Conserving Breeding and Wintering Grasslands: Protocol for Sprague's Pipit (*Anthus spragueii*)

Population Management

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Year: Spring 2019

Submitted: May 2019

Photo by Gerald Romanchuk Adult Sprague's Pipit (*Anthus spragueii)*

A paper submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Fisheries & Wildlife – Wildlife Concentration at Paul Smith's College.

Executive summary

The Sprague's Pipit is a small North American passerine specializing in grassland ecosystems in both its breeding and wintering ranges. Historically, Sprague's Pipit was among the most numerous grassland birds present on ranges across the United States. Now face a 75% decline in population. The main conservation issues impacting the Sprague's Pipit is habitat availability and suitability. Fragmented habitat caused by anthropogenic suppression of natural disturbances such as fire and changes in grazing regimes, urbanization and continual conversion of pristine grassland to crop land greatly reduces potential habitat. The goal of this management plan is to increase the population of Sprague's Pipit to create a stable community over ten years. This will be achieved by increasing adult survivorship by 20% and habitat availability and suitability over 10 years. Actions required to achieve are communicate and educate farmers on the importance of fallow fields as bird habitat. Land easements will increase wintering area availability and removing woody structures will increase habitat suitability. By increasing available grassland habitat in Montana, there will be an increase in available breeding habitat. This will be achieved with land easements and incentives to farmers to avoid grassland conversion. Seeding areas with cold and warm season grasses will transition unsuitable habitat to suitable grassland habitat. Habitat suitability will increase with moderate to low grazing practices paired with burning every 2-5 years. Mechanical removal will reduce woody structures and invasive plants. Hay fields are not preferred habitat but will be used for nesting. Thus to increase fledgling rate, mowing will be regulated on an area-dependent basis. After ten years, population of Sprague's Pipit are expected to stabilize with an increase in available and suitable habitat. This plan will be templet for future states to implement conservation of such a novel species.

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History and Factors

Sprague's Pipit (*Anthus spragueii*) populations between its two breeding ranges from Canada to the United States are estimated at 1,200,000 individuals (Rosenburg 2016). Based on PIF (Partners in flight) score six factors are measured to assess the vulnerability of the species. Sprague's Pipit scored a total of 14: population size (3), Breeding threats (4), Non-breeding threats (4) and Population trend (5) (Rosenburg 2016). A population trend measured from 1970-2014 suggested a 75% population decline (Rosenburg 2016). These significant threats and decline in abundance justify the IUCN (International Union for Conservation of Nature) listing as vulnerable; Sprague's Pipit has been listed since 2000 (Birdlife international 2018).

Endemic to mixed grassland prairies, Sprague's Pipit have multiple factors influencing population declines overtime; the most imminent factor is a reduction in pristine grassland across the great plans by 70-90% (Grant et all. 2010, Fisher and Davis 2011). This is a result of converting land for agricultural uses and developmental reasonings (Davis and Robbins 2014). Sprague's Pipit evolved with disturbances, such as grazing, precipitation changes and fire (Grant et al. 2010). Anthropogenic changes in these natural cycles from management variation and land use practices such as the use/misuse of fire, grazing, planting non-native grasses can have lasting community changes in an ecosystem (Grant et al. 2010). Changes in climate has also influenced the ranges of Sprague's Pipit influencing their habitat selection (Lipsey et al. 2015).

Native grasses found in large sectioned areas are essential for the survival of Sprague's Pipit, historically Montana supplied these areas, post European settlement these areas resulted in fragmented. Currently 63% of breeding populations in the United States is found in Montana (Lipsey et al. 2015). Since 1966 Sprague's Pipit population across North America have seen a 81.4% decline over 47 years (BirdLife International 2018). Using breeding bird surveys and

breeding data from Montana population model were created to show the current projected population trend and projected trends post management (Fig 1) see (appendix A) (Jones et al. 2010).

