Bachman's Sparrow (*Peucaea aestivalis*) Populations and Prescribed Fires in Jay B. Starkey Wilderness Park

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Photo courtesy of Patricia Goldberg.

Abstract

Members of the Passerellidae family, Bachman's sparrows live almost exclusively in the longleaf pine ecosystems of the United States that are maintained by forest fires. Our objective for this project is to investigate the relationship between Bachman's sparrow (*Peucaea aestivalis*) abundance and year of most recent prescribed burn in Jay B. Starkey Wilderness Park. With this information, we hope to assess and analyze the preferred burn rotation of Bachman's sparrows. Population surveys were conducted over three dates during the sparrows' breeding season. We selected zones that were last burned in 2017, 2018, 2020, and 2021 for surveying. The majority of observed sparrows occurred in zones that were burned in 2020 and 2021, with the 2020 burn zone having the densest concentration of sparrows. On average, there were more sparrows in the 2020 and 2021 zones (μ=35.5 birds) than in the 2017 and 2018 zones (μ=9 birds), suggesting a preferred 2-3 year rotation of burns.

Introduction

Purpose

Our objective for this project is to investigate the relationship between Bachman's sparrow (*Peucaea aestivalis*) abundance and year of most recent prescribed fire to determine the preferred burn rotation of Bachman's sparrows. To do this, we measured the frequency of individual Bachman's sparrows in four different burn year sites. The oldest area of interest was last burned in 2017. The other regions in which we recorded observations were most recently burned in 2018, 2020, and 2021. Due to the rapid regrowth that happens in flatwood pine forests after a burn, there exist significant differences in vegetation makeup between years (figure 1, methods section). We used the abundance of sparrows in each burn area to measure their preferred habitat. With the knowledge that *P. aestivalis* is an indicator species for the status of longleaf pine habitat, we hope to evaluate the effectiveness of the current five-year burn rotation.

The Bachman's Sparrow as an Indicator Species

Bachman's sparrows live almost exclusively in longleaf pine ecosystems that are maintained by forest fires (Taillie et al. 2015, etc.). A ground-dwelling bird, the Bachman's sparrow nests in patches of grass, and in Florida, palmettos. They have been found to prefer habitats with dense, diverse layers of low-lying herbaceous vegetation, while avoiding areas with dense hardwood tree coverings with a thick mid or upper canopy (Engstrom 1984; Haggerty 1998, 2000; Tucker et al. 1998; Choi et al. 2021). Sparrows rely on patches of grasses for protection from predators (Dean and Vickery 2003). Breeding also tends to be more successful in areas that provide patches of a dense, grassy low layer and sparser woody vegetation (Tucker et al. 2006; Haggerty 1998). However, it is important to note that an upper limit to ground cover density exists. For example, Jones et al. (2013) found that while sparrow populations may be higher in habitats with thick ground cover, the nests themselves are most likely to be placed in a small space where there is no grass, or a low density of grass. Because they are so dependent on a short herbaceous layer, Bachman's sparrows are particularly sensitive to overgrowth in longleaf pine habitats. The general consensus among researchers is that Bachman's sparrows are most abundant in forests that were burned within the last 2-3 years. After 3 years, however, the ground layer becomes so overgrown with woody vegetation that sparrows no longer find the habitat suitable (Tucker et al. 2004; Tucker et al. 2006; Jones et al. 2013; Korosy 2016). These habitat requirements dictate a relatively narrow niche that the Bachman's sparrow needs to survive and reproduce. Because of this, it has often been used by researchers as an indicator species of longleaf pine ecosystems.

The longleaf pine habitat has historically comprised much of the Southeastern United States, including Central Florida, but these forests have been declining precipitously over the last several centuries (Noss et al. 1995; Noss 1989). Prior to European colonization, around 40% of the upland area in Florida was covered by longleaf pines, but by 1986, that percentage had dropped to just 0.7%. Today, it is regarded as one of the most endangered ecosystems in the United States, surpassing even wetlands (Noss et al. 1995). In the past several centuries, humans have increasingly encroached on wilderness, fragmenting and destroying habitat. In areas that haven't been outright destroyed, the anthropogenic suppression of regular forest burning, hardwood species outcompete the longleaf pines for both water and sunlight (Walker and Wiant 1966). As a result of this, climax communities form where they historically never have, and key habitat that many animals rely on is lost.

Controlled Burns and Longleaf Pine Habitats

Longleaf pine communities are characterized by tall, spaced out longleaf pine (*Pinus palustris)* trees, which dominate the canopy layer. Longleaf pines are evergreen conifers that reach up to 120 feet tall when mature (Owsley 2011). The relatively spread out pines allow plenty of light to pass through to the ground level, which supports a diverse array of shorter vegetation. The ground layer is composed of smaller grasses and shrubs, with wiregrasses being dominant (Oswalt et al. 2012, Jose et al. 2007). In a true longleaf pine climax community, the midcanopy is absent, due to regular forest fires that keep any woody understory plants from becoming tall (Owsley 2011). At first glance, the sparse distribution of *P. palustris* may give the appearance of a barren burn site, but these grasslands and forests support a remarkable diversity of both plant and animal taxa. In fact, these habitats are crucial to endangered species. For example, the Gopher Tortoise relies on the open canopy and dense groundcover provided by longleaf pines (Auffenberg and Franz 1982).

