FLORIDA GRASSHOPPER SPARROW (*AMMODRAMUS SAVANNARUM FLORIDANUS*) CONSPECIFIC ATTRACTION EXPERIMENT

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REPORT TO
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Contents

1.0 Executive Summary

This report provides a summary of our Florida grasshopper sparrow (*Ammodramus savanarum floridanus*) conspecific attraction experiment conducted at Kissimmee Prairie Preserve State Park (KPPSP) in 2015. In collaboration with staff at KPPSP and the U.S. Fish & Wildlife Service (USFWS) we examined the efficacy of using artificial song playback to attract naturally dispersing Florida grasshopper sparrows (hereafter "the sparrow" or FGSP) into suitable but currently unoccupied dry prairie habitat at the preserve. Our main objective was to help reestablish a breeding population at KPPSP in areas formerly occupied by the sparrow. We were also interested in examining the effect of conspecific attraction on influencing the territory establishment of FGPSs, and in testing the use of remote recording devices as a monitoring method to aid in sparrow detection.

This report is divided into three main sections. **Section 2.0** is an introduction to this report, providing an overview of the project. **Section 3.0** reports the results of our FGSP conspecific song playback experiment conducted during the 2015 breeding season KPPSP. **Section 4.0** reports the results of acoustic monitoring surveys conducted in conjunction with our playback experiment. A more detailed overview of each of these sections is provided below. The final section of this report provides literature cited (**Section 5.0**).

Section 2.0

The Florida grasshopper sparrow is a critically-endangered subspecies of grasshopper sparrow endemic to the rapidly diminishing dry prairies of central Florida. Habitat loss and alteration has led to a drastic decline in sparrow numbers, and currently the subspecies is at risk of extinction in the next 3-5 years without management intervention. One of the primary recovery goals for downlisting the FGSP calls for the establishment of 10 protected and managed sites containing stable, self-sustaining populations of at least 50 breeding pairs. Presently, recovery goals fall far short of this with only a single breeding population of this size known to exist on protected land.

Our main objective in 2015 was to aid in the attempt to reestablish a breeding population at KPPSP, a former breeding site with a population that is presently functionally extirpated. Past consideration has been given to management actions such as the translocation of individuals from other breeding populations; however, the current small size of the remaining populations prohibits this action due to the high level of risk to donor populations. Our conspecific attraction experiment offers an alternative method that might aid in the reestablishment of breeding populations in suitable yet unoccupied habitat. At present little is known as to the extent to which FGSPs use information provided by conspecific cues (i.e.., conspecific song) in their habitat selection criteria; however, it should be expected that the subspecies uses these cues to some degree similar to many other *Ammodramus* sparrows. If this is true, we hope that providing artificial cues in the form of song playback might encourage naturally dispersing individuals to settle in suitable unoccupied habitat.

Section 3.0

In 2015, we deployed two artificial song playback units in study plots located in suitable, but unoccupied, dry prairie habitat at KPPSP. Conspecific song was broadcast during the early-season (Mar) to encourage settlement at KPPSP by sparrows that might naturally disperse into the area this breeding season, and during the late-season (Jul) to provide cues for any current year juveniles or failed breeders that might be exploring areas for the next breeding season. The response to our song playback was measured by sparrow detections recorded using two monitoring methods: (1) point count surveys conducted by KPPSP and USFWS, and (2) acoustic monitoring through the use of remote field recording devices.

Unfortunately, no FGPSs were detected at our conspecific attraction experiment study plots in 2015. There were some detections of grasshopper sparrows at, and adjacent to, our study plots in early-spring 2015; however, these detections were likely of the migratory subspecies of grasshopper sparrow present at KPPSP during the winter. There was a confirmed detection of one FGSP in an area directly adjacent to one of our study plots, but this individual did not establish a breeding territory at KPPSP. Due to the limited number of sparrow detections at

KPPSP in 2015 it is difficult to say whether our song playback contributed to the use of our study areas and adjacent habitat by sparrows.

Further research is needed to better understand the effect of conspecific attraction on influencing the settlement decisions of FGSPs, and to conclude whether the use of artificial song playback is a viable management action to aid in the reestablishment of breeding populations. It is still possible that our late-season song playback will be successful; however, follow-up surveys in 2016 will be necessary to form any conclusions. We recommend that in early 2016 (Mar – Apr) ground-based point count surveys be conducted at all survey points established in our conspecific attraction study plots, and that consideration should be given to redeploying remote recorders during the same period to maximize the chance of detecting sparrows.

Section 4.0

As part of our conspecific attraction experiment, we tested the efficacy of using remote recording devices (SM2+ Song Meters; Wildlife Acoustics, Inc.) as a monitoring method to detect singing male FGSPs at our study plots. These recorders have been used successfully to monitor a closely-related *Ammodramus* subspecies in south Florida, the Cape Sable seaside sparrow (*A. maritimus mirabilis*). Four remote recorders were deployed at our study plots for the entire duration of the 2015 FGSP breeding season (Mar – Aug) recording all ambient sounds for four hours each day beginning at 30 minutes prior to sunrise. We then used specialized sound analysis software (Song Scope; Wildlife Acoustics, Inc.) to develop a song recognizer to automatically scan the hours of field recordings to detect any singing male grasshopper sparrows present on our study plots.

We were successful at developing a FGSP song recognizer to scan hours of field recordings saving a substantial amount of data analysis time. All detections made by the recognizer were then validated by visually inspecting sonograms created by the software to determine if they were true positive detections (i.e., actual grasshopper sparrow detections). We only detected singing male grasshopper sparrows on field recordings from one of the recording devices at one of our study plots in 2015, and all of these detections were made prior to 12 Apr. Our song recognizer could not be used to distinguish between FGPSs and other migratory subspecies; this would require further analysis with more specialized sound analysis software. We had planned to collaborate with Dr. Bernie Lohr at the University of Maryland, Baltimore County for these analyses if deemed necessary; however, since all of our detections were made during the early part of the breeding season when migratory subspecies are still present at KPPSP we determined that our field recordings were likely not FGSPs. This conclusion was supported by the absence of any FGSP detections at our study plots during ground-based surveys as well.

We suggest that the SM+ Song Meters developed by Wildlife Acoustics, Inc. are a useful monitoring device for FGSP research, and consideration should be given to using these in conjunction with ground-based surveys to increase detection probability in areas where sparrow numbers are expected to be low. The season-long deployment of such devices could result in some sparrow detections that might otherwise be missed using traditional point count surveys conducted on only several occasions. Data analysis will be relatively fast now that a song recognizer has already been developed, although some time will still be necessary to visually inspect sonograms to validate any detections made by the recognizer.

Acknowledgements

We would like to thank Mary Peterson and Sandra Sneckenberger from the U.S. Fish and Wildlife Service for all of their help and valuable input related to the project. We would also like to thank everyone at Kissimmee Prairie Preserve State Park for all of their help with the project, especially Evan Hall, Missy Clauson, and Shayna Jacques. A special thanks to Paul Miller for sharing his knowledge about Florida grasshopper sparrows at Kissimmee Prairie and for helping to get the project up and running. We thank Bernie Lohr at the University of Maryland, Baltimore County for sharing sparrow recordings and providing valuable input into the project. Thanks to Michelle Davis for assisting with the project. Thanks to everyone involved with the Florida Grasshopper Sparrow Working Group for sharing so much information about recovery efforts for the sparrow. Finally, we thank the Fish & Wildlife Foundation of Florida for funding the project.

