Integrating Birds into Sagebrush Management

Version 1

Acknowledgements

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Purpose

The sagebrush sea is a critical landscape in North America in that it provides vital ecological, hydrological, biological, agricultural, and recreational ecosystem services and is managed for equally diverse uses (Homer et al 2015). Several birds (Appendix A) found in this landscape are termed 'sagebrush obligate' (i.e. sage-grouse, Sagebrush Sparrow, Sage Thrasher) and rely upon the sagebrush ecosystem for their survival. Integrating birds into land management decisions on public and private land can lead to win-win results for land manager, wildlife and other natural resources. Thus, conservation practitioners should work cooperatively and pro-actively for seamless (cross-boundary), large-scale conservation of birds and their habitats. This manual provides general information about the sagebrush ecosystem, its relationship with bird communities, and habitat requirements and conservation measures for birds typically found within habitats of the eastern range of the sagebrush footprint. While tools to help guide land management decisions to enhance decisions that foster a multi-species approach to conservation are described here, they are not meant to replace site-specific knowledge and goals (Knapp and Fernandez-Gimenez 2008; Davis and Wagner 2003) gained from long-term interactions with the land being managed.

How to use this guide

This guide is intended for conservation practitioners working in the sagebrush ecosystem in the eastern part of sagebrush range, including Colorado, Wyoming, western South Dakota, Montana and southeast Idaho, as some of the management tools described are only valid in those areas. Information in this guide is applicable on both public and private lands but goals for management should be determined by site potential. Management goals and objectives are usually very site specific and will be different under

different environmental, political, social, and economic circumstances (Knapp and Fernandez-Gimenez 2009).

The guide has five sections. The **Introduction** provides the justification of why it is important to consider all sagebrush obligate birds when planning for land management. The **Sagebrush Ecosystem** section gives general information about the ecosystem. This ecosystem is not just one expansive field of sagebrush; there are many microhabitats and different plant associations that make up the overall ecosystem that are each important to different species of birds. Understanding the ecological classification system used to describe those plant associations will be important for making informed management decisions. We provide general information about Major Land Resource Areas and ecological site descriptions, used by resource agencies to describe ecosystem dynamics and give reference for additional information sources. The section on **Birds as Indicators** to habitat will give the reader a general understanding of the different components of habitat that are potentially important for the presence or absence of a bird species. The **Conservation Actions** section provides general management suggestions when a particular activity is occurring at a site. The **Tools for Management** section provides a more detailed description of several tools land managers can use to enhance decisions that foster a multi-species approach to conservation. **Appendix A** provides details for 19 bird species found within the sagebrush ecosystem. These details will give readers a better understanding of specific habitat requirements necessary for a species to be present and will give managers the knowledge necessary for bird conservation. **Appendix B** give an explanation of the two larger scale monitoring efforts in North America that can provide more rigorous population statuses for bird species.

Contents

Introduction

Birds provide critical ecological services to the world including insect control, seed dispersal, and serving as prey for a diversity of wildlife species (Sekercioglu 2006; Whelan 2008). Birds also play an economic role, as bird-watching and hunting generates billions of dollars in tax revenues (Sekercioglu 2002; Leonard 2008; Carver 2009). All over the world, however, various factors have contributed to the degradation, fragmentation, and loss of habitat, resulting in widespread population declines of birds.

The sagebrush sea and bird species it supports are among the highest conservation priorities of North America (Noss et. al. 1995; Center for Science, Economics, and Environment 2002). More than 350 sagebrush associated plants and animals have been identified as species of conservation concern (Wisdom et. al. 2003). Human use and fragmentation of the landscape has resulted in the loss and alteration of millions of acres of sagebrush habitats (West 1999; Tweit 2000; Knick et. al. 2003; Miller et. al. 2011). Threats, including sod-busting, unsustainable livestock grazing, exotic plant invasion and an altered fire cycle, often cause habitat to transition from highly suitable to subpar conditions. This has had detrimental effects on bird species populations (Baker et al. 1976; Paige and Ritter 1999; Knick and Rotenberry 2002; Hobbs et al. 2008). The 2011 State of the Birds Report (NABCI 2011) accounts 39% of aridland (including sagebrush) bird species are of conservation concern and more than 75% are in decline. Several sagebrush obligate bird species (e.g., Brewer's Sparrow, Sage Thrasher, and Sagebrush Sparrow) have been listed by state agencies as threatened or sensitive (Knick and Rotenberry 2002; Knick et al. 2003; Rich et al. 2005). Other taxa (e.g., Great Basin butterflies, sand dune beetles, leatherside chub) have been petitioned for listing under the federal Endangered Species Act (ESA) (Forest Guardians 2007; Wildearth Guardians 2010a & b).

Starting in 1999, the Greater Sage-grouse became a target of several petitions requesting the species to be listed under the Endangered Species Act (Kritz and Diebert 2008). In 2010, it was determined to have "Warranted but Precluded" status (USFWS 2010a). The immediate need for strategic actions to protect the sage-grouse, the sagebrush ecosystem and the agricultural producers dependent on it was realized. Due to science-based, partnership-driven efforts, in 2015 the US Fish and Wildlife Service determined protection for the Greater Sage-grouse is not warranted and the species was withdrawn from the candidate species list. While the sage-grouse conservation effort has been positive, conservation efforts based on a single-species approach may not be effective in reversing population declines of many migratory bird species (Block et al. 1995; Moilanen et al. 2005). Many other species, including Species of Greatest Conservation Need (Wyoming Game and Fish Department 2010; Colorado Parks and Wildlife 2015; Montana Fish, Wildlife & Parks 2015), will likely benefit from the management that has occurred for sage-grouse. However, to assess the effectiveness of certain conservation measures on non-target species and increase our confidence in management decisions and strategies, there is an increased need to monitor wildlife responses (Favreau et al. 2006). Thus, the implementation of management actions across the landscape and their effects on multiple bird species need to be considered carefully and strategically to get the biggest bang for the conservation dollar.

Sagebrush Ecosystems

The vast sagebrush sea extends across 13 states in the West (Fig. 1). It is a complex system comprised of a mosaic of different plant communities that support numerous wildlife species and provide valuable ecosystem services to people, including soil stabilization, water filtration, flood control, and nutrient cycling (McArthur 1994; Paige and Ritter 1999; Knick et al. 2003; Miller et al 2011). The make-up of these communities is determined by factors such as climate, soil type, topography, elevation, and disturbance, which vary across different regions in the West.

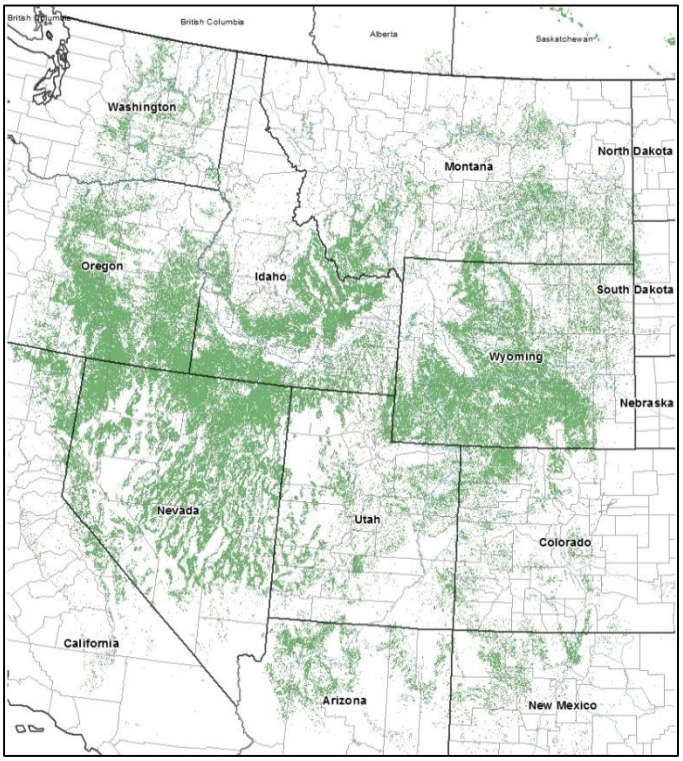


Figure 1. Map of the extent of sagebrush throughout western U.S.

Sagebrush species & habitat types

The genus *Artemisia* (mugwort, wormwood, sagebrush) comprises up to 400 species worldwide, of which some two dozen species and subspecies are sagebrush shrubs of western North America (McArthur 1994; Schultz 2009). The most common and widely distributed in North America is big sagebrush (*Artemisia tridentata*) with its predominant subspecies basin big sagebrush (*Artemisia tridentata tridentata*), mountain big sagebrush (*Artemisia tridentata vaseyana*), and Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) (McArthur 1994). Other less prevalent species are restricted by soil and climate conditions and include little or low sagebrush (*Artemisia arbuscula*), silver sagebrush (*Artemisia cana*), and black sagebrush (*Artemisia nova*) (Connelly et al. 2000c).

Correct identification of sagebrush species is needed for effective management since species provide different foraging value and palatability for wildlife and domestic animals (Rosentreter 2005), have different structural characteristics, and respond differently to management actions (Wambolt and Frisina 2002).. For example, some but not all species will re-sprout after fire, and species vary in their sensitivity to herbicides and their responses to mechanical control and grazing. Refer to Table 1 for some general habitat relationships for the more prevalent sagebrush species. Identifying sagebrush to species can be challenging. Information to aid identification is available in various technical (Wambolt and Frisina 2002; Rosentreter 2005; Schultz 2009) and nontechnical (Shultz 2012) formats. Pocket Guide to Sagebrush (Shultz 2012) is an excellent resource while in the field and is a good reference for species ranges.

Table 1. Habitat relationships of sagebrush (*Artemisia*) species. Modified from Wambolt and Frisina (2002).

	low sagebrush	plains silver	mountain silver	black	basin big	Wyoming big	mountain big	tall threetip	Wyoming threetip
Species Subspecies:	***arbuscula arbuscula***	***cana cana***	***cana viscidula***	***nova***	***tridentata tridentata***	***tridentata wyomingensis***	***tridentata vaseyana***	***tripartita tripartita***	***tripartita rupicola***
Precipitation	10-14"	10-14"	14+"	10-14"	10-14"	10-14"	14+"	10-14"	10"
Landforms[1]	F	P, B	M	F, B	F	P, F, B	F, M	F	F
Soils	Well drained, Alkaline	Well drained, Clayey	Well drained, Rocky	Shallow, Limestone rich	Deep, Well drained	Shallow clay, Xeric, Sometimes silt	Variety	Deep, Well drained	Shallow
Height at maturity[2]	small	med	med	sm	lg	med	med	sm	dwarf
Relative fire tolerance[3]	L	M	M	L	L	L	L	M	L
Relative browsing tolerance[3]	L	M	M	M	L	L	L	M	L
Vegetative reproduction[4]	N	Y	Y	N	N	N	N	Y	?

[1] P = plains; F = foothills; M = mountains; B = breaks
[2] (Exclusive of inflorescenses) Dwarf = <= 1dm (4in.); sm = 1-4dm (4-16in.); med = 4dm - 1m (16-39in.); lg = > 1m (39in.)
[3] L = Low; M = Moderate; U = Unknown
[4] N = reproduces by seed; Y = able to resprout from plant base

Some of the habitats within the sagebrush region include sagebrush steppe, desert shrublands, grasslands, riparian areas and woodlands (Pitkin and Quattrini 2010). These habitats are all integral parts of the landscape and support over 90 species of birds and 80 mammal species (Welch 2005).

Sagebrush Steppe

The sagebrush steppe is a habitat type where grasses and shrubs are co-dominant. The dominant shrub is sagebrush, of which many species grows throughout the West. Other important shrub species include antelope bitterbrush (*Purshia tridentate*), horsebrush (*Tetradymia canescens*), and rabbitbrush (*Ericameria nauseosa*). Rabbitbrush is particularly important, providing forage for insects and herbivores, and as a primary successor in restoring degraded sagebrush sites. The understory consists of perennial bunch grasses, flowering forbs, and biological soil crust. Forbs (e.g., larkspur [*Delphinium nuttallianum*], bitterroot [*Lewisia rediviva*], Indian paintbrush [*Castilleia linariifolia*], silvery lupine [*Lupinus argenteus*], and arrowleaf balsamroot [*Balsamorhiza sagittata*]) are particularly valuable for many wildlife species as they are a food source, they attract food sources (i.e., insects), and they can provide significant cover.

Desert Shrublands

"Desert shrublands" is a term used to describe shrub communities that generally lack a co-dominant grass layer. Dominant shrubs, often occurring in mixed stands, include big sagebrush, black greasewood,

spiny hop-sage, and saltbush. The understory is often dominated by bare ground and rock, with relatively less cover of flowering forbs and grasses.

Grasslands

Within the sagebrush steppe there are patches of habitat dominated by grasses, both perennial and annual types. Grasses tend to be more plentiful at higher elevations and around wetlands in the gradient between sage and water. Grasses can also be early successional vegetation after disturbance, such as fire. Grassland habitat is often found on the eastern edge of the sagebrush biome as it grades into shortgrass prairie communities. Grasses are important for preventing soil erosion, returning minerals to the soil, and providing a food base for many birds.

Riparian/Wet meadows

The term riparian refers to the interface between a river or stream and the upland landscape. Due to a higher water table this area has a dramatically different vegetative component than the drier upland area, including more trees, shrubs, and forbs. Riparian habitat provides riverbank protection, erosion control, and improves water quality. It is extremely important to many birds for migratory and stopover habitat. Wetlands are typically associated with riparian areas due to their proximity to each other, both shaped by a higher water table. The shallow and sedentary water is ideal habitat for many plants and wildlife, providing a food source for many birds.

Woodlands

The extent of woodlands in the West, especially those including aspen, pinyon, and juniper, has increased in the last 150 years. This increase in the cover of trees has caused some plant communities to shift from shrubs, grasses, and forbs with scattered trees to communities dominated by trees. Lack of fire, unsustainable livestock grazing, and changes in climate are likely the cause of the transition from sagebrush to woodland habitats.

Biological Soil Crusts

Biological soil crusts play a key role in arid environments such as the sagebrush ecosystem. Comprised of bacteria, algae, fungi, lichens, and mosses, and depending on the composition of the aforementioned, the crust can stabilize fragile soils (Belnap and Gardner 1993; Mazor et al. 1996), traps moisture (Belnap 2006), and fixes important carbon and nitrogen in the soil (Evans & Ehleringer 1993; Lange et al. 1994). This soil community may be crucial for the establishment of vascular plants in such a harsh environment (Chapin et al. 1994; Elmarsdottir et al. 2003; Hawkes 2004). In fact, a biological crust could be considered an indicator of soil health (Pellant et al. 2000). When disturbed by actions such as compaction or fire, it can take up to a few hundred years to redevelop (Belnap and Eldridge 2001). Once gone, it can increase the likelihood of transition between states of an ecological site (see below for discussion of ecological sites; Belnap 1995, Maestre et al. 2005; Miller 2005). Thus, maintaining the soil crusts should be considered in every sagebrush management plan.General plant associations within the sagebrush ecosystem

Ecological Sites/Units

Plant communities within the same region often have the same composition and structure characteristics. These regions are classified into different units and defined according to their "ecologically relevant characteristics" for the purposes of land planning and management. The definitions help predict how the vegetation in an ecoregion will respond to disturbances. Continued disturbances to the environment in an ecoregion may be favorable to some species and unfavorable to others. This furthers the need to understand what the habitat requirements are for Species of Greatest Conservation Need.

One ecological classification systems is the Major Land Resource Areas (MLRAs), first developed by the U.S. Department of Agriculture's Soil Conservation Service (now the Natural Resources Conservation Service [NRCS]). This classification system has an agricultural focus with major defining characteristics being soils, climate, water resources, and land use patterns. NRCS and other partners including the US Forest Service and Bureau of Land Management (BLM) have further broken down each of their larger land resource units into Ecological Sites (Pellant et al. 2005; Caudle et al. 2013) to describe local scale ecosystem processes. Ecological sites are land areas with specific soil, geomorphology, hydrology, and climate that differ from other kinds of land in their ability to produce distinctive kinds and amounts of vegetation and in their response to management actions (UDSA 1997; Pellant et al. 2005). They describe the ecological potential and ecosystem dynamics of land areas. A state and transition model (STM) is used to describe those dynamics (see Fig. 2 for example; Westoby et al. 1989; West 1999; Stringham et al. 2003; Caudle et al. 2013). A model includes different states consisting of plant community phases (seral stages) with varying levels of resistance and resilience to ecosystem drivers or disturbances such as management or climatic events. Each state and transition model has a reference state which describes the ecological potential or historic plant communities of the site. Ecosystem drivers may be strong enough to push a reference state out of equilibrium, across a threshold, and transition to new

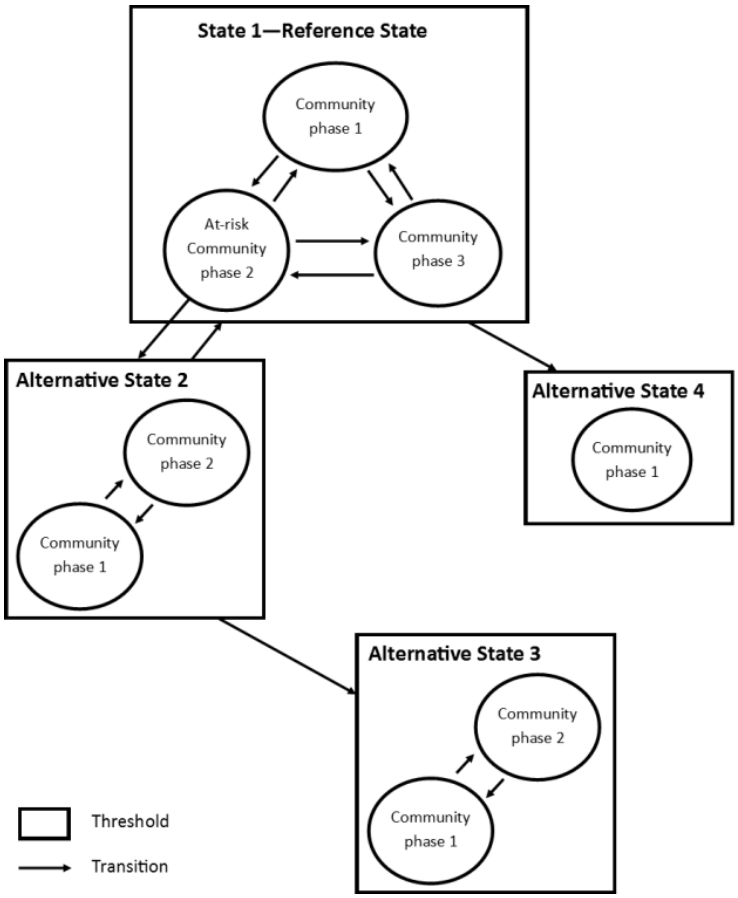


Figure 2. Nonspecific state and transition pathways for ecological site (modified from Caudle et al. 2013).

state (Stringham et al. 2003; Caudle et al. 2013). Once pushed beyond that threshold intensive inputs are required to reverse the transition. Oftentimes, when some ecological sites get to such a degraded state, it is nearly impossible to return to the reference state. Ecological site descriptions and state and transition models are used by land managers to 1) assess condition of current resources, 2) assess management opportunities, and 3) predict the outcome of management decisions.

Refer to the NRCS website (USDA NRCS 2016) to see if Ecological Site Descriptions (ESD) have been created for the areas in which you work. In the eastern parts of sagebrush range the densest areas of sagebrush fall within the following MLRAs: Cool Central Desertic Basins and Plateaus, Northern Intermountain Desertic Basins, Northern Rolling High Plains (Northern Part), Northern Rolling High Plains (Southern Part), Pierre Shale Plains (Northern Part), Warm Central Desertic Basins and Plateaus, Northern Rocky Mountain Valleys, Lost River Valleys and Mountains, Snake River Plains, Eastern Idaho Plateaus, and parts of Central Rocky Mountains, Wasatch and Uinta Mountains, Southern Rocky Mountains, and Southern Rocky Mountain Foothills (Fig. 3).

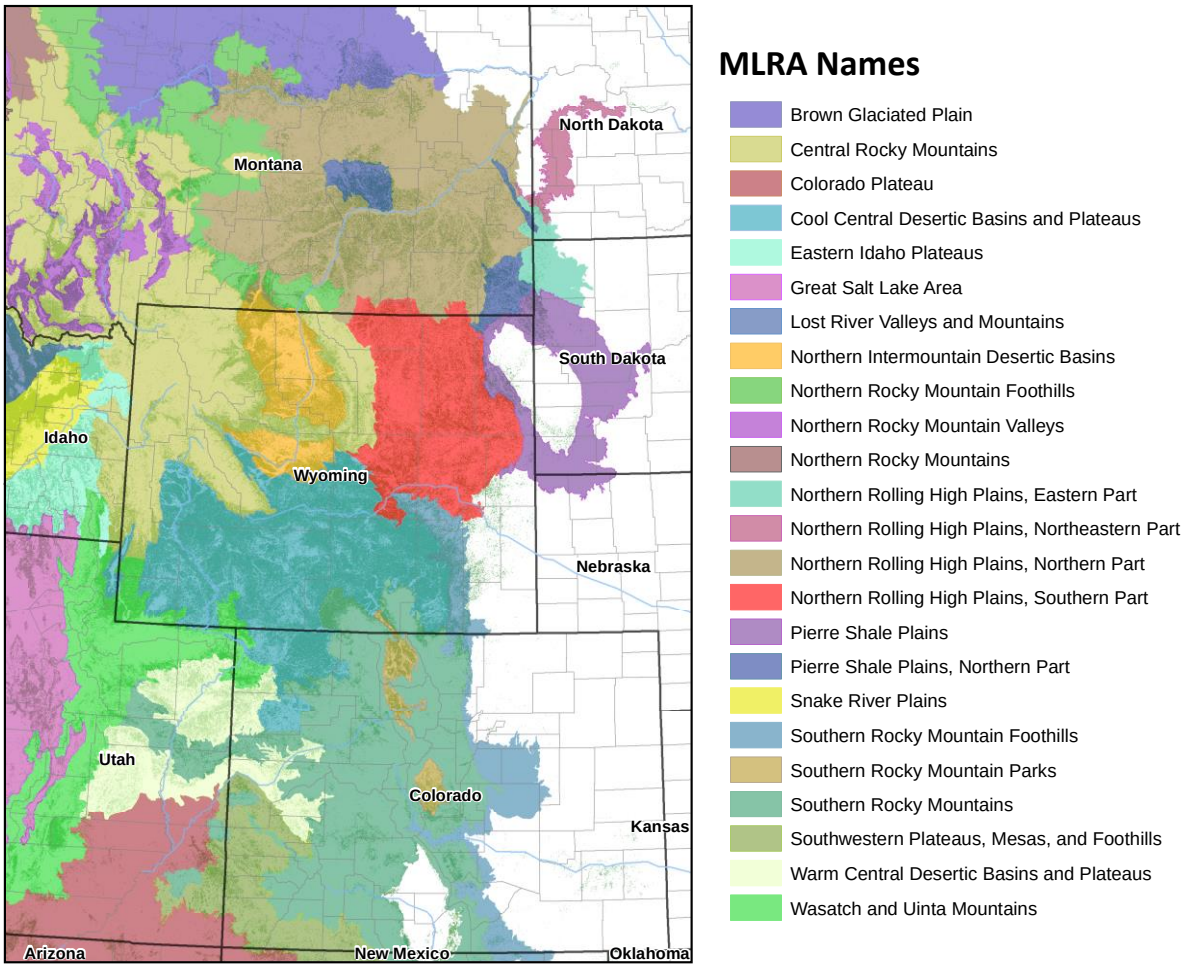


Figure 3. Location and extent of MLRAs in relation to the distribution of sagebrush (green shaded) in the eastern part of the range.

Birds as Indicators

Each bird species has specific ecological requirements (See Appendix A). Some species are adapted to a restricted range of environmental conditions in order to survive (specialists). Greater Sage-grouse is such a specialist as they are rely on sagebrush as a food source throughout the year. On the other hand, other species can take advantage of a variety of different resources in a wide variety of environmental conditions (generalists), or as Rotenberry and Wiens (1980) describe as a wider niche breadth. Generalists aren't as choosy as specialists and adapt more easily to a changing environment. You may find generalists, such as the Common Raven, in diverse habitat types. Thus, the availability of resources, such as food or nesting sites, will determine which species are present (Wiens and Rotenberry 1981).

Because of their dependence on habitat conditions and their higher reproductive potential and ability to move quickly across the landscape, many birds can respond quickly to changes in habitat features (Knick and Rotenberry 2000). As such they can be considered indicators of habitat condition and can be used to gauge the integrity of the habitat. Understanding habitat needs of bird species can be a critical piece to making more enhanced land management decisions.

When management actions are implemented it is common for several environmental variables to be measured long-term to assess the efficacy of those actions. The presence and absence of specific birds can be used as an index for performance monitoring for land management actions (Hutto 1998). For example, a goal of management might be to diversify forage (grass and forb) and improve plant health and vigor. To measure this response to management actions, indicators might include composition of plants, percent cover of those plant species, and height of grasses. An additional indicator could be that the presence or absence of birds that favor increased vegetation, such as Vesper Sparrow and Western Meadowlark. See the Tools for Management section and Appendix B for information on how to conduct a bird survey.

Over time, results of bird surveys can be used to assess performance of management actions and also track trends local bird populations. In addition, the local trends can be compared to more regional or national trends for particular species (see Appendix B for monitoring programs). This data can be used document how the land being managed is contributing to bird conservation.

Bird – Habitat Relationships

Birds judge the habitat according to different gradients of geographic scale (Kristan 2006; Weins 1989). At the largest scale, the site a bird chooses must be within a broad geographic area that has the proper climate, with suitable temperatures and precipitation. It is important to think about species conservation at the largest level. Continental or region-wide population studies can provide insights into broad factors influencing bird distribution and abundance. This information will help resource professionals plan for conservation efforts and policies that may need to be initiated. In addition, for species with declining populations, understanding how species are distributed regionally can identify areas with high conservation potential. This is especially important for migratory birds that have different home ranges at different times of year. At this scale management efforts and conservation

plans should occur across jurisdictional boundaries (countries, states, land management agencies and private lands).