Longleaf pine forests have a dynamic ecology and are naturally maintained by periodic disturbance events – namely forest fires. The dominant plant species – longleaf pines and wiregrass – are not only fire-resistant, but also function to facilitate regular burns (Brockway et al. 2005). For example, several species in the genus *Pinus,* including *P. palustris,* exhibit a unique adaptation to these fires during seedling development. For the first 3-5 years, the seedling exists in a morphological "grass stage," which insulates and protects the terminal bud of the plant from fires. Root development is favored over height development during the grass stage, and the plant remains around the same height. This root growth is critical for reserving carbohydrates for the following "bolting" phase, during which the seedling has a "growth spurt," and quickly grows to a height that protects the terminal bud from fires (Croker and Boyer 1975; Aubrey 2021). Mature adult longleaf pines have an especially thick outer bark that protects the plant from overheating during a fire (Brockway et al. 2005).

The seedlings of competing hardwood tree species, such as oaks, are usually purged by natural forest fires (Walker and Wiant 1966). Due to the frequency of thunderstorms in the Southeast US, lightning strikes are a common cause of such fires. Prior to extensive European settlement in the Southeastern US, longleaf pine fires likely occurred every two to three years (Huffman 2006; Stambaugh et al. 2011), although some estimates suggest that fires may have been as frequent as twice a year (Rother et al. 2020). The disturbance caused by frequent fires is critical to maintaining habitats with longleaf pines. *Pinus palustris* seedlings are poor competitors against hardwood trees after hardwoods have been established in the overstory. Walker and Wiant (1966) show that the removal of oak trees can significantly improve *P. palustris* seedling growth rates, and suggest that this is due to both competition for sunlight via leaves and competition for water via roots. Silviculture literature on longleaf pines emphasizes the importance of reducing competition in seedling survival (Walker and Wiant 1966; Croker and Boyer 1975; Jose et al. 2007). Not only is *P. palustris* a weak competitor for limited resources, but it also has a relatively low dispersal (Carey 1992). The seeds of the longleaf pines are larger and heavier than any other southern pine species, meaning that they typically do not travel very far from the parent tree (North Carolina Forest Service). Lower dispersal is another factor that makes *P. palustris* especially sensitive to competition. Another notable habitat change associated with burn suppression is the accumulation of ground-level litter, which is typically cleared after a burn. Without periodic fires, grasses and litter accumulate, creating a thick and dense herbaceous layer that is unsuitable for Bachman's sparrows (Tucker et al. 2004, Tucker et al. 2006, Jones et al. 2013).

Methods

Population surveys were conducted on three dates during March and April of 2022. Bachman's sparrows typically nest from mid-April to August, and males actively sing from February to August (Stevenson and Anderson 1994). Because of this, we chose March 22nd, April 5th, and April 26th as our survey days. These dates were chosen to take advantage of territorial aggression, which is characteristic of male Bachman's sparrows during their breeding season. When males feel threatened by competing males, they sing, thereby making them easier to observe. All three days had clear weather conditions and little to no wind. The final date was rescheduled from April 19th to the 26th due to heavy winds forecasted on the 19th. Sparrows are less likely to sing or otherwise be active on windy or rainy days (Rowland 2022, Cox 2022). Surveys were conducted in Jay B. Starkey Wilderness Park, with special authorization from the Southwest Florida Water Management District (SWFWMD), which manages the park. We were issued a Special Use Authorization (SUA) permit by SWFWMD to drive vehicles into the park to travel to and between survey points.

Description of study site

Surveys were conducted in Jay B. Starkey Wilderness Park, in Pasco County, Florida. GPS coordinates of the park are approximately: 28.2523° N, 82.6492° W. This wilderness park is owned and managed by the Southwest Florida Water Management District (SWFWMD). The mesic flatwoods of Starkey Park are treated with a regular prescribed burn rotation every several years. According to SWFWMD, mesic flatwoods are burned "annually to every 7 years" (*Starkey Wilderness Preserve: Draft Land Management Plan,* 2021). We selected zones that were last burned in 2017, 2018, 2020, and 2021 to conduct surveys in. The 2019 burn zones were excluded from this study, as they were inaccessible at the time of surveying. Construction was taking place on Ridge Road, and the 2019 zones were declared "out of bounds." Figure 1 shows images that represent the vegetation structure within each of these zones.