2.0 Introduction

2.1 Purpose

The Florida grasshopper sparrow (*Ammodramus savannarum floridanus*) is a critically-endangered subspecies of grasshopper sparrow endemic to the rapidly diminishing dry prairies of central Florida. The Florida Grasshopper sparrow (hereafter “the sparrow” or FGSP) was listed by the U.S. Fish and Wildlife Service (USFWS) as endangered in 1986 due to its limited distribution and restricted geographical range. Until relatively recently, the subspecies population estimate was approximately 1,000 individuals spread out across six somewhat isolated subpopulations (Pranty and Tucker 2006). Presently, the total population is estimated to be below 150 individuals, and the subspecies is predicted to go extinct in the next 3-5 years (USFWS 2014). Over the past century, a large proportion of the sparrow’s dry prairie habitat has been converted to orange groves and cattle pastures resulting in a fragmented landscape with few remaining large patches of highly-suitable habitat. Due to the fragmentation of its habitat one of the issues facing the FGSP is a lack of connectivity between habitat patches which may limit dispersal among subpopulations and has contributed towards the current high risk of extinction of the subspecies (Perkins et al. 2008).

In recent years there has been substantial research conducted on the FGSP including studies of habitat availability, demographic rates, and overall population viability (Perkins and Vickery 2001; Pranty and Tucker 2006; Delany et al. 2007); however, the subspecies continues its drastic decline. Presently, the FGSP is thought to remain in a single large subpopulation (> 50 pairs) located at Twin Lakes Wildlife Management Area (TLWMA) with few other small aggregations possibly remaining on private land. Recently, the sparrow was distributed among three distinct subpopulations with large subpopulations located at TLWMA and Kissimmee Prairie Preserve State Park (KPPSP), and a small subpopulation located at Avon Park Air Force Base (APAFB). However, the APAFB has been functionally extirpated since 2009, and as of 2014 the KPPSP subpopulation may also be extirpated (USFWS 2014). Sparrows were detected at KPPSP in 2014; however, it is thought that these detections may have been of migratory grasshopper sparrows (*A. s. pratensis*) which are known to winter at this site.

The recovery goal for downlisting the FGSP calls for the establishment of 10 protected and managed sites containing stable, self-sustaining populations of at least 50 breeding pairs (USFWS 1999). With only one such site remaining, TLWMA, there is an urgent need to re-establish populations in areas where the subspecies formerly occurred. It has been suggested that due to habitat fragmentation, large distances between suitable habitat, and limited dispersal in the FGSP it may be necessary to translocate individuals from existing subpopulations to new areas to achieve this conservation goal (Pranty and Tucker 2006; Delany et al. 2007; USFWS 2008). However, at present there are likely too few sparrows remaining in the last wild population to safely attempt translocation. The research summarized in this report offers an alternative option besides translocation that may be more feasible at this time to help establish additional FGSP subpopulations.

A recent population viability analysis supports the recovery plan goal of increasing the number of FGSP subpopulations to sustain the persistence of the subspecies, showing that an increased number of functioning subpopulations is a major contributing factor towards lowering extinction probability (Perkins et al. 2008). Formerly, when there were still three remaining subpopulations of FGSP, it was shown that the overall population was functioning as a metapopulation (Tucker et al. 2010). Although these former subpopulations are separated by distances of 15 – 30 km, there is strong evidence that FGPSs did disperse between all three subpopulations (Delany et al. 2000; Miller 2005; Mylecraine et al. 2008; Tucker et al. 2010). The FGSP is generally a resident subspecies with most evidence of dispersal and movements reported by mark-recapture studies pointing towards short-distances of less than 3 km. However, long-distance dispersal has been reported in these studies: one individual originally banded in APAFB dispersed to KPPSP travelling approximately 18.5 km, and a second individual dispersed from KPPSP to TLWMA travelling approximately 30 km. Genetic analysis of FGSPs from the former remaining subpopulations shows that approximately 8% of individuals in the subpopulations were migrants, supporting the idea that the overall FGSP did function as a metapopulation with at least limited dispersal among subpopulations (Mylecraine et al. 2008).

Although there has been limited research conducted on dispersal distances in the FGSP, it should be expected that long-distance dispersal events like those described in the previous paragraph are quite rare. However, based on metapopulation theory these rare events are important drivers of subpopulation persistence, often with only one dispersal event per generation required to sustain genetic diversity in small, satellite subpopulations (Wang 2004). FGSP genetic research suggests that more dispersal (1 – 10 events) is required to sustain the genetic diversity required to reduce the risk of inbreeding depression in small subpopulations, and that this was indeed the case when there were still three functioning subpopulations (Mylecraine et al. 2008). With a single large and functioning subpopulation of FGSP remaining this may no longer be the case. While translocation of individuals to unoccupied suitable habitat may have been a viable management option previously, more current research suggests that the risks to the removal population likely outweigh the potential benefits to the metapopulation as a whole (Perkins et al. 2008; Tucker et al. 2010).

Our research offers another possible solution to the problem of creating new FGSP subpopulations in other areas with seemingly suitable yet unoccupied habitat. Natural long-distance dispersal in the subspecies may still occur despite the current small population size as fledglings from the TLWMA population depart from their natal sites in search of breeding habitat. The minimum distance between TLWMA and each of the other former FGSP subpopulations (APAFB and KPPSP) is approximately 17 km, well below the reported maximum dispersal distance for the subspecies. In 2015, we tested the feasibility of using song playback to provide artificial conspecific cues to encourage the settlement of any FGSPs that naturally disperse over long distances into currently available unoccupied sparrow habitat at KPPSP (**Figure 2.1**). We expect that FGSPs use conspecific cues as one source of information in their habitat selection criteria, similar to many other species of grassland birds (Ahlering et al. 2006; Nocera et al. 2006, 2009). Many migratory avian species use conspecific cues along with other habitat selection criteria as a way to evaluate potential breeding habitat (Ahlering and Faaborg 2006; Ward and Schlossberg 2004; Hahn and Silverman 2006, 2007). Further, one other closely-related resident species in south Florida, the Cape Sable seaside sparrow (*A. maritimus mirabilis*) is known to use conspecific cues as part of its habitat selection criteria (Virzi et al.

2012). Without proper conspecific cues, which tends to occur in small populations, dispersing individuals of threatened species may not choose to settle in otherwise seemingly suitable breeding habitat (Ahlering et al. 2006).

We recognize that with such a small remaining population of FGSPs our chances of witnessing a long-distance dispersal event into any of the former subpopulations including KPPSP is small; however, our attempt to encourage the settlement of dispersing individuals to naturally create new subpopulations is far less risky than translocating individuals from the last remaining large, functioning subpopulation. One risk that we do take by encouraging settlement of FGSPs into unoccupied areas via conspecific attraction is that we could assess habitat conditions in the attraction areas incorrectly and thus could be encouraging sparrows to settle in unsuitable habitat. However, we offer three assessments of this risk. First, we expect that sparrows will not rely solely on our artificial conspecific cues in their habitat selection criteria. Instead, we expect that sparrows will initially make their own assessment of habitat quality based on other criteria (e.g., vegetation characteristics) and that our artificial conspecific cues will only provide additional encouragement to settle in areas that may otherwise appear unsuitable solely because of the lack of conspecific cues. Second, we deployed our song playback units in areas that recently held sparrows and coordinated with KPPSP and USFWS to ensure placement in areas with suitable breeding habitat based on current habitat assessments (**Figure 2.2**). Finally, we consider the risks associated with this experiment to be much lower than the risk of inaction and thus the continuation of the present risk of having only a single functioning subpopulation of FGSP remaining in the wild.

The results of our conspecific attraction experiment are presented in the following two sections of this report. **Section 3.0** presents the song playback experimental design and results. As part of this experiment, we tested the efficacy of using remote field recording devices to detect singing male Florida grasshopper sparrows on our study plots. **Section 4.0** presents the results of this component of our conspecific attraction experiment separately.