Within the broad geographic area, birds choose local sites with an area suitable for the bird's home range, including nesting sites, that incorporates proper vegetation types, vegetative structure (horizontal and vertical), and configuration (density and adjacency to other landscape features) (Knick et. al. 2003). These factors are what organize different bird communities within the sagebrush ecosystem.

A bird's home range may contain multiple habitats, which provide all the necessary resources, including food, water, cover, and nesting sites. A bird's territory is its defended area and is classified according to the type of resource(s) being defended. Many songbirds have a "Type A" territory in which they defend a territory providing mating, nesting and feeding resources (although it is possible to have different territory types with a combination of resources being defended). The relation between territory size and food supply is often suggested (Odum and Kuenzler 1955; Enoksen and Nilsson 1983; Greenberg 1986). If you consider the territory size requirements needed by bird species it will help to determine if an area (a ranch for example) and its adjacent neighbors can provide enough area to sustain particular species (Table 2). Some species, however, are sensitive to sagebrush fragmentation. Just because there is an area large enough to sustain a territory size doesn't mean it is adequate for the species (Paige and Ritter 1999). The general rule of thumb for birds in the sagebrush ecosystem is that large, unfragmented areas with diversity in plant assemblages are most beneficial to support a higher species richness (Paige and Ritter 1999).

Table 2. Territory/home range requirements for 19 species found within the eastern parts of sagebrush range. We report on data available via the Birds of North America species accounts unless otherwise noted.

Species[1]	Territory Size/Distance[2]	Notes:	BNA Reference
Brewer's Sparrow	0.55 - 2.36 ha	Information from central OR and north NV	Rotenberry et al. 1999
Burrowing Owl	4 - 6 ha; 14 - 481 ha	Information from ND and Saskatchewan; foraging areas are considerably larger than nesting areas; semi-colonial species	Poulin et al. 2011
Common Raven	5.1 - 40.5 km^2	Information from MI	Boarman and Heinrich 1999
Ferruginous Hawk	nests 0.8 - 7.2 km apart		Bechard et al. 1995
Golden Eagle	nests 3.1 - 16 km apart	Info from WY and ID	Kochert et al. 2002
Greater Sage-grouse	Summer home range: 3 - 7km^2 Annual home range of migratory populations: 2,764 km^2 (summary in Connelly et al. 2000)	Lek size: 1 - 16 ha	Schroeder et al. 1999
Gray Flycatcher	1 - 10 ha	Information from CA, NV, AZ, NM, WA	Schlossberg and Sterling 2013
Green-tailed Towhee	0.9 ha	Information from UT shrub steppe	Dobbs et al. 2012
Gunnison Sage-grouse	5 - 100 m^2 0.3 km^2 - 129.5 km^2 (Apa 2004)	Lek size: 1 - 20 ha	Young et al. 2015

Species[1]	Territory Size/Distance[2]	Notes:	BNA Reference
Lark Sparrow	66 - 248 m^2	Information from KS	Martin and Parrish 2000
Loggerhead Shrike	4.6 - 25 ha	Information from MI, CA, ID, and Manitoba	Yosef 1996
Long-billed Curlew	14 ha (with 300 - 500 m buffer)	Information from ID	Dugger and Dugger 2002
Mountain Plover	16 ha	Information from CO	Knopf and Wunder 2006
Prairie Falcon	nests 0.5 - 7.8 km apart	Information from WY, ID, and MT; distances between nests are closer when adjacent cliffs are available; farther apart without continuous cliffs	Steenhof 2013
Sagebrush Sparrow	1.06 - 7.06 ha; 1.21 - 1.79 ha	Information from ID and UT; territories with grass and sagebrush are smaller than those in heterogeneous vegetation dominated by spiny shrubs.	Martin and Carlson 1998
Sage Thrasher	0.64 - 1.64 ha	Information from southeast ID	Reynolds et al. 1999
Sharp-tailed Grouse	Individuals travel, generally, an average <10km but could exceed 40km (Hoffman et. al. 2015)		
Vesper Sparrow	0.29-8.19 ha	No reports of size within sagebrush	Jones and Cornely 2002
Western Meadowlark	1.2 - 13 ha	Information from WI, Manitoba, IA	Davis and Lanyon 2008
* These measurements may be based on approximations, depending on the research done. Great variation in the procedures used (including the location of the research) and the intensiveness of the observation gives little confidence in the comparison of measurements. In addition, sizes will vary depending on the quality of habitat. Generally, where habitat is better, a smaller territory is needed.			

Habitat Structure

Habitat structure consists of multiple factors, including height and density of vegetation, ground cover, and adjacency to other topographic features (natural and man-made). The vegetative components that create structure in a shrubland ecosystem include grasses, forbs, sagebrush and other shrubs and juniper, all of which provide varying amounts of vertical and horizontal structure depending on their height and density. Non-vegetative components include bare ground, streams and ponds, burrowing animals, topography, and man-made structures.

Vegetative structure is important in providing protection from predators, shelter from harsh weather, display stations, nesting substrates and opportunities for feeding, resting, and perching (MacArthur and MacArthur 1961). Spatial structure of vegetation is important for determining the distribution of birds (Wiens 1976). Thus, the site and spatial structures of vegetation determine the bird community present in an area.

Generally, the more structurally diverse a habitat, the more species-rich the bird community found there (MacArthur and Wilson 1967, Lack 1969). For example, the species richness and diversity of bird communities were highest in old-growth and mid-successional juniper and lowest in grasslands for one

study (Reinkensmeyer et. al. 2007). Compared to grasslands, shrublands are more diverse structurally due to the addition of the shrub layer above the ground-cover layer. There are many opportunities for different species to co-exist in this habitat. In contrast, grasslands are one of the least structurally diverse habitats, and support a comparatively simple bird community.

Shrubs: Shrubs provide an additional layer of structural complexity and their presence greatly influences the bird community. Shrubs create opportunities for nesting, perching, and foraging in addition to the opportunities created by the ground-cover layer. Bird species vary in their need for shrubs, with some avoiding them entirely and others selecting particular combinations of shrub height and density. Shrubs such as sagebrush are important for creating micro-climates for other plant species. It reduces solar radiation to provide favorable conditions for numerous other grass and forb species important for wildlife (Welch 2005).

Ground cover: The height and density of grasses and forbs, and the amount of bare ground, are important factors in the structure of sagebrush habitat and influence the bird species present. Abundant cover provided by low vegetation is important for birds that nest on the ground—they need that concealing cover to hide their nests. Ground cover also supports other wildlife species and seeds that bird species utilize. On the other hand, some species search for food on the ground and may need an abundance of bare ground to facilitate their foraging activities.

Streams and ponds: The presence of water in an otherwise dry ecosystem creates unique and valuable habitat. The water and lush vegetation support diverse communities of invertebrates, which become important food items for many bird species. This is especially important during the nestling and fledgling stages, when young birds need abundant protein and fats in order to properly grow and develop.

Burrowing animals: Grazing and burrowing actions of prairie dogs, pocket gophers, ground squirrels, and badgers alter habitat by decreasing woody vegetation, aerating soil, and reducing the dominance of perennial grasses. These alterations increase plant and animal diversity by direct action and by creating unique microhabitats. These burrowing animals also serve as important food items for birds of prey such as Golden Eagles and Ferruginous Hawks. Also, the burrows serve as nest sites for Burrowing Owls.

Topography: Geological features such as rock outcrops and cliffs provide nest sites and perching sites for some bird species, especially raptors such as Prairie Falcons.

Man-made structures: Roads, fences, and utility lines are necessary components of a working landscape. Unfortunately, they can be detrimental to some bird species. Some species, such as Burrowing Owls, often collide with vehicles. Other species, such as the sage-grouse, can collide with fences in areas of flat terrain (Stevens et al. 2012). Utility poles provide more nesting and perching sites than would be present naturally while also providing a source for raptor electrocutions and collisions. These supplemental perch sites can help grow Common Raven populations to unnaturally high levels, to the detriment of sage-grouse and other bird species that lose eggs and young to predation by ravens. Additionally, the roads built to service powerlines provide movement corridors for ground predators, such as coyotes.

Bird Indicator Species

The presence or absence of certain bird species on the landscape reflects the conditions and quality of the habitat. In sagebrush shrublands, "indicator species" are tied to particular combinations of shrub and herbaceous cover. Although birds are very mobile and will use a variety of habitat, they will be found most often in the habitats that fulfill their resource needs. Table 3 is useful as a quick reference habitat types used by several species found in the eastern edge of sagebrush range. Any changes in the presence of these indicator species over time reflects changes in habitat structure. Changes in the bird community could suggest a need for changes in management, depending on the goals for a particular parcel of land.

Table 3. General* habitat components used by 19 birds found in the eastern portions of the sagebrush range (modified from Paige and Ritter 1999).

	Tall, dense sagebrush	Open, patchy sagebrush (less dense)	Grass cover for nests	Grassland	Short grass, bare ground	Seeps, wet habitat	Dry woodland (juniper and pinyon)	Riparian
Sagebrush Obligate Species								
Greater Sage-grouse	x	x	x	x	x	x		x
Gunnison Sage-grouse	x	x	x	x	x	x		
Sage Thrasher	x	x	x		x			
Brewer's Sparrow	x	x	x		x			
Sagebrush Sparrow	x		x		x			
Shrubland Species								
Green-tailed Towhee	x	x	x				x	
Lark Sparrow		x	x	x			x	
Shrubland and Grassland Species								
Ferruginous Hawk		x		x	x		x	
Golden Eagle		x		x	x		x	x
Prairie Falcon		x		x			x	
Sharp-tailed Grouse	x	x	x	x		x		x
Loggerhead Shrike	x	x			x		x	x
Grassland Species								
Mountain Plover				x	x			
Long-billed Curlew		x		x	x	x		
Burrowing Owl		x		x	x			
Vesper Sparrow		x	x	x				
Western Meadowlark		x	x	x	x			
Dry Woodland Species								
Gray Flycatcher	x						x	
Habitat Generalist								
Common Raven		x		x	x		x	x

*These species may also be found in other habitat types. For example, Sagebrush Sparrow may not necessarily just be found in sagebrush; they also can be found in other shrub types.

Conservation Actions: A multi-species, multi-resource approach

For landscapes that require management of multiple resources, management plans should balance both the needs of people (i.e., food and fiber) and ecological services (i.e., recreation, clean water, and wildlife habitat) to sustain natural ecological systems. Public land management agencies are tasked with managing the land for multiple uses. Private landowners are also generally interested in managing for more than one type of resource (Kachergis et al. 2013; Quattrini et. al. 2012) in addition to meeting their bottom dollar for agriculture. Any multi-resource management actions taken should have a goal to determine the best scenario for maximizing wildlife species diversity and occupancy while maximizing other resource interests (i.e., agriculture, recreation, etc.) – tradeoffs will need to happen. Clear objectives need to be realistic and clearly defined at the onset of the planning process.

It is important for resource agencies and conservation groups to work proactively and cooperatively with agricultural producers to conserve sagebrush birds and their habitats. These partnerships should occur for a more coordinated approach to seamless conservation of sagebrush shrublands across public and private lands to prevent Endangered Species Act listing and subsequent federal regulation (Meinke et al. 2009). In addition to enhanced resource management, advantages of partnerships include shared costs, labor, resources, and responsibilities.

General Habitat Recommendations:

Grazing

Grazing management activities will include the manipulation of the intensity, duration, and frequency of grazing so as to maintain or enhance the densities, heights, and diversity of sagebrush, grass, and forbs for sagebrush obligate birds.

- Graze at a time and intensity that allows for enough grass to be available for nesting sage-grouse; maintain a perennial herbaceous cover height of at least 18 cm on average with at least 15% cover for grasses and 10% cover for forbs (Connelly et al. 2000).
- Graze to utilize no more than 35–50% of annual vegetative growth.
- Graze when plant growth is slow and before plant reproduction has begun (Pyke 2011).
- Graze at an intensity that allows for the retention of some leaf litter for conserving soil moisture and enhancing insect populations.
- Aim for a diversity of native grass species and heights, with no cheatgrass or other exotic invaders.
- Rest grazing units in some years, to optimize the quality of nesting cover. Rest-rotation systems typically have the added benefits of reducing soil compaction and erosion.
- Provide at least two seasons of rest in areas reseeded with native species to give the young plants a chance to develop root systems capable of withstanding grazing pressure.
- Where biological soil crusts occur, protect them from damage by stocking at light to moderate levels during spring and by removing livestock before the hot and dry conditions of summer set in, to allow the crusts to recover while moisture is still available. Other strategies include employing a rest-rotation system, keeping livestock dispersed through strategic placement of water and salt, and grazing during wet periods or winter—the crusts are less susceptible to damage when wet or frozen (Belnap et al. 2001).

- Mark fences with plastic tags or other materials to increase the visibility of fences to grouse, thereby reducing potentially fatal collisions (Stevens et al. 2012).

Agriculture

- Return agriculture lands back to native plants. Plant Conservation Reserve Program (CRP) fields with native grasses, forbs, and sagebrush, from locally sourced seeds, when possible, that match the species distribution of surrounding lands, as a long-term investment in sagebrush birds (Schroeder and Vander Haegen 2011). Lambert (2005) provides a good synopsis for restoring big sagebrush communities for wildlife.
- To reduce bird mortality when haying, drive your equipment slowly, start from the edge of the plot and use a back-and-forth pattern to push birds toward uncut areas. A flushing bar mounted on the front will further reduce mortality.
- Avoid haying within the primary nesting season when possible – wait until after ~July 15.
- Minimize the use of insecticides, particularly during the nesting season (late April – mid- July), when birds are in search of wetter areas with forbs and insects.

Sagebrush management

The best management of sagebrush involves maintaining large, intact stands. As Paige and Ritter (1999) suggest, there should be no net loss of sagebrush. However, dense stands of sagebrush are thinned by fire, mechanical removal, or herbicides to increase grass and forb cover (Pyke 2011), although expected benefits sometimes do not occur (Davies et al. 2012). Managers must use extreme caution as clearing sagebrush can create an opening for invasive plants, such as cheatgrass, to gain a foothold. Once established, invasive plants may condemn the system to a pattern of frequent fires, with sagebrush gradually being eliminated and the exotic annuals taking over. Of course if any sagebrush is heavily disturbed, restoring it back to previous conditions is good policy.

- Schedule sagebrush removal activities outside the bulk of the bird nesting season of late April to early July.
- Exercise careful judgment when removing sagebrush used by sage-grouse in winter, which sage-grouse use as a food source during a comparatively long portion of the year (Connelly et al. 2011). Classic wintering habitat may be tall plants on gentle south or southwest-facing slopes offer exposed portions above the snow (Connelly et al. 2011). Frye et al. (2013), however, concluded sage-grouse use black and low sagebrush for cover and food as well, suggesting the need to consider new research informing habitat use.
- If sagebrush manipulation is called for, leave at least 80% of breeding and wintering habitat intact (Connelly et al. 2011).
- To prevent Wyoming big sagebrush from becoming dominated by cheatgrass prevent and control fires in sagebrush (Baker 2011).

Pinyon/juniper management

Active control of wildfires in western rangelands has allowed encroachment by trees. In particular, Utah juniper (*Juniperus osteosperma*), western juniper (*J. occidentalis*), single-leaf pinyon (*Pinus monophylla*), and two-needle pinyon (*P. edulis*) are invading sagebrush shrublands (Miller et al. 2011). Removal of encroaching trees is an effective means of enhancing the suitability of an area for sagebrush obligate birds (Holmes et al. 2015), and has the added benefit of increasing groundwater, making it available for

use by other plants including sagebrush, grass, and forbs. Note however that other bird species of conservation concern such as the Black-chinned Hummingbird (*Archilochus alexandri*), Pinyon Jay (*Gymnorhinus cyanocephalus*), Western Bluebird (*Sialia Mexicana*), and Black-throated Gray Warbler (*Setophaga nigrescens*) are species that rely on Pinyon/Juniper ecosystems (Balda and Masters 1980) and will likely be negatively impacted by P/J removal. Even further, a higher diversity of bird species use transition zones between different habitat types suggesting the need to maintain a heterogeneous landscape with different successional stages (Reinkensmeyer et al. 2008). Refer to Ecological Site Descriptions to see whether P/J woodlands are a reference state. Remove trees in a way that preserves the sagebrush, such as by cutting individual trees. The downed trees can be left in place or removed for firewood, fence posts, or other uses.

- By using supporting guidelines (such as ESDs), remove individual conifer trees where invading the sagebrush ecosystem, by cutting individual trees. The downed trees should be removed to reduce the fuel load and remove predator perching locations (Holmes et al. 2015).
- Focus removal efforts on trees near leks; sage-grouse may use areas with scattered trees during fall and winter months (Commons et al. 1999).
- Schedule tree removal outside of the bulk of the bird nesting season of late April to early July.
- Where possible, create corridors from lower to higher elevations so as to allow for sage-grouse to move upslope in summer.
- Ensure that corridors and openings are large enough so as not to create ecological traps for sage-grouse making them easy targets for predators.

Water Development

- Carefully consider decisions to build or maintain water developments (such as guzzlers) for native wildlife already adapted to dry conditions. Sage-grouse can meet their water requirements by consuming succulent vegetation (Connelly et al. 2011). Water developments can result in increased predation if predators key in on them.
- Install bird “weeps or seeps” if and when excess well or spring development water is available. Be cautious not to impound or pond water. These sites should be created to promote succulent vegetation and insects along a green line or within a swale. Be cautious not to impound or pond water; stagnant water could promote mosquitoes carrying West Nile Virus.
- Install escape ladders in stock tanks and wildlife water tanks to prevent birds and other wildlife from drowning.

Energy Production & Development

- Minimize the number of roads built, and the volume of traffic on them (such as by remote instrumentation)—roads create an opening for, and a path for expansion of invasive plants; roads provide a travel corridor for ground predators such as coyotes; also, vehicle traffic causes disturbance to sage-grouse and other birds (Ingelfinger & Anderson 2004; McClure et al. 2013; Shannon et al. 2015).
- Reduce disturbance of sage-grouse by locating energy-production–related facilities *at least* 3.2 km (2 mi) from leks, and minimize early morning and late evening activities within 0.5 km (0.3 mi) of leks (Connelly et al. 2000).
- Encourage the use of directional drilling and the placement of multiple wells per well pad to reduce areas of impact from drill pads and roads.

- Fit the tops of gas field heater-treater stacks with perch baffles to prevent bird mortalities.
- Containerize toxic or oily waste fluids or use netting over waste pits (reserve pits) to prevent wildlife mortalities. The netting should have a mesh no greater than 3.8 cm (1.5 in) and be suspended 120–150 cm (4–5 ft) above the liquid.

Some of these recommendations were taken from Paige and Ritter (1999); managers are encouraged to consult that publication for more information. Table 4 summarizes impacts the below management practices have on the bird species described in Appendix A.

Table 4. Summary of management actions impact on bird species found in sagebrush steppe habitat. "-" indicates species responds negatively to the treatment, "+" indicates the species responds positively to the treatment, and "+/-" indicates the species may respond either positively or negatively to the treatment (variation stemming from different sources or from differences in the implementation or intensity of the management practice). Blank cells indicate we could not find supporting documentation. Please consult the "Management Practices" section within the corresponding species account for references relating to the summarized management impacts in this table.

Species	Prescribed Fire	Grazing	Mech. Trtmt/Mowing*	Herbicide Treatment	Juniper Removal	Inv. Spp. Control**
Brewer's Sparrow	-		-	-	+	+
Burrowing Owl		+	+			
Common Raven						
Ferruginous Hawk	-					
Golden Eagle	-					
Gray Flycatcher	-	-			-	
Greater Sage-grouse	-	+/-	-	+/-	+	+
Green-tailed Towhee	+/-		-	-	-	
Gunnison Sage-grouse	-	+/-	-	-		+
Lark Sparrow	+	+			-	
Loggerhead Shrike	-	-	-			
Long-billed Curlew	+	+/-	-			+
Mountain Plover	+					+
Prairie Falcon						
Sage Thrasher	-	-	-	-	+	+
Sagebrush Sparrow	-		-	-		+
Sharp-tailed Grouse	+/-	+/-				
Vesper Sparrow	-	-			+	
Western Meadowlark	+/-					

***"Mech. Trtmt/Mowing" represents mechanical or mowing treatments to remove shrubs or reduce grass height.**

****"Inv. Spp. Control" represents treatments to reduce the amount of invasive plant species**

Bird Surveys

This section will give resource managers an overview of how to survey birds as a component of their performance monitoring efforts. Performance monitoring allows conservation professionals to assess the response of birds, vegetation and other targeted natural resources to the conservation measures implemented. It is an integral part to conservation planning as it provides an adaptive feedback loop to ensure efficacy. Surveys, when designed with robust sampling methods and analyzed with species' detectability, can provide information used to estimate population size in a given area over time, assess species composition, quantify species' distributions in relation to habitat, and determine responses to environmental changes (natural or human caused) (see Appendix B). It is possible, however, for simple surveys to be performed to provide an index of relative abundance of species. This is a simple technique that can be done in conjunction with existing range monitoring efforts. While this survey method should give you an idea of what is happening on your land with regard to bird habitat, this is not a statistically rigorous method.

The most important part of doing a bird survey is being able to properly identify the species. Having a good bird guide can help you on your way to learning the species. The Pocket Guide to Sagebrush Birds (Pitkin and Quattrini 2010) is a smaller guide that showcases the species that may often be found in the sagebrush ecosystem. Several phone apps are also available for handy bird identification tips. If you are interested in using a few species as indices for monitoring purposes, learn those species well. The more you get out to learn to identify the species the easier it will be to do the surveys.

Planning for your survey

Bird surveys can be done year-round, but the easiest time to do them is in the spring. This is when breeding birds return from winter migration and males sing to attract their mates. As described above, different species are reliant on different components of the new vegetative growth for nesting. Alternatively, surveys can also be performed in the winter (e.g., Christmas Bird Count).

A few things should be taken into consideration before conducting a survey.

- The best time to survey breeding songbirds is from mid-May until the end of June.
- Birds should be surveyed from dawn until 10:00 am because activity diminishes as the day progresses.
- Your bird survey location(s) should correspond to discrete management units, such as summer grazed versus winter grazed pastures. At least one transect, point, or area search should be done per habitat type on the site being managed.
- Keep written notes or mark bird survey locations with flags and/or GPS units to ensure repeatability of counts.
- Decide which type of survey you will do before you begin the survey (see below). If an area search or transect method is not feasible, simply select a location within a management unit, and stand at that point for 5 minutes, recording all birds heard and seen.
- Points where birds are recorded should be at least 250 yards apart to avoid double counting

- When recording bird species, try to keep track of their locations and movements to avoid double counting.
- If possible, do a survey two or three times during the breeding season, using the same methodology, so you can get an average number of indicator birds on your land. If you are able to conduct multiple surveys, note any significant changes in the habitat including increases or decreases in the available residual cover.

Before you begin

The following items will be necessary:

- binoculars
- watch which indicates seconds
- at least 2 pens
- bird survey worksheet (Figure XX)
- clipboard
- field guide to bird identification

We've developed a generic bird survey worksheet that you may use to record information for the bird surveys (Figure 4).

Defining the habitat

If a standardized range monitoring protocol is not in place, our simple bird Survey Worksheet can be easily used (Figure 4). In order to link the species you will observe to the type of habitat and management present, the first step, is determining the habitat type you are performing the survey in. You will be recording information on habitat structure in regards to brush and herbaceous cover as these may be the driving factors of which bird species are present at this pasture. Refer to Figure 5 to help you estimate the percent of vegetation cover. When defining a habitat type, look at the landscape as a whole. There will be some unique habitats nested within the landscape, but don't get overwhelmed with details. However, where woodlots, marshes, or other wetlands exist, the bird community will change. Recognize this and avoid placing your survey points closer than 250 yards to these unique patches so you do not record bird species using a different habitat type. We encourage surveying the birds within these unique patches but separate from the habitat you have defined within your pasture.

Conducting the surveys

Once you have defined the habitat, identify the indicator birds for that habitat. Refer to a field guide for physical features of these birds. Bird surveying can be easily incorporated into normal range-monitoring efforts. Whether you conduct a point assessment or a transect for vegetation analyses, simply record the indicator birds observed. Before you start the five-minute survey however, make sure you approach the point with as little disturbance to the birds as possible. If that is unavoidable, wait for a few minutes before you begin the survey. In addition, do not conduct surveys during weather that would reduce detectability (i.e., high wind or rain). You can easily do timed area searches or point transect methods.

Timed area search – Walk through the habitat you are monitoring for 5 minutes and record the names and numbers of all indicator birds heard and/or seen within the area. Estimate the amount of area you have covered during the 5-minute period in order to quantify your effort and allow for consistency over time.

Point transect methods – If your vegetation monitoring follows a transect, you can conduct one or more bird counts along each transect depending on the length of the transect. When more than one count is conducted along a transect, a minimum distance of 250 yards should be maintained between count locations to avoid double counting individual birds. If the transect is less than 250 yards, conduct a single bird count at the mid-point of the transect so it maximizes the overlap of the vegetation and bird data. Record all indicator bird species heard and/or seen during a 5-minute period. Avoid recording birds that are located beyond 250 yards from your bird survey point.

Other options – If you have a normal driving route for checking cattle, fences, etc. you can stop for 5 minutes and record indicator birds for the site. Select an area that falls within a single pasture. Avoid stopping next to windmills since some of the birds using stock tanks may not actually be nesting in your nearby pasture. (However, Mountain Plovers could occur here if the area around the stock tank is dry, so it would be beneficial to record their presence).

This protocol should give you an idea of bird trends, within surveyed areas, over several years.