Figure 1: The Four Different Burn Zones

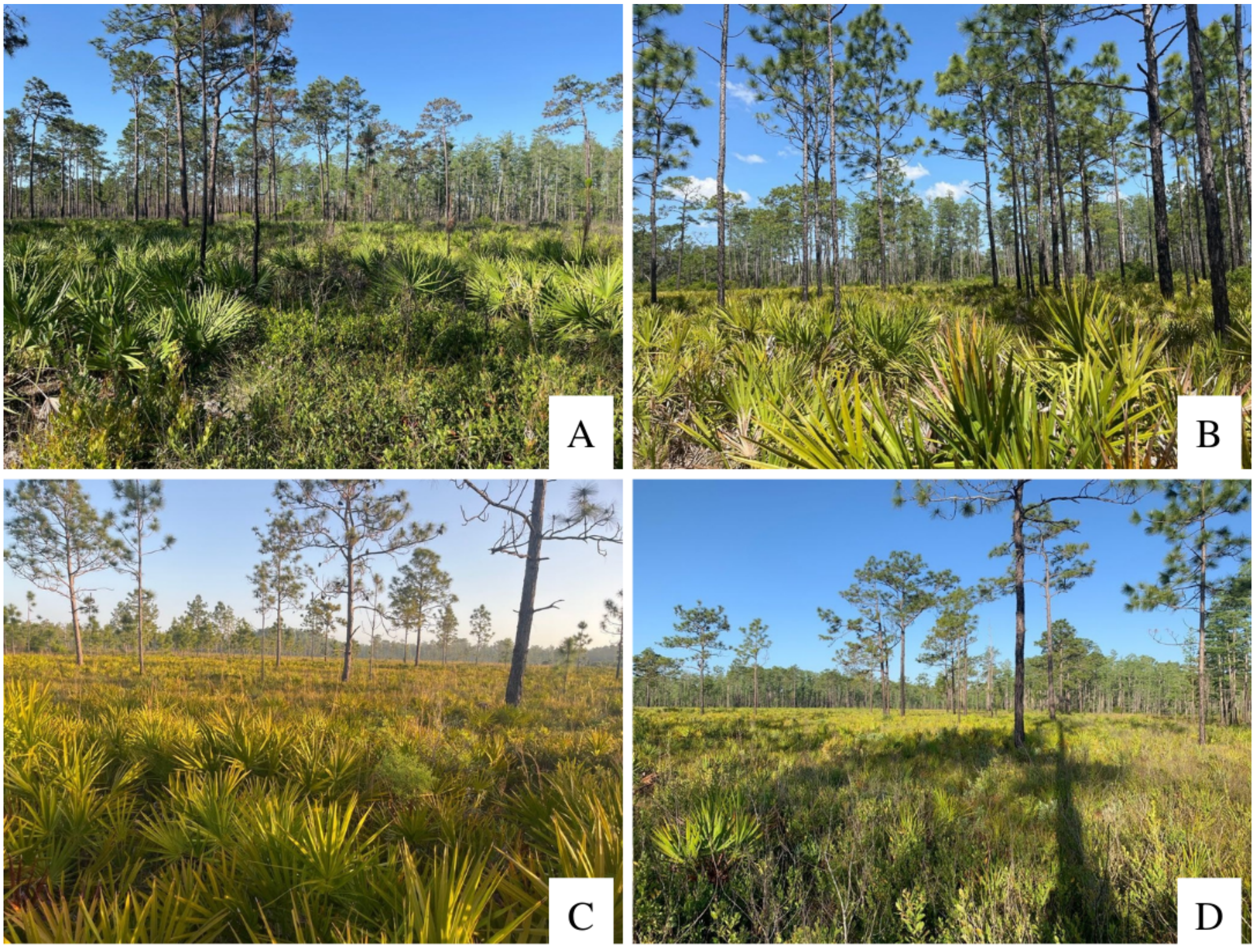

Figure 1: These images are from four points at which we conducted surveys. Picture A was taken at point 83, which was last burned in 2017. Picture B was taken at point 91, in the zone that was last burned in 2018. Picture C was taken at point 59, which is within the zone last burned in 2020. Finally, picture D was taken at point number 70, which was last burned in 2021. Note how the ground-layer vegetation height and density increases with time from the most recent burn. Also note how the longleaf pine trees remain largely unchanged as time progresses. A "burn zone" refers to a section of the park that was burned during a specific year. For example, the 2017 burn zone was last burned in 2017 .

Procedure

Prior to the first survey day, ten points were randomly selected within each of the four burn zones, for a total of forty points throughout the park. A computerized random point generation program was used to remove human bias. The forty points were delegated to two teams of surveyors, a "green" team and an "orange" team. Each team was responsible for surveying twenty points, with five in each burn zone. A map of the forty survey points within their burn zones is shown below in Figure 2. Surveys were conducted in identical ways and at approximately the same points over the three dates. Each team consisted of three people: a navigator, a photographer, and a recorder. The authors were each designated to be the recorder of a team. The navigators and photographers were experienced members of the West Pasco Audubon Chapter who graciously volunteered their time with us. The navigator was responsible for driving to each point; the photographer was responsible for taking pictures, and the recorder was responsible for playing an audio clip and noting observations.