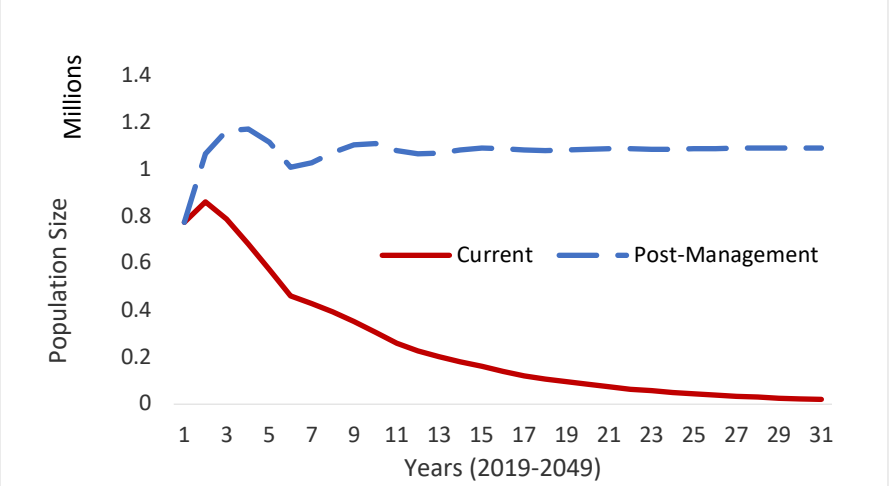

Figure 1. Population projections of current Sprague's Pipit communities and Population projections with an increase of Adult survival by 20%

Natural History

Description

Sprague's Pipit (*Anthus spragueii*) are small ground dwelling passerines endemic to North American grassland plains (Jones 2010, Davies et al. 2014). Species are not sexually dimorphic, with size ranging from 15-17 cm

Figure 2. Adult Sprague's Pipit derived from allaboutbirds.org

(COSEWIC 2010 and Davies et al. 2014). Overall, they have a drab, buff color profile except for dark brown wings and tail (Jones 2010 and Davies et al. 2014). Bluff head and body possessing black streaks on crown, nape, upper parts and breast (Jones 2010 and Davies et al. 2014). Chin, throat, chest and belly whiteish with buff washed flank and breast (Jones 2010 and Davies et al. 2014). Mean bill length for males is 8.8mm and 8.6mm for female mandible multiple colors upper being black lower white with a black tip (Jones 2010 and Davies et al. 2014). Mean tarsus length in males 21.7mm and females 22.0mm color is yellow to pinkish brown hallux possessing an elongated nail (Jones 2010 and Davies et al. 2014). Juveniles are primary terrestrial and share similarities with adults except for thick black streaks on breast (Davis et al. 2014).

Breeding and Winter Ranges

Sprague's Pipit populations within their breeding range from Canada to the United states are unevenly distributed with high proportions found in grassland areas (Lipsey et al. 2015). Canada contains 60% of the global breeding population (Lipsey et al. 2015) including south eastern Alberta on the westerly sided to the Rocky Mountain foot hills , South Saskatchewan (Davis et al 2015) and Alberta in west central and southwestern portions (Jones 2010). Within Canada 97% of the breeding populations are found in Alberta and Saskatchewan (Lipsey et al. 2015). The remaining 40% of Sprague's Pipit

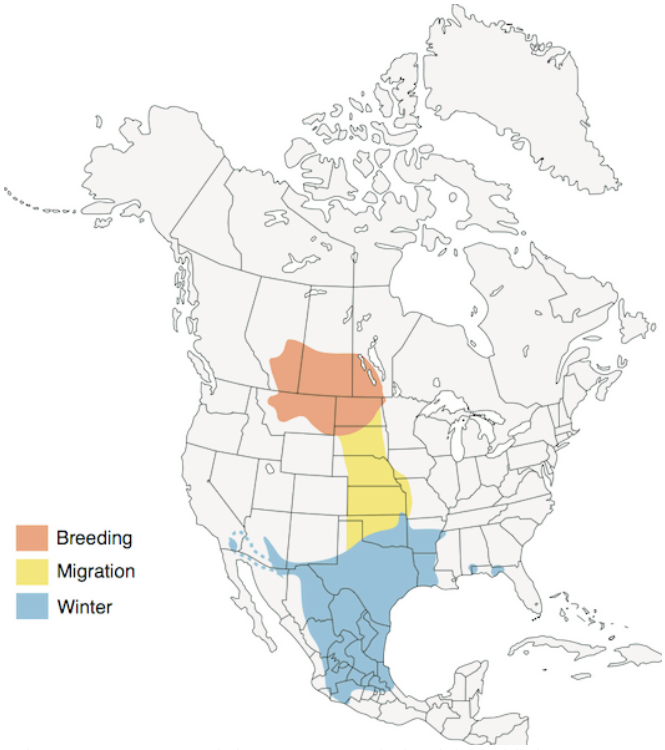

Figure 3. Sprague's Pipit Range Map derived from birdsna.org

population is found in the United States (Lipsey et al. 2015). With in the United states population 63% are found in north-central and eastern Montana (Jones 2010 and Lipsey et al. 2015). They are also found in North and South Dakota with record of existence in Minnesota (Jones 2010 and Davis et al. 2014).