2.2 Figures

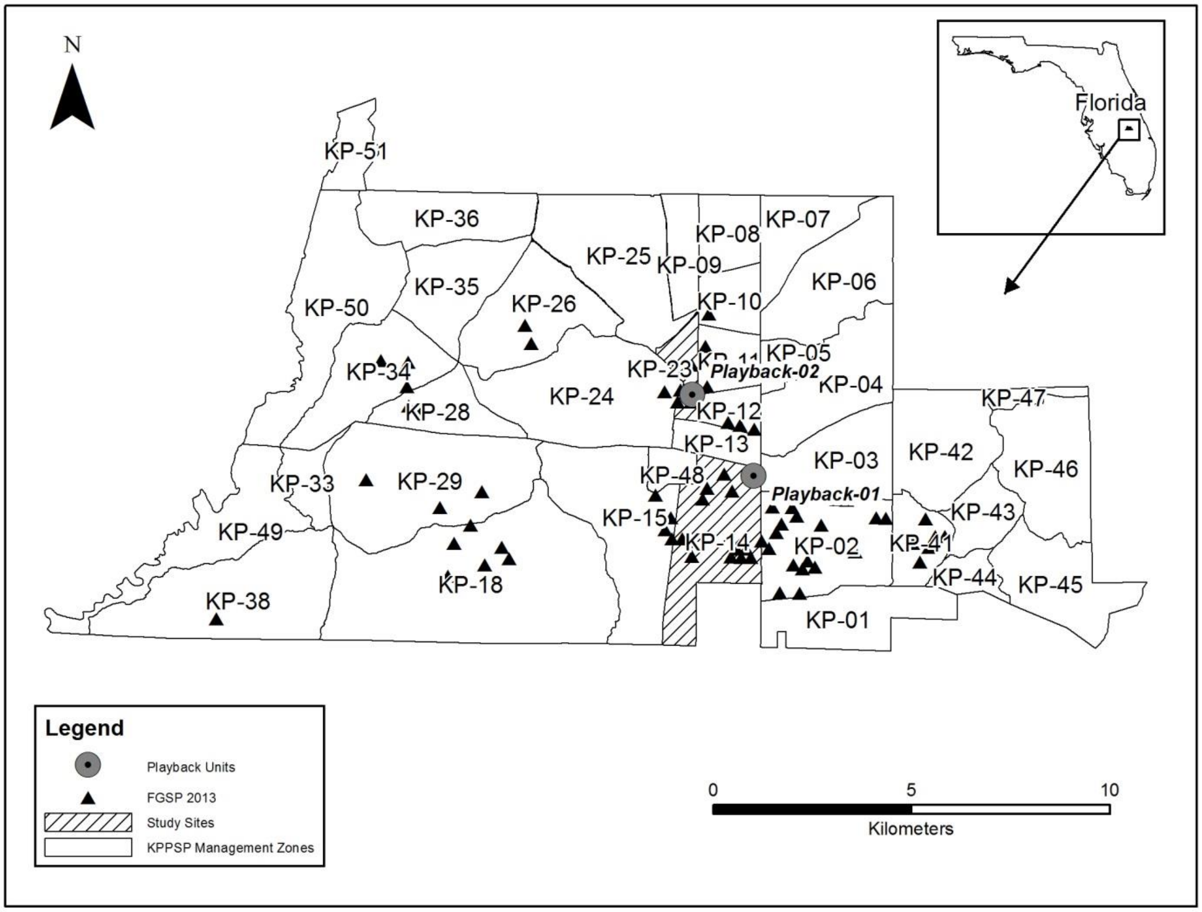


Figure 2.1: Map of study area in Kissimmee Prairie Preserve State Park (KPPSP) in central Florida. KPPSP is divided into prairie management units; study sites for our playback experiment indicated by hatched lines (KP-14 and KP-23). Grey circles represent exact locations of playback units within our study plots. Black triangles represent locations of Florida grasshopper sparrow detections in 2013 – the most recent confirmed detections at KPPSP.

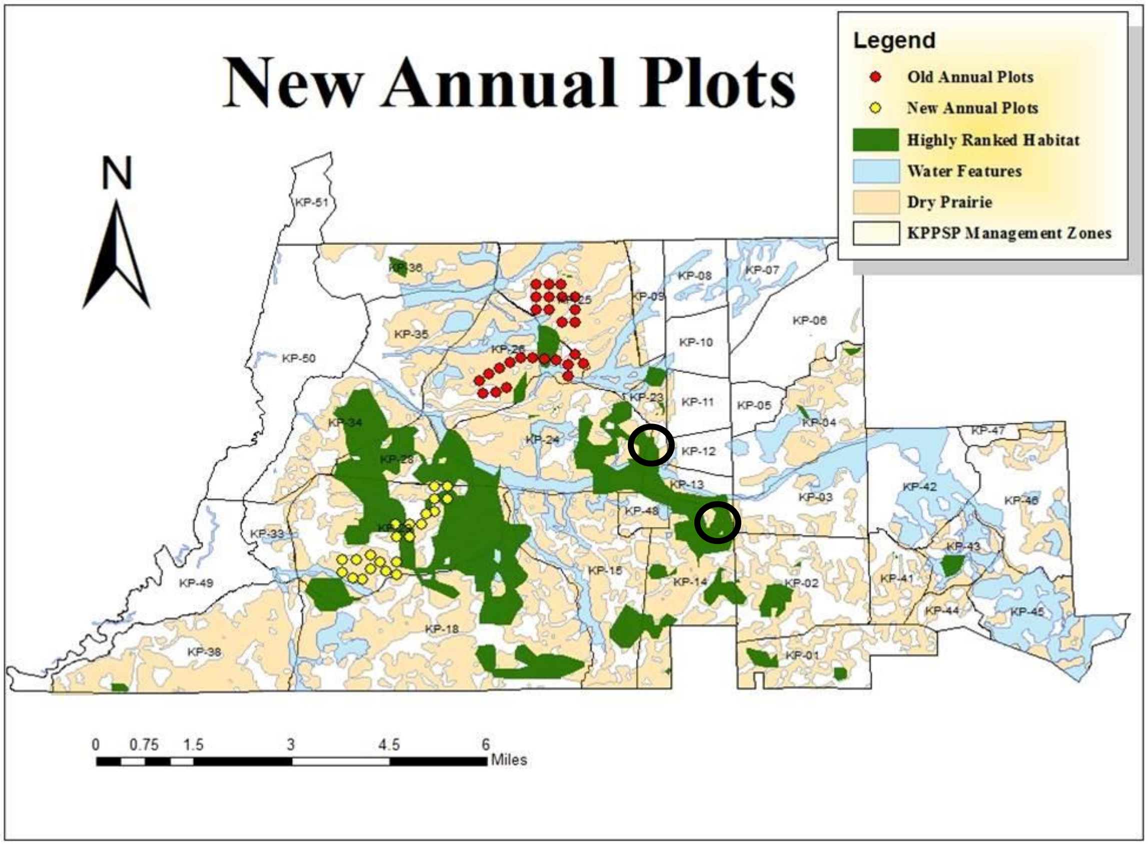


Figure 2.2: Map of current habitat quality assessment at Kissimmee Prairie Pr eserve State Park (provided by KPPSP 2015). In 2015, KPPSP staff collected habitat data at points located in all prairie management units and used these data to spatially interpolate and assess habitat quality across the landscape. Green shading represents high-quality dry prairie habitat available in 2015. Black circles represent conspecific attraction experiment study plots (added to map).

3.0 Playback Experiment

3.1 Background

As discussed in **Section 2.0**, during the 2015 sparrow breeding season we tested the feasibility of using song playback to provide artificial conspecific cues to encourage the settlement of naturally dispersing FGSPs into available unoccupied dry prairie habitat at KPPSP. Our main objective was to help reestablish a breeding population at KPPSP, which is currently functionally extirpated (USFWS 2014). While the extent to which FGSPs use conspecific cues as a source of information in their habitat selection criteria is currently unknown, it is likely that the subspecies uses these cues similar to many other grassland birds. Further, due to the small population size anticipated at KPPSP there is likely a limitation of conspecific cues available for use by dispersing individuals to help assess habitat quality.

