BIRDS IN A SAGEBRUSH SEA

MANAGING SAGEBRUSH HABITATS FOR BIRD COMMUNITIES

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BIRDS IN A SAGEBRUSH SEA

To many of us, sagebrush country symbolizes the wild, wide-open spaces of the West, populated by scattered herds of cattle and sheep, a few pronghorn antelope, and a loose-knit community of rugged ranchers. When you stand in the midst of the arid western range, dusty gray-green sagebrush stretches to the horizon in a boundless, tranquil sea. Your first impression may be of sameness and lifelessness—a monotony of low shrubs, the over-reaching sky, a scattering of little brown birds darting away through the brush, and that heady, ever-present sage perfume.

Michael Mancuso, Idaho Conservation Data Center

Although sagebrush may appear to stretch on in an endless sea, a closer look reveals a mosaic of openings, wet and dry areas, a variety of plant species, and varying ages of shrubs.

But a closer look reveals just how complex and variable sagebrush landscapes can be. From shrublands to grasslands, wet meadows, and woodland edges, a mosaic of habitats supports an abundance of birds, animals, and native plants, some specially adapted to these semi-deserts. Far from pristine, however, sagebrush habitats across the West have been greatly altered by a century of settlement, livestock grazing, agriculture, weed invasion, and changes in wildfire frequency.

This booklet presents land management recommendations to help bird communities in sagebrush habitats. It was prepared for the Western Working Group of Partners in Flight, a partnership of private citizens, industry groups, government agencies, universities, nongovernment organizations, and others interested in bird conservation.

Why are we concerned about birds in sagebrush habitats? Nationally, grassland and shrubland birds show the most consistent population declines over the last 30 years of any group of bird species. Across the U.S., the populations of 63% of shrubland and shrub-dependent bird species and 70% of grassland species are declining. In the Intermountain West, more than 50% of grassland and shrubland species show downward trends (Sauer et al. 1996). A recent broad-scale assessment of the Columbia River Basin identified sagebrush steppe as the highest priority habitat for conservation based on trends in bird populations and habitat (Saab and Rich 1997).

Although the variety of bird species found in sagebrush habitats is far less than in a lush forest, many sagebrush birds, such as sage grouse, live nowhere else. The birds in these shrublands not only add to the West's diversity of wildlife, they are important to the sagebrush ecosystem itself, providing crucial services such as dispersing seeds and preying on insects and rodents. Other wildlife species, including pronghorn, sagebrush lizard, sagebrush vole, and pygmy rabbit, also depend on healthy sagebrush habitat.

Thoughtful land management can help rejuvenate native sagebrush habitats and may turn the tide for the birds of the sagebrush sea. The recommendations presented here are not regulations or policies. **This document has one purpose: to help anyone who is a steward of sagebrush shrublands include management practices that help support a thriving community of wild birds. These recommendations are entirely voluntary.** Whether you manage public lands or private, and whether your goal is livestock production, farming, mining, recreation management, wildlife conservation, or a combination of these, we hope this document will help you combine your management goals with steps to enrich habitat for sagebrush birds. Not all of the suggestions in this document will be appropriate in all places, depending

We hope this document will help you combine your management goals with steps to enrich habitat for sagebrush birds.

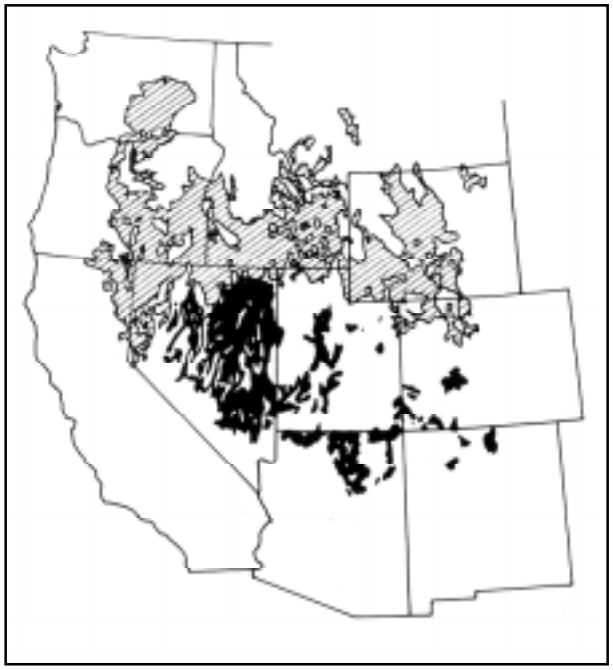
on local conditions and management needs, but even if you adopt only a few of the suggestions, you can give a boost to birds. In addition, we believe these recommendations will result in a healthy, diverse shrubsteppe ecosystem.

Sagebrush bird communities are not well studied, with the exception of the work by Wiens and Rotenberry and many studies on raptors and grouse (see "Literature Cited"). The lack of quantitative information on many species' habitat needs reflects a severe shortage of ecological studies in sagebrush habitats—often even major life history details are known only from anecdotal accounts. We prepared this document with the best information currently available.

ECOLOGY OF SAGEBRUSH HABITATS

Climate

Sagebrush occurs in cold semi-deserts across the Intermountain West. In much of this region, winters are long, summers are hot and dry, and winds are persistent. In these semi-deserts, most of the annual precipitation comes as snow and early spring rain. This winter precipitation recharges soil moisture, and the short growing season follows snow-melt. Summer storms are brief and intense, and most summer rain runs off or evaporates in hot winds, relatively little of it penetrating the soil and captured for plant growth. All in all, only about half the annual precipitation becomes available for plant growth (West 1988). Annual precipitation in the northern portion of the Intermountain Region averages 246 mm (9.6 in; West 1983, 1988). From the Great Basin southward, annual precipitation is more variable, ranging from 158 to 419 mm (6.2 to 16.4 in; West 1983, 1988).



From West 1988, reprinted with permission from Cambridge University Press.

Map of the sagebrush steppe and the Great Basin sagebrush types (adapted from Küchler 1970). Some sagebrush vegetation in California is not shown.

▨ = Sagebrush steppe ■ = Great Basin sagebrush

Vegetation

The entire sagebrush region covers approximately 63 million ha (155.5 million ac) of the West (see map to left). Sagebrush covers much of the Great Basin and Wyoming Basin, and reaches into the Snake River Plain, Columbia Basin, southwestern Montana, the Colorado Plateau, southwestern Colorado, and northern New Mexico. This broad zone is divided into two general vegetation types. The true "sagebrush steppe" type covers the northern portion of the Intermountain region, where sagebrush is co-dominant with perennial bunchgrasses (about 45 million ha or 111 million ac; West 1996). From the Great Basin southward, in the much drier "Great Basin sagebrush" vegetation type, sagebrush is dominant and grasses are few and sparse (18 million ha or 44.5 million ac; West 1988).

The focus of this booklet is on sagebrush habitats in general. We use "sagebrush habitat" and "sagebrush shrubland" as general terms covering the sagebrush region. "Sagebrush steppe" or "shrubsteppe" includes a significant component of native grass. However, there are no clear dividing lines. Across the sagebrush region, sagebrush habitat ranges from semi-arid grasslands with a scattering of sagebrush to arid sagebrush-dominated shrublands with few grasses.

Several species and subspecies of sagebrush grow in the west, from semi-desert lowlands to subalpine meadows (species' scientific names are in

Terry Rich

Sagebrush habitat ranges from grasslands with a scattering of sagebrush (above) to shrublands with a scattering of grassy openings (left).