Sprague's Pipit winter range from the United States to Northern Mexico (Davis et al 2014). Longitudinal ranges include South Arkansas, South Oklahoma, Texas in the United states and Sonora, Chihuahua, and Nuevo Mexico. (Jones 2010 and Davis et al. 2014). Latitudinal ranges in the United states include south eastern Arizona to southern Arkansas with record of occurrences in Florida and Alabama (Davis et al. 2015).

Cover

Sprague's Pipit is a grassland specialist with highest abundances in vegetation heights between 20-25cm (Fisher and Davis 2011) and Sprague's Pipit have been found to leave planted hayfields after heights extended past this range (Fisher and Davis 2011). Sprague's Pipit are found to be more common in native grasslands and abundance increases as surrounding native grasses increase (Davis et al. 2013) Native grasses in Saskatchewan and Montana include northern wheatgrass (*Elymus lanceolatus*), western wheatgrass (*Pascopyrum smithii*), junegrass (*Koeleria gracilis*), fescue (*Festuca spp*.), spear grasses (*Hesperostipa spp*), blue gramma grass (*Bouteloua gracilis*) (Davis et al 2014). Sprague's Pipit preference for bare ground has a small range with territory's representing areas with 15% bare ground (Fisher and Davis 2011). Average territory size in native grasslands were 1.9 with ranges 0.4–6.4 ha and in planted hay fields territory average was 1.7 ha with ranges from 0.1–5.4 ha (Davis et al. 2014). Overwintering habitat structure preference is similar to breeding structure conditions (Saalfeld et al. 2016). High

grass cover (80%) is preferred along with 28 cm grass height and 20 cm forbs (Davis et al. 2014).

Sprague's Pipit nest in areas with grass 25-30 cm both in native grasses and planted hay fields (Fisher and Davis 2011). There is a positive association with standing dead vegetation in native grassland and nest fabrication (Fisher and Davis 2011). Bare ground <17% and forbs cover <30% was typically near nest sites of Sprague's Pipit (Fisher and Davis 2011).

Mating Behavior

Sprague's Pipit are monogamous with records of polygynous behavior (Davis et al 2014). From the third week in April to May Sprague's Pipit end their migration at breeding grounds (Jones 2010, Davis et al. 2014). At the same time arriving males begin a unique areal display incorporating songs, some lasting longer than an hour while flying at heights of 100m; this is also when pairs are formed (Jones 2010, Davis et al. 2014). These aerial displays are hypothesized to also establish breeding territories (Jones 2010, Davis et al. 2014). Three-months are spent at breeding grounds (Davis et al. 2014) and during May, nests are built (Davis et al. 2014). Females independently construct nest made of dried grass on the ground in holes or cattle foot prints (Davis et al. 2014). Nests utilize adjacent grass to weave a dome in some cases with an open top in others (Davis et al. 2014). Runways 15cm long are also associated with nest entrances (Davis et al. 2014). Bare ground and vegetation characteristics of nest sites include dead tall grass (25 cm native vs 30 cm hay fields) (Davis et al. 2014). Limited forb and shrubs are also affiliated with nest location (Davis et al. 2014).

Clutch initiation spatially varies with a range from May to July, in Montana median initiation date is May 25th (Davies et al. 2014). This process begins after the nest is complete and is followed by incubation once the last egg is laid, (Davis et al. 2014). Four or five oval, white to

buffy eggs with brown splotches are laid one egg a day incubation lasts for 12-15 days (Davis et al. 2014).

Diet

There is no information of the diet of Sprague's Pipit (*Anthus spragueii*) in Montana. The Sprague's Pipit diet consist primarily of insects with evidence of seed consumption being less than 3% (Champagne 2011, Davis et al. 2014). Adult Sprague's Pipit diets consist mainly of insects in order Coleoptera and Orthoptera (Champagne 2011). Additionally
False chinch bugs (*Nysius sp.; Lygaeidae*), weevils (*Curculionidae*), stinkbugs (*Euschistus sp.; Pentatomidae*), ants (*Formica sp.*), leaf beetles (*Chrysomelidae*), ground beetles (*Carabidae*), caterpillars (*Lepidoptera*) and spiders (*Arachnida*) (Champagne 2011, Davis et al. 2014). The seeds found in Sprague's Pipit were spurge seeds (Euphorbia; Euphorbiaceae) (Davis et al. 2014). Nestlings are fed insects such as grasshoppers, crickets, moths, spiders and sawflies (Tenthredinidae) (Davis et al. 2014).

