

# Forum

To the Editor:

## RESPONSE TO MAHR AND LARKIN

### NATURAL FIRE REGIMES IN SOUTHERN FLORIDA

Fire plays a critical role in the dynamics of south Florida ecosystems and ecologically sound fire management is necessary for the restoration and preservation of the greater Everglades landscape and its biodiversity (Lockwood et al. 2003). Fire management should be based on the natural fire regimes that have provided the evolutionary conditions leading to the formation of fire-adapted ecological communities in southern Florida (Platt 1999). The challenge comes in defining the natural season and frequency of fire, i.e., the natural fire regime, given limited data on historic fires. Maehr and Larkin (NAJ 24(3):188-197; henceforth M&L) define the natural fire season as the summer rainy season from May to October because thunderstorms during this time period provide lightning strikes as a natural source of ignition for fires. In southern Florida, however, the largest areas burn (~80%) during the period when lightning strikes overlap with drought conditions during the spring transition from dry- to wet-season conditions in April, May, and June (Beckage et al. 2003). During this transition period, regional water deficits still prevail but the onset of thunderstorm activity provides lightning strike ignitions, leading to large fires that move across vegetation types (Beckage et al. 2003). With regards to the natural frequency of fire, M&L argue for less frequent fires than is considered natural for southeastern pinelands, claiming that there is little evidence to suggest that pine forests historically burned as frequently as once every three years. However, the greatest diversity of plant species occurs in pinelands that are burned as frequently as every year (Lewis and Harshbarger 1976, Walker and Peet 1983, Mehlman 1992) and species richness begins to dramatically decline when fires become less frequent than every six to eight years (Beckage and Stout 2000). Fire intervals of 20 years as suggested by M&L could risk the conversion of pinelands to hardwood hammocks (Robertson 1953, Platt 1999, Lockwood et al. 2003) while the dense palmetto patches that M&L advocate could lead to fires that are more intense than is natural and high mortality of pines (Duever et al. 1986).

Natural fire regimes in southern Florida should be inferred from climatic cycles rather than the responses of a limited set of species. Species respond differently to fires and their variable responses

can lead to contradictory 'natural' fire regimes being inferred from autoecological data. Fire management based on the responses of different species can lead to conflicting results when determining the natural fire regime, because the fire regime that is optimal for one species may be less than optimal for another. In contrast, fire regimes in southern Florida are strongly linked to climatic cycles through the El Niño Southern Oscillation and resultant effects on precipitation and lightning strike frequency (Beckage and Platt 2003, Beckage et al. 2003). Extreme La Niña events create severe regional spring droughts and increased frequencies of lightning strikes, resulting in widespread and large fires such as the ~40,000 ha lightning-initiated Ingraham Fire in 1989. El Niño events have the opposite effect: wet springs, widespread standing water, decreased lightning strikes, and reduced fires. ENSO cycles generally display a periodicity of two to seven years, which is consistent with the high frequency of fire (three to seven years; Hofstetter 1973) considered natural for pineland communities in south Florida.

While computer simulations of fire provide a sensible means to explore natural fire regimes, M&L's fire simulations suffer from a series of shortcomings that lead to biased and poorly constrained estimates of fire frequency. M&L model fire size as being fixed at 3 ha based on estimates from palmetto-gallberry habitat, but Duever et al. (1986) report a mean annual fire size of 297 ha, a mean monthly fire size of 165 ha for the May-October summer rainy season, and a mean fire size of nearly 1000 ha during the dry- to wet-season transition in May for palmetto-gallberry habitat. In addition, fires do not limit themselves to a particular habitat type as assumed by M&L but burn across landscapes and vegetation types. Even with M&L's conservative assumption of fire size, their results from one of two sets of simulations (387, 264, and 320 ha burned in consecutive years) suggest a fire return interval of slightly over four years. We emphasize that the lack of consideration of fire spread across ecological units and the small fire size biases their estimates towards small and infrequent fires. Model assumptions for ignition probability and lightning strike frequency are only weakly grounded in empirical data, but M&L do not explore the model sensitivity to parameter misspecification nor do they examine the range of variability in results with repeated model runs. For comparison, we conducted fire simulations based on similar assumptions to M&L's but ran 1000 simulations of 100 years, alternatively assuming a fire size of 3 ha, 165 ha, and the full size distribution of lightning fires observed in Everglades National Park over the last half century. Our simulation results are consistent with high frequencies of fire and short intervals between fires (Table 1). We note that simulations (both ours and those of M&L) were limited by a lack of data on the probability of lightning strikes igniting fires and did not consider seasonal and annual variability in fire processes.