We coordinated with KPPSP and USFWS to select our study sites, making sure that we chose sites with suitable breeding habitat that is currently being managed for FGSPs (see **Figures 2.1 and 2.2**). We selected sites in KPPSP prairie management units KP-14 and KP-23 (including parts of KP-24) for our playback experiment. KPPSP managers are actively managing habitat for the sparrow in these areas, largely through the use of prescribed fire to maintain high-quality dry prairie habitat. Our study site located in KP-14 was burned in Mar 2015 just prior to the current FGSP breeding season; the site was burned early enough in the growing season to allow for adequate recovery of prairie habitat for sparrow breeding in 2015. Our second study site located in KP-23 was burned in Mar 2014, and thus had a denser vegetation structure than the previous study site. Still, the habitat quality at this site was also assessed to be appropriate for breeding in 2015.

3.2 Methods

3.2.1 Song Playback

Our study design followed Virzi et al. (2012); in fact utilizing the same song playback units used to study the effects of conspecific attraction on the settlement decisions of Cape Sable seaside sparrows in marl prairies in the Florida Everglades (**Figure 3.1**). For a detailed description of the playback unit design see Virzi et al. (2012). Song playback units were deployed in two study plots with apparently suitable yet currently unoccupied FGSP habitat located in KPPSP prairie management units KP-14 and KP-23 (**Figure 3.2**). The playback units were used to broadcast song over large areas of prairie habitat, with each unit expected to be audible at distances of up to approximately 500 m from the speakers. Each unit has two speakers facing in opposite directions to maximize sound coverage across the study plot. The playback units were set to broadcast FGSP song at two different times during the sparrow breeding season: (1) during the early part of the FGSP breeding season (Mar – Apr) when sparrows may be exploring areas to breed during the current year, and (2) later in the breeding season (Jul – Aug) when current year fledgelings or failed breeders may be exploring areas for breeding in the following year. We deployed the playback units during these two periods because it is presently unknown when FGSPs make their habitat selection choices and these choices may be made at either time by birds (Doligez et al. 2002; Danchin et al. 2004).

Both playback units were deployed on 02 Mar for the early-season playback since male sparrows typically begin to establish territories at this time (P. Miller, personal observation). The units were turned off on 09 Apr at the time when we anticipated potential nesting by sparrows at KPPSP to reduce the risk of the song playback interfering with breeding activity. This date also coincides with the start of annual point count surveys at KPPSP and we did not want our song playback to affect survey results. The playback units were redeployed on 06 Jul for the late-season playback period, which lasted until 03 Aug. Timers were set to turn on the units and broadcast sparrow song beginning 30 minutes before sunrise for a period of four hours, which is the expected time of peak singing by sparrows. The start time was adjusted earlier as the breeding season progressed to account for the change in sunrise. We used a medley of sparrow “buzz” songs recorded from several FGPSs provided by Dr. Bernie Lohr at the University of Maryland, Baltimore County as our song broadcast from the playback units. We chose to use only “buzz” songs (vs. “warble” songs) because these are thought to be the most important songs used by FGSPs to signal territorial boundaries (Lohr et al. 2013).

In order to properly evaluate the effect of artificial song playback on influencing the settlement decisions of breeding birds it is important to quantify the extent to which the song may be heard across the study area (Virzi et al. 2012). Following Virzi et al. 2012, we used sound data collected in the field to seed a sound model that spatially depicts sound amplitude and quality across our study plots. One observer (T. Virzi) walked line transects away from one of the playback units (Playback-01) stopping every 50 m to record the level of sound being broadcast by the speakers using a handheld dB meter, and to record qualitative observations regarding sound quality. Data was collected at only one of our playback units because all settings/levels for the second unit were identical to the first, and habitat characteristics at the study plots were very similar. The sound level was placed in one of four categories: (1) song heard faintly – sounds natural, (2) song heard well – sounds natural, (3) song loud – sounds unnatural, and (4) song very loud – sound quality degraded by distortion. These data were entered into a geographic information system (ESRI® ArcMap version 10.2) and used to spatially interpolate a sound field where artificial song could be heard around the playback unit using the kriging function in ArcMap. The sound field was mapped using two methods: (1) based on dB level measurements (quantitative map), and (2) based on the sound categories indicated above providing a map of sound quality (qualitative map). We expected that if artificial song is used by FGSPs to decide where to place their breeding territories, sparrows would be more likely to place their territories within the mapped sound field.

3.2.2 Sparrow Detection

We used two methods to detect the presence of FGSPs in the areas where song playback was broadcast: (1) traditional point-count surveys, and (2) acoustic monitoring with remote recording devices. First, we relied on data collected by KPPSP and USFWS from on the ground surveys conducted at point count stations located within our study plots as one method to detect the presence of male FGSPs near our playback units. We do not provide details regarding the survey methods implemented by KPPSP-USFWS here; rather, we rely on the well-established survey methods being used for annual FGSP surveys being conducted by our collaborators. We did recommend that additional survey points be added to ensure adequate coverage of our study plots (**Figure 3.2**). Further, annual surveys are typically conducted over three replicate surveys (Apr – May); however, we recommended that three additional replicates be conducted to cover the entire duration of our playback study (Mar – Aug).

For our second survey method we used remote field recording devices to detect the presence of singing male sparrows that may not have been detected during ground surveys. We deployed four SM2+ Song Meters (Wildlife Acoustics, Inc.; see **Section 4.0**) to record all ambient environmental sounds that occur in the areas where we deployed our playback units. The efficacy and accuracy of these remote recording devices have previously been tested in a separate field experiment to detect singing male Cape Sable seaside sparrows in marl prairies (Virzi and Davis 2012). The units were found to be successful at detecting singing males at distances of up to approximately 500 m. Thus, with proper placement of the remote recorders we expected to cover a substantial proportion of the area where our artificial song playback could be heard by FGSPs. See **Section 4.0** for further details regarding this component of our conspecific attraction experiment.

3.3 Results and Discussion

3.3.1 Song Playback

Our playback units broadcast FGSP song across our study plots from 02 Mar – 09 Apr during the early-season playback period, and from 06 Jul – 03 Aug during the late-season playback period. Our sound mapping shows the extent of song coverage across our study plots, and thus quantifies the areas where we expected settlement by any breeding FGSPs that arrived at KPPSP during 2015 (**Figure 3.3**). The quantitative sound map created shows a smaller area of sound coverage than the qualitative sound map, likely due to inaccuracy in the dB meter used for measurements and interference with background noise during data collection. Thus, in our opinion the qualitative sound map is a better representation of the total song coverage area across our study plots. The sound field generated by our playback units, therefore, appeared to adequately cover our study plots. Unfortunately, no FGPSs were detected on our conspecific attraction study plots during 2015 (see **Section 3.3.2**).

3.3.2 Sparrow Detections

Six replicates of point count surveys were conducted by our collaborators at KPPSP and USFWS at our conspecific attraction study plots between 08 Apr and 06 Aug 2015 (see **Table 3.1** for a tabular summary of results). At Playback-01 located in prairie management unit KP-14 there were no grasshopper sparrow detections within our study plot during 2015. However, there were two grasshopper sparrow detections at annual survey points located just west of our study plot on the first replicate survey conducted on 08 Apr. These birds were not detected on any later replicate surveys; thus, these observations were likely of the migratory subspecies of grasshopper sparrow present at KPPSP during the winter. As an anecdotal observation, we did observe grasshopper sparrows responding to our song playback on the day that we deployed Playback-01 in this study plot on 02 Mar; however, these were the only such observations in this area made during 2015.

At Playback-02 located in prairie management unit KP-23 there were grasshopper sparrow detections made within our study plot on the first and second replicate surveys conducted on 09 Apr and 07 May, respectively. Three grasshopper sparrows were detected at two survey points (AP-14 and AP-18) located within our study plot on 09 Apr, and an additional two sparrows were detected at points just west of our study plot on this replicate as well. One additional grasshopper sparrow was detected again at point AP-18 located within our study plot on 07 May. There were no further detections on any later replicate surveys. Due to the timing of these early detections, and the lack of any further detections, it is also likely that these individuals were of the migratory subspecies of grasshopper sparrow present at KPPSP during the winter. Thus, it appears likely that no FGSPs were detected on this study plot during 2015.

