Final Report to the Texas Comptroller's Office: Sprague's Pipit Research Project

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Preface

The project was initiated in response to RFP #209c "*Requests for Proposals for Endangered Species Research Projects for the Sprague's Pipit*" issued by the Economic Growth and Endangered Species Management Division of the Office of the Texas Comptroller of Public Accounts (CPA) on April 25, 2014. Funds were eventually awarded to Texas State University with Dr. Joseph A. Veech as the Principal Investigator for the project that had an approximate start date of November 1, 2015 and termination date of December 31, 2016. The State of Texas and more specifically the CPA Office desired to obtain information and knowledge on the distribution, abundance, population trends, broad-scale habitat associations, and possible threats to Sprague's Pipits (*Anthus spragueii*) wintering in Texas with the intent that such knowledge and information could potentially be of use to the United States Fish and Wildlife Service (USFWS) in their assessment of the conservation status of Sprague's Pipit (more formally the Species Status Assessment). More detailed description of the sought-after knowledge and information (including project deliverables) can be found in "*Section 3.1 – Technical Specifications*" of the original RFP. This final report is divided into sections as instructed and specified by the Texas CPA Office.

The project activities were conducted by Joseph Veech (PI) and two exemplary M.S. graduate students (John Muller and Laura Bliss) both of whom at the time of this writing are planning on continuing their graduate educations in working on Ph.D. degrees at the University of Louisiana – Lafayette and the University of Manitoba, respectively. Various volunteers also assisted with field activities on different occasions. We thank them for their assistance.

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Introduction

Sprague's Pipit (*Anthus spragueii*) is a small-bodied migratory grassland bird species that may be in need of some explicit conservation action. However, as is the case with many species, greater knowledge of its ecology, distribution, and abundance is required to inform conservation actions and decisions. Prior to initiation of this project, there was some concern among various conservation groups, federal and state agencies (including the Canadian government), scientists, and working conservation professionals that the overall continental population of Sprague's Pipit (SPPI) might be declining and further that the declines could be due to loss of both breeding habitat in the northern Great Plains and wintering habitat in Texas, adjacent states, and Mexico. Sauer et al. (2011) reported a population decline of 65.7% from 1966 through 2011 based upon an analysis of data from the North American Breeding Bird Survey (BBS). Abundance data for a few hundred bird species are collected annually by the BBS and the data are routinely analyzed by Dr. John Sauer and other staff at the Patuxent Wildlife Research Center (United States Geological Survey) to estimate population trends for the various species. So, it is important to note that Sprague's Pipit was one of many species analyzed in the Sauer et al. (2011) report. In addition, Schmidt (2010) reports a continental-level population decline of 73.1% between 1967 and 2006 based upon analysis of data from the Christmas Bird Count, another nation-wide survey conducted annually for hundreds of bird species. Schmidt (2010) is actually the text of the 12-month finding issued by USFWS in response to a petition to list Sprague's Pipit; it is not clear in that document who conducted the analysis of CBC data. BBS and CBC data are trustworthy and the estimates of SPPI decline have been independently verified. However, these estimates were not derived from surveys intended to exclusively focus on Sprague's Pipit and to survey for that particular species in the most appropriate way. Unfortunately, no species-specific monitoring program for SPPI has ever been established, at least not for providing long-term historical data.

Nonetheless, the possible declines of 65 – 73% were large enough to garner some concern for the status of SPPI. In addition, the species was known to be a habitat specialist requiring relatively extensive areas of short-grass prairie for breeding. Further, such habitat can often be very fragile and highly sensitive to over-grazing and drought. In some areas of the species breeding range, energy exploration and extraction activities were thought to possibly be involved in disrupting breeding activity. Similarly, over-grazing in the grasslands of northern Mexico was identified as a possible cause of population declines or at least a threat to the species wintering habitat. In a relatively recent USFWS status report, Jones (2010) had called for documentation of SPPI habitat requirements on the wintering grounds and the need for a better monitoring strategy. In addition, our knowledge of the basic ecology of SPPI had (and still is) dominated by studies of the species on the breeding range. Thus, there has been a past and still somewhat ongoing need to obtain more information and knowledge about the species on its wintering grounds, of which the vastness of Texas makes the state very important to the wintering ecology and conservation of Sprague's Pipits.

According to data from the eBird database, each year SPPI individuals begin arriving in north Texas as early as October and some remain in the state to the end of April. Prior to the present

study, there was very little knowledge of its habitat associations on the wintering grounds. On the summer breeding grounds the species seems to prefer native short-grass prairie (Davis 2004, Davis et al. 2006, Jones 2010). Thus, one of the goals of the project was to determine if SPPI had similar habitat specificity (i.e., strong preference for native grassy vegetation of low height) while wintering in Texas or whether they could also use anthropogenic land cover types such as pasture, fallow crop fields, turf grass production fields, and recreational fields in parks that structurally mimic short-grass prairie. A few previous studies had recorded wintering pipits on agricultural land and partially degraded natural grasslands (Grzybowski 1982, Contreras-Balderas et al 1997, Lockwood and Freeman 2004, Engelman and Kostecke 2009) but without doing a thorough quantitative analysis. These studies were primarily anecdotal.

This project also sought to document whether Sprague's Pipits on wintering grounds in Texas have actually declined over the long term (e.g., past few decades) and in reference to other very similar species (e.g., American Pipit). Again, as mentioned previously, this task is difficult in the sense that there is no long-term population data for SPPI from a survey designed and intended to monitor (focus on) SPPI.

Whether Sprague's Pipit is ever in need of federal protection (i.e., listing) or not, it would be useful to the conservation of this unique species to identify publically-owned protected areas with known wintering populations or groups of resident individuals. Although arriving in north Texas as early as October, most individuals will continue south to permanent wintering locations in south Texas, along the Texas coast, and in parts of west Texas (Stockton Plateau and perhaps trans-Pecos region). Then starting in March, individuals begin the return trip north. The species migrates as individuals, not in flocks. Thus, the wintering "population" in Texas does not really exist as a set of discrete localized populations, but rather as individuals widely scattered. Nonetheless, some areas of expansive open terrain (natural or human modified) might be more likely to harbor concentrations of individuals more so than do other areas that have substantial woody vegetation (i.e., forest and dense shrubland). Based on this perspective of the species' wintering ecology, we conducted a field survey across a large part of central and southeast Texas and the Rio Grande Valley to identify wintering areas that are currently protected. This involved conducting visits to pre-selected sites (properties) to assess SPPI abundance and habitat condition.

Lastly, most USFWS Species Status Assessments include some evaluation or analysis of threats to the species or its habitat. In preparing the original research proposal and reviewing the literature, my impression is that there were not any specific and overwhelming threats to the species in its wintering grounds in Texas. At least there did not appear to be any that would require immediate attention. The species is not utilized (collected or harvested) for any purpose, so that is not a factor. There is no known disease, predator, or invasive species threatening the species in Texas. Although habitat alteration and destruction in northern Mexico has been suggested as a possible threat, it is also possible that Sprague's Pipits given may be capable of tolerating (and perhaps benefitting) from some types of land cover modification. This could be occurring if agricultural activities actually lead to increase in the amount of open terrain lacking any woody vegetation and with either bare ground or short

grass as the substrate. As previously mentioned, the landscape-level habitat analysis examined this possibility.

IAC Final Report Deliverables

Below I describe the deliverables as listed in the IAC. More details on each can be found in the "Results/Findings" and "Discussion" sections of this report.

1. GIS analysis of suitable habitats at a landscape level. Using land cover data from the NLCD, we examined the proportion of open water, developed open space, developed land, forest, shrubland, grassland/pasture, cropland, and wetland in landscapes occupied by SPPI compared to randomly-located landscapes. SPPI location data were obtained either from eBird or CBC databases. For the eBird data, landscapes were defined as 1, 2, and 5-km radii circles centered on the SPPI location (or nearby random point). For the CBC data, we defined the landscape as the entire 12.5-km radius circle of the standard CBC survey circle. These analyses generally confirmed the expectation that the landscapes occupied by SPPI would have less forest and shrubland than randomly-located landscapes. However, the SPPI landscapes did not necessarily have more habitat (grassland, pasture/hay, open developed space) than did random landscapes. This latter result probably arose do to the great prevalence of these cover types in the larger region overall and hence our analysis had low power to detect an effect. The result was definitely not an indication that SPPI choose landscapes randomly or that grassland, pasture/hay, and open space are not needed and used by SPPI.

2. Temporal model of potential wintering abundance and distribution. We used eBird data to try to more definitively delineate the boundaries of SPPI wintering range in addition to mapping *potentially* suitable habitat. In particular, we sought a visual assessment of the amount of the range that resides in Texas versus neighboring states and Mexico. The analysis revealed that roughly half the range covers Texas. Further, our best estimate is that the northern boundary of the true wintering range (as in residency of SPPI from December to January) is at about the 32° N latitude line. Observations of SPPI north of this boundary probably represent individuals in the process of migration (i.e., movement to the residency wintering grounds). Based on the mapping of land cover types, there appears to be substantial amounts of habitat within the true wintering range and elsewhere, although this is at best a crude estimate in that the assessment does not take into account the ground-level structure of the vegetation.

3. Analysis and comments on statewide population change in past 10 years. As previously stated, this is a task that is difficult to accomplish with any great amount of precision or confidence simply because there is not much data available to accomplish the task. Nonetheless, we made an attempt at this using data from the Christmas Bird Count. Our analysis revealed that the continental population of *wintering* Sprague's Pipits appears to be stable in recent decades, although low in comparison to the closely-related American Pipit. We were not able to analyze population trend for Texas alone; however, given that Texas includes half the species wintering range and the central portion, dynamics for the continental population likely would also hold for Texas. Although we were not able to detect a recent

negative population trend for SPPI, our analysis provided some indication that Sprague's Pipits may have been historically (during period 1950 – 1988) more abundant than they currently are. CBC observers appear to have been more likely to detect the species in any given survey circle in any given year prior to 1988-89 as compared to more recent years.

4. Identification and description of pipit safe havens. We initially developed a long list of about 35 publicly-owned properties (e.g., state parks, reservoirs, county parks, historic sites, nature preserves) that could potentially have SPPI based upon their location on central, southeast, coastal, and the Rio Grande Valley regions of Texas. We then examined eBird and other sources to determine if SPPI had ever been reported nearby. We also examined aerial imagery (through Google Earth) to assess whether the property appear to have open terrain (i.e., habitat) and we read literature describing the properties. From this process, we winnowed our initial list down to about half and then made site visits mostly between January and March 2016. We found SPPI at nearly all the sites that we visited. This reaffirmed that our knowledge of SPPI wintering habitat ecology had been developed (by ongoing project activities) well enough that we could "predict" ahead of time where SPPI were likely to occur. More importantly, this part of the project revealed that SPPI is fairly widely distributed in southern parts of Texas during the winter and that a good number of protected areas currently harbor SPPI – these locations are important to the ongoing conservation of the species.

5. Comments on species management, protection, and survey methods. Please see the Discussion and Additional Research Needs sections of this report.

Materials, Methods, and Quality Control Measures Used

The project mainly involved the use of pre-existing data on SPPI distribution and abundance from the Christmas Bird Count and eBird. Some original field-based data on SPPI abundance was collected during the site visits to identify protected areas or safe havens for SPPI in central, southeast, coastal, and the Rio Grande Valley regions of Texas. To examine broad-scale habitat associations, land cover and related data from the National Land Cover Database were used in a GIS-computing environment. When appropriate, data were analyzed with various statistical procedures. More detail on the methods in the context of results can be found in other sections of this document.

Technical Advisory Panel Reviews

The TAP for this project consisted of Dr. Rich Kostecke (The Nature Conservancy), Dr. Jim Giacomo (Oaks and Prairie Joint Venture, Texas Parks and Wildlife Department, and American Bird Observatory), and Dr. Stephanie Jones (retired from USGS Migratory Bird Division). The TAP members were helpful in reviewing the project activities. They often provided useful feedback and never reported on any flaws in the execution of the project (i.e., methodology used) or interpretation of results. Prior to initiation of this project and the projects of other PIs funded through the Endangered Species Research Program, the Texas CPA Office required that

TAP members review each quarterly report and that the PI respond in writing to the reviews. The TAP reviews and my responses are compiled in **Appendix A** of this document.

Results/Findings

Landscape-level analysis of land-cover associations

On the breeding grounds of the northern Great Plains (south-central Canada and north-central USA), Sprague's Pipits prefer and indeed require native short-grass prairie. However, current knowledge of their habitat associations in the wintering grounds is generally lacking, except for areas of Mexico. Previous studies in the Chihuahuan Desert grasslands of northern Mexico have shown an association of Sprague's Pipits with natural grasslands and avoidance of shrub land areas that have canopy cover greater than 5% [see Fig. 24 in Pool et al. (2012)]. In past years, there have also been some anecdotal (qualitative) observations of Sprague's Pipits using (residing in) cropland, pasture, golf courses, and grazed rangeland on their wintering grounds in Texas. However, no one had quantitatively analyzed land cover associations of Sprague's Pipits particularly at landscape scales (i.e., scale of 1 – 10s km^2) until the present study. Thus, a main goal of the project was to examine whether Sprague's Pipits non-randomly associate with some land cover types and avoid other types. To accomplish this goal, we undertook three separate analyses, each described in turn below.

Analysis 1 – We used spatially-referenced eBird sightings of Sprague's Pipits to identify the characteristics of landscapes that the species associates with (and those that it avoids) at multiple spatial scales. The land cover data were from the National Land Cover Database 2011 edition (NLCD). The NLCD classifies land cover in the continental USA into one of 15 categories at a resolution of 30 m. For our purposes, we combined the 15 categories into 8 broader categories of (1) open water, (2) developed open space (e.g., recreational fields, city parks), (3) developed land (suburban to highly urban), (4) forest (deciduous and evergreen trees > 5m height), (5) shrub land (woody vegetation < 5m height and no overhead canopy), (6) grassland/pasture (natural vegetation with or without livestock grazing), (7) cropland, and (8) wetland. Given that similar categories (e.g., deciduous forest and evergreen forest) were combined, we effectively reduced the classification error rate inherent in the data and limited the overall number of variables being examined (and hence limited the possibility of finding a spurious positive or negative effect). From the eBird database, we obtained 462 sighting locations of Sprague's Pipit (SPPI) (405 from Texas, remainder from LA, NM, AZ) between the years 2008 to 2013. Each of these locations is spatially unique in that we included a location only one time (in our sample of 462) even if it had sightings of pipits on multiple dates. We also did not use any sighting locations in which the latitude and longitude coordinates appeared to be imprecise (e.g., coordinates for a town center). The temporal span of 2008 to 2013 corresponds with the date of our land cover data (NLCD 2011 database). We generated a random set of 462 point locations ("RNDM near") by matching each pipit sighting location with a point that was within 8 - 10 km of the pipit location and in a random direction from it. We also generated a set of 500 points randomly located anywhere and throughout the wintering

range of Sprague's Pipit ("wintering range" as described later in this report). We refer to this set of points as "RNDM any". From the eBird database, we also obtained a set of 1,064 sighting locations for American Pipit (AMPI) (694 from Texas) as a species comparison. For the pipit locations and random points, we used ArcGIS to define buffers of radii 1, 2, and 5 km. For each of these buffers, we derived the percent cover for each of our eight land cover categories. We then determined the mean value of percent cover for each category for each of the four groups: SPPI locations, AMPI locations, RNDM near, and RNDM any. Lastly, a customized data randomization procedure was used to test whether the mean percent cover values differed between SPPI vs. AMPI, SPPI vs. RNDM near, and SPPI vs. RNDM any. This test was done separately for each land cover type.

At small scales (1, 2, and 5 km buffers around eBird point locations) the cover-type composition of landscapes occupied by Sprague's Pipits differed slightly but significantly from those occupied by American Pipits (**Figure 1**, Table 1). Most notably, Sprague's Pipits were recorded in landscapes with less forest than those of American Pipits (SPPI, mean percent cover = 8.13%; AMPI, mean percent cover = 13.32%) and less developed urban land (SPPI, mean percent cover = 6.45%; AMPI, mean percent cover = 12.05%). Compared to American Pipits, the landscapes of Sprague's Pipits also had on average, a greater percentage of grassland (SPPI, mean percent cover = 26.47%; AMPI, mean percent cover = 18.39%) and slightly greater percentage of cropland (SPPI, mean percent cover = 19.78%; AMPI, mean percent cover = 16.58%). These results indicate an overall difference between the two species in their broad-scale habitat associations – Sprague's Pipits appear to be less "tolerant" of forest and developed land and more "reliant" on grassland and possibly more "receptive" to cropland.

The comparison of SPPI eBird locations to nearby random points ("RNDM near") allows for a more direct assessment of whether Sprague's Pipits are associating with each land cover types either more or less than the general availability or frequency of the land cover type. In this comparison, SPPI landscapes had a significantly greater percentage of open water than did landscapes of random points (7.36% compared to 2.98%), slightly greater percentage of developed open land (6.01% vs. 5.21%), lower percentage of forest land (8.13% vs. 11.98%), and slightly lower percentage of shrub land (17.13% vs. 19.28%) (Table 1). Notably, the SPPI landscapes and landscapes of nearby random points did not differ significantly in grassland (26.47% vs. 27.16%) or cropland (19.78% vs. 18.59%). The comparison of SPPI eBird locations to random points anywhere within the winter range ("RNDM any") is an assessment of "habitat selection" at a very broad geographic scale. In this comparison, all eight of the cover types differed significantly ($P < 0.001$) between SPPI locations and random points, difference in grassland was marginally significant ($P = 0.066$) (Table 1). The landscapes occupied by Sprague's Pipits had a substantially lower percentage of shrub land (17.13% vs. 38.26%) and forest (8.13% vs. 14.60%) and slightly greater percentages of developed open (6.01% vs. 4.19%), grassland (26.47% vs. 24.15%), and cropland (19.78% vs. 11.68%). Interestingly, the percent cover of developed urban land was greater for the SPPI locations than for the random points (6.45% vs. 3.53%). We believe this particular result is an artefact of many eBirders tending to go birding at locations not too far "off the beaten path" whereas the "RNDM any" set of points included many points far from any anthropogenic development. Regarding the other cover types, this

analysis further supports that Sprague's Pipits are associating with open habitat types such as developed open land, grassland, and cropland and "avoiding" closed canopy areas such as forested land and shrub land. If we consider developed open space, grassland, and cropland combined as "winter habitat" for Sprague's Pipit then the landscapes occupied by Sprague's Pipits had on average 52.26% habitat cover which was greater than the amount generally available at any one location within the winter range, 40.02%.

Analysis 2 – We used data from the Christmas Bird Count (CBC) and the NLCD "Land Cover From To Change" database (2001 to 2011) to quantify land conversion rates within the CBC survey circles within the USA portion of Sprague's Pipit wintering range delineated later in this report. There were 129 survey circles of which 92 had records of Sprague's Pipits. The NLCD "From-To" database classifies 30 m pixels (land area) to "change categories" rather than static cover categories. We were particularly interested in gains and losses (net change) in grassland, cropland, pasture/hay, and developed open space given that our previous analyses (just described) indicated that Sprague's Pipits associate with (or at least do not avoid) these cover types. Further and more specifically we were also interested in conversion rates of grassland into cropland, shrub land, and developed urban land given that grassland is the main natural habitat of Sprague's Pipits and the other cover types are either anthropogenic and useable cover types (cropland), natural but non-useable (shrub land), and anthropogenic and non-useable (developed urban). The original intent was to examine the relationship between temporal trends in SPPI counts within each survey circle and rates of land conversion. However, the relatively short time span (16 years) and sporadic counts (many zero values) of SPPI in most survey circles did not allow us to confidently estimate temporal trend within the circles. Therefore, this analysis primarily became a documentation of land conversion rates and a visual assessment of those rates with regard to SPPI abundance (mean CPH values) within the circles. We also had intended to conduct the same analysis on so-called "birding hotspots" in the eBird database. A birding hotspot is a particular location that birders often visit for birding. However, we found that there was an insufficient number of these birding hotspots in which Sprague's Pipits have been recorded and many of these hotspots were somewhat near to one another and likely would represent redundant locations given the type of analysis that we wanted to conduct. Determining a metric equivalent to CPH also would have been problematic for the eBird data. Therefore, we only used CBC data for this analysis.

We examined the land cover composition within 129 CBC survey circles that had recorded Sprague's Pipits at least one time between Winter 1998/99 and Winter 2013/14. Also, all of the circles were within the wintering range of Sprague's Pipit. This analysis revealed that even with substantial amounts (>10%) of open land (grassland, pasture/hay, cropland, and developed open space) there is no guarantee of having higher abundance (e.g., CPH > 0.1) of Sprague's Pipit (**Figure 2**). Indeed several CBC circles with substantial amount of grassland also had very low CPH values. However, CBC circles with the highest CPH values (e.g., CPH > 0.1) did tend to have substantial amounts of either cropland and/or pasture-hay (**Figure 2**). The CBC circle with the highest mean CPH (located at Attwater Prairie Chicken National Wildlife Refuge) of 0.82 consisted of 47.2% pasture/hay, 35.5% cropland, 4.0% developed open space, and 2.1% grassland all of which can to some extent form "wintering habitat" for Sprague's Pipits. Much

of the refuge is grazed (i.e., pasture) and some is intentionally planted with crops. Much of the surrounding greater landscape is also agricultural land. As for non-habitat, this CBC circle consisted of only 4.6% shrub land, 1.8% forest, and 1.3% developed urban land.