We finally emphasize that fires are extremely spatially heterogeneous. Fires burn some patches of vegetation while leaving adjacent areas unscathed. The characterization that a fire unit burned can mean that as little as 20% percent of the area in that fire block burned (Slocum et al. 2003). Spatial variability in fire, often on

**Table 1. Simulated area burned in the Florida Panther National Wildlife Refuge (FPNWR). We made similar assumptions to those of Maehr and Larkin (2004): fires were limited to patches of slash pine/palmetto habitat and ignition probabilities from lightning strikes were either 0.05 or 0.49. The density of lightning strikes was modeled as a Poisson process with a mean intensity of 0.384 strikes per ha (4100 strikes/10,688 ha). Fire sizes were either fixed at 3 ha, 165 ha (mean monthly fire size during the May-October summer rainy season) or were randomly sampled from a Weibull distribution fit to all lightning fires that occurred over the last half century in Everglades National Park. Estimated fire return intervals were based on mean annual area burned in 1,000 simulations of 100 years. We determined the patch size of slash pine/palmetto habitats in FPNWR from FGAP version 6.6 (Pearlstone et al. 2002) using two different clustering algorithms that resulted in 249 (mn size = 5.7 ha, sd=26.6) and 121 habitat patches (mean size = 11.7 ha, sd = 60.3) for a total area of 1411.5 ha.**

Ignition Probability	Clustering Scheme	Fire Size (ha)	Annual Area Burned (ha)				Fire Return Interval (yrs)
			mn	sd	min	max	
0.05	1	3	72.9	14.6	22.4	142.8	19.4
0.05	1	165	493.2	132.9	11.2	930.1	2.9
0.05	1	random	345.4	143.9	6.5	936.9	4.1
0.05	2	3	74.9	15	19.4	147	18.8
0.05	2	165	432.1	68.7	0	685.9	3.3
0.05	2	random	407.7	195.5	0	1153.2	3.5
0.49	1	3	457	42.5	291.4	637.6	3.1
0.49	1	165	650.5	101.1	391.3	903.5	2.2
0.49	1	random	508	124.6	111.9	1009.9	2.8
0.49	2	3	481.8	45	291.8	681	2.9
0.49	2	165	513.4	61.9	339	698.7	2.7
0.49	2	random	479	187.7	59.5	1199.3	2.9

the scale of meters, can be related to underlying heterogeneity in substrate or elevation and can lead to areas of fire-intolerant hardwood hammocks persisting in landscape units that have been burned on a one to four year interval for over a decade in Everglades National Park (ENP fire records). Long fire-free intervals are not required to maintain a mixture of vegetation types since this will result from natural spatial heterogeneity in fire. In conclusion, while we applaud M&L's emphasis on emulating natural fire regimes, we stress that much better quantification of the natural range of fire frequency and the spatial heterogeneity of fires is required.

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*To the Editor:*

## RESPONSE TO BECKAGE ET AL.

### FIRE REGIMES AND LARGE TERRESTRIAL CARNIVORES IN SOUTH FLORIDA

We appreciate the response by Beckage et al. (2005) regarding the predictive model that augmented our discussion about fire effects on black bear (*Ursus americanus floridanus*) and Florida panther (*Puma concolor coryi*) in south Florida (Maehr and Larkin 2004). Clearly, the inputs to our model were poorly verified and resulted in erroneous conclusions. We regret any inconveniences that this may have caused readers of *Natural Areas Journal*, but are glad that this problem has been pointed out. Nonetheless, the primary focus of our paper was to consider the potential impacts of artificial fire regimes on two imperiled carnivore species that exhibit tendencies to utilize upland habitats dominated by saw palmetto (*Serenoa repens*), a fire-adapted, but very flammable understory shrub. Even without the model as part of our argument, we believe that the behavior of these large carnivores and the autecology of saw palmetto provide sufficient evidence to reconsider burn prescriptions of four years or less because they may compromise important habitat features including food and reproductive cover for the bear and panther. At the very least, there can be no debate that winter prescribed fires in palmetto-dominated habitat may cause fatalities among neonatal offspring of both species, especially the black bear, because females give birth to helpless young during late February when lightning and natural fires are unlikely to occur.