Worth noting, however, is that it was confirmed that one of the grasshopper sparrows detected just west of our study plot in prairie management unit KP-24 was a FGSP. This individual was subsequently banded, but did not establish a breeding territory and was not observed again at KPPSP. There were a total of four confirmed FGSP detections at KPPSP during 2015, however, none of these individuals were found on our conspecific attraction experiment study plots. Our acoustic monitoring results (see **Section 4.0**) support the conclusion that there were likely no FGSPs found on our conspecific attraction study plots during 2015.

3.3.3 Conclusions

The lack of FGSP detections at our conspecific attraction study plots might indicate that our experiment was unsuccessful at this time. However, it is possible that sparrows will respond to our late-season song playback and settle in these areas in 2016. Many other avian species have shown such a response, and at this time our knowledge of the effects of conspecific attraction on influencing the settlement decisions of FGSPs remains limited. Failed breeders or current year juveniles might explore areas late in the current breeding season searching for information (e.g., in the form of conspecific cues) to aid them in making settlement decisions for the following year. Thus, before we make any final conclusions regarding the success of our playback experiment we suggest that follow-up surveys be conducted early in the 2016 FGSP breeding season to look for a potential lagged response.

Detecting a measurable response to this experiment is challenging due to the limited number of dispersing individuals that could be expected to arrive at KPPSP as a result of the extremely small FGSP population size range-wide. We understood this challenge upon initiation of our conspecific attraction experiment, but our hope was to assist in any way possible to help reestablish a breeding population at KPPSP using this non-evasive technique. Despite the lack of a measurable response so far, we still feel that this area of research holds great potential for aiding in the reestablishment of breeding populations in suitable prairie habitat in formerly occupied areas. Risks are relatively low, and the cost minimal, but the potential rewards are substantial if new populations can be established. Further, the use of artificial song playback to provide conspecific cues to released individuals may be an important factor to consider in future attempts to reestablish breeding populations through captive breeding programs.

3.4 Tables and Figures

Table 3.1: Tabular summary of Kissimmee Prairie Preserve State Park (KPPSP) survey results for point count surveys conducted in the conspecific attraction experiment study plots during 2015. Six replicates of point count surveys were conducted at Playback-01 and Playback-02 (shaded grey) study plots between 08 Apr and 06 Aug 2015. All surveys with any grasshopper sparrow detections are indicated in bold red print. Some presence-absence (PA) survey points were added later in the field season to increase coverage of study plots.

Survey	Unit	Comments
1	1	KPPSP points surveyed 4/8; no detections in study area
1	1	New PA points not established yet (added 2nd replicate)
1	**1**	**2 detections just outside playback/recording area**
2	1	KPPSP points surveyed 5/2; no detections
2	1	Added 5 new PA points on 5/2; no detections
3	1	All points surveyed on 5/29; no detections
4	1	All points surveyed on 6/14; no detections
5	1	All points surveyed on 7/18; no detections
5	1	Missed one point (AP-11) in error
6	1	All points surveyed on 8/6; no detections
1	**2**	**KPPSP points surveyed 4/9; detections at 2 points (3 birds)**
1	2	New PA points not established yet (added 3rd replicate)
1	**2**	**2 additional detections just outside playback/recording area**
2	**2**	**KPPSP points surveyed 5/7; detection at 1 point (1 bird)**
2	2	New PA points not established yet (added 3rd replicate)
3	2	KPPSP points surveyed 5/19; no detections
3	2	Added 3 new PA points on 5/29; no detections
4	2	KPPSP surveyed on 6/12; new PA points on 6/23; no detections
5	2	All points surveyed on 7/16; no detections
6	2	All points surveyed on 8/6; no detections

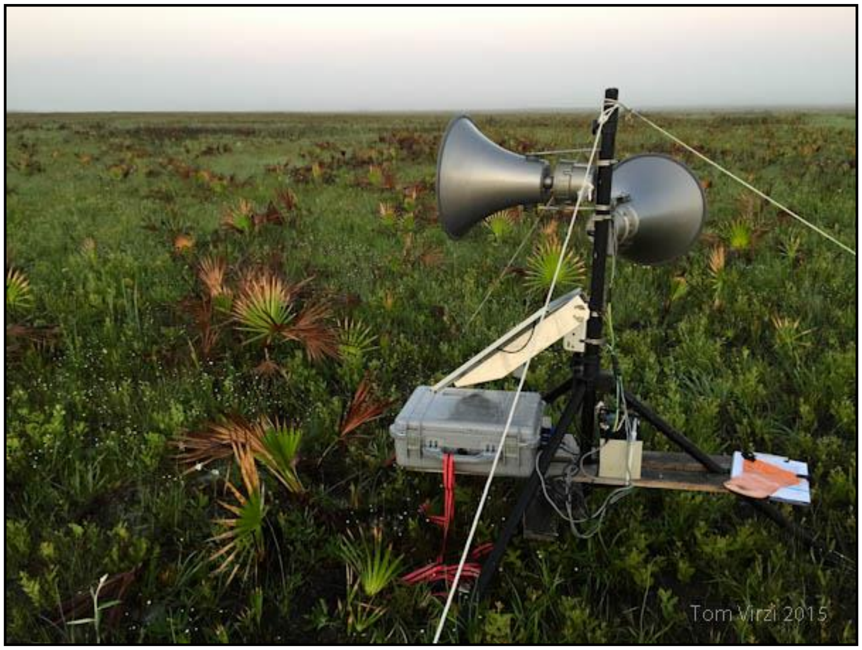
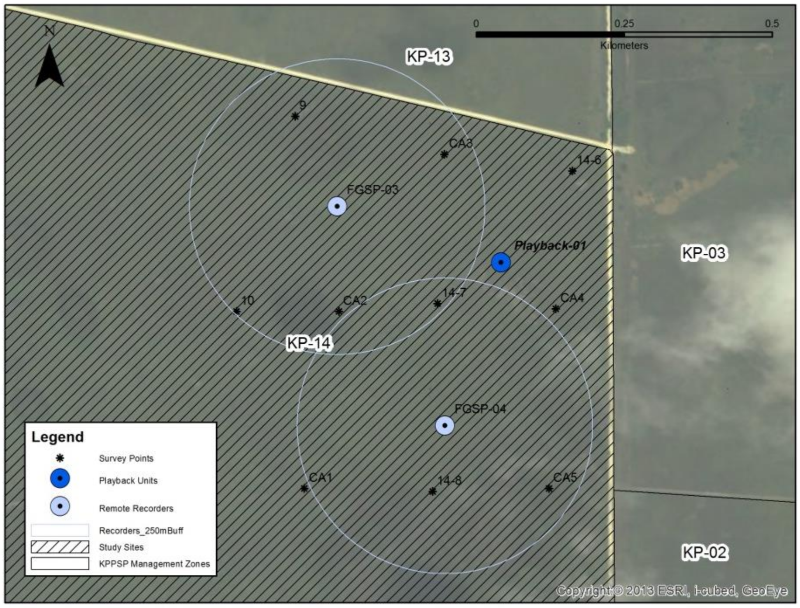
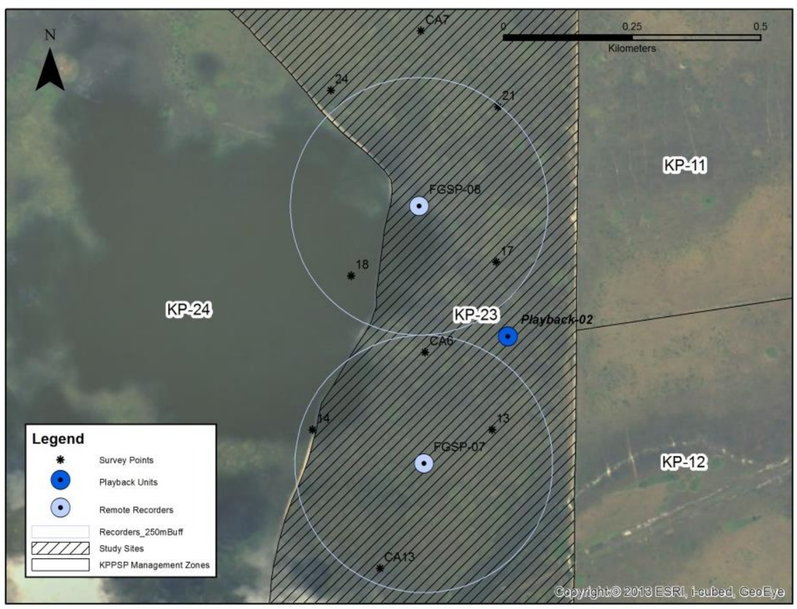