There was almost no pattern evident in the examination of land conversion rates as they might affect mean CPH (**Figure 3**). The lack of any definitive patterns may be due to the time span (1998-99 to 2013-14) being too short to detect an effect on Sprague's Pipits, especially given that the net change for all cover types and most survey circles was typically in the range of just -10 to +10 km^2 over the entire time span. Essentially, the CBC circles have been relatively static in land cover composition. In particular, note that the CBC circle with highest CPH (APC NWR) has been very static for all land cover types. It is also worth noting that the one cover type with consistent gains is developed urban land; it rarely gets converted into another cover type. The six CBC circles with increases of >30 km^2 of developed urban land had either no Sprague's Pipits recorded or only a few (CPH at or near zero) (**Figure 3**).

Grassland is the natural (native) habitat of Sprague's Pipits on both the summer breeding grounds and the wintering grounds. Conversion of natural grasslands (in Texas and elsewhere) typically occurs into three other cover types: cropland, developed land, and shrub land (the latter is through natural succession or shrub encroachment enabled by humans). Therefore, we examined land conversion in a little more detail by quantifying the rate at which grassland has been converted into each of these cover types within the CBC survey circles. This was then followed by an assessment of whether these conversions might be associated with low CPH values. The grassland-to-cropland conversion was minimal, never greater than 5 km^2 in any survey circle and typically less than 1 km^2 (**Figure 4**). The grassland-to-developed-urban conversion was more extensive and common although not large. Nonetheless, CBC circles that had more than 2 km^2 of grassland converted into developed urban land also had very low CPH values never greater than 0.05 and often zero (**Figure 4**). Grassland-to-shrub-land conversion also was not very great except for a few CBC circles in which more than 10 km^2 of grassland has been converted to shrub land (**Figure 4**). There was no clear pattern with regard to CPH values; even with relatively large conversion of grassland into shrub land, CPH values were often relatively high. This unexpected result may have occurred in circles that already had substantial grassland and cropland cover such that loss of a little more grassland did not have a detectable effect on CPH values.

Analysis 3 – We used eBird SPPI observations that had high locational accuracy (reported latitude and longitude coordinates likely accurate to 100 m or less) to test whether the distance between the locations and the nearest substantial (10 hectares or more) cropland, shrub land, and developed land is significantly different from random. We paired each SPPI location with a random point 3 km distant. We then tested whether the distances for the random points and those for the SPPI locations were significantly different. This analysis was an attempt to more thoroughly test whether Sprague's Pipits avoid these types of land cover. As with the other analyses, we used NLCD data and conducted the landscape analysis in ArcGIS.

With this analysis our intention here was to more thoroughly test whether Sprague's Pipits were "avoiding" certain cover types and perhaps being "attracted" to other types. In ArcGIS we measured the straight line distances between eBird SPPI locations (N = 29) and the nearest parcel of cropland, developed urban land, forest, and shrub land greater than 10 hectares. We paired each SPPI location with a random point and again measured distances to nearest parcel of the four cover types. The data were analyzed with a paired *t*-test. For each cover type, distances between the Sprague's Pipit locations and the nearest parcel were not significantly different than the distances for the random points: cropland 3.3 vs. 3.2 km ($P = 0.24$), developed urban land 4.9 vs. 5.1 km ($P = 0.31$), forest 6.5 vs. 5.9 km ($P = 0.10$), and shrub land 4.6 vs. 4.3 km ($P = 0.14$). Perhaps, our sample size (N = 29) was too small to find significant results. Also, the outcome of this type of analysis might depend very much on the distance used to set the random points. We used 3 km; however, there is no completely non-arbitrary way to specify this distance.

Delineation of the wintering range

In general, the "wintering range" of Sprague's Pipit extends from the Chihuahuan Desert grasslands of northern Mexico and southern Arizona through southernmost New Mexico and into the southern two-thirds of Texas and across into Louisiana. Further, the eBird database actually has reports of Sprague's Pipits as far west as inland southern California and as far east as Georgia and Florida. Many of these reports as well as those from north Texas and southern Oklahoma may actually represent migrating individuals that were observed while stopping over en route to wintering grounds further south or in some cases vagrant individuals. To date, no one has attempted to delineate the true wintering range defined as the geographic area where individuals actually are over-wintering and not simply en route to somewhere else or "off course". That is, our goal was to uncover the geographic area that actually contains the wintering grounds for the majority of the continental population of this species. This knowledge has implications for conducting other studies and analysis (as demonstrated in the other parts of this report) and practical application with regard to potential conservation action for Sprague's Pipits. Effective conservation will need to recognize the difference between the broad geographic area wherein stopovers may occur and more specific geographic areas that actually contain the wintering grounds – where individuals will have more or less permanent residency during most of the winter.

We first obtained all the eBird locations having Sprague's Pipits in the USA and Mexico between 2002 and 2015 for the months of December, January, and February. Sightings of Sprague's Pipits in other months were considered to be migrating individuals. This initial set of observations consisted of 580 sightings from southern California to Florida. We then determined the centroid (center) of this set of locations (points in geographic space) as the mean latitude and mean longitude. For each point, we calculated the straight line distance to the centroid using the Haversine formula. The mean and standard deviation of the distances were determined and used to cull points that were outliers. Outliers were defined in a statistical sense as points whose distances were more than 1.96 SD units greater than the mean difference. Of course these were points far from the centroid so they were also geographic

outliers. After culling these points, we had a "new" set of points and we repeated the same procedure, each time recalculating the centroid location, distances, means, and standard deviations. This culling procedure was repeated until we arrived at a set of points devoid of any statistical and geographic outliers. The first culling left 526 points, second culling left 497, third left 487, fourth left 476, fifth left 451, sixth left 439, and seventh and final culling left 437 points. In ArcGIS, we then derived the minimum convex polygon around these 437 points – that is, the wintering range of Sprague's Pipit.

The wintering range map for Sprague's Pipits includes a large portion of Texas and northern Mexico as well as small parts of New Mexico, Oklahoma, and Louisiana (**Figure 5, top panel**). Despite our point culling procedure to remove statistical and geographic outliers, some of the point locations in northern Texas and Oklahoma might still represent unusual winter time sightings. Therefore, we derived a second map that did not include these points (**Figure 5, bottom panel**). This reconfigured map still contains more than half of Texas and approximately the same portions of Mexico and Louisiana as the more extensive map.

Temporal model of potential distribution

The broad-scale habitat associations (as identified in the previous analyses) were used to create a temporal model (or map) of SPPI habitat in Texas. The model is "temporal" in the sense that it maps potentially suitable habitat for SPPI given the timing of the species wintering phase in Texas. In interpreting the maps, less weight should be given to areas of habitat in more northerly portions of the state (e.g., areas north of 32° N latitude). As discussed above, these areas might not actually be wintering grounds (in the sense of having resident pipits) but rather only serve as stopover locations where pipits might land and rest for a day or two before continuing migration.

We used NLCD data, specifically the grassland, cropland, emergent herbaceous wetland (EHW), and developed open space (recreational fields/lawns) cover layers to develop habitat suitability maps. Although Sprague's Pipits are not normally found in wetlands per se, we included this cover category as potential habitat because we found a high density of SPPI occurring on a lightly-vegetated mud flat at Laguna Atascosa NWR in south Texas (see **Appendix C**) and we discovered that the NLCD classified that mud flat as EHW. In addition, other locations on the Texas coast where SPPI was recorded are also categorized as EHW. Thus this cover type needed to be included so as to not underestimate potential habitat, particularly in coastal areas. Similarly, cropland (mostly fallow during winter) may not be ideal habitat although it is certainly lacking in woody cover (and hence "attractive" to pipits) and the landscape-level analysis of land-cover associations did not reveal an avoidance by SPPI of this land cover type. We also used NLCD data (GIS cover layers) on percent canopy cover and impervious surface to further refine the habitat. That is, pipits certainly avoid woody canopy cover and substrates of concrete and asphalt. Many grassland bird species exhibit area-sensitivity; i.e., they require some minimal amount of contiguous habitat. We observed this phenomenon in Sprague's Pipits – the minimum-sized area where we observed a pipit was about 16 hectares (a recreational field in a county park in south Texas). Therefore, in order to include possible area-sensitivity we

developed versions of the model that require a minimum patch area (16 and 40 ha) in order to be included (mapped) as potential habitat. Resolution of all maps was a 30 × 30 m pixel size as this is the maximum resolution of the NLCD data layers.

The most inclusive version of the habitat-suitability map was based on a model in which tree canopy cover was < 10%, impervious surface cover < 10%, and the combination of contiguous grassland/cropland/EHW/open-space was > 16 ha (**Figure 6**). This map reveals a substantial amount of potentially useable land cover types throughout north Texas, extending south through a relatively narrow band, and then a relatively expansive coverage in south Texas particular along the coast (**Figure 6**). There is a relative lack of suitable land cover in deep east Texas (likely too forested) and in the Edwards Plateau, trans-Pecos region, and west Texas (shrub coverage too great). Another striking feature of the map is the very high density of suitable land cover in the Panhandle region (**Figure 6**). Of course this is likely not wintering habitat in that it is too far north. Further, this aspect of the map is due to the vast areas of cropland in that part of the state. During fall and spring migration, that cropland may not be fallow and hence possibly not very useable to SPPI as stopover habitat.

The most restrictive version of the habitat-suitability map was based on a model in which tree canopy cover was < 1%, impervious surface cover < 10%, and the combination of contiguous grassland/EHW/open-space was > 40 ha (**Figure 7**). Note that this map does not include cropland and has a larger minimum patch size. There is still a substantial amount of suitable land cover in north Texas (including the Panhandle) and through the narrow band in central Texas and into south and coastal Texas, but the suitable land cover is less dense overall (**Figure 7**).

We used eBird data from checklists submitted between November 2015 and March 2016 to test the accuracy of the model (maps). Note that this was a set of eBird data that was separate from (independent of) the eBird data that we used to develop the model/map. The amount of suitable land cover in 1-km radius circle centered on eBird SPPI locations (n = 147) was compared to the amount in landscapes of the same size but which lacked SPPI (n = 1,059). This latter set of landscapes was derived from eBird checklists (locations) that had recorded American Pipits but not SPPI. So, this means that the observer was probably also searching for SPPI but did not find any. The comparison of SPPI presence to absence points was done separately for each map version. For the inclusive map, SPPI presence points (landscapes) had on average 65.5% suitable land cover whereas absence points had only 34.5%. For the restricted map, SPPI presence points had on average 28.3% suitable land cover whereas absence points had only 18.6%. These differences translate into SPPI-occupied landscapes having 1.8 – 2.3 times the amount of suitable land cover than do landscapes devoid of SPPI. This suggests that the model (maps) is a relatively good general indicator of whether Sprague's Pipits might be found at a location given that it has enough suitable land cover. However, the model and the data used to construct it, simply do not allow for it to be used in any precise way to predict where Sprague's Pipits will occur.

One huge challenge in this modeling endeavor was reconciling the output (map) of the model with the fact that the NLCD data do not tell us anything about grass height. The height of grass is very important to Sprague's Pipits on the wintering grounds (and summer breeding grounds) – this has become more and more evident to us based on the field surveys conducted for this project. Thus, the model is likely over-estimating the availability of suitable habitat as it might currently exist (in real time). Nonetheless, the model can be trusted to indicate areas that could become more suitable if managed in a way to control grass height such as frequent mowing, fire, and grazing. Whether such areas would be used by pipits (even with appropriate land management) is a different matter.

Population trend

Data from the Christmas Bird Count (Audubon Society) provided a unique opportunity to examine whether the continental-level population of Sprague's Pipit has declined over time. Further, because the CBC has been conducted for many decades, we were also able to compare recent population trends to an "historic" population estimate. However, there were several caveats and limitations in this analysis so results have to be interpreted with some amount of caution and acknowledged uncertainty.

The CBC is an annual count (survey) for bird species occurring within survey circles that have approximately 12 km radius. The surveys are typically conducted the last week of December or first week of January. Volunteer participants thoroughly search as much of the circle as possible within about a 24-hour period and record all birds seen or heard. Currently there are hundreds of circles in this citizen science program, but of course fewer surveyed in the early decades of the program. Also, not all circles have been surveyed every year. The number of participants and time spent searching (more generally, survey effort) can vary among circles and even within a given circle from year to year. Since Winter 1950-51, the Audubon Society has kept very good records on survey effort and these metadata are available to researchers analyzing CBC bird data. We made an online request to the Audubon Society for all data from CBC survey circles in Texas, Arizona, New Mexico, Louisiana, and Mexico (these areas include nearly the entire wintering range) that had recorded Sprague's Pipit in at least one year since Winter 1950-51. We then converted the counts in each survey circle each year into "counts per party hour" (CPH) which takes into account survey effort. This is a typical metric used in analyzing or presenting CBC data. For each year, we also calculated and used the "proportion of surveys recorded" as an additional metric to assess whether the "commonness" of Sprague's Pipit has declined. We viewed all data from Winter 50-51 to Winter 87-88 as our historic data. Beginning in Winter 88-89, the annual number of surveyed CBC circles in our dataset increases to over 70 per year whereas previous to this date, the number surveyed per year is < 30 with a mean of 16 per year. Therefore, in order to achieve a large enough sample size (number of circles) for the historic data we had to combine the 38 years from 1950-51 to 1987-88. Thereafter, we calculated mean CPH (as an average over all survey circles) separately for each winter from 1988-89 to 2013-14 because there was a sufficient amount of data each year (**Figure 8**). Our dataset included 167 survey circles for SPPI (Texas – 110, Arizona – 13, New Mexico – 8, Louisiana – 26, Mexico – 9). Of course not every circle was surveyed every year. A

total of 2,798 yearly surveys were represented among the 167 survey circles (**Figure 9**). We plotted and visually assessed the temporal trends in the counts of SPPI (mean CPH values by year).

The historic benchmark count (mean CPH per year prior to 1988-89) for Sprague's Pipit is relatively high compared to the CPH values in recent decades (**Figure 10, top panel**). Much of this is likely due to Sprague's Pipits having a higher frequency (or proportion) occurrence in the historic data interval as compared to data for more recent decades (**Figure 10, bottom panel**). Particularly in last 15 years, CPH values for Sprague's Pipits have been somewhat variable, although steady overall in the time period. As a species comparison, we also obtained data for the American Pipit for Winter 88/89 to Winter 2013/14 for the CBC circles within Texas, Arizona, New Mexico, Louisiana, and Mexico (i.e., the same geographic area as for SPPI even though the range of AMPI extends beyond that of SPPI). We calculated annual mean CPH values for AMPI. In comparison to CPH values for the American Pipit (**Figure 11, top panel**), Sprague's Pipits are not nearly as common. Mean CPH values for Sprague's Pipits hover in the range of 0.03 - 0.15 whereas CPH values for American Pipits are in the range of 2.3 - 6.8.

If we assume that the CPH values of the CBC data are indicative of true abundance then the continental population of Sprague's Pipits appears to be stable in recent decades, although low particularly in comparison to American Pipits (**Figure 12**). For both species, there is also an assumption to some degree that the CBC survey methodology (volunteer observers thoroughly searching for multiple species on foot) is adequate. To some extent, the greater CPH values for American Pipits may be partly due to this species forming flocks during the winter which might be more easily spotted than solitary Sprague's Pipit individuals. Another caveat is that CPH is the best metric for converting the raw count data into a meaningful index of abundance. We also examined temporal trends based on two other metrics: counts per field observer and counts per mile traveled by foot. For both metrics and species, the trends were similar to those indicated by CPH. Our analysis revealed some evidence that Sprague's Pipits may have been historically more abundant than they currently are, assuming that abundance is accurately indexed by CPH. At the very least, observers appear to have been more likely to detect the species in any given survey circle in any given year prior to 1988-89 as compared to more recent years in which Sprague's Pipits appear to be found only intermittently in many circles despite the fact that more observers have participated in the surveys of recent years.

Identification and description of safe havens

We were able to verify the existence of a sizeable group of resident wintering Sprague's Pipits at nine protected areas. In addition, we recognize four additional protected areas that were not surveyed but likely do have pipits. Most of the protected areas are state parks or national wildlife refuges. As such they are afforded a relatively high level of protection by the administrating agency. See **Appendix C** for a detailed and complete report on the identification of these safe havens for Sprague's Pipit.

Table 1 – Results of the randomization test for significant differences between SPPI vs. AMPI, SPPI vs. RNDM near, and SPPI vs. RNDM any, for each of the NLCD cover types. "RNDM near" are random points within 8-10 km of a pipit location and "RNDM any" are random points anywhere within the wintering range of Sprague's Pipit. Reported values are mean percent cover around eBird locations. Results are shown only for the 1 km buffer sizes. In general, similar results were obtained for comparisons at the 2 and 5 km buffer sizes. Significant differences (*P* < 0.05) are shown in bold font and blue shading. Graphical display of these values is shown in Figure 6.

Characteristic	**Mean value**				**P-value**		
	SPPI	AMPI	RNDM near	RNDM any	SPPI vs. AMPI	SPPI vs. RNDM near	SPPI vs. RNDM any
Open water	7.36	10.17	2.98	1.97	**<0.001**	**<0.001**	**<0.001**
Developed open	6.01	7.58	5.21	4.19	**<0.001**	**0.021**	**<0.001**
Developed urban	6.45	12.05	7.53	3.53	**<0.001**	0.119	**<0.001**
Forest	8.13	13.32	11.98	14.60	**<0.001**	**<0.001**	**<0.001**
Shrub land	17.13	14.05	19.28	38.26	**0.002**	**0.064**	**<0.001**
Grassland/pasture	26.47	18.39	27.16	24.15	**<0.001**	0.332	**0.066**
Cropland	19.78	16.58	18.59	11.68	**0.016**	0.225	**<0.001**
Wetland	6.41	6.05	6.11	1.21	0.311	0.361	**<0.001**

Note: Buffered landscapes are not internally homogeneous. Each buffered landscape has thousands of 30 x 30 m pixels (1 km radius = 3,492 pixels; 2 km radius = 13,966 pixels; 5 km radius = 87,265 pixels).