Sprague's Pipit forage individually on the ground across the entire day (Davis et al. 2014). No data exhists for foraging rates, due to camouflage plumage and height of vegetation data (Davis et al. 2014). Sprague's Pipits have been observed foraging in tall grasses, short grasses grazed by cattle with bare ground and along trails created by vehicles and cattle (Davis et al. 2014). Sprague's Pipit have also been observed catching on the wing by skimming the tops of vegetation with short hovering bouts (Davis et al. 2014). Energy expenditures vary between male and females with incubating females estimated at 86.8 kj/d and males with (Vpm) of 5.9 m/s and a (Vmr) of 10.4 m/s (Davis et al. 2014). 1.8% of body mass would be lost after three hours of song display equaling about .157 g/h of fat consumption (Davis et al. 2014).

Ecological and Social Cultural Issues

Historic dynamic vegetation attributes influenced by the disturbance of fire and grazers synergized a complex heterogenous ecosystem (Grant et al. 2010). Anthropogenic changes in natural ecological regimes such as the extirpation and replacement of grazers and the suppression of fire, alter disturbance patterns creating a low-quality homogeneous ecosystem (Grant et al. 2010, Richardson et al. 2014). These changes correlate with declining populations of grassland song birds (Grant et al. 2010, Richardson et al. 2014). The lack of early successional transition by fire can cause a variety of ecological changes depending on the region, arid low grasslands transition into taller shrub lands, introducing more litter into the system altering productivity, reducing abundance of Sprague's Pipit (Grant et al. 2010, Richardson et al. 2014).

Vegetation characteristic and requirements are crucial to understand as many grassland song birds determine nest territories and sites from them (Richardson et al. 2014). When fire was applied to a suppressed area over 20 years native plant communities returned and Sprague's Pipit followed (Grant et al. 2010). Although evidence suggests fire changes vegetation composition and supports biodiversity, postfire areas saw a short-term decline in grassland bird population (Grant et al. 2010, Richardson et al. 2014). This change is concerning as it may lead some to avoid the use of fire, voided by evidence that the neglect of fire can have lasting negative effects on Sprague's Pipit (Grant et al. 2010).

Fire alone may not explain habitat and population dynamics with Sprague's Pipit absent for 40 year in areas of prescribed burns similar to historic conditions (Grand et al. 2010). When grazing is introduced to an area along with prescribed burns, Sprague's Pipit established breeding sites (Grand et al. 2010). This historic interaction creates unique habitats important for bird communities (Richardson 2014). Based off a small sample set moderate grazing may

support management practices for prairie song birds (Lusk and Koper 2013). Although there is supporting evidence for grazing as an important disturbance (Grand et al. 2010), Limited information is available on songbird reproductive success impacts from grazing (Lusk and Koper 2013).

A questionable social cultural anthropogenic change that could cause potential ecological issue is the introduction of planted nonnative grasses. This practice is widely used with a variety of species and has been documented to help generalists but is not suitable for specialist such as Sprague's Pipit (Sutter and Brigham 1998, Fisher and Davis 2011, Davis et al. 2013). A variety of factors may influence habitat selection of Sprague's Pipit. Populations are higher in areas with native grasslands, but birds are found in planted pastures (Davis et al. 2013). Also Sprague's Pipits were found in planted hay fields but leave after vegetation height exceeded 31cm (Fisher and Davis 2011). This suggests that Sprague's Pipits can either obtain nutrients from the planted plot or exploit surrounding native grasslands (Davis et al. 2013). Sprague's Pipit populations are found lower in planted grasses supporting that planted grass areas are lower quality habitat when compared to native (Sutter and Brigham 1998, Davis et al. 2013). Vegetation height in planted grasses influences predation, which alters fledgling dispersal and reduce survival rates (Davis et al. 2011).

