targeted in a prescription, and that small patches of saw palmetto have a lower probability of burning in a given year than a large patch. However, given the tenuous status of large carnivores in the region, we believe that it is prudent to develop management plans that recognize the value of older age saw palmetto habitat and the services it provides bears and panthers, rather than gamble that a short-rotation prescription will not reduce important food and cover for these species. In other words, the maintenance of good, large carnivore habitat in south Florida should not be an accident. While we might agree with Schortemeyer et al. (1991: 524) that frequent fire can "provide maximum benefits for deer and other prey species" in south Florida, a reduction in the extent of mature saw palmetto thickets and their associated structure may locally eliminate stalking cover and restrict kill success rates for the panther even under increased prey conditions. Where boundary issues, such as smoke on highways and private property damage, are important concerns, fire prescriptions could be adjusted to allow winter burning and strategic fuel reduction in restricted peripheral areas. Elsewhere, efforts should be made to optimize older age saw palmetto habitats for large carnivores.

A New Approach

We believe that a mosaic of recently burned and relatively fire-free pine and palmetto habitat is the best approach for maintaining conditions that are conducive to reproduction and nutrition of Florida's large carnivores, especially where both black bear and panther occur. Where detailed, long-range management plans are required by agency stewards, we recommend maintaining saw palmetto in several stages of post-fire recovery. Our approach targets the maintenance of some saw palmetto habitat in a fire-free condition for 20 years or longer. These areas should serve as focal points of management units that would include a network of patches that are burned in a rotating cycle (Figure 4). Patches should be maintained at post-fire intervals ranging from one year to the maximum rotation age. Until further research clarifies the best arrangement of various stages of palmetto and explicates the threshold below which the amount of

