SPECIES ASSESSMENT FOR BREWER'S SPARROW (*SPIZELLA BREWERI*) IN WYOMING

prepared by

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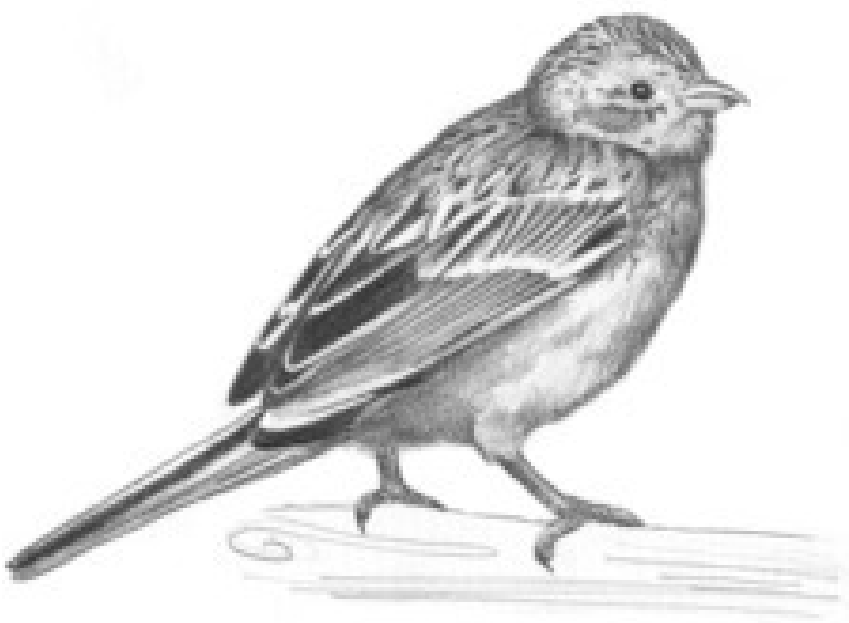

prepared for

United States Department of the Interior
Bureau of Land Management
Wyoming State Office
Cheyenne, Wyoming

September 2004

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Introduction

The Brewer's Sparrow (*Spizella breweri*) has significantly declined throughout its breeding range in the last 25 years (Ashley and Stoval 2004). Despite being thought of by many as the most common bird in spring and summer in shrubsteppe habitat, the Brewer's Sparrow has been given special conservation status in several western states, including Wyoming (Knick and Rotenberry 2000). Habitat fragmentation and other processes threaten Brewer's Sparrow populations in several ways. In this report, shrubsteppe is defined as habitat with a "…co-dominance of sagebrush [*Artemesia* spp.] and native bunch grass and moderate shrub cover" (B. Walker, personal communication).

This report reviews key published literature, identifies experts and current research on the Brewer's Sparrow, and presents existing information on the distribution, biology, ecological niche, and conservation planning being conducted for this species on state and range-wide scales. Included is a brief discussion of the controversy of species versus subspecies status and ecological niche for the subspecies *S. b. taverneri* (Timberline Sparrow), which breeds at high elevations in Alaska, Canada, and western Montana and may breed at high elevations in Wyoming (S. Jones, personal communication). In this assessment, unless specifically noted, the subspecies being discussed is *S. b. breweri.*

Natural History

Morphological Description

An early ornithologist described the Brewer's Sparrow generally drab appearance as follows: "…when we come upon the Brewer's Sparrow, we are ready to wager that [Nature] has done her utmost to produce a bird of non-committal appearance...so far as plumage is concerned, [it] may

be said to have not a mark of distinction whatever—just bird" (Rotenberry et al. 1999). The Brewer's Sparrow is small and slim with a relatively long, notched tail; the sexes are similar (Figure 1). Its length is 12.5 - 15cm, and mass is 9 - 12g (Wiens and Rotenberry 1981). It has a finely streaked, brown crown, dull gray supercilium, unmarked lores, and bold, complete white eye-ring. The iris is dark; lores are pale, ear-coverts brown, malar stripes thin and brown, side of neck grayish-brown to brown and faintly streaked. Its back and rump are brown and the back has dark brown streaks or rows of spots; the wings are brown with median and greater coverts edged with buff, forming two poorly defined wing-bars. The underparts are a pale and unstreaked gray. Its small brown bill is conical with a dusky tip, and the legs and feet are pale pinkish (above description from Rising and Beadle 1996, Rotenberry et al. 1999, Sibley 2000).

In all plumages the Brewer's Sparrow is more drab than the similar Clay-colored Sparrow (*S. pallida*). *Spizella* sparrows are most distinctive in breeding plumage, and fall and winter birds are difficult to separate from each other. Of the seven *Spizella* sparrows, the Chipping (*S. passerina*) and Clay-colored Sparrows look the most like the Brewer's Sparrow. Chipping Sparrows are the easiest to identify due to a dark loral stripe and eye-line. Clay-colored Sparrows are usually brighter and more colorful than the Brewer's Sparrow, but occasionally juvenile Brewer's and Clay-colored Sparrows are impossible to distinguish (Sibley 2000). The Brewer's Sparrow is the most "plain faced" of *Spizella* sparrows. In contrast to the other *Spizellas*, it has a bold white eye-ring, which stands out on dull auriculars, no whitish central crown-stripe, and only a faint buff wash on its breast (Rotenberry et al. 1999).

The *taverneri* subspecies is slightly larger than *S. b. breweri*, has a bolder head pattern, is darker and grayer, has darker streaks on the back, a slightly shorter tail (10 males, averaged 2.5cm shorter; Swarth and Brooks 1925), and a smaller, more slender, slightly longer, darker bill (Klicka

et al. 1999, Rotenberry et al. 1999). It is more similar in appearance to the Clay-colored Sparrow (Rotenberry et al. 1999). Some disagreement exists in the literature regarding descriptions of *S. b. taverneri* (i.e., Paine [1968] described it as having a shorter, stubbier bill). The data regarding bill length cited by Klicka et al. (1999) are based on measurements of over 150 birds. The Timberline Sparrow more closely resembles the Clay-colored Sparrow than does the more sagebrush-associated *S. b. breweri*.

The most distinctive characteristic separating *S. b. taverneri* from *S. b. breweri* is the different breeding song, as described below.

Vocalization

Spizella breweri breweri has two songs; a short song and a long song. The short song is a buzzy trill that lasts 1.5 to 3 seconds; the long song is slightly descending and has 5-10 buzzy trills lasting 10-15 seconds (Rotenberry et al. 1999, Sibley 2000). The short song is delivered in the breeding season and in migration; it is occasionally given during the middle of the night (Rotenberry et al. 1999).

Spizella breweri taverneri has a slower, lower, clearer, less buzzy song with more musical trills (Sibley 2000). B. Walker (personal communication) describes *taverneri's* song as covering a smaller range of frequencies, and the trills as much clearer and more "bell like." The Brewer's Sparrow call note is a sharp *tsip* or *seep* similar to that of other *Spizella* sparrows (Sibley 2000). It commonly sings communally on breeding grounds and in migration (Paine 1968). Brewer's Sparrows may start singing as early as 3:00 AM and sing well into the night. Only males are known to sing.

Taxonomy and Distribution

Taxonomy

Spizella breweri and *S. pallida* may have arisen from a common ancestor during the Pleistocene. The boreal forest may have separated the Great Basin and Northern Great Plains 12K - 25K yrs BP, resulting in separation and eventual reproductive isolation of the common ancestor in each area. When the forest retracted northward ca. 10K yrs BP, *S. breweri* and *S. pallida* came into contact as distinct species (Pernanen 1994).

According to Rising and Beadle (1996), Brewer's Sparrow occasionally hybridizes with Clay-colored Sparrow. Genetic studies indicate that Brewer's, Clay-colored, and Field Sparrows (*S. pusilla*) evolved from a common ancestor at least 100,000 years ago (Klicka et al. 1999).