It is important to know that plant species diversity is highest in frequently burned pinelands, but it is unlikely that implementing a longer, carnivore-friendly fire rotation would negatively impact those species that colonize recently burned areas. This would be especially true if fire managers implemented a landscape scale approach to fire that assured that some percentage of pinelands were burned in every year, providing constant colonization substrates for a variety of plant species (as would have the pre-Columbian landscape). We stress here that we are not advocating fire suppression to obtain cover and food conditions to promote reproduction and nutrition of bears and panthers. We are simply advocating that land managers choose a burning regime that leaves some proportion of older, dense saw palmetto on the landscape.

We recognized, as did Beckage et al. (2005), that south Florida fires could be spatially heterogeneous. In a landscape unconstrained by human infrastructure, lightning-caused fires would have burned according to climate and local site conditions, with

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some consuming thousands of hectares. Even a very large fire would have left vast areas of suitable habitat for large carnivores and early successional plants. Unfortunately, because the remnants of these native landscapes are now virtual islands, fragmented by roads, agriculture, suburbs, and ownership patterns, managers must be careful to represent the full array of successional stages with which a variety of organisms evolved. While leaving some areas unburned for much longer than is currently practiced may lead to some hardwood invasion and occasional hot fires (likely a quite natural part of pre-Columbian landscapes), a fire prescription that recognizes the importance of more than just frequently burned areas will encourage the continued occupation and perpetuation of south Florida's wide-ranging carnivores. In other words, a pattern of very frequent prescribed fires in a particular management unit may promote overall local (alpha) diversity, but it may eliminate some key elements of the local community. Our approach, one that is designed to maintain the full array of conditions necessary to facilitate large carnivore occupation, would ensure that landscape scale (gamma) diversity remains high, and that bears and panthers remain a part of it.

If frequent prescribed fires are targeted to burn all pineland habitat in bear- and panther-inhabited range, it should be demonstrated that the resulting pattern of saw palmetto fruit production (often needing >6 years to recover from a fire) and cover conditions are not detrimental to the health and reproduction of these imperiled subspecies. In this sense, we whole-heartedly agree with Beckage et al. (*in press*) "that much better quantification of the natural range of fire frequency and the spatial heterogeneity of fires is required." This would have been the case even with a model that got it right the first time – there is a lot that we do not yet know about fire in what is now a very denatured landscape. In light of this, we recommend that south Florida land managers coordinate closely with those monitoring the movements of bears and panthers to measure the reproductive, nutritional, and spatial responses of large carnivores to a variety of fire regimes. Finally, we also stress that there is nothing contradictory for managers to consider the needs of listed carnivore species along with those components of the regional biota that are adapted to frequent summer fires. Such an approach will become increasingly important as public lands are increasingly looked to as refugia for regional biodiversity.

In this day of rapid development and landscape change, we must find ways to successfully manage a growing list of native species targeted for conservation. As noted by Beckage et al. (2005), plant diversity "begins to dramatically decline when fires become less frequent than every six to eight years." Certainly, this observation along with saw palmetto autecology, black bear food preferences, and carnivore reproductive patterns, can help us understand the evolutionary relations within this community and to manage it all with landscape patterns in mind. "We cannot simply return natural fires to most of these forests...However, if we understand how the trees, undergrowth plants, and animals respond to fire, we may be able to design substitute treatments that can perpetuate the forest community in some approximation of its historical conditions" (Arno and Allison-Bunnell 2002:52). We are hopeful

that constructive dialogue such as this will lead to future research that enlightens management of south Florida landscapes, including the unusual presence of two imperiled carnivores.

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