Observer:	Weather	precipitation:	temperature:
Date:		wind:	cloud cover:
Property:			

				Habitat Variables										Bird Survey	Management or other changes in habitat since the last time surveyed during the season
Survey ID number	Start time	End time	Survey method	Primary habitat type	Sagebrush shrub cover (%)	Other shrub cover (%)	Shrub height (m)	Juniper woodland tree cover (%)	Herbaceous ground cover (%)	Grass ground cover (%)	Grass/ forb height (cm)	Percent bare ground (%)	Other features nearby	Indicator species present	

Habitat types: Tall, dense sagebrush / Open, patchy sagebrush / Grassland / Short grass, bare ground / Seeps, wet habitat / Dry woodland / Riparian

Figure 4. Bird Survey Worksheet

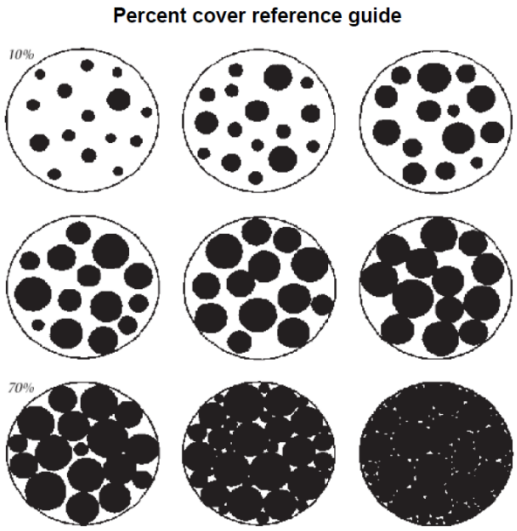


Figure 5. Percent cover reference guide. Graphic representations of increasing levels of percent cover in a circular plot area. Starting in the top left corner with 10% cover and increasing in units of 10% ending in a 90% cover. From "Plant Cover Estimation for Herbaceous Plants: A Quick Field Method" Center for Natural Resource Information Technology (CNRIT).

Rocky Mountain Avian Data Center

The Avian Data Center serves as the portal for avian information collected by the Bird Conservancy of the Rockies and our collaborators in the Rocky Mountains, Great Plains and Intermountain West. The Rocky Mountain Avian Data Center also acts as a regional node of the Avian Knowledge Network (AKN). Use the data center for "one stop shopping" for current bird monitoring data, results, methods and materials produced and/or collected by the Bird Conservancy of the Rockies and our collaborators. This information is available to the public, researchers, land managers, and our partners. By sharing what we have learned, we hope to encourage others to join us in bird and habitat conservation.

The Avian Data Center (**http://rmbo.org/v3/avian/Home.aspx**) has been designed to provide information for specific questions and therefore works best when users select multiple filters for a query. Users run queries to gain information about species presence in an area of interest. Users may add multiple filter types to view results for a very specific inquiry. After running a query the ADC will display a map of all survey locations corresponding to your set of filters in Google Earth. By default, the zoom capability of the maps page is restricted to protect the privacy of private landowners. You may

also view a table and chart of occupancy or density results for species found within the bounds of the filters.

The Integrated Monitoring in Bird Conservation Regions Program (IMBCR; Appendix B) annually collects breeding bird information in all, or portions of, 13 states. Each year, occupancy and density estimates are calculated at a variety of spatial scales. This information can be used in the following ways to inform avian conservation:

1. Bird population estimates can be compared in space and time. For example, area-level estimates can be compared to state and regional estimates to determine whether local populations are above or below estimates for the region;
2. Population estimates can be used to make informed management decisions about where to focus conservation efforts. For example, strata with large populations can be targeted for protection and strata with low populations can be prioritized for conservation action; a threshold could be set to trigger a management action when populations reach a predetermined level;
3. Population estimates of treatment areas can be compared to regional estimates to evaluate effectiveness of management actions. For example, if sagebrush areas are being treated to improve habitat for Greater Sage-grouse (GRSG) and estimates for sagebrush-obligate birds increase in these areas in relation to regional estimates where treatment is not occurring, the results would suggest that the GRSG management actions are also beneficial to other sagebrush-obligate bird species;
4. Annual estimates of density and occupancy can be compared over time to determine if population changes are a result of population growth or decline and/or range expansion or contraction. For example, if population densities of a species declined over time, but the occupancy rates remained constant, then the population change was due to declines in local abundance. In contrast, if both density and occupancy rates of a species declined, then population change was due to range contraction;
5. Occupancy rates can be multiplied by the land area in a region of interest to estimate the area occupied by a species. For example, if a stratum comprises 120,000 km^2 and the occupancy estimate for Western Meadowlark is 0.57, managers can estimate that 68,400 km^2 (120,000 km^2 * 0.57) of habitat within that stratum is occupied by Western Meadowlarks.

Sagebrush Bird Decision Support Tool

A decision support tool (DST) is an interactive computerized system that helps guide decisions when multiple factors must be weighed. Natural resource management groups have been growing more interested in using DSTs to guide management practices (Lancia et al. 1996, D'Erchia et al. 2001, Ruth et al. 2003, Lyons et al. 2008) because, according to D'Erchia et al. (2001):

> "Use of a [DST] helps resource managers better define problems, systematically review the decisions they make, analyze the factors that influence those decisions, identify information that

> is available with respect to these factors, and predict the effects of making decisions with and without desired information. A [DST] can also provide a framework for adaptive management, information feedback loops, and continuous improvement of the decision making process."

A DST provides a screenshot of complex ecological dynamics by incorporating spatial data, habitat features, biological information, economics, stakeholder interests, etc. These systems are most effectively applied when considering different ecosystem management strategies, especially when the land is subjected to multiple uses, stakeholders, and regulatory constraints. Such is the case with much of the privately and publicly owned sagebrush land across the West. Agriculture (including ranching), energy development, recreation, and wildlife use all need to be considered when creating land management plans. In particular, increased attention is being focused on the continuing decline of many sagebrush-associated species.

Bird Conservancy of the Rockies developed the sagebrush bird DST to help land managers achieve viable populations while maximizing sustainable grazing. The DST incorporates existing management planning methods (i.e., State & Transition Models [STMs] for Ecological Sites) and scientifically sound bird monitoring data (see IMBCR in Appendix B) to ensure land managers are using an integrated and standardized framework for evaluating and managing the sagebrush landscape. The DST can identify 1) where, within the sagebrush ecosystem (both within and outside of sage-grouse core areas) resource dollars should be allocated to positively affect sagebrush-obligate bird species and 2) which Conservation Practices (Table 5) are most applicable to achieve positive increases in targeted bird species (including sage-grouse) while maximizing sustainable grazing. The preliminary objectives of the DST are to help land managers increase populations of sage-grouse and other sagebrush obligate songbird species and maximize sustainable grazing.

Table 5. Conservation practices included in DST.

Shrub Management – Sagebrush
Shrub Management – Conifer
Prescribed Grazing
Prescribed Grazing and Shrub Management – Sagebrush
Deferred Grazing

This DST enhances the utility of Ecological Site Descriptions (ESDs) as a management decision tool in the sagebrush ecosystem by incorporating wildlife habitat information. Williams et al. (2011) have tested the ability of ESDs to identify songbird density and diversity in northwest Colorado. Bird Conservancy of the Rockies and partners built and expanded upon these findings by developing a DST that integrates bird monitoring data across public and private lands with ESDs across the sagebrush range so that more informed management decisions can be made. This tool is unique as it incorporates a multi-species approach for conservation planning that complements the SGI by using three years of multi-state bird monitoring data to inform the models and adaptive management strategies. The information used to build the DST and guide management decisions is organized so as to be easily accessed and used by land managers.

We analyzed IMBCR regional monitoring data (Appendix B) to estimate occupancy and density for sage-grouse, Sagebrush Sparrow, Sage Thrasher, and Brewer's Sparrow. Data are collected using the Integrated Monitoring in Bird Conservation Regions (IMBCR) framework and include multi-year data from more than 400 survey locations (resulting in more than 4,700 surveyed points) across the sagebrush ecosystem in Colorado, Wyoming, Montana, Idaho, and North and South Dakota (White et al. 2011). Habitat relationship models help determine how SGI management actions (Table 5) can influence the vegetation structure of different sagebrush communities and in turn affect available habitat. Distribution maps for the bird species can then be created (see species profiles for Sagebrush Sparrow, Sage Thrasher and Brewer's Sparrow).

To be compatible with existing conservation planning efforts, a map of Ecological Sites was overlaid with the bird data within each Major Land Resource Area. See Table 6 for a list of the Ecological Sites incorporated into the model. By overlaying the two types of data the habitat preferences of bird species are linked to ecological sites. The bird occupancy data allows us to make generalizations throughout the eastern portion of the sagebrush habitat. However, incorporating specific Ecological Sites into the model is very time consuming. See Table 6 for locations where the tool has direct relevance. We hope to incorporate additional Ecological Sites in the future.

Table 6. MLRA/Ecological Sites incorporated into the DST (see Fig. 3 for map).

MLRA	Ecological Site
34A - Cool Central Desertic Basins and Plateaus	Clayey 7-9 Green River and Great Divide Basins Clayey 10-14 Foothills and Basins West Clayey 10-14 High Plains Southeast Loamy 7-9 Green River and Great Divide Basins Loamy 10-14 Foothills and Basins West Loamy 10-14 High Plains Southeast Sandy 7-9 Green River and Great Divide Basins Sandy 10-14 Foothills and Basins West Sandy 10-14 High Plains Southeast
58A - Northern Rolling High Plains, Northern Part	Clayey RRU 58A-C 11 14 pz Clayey RRU 58A-E 10 14 pz Silty RRU 58A-C 11 14 pz Silty RRU 58A-E 11 14 pz
58B - Northern Rolling High Plains, Southern Part	Clayey 10-14 Northern Plains Clayey 15-17 Northern Plains Loamy 10-14 Northern Plains Loamy 15-17 Northern Plains

Based on the condition of a particular management unit, land managers can determine not only what the most affordable and effective Conservation Practices are but where on the landscape to implement them. Land managers can input existing and desired landscape conditions into the web-based DST which will quantify changes in the sagebrush obligate bird species densities under different management scenarios to determine which practices will provide the greatest net return at the local scale. At the landscape scale, the DST uses the sage-grouse lek area map and other large-scale GIS to determine the

most effective places to enhance habitat for sagebrush-obligate bird species. Information on how to use it will be taught in our training sessions and webinar. This project will help biologists, landowners, and land managers identify the potential of their land to support a diversity of sagebrush birds. Such documentation will help landowners rank higher when applying for financial or technical assistance programs such as EQIP.

HABPOPS

HABPOPS**,** short for Habitats and Populations Scenarios, is a tool for resource and land managers within the IWJV region. HABPOPS can be used to explore the effects that habitat management activities could have on bird populations. For program and large-scale planning and analyses, it answers the question: what are the population effects of changing habitat types or conditions? Answering this allows managers to be strategic and effective with their activities.

HABPOPS generates population estimates for three sagebrush species (Sagebrush Sparrow, Sage Thrasher, Brewer's Sparrow) and two grassland species (Grasshopper Sparrow, Long-billed Curlew), based on habitat conditions. To do so, HABPOPS combines estimates of current habitat extent and condition (from ReGap layers) with the best available data describing focal species occupancy rates and density to derive population estimates at the Bird Conservation Region (BCR) and state scale. It covers three primary BCRs in the IWJV region: 9, 10, and 16. It also ties to population objectives at the state and BCR level as defined in the IWJV 2013 Implementation Plan.

Visit the web-interface for HABPOPS to get started! It provides map integration and produces reports for your area. There, you can also download the Access database, if you would rather use the tool on your desktop, or the raw data used to build HABPOPS.

HABPOPS was also used to develop content in the Landbird Chapter of the IWJV 2013 Implementation Plan. Check it out to learn more about how HABPOPS can be applied.

The HABPOPS tool was created as a collaboration between IWJV, the American Bird Conservancy, and Point Blue Conservation Science. It was based on an original concept (the Hierarchical All-Bird Strategy (HABS) database developed by Playa Lakes Joint Venture.

Appendix A. Bird species accounts

What follows are brief biographies for sagebrush-obligate and sagebrush-associated bird species. Each species account provides information to aid in identification, plus information about the species' distribution, habitat needs, nesting, food habits, response to management actions, and population status. The Pocket Guide to Sagebrush Birds (RMBO and PRBO 2007) is a handy field guide for these species.

Refer to Appendix B for a description of the two monitoring methods (Breeding Bird Survey (BBS) and Integrated Monitoring in Bird Conservation Regions (IMBCR)) used to get population statuses reported on. Population trends are key to setting priorities for conservation of species. Tables 7 & 8 provide an overview of the state, federal, and Partner's in Flight (PIF) conservation status of the species reported on in this manual. Some species may not have enough of a detectability to have a BBS or IMBCR status report.

BBS trends for Bird Conservation Regions (BCR) and other regional areas are reported in a table format.

IMBCR density and occupancy trends are reported in two graphs. The error bars represent 1 Standard Error above and below the point estimate. Basically, if the error bars don't overlap between 2 estimates (could be different years but the same geographical region or different regions within the same year, etc.) then there is a "significant" difference. This will probably need to be explained somewhere in the intro of the species accounts section.

In addition to population trends, profiles for the Sagebrush Sparrow, Brewer's Sparrow, and Sage Thrasher also have highlighted a few habitat relationship trends developed by Bird Conservancy of the Rockies. These trends indicate specific responses of the species to various components of habitat structure.

Table 7. Species designations by Partners in Flight and state agencies.

Species	PIF					State Agencies							
	BCR 10	BCR 11	BCR 16	BCR 17	BCR 18	CPW	IDFG	MTFWP	NDGFD	NEGP	SDGFP	UDWR	WGFD
Brewer's Sparrow	SD,RC	SD	SD,RC	SD,RC	SD,RC	SGCN	SGCN	S3	LIII	Tier I			SGCN
Burrowing Owl		RC		RC	RC,RS	SGCN, ST	SGCN	S3	LII	Tier I	SGCN	SOC	SGCN
Ferruginous Hawk	RC	RC,RS	RC	RC,RS	RC,RS	SGCN, SC	SGCN	S3	LI	Tier I	SGCN	SOC	SGCN
Golden Eagle	RS	RC	RC	RC		SGCN		S3	LII	Tier II			
Gray Flycatcher						SGCN							
Greater Sage-grouse	RC,RS	RC	RC	RC,RS		SGCN, SC	SGCN	S2	LII	Tier II	SGCN	SOC	SGCN
Gunnison Sage-grouse			RC,RS			SGCN, ST							
Lark Sparrow	RS			RC									

Species	PIF					State Agencies							
	BCR 10	BCR 11	BCR 16	BCR 17	BCR 18	CPW	IDFG	MTFWP	NDGFD	NEGP	SDGFP	UDWR	WGFD
Loggerhead Shrike	SD	SD	SD,RC	SD	SD	SGCN		S3	LII	Tier II			
Long-billed Curlew						SGCN, SC	SGCN	S3	LI	Tier I	SGCN	SOC	SGCN
Mountain Plover						SGCN, SC		S2		Tier I		SOC	SGCN
Prairie Falcon		RC	RC		RC	SGCN			LII	Tier II			
Sagebrush Sparrow	RC		RC	RC		SGCN		S3					SGCN
Sage Thrasher				RC				S3		Tier II			SGCN
Sharp-tailed Grouse	RC	RS		CS,RS	RC		SGCN	S1,S4	LII			SOC	
Sharp-tailed Grouse (Columbian)						SGCN, SC		S1					SGCN
Sharp-tailed Grouse (Plains)						SGCN, SE		S4					
Vesper Sparrow	RC			RC,RS		SGCN							
Western Meadowlark		RC		RS	RC,RS								

PIF = Partners In Flight: BCR = Bird Conservation Region (See Table X); SD = Common Bird in Steep Decline; RC = Regional Concern Species; CS = Continental Stewardship Species; RS = Regional Stewardship Species

State Agencies: CPW = Colorado Department of Parks and Wildlife; SGCN = Species of Greatest Conservation Need; SE = State Endangered; ST = State Threatened; SC = State Candidate. IDFGD = Idaho Fish and Game Department; SGCN = Species of Greatest Conservation Need. MTFWP=Montana Fish Wildlife and Parks; S1 = Species at high risk because of extremely limited and/or rapidly declining numbers, range, and/or habitat; S2 =Species at risk because of very limited and/or declining numbers, range, and/or habitat; S3=Species potentially at risk because of limited and/or declining numbers, range, and/or habitat, even though it may be abundant in some areas. NDGFD = North Dakota Game and Fish Department; LI = Species in greatest need of conservation; LII = Species in need of conservation, but that have had support from other wildlife programs; LIII = Species having a moderate level of conservation priority that are peripheral or nonbreeding in North Dakota. NEGP = Nebraska Game and Parks Commission; Tier I = Globally or nationally most at-risk of extinction; Tier II = State Critically Imperiled. SDGFD = South Dakota Game and Fish Department; SGCN = Species of Greatest Conservation Need. UDWR = Utah Division of Wildlife Resources; SOC = Species of Concern. WGFD = Wyoming Game and Fish Department; SGCN = Species of Greatest Conservation Need.

Table 8. Species designations by federal agencies.

Species	USFWS		USFS				BLM						
	Reg 2	Reg 6	Reg 1	Reg 2	Reg 3	Reg 4	CO	ID	MT	ND	SD	UT	WY
Brewer's Sparrow				SS			SS	T3	SS	SS	SS		SS
Burrowing Owl	BCC	BCC	SS	SS	SS		SS		SS	SS	SS	SS	SS
Ferruginous Hawk		BCC		SS			SS	T3	SS	SS	SS	SS	SS
Golden Eagle	BCC	BCC							SS	SS	SS		
Gray Flycatcher													
Greater Sage-grouse			SS	SS		SS	SS	T2	SS	SS	SS	SS	SS

Species	USFWS		USFS				BLM						
	Reg 2	Reg 6	Reg 1	Reg 2	Reg 3	Reg 4	CO	ID	MT	ND	SD	UT	WY
Gunnison Sage-grouse		FT					SS					SS	
Lark Sparrow													
Loggerhead Shrike	BCC	BCC	SS	SS				T3	SS	SS	SS		SS
Long-billed Curlew	BCC	BCC	SS	SS			SS		SS	SS	SS	SS	SS
Mountain Plover	BCC	BCC		SS	SS		SS		SS	SS	SS	SS	SS
Prairie Falcon		BCC						T3					
Sagebrush Sparrow		BCC		SS				T3	SS	SS	SS		SS
Sage Thrasher		BCC							SS	SS	SS		SS
Sharp-tailed Grouse												SS	
Sharp-tailed Grouse (Columbian)				SS		SS	SS	T3					SS
Sharp-tailed Grouse (Plains)													
Vesper Sparrow													
Western Meadowlark													

USFWS = United States Fish and Wildlife Service: Reg = Region; BCC = Birds of Conservation Concern; FT = Federally Threatened species

USFS = United States Forest Service: SS = Sensitive Species

BLM = United States Bureau of Land Management: SS = Sensitive species for corresponding state; T2 = Range wide/Globally imperiled species; T3 = Regional/State imperiled species

SAGEBRUSH OBLIGATES

Greater Sage-grouse *Centrocercus urophasianus*

Description: Largest grouse in North America—males are as large as a small turkey. The female is about half as large as the male. Mostly brown, mottled on the back and wings, black belly, white breast, and pointed tail. Male has a black throat and white breast; female has a mottled brown head and breast.

Habitat: Uses a variety of habitats during the course of the year, principally sagebrush shrublands but also grasslands and wet meadows. When lekking, sage-grouse avoid areas where even very low levels of tree cover occur—no more than 4%—especially if the trees are small and dispersed across the area or are large and clustered (Baruch-Mordo et al. 2013). Nests on the ground, under a tall (36–79 cm; 14–31 in) sagebrush shrub in an area with 15–38% sagebrush cover (Schroeder et al. 1999). Grass and forbs must be sufficient to conceal the nest and hen, so nest sites need 3–30% residual grass cover (Schroeder et al. 1999) and at least 15% cover of herbaceous plants at least 18 cm (7 in) tall (Connelly et al. 2000). After hatching, broods move to wet meadows with abundant forbs and insects for food (Dobkin and Sauder 2004); forb cover should be at least 12–14% (Aldridge and Brigham 2002). This species spends its winters in sagebrush shrublands with 10–30% cover and shrubs tall enough to leave branches exposed at least 25–36 cm (10–14 in) above the snow (Connelly et al. 2000).

Resident status and Space Requirements: Considered non-migratory, although some populations make large seasonal movements between habitats (Connelly et al. 1988). Breeding individuals gather at leks between March and May to mate. Individuals are particularly sensitive to disturbance and males are highly territorial during this time. Both males and females may visit multiple leks within a breeding season (Emmons and Braun 1984; Dunn and Braun 1985; Dalke et al 1963, Wallestad 1975a). Home ranges vary in size throughout the year based on the distinct breeding, brooding-rearing, and wintering habitat needs described above; however, individuals spend more than 90% of their time throughout the year within 7.5 km of the lek they primarily attended (Coates et al. 2013). Birds are highly philopatric and may return to habitats, even when degraded, which do not allow birds to maximize breeding success.

Diet/feeding: In summer, eats insects and the leaves, buds, and flowers of sagebrush and various forbs (e.g., common dandelion *Taraxacum officinale*, yellow salsify *Tragopogon dubius*, and clover *Trifolium* spp.), and sagebrush leaves (Schroeder et al. 1999). In winter, eats sagebrush leaves almost exclusively.

Management: Maintain extensive area of sagebrush with understory of native grasses and forbs (Crawford et al 2004). Light to moderate grazing (20 – 60% utilization by weight), or grazing under a rest-rotation system, may benefit Greater Sage-grouse by stimulating forb growth (Van Poolen and Lacey 1979, Hart et al. 1988, Beck and Mitchell 2000). Control invasive plants (such as cheatgrass) and encroaching trees (Reinkensmeyer et al. 2007; Baruch-Mordo et al. 2013). Minimize roads, habitat fragmentation, and other disturbances. Do not utilize prescribed fire in suitable grouse habitat as it has been shown to lead to Greater Sage-grouse population declines, lower occupancy, lek failure and may lead to colonization by cheatgrass (Hulet 1983, Nelle et al. 2000, Connelly et al 1994, Arkle et al. 2014). Similarly, mechanical treatment to reduce sagebrush cover does not

typically benefit sage-grouse (Swenson et al. 1987; Hess and Beck 2014). Avoid heavy spraying of herbicide in suitable habitat as nearly all documented cases have resulted in major declines of sage-grouse populations (Enyeart 1956, Higby 1969, Peterson 1970, Wallestad 1975, Crawford et al. 2004). Light herbicide application in areas with extremely dense shrub cover may benefit sage-grouse by increasing grass and forb cover (Crawford et al. 2004). Greater Sage-grouse are susceptible to West Nile Virus (WNV) infection (Naugle et al. 2004); measures to control the mosquito vectors include controlling larvae with chemical or biological agents (e.g., BTI, *Bacillus thuringiensis* v. *israelensis*), or spraying for adults (Walker and Naugle 2011). Ponds should be constructed with steep sides to limit the shallow water needed for aquatic vegetation (such vegetation enhances the suitability of a pond for mosquito larvae); channels and spillways should be lined with crushed rock to preclude establishment of aquatic vegetation; ponds should be fenced to eliminate access by livestock or wild ungulates, which trample shorelines and enrich waters with manure, stimulating the growth of aquatic vegetation (Doherty 2007). Avoid the use of insecticides in Greater Sage-grouse habitat as dimethoate and methamidiphos have been shown to cause mortality (Blus et al. 1989).

Population status: This species is in a long-term decline (Connelly et al. 2004; Garton et. al. 2011; Garton et. al. 2015) and is projected to continue declining unless significant steps are undertaken to stem the loss (Garton et al. 2011). The following table should be viewed with caution, as Breeding Bird Survey (BBS) does not adequately sample this species (Sauer et al. 2012). IMBCR density and occupancy estimates are not currently available due to an insufficient number of detections throughout the program. Systematic, range-wide lek count surveys provide a more valuable population index for this species.

Breeding Bird Survey Population Trends

	Greater Sage-grouse	
Bird Conservation Regions and Regional levels	1966-2013	2003-2013
Continental	- 3.3 s.	- 0.3 n.s.
Western BBS	- 1.6 n.s.	- 4.6 n.s.
Northern Rockies	- 0.8 n.s.	1.0 n.s.
Great Basin	- 2.7 n.s.	- 2.4 n.s.
Southern Rockies/ Colorado Plateau	- 1.2 n.s.	6.8 n.s.
Badlands and Prairie	- 7.5 s.	- 7.6 n.s.

n.s. = not statistically significant; s. = statistically significant

Gunnison Sage-grouse *Centrocercus minimus*

Description: Smaller but otherwise very similar to Greater Sage-grouse except Gunnison Sage-grouse males have longer, thicker, more conspicuous feather plumes extending backward from the head, and shorter, more distinctly banded tail feathers (Young et. al. 2015).

Habitat: Generally similar to that of Greater Sage-grouse: sagebrush shrublands, grasslands, wet meadows. Nests on the ground in areas of 15–25% sagebrush canopy cover provided by plants 25–80 cm (10–32 inches) tall, 10–40% grass cover at least 10 cm (4 inches) tall, 5–40% forb cover; winters in areas with 10–40% sagebrush canopy cover provided by plants 25–55 cm (10–22 inches) tall (Gunnison Sage-grouse Rangewide Steering Committee 2005).

Resident status and Space Requirements: Considered non-migratory, although birds may make large movements between seasonal habitats. Space requirement is assumed to be similar to Greater Sage-grouse. Aldridge et al. (2012) observed a maximum distance of 10.1 km (6.3 mi) between nest sites and leks.

Diet/feeding: In summer, eats insects and sagebrush shoots, buds, and flowers. In winter, eats sagebrush leaves almost exclusively (Patterson 1952; Schroeder et al. 1999).