Spizella breweri was discovered by science in 1850 by John Cassin; after carefully study of specimens at the Philadelphia Academy of Sciences he decided it should be separated from the similar Clay-colored Sparrow. He named it in honor of Thomas Mayo Brewer, one of the foremost 19th century naturalists (Paine 1968, Rising and Beadle 1996). The taxonomic hierarchy of the Brewer's Sparrow is as follows: Class: Aves; Order: Passeriformes; Family: Emberizidae; Genus: *Spizella*; and Species: *breweri*. Two subspecies are formally recognized: *S. b. breweri* of sagebrush and shrubsteppe environments, and *S. b. taverneri* of the subalpine and alpine zones.

Genetic studies show that *S. b. breweri* and *S. b. taverneri* had a late Pleistocene common ancestor and probably separated into distinct forms during the last Wisconsin interglacial (Klicka et al. 1999). Palynological and other evidence shows that ca. 35K yrs BP, during a warmer and drier period, sagebrush and grassland extended much farther north into parts of the Yukon and Alaska (Burns 1996, Vance et al. 1995). The range of sage and grassland vertebrate species

probably extended northward as well (Klicka et al. 1999). As the climate subsequently cooled and became wetter, the northern extent of sage-grasslands moved south. Whereas some northern populations of Brewer's Sparrow tracked this movement southward, others remained and adapted to nesting in birch, willow, and krummholz conifers in Alaska, Canada, and northwestern Montana.

Full species status for *S. b. taverneri* (*S. taverneri*) was first suggested by Swarth and Brooks (1925) based on differences in structure, coloration, altitudinal separation from *S. b. breweri*, allopatric breeding ranges, ecology, and behavior. This is currently supported by various ornithologists, with further emphasis on differences in vocalizations. Klicka et al. (1999) favored full species status because a DNA marker correctly classified 33 of 34 individuals to subspecies. Mayr and Johnson (2001) countered that *S. b. taverneri* should remain a subspecies until more is known. They pointed out that DNA of *S. b. taverneri* and *S. b. breweri* differ by only 0.13% on average, whereas DNA of other *Spizella* species differs by 5.9-6.1%. Furthermore, there is a lack of data proving reproductive isolation of *S. b. taverneri* from *S. b. breweri,* although Klicka et al. (1999) noted that hybrids would be difficult to identify. Klicka et al. (1999, 2001) stated that separate genetic groupings reinforce biological data indicating that *S. b. taverneri* and *S. b. breweri* are allopatric and are, therefore, separate species. Doyle (1997) speculated that differences in songs of the two subspecies may minimize hybridization.

Subspecies status for *S. b. taverneri* is currently accepted by the American Ornithologists Union (1983), with little chance of revision to full species in the near future (S. Jones, personal communication). There is a general consensus that *S. b. taverneri* has simply not evolved long enough to be readily distinguished from *S. b. breweri*.

Distribution and Range

Breeding Range

Spizella breweri breweri breeds in shrubsteppe from central Alberta and southwestern Saskatchewan on the north through Montana, the western Dakotas, and western Nebraska into western Kansas and northwestern Oklahoma on the south. Western boundaries of the breeding range are generally central Arizona through Nevada to extreme northeastern California (Rising and Beadle 1996, Rotenberry et al. 1999) (Figure 2). Recent records indicate that *S. breweri* has been expanding its range northeastward in Montana (Pernanen 1994).

North American Breeding Bird Survey (BBS) data show Brewer's Sparrows most abundant from central Nevada to southeastern Oregon; other routes with high numbers are in southeastern Idaho and southwestern Wyoming (Peterjohn et al. 1995, Sauer et al. 2003) (Figure 2). Sagebrush covers roughly 9,568,981 ha, or 38%, of Wyoming (Knick et al. 2003; Figure 3), and Brewer's Sparrows occupy a similar proportion of the state.

The subspecies *taverneri* was originally described by Swarth and Brooks (1925) and Grinnell (1932) as occurring in the alpine of the Canadian Rocky Mountains. This breeding range generally occurs as two geographic centers: (1) east-central Alaska (Nutzotin Mountains) south to the southwestern Yukon; (2) the interior of northwestern British Columbia and western Alberta (Rotenberry et al. 1999). Recent field work has extended the range of *S. b. taverneri* southward to northwestern Montana, where it is now recognized as a common breeder (Walker 2000). Using GIS-generated maps and follow-up field work, Griffin et al. (2003) extended the known breeding range of *S. b. taverneri* 50 km south and 30 km east of Glacier National Park. Klicka et al. (1999) speculated that *S. b. taverneri* is probably much more widely distributed than is now documented because its preferred alpine habitat is not easily accessible. It probably breeds as far south as Colorado. H. Kingery (personal communication) heard two Brewer's Sparrows singing in willows and saw fledglings near 3,500 m elevation in the Flat Tops Wilderness in northwestern Colorado

in 1988 (Lambeth 2000); many other unconfirmed reports of possible *S. b. taverneri* have come from high elevations in the Wet Mountains in Colorado (R. Levad, personal communication). An isolated breeding population of Brewer's Sparrow (*S. b. taverneri*?) was found at 2,000 m on Mt. Lassen in California (Paine 1968).

This information suggests that alpine areas in Wyoming, particularly the large alpine zones in northwestern Wyoming, may support breeding populations of *S. b. taverneri*. It is important to note (as below) that *S. b. taverneri* is known to winter in areas from southern California eastward to Texas. Because the subspecies can migrate across several thousand kilometers, it is reasonable to assume it can access suitable breeding range throughout the Rocky Mountain cordillera.

Winter Range

The winter range of the Brewer's Sparrow extends from southeastern California, central Arizona, southern New Mexico, southwestern Texas southward throughout Baja California and central Mexico (Rising and Beadle 1996). North American BBS data show wintering Brewer's Sparrows most abundant in southern Arizona, New Mexico, and west Texas. Brewer's Sparrows gather in large flocks with other sparrows throughout their winter range. Mixed flocks of 50-100 individuals are regularly recorded. Brewer's Sparrow may be the most abundant wintering sparrow in Death Valley, even singing "ecstatically" in chorus while bathing (Paine 1968).

The winter range of the Timberline Sparrow is largely unknown, but *S. b. taverneri* has been reported in Texas, California, Arizona, and New Mexico (Rotenberry et al. 1999).

Casual Records

A few out-of-range records have been reported from Minnesota, Nova Scotia, New York, and Ontario (Paine 1968, Rotenberry et al. 1999).

Historical Records

Although *S. b. taverneri* was first described in 1925, its first Alaskan record was not until 1992 (Paige 1968). Early biologists speculated that *S. b. taverneri* probably occurred over a wide area in suitable habitat in the northwestern U.S. (Griscom 1928, Grinnell 1932), and current fieldwork is bearing out these speculations (Walker 2000).

Habitat Requirements

Breeding

Brewer's Sparrow has been called the most common breeding bird in the sagebrush systems of western North America, and is generally considered to be a sagebrush obligate (Braun et al. 1976). Even though big sagebrush (*A. tridentata*) comprised only 30% of shrubs in a study plot in southeastern Idaho, Brewer's Sparrows actively sought out sagebrush for their nests (Petersen and Best 1985). Brewer's Sparrow distribution and abundance in Wyoming generally reflects this vegetation association; both sagebrush and Brewer's Sparrows are rather abundant and widespread in the state (Figure 3). It is important to note, however, that *S. b. breweri* occasionally nests in shrubby areas not dominated by sagebrush (Bailey and Niedrach 1965, Pernanen 1994) and *S. b. taverneri* typically breeds in non-sage shrubs and krummholz near upper timberline.

Brewer's Sparrows typically nest in shrublands dominated by big sagebrush with an average canopy height of <1.5 m (Knick and Rotenberry 1995, Rotenberry et al. 1999). Nests are usually placed in dense foliage 20 - 50 cm above the ground (Petersen and Best 1985). In southeastern Alberta, both Brewer's and Clay-colored Sparrows chose the largest shrubs in the densest stands

in which to nest (Pernanen 1994). Occasionally, where shrubs are lacking, nests have been found in stout forbs (McGee 1976).