Figure 3.1: Song playback unit originally developed for use in a conspecific attraction experiment of the Cape Sable seaside sparrow (Virzi et al. 2012) in marl prairies in the Florida Everglades. Photo here is of one of two playback units deployed in dry prairie habitat at Kissimmee Prairie Preserve State Park in areas with apparently suitable yet currently unoccupied breeding habitat for the Florida grasshopper sparrow.



(a)



(b)

Figure 3.2: Study plots for conspecific attraction experiment conducted at Kissimmee Prairie Preserve State Park (KPPSP) in 2015. Hatched areas are KPPSP management units where playback units were deployed: (a) KP-14 and (b) KP-23. Note that Playback-02 was placed in Unit KP-23, but playback was expected to be audible in the eastern portion of Unit KP-24 as well. Numbered black stars are KPPSP survey sites, including (1) annual surveys, (2) presence-absence surveys, and (3) additional surveys added to accommodate this experiment.

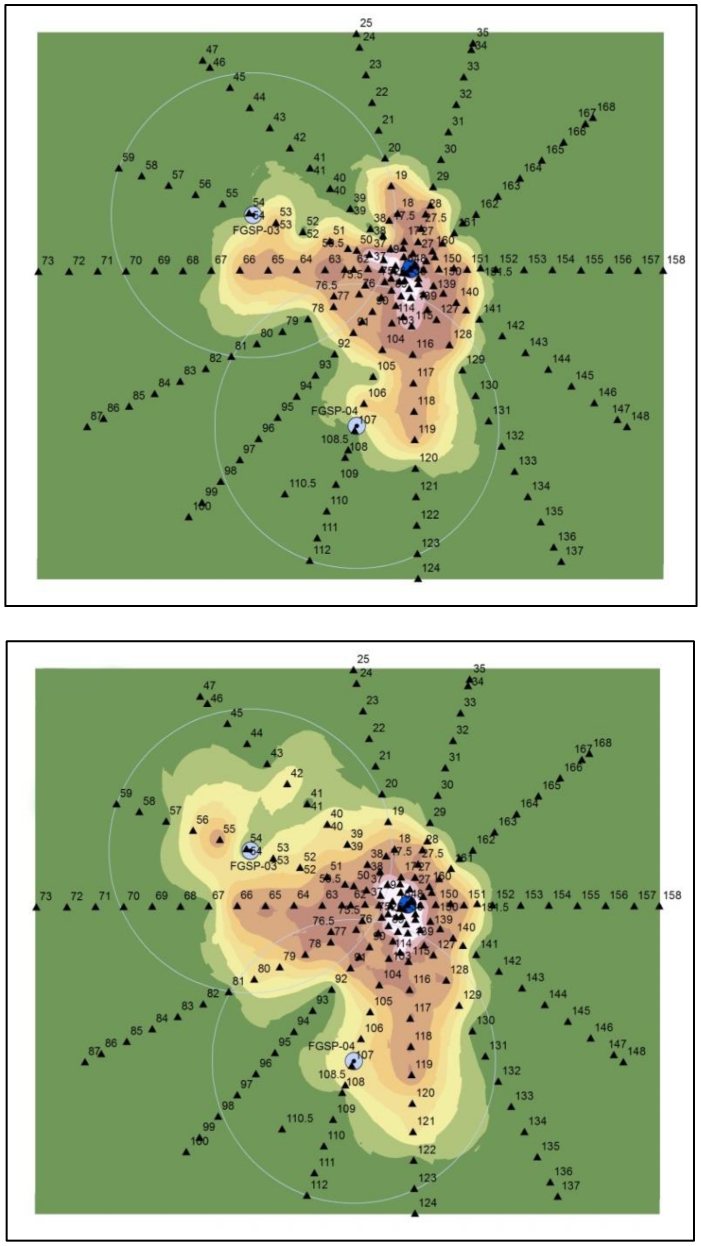


Figure 3.3: Results of sound field analysis conducted at the Playback-01 study site in prairie management unit KP-14 based on: (a) quantitative dB level measurements and (b) qualitative sound measurements. Dark blue circles are location of playback unit, light blue circles are location of remote field recorders, light blue lines surrounding recorders are 250 m buffer lines representing expected recording range, and black numbered triangles are locations of sound measurements. Color code for sound field: dark green = no sound heard; light green, yellow and orange = best sound quality; white = poor sound quality (loud-distorted).

4.0 Acoustic Monitoring

4.1 Background

As part of our conspecific attraction experiment, we used remote field recording devices to detect the presence of singing male sparrows that may not have been detected during ground surveys. The reason that we incorporated this second monitoring method was because we anticipated sparrow numbers to be very low at KPPSP and we wanted to maximize our chance of detecting any sparrows that arrived at our study sites. The remote recorders would capture all ambient sounds on a daily basis throughout the entire FGSP breeding season, and thus provide us with far more data than point count surveys being conducted over only six replicates. One of the challenges of collecting so much recording data, however, is the data analysis time required to scan all of these recordings to detect singing male sparrows. We addressed this challenge by developing a song recognizer to automatically scan these recordings more efficiently (see **Section 4.2.2**).

4.2 Methods

4.2.1 Remote Recorders

We deployed four remote field recording devices (SM2+ Song Meters; Wildlife Acoustics, Inc.; **Figure 4.1**) to record all ambient environmental sounds that occur in the areas where we deployed our playback units. The efficacy and accuracy of these remote recording devices have previously been tested in a separate field experiment to detect singing male Cape Sable seaside sparrows (CSSS) in marl prairies (Virzi and Davis 2012). The units were found to be successful at detecting singing males at distances of up to approximately 500 m. Thus, with proper placement of the remote recorders we expected to cover a substantial proportion of the area where our artificial song playback could be heard by FGSPs (see **Figures 3.2 and 3.3**).

We placed our recorders 300 m from the playback units and 400-500 m apart (2 recorders per study site) to achieve the desired recording coverage. Recorders were placed in line with the direction of the speaker cones, which is the area with the best sound coverage from our playback units at our study sites. We placed our recorders closer together than the placement by Virzi and Davis (2012) because: (1) the song of the FGSP is produced at a lower dB level and higher frequency than that of the CSSS, and (2) we wanted some overlap in recording coverage to increase our chance of detecting any FGSPs that were present on our study plots.

The SM2+ Song Meters are highly programmable, and we set the programming to match that of our playback units. The recorders turned on 30 minutes prior to sunrise daily, and recorded for four hours per day. We deployed the remote recorders on 03 Mar 2015 and removed them on 30 Aug 2015. Unlike the playback units, we kept the remote recorders in the field for the entire duration of the FGSP breeding season because: (1) we wanted to maximize our chance of detecting any sparrows on our study plots at any time, and (2) there was less risk of the recorders interfering with breeding activity than the playback units. We did have an early-season issue with a red-shouldered hawk (*Buteo lineatus*) using one of our recorders as a perch; however, we were able to successfully deter the hawk with the installation of predator guards on the recorder stand. The recorders were serviced approximately once per month throughout the field season to replace batteries and memory cards.