During the first day of the study, both orange and green teams encountered a few proximity errors and accessibility issues due to heavy wind and rainstorms one week prior to the study. When comparing the original GPS point locations with the GPS recorded locations, the differences in point locations are due to those challenges faced.

Figure 2: Map of Original Survey Points

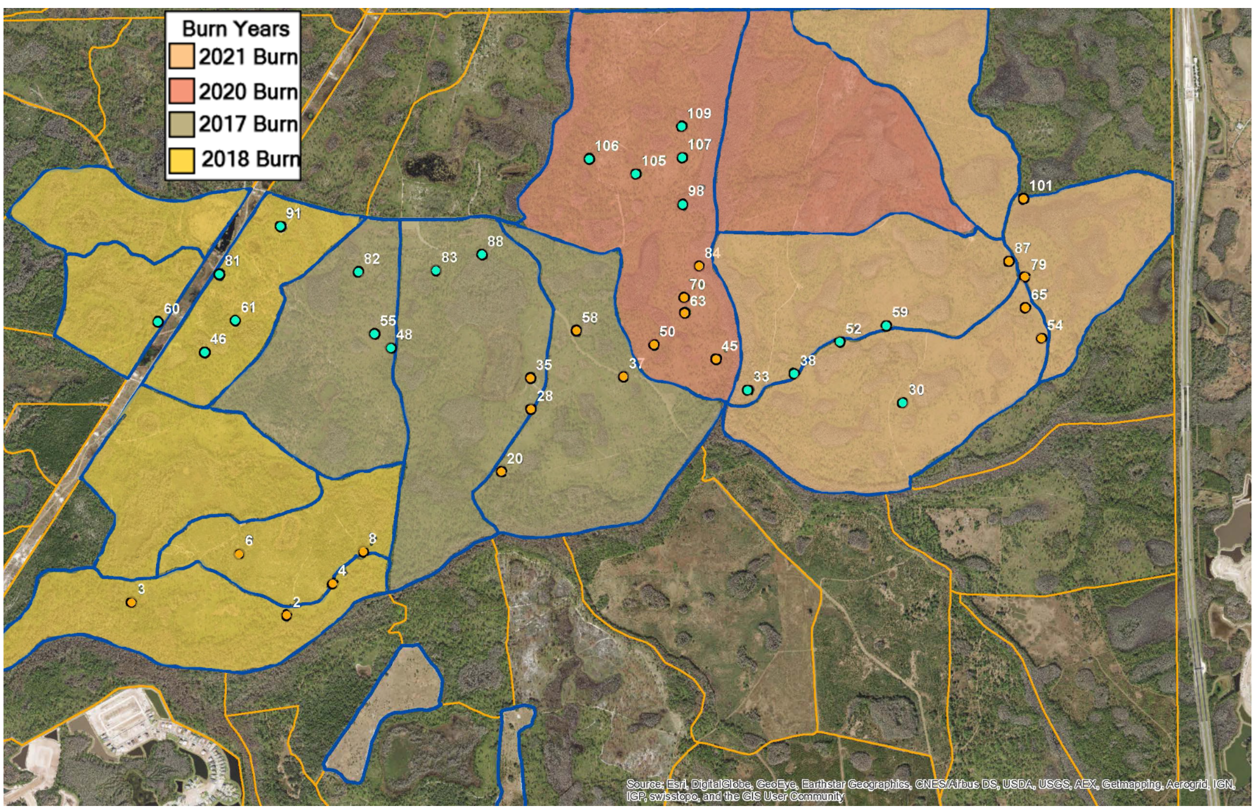

Figure 3. Randomly selected points with burn map overlaid on top. These are the original points, before both teams found accessibility and proximity errors during the first day of study.

Surveys began at approximately 7:30 in the morning each survey day and continued until about 11:00. At each point, all three participants in a team exited the vehicle to observe. The recorder mounted a Bluetooth JBL Clip 3 speaker nearby onto an available tree, shrub, or other vegetation. If no suitable plants were available, the recorder would simply hold the speaker. Next, the recorder would play a three-minute-long audio recording specifically designed by Mr. Jim Cox of the Tall Timbers Research Station for Bachman's sparrow surveillance (Cox 2022). Mr. Cox provided this audio to us for the survey. The recording consists of three repeats of the same segment: 45 seconds of a male Bachman's sparrow call, followed by 15 seconds of silence. The male sparrow's call is intended to stimulate any nearby individuals into a response, and the silent segments allow the birds to respond. The recording was played at the maximum volume allowed by the speaker. As the audio played, all team members acted as birders in order to obtain the most accurate sparrow count possible. Detection of Bachman's sparrows was done via both audio and visual identification. The navigators and photographers of each team were experienced birdwatchers and wildlife photographers. All team members used binoculars to assist in visual identification. Cameras were used by the photographers (and several of the navigators) to capture images of birds when further inspection was needed to confirm identification.