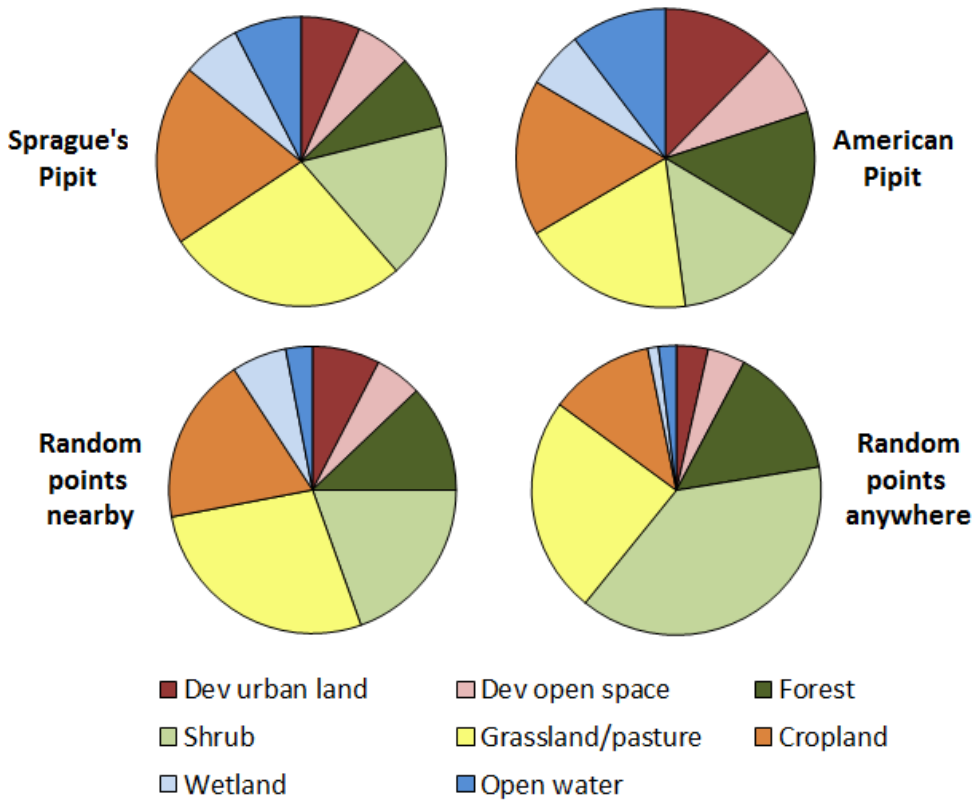
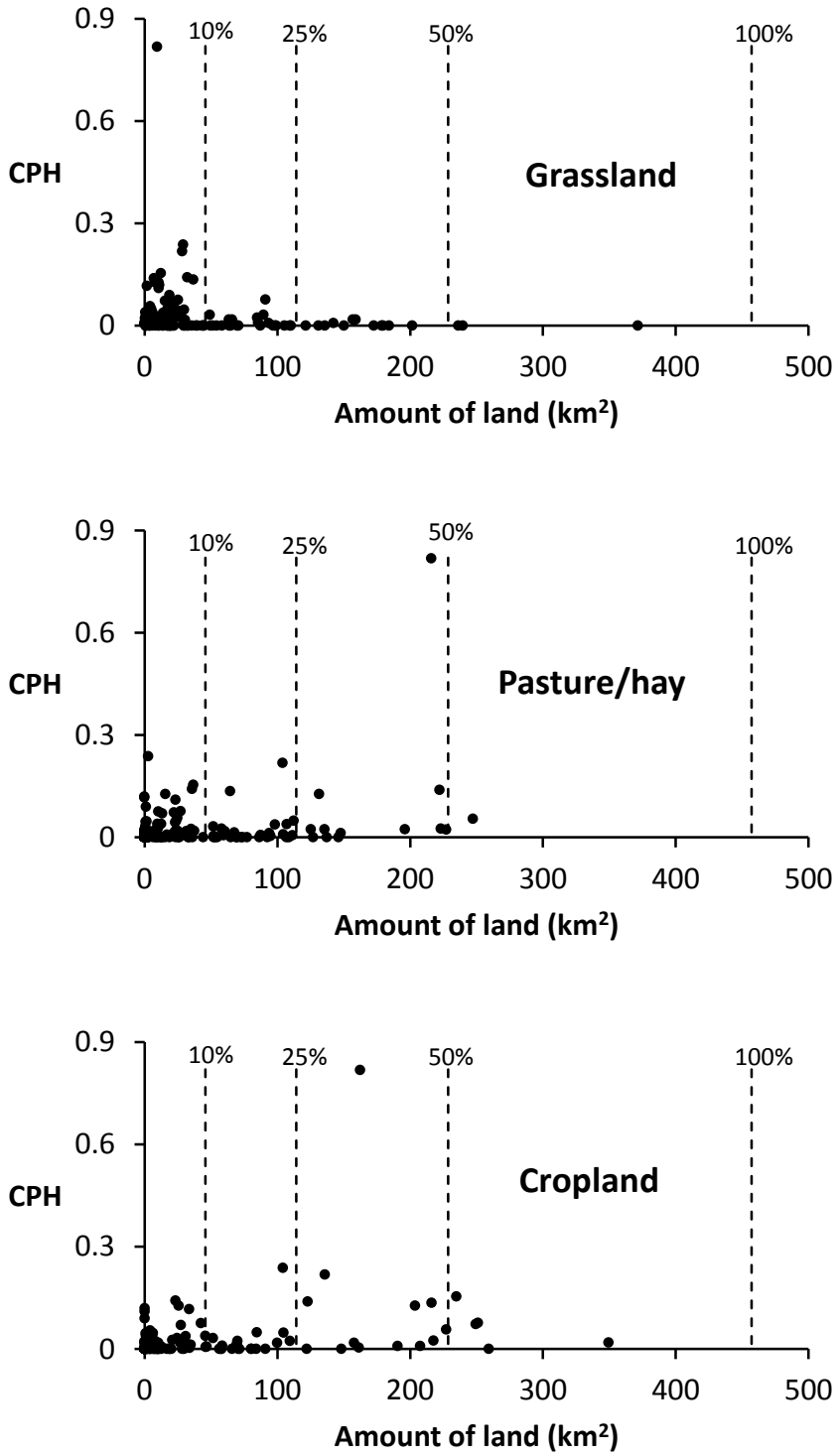


Figure 1 – Mean relative proportions of land cover types within the 1 km buffer areas surrounding Sprague's Pipit locations, American Pipit locations, nearby random points (within 8-10 km of a pipit location), and random points anywhere within the wintering range of Sprague's Pipit. See Table 1 for percent cover values and results of significance testing.



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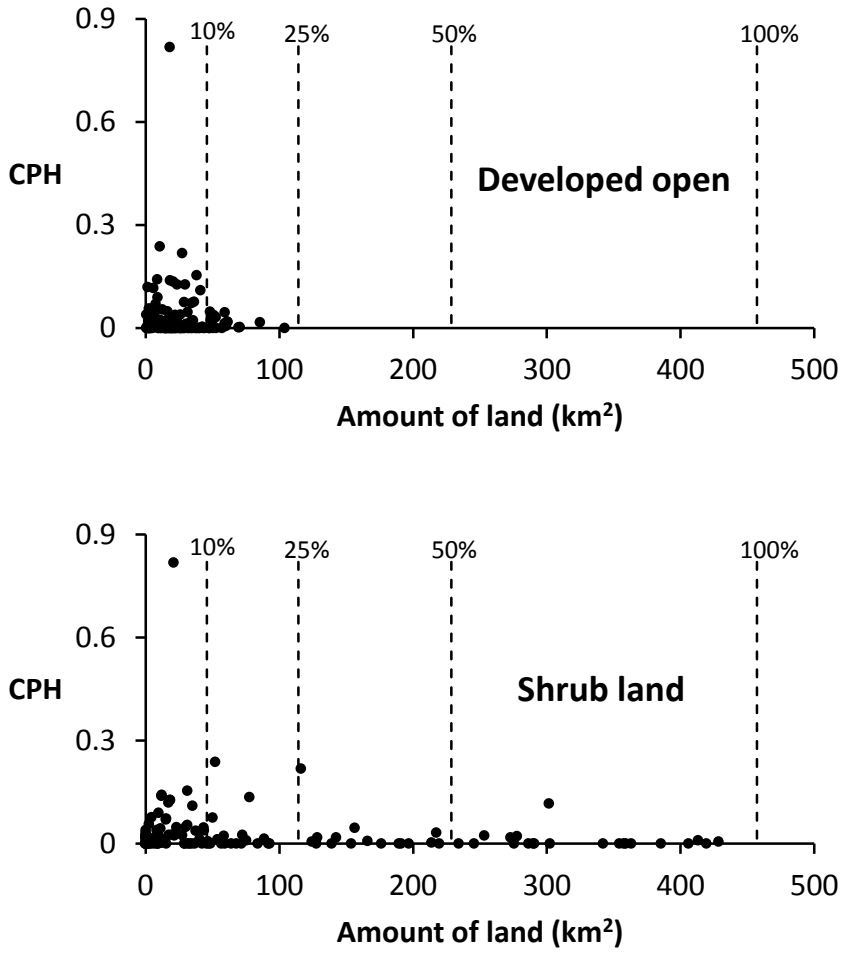
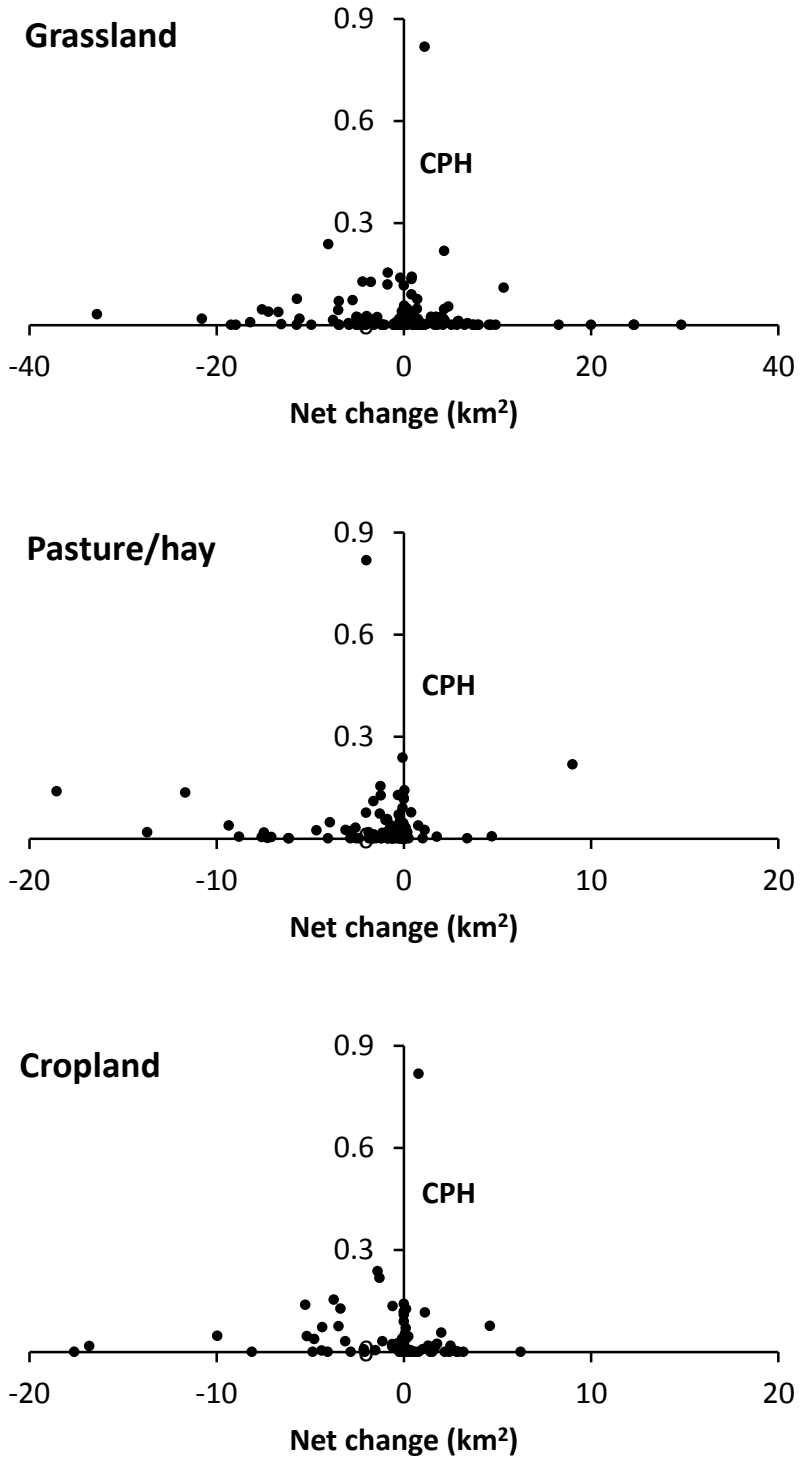


Figure 2 – Relationship between mean abundance of Sprague's Pipits (counts per party hour, CPH) and amount of land of a particular cover type (NLCD 2011) in CBC survey circles. CPH for each survey circle is presented as a mean over all the years (Winter 1998/99 to Winter 2013/14) in which the circle was surveyed, N = 129 circles. For comparison, the dashed vertical lines represent 10, 25, 50, and 100% of the area of a CBC circle (457.4 km2). Forest (not shown) had a pattern similar to shrub land.



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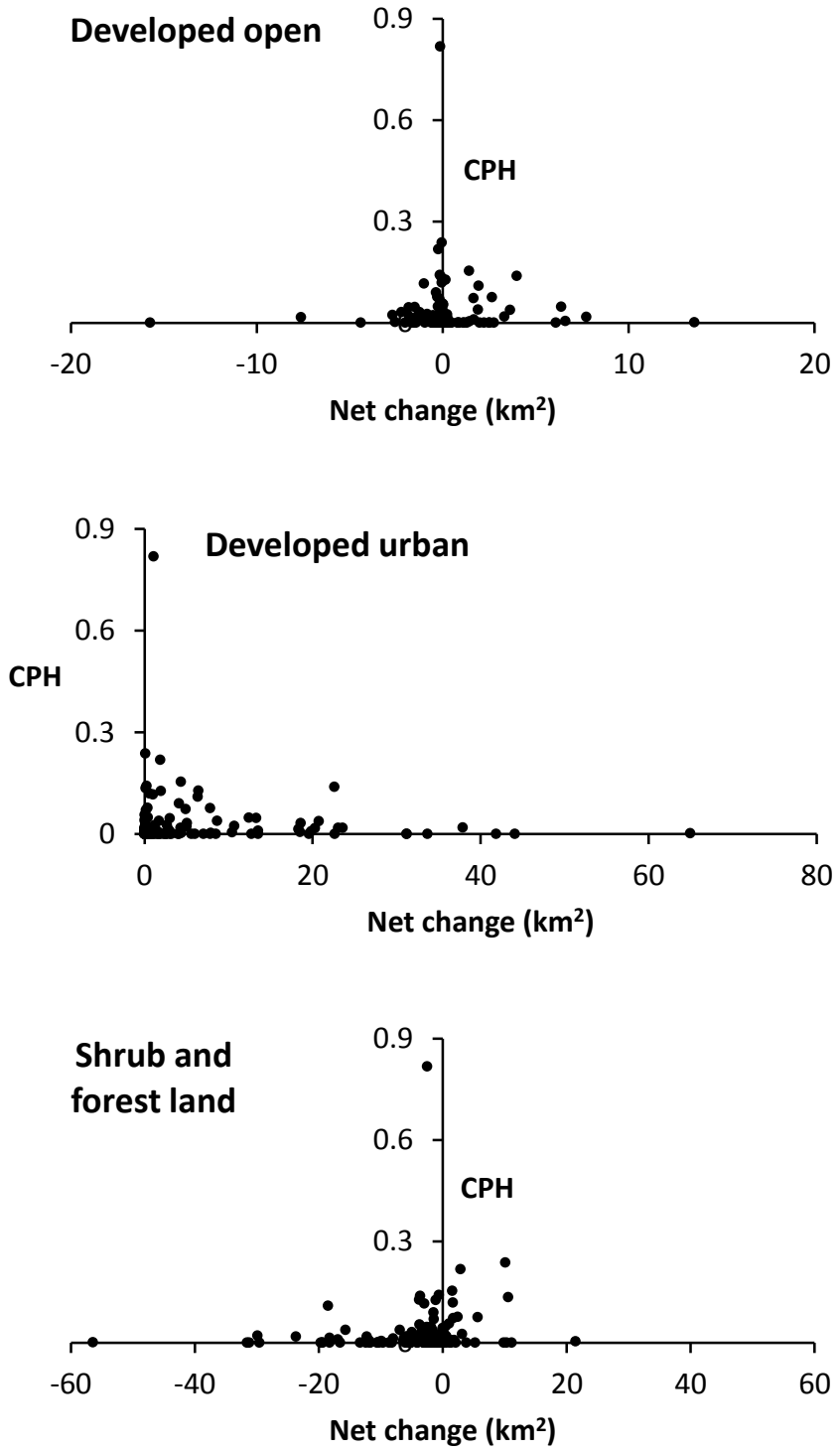


Figure 3 – Relationship between mean abundance of Sprague's Pipits (counts per party hour, CPH) and net change of a particular cover type in CBC survey circles. CPH for each survey circle is presented as a mean over all the years (Winter 1998/99 to Winter 2013/14) in which the circle was surveyed, N = 129 circles. Net change is shown irrespective of the cover type changing from (gains) or changing to (losses). Land cover data from NLCD "Land Cover From To Change 2001 to 2011" database.

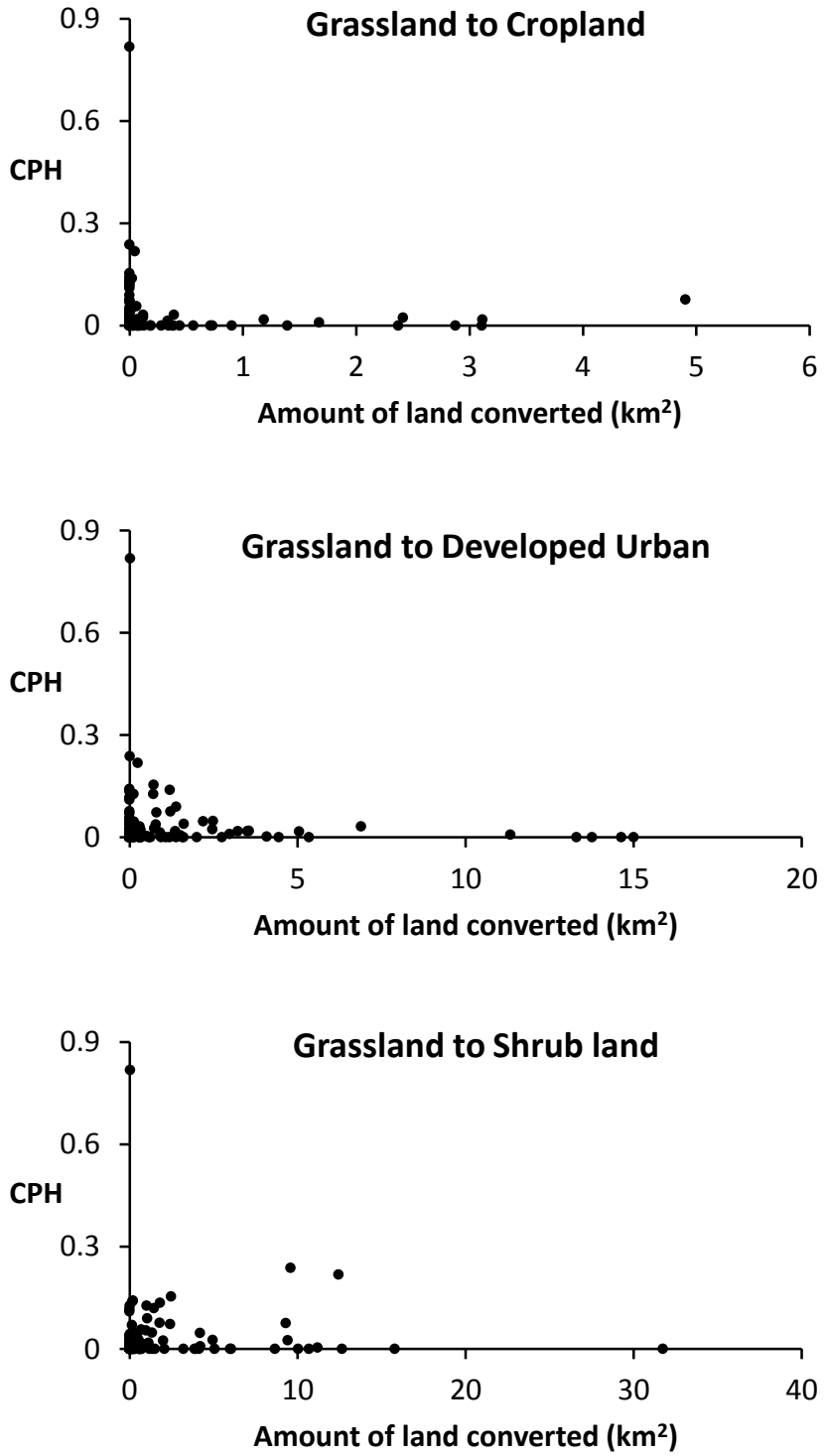


Figure 4 – Mean abundance of Sprague's Pipits (counts per party hour, CPH) in CBC survey circles in which grassland has been converted into either cropland, developed urban land, or shrub land. CPH for each survey circle is presented as a mean over all the years (Winter 1998/99 to Winter 2013/14) in which the circle was surveyed, N = 129 circles.