Management: Management recommendations are similar to those for Greater Sage-grouse. Avoid heavy grazing (Lupis et al 2006), herbicide application, mechanical sagebrush removal treatments, and prescribed fire (Bukowski and Baker 2013) as these reduce shrub canopy cover and degrade habitat. Maintain a large mosaic of tall sagebrush mixed with native grasslands (including perennial bunchgrass), forbs, and legumes. Control invasive plants (such as cheatgrass) and encroaching trees. Minimize roads, habitat fragmentation, and other disturbances (Aldridge et al. 2012). Short-term, high-intensity deferred grazing rotations are recommended to maximize the amount of time substantial grass cover is present within parcels (Lupis et al. 2006).

Population status: Occurs in seven distinct populations in southwestern Colorado and southeastern Utah. Overall, the species appears to be declining (Davis 2012), although that trend might be driven by declines among the six smallest populations, while the largest population is stable. Breeding Bird Survey (BBS) does not adequately sample this species (Sauer et al. 2012). IMBCR density and occupancy estimates are not currently available due to an insufficient number of detections throughout the program.

Breeding Bird Survey Population Trends

	Gunnison Sage-grouse	
Bird Conservation Regions and Regional levels	1966-2013	2003-2013
Continental	n.d.	n.d.
Western BBS	n.d.	n.d.
Northern Rockies	n.d.	n.d.
Great Basin	n.d.	n.d.
Southern Rockies/ Colorado Plateau	n.d.	n.d.
Badlands and Prairie	n.d.	n.d.

n.d. = no data

Sage Thrasher *Oreoscoptes montanus*

Description: Gray tail, back, wings, and head; white chin; white breast and belly with black spots and streaks; pale yellow eyes. Tail is long, with white corners.

Habitat: Sagebrush shrublands, especially taller, older stands of big sagebrush (*Artemisia tridentata*) with limited grass cover. The bulky nest of twigs is placed on the ground under a shrub or up to 1 m (3 ft) high in shrubs; requires tall sagebrush plants for nesting (Reynolds et al. 1999; Rich et al. 2005).

Resident status and Space Requirements: Migratory. Individuals arrive on breeding grounds in early spring (February to May depending upon location within range) and begin southward migration in August or early September. Territory size depends upon quality of habitat and geography. Mean territory sizes are generally between 0.4 and 1.7 ha (Reynolds et al. 1999).

Diet/feeding: Collects insects from the ground, especially ants, beetles, and grasshoppers; occasionally eats seeds and small fruits.

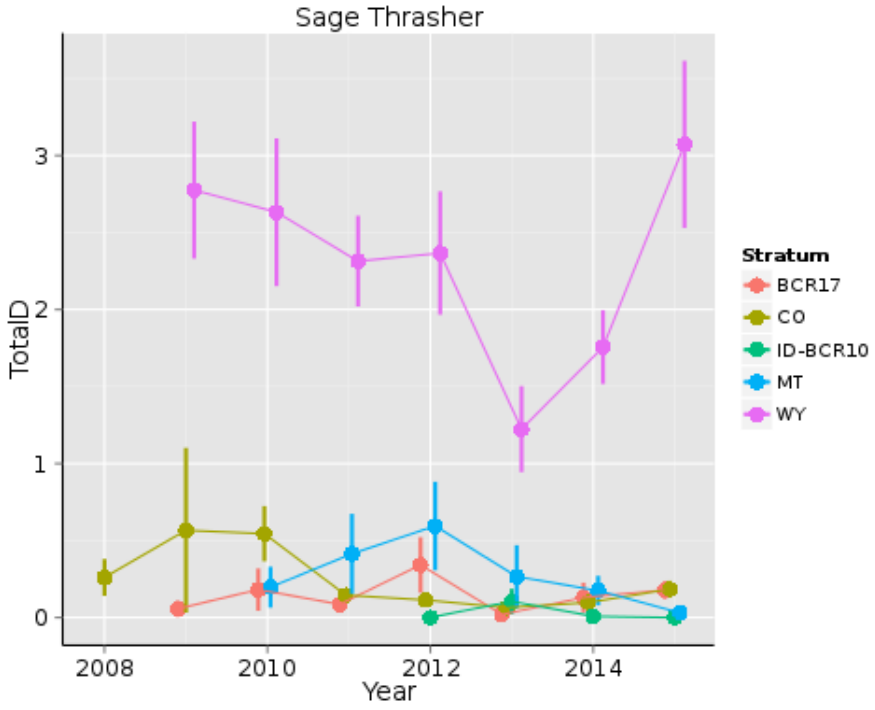
Management: Maintain large stands of older, denser sagebrush (Knick and Rotenberry 1995). Control invasive plants (such as cheatgrass) and encroaching trees (Reynolds, Rich, and Stephens 1999). Avoid utilizing prescribed fire in suitable habitat (Holmes 2007). Additionally, refrain from other management actions that reduce sagebrush canopy cover such as mechanical sagebrush removal, herbicide application, and heavy grazing based on the observed positive correlation between Sage Thrasher densities and the amount of sagebrush canopy cover (Dobler et al. 1996; Noson et al 2006). Juniper removal may increase densities (Noson et al. 2006).

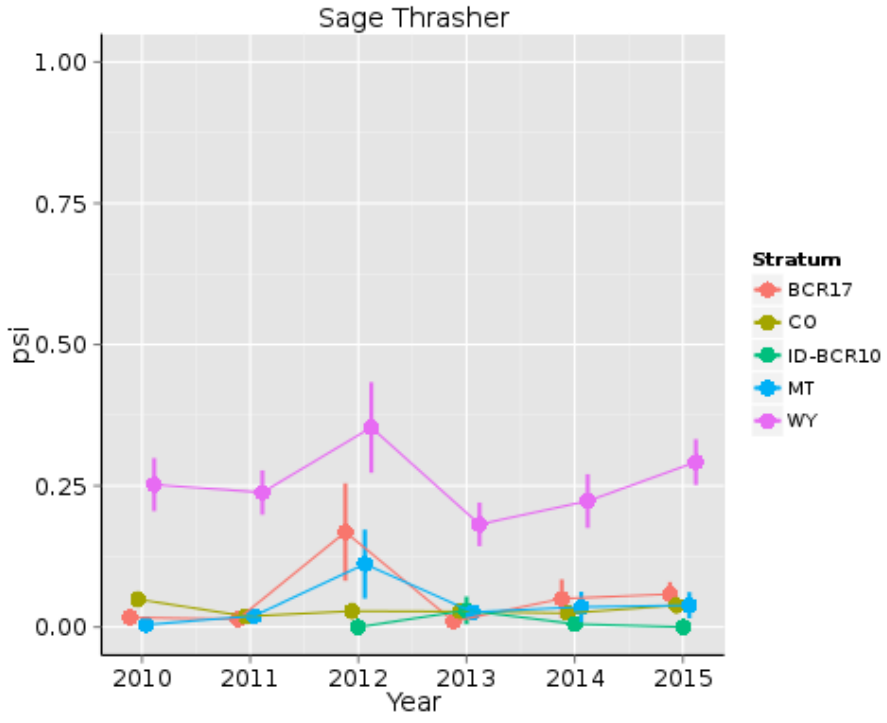
Population status: BBS data show a steady, statistically significant decline across much of this species' range (Sauer et al. 2012). IMBCR data demonstrate reduced statewide densities in 2014 compared to 2009 for Wyoming and Colorado.

Breeding Bird Survey Population Trends

	Sage Thrasher	
Bird Conservation Regions and Regional levels	1966-2013	2003-2013
Continental	- 1.4 s.	- 1.2 n.s.
Western BBS	- 1.4 s.	- 1.2 n.s.
Northern Rockies	- 0.8 n.s.	- 1.9 n.s.
Great Basin	- 1.6 s.	- 1.1 n.s.
Southern Rockies/ Colorado Plateau	- 1.6 s.	0.6 n.s.
Badlands and Prairie	0.4 n.s.	- 2.1 n.s.

n.s. = not statistically significant; s. = statistically significant


Sage Thrasher
TotalD
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY


Sage Thrasher
psi
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY

Habitat Relationship models from IMBCR modeling:

Sage thrasher occupancy at point count locations did not vary by vegetation type, but occupancy increased with increasing forb ground cover (Fig. 6). Sage thrasher occupancy was positively related to shrub cover and was greatest when shrub height was approximately 2 ft (Fig. 7). Finally, the occupancy rates of the sage thrasher declined with increasing tree canopy cover (Fig. 8).

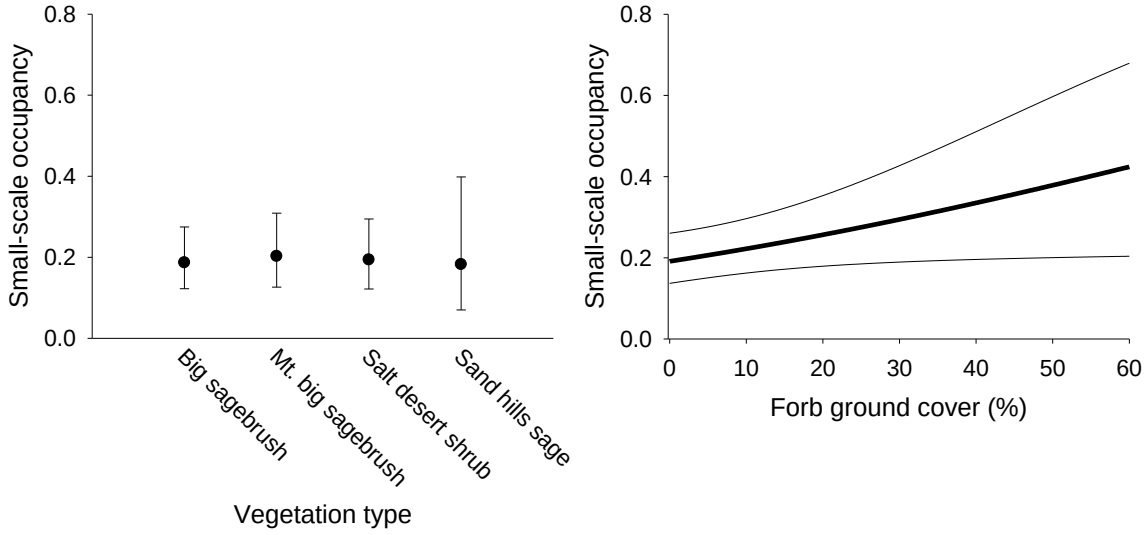


Figure 6. The small-scale occupancy of the sage thrasher by vegetation type and forb ground cover in the big sagebrush vegetation type. The bold symbols and line represent the occupancy rate for point count plots at average values of the other habitat variables, and the error bars and bounding lines are 95% confidence intervals.

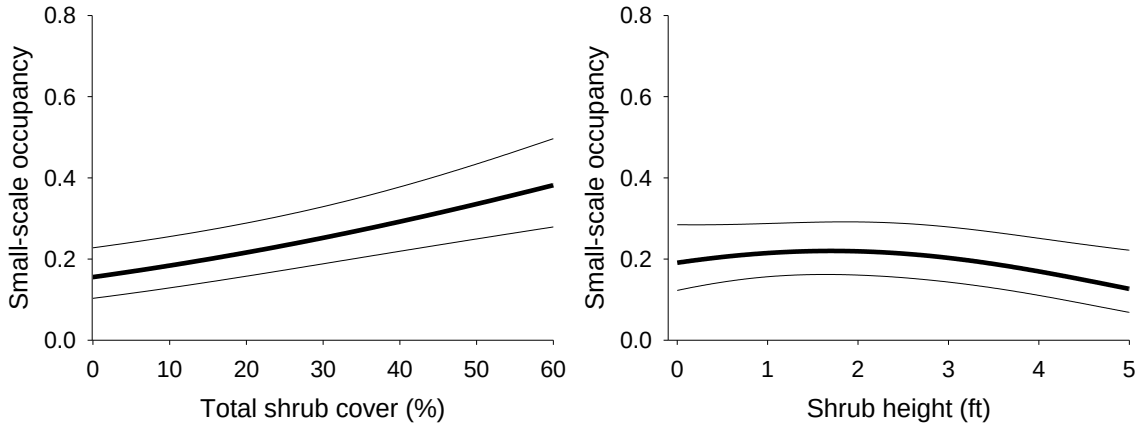


Figure 7. The small-scale occupancy of the sage thrasher by total shrub cover and shrub height in the big sagebrush vegetation type. The bold line represents the occupancy rate at point count locations for average vegetation conditions in the study area and the bounding lines are 95% confidence intervals.

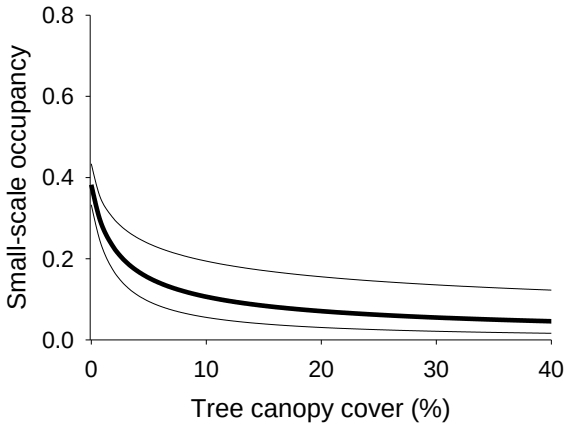


Figure 8. The small-scale occupancy of the sage thrasher by tree canopy cover in the big sagebrush vegetation type. The bold line represents the occupancy rate for point count plots at average values of the other habitat variables and the bounding lines are 95% confidence intervals.

Brewer's Sparrow *Spizella breweri*

Description: Plain, rather small and nondescript sparrow with unmarked gray breast and belly, gray eyebrow; relatively long, notched tail.

Habitat: Sagebrush shrublands, especially large stands of tall big sagebrush with limited grass cover (Dobkin and Sauder 2004); also areas with yucca or other shrubs. Show preference for areas with shrubs between 50 and 150 cm tall (Paige and Ritter 1999, Chalfoun and Martin 2007). May reach highest abundances in areas with deep, loamy soils (Vander Haegen et al. 1999). Nest is placed low (0–3 feet above ground) in a sagebrush shrub; sometimes nests in other shrub species or cactus (Rotenberry et al. 1999). The nest is built of grasses and other plant materials, with a lining of finer plant materials and/or mammal hair.

Resident status and Space Requirements: Migratory. Individuals arrive on the breeding grounds between mid-March and mid-May. Begin southward migration in mid-August through October. Territory sizes vary based on habitat quality and location within range but are generally between 0.5 and 2.3 ha (Rotenberry et al. 1999).

Diet/feeding: Forages for insects in shrubs and low trees; also collects seeds on the ground.

Management: Maintain large patches of sagebrush with dense shrub cover (Knick and Rotenberry 1995). Control invasive plants such as cheatgrass (Rotenberry 1998). Avoid the use of prescribed fire which reduces sagebrush cover and lowers Brewer's Sparrow densities (Holmes 2007). Juniper removal may lead to increased densities (Noson et al. 2006, Crow and van Riper III 2010).

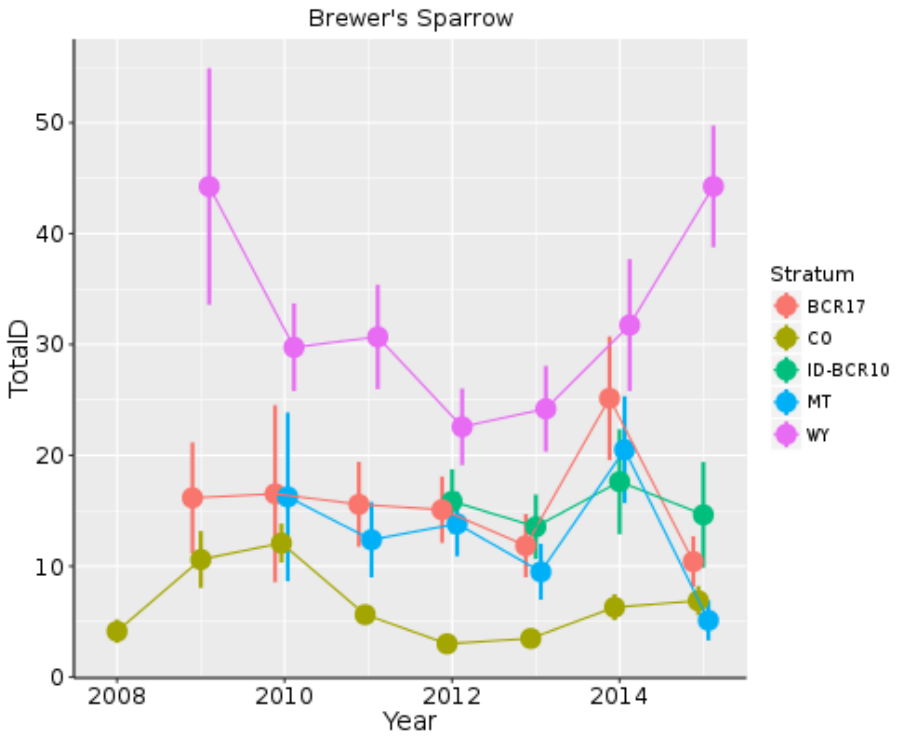
Population status: Difficult to discern from BBS data due to a lack of statistical significance and small sample sizes (Sauer et al. 2012). A different analysis of BBS data suggests that the species is declining at the periphery of its range but increasing in core areas, at least up through 2001 (Dobkin and Sauder 2004). IMBCR results indicate that density and occupancy estimates are holding rather steady (no statistically significant difference) between 2009 and 2014 for most regions sampled.

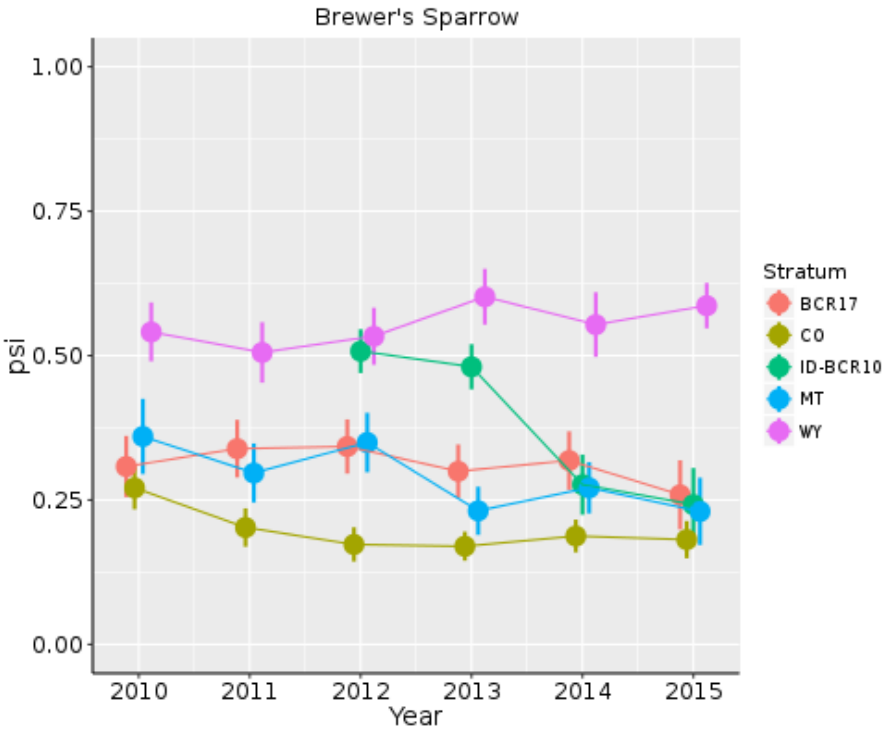
Statistically significant declines did occur from 2009 through 2012 for some regions before rebounding in 2013 and 2014. Wyoming hosts significantly larger densities of Brewer's Sparrow than other regions sampled under the IMBCR program. Occupancy rates have generally held steady; however, occupancy within the Idaho-portion of BCR10 did decline in 2014.

Breeding Bird Survey Population Trends

	Brewer's Sparrow	
Bird Conservation Regions and Regional levels	1966-2013	2003-2013
Continental	- 1.0 s.	- 0.7 n.s.
Western BBS	- 0.6 n.s.	- 0.7 n.s.
Northern Rockies	- 0.3 n.s.	- 0.8 n.s.
Great Basin	- 0.4 n.s.	-0.6 n.s.
Southern Rockies/ Colorado Plateau	- 1.9 s.	- 1.4 n.s.
Badlands and Prairie	- 2.6 s.	1.5 n.s.

n.s. = not statistically significant; s. = statistically significant





Habitat Relationship models from IMBCR modeling:

We discovered that Brewer's sparrow occupancy at point count locations varied by vegetation type and declined with increasing bare ground cover (Fig. 9). The occupancy rates were greatest in mountain big sagebrush and big sagebrush, and were lower in the other vegetation types (Fig. 9). Brewer's sparrow occupancy also increased with big sagebrush cover and was greatest where shrub height was approximately 3 ft (Fig. 10). Finally, Brewer's sparrow occupancy was negatively related to woodland canopy cover (Fig. 11).

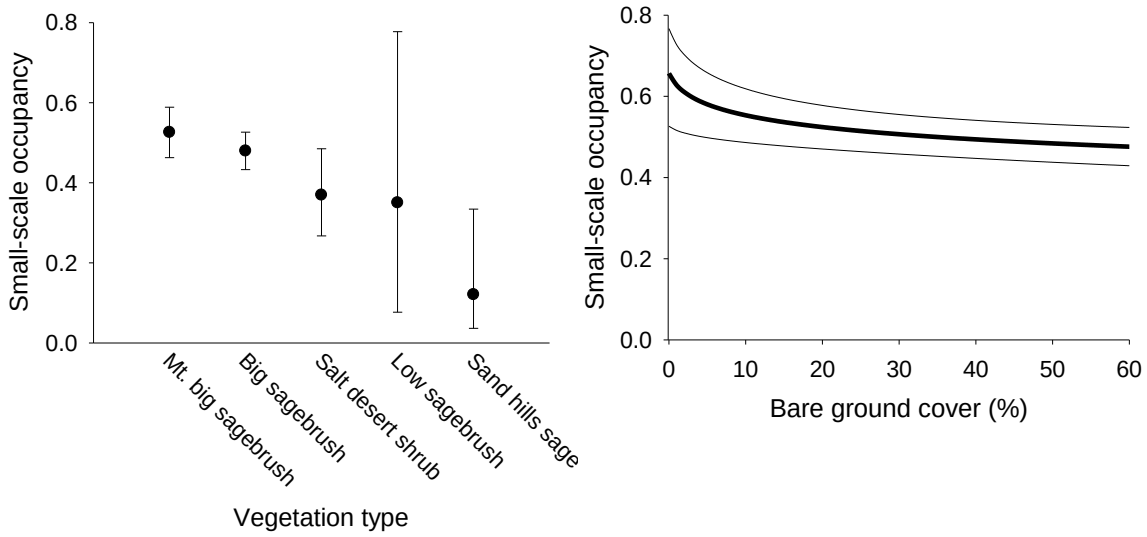


Figure 9. The small-scale occupancy of the Brewer's sparrow by vegetation type and bare ground cover in the big sagebrush vegetation type. The bold symbols and line represent the occupancy rate for point count plots at average values of the other habitat variables, and the error bars and bounding lines are 95% confidence intervals.

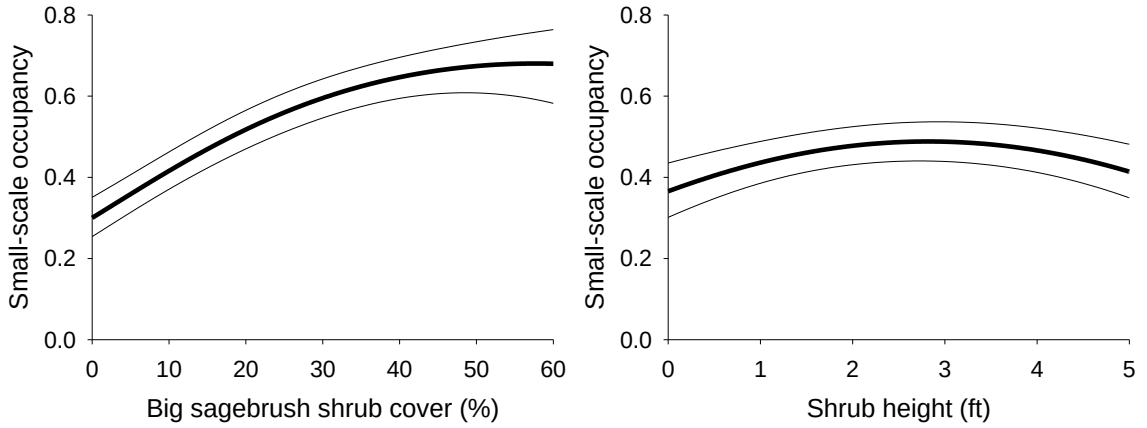


Figure 10. The small-scale occupancy of the Brewer's sparrow by big sagebrush cover and shrub height in the big sagebrush vegetation type. The bold lines represent the occupancy rate at point count locations for point count plots at average values of the other habitat variables and the bounding lines are 95% confidence intervals.

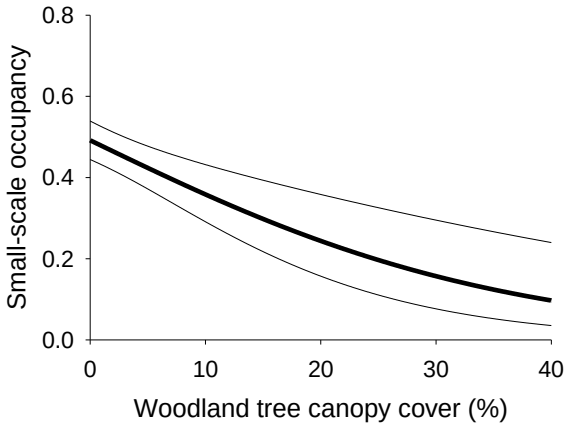


Figure 11. The small-scale occupancy of the Brewer's sparrow by woodland tree canopy cover in the big sagebrush vegetation type. The bold line represents the occupancy rate at point count locations for point count plots at average values of the other habitat variables and the bounding lines are 95% confidence intervals.