Appendices I and II). The species big sagebrush predominates, and has five known subspecies (West 1988; Kartesz 1994). It is often important to differentiate between sagebrush species and subspecies in order to classify rangeland types; understand site potential, palatability to livestock and wildlife, and response to fire; and manage vegetation. However, for many birds the species of sagebrush is less important than its height, density, cover, and patchiness. In this booklet we use "sagebrush" generally, usually referring to the species big sagebrush, and focus on the variables important to birds. The only other distinction made here is between low and tall life forms—two broad categories that separate the species (Appendix II). *The management recommendations presented here may need to be modified to local sagebrush types.*

There is a wide variety of vegetation community types within the sagebrush landscape—the result of differences in soil, climate, topography, and other physical processes (Tisdale and Hironaka 1981; West 1988). Natural and human-induced disturbances also play a role. Usually a single species of sagebrush is dominant in a community, but communities differ widely in understory plants. Understories are usually dominated by one or more perennial bunchgrasses, such as bluebunch wheatgrass, Idaho fescue, Sandberg's bluegrass, Thurber needlegrass, needle-and-thread, bottlebrush squirreltail, or Indian ricegrass. Forbs, such as phlox, milk-vetch, and fleabane, are less common, but can be abundant in moist areas.

Stands of sagebrush may be dense, patchy, or sparse. In tall sagebrush types, sagebrush cover may range from 5% to 30% (Dealy et al. 1981) or greater on some sites. Stands may vary from expanses of single species to multi-species mosaics where sagebrush is intermixed with other shrubs, most commonly rabbitbrush and antelope bitterbrush, but also greasewood, shadscale, Mormon tea, winter fat, and spiny hopsage. Other shrub communities often occur adjacent to sagebrush shrublands, especially at higher elevations, such as those dominated by serviceberry, mountain-mahogany, wild cherry, ceanothus, and snowberry. Grassy openings, springs, seeps, moist meadows, riparian streamsides, juniper woodlands, copses of aspen, and rock outcrops also add to the sagebrush mosaic, and these habitats help attract a broad diversity of birds and wildlife.

Diane Ronayne, IDFG

Most of the denser shrubland types have, or should have, grasses between and under the shrubs. Here is an ungrazed sagebrush area with abundant bunchgrasses.

Biological soil crust is an integral and usually overlooked component of sagebrush shrublands. It creates a rough crust on the soil surface in semi-arid habitats. Biological soil crust (also known as "cryptobiotic crust," "microbiotic crust," or "cryptogamic soil") is a fragile microfloral community composed of blue-green algae, bacteria,

fungi, mosses, and lichens. The diversity and function of crust communities has been little understood and underappreciated (St. Clair et al. 1993; J. Kaltenecker pers. comm.). Many biologists think these crust communities may play an important role in dry regions by stabilizing soils from wind and water erosion, contributing to soil productivity, influencing nutrient levels, retaining moisture, altering soil temperature, and aiding seedling establishment (Belnap 1993, 1994; St. Clair and Johansen 1993; Kaltenecker 1997). Where crust communities are well established in a healthy shrubland, they help prevent the invasion of cheatgrass, and because crusts do not provide much fuel, they also slow the spread of wildfire (Kaltenecker 1997).

Wildlife Dependence on Sagebrush

Approximately 100 bird species and 70 mammal species can be found in sagebrush habitats (Braun et al. 1976; Trimble 1989). Some of these are sagebrush obligates (restricted to sagebrush habitats during the breeding season or year-round) or near-obligates (occurring in both sagebrush and grassland habitats). Sagebrush obligates include the sage sparrow, Brewer's sparrow, sage thrasher, sage grouse, pygmy rabbit, sagebrush vole, sagebrush lizard, and pronghorn.

Sagebrush itself and the native perennial grasses and forbs of the shrubsteppe are important sources of food and cover for wildlife (Dealy et al. 1981). During winter, the evergreen foliage of sagebrush often provides the only available green vegetation, and its protein level and digestibility are higher than most other shrubs and grasses (Peterson 1995). Pronghorn, pygmy rabbits, and sage grouse may eat exclusively sagebrush in winter, and sagebrush also becomes a major portion of mule deer and elk diets. Taller sagebrush provides cover for mule deer and sage grouse (Dealy et al. 1981), and the crowns of sagebrush break up hard-packed snow, making it easier for animals to forage on the grasses beneath (Peterson 1995). Throughout the rest of the year, sagebrush provides food for pygmy rabbits and sage grouse; protective cover for fawns, calves, rabbits, and grouse broods; and nesting sites for many shrub-nesting birds. The sage thrasher, Brewer's sparrow, sage sparrow, and sage grouse most frequently nest in or beneath sagebrush.

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The pronghorn is one of several species that must have sagebrush to survive. These species are called "sagebrush obligates" and are unique to the West.

THE SAGEBRUSH LANDSCAPE BEFORE EUROPEAN SETTLEMENT

Early explorers of the Intermountain West encountered a landscape dominated by shrubs and found grasslands chiefly limited to hillsides and moist valley bottoms (Vale 1975). In presettlement times, the Snake River Plain was a landscape of open-canopied, low-growing shrubs dominated by big sagebrush. Winterfat, antelope bitterbrush, rabbitbrush, greasewood, and shadscale were also abundant. Forbs and perennial bunchgrasses grew lushly in the understory beneath shrubs, including balsamroot, bluebunch wheatgrass, Idaho fescue, Indian ricegrass, Sandberg's bluegrass, bottlebrush squirreltail, Thurber needlegrass, green needlegrass, and needle-and-thread. When the sagebrush steppe was burned or trampled, leaving bare ground, complete revegetation of the community took about 10 years. Snakeweed was an early colonizer, followed by short-lived perennial grasses such as bottlebrush squirreltail and Sandberg's bluegrass, and eventually sagebrush seedlings, large-culmed perennial grasses, and perennial broad-leaved herbs (Yensen 1980, 1981).

Conditions were different in the Great Basin of Nevada. Reading over 100 old newspapers and 175 diaries of early settlers in Nevada, Robert McQuivey, Nevada Division of Wildlife, found that in the Great Basin of Nevada early settlers and travelers reported very tall sagebrush (approximately 2 to 2.5 m; 6-8 ft) with very little grass understory. Grass areas were usually restricted to areas along rivers and streams (R. McQuivey pers. comm.).

For many decades, range scientists believed that grasslands originally dominated the Intermountain West, and that sagebrush invaded because of heavy grazing. More recently, it has become evident that sagebrush was widespread and dominant, and that the boundaries of sagebrush habitats were about the same as they are today. Reports of areas that were once grassland, but are now covered in sagebrush, may have

been a result of repeated burning and mowing for hay in the early days of settlement (Tisdale and Hironaka 1981). Over time, many areas of sagebrush steppe have become more densely packed with sagebrush as livestock eliminated understory grasses and wildfires were suppressed, tipping the competitive advantage toward shrubs (Tisdale and Hironaka 1981; West 1988). Evidence also suggests that fire suppression and heavy grazing have contributed to the invasion of junipers and other conifers in some sagebrush areas (Tisdale and Hironaka 1981).

Biologists theorize that the native plant communities in sagebrush steppe west of the Rockies did not evolve under pressure from large numbers of grazing ungulates and are not adapted for concentrations of large herbivores (Tisdale and Hironaka 1981; Mack and Thompson 1982). The earliest historical accounts of exploration in the Intermountain West suggest that large native grazers were relatively rare and localized in the region. Bison were limited to the northeastern Great Basin, and the only large ungulate found throughout the region was the pronghorn. In southern Idaho's Snake River Plain, mule deer may have been abundant, and mule deer and elk were reported to winter in the Raft River Valley (Yensen 1980). Many explorers of the Great Basin commented on an abundance of forage for their stock and a lack of large game (Tisdale and Hironaka 1981).

Jackrabbits, cottontails, and rodents may have been the major herbivores in the region. The cyclic population explosions of jackrabbits, which can locally deplete range plants, may have had a periodic but influential impact on vegetation ecology (Yensen 1980; Young 1994). Sage grouse were also important grazers on sagebrush and understory plants. Periodic infestations of grasshoppers and crickets could decimate the shrubsteppe (Yensen 1980).