Breeding *S. b. breweri* prefer high densities of medium to tall sagebrush with scant herbaceous cover underneath (Best 1972, Croteau 2002, Petersen and Best 1985, Knopf et al. 1990) (Figure 4). In general, number of birds is inversely correlated with annual grass cover. In Washington, *S. b. breweri* counts showed a strong positive relationship to amount of sage cover; counts were lower in very low shrub densities and increased as cover approached 10% (Dobler 1994). B. Walker (personal communication), however, found that if sagebrush cover exceeded 50% Brewer's Sparrows declined in number. Knopf et al. (1990) used vigor of sagebrush to identify habitat preferred by Brewer's Sparrows. They classified individual shrubs according to a "vigor index" that integrated many variables (i.e., height, diameter of shrub, distance to nearest shrub). Approximately 75% of the shrubs studied were a species of sagebrush, and Brewer's Sparrows choose relatively vigorous shrubs for their nests.

Knick and Rotenberry (1995) showed that probability of occurrence of Brewer's Sparrows was primarily a function of shrub cover (ca. 0% probability at 0% shrub cover; 80% probability at 80% shrub cover), and secondarily a function of shrub patch size (increasing probability with increasing patch size). Altman and Holmes (2000) defined habitat for Brewer's Sparrows as: sagebrush cover 10-30%, mean height >64 cm, high foliage density, average herbaceous cover >10%, bare ground >20%. Sagebrush patches or clumps are generally more desirable than uniform sagebrush cover.

Brewer's Sparrows are xerophilic, adjusting to water stress by efficiently reducing evaporative and cloacal water loss. In a test on individuals collected from the lower Sonoran desert in

Arizona, some tolerated three weeks without drinking while losing only 15-25% of body mass (Dawson et al. 1979). Related species, such as the Chipping Sparrow, cannot tolerate water restriction as well.

In Alaska and Canada *S. b. taverneri* nests in dwarf birch (*Abetula glandulosa*), dwarf spruce (*Ipicea* spp.), willow (*Salix glauca*), and subalpine fir (*Abies lasiocarpa*), commonly in steep and regenerating avalanche chutes (Doyle 1997, Klicka et al. 1999). In Montana, *S. b. taverneri* is found in small and isolated patches of dense krummholz on open alpine slopes or talus fields at timberline (Walker 2000, Griffin et al. 2003) (Figure 5). Recent studies indicate that *S. b. taverneri* has narrow habitat requirements making it somewhat susceptible to climate change and the consequent changes to alpine vegetation (Griffin et al. 2003).

Migration

It is assumed that although Brewer's Sparrows may retain their preference for shrub-dominated habitats through migration, like most passerines they become more general in habitat use during this period.

Winter

Brewer's Sparrows winter in small flocks in the desert scrub of the southwestern U.S. and northern Mexico (Rising and Beadle 1996). There are few winter observations of *S. b. taverneri,* possibly because it is difficult to identify, especially when not singing. Winter habitat is generally shrubland and brushy desert dominated by sagebrush, saltbush (*Atriplex* spp.*)*, and creosote (*Larrea tridentata*) (Rotenberry et al. 1999).

Area Requirements

In the sagebrush of southeastern Idaho shrub patch size was a moderately significant determinant of the presence of Brewer's Sparrow, but not as important as overall shrub cover (Knick and Rotenberry 1995). Other studies in the western U.S. have found that Brewer's Sparrows can successfully breed in shrub patches as small as 6 ha, even when surrounded by unsuitable habitat. In disturbed habitat in southeastern Idaho, however, small and isolated patches of sagebrush were occupied by Brewer's Sparrows less often than were large patches and patches connected to or near other patches (Knick and Rotenberry 1995).

Estimates of breeding densities of Brewer's Sparrows vary: 1.1 - 1.3 birds/ ha in central Oregon; 1.2 - 1.9 birds/ ha in southeastern Idaho; 2 birds/ ha in Montana (Rotenberry et al. 1999). Maximum densities of 5.3 birds/ ha are reported by Wiens and Rotenberry (1981; see also Short 1984). Some study sites have high annual variation, being unoccupied one year and having over 1 bird/ ha the next year.

Landscape Pattern

Based on current literature the ideal landscape for breeding *S. b. breweri* is a relatively flat or mildly rolling plain dominated by stands of sagebrush (with grassland and other shrubs present as minor components) in different seral stages (i.e., stands differ in canopy density and height), with late-seral (i.e., tall and dense) stands present throughout (Figure 4). This "seral mosaic" of sagebrush appears in current descriptions of ideal habitat for other sagebrush vertebrates, including Sage Grouse (*Centrocercus urophasianus*). The occurrence of *S. b. breweri* is negatively correlated with percent cover of grass, litter, small shrubs, shrub species diversity, and presence of a rocky or markedly rolling surface (Wiens and Rotenberry 1981, Short 1984). Short (1984) recommended topographic slopes $<30^{o}$. Although most common on plains, basin floors,

and lower foothill slopes, nesting Brewer's Sparrows are occasionally found in large openings in pinon-juniper (*Pinus edulus-Juniperus* spp.) woodlands and montane forest.

The rather small amount of information on *S. b. taverneri* suggests it prefers open landscapes near upper timberline with scattered stands of krummholz, willows, birch, and alder for nesting and perching substrate (Figure 5). Although the plants used by *S. b. breweri* and *S. b. taverneri* differ taxonomically, they are similar structurally. The latter subspecies is known to breed in avalanche chutes and other steep landforms, and may favor southeastern exposures at the transition between the alpine and subalpine zones (Klicka et al. 1999). It is reasonable to assume that breeding *S. b. taverneri* extend into montane zones in some situations, where they may possibly overlap with *S. b. breweri*.

Movement and Activity Patterns

Dispersal

Little is known about post-natal dispersal. Of 400 young birds banded in a 7-year period, none were observed to return to their natal site (Rotenberry et al. 1999). Breeding males, however, appear to have some fidelity to breeding territories (Petersen and Best 1987); an Idaho study recorded 25% of color-banded adult males returning to their previous breeding areas (Rotenberry et al. 1999).

Migration

Migration occurs at night, as with most other oscines (Rotenberry et al. 1999). Brewer's Sparrows migrate north-south in flocks of 50-100 birds. According to Rotenberry et al. (1999), birds that breed farthest north migrate farthest to the south. Brewer's Sparrows are rarely encountered as migrants west of the California coast ranges or east of western Kansas and the

panhandle of Oklahoma (Rising and Beadle 1996). The first arrivals on breeding grounds in Nevada are in mid- to late March (Paine 1968), but the main migration is in April. Brewer's Sparrows do not arrive in Canada until early May. Average dates of spring arrival in Wyoming are April 28 (Laramie) and April 22 (Albany County) (Paine 1968).

Spizella breweri taverneri arrives in southwestern Alberta in late May (Semenchuk 1992). Small flocks of *S. b. taverneri* have been seen in aspen (*Populus tremuloides*) in early June near Calgary, Alberta, waiting for snow to melt at high elevations, and singing males have been encountered at sea level in Alaska in early June (Doyle 1997). What little documentation exists for migration suggests a slow northward spring migration (two records in west Texas in early March and three records from Washington in mid-April (Rotenberry et al. 1999).

Fall migration may begin as early as late July, but most birds leave from mid-August through October; northernmost birds leave in the earlier part of this interval. Flocks of Brewer's Sparrows appear in their wintering grounds by mid-September. Few details on migration are reported, probably due to a paucity of observers in their wintering areas (Rotenberry et al. 1999).

Daily Activity

Rotenberry et al. (1999) reported that singing and foraging are the most common daily activities, followed by preening, inactivity, flight, and aggression. Brewer's Sparrows intersperse foraging with singing during the day in the breeding season (Wiens et al. 1990), with most foraging occurring early and late in the day. Most foraging is done by gleaning vegetation, with occasional flycatching and walking on the ground. Brewer's Sparrows sing only from elevated perches. As with most other grassland/ sagebrush birds, they typically select the highest available

perch, but rarely select taller trees over shrubs (Castrale 1981, Sedgwick 1987). Songs are audible over large areas.