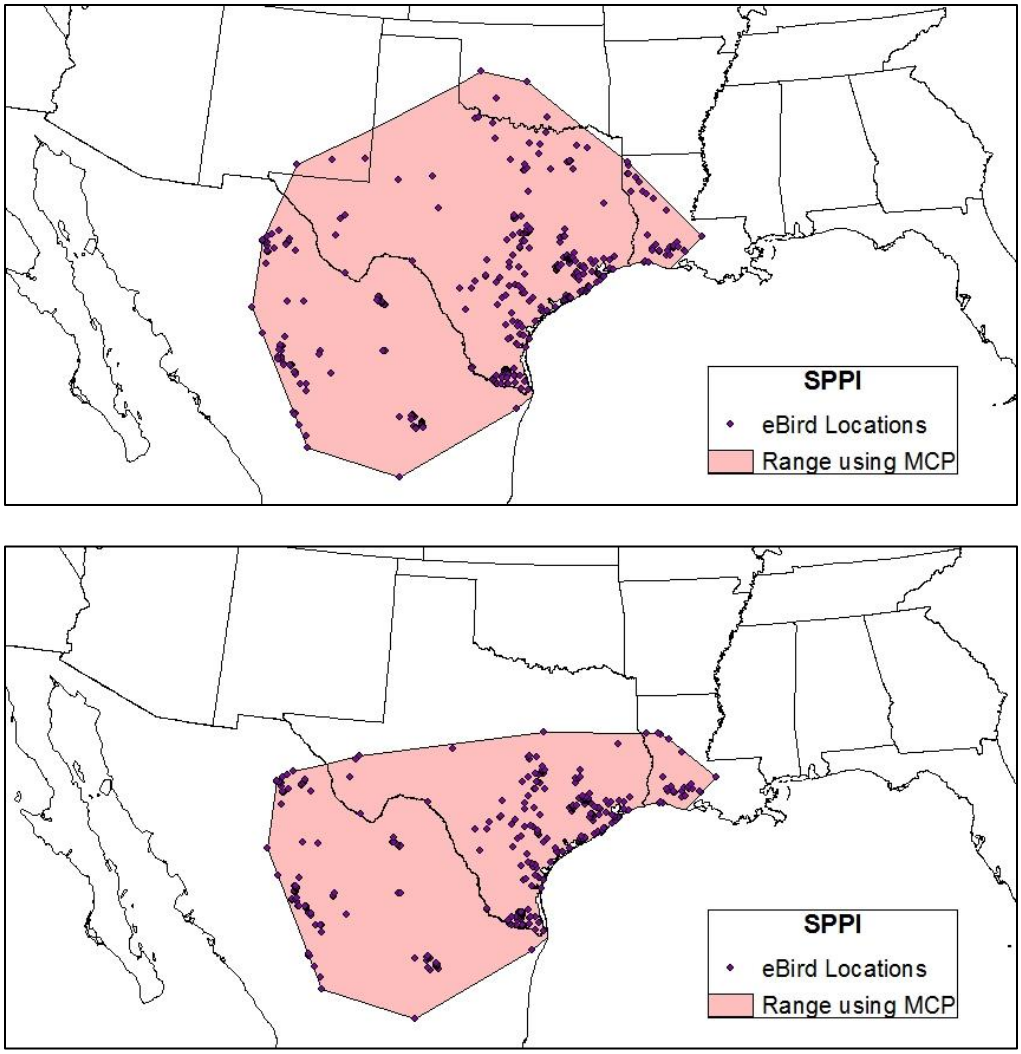


Figure 5 – Wintering range map of Sprague's Pipit based on eBird sightings (N = 437) between 2004 and 2015 for the months of December, January, and February (top panel). In the top map, majority of points (91%) are south of 32°N, hence that area is more likely to contain wintering pipits than is the area above 32°N. Range map (bottom panel) has all points north of 32°N removed and remaining points (N = 398) refitted with a minimum convex polygon.

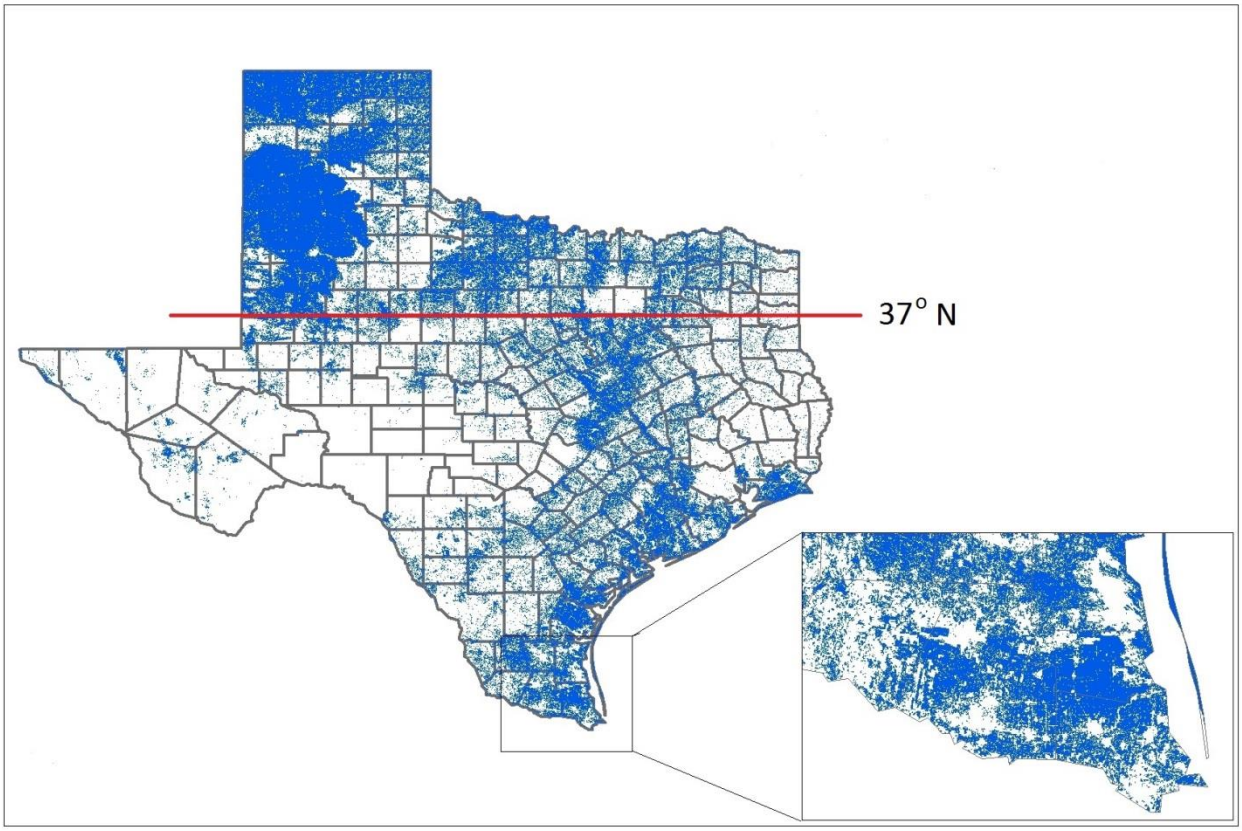


Figure 6 – Map of potentially suitable land cover for use by Sprague's Pipits wintering in Texas. This is the **inclusive version** of the model in which tree canopy cover was < 10%, impervious surface cover < 10%, and the combination of contiguous grassland/cropland/EHW/open-space was > 16 ha. Red line is the approximate location of the 37° N latitude line. The region south of this line can be considered the actual wintering region where pipits reside long-term (December – February).

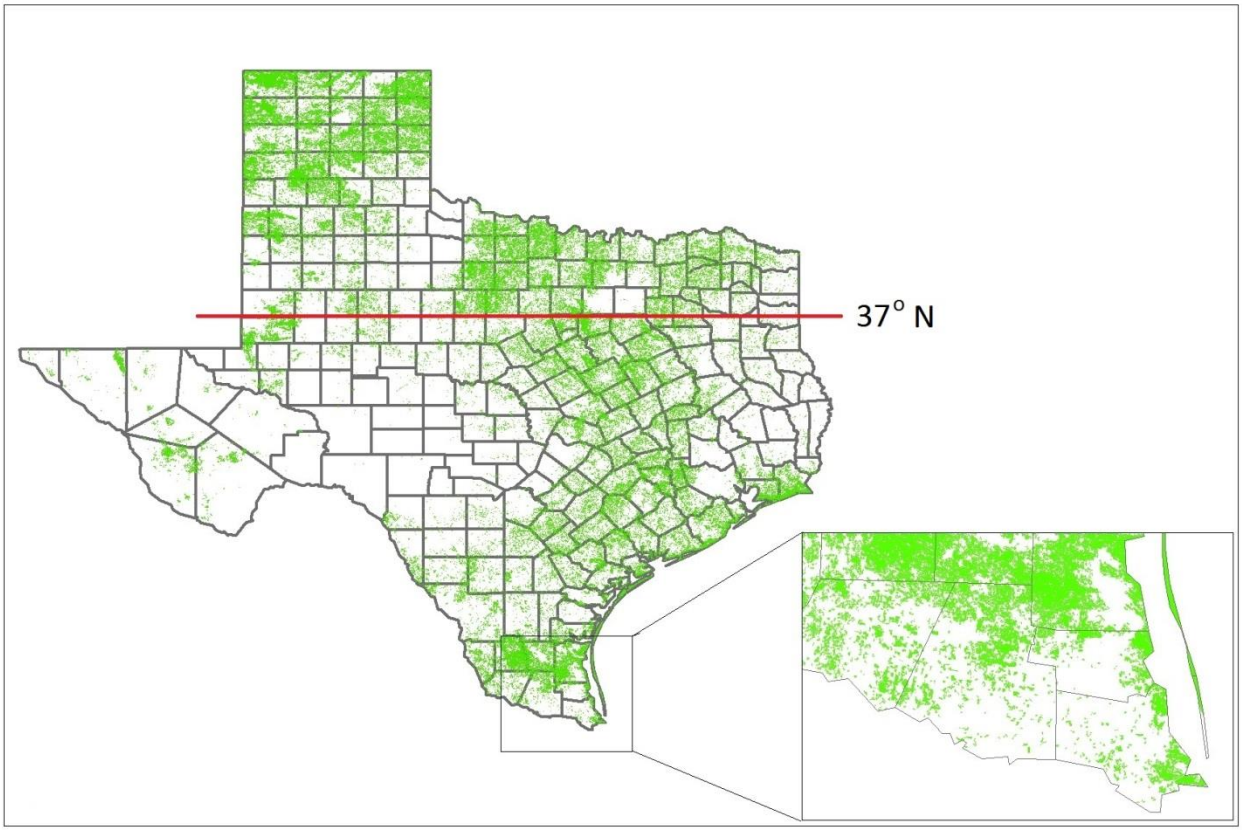


Figure 7 – Map of potentially suitable land cover for use by Sprague's Pipits wintering in Texas. This is the **restricted version** of the model in which tree canopy cover was < 1%, impervious surface cover < 1%, and the combination of contiguous grassland/EHW/open-space was > 40 ha. Red line is the approximate location of the 37° N latitude line. The region south of this line can be considered the actual wintering region where pipits reside long-term (December – February).

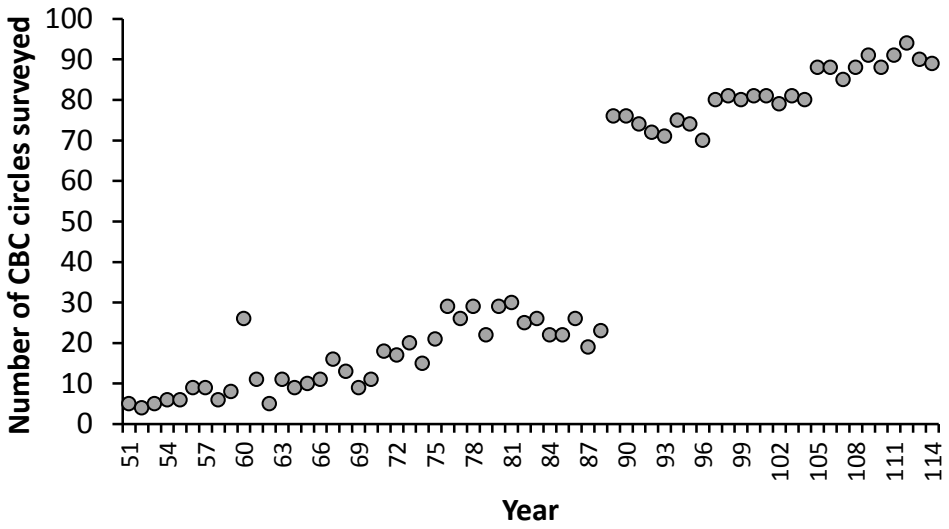


Figure 8 – Number of CBC circles surveyed each year from winter 1950-51 to winter 2013-14 for the SPPI dataset used in the analysis of temporal trends.

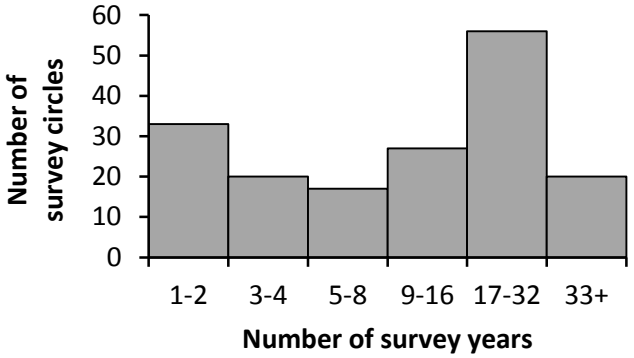
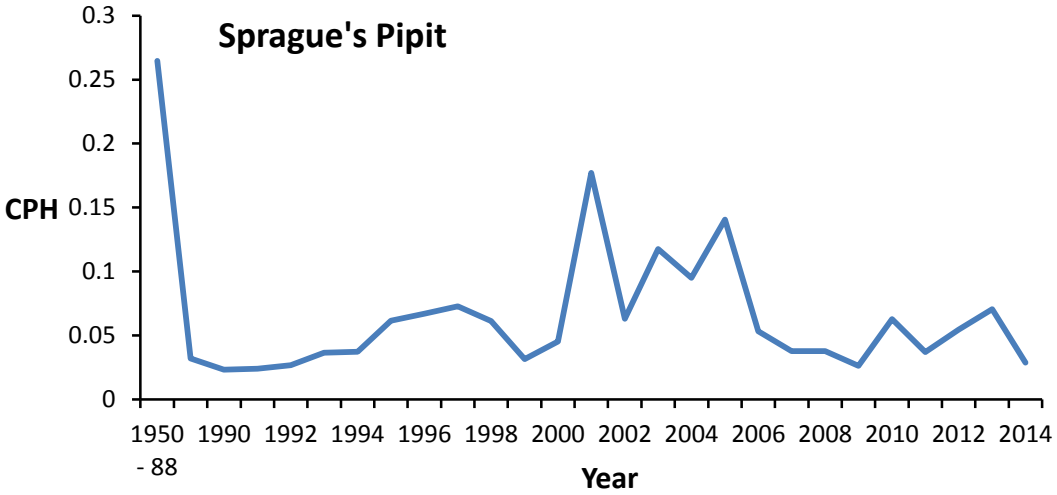


Figure 9 – Distribution of survey years per CBC survey circle for the SPPI dataset used in the analysis of temporal trends.



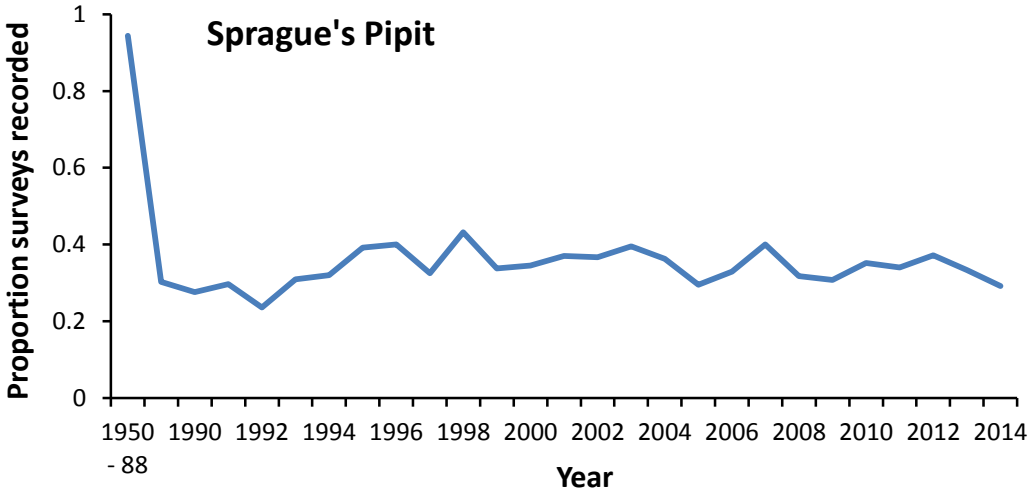


Figure 10 – Temporal trends in the CBC data for Sprague's Pipits. Trends are based on all survey circles where Sprague's Pipits were recorded in at least one year between 1950-51 and 2013-14. All circles used in the analysis were located in Texas, Arizona, New Mexico, Louisiana, or Mexico. Top panel shows data for CPH (counts per party hour) and bottom panel shows number of CBC surveys in the given year that recorded the species.

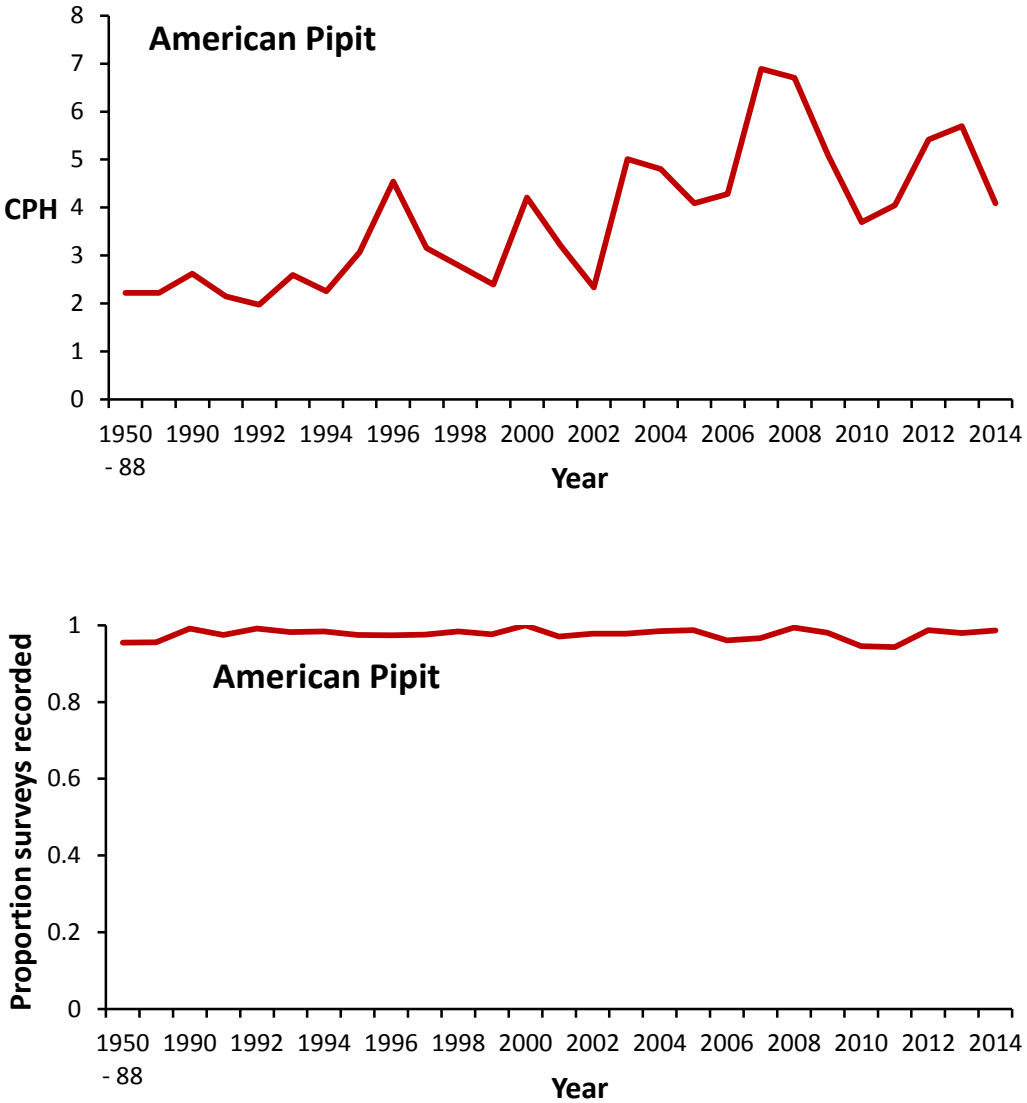


Figure 11 – Temporal trends in the CBC data for American Pipits. Trends are based on all survey circles where American Pipits were recorded in at least one year between 1950-51 and 2013-14. All circles used in the analysis were located in Texas, Arizona, New Mexico, Louisiana, or Mexico. Top panel shows data for CPH (counts per party hour) and bottom panel shows number of CBC surveys in the given year that recorded the species.

