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Status Assessment and Conservation Plan for the Grasshopper Sparrow (*Ammodramus savannarum*)

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U.S. Fish & Wildlife Service

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Version 1.0
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prepared by

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Executive Summary

The Grasshopper Sparrow (*Ammodramus savannarum*) breeds in grassland habitats throughout much of the U.S., southern and southeastern Canada, and northern Mexico. Additional subspecies are resident in Central America, northern South America, and the Caribbean. It winters primarily in the coastal states of the southeastern U.S., southern portions of the southwestern states, and in Mexico, Central America, and the Caribbean. The species prefers relatively open grassland with intermediate grass height and density and patchy bare ground; because it is widely distributed across different grassland types in North America, it selects different vegetation structure and species composition depending on what is available. In the winter, they use a broader range of grassland habitats including open grasslands, as well as weedy fields and grasslands with woody vegetation. Analyses show significant range-wide population declines from the late 1960s through the present, primarily caused by habitat loss, degradation, and fragmentation. Grasshopper Sparrow is still a relatively common and broadly distributed species, but because of significant population declines and stakeholder concerns, the species is considered of conservation concern nationally and at the state level for numerous states. Many factors, often related to different grassland management practices (e.g., grazing, burning, mowing, management of shrub encroachment, etc.) throughout the species' range, have impacts on Grasshopper Sparrow distribution, abundance, and reproduction and may represent limiting factors or threats given steep declines in this species' population.

Because of the concerns for this species, Grasshopper Sparrow has been identified as a focal species by the U.S. Fish and Wildlife Service (USFWS) and this Status Assessment and Conservation Plan for Grasshopper Sparrow has been developed. Through literature searches and input from stakeholders across its range, this plan presents information about Grasshopper Sparrow population status, distribution, habitat needs, threats and limiting factors; synthesis of these resources has identified recommended action items addressing population status and trends, habitat conservation, management, research, inventory and monitoring, and education and outreach components that will facilitate Grasshopper Sparrow conservation across its full annual cycle. Goals and objectives are summarized here (see Appendix A for full presentation of goals, objectives, and prioritized action items).

Goal 1: Determine the population status and distribution of Grasshopper Sparrow to inform conservation planning.

> Objective 1.1 - Determine status and distribution of Grasshopper Sparrow populations based on existing data and professional opinion, and identify priority areas for conservation action
>
> Objective 1.2 - Improve our knowledge of status and distribution of Grasshopper Sparrow

Goal 2: Protect, restore, maintain, and manage grassland habitats that are needed to sustain a stable or increasing Grasshopper Sparrow population across its breeding range

> Objective 2.1 - Maintain and improve current grassland conservation programs to benefit Grasshopper Sparrows (and other grassland birds)
>
> Objective 2.2 - Identify high priority grassland areas for protection and restoration to benefit Grasshopper Sparrows, using information from Population Status and Distribution (Goal 1) and Inventory and Monitoring (Goal 5) sections

Objective 2.3 - Implement general grassland habitat conservation and protection concepts that benefit a suite of grassland birds, including Grasshopper Sparrows

Goal 3: Implement management of grassland habitats to benefit Grasshopper Sparrow

Objective 3.1 - Implement general management practices that benefit a suite of grassland birds, including Grasshopper Sparrow

Objective 3.2 - Implement specific management practices that are known to benefit Grasshopper Sparrows and a suite of other grassland birds

Goal 4: Conduct research necessary to inform conservation planning, actions, and development of Best Management Practices (BMPs) to benefit Grasshopper Sparrow

Objective 4.1 - Conduct research on Grasshopper Sparrow population abundance, distribution, and population trend

Objective 4.2 - Conduct research on Grasshopper Sparrow demographics and ecology, ideally studied concurrently with other priority grassland birds

Objective 4.3 - Conduct research on management-related questions related to Grasshopper Sparrow

Goal 5: Conduct inventory and monitoring activities to inform Grasshopper Sparrow conservation planning and activities

Objective 5.1 - Conduct inventory and monitoring activities on Grasshopper Sparrow grassland habitat

Objective 5.2 - Conduct inventory and monitoring activities on Grasshopper Sparrow distribution, population trend, and habitat use

Goal 6: Develop and produce education and outreach materials, activities and programs that facilitate the conservation of Grasshopper Sparrow

Objective 6.1- Produce BMPs documents on pertinent subjects for target management audiences; see Management (Goal 3) and Research (Goal 4) sections above

Objective 6.2 - Produce other activities, programs, and materials that will facilitate conservation of Grasshopper Sparrows and their grassland habitat by managers and policy-makers

Objective 6.3 - Produce activities, programs and materials that increase awareness of Grasshopper Sparrow and their grassland habitats

Goal 7: Evaluate whether the scale of actions recommended match, or will produce impacts at the scale necessary to achieve the stated population objectives for Grasshopper Sparrow

Objective 7.1 - Develop models and/or decision support tools that will allow conservation planners to determine the population-level impacts of various recommended actions in this plan and how much of these actions at what scales are required to achieve population objectives.

Developing prescriptive, geographically-based Grasshopper Sparrow conservation action plans through collaborative partnerships is necessary to implement the conservation action items recommended in this plan. Implementing effective conservation measures will require the collaboration of a coalition of local, regional, national, and international partners to achieve conservation for Grasshopper Sparrow across its full annual cycle and to integrate actions into plans for the conservation of grassland landscapes and suites of grassland bird species of conservation concern.

I. Introduction

The Grasshopper Sparrow (*Ammodramus savannarum*) has been identified as a focal species by the U.S. Fish and Wildlife Service (USFWS) through its "Focal Species Strategy for Migratory Birds". The strategy was initiated to provide explicit, strategic, and adaptive sets of conservation actions required to return or maintain species of concern at healthy and sustainable levels. As part of the strategy, the USFWS identified 55 species that are to receive increased attention over the short-term. Included on this list was the Grasshopper Sparrow, whose population has shown long-term declines and is negatively affected by grassland habitat loss, fragmentation, and degradation. The need for a continent-wide conservation strategy for Grasshopper Sparrow has been recognized (Wells and Rosenberg 1999), and USFWS has recently chosen it for development of a comprehensive action plan in cooperation with conservation partners and stakeholders. For more information on the Focal Species Strategy, visit http://www.fws.gov/migratorybirds/currentbirdissues/management/FocalSpecies.html.

The Status Assessment and Conservation Plan (the Plan) for Grasshopper Sparrow was developed to facilitate collaborative efforts toward the long-term conservation of the species. The first step in developing a comprehensive Plan was to conduct an extensive literature search for publications that provide additional, new information about this species following the publication of the Birds of North America account (Vickery 1996). Requests also were sent out through various conservation networks such as Partners in Flight, asking for information about status of, and projects and publications about, Grasshopper Sparrow across its range. The partners who provided input for the Plan are committed to taking steps to ensure the long-term viability of the species. The Plan builds on previous reports that have summarized the status, threats, and conservation needs of the Grasshopper Sparrow, including: (1) The Birds of North America Grasshopper Sparrow Species Account (Vickery 1996); (2) the South Florida Multi-species Recovery Plan (USFWS 1999); (3) Partners in Flight (PIF) continental, regional, state and physiographic area plans; and (4) State Wildlife Action Plans. All data presented in the Plan were the most current data available as of December 2014.

II. Systematics

This section summarizes information about the range-wide taxonomy of Grasshopper Sparrow, although the Plan focuses primarily on those subspecies found in the U.S. or its territories at some point during their annual cycle. NOTE: In some cases conservation actions for these subspecies may be required outside the U.S. (e.g., during the nonbreeding season) in order to accomplish full life cycle conservation for the species. Unless otherwise cited, the information in this section is summarized from Vickery (1996) and more information about subspecies can be found there.

Twelve subspecies of Grasshopper Sparrow are recognized, although differentiation is weak for several of these subspecies, requiring further research. Four subspecies breed in North America:

(1) *A.s. pratensis* breeds from southeastern Canada and the northeastern and midwestern U.S. south into some parts of the southeastern U.S. It winters from the southeastern U.S. south into the Caribbean, Mexico and Central America.

(2) *A.s. perpallidus* breeds from the northwestern U.S., prairie Canada, and irregularly into the midwestern U.S., where it overlaps with *A.s. pratensis*, south into southwestern California, and south throughout the Great Plains as far as eastern New Mexico, the panhandle of Texas, and the lower Gulf Coast (Mehlman 1995; Vickery 1996; Kingery 1998; New Mexico Ornithological Society 2007; Benson and Arnold 2001). It winters primarily from the southern parts of the southern tier of U.S. states, south into Mexico and northern Central America.
(3) *A.s. ammolegus* breeds from southeastern Arizona and southwestern New Mexico south to northern Sonora, Mexico (Vickery 1996). Its winter range is poorly known, but it winters from southern Arizona and New Mexico south into Mexico and Central America. It is considered a partial migrant, and at least some birds remain year-round on their breeding grounds in southeastern Arizona (J. Ruth, unpubl. data).
(4) *A.s. floridanus* is now restricted to prairies north and west of Lake Okeechobee to central Osceola County, Florida. It is thought to be sedentary but some winter movement is possible.

A genetic analysis of five populations of Grasshopper Sparrow representing three of the subspecies (*A.s. pratensis*, *floridanus*, and *ammolegus*) used mitochondrial and microsatellite DNA to look at phylogeographic structure and genetic differentiation (Bulgin et al. 2003). They found low but significant differentiation between *floridanus* and all other populations combined, but no differences between the other two subspecies, and concluded that the three subspecies have only recently diverged from each other.

Four subspecies are resident from southern Mexico to northern Ecuador:
(5) *A.s. bimaculatus* from southern Mexico, Guatemala, and central Honduras to northwestern Costa Rica, and disjunctly in western and eastern Panama.
(6) *A.s.cracens* from Belize, eastern Guatemala, and Honduras south to northeastern Nicaragua; it is a possible breeder in the Yucatan, Mexico.
(7) *A.s. beatriceae* is endemic to central Panama.
(8) *A.s. caucae* from Columbia and northern Ecuador.

Four subspecies are resident in the Caribbean:
(9) *A.s. savannarum* on Jamaica.
(10) *A.s. borinquensis* on Puerto Rico, a U.S. Territory.
(11) *A.s. intricatus* on Hispaniola.
(12) *A.s. caribaeus* on Curaçao and Bonaire islands.

III. Legal Status

A. Global - Grasshopper Sparrow has no global legal status.

B. Canada (national and regional) – Grasshopper Sparrow is covered by the Migratory Bird Conservation Act, the Canadian equivalent of the Migratory Bird Treaty Act (see below). Grasshopper Sparrow, *pratensis* subspecies (*A.s. pratensis)*, is listed as a taxon of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), since November 2013. A decision to list legally under the Canadian Species at Risk Act (SARA) has not yet been taken (Government of Canada 2013).

C. United States (national, regional, and state level) - Grasshopper Sparrow is covered by the Migratory Bird Treaty Act, which implements various treaties and conventions between the U.S., Canada, and Mexico, as well as several other countries. Florida Grasshopper Sparrow subspecies (*A.s. floridanus*) is listed as Endangered under the U.S. Endangered Species Act (USFWS 2009). Grasshopper Sparrow also is listed as a state threatened species in five states and a state endangered species in four states (Table 1).

D. Mexico, Caribbean, Central and South America - Grasshopper Sparrow is not listed under the Mexican NORMA Oficial Mexicana NOM-059-SEMARNAT-2010, which lists species that are endangered, threatened, or under special protection in Mexico. No evidence was found for any national legal status for Grasshopper Sparrow in its range outside the U.S. and Canada.

IV. Range and Distribution

A. Breeding (Canada, United States, and Mexico)

Grasshopper Sparrow breeds locally in appropriate grassland habitats throughout the northeastern and mid-Atlantic U.S. and southeastern Canada, the central U.S. and southern Canada, and again locally in grasslands in the northwestern U.S., coastal California and the Central Valley, the southwestern U.S. and northern Mexico, and Florida (Fig. 1). This includes all or part of 48 U.S. states and 1 Territory, and 6 Canadian provinces (Table 1). It also includes the state of Sonora, Mexico, and possibly Chihuahua. More details about range and distribution can be found in Vickery (1996).

Additional distributional information is provided here for regions where Grasshopper Sparrows are rare or of particular conservation concern (see section on **Conservation Status**). In the New England states and New York, a survey of grassland birds in 1140 sites across the region found that Grasshopper Sparrows occurred on <20% of sites and were most abundant in southern New England and most common in the Finger Lakes region (Shriver et al. 2005). In Quebec, Grasshopper Sparrow distribution is mostly restricted to the southern portion of the St. Lawrence Lowlands, in the Pontiac region west of the Ottawa-Gatineau metro region (Jobin and Falardeau 2010; Savignac et al. 2011). In the southwestern U.S., *A. s. ammolegus* is found in southeastern Arizona and southwestern New Mexico, with the main populations located in the San Rafael and Sonoita valleys in Arizona and the Animas Valley of New Mexico; remnant populations continue in the San Bernardino, Sulphur Springs, San Pedro, and Altar valleys of Arizona (Williams 2007; Ruth 2008). The subspecies also is found in northern Sonora, Mexico (Mills 1982; Strong 1988) and may breed in northwestern Chihuahua as well (Manzano-Fischer et al. 1999; J. Ruth, pers. observ.). In British Columbia, Grasshopper Sparrow is found primarily in the Okanagan and lower Similkameen valleys (Cannings 1995). In California, Grasshopper Sparrow is found along the coast and inland in central California; distribution includes the base of the southern Sierra Nevada, the foothills of the Central Valley and locally on the floor of the valley, and along the Pacific Coast with the exception of some areas in coastal southern California (Unitt 2008). In Florida, *A.s. floridanus* is found in the dry

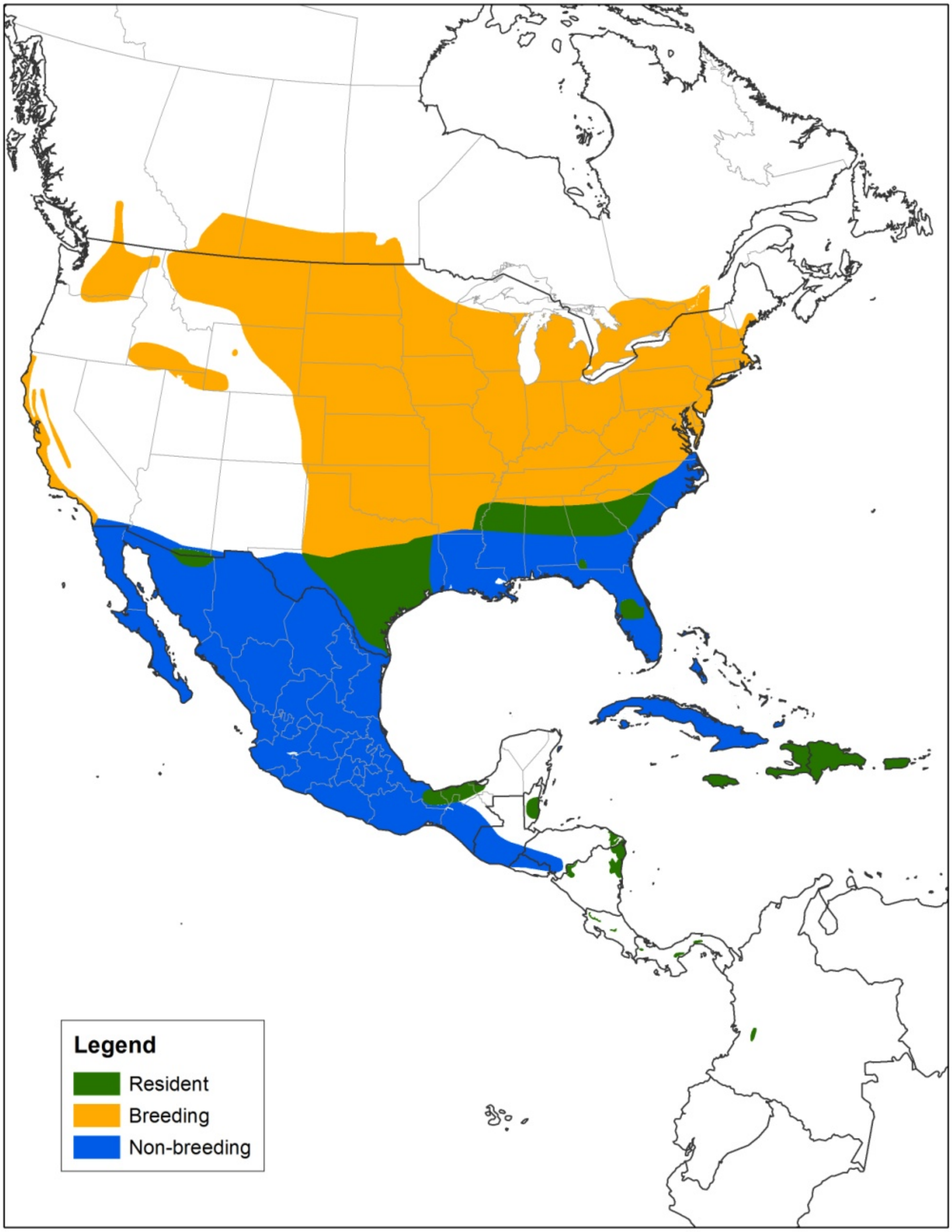

Figure 1. Grasshopper Sparrow range map (BirdLife International [2014] and Nature Serve [2013]). It occurs where suitable habitat is found within the described range.

<u>Table 1.</u> Grasshopper Sparrow (*Ammodramus savannarum*) Status and Trends. Summarized by Federal or State Official Species Status, U.S. State Wildlife Action Plan Status, Natural Heritage rankings, Breeding Bird Survey (BBS) trends for 1966 – 2012, and BBS trends for 2002 – 2012. For Official Species Status designations: Federal (US) U.S. Endangered Species Act, State (S) and Provincial (P) status: E = Endangered; T = Threatened; SC = Special Concern; RL = Red List (in British Columbia lists provincial threatened and endangered species). A single or double asterisk (*) in this column or the next indicates corresponding additional information in the comments column. For State Wildlife Action Plan status: SGCN = Species of Greatest Conservation Need; other state designations are spelled out; no = not designated on the state list of SGCN or equivalent. For the natural heritage rankings, G = global and S = state, where S5 = secure (common, widespread, abundant, and lacking major threats or long-term concerns), S4 = apparently secure (uncommon but not rare, but with some cause for long-term concern, usually having more than 100 occurrences and 10,000 individuals), S3 = Vulnerable (rare; typically having 21 to 100 occurrences, or 3,000 to 10,000 individuals), S2 = Imperiled (typically having six to twenty occurrences, or 1,000 to 3,000 individuals), and S1 = Critically imperiled (typically having five or fewer occurrences, or 1,000 or fewer individuals). Natural Heritage rankings are only for breeding populations. For the BBS trends: n = number of survey routes on which the species was encountered during the long-term (1966 – 2012) interval. A † in this column indicates that the data have an important deficiency and therefore results may not be valid. The BBS trends are presented as yearly percentage change. Numbers in parentheses are credible intervals for the trend estimate; the values represent the 2.5% and 97.5% percentiles of the posterior distribution of trend estimates. Trends for which credible intervals do not include zero can be considered significant (bolded red for negative trend and bolded blue for positive trend) except where there are data deficiencies; n/a throughout = no data available or not applicable. Compiled by Janet M. Ruth.

Region	Official Species Status	U.S. State Wildlife Action Plan	Natural Heritage Ranking	BBS sample size (n)	BBS Trend (1966 – 2012)	BBS Trend (2002 – 2012)	Comments
Rangewide			G4				
Canada				171 †	-3.6% (-10.9, -0.7)	1.0% (-4.0, 7.3)	
United States	E (US)*			1967	**-2.8% (-3.5, -2.3)**	**-1.5% (-2.8, -0.1)**	* *A.s. floridanus*
Survey-wide (BBS)				2138	**-2.9% (-3.9, -2.4)**	**-1.5% (-2.8, -0.1)**	
UNITED STATES							
Alabama		no	S3	33	-2.3% (-4.8, 0.0)	-2.6% (-7.4, 2.5)	
Arizona		SGCN - Tier 1b*	S3	n/a	n/a	n/a	* both *A. s. ammolegus* and *A. s. perpallidus*
Arkansas		SGCN	S3B	22	**4.0% (0.8, 7.4)**	7.1% (-1.9, 16.3)	

Region	Official Species Status	U.S. State Wildlife Action Plan	Natural Heritage Ranking	BBS sample size (n)	BBS Trend (1966 – 2012)	BBS Trend (2002 – 2012)	Comments
California		Species of Special Concern	S2	54	0.1% (-4.3, 3.2)	4.6% (-2.7, 12.6)	
Colorado		no	S3S4B	57	**-3.8% (-5.3, -2.3)**	-0.5% (-4.2, 3.4)	
Connecticut	E (S)	SGCN	S1B	5 †	-34.5% (-100.0, -9.7)	-30.6% (-100.0, 182.0)	
Delaware		no	S3B	14	1.5% (-0.5, 3.6)	1.3% (-4.3, 6.4)	
Florida	E (US;S)*	SGCN**	SNRN	n/a	n/a	n/a	** A.s. floridanus; ** A. s. floridanus and A.s. pratensis (non-breeding)*
Georgia		High Priority Species	S4	37	**-3.9% (-5.5, -2.2)**	-3.6% (-6.9, 0.2)	
Idaho		SGCN	S2B	24	**-2.5% (-4.9, -0.0)**	-4.1% (-12.0, 1.4)	
Illinois		SGCN	S5	98	**-6.6% (-7.8, -5.5)**	**-8.5% (-11.5, -5.5)**	
Indiana		no	S4B	57	**-6.5% (-7.8, -5.4)**	**-5.6% (-9.0, -1.7)**	
Iowa		SGCN	S4B, S4N	38	**-5.5% (-6.6, -4.3)**	**-6.1% (-10.2, -3.0)**	
Kansas		SGCN - Tier II	S4B	64	**-2.3% (-3.9, -1.0)**	**-4.7% (-7.5, -1.9)**	
Kentucky		SGCN	S4B	53	**-6.0% (-7.2, -4.8)**	-4.4% (-9.1, 0.6)	
Louisiana		Species of Conservation Concern	S3N	n/a	n/a	n/a	
Maine	E (S)	SGCN - High Priority	S1B	n/a	n/a	n/a	
Maryland		SGCN	S4B	65	**-5.9% (-6.7, -5.1)**	**-4.5% (-7.0, -1.6)**	
Massachusetts	T (S)	SGCN	S3B	n/a	n/a	n/a	
Michigan	SC (S)	SGCN	S3S4B	69	**-4.8% (-6.3, -3.4)**	-2.6% (-6.7, 0.1)	

Region	Official Species Status	U.S. State Wildlife Action Plan	Natural Heritage Ranking	BBS sample size (n)	BBS Trend (1966 – 2012)	BBS Trend (2002 – 2012)	Comments
Minnesota		SGCN	SNRB	65	**-7.3% (-8.7, -5.9)**	**-9.2% (-13.4, -5.0)**	
Mississippi		SGCN	S3B, S3N	7 †	-3.2% (-9.8, 3.2)	-3.2% (-19.1, 14.2)	
Missouri		no	S3S4B	62	**-2.1% (-3.2, -1.0)**	**-2.4% (-5.0, -0.5)**	
Montana		no	S3B	42	1.7% (-0.2, 3.5)	1.9% (-2.3, 6.0)	
Nebraska		no	S4	49	**-2.6% (-4.3, -1.1)**	-1.8% (-5.3, 1.6)	
Nevada		no	SU	7 †	3.3% (-6.5, 22.6)	21.8% (-13.6, 126.1)	
New Hampshire	T (S)	SGCN	S2B	5 †	-3.6% (-12.4, 5.1)	-4.8% (-34.2, 7.5)	
New Jersey	T (S)*	SGCN	S2B,S3N	27	-3.0% (-6.2, 0.1)	-2.3% (-9.9, 6.3)	* Breeding only
New Mexico	E (S)*	SGCN	S3B, S3N	18	-1.5% (-5.8, 3.5)	5.0% (-9.1, 25.6)	* *A. s. ammolegus*
New York	SC (S)	SGCN	S3B	84	**-8.4% (-9.8, -7.0)**	**-9.0% (-14.5, -5.4)**	
North Carolina		SGCN	S3B, S1N	55	0.1% (-1.6, 1.8)	0.1% (-2.6, 3.0)	
North Dakota	*	Species of Conservation Priority - Level I	SNRB	47	**-3.9% (-5.5, -2.1)**	-3.4% (-7.2, 0.9)	* ND does not have a state T&E list
Ohio		SGCN*	S5	74	**-6.6% (-7.7, -5.4)**	**-5.4% (-9.6, -0.8)**	* Designations may be different than in other states
Oklahoma		no	S4B	58	-0.4% (-1.8, 0.9)	-1.0% (-4.0, 2.0)	
Oregon		Strategy Species	S2B	20	-0.7% (-4.6, 3.2)	-0.4% (-8.3, 9.7)	
Pennsylvania		no	S4B	117	**-5.8% (-6.6, -5.0)**	**-5.9% (-8.0, -3.9)**	
Puerto Rico		SGCN		n/a	n/a	n/a	
Rhode Island	T (S)	SGCN	S1B, S1N	n/a	n/a	n/a	

Region	Official Species Status	U.S. State Wildlife Action Plan	Natural Heritage Ranking	BBS sample size (n)	BBS Trend (1966 – 2012)	BBS Trend (2002 – 2012)	Comments
South Carolina		Highest Priority Conservation Species	SNRB, SNRN	23	**-4.4% (-6.8, -2.1)**	**-4.5% (-8.2, -0.8)**	
South Dakota		no	S4B	53	**-1.6% (-2.6, -0.4)**	2.6% (-1.3, 7.5)	
Tennessee		SGCN	S4	33	**-3.9% (-5.8, -2.1)**	-1.4% (-6.5, 3.7)	
Texas		Priority Species - Low	S3B	138	0.2% (-1.8, 1.7)	-3.0% (-6.8, 0.9)	
Utah		SGCN - Tier II	S2S3B	15 †	1.0% (-6.3, 8.5)	2.4% (-12.0, 19.9)	
Vermont	T (S)	SGCN	S2B	n/a	n/a	n/a	
Virginia		SGCN - Tier IV	S4	53	**-2.7% (-3.6, -1.7)**	**-2.7% (-5.4, -0.3)**	
Washington		no	S3B	33	1.8% (-0.3, 4.4)	2.1% (-3.2, 8.0)	
West Virginia	*	SGCN	S3B	35	**-8.4% (-10.0, -7.0)**	**-8.1% (-12.4, -3.1)**	* WV does not have state T&E legislation
Wisconsin		SGCN	S3B	76	**-6.4% (-7.6, -5.1)**	-3.3% (-7.5, 1.5)	
Wyoming		SGCN - Tier II	S4	65	0.6% (-1.9, 3.2)	-2.8% (-8.5, 3.0)	
CANADA							
Alberta		n/a	S3S4	33	-0.6% (-3.1, 2.0)	0.1% (-3.6, 7.6)	
British Columbia	RL (P)	n/a	S1S2B	n/a	n/a	n/a	
Manitoba		n/a	S2B	30	-2.6% (-7.0, 1.5)	-4.6% (-14.3, 5.9)	
Ontario		n/a	S4B	64	**-1.6% (-2.9, -0.5)**	-1.5% (-3.7, 1.0)	
Quebec		n/a	S2B	n/a	n/a	n/a	
Saskatchewan		n/a	S4B	37 †	-4.4% (-12.3, 0.3)	3.9 (-6.7, 18.2)	

prairies in the south-central part of the state. As recently as 2010 there were three remaining populations at the Avon Park Air Force Range, the Three Lakes Wildlife Management Area, and the Kissimmee Prairie Preserve State Park (Tucker et al. 2010a, b). However, the population at Avon Park appears to have been extirpated in 2012 (Williams 2013). See section on **Systematics** for basic distribution information on resident subspecies found in the Caribbean, Central and South America.

The main source of distribution data for Grasshopper Sparrow in the U.S. and Canada is the North American Breeding Bird Survey (BBS; https://www.pwrc.usgs.gov/bbs/). Additional sources include individual state Breeding Bird Atlas projects, and eBird (http://ebird.org).