Recorders used the Epicollect 5 application to record and save observations. Data was entered into the app on-site at each point and synced to the cloud after each survey day. Recorders noted the number of Bachman's sparrows observed within the three-minute audio playback. Other important identifying information was entered at each point, including point number, date and time, GPS coordinates, and an optional picture of the surrounding area. Information about the wind conditions was also recorded. If applicable, recorders had the option to note the "breeding code" of observed sparrows, although this was rarely used as we mostly relied on audio identification. Mr. Cox kindly developed this entry application for us using the Epicollect 5 program. An example of a complete data entry can be seen below in Figure 3.

Figure 3: A Sample Data Entry in our Epicollect 5 Program

Entry: fad0c7f8-0da1-46e3-b063-40bea033487d

Question	Answer
Point Number	33
Start Time	08:04:00
Date	03/22/2022
Wind Conditions	Wind motion visible in smoke
Observer Initials	AM
Minute 1 Detections	1
Minute 2 Detections	0
Minute 3 Detections	0
Breeding Code	None observed
GPS Location	28.238193, -82.576491
End Time	08:08:29
Additional Notes	3 Barred Owls observed nearby - predator presence. High density of bird calls
Habitat picture (not required)	

Figure 3: The above image shows our Epicollect 5 entry for data point 33 on our March 22nd survey date. All other entries, like this one, contained data about point number, start and end time, date, wind conditions, and bird detections. Entry 33 also contained optional additional notes and a habitat picture.

Results and Analysis

Table 1: Total Observed Sparrows in each Burn Zone

Year since last burn	Total number of birds observed
2017	18
2018	0
2020	38
2021	33

Table 1 shows the total number of Bachman's sparrows found within each burn zone over the three days of the survey. A "burn zone" refers to a section of the park that was burned during a specific year. For example, the 2017 burn zone was last burned in 2017. The totals shown above take into account the subtotals from each survey day (March 22nd, April 5th, and April 26th), and from each team ("green" and "orange").

Table 2: Total Observed Sparrows at each Point

	Burn zone:	Point total:	Burn zone:	Point total:	Burn zone:	Point total:	Burn zone:	Point total:
	2017		**2018**		**2020**		**2021**	
Point numbers:	20	6	2	0	30	2	45	8
	28	2	3	0	33	2	50	6
	35	0	4	0	38	2	63	7
	37	5	6	0	52	6	70	1
	48	0	8	0	54	6	84	2
	55	1	46	0	59	7	98	2
	58	4	60	0	65	4	105	2
	82	0	61	0	79	5	106	1
	83	0	81	0	87	3	107	4
	88	0	91	0	101	1	109	0
	Zone total:	18		0		38		33

Table 2 displays the total number of sparrows observed at each randomized survey point over the three observation days. The totals shown above take into account the subtotals from each survey date (March 22nd, April 5th, and April 26th). Examining the totals at individual points gives us a more detailed picture into sparrow distribution. The above table allows us to view the sparrow abundance at each individual survey point, rather than solely keeping our scale at an entire zone.

Tables 1 and 2 display the numbers of bachman's sparrows observed over the three survey days. Table 1 shows the total number of sparrows counted in each burn zone, and table 2 shows the total number of sparrows counted at each data point. Table 2 allows us to take a closer look at which specific points have the greatest abundance of sparrows. As we can see, while there were a total of 18 sparrows counted in the 2017 zone, these were distributed among only 5 observation points. Just 3 of these survey points (numbers 20, 37, and 48) made up 83% of all observations in the 2017 burn zone.