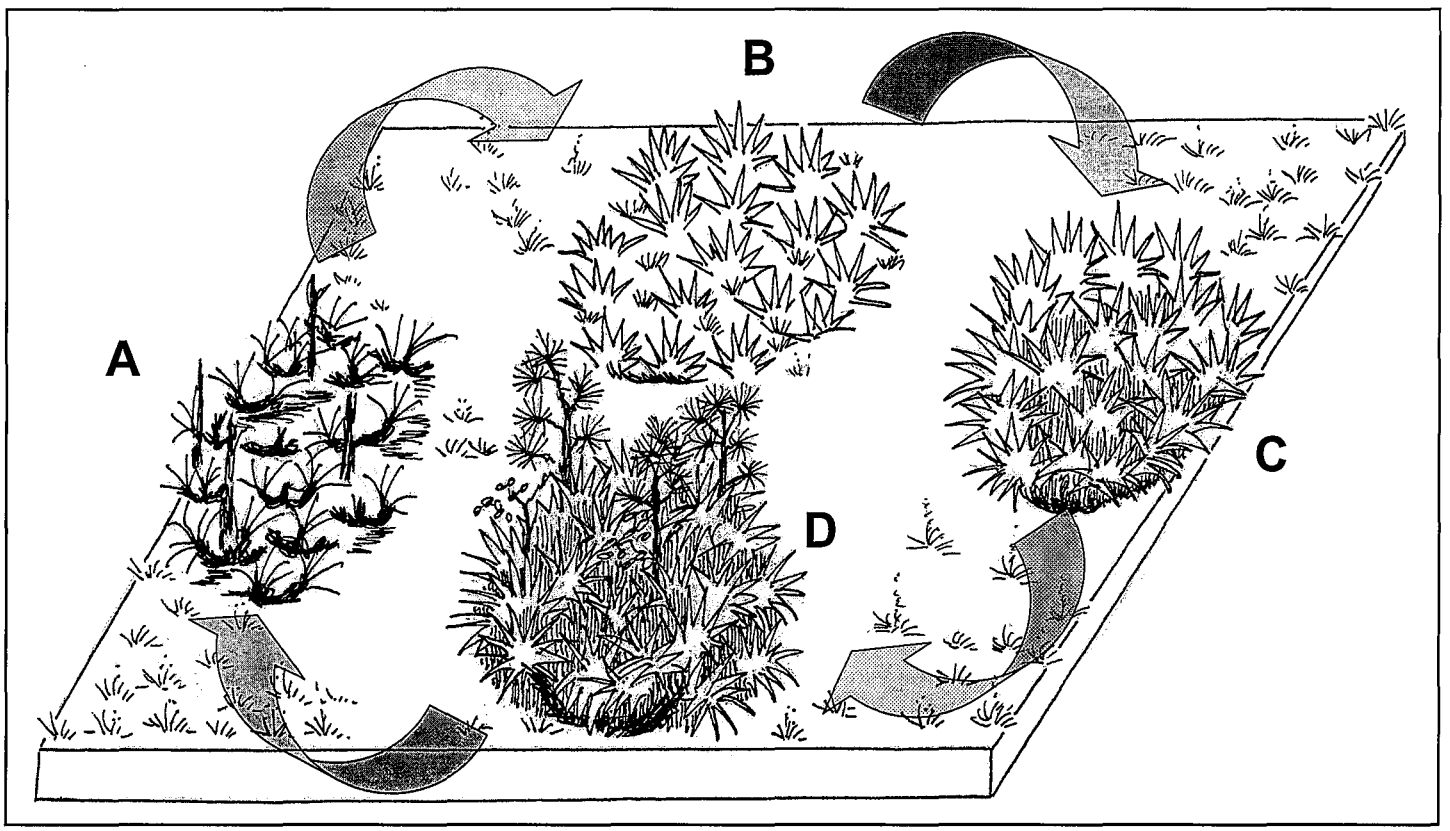

Figure 4. The long-rotation island approach to managing saw palmetto habitats in south Florida involves maintaining some saw palmetto habitat in a fire-free condition for up to 20 years. These areas should serve as focal points of management units that would include a network of patches that are burned in a rotating cycle (e.g., A is burned in year 1 then left unburned for 20 years; B is burned in year 6 then left unburned for 20 years; C is burned in year 11 and left unburned for 20 years; D is burned in year 16 and left unburned for 20 years). Controlled burns could still be planned on an annual basis, but actual prescriptions modified depending on the amount of lightning-caused fires.

old-stage saw palmetto is insufficient to provide stalking cover for panthers, food for bears, and optimal den sites for both species, the core, old-stage patches should cover approximately 25% of each management unit – a rule of thumb developed for maximizing biodiversity benefits in old growth forest (Harris 1984). The ignition of the oldest patches (D in Figure 4) should occur only after an equal number of the next oldest patches (C in Figure 4) are available to replace them. Such a strategy would avoid a one-dimensional approach that ignores several important natural history requirements while retaining the landscape patterns in which south Florida black bear and panther evolved.

CONCLUSION

We agree with Dees et al. (2001) that further investigation is needed to better understand the relation among fire frequency, fire season, south Florida pinelands, and native large carnivores. We suggest a research program that examines the species-specific responses of upland plant communities in habitats utilized by large carnivores in south Florida. Do fires burn homogeneously through saw palmetto-dominated communities? How do plant species composition and structure change relative to the frequency, season, and extent of fire prescriptions? What interval and arrangement of fire in managed forests promote the well being and recovery of south Florida's large carnivores? How does the adoption of such a fire management program affect habitat use and movements of black bear and panther in the new management mosaic? Clearly, basing landscape-scale management solely on a tendency for panthers or their prey to use recently and frequently burned areas ignores important attributes of habitats that have not recently burned and that might otherwise be expected to escape fire for relatively long periods as our modeling and other evidence suggest. Until the correlates of large carnivore reproductive success and nutrition are better understood, especially where bear and panther are the subject of management that targets their recovery, we encourage managers of south Florida pinelands to be more conservative with their fire prescriptions. South Florida may be one of the few places in the southeastern U.S. where networks of public lands are large enough to adopt evolutionarily relevant fire management programs. As the autecology of important cover plants and the preferences of the large carnivores that use them attest, longer fire rotations should be considered as components of management plans that target the Florida panther and black bear. To do otherwise would be to promote traditions based in convenience rather than to adopt enlightened approaches that stem from a greater appreciation for the ecology of fire in a wet, patchy forest landscape.

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