Although Breeding Bird Survey data are generally considered adequate for assessing Grasshopper Sparrow abundance (Rich et al. 2004; Dunn et al. 2005), in some areas BBS data may not provide an accurate assessment of relative abundance or distribution of Grasshopper Sparrow. For example, in the range of *A.s. ammolegus* in southeastern Arizona and southwestern New Mexico, there are few BBS routes and the valleys that support the majority of this subspecies' population (Ruth 2008) are not sampled. Also BBS routes run in June are too early as this subspecies breeds and is most detectable in July/August after monsoon rains start (J.Ruth, pers. observ.). Fig. 2 suggests an average of 0.05 – 3 Grasshopper Sparrows per BBS route (50 stops on a route) in this region. Ruth (2008) used BBS-style

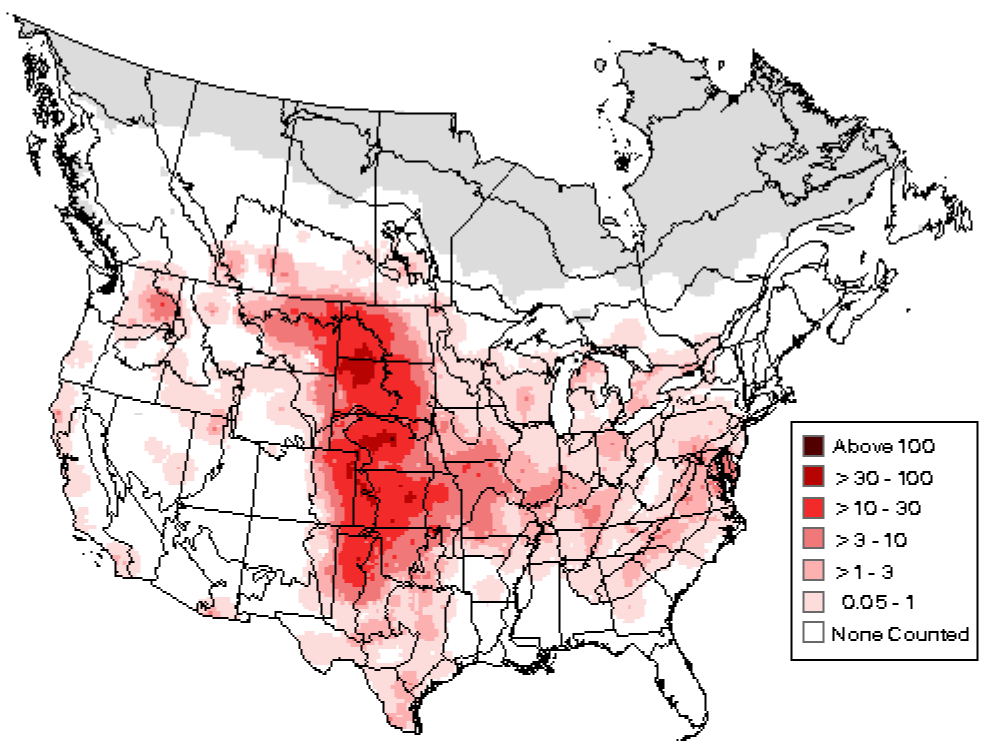

Figure 2. Relative abundance of breeding Grasshopper Sparrows (average number of birds per BBS route) based on the 2006 – 2012 BBS data (Sauer et al. 2014).

roadside surveys through grasslands in this subspecies' range during prime breeding season (July and August). Although there are reasons for caution in comparing these results with those from randomly located BBS routes conducted in June, over two years (2004 and 2005) averages ranged from 1.27 – 2.79 singing males per stop (not per route) in the three valleys supporting the majority of the population – the San Rafael, Sonoita, and Animas valleys (Ruth 2008).

B. Migration

See Vickery (1996) for descriptions of Grasshopper Sparrow migration timing. Limited additional information exists about the distribution and movement patterns of Grasshopper Sparrows during migration. Some of the movement across the U.S. from spring – summer – fall can be seen on the animated map developed from eBird data using their Spatio-Temporal Exploratory Model (STEM). http://ebird.org/content/ebird/occurrence/grasshopper-sparrow/ (Cornell Lab of Ornithology). However, because Grasshopper Sparrows are very cryptic outside of the breeding season, this resource is limited in its ability to document migration patterns.

C. Wintering (United States, Mexico, Caribbean, Central and South America)

During the nonbreeding season (winter), Grasshopper Sparrows are found primarily in the coastal states of the southeastern U.S., southern portions of the southwestern states, and in Mexico, Central America, and the Caribbean. The northern boundaries of the winter range are poorly understood but basically stretch from eastern North Carolina along the Atlantic and Gulf coasts through the southern half of Texas, and southern New Mexico, Arizona, and California.

The relative abundance data from the Christmas Bird Count (CBC) (Fig. 3 and Table 2) may represent basic winter distribution of Grasshopper Sparrow in the U.S., but not the actual abundance. This cryptic species is poorly sampled by the CBC protocol and there is substantial annual variation in wintering grassland bird numbers. As a single example, a flush mist-netting project on wintering grassland birds on two sites in southeastern Arizona during the winters of 2011 – 2013 using a standard effort of 2 days/site with 3 7-ha plots flushed each day – has captured 0 – 59 Grasshopper Sparrows on one site and 9 – 17 on the other site (J. Ruth, unpubl. data). This suggests that in appropriate open grassland habitat, wintering Grasshopper Sparrows can be much more abundant than the CBC maps would suggest.

Similar distribution maps for Grasshopper Sparrows wintering in Mexico do not exist, but the Rocky Mountain Bird Observatory (RMBO) has been conducting winter grassland bird surveys on the Grassland Priority Conservation Areas (GPCAs) designated by the trinational Commission for Environmental Cooperation (CEC) in northern Mexico, western Texas, and southern New Mexico and Arizona since 2007 (Macías-Duarte et al. 2011b). In Mexico they have documented Grasshopper Sparrows wintering in the following GPCAs located primarily in the states of Sonora, Chihuahua, Coahuila, and Durango: Cuchillas de la Zarca, Janos, Lagunas del Este, Malpais, Sonoita, El Tokio, Valles Centrales, and Valle Columbia (Macías-Duarte et al. 2011b).

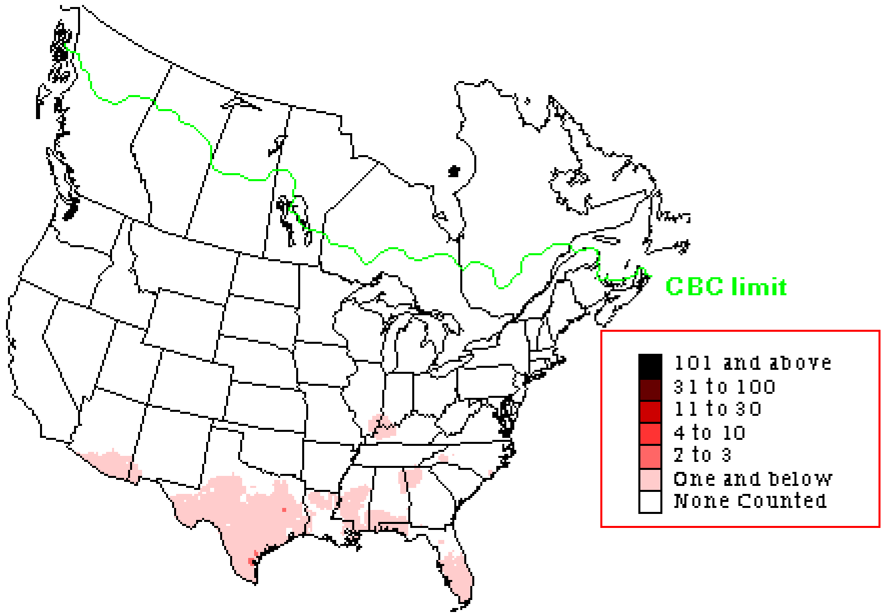

Figure 3. Relative abundance of wintering Grasshopper Sparrows (birds/100 party hours) averaged over CBC survey years 1966 – 1989 (Sauer et al. 1996).

V. Status, Population Estimates, and Trends

A. Conservation Status

This section provides information about the conservation status of Grasshopper Sparrow, beyond any legal status described above. See the following website for a map of Bird Conservation Regions (BCRs) http://www.nabci-us.org/map.html .

Global – Grasshopper Sparrow is classified as "Least Concern" by the IUCN RedList (BirdLife International 2014). Although BirdLife International indicates large, statistically significant population decreases over the last 40 years (based on BBS data), the species does not meet thresholds for a Vulnerable classification based on range size, population trend, or population size. The species is classified globally as G5 (Secure) by NatureServe (NatureServe 2013). In *Saving Our Shared Birds: Partners in Flight Tri-National Vision for Landbird Conservation*, Grasshopper Sparrow is listed as a "Common Bird in Steep Decline" with an estimated 78% of population lost based on BBS trend since the mid-1960s (Berlanga et al. 2010).

Canada – National - Grasshopper Sparrow does not have a national-level conservation designation in Canada, but see the tri-national PIF status from Berlanga et al. (2010) discussed above.

Canada - Regional/Provincial - Grasshopper Sparrow is on the British Columbia provincial Red List which provides a list of species to be considered for more formal listing under the British Columbia Wildlife Act. It also is listed as likely to be designated as threatened or endangered in Quebec.

Table 2: Number of Grasshopper Sparrows recorded on Christmas Bird Counts from 2001 – 2011. Data presented as number of count circles where Grasshopper Sparrows were recorded (total number of individual birds; National Audubon Society [2010]).

	Year									
State	**2001-02**	**2002-03**	**2003-04**	**2004-05**	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**
Alabama	1(1)	3(3)	2(2)	1(3)	2(4)	3(6)	1(3)	2(4)	2(3)	1(2)
Arizona	5(13)	5(40)	2(10)	2(49)	5(10)	9(39)	6(37)	4(12)	6(29)	11(48)
Arkansas	1(6)	0(0)	0(0)	0(0)	2(4)	0(0)	1(2)	0(0)	1(1)	1(1)
California	7(13)	5(7)	3(9)	2(2)	3(6)	7(14)	9(9)	2(3)	6(11)	6(9)
Florida	24(105)	28(69)	25(77)	27(119)	20(106)	27(118)	24(129)	36(184)	26(156)	34(150)
Georgia	2(2)	2(4)	0(0)	1(1)	1(1)	0(0)	2(3)	2(4)	1(1)	0(0)
Louisiana	2(2)	4(5)	2(2)	0(0)	1(1)	4(3)	0(0)	1(1)	2(3)	1(1)
Mississippi	0(0)	1(1)	1(1)	1(3)	0(0)	1(1)	1(1)	2(5)	2(2)	0(0)
New Mexico	1(10)	1(1)	0(0)	1(27)	2(24)	1(30)	1(16)	2(1)	3(3)	2(3)
North Carolina	2(8)	3(3)	2(2)	2(2)	4(3)	2(2)	0(0)	3(4)	1(1)	0(0)
Oklahoma	1(1)	0(0)	0(0)	0(0)	2(3)	0(0)	1(1)	1(1)	0(0)	1(2)
South Carolina	0(0)	1(2)	3(3)	3(20)	2(11)	2(4)	2(2)	2(2)	2(2)	2(2)
Texas	33(155)	32(197)	32(181)	34(142)	25(184)	32(147)	28(214)	28(98)	37(493)	41(573)
MEXICO	3(24)	2(24)	6(48)	4(60)	5(46)	1(62)	1(10)	3(15)	2(28)	7(23)
Totals	82(340)	87(356)	78(335)	78(428)	74(403)	89(426)	77(427)	88(334)	91(733)	107(814)

Grasshopper Sparrow is a priority species in the Canadian portions of BCR 9 (Great Basin), BCR 11 (Prairie Potholes), and BCR 13 – Quebec and Ontario (Lower Great Lakes/St. Lawrence Plain) (Environment Canada 2013a, b, c; Environment Canada 2014).

United States - National – In the U.S., the primary sources of information about the conservation status of the Grasshopper Sparrow are the U.S. Fish and Wildlife Service (USFWS) and Partners in Flight (PIF). The Grasshopper Sparrow is not classified by the USFWS as a "Bird of Conservation Concern" at the national, range-wide level (USFWS 2008a) although it has identified it as a focal species in its "Focal Species Strategy for Migratory Birds". The *PIF North American Landbird Conservation Plan* lists Grasshopper Sparrow as a "Stewardship Species", with a large proportion of its population in a single biome (Prairie Biome) and in need of Management Action (Rich et al. 2004). The U.S. 2014 State of the Birds Report identified Grasshopper Sparrow as a Common Bird in Steep Decline (NABCI U.S. 2014).

United States – Regional – The Grasshopper Sparrow is classified by USFWS as a "Bird of Conservation Concern" in USFWS Region 6, and the Arizona Grasshopper Sparrow subspecies (*A.s. ammolegus*) is classified as a "Bird of Conservation Concern" in USFWS Region 2 (USFWS 2008a). The species also is classified by USFWS as a breeding "Bird of Conservation Concern" in the following Bird Conservation Regions (BCRs): Prairie Potholes BCR #11, Southern Rockies/Colorado Plateau BCR #16, Badlands and Prairies BCR #17, Eastern Tallgrass Prairie BCR #22, Peninsular Florida BCR #31, and Gulf Coastal Prairie BCR #37. In addition, the USFWS classifies the Grasshopper Sparrow species (nonbreeding) and the Arizona Grasshopper Sparrow subspecies as a "Bird of Conservation Concern" for Sierra Madre Occidental BCR #34 (USFWS 2008a).

In addition, based on the updated Partners in Flight species assessment database (PIF Science Committee 2012; http://rmbo.org/pifassessment), the Grasshopper Sparrow is classified as a regional conservation priority in 11 BCRs (Table 3). These 11 BCRs support over 90% of the breeding population of Grasshopper Sparrow. PIF State and regional plans can be viewed at http://www.partnersinflight.org/bcps/pifplans.htm . One of the primary delivery systems for landbird conservation in the U.S. and Canada is the migratory bird habitat Joint Ventures (JV). Information about Joint Ventures can be viewed at http://mbjv.org/. Grasshopper Sparrow is designated as a priority species many Joint Ventures (JVs); JVs have used a variety of terms for priority species and it is beyond the scope of this document to provide separate definitions: Prairie Potholes JV (focal species); Canadian Prairie Habitat JV (priority species); Central Hardwoods JV (regional priority species); Intermountain West JV (priority species); Oaks and Prairies JV (priority species); Playa Lakes JV (priority species); Rainwater Basin JV (priority species); Rio Grande JV (priority stewardship species); Sonoran JV (regional priority species, especially *A.s. ammolegus*); East Gulf Coastal Plain JV (priority species); Upper Mississippi River/Great Lakes JV (focal species); Appalachian Mountains JV (moderate priority); and Atlantic Coast JV (priority species in some regions within the JV).

United States – State/Territory - Grasshopper Sparrow is listed as endangered in 4 states, threatened in 5 states, and of special concern in 2 states (Table 1). Also, Grasshopper Sparrow is included as a "Species of Greatest Conservation Need (SGCN)" (or similar category) in 36 state (and Puerto Rico) wildlife action plans (Table 1). Links to state wildlife action plans can be found at http://teaming.com/state-wildlife-action-plans-swaps .

Mexico, Central America, Caribbean - Grasshopper Sparrow does not have a national-level conservation designation in Mexico, but see the tri-national PIF status from Berlanga et al. (2010) discussed above. No evidence was found of any conservation status for Grasshopper Sparrow in Central America or the Caribbean, but see reference to Puerto Rico's wildlife action plan as a U.S. Territory above.

B. Population Estimates

In 2004, the *PIF North America Landbird Conservation Plan* estimated a global population of 15,000,000 Grasshopper Sparrows with an accuracy rating of 4 (moderate) and estimated precision of "A (very high)" (Rich et al. 2004). The methodology for these initial PIF landbird population estimates are described in Rosenberg and Blancher (2005), and several evaluations, field tests, and tests of assumptions (Thogmartin et al. 2006; Confer et al. 2008; Hamel et al. 2009; Thogmartin 2010) have been conducted since the initial results were published in Rich et al. (2004). In response to reviews and publications, PIF has revised the population estimation methodology; (1) detection distance categories assigned to species have been revised using additional data and more refined distance categories, (2) instead of using a standard pair adjustment of 2X, species are now assigned to one of five different categories between 1.0 and 2.0, and (3) time-of-day adjustments have been revised in response to suggestions in Thogmartin et al. (2006). In the case of Grasshopper Sparrow, the primary revision was a reduction of detection distance from 200 m to 125 m, thereby revising the global population estimate for Grasshopper Sparrow to 31,000,000 (PIF Science Committee 2012).

There is a Puerto Rico/U.S. Virgin Islands report on avian conservation planning priorities nearing completion, which may provide additional information regarding the conservation of the *borinquensis* subspecies in Puerto Rico (Nytch et al. In Review); the draft estimates <500 pairs of Grasshopper Sparrows on the island.

C. Population Trends

The North American Breeding Bird Survey (BBS) is the primary source of data used to estimate population change for many migratory birds, including Grasshopper Sparrow (Sauer et al. 2014). Tables 1 and 3 present long-term and short-term population trends for Grasshopper Sparrow by BCR, state, and survey-wide. The range-wide and national trend data, as well as the trend scores for the BCRs that support the majority of the Grasshopper Sparrow population in the U.S. and Canada, received a blue credibility score, which indicates sufficient sample size, precision and abundance to calculate trends (Sauer et al. 2014). The BBS is considered sufficient for calculating Grasshopper Sparrow population trends by Dunn et al. (2005). Trends and indices in Tables 1 and 3 were estimated using hierarchical model methods described in Sauer and Link (2011). Survey-wide, over the long-term (1966 – 2012) Grasshopper Sparrows show a declining population trend of -2.9% per year (Table 1; Sauer et al. 2014). Berlanga et al. (2010) estimates that 78% of the Grasshopper Sparrow population has been lost since the mid-1960s based on BBS trends. The steepest declines occurred prior to and through the 1990s (Fig. 4); in the recent short-term (2002 – 2012) the trend is a decline of -1.5% per year (Fig. 4; Table 1; Sauer et al. 2014). The BCRs that show significant population declines (Table 3) are consistent with the BCRs that classify Grasshopper Sparrow as a PIF Regional Conservation Priority (Table 3). The BCRs with

significant long-term declines represent >92% of the breeding population in the U.S. and Canada. Most other BCRs show non-significant negative population trends.

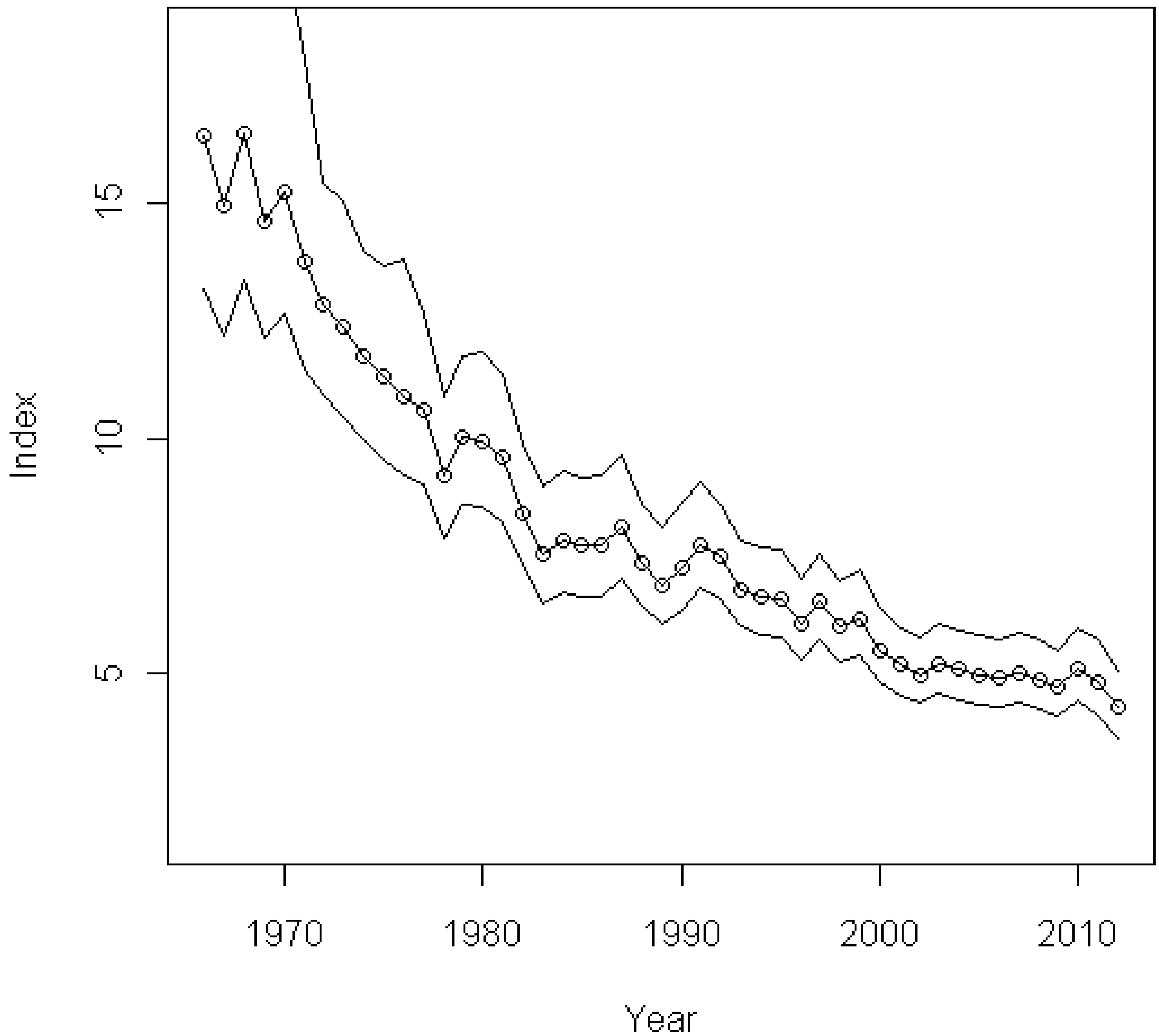

Figure 4. Annual range-wide indices of Grasshopper Sparrow relative abundance (mean birds/route) from Breeding Bird Survey calculated using hierarchical modeling methods, 1966 – 2012 (Sauer et al. 2014). Open circles show annual indices of relative abundance; lines above and below represent credible intervals (2.5% and 97.5%).

<u>Table 3.</u> Grasshopper Sparrow (*Ammodramus savannarum*) Status and Trends by Bird Conservation Region (http://www.nabci-us.org/map.html). Summarized by Partners in Flight (PIF) Regional Conservation Priority, Percent Breeding Population, Breeding Bird Survey (BBS) trends for 1966 – 2012, and BBS trends for 2002 – 2012. The PIF regional conservation priorities and percent population data were extracted from the PIF Species Assessment database (PIF Science Committee 2012). For the BBS trends: n = number of survey routes on which the species was encountered during the long-term (1966 – 2012) interval. A † in this column indicates that the data have an important deficiency and therefore results may not be valid. The BBS trends are presented as yearly percentage change. Numbers in parentheses are credible intervals for the trend estimate; the values represent the 2.5% and 97.5% percentiles of the posterior distribution of trend estimates. Trends for which credible intervals do not include zero can be considered significant (bolded red for negative trend and bolded blue for positive trend) except where there are data deficiencies; n/a throughout = no data available or not applicable. Compiled by Janet M. Ruth.

Bird Conservation Region (BCR)	BCR number	PIF Regional Conservation Priority	Percent Breeding Population	BBS sample size (n)	BBS Trend (1966 – 2012)	BBS Trend (2002 – 2012)
Central Mixed Grass Prairie	19	X	22	108	**-1.7% (-2.5, -0.9)**	**-2.7% (-4.9, -0.6)**
Badlands and Prairies	17	X	17	99	**-2.1% (-3.5, -0.8)**	1.2% (-2.1, 4.8)
Shortgrass Prairie	18	X	17	111	**-3.3% (-4.8, -1.9)**	**-3.4% (-6.6, -0.4)**
Prairie Potholes	11	X	16	187	**-2.2% (-3.1, -1.2)**	-0.6% (-3.2, 2.1)
Eastern Tallgrass Prairie	22	X	11	249	**-4.1% (-4.8, -3.4)**	**-5.0% (-7.0, -3.3)**
Central Hardwoods	24	X	3	129	**-4.0% (-4.8, -3.2)**	-1.8% (-4.0, 0.4)
Piedmont	29	X	2	135	**-3.1% (-3.9, -2.4)**	**-2.4% (-4.5, -0.5)**
Appalachian Mountains	28	X	1	268	**-5.8% (-6.5, -5.0)**	**-4.9% (-6.5, -2.7)**
Prairie Hardwood Transition	23	X	1	116	**-6.8% (-7.9, -5.7)**	**-6.3% (-9.8, -2.6)**
Lower Great Lakes/St. Lawrence	13		≤ 0.5	127	**-3.6% (-4.7, -2.5)**	**-2.6% (-5.0, -0.3)**
New England/Mid-Atlantic Coast	30	X	≤ 0.5	80	**-3.8% (-4.7, -2.8)**	-2.4% (-5.3, 0.9)
Boreal Hardwood Transition	12		1	90	**-2.1% (-4.3, -0.5)**	**-5.4% (-10.9, -1.3)**
Great Basin	9		1	88	-0.6% (-2.7, 1.1)	-0.4% (-4.6, 3.9)
Southeast Coastal Plain	27		≤ 0.5	62	-1.4% (-3.3, 0.4)	-0.6% (-4.0, 2.8)
Oaks and Prairies	21		1	61	-0.7% (-2.2, 0.9)	-2.8% (-7.2, 1.7)
Northern Rockies	10		1	50	**-4.5% (-7.1, -1.4)**	-3.1% (-10.3, 7.9)
Coastal California	32		≤ 0.5	30	1.3% (-2.5, 5.8)	2.8% (-7.0, 13.9)
West Gulf Coastal Plain/Ouachitas	25		≤ 0.5	19	3.1% (-1.6, 8.1)	3.3% (-10.4, 11.2)
Mississippi Alluvial Valley	26		≤ 0.5	16	-1.0% (-4.7, 2.9)	-1.5% (-9.8, 4.8)
Edwards Plateau	20		≤ 0.5	15 †	-5.8% (-11.0, -1.0)	-16.8% (-32.0, -2.5)
Peninsular Florida	31	X	n/a	n/a	n/a	n/a
Sierra Madre Occidental	34		≤ 0.5	n/a	n/a	n/a

Figure 5 shows patterns in Grasshopper Sparrow population trends across the 1966 – 2012 interval using standard route regression methods (Link and Sauer 1994). For the most part, the core range of the subspecies of Grasshopper Sparrows that are sufficiently surveyed by BBS show declines. In contrast, the regions showing increases are in the periphery of their range and the analyses results in Table 3 do not show any BCRs with significant long-term positive population trends.