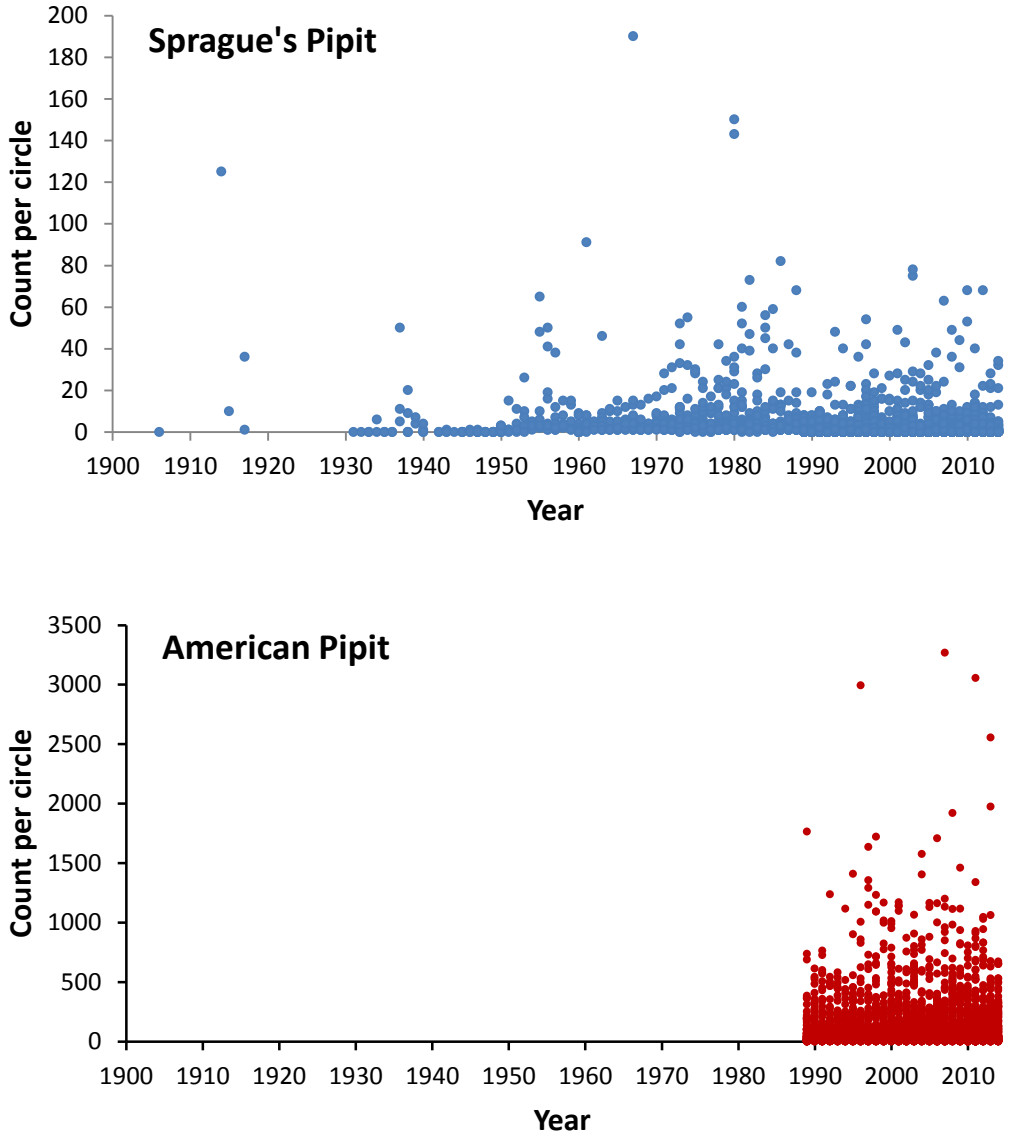


Figure 12 – Raw counts of Sprague's Pipits and American Pipits in CBC survey circles located within Texas, Arizona, New Mexico, Louisiana, and Mexico. Each data point represents a given circle surveyed in a given year. Data not analyzed for American Pipit prior to 1988-89.

Discussion (with comments that could be useful in listing decisions)

This project covered a lot of knowledge gaps regarding the wintering ecology of Sprague's Pipits in Texas. We obtained a more thorough understanding of their associations with (and avoidance of) particular land cover types at a landscape scale, including their ability to use (reside in or on) substrates that are essentially anthropogenic such as fallow crop fields and short or mowed grass on recreational fields, flood-control easements, and the dams of reservoirs. Of particular importance, these fields are typically expansive (on the scale of 10s to 100s of hectares or more), devoid of any kind of woody vegetation or vertical structure, and have ground-level vegetation (preferably grass) that is low (< 10 – 15 cm) with some amount of bare ground. We derived this knowledge partly from our landscape-level (GIS) assessment of land-cover associations as well as through the on-the-ground surveys in the process of identifying the pipit safe havens.

When on the breeding grounds in the northern Great Plains, Sprague's Pipits may be very much dependent on natural short-grass prairie without any kind of human presence in their immediate surroundings. When breeding and attempting to raise a brood of offspring, the physiological, time, and energy demands on pipits (as with any species with parental care) is probably much greater than on the wintering grounds where the sole selective pressure is simply to survive from day to day. Moreover, when on the wintering grounds, pipits have more leeway to relocate (i.e., fly off to another location perhaps 10 km or more distant) than they do on the breeding grounds which essentially would entail nest abandonment. Given this perspective, it makes sense in an ecological-evolutionary context that Sprague's Pipits are not as selective in their "habitat use" on the wintering grounds. This is not to say that pipits can survive well in an environment with a lot of human disruption. In our field surveys, we were always struck by how wary the pipits were even in areas (e.g., county parks and reservoirs) where they likely see humans on a daily basis. Their behavior and ecological needs are vastly different than the typical "backyard bird" species (e.g., grackles, doves, bluejays) typically seen in parks and around human habitation. In fact, it would be erroneous to conclude that Sprague's Pipits are in any way adapted or conditioned to be near human habitation or in any kind of areas highly modified by humans.

This report should not be viewed as a definitive and final assessment of long-term trends in the continental or local populations of Sprague's Pipits or landscape-scale habitat associations of the species. To date, our main finding from this research can be summarized as follows: In the USA portion of the wintering range, Sprague's Pipits seem to seek out wintering grounds so as to avoid areas with woody vegetation (shrub land, forest) and urbanization (suburban neighborhoods, towns, cities). Here we are conceiving of the "wintering grounds" as areas of several km^2 to 10s km^2 where individual birds will be residing for the majority of the winter (December through February). We do not know how much individual resident birds move on a daily or weekly basis while resident on the wintering grounds (to our knowledge no one has published a study). However, in general, we assume that an individual Sprague's Pipit might move as much as several km in a given day but remain in the same vicinity (e.g. an area of 10 km^2 or less) from day to day and week to week. Perhaps "long distance" relocation (e.g., 10 -

50 km) of some individuals among appropriate wintering areas also occurs on occasion. Our results do not suggest as strongly that Sprague's Pipits intentionally seek out natural (native) grassland for wintering. Although, based on the natural history of the species and its long-term evolution as a grassland species inhabiting the Great Plains, grassland probably is the ideal and most preferred habitat type. Sprague's Pipits appear to be capable of wintering in or using a variety of open (no woody canopy) cover types such as grassland, cropland (fallow during the winter), pasture and hayfields, and developed open space such as extensive grassy areas (e.g., low-use recreational fields and greenspaces) in large parks and easements (e.g. dikes). Although some pipits certainly use such human-modified areas, we do not know if their over-winter survival and physiological condition prior to spring migration is equivalent to that of individuals primarily wintering in natural grassland; again, no one has conducted the relevant study. Given these findings, shrub encroachment and development of any woody vegetation (in areas that are otherwise devoid of woody vegetation) could be a definite threat to Sprague's Pipits on the wintering grounds. In our study, we did not estimate rates of broad-scale shrub encroachment so we cannot comment on that.

Sprague's Pipits appear to have a very strong aversion to any kind of woody or other vertical structure in their immediate surroundings. From a purely ecological perspective this is an interesting finding. It is probably a legacy of the species having evolved and subsequently having existed in the vast treeless western region of the Great Plains for millennia. Sprague's Pipits are typically solitary on the wintering grounds and of course in pairs on the summer breeding grounds – they very rarely form cohesive flocks. When not flying, they spend all their time on the ground walking about while foraging or sitting relatively cryptic and motionless. They do not perch on any kind of structure, not even on tall grass stalks as do many other grassland birds. They are found nearly exclusively on a substrate consisting of short grass (< 10 cm) and perhaps some bare ground with scattered taller grass clumps. They are typically very wary of large approaching objects (e.g., humans) and seem to be very vigilant. Their complete avoidance of being near (within 50 m) of any solitary vertical structure or near (within 150 m) of any extensive vertical structure (e.g., forest edge) is probably an anti-predator adaptation. They rely on sight to detect an approaching ground-based predator (e.g., coyote or fox) and probably have evolved a behavior to have a clear unobstructed line of sight and to "automatically" avoid getting close to any type of woody structure that might conceal an approaching predator. In addition, given that they do not perch, they have no use for trees, shrubs, or other standing objects as perches. Moreover, the lack of flocking or colonial living of any kind precludes Sprague's Pipits from relying on conspecifics to detect predators.

Although the strong aversion to woody structures is interesting with regard to the ecology and evolution of Sprague's Pipits, this behavior could present unique conservation challenges. With the goal of maintaining good wintering habitat on a piece of land (public or private), tall woody vegetation (> 1 m) should be eliminated as thoroughly as possible. In addition, the ground-level vegetation must be kept low (< 15 cm and ideally < 10 cm). Essentially, any management practice that mimics the native short-grass prairie will likely lead to useable pipit habitat given that the habitat area is large and contiguous enough (e.g., 16 ha or more) – and an added benefit is that the habitat does not necessarily have to have natural (native) vegetation.

Regarding population trends and current population size of Sprague's Pipits on the wintering grounds, assessments are hampered by the lack of good long-term (decades) data in a sufficient amount for a definitive analysis. In particular, estimating historic (pre-1989) population size is difficult given the relative lack of data. However, there are more data (Christmas Bird Count) for recent decades. Since 1989, the wintering population of Sprague's Pipits appears to have been relatively stable, fluctuating somewhat from year to year but without any discernible trend toward increasing or decreasing. Of course, an important assumption here is that the CPH metric derived from CBC data is a reliable indicator of wintering population size. Even though the wintering population of Sprague's Pipit is relatively stable, the species is not very common. Of all North American species, the American Pipit is most-closely related to the Sprague's Pipit and relatively similar in its ecological niche. American Pipits are far more abundant than Sprague's Pipits and the difference is not completely due to the latter possibly being more easily detected since it often occurs in flocks. Since 2006, CPH values for Sprague's Pipit have averaged about 0.05 per year. Taking the inverse of this value, it takes on average one person searching for 20 hours (or two for 10 hours and so on) to find one Sprague's Pipit in a CBC survey circle.

Given that the Sprague's Pipit is uncommon and occurs at very low densities and considering that it requires a relatively specialized method of surveying (walking line transects to flush individuals), attention needs to be devoted to tracking its population size (see next section). The possibility remains that it could undergo population declines that are difficult to detect based simply on analyzing data from the standard continental databases such as North American Breeding Bird Survey, eBird, and Christmas Bird Count.

Additional Research Needs

At the moment there are not any urgent *research needs* per se. Related to tracking possible changes in population size, we (conservation practitioners and other stake holders) need a species-specific annual survey program. This program could use the line-transect-flush method of surveying and should be conducted at a sufficient number of permanent monitoring locations (e.g., 30 - 60) in Texas and perhaps adjacent states. Ideally, the monitoring sites would be surveyed multiple times per winter given the still unknown possibility that Sprague's Pipits are fairly nomadic on the wintering grounds. **The PI of the study and author of this report urges Texas Parks and Wildlife Department to consider creating a permanent biologist position (e.g., Natural Resources Specialist at Level IV) to coordinate such a program not only for Sprague's Pipits but also the group of about 6 – 12 other grassland bird species that winter in Texas.** In addition, the position should come with a sufficient internal budget for conducting monitoring, management, and research activities. The position could also entail many other job duties related to the conservation of migratory grassland birds wintering within the state.

Literature Review

A very extensive and thorough literature review was conducted for this study. See **Appendix B** of this document.

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Appendix A – Response to TAP comments on quarterly research activities and progress
(*Below is the text of TAP reviews that accompanied each quarterly report. In many cases, the TAP members did not recommend a specific change or offer any suggestions/advice and thus an explicit response from the PI was not necessitated or included.*)

Quarterly Report 1 – December 11, 2014

1. All three TAP members commented on the use of eBird and CBC databases with regard to being cautious in the use of the data. In particular, they recommend taking into account survey effort as this can vary spatially (geographically) in the database. My response: I'm aware of the limitations of eBird and CBC data. In advance of any analysis, I will filter the data to remove those data that are not appropriate for analysis (e.g., data that do not give a precise enough geographical location, data that are essentially repeat visits to exact same location during very short period of time). During the analysis (modeling) phase, I will control for variation in survey effort. For example, variation among counties can be controlled by including total number of submitted checklists as an additional variable in the analyses or standardizing to total number of checklists. Admittedly, the proposal does not completely convey that I am aware of all the limitations/caveats in using eBird data – and that I will be cautious in using these data.
2. Reviewers were somewhat concerned about the use of American Pipit as a "comparison" species – main concern was that eBird observers cannot distinguish the two species. My response: to the contrary, eBirders that list both species are distinguishing the two. Granted there could be some error (cross-identification) of the two species. Nonetheless, that error does not negate the use of AMPI as a reference species against which to compare SPPI. However, as noted by Jones, there could be other reference species – I will explore that possibility.
3. Jones was concerned about estimating abundance in the field and suggested that a method to also estimate detection probability would be needed. My response: I generally agree with her. However, none of the project tasks (goals) require the precise estimation of abundance at field sites. Rather, presence/absence data will suffice for Task #4, and for Task #5 I will use a CBC-style exhaustive area-based search. Jones mentions area- and time-constrained searches – this is what we will employ for Task #5 (again, proposal was a bit vague on details).
4. Giocomo recommends the use of a Texas-specific land cover database rather than the national level NLCD database. My response: I am aware of the database that he recommends although I have not used it. I will look into whether it is a more appropriate source of land cover data.
5. Jones suggests that the development of a monitoring program seems a bit too grand. My response: Again, the proposal was not specific enough about this. Referring to Task #6, the emphasis should be on testing out (in the field) creative methods of surveying for Sprague's Pipit that induce the birds to flush with the possibility that we might find a method that could be used in future repeat field surveys (i.e. monitoring). Proposal was not meant to convey that a state-wide monitoring program would be developed and put into action. Rather, I will access the feasibility of possibly developing an eBird-style program wherein highly skilled observers (eBirders) are recruited to specifically survey for SPPI.

Quarterly Report 2 – February 26, 2015

Members responded to the report with the following:
Stephanie Jones – "I looked these over, and they seem fine. What are you going to do with #4?"
My response – Task #4 is still scheduled as planned for winter season 2014 – 2015.
Rich Kostecke – "Looks fine to me, Joe. No questions at this point."
Jim Giocomo – "The action items in the quarterly report and the expected timelines are reasonable to achieve objectives at this time. Minor hiring issues dictated by the academic calendar are typical in these kinds of projects. From my limited direct experience specifically with Sprague's Pipit in the field, they seemed to be fairly easily flushed in open fields with limited ground cover. Changes to effort allocation in Task 6 seem reasonable."

Quarterly Report 3 – June 16, 2015

All of the TAP members (Rich Kostecke, Jim Giocomo, Stephanie Jones) stated that they had read the progress report and did not see any major issues with the research currently completed.

Quarterly Report 4 – October 23, 2015

Rich Kostecke (email of Sept 18, 2015) commented: "Looks good. No real questions at this point."
My Response: Rich is familiar with the project beyond just having read the report. He was present at the Scientific Roundtable meeting organized by Comptroller's Office on September 1. During that meeting, I verbally presented the report and also took questions.
Jim Giocomo (email of Sept 30, 2015) commented: "Looking over your recent report, I saw two things you might want to emphasize. First, for the CBC observers, there is a premium placed on the number of species found in a circle. This means that traditionally difficult to find birds like SPPI would probably be scouted prior to the CBC count day or would have extra effort to explore habitat types for a record. This should increase the likelihood of detection and have an effect on the detection probability (positive effect?) The CBC analysis looks reasonable. Second, is there any possibility of looking at large grasslands or aggregates of contiguous large areas of grassland and cropland (like APC NWR) to see if that is related to the CBC or ebird observations of SPPI. Maybe getting at the fragmentation/connectivity , but you question?"
My Response: Jim makes a good point about how CBC observers might "go out of their way" to find and record Sprague's Pipit in the survey circles. On the one hand, this is good if it means few birds get overlooked. On the other hand, might make it difficult to compare counts for SPPI to those of other species that are not "targeted" as much. In his second comment, Jim is referring to the need to examine spatial arrangement and patch properties in addition to overall amount of habitat. The county-based modeling that we are currently doing (not included in the most recent progress report) will take into account habitat patch size and connectivity.
Stephanie Jones: As of October 23, Stephanie had not provided any comments on the progress report.

Quarterly Report 5 – December 10, 2015

TAP members did not raise any particular concerns about the research to date.

Quarterly Report 6 – March 9, 2016

On February 29, Rich Kostecke replied via email:"Looks fine to me, but can you briefly remind me of how protected areas were selected? Obviously there were a lot of publicly accessible areas that weren't selected. Rich"
Which I then replied: "Hi Rich, Essentially John combed through eBird checklists to see if there were any nearby to a long list of protected areas. In other words, we intentionally targeted places that we thought would have pipits and then went to survey to verify and to get a better estimate of numbers. So, selecting the survey locations has not been random – something we'll need to keep in mind when we write this up. Joe"

On March 3, Jim Giocomo replied via email: "It looks like the project is making progress. When you say,"Thus, the model is likely overestimating the availability of suitable habitat as it might currently exist (in real time). Nonetheless, the model can be trusted to indicate areas that could become more suitable if managed in a way to control grass height such as frequent mowing, fire, and grazing."... are you planning to include best management practices (BMP) or descriptions of idea management conditions based upon observations to be paired with the "potential habitat" you are creating. Overestimating grassland habitat based upon satellite derived habitat data is a common problem in large scale projects, because of the quick changing (annually) habitat conditions through succession (plants growing up to increase habitat height and diversity) and management (usually reducing habitat height through mowing or prescribed fire). Having a potential habitat map with species specific BMPs can help target management for priority early successional species like Sprague's Pipit. Jim"

Which I then replied: “Hi Jim, Not sure yet whether my final project report to Texas Comptroller will give specific details on best management practices. They did not include that in the deliverables, nonetheless, I will make clear what we’ve learned about its preferred habitat here in Texas. I agree with you about “grassland” categories in land cover databases; for sensitive (picky) species not all grassland habitat is equal. For Sprague’s Pipit, the critical factor seems to be grass height being less than about 15 cm and sparse enough that there is some bare ground or at least areas with really low grass (also they strongly avoid even the slightest woody cover). We are taking a lot of pictures of the sites that we visit so as to also get a visual indicator of good pipit habitat – this is often easiest for landowners to understand and use. Thanks for your comments and idea about discussing BMPs – we’ll likely include that to some extent. Joe”

On March 8, Stephanie Jones replied via email:“Hi Joe: I read the two documents (you are correct, Attachment A is the more interesting) and do not have any specific comments. You seem to be doing exactly what was proposed, and progressing nicely. I look forward to the more extensive report in June. South Padre Island results do not seem surprising to me, but I agree Laguna Atacosa NWR is. Best, Steph”

Quarterly Report 7 – June 24, 2016

TAP members did not raise any concerns or have any suggestions on project activities.

Quarterly Report 8 – September 16, 2016

No meetings or correspondence with TAP during this period as there was no new information/findings to report on.

Quarterly Report 9 – January 11, 2017

No meetings or correspondence with TAP during this period as there was no new information/findings to report on.

End of Appendix

Appendix B

Review of the Scientific Literature on Sprague's Pipit

Report prepared by Joseph Veech and John Muller (Texas State University) for the State of Texas Comptroller's Office – Endangered Species Research Program (Date: 11-17-2015)

This report presents a comprehensive review of the scientific literature on research related to the general ecology of Sprague's Pipits. Relevant documents were located using keyword searches in ISI Web of Science database and Google Scholar. There is no guarantee that the set of documents is complete and exhaustive – although the search was thorough in that both sources (WoS and GS) cover much literature including some that is not published in journals.

This literature review is intended as an "easy-to-use" guide to documents describing research on Sprague's Pipits. Characteristics of each study are described and classified in the guide. The literature review intentionally does not present the results and conclusions of each study given that this would be second-hand interpretation, might inadvertently leave out some important results, and add considerable length to the review. Readers wanting more details on the results and conclusions of each study are advised to consult the relevant documents.

Based on this literature review, research on Sprague's Pipits can be characterized in the following ways. **(1)** The vast majority of research effort has occurred on the species in its summer breeding range in the north-central USA and south-central Canada. Of the 64 documents that were reviewed, 52 (81%) describe studies that occurred exclusively at locations in the breeding range and during the spring and summer. **(2)** Most studies (77%) do not focus exclusively on Sprague's Pipit but rather include other grassland bird species, sometimes only a few or up to 20 or more. **(3)** Habitat data are often collected (58% of studies), particularly with regard to assessing height and density of grass as well as density of shrubs or proximity to shrubs. Also, of note, researchers often measure litter depth that obviously could be important to a primarily ground-dwelling bird that forages for insects on the ground. **(4)** Abundance (and less often density) is typically estimated as part of the research project, 45% of the studies. However, the actual estimates of abundance are not often presented or easily deduced from the published document. Except possibly citation [1] in the list, there have not been any studies that specifically attempted to estimate population trend – this is obviously a more difficult and time-consuming task that requires abundance data over multiple years. The North American Breeding Bird Survey does have the data to estimate population trend and it has been done for Sprague's Pipit along with hundreds of other species in the general assessments of trend in BBS data regularly produced by the BBS staff. But there is no study of population trend as derived from non-BBS data.