Wildfire Patterns

Explorers' reports of abundant and widespread sagebrush probably indicate that fires were relatively infrequent in sagebrush habitats. Big sagebrush does not resprout after a fire and even "cool" burns may be enough to kill these plants. In wetter areas, where fuels are more abundant, low severity fires may have been more common, and on some sites burns must have been frequent enough to prevent the invasion of juniper and conifers (Tisdale and Hironaka 1981). Because bunchgrasses generally do not provide a continuous fuel layer to carry fire long distances, fires in presettlement times were probably patchy and small except in very dry years. Presettlement fire intervals have been estimated at 20 to 25 years in wetter regions, and 60 to 110 years in the arid sagebrush steppe of southern Idaho (Tisdale and Hironaka 1981; Whisenant 1990). McQuivey (pers. comm.) concluded that the prevalence of tall sagebrush and lack of a grass understory in the Great Basin sagebrush of Nevada indicate that fire was not an important influence on this vegetation.

After a fire, big sagebrush must be re-established by wind-dispersed seed or seeds in the soil. Most sagebrush seeds fall within 1 m (3 ft) of the shrub canopy, although wind can disperse seeds up to 30 m (90 ft; Meyer 1994), so the rate of big sagebrush recolonization in a burn depends on the distance from a seed source and the amount and condition of seed in the soil. Depending on the species, sagebrush can re-establish itself within 5 years of a burn, but a return to pre-burn densities can take 15 to 30 years (Bunting 1984; Britton and Clark 1984). Eventually sagebrush seedlings, large-culmed perennial grasses, and perennial broad-leaved herbs become established (Yensen 1980, 1981). Often rabbitbrush, perennial bunchgrasses, and forbs present before a fire resprout vigorously soon afterwards, and some greenup of perennial bunchgrasses can occur soon after fall rains, depending on the fire's severity (P. Makela pers. comm.).

Environmental Science and Research Foundation

Fire was, and still is, an important part of the sagebrush shrubland ecosystem. Part of the mosaic pattern in sagebrush is due to fires, which tend to burn in patches, creating stands of sagebrush of varying ages.

Before European settlement, then, spotty and occasional wildfire probably created a patchwork of young and old sagebrush stands across the landscape, interspersed with grassland openings, wet meadows, and other shrub communities. In drier regions, such as Nevada, fire likely had less of an influence.

CHANGES IN SAGEBRUSH COUNTRY

Sagebrush communities have suffered severe degradation and loss, and the future for remaining sagebrush steppe in particular is bleak. The ecology, natural disturbance patterns, and vegetation communities have been altered by agricultural conversion, invasion of non-native plants, extensive grazing, development, sagebrush eradication programs, and changes in fire regimes. Within the Interior Columbia River Basin, for example, sagebrush and bunchgrass cover types experienced greater losses than any other habitat and will probably continue to decline with the cumulative impacts of present land uses (Saab and Rich 1997, citing Hann et al. 1997).

Influence of Livestock Grazing

The arrival of cattle and sheep in the Great Basin in the late 19th century triggered a rapid change in sagebrush plant communities (Yensen 1981; Dobkin 1994). Observers of the time indicated that sites may have lost their native perennial grasses less than 15 years after livestock introduction. By 1900, some range managers judged that livestock had already exceeded the grazing capacity of the Intermountain rangelands, and they recommended changes to restore range productivity (Young 1994; West 1996). In addition, settlers burned off sagebrush to produce more grass for horses, sheep, and cattle and to clear the land for farming (R. McQuivey pers. comm.). Today, grazing pressure has decreased considerably compared to the early 1900s. However, less than 1% of the sagebrush steppe remains untouched by livestock; roughly 20% is lightly grazed, 30% is moderately grazed and has remnants of native herbs, and 30% is heavily grazed with the native understory replaced by introduced annuals (West 1988, 1996).

As cattle graze sagebrush steppe, they first select grasses and forbs and avoid browsing on sagebrush,

Terry Rich

Grazing pressure from livestock has decreased since the late 19th century, a period when rapid changes took place in the sagebrush plant communities. Today, good land managers recognize the importance of properly grazing their land to maintain its health.

which can have a toxic effect on the microorganisms in their rumen (Young 1994). Even light grazing can put pressure on the herbaceous plants favored by livestock (West 1996), but the effect of grazing in any region depends on season of use, intensity, type of livestock, and the plant species themselves (Tisdale and Hironaka 1981). In the Great Basin, for example, perennial bunchgrasses must grow quickly to set seed over the short growing season, so intensive spring grazing prevents the plants from reproducing, eventually eliminating the palatable native bunchgrasses (Mack and Thompson 1982). Where grazing removes the herbaceous understory altogether, the balance is tipped in favor of shrubs, allowing sagebrush to spread and creating overly dense sagebrush stands with a sparse understory of annuals and unpalatable perennials (Tisdale and Hironaka 1981). This situation ultimately discourages livestock use, and throughout this century range managers have employed fire, herbicides, chaining, and other methods to remove dense sagebrush stands and re-establish grass forage, often reseeding with introduced grass species.

Livestock also trample and damage biological soil crusts. Excessive grazing in the 19th and early 20th centuries likely reduced crust communities throughout the Intermountain West, and it is difficult now to piece together their original extent and role in sagebrush habitats (Mack and Thompson 1982; St. Clair et al. 1993). Recovery that includes a well-developed crust community can take a decade or more, depending on the type of disturbance, presence of inoculants from nearby crust communities, and occurrence of invasive weeds (Belnap 1993; St. Clair and Johansen 1993; Kaltenecker 1997).

Sagebrush steppe can take time to recover from excessive grazing, especially on drier sites. A study on Idaho National Engineering and Environmental Laboratory grounds found that 25 years after the heavily depleted range had been closed to cattle and sheep grazing, both perennial grass and big sagebrush cover had nearly doubled, but the most rapid recovery of grasses occurred after a lag period of 15 years (Anderson and Holte 1981). Even if livestock are removed, the presence of invasive weeds, an overly dense stand of sagebrush, or heavy browsing by rodents and rabbits can inhibit recovery of grasses and forbs (Tisdale and Hironaka 1981).

As well as affecting vegetation, grazing can influence bird communities in another way. The presence of livestock (particularly cattle and horses) creates feeding habitat for the brown-headed cowbird, a "brood parasite" that lays its eggs in the nests of other

songbirds for the host parents to raise. This reduces the number of young that the host species population can produce in a year. Cowbirds feed on insects stirred up by grazing herbivores and parasitize nests in nearby shrublands and woodlands. A native of the Great Plains, the brown-headed cowbird adapted to follow the herds of migratory bison. With settlement and the spread of livestock throughout the West, the cowbird's range expanded, exposing new populations and species of songbirds to brood parasitism for the first time. Where cowbird populations are high and there is no year-to-year relief from parasitism pressure, cowbird parasitism may be a significant factor in the decline of some songbird populations.

Non-native Grasses and Sagebrush Habitat Conversion

From the 1930s through the 1960s, and to a much lesser extent today, land managers controlled sagebrush on degraded rangeland by burning, plowing, chaining, disking, and spraying herbicides to increase livestock forage on sites where the native grasses had been lost. Many areas were seeded with crested wheatgrass, a non-native perennial bunchgrass, to provide forage. In addition to the thousands of hectares where non-native grasses are mixed with sagebrush, approximately 10% of native sagebrush steppe has now been completely replaced by invasive annuals or by intentionally seeded non-native grasses (West 1988, 1996). Another 10% of the sagebrush steppe has been converted to dryland or irrigated agriculture (West 1988, 1996). In eastern Washington, only 40% remains of 4.2 million ha (10.4 million ac) of shrubsteppe that existed before the arrival of settlers (Dobler et al. 1996).