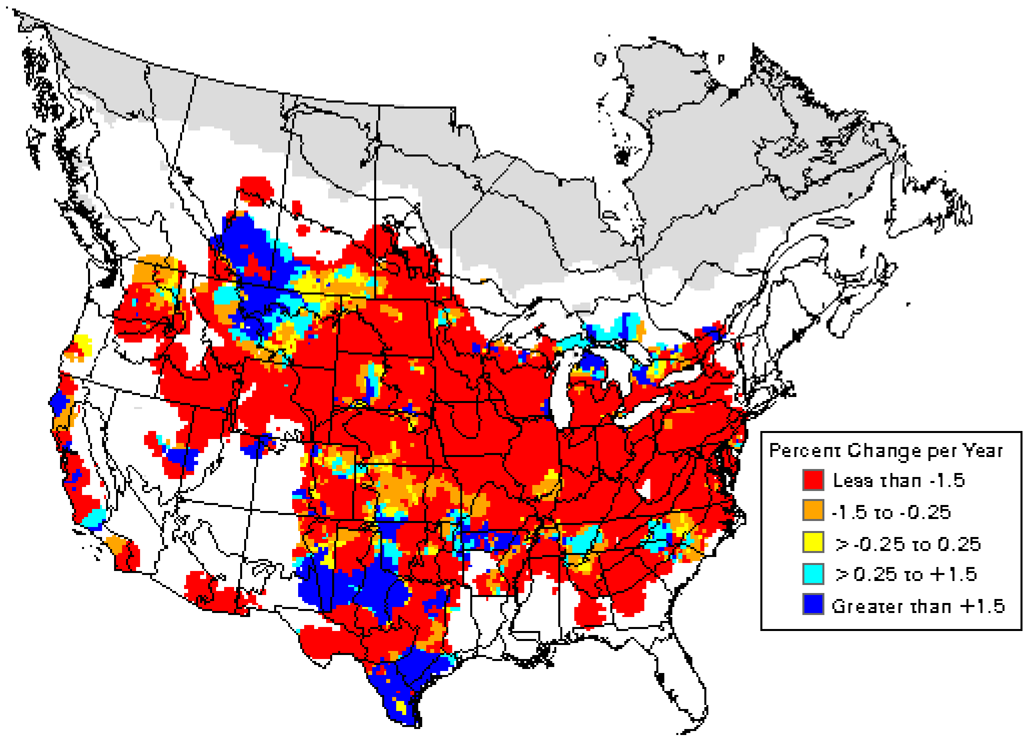

Figure 5. Geographic patterns in population change for Grasshopper Sparrow from 1966 – 2012 based on point estimates of trend using BBS data. Warm colors (red and orange) indicate population declines, and cool colors (blues) indicate population increases (Link and Sauer 1994; Sauer et al. 2014).

D. Population Goals and Objectives

Although many bird conservation plans (e.g., for Joint Ventures, Bird Conservation Regions) are beginning to establish population objectives for priority species, most of these are necessarily general due to limited data and the uncertainty associated with available population estimates. For example, below are Grasshopper Sparrow population objectives from some plans for which it is a priority. Please note that methodologies and interpretations vary among planning efforts.

- Continental population objective – maintain current population - *PIF North American Landbird Conservation Plan* (Rich et al. 2004).
- Prairie Pothole Joint Venture (U.S. portion of BCR 11) – maintain current population and increase where possible (Prairie Pothole Joint Venture 2005)

- Prairie Habitat Joint Venture (Canadian portion of BCR 11) – increase 1990 – 2000 average relative abundance by 100% over next 30 years (Canadian Prairie Partners in Flight 2004).
- Playa Lakes Joint Venture (BCRs 18 and 19) – in the Shortgrass Prairie BCR portion of the JV (BCR 18) Grasshopper Sparrow is one of the species driving plans and they target doubling current population; in the Central Mixed Grass Prairie portion (BCR 19), other species are driving plans, but they do recommend management, especially increasing Conservation Reserve Program (CRP) acreage, to benefit Grasshopper Sparrows and increase populations (Playa Lakes Joint Venture 2008)
- Atlantic Coast Joint Venture (BCRs 13, 14, 27, 29, 30, and 31) – Some BCR level objectives have been identified; double current populations in the U.S. portion of Lower Great Lakes/St. Lawrence (BCR 13) and in New England/Mid-Atlantic (BCR 30) (Atlantic Coast Joint Venture website http://acjv.org/planning/bird-conservation-regions/).
- Sonoran Joint Venture (BCRs 32, 33, 34, 39, 40, 41, 43) – in the desert grasslands of the Sierra Madre Occidental (BCR 34) the 30-year objective is to double the population of the Arizona Grasshopper Sparrow subspecies. In the chaparral shrublands of Coastal California (BCR 32) the 30-year objective is to double the species' population (Sonoran Joint Venture Technical Committee 2006).
- Rainwater Basin Joint Venture (BCR 19) – based on BBS trend data and estimates of current carrying capacity, their 20-year population goal for Grasshopper Sparrow is 6,018,052 birds (Rainwater Basin Joint Venture 2013).
- Intermountain West Joint Venture (primarily BCRs 9, 10, 16, with small portions of 34, 35) - in the grasslands within the IWJV boundaries, Grasshopper Sparrow is a focal species. The IWJV has gone through an objective-setting process by State-BCR polygon, and after compiling these, has the following objectives by BCR – increase Grasshopper Sparrow populations by 90% (BCR 9), 100% (BCR 10), and 40% (BCR 16) (Intermountain West Joint Venture 2013).
- Although Grasshopper Sparrow is a priority grassland species for the Central Hardwood Joint Venture (BCR 24), they have not yet established population objectives, as they are analyzing the results of their grassland bird monitoring project (Central Hardwoods Joint Venture website http://www.chjv.org/index.html)
- The Northern Great Plains Joint Venture (BCR 17) is a relatively new Joint Venture in the core of the Grasshopper Sparrow's range; it has not yet established any population objectives.
- There is a Puerto Rico/U.S. Virgin Islands report on avian conservation planning priorities nearing completion, which may provide additional information regarding the conservation of the *borinquensis* subspecies in Puerto Rico (Nytch et al. In Review); the draft objective is to maintain the current population of *A.s. borinquensis*.

Given the recent revisions in the PIF estimate of Grasshopper Sparrow population (PIF Science Committee 2012), it would be premature to recommend anything other than retention of the existing PIF range-wide population objective of maintaining the current population (Rich et al. 2004). Results from Objectives and Action Items in Appendix A will enable the updating of population objectives in the future, if necessary. The approach promoted in the Henslow's Sparrow Conservation Plan (Cooper 2012) is relevant to the Grasshopper Sparrow plan as well; they acknowledged that separate geographic population objectives might be warranted but argued that the role of a range-wide plan was to establish a range-wide population objective and that the partners in such a conservation effort should then establish relevant regional population objectives (e.g., for states, BCRs, Joint Ventures, and/or subspecies).

VI. Habitat and Landscape Requirements Overview

A. Breeding

Grasshopper Sparrows generally prefer relatively open grassland with patchy bare ground. Because this species is widely distributed across grassland habitats in North America, it selects different vegetation structure and species composition depending on what is available in the particular grassland habitats. In the more mesic grasslands of the East and Midwest (e.g., tallgrass and mixed grass prairie), Grasshopper Sparrow is found in sparser grassland vegetation, whereas in the arid grasslands of the West and Southwest (e.g., shortgrass and semidesert grasslands), it is found in more lush vegetation. Breeding Grasshopper Sparrows are found in native grasslands, as well as CRP fields, and tame or planted grasslands including pastures, hay fields, airports, and reclaimed surface mines and landfills. They can occasionally be found in croplands such as corn and oats, but at much lower densities than in grassland habitats. They generally avoid grasslands with high shrub cover, although this varies somewhat across its range (Vickery 1996; Dechant et al. 1998).

In the western two-thirds of Canada and the U.S., the distribution of Grasshopper Sparrow as shown by BBS data (Fig. 2) is remarkably similar to the distribution of grassland habitats in North America (Fig. 6). Eastern grasslands, due to their sparse, patchy distribution, have been poorly mapped; see Figure 7 below for one of the few available depictions of eastern grassland distribution. Because of the broad distribution of Grasshopper Sparrow across multiple grassland habitat types, basic summaries of the history and driving forces (Askins et al. 2007) and general Grasshopper Sparrow habitat preferences in each grassland type are provided below. These summaries focus especially on more recent information that was not available in Vickery (1996) and Dechant et al. (1998).

Mixed-grass – Mixed-grass prairie occupies the central third of the Great Plains, bounded by tallgrass in the east, shortgrass to the west, aspen parkland to the north, and juniper-oak savanna to the south (this coincides approximately with Mid-grass Prairie in Fig. 6). It is characterized by seasonal moisture and temperature extremes, and annual precipitation increases from west to east, and from north to south. See the following website for a map showing 30-year average annual precipitation for the contiguous U.S. (http://prism.oregonstate.edu/normals). Mixed-grass prairie is often divided into northern mixed-grass prairie (Nebraska, South and North Dakota, and southern Canada), sandhill prairies (Nebraska and Kansas), and southern mixed-grass prairie (Kansas, Oklahoma, and Texas). In northern prairies, cool-season grasses become increasingly more dominant as you go further north, warm-season grasses dominate in sandhill prairies, and warm-season grasses increasingly dominate in southern prairies (Samson and Knopf 1996). Today, grasslands in the mixed-grass prairie province represent 29% of what was historically present (Samson et al. 2004). The primary ecological drivers are precipitation, grazing, and fire. Historical grazers included bison, pronghorn, elk, jackrabbits and cottontails, ground squirrels, and prairie dogs [see Appendix B for scientific names of all non-avian animal taxa and plants]. Habitat loss has been due to conversion to agriculture and more recently includes conversion to urban and suburban development; the return of perennial, but frequently non-native, vegetation under the CRP adds additional complications to the historical changes in this region. Changes in grassland quality/condition and fragmentation from multiple sources (e.g., fire suppression, shrub invasion, intensive grazing, invasive plants, roads and energy infrastructure/extraction) are also threats (Samson and Knopf 1996;

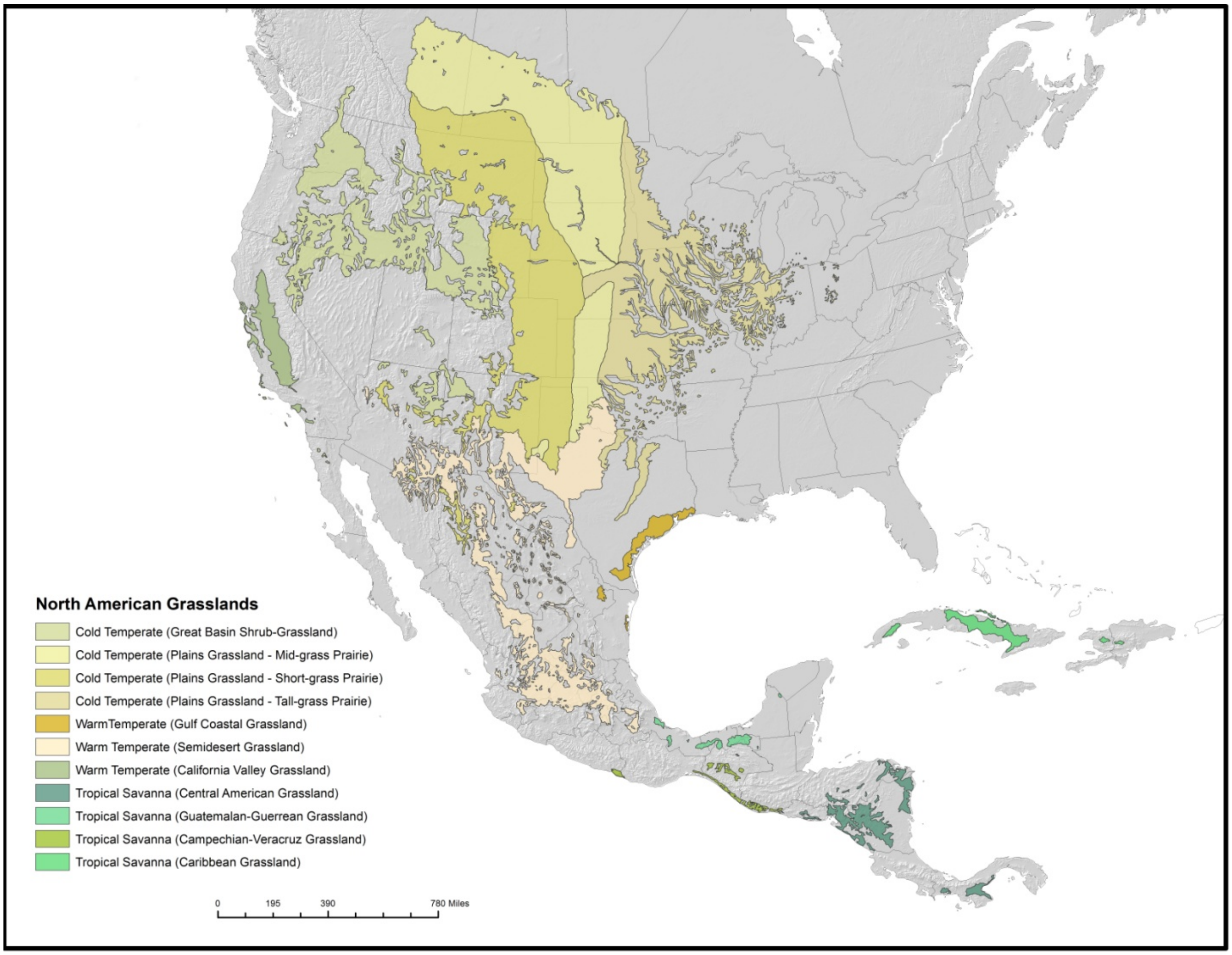

Figure 6. Distribution of North American Grasslands (Brown and Makings 2014).

Askins et al. 2007). Studies of Grasshopper Sparrow habitat use in mixed-grass prairie found that they preferred native grassland to fallow field or croplands, were negatively associated with shrub density, and responded to vertical and horizontal vegetative structure and density in somewhat different ways across the region depending on available habitat (Chapman et al. 2004; Davis 2004; DeJong et al. 2004; Ahlering 2005; Grant et al. 2010). Overall, Grasshopper Sparrows seem positively associated with intermediate grass height and density. They select nest sites with less bare ground and more vertical structure (Dieni and Jones 2003).

Shortgrass – The western shortgrass prairies stretch from the Rocky Mountains eastward to the mixed-grass prairies, and reach south from central Alberta to central Texas; they are characterized by short, warm-season grasses on shallow, poor soils (this coincides approximately with Short-grass Prairie in Fig. 6). Climate varies strongly from north to south, with higher temperatures and more precipitation to the south. However increases in evaporation rates from north to south counteract these patterns, resulting in similar levels of water availability (Samson and Knopf 1996; Vickery et al. 2000). Today, the shortgrass prairies represent about 52% of what was historically present (Samson et al. 2004). Drought was the primary ecological driver in the shortgrass, secondarily maintained by grazing. The primary historical grazers were prairie dogs, bison, and elk; pronghorn which selectively forage on forbs also were present. The dominant native grasses require and benefit from intensive grazing, which prevents transformation

into shrub- or forb-dominated landscapes. Fire was not an important driver in this system, as shortgrass prairies do not provide adequate fuel to carry a fire. However, there is evidence that in some places fire may have excluded shrubs and trees from grasslands (Samson and Knopf 1996; Vickery et al. 2000; Askins et al. 2007). Extensive fragmentation of the landscape has occurred as a result of conversion to agricultural crops, especially cereal grains. Today public lands represent a large component of remaining shortgrass prairie (Askins et al. 2007); the primary land use is cattle grazing, which remains the principal tool available to maintain shortgrass prairie. Studies of Grasshopper Sparrow habitat use in shortgrass prairie are somewhat limited. They are found in native shortgrass prairie and fallow fields where they prefer taller grasses and some bare ground for foraging; they can tolerate some scattered shrubs but avoid areas where shrub cover becomes too high. They also use CRP lands, which are sometimes preferred over other available habitats and sometimes are the only suitable habitat in a given area (Sparks et al. 2005; Fogg and Pavlacky 2012)

<u>Tallgrass</u> – Historically the tallgrass prairie extended from the central Great Plains to the Midwest, from southern Texas to southern Manitoba, and was characterized by taller grasses, deeper soils, and is the most mesic of the Great Plains grasslands (Samson and Knopf 1996; Vickery et al. 2000) (this coincides approximately with Tall-grass Prairie in Fig. 6). Disturbance was a major factor in maintaining tallgrass prairie communities; major ecological drivers were fire (both natural and human-caused), grazing, and drought. Historical grazers and browsers included bison, elk, deer, and many small vertebrates and invertebrates. Periodic droughts occurred, but less frequently than in mixed- or shortgrass prairie (Askins et al. 2007). Very little native tallgrass remains (historical loss has been estimated at 88 – 99%), in mostly scattered, relatively small remnants. The exceptions are the Flint Hills in eastern Kansas and northeastern Oklahoma, and large tracts on glacial moraines in northeast South Dakota (Samson and Knopf 1996). Loss has been primarily due to conversion to row-crop agriculture. Today non-native grasslands, including pastures and hayfields, represent the majority of grassland in the tallgrass region; they are primarily privately owned and their acreage also is declining sharply. New grassland resources have been created in the form of reclaimed surface mines and CRP grasslands; however, reclaimed and planted grassland frequently are not planted to native tallgrass species (see sections on **Non-Native Grasses/Forbs** and **Conservation Reserve Program** below). Other important factors affecting grassland birds in the tallgrass are patch size, woody edges and woody encroachment (Samson and Knopf 1996; Vickery et al. 2000; Askins et al. 2007). Studies of Grasshopper Sparrow habitat use in tallgrass prairies have found that they prefer mesic grasslands of intermediate height, diverse structure, and some bare ground; abundance is negatively correlated with litter depth and shrub cover. At the landscape scale they prefer larger core grassland areas and more surrounding grasslands at multiple scales (Patterson and Best 1996; Swengel 1996; Sample and Mossman 1997; Swengel and Swengel 2001; Askins et al. 2007; Renfrew and Ribic 2008; Jacobs et al. 2012).

<u>Eastern Grasslands</u> **-** Grasslands in eastern North America occur sporadically from Maine to Florida (see separate sub-section on <u>Florida</u> below) and west to coastal Texas (although more difficult to map than in the west, this coincides approximately with the grasslands mapped in Fig. 7, one of the few available maps). They range from poor, xeric soils in New England, to mountain balds in the Appalachians, to transitional grasslands emerging from tallgrass prairie and longleaf pine ecosystems, to coastal prairies in Texas. Prior to European settlement grasslands were uncommon, a result of natural disturbance from fire, wind, disease, beaver activity, flooding, and insect damage. They included scattered openings in river floodplains, wetlands, meadows, salt marshes, coastal sandplain grasslands, and heathlands. The extent

of grasslands in this region has varied drastically over the last 400 years. With European settlement, the expansion of lands cleared for pastures and hayfields provided habitat for many grassland birds including Grasshopper Sparrow. With more recent changes in agriculture technology, decreases in farming, fire suppression, reversion to forested habitat, and increased suburban/urban development in the Northeast, grasslands have again declined in quantity, size, and quality. Private agricultural lands represent the largest proportion and hayfields make up >50% of grassland habitat in the northeast. Federal, state, and municipal land, including military lands and airports, and reclaimed surface mines account for additional grassland habitats. Grassland habitat in this region is created and maintained primarily through mowing, livestock grazing, and in some parts of the northeast through prescribed burning (Jones and Vickery 1997; Vickery et al. 2000; Vickery et al. 2005; Askins et al. 2007). See Vickery and Dunwiddie (1997) and Norment (2002) for summaries of grassland conservation issues in the northeast. In the southeast, in addition to agricultural lands, some treeless grasslands are embedded within southern pine savanna habitat as a result of dry conditions and annual fire (Askins et al. 2007). Noss (2012) argues that more grasslands exist in the southeast than usually recognized, including: longleaf pine ecosystems (sometimes defined as pyrogenic grasslands), the pine rocklands and marl prairie of Florida, Atlantic and Gulf coastal grasslands, prairies of the Piedmont, grassy balds in the southern Appalachians, riverscour prairies, barrens, limestone, shale and sandstone glades, shortleaf pine grasslands, and blackland prairies. A primary distinction between southeastern grasslands and those of the Midwest and West is the relatively wet climate, with annual rainfalls of 120 – 200 cm (48 – 80 inches) (Noss 2012). In a study aimed at identifying military installations that could make substantial contributions to grassland bird conservation in the eastern U.S., Giocomo and Buehler (2005) used National Land Cover Data to map the distribution of grassland habitats in this region (Fig. 7); given the limited mapping available for eastern grasslands, it is provided here as one presentation of grassland distribution in the region.

In northeastern North America, Grasshopper Sparrows use upland meadows or pastures, old fields, sandplain grassland, blueberry barrens, reclaimed surface mines and grasslands, coastal grassland barrens, airfields, and capped landfills (Jones and Vickery 1997; Mitchell et al. 2000). Studies of Grasshopper Sparrow habitat use in the Northeast found that they are associated with grasslands dominated by native bunchgrasses, less dense vegetation, patches of bare ground, and low shrub cover (Bollinger 1995; Vickery et al. 1997; Vickery et al. 1999a; Mitchell et al. 2000; Askins et al. 2007; Hodgman 2009; Wentworth et al. 2010). Bollinger (1995) found Grasshopper Sparrows were only detected in hayfields older than 10 years. More limited studies of habitat use in the southeast found that Grasshopper Sparrows use larger fields with shorter grass, less forbs, less litter, and less woody vegetation (Moss 2001; Giocomo et al. 2008; Hinnebusch 2008).

<u>Florida</u> – Florida Grasshopper Sparrows are found in south-central Florida, in treeless, relatively flat, and moderately to poorly drained dry prairies and to a lesser extent in cutover longleaf pine savannah maintained in a treeless state by frequent fires (Tucker et al. 2010a). They occupy habitats ranging from thick, low saw palmetto scrub to grass pastures with a sparse or patchy cover of shrubs and saw palmetto (Delany et al. 2007). A recent project that modeled Florida Grasshopper Sparrow population responses to land cover changes defined optimal habitat as areas of prairie that had been burned within two years, had one or no trees, and was >400 m from forest edge (Breininger 2009). There is extensive literature available describing the breeding ecology and natural history of this listed sub-species; it is beyond the scope of this document.

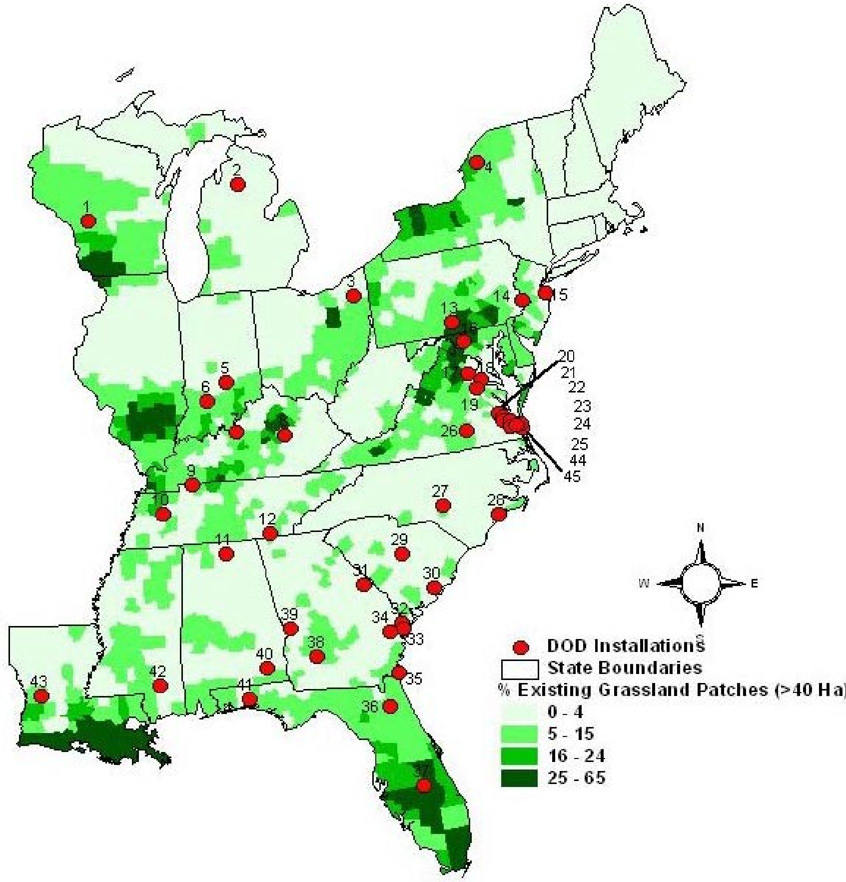

Figure 7. Proportion of county in 40-ha grassland patches in the eastern US. Darker green areas represent higher proportions. This figure is from a study of grassland bird conservation potential on Department of Defense installations (from Giocomo and Buehler 2005).

<u>Semidesert grassland</u> – Semidesert grasslands stretch from the southwestern U.S. into northern Mexico (this coincides with Semidesert Grasslands in Fig. 6). Land ownership in the U. S. includes state and federal public lands, and private lands; in Mexico it is primarily private lands and communal property known as ejidos. The main ecological driver in this region is drought/precipitation, with fire and grazing as secondary drivers. Fire can have major effects; it reduces vegetative cover in the short term and reduces woody species density in the long term. The primary historical grazers were prairie-dogs (Askins et al. 2007). There is some disagreement in the literature on the impact of bison in this region, but it is likely that they occurred only sporadically this far south. For details about the ecology of semidesert grasslands, see McClaran and Van Devender (1995). These semidesert grasslands provide breeding grounds for the endemic Arizona Grasshopper Sparrow (*A. s. ammolegus*) subspecies, and also wintering grounds for both this subspecies and migratory subspecies from further north. Studies of Arizona Grasshopper Sparrow habitat use in semidesert grassland found that they preferred grasslands with greater percent grass cover, taller grass, less bare ground, and low to intermediate amounts of woody cover depending on the available landscape (Bock and Webb 1984; Block and Morrison 2010). The apparent contradiction between the response of Grasshopper Sparrows to shrub cover in these studies may be a function of different locations along the continuum of shrub densities available. In northwestern

Chihuahua, where records of Grasshopper Sparrows in spring and summer suggest a breeding population, they were found primarily in grasslands without prairie dog colonies (Manzano-Fischer et al. 1999).

Northwest – In the northwest, sagebrush and sagebrush steppe habitats cover much of the Great Basin and Wyoming Basin, and extend into the Columbia Basin, Snake River Plain, southwestern Montana, the Colorado Plateau, southwestern Colorado, and northern New Mexico (this coincides approximately with Great Basin shrub-grassland in Fig. 6). Sagebrush steppe, where sagebrush is co-dominant with perennial bunchgrasses, covers the northern portion of the Intermountain region. Across this entire region, habitats range from semi-arid grasslands with a scattering of sagebrush to sagebrush-dominated shrublands. Jackrabbits, cottontails, and rodents may have been the major herbivores in the region and it has been suggested that this region did not evolve under pressure from large numbers of grazing ungulates. Pronghorn were found throughout the region, in some areas mule deer and elk were present, and bison were limited to the northeastern Great Basin. Fire prior to settlement was probably patchy, small, and relatively infrequent. However, the mosaic of grasslands and sagebrush shrublands in this ecosystem is partially a result of fires, which open areas to grassland until sagebrush can reestablish, which takes many years after a fire (Paige and Ritter 1999). The proportion of grassland and sagebrush in the mosaic is influenced by intensity and frequency of fire over time. There are other grassland habitats in the Northwest. In the Willamette Valley native grassland and savanna habitats, once dominant, are now found only in remnants. In southeastern Washington and adjacent Idaho, the Palouse Prairie was historically dominated by perennial bunchgrasses; much of this has been converted to agriculture. In the sagebrush steppe, Grasshopper Sparrows are found at the end of the habitat gradient characterized by increased grassland and disturbance (Knick and Rotenberry 2002). They are most abundant in perennial bunchgrass grasslands, and to a lesser extent in sagebrush-bunchgrass habitat of the Columbia Basin, and least abundant in depleted sagebrush and sagebrush with annual understory dominated by cheatgrass (Vander Haegen et al. 2000; Holmes and Miller 2010; Earnst and Holmes 2012). Grasshopper Sparrows are found locally in other habitats dominated by grass with few shrubs in the northwest: grasslands in the Snake River Plain, the Palouse, on non-lava strata dominated by grass in Craters of the Moon National Monument, native bunchgrass communities in the Willamette Valley (Janes 1983; Myers and Kreager 2010; Carlisle et al. 2012).