(5) There have been 15 (23%) studies of nest survival that sometimes include estimates of productivity (nest density) and dispersal. Assessing dispersal almost always requires hands-on work such as capturing birds and thus these types of studies are not as common. Also, finding nests can be difficult in studies of grassland birds and be labor-intensive (e.g., rope-dragging); this partially explains the relatively low numbers of studies on nesting and nest survival. **(6)** Studies that assess the effect of anthropogenic factors on Sprague's Pipits are becoming relatively more common. In particular, effects of livestock grazing, grassland conversion to cropland, oil and natural gas extraction, and road infrastructure have been studied. Again though, the studies do not always present a clear and quantifiable effect, but rather just interpret qualitatively the outcome of statistical models. **(7)** There is some standardization of field methods among researchers studying Sprague's Pipits. For example, 5-minute point counts that survey a circle of radius 100 meters is the most common method for estimating abundance, particularly on the breeding grounds. Males of the species have a very distinctive song and upward spiraling flight pattern that can be detected during a point count. Surveys on the wintering grounds are more likely to use some type of method (such as walking line transects) that require flushing the birds – perhaps because during the winter the birds are not involved in courtship and hence are less active and less vocal.

Overall, given that Sprague's Pipit is a species of conservation concern for various natural resource entities, government agencies, and conservation organizations, there needs to be more research on the species. In particular, studies that could assess density (on both breeding and wintering grounds) and population trend are very worthwhile and are always needed. With regard to habitat requirements and preferences, our knowledge is becoming fairly complete, especially with regard to the breeding grounds. By their very nature, Sprague's Pipits are not the kind of species that can adapt to intensive human modifications of the environment. As such, there will always be a need for studies of the anthropogenic factors that affect their populations, and ideally efforts will be made to find ways to mitigate any negative effects.

Guide to Documents

Characteristics of each study are summarized below. Most characteristics are self-explanatory. Note that "Focus of study on SPPI?" refers to whether the study was *exclusively* focused on Sprague's Pipits or not. "Field methods used" refers to the procedures used to obtain the bird-based data (e.g., abundance, survival, dispersal) not habitat-based data. There are 64 documents summarized, each has a unique numerical identifier in the upper left corner that corresponds to the numbering in the bibliography section (see that section for full references). We were able to obtain the following theses/dissertations but did not include them in the review due to the strong possibility of redundancy with published studies that were included in the review: MS Sliwinski (University of Manitoba, 2011), MK Lipsey (University of Montana, 2015), EM Pipher (University of Manitoba, 2011), J Champagne (University of Manitoba, 2011), K Molloy (University of Manitoba, 2014), K Mozel (University of Manitoba, 2010), AE Henderson (University of Saskatchewan, 2014), and LC Kovatch (University of Regina, 2015).

[1] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Macias-Duarte et al. 2011	Report	Mexico	5 years	Wintering	No
Analysis of habitat?		Yes, grass height and percent cover, percent bare ground, shrub cover			
Estimates of abundance, density, or population trend?		Yes, abundance and density (population trend indirectly estimated by comparing densities over the five-year period).			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Not directly analyzed, but report briefly mentions overgrazing, shrub encroachment, and land conversion as factors negatively affecting natural grassland areas			
Field methods used		Walking 1-km line transects and distance sampling			
Notes		This is the report on "Wintering Grassland Bird Densities in Chihuahuan Desert Grassland Priority Conservation Areas" by the Rocky Mountain Bird Observatory			

[2] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Pool et al. 2012	Report	Mexico	5 years	Wintering	No
Analysis of habitat?		See [1] above.			
Estimates of abundance, density, or population trend?		See [1] above.			
Estimates of survival or productivity?		See [1] above.			

Estimates of individual dispersal?	See [1] above.
Analysis of anthropogenic factors?	See [1] above.
Field methods used	See [1] above.
Notes	This is the "Chihuahuan Desert Grassland Bird Conservation Plan" produced by the Rocky Mountain Bird Observatory. It is a more detailed assessment than [1] above, but should not be considered as a completely separate analysis.

[3] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
USFWS 2008	Report	N/A	N/A	Breeding	No
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		Yes but indirectly, for each Bird Conservation Region, the report provides a list of species of conservation concern. SPPI is on the list for two BCRs (breeding) and eight BCRs (non-breeding) out of a total of 35 BCRs. *See note below.*			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No, not directly, but only as derived from other conservation assessments. *See note below.*			
Field methods used		N/A			
Notes		This is the "Birds of Conservation Concern" report that is derived from several continental-scale population assessments, including the Partners-in-Flight North American Landbird Conservation Plan. The report does not present any *original* data or analysis.			

[4] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Bogard and Davis 2014	Journal paper	Saskatchewan	2 years	Breeding	No
Analysis of habitat?		Yes, percent cover of grass, vegetation height			
Estimates of abundance, density, or population trend?		Yes, abundance per point count location			

Estimates of survival or productivity?	No
Estimates of individual dispersal?	No
Analysis of anthropogenic factors?	Yes, distance to gas well and density of gas wells
Field methods used	Point counts of 15-minute duration
Notes	None

[5] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Crawford et al. 2009	Journal paper	Saskatchewan	N/A	Breeding	Yes
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No			
Field methods used		N/A			
Notes		This study identified genetic markers that could be used in future studies of parentage, dispersal, and population structure.			

[6] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Dale et al. 1997	Journal paper	Saskatchewan	4 years	Breeding	No
Analysis of habitat?		Yes, comparison of hay fields to native grassland			
Estimates of abundance, density, or population trend?		Yes, abundance. Also used an index of productivity which was the proportion of sample plots that showed some evidence of reproduction occurring.			
Estimates of survival or productivity?		Yes, nest survival monitored although not intensively.			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, mowing of hay fields			

Field methods used	Point counts of 5-minute duration
Notes	None

[7] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Davis 2003	Journal paper	Saskatchewan	5 years	Breeding	No
Analysis of habitat?		No analysis of habitat. Monitored nests were all on native pasture with light to moderate grazing.			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		Yes, nest survival analyzed, particularly with regard to predation (possibly by voles) and parasitism by cowbirds.			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No			
Field methods used		N/A			
Notes		None			

[8] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Davis 2004	Journal paper	Saskatchewan	2 years	Breeding	No
Analysis of habitat?		Yes, habitat fragmentation, patch size, edge to interior ratio of patches. At local plot level, vegetation height, litter depth, distance to nearest shrub.			
Estimates of abundance, density, or population trend?		Yes, abundance and probability of occurrence			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Indirectly in that human activities cause fragmentation			
Field methods used		Point counts of 5-minute duration			
Notes		None			

[9] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Davis 2005	Journal paper	Saskatchewan	4 years	Breeding	No
Analysis of habitat?		Yes, vegetation height, depth of ground litter, distance from nest to nearest shrub			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		Yes, nest survival			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No, but some study sites in lightly grazed pastures			
Field methods used		Rope dragging and visual searching used to find nests			
Notes		None			

[10] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Davis 2009	Journal paper	Saskatchewan and Manitoba	5 years	Breeding	Yes
Analysis of habitat?		No, but information on pasture and hayfield size and plant species composition is reported.			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		Yes, nest survival (nests monitored intensively to record hatching and fledging dates and nest initiation).			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No, not directly, but pastures and hayfields were grazed and mowed.			
Field methods used		Rope dragging and visual searching used to find nests, mist-netting used to capture adults			
Notes		None			

[11] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Davis and Fisher 2009	Journal paper	Saskatchewan	2 years	Breeding	Yes
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		Yes, nestling and juvenile survival			
Estimates of individual dispersal?		Yes			
Analysis of anthropogenic factors?		No			
Field methods used		Rope dragging and visual searching used to find nests, radio-telemetry on juveniles			
Notes		None			

[12] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Davis et al. 1999	Journal paper	Saskatchewan	1 year	Breeding	No
Analysis of habitat?		Yes, vegetation height, litter depth, distance to nearest shrub			
Estimates of abundance, density, or population trend?		No, but abundance indirectly estimated as percent occurrence at point counts			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, grazing intensity, natural vs. manmade habitat types			
Field methods used		Point counts of 5-minute duration			
Notes		None			

[13] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Davis et al. 2006	Journal paper	Saskatchewan	4 years	Breeding	No
Analysis of habitat?		Yes, habitat patch size, shape, and distance to edge, land cover types (cropland, pasture, native			

	prairie)
Estimates of abundance, density, or population trend?	Yes, density
Estimates of survival or productivity?	Yes, nest survival and productivity
Estimates of individual dispersal?	No
Analysis of anthropogenic factors?	Yes, indirectly examined habitat fragmentation and land use practices
Field methods used	Various, see summaries of other papers by Davis
Notes	Very comprehensive study

[14] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Davis et al. 2013	Journal paper	Saskatchewan and Alberta	2 years	Breeding	No
Analysis of habitat?		Yes, at landscape level, habitat type and land use, grassland composition			
Estimates of abundance, density, or population trend?		Yes, abundance			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, examined land use practices			
Field methods used		Point counts of 5-minute duration			
Notes		Abundance estimated with sophisticated statistical models that involve estimating detection probability			

[15] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Dieni and Jones 2003	Journal paper	Montana	4 years	Breeding	No
Analysis of habitat?		Yes, vegetation height and thickness, litter depth, percent cover of bare ground, cactus, forbs, grasses, and other; slope of terrain			

Estimates of abundance, density, or population trend?	No
Estimates of survival or productivity?	No (study examined differences between nest site locations and random locations, but did not estimate nest survival although nests were monitored)
Estimates of individual dispersal?	No
Analysis of anthropogenic factors?	No
Field methods used	Various methods used to locate nests
Notes	Very comprehensive measurement of vegetation around nests

[16] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Dohms and Davis 2009	Journal paper	Saskatchewan	5 years	Breeding	Yes
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		No, nesting was studied but no estimates of survival or productivity given			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No			
Field methods used		Rope dragging and visual searching used to find nests, mist-netting of females, video-taping of pipit behavior at nest			
Notes		This is primarily a behavioral study.			

[17] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Downey et al 2013	Journal paper	Alberta	3 years	Breeding	No
Analysis of habitat?		Yes, plant species composition was assessed in a native prairie			
Estimates of abundance, density, or population trend?		No			

Estimates of survival or productivity?	No
Estimates of individual dispersal?	No
Analysis of anthropogenic factors?	No
Field methods used	Point counts of 5-minute duration
Notes	Paper primarily reports on a prairie restoration effort and the diversity of grassland birds that re-established at the location; not much data on Sprague's Pipit

[18] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Fisher and Davis 2011a	Journal paper	Saskatchewan	3 years	Breeding	Yes
Analysis of habitat?		Yes, percent cover of vegetation, bare ground; vegetation height; litter depth			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, indirectly. Pastures and hayfields were either grazed or mowed.			
Field methods used		Rope-dragging to find nests, mist-netting and marking of birds in order to do spot-mapping of territories			
Notes		This is primarily a study of the differences between native prairie and planted (artificial) pasture in vegetation characteristics of nest sites and territories.			

[19] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Fisher and Davis 2011b	Journal paper	Saskatchewan	5 years	Breeding	Yes
Analysis of habitat?		Yes, native vs. planted pasture; also the microhabitat variables as in [18]. Also examined effect of temperature and precipitation on survival.			
Estimates of abundance, density, or population trend?		No			

Estimates of survival or productivity?	Yes, survival of first-year juveniles post-fledging
Estimates of individual dispersal?	Yes
Analysis of anthropogenic factors?	Yes, but indirectly in the comparison of juvenile survival in natural prairie and manmade pastures
Field methods used	Rope-dragging to find nests, mist-netting and telemetry of adult birds
Notes	This is essentially a companion paper to Fisher and Davis 2011a or [18] in the list.

[20] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Grant et al. 2004	Journal paper	North Dakota	2 years	Breeding	No
Analysis of habitat?		Yes, vegetation density, litter depth, species composition, percentage of shrub cover. Percentage of woodland within 500 m of center of plot.			
Estimates of abundance, density, or population trend?		Yes, probability of occurrence or incidence rates rather than abundance			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No, not directly, but some of the habitat variables included non-native plant species			
Field methods used		10-minute searches of 100-m radius plots			
Notes		None			

[21] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Grzybowski 1982	Journal paper	Oklahoma and Texas	3 years	Wintering	No
Analysis of habitat?		Yes, vegetation height and species composition, land use			
Estimates of abundance, density, or population trend?		Yes, estimates of proportion occurrence among study sites. Also, total bird biomass but not broken down by species. Density estimates given for some species but not SPPI.			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			

Analysis of anthropogenic factors?	Yes, some survey sites were grazed and/or had nearby cultivation (cropland).
Field methods used	Walking along line transects
Notes	None

[22] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Hamilton et al. 2011	Journal paper	Alberta	2 years	Breeding	No
Analysis of habitat?		No, not directly. Study located survey plots based on soil type. Also included a "topographic index".			
Estimates of abundance, density, or population trend?		Yes, abundance as birds detected per survey point			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, natural gas extraction and its impact on vegetation (habitat)			
Field methods used		Point counts of 5-minute duration			
Notes		None			

[23] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Jones 2011	Journal paper	Montana	3 years	Breeding	No
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		Yes, territory size was estimated (which inversely relates to density).			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No			
Field methods used		Visual observation of males displaying the species' characteristic courtship flight			
Notes		None			

[24] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Jones and White 2012	Journal paper	Montana	11 years	Breeding	Yes
Analysis of habitat?		Yes, distance from nest to grassland edge, roads, cropland, lake			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		Yes, daily survival rate of nests			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, nearby roads and other man-made landscape features			
Field methods used		Rope-dragging and visual searching to find nests			
Notes		None			

[25] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Jones et al. 2007	Journal paper	Montana	7 years	Breeding	No
Analysis of habitat?		No, although site descriptions are provided			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		Yes, goal of study was to assess return rates to summer breeding territories, so adult survival was indirectly estimated.			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No, although some of the study sites had been intentionally burned prior to the study			
Field methods used		Mist-netting and banding to uniquely mark individual birds			
Notes		None			

[26] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Jones et al. 2010	Journal paper	Montana	11 years	Breeding	No
Analysis of habitat?		No, but study site descriptions provided			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		Yes, nest density, productivity, survival, parasitism by cowbirds, timing of nesting events			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No, although some of the study sites had been intentionally burned prior to the study			
Field methods used		Rope-dragging and visual searching to find nests, repeated visits to nests for monitoring			
Notes		Some overlap with Jones and White 2012 [24]. This and the other studies by Jones occurred at Bowdoin National Wildlife Refuge.			

[27] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Koper et al. 2009	Journal paper	Alberta	3 years	Breeding	Yes
Analysis of habitat?		Yes, distance of point count location to grassland, cropland, roads, and water body			
Estimates of abundance, density, or population trend?		Yes, relative abundance defined as number of individuals detected per point count			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, human modification of landscapes			
Field methods used		Point counts of 5-minute duration			
Notes		None			

[28] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Leston et al. 2015	Journal paper	Alberta	1 year	Breeding	No
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		No, only a limited amount of information on abundance			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No, not directly, although some of the point counts took place near to gas wells and other energy extraction infrastructure			
Field methods used		Double-observer point counts of 5-minute duration			
Notes		Primary goal of study was to test out the double-observer approach for surveying grassland birds			

[29] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Lipsey et al. 2015	Journal paper	Canada and USA	N/A	Breeding	Yes
Analysis of habitat?		Yes, at landscape scales, proportion of grassland, forest, and cropland. Also included some climate variables in the models.			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, cropland expansion (conversion of natural grassland/rangeland into cropland). Study also examined proportion of breeding distribution in protected areas (as defined by ownership).			
Field methods used		N/A			
Notes		Study was an attempt to model and map the breeding range distribution of SPPI			

[30] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Ludlow et al. 2014	Journal paper	Alberta	2 years	Breeding	No
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		Yes, clutch size and nest survival, including rates of parasitism by cowbirds			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No			
Field methods used		Rope-dragging and visual searching to locate nests			
Notes		None			

[31] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Ludlow et al. 2015	Journal paper	Alberta	2 years	Breeding	No
Analysis of habitat?		Yes, percent cover of grass, bare ground, forbs, and other; vegetation height; litter depth; distance to nearest gas well, road, and trail.			
Estimates of abundance, density, or population trend?		Yes, territory density			
Estimates of survival or productivity?		Yes, nest survival and number of young fledged			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, oil and natural gas extraction and associated infrastructure			
Field methods used		Rope-dragging to locate nests, spot-mapping surveys to estimate bird density			
Notes		None			

[32] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Lueders et al. 2006	Journal paper	North Dakota	2 years	Breeding	No
Analysis of habitat?		Yes, height and density of vegetation, litter depth, percent cover of grass and other			
Estimates of abundance, density, or population trend?		Yes, density			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, cattle grazing			
Field methods used		Point counts of 5-minute duration			
Notes		Distance-sampling models used to estimate density			

[33] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Lusk and Koper 2013	Journal paper	Saskatchewan	2 years	Breeding	No
Analysis of habitat?		Yes, vegetation density and litter depth			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		Yes, nest survival			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, cattle grazing			
Field methods used		Rope-dragging to locate nests			
Notes		None			

[34] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Macias-Duarte et al. 2009	Journal paper	Chihuahua	10 years	Wintering	No
Analysis of habitat?		Yes, grass cover and height, woody plant height; six broad-habitat types			

Estimates of abundance, density, or population trend?	Yes, but not for individual species
Estimates of survival or productivity?	No
Estimates of individual dispersal?	No
Analysis of anthropogenic factors?	No, not directly studied, but authors did mention grassland conversion to agricultural land
Field methods used	Walking of 3-ha plots in zigzag fashion for 20 minutes to visually detect birds
Notes	Most of the collected data was for species other than SPPI

[35] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Madden et al. 1999	Journal paper	North Dakota	2 years	Breeding	No
Analysis of habitat?		Yes, vegetation density, litter depth; percent cover of shrubs, forbs, grass			
Estimates of abundance, density, or population trend?		Yes, abundance and percent occurrence per point count			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, indirectly, some study plots had been previously and intentionally burned prior to the study			
Field methods used		Point counts of 10-minute duration			
Notes		None			

[36] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Madden et al. 2000	Journal paper	North Dakota	2 years	Breeding	No
Analysis of habitat?		Yes, vegetation height and density, litter depth; percent cover of grass, forbs, shrubs; grass species composition			
Estimates of abundance, density, or population trend?		Yes, but “abundance” as probability of occurrence			
Estimates of survival or productivity?		No			

Estimates of individual dispersal?	No
Analysis of anthropogenic factors?	Yes, burning on plots prior to study
Field methods used	Point counts of 10-minute duration
Notes	Substantial overlap in the data with Madden et al. 1999 [35]. This paper presents a much more sophisticated estimation of abundance (or % occurrence using logistic regression) and detailed analysis of habitat (vegetation) data.

[37] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Martin et al. 2010	Journal paper	Saskatchewan	2 months	Breeding	Yes
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No			
Field methods used		N/A			
Notes		This is solely a study of pipit song and singing behavior			

[38] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Pool et al. 2014	Journal paper	Chihuahua	N/A	Wintering	No
Analysis of habitat?		Yes, landscape-level habitat availability			
Estimates of abundance, density, or population trend?		Yes, density			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, cropland expansion from 2006 – 2011			

Field methods used	As in Pool et al. (2012) [2]
Notes	This is a "follow-up" paper to Pool et al. (2012) [2], focusing more on land cover data than bird data. The bird data in this paper likely overlaps that of Pool et al. (2012).

[39] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Pylypec (1991)	Journal paper	Saskatchewan	3 years	Breeding	No
Analysis of habitat?		No, not explicitly			
Estimates of abundance, density, or population trend?		Yes, density			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, survey plots were intentionally burned prior to the study			
Field methods used		No details given other than "censuses of approximately 2.5 h duration".			
Notes		None			

[40] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Ranellucci et al. 2012	Journal paper	Manitoba	2 years	Breeding	No
Analysis of habitat?		Yes, litter depth, vegetation height; percent cover of grass, forbs, litter, shrubs			
Estimates of abundance, density, or population trend?		Yes, abundance per point count			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, different livestock grazing practices			
Field methods used		Point counts of 6-minute duration			
Notes		None			

[41] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Ribic et al. 2009	Journal paper	N/A	N/A	N/A	No
Analysis of habitat?		N/A			
Estimates of abundance, density, or population trend?		N/A			
Estimates of survival or productivity?		N/A			
Estimates of individual dispersal?		N/A			
Analysis of anthropogenic factors?		N/A			
Field methods used		N/A			
Notes		This is a review/synthesis paper of area-sensitivity in grassland birds. It does not present any original data.			