The greatest change to sagebrush plant communities came with the invasion of non-native annual grasses and forbs, particularly cheatgrass. Inadvertently introduced in the late 19th century, cheatgrass spread like an epidemic across the Intermountain West along transportation corridors and in the wake of grazing and agriculture, and reached its present geographic range by about 1928 (Mack 1981; Yensen 1981). Cheatgrass readily invades disturbed sites as livestock churn up soil and biological soil crusts and graze native bunchgrasses. Today, cheatgrass threatens to dominate 25 million ha (62 million ac)—more than half of the West's sagebrush region (Rich 1996). Cheatgrass is a rapid colonizer of disturbed sites and a persistent resident, replacing native species (Mack 1981; Yensen 1981; Whisenant 1990). Other non-native species, such as medusahead, yellow star thistle, knapweed, tumble mustard, and halogeton, are also becoming increasing problems (Yensen 1980; West 1996).

Cheatgrass invasion fundamentally alters fire and vegetation patterns in sagebrush habitats. Unlike native bunchgrasses, cheatgrass creates a bed of continuous, fine fuel that readily carries fire. Where cheatgrass dominates the understory, it carries fire over great distances, and the range burns far more frequently—at intervals of 3 to 5 years. Cheatgrass also matures and dries earlier than native bunchgrasses, increasing the chance of fire earlier in the season (Young and Evans 1978; Whisenant 1990; Knick and Rotenberry 1997).

Because sagebrush may take several years to mature before producing seed, repeated, frequent fires can eliminate sagebrush entirely. As the fire cycle escalates, cheatgrass persists and on some sites is eventually replaced by medusahead and other non-native annuals, causing a downward spiral toward permanent dominance of non-native species and deterioration of the site. Cheatgrass dominance eventually creates a uniform annual grassland perpetuated by large, frequent fires and void of remaining patches of native plant communities (Whisenant 1990). Restoring native plants is then extremely difficult if not impossible (West 1988). There is some indication, however, that native shrubs, perennial grasses, and forbs can re-establish on a cheatgrass-dominated site over a course of several years if fire is suppressed, rainfall is low (Hosten and West 1994), and there is a seed source for native species.

The presence of invasive weeds also affects biological soil crusts. In the western Great Basin, Young (1992) noted that communities dominated by medusahead lack biological soil crusts, and in the Snake River Plain, Kaltenecker (1997) found that where cheatgrass and medusahead invaded, biological soil crusts were shaded out.

Terry Rich

Of all the changes that have occurred in sagebrush shrublands, the invasion of non-native cheatgrass is probably the most harmful. This photo, taken in June, shows the almost continuous fuel chain created by cheatgrass.

HOW TO HELP BIRDS IN SAGEBRUSH HABITATS

The maintenance and restoration of sagebrush bird habitats depend on our ability to provide a mosaic of native plant communities across the landscape (see box, "Managing Sagebrush Habitats on Different Scales"). This goal goes hand in hand with sustainable rangeland management. Because non-native grasses and agricultural conversion now dominate so much area in the Intermountain West, it is especially important to sustain remaining native plant communities in a healthy state to support native birds and other wildlife.

Managing a single site for all sagebrush wildlife species is not possible because practices that benefit some species may be detrimental to others. For example, the sage grouse and sage sparrow prefer areas of extensive sagebrush, but vesper sparrows in sagebrush steppe use stands with scattered shrubs mixed with short grassland. Management for a particular site will depend on that site's potential. The idea is to strike a balance so that all habitats originally occurring (such as young and old sagebrush stands, grassland openings, wet meadows, springs, and riparian habitat) are represented across a large area.

The following management recommendations are *voluntary* and are meant to aid the land manager in enhancing habitat for sagebrush birds. First we give general management recommendations based on habitat components within sagebrush steppe. We then offer suggestions for habitat management under different land uses and management activities. These recommendations are based on our current knowledge of habitat requirements of sagebrush birds. Although we provide some ideas on specific vegetation management techniques, our main goal is to describe what birds need. Most of these suggestions will also benefit other wildlife species. A summary of these recommendations follows this section (see "Summary of Bird Management Goals and Recommendations").

You may find that certain recommendations are not appropriate for your situation, depending on your management goals, vegetation types, site potential, costs, and opportunities. But even if you can implement only a few of the recommendations, you can help improve habitat for birds.

Natural history accounts for bird species of concern in sagebrush steppe habitats are in Appendix I. Each account briefly mentions conservation considerations for the individual species. Your local wildlife agency or State Natural Heritage Program can provide specific information about which species occur in your particular region.

MANAGING SAGEBRUSH HABITATS ON DIFFERENT SCALES

Wildlife species respond to their environment at different scales. In this document, we use the terms "landscape," "stand," and "patch" (Table 1). Some of our recommendations may seem contradictory. On one hand, we say we need large areas of continuous sagebrush habitat, then we say that we want a patchwork or mosaic of plant communities. Well, which is it? It's both.

When you look across a landscape of sagebrush, you may see a monotonous and uniform shrubland, yet as you travel through the area, you notice a lot of variation from one spot to the next. A low swale that catches moisture has taller shrubs than the surrounding area, a knob may have a grassy opening, a burned area may have just a scattering of shrubs, a streamside adds willows and water to the landscape. Each habitat patch provides some of the resources needed by individual birds, from feeding to nesting sites. Combined into stands, these habitat patches provide enough total habitat for a pair to survive and raise its young. Many stands across a landscape can support a population of a particular species. The exact size of patches, stands, and landscapes depends on the needs of each species.

General Sagebrush Habitat Management

We recommend no *net* loss of sagebrush steppe habitat in a landscape. No net loss does not preclude management activities (see the box, "No Net Loss"). Future habitat conversions should be mitigated by restoration elsewhere, and range managers should plan for a dynamic pattern of different aged stands across a landscape. A loss of sagebrush steppe habitat, both in amount and quality, is thought to be responsible for declines in sage grouse in Idaho (Idaho Sage Grouse Task Force 1997) and Brewer's sparrow in the Interior Columbia River Basin (Saab and Rich 1997).

- Identify and protect those habitats that still have a thriving community of native understory and sagebrush plants. Those areas that have remained untouched by livestock grazing or habitat conversion, have not been grazed for many years, or otherwise have high biological integrity, might be managed as conservation easements (which do not necessarily exclude economic land uses), refuges, protected areas, sanctuaries, or research areas.
- Where possible, restore or rehabilitate degraded and disturbed sites to native plant communities. On severely damaged or degraded sites, the restoration of an entirely native plant community may be Management should focus on restoring natural disturbance processes, such as fire, and removing invasive non-native plants. Where major habitat conversion has occurred, even small parcels have value to wildlife and should be protected.

Table 1. Different scales at which birds respond to their environment and how we want to direct management activities.

SCALE Size is Dependent on Species[a]	Birds are Affected at This Level:	Management Activities and Natural Processes Affect These:	Desired Conditions for Birds:
LANDSCAPE 1000s to 100,000s of acres[b]	Populations	The size, age, and distribution of stands and patches, including areas inhospitable to the species Spread of non-native plants Ability of populations to recover from large-scale events such as wildfire and drought	Large areas of continuous shrubsteppe habitat containing a mosaic of stands with different ages, species, and canopy cover to support bird populations
STAND 1 to 1000s of acres	Home ranges of individuals and pairs	Plant species composition Proximity of all resources and whether they are all present and accessible	All of the nesting, cover, and foraging resources for individuals and pairs are present (for grouse, this would include wintering resources)
PATCH <1 to 100s of acres	Specific needs of individuals and pairs (i.e., food, water, nest site, escape cover)	Height, density, and cover of vegetation within the patch Insect, other prey, seeds, and other food abundance	One or more of the resources needed by individuals and pairs are present

[a] The smaller number might apply to Brewer's sparrows, which have small home ranges, while the larger number might apply to sage grouse, which range over large breeding and wintering ranges.