California – Since European settlement of California, most native, perennial bunchgrass grasslands have been replaced with introduced, annual grasses and forbs (Goerrissen 2005; Barry et al. 2006; Gennet 2007). Gennet (2007) describes the two major grassland types as coastal prairie (along the Pacific), and valley grasslands (in the Central Valley, Coast Ranges, and Sierra Nevada foothills) (this coincides approximately with California Valley grassland in Fig. 6). The largest swath of grasslands was in the Central Valley of California; however a large majority of it has been converted to agricultural land. Oak woodlands and savannas in many foothills surrounding the Central Valley have been cleared and represent a large portion of existing grasslands. In California, Grasshopper Sparrows prefer short to medium-height, moderately open grasslands with scattered shrubs; where native bunchgrasses still exist, they are important Grasshopper Sparrow habitat (Unitt 2008). Grasshopper Sparrows occur on (1) remaining prairies, salt-grass meadows, pastures, and foothills along the California coast; (2) the edges, foothills, and occasionally the valley floor in the Central Valley; and (3) at the southern end of the Sierra Nevada range (Unitt 2008). Absence of trees and vegetative structure appears more important than presence of native grasses in Grasshopper Sparrow habitat selection in southern California. In one study Grasshopper Sparrow presence was associated with several measures of the surrounding habitat landscape

matrix – more Grasshopper Sparrows in larger grassland patches, and in one year fewer in sites with more land cover types (less grassland) (Rao et al. 2008).

Puerto Rico – Plains habitat, dominated by grasslands, make up 25 – 30% of Puerto Rico's landscape. Most of these grasslands are dry habitat located on the coasts of the island, and the majority is in private ownership. Grasshopper Sparrow is one of the few resident species exclusively allied with grassland habitat; nevertheless very little is known about its ecology or limiting factors. It is considered to prefer tall grass.

Mexico, Central America, other Caribbean – Grassland is an important habitat component of the Chihuahuan Desert on the Mexican Plateau, where it is scattered in a mosaic with desertscrub (this coincides approximately with Semidesert Grasslands in Mexico in Fig. 6). Although the very northern parts of Sonora and probably Chihuahua support some breeding *A.s. ammolegus*, this region is most important as the wintering ground for several subspecies of migratory Grasshopper Sparrow. Most native grasslands of the region have been human-altered, especially through grazing or conversion to agriculture. In Central America, additional grassland types are found, such as savannas (native grasslands with scattered trees and bushes) (this coincides with the Tropical Savanna habitat types in Fig. 6). Pine savannas are found locally on sandy soils from northern Guatemala to northern Nicaragua. These habitats also are altered by grazing and periodic burning, and have been converted to agriculture (Howell and Webb 1995). The resident *A.s. cracens* frequently occurs in Central American pine savannas (Monroe 1968; Howell 1971, 1972; Arguedas-Negrini 2001). Arguedas-Negrini (2001) surveyed available pine savanna habitat in northeastern Nicaragua for Grasshopper Sparrows. Grasshopper Sparrows were only found at 11 of the 600 points surveyed. None of these 11 sites were in either intensively cultivated pine plantations or where brush or pine cover was extensive. Five large breeding populations (>15 singing males) were located; all breeding populations were found in areas that had experienced at least one fire at the beginning of the dry season, less than two months prior to the survey. The vegetative characteristics of the sites with large breeding populations ranged from (1) scattered, mostly mature *Pinus caribea* stands; (2) low, herbaceous vegetation; (3) thick grasses with scattered brush; to (4) young, fire-damaged *P. caribea* plantations among clusters of volcanic rocks. All territories were dominated by low, sparse vegetation (mostly grass, but some forbs, etc.), included some *P. caribea*, and a few *Sabal* sp. and *Byrsonima* sp. I am not familiar with any other literature providing information about habitat associations of other Central American or Caribbean subspecies.

B. Migration

Very little is known about the habitats used by Grasshopper Sparrows in spring or fall migration. It is generally considered to be similar to habitats in the breeding and winter seasons (Vickery 1996). In south Texas, Igl and Ballard (1999) found that grassland birds (during migration and in winter) were more abundant in the most structurally simple habitats that most closely resembled their breeding habitats, and grassland specialists tended to be more habitat-specific during the nonbreeding season than shrub-grassland specialists. In 1993 spring migration Grasshopper Sparrows occurred at significantly higher densities in open habitats than in habitats with dense woody vegetation. Across spring and fall migration and winter, Grasshopper Sparrow mean densities were highest in the grassland habitat. However, like many migratory birds, Grasshopper Sparrows do use a broader range of nonbreeding habitats in migration

than used during breeding (Igl and Ballard 1999). Grasshopper Sparrow is classified as a grassland specialist, defined as species that use herbaceous grasslands on the temperate breeding grounds. However, in addition to finding relatively high mean densities of nonbreeding Grasshopper Sparrows in grassland habitat, dominated by grass and forbs with <10% woody cover (8.33 ± 2.11 birds per 10 ha), which is most similar to their breeding habitat, Igl and Ballard (1999) also found them in notable densities in habitats unlike their breeding habitat: (1) shrub-grassland, interspersed grass and woody plants <3 m with <30% woody cover (7.38 ± 1.77); (2) parkland, interspersed grass and woodland plants ≥3 m with <50% woody cover (5.11 ± 1.44); (3) brushland, dominated by woody plants <3 m with ≥30% woody cover (4.57 ± 1.70); and (4) woodland, dominated by trees ≥3 m with a closed canopy (1.30 ± 0.44).

C. Wintering

The most important habitats for wintering Grasshopper Sparrows are the grasslands of the southeastern U.S. and the semidesert grasslands of the U.S. Southwest and northern Mexico. The semidesert grasslands are located in southeastern Arizona, and otherwise primarily defined by the Chihuahuan Desert ecoregion in southern New Mexico, west Texas, and the Central Plateau of Mexico, which is bordered by the Sierra Madre Occidental and Oriental, south to approximately the Transvolcanic belt (Askins et al. 2007).

Relatively little is known about the winter habitat of Grasshopper Sparrows, although current and recent studies are beginning to fill in the gaps in that knowledge. In general grassland birds are assumed to use winter habitats that are similar to those used in the breeding season. More detail from recent literature is included here, given the lack of information on winter habitat provided in Vickery (1996). Much of the limited information available about Grasshopper Sparrow wintering habitats is from the Southwest U.S. and from northern Mexico; much less is available from the Southeast U.S. and there appears to be no information from the Caribbean or Central America regarding wintering migrant Grasshopper Sparrow habitat. The wider range of habitats used by migrating and wintering grassland birds in south Texas (Igl and Ballard 1999 – described under **Migration** section above) is consistent with other literature showing Grasshopper Sparrows using a broader range of winter habitat that includes not only grasslands but weedy fields and various habitats with dense woody vegetation (Emlen 1972, Dunning and Pulliam 1989, Hutto 1992, Block and Morrison 2010).

In winter, migratory *A.s. pratensis* are sympatric with resident *A.s. floridanus* in south-central Florida. The migratory subspecies was more abundant in grass-dominated wet-mesic patches than in shrubby dry-mesic prairie (Korosy et al. 2013); sample size was too small to draw similar inferences for the wintering Florida Grasshopper Sparrow. Grasshopper Sparrows are widespread and locally common in winter throughout the Chihuahuan Desert grasslands in Mexico and the southern parts of Texas, New Mexico, and Arizona; they were found in nearly all Grassland Priority Conservation Areas (GPCAs) in all years (2007-2011) (Panjabi et al. 2010; Macías-Duarte et al. 2011b). Wintering Grasshopper Sparrows in this region are found in grasslands but not in agricultural field borders; they are positively associated with grass height and grass cover, and negatively associated with amounts of bare ground (Desmond 2004; Desmond et al. 2005; Macías-Duarte et al. 2009; Martinez et al. 2010; Grageda García 2011; Ruth et al. 2014). Information about Grasshopper Sparrow response to woody vegetation in the winter is mixed. Some studies indicate a negative association with shrub cover (Desmond et al. 2005; Panjabi et al. 2010),

others showed no association (Block and Morrison 2010; Ruth et al. 2014), while one found that they were more frequently found in areas with tall woody plants (Macías-Duarte et al. 2009).

VII. Known or Suspected Limiting Factors and Threats

Most of the information provided regarding limiting factors and threats comes from research conducted on the breeding grounds. However, given that Grasshopper Sparrows are found primarily in similar grassland habitat during the nonbreeding season, it is assumed that most of the information applies to other seasons as well. Where there is information to the contrary, or information specific to nonbreeding ground factors, it is identified. It is important to note that there are many interactions among limiting factors, threats and bird responses, which for the most part are beyond the scope of this document. As in previous sections, the information provided here is primarily more recent information not available at the time of the publication of Vickery (1996) and Dechant et al. (1998).

The following breeding phenology information about Grasshopper Sparrows is important in understanding the effects of and recommendations regarding management activities like mowing, grazing, and burning, especially timing and frequency, and will be referenced in sections below. The breeding seasons for both *A.s. pratensis* and *A.s. perpallidus* are about 90 days long, generally beginning in May; there are bimodal breeding seasons for *A.s. floridanus* with more than 200 days following summer fires, the first peak in March to late June, and the second peak in response to fire from July to September (Vickery 1996). The primary breeding season for *A.s. ammolegus* begins with the start of summer monsoons and spans July through the end of August (J. Ruth, pers. observation). Under good conditions, Grasshopper Sparrows can produce $\geq$2 broods annually, and in some more southern areas as many as 3 or 4 broods (Vickery 1996). It takes an average of 32 days from the beginning of nest construction, including egg laying, incubation, hatching, fledging, and the time period until juveniles can fly; it can take another two weeks until juveniles are independent of adults (Vickery 1996).

A. Habitat Loss/Degradation

Habitat loss/degradation/fragmentation is one of the greatest threats to grasslands and causes of grassland bird population declines (Vickery et al. 1999b; Askins et al. 2007), and therefore poses a threat to Grasshopper Sparrows across much of its range. The primary sources of grassland habitat loss have been identified by sources too many to cite here, and include: (1) grassland conversion for agriculture (especially cropland); (2) conversion for suburban/urban development; (3) conversion for energy development; and (4) natural or anthropogenic transformations of grassland habitats into habitats of a different kind (e.g., shrub/scrub, woodland, or forest). More recently, in regions where most remaining surrogate grasslands are agricultural (hayfields and pastures), the loss of these grasslands through conversion to other uses, is also a severe problem. In a landscape scale study of the association between avian trends and changing agricultural landscapes in the central and eastern U.S., the population trends for 12 species, including Grasshopper Sparrow, were significantly and positively associated with the amount of rangeland (Murphy 2003). Murphy suggested that the loss of rangeland east of the Rocky Mountains was associated with negative bird population trends. In the eastern U.S. and tallgrass prairies, much of the habitat loss has already occurred, with little original prairie remaining. In other grassland regions

habitat conversion continues. Of particular concern for the conservation of wintering grassland birds, including Grasshopper Sparrows, is the rapid rate of grassland conversion to croplands in the Chihuahuan Desert grasslands of northern Mexico (Pool et al. 2014).

In addition to the effects of direct habitat loss, there are many sources of grassland habitat degradation that affect grassland birds and Grasshopper Sparrows in particular. Most of these are discussed in more detail below: (1) habitat fragmentation; (2) intense agriculture practices and grazing practices; (3) altered fire regimes; (4) exotic grasses; (5) invasion of exotic shrubs and encroachment of native shrubs; (6) alteration of floristic structure and composition; (7) pesticides/contaminants; and (8) human disturbance. Where the habitat and Grasshopper Sparrow responses to the factor differ geographically, information is provided according to grassland types. Many of the limiting factors and/or threats discussed below are factors over which managers may have some control. For this reason, recommended conservation actions are located in Appendix A; some recommendations apply to a specific limiting factor or threat, and others can be more generally applied to grassland management.

B. Grazing

Grazing by native ungulates, small mammals, and invertebrates has been an important driving factor in many North American grasslands, and today domestic livestock grazing is the most widespread economic use of public lands in the West, covering approximately 86 million hectares of US federal land in 17 western states (Saab et al. 1995). There are few direct impacts of cattle on grassland birds, although some studies have documented low levels of direct nest loss and mortality (adults and fledglings) due to trampling by cows (Hovick et al. 2011; Johnson et al, 2012; Ribic et al. 2012; Ruth, unpub. data), and one study documented nest predation by cattle for several grassland species (Nack and Ribic 2005). Most grazing impacts are indirect effects on grassland birds as a result of changes in vegetation structure and composition (Bock and Webb 1984). However, grazing *per se* is not inconsistent with managing grasslands for grassland birds. Frequently negative effects on birds are associated with what is variously described as inappropriate grazing practices, overgrazing, or high intensity grazing, which has been associated with overuse, loss of range health, loss of floristic or structural heterogeneity, invasion of exotic plants, changes in vegetation composition, reduced ground nest cover, interruption of fire cycles due to reduced fine fuel, and erosion. Another important factor is the differential response of grassland bird species to grazing in different grassland types and regions; the impact of grazing can vary greatly depending on such factors as season, frequency, stocking rate, grazing history, environmental conditions, and evolutionary history of grazing in the region (Finch 2004). Grasshopper Sparrows are representative of species that prefer intermediate amounts of grass cover, benefiting from grazing in tallgrass and some mixed-grass systems but showing lower abundance or avoiding grazed sites in shorter or dryer grasslands (Saab et al. 1995). In addition, for some grassland types, appropriately managed grazing is one of the best means of maintaining grassland habitat, and in many areas maintaining grazing land uses protects these grasslands from conversion to other uses which do not provide habitat for grassland birds.

Because of the Grasshopper Sparrow's broad range and differences in how they respond to grazing, separate sections for each grassland region are presented. [See Saab et al. (1995) Appendix for definitions of most commonly used grazing systems: continuous season-long, rest rotation, deferred rotation, seasonal suitability, and short duration.]

Mixed-grass – The mixed-grass prairie historically supported large numbers of bison, and large herbivore grazing is a required process for sustaining mixed-grass communities. However, the grasses do require regular grazed and ungrazed periods during the growing season for optimum growth, so continuous heavy grazing, or lack of grazing and the resulting excessive litter accumulation are problematic. Therefore, for much of the mixed-grass prairie, grazing, if managed appropriately, is an acceptable and often necessary tool for maintaining healthy grasslands and bird communities (Samson and Knopf 1996; Askins et al. 2007). Grazing effects studies of Grasshopper Sparrows in mixed-grass prairie found a positive correlation with low intensity grazing which resulted in greater grass height, grass density, and litter depth than more intense grazing; negative responses were seen as stocking and intensity of cattle and bison grazing increased (Kantrud 1981; Kantrud and Kologiski 1982; Fritcher et al. 2004; Sliwinski 2011). Some studies found that Grasshopper Sparrow abundance was higher on ungrazed than grazed plots (Richardson 2012). Several other studies showed little evidence of a response of any kind to grazing in mixed-grass prairie (Danley et al. 2004; Kim et al. 2008). Some of these studies demonstrated interactions between grazing and burning effects (Danley et al. 2004; Richardson 2012).

Shortgrass – Grazing is the second most important driver in shortgrass prairie, after drought. The shorter grasses of the shortgrass steppe are equally tolerant of frequent droughts and grazing by native ungulates (Saab et al. 1995). Today the primary grazers are domestic cattle, and grazing is the principal management tool for maintaining shortgrass. Historically different grassland bird species exploited the heterogeneous niches created by different intensities of grazing by native ungulates (Askins et al. 2007), but current range management practices in shortgrass prairie result in a uniform, homogeneous grassland landscape (Vickery et al. 2000). However, cattle grazing can be managed to imitate the grazing patterns of bison (Samson and Knopf 1996; Askins et al. 2007). Unfortunately few studies provide information about how Grasshopper Sparrows respond to cattle or bison grazing in shortgrass prairie. They are known to respond negatively to grazing in shortgrass where grass is short and sparse (Colorado Partners in Flight 2000). Grasshopper Sparrows were more abundant on ungrazed shortgrass than on grazed plots and showed higher occupancy on sites with low-moderate grazing intensity compared with high intensity (Wiens 1973; Fogg and Pavlacky 2012).

Tallgrass – The extent to which grazing drove tallgrass prairie dynamics remains somewhat unclear, with the greatest frequency and intensity of grazing likely in the western portions close to the mixed grass region (Samson and Knopf 1996; Askins et al. 2007). Nevertheless, grazing is one of the three most common management practices for grasslands in the tallgrass region. Grazing can result in a more heterogeneous vegetation structure than either mowing or burning (Sample and Mossman 1997). Because Grasshopper Sparrows respond to grass structure and tend to prefer intermediate grass height, density, and litter levels, cattle grazing in tallgrass communities can be beneficial in providing preferred habitat structure for them. It is likely that successional increases in vegetation height and density without grazing or other managed disturbance may result in the gradual reduction of habitat suitability for Grasshopper Sparrows (Rohrbaugh et al. 1999). Grasshopper Sparrows occurred in moderately grazed fields in Wisconsin (Sample and Mossman 1997). Many of the studies in the tallgrass prairie region looked at response to multiple management practices (grazing, fire, mowing, undisturbed, CRP). Nevertheless, studies indicate that grazing resulted in the greatest abundance or density of Grasshopper Sparrows among various management treatments (Walk and Warner 2000; Powell 2008; With et al. 2008; Ramig et al. 2009; Jacobs et al. 2012). Interactions between grazing and patch-burning were found (Missouri

Department of Conservation 2008). In addition, grazing by bison in the Flint Hills had a positive effect on Grasshopper Sparrow abundance (Powell 2006). Studies that evaluate population demographics are especially important in understanding the effects of grazing on Grasshopper Sparrows. Demographic studies in the tallgrass prairie region have produced mixed results. Clutch size and nest success in grazed pastures were found to be lower than in ungrazed sites or hayfields (Sutter and Ritchison 2005; With et al. 2008; Rahmig et al. 2009). In contrast, several other studies found no differences in Grasshopper Sparrow demographics between grazed and ungrazed sites - in daily nest survival probabilities (Zimmerman 1997) and nest success (Rohrbaugh et al. 1999). Similarly, comparisons of Grasshopper Sparrow responses to different combinations of grazing and/or burning practices frequently found no differences in abundance (Clower 2011), post-fledging survival (Hovick et al. 2011), or clutch size (Hovick et al. 2012).

Eastern grasslands – Given that pastures frequently serve as replacement habitat for grassland birds in the East, livestock grazing is an important management tool affecting grassland birds (Jones and Vickery 1997; Vickery et al. 2005). Grazing and/or periodic fires serve to maintain grasslands and control woody vegetation. The limited studies on grazing effects in the east found that Grasshopper Sparrow nest success and clutch size were greater on ungrazed than grazed sites (Sutter and Ritchison 2005). High intensity grazing created unsuitable habitat for Grasshopper Sparrows (Sutter and Ritchison 2005), although light to moderate intensity grazing created suitable habitat (Smith 1997). However, a study comparing abundance on high-intensity rotational grazing and continuous grazing sites found no differences (Clower 2011).

Florida – Although USFWS (2008b) indicated that the effect of grazing on dry prairie habitat and Florida Grasshopper Sparrows is not known, others consider intensive management of grasslands for cattle grazing as one of the greatest threats to Florida Grasshopper Sparrows (Delany et al. 2002), and sparrow occupancy was significantly greater in an area where cattle were excluded (Tucker and Bowman 2006). Of the three areas where populations of Florida Grasshopper Sparrow were recently known, one of them (Avon Park Air Force Range) is grazed (1 cow-calf pair/8 ha), while the remaining two sites (Three Lakes Wildlife Management Area and Kissimmee Prairie Preserve State Park) are not grazed. Populations are relatively stable at the two ungrazed sites in comparison with the population at the grazed site (USFWS 2009); it is the Avon Park population which may have been extirpated recently (Williams 2013). Additionally, there has been some concern about the potential negative impacts of imported fire ants on Grasshopper Sparrow nest survival and foraging ecology and possible ties between grazing and the presence of fire ants. Densities of fire ant mounds were higher in areas with active grazing programs, but more site specific studies using bait stations and cattle exclosure did not find significant differences in fire ant detections (although there were 50% fewer detections at bait stations within exclosures) (Tucker et al. 2010b).

Semidesert grasslands – The primary land use in semidesert grasslands is domestic cattle grazing. In the late 1800s and early 1900s, massive overstocking and overgrazing in the semidesert grasslands, followed by drought, resulted in major degradation of these grassland ecosystems (McClaran and Van Devender 1995; Finch 2004). Although changes in range management since then have resulted in restoration of many ecosystem functions and communities, grazing continues to have a major impact on grasslands. Much of the research on grazing effects in semidesert grasslands have occurred on a small area of public and private grassland sites in southeast Arizona. Several of these studies found breeding and wintering

Grasshopper Sparrows only on an ungrazed site (Bock and Webb 1984; Bock and Bock 1999), and other studies found that breeding and/or wintering Grasshopper Sparrows were more abundant on an ungrazed site (Bock et al. 1984; Bock and Bock 1988). However, all of these Bock studies were conducted on a single ungrazed site (the Audubon Research Ranch) and a single adjacent ranch that employs high-density, short-duration, rotational grazing according to the principles of holistic resource management (Savory 1988). In desert grasslands in Chihuahua, Grasshopper Sparrows were not found on continuously overgrazed ejido grasslands (Desmond 2004; Desmond et al. 2005). Recent studies on more sites in southeastern Arizona have found more complicated results. On multiple sites in the Sonoita Valley, Bock et al. (2008) found more complex results; in an exurban environment, breeding and wintering Grasshopper Sparrows were more abundant on ungrazed sites but in an undeveloped environment, they were more abundant on grazed sites (Bock et al. 2008). Gordon (2000) also found annual variation in wintering Grasshopper Sparrow response to grazing. Densities of singing male Grasshopper Sparrows were highest in the grazed grasslands of the San Rafael Valley, with sequentially lower densities in the Sonoita Valley (mostly grazed, but one ungrazed site), the grazed Animas Valley, and remnant populations at ungrazed locations in the Altar Valley, and grazed grasslands in the San Pedro, Sulphur Springs, and San Bernardino valleys (Ruth 2008).

<u>Northwest</u> – Grazing by cattle and sheep in sagebrush habitat can have major impacts on vegetation composition, reducing fine fuels and frequency of fire. In addition, cattle selectively graze first on grasses and forbs before browsing on sagebrush. Impacts can be dependent on the timing and intensity of grazing; intensive spring grazing can negatively impact perennial bunchgrasses by preventing them from reproducing during the short growing season. If the grass and forb understory is completely removed, the community tends toward dense sagebrush stands with little or no perennial or annual understory (Knick et al. 2005). In the Columbia Basin, Grasshopper Sparrows were most abundant in perennial grasslands and least abundant in depleted sagebrush and sagebrush annual communities; models suggest that conversions from one habitat type to another can be brought about by extended periods of unsustainable grazing or fire (Holmes and Miller 2010). The models more specifically projected that a change from tall perennial grasses to a codominance of short perennial and/or annual grasses would result in fewer Grasshopper Sparrows. In a bunchgrass prairie habitat in northeastern Oregon, a study of bird response to cattle stocking rates found no significant effects of stocking rate on Grasshopper Sparrow population density, although nest density decreased with increased stocking rates, and no nests were found in the highest stocking treatment (Johnson et al. 2011).

<u>California</u> – There is very limited information about the impacts of grazing on Grasshopper Sparrows in California. In a study of the effects of topographic factors and vegetative structure on grassland birds in the Coast Range grasslands near San Francisco Bay, Grasshopper Sparrow presence was positively associated with grazing in one year although it was not a significant association; in the other year the presence of the grassland bird guild (including Grasshopper Sparrow) also was positively associated with grazing but the pattern did not show for individual species (Gennet 2007).

No information was found regarding grazing impacts on Grasshopper Sparrow in other regions within its range.

C. Fire

Fire has been an important ecological driver in many grassland types, with many different effects on ecosystems and grassland birds. There are direct fire effects (i.e., mortality of adults, eggs, nestlings, or fledglings) which are likely not important to Grasshopper Sparrows at the population level. There are also multiple indirect effects. Grasshopper Sparrows may respond negatively to burn areas immediately following fire and for some limited period thereafter as a result of fire-caused reductions in food availability and vegetative structure. There are also longer-term indirect effects of fire, most related to time periods after fire during which preferred habitat characteristics or resources are available. In addition to natural effects of fire and bird responses, there are several important interacting anthropogenic and environmental factors that have influenced fire ecology (frequency, intensity, and extent) and therefore grassland birds. These could involve (1) direct fire suppression, (2) changes in fire regime related to fuel loads (both reduced fuel loads due to grazing and increased fuels loads or flammability of fuel loads due to exotics like buffelgrass) or drought, or (3) changes in habitat potential such as shrub encroachment or ecological succession. As with grazing, Grasshopper Sparrows exhibit variable responses to fire across their range and therefore information is presented below by grassland type.

Mixed-grass Prairie – Fire was relatively frequent in the mixed-grass prairie, with some estimates of a frequency between 4 – 8 years. It is an ecological driver in the region along with precipitation and grazing. Season, intensity and frequency of fire are the variables that influence its effects on the community. Fire, both human and lightning-caused, serves to prevent the encroachment of trees and shrubs; it is important in the establishment of seedlings for some plants, and improves forage for grazing animals. Fire intervals varied with soil type, moisture, and grazing. It is used less often for management in mixed-grass than it is believed to have occurred in the past, and is frequently used in combination with grazing (Samson and Knopf 1996; Askins et al. 2007). Many of the apparent differences in the results described in the literature may actually represent bird responses to fire in different types of mixed-grass grasslands, particularly how tall and dense the vegetation was prior to burning, different frequencies of fire, or even the season when the fire occurred. In addition, some studies focused on the responses of grassland birds in the first years following fires, while others compared grassland birds on sites that had been either burned or unburned for various periods of time. Although one study found little influence of fire on Grasshopper Sparrows post-fire (Grant et al. 2010), most studies of bird response in the years following fire showed relatively consistent results. Grasshopper Sparrow abundance or density was depressed for 2 – 4 years post fire, gradually increasing over that time period (Bock and Bock 1987; Johnson 1997, Madden et al. 1999; Danley et al. 2004; Richardson 2012; Roberts et al. 2012). However, in the arid southern mixed-grass prairie the pattern may be somewhat different, with longer times post-fire before grassland habitat is suitable for Grasshopper Sparrows. In the Red Rolling Plains of Texas, they began using burned sites at about 6 – 8 years post-fire (Lee 2006). There was some evidence that over a longer time post-fire, Grasshopper Sparrow numbers declined again as vegetation became too tall and dense (Johnson 1997; Lee 2006). Comparisons of Grasshopper Sparrow use of burned and unburned sites are undoubtedly affected by the frequency of fire and its influence on the height and density of vegetation structure, with Grasshopper Sparrows associated with intermediate grass height and density and litter depth. Breeding and wintering Grasshopper Sparrows were found more frequently and with higher abundance on unburned sites (Bock and Bock 1987; Reynolds and Krausman 1998; Roberts et al. 2012). In contrast, a study in North Dakota found that Grasshopper Sparrow abundance was positively associated

with the amount of fire and they were completely absent from the unburned site (Madden et al. 1999), but the unburned site had remained unburned for >80 years.

Shortgrass Prairie – In the shortgrass prairie, fire is not a primary ecological driver; drought is the primary ecological driver and grasslands are secondarily maintained by grazing. Shortgrass species frequently do not provide adequate fuel to carry a fire, and therefore it is rarely used as a management tool in shortgrass (Askins et al. 2007). Information about the effects of fire on shortgrass prairie are quite limited, although as elsewhere in the Great Plains, where it occurs, fire controls woody vegetation, removes plant material, recycles nutrients, and may either compete with grazers or benefit them by stimulating new growth (Samson and Knopf 1996). Grasshopper Sparrows respond negatively to fire where grass is short and sparse (Colorado Partners in Flight 2000). Grasshopper Sparrow abundance and density did not differ between spring burned and unburned sites in the Texas panhandle (Roberts et al. 2012).