Economic issues

An increase in land use for the production of agrofuels and other agricultural conversion practices can drastically change ecosystems and influence Sprague's Pipit abundance (Robertson et al. 2012). This conversion has left grassland song birds with 20% of there historic range and threats grow today by government policy and subsidies for the growth in crop production (Robertson et al. 2012, Ludlow et al. 2014). Monoculture crop growth lowers biodiversity

resulting in a lower quality ecosystem (Robertson et al. 2012). With the complete shift to monoculture practices and increased need of food with projected population growth the demand for food could extirpate the Sprague's Pipit. (Lipsey et al. 2015). Sprague's Pipit have favor native grassland plots and tend to avoid croplands, even found at rates three times lower than that of other land uses (Lipsey et al. 2015). An estimated 21% of Sprague's Pipits fall under protection from cropland conversion with large proportions still at risk (Lipsey et al. 2015). Species demonstrates high population densities 63% of Sprague's Pipit breeding population occupy Montana (Lipsey et al. 2015) and 80% of population falling on private land, converting small areas could have lasting impacts (Lipsey et al. 2015, Rosenburg 2016).

Legal, Regulatory, Policy.

The Migratory Bird Treat Act (MBTA) of 1918 (16 U.S.C. 703-712) made it illegal to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts (US Fish and Wildlife). This at the time was used to stop the spread of the millinery trade but rolls into effect today. Currently it still prevents the take of Sprague Pipit and helps to give reasoning to continue its protection. Federal Aid in Wildlife Restoration Act (16 U.S.C. 669-669i; 50 Stat. 917) of September 2, 1937, or Pitman Robinson act allocated a 11% tax on fire arms and other wildlife related purchase to return to the state department of wildlife. This tax provides a majority of the states funding and is crucial for wildlife management.

Statement of Need:

The conservation need for Sprague's Pipit is an increase in habitat management. Allocated land that provides native habitat for Sprague's Pipit would result in an increase in

suitable breeding habitat. A combination of prescribed fire and grazing practice are needed to recreate historic range conditions. Additionally preservation of remaining native grasslands will sustain populations of Sprague's Pipits.

Goal and Objectives:

Goal: Increase the population of Sprague's Pipit to create a stable community over ten years

Objective 1: Increase adult survival rates by 20% in winter ranges over ten years.

Objective 2: Increase available breeding habitat by 5% over ten years.

Objective 3: Improve habitat suitability of the existing grassland habitat in breeding ranges by 20% over 10 years.

Actions

Objective 1- Increase adult survival rate by 20% in winter ranges over ten years.

Action 1.1- Conduct research to find the correlation between wintering and adult survival and winter habitat characteristics. Additional research is needed to understand the importance of developed open spaces in correlation to Sprague's Pipit habitat selection (Muller et al 2018). Species occurrence in these areas such as golf courses, large lawns, and other recreation areas suggest this is potential suitable habitat when vegetation is properly managed in the form of mowing height and the reduction of woody structures (Muller et al. 2018). A four-year study to evaluate rate of occurrences and survival within will be done by point count and capture and radiotelemetry addition vegetation surveys will help to determine vegetation characteristics. Study areas will be established by developing partnerships with two golf courses, two sports complexes, two parks, and two airports. Using mist nets to capture Sprague's Pipits we will fit them with radio

transmitters (Macías-Duarte and Panjabi 2013). Twice a day from January 1st to March 1st we will track signals (Macías-Duarte and Panjabi 2013). Within these areas, ArcGIS will be used to generate 10 random points to create transects (Kostecke et al. 2015) spaced >400m apart to reduce double counting (Davis et al. 2013). Six-minute point counts (Bernath-Plaisted 2018) will be conducted from January 1st to March 1st (Pool et al. 2012) occurring three times at each transect between 0500-0930 (Davis et al. 2013) allowing 10 days before conducting another survey (Bernath-Plaisted 2018). Vegetation surveys will occur at each transect with two additional IR (independent random) transect produced by ArcGIS. Vegetation surveys will be conducted twice, occurring in early season and late season (Bernath-Plaisted 2018). Vegetation characteristic will be determined by conducting line-intercept method (Pool et al 2012) cover will be visually estimated (Kostecke et al. 2015). Parametric regression models will be created to identify the relationship between survival and vegetation characteristics (Macías-Duarte and Panjabi 2013). If data suggest that these areas are suitable habitat, mowing heights and occurrence will be recommended to stakeholders to improve suitability and available habitat.