Sagebrush Sparrow *Artemisiospiza nevadensis*

Description: Grayish brown back, wings, and head; white "eyebrows," throat, breast, and belly. Dark spot in center of the breast. White ring around the eye.

Habitat: Shrublands with evenly spaced shrubs, especially big sagebrush (Hanser and Knick 2011). Positively associated with shrub cover and taller grasses. Nests on the ground beneath a shrub, or low in a shrub; the nest is constructed of twigs, grasses and other plant materials, the cup is lined with fine plant materials, feathers, and/or mammal hair (Martin and Carlson 1998). Have reached high densities in deep, loamy soils (Vander Haegen et al. 1999)

Resident status and Space Requirements: Migratory. Individuals arrive on breeding grounds between mid-March and early May. Begin southward migration between early September and mid-November (Martin and Carlson 1998). Mean territory sizes are quite variable depending upon geographical location and can range from about 0.5 to 4.5 ha. Demonstrate strong breeding site fidelity (Wiens and Rotenberry 1985, Wiens et al. 1986, and Knick and Rotenberry 2000).

Diet/feeding: Collects insects, seeds, and small fruits from the ground and low in shrubs or other vegetation.

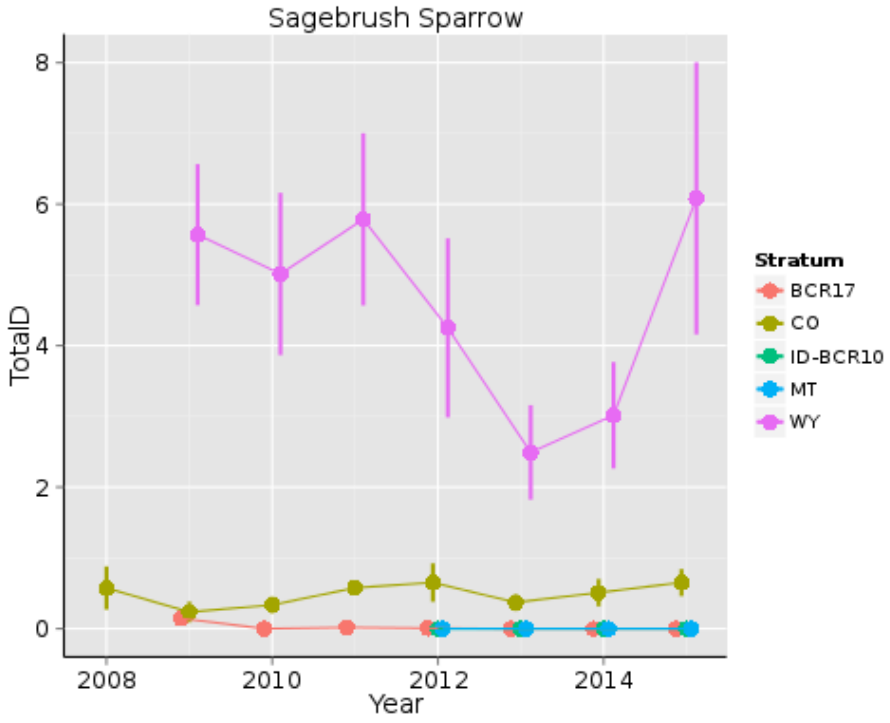
Management: Maintain sagebrush shrublands, especially old, open stands; control invasive plants (such as cheatgrass) (Wiens 1985, Rogers et al. 1988) and encroaching trees. Maintaining large patches of sagebrush may help minimize brood parasitism (Martin and Carlson 1998). Minimize management actions that reduce sagebrush cover; including prescribed fire, herbicide application, chaining, mowing, and other mechanical shrub removal treatments (Noson et al. 2006, Earnst et al. 2009, Hanser and Knick 2011, Holmes and Robinson 2013, Norvell et al. 2014). Juniper removal may increase densities (Reinkensmeyer et al. 2007).

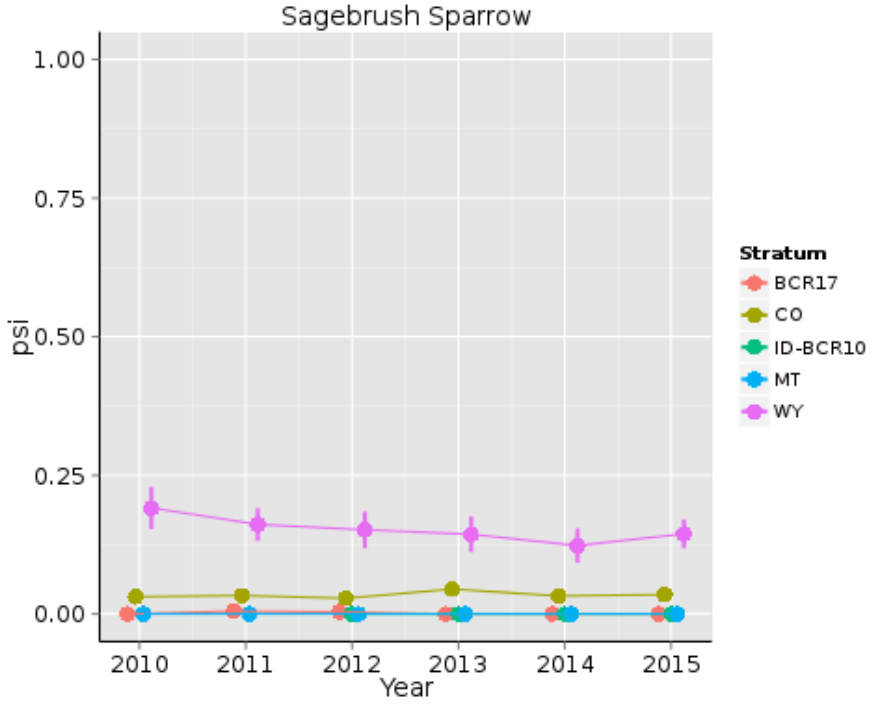
Population status: Difficult to discern from BBS data due to a lack of statistical significance and small sample sizes (Sauer et al. 2012). A different analysis of BBS data suggests a decline, at least up through 2001 (Dobkin and Sauder 2004). Data indicate that Wyoming hosts by far the largest densities of Sagebrush Sparrow within the region covered by the IMBCR program. Wyoming densities of Sagebrush Sparrows have declined significantly from 2009 to 2014. Occupancy and density estimates have held steady for Sagebrush Sparrow throughout the other regions covered by the IMBCR program.

Breeding Bird Survey Population Trends

	Sagebrush Sparrow	
Bird Conservation Regions and Regional levels	1966-2013	2003-2013
Continental	- 0.7 n.s.	- 2.7 n.s.
Western BBS	- 0.7 n.s.	- 0.1 n.s.
Northern Rockies	0.3 n.s.	2.0 n.s.
Great Basin	- 0.7 n.s.	- 0.8 n.s.
Southern Rockies/ Colorado Plateau	- 1.1 n.s.	- 0.8 n.s.
Badlands and Prairie	0.0 n.s.	-15.0 n.s.

n.s. = not statistically significant; s. = statistically significant


Sagebrush Sparrow
TotalD
8
6
4
2
0
2008
2010
2012
2014
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY


Sagebrush Sparrow
psi
1.00
0.75
0.50
0.25
0.00
2010
2011
2012
2013
2014
2015
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY

Habitat Relationship models from IMBCR modeling:

The occupancy rates of the sagebrush sparrow varied by vegetation type and increased with increasing grass height (Fig. 12). Sagebrush sparrows occurred more frequently in the salt desert shrub vegetation type and less frequently in mountain big sagebrush and big sagebrush (Fig. 12). The occupancy rates of the sagebrush sparrow occupancy were positively related to big sagebrush cover and negatively related to shrub height (Fig. 13). In addition, the occupancy rates of the sagebrush sparrow declined with increasing woodland canopy cover (Fig. 14).

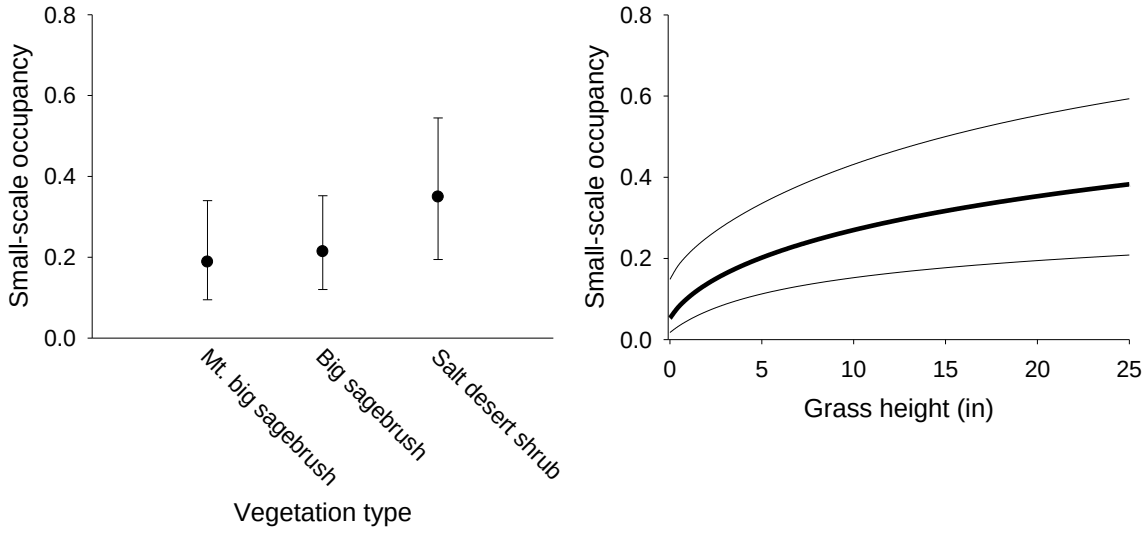


Figure 12. The small-scale occupancy of the sagebrush sparrow by vegetation type and grass height in the big sagebrush vegetation type. The bold symbols and line represent the occupancy rate for point count plots at average values of the other habitat variables, and the error bars and bounding lines are 95% confidence intervals.

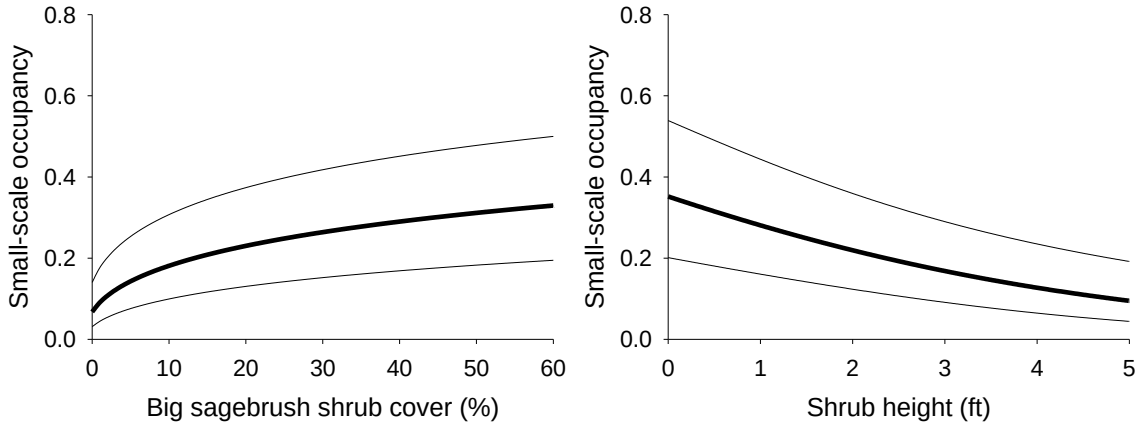


Figure 13. The small-scale occupancy of sagebrush sparrow by big sagebrush cover and shrub height in the big sagebrush vegetation type. The bold line represents the occupancy rate at point count locations for point count plots at average values of the other habitat variables and the bounding lines are 95% confidence intervals.

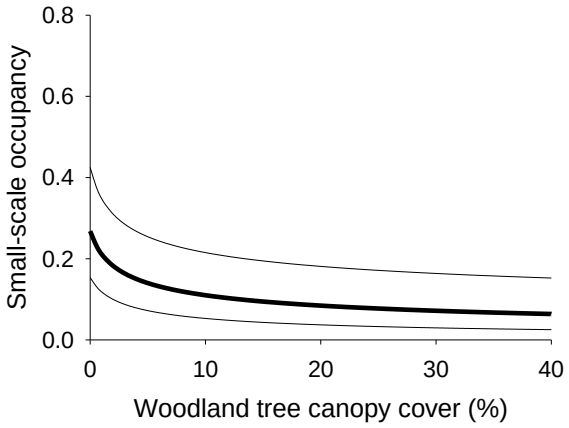


Figure 14. The small-scale occupancy of the sagebrush sparrow by woodland tree canopy cover in the big sagebrush vegetation type. The bold line represents the occupancy rate at point count locations for point count plots at average values of the other habitat variables and the bounding lines are 95% confidence intervals.

OTHER SAGEBRUSH-ASSOCIATED SPECIES

Sharp-tailed Grouse *Tympanuchus phasianellus*

Description: Mottled, mostly dark brown back and wings, dark brown spots on white breast and belly. Most distinctive feature is the pointed tail, a result of the central tail feathers being longer than the rest. During courtship displays, male displays purple-colored air sacs on sides of the neck.

Habitat: Breeds in sagebrush shrubland interspersed with open grassy areas; prefers sagebrush with an abundance of herbaceous plants (Connelly et al. 1998). Will sometimes nest in alfalfa or wheat stubble (Connelly et al. 1998). Lays its eggs in a shallow depression scraped into the ground, under a shrub where vegetation is dense and at least 30 cm (12 in) tall (Connelly et al. 1998). Breeding usually begins in April or May. As with Greater Sage-grouse, newly hatched broods are moved to areas rich in forbs and insects for food (Dobkin and Sauder 2004). Winters in riparian areas and woodlands.

Resident status and Space Requirements: Not considered long-distance migrants but may relocate to sheltered and wooded habitats when grasslands become snow-covered (Connely et al. 1998). Mean distance between lek and nest is 0.4 - 1.8 km.

Diet/feeding: Collects seeds, berries, buds, and insects from the ground or low shrubs.

Management: Maintain a mosaic of tall sagebrush mixed with native grasslands (including perennial bunchgrass) and abundant forbs and legumes for nesting and brood-rearing habitats (Dobkin and Sauder 2004). Shrub canopy cover between 20 and 40% is considered optimal (Marks and Marks 1977). Prescribed fire has shown mixed effects with benefits occurring in dense sagebrush where small openings are made in the sagebrush canopy. Substantial removal of sagebrush cover through fire is not thought to be beneficial (Rogers 1969, Oedekoven 1985). Moderate to light cattle stocking rates should be maintained to prevent habitat loss through cover removal, loss of palatable herbaceous vegetation, trampling of nests, and degradation of riparian areas (Zeigler 1970, Kessler

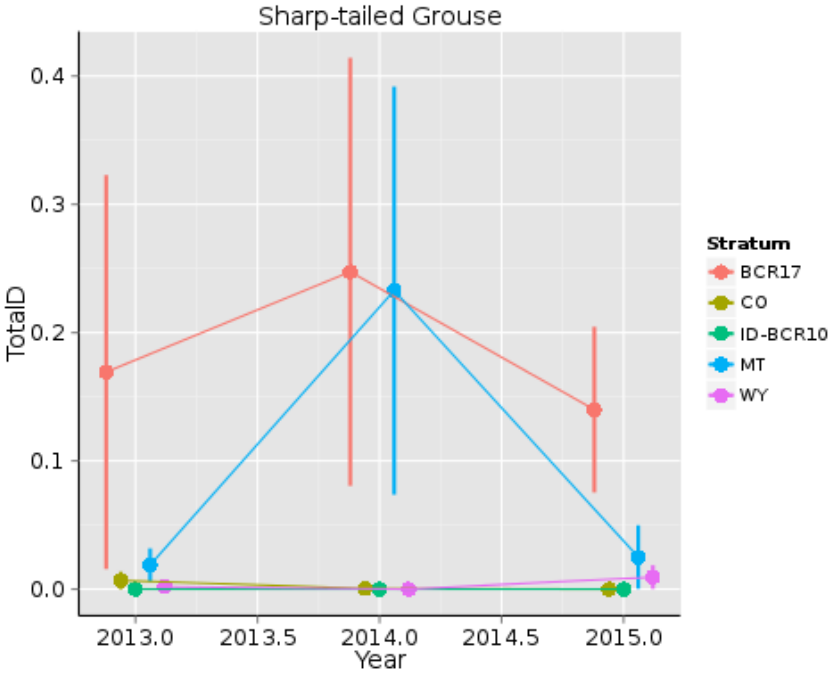
and Bosch 1982, and Marks and Marks 1987, Saab and Marks 1992). Avoid disturbance at leks during breeding season and within a 2-km (1.25-mi) radius (Connelly et al. 1998).

Population status: Declining. The following table should be viewed with caution, as Breeding Bird Survey (BBS) does not adequately sample this species (Sauer et al. 2012). The IMBCR program has produced density and occupancy estimates for 2013 and 2014; however, data are insufficient to provide information on population status at this time.

Breeding Bird Survey Population Trends

	Sharp-tailed Grouse	
Bird Conservation Regions and Regional levels	1966-2013	2003-2013
Continental	0.2 n.s.	3.2 n.s.
Western BBS	2.0 n.s.	3.7 n.s.
Northern Rockies	2.0 n.s.	3.7 n.s.
Great Basin	n.d.	n.d.
Southern Rockies/ Colorado Plateau	n.d.	n.d.
Badlands and Prairie	0.3 n.s.	4.6 n.s.

n.s. = not statistically significant; s. = statistically significant, n.d. = no data


Sharp-tailed Grouse
TotalD
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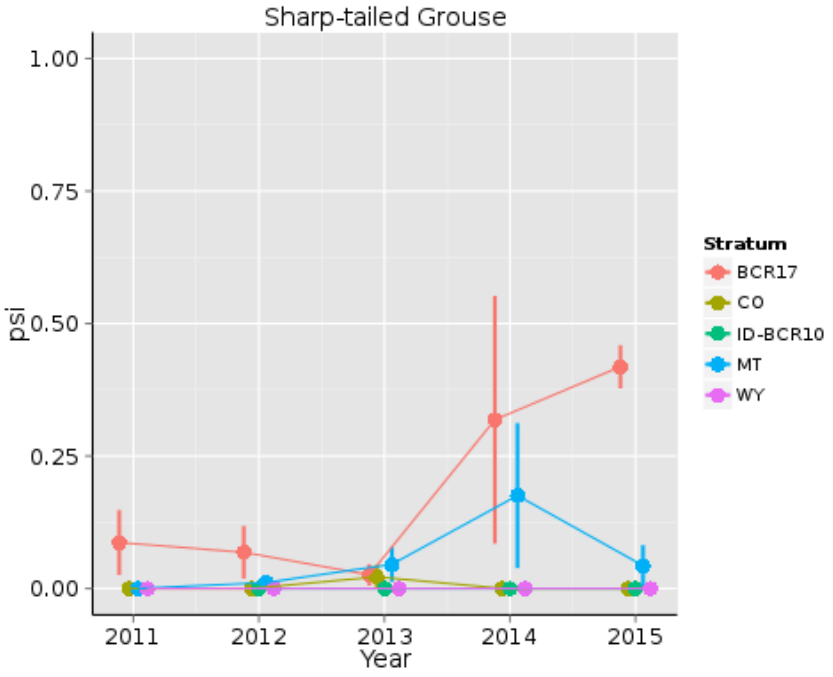
0.3
0.2
0.1
0.0
2013.0
2013.5
2014.0
2014.5
2015.0
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY


Sharp-tailed Grouse
psi
1.00
0.75
0.50
0.25
0.00
2011
2012
2013
2014
2015
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY

Ferruginous Hawk *Buteo regalis*

Description: Large-bodied buteo. Shape resembles a stocky Red-tailed Hawk. Typical adults viewed from below look almost all white; the back and upperparts are rust-colored. The legs are rust-colored and form a sharp contrast with the white belly and tail. The tail lacks the dark bands seen on most hawks.

Habitat: Open areas including grasslands and sagebrush shrublands. The large nest is usually placed in a tree or shrub or other elevated surface, but occasionally on the ground. Select for nest sites in juniper trees in some areas (Keough and Conover 2012, Coates et al. 2014). Will not regularly nest on anthropogenic structures (Coates et al. 2014). Nest is built of sticks, bones, and grass (Bechard and Schmutz 1995).

Resident status and Space Requirements: Migratory; however, small populations may winter in sagebrush regions. Ferruginous Hawk density will likely decline in sagebrush habitats in early August to late September with the onset of southward migration. Most individuals return to breeding grounds between late February and early April (Bechard and Schmutz 1995). Nearest-neighbor distances between nests in 11 studies were an average of 3.4 km apart.

Diet/feeding: Hunts for small to medium-sized mammals (especially rabbits, jackrabbits, ground squirrels, and prairie dogs) from the ground or from an elevated perch. Occasionally takes birds and reptiles.

Management: Manage for large, intact, parcels of sagebrush and grassland as this species can be sensitive to disturbance and avoids edges (Coates et al. 2014). Maintain some interface with sagebrush and pinyon-juniper habitat for nesting sites. Retain known nest trees and avoid disturbance of active nests. Avoid prescribed and wild-fires within occupied area (Coates et al. 2014). Maintain populations of small mammals, especially prairie dogs and jackrabbits. Follow bird-friendly practices for wind-energy developments and raptor-friendly practices for power lines/poles to prevent electrocutions.

Population status: Difficult to discern from BBS data due to a lack of statistical significance and small sample sizes (Sauer et al. 2012), although a different analysis of BBS data suggests a slight increasing trend, at least up through 2001 (Dobkin and Sauder 2004). IMBCR density and occupancy estimates are not currently available due to an insufficient number of detections throughout the program.

Breeding Bird Survey Population Trends

	Ferruginous Hawk	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	0.7 n.s.	1.5 n.s.
Western BBS	1.0 n.s.	1.4 n.s.
Northern Rockies	1.8 n.s.	2.1 n.s.
Great Basin	0.5 n.s.	0.9 n.s.
Southern Rockies/ Colorado Plateau	1.4 n.s.	1.3 n.s.
Badlands and Prairie	1.5 n.s.	2.8 n.s.

n.s. = not statistically significant; s. = statistically significant

Golden Eagle *Aquila chrysaetos*

Description: Adult is dark brown all over with a golden brown head; immature birds have a white patch toward the end of each wing (visible while in flight) and at the base of the tail.

Habitat: Nests in mountainous areas or open country, spends winters in open areas. The bulky nest of sticks is placed on cliffs, rock outcrops, or in trees; nest site usually offers a commanding view of the surrounding area (Kochert et al. 2002).

Resident status and Space Requirements: Considered short to medium-distance migrant; however, can be found in sagebrush shrublands throughout the year (Kochert et al 2002). Territory size and spacing is highly variable based on geography but mean distances between nests probably average about 4 to 5 km based on research in Idaho and Wyoming (Kochert 1972, Phillips et al. 1984). Territories may overlap slightly.

Diet/feeding: Hunts for small to medium-sized mammals (especially rabbits, jackrabbits, and prairie dogs), primarily by soaring but also by watching from a perch. May scavenge on carrion, especially during winter. Occasionally takes adult birds, eggs, and nestlings (Kochert et al. 2002).

Management: Maintain shrub communities within 3 km (about 2 mi) of nests by controlling wildfires and re-vegetating burned areas with native shrubs (Kochert et al. 1999). Avoid practices that result in substantial loss of shrub canopy cover (Kochert et al. 1999) including mowing, chaining, herbicide application, and prescribed fire. Maintain rabbit, jackrabbit, and prairie dog populations (Marzluff et al. 1997). Avoid disturbing active nests by staying as far away as possible and/or limiting the number and duration of disturbance events. Follow bird-friendly practices for wind-energy developments and raptor-friendly practices for power lines/poles to prevent electrocutions (Kochert et al. 2002).

Population status: Difficult to discern from BBS data due to a lack of statistical significance (Sauer et al. 2012), but other data sources suggest that the species is stable in the West (Farmer et al. 2008, Millsap et al. 2013). IMBCR density and occupancy estimates are not currently available due to an insufficient number of detections throughout the program.

Breeding Bird Survey Population Trends

	Golden Eagle	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	- 0.1 n.s.	- 0.9 n.s.
Western BBS	- 0.2 n.s.	0.3 n.s.
Northern Rockies	0.5 n.s.	0.7 n.s.
Great Basin	0.4 n.s.	0.2 n.s.
Southern Rockies/ Colorado Plateau	- 1.6 n.s.	- 0.1 n.s.
Badlands and Prairie	- 1.0 n.s.	0.5 n.s.

n.s. = not statistically significant; s. = statistically significant

Prairie Falcon *Falco mexicanus*

Description: Pointed wings typical of falcons. Back and upper side of wings are brown; from below, wings and body are pale, contrasting with dark brown "armpits" under the wings, close to the body. A narrow, dark brown bar extends below each eye.

Habitat: Open areas with cliffs or rocky outcrops, including grasslands and sagebrush shrublands. Nest is a shallow depression scraped in the soil and debris of cliff ledges. Will sometimes use stick nests built previously by other species such as Common Ravens and Golden Eagles (Steenhof 2013). Can be found in sagebrush shrublands throughout the year.

Resident status and Space Requirements: Some individuals may leave breeding grounds in June or July and migrate to higher elevations or latitudes in search of prey. Southward migration occurs mostly between early September and late October. Individuals return to breeding grounds in late February to early May (Steenhof 1998). Do not defend wintering sites and only defend area immediately around the nest during the breeding season. Spacing likely depends upon prey and nest site availability. In areas with abundant nest sites minimum distances between nests may be approximately 700m or less. Where nest sites are more limiting, and cliffs are more widely spaced, distances between nests may be closer to 8 to 10 km (Stenhoff 1999).