Tallgrass Prairie – Fire played a major role in the formation and maintenance of the tallgrass prairie. This included both naturally ignited (lightning) fire and human-caused fires (Askins et al. 2007); a high proportion of pre-settlement fires occurred in the late growing season (Reinking 2005). Estimates of historical fire frequency in tallgrass range from two to five years (Samson and Knopf 1996). Fire restricts woody and other fire-tolerant species to riparian zones and other protected areas; it also releases nutrients into soil, reduces litter, and affects plant diversity in complex ways (Samson and Knopf 1996). Askins et al. (2007) suggest that response of grassland birds to fire may be influenced by factors such as prairie size. Fire has been increasingly used to manage ungrazed areas and improve productivity in grazed areas, primarily using annual or biennial spring burns. See Reinking (2005) for a detailed summary of fire ecology in the central tallgrass prairie. As elsewhere, studies of grassland bird response to fire include some comparing bird response over a number of years following fire, while others compare bird use of burned vs. unburned sites. Multiple studies have found similar Grasshopper Sparrow responses over time following a fire, suggesting that in tallgrass, fire provides acceptable habitat for Grasshopper Sparrows (shorter, less dense vegetation and less litter) for only 1 – 3 years following a fire. Following the year of the fire, Grasshopper Sparrows were significantly more abundant on sites 1 – 3 years post-fire (Herkert 1994a; Reinking 2005; Powell 2006), and then declined with increasing time since the last burn (Swengel 1996; Reinking 2005; Missouri Department of Conservation 2008). There was some difference in how Grasshopper Sparrows responded in the same year as a spring burn (Sample and Mossman 1997; Reinking 2005; Powell 2006, 2008; Missouri Department of Conservation 2008). Similarly, Grasshopper Sparrows were more abundant on sites with shorter burn cycles (1-3 years) than sites with 4 year burn cycles (Powell 2008). Reinking (2005) concludes that annual burning either benefits or poses little threat to Grasshopper Sparrows in tallgrass prairies. Several studies found no difference in Grasshopper Sparrow abundance, density, or nesting success in burned and unburned grasslands (Zimmerman 1992, 1997; Robel et al. 1998; Rohrbaugh et al. 1999; Van Dyke et al. 2004). Zimmerman (1992) noted that abundance was not affected by burning in moist years, but may be reduced in drought years. There were a number of studies comparing grassland bird responses to different management practices and/or undisturbed grasslands. Comparisons of burn practices found that Grasshopper Sparrows were more abundant in a traditional homogeneous burn (the whole field) than a heterogeneous patch-burn (Coppedge et al. 2008), but nest survival and post-fledging survival were not significantly different between these two burn practices (Hovick et al. 2011, 2012). These studies did not compare abundance or survival in undisturbed sites. Complex interactions were found in studies comparing combinations of burning,

haying, and grazing practices, and sites with different grass types (Walk and Warner 2000; Swengel and Swengel 2001; Missouri Department of Conservation 2008; With et al. 2008).

Eastern grasslands – In the Northeast fire is used to manage for rare plant and animal assemblages, for maintenance of commercial blueberry fields (Askins et al. 2007), and in a few instances for maintaining airfield grasslands between runways (Rudnicky et al. 1997), although it is relatively unimportant for maintaining large tracts of grassland (Vickery et al. 2005). See Vickery et al. (2005) for a history of fire in New England grasslands. Although Grasshopper Sparrows were found in both burned and unburned areas in northeastern grasslands (Jones and Vickery 1997), similar to tallgrass prairie, they benefit from burning, with highest abundance and densities found 2 – 5 years post-fire (Jones and Vickery 1997; Harris 1998; Vickery et al. 1999a). A population viability model of Grasshopper Sparrows in Maine comparing management options determined that the best quality habitat was found on a site that had been burned two years previously; the greatest increase in abundance and lowest variance was found on sites in which 25% was burned every year (Wells 1997). In some cases prescribed burns were found to produce better habitat for grassland birds on airfields (between runways) than mowing because it increased bare soil cover (Rudnicky et al. 1997).

In the southeast, fire is used to control woody vegetation (Giocomo 2005). In southeastern pine savannas annual fire combined with dry conditions can result in treeless grasslands that are used by species such as Grasshopper Sparrows (Askins et al. 2007). Less information is available about the effects of burning in southeastern grasslands. Giocomo (2005) suggested that annual prescribed burns on grasslands in Kentucky were too frequent to provide the structure (taller grass and deeper litter) used by nesting grassland birds including Grasshopper Sparrows.

Florida – Prescribed fire is the main habitat management option in Florida dry prairies; it reduces litter, exposes bare ground, and reduces shrub encroachment (Engstrom et al. 2005). Management of dry prairie grasslands in central Florida usually involves late-fall and winter prescribed fire, although naturally ignited fires occur most frequently in summer. Frequent fire (every 2 – 3 years) is essential to maintaining habitat for Florida Grasshopper Sparrow. Florida Grasshopper Sparrow densities were higher in areas that had been burned more recently and reproductive success was higher on the most recently burned sites (Shriver and Vickery 2001; Perkins et al. 2009; but see Delany et al. 2002). Also, the probability of reproductive success was significantly higher at 0.5 years post-burn than at 1.5 and 2.5 years post-burn (Delany et al. 2002). Results above describe Grasshopper Sparrow response to winter burns. With summer burns, Florida Grasshopper Sparrow densities increased following burns prior to the end of June and breeding continued into late August, but densities declined if fires occurred after the end of June (Shriver et al. 1996; Shriver et al. 1999). Similarly, in winter, Florida Grasshopper Sparrows were found only in one- and two-year post-burn plots, and not in three- or four-year post burn plots (Korosy et al. 2013).

In addition, time since fire was an important factor explaining the occupancy of wintering migratory Grasshopper Sparrows (*A.s. pratensis*) in Florida. Butler et al. (2009) found that the probability of occurrence in one-year-old burns was double that for older burns; another study found that migrants were least abundant in four-year post-burn sites compared with one to three-year post-burn (Korosy et al. 2013), although also responding to plant community type across all burn regimes.

Semidesert grasslands – Along with drought/precipitation, fire is a strong ecological force in semidesert grasslands and was historically common in most grasslands in this region. It maintains relatively shrub-free grasslands. With widespread livestock grazing, fine fuel is reduced and fire frequency is reduced. However, prescribed fire has become an important land management tool and fire frequency (natural and prescribed) changes depending on interactions with grazing intensity, exotic grass cover, smoke management concerns, and climate change (McPherson 1995, Bock and Block 2005). See McPherson (1995) and Bock and Block (2005) for details on fire ecology in semidesert grasslands. Fire in desert grasslands reduces grass cover for one to three post-fire growing seasons, stimulates abundance and variety of forbs, and generally increases seed production (Bock and Block 2005). Most research on fire effects on semidesert grassland birds has been conducted in southeastern Arizona. Significantly fewer breeding Arizona Grasshopper Sparrows were found on burned sites than on an unburned site (Bock et al. 1976, Bock and Bock 1988); breeding Grasshopper Sparrows also avoided burned plots for two years following the fire (Bock and Bock 1992). There is less evidence of Grasshopper Sparrow response to fire during the nonbreeding season in semidesert grasslands. There was no significant evidence that wintering Grasshopper Sparrows avoided grasslands in the two years following spring or summer burns (Bock and Bock 1992; Gordon 2000; Kirkpatrick et al. 2002).

Northwest – Fire is a dominant driving force in sagebrush ecosystems, maintaining forb and grass components. The historical fire regime varied in frequency and severity at a landscape scale, resulting in a mosaic of sagebrush and grassland communities in various stages of succession. Fire in the sagebrush region prior to settlement was probably patchy, small, and relatively infrequent; fire regimes were spatially and temporally variable. Bunchgrass understory does not provide the continuous fuel layer required to carry fire. The mosaic of grasslands and sagebrush shrublands are partially a result of fires, since sagebrush takes many years to reestablish after a fire. Several recent factors have disturbed historical dynamics. The invasion of exotic, flammable cheatgrass has fundamentally altered fire regimes, resulting in loss of sagebrush and persistence or expansion of cheatgrass at the expense of native perennial bunchgrasses. In other areas, suppression of fire or reduction in fine fuels due to grazing has decreased fire frequency. Finally, prescribed fire is frequently used as a management tool to control annual grasses, reduce sagebrush cover, promote grass and forb growth, and control pinyon-juniper. Fire does benefit Grasshopper Sparrows by creating more grassland habitat in this mosaic landscape (Knick et al. 2005; Carlisle et al. 2012). Grasshopper Sparrow abundance was highest in perennial grassland habitat and declined with a transition toward sagebrush (Holmes and Miller 2010). Following a wildfire, Grasshopper Sparrow numbers showed a short-lived increase in years three and four post-fire (Earnst et al. 2009).

No information about the impacts of fire on Grasshopper Sparrows in other grassland regions was found.

D. Mowing

Where native or non-native grasslands are harvested for hay or biomass, or mowed for other habitat management reasons (e.g., controlling woody vegetation and weeds, reducing litter layers, and altering plant composition), mowing can pose substantial threats to grassland birds. There are direct effects – destruction of nests, and mortality of eggs, nestlings, fledglings, and incubating adults. There are also multiple indirect effects, some of which are always negative (e.g., abandonment of nests, lower breeding

bird densities in subsequent years due to nest failures, and reduced site fidelity) and some of which are positive or negative depending on the habitat needs of the species (e.g., alteration of habitat structure or vegetation composition) (Horn and Koford 2000). Multiple harvests also may result in birds nesting or renesting after one cut, only to have a second cut occur before they are able to fledge young. Some studies have concluded that mowing has contributed to population declines in some grassland bird species (Rodenhouse et al. 1995). The direct effects of mowing on nesting grassland birds have been clearly demonstrated and will not be discussed in detail here (see Rodenhouse et al. 1995; Horn and Koford 2000). The frequency and timing of mowing will determine the extent of its direct effects on the species. Hayfields are typically mowed at least once per year, and frequently 2 – 4 times (Troy et al. 2005; Corace et al. 2009). The dates for mowing frequently coincide with the breeding season for grassland birds. Both dates for mowing and breeding dates for Grasshopper Sparrows vary across the breeding range of this species. In addition, trends in forage crop production are toward earlier first-cutting and more rapid rotation of hayfields due to faster growing crop hybrids and shifts from timothy-clover to alfalfa hays (Rodenhouse et al. 1995; Troy et al. 2005) See introductory paragraphs in section on **Known or Suspected Limiting Factors and Threats** for information on timing and length of breeding season for Grasshopper Sparrow throughout its range.

Population models for direct impacts of haying on Grasshopper Sparrows in Kentucky found that mowing in early to mid-summer resulted in population sinks, whereas both “no mowing” options or mowing in late summer allowed for source populations in most years (Giocomo 2005). In New York, Bollinger (1995) suggested that nest destruction from early mowing resulted in lower densities of breeding birds in the subsequent year. Therefore, the most common recommendation for reducing direct negative impacts of haying on Grasshopper Sparrows and other grassland birds is to delay haying until after the breeding season, or near the end of the breeding season where there is more than one breeding attempt in a season. One reason it is difficult to get private landowners to delay haying is an economic one; for at least some hay crops nutritional value peaks with first flower and then degrades in quality. For farmers who need high quality forage for calving dairy cows and finishing beef cattle, delayed mowing will not provide the needed nutritional feed. Later-cut hay has lower moisture content, lower digestibility, and lower protein. However, hay from delayed mowing can be used as feed for animals that tolerate moderately lower nutritive values – horses, sheep, dairy heifers, and mature beef (Sample and Mossman 1997; Dale et al. 1997).

There are indirect effects of mowing on Grasshopper Sparrows, although response varies geographically. As with other management regimes, these different responses are most likely related to the preference of Grasshopper Sparrows for intermediate grass height and some bare ground and the types of habitat created by mowing or not mowing habitats in particular regions. Appropriate habitats created by mowing may be present for short or long periods of time following mowing depending on how long it takes for the grass to grow tall again. In mixed-grass and tallgrass regions, there is evidence that mowing can benefit Grasshopper Sparrows because of the creation of preferred vegetation structure or composition (Frawley and Best 1991; Swengel 1996; Horn and Koford 2000; Swengel and Swengel 2001; Rahmig et al. 2009). However, Grasshopper Sparrow’s positive response to appropriate habitat structure created by haying may result in sink habitats if the time before the next haying is not sufficient for the birds to complete the nesting cycle. It is also the case that some studies have found annual variation in Grasshopper Sparrow response to mowing or no evidence of differences between mowed and unmowed sites (Dale et al. 1997; Van Dyke et al. 2004). Grasshopper Sparrow response to mowing in the Northeast may be different.

There is evidence that they require hayfields that have been left unmowed for longer periods of time (sometimes as many as 10 years) (Bollinger 1995; Smith 1997). The problem is that very few hayfields are left unmowed for over 5 – 6 years. See Appendix A for specific mowing management practices that may reduce negative impacts on breeding Grasshopper Sparrows and other grassland birds.

Below is additional information about mowing under specific types of management.

Mowing on reclaimed mine lands – Studies of the effects of early-season mowing on reclaimed surface mine patches in Ohio found no effect on Grasshopper Sparrow nest densities, or return rates in the following year; mean annual survival probabilities were higher in mowed areas (Ingold 2002; Ingold et al. 2010). They did find that early mowing forced a delay in nesting and may have limited Grasshopper Sparrows to one clutch. See section on **Surface Mine Reclamation** for more information.

Mowing on airport grasslands – Mowing grasslands around civilian and military airfields is important to prevent the growth of woody vegetation and to comply with safety regulations related to bird-aircraft strikes. For example, U.S. Air Force regulations require that airfields be mowed to a uniform height of 18 – 36 cm (7 – 14 inches) to reduce food resources and habitat quality for species of concern by the Bird/Wildlife Aircraft Strike Hazard (BASH) program (Milroy 2007). Some of the large birds that pose the greatest threats to aircraft prefer very short grass, so avoiding mowing grass very short can deter larger flocking birds and at the same time may benefit smaller grassland birds that require taller grass (Jones and Vickery 1997). In fact, at Westover Air Reserve Base in Massachusetts, Grasshopper Sparrows were more abundant in the unmowed portions of the airfield (Milroy 2007). Although they are not considered a priority threat to aircraft, there are several instances of a Grasshopper Sparrow being struck by an aircraft (Milroy 2007). Given that mowing airport grasslands for safety reasons is often required, a major question is whether these grasslands represent source or sink habitats for grassland birds. A study at three military airfields in the Mid-Atlantic and Northeast found that although mowing was a source of nest failure, it did not emerge as a significant predictor of nest survival rates for Grasshopper Sparrows (Peters and Allen 2010).

Mowing to harvest biofuels – Increased interest in the development of renewable fuels, including biomass production from perennial grass in the tallgrass region, has generated questions about the impact on grassland birds. It has been suggested that compared to other bioenergy crops, perennial, native grass species are more likely to benefit grassland bird species (Fargione et al. 2009). Switchgrass, a native perennial, is well suited as a biofuel. Because switchgrass is usually harvested for biomass in late summer or fall, mowing impacts are most likely related to change in vegetation structure (lower height-density and shallower litter layer) in the subsequent year (Roth et al. 2005). Grasshopper Sparrows, which are associated with shorter, less dense vegetation in the tallgrass region, appear to benefit from the harvest (mowing) of switchgrass when compared with unmowed switchgrass (Murray and Best 2003; Roth et al. 2005), and therefore may benefit from the conversion of less appropriate habitats (e.g., cropland and unmowed CRP switchgrass to switchgrass harvested for biomass; Murray et al. 2003). However, Grasshopper Sparrows were even more abundant in hayfields, pastures, and other unmowed, ungrazed cool-season grasses, than in those harvested switchgrass fields (Murray et al. 2003), and therefore conversion of these hayfields and pastures to switchgrass would not benefit them. Nor would harvesting of switchgrass benefit those grassland species that prefer taller, denser grasslands.

E. Shrub/Woody Vegetation Encroachment

Prior to European settlement, woodlands and woody species in the tallgrass, mixed-grass, and shortgrass prairies were limited primarily to riparian and wetland margins, and isolated buttes and scarps (Samson and Knopf 1996; Grant et al. 2004). Many factors, including reduction in frequency and intensity of fires, loss of bison and other native herbivores, loss of competing native grasses, and grazing by domestic cattle, have been implicated in the expansion of woody plants into North American grasslands. Some invaders are non-native, but many are natives that have expanded beyond historical distributions or habitats. In some areas, agricultural programs also have encouraged the planting of woody vegetation in hedgerows, shelterbelts, and for wildlife cover. Although the semidesert grasslands of the Southwest have historically been patchily distributed in a mosaic with desertscrub at lower elevations and evergreen-oak woodlands at higher elevations (McClaran 1995), there also has been an increase of trees and shrubs into grasslands beginning in the late 19th century (Bahre 1995). Substantial increases in juniper were projected on the southern mixed-grass prairie landscape from 1995 – 2015, with or without control efforts (Coppedge et al. 2004). Discussion of the causes of shrub/tree encroachment is beyond the scope of this document. This presentation focuses on the response of Grasshopper Sparrows to the presence and/or expansion of woody vegetation into grassland ecosystems and management recommendations. In some regions encroachment of a particular species of woody vegetation poses threats to grasslands and certain grassland bird species; in other regions it is any kind of woody plant that encroaches into grasslands, transforming the habitat from grassland to desert shrubland. Examples of invasive woody species are mesquite in the Southwest, and eastern red cedar and various juniper species in the southern Great Plains. In addition to the encroachment of various woody plants, there are some areas, such as the Rio Grande Joint Venture region, where increases in distribution and density of succulents and rosette plants are affecting the quality of native grasslands.

Much of the literature regarding grassland bird response, and Grasshopper Sparrow response specifically, to woody encroachment is from the tall and mixed-grass prairies. However, over the entire range of the species, multiple measures of abundance, occupancy, probability of occurrence, and association indicate that Grasshopper Sparrows respond negatively to increased woody cover. The point along the continuum of shrub density at which these negative responses occur varies geographically. In northern mixed-grass and tallgrass prairie, Grasshopper Sparrow abundance/occupancy/occurrence was highest in open, treeless grasslands and declined with increased woodland and shrub cover or density on the landscape (Bakker et al. 2002; Fletcher and Koford 2002; Davis 2004; Grant et al. 2004; Cunningham and Johnson 2006; Ahlering et al. 2009). Spring arrival densities, nest abundance, and nest success also were negatively associated with woody cover (Johnson 2001; Scheiman et al. 2003). Grasshopper Sparrows were sensitive to the presence of woodlands and aspen at both the territory and landscape scale (Grant et al. 2004; Cunningham and Johnson 2006). Similarly, Grasshopper Sparrows in the shortgrass prairie (Sparks et al. 2005; Gillihan et al. 2006), eastern grasslands (Jones and Vickery 1997; Lent et al. 1997; Graves et al. 2010), and Columbia Basin shrubsteppe (Earnst and Holmes 2012) were negatively associated with shrub cover or more abundant with low shrub cover. There are seasonal differences in Grasshopper Sparrow response to shrub cover in the semidesert grasslands of Arizona and New Mexico. Abundance showed no significant correlation with shrub cover in the winter (Block and Morrison 2010; Ruth et al. 2014). In the summer, abundance was negatively correlated with woody cover (Bock and Webb 1984; Pidgeon et al. 2001; Block and Morrison 2010).

F. Non-native grasses/forbs

Another potential threat facing most grassland systems in the U.S. is the presence of non-native (exotic) grasses or forbs. Those that exhibit invasive characteristics and have expanded their distribution beyond the locations where they were introduced are particularly problematic. Some species were intentionally introduced; grasses are planted as forage (grazing or hayfields), erosion control, and on CRP lands (CRP cover type Conservation Practice 1, or CP1) because they are inexpensive, easy to establish and manage, and hardy (Davis and Duncan 1999). Some forbs were planted as ornamentals; other grasses and forbs were accidentally introduced via contaminated seed or grain, or in ballast water. The spread of non-native grasses or forbs, once introduced, has been attributed to many factors including their abilities to invade disturbed habitat, respond positively to fire and/or provide greater fuels for fire, and out-compete native grasses. In addition, anthropogenic activities such as movement of livestock and transportation on vehicle tires and undercarriages have been suggested.

The non-native grasses are primarily cool-season species that: (1) produce most biomass in spring, and so are usually mowed or grazed during late spring or early summer (when most grassland birds are nesting); (2) experience ideal growing conditions in the Northeast; (3) do not grow well in dry or nutrient-poor soils; (4) can be grazed closer than warm-season grasses without reducing vigor; and (5) produce a dense cover that is not ideal habitat for some grassland birds. Non-native cool-season grasses include orchardgrass, timothy grass, smooth brome, tall fescue, Kentucky bluegrass, crested and intermediate wheatgrass. Warm-season grasses are an alternative promoted to increase forage production, nutrition, and economic benefits to farmers while providing more suitable wildlife habitat (Jones and Vickery 1997; Giuliano and Daves 2001). Warm-season grasses: (1) grow and produce most biomass in summer, and so grazing and mowing can be delayed until late summer; and (2) are drought resistant, winter hardy, and adapted to sandy, infertile soils (Giuliano and Daves 2001; Jones and Vickery 1997). In many regions warm-season species are native to North America (e.g., switchgrass, big and little bluestem, indiangrass, blue and side-oats grama). However in the southwest, some are non-native (e.g., kleingrass, Old World bluestem, Lehmann, Boer's and wheeping lovegrass). U.S. Department of Agriculture Natural Resources Conservation Service (USDA NRCS) programs such as the Wildlife Habitat Incentive Program (WHIP) and the Environmental Quality Incentives Program (EQIP), as well as the USFWS Partners for Wildlife Program, promote the establishment of warm-season grasses in pastures and hayfields. Additionally, NRCS provides guidance on which warm-season grasses and cool-season grasses to plant by region (Giuliano and Daves 2001). Starting in 1996, enacted Farm Bills (including the 2014 Farm Bill) have increased incentives that encourage landowners who are re-enrolling CRP contracts and enrolling new acreage to seed with native grass mixes (Conservation Practice 2, or CP2) and mixes of forbs with native grasses (CP4D). Native grass mixes are more expensive than non-natives (Thompson et al. 2009), but CRP contracts proposing the use of these CPs rank higher and are more likely to be included in the CRP program. A recent overview of the CRP program across the U.S. indicates that there are substantial differences among states in how much is being or has been seeded to CP1 (non-native) and CP2 (native). The patterns do not appear to be clearly geographical or tied to grassland regions (USDA 2006) and may be related to patterns of CRP contract renewal and expiration.

Comparisons of the responses of grassland birds to native vs. non-native grasses are often presented as cold-season vs. warm-season grasses, although this is complicated by several facts: (1) responses can vary geographically; and (2) the way these grasslands are managed and the resulting differences in vegetative

structure may be more important to Grasshopper Sparrows than the grass species (i.e., whether it is native/non-native or warm-/cool-season).

The response of Grasshopper Sparrows to warm-season vs. cool-season, and native vs. non-native grasses varies. In eastern, mixed- and tallgrass regions, some studies found more Grasshopper Sparrows in non-native, cool-season grasses than in warm-season or native prairie (Davis and Duncan 1999; Koford 1999; McCoy et al. 2001; Wentworth et al. 2010; George et al. 2013), while another found higher densities in cool-season grasses when they were mowed or grazed (Walk and Warner 2000). However, no difference was found in nesting success, nest density, or fecundity between CP1 and CP2 treatments (McCoy et al. 2001). Studies in north-central Oklahoma found that in spite of lower arthropod biomass, Grasshopper Sparrow densities were higher in non-native, warm-season monocultures than in native fields (George et al. 2009; George et al. 2013). Similarly, some studies in tallgrass and eastern grasslands found that Grasshopper Sparrows preferred native and warm-season grasslands over cool-season grasses (Giulano and Daves 2001; Ribic and Sample 2001; Bakker and Higgins 2009). And some studies in multiple grassland regions showed no apparent differences in Grasshopper Sparrow response to grassland types (warm- vs. cool-season or native vs. non-native) or management practices (Berthelesen and Smith 1995; Delisle and Savidge 1997; Chapman et al. 2004; Hickman et al. 2006; Thompson et al. 2009). It is possible that complicated combinations of grassland types, time since grass planting/treatment/restoration, and management practices in some of these comparisons may have affected or obscured any patterns in response. There is reason to think that Grasshopper Sparrows are responding to the structure of the grasslands rather than the species of grass or whether it was warm- or cool-season (George et al. 2009; Rahmig et al. 2009; Thompson et al. 2009).

In semidesert grasslands of the Southwest, Lehmann and Boer lovegrasses, non-native warm-season grasses, were introduced from South Africa (Bahre 1995). These species have subsequently spread far beyond the bounds of the original plantings and often occur in homogeneous stands excluding many native plants. Grasshopper Sparrows were more abundant on sites dominated by native grasses than those dominated by exotic lovegrasses (Bock et al. 1986; Bock and Bock 1988). In the sagebrush and sagebrush steppe habitats of the northwest, the non-native, cool-season cheatgrass readily invades disturbed sites and, because it readily carries fire, it alters fire and vegetation patterns (Paige and Ritter 1999). In the Columbia Basin shrubsteppe, Grasshopper Sparrows were more abundant in native bunchgrass and sagebrush-bunchgrass than in sagebrush-cheatgrass (Vander Haegen et al. 2000; Holmes and Miller 2010; Earnst and Holmes 2012). Holmes and Miller's (2010) state-and-transition models projected that loss of native perennial grasses would result in decreases in Grasshopper Sparrow abundance. Similarly in California, Grasshopper Sparrows are positively associated with native bunchgrass habitats (Collier 1994; Goerrissen 2005; Gennet 2007). In one study of response to an invasive non-native forb in North Dakota, Grasshopper Sparrow density was significantly lower at sites with high density of leafy spurge, than at sites with low to medium leafy spurge density (Scheiman et al. 2003).

G. Predation/Nest Parasitism

Grasshopper Sparrow nest parasitism by Brown-headed Cowbirds (*Molothrus ater*) is lower than for many other grassland birds (Vickery 1996; Patten et al. 2006; Giocomo et al. 2008; Vos and Ribic 2013),

probably because of the cryptic nature of Grasshopper Sparrow nests (Vickery 1996) and in some cases its avoidance of nest sites near edge habitat where parasitism rates are higher (Patten et al. 2006). Nest predation is also a significant cause of nest failure for many grassland birds and Grasshopper Sparrows are no exception. Both predation, and to some extent, parasitism effects are complicated by interactions with factors such as habitat fragmentation and surrounding land use types (Herkert et al. 2003); these complications are beyond the scope of this document. In general, potential nest predators in grassland habitats include native small mammals (e.g., ground squirrels), medium-sized mammals (e.g., skunks, raccoons, foxes), snakes, birds, deer, domestic cattle, and domestic/feral cats. There is some limited information about the specific effects of predation and parasitism on Grasshopper Sparrow nests and fledglings in tall and mixed-grass grasslands. In a series of studies in tallgrass habitat in Wisconsin, Grasshopper Sparrows primarily used remnant prairie sites; the majority of predators were thirteen-lined ground squirrels. Surprisingly, given their negative response to woody vegetation cover, Grasshopper Sparrow daily nest survival was higher near woody edges, which may be explained by the fact that ground squirrels avoided woody edges (Ribic et al. 2012). Over 85% of failed Grasshopper Sparrow nests were due to predation; potential mammalian, avian, and reptilian nest predators were observed on sites (Vos and Ribic 2013). Similarly, the leading cause of post-fledgling mortality was predation (49%; 17/35); 15 of these deaths were attributed to mesopredators (e.g., raccoons, skunks, foxes, cats) and 2 to snakes. Other sources of death were exposure, trampling, and unknown (Hovick et al. 2011). In Kentucky the majority of predators of Grasshopper Sparrow nests were thought to be snakes (Sutter and Ritchison 2005; Giocomo et al. 2008). In mixed-grass prairie, 35 – 46% of Grasshopper Sparrow nests were depredated (Davis and Sealy 2000; Jones et al. 2010). However, there was also evidence that nest parasitism had some impact, with significant reductions in the number of Grasshopper Sparrows fledged from parasitized nests (Davis and Sealy 2000).

There is even less information on the impacts of predation on adult survival. A major source of mortality in wintering adult grassland birds with radio transmitters in Chihuahua was Loggerhead Shrikes (*Lanius ludovicianus*) (G. Levandoski, unpubl. data); similarly avian predation was the primary cause of winter mortality in radio-collared Florida Grasshopper Sparrows (Vickery and Dean 1997).