Figure 4: Map of Points at Which Sparrows were Detected

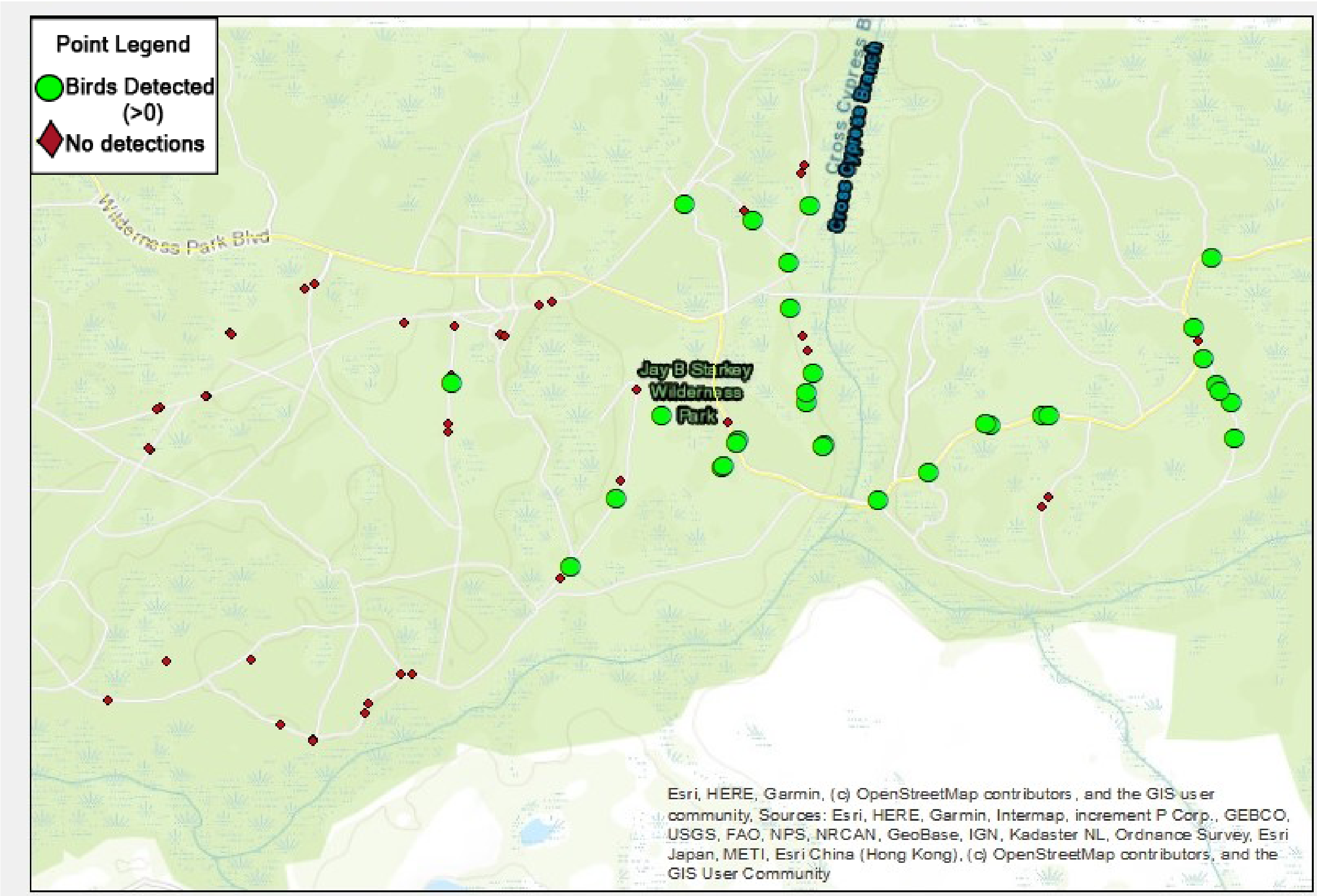

Figure 4. Map of record point data downloaded with Epicollect5 and uploaded into arcMap. Points highlighted in green are collection points where the total sum of birds from all three events are greater than zero (>0). Red diamonds are points where no detections were recorded (Sum 0).