[b] 1 acre = 0.4 hectares

expensive, long-term, or nearly impossible, but it may be possible to restore the vegetative structure (e.g., variation in shrub heights, mosaic pattern) to benefit some bird species.

- To benefit area-sensitive species such as sage grouse, sharp-tailed grouse, and sage sparrows, maintain sagebrush in large, continuous areas composed of a mosaic of open to moderate shrub densities (5 to 20%) and multiple age and height classes. An area-sensitive species is one that requires a large block of unfragmented habitat to successfully breed and survive. For sage sparrows, continuous areas should be greater than 130 ha (about a half-section). Sage grouse and sharp-tailed grouse need several thousand hectares of adequately connected habitat to maintain self-sustaining populations.
- Within extensive areas of sagebrush habitat, manage for a patchwork or mosaic of native plant communities across the local landscape. These patchworks or mosaics may include stands of young and old sagebrush, openings (ranging from bare ground to short vegetation to high grass density), wet meadows, seeps, healthy streamside (riparian) vegetation, and other interspersed shrub and woodland habitats. Mosaics support many bird species with different needs. Young sparse stands support vesper sparrows and lark sparrows. Older, denser stands benefit sage grouse, Brewer's sparrows, sage sparrows, black-throated sparrows, gray flycatchers, and sage thrashers. Shrubsteppe with small, grassy openings supports sage grouse, long-billed curlews, and burrowing owls. Broad-leaved shrub thickets and riparian areas provide winter habitat for sharp-tailed grouse. Forested streamsides provide nest sites for Swainson's hawks, and interspersed juniper woodlands supply nesting areas for loggerhead shrikes, gray flycatchers, ferruginous hawks, and green-tailed towhees (see Tables 2 and 3).
- Openings of short vegetation surrounded by sagebrush are particularly important for sage grouse leks (especially openings, knolls, and exposed ridges) and for ground foraging by sage thrashers, loggerhead shrikes, Brewer's sparrows, and sage sparrows. Openings of short vegetation (5 to 20 cm; 2 to 8 in) with wide visibility provide long-billed curlew and burrowing owl breeding habitat.
- Maintain remaining biological soil crust communities by minimizing sources of soil disturbance, such as off-road vehicle use or heavy grazing.
- Maintain seeps, springs, wet meadows, and riparian vegetation in a healthy state for young sage grouse and other species that depend on the forbs and insects available in moist places. Wetlands and riparian zones also provide habitat for prey species and foraging opportunities for other sagebrush birds. Use buffers of 30 m (100 ft) or greater around these areas (Braun et al. 1977; Blaisdell et al. 1982).
- Maintain ground squirrel and prairie dog colonies to provide nesting burrows for burrowing owls, and maintain small mammal populations as prey for many bird and mammal predators.

NO NET LOSS

Sagebrush habitats are dynamic communities influenced by patterns in rainfall, fire, and the movements and population fluctuations of grazing animals. A fire, for instance, may kill a large area of sagebrush shrubs, yet as long as the land has the potential to return to sagebrush, it is not lost—the area has just become part of the natural mosaic of habitats within the landscape. However, if non-native plants, like cheatgrass or medusahead, invade and become dominant or if sagebrush habitat is plowed under or paved over, then that area may be lost forever to the sagebrush wildlife community. Where habitat conversion fragments the landscape into isolated strips and islands of habitat, that conversion also reduces the remaining native habitat's capacity to support wildlife populations.

When we recommend "no net loss" of sagebrush steppe, we accept that natural forces and land management activities will alter the landscape. What we hope is that human-induced habitat conversion will be accompanied by habitat restoration and conservation elsewhere.

Sagebrush

Sagebrush plants provide nest sites and cover from wind and predators, harbor insects for insect-eating wildlife, and are the main food for sage grouse and pronghorn in the winter. Bird species of concern that nest in sagebrush shrubs include the sage thrasher, Brewer's sparrow, sage sparrow, green-tailed towhee, loggerhead shrike, gray flycatcher, and occasionally the Swainson's hawk. In addition, many of the ground nesters nest beneath sagebrush (Table 3).

- Avoid practices that permanently convert sagebrush shrubland to non-native grassland or farm land.
- Manage existing stands of sagebrush steppe for a balance between shrub and perennial grass cover,

Table 2. Habitat components used by 17 sagebrush shrubland bird species of concern.

Species	Tall, dense sage-brush	Open, patchy sage-brush	Grass cover for nests	Grass-land	Short grass, bare ground	Seeps, wet habitat	Dry wood-land	Ripar-ian
SAGEBRUSH OBLIGATE SPECIES								
Sage grouse	✔	✔	✔	✔	✔	✔		
Sage thrasher	✔	✔	✔		✔			
Sage sparrow	✔		✔		✔			
Brewer's sparrow	✔	✔	✔		✔			
SHRUBLAND SPECIES								
Black-throated sparrow		✔	✔					
Green-tailed towhee	✔	✔	✔				✔	
Lark sparrow		✔	✔	✔			✔	
SHRUBLAND AND GRASSLAND SPECIES								
Swainson's hawk		✔		✔	✔	✔		✔
Ferruginous hawk		✔		✔	✔		✔	
Prairie falcon		✔		✔			✔	
Sharp-tailed grouse	✔	✔	✔	✔		✔		✔
Loggerhead shrike	✔	✔			✔		✔	✔
GRASSLAND SPECIES								
Long-billed curlew		✔		✔	✔	✔		
Burrowing owl		✔		✔	✔			
Short-eared owl		✔	✔	✔		✔		
Vesper sparrow		✔	✔	✔				
DRY WOODLAND SPECIES								
Gray flycatcher	✔						✔	

and for open to moderate shrub cover (5 to 25%) and multiple height classes.

- Extensive, overly dense and crowded sagebrush stands that have lost much of the native herbaceous understory and plant diversity may require selective removal of shrubs (rather than broad-scale eradication) to re-establish a balance between shrub cover and perennial grass and forb cover. For example, it may be possible to thin sagebrush cover by clearing patches that can be reseeded naturally at lower densities, by using prescribed fires that produce a patchy burn pattern, or by applying reduced rates of herbicide (see Carrithers and Halstvedt 1996 for an example using tebuthiuron on big sagebrush). Only use prescribed fire in areas not threatened by cheatgrass or medusahead invasion.
- In large disturbed areas, sagebrush and perennial grasses may need to be reseeded to shorten the recovery time and prevent dominance by non-native grasses and forbs.

Table 3. Nesting substrates for 17 sagebrush shrubland bird species of concern.

Species	Burrow	Ground	Shrub	Tree	Cliff
SAGEBRUSH OBLIGATE SPECIES					
Sage grouse		✔			
Sage thrasher		✔	✔		
Sage sparrow		✔	✔		
Brewer's sparrow			✔		
SHRUBLAND SPECIES					
Black-throated sparrow		✔			
Green-tailed towhee			✔		
Lark sparrow		✔			
SHRUBLAND AND GRASSLAND SPECIES					
Swainson's hawk			✔	✔	✔
Ferruginous hawk		✔		✔	✔
Prairie falcon					✔
Sharp-tailed grouse		✔			
Loggerhead shrike			✔	✔	
GRASSLAND SPECIES					
Long-billed curlew		✔			
Burrowing owl	✔				
Short-eared owl		✔			
Vesper sparrow		✔			
DRY WOODLAND SPECIES					
Gray flycatcher			✔	✔	

Understory Grasses and Forbs

Perennial bunchgrasses and native forbs provide food and cover for many sagebrush birds. Several species (e.g., sage grouse, sharp-tailed grouse, and sage sparrow) are more common and more productive where perennial grasses in sagebrush steppe are tall, dense, and healthy, and many species that nest on the ground or low in woody shrubs rely on grasses for nesting cover (see Tables 2 and 3). Also, there is experimental evidence that shrubsteppe birds prefer to eat native grass seeds rather than cheatgrass or medusahead (Goebel and Berry 1976; Kelrick et al. 1986).