H. Precipitation/Drought

Precipitation/drought is the primary driving factor in the mixed-grass prairie of the northern plains, shortgrass prairie, and semidesert grasslands, affecting the extent of grass, height and density of herbs, amount of litter, and shrub encroachment (Askins et al. 2007). Precipitation patterns also can affect birds indirectly through its effects on food production, invertebrates during the breeding season, and grass and forb seeds during the winter. The limited literature on the effects of drought on grassland birds comes from these regions. Grasshopper Sparrow densities declined sharply in the year of a severe one-year drought in North Dakota, but recovered completely in the following year (George et al. 1992). The authors suggest that these declines were due to reduced recruitment of birds returning the next spring, and that in spite of low productivity in the year of the drought, recruitment back from a larger area in the following spring caused the recovery. They also suggested that longer term droughts would have more severe impacts on grassland birds. Similarly, in North Dakota and Saskatchewan, the density of spring arriving Grasshopper Sparrows was positively correlated with concurrent May precipitation (Ahlering et al. 2009). In Arizona, wintering Grasshopper Sparrows were less abundant in a winter following two

years of drought than in a winter with more rain (Bock and Bock 1999). However, there is evidence that grassland birds are only limited by seed resources in years of extremely low seed production (Pulliam and Parker 1979).

I. Climate Change

Two recent publications provide valuable summaries of climate change predictions pertinent to North American grasslands and grassland birds: the U.S. State of the Birds 2010 (NABCI 2010), which summarized climate change predictions for the U.S.; and a review of information on climate change in the grasslands, shrublands and deserts of the interior American west (Finch 2012). Although available models often disagree, there seems to be relative agreement that the grasslands of the West will experience increased mean temperatures and increased frequency of extreme events (e.g., droughts, flooding, storms). Increased duration and spatial extent of drought events also are predicted (Finch 2012). More variable decreases or increases in precipitation are predicted, although combined with increased temperatures the predicted result is the drying of most grasslands. For example, although more precipitation is predicted for northern grasslands, they are expected to get drier as higher temperatures will increase evaporation (NABCI 2010). Southwestern grasslands, especially the Chihuahuan desert grasslands of the U.S. and Mexico, are predicted to become drier due to both reduced precipitation and higher temperatures. In combination with the changes mentioned above, increased atmospheric carbon dioxide and ecosystem stress are expected to result in floristic composition changes, including the facilitation of invasion by woody vegetation and other non-native plants into grasslands. Although projections of vegetation changes do not suggest major declines in total amount of grassland in the Great Plains, they suggest that climate conducive to Plains grassland in the south will decline, semidesert grasslands will expand northward into the southern Great Plains, and Great Basin shrub grassland will decrease (Finch 2012). No information was found about climate effect projections for eastern grasslands.

It is crucial to understand the impacts that climate change will have on birds in general, and grassland birds and Grasshopper Sparrows in particular. However, climate change models are complex and sometimes contradictory; much work remains to be done on how climate change will affect habitat distribution and how birds will respond to changes in climate and habitat. Our species-specific knowledge about bird response to climatic factors is even more limited than our understanding of how they use habitats. For a summary of how climate models can be applied to ornithology, see Seavy et al. (2008). Nevertheless, efforts are underway to assess the vulnerability of birds to climate change, based on what we do know (NABCI 2010). Grassland birds as a whole show a medium level of vulnerability to climate change when compared with other habitat groups, but species wintering in the Chihuahuan Desert grasslands may be particularly vulnerable to higher temperatures and declining precipitation that may make this area uninhabitable (NABCI 2010). Christmas Bird Count data show that grassland birds were the only group that failed to shift north during the past 40 years in response to warmer winter weather; this may be due to lack of quality northern grasslands to sustain wintering birds (NABCI 2010).

Bird response to climate change may manifest in ways including: (1) changes in the phenology of migration or reproduction along with possible disconnects from historical food resources; (2) expansion, contraction, or displacement in the distribution of individuals across the changing landscape; and (3)

changes in productivity, survival, behavior, etc. in response to increased temperatures, water-balance requirements, and severe weather.

A large modeling effort comparing the effects of climate change on bird species restricted to either the montane or Great Plains regions of central and western North America, predicted that plains species would be more heavily influenced, with drastic area reductions and dramatic spatial movements of appropriate habitat (Peterson 2003). Although Grasshopper Sparrow was not modeled, Baird's Sparrow (*Ammodramus bairdii*), which shares general habitat types where their breeding ranges overlap in the Great Plains, was projected to retreat from much of its current geographic distribution, with only minor expansions at the northwestern boundary of its current distribution. When modeling changes in species distributions in Mexico under various climate change scenarios, one of the foci of extinctions and species turnovers was the Chihuahuan Desert in northern Mexico (Peterson et al. 2002), an area of extreme importance to wintering Grasshopper Sparrows. Very little specific literature is available about Grasshopper Sparrow responses to climate change, but first spring arrival dates for Grasshopper Sparrow in the northeast have changed significantly across the 20th century (15.1 days earlier, Butler 2003).

Recently the National Audubon Society (NAS) has begun to release information about a comprehensive, continental analysis of how North American birds (U.S. and Canada) may respond to climate change (NAS 2014). Using Christmas Bird Count and Breeding Bird Survey data in combination with climate data and projections described by the Intergovernmental Panel on Climate Change (IPCC), they have estimated current and future ranges for 588 North American species, including Grasshopper Sparrows (NAS 2013; NAS 2014). These models assume that species can and will track their climatic niches perfectly through time and across geographic space. Models present information about areas where a species could occur if other variables necessary for survival are present, such as suitable habitat and biotic interactions, and if dispersal is not limited (NAS 2013). Grasshopper Sparrow was not listed as one of the 314 climate-endangered or threatened species for which results were presented online in September 2014, http://climate.audubon.org/. However, unpublished data from the Grasshopper Sparrow models (J. Schuetz, in litt.) predict loss of climate suitability for breeding Grasshopper Sparrows along the southern edge of its core range, and expansion of suitability in the northern and northeastern parts of its range. In winter (non-breeding), the models predict northern expansion of wintering Grasshopper Sparrows into northeast Texas, and expansion to a more variable extent into the southeastern U.S. The winter models do not include the extensive distribution of Grasshopper Sparrows wintering in the grasslands of northern Mexico, so there are no predictions of whether there are related withdrawals from the southern portion of their winter distribution. Eventual publication of this information in a peer-reviewed journal may provide additional useful information about Grasshopper Sparrows and climate change.

At a regional level, bioclimatic-envelope models in California projected changes in the distribution of climate space for 11 priority species (including Grasshopper Sparrow) within the Mount Hamilton Project area. The models projected that climatically suitable areas for Grasshopper Sparrow declined at all decadal steps through 2050 and by 2100 there was not suitable climate space within the area for Grasshopper Sparrows (Shaw et al. 2012). For all of California, an online mapping tool created to model bird distribution responses to climate change predicts an overall decrease in habitat suitability for the Grasshopper Sparrow, especially in the San Francisco Bay Area and south in California, but projects possible increases along the northern coast (Point Blue Conservation Science 2014).

J. Energy Development (Renewable and Nonrenewable)

Energy development can impact grassland birds both during the construction phase and in the long term due to permanent infrastructure and maintenance activities associated with extraction and transport. Effects can be direct in the form of direct mortality and habitat loss, or indirect in the form of habitat degradation, and effects on bird behavior and ecosystem function. Birds may be affected by the actual infrastructure of energy extraction (e.g., oil and gas pumps, wind turbines, solar panels, biomass harvesting machinery) or by the associated transportation infrastructure (e.g., trails, roads, rights-of-way, power lines, power stations, and pipelines). They also can be affected by other results of energy development, extraction and delivery – edge habitat created at extraction sites and along roads, increased predators or nest parasites, invasion of exotic species, and increased intensity of vehicle traffic and human disturbance (Linnen 2008; Bayne and Dale 2011). Publications are available that provide a synthesis of known and potential impacts of nonrenewable energy (Bayne and Dale 2011) and renewable energy on the environment and wildlife (Pimentel et al. 1994; Abbasi and Abbasi 2000; Tsoutsos et al. 2005; Lovich and Ennen 2011; Northrup and Wittemyer 2013). However, there are fewer research studies documenting effects on small passerine birds.

<u>Wind Power</u> - Effects of wind turbine development on birds can be direct (e.g., collision mortality) or indirect (e.g., habitat loss or change, or displacement due to visual intrusion or disturbance). Little research has been conducted on the effects of wind farm development on grassland passerines. Collision fatalities are generally not thought to be sufficient to impact most bird populations (Kuvlesky et al. 2007). Given their typical flight behavior during the breeding season (i.e., flying low and for only short distances) it seems unlikely that direct mortality is a substantial threat to Grasshopper Sparrow populations. However during post-breeding season dispersal or migration there may be more chances for collisions. A study of the impacts of wind turbines in northeastern Wisconsin documented two Grasshopper Sparrow mortalities on a single date in late August (Howe et al. 2002). The loss of habitat to wind turbines and delivery infrastructure, and the simple presence of vertical structure in landscapes that generally lack them may present more of a threat to Grasshopper Sparrows, especially given their avoidance of natural vertical structure in the form of trees [see section on **Shrub/Woody Vegetation Encroachment**]. A study comparing grassland bird use of CRP grasslands with and without wind turbines in Minnesota found that CRP grasslands without wind turbines and those areas located 180 m from turbines supported significantly higher densities of grassland birds than sites located within 80 m of turbines (Leddy et al. 1999). Insufficient Grasshopper Sparrows were detected on these sites for species-level comparisons. Preliminary results of a study of breeding grassland bird displacement response to wind turbines in North and South Dakota, found that Grasshopper Sparrows appeared to exhibit avoidance of turbines out to 200 m resulting in a 45% reduction in bird abundance at experimental sites after development; Grasshopper Sparrow densities also declined following the establishment of wind turbines, although on at least one site they avoided turbines in the first year post-construction but showed no evidence of avoidance in the second (Shaffer and Johnson 2008; Johnson 2013). In contrast, a study of grassland bird densities in relation to wind turbines in north-central Texas found no evidence that three breeding grassland bird species, including Grasshopper Sparrow, were displaced within 500 or 750 m of wind turbines (Hale et al. 2014). There is also reason to consider the response of wintering birds, including Grasshopper Sparrows, to the presence of wind turbines. At a wind facility in north-central Texas, wintering Le Conte's Sparrows (*Ammodramus leconteii*) were found to be significantly displaced away from wind turbines, even though several other grassland species were not (Stevens et al. 2013). The

authors suggested that species dependent on more natural (less disturbed) habitats and cryptic predator evasion strategies, which describes *Ammodramus* species including both Le Conte's and Grasshopper sparrows, may be especially displaced from wind turbines.

Solar – Beyond the small scale solar photovoltaics and water heaters commonly installed on homes and other buildings, the U.S. is poised to expand the use of utility-scale solar energy facilities. Much of this development is occurring on public land in the Southwest due to the high concentrating solar energy potential in this region (Lovich and Ennen 2011). Two common methods are large fields of photovoltaic panels and solar concentration technologies that use mirrors to direct sunlight to a centrally located collector. Publications are available that provide a synthesis of known and potential impacts of solar and other renewable energy on the environment and wildlife (Pimentel et al. 1994; Abbasi and Abbasi 2000; Tsoutsos et al. 2005; Lovich and Ennen 2011). Potential impacts on wildlife including loss, modification, and fragmentation of habitat, direct mortality, dust and dust suppression, road effects, noise, electromagnetic fields, toxic waste products, etc. (Tsoutsos et al. 2005; Lovich and Ennen 2011). However, there is little in the way of research documenting effects. There were two primary causes of avian mortality at a solar concentration facility in the Mojave Desert (McCrary et al. 1986): (1) collision with structures, primarily the heliostats (focusing mirrors) – 81%; and (2) burning from standby points – 19% (when not directed at the central tower-mounted boiler, during startup, testing and maintenance, the heliostats are focused on standby points – small areas of sky around the tower at a height of 80 m). The heat in these concentrated beams of light can burn or incinerate birds or insects that fly through them; estimated total mortality rates was 2 birds/week at this facility (McCrary et al. 1986). The discussion regarding the siting of such solar facilities have focused on desert scrub habitats which are not habitat for Grasshopper Sparrows. However, some of the regions with the highest solar energy potential, especially in Arizona, New Mexico, and west Texas fall within the breeding and/or wintering range of the species, and includes desert grassland or southern Great Plains grasslands. As examples, a region of Chihuahuan Desert grassland in southern New Mexico already contains a 5 megawatt solar power plant near Hatch; plans are also underway to install an 80 megawatt solar power plant near Nutt, NM. Both of these facilities are large fields of photovoltaic panels.

Biomass – Increased interest in the development of renewable fuels has included the development of biomass for fuel. The most common crops being explored for biofuel in the U.S. are corn and soybeans; in addition, cellulosic ethanol crops being explored in the U.S. include *Miscanthus*, a perennial, exotic tropical grass genus, and switchgrass, a perennial, native warm-season grass. The primary potential impact of crop biofuels on grassland birds is through the conversion of existing grassland habitat into additional fuel crops. Although the use of perennial, native grasses for biomass may be most likely to benefit grassland species compared to other biomass crops (Fargione et al. 2009), questions have been raised about what the impacts would be on grassland birds (Robertson et al. 2012). Switchgrass is well suited as a biofuel. Because switchgrass for biomass is usually harvested in late summer or fall, impacts are most likely associated with change in vegetation structure (lower height-density and shallower litter layer) in the subsequent year (Roth et al. 2005), which may benefit species like Grasshopper Sparrow that prefer this habitat structure (Fargione et al. 2009). See the section above on **Mowing** for a more detailed discussion of bird responses to mowing for biomass.

Oil and Gas - Few studies have been conducted on grassland passerine response to oil or gas development and fewer contain information about Grasshopper Sparrows. In Alberta, Canada, Sprague's Pipit (*Anthus*

spragueii) and Baird's Sparrow abundance was negatively associated with natural gas well density (Dale et al. 2009). None of seven grassland species, including Grasshopper Sparrow, showed a significant response to a minimal disturbance natural gas development in Saskatchewan, but Chestnut-collared Longspur (*Calcarius ornatus*), Sprague's Pipit, and Baird's Sparrow showed significant avoidance of areas near a traditionally constructed oil field development in Alberta; unfortunately Grasshopper Sparrow did not occur in adequate numbers on this site for analysis. In southwestern Saskatchewan, Grasshopper Sparrow abundance was influenced by vegetative structure, but abundance was also positively associated with distance from gas wells (Bogard and Davis 2014). In the sagebrush steppe of Wyoming, Brewer's Sparrow (*Spizella breweri*) and Sagebrush Sparrow (*Artemisiospiza nevadensis*) densities and abundances were negatively associated with roads tied to natural gas extraction and natural gas well density respectively (Ingelfinger and Anderson 2004; Gilbert and Chalfoun 2011). These results are similar to evidence that Greater and Lesser Prairie-Chickens (*Tympanuchus cupido* and *T. pallidicinctus*) and Greater Sage-Grouse (*Centrocercus urophasianus*) avoid infrastructure related to oil and gas extraction and delivery (Lyon and Anderson 2003; Pitman et al. 2005; Pruett et al. 2009). See Linnen (2008) for a detailed treatment of the potential effects of oil and gas development on grassland birds. Environment Canada has developed guidelines for petroleum industry activities that affect species at risk (Scobie and Faminow 2000). The oil and gas industry commonly employs mowing of oil and gas well sites and roadways in the summer to address the invasion of exotic and invasive plant species and mitigate fire risks (Linnen 2008; Bayne and Dale 2011). See section on **Mowing** for information and recommendations about mowing practices.

K. Suburban/Exurban Development

As with many anthropogenic limiting factors affecting grassland birds, the expansion of urban, suburban, and exurban (growth beyond incorporated city limits) developments into grasslands result in habitat loss, degradation and fragmentation, as well as potential impacts such as increased non-native predators, invasive plant species, fire suppression, noise, human disturbance, and decreased water resources in arid systems. See Hansen et al. (2005) and Bock and Bock (2009) for syntheses of information about the effects of residential, exurban development on biodiversity.

The literature on effects of these kinds of development on grassland birds is limited but there is evidence for negative impacts on Grasshopper Sparrows. A multi-scale occupancy model for Grasshopper Sparrow applied to the Delmarva Peninsula found that at the landscape scale, occupancy was negatively associated with amount of low intensity development (Irvin et al. 2013). In tallgrass prairie remnants in Nebraska and Iowa, surrounding urbanization did not affect occurrence, but the sites with the highest level of surrounding urbanization supported the lowest densities of Grasshopper Sparrows (McLaughlin et al. 2014). A series of studies conducted in the tall and mixed-grass open spaces surrounding Boulder, Colorado found that Grasshopper Sparrow abundance was negatively associated with the amount of urban area in the landscape (Haire et al. 2000), and densities were significantly higher in undeveloped areas than either dispersed (lowest densities) or clustered housing developments (intermediate) (Lenth et al. 2006). Grassland bird nest densities (pooled across species including Grasshopper Sparrow) were significantly higher in undeveloped areas than near developments, although nest survival did not differ across treatments. In southeastern Arizona, breeding Grasshopper Sparrows occurred less frequently in exurban

areas than in undeveloped areas and abundance was negatively correlated with the number of homes within 250 m (Bock et al. 2008).

Recreational Impacts – The impacts of human recreation can be associated with urban/suburban development. In Boulder, CO open spaces, Grasshopper Sparrows were significantly more abundant along control transects through grasslands than along recreational trails, and abundance increased with increased distance from trails (Miller et al. 1998). In general, grassland bird nests (pooled across species but including Grasshopper Sparrows) were less likely to occur near trails than away from them, and there was a significant positive relationship between nest survival and distance from trails. No information was found for research on recreation impacts in more open, undisturbed grasslands.

L. Habitat Fragmentation (Patch Size/Area Sensitivity/Edge Effects)

There is substantial evidence that many grassland birds are sensitive to the fragmentation of their grassland habitats. Their response may be to patch size (i.e., area sensitivity, in which birds are positively associated with patch size), patch shape, or to edge (i.e., response to vegetation structures or predators associated with edge habitat; "interior species" avoid the portions of habitat closest to edges). In addition to site-specific responses, many species respond to fragmentation at a landscape scale (e.g., continuity of habitat, isolation/distance to nearest other grassland, percent cover in grassland within XX km of site). Bird response has been measured by abundance, density, probability of occurrence, or nesting success. See Johnson (2001) and Ribic et al. (2009b) for an extended discussion of patterns, processes, and issues associated with area sensitivity in grassland birds. Both of these references express concern about studies that do not take into account passive-sampling issues, which describe a problem when species incidence is used to compare patches of different sizes with unequal sample effort.

Johnson (2001) and Ribic et al. (2009b) identified studies that they felt had addressed these issues. The response of Grasshopper Sparrows to fragmentation and whether they are considered area sensitive species shows some variation across its broad range. Among the studies determined to address passive sampling issues (Ribic et al. 2009b), Grasshopper Sparrows showed evidence of area sensitivity in the tallgrass region (Herkert 1994b; Horn et al. 2002; Renfrew and Ribic 2002; Renfrew and Ribic 2008), in the mixed-grass region (Bakker et al. 2002; Davis 2004; DeJong et al. 2004), and in the northeast (Vickery et al. 1994; Bollinger 1995). However, a regional analysis in mixed-grass prairie found variability in Grasshopper Sparrow response to patch size (positive, negative, and no response) in mixed-grass prairie (Johnson and Igl 2001). These mixed results demonstrate the importance of looking at regional rather than only site-specific responses.

Below is a summary of additional literature that may or may not meet the standards advocated by Ribic et al. (2009b). It is beyond the scope of this document to evaluate the methodology of studies mentioned below, so conclusions should be viewed with caution.

In the East, Grasshopper Sparrow is generally considered area sensitive (Jones and Vickery 1997; Mitchell et al. 2000) and most of the literature seems to bear this out. Evidence that Grasshopper Sparrow occurrence, abundance, density, nest placement, productivity, and adult return rate were positively associated with grassland patch size was found throughout eastern grasslands (Vickery et al. 1997, Moss

2001, Balent and Norment 2003, Jobin and Falardeau 2010; Wentworth et al. 2010). The apparent threshold patch sizes differed among studies. There is reason for concern regarding the productivity of Grasshopper Sparrows using smaller patches. In New York, where Grasshopper Sparrows were using small patches, the largest of which was 13.2 ha, all patches appeared to function as sink habitats (Balent and Norment 2003). Response to fragmentation at the landscape scale also can be important. In the Delmarva Peninsula, a multi-scale model found that at the landscape scale Grasshopper Sparrow occupancy was positively associated with amount of grassland/pasture and negatively associated with inter-patch distance to grasslands and amount of low intensity development (Irvin et al. 2013). Similarly, Grasshopper Sparrows elsewhere in the northeast showed a strong positive response to the proportion of grassland area in the landscape (Jobin and Falardeau 2010; Wentworth et al. 2010; Clower 2011).

In the tallgrass and mixed-grass regions, additional literature not meeting the Ribic et al. (2009b) standards suggests variability in Grasshopper Sparrow response to patch size – positive association with patch size (Helzer and Jelinski 1999; McMaster and Davis 2001; Bakker et al. 2002; Davis 2004), and no significant association (Swengel 1996; Walk and Warner 1999; Winter and Faaborg 1999; Murray et al. 2008; Ribic et al. 2009a). Note that non-significant results do not demonstrate a lack of effect (Ribic et al. 2009b). Again Grasshopper Sparrows were positively associated with the amount of grasslands in the larger landscape (Ribic and Sample 2001). Other types of responses to or effects of patch size were documented, including avoidance of edge habitat between grassland and other habitats (Delisle and Savidge 1996; Bakker et al. 2002; Renfrew et al. 2005; Patten et al. 2006), and increased nest predation in smaller patches (Herkert et al. 2003),

Little information is available about Grasshopper Sparrow response to patch size in other grassland regions. Florida Grasshopper Sparrow density was higher in core plots than in edge plots on the few remaining sites where they are still found (Perkins et al. 2003); nest success generally increased as nests were further from edge and was higher in core plots than edge plots at one site. In general, core areas appeared to function as source habitats in at least some years, whereas edge areas were consistently sink habitats. Grasshopper Sparrows in the Front Range in Colorado were significantly more abundant on interior plots than they were on edge plots directly adjacent to suburban development (Bock et al. 1999).

See section on **Shrub/Woody Vegetation Encroachment** for info on response to specific edge habitat components like woody vegetation.

M. Pesticides

The information about effects of pesticides (herbicides and insecticides) on Grasshopper Sparrows is extremely limited. Effects could take two forms: (1) direct effects resulting in mortality or reduced productivity; or (2) indirect effects on birds through pesticide effects on habitat or food resources or behavior. Insecticides appear to be of most concern; Mineau and Whiteside (2006) limited their analyses to the lethal risk of insecticides to birds because few herbicides or fungicides are of comparable toxicity. Overall, they found that corn and cotton were the crops responsible for most potential bird mortality in the U.S., followed more distantly by alfalfa, wheat, potato, peanut, sugar beet, sorghum, tobacco, and citrus. Grassland birds may be at greater risk for exposure to organochlorine pesticides than other passerines because their breeding and wintering grounds may be in closer proximity to agricultural areas where these

pesticides are used (Bartuszevige et al. 2002). Authors of a recent publication suggest that pesticide toxicity should be considered more seriously as a factor causing grassland bird population declines (Mineau and Whiteside 2013). Using population trends from BBS data and state-by-state pesticide use data from USDA, they modeled which agricultural variables best predicted population declines. They found that lethal risk from pesticide use (based on the results of avian field studies) was the best predictor of species declines; habitat loss and measures of agricultural intensification did not explain declines as well. Grasshopper Sparrow was one of the species with the most states showing population declines and it has been killed in pesticide field trials.

A few other studies have suggested that pesticides may be a cause of grassland bird population declines. Forty-four of 99 individuals collected in Illinois, including six of 25 Grasshopper Sparrows, contained organochlorine pesticides above the detection limit (Bartuszevige et al. 2002), although five of the ten species tested had higher mean levels of p,p'-DDE than Grasshopper Sparrows. In addition to pesticide application to croplands, grasshopper damage in western North American rangelands causes substantial economic damage and the response has historically been large-scale application of chemical controls (broad spectrum insecticides) to millions of ha of U.S. grasslands (Branson et al. 2006). Martin et al. (2000) found that pesticides applied to control grasshopper infestations in Canada (Furadan and Decis) did not appear to affect reproductive output of Chestnut-collared Longspur. However, using a productivity index for Baird's Sparrows, in the same genus as Grasshopper Sparrow, among occupied plots, those sprayed with Furadan had fewer productive Baird's Sparrow territories and more abandoned territories than those unsprayed or sprayed with Decis (Martin et al. 2000). Previous studies of the effects of grasshopper pesticides on birds did not focus on productivity or specific species. Variation and/or few differences were found in bird response (total density, species richness, diversity) to various pesticide treatments and controls (George et al. 1995; Norelius and Lockwood 1999). However, both of these studies found some evidence that bird densities were suppressed for up to a month post-treatment; given the extended period after treatment, they suggested that the density declines were a result of reduced food availability (fewer grasshoppers) rather than direct toxic effects.

In an example of indirect effects, the application of herbicides to a grassland in southern Maine used for commercial blueberry production had significant effects on vegetation physiognomy and in turn affected territory occupancy of Grasshopper Sparrows (Vickery et al. 1999a). Herbicides reduced forb, short shrub, and short graminoid cover, all of which were important to Grasshopper Sparrows. As a result Grasshopper Sparrow densities were reduced and recovery took 2-6 years depending on the number of herbicide applications. In contrast, it seems possible that Grasshopper Sparrows may respond positively to herbicide treatments to reduce shrub components as have other grassland birds like Cassin's Sparrows (*Peucaea cassinii*) in New Mexico (Smythe and Haukos 2010).

N. Agriculture – Crops

Information has been provided in other sections about agricultural impacts on Grasshopper Sparrows related to mowing, grazing, burning, and pesticides (and see the section below about the **Conservation Reserve Program**). Because Grasshopper Sparrows only occasionally use cropland, such as corn and oats, and then at much lower densities than in grassland/pasture/hayland habitats (Dechant et al. 1998), there is very little to be discussed in this section. As discussed in more detail with regard to mowing,

agricultural practices such as tillage, planting, and cultivation of crop fields result in direct effects, predominately involving the destruction of nests; similar indirect effects are related to changes in the vegetative structure and food resources (Rodenhouse et al. 1995).

<u>Shelterbelts, fencerows, roadsides, etc.</u> - Koford and Best (1996) describe the wildlife value of various strip cover habitats in agricultural landscapes (e.g., fencerows, roadsides, and windbreaks/shelterbelts). However, for the most part, these kinds of habitat are not of value to Grasshopper Sparrows and in some cases are actively avoided. Patterson and Best (1996) report that Grasshopper Sparrows do not use roadside habitats in Iowa, although Warner (1992) reported Grasshopper Sparrows nesting in Illinois roadsides.

VIII. Management Programs and Impacts

A. Conservation Reserve Program

The Conservation Reserve Program (CRP) was established by the 1985 Farm Bill and is administered by the USDA Farm Services Agency (FSA). It is a voluntary program for agricultural landowners, who receive payments for retiring highly erodible lands from agricultural production and establishing permanent cover. CRP contracts are for 10 – 15 years, at which point they expire and producers have to compete to re-enroll these acres. Some CRP practices have the potential to benefit grassland birds (e.g., creation of wildlife habitat, use of native grasses) while others have the potential to cause problems for grassland birds (e.g., planting of windbreaks, shelterbelts, trees). Haying and grazing are permitted in some CRP contracts under certain defined circumstances including a restriction during nesting season and a reduction in CRP payments; the frequency at which this is permitted will affect vegetation structure and therefore determine whether it would have positive or negative effects on Grasshopper Sparrows. Emergency haying and grazing are permitted under certain prescribed conditions (e.g., drought); in the past this has also involved a reduction in CRP payments, but the 2014 Farm Bill removed the provision for reduced payments for emergency haying and grazing. Continuous years of drought and emergency haying or grazing on CRP acres may have cumulative effects on grassland birds.

<u>Value of CRP to Grasshopper Sparrows</u> - The literature includes information about the overall value of CRP land and the effects of specific CRP plantings or management practices on grassland birds and Grasshopper Sparrows specifically. See Jones-Farrand et al. (2007) and Gray (2009) for more information about CRP and its impacts on wildlife.