Reproduction and Survivorship

Breeding Behavior

Brewer's Sparrows nest in loose colonies with separate breeding territories. In southeastern Idaho, about 25% of color-banded males returned to the same area that they had used the previous year (Rotenberry et al. 1999).

The nest is open and cup shaped, about 8 cm in diameter (Rich 1980), and is usually placed in big sagebrush shrubs in dense foliage (Petersen and Best 1985, Rotenberry et al. 1999). In southeastern Idaho, 90% of nests were 20-50 cm above the ground (Petersen and Best 1985; see also Rich 1980, and Castrale 1981, 1982). When comparing locations of nests of Sage Thrashers (*Oreoscoptes montanus*), Sage Sparrows (*Amphispiza belli*), and Brewer's Sparrows, Rich (1980) found that each species placed nests in different microhabitats. Brewer's Sparrows placed their nests higher in shrubs than the other 2 species. Furthermore, breeding cycles of the three species do not appreciably overlap; for instance, Brewer's Sparrows did not start laying eggs until early June, long after thrashers had laid theirs.

Males are very aggressive in establishing and defending territories (Croteau 2002), and females have been known to chase away males that are not mates. Males sing from elevated perches in sagebrush even when taller trees are present, both long and short songs are used to advertise territories, and male-male counter singing is common (Rotenberry et al. 1999).

Territory size varies, but usually ranges from 0.25 - 2.0 ha (Wiens et al. 1985). In southeastern Alberta, mean (n = 19) territory size for Brewer's Sparrows in sagebrush-grassland was only 0.25 ha (Short 1984, Pernanen 1994). Territories averaged 0.55 - 2.36 ha in Oregon and northern Nevada, 0.1 ha in central Washington, and 0.5 ha in southeastern Idaho (Reynolds 1981, Wiens et al. 1985).

Brewer's Sparrows are thought to be monogamous (Paine 1968). Few incidences of male incubation or multiple brooding were reported until color-banded birds were studied. Mahony et al. (2001) recorded many instances of male incubation and multiple brooding in Washington and southern British Columbia. A male with a partly developed brood patch was discovered by B. Walker in June 2000 in western Montana (Mahony et al. 2001). Male brooding time was greater on colder days. Both parents forage close (<50 m) to the nest (Rotenberry et al. 1999). One instance of cooperative behavior, wherein a female tended another bird's nest following failure of her own nest, has been reported (Gill and Krannitz 1997).

Breeding Phenology

Spizella breweri breweri can breed during the first year of life. Pairs establish breeding territories in mid-April in the southern part of the species' range, and by the end of April in the north (Alberta) (Pernanen 1994). Nesting season lasts until early August (Paine 1968). In contrast, *S. b. taverneri* doesn't begin breeding in Alaska and Canada until June or July (Klicka et al. 1999). Construction of nests takes 4-5 days (Rotenberry et al. 1999); clutch size varies from 3-4 eggs; incubation lasts 10-12 days (Reynolds 1981). Egg-laying to fledging is about 20-22 days. *Spizella breweri breweri* may raise two broods, beginning a second clutch about 10 days after fledging the first brood. In British Columbia, 17% of females fledged two broods; one female produced three broods in one season. Fledging begins in mid-June and continues to the end of

July (Rotenberry et al. 1999). Young are altricial and may be fed by the parents for up to 30 days after fledging (B. Walker, personal communication).

Fecundity and Survivorship

Estimates of nest success vary widely: 9% (n = 7; Reynolds 1981) in southeastern Idaho; 39% in eastern Washington (n = 495); 46% in eastern Washington (n =59); 61 - 100% in Oregon (Rotenberry and Wiens 1989). Reproductive success is lower in more fragmented habitat (M. Vander Haegen, unpublished data in Altman and Holmes [2000]). Number of fledglings per nest varies widely and depends on many factors including predation, cowbird parasitism, and weather (Rotenberry et al. 1999).

Population Demographics

Limiting Factors

According to Rotenberry et al. (1999), processes regulating populations are largely unknown. There is no indication that reproductive success is influenced by local density or intra- or interspecific competition (Rotenberry and Wiens 1989). Local reproductive success may be a function of nest predation; Rotenberry and Wiens (1989) describe nest predation as a major influence on all birds nesting in shrubsteppe habitat. New data show that impacts to Brewer's Sparrows on wintering grounds may also substantially influence population size (Rotenberry and Knick 1999).

Reproductive success is probably generally correlated with climatic variation; for instance, clutch size appears to increase in wetter years, and larger clutches tend to fledge more young (Rotenberry and Wiens 1989, 1991). Petersen and Best (1985; see also Lack 1966) suggested that the number of fledglings per nest is positively correlated with precipitation the preceding winter,

presumably because such precipitation increases food supply during the breeding season. However, Petersen and Best (1986) found no significant increase in clutch size in response to increased food supply, and Howe (1993; see also Howe et al. 1996) reported that reproductive success of Brewer's Sparrows did not decrease on plots where insects (primary food source) were reduced by Malathion treatment. The treatment may not have reduced food supplies enough to impact the birds, an idea echoed by Wiens (1984) who suggested that food in shrubsteppe habitat is "superabundant" during the breeding season and is difficult to diminish enough to impact bird productivity.

As detailed below, Brewer's Sparrows are highly insectivorous, especially during the breeding season when hatchlings and fledglings depend strongly on insect protein for growth and development. Unusually cold weather during the nesting and fledging periods could reduce survival of young by reducing or delaying insect production in sagebrush systems, despite the claims of Wiens (1984). This could be a major constraint on populations of many other sagebrush obligates such as Sage Grouse, Sage Thrashers, and Sage Sparrows, and requires more research. Very little is known about insect ecology in the sagebrush of western North America. The issue of weather influences on insect production could also be very important for populations of *S. b. taverneri*, which occupy even more severe climates in the alpine and subalpine zones.

Metapopulation Dynamics

Although populations of Brewer's Sparrows are patchy at several scales (e.g., continental, regional, local), there is no data to suggest that they form formal metapopulations. Shrub-dominated habitats are well-distributed throughout the breeding range, and Brewer's Sparrows have enough habitat generality and mobility to suggest that major breeding centers are linked through occasional, if not regular, exchange of individuals.

Because of it's affinity for subalpine and alpine areas, and because such areas are distributed in a rather patchy pattern across western North America, there is a reasonable potential for *S. b. taverneri* to be organized as a metapopulation. More research is clearly needed to inform this issue.

Genetic Concerns

Current knowledge does not suggest that *S. b. breweri* is subdivided into genetically distinct populations, or is threatened by inbreeding or significant genetic homogeneity, in the western U.S. Populations at the periphery of the subspecies range, such as southern Canada, may be experiencing some of the deleterious genetic effects typically associated with small and isolated populations (Croteau 2002).

Whether the 0.13% difference in DNA between *S. b. breweri* and *S. b. taverneri* indicates legitimate subspecific or specific status is currently under debate. Many biologists believe that *S. b. breweri* and *S. b. taverneri* are sufficiently different in so many other traits (habitat use, song, morphology, breeding behavior and phenology) that this rather small genetic difference should not take precedence in discussions of uniqueness. More studies are currently underway to clarify this issue.

Food Habits

Food Items

In southeastern Idaho Brewer's Sparrows are primarily insectivorous during the breeding season and feed their young almost exclusively on arthropods (Petersen and Best 1986, Petersen et al. 1986). Other field work suggests Brewer's Sparrows feed their nestlings a significant number of spiders, and that older nestlings are fed larger arthropods. The diet of nestlings primarily

consists of larvae of Lepidoptera, arachinoids, hemiptera, homoptera (Petersen and Best 1986). Rotenberry et al. (1999) found barklice accounting for 52% of nestling diet. Brewer's Sparrows predominantly eat seeds and seed-heads during migration and on their wintering range; during these times, insects comprise only about 10% of their diet (Short 1984). As mentioned above, the relationships between climate, understory productivity, and invertebrate availability in sagebrush systems are largely unknown, and could be of great importance in managing Brewer's Sparrows and other sagebrush obligate vertebrates.