[42] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Richardson et al. 2014	Journal paper	Saskatchewan	5 years	Breeding	No
Analysis of habitat?		Yes, vegetation biomass and height, litter depth			
Estimates of abundance, density, or population trend?		Yes, abundance and density			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, burning and grazing			
Field methods used		Point counts of 5-minute duration			
Notes		None			

[43] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Skinner and Clark 2008	Journal paper	Saskatchewan	2 years	Breeding	No

Analysis of habitat?	Yes, at landscape-level, land cover composition and configuration
Estimates of abundance, density, or population trend?	Yes, but not for individual species
Estimates of survival or productivity?	No
Estimates of individual dispersal?	No
Analysis of anthropogenic factors?	No
Field methods used	Point counts of 3-minute duration along survey routes
Notes	Paper does not have much mention of SPPI.

[44] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Sliwinski and Koper 2012	Journal paper	Alberta	3 years	Breeding	No
Analysis of habitat?		Yes, distance to cropland, wetland, road			
Estimates of abundance, density, or population trend?		Yes, but not specifically for SPPI.			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, indirectly, presence of roads and cropland in the landscape			
Field methods used		Point counts of 5-minute duration			
Notes		None			

[45] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
SPPI Conservation Plan Jones 2010, USFWS	Report	N/A	N/A	Both, primarily breeding	Yes
Analysis of habitat?		N/A			
Estimates of abundance, density, or population trend?		N/A			

Estimates of survival or productivity?	N/A
Estimates of individual dispersal?	N/A
Analysis of anthropogenic factors?	N/A
Field methods used	N/A
Notes	This is the latest USFWS Conservation Plan for Sprague's Pipit. As such, it does not have original data, but it is a good review and synthesis of our knowledge at the time, particularly with regard to conservation action that is needed.

[46] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Stevens et al. 2013	Journal paper	Texas	2 years	Wintering	No
Analysis of habitat?		Yes, percent composition grass/forb/tree/shrub/litter/bare ground; vegetation height, land use			
Estimates of abundance, density, or population trend?		Yes, abundance and percent occurrence			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, wind turbines			
Field methods used		Flushing of birds by walking through 1 ha plots			
Notes		None			

[47] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Sutter 1997	Journal paper	Saskatchewan	2 years	Breeding	Yes
Analysis of habitat?		Yes, percent cover of grasses, forbs, shrubs, bare soil, and litter; vegetation density and height, litter depth			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		No			

Estimates of individual dispersal?	No
Analysis of anthropogenic factors?	No
Field methods used	Rope-dragging to locate nests
Notes	Study has detailed information on nest construction/structure and microhabitat

[48] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Sutter and Brigham 1998	Journal paper	Saskatchewan	2 years	Breeding	No
Analysis of habitat?		Yes, percent cover of grass, forbs, shrubs, bare ground, and litter; forb density; vegetation height			
Estimates of abundance, density, or population trend?		Yes, mean abundance per plot			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, comparison of native prairie to man-made pastures of crested wheatgrass			
Field methods used		Point counts of 5-minute duration			
Notes		None			

[49] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Sutter et al. 1996	Journal paper	Saskatchewan	2 years	Breeding	Yes
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		Yes, indirectly nest survival in that study examined re-nesting by females			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No			
Field methods used		Rope-dragging to locate nests; mist-netting and then radiotelemetry on adults			
Notes		This was mostly a study of frequency of re-nesting and amount of time involved.			

[50] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Sutter et al. 2000	Journal paper	Saskatchewan	Approx. 1 month	Breeding	No
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		Yes, abundance			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, comparison of abundance along roadside to that away from roadside			
Field methods used		Point counts of 5-minute duration			
Notes		None			

[51] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Van Wilgenburg et al 2012	Journal paper	Saskatchewan	2 years	Breeding	No
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No, not individual dispersal, but study does estimate number of new “immigrant” birds in breeding population			
Analysis of anthropogenic factors?		No			
Field methods used		Mist-netting to capture adults			
Notes		Study uses stable isotopes (from feathers) to estimate number of birds that are new to the summertime breeding population.			

[52] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Wayne 1901	Journal paper	See below	N/A	Wintering	Yes
Analysis of habitat?		N/A			
Estimates of abundance, density, or population trend?		N/A			
Estimates of survival or productivity?		N/A			
Estimates of individual dispersal?		N/A			
Analysis of anthropogenic factors?		N/A			
Field methods used		N/A			
Notes		This is a very brief report of a female SPPI being collected in South Carolina (presumably) in November 1900.			

[53] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Wellicome et al. 2014	Journal paper	Alberta	Approx. 2 mos.	Breeding	No
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		Yes, mean abundance per point count			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No, although there is a comparison of roadside abundance to that away from roads			
Field methods used		Point counts along roads (as in style of NA Breeding Bird Survey) and off-road.			
Notes		None			

[54] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Wiens et al. 2008	Journal paper	Alberta	6 years	Breeding	No

Analysis of habitat?	No, not directly, however habitat indirectly quantified using climatic, topographic, and remote-sensing imagery
Estimates of abundance, density, or population trend?	Yes, abundance as percent occurrence among points
Estimates of survival or productivity?	No
Estimates of individual dispersal?	No
Analysis of anthropogenic factors?	No
Field methods used	Point counts of 5-minute duration
Notes	None

[55] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Wilson and Belcher 1989	Journal paper	Manitoba	Approx. 1 month	Breeding	No
Analysis of habitat?		Yes, percent cover of different plant species			
Estimates of abundance, density, or population trend?		Yes, abundance per transect			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, comparison of native prairie to non-native pasture			
Field methods used		Point counts of 2-minute duration			
Notes		None			

[56] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Ruth et al. 2014	Journal paper	Arizona	3 years	Wintering	No
Analysis of habitat?		Yes, grass density (thickness); shrub density; percent cover litter and bare ground			
Estimates of abundance, density, or population trend?		Yes, abundance			

Estimates of survival or productivity?	No
Estimates of individual dispersal?	No
Analysis of anthropogenic factors?	No
Field methods used	Walking transects to flush birds and mist-netting
Notes	None

[57] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Thompson et al. 2015	Journal paper	North Dakota	3 years	Breeding	No
Analysis of habitat?		No, not explicitly			
Estimates of abundance, density, or population trend?		Yes, density			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, oil well drilling and roads			
Field methods used		Walking survey transects			
Notes		None			

[58] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Bleho et al 2014	Journal paper	Canada	N/A	Breeding	No
Analysis of habitat?		N/A			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		Yes, rates of nest destruction			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, cattle grazing			
Field methods used		N/A			

Notes	This study is a meta-analysis of other studies. As such it does not have original data, although the statistical analysis may be new.

[59] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Winter et al. 2007	Report	South Dakota	2 years	Breeding	Yes, along with Baird's Sparrow
Analysis of habitat?		Yes, percentage of woody vegetation; distance to shrub/tree; vegetation height, litter depth, percent cover of litter and bare ground			
Estimates of abundance, density, or population trend?		Yes, abundance per point count			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, indirectly, survey plots were grazed			
Field methods used		Point counts of unspecified duration			
Notes		None			

[60] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Sliwinski and Koper 2015	Journal paper	Saskatchewan	3 years	Breeding	No
Analysis of habitat?		Yes, vegetation density, height; litter depth			
Estimates of abundance, density, or population trend?		Yes, abundance as birds per pasture			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, cattle grazing			
Field methods used		Point counts of 5-minute duration			
Notes		None			

[61] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Nixon et al. 2015	Report	N/A	N/A	N/A	No
Analysis of habitat?		No, not directly			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, possibly with regard to changes in climate and land use			
Field methods used		N/A			
Notes		This is a modeling paper that used current climate data to predict future species distribution. As such, the paper does not include original data. However, the models and analysis are new.			

[62] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Davis et al. 2014	Journal paper	Saskatchewan	1 year	Breeding	No
Analysis of habitat?		Yes, various as in previous papers by Davis			
Estimates of abundance, density, or population trend?		Yes, abundance			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, cattle grazing			
Field methods used		Point counts of 5-minute duration			
Notes		Some of the data used in this paper likely overlap that of previous papers by Davis and colleagues. This paper has new models and analysis based on information-theoretic (AIC) methods.			

[63] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Contreras-Balderas et al. 1997	Journal paper	Coahuila	1 year	Wintering	No
Analysis of habitat?		No			
Estimates of abundance, density, or population trend?		No			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		No			
Field methods used		Visual surveying			
Notes		This paper presents a site description of the Cuatrocienegas Valley and the bird species that were found there during repeat visits over one year, one species of which was Sprague's Pipit.			

[64] Author(s) and Date	Type of article	Study location	Duration of study	Breeding or wintering range?	Focus of study on SPPI?
Hovick et al. 2014	Journal paper	Oklahoma	3 years	Wintering	No
Analysis of habitat?		Yes, vegetation height and litter depth; percent cover of grass, forb, shrub, bare ground and litter			
Estimates of abundance, density, or population trend?		No, study reports that Sprague's Pipit was infrequently encountered.			
Estimates of survival or productivity?		No			
Estimates of individual dispersal?		No			
Analysis of anthropogenic factors?		Yes, burning and cattle grazing			
Field methods used		Visual and auditory surveys while walking line transects			
Notes		None			

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Appendix C

Survey of Sprague's Pipits Using Protected Areas in the State of Texas During the Winter of 2015-2016

Report provided to the Texas Comptroller's Office – Endangered Species Research Program

Report prepared by

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June 13, 2016

Sprague's Pipit at Attwater Prairie Chicken NWR, December 2015
(Photo by John Muller)

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Introduction

This report contains information obtained from a winter survey (December 2015 – March 2016) of Sprague's Pipits at various protected areas within central, south, and coastal Texas. For the purposes of this survey, we define "protected area" as publicly-owned property administered and maintained by a government agency, utility, or conservation organization. Use of the word "protected" follows the general convention in the conservation literature, herein "protected" simply means that the property is not destined to be sold, developed, or highly modified in any way. "Protected" does not convey any status as to the extent to which the property is freely accessible to the general public nor anything about how the public (or anyone else) can use the property. Further, "protected" does not indicate any particular status about a property's boundary (such as fencing) and land use on properties immediately adjacent to the protected area. As such, we surveyed for pipits at various federal properties (e.g., National Wildlife Refuges), state parks, county-owned parks, and nature preserves. Our intent was to identify at least 10 – 14 protected areas that function as wintering grounds for Sprague's Pipits as such areas could become important "safe harbor" areas should the species ever require greater conservation attention and protection. With this goal, we intentionally selected protected areas that we suspected would have pipits (see next section). Therefore, our survey effort was intentionally biased toward surveying for pipits where we thought they would occur and as such the information that we present cannot be taken as a statistically-designed survey to estimate distribution and abundance of the species.

Methods

Prior to the survey season, we spent a few months in reviewing eBird data, various bird species lists, locations and descriptions of protected areas, and occasional conversation with birders to develop an initial list of protected areas to visit. With this initial pre-survey scouting phase we were attempting to prioritize and make our survey more efficient given that we would be surveying at locations over a fairly broad geographic stretch from the Rio Grande Valley of south Texas to central Texas and eastward to the Texas coast. Our goal at each protected area was to survey enough of the property and visually assess habitat so that we could confidently categorize the protected area into one of three categories: few resident pipits (≤ 10), moderate number of pipits (11 – 50), and high numbers of pipits (>50), as well as a category of "negligible" if no pipits found. The categories should be taken as relative assessments of the potential of a protected area to harbor pipits during the winter; the categories (and raw counts) of pipits are certainly not intended to be a census.

At each protected area, counts of pipits were obtained by 2 – 4 people visually and acoustically scanning for pipits while slowly walking in a direct linear path through pipit habitat (typically considered as relatively short grass with minimal shrub cover). Pipit observers walked parallel to one another about 50 – 75 m apart (Fig. 1). Repeated passes (in a lawn-mowing fashion) were conducted until the entire habitat area had been searched. Most detections involved

flushing birds that had been sitting on the ground. Direction and distance of the flushed bird was noted to avoid double-counting. Some of the counts also consisted of “flyover” birds that usually were first detected acoustically. We used a GPS unit to get latitude and longitude coordinates of each counted bird. The survey at each protected area took either one or two days depending on the amount of habitat area searched.

Figure 1. Two observers surveying for pipits. Photo taken by Observer #1.

Survey Results

We visited 10 different protected areas and conducted a total of 12 surveys (Fig. 2); two sites were surveyed twice. We found Sprague’s Pipits at most of the protected areas that we visited and surveyed (Table 1). The three sites (Lower Rio Grande Valley NWR, Palo Alto Battlefield NHS, and South Padre Island – Andy Bowie Park) where we did not find pipits appeared to have very little or no pipit habitat. At each site, there were some grassy areas but the grass was generally too high (>50 cm) and or too brushy. Based on our counts of pipits, estimated amount of habitat at each site, amount of surveying effort, and overall size of the protected area, we classified each protected area into one of the four abundance categories previously described. For most sites, the classified abundance category indicates a greater number of wintering pipits than actually counted (Table 1) – this is simply a realization that our counts were not censuses and thus many pipits (within the overall boundaries of the protected area) went undetected. Even within the specific habitat areas that were searched, we may have missed some pipits that did not flush.

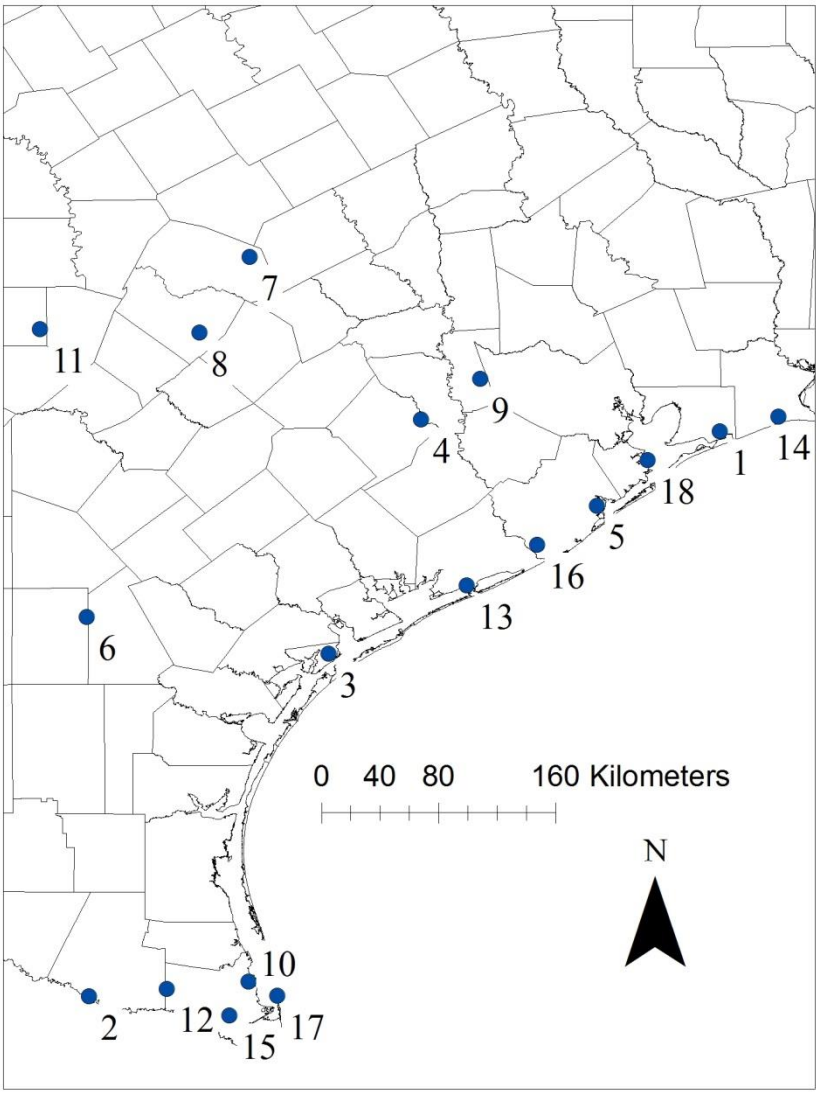

Figure 2. Locations of protected areas in south, central, and coastal Texas that were surveyed for Sprague's Pipits

1 – Anahuac NWR
2 – Anzalduas County Park
3 – Aransas National Wildlife Refuge*
4 – Attwater Prairie Chicken NWR
5 – Brazoria NWR*
6 – Choke Canyon State Park
7 – Granger Lake Park
8 – Hornsby Bend
9 – Katy Prairie Conservancy
10 – Laguna Atascosa NWR
11 – LBJ Ranch NHS
12 – Lower Rio Grande Valley NWR
13 – Mad Island Preserve and Wildlife Management Area
14 – McFadden NWR*
15 – Palo Alto Battlefield NHS
16 – San Bernard NWR*
17 – South Padre Island (Andy Bowie Park) and north end of island
18 – Texas City Dike (Beach Drive portion)

* Location not surveyed, however Sprague's Pipits likely exist at the park.

We identified a total of nine protected areas having either moderate or high abundance of wintering pipits. These nine include three sites (Attwater Prairie Chicken NWR, Mad Island Preserve and Wildlife Management Area, and the grassy berm portion of the Texas City dike) where we had previously (prior to Winter 2015-16) conducted extensive research on Sprague's Pipit but not actually surveyed this past winter. These nine protected areas appear to have relatively high numbers of wintering pipits and substantial amounts of habitat such that they can be considered important wintering locations for the species. Moreover, the sites are dispersed from the Rio Grande Valley of south Texas to central Texas and eastward into coastal and southeast Texas (Fig. 2). The sites also represent a variety of ownership identities. Clearly the responsibility for conservation of wintering areas for Sprague's Pipit in Texas can be spread across many different federal, state, and local agencies and conservation organizations.

In addition to the protected areas listed in Table 1, Sprague's Pipits likely also exist at some protected areas on the mid- and upper-Texas coast that were not visited or surveyed. These are Aransas NWR, Brazoria NWR, Anahuac NWR, McFadden NWR, and San Bernard NWR (Fig. 2). All of these protected areas appear to have potential habitat for Sprague's Pipits and the "Bird Lists" for some of them include Sprague's Pipits. Further, some of these protected areas have management practices (e.g., livestock grazing and prescribed burning) that could benefit Sprague's Pipits. We did not visit and survey any protected areas in west Texas, although pipits likely winter in this region, particularly the relatively homogenous and vast rangeland on the Stockton Plateau. Unfortunately, our initial scouting phase was not able to reveal any protected areas potentially accessible for surveys in that part of Texas.

More detailed reports on the surveys at each protected area can be found in Appendix 1.

Conclusion

Protected areas, or publicly-owned properties with natural habitat, within the state of Texas currently function as important and possibly unrecognized wintering areas for Sprague's Pipits. Given that there is very little protected habitat for the species in the northern Mexico part of its wintering range, the protected habitat in Texas is vitally important. Although our survey was not intended to thoroughly assess the long-term value of each protected area with regard to conservation of Sprague's Pipits, we were struck by the potential of the larger protected areas to become even better "havens" for pipits given some management effort toward this goal. Again, some of these protected areas have current management plans that are compatible with pipit conservation although (to our knowledge) provisioning of habitat for Sprague's Pipits is not a formal part of the park management plans at any of these protected areas. If the species ever requires greater legal protection then the protected areas identified in this report (and likely some others not surveyed) are a good foundation for protecting the species in its Texas wintering range.

Table 1. Summarized results of the Winter 2015-16 survey of Sprague's Pipit at select Protected Areas within Texas.

Name of Protected Area[‡]	Administration[‡]	County	Region	Size (km^2)[†]	Pipits counted	Abundance Category
Attwater Prairie Chicken NWR	USFWS	Colorado	Southeast	42.6	—	High
Anzalduas County Park	Hidalgo County	Hidalgo	South/RGV	0.4	11	Moderate
Choke Canyon State Park (reservoir)	TPWD	McMullen	Central	6	7	Few
Granger Lake Park	USACE	Williamson	Central	1.1	29(1), 6(2)*	High
Hornsby Bend	Austin Water Utility	Travis	Central	4.9	20	Moderate
Katy Prairie	Katy Prairie Conservancy	Waller	Southeast	52.6	36	High
Laguna Atascosa NWR	USFWS	Cameron	South/RGV	263	139	High
LBJ Ranch NHS	NPS	Gillespie	Central	6.4	19(1), 18(2)*	Moderate
Lower Rio Grande Valley NWR	USFWS	Cameron	South/RGV	366	0	Negligible
Mad Island Preserve and Wildlife Management Area	TNC and TPWD	Matagorda	Coastal	29	—	High
Palo Alto Battlefield NHS	NPS	Cameron	South/RGV	14	0	Negligible
South Padre Island (Andy Bowie Park) and north end of island	Cameron County	Cameron	South/RGV	1.0	0	Negligible
Texas City Dike (Beach Drive portion)	Government of Texas City	Galveston	Coastal	1.5 - 2	—	Moderate

[‡]Abbreviations are as follows: USFWS – United States Fish and Wildlife Service, TPWD – Texas Parks and Wildlife Department, USACE – United States Army Corps of Engineers, NPS – National Park Service, TNC – The Nature Conservancy, NWR – National Wildlife Refuge, NHS – National Historic Site.
[†]Size of the protected area refers to total *land* area of the park; this does not indicate the amount of pipit habitat as some of the land area in all the parks consists of non-habitat.
*Granger Lake Park was surveyed twice, December 30, 2015 and March 18, 2016. LBJ NHS was surveyed twice, December 22, 2015 and March 17, 2016.

