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FLORIDA SCRUB-JAYS (*Aphelocoma coerulescens*) AND FIRE: UPDATE FROM AN ON-GOING, MULTI-DECADAL EXPERIMENT

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The Florida Scrub-Jay (*Aphelocoma coerulescens*, hereafter FSJ) is the only bird species fully endemic to Florida, where it is primarily restricted to upland xeric oak scrub habitats. A significant threat to this charismatic, cooperatively breeding, federally Threatened (Woolfenden and Fitzpatrick 1996) species is the loss of its preferred habitat. The FSJ has lost over 90% of its historic population to habitat conversion. A continuing problem for existing FSJ populations, even on conservation lands, is the species' heavy reliance on habitats that are periodically burned. Historically, fires occurred naturally in the pyrogenic Florida oak scrub, creating mosaics of habitat patches of oak scrub of varying height, vegetation density, herbaceous cover, and leaf litter based on the time since they last burned.

Thanks to decades of intensive research within several major FSJ populations, it is now widely understood that FSJs prefer scrub that is relatively early in post-fire succession, and of medium height, usually 1m-3m (Fitzpatrick and Bowman 2016). Indeed, FSJ populations experience positive growth rates in scrub falling within this height range, but zero or negative growth in very short or very tall scrub (Breininger and Carter 2003). Consequently, land managers across the Florida peninsula are advised to use prescribed fire to maintain significant tracts of oak scrub at or near optimal conditions for FSJ population persistence.

An important source of information about FSJ dependence on fire is the long-term study carried out since the early 1970s at the 4,000 ha. Archbold Biological Station, in Highlands County, FL (Fitzpatrick and Bowman 2016). For decades, Archbold scientists and staff have conducted prescribed burns and selectively prohibited wildfires to produce experimentally controlled conditions for documenting how scrub-adapted organisms respond to fire. Beginning around 1980, we began one such long-term experiment that continues to this day. We focused on a 55 ha. fire-unit (Unit 18E, hereafter '18E') located along

the southeastern corner of our 1,000 ha. long-term demography study site. 18E is a rectangular unit entirely covered with oak scrub and bordered on all sides by 5-m-wide fire lanes of exposed dry sandy soil.

Our objectives have been to document (1) how occupancy and territory density increase and decrease in association with successional stages that alternate between pre- and post-fire conditions, and (2) how demographic parameters vary across these fire cycle stages. Our ultimate goal, like that of several other long-term studies at Archbold, has been to infer temporal and demographic characteristics of the natural "fire cycles" that were experienced by scrub-inhabiting organisms before humans altered the regimes. In this way, our long-term experiment might help quantify the approximate periodicity with which to apply prescribed fire to benefit the FSJ on tracts of oak scrub managed for conservation. Here, we provide an update at the 45-year mark of our ongoing experiment.

FSJs live on strongly defended year-round territories, most of which are tightly contiguous with one another along extraordinarily narrow boundaries (Woolfenden and Fitzpatrick 1984). Since 1973, we have mapped FSJ territories across our entire study tract at Archbold. We map territories during April, coinciding with the peak of FSJ breeding. Logging our observations onto detailed aerial photos, we carefully document boundary disputes between family groups occupying all contiguous territories, as well as all home range boundaries that abut unoccupied habitat (e.g., pine or bayhead forest, open prairie, marshy swales). All jays in our study tract are habituated to humans, and we periodically reward their close approach with small peanut morsels. As a result, for mapping purposes, we can instigate and record territorial disputes between neighbors simply by enticing adjacent pairs or family groups to approach their shared boundaries. Upon spotting one another, the jays in different family groups commence active territorial vocalizations and ritualized displays, often flying long, undulating flights paralleling their shared boundary (see detailed behavioral descriptions and examples of finished territory maps in Woolfenden and Fitzpatrick 1984). Repeated visits to documented or suspected boundaries reveal that their precise locations are recognized and conspicuously respected by the jays, remaining stable over many months and even years.

We tracked FSJ territory occupancy within 18E annually by summing the proportions of all territories mapped in April as having at least ten percent of their total area within the boundaries of 18E. In March 1990 and again in June 2010 we conducted prescribed fires during which we attempted to burn the entire unit. We chose these dates by determining when the sum of all the proportions of territories within 18E fell below about 2 territories. The 1990 prescribed fire was exceptionally hot and complete, burning over 90% of 18E. The 2010 fire

was less complete, burning about 70% of the unit and leaving several significant patches of tall, overgrown scrub unburned.