Foraging Strategy

Brewer's Sparrows glean a wide variety of small insects from foliage, stems, and bark of shrubs. At times they may flycatch insects, darting 1-3 m into the air from vegetation perches (Rotenberry et al. 1999). They occasionally eat seeds from the ground, especially during migration and on wintering grounds. Brewer's Sparrows are well-adapted to dry environments (Dawson et al. 1979); they drink water when available, but usually derive water from food (Rotenberry et al. 1999).

Foraging Variation

Brewer's Sparrows feed on a wide variety of invertebrate taxa, and therefore are unlikely to be affected by variations in the availability of specific taxa. It is assumed that the composition of the diet in breeding season reflects local availability of invertebrates.

Community Ecology

Predation

The major cause of nest failure is probably predation (Rotenberry et al. 1999). Nest predators include a variety of chipmunks, ground squirrels, snakes, and weasels, as well as corvids, shrikes,

and raptors (Rotenberry et al. 1999). Wiens and Rotenberry (1981) noted a significant negative correlation between Loggerhead Shrike (*Lanius ludovicianus*) and Brewer's Sparrows densities. According to Rotenberry and Wiens (1989), nest predation greatly affects reproductive success of almost all birds nesting in shrubsteppe habitat. In a study of the similar Clay-colored Sparrow, Knapton (1994) found that nests placed closer to other Clay-colored Sparrow nests were more subject to predation. He concluded that, partly for this reason, *Spizella* nests are not placed randomly but rather in scattered patterns that minimize nest predation.

Nest predation was found to be higher in fragmented habitat than in areas of continuous shrubsteppe (Vander Haegen et al. 2000). Brewer's Sparrows will join other sage-nesting species to chase predators away (Rotenberry et al. 1999).

Competition

There is no evidence that intra- or interspecific competition significantly affects nesting success or population size of Brewer's Sparrows (Rotenberry et al. 1999). Reynolds (1981) suggested that Sage Sparrows can suppress numbers of Brewer's Sparrows under some circumstances. The extent to which invertebrates are competed for during the spring and early summer (when invertebrate use by many sagebrush obligate vertebrates is high) is an area of potentially valuable research.

Parasites and Disease

Little is known about diseases in Brewer's Sparrows (Rotenberry et al. 1999). Petersen et al. (1986) found only 4% of Brewer's Sparrow broods parasitized by flesh fly larvae, and mortality related to these ectoparasites was rare. Larvae of the parasitic blowfly *Protocalliphora braueri*

were reported from 6% of nests in Idaho (Howe 1993). In contrast, Greiner et al. (1975) found 3 of 4 Brewer's Sparrows infected with blood protozoans.

Brown-headed Cowbirds (*Molothrus ater*) rarely lay eggs in Brewer's Sparrow nests, and parasitized nests are usually abandoned (Rotenberry et al. 1999). Brood parasitism by the Brown-headed Cowbird has been reported in 13% of nests in southern Idaho, 5% in eastern Washington (Altman and Holmes 2000), and 0% in central Oregon and Nevada (Rotenberry et al. 1999). In contrast Biermann et al. (1987) reported 18 instances of cowbird parasitism in 13 of 25 Brewer's Sparrow nests in southeastern Alberta. Nine of the parasitized nests were abandoned. Brewer's Sparrows apparently use nest abandonment as a strategy to thwart parasitism, because no unparasitized nests were abandoned (Biermann et al. 1987).

Symbiotic and mutualistic interactions

No significant symbiotic or mutualistic interactions are known for Brewer's Sparrows.

Conservation

Conservation Status

The Brewer's Sparrow is not on any official state or federal endangered species list in the U.S. In British Columbia, it is on the "Red List" and is currently the subject of intense study (Croteau 2002). The Brewer's Sparrow is protected under the Migratory Bird Treaty Act (1918) in the U.S., Migratory Bird Conservation Act (1916) in Canada, and the Convention for the Protection of Migratory Birds and Game Mammals (1936) in Mexico.

Despite the fact that it is currently rather abundant and widespread, several factors suggest that the Brewer's Sparrow is quickly becoming a species of major conservation concern throughout its

breeding range. BBS data indicate rangewide declines in distribution and abundance (~3.7% per year from 1966 to 1996; Sauer et al. 2003), and there is solid evidence of widespread reduction in the amount and quality of breeding habitat. The greatest population declines have occurred at the range core, with apparently greater stability on the range margins (Mahony et al. 2001). Furthermore, there is clearly increasing concern over other sagebrush obligates (e.g., Sage Grouse, Sage Thrasher, Sage Sparrow, pygmy rabbit [*Brachylagus idahoensis*]) whose ranges overlap that of the Brewer's Sparrow. Conservation of Brewer's Sparrows may be very cost effective now, when populations are still relatively healthy, rather than waiting until large declines in abundance and distribution force more costly, "crisis" management actions.

USDI Fish and Wildlife Service

The USDI Fish and Wildlife Service confers no special status to the Brewer's Sparrow at this time.

USDI Bureau of Land Management

The Wyoming State Office of the USDI Bureau of Land Management (BLM) has designated the Brewer's Sparrow (*S. b. breweri*) as a Sensitive Species. This is the case with other state offices of the BLM in the west, most notably Idaho where the BLM has listed Brewer's Sparrow as a "priority species".

USDA Forest Service

The Rocky Mountain Region (Region 2) of the USDA Forest Service (USFS), which includes USFS units in most of Wyoming, considers the Brewer's Sparrow a Sensitive Species. At this time the USFS Intermountain Region (Region 4), which includes USFS units in southwest

Wyoming, confers no special status to the species (see http://www.fs.fed.us/biology/resources/pubs/tes/fs_ss_2sept04.pdf).

Recognition of *S. b. taverneri* as a distinct subspecies, or full species, would likely result in several USDA Forest Service Regions conferring special status to the taxon, because its alpine/ subalpine habitat is almost entirely managed by that agency.

State Wildlife Agencies

The Wyoming Game and Fish Department confers no special status to the Brewer's Sparrow at this time.

State Natural Heritage Program

The Wyoming Natural Diversity Database (WYNDD; University of Wyoming) ranks the Brewer's Sparrow as **G5 / S5** with a Wyoming Contribution Rank of **Medium**. The "G5" indicates that the full species *S. breweri* is demonstrably secure at the continental scale; "S5" indicates demonstrable security at the state scale. The Wyoming Contribution Rank indicates that because Wyoming forms part of the core of Brewer's Sparrow breeding range, and because that range is rather large, Wyoming populations contribute moderately to the persistence of the species as a whole in North America (Keinath et al. 2003).

Currently, WYNDD does not track *S. b. taverneri* as a separate taxon. Depending on the results of on-going taxonomic and distributional research, WYNDD may begin tracking this subspecies as a distinct taxon in the future. In this context the most critical question is whether Wyoming supports substantial occurrences of *S. b. taverneri*.

Other

The Audubon WatchList 2002 classifies the Brewer's Sparrow in Wyoming as being in the "yellow" category, which is defined as a species of moderate to moderately high priority. "Yellow-listed" birds are declining at slower rates than those in the red category, are typically of national conservation concern, and are those whose conservation is rather cost-effective at present.

The Audubon WatchList 2002 is a synthesis of species assessments compiled by BirdLife International (BLI) and Partners In Flight (PIF). Methodology used in the WatchList was developed in conjunction with Partners in Flight, a coalition of North American ornithological groups of which Audubon is a leading member. Bird Life International developed global methodology; Audubon is the U.S. partner designate for BLI.On the Columbia Plateau, Oregon-Washington Partner's in Flight considers the Brewer's Sparrow to be a focal species for conservation planning (Altman and Holmes 2000).

Biological Conservation Issues

Abundance

The Brewer's Sparrow is locally abundant in good sagebrush habitat, but is decreasing in disturbed, fragmented habitat. Recent (1980-2000) surveys have shown the Brewer's Sparrow is in significant decline throughout its range (Rotenberry et al. 1999, Sauer et al. 2003).