- Wherever perennial bunchgrasses and native forbs persist, choose practices that stabilize or increase native grass and forb cover in balance with open to moderate (5 to 25%) sagebrush cover.

Terry Rich

This Agoseris*, or mountain-dandelion, is "sage grouse ice cream." It's one of many forbs that grouse and other wildlife eat.*

- To maintain bluebunch wheatgrass vigor (its capacity for growth and reproduction), avoid grazing during the growing season until plants begin to cure. Bluebunch wheatgrass, one of the most widespread of native bunchgrasses, is particularly sensitive to heavy grazing during the growing season. In a recent review of defoliation effects on bluebunch wheatgrass, Anderson (1991) asserts that recovery from a single heavy spring grazing season (50% or more defoliation) can require over 8 years under the best management, and depends on the number of growing tips remaining, soil moisture, and degree of competition.
- Rehabilitating sites depleted of native grasses and forbs may require seeding native species, temporarily eliminating or reducing livestock grazing, conducting appropriate fall-winter grazing, thinning sagebrush stands, creating small clearings, or other strategies.
- Where reseeding disturbed and degraded sites, try to use local, native genotypes that are competitive with non-native weeds, and use seed priming and enhancement techniques that increase germination rates. Where native plant community restoration is the goal, land managers may need to use contractors to collect and propagate local seed to produce enough seed for a project site or may need to transplant from adjacent sites. The availability and cost of native seeds remain the greatest obstacles to revegetation with native species, and using native generalist species or non-native perennials may be the only commercially available alternatives. On severely degraded sites, non-native forbs and perennial grasses may be preferable to monocultures of non-native annuals.
- Maintain native forb diversity. Although forb species may make up only a small portion of plant composition and cover in sagebrush habitats, they are extremely important to the diets of sage grouse broods, pronghorn, and other wildlife. Use practices that allow forb growth to continue through spring and summer, particularly in sage grouse breeding habitat (see "Grazing" below). Some forbs that are especially valuable to sage grouse are common dandelion,

Paul D. Makela

This native grass understory within big sagebrush is excellent nesting cover for sage grouse and other ground-nesting species. These birds use native grasses and forbs to construct their nests, shade them, and hide them from predators.

yellow salsify, hawksbeard, prickly lettuce, mountain-dandelion, sweet-clover and other clover species (*Melilota* spp. and *Trifolium* spp.), buckwheat, and common yarrow (J. Connelly pers. comm.).

- Allow herbaceous cover to conceal nests through the first incubation period for birds that nest on the ground or low in shrubs. Maintain the current season's growth through mid-July, and manage for 50% or more of the annual vegetative growth to remain through the following nesting season (Saab et al. 1995).

Biological Soil Crusts

Although not used directly by birds, biological soil crusts are thought by some biologists to promote soil development and productivity in sagebrush habitats, and therefore benefit the native plant community.

- To maintain biological soil crusts, minimize soil disturbances. Crusts are sensitive to trampling by hikers, livestock, and vehicles. There is considerable debate over recovery times for biological soil crusts, from a few years for visual recovery of the crust structure to several decades for full community recovery; recovery times depend on the site and degree of disturbance (Cole 1990; Belnap 1993; Johansen et al. 1993).
- Where restoring biological soil crusts is the goal, use exclosures or non-fence methods to eliminate trampling. Inoculating disturbed soils with material from surrounding biological crusts can hasten recovery times (Belnap 1993).

Grazing

There are many possibilities for harmonizing grazing practices with habitat management for birds. No single grazing strategy is appropriate for all sagebrush habitats, and grazing management should be tailored to the condition and potential of each grazing unit. In general, sagebrush birds will benefit if grazing plans promote a mosaic of different amounts of shrub cover, perennial grass and forb cover, and openings of bare ground, short grass, or high grass density. Proper seasonal grazing management can also ensure nesting cover and provide protection from trampling of nests or broods during the nesting season. Management plans also need to consider other grazers, such as elk and deer, and their influence on vegetation.

- Use stocking levels that stabilize or increase native perennial grass cover, reduce disturbance to biological soil crusts, and prevent sagebrush over-dominance or non-native grass and forb invasion.
- Grazing plans will depend on the current condition and plant composition of the range. Use grazing practices (seasons, stocking, kinds of stock, and distribution) that promote the growth of native grasses and forbs needed by birds for food and concealment. Options could include increasing rest cycles in rest-rotation, two-crop short rotation (early spring before boot stage and fall after seed-set), or deferred grazing. To maintain native bunchgrasses on a given unit, defer grazing until after crucial growth periods, waiting until grasses have begun to cure. Moderate to heavy spring grazing reduces or eliminates native bunchgrasses by preventing seed-set (but note that deferred grazing can favor cheatgrass unless perennial grasses are a significant component of the vegetation). In stands where cheatgrass and native perennial grasses are mixed, grazing during the dormant period may favor perennial species (Young 1992; Vallentine and Stevens 1994).
- Where your goal is to protect or recover biological soil crusts, limit grazing to wet periods and winter months. Crusts are more sensitive to damage in dry months and can better tolerate the impact of hooves when wet or frozen.
- Reduce stock, time grazing, or rotate pastures to reduce or eliminate trampling of ground nests and nestlings (from May through mid-July).
- Maintain herbaceous cover for nest concealment by protecting the current season's growth through the nesting season and by managing for at least 50% of annual vegetative growth to remain through the following nesting season (Saab et al. 1995). For sage grouse, average grass height of at least 18 cm (7 in), measured in May and early June, provides adequate

herbaceous cover for successful nesting (Idaho Sage Grouse Task Force 1997). For sharp-tailed grouse, retain a residual cover of perennial grasses and forbs of at least 20 cm (8 in) to provide sufficient nesting cover.

- Consider temporarily removing livestock from an area that is damaged or otherwise needing protection. Livestock exclusion can be considered as a short- or long-term option for locally or regionally rare vegetation types, sites undergoing restoration, recently burned areas, wet sites (springs, seeps, wet meadows, streams—see "Water Developments" below), and other areas that are easily degraded. By itself, removing livestock may not reverse the condition of severely damaged habitats and often must be combined with reseeding and other rehabilitation methods to restore site condition.
- Situations that concentrate livestock during the songbird breeding season (April through June) increase the influence of brown-headed cowbird brood parasitism on songbird breeding success. Corrals, feedlots, and watering sites provide feeding sites for cowbirds. Where possible, consider rotating livestock use in order to rest units from cowbird concentrations in alternate years and to give local songbird populations (within a radius of 6.5 km or 4 mi) breeding opportunity without high parasitism pressure.

Bob Moseley, Conservation Data Center, IDFG

Excessive grazing removes the grasses and forbs between and even under the shrubs. Grazers also trample the soil and occasionally a ground nest.

Water Developments

We cannot overstate the importance of healthy plant communities around streams, ponds, springs, seeps, wet meadows, and wetlands to birds and other wildlife, especially in arid country. These areas provide water, abundant insects and forbs for eating, and grasses and forbs for cover. Water developments for livestock or wildlife can use water that is already available (such as springs and seeps) or harvest water that is otherwise unavailable (such as wells and catchments). Be sure to evaluate the benefit of water developments against their effect on aquatic and riparian vegetation, the water table, and potential for attracting undesirable animals or plants.