Figure 5: Bachman's Sparrows Presence Overlain with Burn Cell Shading

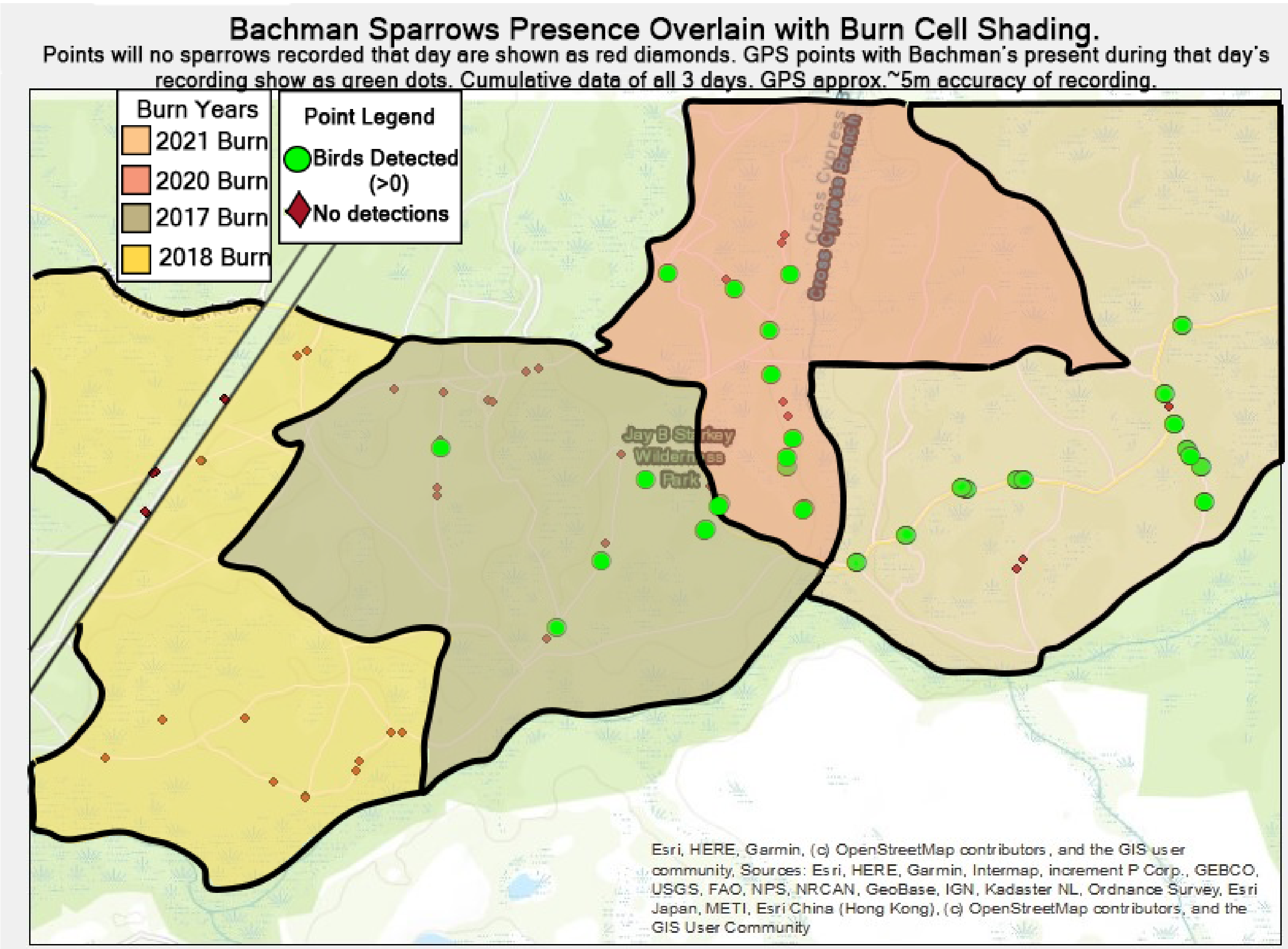

Figure 5. Burn areas color-coded and overlain on top of data point collection to visually show areas of interest and frequency of bird detections in specific areas.

The data uploaded into arcMap after downloading from Epicollect5 is visually represented in Figures 4 and 5, with Figure 5 being overlaid with the burn year zones. All points in arcMap that are ("minute_1"+"minute_2"+"minute_3")>0 are shown with green circles to denote that there was at least one (1) bird detected at that GPS point regardless of minute time detection. The burn zones with the highest number of detections also have the highest number of counted birds, correlating density and frequency in our observations.