Diet/feeding: Hunts while flying, catching birds in midair and small mammals on the ground; primary prey is ground squirrels and songbirds, but occasionally takes lizards or flying insects (Steenhof 2013).

Management: Maintain open sagebrush shrublands, (i.e., low, scattered shrubs with moderate grass cover) (Dobkin and Sauder 2004) and small-mammal populations. Avoid disturbances near cliffs that hold (or could potentially hold) nests by staying as far away as possible and/or limiting the number and duration of disturbance events. Restrict access within 1km of known active nest sites. Construction of artificial nest sites may be effective in areas with highly eroded cliffs (e.g., sandstone) (Stenhof 1999).

Population status: Difficult to discern from BBS data due to a lack of statistical significance and small sample sizes (Sauer et al. 2012), but data from other sources suggest a stable population (Farmer et al. 2008). IMBCR density and occupancy estimates are not currently available due to an insufficient number of detections throughout the program.

Breeding Bird Survey Population Trends

	Prairie Falcon	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	0.8 n.s.	1.4 n.s.
Western BBS	1.0 n.s.	1.8 n.s.
Northern Rockies	0.1 n.s.	0.6 n.s.
Great Basin	1.4 s.	2.0 n.s.
Southern Rockies/ Colorado Plateau	1.9 n.s.	1.8 n.s.
Badlands and Prairie	- 1.1 n.s.	- 3.2 n.s.

n.s. = not statistically significant; s. = statistically significant

Mountain Plover *Charadrius montanus*

Description: Pale tan back and wings, white breast and belly, a black patch above the white forehead, and a black stripe between the black beak and eye.

Habitat: A grassland species, it also breeds in open grassy areas within sagebrush shrublands, freshly plowed fields, or other areas with vegetation shorter than about 5 cm (2 in) and areas of bare ground. Show a preference for areas with very little slope (Beauvais and Smith 2003). Within sagebrush shrublands, habitat is likely dictated by poor soil quality, high winds, and low precipitation. Since these drivers are likely to be consistent, suitable habitat may be stable across years (Beauvais and Smith 2003). Nest sites typically have shorter vegetation and a larger percentage of rock cover than surrounding areas (Manning and White 2001). In Wyoming, nests are located in areas of dense birdsfoot sage (*Artemisia pedatifida*), or miniature sagebrush about 10 cm (4 in tall). The heavily camouflaged eggs are laid in a simple depression scraped out in gravel or soil; adults add material to the nest, including lichen, bits of cow manure, and plant parts, until the eggs are partially buried (Knopf and Wunder 2006).

Resident status and Space Requirements: Migratory. Individuals typically arrive on breeding grounds in early March to mid-April. Southern breeding individuals tend to arrive on breeding grounds earlier. Individuals depart for wintering grounds between early July and early August (Knopf 1996). Mean territory sizes in Colorado ranged from 131 to 243 ha, depending upon habitat (Dreitz et al. 2005).

Diet/feeding: Captures insects on the ground; prey items include grasshoppers, crickets, and beetles (Knopf and Wunder 2006).

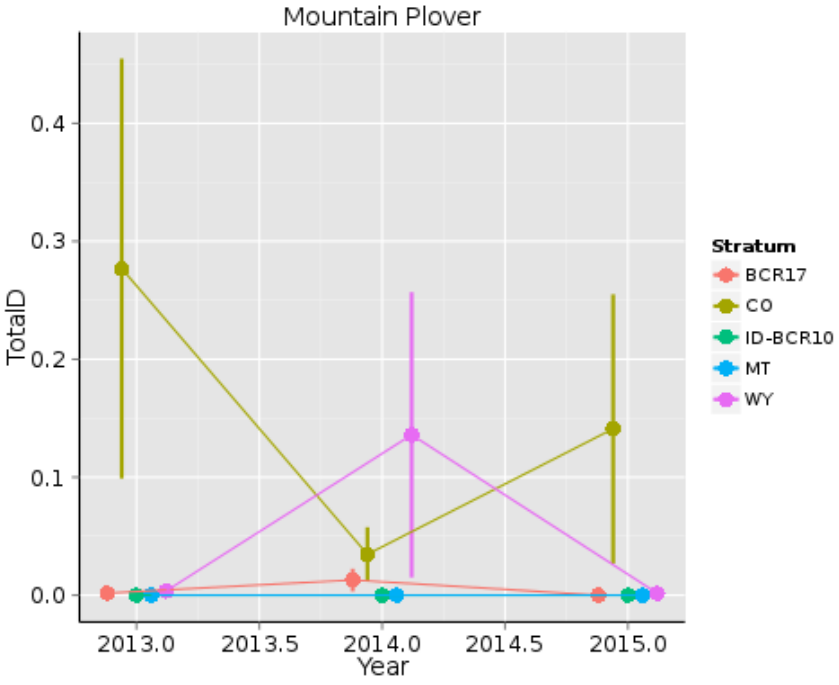
Management: Maintain open grassy areas with extensive bare ground; maintain prairie dog colonies (Augustine and Derner 2012). Avoid tilling agricultural fields between early April and late June when nesting occurs. Remove exotic vegetation in arid environments that grow taller than native, historic plant species (Knopf 1996). Prescribed burns in March and early April may also improve Mountain Plover habitat by increasing the amount of bare ground and prostrate vegetation (Augustine and Derner 2012).

Population status: Trends are difficult to discern from BBS due to a lack of statistical significance and small sample sizes (Sauer et al. 2012) but populations are believed to be declining (USDI Fish and Wildlife Service 2011). The IMBCR program has produced density and occupancy estimates for 2013 and 2014; however, data are insufficient to provide information on population status at this time.

Breeding Bird Survey Population Trends

	Mountain Plover	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	- 3.1 s.	- 1.0 n.s.
Western BBS	- 3.3 n.s.	- 1.1 n.s.
Northern Rockies	- 0.6 n.s.	- 0.1 n.s.
Great Basin	n.d.	n.d.
Southern Rockies/ Colorado Plateau	- 5.8 n.s.	- 4.7 n.s.
Badlands and Prairie	n.d.	n.d.

n.s. = not statistically significant; s. = statistically significant, n.d. = no data


Mountain Plover
TotalD
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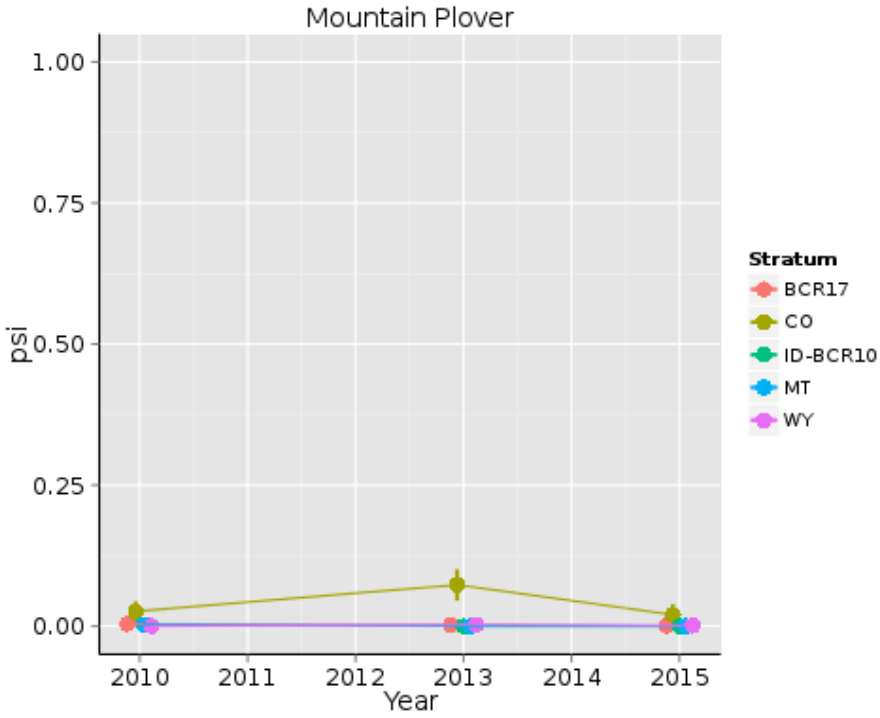
0.3
0.2
0.1
0.0
2013.0
2013.5
2014.0
2014.5
2015.0
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY


Mountain Plover
psi
1.00
0.75
0.50
0.25
0.00
2010
2011
2012
2013
2014
2015
Year
Stratum
BCR17
CO
ID-BCR10
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WY

Long-billed Curlew *Numenius americanus*

Description: Extremely long (6–8"), downward-curving bill. Body and wings are colored brown and cinnamon. The call is a loud *cur-lew* or *cur-lee*. This is North America's largest shorebird, standing about 60 cm (24 in) tall.

Habitat: A grassland species, it also breeds in areas of short grass within sagebrush shrublands. Will forage in hayfields and croplands. Nest is a shallow depression in the ground lined with various materials including pebbles, plant parts, and cattle manure. After hatching, the precocial young are moved to areas of taller, denser grass, presumably for shade and protection from predators (Dugger and Dugger 2002).

Resident status and Space Requirements: Migratory. Individuals typically arrive on breeding grounds between early March and mid-April. Southward migration to wintering grounds begins mid-June to early August; depending upon breeding locale. Territory size ranges from 6 to 14 ha based on previous studies (Allen 1980, Jenni et al. 1981).

Diet/feeding: Feeds by walking slowly, watching for large insects, toads, bird eggs, and nesting songbirds. Uses its long bill to pull prey such as spiders and crickets from their underground burrows.

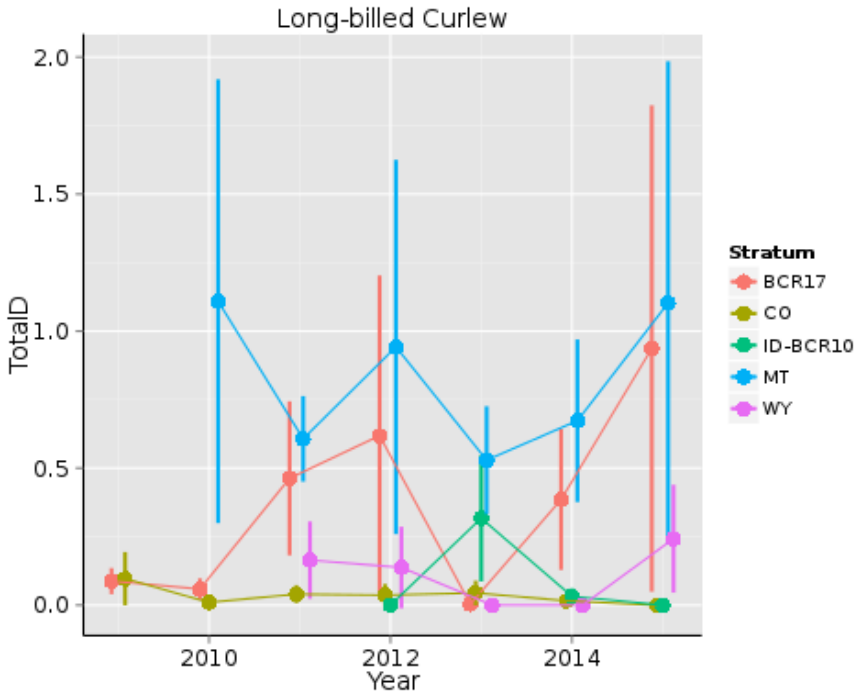
Management: Maintain a patchwork of short and tall grasses mixed with scattered shrubs and wetlands; control encroaching trees. Avoid planting exotic grass species and control exotic invasives such as knapweed (*Centaurea* spp.). Avoid activity near nest sites. Mowing and heavy grazing should be avoided during nesting and brood rearing (April through July) to prevent loss of nests or trampling of flightless young. Light grazing has been associated with increased densities (King, 1978, Pampush 1980, Jenni et al. 1981). Fires during late summer may be beneficial (Cannings 1999).

Population status: Trends are difficult to discern from BBS data due to a lack of statistical significance (Sauer et al. 2012), but a different analysis of BBS data suggests a slight increasing trend, at least up through 2001 (Dobkin and Sauder 2004). IMBCR density and occupancy estimates do not provide evidence for any population trends at this time. The Idaho portion of BCR10 appears to host higher densities of Long-billed Curlews compared to other regions sampled under the IMBCR program.

Breeding Bird Survey Population Trends

	Long-billed Curlew *Numenius americanus*	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	0.3 n.s.	2.5 s.
Western BBS	1.3 s.	2.8 s.
Northern Rockies	1.0 n.s.	2.3 n.s.
Great Basin	1.4 n.s.	3.0 n.s.
Southern Rockies/ Colorado Plateau	0.2 n.s.	0.1 n.s.
Badlands and Prairie	2.4 s.	6.2 s.

n.s. = not statistically significant; s. = statistically significant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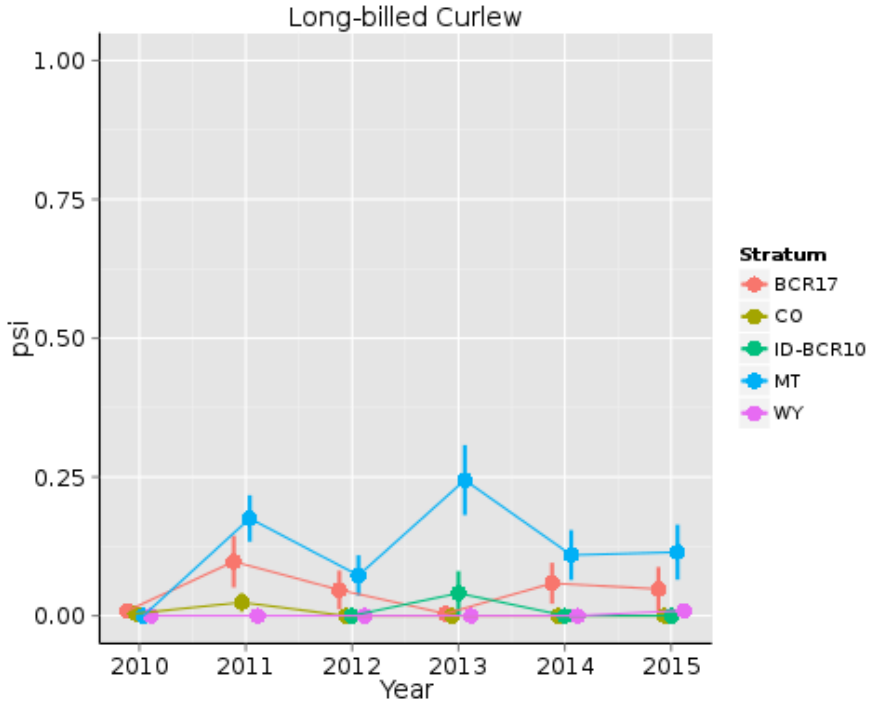
1.5
1.0
0.5
0.0
2010
2012
2014
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY


Long-billed Curlew
psi
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0.75
0.50
0.25
0.00
2010
2011
2012
2013
2014
2015
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY

Burrowing Owl *Athene cunicularia*

Description: Long legs, brown coloration with white spots on back and wings, dark brown barring on the light brown breast and belly, white throat and "eyebrow," yellow eyes.

Habitat: Open areas with short grass and other vegetation—less than 10 cm (4 in) tall—within sagebrush shrublands, often in prairie dog towns. The nest is underground in old mammal burrows. The entrance to the burrow and the nest itself are sometimes lined with dried cow manure, which apparently serves multiple purposes: bedding for the chicks, a signal to other Burrowing Owls that the burrow is occupied, and a lure for insect prey. The nest may also contain vegetation and feathers.

Resident status and Space Requirements: Migratory. Individuals typically arrive on breeding grounds between mid-March and early May. Departure for wintering grounds begins in September and October (Haug et al. 1993). Groups of Burrowing Owls nest in small colonies (Poulin et al. 2011). Home range size of nesting colonies is not well documented.

Diet/feeding: Captures grasshoppers, crickets, beetles, and other insects during the day, birds, small mammals, reptiles, and amphibians at dawn, dusk, and at night. Hunts from a perch, by hovering, or by walking or hopping across the ground (Poulin et al. 2011).

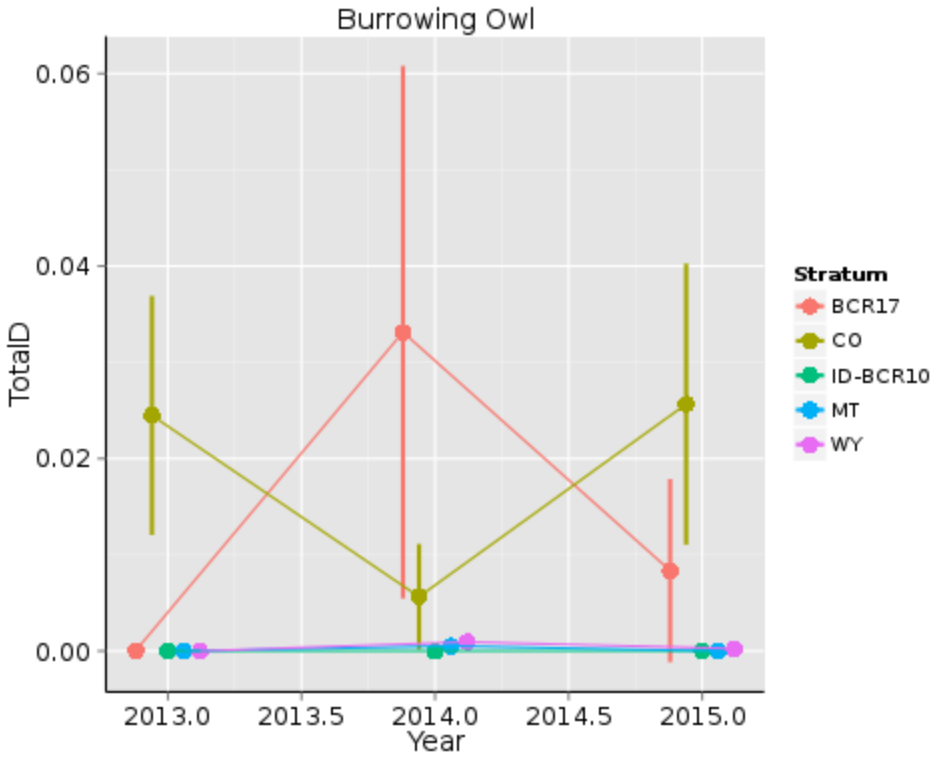
Management: Maintain open grasslands and populations of burrowing mammals (e.g., prairie dogs, ground squirrels, and badgers). Minimize use of pesticides. Restrict dog access in nesting areas which has been shown to cause nest failure (Haug et al 1993). Mowing abandoned prairie dog colonies to reduce vegetation may increase likelihood of occupancy (Dechant et al. 1999). Also, heavy to moderate grazing, particularly at abandoned prairie dog colonies, is generally beneficial (James and Seabloom 1968, Butts 1973, Wedgwood 1976). Avoid the use of pesticides and rodenticides. Maintaining a mosaic of mixed and short-grass habitats can provide both nesting and breeding sites (Dechant et al. 1999).

Population status: Trends are difficult to discern from BBS data due to low sample sizes and a lack of statistical significance (Sauer et al. 2012), although a different analysis of BBS data suggests that the population is stable, at least up through 2001 (Dobkin and Sauder 2004). The IMBCR program has produced density and occupancy estimates for 2013 and 2014; however, data are insufficient to provide information on population status at this time.

Breeding Bird Survey Population Trends

	Burrowing Owl Athene cunicularia	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	- 1.1 s.	- 0.8 n.s.
Western BBS	- 0.8 n.s.	0.1 n.s.
Northern Rockies	- 0.8 n.s.	- 0.0 n.s.
Great Basin	- 0.9 n.s.	- 0.3 n.s.
Southern Rockies/ Colorado Plateau	- 0.5 n.s.	1.3 n.s.
Badlands and Prairie	- 1.8 n.s.	- 2.7 n.s.

n.s. = not statistically significant; s. = statistically significant


Burrowing Owl
TotalD
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0.02
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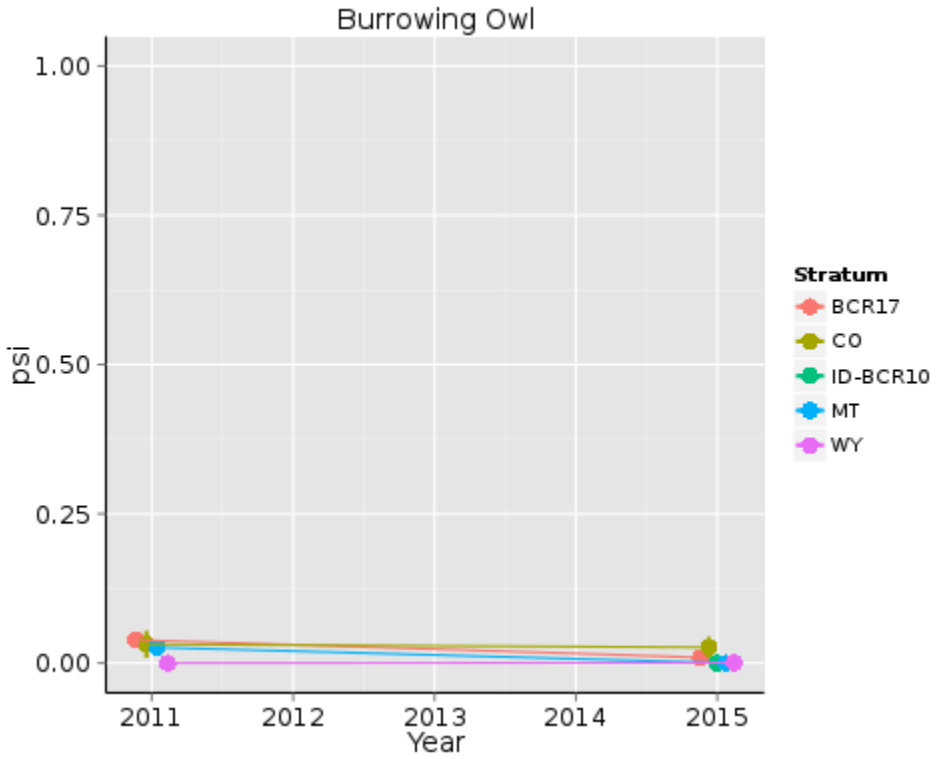
2013.0
2013.5
2014.0
2014.5
2015.0
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY


Burrowing Owl
psi
1.00
0.75
0.50
0.25
0.00
2011
2012
2013
2014
2015
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY

Green-tailed Towhee *Pipilo chlorurus*

Description: Greenish yellow back and wings, dark gray breast and belly, white throat, rust-colored cap.

Habitat: Sagebrush shrublands, woodlands, and riparian areas, often at higher elevations. Prefers areas with tall, dense shrubs and a diversity of shrub species (Dobkin and Sauder2004); the shrub cover diversity is a reflection of this species' preference for ecotones between sagebrush and other shrub-cover types (Knopf et al. 1990). The bulky but well-concealed nest is built on the ground or in shrubs in thick sagebrush or wooded stream edges; the nest is composed of twigs and other plant parts, and lined with fine plant parts and mammal hair (Dobbs et al. 2012).

Resident status and Space Requirements: Migratory. Arrive on breeding grounds in April and early May. Leave breeding grounds for staging areas in July and August and depart for wintering grounds in late August to early October (Dobbs et al. 2012). Territory size during breeding season is approximately 1 ha (Dotson 1971).

Diet/feeding: Searches for seeds and insects (e.g., beetles, grasshoppers, and flies) by using its feet to rake away leaves and other ground litter; also captures insects low in shrubs (Dobbs et al. 2012).

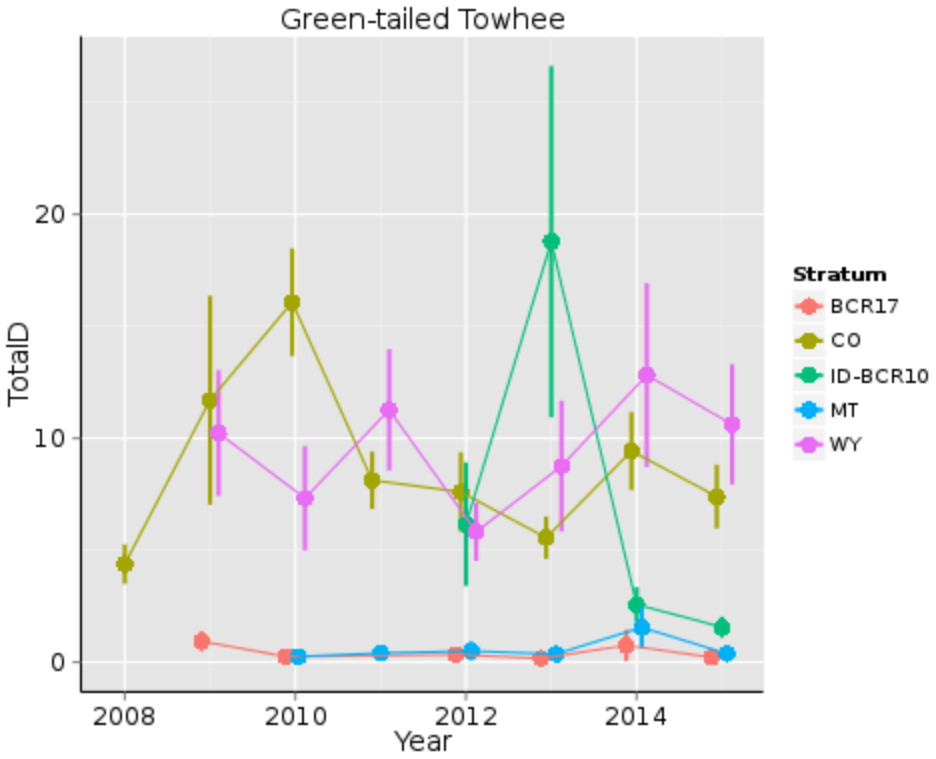
Management: Maintain dense, older stands of sagebrush. Managers should maximize shrub cover within sagebrush steppe habitats (Noson et al. 2006, Jehle et al. 2006); therefore prescribed fire, chaining, mowing and herbicide application should be avoided. Retaining young junipers may benefit this species (Jehle et al. 2006). Periodic fires within high-elevation forests are beneficial; particularly after 8 to 15 years (Dobbs et al. 1998). Avoid fire suppression in forested areas.