Action 1.2 – Increase availability of food and cover by conservation enrollment by educating land owners with pamphlets. This will increase public understanding of the importance that fallow and harvest fields as Sprague's Pipit wintering habitat. Habitat suitability and characteristic in wintering ranges have significant correlation to fitness and abundance by providing increase food availability and possible predator avoidance which positively influence survival (Macías-Duarte and Panjabi 2013). By informing

farmers that harvested and fallow fields may mimic similar conditions to grassland habitat we can increase quantity of available suitable habitat (Muller et al. 2018). This would be particularly beneficial in areas with limited surrounding natural grassland habitat (Muller et al. 2018). This will be accomplished through flyers will be mailed to all registered farms in Texas providing an identification picture of Sprague's Pipit. Additional information includes; a short description of historic populations and current declines, habitat characteristics, the importance of fallow fields and how their contribution can be beneficial. Also possible opportunities for land easements and incentives will be included to encourage further conservation efforts. Posters will also be made and hung around areas with high agriculture activity. Posters (Appendix B) will include an identification picture, importance of fallow fields and possible easement opportunities (Jones 2010).

Action 1.3 – Decrease overall amount of woody structures in wintering ranges. Sprague's Pipit actively avoid shrublands in over wintering areas (Muller et al. 2018). To increase the quality of overwinter habitat, a decrease in the amount of woody vegetation must be achieved. This can be done through regulated prescribed burns that mimic historic burns every 5-6 years (Grand et al. 2010). Prescribed burns will reduce woody structures with the combination of mechanical removal of woody structures in the form of chain saws and herbicides use. Also regulated low to moderate grazing practices can be used to control and reduce overall cover amounts (Muller et al. 2018).

Action 1.4 – Reduce predator abundance by decreasing the amount of edge associated wintering habitat. Habitat which would increase survival by reduced predator abundance and predator activity. increasing the amount of over winter habitat would combat current population declines due to habitat fragmentation (Lusk and Koper 2013). This can be accomplished through buying up available land to allocate protected areas. Also converting cropland and non-suitable habitat back to former conditions (Muller et al. 2018).

Although these management strategies would be optimal for the recovery of the species it is not economically feasible to spend funds on purchasing land. In addition, converting existing crop lands to states prior to agriculture is unrealistic when land priority goes to the growing need for humans and livestock food of (Muller et al. 2018).

No Action: Without increasing adult survivalship Sprague's Pipit populations will continue to decline based off population models. This would decline in population would result in possible extinction of the species.

Final Course of Action: Final courses of actions that will be implemented will be 1.1, 1.2, 1.3 and 1.4.

Assessment Protocol: An increase in adult and juvenile survival rate by 20% within 10 years will determine if objective 1 is successful. To assess survival rate adults will be captured using standard mist netting techniques and fitted with radio transmitters

(Bernath-Plaisted et al. 2018) in wintering ranges. The birds will also be banded with color and USGS aluminum bands for future recapture studies (Bernath-Plaisted et al. 2018). Quantifiable categories such as site, day of year, weekly average temperature will be used in Models to evaluate survival ship (Bernath-Plaisted et al. 2018). A sample size of 65 will help to determine statically significant information.

If there is not a 20% increase in adults Sprague's Pipit over ten years objective 1 will be considered unsuccessful. A further evaluation of actions will be implemented to determine cause of failure. This will be done by quantifying what actions produced desired results. Such as communicating habitat importance in the form of a educational documents may be ranked as having low effect rate in action 1.1. So we would respond by having direct connection to a stakeholder or modifying information on posters.

Objective 2- Increase available breeding habitat by 5% over ten years

Action 2.1- Conserve existing suitable habitat through rental contracts and easements. This will be achieved by increasing private land partnerships with conservation land easements established with the grassland reserve program 69 Fed. Reg. 29,173 (May 21, 2004)(to be codified at 7 C.F.R. § 1415). this would compensate land owners for economic loss from reduced crop production (Lipsey et al. 2015). By creating contracts with land owners lasting no longer than 10 years land will be made available for long term biodiversity protection while compensating farmers and land owners.

Action 2.2- Restore potential suitable land into viable habitat. This will be done through restoration programs (Jones 2010). Once lands are established croplands that neighbor native grasslands to non-native grasslands will be restored to potential breeding habitat. This will be achieved through seeding areas with a combination of cool and warm season grasses (Jones 2010, Davis et al. 2013).

No Action – Without proper breeding habitat protection and conservation populations land will continue to be converted to agriculture fields or unsuitable habitat. With unconstrained growth of 12.39 million Ha would result in a 27% decline in Sprague's Pipit population (Lipsey et al. 2015).

Final Course of Actions: Final course of actions will include 2.1 and 2.2 given proper funds are provided from reserve programs.