Throughout the Great Plains many CRP lands have been found to support abundant populations of Grasshopper Sparrow (Johnson 2000; Herkert 2009). Grasshopper Sparrows were among the most common species found in CRP acres in northern Great Plains states; they were not commonly observed in paired croplands (Berthelesen and Smith 1995; Patterson and Best 1996; Best et al. 1997). Establishment of CRP has been shown to have had a positive impact on Grasshopper Sparrow populations in the mid-continental U.S. (Herkert 1998; Herkert 2009). Grasshopper Sparrow abundance has been positively associated with CRP acreage (O'Connor et al. 1999; Riffell et al. 2008). However, at the landscape level this may also have been true prior to CRP (i.e., in many of these areas CRP acreage was established in landscapes that already supported more Grasshopper Sparrows (J. Herkert, pers. commun.). In contrast, a

study in Kansas found that Grasshopper Sparrow densities were lowest in CRP fields compared to grazed pastures and hayfields, even though CRP was planted to native warm-season grasses (Rahmig et al. 2009). Although the eastern U.S. supports less CRP land, there are also limited grassland habitats available, so CRP can be quite important to grassland birds. Grasshopper Sparrows responded positively and almost immediately to the planting and restoration of grasses on CRP land in Maryland (Gill et al. 2006). Models of the effect of increased CRP hayfield enrollment in New Jersey on Grasshopper Sparrow population viability found that the probability of metapopulation extinction was reduced below 10% when half of available agricultural land was enrolled (Seigel and Lockwood 2010). In the shortgrass prairie, most CRP fields have been planted to taller grasses than historically found across the region, which can be a problem for species that require short grass (Askins et al. 2007). But given Grasshopper Sparrow preference for intermediate grass height and density, this may not be problematic for them in the shortgrass region. In fact, Grasshopper Sparrow was determined to be the species that most benefitted from CRP lands in the shortgrass prairie (Playa Lakes Joint Venture 2009). In the high plains of Texas, Grasshopper Sparrows showed preference for two non-native CRP mixes and a native mix with buffalograss because they provided appropriate forb height, less bare ground, and more grass cover than the other native mix (Thompson et al. 2009). Although numerous studies have evaluated the abundance and reproductive success of grassland birds in CRP fields, few have attempted to determine whether CRP land contributes to population growth of grassland birds (McCoy et al. 1999). Resulting tests of whether CRP fields were source habitats for grassland birds found that CRP lands (both cool-season and warm-season planted grasslands) were source habitats for Grasshopper Sparrows (McCoy et al. 1999; McCoy et al. 2001).

However CRP lands do not necessarily provide the best grassland habitat for Grasshopper Sparrows, although they may represent a “best alternative” habitat where native grassland no longer exists. Where native grasslands remain, they frequently support higher Grasshopper Sparrow abundance or densities than CRP grasslands, even when native remnants are smaller (Ribic et al. 2009a). Increased abundance of Grasshopper Sparrows in CRP grasslands can be context-dependent; in one study it was only documented in landscapes where juniper was encroaching, and not in landscapes where substantial amounts of native grassland remained (Coppedge et al. 2001).

In spite of the evidence regarding the value of CRP lands to Grasshopper Sparrows, some cautionary notes are warranted. First, it is important to note that different species of grasses are planted on CRP lands and they may have different effects on habitat suitability. In addition, given Grasshopper Sparrow preference for intermediate height and density of grass, as time since grass planting/restoration increases and in the absence of periodic disturbance or management, vegetation on CRP lands in much of the species’ range becomes too tall and dense to be suitable Grasshopper Sparrow habitat. In fact, follow-up monitoring on previously studied CRP sites where Grasshopper Sparrow abundance had been high (Herkert 1998), found that trends were back to pre-CRP levels and Grasshopper Sparrows were absent or rare when these CRP fields matured (J. Herkert, pers. commun.). Periodic management to reduce vegetation height and litter buildup is required to maintain CRP as suitable habitat for Grasshopper Sparrows and in some cases, even such management of older CRP acres does not match the benefits of newly planted CRP (J. Herkert, pers. commun.). In addition, management of CRP acres to continue to benefit Grasshopper Sparrows may run counter to the needs of other priority species such as Henslow’s Sparrow (*Ammodramus henslowii*) (Herkert 1998) and requires a balance of management practices. See

the sections above on **Mowing**, **Grazing**, and **Fire**, three of the practices used under some circumstances to manage CRP.

Given the many factors that can influence the impact of CRP on Grasshopper Sparrow numbers, an important aspect of conservation planning is to determine whether managing CRP lands can have a population-level effect on Grasshopper Sparrows and how much CRP land would be required to achieve population objectives. Some of the Joint Ventures within the range of Grasshopper Sparrows are beginning to develop these decision-making analyses. The Central Hardwoods Joint Venture evaluated the contributions that CRP land could make to the conservation of Northern Bobwhites and other early successional bird species including Grasshopper Sparrow (Giocomo et al. 2009) in focal areas within the Central Hardwoods BCR. They found that Grasshopper Sparrow would need more than twice the managed area on a 10-year rotation than on a 3-year rotation (614,440 to 1,755,544 ha respectively) because of the species' preferred intermediate habitat. This represents 3-10 times more CRP land than occurred in these focal areas in 2005, making it clear that CRP alone will not meet Grasshopper Sparrow population objectives there (Giocomo et al. 2009). It is these kinds of analyses that are needed across the species' range to focus conservation actions, especially in regions that support larger portions of the Grasshopper Sparrow population.

<u>Possible Changes in CRP</u> - As of March 2014, there were approximately 25.6 million acres enrolled in CRP (down from 34.7 million acres in 2008), distributed unevenly across the U.S.; 18.3 million acres of that is in grass. The contracts for 4.9 million acres are scheduled to expire from 2014 – 2016. The level of participation in the program is changing as a result of increasing agricultural commodity prices that are outpacing CRP rental payments and a continued lowering of the CRP acreage cap from 27.5 to 24.0 million acres between 2014 and 2017, implemented in the 2014 Farm Bill. The effect of reduction in CRP acreages on grassland birds is of concern (Johnson and Igl 1995; Klute et al. 1997; Herkert 1998; McLachlan et al. 2007; Herkert 2009).

Using actual land use choices following CRP contract expirations from 1995 – 1997, a study of economic motivations driving land set-aside programs predicted the fate of CRP acreage if the CRP program had expired in 1997 (Roberts and Lubowski 2007). What is striking about this study is the similarity between the distribution of CRP (Figure 1, Roberts and Lubowski 2007) and the distribution of Grasshopper Sparrows. Given the positive response of Grasshopper Sparrow to CRP lands in much of its range, the study's prediction that 50 – 75% of the northern Great Plains CRP acreage (and in many areas more than 75%) will return to cropland (Roberts and Lubowski 2007) has serious implications for Grasshopper Sparrows and other grassland birds that benefit from CRP. There also have been several efforts to model the effects of the loss of CRP lands on grassland birds. If North Dakota CRP lands reverted to cropland, Johnson and Igl (1995) project that it would result in a 20.5% reduction in the number of Grasshopper Sparrows in the state. Reversion of all CRP back to cropland in the Mixed-Grass Prairie Bird Conservation Region (#19) is projected to have a serious negative impact on the ability to meet Grasshopper Sparrow conservation population goals in Texas and Kansas where there is relatively little native grassland and large amounts of CRP (McLachlan et al. 2007). In contrast, reversion of CRP land to moderately grazed pastureland in Kansas was projected to have minimal effects on Grasshopper Sparrows and other grassland birds (Klute et al. 1997), emphasizing that it is conversion to cropland that poses the largest threat.

Mid-contract disking and interseeding – There are cases in which mid-contract management of CRP acreages with disking and interseeding, often with forbs, is permitted and even encouraged to maintain intended CRP plantings. In eastern Nebraska, Grasshopper Sparrows were among the most abundant species on both untreated and treated sites (disked and interseeded with legumes) (Negus et al. 2010). Response to treatment was mixed. Negus et al. (2010) attributed the equal use of treated and untreated in the first year to the structure characteristics created by disking (shorter vegetation and more bare ground), but the preference for untreated sites in the second year because treated fields had taller, denser vegetation, making them less suitable Grasshopper Sparrow habitat.

See sections on **Shrub/Woody Vegetation Encroachment**, **Mowing**, **Grazing**, and **Fire** for information that may be appropriate for CRP management.

B. Other Grassland Conservation Programs

There are other programs that may apply to grasslands and may benefit grassland birds and Grasshopper Sparrows in particular. Only a few are mentioned here.

USDA Conservation Reserve Enhancement Program (CREP) – The CREP is a federal/state/private partnership program providing increased incentives to enroll in CRP and address soil erosion, water quality, and wildlife habitat issues (Wilson and Brittingham 2012). In Pennsylvania where this program is popular, Grasshopper Sparrows were found to use CREP fields but they were not very common (Wentworth et al. 2010; Wilson and Brittingham 2012; Pabian et al. 2013). The CREP was not found to have any effect on Grasshopper Sparrow abundance and population trends (Wilson and Brittingham 2012; Pabian et al. 2013). Wilson and Brittingham (2012) noted that CREP fields were very small and in a forested landscape matrix; given that Grasshopper Sparrows in this area are area sensitive (Wentworth et al. 2010), this may explain the pattern.

USDA Grassland Reserve Program – The USDA FSA also administers the Grassland Reserve Program (GRP). Similar to CRP, landowners enter a contract for 10, 15, or 20 years, or for an indefinite period of time; they receive an annual rental payment. The goal is to prevent grazing and pastureland from being converted into cropland, or urban development, etc. Landowners can still use the land for grazing and conduct activities related to forage and seed production; there are some restrictions for activities during bird nesting season. FSA also provides cost-sharing and other incentives to offset costs of management. The 2014 Farm Bill has rolled the GRP, along with other reserve programs, into the Agricultural Conservation Easement Program.

USDA NRCS Conservation Stewardship Program (CSP) The NRCS administers the CSP as a voluntary partnership with private landowners to implement conservation activities. A study of the effects of the CSP program and grazing deferment on grassland birds in northeastern Colorado found that Grasshopper Sparrows occurred at higher densities and more frequently on lands enrolled in CSP than in other grasslands (Fogg and Pavlacky 2012).

USFWS Grassland Easement Program – The USFWS administers an easement program that pays landowners to permanently keep their land in grass. It may not be cultivated; grazing is not restricted, but mowing, harvesting, or grass seed harvesting must be delayed until after July 15 to protect nesting birds.

Canada's Permanent Cover Program (PCP) – In the early 1990s, Agriculture and Agrifood Canada established a program similar to the U.S. CRP that was called Permanent Cover Program (PCP). It encouraged landowners to convert cultivated land into perennial vegetative cover through a one-time financial incentive; landowners committed to maintain permanent cover for a 10- or 21-year period and used the forage produced annually for pasture or hay (McMaster and Davis 2001). PCP has resulted in more grassland habitat in the prairie provinces and British Columbia; as of 2003, approximately 518,000 ha were enrolled (Askins et al. 2007). In the mixed-grass and aspen parklands of Alberta, Saskatchewan, and Manitoba, Grasshopper Sparrows were detected more frequently at PCP sites than in surrounding croplands; within PCP sites they were marginally more frequently detected on pasture (which had shorter vegetation with more bare ground) than on hayed PCP (McMaster and Davis 2001). From 2005-2009, the PCP was replaced by the five-year Greencover Canada Program, an initiative to help producers improve their grassland-management practices, convert sensitive lands to perennial cover, and enhance biodiversity and wildlife habitat; this program expired in 2009. The subsequent Growing Forward programs focus on innovation, competitiveness, and market development in the Canadian agriculture and agri-food sector through federal-provincial-territorial partnerships. The details of these programs are beyond the scope of this document, but they do appear to include provisions for environmental farm planning and best management practices.

The programs described above are federal government programs. Although it is beyond the scope of this document to list or summarize, there are also many regional, state, and local grassland initiatives or grassland bird initiatives that would benefit Grasshopper Sparrows. In many cases these initiatives identify Grasshopper Sparrows as a priority or target species. Engagement of these initiatives in planning for activities developed in response to this plan will likely improve the effectiveness of those actions.

C. Surface mine and mountaintop mine reclamation

In the eastern U.S. and some parts of the Midwest where grassland habitat is limited, areas with large numbers of reclaimed surface mines planted to grass offer potential habitat for Grasshopper Sparrows and other grassland birds. Scott and Lima (2004) state that the largest grasslands in Indiana and Illinois are on reclaimed surface mines. Because rapid establishment of ground cover is required and reforestation proved unsuccessful, most surface mine reclamation sites are dominated by cool-season non-native grasses (DeVault et al. 2002). However as cost of native seed declines and more is known about how to restore native grassland, there are efforts to test replacement of cool-season with native warm-season grasses (Scott and Lima 2004). Many reclaimed sites are undisturbed, while some are managed by mowing or grazing; this may have to do with whether sites have a tendency to undergo succession toward a woody plant community or not. The sizes of these sites can vary substantially geographically; sites in southwestern Indiana ranged from 110 – 3180 ha (DeVault et al. 2002); in western Pennsylvania from 1 – 180 ha (Mattice et al. 2005; Stauffer et al. 2011); in West Virginia from 40 – 2431 ha (Wray et al. 1982; Ammer 2003); and in Ohio from 1200 – 3700 ha (Ingold 2002; Graves et al. 2010).

Grasshopper Sparrows were among the most abundant grassland species found on reclaimed minelands planted to grass (Wray et al. 1982; DeVault et a. 2002; Ingold 2002; Scott et al. 2002; Mattice et al. 2005; Galligan et al. 2006; Graves et al. 2010; Duncan 2011). They were found in lower numbers in hayfields being used as control sites (Ingold 2002). Grasshopper Sparrows on reclaimed mine grasslands were positively associated with grassland size and grass-dominated sites, and negatively associated with litter cover and depth, vegetation density, and forb-dominated sites (Scott et al. 2002; Duncan 2011). Daily nest survival (DNS) was higher in more open habitats (Galligan et al. 2006). Another study found that Grasshopper Sparrow DNS was positively associated with height of non-woody vegetation and greater fledgling production was associated with greater thatch depth and less bare ground, but neither DNS nor fledgling production was associated with measures of shrub cover (Hill and Diefenbach 2013). Average nest survival was also greater on newer sites than on older sites (Ammer 2003). Nest success can vary substantially among years (Wray et al. 1982); there was evidence that nest success was positively associated with higher nearby vegetation and negatively associated with larger shrubs (Ammer 2003; Galligan et al. 2006). A demographic study concluded that a West Virginia site was functioning as a sink habitat for Grasshopper Sparrows and other grassland birds in most years (Wray et al. 1982). In Pennsylvania, Grasshopper Sparrows were more likely to occupy reclaimed grassland sites with low woody shrub density, and sparrow density declined over ten years during which woody vegetation increased on these sites (Hill and Diefenbach 2014); they suggest that without management intervention to control increases in woody vegetation, reclaimed surface mine grasslands are ephemeral habitats for Grasshopper Sparrows.

See sections on **Mowing, Shrub/Woody Vegetation Encroachment, Grazing, Fire, and Non-native grasses/forbs** for information that may be appropriate for managing mine reclamation sites.

D. Managing Military Installations

The U.S. Department of Defense manages 25 million acres, much of it undeveloped for safety reasons or as security buffers. In some regions, military installations possess some of the best remaining grasslands (Eberly 2002) and grassland habitats are one of the highest conservation priorities for Department of Defense-Partners in Flight (DoD-PIF 2002). In addition to military activities, prescribed burning can mimic native fire regimes; both prescribed burning and mowing also are frequently used to manage grasslands around airfields for air safety issues. Installations with significant grassland habitat are found throughout the eastern U.S., concentrated in the southeast, with some in the Midwest and northeast (Giocomo and Buehler 2005). Military installations with substantial grasslands include (1) Fort Sill, Oklahoma; (2) Fort Riley, Kansas; (3) Fort Campbell, Kentucky-Tennessee; (4) Fort Drum, New York; (5) Westover Air Reserve Base, Massachusetts; (6) Naval Air Engineering Station, New Jersey; (7) Fort Bragg, North Carolina; and (8) Avon Park Air Force Range, Florida (Eberly 2002, P. Vickery, pers. commun.).

See sections on **Fire** and **Mowing** for information appropriate for managing military installation grasslands.

E. Habitat Restoration

Because of the loss of most native tallgrass prairie, much of the need and work to develop methods for grassland restoration have occurred in that region. In comparison, few ecological restoration methods have been developed for shortgrass prairie (Askins et al. 2007). It is beyond the scope of this document to summarize information on the actual restoration of prairie grasslands. This section presents available information on the response of Grasshopper Sparrows to grassland restoration in the tallgrass region; as elsewhere in this document, it appears that Grasshopper Sparrow response to restored vs. native grasslands is driven primarily by the differences in grassland structure. A comparison of grassland birds using native tallgrass prairie remnants and restored grasslands (both warm- and cool-season grasses) found that Grasshopper Sparrow density was higher in restored grasslands (Fletcher and Koford 2002). Grasshopper Sparrow density was negatively associated with total vegetation cover, vertical vegetation density, and the amount of grassland-woody edge habitat in the landscape; restored grasslands had significantly lower total vegetation cover than native prairie. Bakker and Higgins (2009) compared native sod prairie and four different planted grasslands (cool- and warm-season grasses); although Grasshopper Sparrow density did not differ significantly among the grassland types, densities were twice as high in native sod prairie and native warm-season mix grasslands, which had lower grass height and density, compared to the other grassland types. The results from both of these studies may be explained by differences in vegetative structure and Grasshopper Sparrow preference for sites with intermediate grass height and density.

See sections on **Non-native Grasses/Forbs** and **Shrub/Woody Vegetation Encroachment** for additional information that may be appropriate for grassland restoration.

IX. Recent/Ongoing Conservation Actions

A. Monitoring

Long-term, broad scale population trend monitoring, using Breeding Bird Survey data, is generally considered adequate for Grasshopper Sparrow, although some issues like bias may not have been accounted for (Rich et al. 2004; Dunn et al. 2005). Nevertheless, there are states or regions where targeted monitoring of priority grassland birds has occurred, is planned, or is being conducted to address regional information needs. Following are some examples; where citations or websites were available, they are provided:

- grassland bird survey program in New England and New York by Massachusetts Audubon (1997 – 2000); this effort produced a map of Grasshopper Sparrow distribution for this region http://www.massaudubon.org/our-conservation-work/wildlife-research-conservation/grassland-birds
- systematic roadside surveys throughout the Central Hardwoods BCR (2008 – 2012) for Northern Bobwhite and priority grassland birds - counties in MO, AR, IL, IN, OK, KY, TN (Lituma and Buehler 2012);
- the Arizona Bird Conservation Initiative is gearing up to begin a targeted grassland bird monitoring program; http://www.azgfd.gov/w_c/abci_resources.shtml

- Rocky Mountain Bird Observatory conducts monitoring programs at various scales – for Colorado and some surrounding states, for various federal agencies, etc. – that include grassland birds - work includes surveys in CO, KS, MT, ND, NE, SD, TX, and WY; they also conduct wintering grassland bird monitoring and research in Mexico, TX, NM and AZ. http://rmbo.org/v3/OurWork/Science_/BirdPopulationMonitoring.aspx
- development of a multi-scale occupancy model for Grasshopper Sparrow in the DelMarVa peninsula (Irvin et al. 2013);
- Predictive modeling for Grasshopper Sparrow within the Prairie Pothole Joint Venture boundaries (Niemuth et al. 2005); contact USFWS HAPET office http://www.fws.gov/midwest/hapet/
- Missouri Department of Conservation surveys of grassland management focus areas and for comparison, grasslands management areas that are not managed for birds or other wildlife (2001 – present) (contact: Brad Jacobs, Missouri Department of Conservation);
- Missouri River Bird Observatory monitors grassland birds in the state as part of National Audubon Society's Prairie Bird Initiative http://mrbo.org/grasslandbirds/
- New Jersey Division of Fish and Wildlife and New Jersey Audubon have conducted collaborative citizen science grassland bird surveys for seven years, including data on general and micro-habitat; http://www.njaudubon.org/SectionCitizenScience/GrasslandBirdSurveys.aspx
- New Mexico Department of Game and Fish conducted annual roadside surveys for Arizona Grasshopper Sparrow in the Animas and Playas valleys in southwestern New Mexico from 1992 – 2006 (Williams 2007); partial surveys from 2008 – 2011.
- Smithsonian Conservation Biology Institute, in collaboration with Virginia Working Landscapes, conducts a citizen science grassland bird survey program on property of participating landowners in the state; http://www.vaworkinglandscapes.org/grassland
- Wisconsin Bird Conservation Initiative is working on strategic habitat conservation for grasslands; Grasshopper Sparrow is one of the focal species and will be used to evaluate the success of activities for species requiring shorter grass habitats. To facilitate this they are collecting data on multiple Grassland Bird Conservation Areas for three years and developing density/occupancy estimates for Grasshopper Sparrows; http://www.wisconsinbirds.org/

The above is not a comprehensive list; there are numerous additional place-based inventories and monitoring programs on wildlife refuges, national grasslands, military installations, BLM lands, etc. Additional monitoring needs are included in the Conservation Plan: Recommended Actions (Appendix A).

B. Research

It is beyond the scope of this document to provide information about all current/ongoing research projects that include Grasshopper Sparrows. However, here is a partial list of projects and Principal Investigators who are working specifically on Grasshopper Sparrows or on grassland bird suites that include Grasshopper Sparrow (websites were functional at time of publication):

- Evolutionary and physiological ecology of dispersal in Grasshopper Sparrows (Alice Boyle, Kansas State University) http://www.aliceboyle.net/
- Distribution of Grasshopper Sparrows across southwestern Minnesota; evaluate existing habitat models; explore Grasshopper Sparrow as indicator/umbrella species (Grad student at University of Minnesota (Lisa Harn) and Doug Johnson, UMN/USGS Northern Prairie Wildlife Research Center, advisor) http://www.npwrc.usgs.gov/staff/johnson.htm

- Death of a Meadowlark: are conservation lands helping grassland bird populations? The objective of this project is to determine the role that public lands play for grassland birds by evaluating their population status; in tallgrass prairie in Minnesota and Iowa (Marissa Ahlering, The Nature Conservancy, MN,ND and SD) http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/minnesota/howwework/death-of-a-meadowlark.xml
- Breeding ecology of Arizona Grasshopper Sparrow (Janet Ruth, USGS Arid Lands Field Station, Albuquerque, NM) http://www.fort.usgs.gov/Staff/staffprofile.asp?StaffID=126
- Florida Grasshopper Sparrow study (Erin Ragheb, Florida Fish and Wildlife Conservation Commission) http://elhewett.wix.com/erinhewettragheb#
- Grassland bird population dynamics in an agricultural landscape – includes study of cues used by Grasshopper Sparrow in selecting breeding sites (Michael Ward and students, University of Illinois) http://ward.nres.illinois.edu/
- Monitoring grassland birds and nests, and studying restoration ecology in a working landscape on Grand River Grasslands in Iowa and Missouri (Jim Miller and students, University of Illinois) http://millerlab.nres.illinois.edu/index.html
- Grassland bird studies on Fort Campbell Military Reservation and surrounding public and private lands in Tennessee and Kentucky (David Buehler and students, University of Tennessee) http://fwf.ag.utk.edu/personnel/dbuehler.htm
- Ecology of birds in managed grasslands program – reproductive success of grassland birds on regional airfields and factors causing nest failure/success (New Jersey Audubon, funded primarily by DoD) http://www.njaudubon.org/SectionResearch/Projects/Grasslands.aspx
- Winter survival and daily movements of grassland birds in Chihuahuan Desert grasslands (including Grasshopper Sparrows) (Rocky Mountain Bird Observatory) http://rmbo.org/v3/OurWork/International/ChihuahuanDesertGrasslands.aspx

Additional research needs are included in the Conservation Plan: Recommended Actions (Appendix A).

C. Habitat Planning and Delivery

As the landbird conservation initiative in North America, Partners in Flight (PIF) is the primary source of landbird conservation assessments and priorities, and population estimates (Partners in Flight Science Committee 2012). It is the Migratory Bird Joint Ventures (JVs) that serve as the delivery mechanism for all-bird conservation actions http://mbjv.org. Given the broad distribution of Grasshopper Sparrow throughout the U.S., southern Canada, and northern Mexico, they are found within all U.S. Joint Ventures at some time during their life cycle. Grasshopper Sparrow is identified as a priority species in the following U.S. Joint Ventures. Where JV publications were available, they are cited; JV websites are also provided.

- Prairie Potholes Joint Venture - breeding (Prairie Pothole Joint Venture 2005) http://ppjv.org/
- Rainwater Basin Joint Venture – breeding (Rainwater Basin Joint Venture 2013) http://rwbjv.org/
- Playa Lakes Joint Venture – breeding (Playa Lakes Joint Venture 2008) http://www.pljv.org/
- Intermountain West Joint Venture – primarily breeding (Intermountain West Joint Venture 2013) http://iwjv.org/
- Sonoran Joint Venture (U.S. and Mexico) – breeding/winter (Sonoran Joint Venture Technical Committee 2006) http://sonoranjv.org/
- Oaks and Prairies Joint Venture – breeding/winter (Oaks & Prairies Joint Venture website – http://www.opjv.org)

- East Gulf Coastal Plain Joint Venture – breeding/winter (East Gulf Coastal Plain Joint Venture 2008) http://www.egcpjv.org/
- Upper Mississippi River/Great Lakes Joint Venture – breeding (A. Forbes, pers. commun.)
- Rio Grande Joint Venture (U.S. and Mexico) – primarily winter (Rio Grande Joint Venture website - http://www.rgjv.org/)
- Central Hardwoods Joint Venture – breeding (Central Hardwoods Joint Venture website - http://www.chjv.org/)
- Atlantic Coast Joint Venture – breeding/winter (Atlantic Coast Joint Venture website - http://www.acjv.org/)
- Appalachian Mountains Joint Venture – primarily breeding (moderate priority) (Appalachian Mountains Joint Venture website – http://amjv.org)

Information about habitat planning and delivery that will benefit Grasshopper Sparrows can be found in Joint Venture materials, as well as individual State Wildlife Action Plans http://teaming.com/state-wildlife-action-plans-swaps , and landbird conservation plans developed through Partners in Flight http://www.partnersinflight.org/conservation_plans/default.php.

D. Education/Outreach/Management Guidelines

Below is a list of some materials available regarding managing for grassland birds or Grasshopper Sparrows in particular, or other related information, for landowners and the general public:

- Audubon California website landowner resource – *Making a Good Home for Grasshopper Sparrows* http://ca.audubon.org/making-good-home-grasshopper-sparrows ;
- Rocky Mountain Bird Observatory's (RMBO) landowner resources – *Sharing Your Land with Prairie Wildlife* (Gillihan et al. 2006), *Integrating Bird Conservation into Range Management* (VerCauteren and Gillihan 2004), *Compartiendo sus Agostaderos con las Aves de Pastizal* (Macías Duarte et al. 2011a), and *Grazing Management for Wildlife Benefits* – all can be found at http://rmbo.org/v3/InfoCenter/Publications/ManualsGuides.aspx and all contain specific information about Grasshopper Sparrows.
- Massachusetts Audubon resource – *Conserving Grassland Birds* http://www.massaudubon.org/our-conservation-work/wildlife-research-conservation/grassland-birds/grassland-birds-manual ; specific information about Grasshopper Sparrow - http://www.massaudubon.org/our-conservation-work/wildlife-research-conservation/grassland-birds/grassland-birds-manual/species/grasshopper-sparrow
- Partners in Flight - *Birds in a sagebrush sea: managing sagebrush habitats for bird communities* (Paige and Ritter 1999) http://www.partnersinflight.org/wwg/sagebrush.pdf
- Cornell University Cooperative Extension resources **-** *Enhancing pastures for grassland bird habitat* (Ochterski 2005); *Hayfield management and grassland bird conservation* (Ochterski 2006a); *Transforming fields into grassland bird habitat* (Ochterski 2006b)
- U.S. Department of Agriculture resources - *USDA National Invasive Species Information Center* - http://www.invasivespeciesinfo.gov/index.shtml ; *USDA NRCS Introduced, Invasive, and Noxious Plants* - http://plants.usda.gov/java/noxiousDriver
- Conservation Reserve Program resource - *Field guide to the 2008 Farm Bill for fish and wildlife conservation* (Gray 2009) http://www.iwjv.org/sites/default/files/field_guide_to_the_2008_farm_bill.pdf

X. Conservation Plan

A. Conservation Action Items

This Conservation Plan (Plan – see Appendix A) was designed to highlight actions that will help managers to achieve conservation for Grasshopper Sparrow. This Plan includes a list of actions and needs that will begin to address the requirements to achieve long-term conservation of Grasshopper Sparrow, focused on those subspecies found in the U.S. or its territories at some point during their annual cycle. Although not addressed specifically here, it is expected that many of these actions would also be relevant for conservation elsewhere in the species' range. The recommended Grasshopper Sparrow Conservation Action Items are presented in Appendix A, which also can be downloaded from http://www.fws.gov/mountain-prairie/species/birds/grasshoppersparrow/index.html as a PDF or as an Excel spreadsheet to allow manipulation by users. The conservation action items are organized into the following major sections, addressing priority action items that contribute to and enhance this plan.