4.2.2 Song Recognizer

As part of our study, we developed a song recognizer using the specialized sound analysis software Song Scope (Wildlife Acoustics, Inc.; version 4.1.3A) to identify FGSP song in the field recordings. The use of song recognizers to detect the species of interest saves a tremendous amount of time that would otherwise be required if field recordings were audibly or visually inspected (via sonograms) because of the large amount of sound data that is collected. Our song recognizer was used to automatically scan the hours of field recordings to detect any singing male FGSPs in our study areas. There is a risk that we will record singing male grasshopper sparrows from other migratory subspecies (e.g., *A. s. pratensis*), which could occur at KPPSP during the duration of our study (especially early-season). For any grasshopper sparrow detections that we deem could be of FGSPs and not migratory subspecies (e.g., late-season detections), we plan to work with Dr. Bernie Lohr at the University of Maryland, Baltimore County to try to determine the proper subspecies using more specialized sound analysis software.

We describe some of the pertinent information necessary for development of the song recognizer used in our study and our model validation approach below; however, we refer readers to the Song Scope documentation for a more detailed description of this software and the methods used to construct and validate recognizers (Wildlife Acoustics, Inc. 2012).

The first step in developing a song recognizer is to obtain high quality field recordings of the species of interest to be used as training data for the recognizer model. We obtained FGSP buzz song recordings from eight individual male sparrows from Dr. Bernie Lohr. Next, we annotated these recordings for use as the training data in the recognizer model. Once the training data was entered into Song Scope, we constructed a first pass FGSP recognizer using the default settings for all model parameters (for a list of the final model parameters that were used in our FGSP recognizer see **Table 4.2** in **Section 4.3** below). This is the suggested procedure for developing song recognizers in Song Scope because there is some degree of trial-and-error required in creating recognizers. However, many model parameters can be modified based on the sound qualities of the vocalizations of the species of interest. In our case, models were created by adjusting these parameters in a systematic approach, adjusting levels of individual parameters one at a time (based on measured characteristics of FGSP songs) until a final model was achieved which had the lowest error rates (discussed below). We created 22 separate FGSP recognizers before settling on a final best model based on the validation procedure described below.

The first recognizer model validation procedure was conducted automatically by the Song Scope software. Models with low Cross Training (CT) scores and low CT Error are considered the best performing models by Song Scope (Wildlife Acoustics, Inc. 2012). High CT scores are considered any values > 50%. Low CT Error rates are considered any standard deviation < 15%. The second model validation procedure was performed outside of Song Scope as an additional test of model performance. After running the final FGSP song recognizer model on a 15-min subsample of field recordings made with the SM2+ Song Meters with annotated detections of FGSPs, we validated the results by examining the rates of True Positive Predictions (TP), False Positive Predictions (FP) and False Negative Predictions (FN). High error rates by any of these causes could be an indication of a poorly performing recognizer model. To determine the TP, FP and FN error rates we visually inspected all Song Scope detection results in the 15-min subsample of field recordings derived using the final FGSP song recognizer. We scored FGSP detections as either correct sparrow detections (TP) or false sparrow detections (FP). We also visually inspected the results to look for any sparrows that were singing but were not detected by the recognizer (FN).

4.3 Results and Discussion

4.3.1 Song Recognizer

Using four SM2+ Song Meters, we made 2,872 hours of field recordings over 179-180 recording days at our two conspecific attraction experiment study plots (**Table 4.1**). Using Song Scope, we were able to develop a recognizer that was successful at detecting male grasshopper sparrow song in the field recordings (see **Table 4.2** for final model parameters). We tested 22 different recognizer models before settling on a final model that best detected grasshopper sparrow song with adequate error rates. Validation of the final model based on the Song Scope software indicated that the model performed quite well (**Table 4.3**; CT Error = 81.51% +/- 2.31%). Error rates were low for TP (0.30) and FP (0.28) predictions, but high for FN (0.70) predictions. The high FN rate was by design because we needed to allow a high FN rate in order to reduce the FP rate, which substantially reduced data analysis time. We feel that the TP rate achieved by our model provided us with enough daily detections of singing bouts to ensure adequate detection of all grasshopper sparrows singing on any given morning – this point is discussed further in the next section.

4.3.2 Acoustic Monitoring

The FGSP song recognizer developed based on the final model was run on all recording data collected by the four remote recording devices deployed from Apr – Aug 2015. In total, the Song Scope recognizer made 7,370 detections of vocalizations that were classified as grasshopper sparrow song. Of the total detections made there were only 625 TP detections (8.5%) and 6,745 FP detections (91.5%) based on visual inspections of the sonograms for the Song Scope results (see **Figure 4.2** for an example sonogram of results). It should be pointed out that the TP detections represent "singing bouts" and not detections of individual sparrows (i.e., an individual may have multiple singing bouts each day). False positive detections were most often caused by late-morning insect vocalizations, which generate sounds at frequencies in a range similar to the FGSP. Other FP detections were caused by a variety of birds singing simultaneously with FGSPs on the landscape, and most often caused by singing male Bachman's sparrows (*Peucaea aestivalis*).

Of the 625 TP detections (i.e., grasshopper sparrow detections), all were made from a single remote recording unit (FGSP03) located at our Playback-01 study plot in prairie management unit KP-14. Further, all of these detections occurred prior to 12 Apr (**Figure 4.3**). Due to the timing of these recordings, combined with the results of the concurrent ground-based surveys, we feel confident that these recordings were likely of the migratory subspecies of grasshopper sparrow present at KPPSP during the winter. Thus, we conclude that our acoustic monitoring did not detect any FGSPs at our conspecific attraction study plots in 2015.

4.3.3 Conclusions

We are encouraged at our ability to generate a FGSP song recognizer, or perhaps more appropriately termed a "grasshopper sparrow" song recognizer. The recognizer can detect the buzz song of grasshopper sparrows in noisy field recordings with an acceptable degree of error. This could be a valuable tool for future acoustic monitoring studies of the FGSP. Two important caveats should be mentioned. First, sonograms of detections do still need to be visually inspected manually to distinguish between TP and FP predictions. I high rate of FP predictions is unavoidable in the field recordings so there will always be some amount of data analysis time necessary to differentiate between TP and FP predictions. Second, detections may need to be analyzed further in more specialized software to distinguish FGSP detections from other subspecies. This is an ongoing area of research but is likely possible if more sophisticated song analysis software is utilized (B. Lohr, personal communication). Still, our results offer promise towards using acoustic monitoring for the FGSP and our song recognizer will save a substantial amount of data analysis time in future studies.

4.4 Tables and Figures

Table 4.1: Summary of field recording data collected at four remote recording units deployed in conspecific attraction experiment study plots at Kissimmee Prairie Preserve State Park in 2015. Remote field recorders were set to record four hours per day beginning at 30 minutes before sunrise.

Remote Recorder	Playback Site	Prairie Unit	Date Deployed	Date Removed	Recording Days	Recording Hours
FGSP03	Playback-01	KP-14	3-Mar	29-Aug	179	716
FGSP04	Playback-01	KP-14	3-Mar	29-Aug	179	716
FGSP07	Playback-02	KP-23	3-Mar	30-Aug	180	720
FGSP08	Playback-02	KP-23	3-Mar	30-Aug	180	720
Total						**2,872**

Table 4.2: Model parameters used in final Florida grasshopper sparrow song recognizer developed in Song Scope software (Wildlife Acoustics, Inc.). The final two parameters (Minimum Quality and Minimum Score) were settings used when applying the final song recognizer to field recordings to detect sparrows.