Assessment Protocol: Objective 2 will be deemed successful and complete when available breeding habitat for Sprague's Pipit is increased by 5% over ten years. This will be assessed using GIS to map potential habitat to evaluate growth of breeding habitat over ten years (Montana Natural Heritage Program 2016). If available breeding habitat demonstrates a 5% increase in ten years it will be considered successful. This is an crucial for the success of Sprague's Pipit as fragmentation of habitat is one of the many factors influencing population declines (Fisher and Davis 2011).

If objective 2 does not meet the requirement of a 5% increase in breeding habitat within ten years it will be deemed unsuccessful. Further evaluation of action 2.2 to increase available habitat will have to be explored such as increase incentives for farmers to convert crops to grasslands (Lipsey et al. 2015). Additionally improvements to current and future policies would reduce conversion risk (Lipsey et al. 2015). This will be done by lobbying and advocating funds for grassland reserve programs.

Objective 3- Improve habitat suitability of the existing grassland breeding habitat by 20% over 10 years

Action 3.1- Standardize the range grazing management practices. Implement low to moderate grazing practices in current range practices. Sprague's Pipit have evolved with natural disturbances from large ungulates in the form of Bison herds (*Bison bison) (*Lusk and Koper 2013) and fire (Richardson et al. 2014). Anthropogenic changes in these disturbances such as the removal and replacement to cattle grazing could possible fill the historic grazing niche (Lusk and Koper 2013). Low to moderate grazing intensity is recommended in grassland prairies (Lusk and Koper 2013).

A**ction 3.2** -. Apply prescribed fires every 5 years to Sprague's Pipit habitat. Fire has observable and immediate effects on vegetation but litter accumulates almost immediately post burn. Accumulation rates are influenced by grazing practices (Richardson et al. 2014). Study in Montana recorded Sprague's Pipits leaving areas post burn but return after vegetation recovers (Richardson 2014). In order to reduce the total

amount of vegetation waste in habitat locations areas should be burned every 2-4 years (Dechant 2001, Jones 2010).

Action 3.3 –Mow hay fields on a biannual rotating schedule. Sprague's Pipit prefer native grasslands but have alternatively been found in planted hay fields. Although the vegetative structure diversity of these planted fields is limited, height of vegetation plays an important role. Highest occurrence of Sprague's Pipit found in fields with heights between 22-31cm (Fisher and Davis 2011). To provide the best suitable habitat and most productivity from hay fields mowing should occur on a biannually rotating schedule, separating larger fields in half with altering each year mowed (Dechant 2001, Jones 2010).

Action 3.4 – Delay mowing dates of hay fields to be no sooner than July 15 and later July-August in dryer areas. Although hay fields can support populations of Sprague's Pipit, they depart these planted fields once heights of vegetation exceeds 31cm (Fisher and Davis 2011). To improve fledging rates in these areas to greater than 70% a minimum mowing date should be no sooner than the 15 of July and in dryer areas mowing should be delayed till the end of July or August (Dechant 2001, Jones 2010).

Action 3.5 – Remove woody structures from breeding habitat. By removing woody structures from grasslands, we can optimized breeding habitat (Jones 2010). This can be done through a variety of means listed above in action 1.3. Additionally, to reduce woody

structures planting trees and shrubs should not occur within 100m of grasslands (Jones 2010).

Action 3.6 – Reduce total abundance of invasive plants in associates Sprague's Pipit habitat. Invasive plants have lasting negative impacts on native communities, resulting in degraded habitat and a reduced population fitness (Ellis-Felege et al. 2013). Evidence supports the chemical imazapyr as an effective means for controlling invasive plants but this is not a preferred method (Ellis-Felege et al. 2013). To mimic historic and evolutionary disturbances as means to control invasive plants a combination of burning and grazing is required (Ellis-Felege et al. 2013). Grazing practices should be low to moderate with burns accruing every 5-6 years.

No Action – Without proper management of habitat populations of Sprague's Pipit will continue to face a steady decline. Fragmentation and degradation of ecosystems due to neglected hay fields, crop conversion and invasive species will limit available suitable habitat.

Final Course of Actions: Actions 3.1, 3.2, 3.3, 3.4, 3.5 and 3.6 will all be implemented to improve available suitable habitat.

Assessment Protocol: Habitat suitability of existing grassland breeding ranges of Sprague's Pipit will be considered improved when it receives a 20% increase compared to current standards. Habitat suitability will be assessed using a variety of vegetation and

abundance surveys. By using unmanned Aircraft systems (UAS) to evaluate vegetation structure in designated areas over ten years (Bernath-Plaisted et al. 2018). Point count surveys will also be conducted to evaluate habitat use and abundance in study areas (Bernath-Plaisted et al. 2018). Vegetation surveys will be conducted and nest sites and random location as control (Bernath-Plaisted et al. 2018).