North American BBS transect data show Brewer's Sparrows most abundant from central Nevada to southeastern Oregon; other routes with high numbers are in southeastern Idaho and southwestern Wyoming (Peterjohn et al. 1995, Sauer et al. 2003). The species is relatively common throughout Wyoming. Winter counts show highest U.S. numbers are in southern Arizona and New Mexico and west Texas.

Not enough data are available to discuss the abundance of *S. b. taverneri* in the U.S. in general, or Wyoming in particular.

Trends

Abundance Trends

At one time *S. b. breweri* may have been the most abundant bird in the intermountain west (Paige and Ritter 1999), but it is now generally accepted as declining rangewide. The Brewer's Sparrow is still locally common in shrubsteppe habitat throughout its range, and is easily found in most portions of Wyoming.

North American BBS trend data over a 30-year period show a strong range-wide decline of the Brewer's Sparrow averaging 3.7% per year (n = 397 survey routes) (Ashley and Stoval 2004). BBS data show significant declines in California, Colorado, Montana, Oregon, and Wyoming, but the steepest decline (-6%) is in Idaho. Only Utah apparently has a stable population.

Bird censuses at the Idaho National Engineering and Environmental Laboratory reported an increase in Brewer's Sparrow abundance between 1985 and 1991; however, a close look at the data shows very high variation (9.6 to 99.5 birds along 12-13 transects), which makes trend determination questionable. Dobkin (1994) reported that Brewer's Sparrow numbers in Idaho have significantly declined.

Much more field data is needed before a confident discussion of abundance trends for *S. b. taverneri* is possible.

Extent and Connectivity Trends

Brewer's Sparrow populations generally follow the distribution of shrubsteppe habitat in western North America, with major centers of occurrence in landscapes dominated by big

sagebrush. Although still relatively widespread, over the past 100 years such habitat has been reduced, fragmented, and degraded in many areas (see Extrinsic Threats). The distribution of Brewer's Sparrow has been similarly reduced and fragmented (Rotenberry et al. 1999).

In general, the alpine/ subalpine habitat used by *S. b. taverneri* has remained relatively stable in distribution during the recent past.

It is assumed that Brewer's Sparrow distribution in Wyoming is close to historic levels, with only localized extirpations in major urban centers, surface mines, and other highly disturbed sites.

Habitat Trends

As mentioned above and discussed in more detail under Extrinsic Threats, sagebrush-dominated landscapes in western North America have undergone a general trend of reduction, fragmentation, and degradation over the past 100 years which has lead to a corresponding reduction in distribution and abundance of Brewer's Sparrows. Processes responsible for this trend, especially road construction and cheatgrass (*Bromus tectorum*) invasion, are not expected to abate substantially in the near future; this holds both rangewide and specifically for Wyoming.

In general, the alpine/ subalpine habitat used by *S. b. taverneri* has remained relatively undisturbed, with local exceptions, over the past century.

Range Context

Wyoming forms part of the core of *S. b. breweri* range, with the southwestern corner of the state (Green River and Bear River basins) supporting especially high numbers of the species (Figure 2). Due to lack of data, the amount of *S. b. taverneri* range within Wyoming is not known;

it is possible that the mountains of northwestern Wyoming support significant breeding concentrations of this subspecies.

Extrinsic Threats and Reasons for Decline

Anthropogenic Impacts

Due to a paucity of field data and an uncertainty over the degree to which the subspecies occupies Wyoming, it is difficult to speculate on the anthropogenic impacts to *S. b. taverneri*. This discussion will be restricted to *S. b. breweri*.

The primary threat to Brewer's Sparrows is from anthropogenic activities that alter, both deliberately and inadvertently, the structure and composition of sagebrush-dominated ecosystems in western North America. In many areas human actions have replaced sagebrush systems with other land cover types, fragmenting both native sagebrush habitat and dependent populations of Brewer's Sparrows and other taxa of concern (Braun et al. 1976, Rotenberry and Wiens 1980, Reynolds 1981, Rotenberry et al. 1999).

In portions of Washington, Idaho, Oregon, and the western Great Plains much former sagebrush is now under cultivation (e.g., Dobler 1994). In the mid-1970's, 10% of native sagebrush in the U.S. was converted to agriculture (Braun et al. 1976), and, since that time, the rate of disappearance has accelerated (Knick and Rotenberry 1995). Cultivation is not a major concern in Wyoming basins, affecting only a small amount of range in the state. Similarly, in some states urbanization has eliminated significant areas of former sagebrush, but this has not occurred to any large degree in Wyoming.

Several techniques have been used across North America to convert sagebrush into grassland for agricultural purposes. Discing, chaining, and herbicides have been employed to this end.

Some Wyoming sagebrush range has undergone these treatments, probably to the detriment of Brewer's Sparrows and other sagebrush obligates. The effects of discing and chaining probably depend on exactly how these operations are carried out; specifically, the size of sagebrush patches treated. For example, Brewer's Sparrow populations were apparently not affected by chaining strips <30 m wide (Best 1972, Pyrah and Jorgensen 1974). In contrast, treatment of sagebrush with 2, 4-D resulted in complete avoidance of the area by Brewer's Sparrows even five years after treatment (Pyrah and Jorgensen 1974). Herbicide application in Oregon is also known to reduce the density of Brewer's Sparrows (Wiens 1985). Pesticides have the potential to affect Brewer's Sparrows via reduction in important insect food items, although Howe (1993; see also Howe et al. 1996) found no evidence of such effect. More research into this issue is needed.

Resource managers often re-seed areas of disturbed sagebrush with exotic grasses, commonly crested wheatgrass (*Agropyron cristatum*), which degrades habitat quality for Brewer's Sparrows. Regions of southeastern Idaho which had been totally converted from sagebrush to crested wheatgrass showed significantly reduced bird species richness, with the Brewer's Sparrow being most affected (Bradford et al. 1998).

Moderate levels of livestock grazing typically impact bird species only slightly. West of the Rocky Mountains in the Great Basin and interior Columbia Basin there is concern that livestock grazing can damage soil, specifically the delicate cryptogamic layer, to the extent that vegetative succession is altered and recovery is hampered (Saab et al. 1995). This is not of as much concern in the sagebrush basins of Wyoming where, in contrast to more western regions, vegetation evolved with the influence of large grazing mammals.

Probably the largest threat to sagebrush ecosystems in western North America, and by extension to Brewer's Sparrows and other sagebrush obligates, is the complex interaction between invasion by the Asian annual cheatgrass and alteration of native fire regimes. Cheatgrass is steadily invading sagebrush-dominated basins from west-to-east, having already saturated many portions of the Great Basin and replacing native sagebrush steppe with an exotic grassland. Cheatgrass can apparently colonize sites that are disturbed by almost any process, including wildfire, road building, off-road motorized use, heavy livestock grazing, chaining or discing, and surface mining.

Once stands of the highly-flammable cheatgrass become established in an area, the probability of fire increases. Fire reduces sagebrush coverage and reproduction, but encourages cheatgrass spread, thus beginning a conversion cycle that is difficult to stop (Young et al. 1979, Knick and Rotenberry 1995, 2000). In southeastern Idaho from 1950 to 1979, the cheatgrass/ fire cycle reduced shrubsteppe from 51% to 30% of the total area, and also reduced intervals between wildfires from 80.5 to 27.5 years (U.S. Department of the Interior 1996). Large areas of Nevada and Utah have also been affected, with an almost complete replacement of native shrubs in some areas.

Brewer's Sparrows are negatively impacted by intense burning of shrubs, at least until shrub species recover, and the presence of cheatgrass can eliminate shrub recovery. Castrale (1981, 1982) showed Brewer's Sparrows are more sensitive to burning than chaining or herbicide spraying; 3-4 years post-treatment, Brewer's Sparrow were less abundant in burned plots than in untreated and chained plots. Some studies indicate that Brewer's Sparrow abundance is not affected by patchy fires which leave unburned stands of shrubs (e.g., Petersen and Best 1987). Brewer's Sparrows abandoned a Montana site that underwent 100% conversion from sagebrush to

grassland following a fire; however, they nested in partially burned adjacent areas where some big sagebrush remained (Bock and Bock 1987). The presence of cheatgrass can make patchy burns less likely than larger and more homogeneous burns.