Birders from as far away as Vermont come to south Texas to see various winter-time species including Sprague's Pipit. This vehicle was photographed at Anzalduas County Park (Hidalgo County) the day of our survey.

Acknowledgements

We thank all the park personnel that kindly provided us access and guidance in surveying for pipits. These people include Leo Gustafson (LA NWR), John Magera (APC NWR), Wes Newman and Bob Honig (Katy Prairie), Chris Perez (LRGV NWR), and Kevin Anderson (Hornsby Bend).

Appendix 1 – Description of surveyed sites

Date: 1-4-2016

Location: Anzalduas Park

Survey Period: 9:00-11:00 AM

Distance: 2 Miles

Observers: John Muller, Laura Bliss, Joseph Veech

Weather: Cool, no breeze

Anzalduas Park is a small (96 acre) county park in Mission Texas along the Rio Grande. Sprague's Pipits were only found in the Northeastern Field, this field was mowed turf grass (Figure 1). American Pipits were found throughout the park.

Figure 1. Northeastern Field.

Figure 2. Pipit sightings within Anzalduas Park boundaries.

Date: February 12, 2016

Location: Choke Canyon State Park

Survey Period: 10:15 AM - 3:45 PM

Distance: 6 Miles

Observers: John Muller, Laura Bliss

Weather: Sunny, Wind, 60°F-83°F

Choke Canyon State Park is 6000 acres, most of which is located in the floodplain of Choke Canyon Reservoir (26,000 acres). Choke Canyon Reservoir is owned by the Bureau of Reclamation and the water is righted to the city of Corpus Christi. Sprague's Pipits were found in areas in the grassy areas between the current water level and the full lake water line (Figure 1). We found seven Sprague's Pipits in two areas around the lake. We only surveyed a small area compared to the entire reservoir, it is, thus, likely that there were many more pipits around Choke Canyon Reservoir. The areas where pipits were found were areas that are intermittently covered with water, which drowns out woody vegetation and allows for grass and forbs to be the dominant vegetation when the reservoir is not at capacity. It is likely that Sprague's Pipits use similar areas at many reservoirs around the state of Texas when they are not at capacity. The dike was completely off limits and no access was allowed.

Figure 1. Pipits were found in the area between the current water level and the full lake water line.

Figure 2. Typical habitat at Choke Canyon State Park.

Figure 3. Pipit sightings within the survey area.

Date: Dec 30, 2015

Location: Granger Lake Dam/ Granger WMA

Survey Period: 9:30 AM – 4:00 PM

Distance: 10.6 Miles

Observers: John Muller, Laura Bliss, Joseph Veech

Weather: Overcast, Windy, 45°F-60°F

Granger Lake is a flood control lake controlled and operated by the U.S. Army Corps of Engineers. The area surrounding the lake is comprised of Granger WMA (TPWD), Friendship Park, Willis Creek Park, Taylor Park, and Wilson H. Fox Park. The main portion that was surveyed was the Granger Dam which is mostly mowed Bermuda grass (Figure 1); we also surveyed various parts of the WMA and several of the developed parks. We had 29 Pipit Detections from 23 GPS Locations all from the dam area. The Granger Dam is about 4 Kilometers long (Figure 2).

Figure 1. Picture taken from Granger Dam. Uniform turf grass.

Figure 2. All Pipits were seen from the dam area.

Date: March, 18 2016

Location: Granger Lake Dam/ Granger WMA

Survey Period: 9:30 – 12:30

Distance: 2.5 Miles

Observers: John Muller, Laura Bliss

Weather: Overcast, Windy 60°F

We resurveyed re-survey the Granger Lake Dam to see if Sprague's Pipits would be using the area still at the end of winter. Pipits were fewer but still present. The grass was much taller than it was in December and appeared to have not been mowed (Figure 3). All Sprague's sightings came from areas where the grass was significantly shorter or was replaced by short forbs (Figure 4). Because of an impending weather system only half of the dam was surveyed. Figure 5 shows their locations.

Figure 3. Grass that had not been mowed and was knee high.

Figure 4. Area where tall turf grass was replaced by short growing forbs

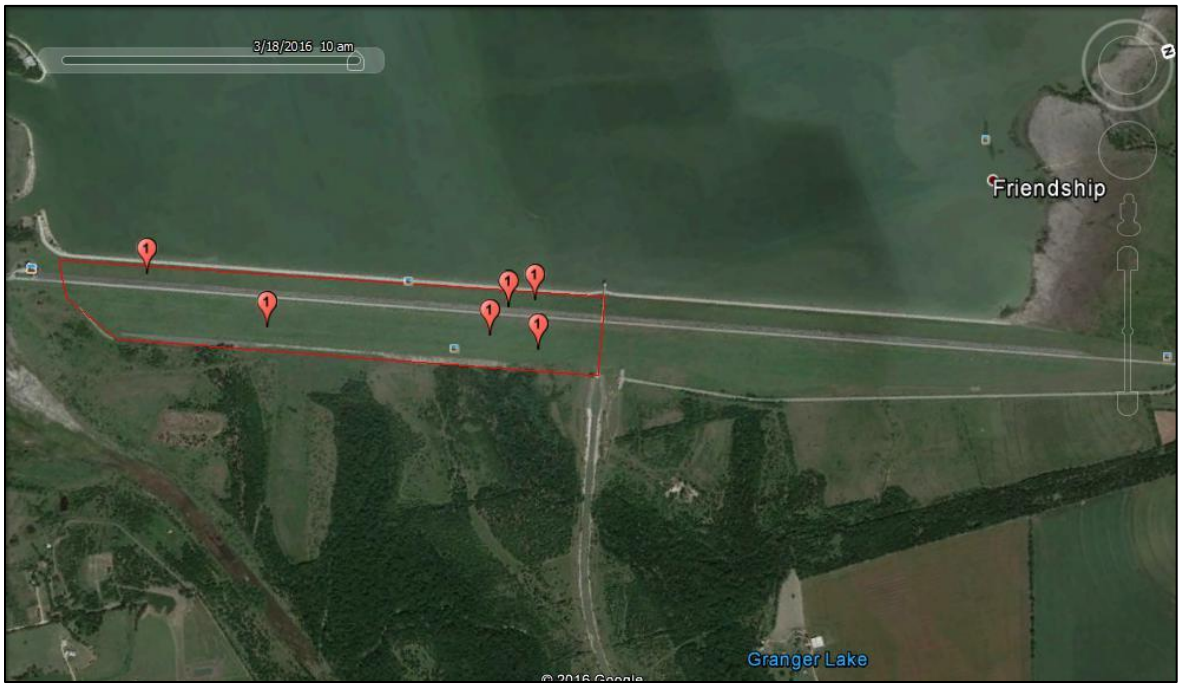

Figure 5. Pipit locations during second survey at Granger Lake dam.

Date: Dec 17, 2015

Location: Center for Environmental Research at the Hornsby Bend Biosolids Management Plant Survey

Period: 9:10 AM – 12:30 PM

Distance: 7.5 Miles

Observers: John Muller, Laura Bliss, Justin Muller

Weather: Sunny, Minimal Wind, 40°F-55°F

Hornsby Bend is roughly 1,200 acres, about half that acreage is hay fields. We (three observers) surveyed for roughly 3 ½ hours and had 25 visual detections of Sprague's Pipits including 10 flush points (20 pipits) and five observed flyovers where the flush location was unknown. There were also multiple auditory detections in which the pipit was heard in the area but never visually observed. Multiple observations came from disturbed sites where feral hogs had torn up ground while rooting. Ultra-conservative estimate seven pipits, optimistic estimate 20 pipits.

Figure 1. Typical habitat of the survey area.

Figure 2. Feral hog rooting sites.

Figure 3. Typical habitat of the survey area.

Figure 4. Pipit sightings within the survey area.

Date: 3/1/2016-3/2/2016

Location: Katy Prairie Conservancy

Survey Period: 11 AM – 4 PM, 9 AM -2:30 PM

Distance: 13 Miles

Observers: John Muller, Laura Bliss, Joseph Veech, Bob Honig

Weather: Overcast, cool, windy

The Katy Prairie Conservancy (KPC) is a nonprofit land trust northwest of Katy, Texas. KPC owns around 13,000 acres and actively manages through grazing, seasonal wetland flooding, prescribed fire, invasive removal and replanting of native species.

The four of us walked areas of Indiangrass preserve as well as small areas of both the Chase East and Manor sections over the course of two days. There was plenty of quality habitat (Figures 1-4 show examples) at all three sections although we were only able to find a total of 36 Sprague's Pipits. Considering the quality of habitat that we saw we felt that 36 pipits is likely an underestimate. Because of the very windy conditions the birds may have been less likely to flush or could have been in more protective cover (tall dense grass) that they normally don't use. It is also possible that because of the mild winter and the apparent early onset of spring that Sprague's Pipits might be exhibiting migratory behavior earlier than usual, and may no longer be in the areas that they over wintered and are moving.

Figure 1. Short and sparsely distributed grass was prevalent at KPC.

Figure 2. Cattle are used as grazing tools on KPC

Figure 3. Pipit habitat at KPC

Figure 4. Pipit habitat at KPC

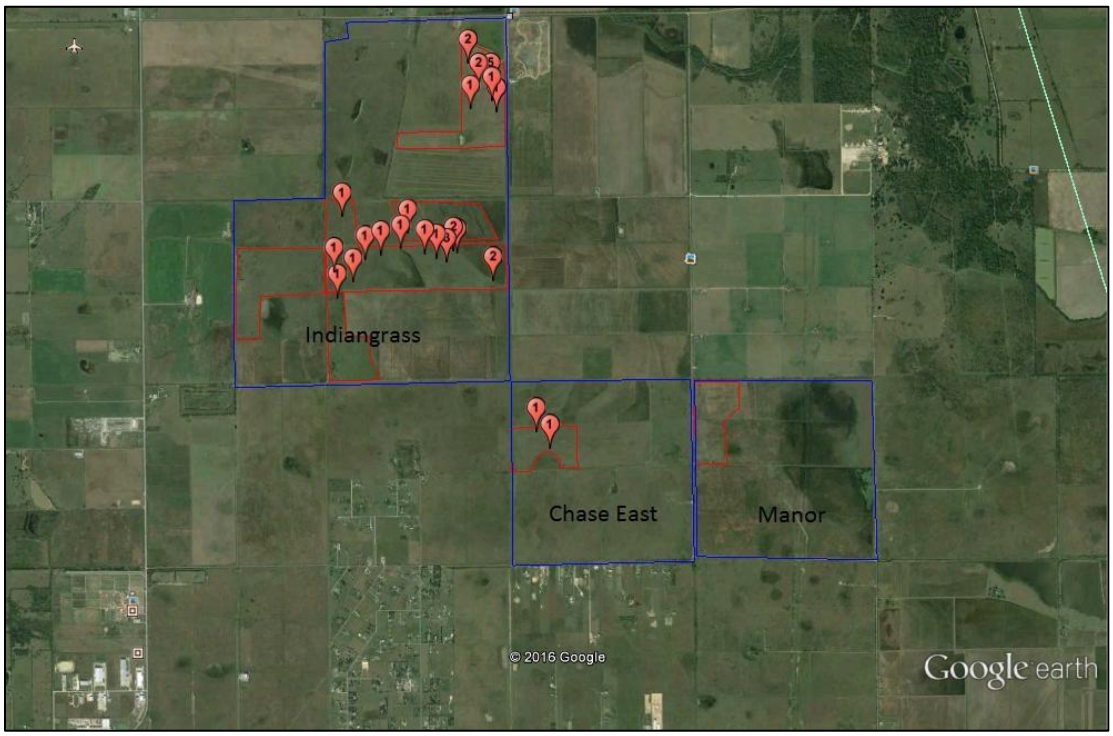

Figure 5. Distribution of detections and areas surveyed (red).

Date: 1/5/2016

Location: Laguna Atascosa National Wildlife Refuge

Survey Period: 9:45 AM -4:15 PM

Distance: 13 Miles

Observers: John Muller, Laura Bliss, Joseph Veech

Weather: Overcast-clear, cool

Laguna Atascosa National Wildlife Refuge in its entirety is 97,000 acres; 45,000 acres compose the main unit. We surveyed several sections within the interior of bayside drive and found 139 Sprague's Pipits and several hundred American Pipits.

The large numbers of Sprague's Pipits were flushed from areas that contained a large amount of shore grass *(Monanthochloe littoralis)* (Figure 1) which grows in mats in salty soil.

Figure 1. Shore grass. The shore grass was growing in areas with just higher elevation than the mudflats which are almost at sea level. Battery is shown for scale.

Figure 2. Typical habitat of the area.

Figure 3. The soil of the survey area was very saturated.

Figure 4. Other areas that contained a few Sprague's pipits were in recently burned cordgrass fields (*Spartina spartinae*).

Figure 5. Typical habitat of the survey area.

Figure 6. Pipit sightings within the survey area. We also looked at the Bahia Grande unit but there was not any available access.

Date: Dec 22, 2015

Location: LBJ State Park and Historic Site- LBJ Ranch

Survey Period: 9:40 AM – 1:30 PM

Distance: 4.2 Miles

Observers: John Muller, Laura Bliss, Joseph Veech

Weather: Sunny, Wind, 55°F-75°F

LBJ state park and LBJ national historic site are around 800 combined acres, the federal site being the larger of the two. There were 20 pipit detections from 14 flush points. Of all areas surveyed, only two main areas contained pipits. Area one (Figure 1) was mainly small bunch grasses with a floor of forbs, area two (Figure 2) was mainly turf grass that had been grazed to a shorter level. There were several areas that were surveyed thoroughly but did not yield any pipits; these areas were dense un-grazed turf grass (Figure 3), and short 1-2 inch grazed and planted winter wheat.

Figure 1. Area one, small bunch grasses with a floor of forbs.

Figure 2. Area two, grazed turf grass.

Figure 3. Dense un-grazed turf grass.

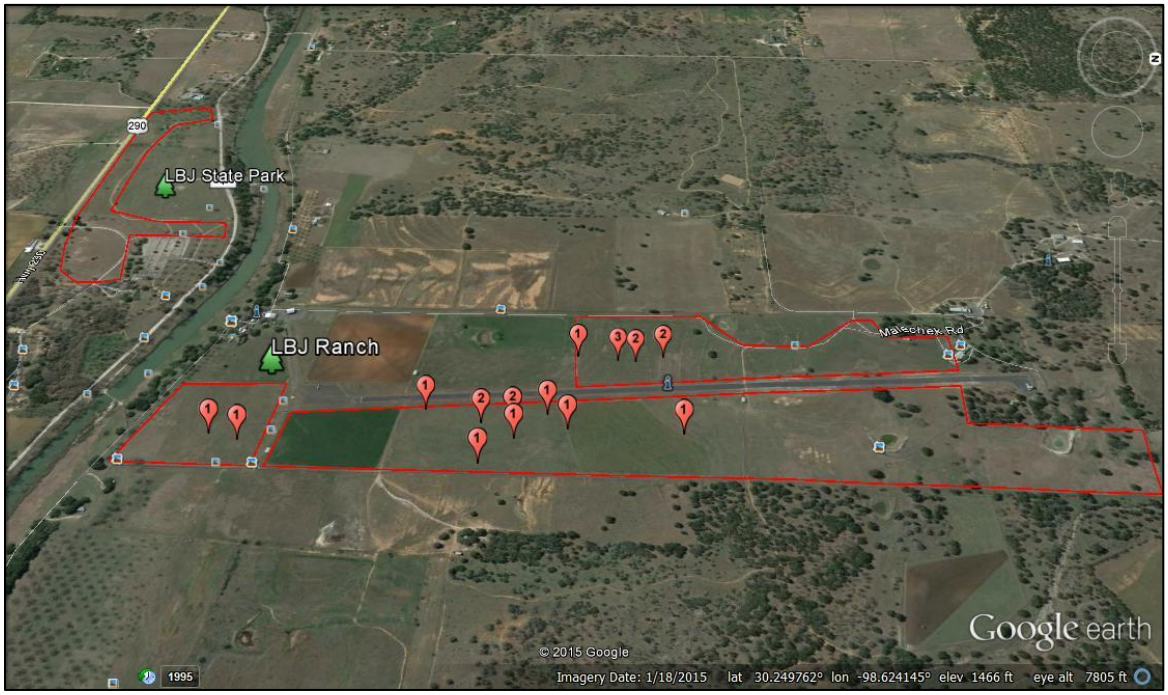

Figure 4. Pipit sightings within survey area.

Date: March, 17 2016

Location: LBJ State Park and Historic Site- LBJ Ranch

Survey Period: 9:00 AM – 12:30 PM

Distance: 4.2 Miles

Observers: John Muller, Laura Bliss

Weather: Overcast, foggy, 70°F-80°F

We decided to re-survey LBJ NHS to see if Sprague's Pipits would be using the area still at the end of winter. We found 18 Pipits the second survey, all were in the same native vegetation (Figures 5 and 6). Although Sprague's were found in turf grass back in December no Sprague's were found in turf grass this time around.

Figure 5. Pipit habitat at LBJ Ranch.

Figure 6. Pipit locations at LBJ Ranch during the second visit.

Date: 1/4/2016, 1/7/2016

Location: Lower Rio Grande Valley National Wildlife Refuge

Survey Period: 3:00-5:00 PM, 9:45-11:00 AM

Distance: not recorded

Observers: John Muller, Laura Bliss, Joseph Veech

Weather: Sunny

Lower Rio Grande Valley National Wildlife Refuge (LRGVNWR) is around 90,000 acres but is composed of multiple detached and isolated units spread over the southern tip of Texas. Due to recent rains and the isolated nature of the refuge units, most of the refuge was inaccessible and we were only able to briefly survey two units of LRGVNWR. We did not see any Sprague's Pipits, but there is plenty of suitable habitat and records of Pipits occurring there.

Boca Chica Unit is a large unit located on the southeastern tip of Texas along the Rio Grande and is the site of the battle of Palmito Ranch the last battle of the Civil War. Sprague's Pipits have been found there in the past and the habitat was open but a little overgrown.

La Sal Del Rey Unit contains a large 530-acre inland salt lake and is mostly woodland, but the unit does contain a sizable wheat field (Figure 1). We did not have access to the unit but the habitat seemed likely to contain at least a few Sprague's.

Figure 1. La Sal Del Rey Unit wheat field.

Date: 1/3/2016

Location: Palo Alto Battlefield

Survey Period: 4:00- 5:30 PM

Distance: 1 Mile

Observers: John Muller, Laura Bliss, Joseph Veech

Weather: Overcast

Palo Alto Battlefield is a National Historic Site with the National Park Service. It is roughly 2,000 acres of fairly open coastal prairie. Although the park has a very open grassy landscape, the vegetation is very dense and, therefore, is unsuitable for Sprague's Pipit. We did not find any Sprague's and there is no historical Sprague's sighting but, if the park were to start managing the habitat with prescribed burning or grazing to reduce vegetation, the park surely would become very good option for Sprague's pipit habitat.

Figure 1. Typical grass-shrub mix vegetation of the survey area.

Figure 2. Typical brushy vegetation of the survey area.

Date: 1-6-2016

Location: South Padre Island, including Andy Bowie County Park and various points at north end.

Survey Period: 9:00-11:30 AM

Distance: 1 Mile

Observers: John Muller, Laura Bliss, Joseph Veech

Weather: Foggy, wet

There are multiple reports of Sprague's Pipits on South Padre Island but they are few and scattered. We were unable to find any Sprague's in the sand dune habitat on the gulf side of the island. There appeared to be suitable habitat along the bayside of the island, but it was on private land. We have found Sprague's Pipits during a previous project on Mustang Island to the North and the habitat there is very similar to that of South Padre. Padre Island National Seashore just north of South Padre is 130,000 acres, Laguna Atascosa NWR also owns land on Padre Island. Although we were unable to find any pipits, considering the size of the island there are most likely many pipits along Padre Island.

Figure 1. Andy Bowie park within the town of South Padre Island.

Figure 2. Sand dune habitat on north end of South Padre Island.

Figure 3. The north end of South Padre Island has some extensive and relatively flat grassy terrain (potential pipit habitat) but it is private land and was not surveyed.