If there is not a 20% increase of habitat suitability within ten years this objective will be considered unsuccessful. A full assessment of what caused an unsuccessful return will be conducted. Further research will be conducted on what methods best fit into the future needs of agriculture and native communities. Conservation easements will be implemented to improve rates of success (Lipsey et al. 2015).

Conclusion

Conserving and increasing available habitat for Sprague's Pipit are the first steps in combating declining population trends. This will be achieved by completing the primary objectives listed above through primary actions. Preservation of biodiversity is crucial in response to current Anthropocene extinction event. The use of bottom-up control through proper land management techniques will benefit not only Sprague's Pipit but other organisms found in this unique ecosystem as well. When dealing with such a limited area like the remaining grasslands it is important to enlist proper management techniques the first time. Consequences of miss use can have lasting impacts when dealing with large disturbances such as fire and grazing. Without proper management these disturbances can transformed areas in the case of over grazing site can be stripped of their native vegetation and lack of fire can allow large amounts of litter to

accumulate disturbing productivity. By properly managing these disturbances we can mimic a historic disturbance regime similar to one these species have evolved with.

Acknowledgements

I would like to thank Jesus for the strength and knowledge to succeed through my science career. I would also like to thank Dr. Ross Conover for guidance, support and encouragement to peruse a wildlife science career. Additionally, the many professors at Paul Smith's college that have helped to evolve my ecological conscience. Finally, my fellow peers who have provided constant motivation and encouragement throughout my collegiate career.

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Appendix A

Population Model: Projections, Sensitivity, Elasticity

Example: Sprague's Pipit

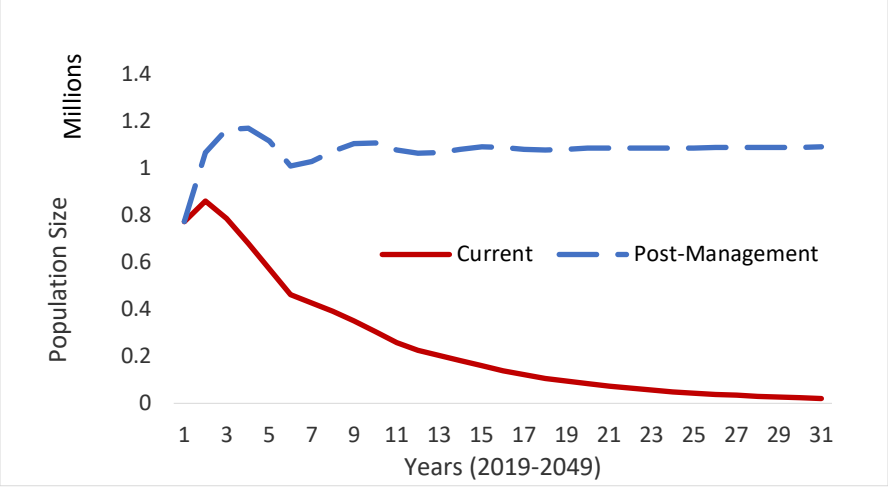
	F(*h*)	*F*(*sj*)	*F*(*lj*)	*F*(*sa*)	*F*(*a*)
Egg:	0	0	0	0	1.863
Nestling:	0.5523	0	0	0	0
Fledgling:	0	0.54	0	0	0
Juveline:	0	0	0.64	0	0
Adults:	0	0	0	0.64	0.5

Sensitivity matrix

	F(*sj*)	*F*(*lj*)	*F*(*sa*)	*F*(*a*)
0.1672	0.0994	0.0610	0.0444	0.0748
0.2522	0.1583	0.0972	0.0707	0.1191
0.4109	0.2579	0.1583	0.1152	0.1941
0.5649	0.3546	0.2176	0.1583	0.2668
0.7765	0.4875	0.2992	0.2176	0.3667

Elasticity matrix

F(*h*)	*F*(*sj*)	*F*(*lj*)	*F*(*sa*)	*F*(*a*)
0	0	0	0	0.15831738
0.158317408	0	0	0	0
0	0.158317409	0	0	0
0	0	0.158317395	0	0
0	0	0	0.158317382	0.208413061



Appendix B

Keep fallow fields

Sprague's Pipit have declining populations partially due to lack of available habitat. By leaving fallow fields we can increase additional available habitat. You can help this Population become stable again!

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