Terry Rich

Springs, wet meadows, and riparian areas within sagebrush shrublands add diversity. They provide water, succulent forbs, and abundant insects for many wildlife species. Sage grouse rely on these areas in the brood-rearing period.

- After evaluating the distribution and condition of natural water sources, avoid practices that degrade or destroy natural water flow or the vegetation in and around wetland habitats. Restore and enhance natural riparian and aquatic habitats wherever possible. For information on managing riparian areas for birds, see *Riparian Riches: Habitat Management for Birds in Idaho* (available from the same source as this publication).
- Sage grouse are attracted to wet areas more for the availability of succulent forbs and associated insects than for the free water. Protect and enhance the growth of native forbs around natural and constructed water

developments. Enhance water developments for grouse by placing them in known summer ranges and migration routes (Connelly and Doughty 1990).

- Exclosures or non-fencing methods of controlling livestock around riparian habitats, seeps, springs, ponds, and catchments will protect shoreline and wetland vegetation and benefit birds. However, fences can be hazardous to birds and mammals. If they are necessary, use smooth wires on top and bottom, and don't string fences across the water. Limiting grazing to the plants' dormant season (November to March) can help prevent damage to these areas (C. Merker pers. comm.).
- Livestock water developments can decrease stock concentrations and distribute grazing more evenly across the range to prevent degradation (Candelaria and Wood 1981). However, the tradeoff is that establishing new water developments can result in degradation of sites not previously grazed or only lightly grazed.
- Small birds sometimes drown in stock tanks and troughs. Provide escape ramps or floats to prevent drowning (Candelaria and Wood 1981).

Insecticides

Although withdrawal in the U.S. of many organochlorine insecticides, including DDT, eliminated the massive bird die-offs caused by these chemicals, many migratory birds are still exposed to these insecticides on their wintering grounds in other countries. Incorrect applications of legal insecticides in birds' breeding ranges also continue to cause direct mortality, sickness, behavioral changes, and reduced survival in many species. The full impact of insecticides on bird behavior and survival is still largely unknown.

In sagebrush shrublands, grasshoppers are traditionally viewed as a major pest, and poor range condition, drought, and certain weather patterns can lead to grasshopper outbreaks. Intensive insecticidal control programs that eliminate beneficial insects as well as grasshoppers can trigger a rapid resurgence in pest species and actually increase the probability and duration of economically damaging grasshopper outbreaks (Lockwood et al. 1988). However, at low, endemic levels grasshoppers play a major role in rangeland ecosystems. Grasshoppers stimulate plant growth by feeding on them and contribute to nutrient cycling by producing leaf litter, and grasshoppers themselves are a major protein-rich food source for many shrubsteppe and grassland birds in summer and early fall. Although birds cannot control large pest outbreaks once they have erupted, as predators they play an important role in preventing pest buildups (McEwen 1982). Bird densities will likely decline as insect food sources decline (George et al. 1995). In the long term, insecticide applications that adversely affect insectivorous birds are counterproductive to pest control.

- Land managers concerned with maintaining productive bird populations should reduce insecticide use wherever possible.
- Include birds in integrated pest management plans for grasshopper and other insect control, along with natural pathogens, suitable crop and grazing practices, pest-resistant crop strains, minimal use of insecticides (George et al. 1995), and using less toxic forms of insecticides.
- Reduce or avoid the direct toxic effects of insecticides on birds by using insecticide baits and natural pathogens (such as *Nosema locustae* for grasshoppers) instead of broad-spectrum insecticides. Ulliman et al. (1998) recommend using chemicals that are least damaging to sharp-tailed grouse such as Sevin bran bait. Target pest control toward key problem areas, and time applications to be effective in minimum doses. Avoid broadcast spraying. Use ground applications rather than aerial spraying to prevent drift into nontarget areas.
- Avoid applying pesticides to sharp-tailed and sage grouse breeding habitat during the brood-rearing season (mid-May through mid-July) to reduce the loss of food supply to chicks and avoid the chance of secondary poisoning (Ulliman et al. 1998).
- Restrict use of insecticides to the minimum application rates on croplands that border sagebrush habitat. Organophosphate insecticides (dimethoate and methamidophos at maximum rates) have been shown to cause die-offs and sickness in sage grouse when aerially sprayed on croplands bordered by sagebrush habitat (Blus et al. 1989) and may affect many other species. Burrowing owls and other species attracted to agricultural areas by high densities of small mammals are also at risk from agricultural chemicals (King 1996).

Recreation

Recreation activities, such as camping, hiking, biking, and off-road driving, can also degrade sagebrush habitats. Recreationists may trample plants and biological soil crusts, and increase the incidence of fire, weed invasion, and roadkills. Humans may also disrupt bird breeding activities, causing nest failures or decreased production of young.

- Design recreation sites so they reduce impact on native vegetation and do not contribute to erosion or contaminate water. Protect springs and wetlands. Encourage use of established sites and minimum-impact recreation ethics. Avoid placing recreation sites near sharp-tailed and sage grouse leks and breeding habitat, or near raptor nest areas, such as outcrops, cliffs, and forested riparian zones (see "Mining and Oil/Gas Development" below).
- Driving vehicles off-road across sagebrush habitats destroys vegetation and biological soil crusts, contributes to soil erosion, and can destroy nests and nestlings. Keep all vehicles on established roads and trails or confined within areas established specifically for off-road recreation.
- In sensitive areas, hikers, mountain bikers, and horseback riders can damage vegetation and biological soil crusts and contribute to soil erosion. Reduce impacts by keeping these users to established trails.
- Limit the number of roads, and reclaim unused roadbeds with sagebrush and native grasses and forbs. This will reduce weed invasion, roadkills, and fragmentation (see "Habitat Fragmentation" below). On remaining roads, use annual weed and fire control to protect adjacent sagebrush habitat.
- Restrict target practice to established shooting and archery ranges to avoid irresponsible or inadvertent killing of living targets.

Prescribed Fire and Wildfire

Burning over large areas to eradicate sagebrush is detrimental to birds in sagebrush habitats because it removes shrub cover. More alarmingly, it promotes the vegetation communities' conversion to non-native annuals such as cheatgrass. Historically, small, patchy fires at frequencies of 25 to 100 years appear to have been the norm in some sagebrush shrublands, while larger fires at lower frequencies occurred in other areas, depending on the climate, topography, plant composition, and aridity of the site. (See Hann et al. 1997 for a discussion of historic and current wildfire intensity and frequency in the Columbia River Basin). Wildfire suppression is the best management prescription in areas prone to cheatgrass invasion and to subsequent increase in fire frequency and loss of sagebrush. Prescribed fire can be used to fulfill fire's natural role where needed.

- Burns to create openings in continuous or dense sagebrush should be on a small scale and designed to allow gradual re-establishment of sagebrush from upwind stands or soil-banked seeds. This will provide multiple ages of sagebrush over area and time.
- Burns should be timed to consider the development and susceptibility of desired plants. Mid-summer burns can devastate native perennial grasses and forbs because they destroy plants before they have reached maturity. Midsummer fires also favor cheatgrass, which matures earlier than native grasses, and can increase erosion when the soil is exposed to severe rain storms. Early spring and late fall burns when the soil is moist and grasses are dormant (before growth begins or after maturity) have less impact on native bunchgrasses and forbs (Blaisdell et al. 1982; West 1983, 1988; Young 1983; Rotenberry 1998). See Young (1983) for a summary of fire impacts on various grass and forb species and Blaisdell et al. (1982) for burning guidelines to minimize impacts on native species in sagebrush rangeland.
- Burns may require reseeding with native bunchgrass and forb species in order to stem the invasion of non-native annuals. Avoid reseeding with crested wheatgrass or other non-native species that create a continuous herbaceous cover and outcompete native species. However, crested wheatgrass may be appropriate in seed mixtures on severely degraded sites (Kaltenecker 1997) and may provide some structure valuable to birds. It is preferable to the more aggressive cheatgrass and medusahead. Keep cattle off recovering sites for one to two growing

seasons; grazing after a burn can seriously damage soil and native perennials, delaying recovery (Blaisdell et al. 1982).