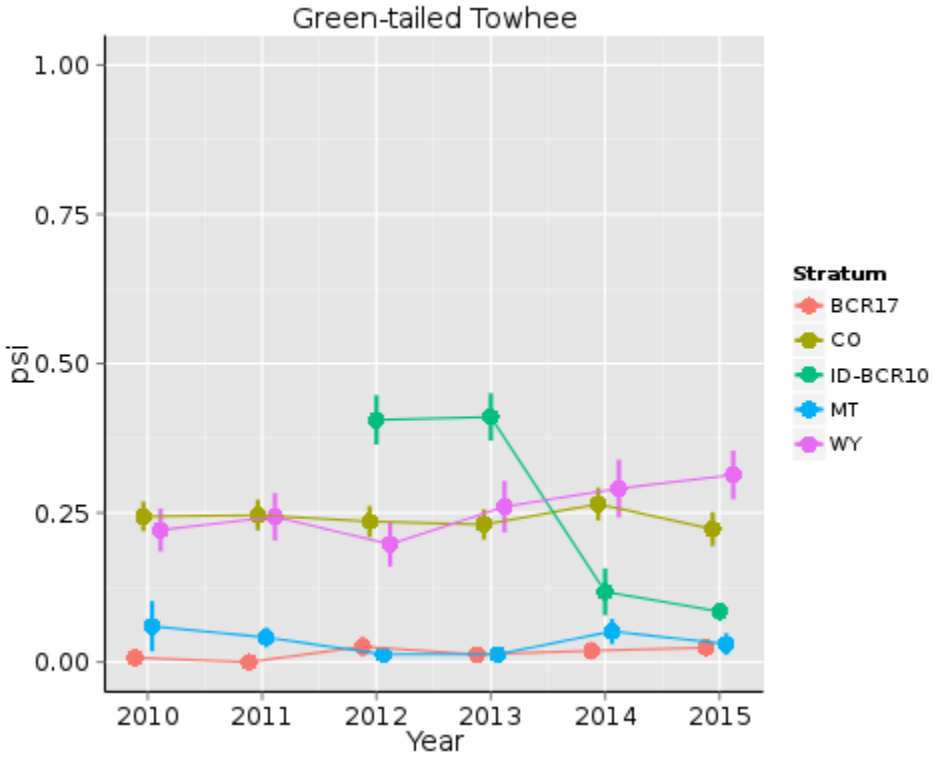
Population status: Trends are difficult to discern from BBS data due to a lack of statistical significance (Sauer et al. 2012) but a different analysis of BBS data suggests an increasing trend, at least up through 2001 (Dobkin and Sauder 2004). IMBCR occupancy and density estimates for 2009 through 2014 do not appear to show any significant differences for the regions covered under the program with one exception. Occupancy and density declined for the Idaho portion of BCR10 in 2014.

Breeding Bird Survey Population Trends

	Green-tailed Towhee *Pipilo chlorurus*	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	- 0.5 n.s.	0.4 n.s.
Western BBS	- 0.4 n.s.	0.4 n.s.
Northern Rockies	- 0.8 n.s.	0.1 n.s.
Great Basin	- 1.0 n.s.	-0.2 n.s.
Southern Rockies/ Colorado Plateau	0.0 n.s.	0.5 n.s.
Badlands and Prairie	- 6.3 n.s.	- 3.3 n.s.

n.s. = not statistically significant


Green-tailed Towhee
TotalID
20
10
0
2008
2010
2012
2014
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY


Green-tailed Towhee
psi
1.00
0.75
0.50
0.25
0.00
2010
2011
2012
2013
2014
2015
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY

Gray Flycatcher *Empidonax wrightii*

Description: Grayish overall, with olive-gray upperparts. Distinguished from similar species by its habit of moving its tail *down and then up* in a fairly slow movement; all other similar-looking flycatchers rapidly flick their tails *up then down* (Schlossberg and Sterling 2013).

Habitat: Sagebrush or mountain mahogany shrublands, pinyon-juniper woodlands. Nest is built 0.6–6 m (2–20 ft) above ground in tall sagebrush, bitterbrush, and trees. The nest is constructed of strips of bark, stems, grasses, and other plant materials, lined with fine plant materials, feathers, and/or mammal hair (Schlossberg and Sterling 2013).

Resident status and Space Requirements: Migratory. Arrive on breeding grounds mid-April to mid-May and depart for wintering grounds in mid-August to mid-September (Sterling 1999). Territory size on breeding grounds varies from approximately 1 to 5 ha.

Diet/feeding: Flies out from an exposed perch to capture insects in midair; also gleans insects from the ground or from foliage, branches, and trunks of trees and shrubs.

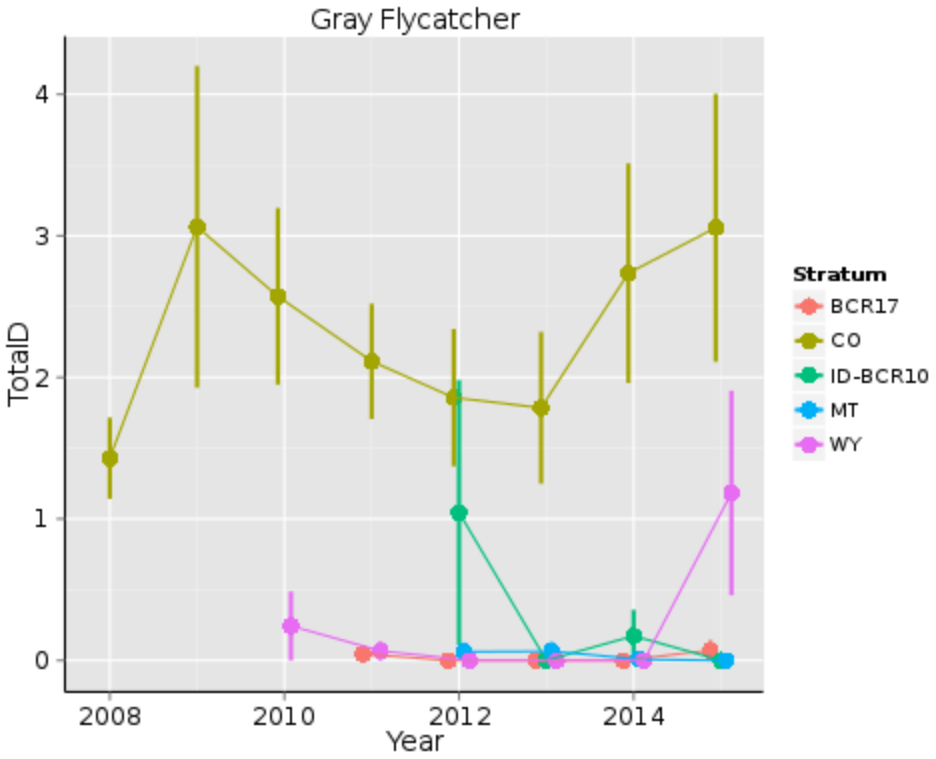
Management: Maintain older, denser patches of sagebrush with a layered canopy. Discourage Brown-headed Cowbird populations by keeping livestock dispersed or move them frequently, and periodically rest grazing units for at least a year to allow local bird populations to develop without cowbird pressure. Avoid using prescribed fire in inhabited areas (Holmes and Robinson 2013). Maintain areas with high juniper cover in overstory (Pavlacky and Anderson 2001).

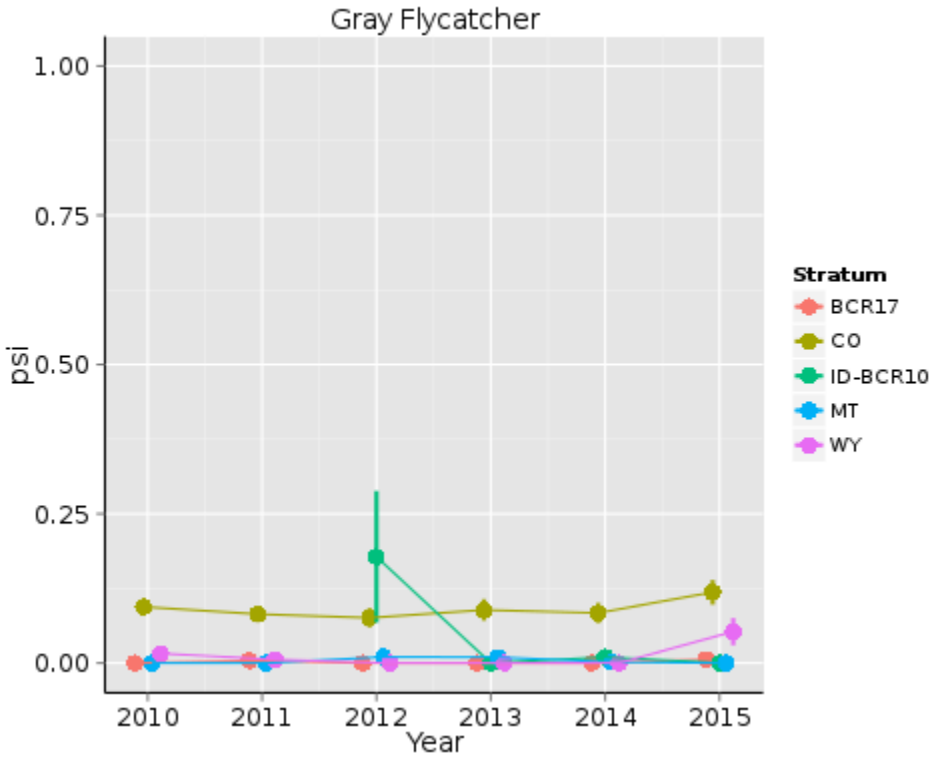
Population status: BBS data indicate a population increase overall in its range, including the Great Basin region. IMBCR occupancy and density estimates do not show significant differences from 2009 to 2014 where sampling occurred.

Breeding Bird Survey Population Trends

	Gray Flycatcher *Empidonax wrightii*	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	2.5 s.	3.2 s.
Western BBS	2.5 s.	3.2 s.
Northern Rockies	3.2 n.s.	4.5 n.s.
Great Basin	2.4 s.	2.6 s.
Southern Rockies/ Colorado Plateau	1.7 n.s.	2.1 n.s.
Badlands and Prairie	n.d.	n.d.

n.s. = not statistically significant; s. = statistically significant; n.d. = no data


Gray Flycatcher
TotalD
4
3
2
1
0
2008
2010
2012
2014
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY


Gray Flycatcher
psi
1.00
0.75
0.50
0.25
0.00
2010
2011
2012
2013
2014
2015
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY

Loggerhead Shrike *Lanius ludovicianus*

Description: Gray body, black wings with white patches, black mask. Flashes of black and white in the wings and tail are obvious when in flight.

Habitat: Open areas where there are some trees or shrubs (especially ones with thorns), including sagebrush shrublands. Prefers areas with sparse ground cover and abundant bare ground (Dobkin and Sauder 2004). The bulky but well-hidden nest is built in a tree or tall shrub, below the crown; construction materials include twigs, bark strips, and other plant materials, with an inner lining of soft plant parts, feathers, and/or mammal hair (Rich et al. 2005, Yosef 1996). Reach highest densities in deep, sandy soils (Vander Haegen et al. 1999).

Resident status and Space Requirements: Migratory. Individuals arrive on breeding grounds between March and late April and depart for wintering grounds August through September. Breeding territories are approximately 5 to 13 ha (Yosef 1996).

Diet/feeding: Watches from a perch, then swoops down to capture insects, reptiles, amphibians, small birds, or small mammals. Skewers prey on thorns or barbed wire, or wedges it into a small fork of a tree or shrub, to hold the prey in place during feeding.

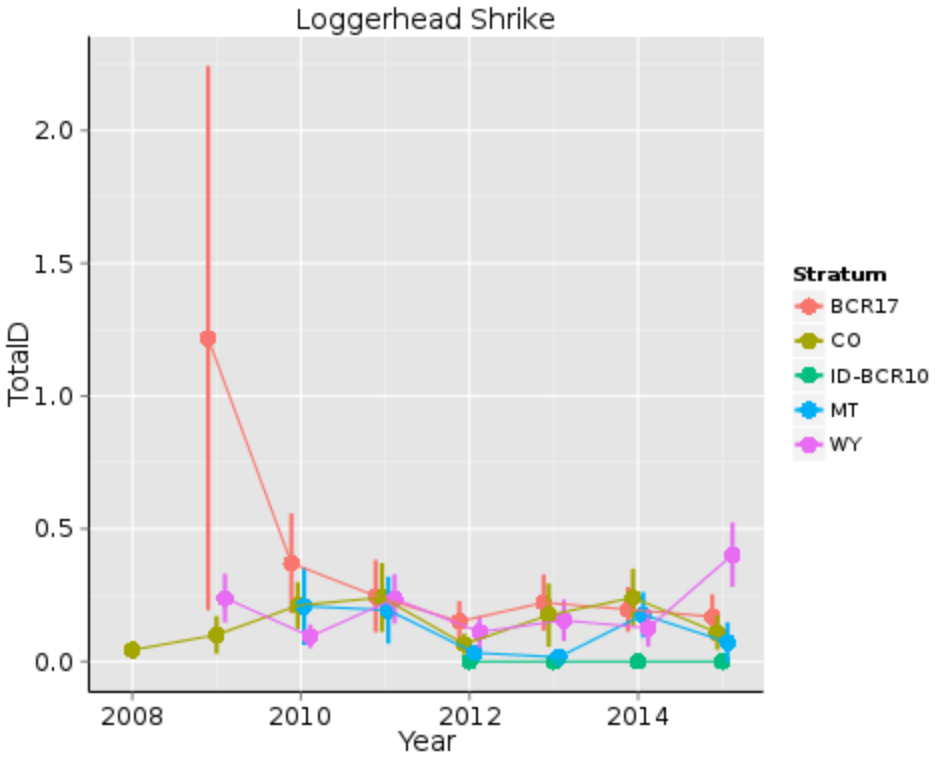
Management: Maintain large, mature sagebrush and open grasslands with scattered shrubs and/or juniper for nesting (Humple and Holmes 2006). Minimize pesticide use. Avoid using prescribed fire which reduces shrub cover (Holmes and Robinson 2013). Maintain taller grass heights east of the Rocky Mountains by eliminating mowing and reducing grazing (Yosef and Grubb 1993, Collister 1994). Retain scattered, trees or larger shrubs in grasslands and pastures for nest sites (Collister 1994, Yosef 1994).

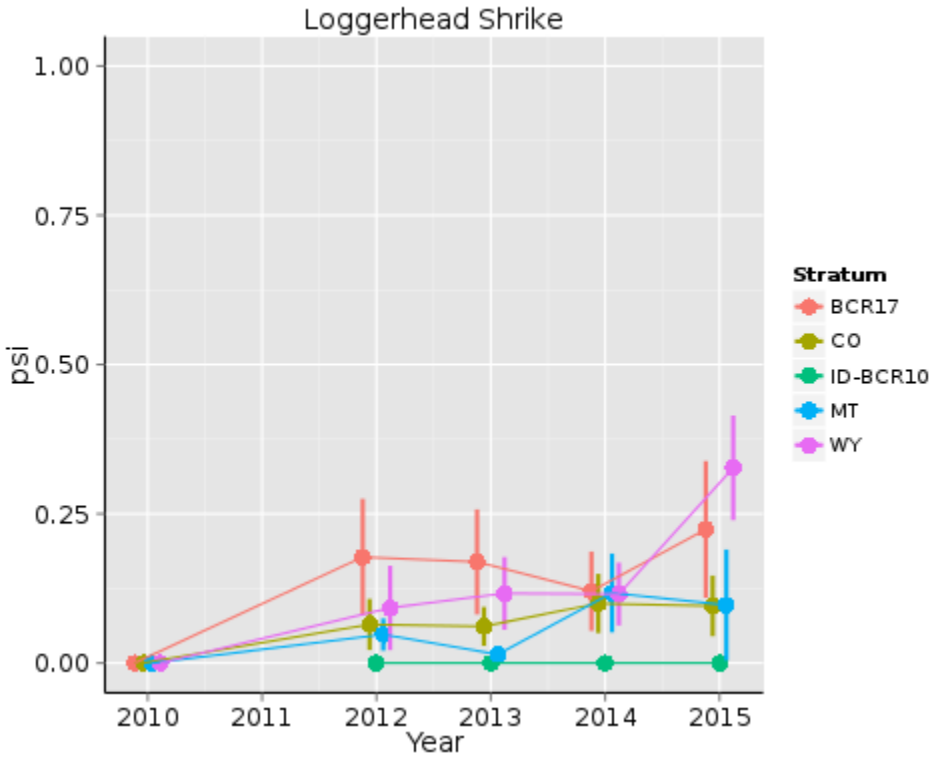
Population status: Declining at the continental level and in the West; finer-scale trends are difficult to discern due to small sample size (Sauer et al. 2012). IMBCR density estimates indicate no change in populations from 2009 to 2014 where sampling occurs. IMBCR occupancy estimates indicate a slight increase in the proportion of occupied sites throughout much of the region where IMBCR sampling is occurring (e.g., BCR17, MT, WY, and CO).

Breeding Bird Survey Population Trends

	Loggerhead Shrike *Lanius ludovicianus*	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	- 3.2 s.	- 2.6 s.
Western BBS	- 1.8 s.	- 1.4 n.s.
Northern Rockies	0.4 n.s.	0.8 n.s.
Great Basin	- 0.7 n.s.	- 0.4 n.s.
Southern Rockies/ Colorado Plateau	- 1.0 n.s.	- 0.2 n.s.
Badlands and Prairie	- 1.8 s.	- 2.4 s.

n.s. = not statistically significant; s. = statistically significant


Loggerhead Shrike
TotalD
2.0
1.5
1.0
0.5
0.0
2008
2010
2012
2014
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY


Loggerhead Shrike
psi
1.00
0.75
0.50
0.25
0.00
2010
2011
2012
2013
2014
2015
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY

Common Raven *Corvus corax*

Description: Black overall, larger and with a heavier bill and deeper voice than a crow. In flight, it frequently soars and glides rather than flapping its wings continuously.

Habitat: Present in a wide variety of habitats including sagebrush shrublands, grasslands, and forests. Builds a rough stick nest in treetops, on cliff ledges, and on utility poles.

Resident status and Space Requirements: Year-round resident. Territory size may be highly variable based on availability of food and nest sites but may be approximately 500 ha.

Diet/Feeding: Wide array of foods, including dead animals, rodents, insects, seeds, fruit, birds, and bird eggs. Finds its food by searching from the air or walking on the ground; often seen searching for roadkill along busy roads (Boarman and Heinrich 1999).

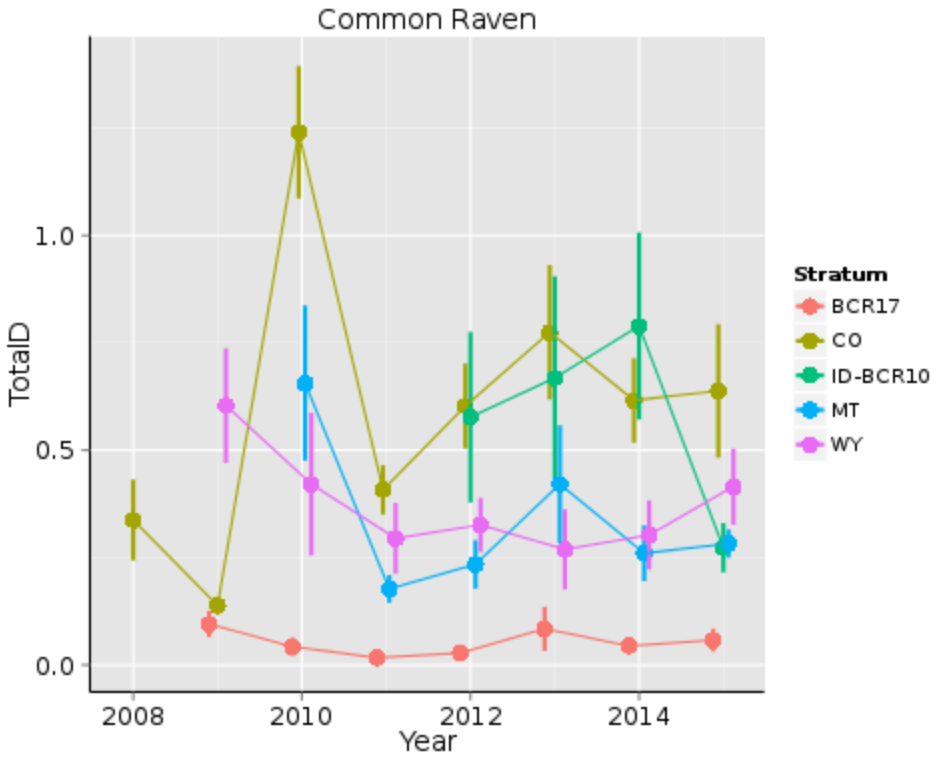
Management: Use utility poles for nesting and perching, and fence posts for perching. These artificial perches can enhance the hunting success of ravens on sage-grouse and other species, thereby increasing their breeding success, population size, and geographic range (Howe et al. 2014). Reducing anthropogenic structures and preventing access to trash associated with humans may discourage presence (Goodwin 1976; Engel and Young 1992).

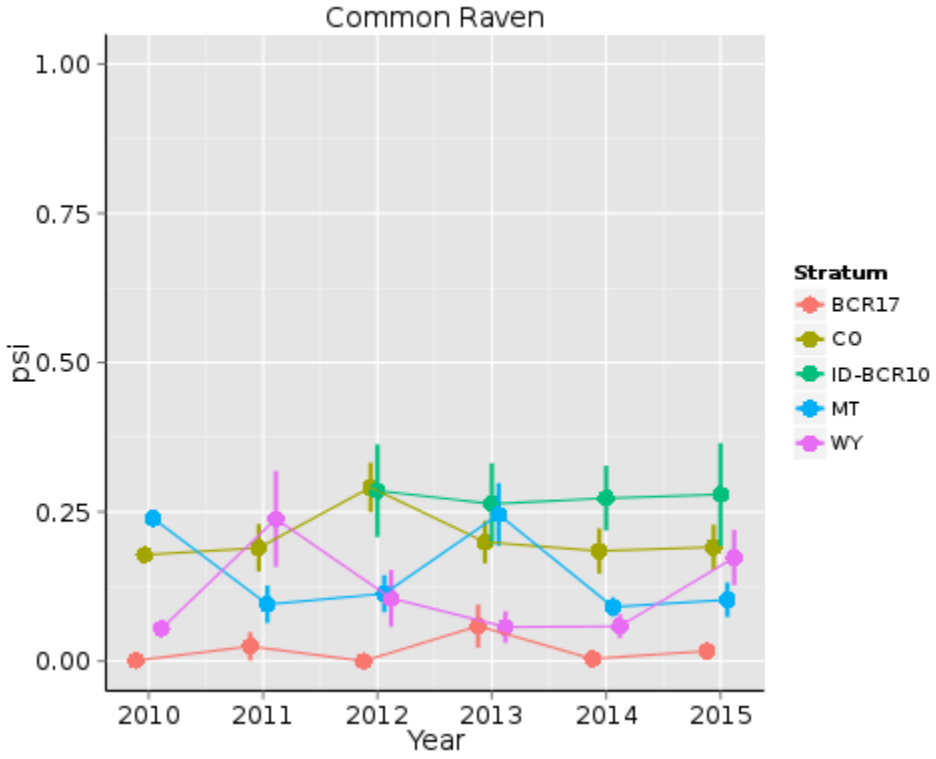
Population status: Increasing significantly throughout nearly every part of its range.

Breeding Bird Survey Population Trends

	Common Raven *Corvus corax*	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	2.2 s.	3.5 s.
Western BBS	2.4 s.	2.7 s.
Northern Rockies	1.9 s.	2.2 s.
Great Basin	3.2 s.	3.5 s.
Southern Rockies/ Colorado Plateau	2.0 s.	1.8 s.
Badlands and Prairie	14.3 n.s.	14.9 n.s.

n.s. = not statistically significant; s. = statistically significant


Common Raven
TotalD
1.0
0.5
0.0
2008
2010
2012
2014
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY


Common Raven
psi
1.00
0.75
0.50
0.25
0.00
2010
2011
2012
2013
2014
2015
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY

Vesper Sparrow *Pooecetes gramineus*

Description: Gray and brown with black markings on back and wings, fine black streaks on the breast. White outer tail feathers are conspicuous when the bird flies. At close range a small reddish-brown shoulder patch is sometimes obvious.

Habitat: Present in a wide variety of habitats including sagebrush shrublands, grasslands, ditches, and grass strips in cropland—the common elements are low shrubs, sparse ground cover, and bare ground. The simple nest of woven grasses is built on the ground, well concealed under bunchgrass or next to a clump of vegetation (Jones and Cornely 2002).

Resident status and Space Requirements: Migratory. Individuals arrive on breeding grounds between March and first week of May and depart for wintering grounds late July to early September (Jones and Cornely 2002). Breeding territory size shown to vary from 0.29 to 8.19 ha (Jones and Cornely 2002).

Diet/feeding: Collects insects and seeds from the ground and low in vegetation.