Model Parameter	**Value**
Sample Rate (Hz)	44100
Max Sample Delay	64
Maximum Complexity	40
Maximum Resolution	8
FFT Size	256
FFT Overlap	1/2
Frequency Minimum (log scale)	32
Frequency Range (log scale)	35
Amplitude Gain (dB)	0
Background Filter (s)	2
Max Syllable (ms)	525
Max Syllable Gap (ms)	26
Max Song (ms)	2003
Dynamic Range (dB)	26
Algorithm	2
Minimum Quality	20
Minimum Score	50

Table 4.3: Model results for final Florida grasshopper sparrow (FGSP) song recognizer developed in Song Scope software (Wildlife Acoustics, Inc.). The final model was validated outside of Song Scope using independent validation data (i.e., field recordings with known numbers of FGSP singing bouts) to examine detection error rates.

Results	**Value**	**Error**
Cross Training	81.51%	+/- 2.31%
Total Training	80.57%	+/- 4.04%
States	35	na
Vectors	8	na
Syllables	2	na
State Usage	21	+/- 4
Mean Syllables	386	+/- 55
Mean Duration (s)	1.21	+/- 0.12
Validation - Test Data		
True Positive Rate	0.30	na
False Positive Rate	0.28	na
False Negative Rate	0.70	na

Figure 4.1: Example remote recording device (SM2+ Song Meter; Wildlife Acoustics, Inc.) deployed in the areas where song playback was broadcast in order to detect singing male Florida grasshopper sparrows (FGSP) at Kissimmee Prairie Preserve State Park. Two such recorders were deployed at each study site. This recorder is located in an area where a prescribed burn was performed just prior to the 2015 FGSP breeding season.

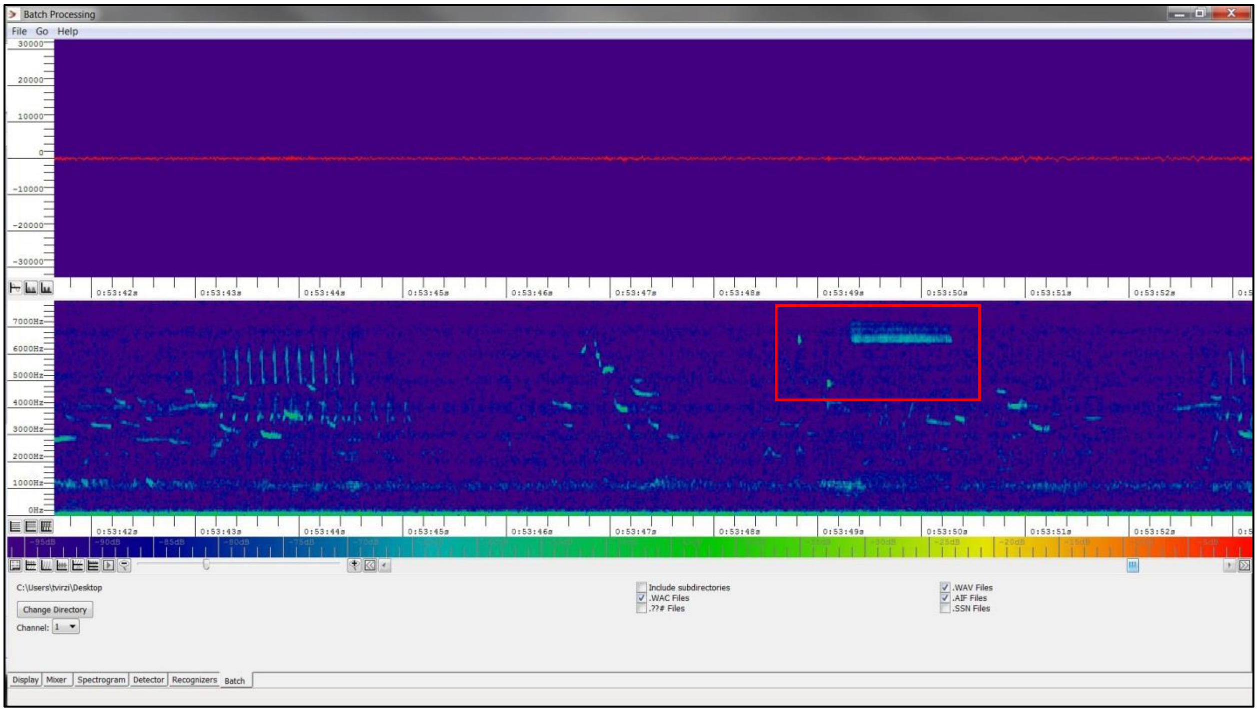


Figure 4.2: Example sonogram of a singing male grasshopper sparrow (unknown subspecies) recorded on remote recording unit FGSP03 during Mar 2015. The sonogram shows an example of a typical buzz song extracted from field recordings using the song recognizer developed in Song Scope software (red outline). The sonogram also shows examples of the background noise that is typically recorded by the SM2+ Song Meters used in our study (e.g., other bird songs, insects, etc.). Note the higher frequency range of the grasshopper sparrow song compared to all other background noise.

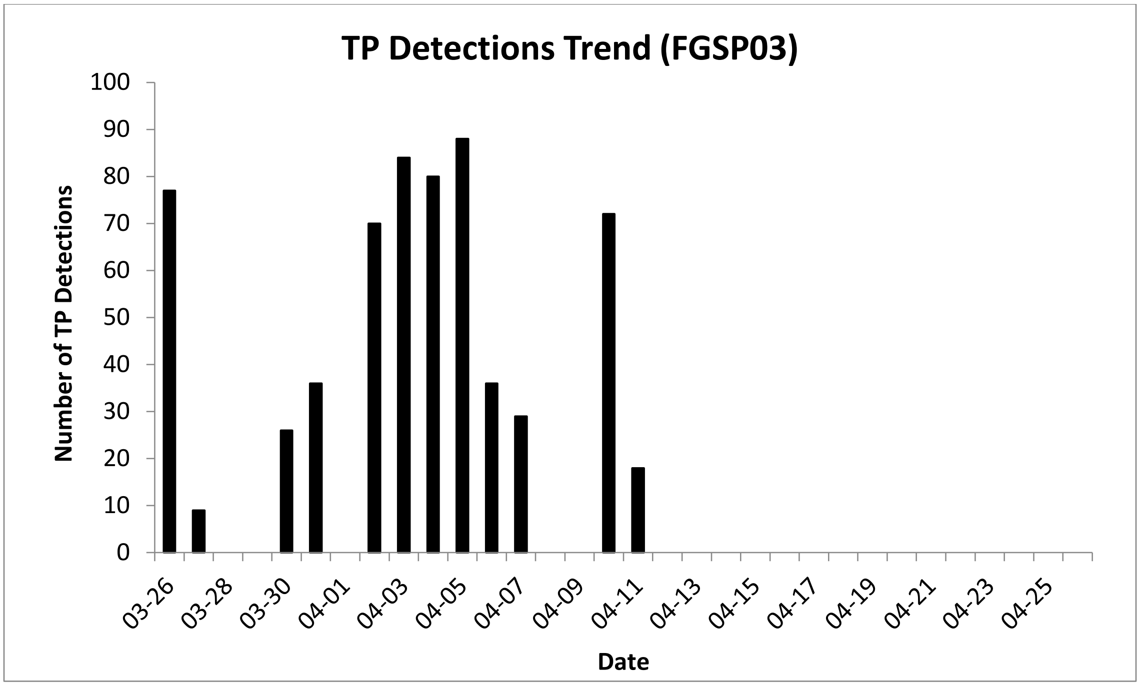


Figure 4.3: Trend in true positive (TP) grasshopper sparrow detections made at remote recording unit FGSP03 deployed in Playback-01 study plot in prairie management unit KP-14 at Kissimmee Prairie Preserve State Park (KPPSP) during 2015. There were no TP detections at any of the other three remote recording units deployed as part of the conspecific attraction experiment conducted at KPPSP in 2015. The last detection of a male grasshopper sparrow singing at KPPSP (at KP-14) was on 11 Apr 2015 based on field recordings.

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