Cheatgrass is present throughout Wyoming and is generally considered to be increasing in both distribution and abundance in the state. It has not yet established to the point where it dominates large areas, and there is speculation that much of Wyoming may have too short of a growing season and receive too much summer moisture to allow cheatgrass to dominate as it has in portions of the Great Basin. However, cheatgrass is an annual that can evolve very quickly to novel environments, and human disturbance of vegetation and soil are pervasive enough in Wyoming to greatly assist cheatgrass increase and colonization. Wildfires and prescribed burns occur regularly, off-road motorized use appears to be increasing, and road development continues in rather unabated fashion throughout much of the state, especially as a function of increased petroleum exploration and development.

Stochastic Factors (e.g., weather events)

The effects of weather on Brewer's Sparrows are not well understood, but there appears to be a rather straightforward relationship between precipitation, temperature, and Brewer's Sparrow reproductive success that may be mediated through invertebrate (i.e., food) productivity. High winter and spring precipitation can lead to higher grass and forb productivity, which in turn leads to higher invertebrate production and, finally, increased Brewer's Sparrow clutch size and survival. In contrast, cold snaps late in the spring may reduce and delay invertebrate production and, depending on timing and duration, reduce Brewer's Sparrow nesting success (Lack 1966, Petersen et al. 1986; Rotenberry and Wiens 1989, 1991).

Natural Predation

In general, nest predation is regarded as a threat to most passerines nesting in shrub habitats (Rotenberry and Wiens 1989).

Protected Areas

Most shrubsteppe habitat in Wyoming does not receive any special protection (Knick et al. 2003) from the threats discussed above. Local exceptions would include scattered BLM Areas of Critical Environmental Concern, National Wildlife Refuges (e.g., Seedskadee NWR), and small USDI National Park Service units (e.g., Fossil Butte National Monument, Devils Tower National Monument).

In contrast, much of the alpine/ subalpine habitat associated with *S. b. taverneri* is protected in USDI National Park Service and USFS Designated Wilderness in Wyoming.

Intrinsic Vulnerability

Habitat Specificity

The Brewer's Sparrow has been classified as a sagebrush obligate (Braun et al. 1976), but may be more accurately described as a shrub obligate with a strong affinity for sagebrush. Nevertheless, the association is strong enough to link the fate of Brewer's Sparrows to the fate of sagebrush cover itself. Management of sagebrush ecosystems will directly impact Brewer's Sparrows in Wyoming and adjacent states.

Based on limited information, *S. b. taverneri* is probably specialized to a rather narrow type of habitat at the alpine/ subalpine transition; namely, open tundra and subalpine meadows that support scattered stands of shrubs and small trees adequate for nesting.

Territoriality and Area Requirements

Brewer's Sparrows use rather small territories (0.25 - 2.0 ha; Wiens et al. 1985), and probably have enough mobility and habitat generality to discover and occupy rather small patches of suitable habitat.

Susceptibility to Disease

There is no information to suggest that disease is a significant impact to Brewer's Sparrows.

Disperal Capability

Brewer's Sparrows are long distance migrators, and are quite mobile.

Reproductive Capacity

Reproductive rates are generally what would be expected for a bird of this size and life history. Brewer's Sparrows can double-clutch, and can increase reproductive output in response to favorable environmental conditions.

Sensitivity to Disturbance

Brewer's Sparrows are sensitive to a suite of disturbances that affect the distribution and abundance of shrubs, with the highest sensitivity to those disturbances that completely remove shrubs (e.g., cultivation, urbanization, surface mining, intense fire). Of most concern is the cheatgrass/ fire cycle that can eliminate shrubs from large areas and essentially convert shrublands into annual grasslands.

Genetic Factors

No current information suggests that genetic factors are reducing the persistence of Brewer's Sparrow populations. As expected, certain peripheral populations may be experiencing some inbreeding and other genetic processes typical of small and isolated populations (Croteau 2002).

Population Viability Analyses (PVAs)

At this time there are no formal population viability analyses for Brewer's Sparrows in the literature.

Conservation Action

Beyond those management actions aimed at conserving native sagebrush habitats in general, there are no conservation actions specifically directed towards Brewer's Sparrows.

Existing or Future Conservation Plans

Brewer's Sparrows receive some general conservation protection via the U.S. Migratory Bird Treaty Act (1918), Canadian Migratory Bird Conservation Act (1916), and the Mexican Convention for the Protection of Migratory Birds and Game Mammals (1936). It is assumed that most state wildlife agencies also prohibit the take and collection of native songbirds like Brewer's Sparrows. In Wyoming the designation of Brewer's Sparrows as Sensitive Species by BLM - Wyoming State Office and USFS - Region 2 provides some additional protection, as such designation requires these agencies to formally consider the effect of management actions on the health and persistence of Brewer's Sparrow populations.

Beyond the instruments outlined above there are no conservation or management plans specifically targeting Brewer's Sparrows. Currently there is much interest in the proper management of sagebrush in western North America, due in part to concern over downward trends in sagebrush obligates such as pygmy rabbit, Sage Grouse, Sage Thrasher, Sage Sparrow, and Brewer's Sparrow, as well as big game species that depend on sagebrush for winter and year-round habitat. Many agencies, including the Wyoming Game and Fish Department, anticipate the opportunity to formulate and implement management plans for sagebrush ecosystems as a whole,

rather than relying on the traditional single-species management approach (R. Rothwell, personal communication). Current knowledge of Brewer's Sparrow ecology suggests that such plans need to center on (1) the maintenance of seral mosaics of sagebrush rather than large and even-aged stands, (2) the effects of fire on shrub regeneration, especially in the context of the complicating and potentially devastating effects of cheatgrass and the processes that encourage cheatgrass invasion, and (3) the critical role played by insects in providing a forage base, especially during the nestling stage.

Conservation Elements

Inventory and Monitoring

Existing bird-monitoring programs such as the North American (BBS) and the Christmas Bird Count (not applicable to Brewer's Sparrows in Wyoming) may not adequately sample species' abundance and trends in sagebrush habitats (Knick et al. 2003). The BBS survey routes generally follow roads, and thus BBS data may be biased towards particular species. Also, only 27 of 117 total Wyoming BBS routes include sagebrush habitat, resulting in only 6,871 ha (3% of the statewide total) of sagebrush being sampled (Knick et al. 2003). Nevertheless, BBS data streams represent the best available information from which to derive regional and rangewide trend estimates, and this sampling should continue.

In 2003 the Rocky Mountain Bird Observatory (RMBO) began a systematic survey of breeding birds throughout Wyoming, with sampling transects stratified by habitat type. Similar sampling is being pursued by RMBO in adjacent states, and has the potential to produce powerful data on abundance, distribution, and trends of Brewer's Sparrows and many other species. However, probably at least 3 more years of sampling will be needed before reliable estimates can

be made. The large scale, multi-species sampling approach taken by RMBO appears to have great potential for informing conservation and management of many native birds, and should be considered an example to follow for field inventory of other taxa.

For all bird inventory and monitoring projects it is important that field workers become aware of and familiar with *S. b. taverneri* in order to increase knowledge of distribution and abundance in Wyoming and the region.

Habitat Preservation and Restoration

As discussed above there are no habitat preservation or management plans specifically targeting Brewer's Sparrows at this time, but there is much interest in the management of sagebrush systems in western North America in general. The Wyoming Game and Fish Department anticipates formulating and implementing a holistic sagebrush ecosystem management plan in the next few years (R. Rothwell, personal communication).

Captive Propagation and Reintroduction

There are no captive propagation or reintroduction efforts for Brewer's Sparrow at this time, nor are such crisis efforts anticipated to be necessary in the near future.

Information Needs

Rangewide

More comparative research into the genetics, morphology, and life histories of *S. b. breweri* and *S. b. taverneri* is needed in order to inform the debate over the distinctness of these 2 taxa. A multidisciplinary, "weight-of-evidence" approach is necessary, because no single line of evidence is adequate to assess overall differences between the 2.