Figure 6: Density Map of Sparrow Observations by Burn Zone

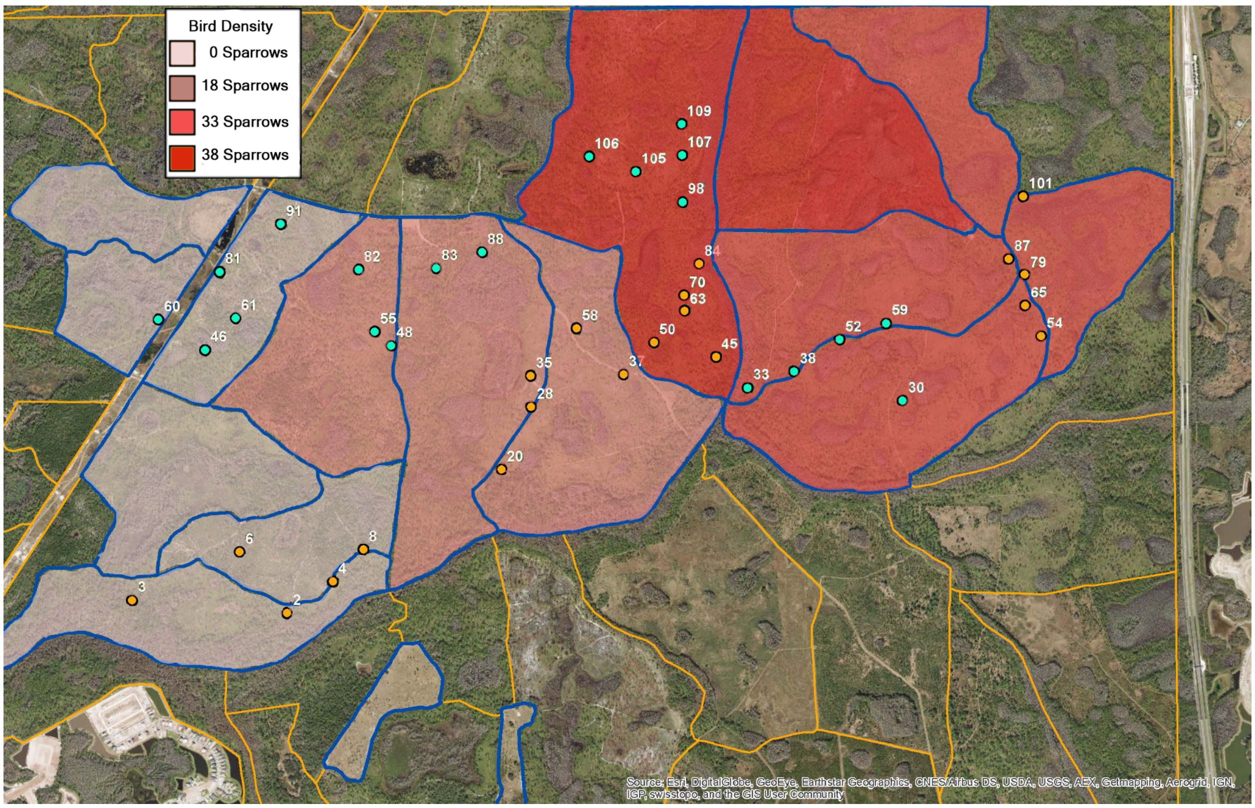

Figure 6. Map depicting the density of bird detection by burn year zone. Burn year 2018 is the farthest from 2020 and 2021, supporting the hypothesis that the birds detected in the 2017 burn year are present due to proximity to burn zones 2020 and 2021 rather than preference.

Discussion

Perhaps most notably, the only area in which we found no Bachman's sparrows was the 2018 burn zone. The majority of observed sparrows occurred in zones that were burned in 2020 and 2021, with the 2020 burn zone having the densest concentration of sparrows. A total of 38 sparrows were seen over the three survey dates in 2020 burn zones, and 33 were seen in 2021 burn zones. 18 were found in the 2017 zone; however, the birds found within 2017 were primarily on the eastern side of the 2017 burn zone, which borders the 2020 and 2021 zones. The birds detected in 2017 may keep the 2020/2021 areas as primary residences and simply be out foraging, or males unable to compete in the more densely populated zones. Figure 6 is a density map of the detections based on burn zone year. Visually, figure 6 shows that there are no birds in the 2018 burn zone (which is farther from the 2020/2021 zones than the 2017 zone is). It also shows that there were 18 birds in the 2017 burn zone (which is closer to the 2020/2021 zones than the 2018 zone is). We suspect that many of the sparrows found in the 2017 zone do not primarily live there. Because we relied primarily on auditory identification, and because so many of the points in the 2017 zone were close to the 2020 zone, we may have mistakenly attributed birds in the 2020 zone to the 2017 zone.

Based on previous literature, we would have expected that Bachman's sparrows would be most abundant in the areas that had been most recently burned (i.e. 2020 and 2021 burn zones). Tucker et al. (2004) suggest that "[the] density of Bachman's sparrows rapidly declined with burning rotations >3 years" (Tucker et al. 2004). Many other studies report a Bachman's preference for habitat treated with a 2-3 year burn rotation, including Tucker et al. 2006, Tucker et al. 2004, Jones et al. 2013, and Korosy 2016. Because of this, we would have expected the most sparrows in the 2021 burn zone and the fewest in the 2017 zone. Indeed, on average, there were more sparrows in the 2020 and 2021 zones (μ=35.5 birds) than in the 2017 and 2018 zones (μ=9 birds), suggesting a preferred 2-3 year rotation of burns.

Potential Errors

The majority of our observations were detected via birdsong. Some difficulty naturally came up not only in the identification of Bachman's sparrows' calls, but also in parsing it from other bird calls in the area - it was not always so clear-cut that a Bachman's was calling back or if another bird was drowning out our target species' calls. Visual identification was easier, as there were few lookalike species present in Starkey Park, aside from Pine Warblers or Grasshopper Sparrows. Human error is always a potential in studies like this, such as the ability to identify all sparrows nearby can be challenged by eyesight, visual obstruction via branches or overgrowth can cause instances of a bird's presence not being recognized and recorded by the researching party. As we had obtained Special Use Authorization Permits, issued by SWFWMD, for vehicular usage within Starkey Park for ease of access to cover such a vast range, another potential error in recording data is that the vehicles noise and presence might have startled some sparrow individuals, creating an artificial absence in detection either visual or auditory. Our study design is primarily based on male sparrow response to our audio recording due to the male's territorial response it would elicit, potentially skewing our results to show less sparrow presence than there actually may be, as female sparrows were not expected to respond. Out of the entire study, only one confirmed female was spotted visually.

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