Management: Maintain sagebrush shrublands with bunchgrass. Large, unbroken tracts of sagebrush are better than tracts fragmented by other land-cover types because such fragmentation favors the Brown-headed Cowbird; the Vesper Sparrow is a frequent host of cowbirds, which lay their eggs in the nests of hosts and reduce the hosts' nesting success (Dobkin and Sauder 2004). Use no-till or reduced-till practices in croplands; delay haying of grass strips until after mid July. Avoid the use of prescribed fire (Earnst et al. 2009). Grazing may negatively impact this species (Harrison et al. 2011). Remove juniper from suitable habitat (Noson et al. 2006).

Population status: BBS data indicate steadily declining trends across its range. IMBCR data from 2009 to 2014 indicate slight density declines in Montana and Wyoming and a slight increase within Colorado. IMBCR occupancy estimates appear somewhat variable with no discernable trends apparent at this time for 2010 to 2014.

Breeding Bird Survey Population Trends

	Vesper Sparrow *Pooecetes gramineus*	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	- 0.9 s.	- 0.4 n.s.
Western BBS	- 1.2 s.	- 1.1 n.s.
Northern Rockies	- 1.1 s.	- 1.0 n.s.
Great Basin	- 0.9 s.	- 1.7 s.
Southern Rockies/ Colorado Plateau	- 1.4 s.	- 0.7 n.s.
Badlands and Prairie	- 1.4 s.	1.6 n.s.

n.s. = not statistically significant; s. = statistically significant

Lark Sparrow *Chondestes grammacus*

Description: Gray, black, and tan on the back and wings; grayish breast with black central spot; white belly; white stripe through a reddish brown cap; reddish brown cheek patch; striking black, white, and rusty brown pattern on the face. Large white corners on the tail are obvious when the bird flies.

Habitat: Sagebrush shrublands that contain grassy openings or are adjacent to grassy areas (the Lark Sparrow prefers grass-shrubland edges); also drier grasslands with patches of bare ground, moderate to heavy herbaceous cover, and scattered shrubs or trees. The nest, built of grasses, weed stems, and other plant materials, is usually placed on the ground under a shrub or bunchgrass, but frequently is built in a shrub or tree (Martin and Parrish 2000).

Resident status and Space Requirements: Migratory. Individuals arrive on breeding grounds late March through early May and depart for wintering grounds in early August to early October (Martin and Parrish 2000). Territory size is not well understood but territories were observed to be as small as 0.001 and as large as 100 ha (Martin and Parrish 2000).

Diet/feeding: Collects insects and seeds on the ground and low in vegetation.

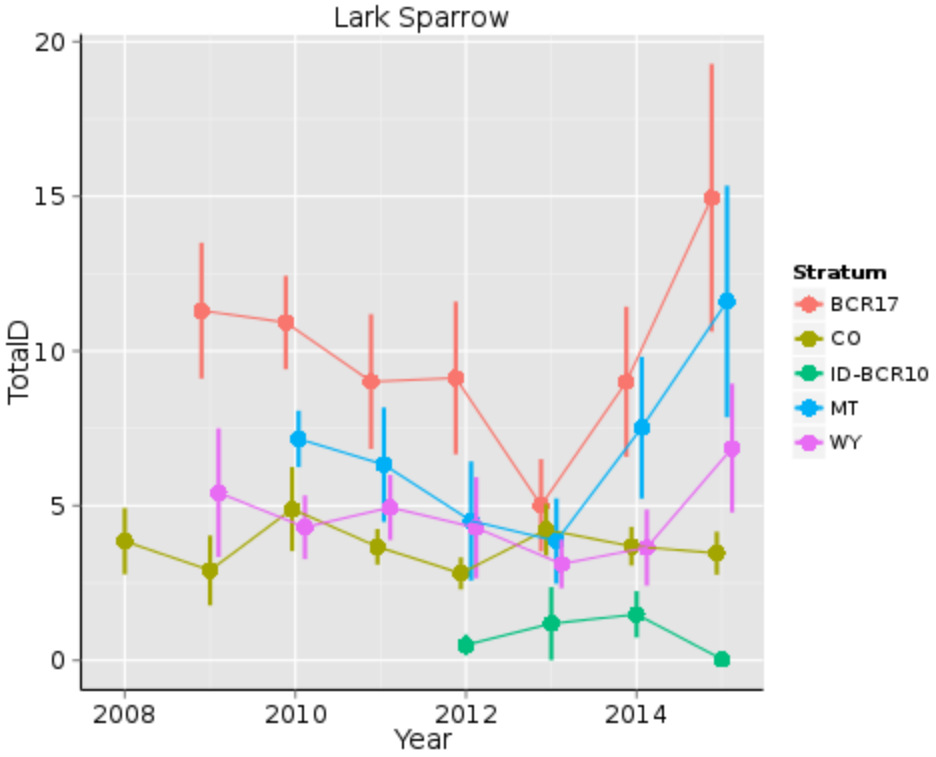
Management: Maintain grassy openings in sagebrush shrublands; also grassland with scattered trees and shrubs, especially in mountain foothills areas. Patch-burn treatments are likely beneficial in the short-term due to affinity for bare ground (Earnst et al. 2009; Holcomb et al 2014). Similarly, show preference for grazed versus un-grazed areas (Fitch 1958, Jacobson 1972, Bock et al. 1984, and Holmes and Geupel 1998). Avoid the use of pesticides (Paige and Ritter 1999).

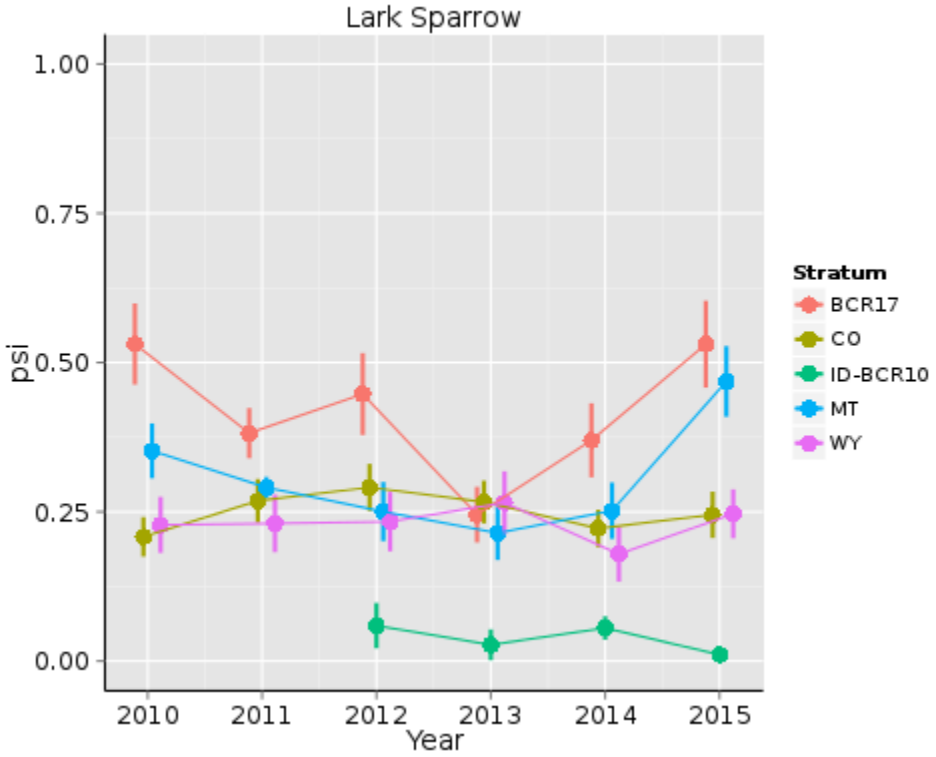
Population status: Increasing in recent years at the continental level after declining earlier; finer-scale trends are difficult to discern due to small sample size (Sauer et al. 2012) from BBS data. IMBCR occupancy and density estimates from 2009 to 2014 do not indicate substantial discernable patterns. Occupancy rates for BCR17 are statistically lower in 2014 than in 2009 but may be rebounding.

Breeding Bird Survey Population Trends

	Lark Sparrow *Chondestes grammacus*	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	- 0.9 s.	0.0 n.s.
Western BBS	- 0.2 n.s.	0.8 n.s.
Northern Rockies	1.4 n.s.	- 1.9 n.s.
Great Basin	- 0.4 n.s.	1.3 n.s
Southern Rockies/ Colorado Plateau	0.9 n.s.	1.4 n.s.
Badlands and Prairie	0.6 n.s.	1.7 n.s.

n.s. = not statistically significant; s. = statistically significant


Lark Sparrow
TotalD
20
15
10
5
0
2008
2010
2012
2014
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY


Lark Sparrow
psi
1.00
0.75
0.50
0.25
0.00
2010
2011
2012
2013
2014
2015
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY

Western Meadowlark *Sturnella neglecta*

Description: Black and brown on the back and wings; yellow throat, breast, and belly with a black "V" on the breast. White outer tail feathers are obvious in flying birds.

Habitat: Areas with good grass and forb cover adjacent to sagebrush shrublands; also shrublands with sparse shrub cover, abundant herbaceous cover and leaf litter (Dobkin and Sauder 2004) and croplands (Davis and Lanyon 2008). The ground nest is well hidden under a dome of vegetation and built of dried grasses and other plant materials woven into the surrounding vegetation.

Resident status and Space Requirements: Year-round resident throughout much of range. Individuals that do migrate generally return to breeding grounds in March and depart for wintering grounds in November (Lanyon 1994). Territory size varies across range and is likely dependent upon habitat quality. Mean territory sizes from research efforts range from approximately 2 to 7 ha (Kendeigh 1941, Schaeff and Picman 1988).

Diet/feeding: Collects insects and seeds from the surface of the ground; probes beneath soil surface with bill to find seeds. Occasionally eats eggs, nestlings, or even adults of other bird species; occasionally eats carrion.

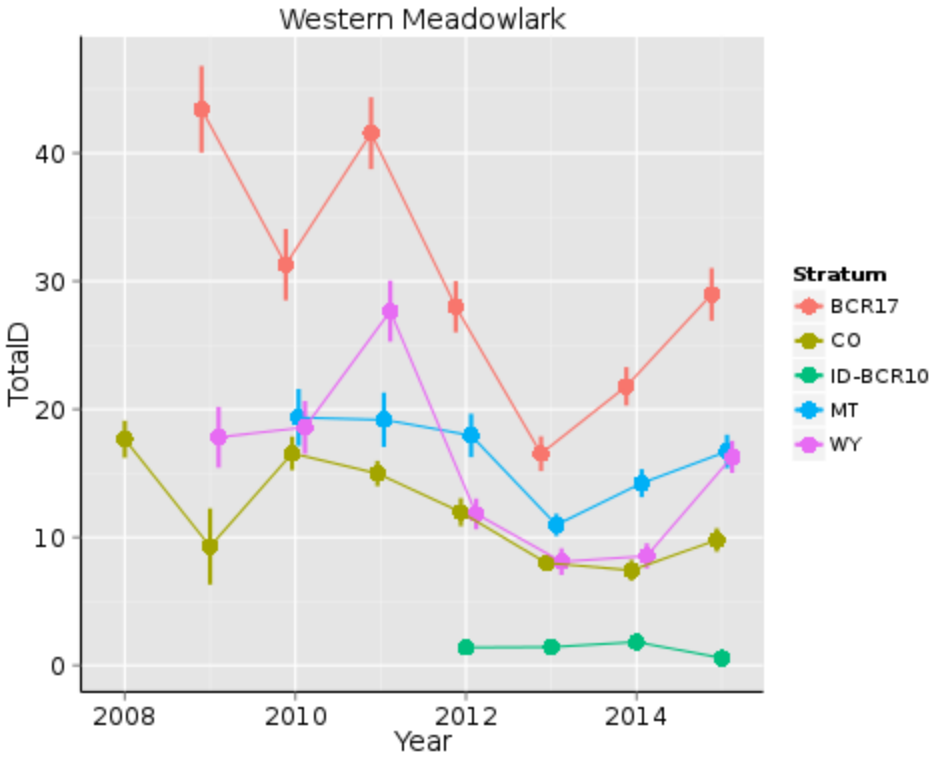
Management: Maintain grassy areas within sagebrush shrublands. Minimize disturbance at known or suspected nest sites during the nesting season—they are very sensitive and easily abandon their nests. Delay mowing until after mid-July. Prescribed fire has reduced populations in one study (Earnst et al 2009) but may be necessary at times to prevent succession, brood parasitism and predation (Johnson and Temple 1990).

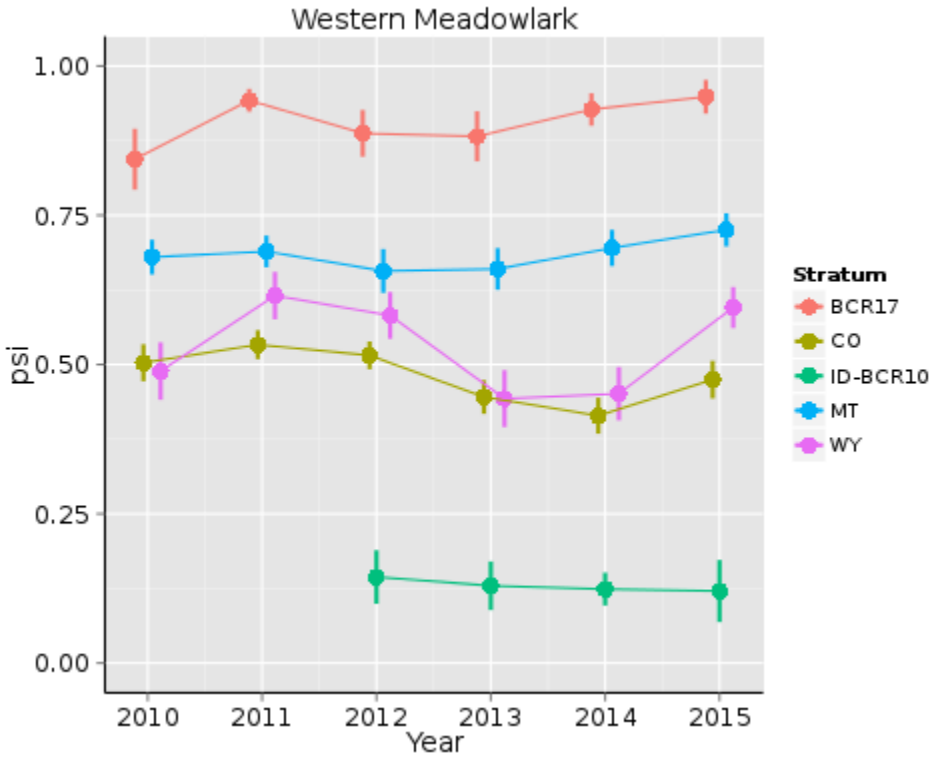
Population status: BBS data demonstrate long-term declines across much of its range. IMBCR data provide additional evidence for reduced densities within BCR17, Montana, Colorado, and Wyoming with estimates for BCR17, Colorado, and Wyoming showing a nearly 50% reduction from 2009 to 2014. IMBCR occupancy rates appear steady from 2010 through 2014.

Breeding Bird Survey Population Trends

	Western Meadowlark *Sturnella neglecta*	
Bird Conservation Regions and Regional areas	1966-2013	2003-2013
Continental	- 1.3 s.	- 1.5 s.
Western BBS	- 1.4 s.	- 1.7 s.
Northern Rockies	- 0.5 n.s.	- 1.8 s.
Great Basin	- 1.1 s.	- 1.4 s.
Southern Rockies/ Colorado Plateau	- 1.9 s.	- 2.1 s.
Badlands and Prairie	- 0.2 n.s.	- 0.3 n.s.

n.s. = not statistically significant; s. = statistically significant


Western Meadowlark
TotalD
40
30
20
10
0
2008
2010
2012
2014
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY


Western Meadowlark
psi
1.00
0.75
0.50
0.25
0.00
2010
2011
2012
2013
2014
2015
Year
Stratum
BCR17
CO
ID-BCR10
MT
WY

Appendix B. Monitoring methods used for population trends in species profiles.

Monitoring is an essential component of wildlife management and conservation science (Witmer 2005, Marsh and Trenham 2008). Common goals of population monitoring are to estimate the population status of target species and to detect changes in populations over time (Thompson et al. 1998, Sauer and Knutson 2008). Effective monitoring programs can identify species that are at-risk due to small or declining populations (Dreitz et al. 2006); provide an understanding of how management actions affect populations(Alexander et al. 2008, Lyons et al. 2008); evaluate population responses to landscape alteration and climate change (Baron et al. 2008, Lindenmayer and Likens 2009); and provide basic information on species distributions.

Breeding Bird Survey

The only long-term dataset that tracks the population status of breeding birds in North America is the Breeding Bird Survey (BBS). Begun in 1966, this systematic survey relies on volunteers who travel predetermined 24.5-mile routes along roads, stopping every 0.5 mile to list every bird seen or heard within a 0.25-mile radius during a 3-minute period. In a typical year, almost 2,900 such routes are run throughout the continent, resulting in nearly 145,000 individual point counts. These survey results have proven to be extremely valuable sources of information on bird population trends. Unfortunately, the BBS is not very effective at counting the various grouse species, and other sources of information (such as lek counts) are needed to adequately track them.

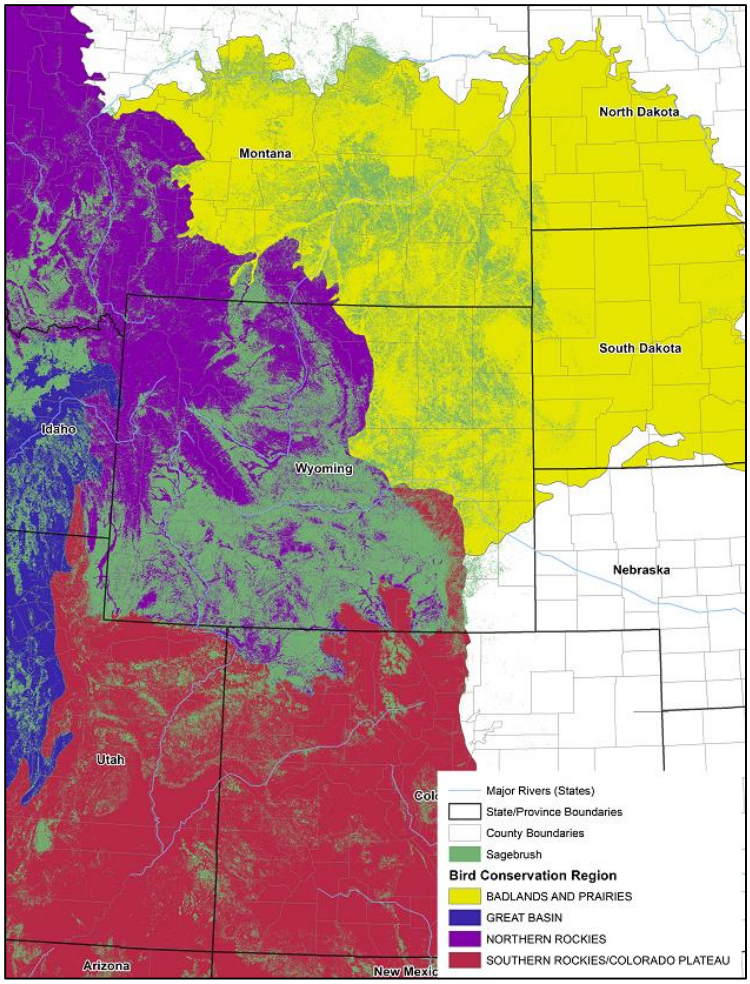


Figure 6. Bird Conservation Regions of eastern edge of sagebrush range.

To gain a clearer picture of population trends, BBS data can be analyzed by geographic region. In this manual we present trends at the continental level and at the level of smaller areas, called Bird Conservation Regions (BCRs), which are “ecologically distinct regions in North America with similar bird communities, habitats, and resource management issues” (NABCI 2013). The BCRs that contain the bulk of the sagebrush habitat are Badlands and Prairies, Northern Rockies, Southern Rockies / Colorado Plateau and eastern parts of Great Basin (Figure XX). The Western BBS region encompasses all these parts of the latter three BCRs (plus all others to the west.

Integrated Monitoring in Bird Conservation Regions (IMBCR) and the Avian Data Center (ADC)

In 2007 the North American Bird Conservation Initiative released the report, "Opportunities for Improving Avian Monitoring" (NABCI 2007). This report outlined goals and recommendations to further improve avian monitoring programs including: using more rigorous statistical methodology, integrating monitoring programs, and making data and results widely accessible to land managers and the public. With these recommendations in mind, bird conservation partners from across much of the western United States have collaborated to implement a new broad-scale all-lands monitoring program known as "Integrated Monitoring in Bird Conservation Regions" (IMBCR).

Objectives of the IMBCR program are to: 1) provide a framework to integrate bird monitoring efforts across bird conservation regions, 2) provide robust population density and occupancy estimates that account for incomplete detection and are comparable at different geographic extents, 3) use annual population estimates to monitor population trends and evaluate causes of population change, 4) provide basic habitat association data for most landbird species to address habitat management issues, 5) maintain a high-quality database that is web-accessible to all of our collaborators, as well as to the public, in the form of raw and summarized data, and 6) generate decision support tools that help guide conservation efforts and provide a quantitative measure of conservation success. The IMBCR program is one of the largest bird monitoring programs in geographic scope and in the number of partners in the United States. The strength of the IMBCR program is based in its broad partnership support, spanning 13 states and 15 partners (Fig. 9).

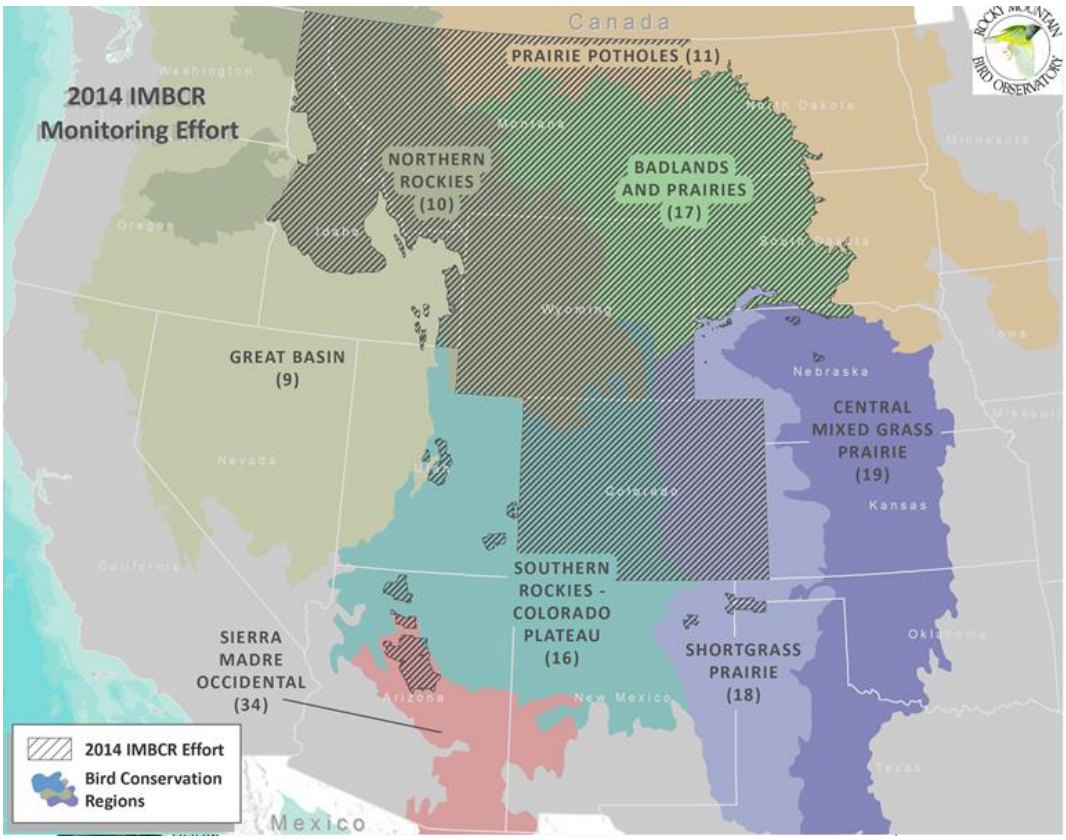


Figure 7. Extent of IMBCR monitoring effort.

The IMBCR program has inference to over 1 million acres and can provide density and/or occupancy estimates for 284 species. The data collected under this program are available to managers in a variety of formats through the Avian Data Center http://rmbo.org/v3/avian/Home.aspx. This information can be used in the following ways to inform avian conservation:

1. Bird Population estimates can be compared in space and time. For example, stratum-level estimates can be compared to state and regional estimates to determine whether local populations are above or below estimates for the region;
2. Population estimates can be used to make informed management decisions about where to focus conservation efforts. For example, strata with large populations can be targeted for protection and strata with low populations can be prioritized for conservation action; a threshold could be set to trigger a management action when populations reach a predetermined level;
3. Population estimates of treatment areas can also be compared to regional estimates to evaluate effectiveness of management actions. For example, if sagebrush areas are being treated to improve habitat for Greater Sage-grouse (GRSG) and estimates for sagebrush-obligate birds increase in these areas in relation to regional estimates where treatment is not occurring, the results would suggest that the GRSG management actions are also beneficial to other sagebrush-obligate bird species;
4. Annual estimates of density and occupancy can be compared over time to determine if population changes are a result of population growth or decline and/or range expansion or

contraction. For example, if population densities of a species declined over time, but the occupancy rates remained constant, then the population change was due to declines in local abundance. In contrast, if both density and occupancy rates of a species declined, then population change was due to range contraction.

5. Occupancy rates can be multiplied by the land area in a region of interest to estimate the area occupied by a species. For example, if a stratum comprises 120,000 km^2 and the occupancy estimate for Western Meadowlark is 0.57, managers can estimate that 68,400 km^2 (120,000 km^2 * 0.57) of habitat within that stratum are occupied by Western Meadowlarks.
6. Survey locations and the birds observed at the locations can be displayed.

More information about the IMBCR sampling protocol can be found in the 2013 Annual Report (White et al. 2014). Refer to Avian Data Center on page 22.

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