There needs to be more basic field inventories of *S. b. taverneri* in the Central and Southern Rocky Mountains, because current information is not enough to confidently assess its distribution and abundance. Inventories should be structured to sample a variety of habitats in the alpine, subalpine, and boreal zones. This will help ensure adequate spatial sampling of the taxon and also provide information on habitat selection, which can then inform discussions of habitat management and the potential effects of climate change and other coarse-scale processes.

Studies of invertebrate production in sagebrush-dominated landscapes, especially during the nesting and fledging periods, could identify very important relationships between Brewer's Sparrow reproductive fitness and food availability, vegetation, and climate. Such research will have important implications for many other sagebrush obligate birds.

Some data (Rotenberry and Knick 1999) suggests that Brewer's Sparrow populations may be limited by processes occurring on winter range; clearly, this issue needs to be explored further. If population persistence is determined mostly by winter dynamics, managers may want to allocate most resources to countering those effects.

Nest predation has been identified as an important limit on populations of many shrubsteppe passerines (Rotenberry and Wiens 1989). The extent to which this affects Brewer's Sparrows, and the habitat conditions that encourage/ discourage such predation, should be researched in the field.

Continued research into cheatgrass ecology and the dynamics of the cheatgrass/ fire cycle will provide information important to habitat conservation and restoration efforts.

Although seral mosaics of sagebrush (i.e., landscapes dominated primarily by stands of sagebrush that are in different seral stages) are generally identified as good habitat for Brewer's Sparrows, the quantitative parameters (e.g., stand sizes, stand shapes, proportion of different seral

classes) of mosaics that support Brewer's Sparrows are not well-known and are required by habitat managers in order to effectively manage for this species.

Wyoming

All research priorities identified above are pertinent to and important for management of Brewer's Sparrows in Wyoming. Field inventories of *S. b. taverneri* in Wyoming mountain ranges can be readily assisted by GIS mapping of likely habitat (digital datasets pertaining to the relevant physical and biological variables are already compiled and available). Despite the current situation of relatively low cheatgrass prevalence in Wyoming, research into its ecology and management here is still rather important. It is generally accepted that cheatgrass will increase in distribution and abundance in the state, and climatic and biogeographic differences may reduce the applicability of research results from the Great Basin and Interior Columbia Basin to Wyoming.

Figures

Figure 1. Brewer's Sparrow (*Spizella breweri breweri*). Photograph by G. Lasley; reprinted here with permission.

Figure 2. Breeding range of the Brewer's Sparrow (*Spizella breweri breweri*) as delineated by North American Breeding Bird Survey (BBS) data. Darkest red indicates highest breeding densities, as summarized from 30 years of BBS data (Sauer et al. 2003).

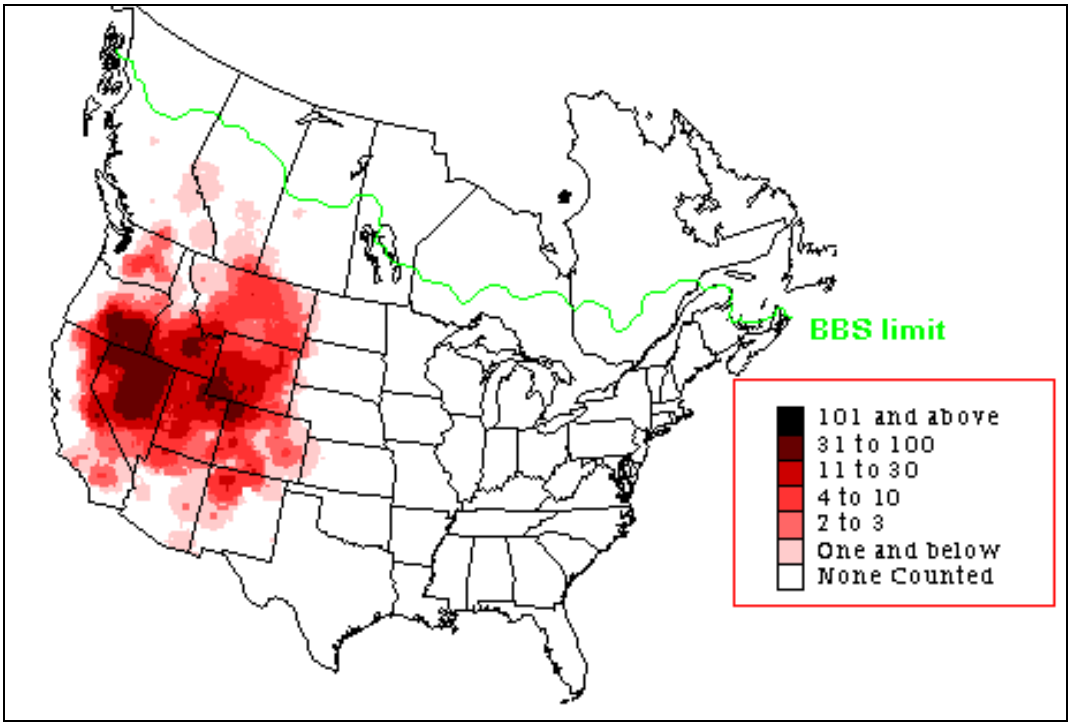

Figure 3. Map of sagebrush habitat in Wyoming. Darkest areas are dominated by sagebrush; lighter areas have decreasing amounts of sagebrush. Generated by the Wyoming Natural Diversity Database (University of Wyoming) based on Merrill et al. (1996).

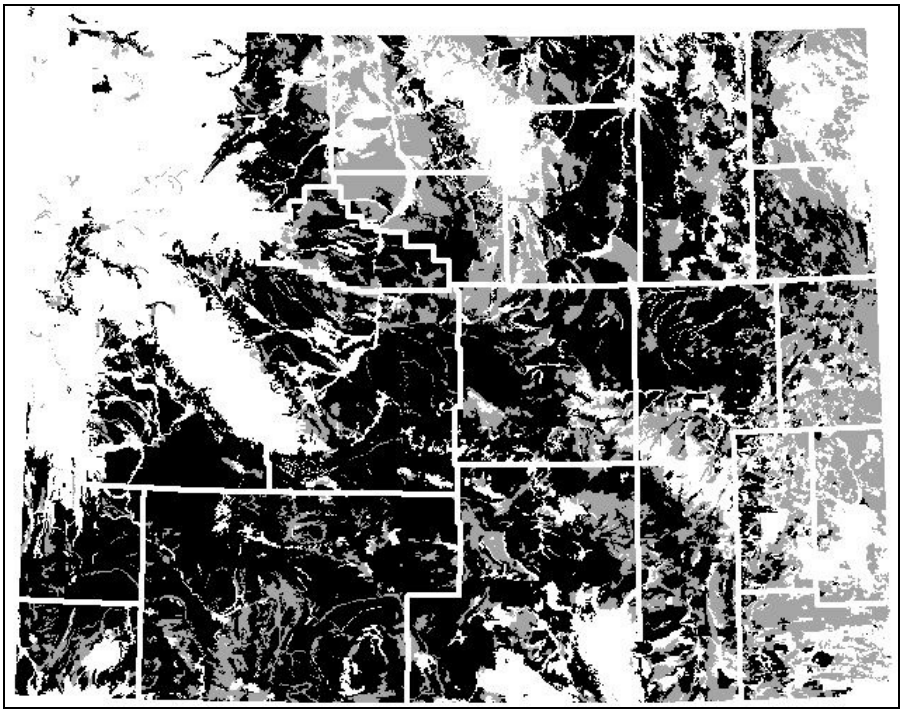

Figure 4. Typical Brewer's Sparrow (*Spizella breweri breweri*) shrubsteppe habitat in the Thunder Basin National Grassland, Wyoming (photograph by S. R. Jones [Jones and Cushman 2004]; reprinted here with permission).

Figure 5. Typical Timberline Sparrow (*Spizella breweri taverneri*) habitat in Glacier National Park (photo by Suzanne Cox Griffin; reprinted here with permission).

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