- Population status and distribution
- Habitat conservation
- Management
- Research
- Inventory and Monitoring
- Education and Outreach

Although it is beyond the scope of this document to discuss in detail all sections and items within Appendix A, there is an issue that warrants discussion, because addressing it will be crucial to success in achieving the goals of a Grasshopper Sparrow conservation action plan (and many other population-level plans of this sort). It has to do with scale and the need to ensure that the scale of the actions recommended (and subsequently implemented) matches, or will produce, impacts at the scale necessary to achieve the stated goals and population objectives for Grasshopper Sparrow. Maintaining the population of such a wide-spread, abundant grassland species as Grasshopper Sparrow, in light of the pressures that grassland habitat faces, will require a sizeable set of actions. As partners move forward to implement the recommended goals, objectives, and action items in this plan it is important to determine at what scale actions should be implemented, and whether these actions will be sufficient to accomplish our collective goals. This requires answering questions such as:

- How much grassland in what conditions and under what management regimes will be required to meet our goal for Grasshopper Sparrow populations?
- How much of a population-level impact is CRP having on Grasshopper Sparrow populations? What percentage of the population occurs in CRP? Will the scale of actions possible in manipulating CRP policies be sufficient to impact populations (see McLachlan et al. 2007; Giocomo et al. 2009; McLachlan and Carter 2009)?
- How much local grassland management (e.g., How much haying would have to be delayed? How much change in burn regimes?) must occur to achieve population-level impacts?

This is a difficult issue and has rarely been addressed in plans of this sort (J. Herkert, pers. commun.). Many of the recommended actions in Appendix A can be implemented at local or much larger scales. Local applications will produce local changes, but very large scale applications will be required to influence Grasshopper Sparrow range-wide populations, and evaluations will be required to determine

whether the recommended large scale actions will be sufficient to achieve our range-wide goal of maintaining Grasshopper Sparrow populations. Answering these questions will require a combination of research, monitoring, development of decision support tools, and collaboration with conservation planners. This issue, addressed under Goal 7, may well be one of the highest priority objectives and will inform our implementation of Goals 2 and 3.

Some Joint Ventures have already developed tools that will enable them to address the sort of scale issues described above. Two examples are the Playa Lakes JV Hierarchical All-Bird System (HABS), and the similar Intermountain West JV Habitats and Populations Strategies (HABPOPS) model. These are strategic tools that allow the JV to calculate landscape capacity to achieve population objectives both currently and in the future based on alternative scenarios and future habitat extent and condition.

In the PLJV the HABS tool is already being used to assess the current carrying capacity of CRP lands in the PLJV for Grasshopper Sparrows and the impact of conversion back to croplands (McLachlan et al. 2007; McLachlan and Carter 2009). In the IWJV the HABPOPS tool is being used to revise regional Grasshopper Sparrow population estimates and test scenarios (conversion of agricultural land to grassland, management of grasslands to improve habitat suitability or nesting densities, and altering management of woody habitats with a grass component) to assess the feasibility of meeting Grasshopper Sparrow population objectives in the IWJV (Intermountain West Joint Venture 2013). The challenge will be to scale these capabilities up to encompass the entire range of Grasshopper Sparrow.

It is important to strategically implement the action items identified in Appendix A with a focus on high-priority landscapes. The “Five Elements Process”, which is an adaptive process developed by Partners in Flight (Will et al. 2005), would be useful in delineating such high-priority landscapes. The five components of the process, with a brief explanation of each component, are:

1) **Landscape Characterization** – What habitats are important, where are they located on the current landscape, in what amounts, and in what condition?

2) **Bird Population Response Modeling** – Based on the best science, how do we think bird populations will respond to current landscape/habitat conditions as well as proposed management alternatives? How do population goals translate into habitat goals?

3) **Conservation Opportunities Assessment** – Where do opportunities for habitat protection, management, or restoration exist based on current landscape conditions? Who are the main partners within a landscape?

4) **Optimal Landscape Design** – How can we bring together conservation strategies for a diverse array of species with different habitat requirements and design landscapes beneficial to all species in a particular area? What are the priority species, landscape capabilities, and costs?

5) **Monitoring and Evaluation** – We need to monitor conservation actions in order to measure the success of our projects and to evaluate the assumptions on which decisions and actions were based in the previous four steps. Performance-based objectives need to be developed that can be measured.

B. Other Species that will benefit

Information about other species that would benefit from management actions targeting Grasshopper Sparrows is provided in Table 4.

C. Closing

Developing prescriptive, geographically-based Grasshopper Sparrow conservation action plans through collaborative partnerships is necessary to implement the conservation action items recommended here. The action plans should address and prioritize particular action items, include cost estimates, and identify the partners that will take the lead on and undertake each action item. However, there are currently no specific funding sources available for Grasshopper Sparrow conservation in the United States, Canada, and México. Therefore, implementing effective conservation measures will require the collaboration of a coalition of local, state, regional, national, and international partners to integrate actions into existing programs or identify new funding sources. In addition to this Conservation Plan, several state, provincial, and regional agencies and organizations have developed objectives and actions designed to address conservation of Grasshopper Sparrows. The conservation of Grasshopper Sparrows will require implementation in multiple North American, Central American, and Caribbean countries, five Canadian provinces, many U. S. and Mexican states, and by public and private organizations. Implementing these conservation actions will encompass different issues in each country, but will require partnerships regardless of the geography.

Table 4. Migratory bird species that could benefit from conservation actions targeting Grasshopper Sparrow (*Ammodramus savannarum*), in some geographic areas. Note that in many cases the opposite is not true (i.e., managing for these species will not necessarily benefit Grasshopper Sparrows).

Scientific Name	English Common Name	Season
Circus cyaneus	Northern Harrier	Breeding, Winter
Buteo swainsoni	Swainson’s Hawk	Breeding
Bartramia longicauda	Upland Sandpiper	Breeding
Numenius americanus	Long-billed Curlew	Breeding, Winter
Asio flammeus	Short-eared Owl	Breeding
Eremophila alpestris	Horned Lark	Breeding, Winter
Anthus spragueii	Sprague’s Pipit	Breeding, Winter
Calcarius ornatus	Chestnut-collared Longspur	Breeding, Winter
Rhynchophanes mccownii	McCown’s Longspur	Breeding
Peucaea aestivalis	Bachman’s Sparrow	Breeding, Winter
Pooecetes gramineus	Vesper Sparrow	Breeding, Winter
Calamospiza melanocorys	Lark Bunting	Breeding, Winter
Passerculus sandwichensis	Savannah Sparrow	Breeding, Winter
Ammodramus bairdii	Baird’s Sparrow	Breeding, Winter
Spiza americana	Dickcissel	Breeding
Dolichonyx oryzivorus	Bobolink	Breeding
Sturnella magna	Eastern Meadowlark	Breeding, Winter
Sturnella neglecta	Western Meadowlark	Breeding, Winter

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<u>Appendix A.</u> Grasshopper Sparrow Conservation Plan: Recommended Actions. The actions recommended in this Plan are primarily for the migratory subspecies of Grasshopper Sparrow (*Ammodramus savannarum pratensis* and *A.s. perpallidus*), and the Southwest subspecies (*A.s. ammolegus*), where applicable. The resident Florida subspecies (*A.s. floridanus*) is listed under the Endangered Species Act (ESA); therefore, its ESA Recovery Plan takes precedence. Conservation of the Puerto Rican Grasshopper Sparrow (*A.s. borinquensis*) will need to be addressed by a local partnership or conservation organization. Some of the action items may be relevant for the conservation of these other subspecies. In the table below, the sequence in which goals and objectives are listed does not imply that one goal (or one objective) is necessarily more important than another goal (or objective). However, action items within each objective are ranked in a suggested priority order. Implementing this comprehensive conservation plan for Grasshopper Sparrow will require collaboration among many partners and organizations with different missions and capabilities, so prioritization at all levels might discourage partner participation. Background information and justification for these recommended actions can be found in the text of this Plan. Where actions have already been taken on some recommended action items, these have also been summarized in the text. Compiled by Stephanie L. Jones (USFWS) and Janet M. Ruth (USGS).

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
1	1	Population Status & Distribution				Goal 1: Determine the population status and distribution of Grasshopper Sparrow (GRSP) to inform conservation planning. Grasshopper Sparrow breeding range is geographically broad and encompasses a wide range of grassland habitat types.	All
2	1	Population Status & Distribution	1.1			Objective 1.1 - Determine status and distribution of Grasshopper Sparrow populations based on existing data and professional opinion, and identify priority areas for conservation action; see **Conservation** and **Management** sections below.	All
3	1	Population Status & Distribution	1.1	1.1.1	1	Analyze BBS data to identify areas of declining GRSP population trends and gaps in BBS coverage.	Breeding

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
4	1	Population Status & Distribution	1.1	1.1.2	1	Identify high priority landscapes for GRSP conservation actions based on trend and distribution data from actions 1.1.1 and 1.1.3 and products from any available modeling efforts to strategically focus conservation efforts for breeding GRSPs.	Breeding
5	1	Population Status & Distribution	1.1	1.1.3	2	Review and summarize other data sources (e.g.; banding data; research studies; avian checklists, breeding bird atlases, e-Bird, Natural Heritage programs, state wildlife agency records and state wildlife action plans, etc.) to refine GRSP distribution and population data in all seasons, particularly on the winter range and during migration.	All
6	1	Population Status & Distribution	1.1	1.1.4	3	Analyze existing data (CBC data, research studies, eBird, etc.) to improve knowledge of winter distribution of GRSP and identify areas to target coordinated winter survey and monitoring efforts.	Wintering
7	1	Population Status & Distribution	1.2			Objective 1.2 - Improve our knowledge of status and distribution of Grasshopper Sparrow	
8	1	Population Status & Distribution	1.2	1.2.1	1	Increase grassland bird monitoring using the Grassland Bird Monitoring programs in Canada and the US.	Breeding
9		Population Status & Distribution	1.3			Objective 1.3 - Update Grasshopper Sparrow population objectives	
10	1	Population Status & Distribution	1.3	1.3.1	1	Review results from other Population Status and Distribution objectives and use this information to update Grasshopper Sparrow rangewide population objectives.	All

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
11	1	Population Status & Distribution	1.3	1.3.2	2	Based on updated rangewide population objectives, partners should determine appropriate step-down population objectives (e.g., for Joint Ventures, BCRs, states) and evaluate the value of establishing separate subspecies population objectives.	All
12	2	Habitat Conservation				Goal 2: Protect, restore, maintain, and manage grassland habitats that are needed to sustain a stable or increasing Grasshopper Sparrow population across its breeding range	
13	2	Habitat Conservation	2.1			Objective 2.1 - Maintain and improve current grassland conservation programs to benefit Grasshopper Sparrows (and other grassland birds)	
14	2	Habitat Conservation	2.1	2.1.1	1	Ensure the future of the Conservation Reserve Program (CRP) and Grassland Reserve Program in the US, and similar programs in Canada. Ensure that these programs continue to protect existing grasslands.	Breeding (may affect migration and winter)
15	2	Habitat Conservation	2.1	2.1.2	1	Work with CRP in the US and equivalent programs in Canada to design management guidelines to provide grassland habitat that benefits GRSP (and other grassland species of concern), ensuring that management where permitted (including grazing, mowing, and haying) protects nesting birds, is appropriate for GRSP, and is restricted where it is not beneficial.	Breeding (may affect migration and winter)
16	2	Habitat Conservation	2.1	2.1.3	2	Develop a compensation/subsidy program to compensate farmers for declines in the value of their hay crop if they delay harvest, or for taking sub-optimal land out of hay production (Dale et al. 1997; Troy et al. 2005).	Breeding (may affect migration and winter)

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
17	2	Habitat Conservation	2.1	2.1.4	2	Apply existing programs that provide social and economic incentives to discourage conversion of grasslands to croplands (e.g., Grassland Reserve Program), and explore opportunities to improve them and develop additional, complementary programs.	All
18	2	Habitat Conservation	2.1	2.1.5	2	Where programs provide conservation easement (voluntary and paid) or fee-title acquisition capabilities, focus on purchasing large tracts of land with native grasslands, to protect them from conversion and fragmentation, and to establish large expanses of continuous grassland.	All
19	2	Habitat Conservation	2.2			Objective 2.2 - Identify high priority grassland areas for protection and restoration to benefit Grasshopper Sparrows, using information from **Population Status and Distribution** and **Inventory and Monitoring** sections	All
20	2	Habitat Conservation	2.2	2.2.1	1	Develop maps of high priority grassland areas for protection and restoration using spatial data and GRSP population and habitat status and distribution data.	All
21	2	Habitat Conservation	2.2	2.2.2	1	Assess wintering areas in the southern US and Mexico to identify and protect/restore areas of high conservation value for GRSP populations, especially those facing major threats.	Winter
22	2	Habitat Conservation	2.2	2.2.3	2	Establish protected natural areas. Establish a system for public rangelands (especially US Forest Service National Grasslands) that are protected from loss or degradation in order to create a mosaic of grassland habitat types (Saab et al. 1995; Askins et al. 2007).	All

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
23	2	Habitat Conservation	2.2	2.2.4	2	Identify and protect habitats primarily in native perennial grasses where possible.	All
24	2	Habitat Conservation	2.3			Objective 2.3 - Implement general grassland habitat conservation and protection concepts that benefit a suite of grassland birds, including Grasshopper Sparrows	All
25	2	Habitat Conservation	2.3	2.3.1	1	Focus grassland protection and restoration on increasing the percentage of grassland on the landscape, reducing the distance between grassland patches, and conserving closely connected patches of grassland in landscapes with less human development and woody vegetation where possible.	All
26	3	Management				Goal 3: Implement management of grassland habitats to benefit Grasshopper Sparrow	All
27	3	Management	3.1			Objective 3.1 - Implement general management practices that benefit a suite of grassland birds, including Grasshopper Sparrow	All
28	3	Management	3.1	3.1.1	1	Manage grasslands to include a mosaic of management prescriptions, including both recently disturbed and undisturbed grassland areas.	All
29	3	Management	3.1	3.1.2	1	Use management practices (grazing, mowing, burning) that leave large acreages of grasslands in a mosaic of taller and shorter grasses.	All
30	3	Management	3.1	3.1.3	1	Use management practices on protected grasslands that focus on restoring natural disturbances and removing invasive, non-native plant species. Use local, native genotypes and seed priming protocols, if available.	All

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
31	3	Management	3.2			Objective 3.2 - Implement specific management practices that are known to benefit Grasshopper Sparrows and a suite of other grassland birds	All
32	3	Management	3.2	3.2.1	1	Defer or reduce management disturbances from grazing and burning where practicable during the GRSP breeding season, especially on public lands and on lands enrolled in grassland and wildlife conservation programs.	Breeding
33	3	Management	3.2	3.2.2	1	Delay mowing until after the GRSP breeding season where practicable, to avoid destruction of nests, eggs, nestlings, fledglings, or roosting birds. When mowing cannot be delayed on all fields, (1) delay mowing on public and private lands being managed for wildlife conservation purposes, (2) use hayfield rotational management to rotate sizable fields that are mowed early with those mowed later in the season to provide some fields for nesting birds, and (3) avoid nighttime mowing.	Breeding
34	3	Management	3.2	3.2.3	1	Design management disturbance (grazing, mowing, burning) to provide nesting refuges, in contiguous areas, away from trees, buildings, roads, and crop fields.	Breeding
35	3	Management	3.2	3.2.4	1	Burn parcels in a rotational pattern across multiple years to maintain a mosaic of different vegetation structures, compositions, and successional stages. Use a fire regime that is appropriate for the geographic area and type of grassland. Fire should attempt to mimic the effects of natural wildfires in the geographic area.	All

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
36	3	Management	3.2	3.2.5	2	Employ grassland management practices that reduce woody cover. Focus efforts on grasslands that have less woody encroachment than the threshold exhibited by GRSP.	Breeding (may affect migration and winter)
37	3	Management	3.2	3.2.6	2	Where possible and when managing for GRSP and other open grassland species, consolidate adjacent grassland fields and eliminate linear strips of woody vegetation (shelterbelts, hedgerows, fence lines and tree lines).	All
38	3	Management	3.2	3.2.7	3	Promote existing guidelines related to energy development.	All
39	3	Management	3.2	3.2.8	4	Minimize crop field operations that destroy nests (e.g., subsurface tillage) where possible. Avoid mowing or spraying herbicide in uncultivated adjacent areas such as fencerows and grassed waterways whenever possible.	Breeding
40	3	Management	3.2	3.2.9	4	Use Integrated Pest Management (IPM) to manage pest weeds and arthropods, and include GRSP in IPM planning programs	Breeding
41	3	Management	3.2	3.2.10	4	Implement new Best Management Practices (BMPs) as they are produced.	All
42	4	Research				Goal 4: Conduct research necessary to inform conservation planning, actions, and development of BMPs to benefit Grasshopper Sparrow	All
43	4	Research	4.1			Objective 4.1 - Conduct research on Grasshopper Sparrow population abundance, distribution, and population trend	All

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
44	4	Research	4.1	4.1.1	1	Develop and refine predictive models of occurrence and abundance using existing data to identify potential source breeding areas. Produce geographic information system (GIS) maps to delineate regions of high probability of occurrence and abundance, in all seasons.	All
45	4	Research	4.1	4.1.2	1	Develop and assess techniques to recover GRSP populations in areas that have experienced declines and range contractions.	All
46	4	Research	4.1	4.1.3	2	Describe migration and wintering distribution of GRSP.	Winter, migration
47	4	Research	4.1	4.1.4	2	Determine the relative importance of various threats and limiting factors in explaining GRSP population declines and changes in distribution, including a comparison of factors affecting GRSP on breeding, migration, and wintering grounds; see results of other research described below.	All
48	4	Research	4.1	4.1.5	3	Determine the taxonomy of the GRSP population in the Chino Valley, AZ (is it *ammolegus*? Or *perpallidus*?)	Breeding
49	4	Research	4.2			Objective 4.2 - Conduct research on Grasshopper Sparrow demographics and ecology, ideally studied concurrently with other priority grassland birds	All
50	4	Research	4.2	4.2.1	1	Establish long-term study plots throughout the breeding range to monitor demographic parameters.	Breeding

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
51	4	Research	4.2	4.2.2	1	Conduct demographic studies of GRSP survival/mortality and productivity throughout life cycle (breeding, non-breeding) and across its range to determine when and where populations are most limited, what limiting factors may be contributing to population declines, and whether various populations are source or sink populations.	All
52	4	Research	4.2	4.2.3	1	Conduct research on GRSP winter ecology, including the identification of important winter habitat needs, and the important threats and limiting factors on winter populations (e.g., perhaps seed resources, precipitation, non-native vegetation). Use to determine relative importance of threats during breeding and non-breeding seasons to GRSP populations.	Winter
53	4	Research	4.2	4.2.4	2	Conduct studies on GRSP post-fledging biology, behavior and demographics.	Breeding
54	4	Research	4.2	4.2.5	2	Conduct research on GRSP site fidelity, return rates, and survivorship in different geographic areas.	Breeding, wintering
55	4	Research	4.2	4.2.6	2	Conduct research on GRSP migration ecology including stopover habitat use, migration routes, migration behavior, etc.	Migration
56	4	Research	4.3			Objective 4.3 - Conduct research on management-related questions related to Grasshopper Sparrow	All

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
57	4	Research	4.3	4.3.1	1	Conduct studies on the effects of different types of key grassland management practices (e.g. grazing, mowing, burning, woody vegetation control) on GRSP productivity, survival and Brown-headed Cowbird nest parasitism, and how these effects are influenced by scale (patch size and landscape matrix). It is particularly important to do comparisons across geographic range and for different GRSP subspecies. NOTE: this includes a study of short-duration, high intensity grazing (Savory 1988) on GRSP in the Southwest.	All
58	4	Research	4.3	4.3.2	2	Determine what management practices (e.g., timing, frequency, and intensity of grazing, fire, and mowing regimes) create suitable GRSP habitat in different geographic regions and at what levels these practices become a threat (begin showing negative impacts) to GRSP habitat and populations.	All
59	4	Research	4.3	4.3.3	2	Conduct research to test the assumptions on which existing management recommendations (and future BMPs as they are implemented) are based to determine whether they produce the intended results/benefits.	All
60	4	Research	4.3	4.3.4	3	Determine the effects of tall structures (e.g., telecommunication and powerline transmission towers, wind turbines, buildings, etc.) on GRSP behavior, productivity, survival, and habitat use	All
61	4	Research	4.3	4.3.5	3	Determine the effects of energy development, production, and transmission (oil & gas, wind, solar, biomass) on GRSP behavior, productivity, and GRSP habitat (e.g., fragmentation, non-native plants, etc.)	All

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
62	5	Inventory & Monitoring				Goal 5: Conduct inventory and monitoring activities to inform Grasshopper Sparrow conservation planning and activities	All
63	5	Inventory & Monitoring	5.1			Objective 5.1 - Conduct inventory and monitoring activities on Grasshopper Sparrow grassland habitat	All
64	5	Inventory & Monitoring	5.1	5.1.1	1	Determine the distribution, quantity, quality, and protection status of grassland habitat suitable (or potentially suitable) for GRSP throughout its annual cycle; monitor changes in these characteristics over time.	All
65	5	Inventory & Monitoring	5.1	5.1.2	2	Evaluate the existing data on GRSP habitat to identify gaps, particularly on the wintering range.	All (especially Winter)
66	5	Inventory & Monitoring	5.2			Objective 5.2 - Conduct inventory and monitoring activities on Grasshopper Sparrow distribution, population trend, and habitat use	All
67	5	Inventory & Monitoring	5.2	5.2.1	1	Ground-truth or use expert knowledge to validate GIS information on GRSP distribution, abundance, and habitat associations.	All
68	5	Inventory & Monitoring	5.2	5.2.2	1	Improve the value of BBS for understanding GRSP population trends by increasing the number of routes and trained observers in grassland habitats where GRSP are found, and by encouraging increased participation in BBS.	Breeding
69	5	Inventory & Monitoring	5.2	5.2.3	2	Evaluate the existing data on GRSP populations and distribution to identify gaps, particularly on the wintering range.	All (especially Winter)
70	5	Inventory & Monitoring	5.2	5.2.4	3	Inventory and monitor GRSP distribution and habitat use on wintering grounds.	Winter

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
71	6	Education & Outreach				Goal 6: Develop and produce education and outreach materials, activities and programs that facilitate the conservation of Grasshopper Sparrow	All
72	6	Education & Outreach	6.1			Objective 6.1- Produce Best Management Practices (BMPs) documents on pertinent subjects for target management audiences; see **Management** and **Research** sections above	All
73	6	Education & Outreach	6.1	6.1.1	1	Develop BMPs for grazing, mowing, burning, and other practices in GRSP habitat across its range, with BMPs appropriate and specific to geographic area and grassland type.	All (especially Breeding and Migration)
74	6	Education & Outreach	6.1	6.1.2	1	Develop BMPs for grassland restoration in GRSP habitat across its range, with BMPs appropriate and specific to geographic area and grassland type.	All (especially Breeding and Migration)
75	6	Education & Outreach	6.1	6.1.3	2	Develop additional BMPs and guidelines for energy development and delivery activities (e.g., oil & gas, wind, solar, and biomass) in GRSP habitat across its range.	All
76	6	Education & Outreach	6.2			Objective 6.2 - Produce other activities, programs, and materials that will facilitate conservation of Grasshopper Sparrows and their grassland habitat by managers and policy-makers	All
77	6	Education & Outreach	6.2	6.2.1	1	Produce outreach documents to inform and influence land use decisions and policies that affect grassland habitat.	All
78	6	Education & Outreach	6.2	6.2.2	2	Integrate GRSP needs into land management programs and grassland conservation initiatives.	All
79	6	Education & Outreach	6.2	6.2.3	3	Develop collaborations and outreach to Mexican government agencies and NGOs to work together to conserve GRSP populations and habitats across their full annual cycle.	Winter

Order	Goal #	Goal	Objective #	Action Item #	Priority	Description of Goal/Objective/or Action Item	Annual Cycle
80	6	Education & Outreach	6.3			Objective 6.3 - Produce activities, programs and materials that increase awareness of Grasshopper Sparrow and their grassland habitats	All
81	6	Education & Outreach	6.3	6.3.1	1	Develop education and outreach tools and communication programs for public and landowner education and outreach about the value of conserving grasslands, especially intact native prairie.	All
82	6	Education & Outreach	6.3	6.3.2	2	Develop education and outreach tools for youth, land managers, and the general public that increase their awareness of GRSPs and their habitat requirements.	All
83	7	Conservation Planning				Goal 7: Evaluate whether the scale of actions recommended match, or will produce impacts at the scale necessary to achieve the stated population objectives for Grasshopper Sparrow	
84	7	Conservation Planning	7.1			Objective 7.1 - Develop models and/or decision support tools that will allow conservation planners to determine the population-level impacts of various recommended actions in this plan and how much of these actions at what scales are required to achieve population objectives.	All
85	7	Conservation Planning	7.1	7.1.1	1	Explore the applicability of existing tools, such as the Playa Lakes JV HABS database and the Intermountain West JV HABPOPS model, and determine how to scale them up for rangewide applications.	All

Appendix B: Scientific names for non-avian animal taxa and plants mentioned in document

Scientific Name	**English Common Name**
Animals	
Jackrabbits	*Lepus* species
Cottontails	*Sylvilagus* species
Rodents	Order Rodentia
Ground squirrels	*Spermophilus* species
Thirteen-lined ground squirrel	*S. tridecemlineatus*
Prairie dogs	*Cynomys* species
Pronghorn	*Antilocapra americanus*
Elk	*Cervus elaphus*
Deer	*Odocoileus* species
Mule deer	*O. hemionus*
Bison	*Bison bison*
Domestic/feral cat	*Felis catus*
Foxes	*Vulpes* and *Urocyon* species
Skunks	*Spilogale, Conepatus,* and *Mephitis* species
Raccoon	*Procyon lotor*
Snakes	Suborder Serpentes
Plants	
pine	*Pinus* species
pinyon pine	*Pinus* species
juniper	*Juniperus* species
eastern red cedar	*Juniperus virginiana*
oak	*Quercus* species
sagebrush	*Artemisia* species
mesquite	*Prosopis* species
buffelgrass	*Pennisetum ciliare*
cheatgrass	*Bromus tectorum*
switchgrass	*Panicum virgatum*
orchardgrass	*Dactylis glomerata*
timothy grass	*Phleum pratense*
smooth brome	*Bromus inermis*
tall fescue	*Festuca arundinacea*
Kentucky bluegrass	*Poa pratensis*
crested wheatgrass	*Agropyron cristatum*
intermediate wheatgrass	*Thinopyrum intermedium*
big bluestem	*Andropogon gerardii*

little bluestem	*Schizachyrium scoparium*
Indiangrass	*Sorghastrum nutans*
blue grama	*Bouteloua gracilis*
side-oats grama	*B. curtipendula*
buffalograss	*Buchloe dactyloides*
kleingrass	*Panicum coloratum*
Old World bluestem	*Bothriochloa ischaemum*
Lehmann lovegrass	*Eragrostis lehmanniana*
Boer's lovegrass	*E. chloromelas*
wheeping lovegrass	*E. curvula*
miscanthus	*Miscanthus* species (esp. hybrid *M. giganteus*)
leafy spurge	*Euphorbia esula*

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