FSJ family groups showed positive responses almost immediately following both fires. Jays that were previously established around the perimeter of 18E gradually expanded their occupancy within the unit over several ensuing years. In addition, jays dispersing from more distant territories began colonizing and establishing new pairs within the unit. Many of the latter were unbanded immigrants, originating from unidentified scrub tracts external to Archbold Biological Station. Eventually, jay density leveled off, then began to decline as the habitat regenerated and approached tall, overgrown conditions less suitable for FSJ survival and reproduction.

Territory density within 18E peaked between 6 and 9 years post-fire following the 1990 burn, and between 6 and 8 years post-fire following the less complete 2010 burn. Peak density was substantially higher after the 1990 burn (6.2 vs. 4.2 territories, respectively), presumably because the earlier fire was considerably more severe and more complete than in 2010. In 2024, just 8 years after the most recent peak, territory density again fell below our threshold of 2 territories, suggesting the need for another prescribed burn. The comparable drop took about 13 years following the peak resulting from the extremely complete 1990 burn (Fig. 1).

Fitzpatrick and Bowman (2016) showed important demographic correlates of these cyclic post-fire responses between 1983 and 2009: during years in which population density was increasing in Unit 18E, (1) survival of FSJ fledglings (N yearlings/ N fledglings for every group) was significantly higher (0.50 during periods of density increase and

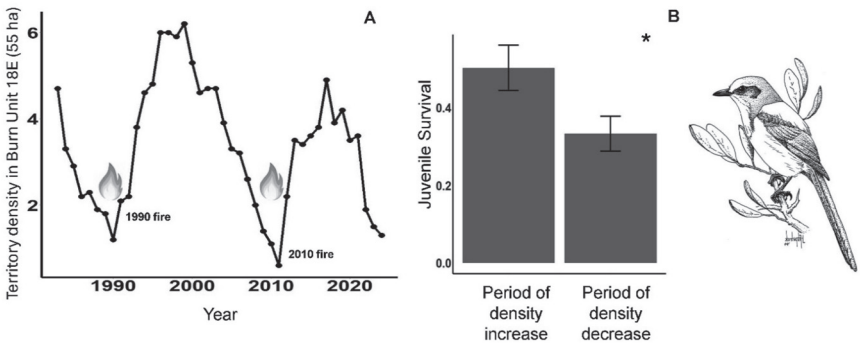

Figure 1. (A) Florida Scrub-Jay territory densities and responses to prescribed fires in Unit 18E (55 ha.) at Archbold Biological Station. (B) Juvenile survival was higher during periods of population density increase versus decrease in 18E territories (Asterisk denotes statistical significance). Artwork © John W. Fitzpatrick.

0.30 during periods of decrease), (2) widowed breeders more frequently re-paired without leaving their territories, and (3) newly colonizing pairs were more frequent, all compared to years characterized by density decreases. Incorporating continuous data from 1983-2024 (i.e., 15 years of additional data since those reported in Fitzpatrick and Bowman (2016)), we used an Analysis of Variance test to investigate whether juvenile survival changed between periods of density increase versus decrease. The difference in juvenile survival remains virtually unchanged. Between 1983 and 2024 in Unit 18E, juvenile survival after fire was significantly greater during periods of density increase (mean ± standard error 0.50 ± 0.05) versus periods of density decrease (0.33 ± 0.04, N=99, F=5.32, P=0.02).

It bears emphasis, as our data from two different prescribed burns underscore, that land managers striving to replicate natural fire cycles in oak scrub habitats suitable for the FSJ have considerable leeway in choosing inter-fire intervals (Breininger et al. 2014). Scrub habitats used successfully by FSJs around the peninsula vary considerably in vegetation structure, composition, and regeneration rates, frequency and spatial distribution of small clearings in the scrub, rates at which these clearings close post-burn, and variations in the annual wet-dry cycles of peninsular Florida. Additionally, as seen in our case, how scrub vegetation structure recovers from fire varies not only by the severity of the fire but also by the local environment in the interim, such as rainfall, soil, etc. These variables, in turn, affect the natural proclivity of individual tracts to burn, thus exacerbating the always fickle nature of individual fires even on the same habitat tract. Consequently, optimal inter-fire intervals vary significantly with location, vegetation characteristics, and burn history, as emphasized by a recent summary of scrub management guidelines (e.g. coastal scrub versus Lake Wales Ridge scrub) (FWC 2019). Our data in this study represent 45 years of FSJ population responses on just a single 55 ha. tract (N=1) and across just two fires twenty years apart (N=2). These caveats stated, our data suggest that along the Lake Wales Ridge, especially in scrub tracts dominated by *Quercus inopina*, optimal fire return intervals for maintaining FSJ populations having positive growth rates are between 8 and 12 years, with some leeway on the longer side following fires that were exceptionally hot and complete.

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