- In cheatgrass-dominated landscapes, "greenstripping" offers an option for slowing the spread of wildfire and reducing the size of range fires (Pellant 1994). Greenstrips are fuelbreaks of fire-resistant vegetation placed at strategic locations on the landscape. Greenstrips replace cheatgrass and other mat-like annual grasses with bunchgrasses or other plants that remain green, cure later than cheatgrass, or have a tufted (caespitose) growth-form so they don't carry fire as easily. However, because greenstrips fragment sagebrush habitat and can bring in more non-native weeds if the seeding is unsuccessful (J. Rotenberry pers. comm.), only use greenstripping in areas where there is a high threat of invasion of annual grasses and where there is a real threat to high-value sagebrush sites. For example, the Idaho Sage Grouse Management Plan—1997 (Idaho Sage Grouse Task Force 1997) recommends rating sage grouse wintering and nesting habitats as high priority for wildfire suppression.

The following activities convert sagebrush shrubland to other habitat types, replacing plants and wildlife with other (often non-native) species. Above, we recommended no net loss of sagebrush steppe habitat. Where habitat conversions do occur, we recommend the following practices to help reduce impacts to adjacent sagebrush habitat or to provide some of the requirements of sagebrush birds, such as a prey base.

One option for restoring converted land back to a sagebrush steppe community is the Conservation Reserve Program (CRP), a federal set-aside program that pays landowners to plant agricultural lands with permanent cover, including native species. Although planned as temporary reserve lands, CRP plantings could provide important habitat to sagebrush birds, especially in areas suffering large losses of sagebrush shrublands. The CRP has had a major positive impact on sharp-tailed grouse populations in Idaho (Ulliman et al. 1998).

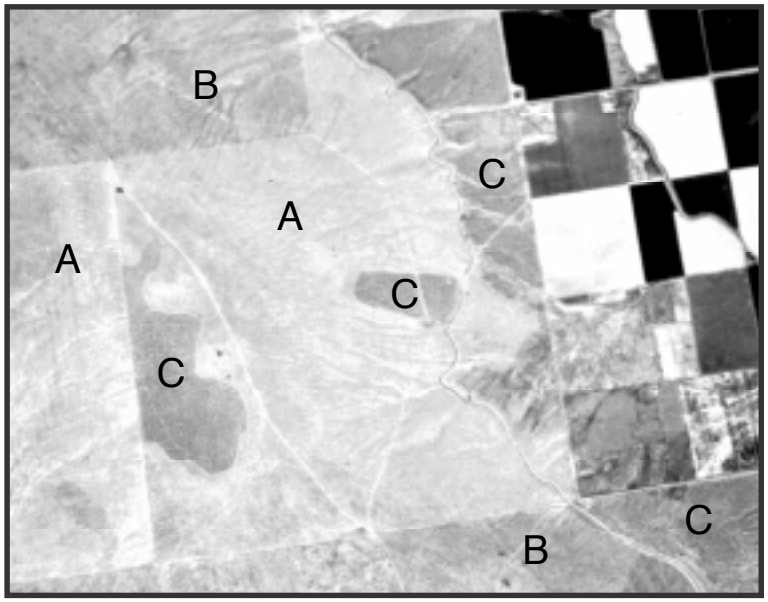
Habitat Fragmentation

Although not a management "activity," habitat fragmentation can result from land conversion to annual grassland or tilled cropland, mining, and development. These activities break sagebrush communities into small and sometimes isolated stands. Habitat fragmentation threatens sagebrush obligate species that evolved in a vast, continuous landscape of sagebrush habitat. Sage grouse and long-billed curlews are not as productive in small stands of habitat as in large stands. Sagebrush-obligate songbirds (sage thrasher, sage sparrow, and Brewer's sparrow) are also sensitive to fragmentation. These species prefer larger stands with high shrub cover and decline with increasing disturbance (Knick and Rotenberry 1995; Knick 1996). Nest predation and cowbird brood parasitism may also play a role in reducing bird productivity in fragmented sagebrush habitat, but have not been studied much (T. Rich pers. comm.).

But how big is big enough? Unfortunately, the minimum or optimum sizes of habitat patches required to sustain populations of birds and other wildlife species are still largely unknown (J. Rotenberry pers. comm.). M. Vander Haegan (pers. comm.), in a study in Washington, did not find sage sparrows on patches smaller than about 130 ha (1/2 section). J. Rotenberry (pers. comm.) suggests that patches should be that size or larger.

- The safest approach to the habitat fragmentation issue is to manage for no *net* loss of sagebrush steppe habitat and to maintain native vegetation communities in large and continuous stands wherever possible (see box, "No Net Loss").

- Maintain existing larger stands of sagebrush and continuity between stands wherever possible. Avoid designs and practices that create or increase the amount of edge between sagebrush habitat and converted or highly altered land. These edges support cowbirds, nest predators, and invasive grasses and forbs, and they expose wildlife to insecticides, shooting, collisions with vehicles, and other hazards.
- To benefit sage grouse and sharp-tailed grouse, maintain large expanses of sagebrush habitat.



BLM Stock Photo, Burley Field Office

Agricultural conversion (on the right) and rangeland seeding of crested wheatgrass (marked A *and* B*, the latter also having sagebrush at low density) have fragmented this sagebrush shrubland in southern Idaho. Note the small, dark patches of Wyoming big sagebrush (marked* C*) in the middle of the photo and bordering the farmland. These patches are too small to support area-sensitive species such as the sage sparrow. The square containing the middle three sagebrush patches is 1.6 km x 1.6 km (1 mi x 1 mi).*

Summer sage grouse home ranges vary from 3 to 7 km^2 (1 to 2.5 mi^2) and may be larger in fragmented habitats. However, this area may be insufficient for year-long habitat use, and surveying the seasonal movements and winter habits of local sage grouse populations will better define a population's area requirements. Sage grouse winter home ranges may exceed 140 km^2 (53 mi^2). Large expanses of sagebrush across a landscape with stands of 10% to >20% canopy cover and tall shrubs (25 to 30 cm; 10 to 12 in) provide winter habitat. Sharp-tailed grouse require thousands of hectares (acres) to support a self-sustaining population; large blocks of agriculture are not conducive to sharp-tail occupancy (Ulliman et al. 1998).

- To benefit sagebrush-obligate songbirds, maintain large continuous areas of sagebrush with multiple height classes and variable shrub cover. Prevent sagebrush conversion to annual grasslands or croplands. Suppress range fires that threaten to eradicate large areas of sagebrush.
- Some landscapes may require restoration of sagebrush and perennial bunchgrass communities to augment remaining sagebrush habitat and to avoid further fragmentation by wildfire carried by annual grasses.
- Roads also fragment sagebrush communities and play a role in the spread of noxious weeds. Limit the number of roads and consider closing and rehabilitating old roads.

Invasion of Non-native Grasses and Forbs

The invasion of non-native grasses and forbs is a major threat to remaining sagebrush habitats and in some areas overshadows all other concerns. Controlling these invaders is perhaps the most difficult and perplexing problem facing range managers. Once established, cheatgrass, medusahead, and other non-natives change the vegetation ecology of sagebrush habitats. There are no simple prescriptions for eliminating these noxious weeds, and it is far beyond the scope of this document to provide a complete review of weed management.

- Where stands contain a community of native grasses and forbs, reduce the likelihood of weed invasion by maintaining the vigor of native species, controlling livestock stocking levels, avoiding large-scale soil disturbances, and minimizing habitat fragmentation.
- Weed control with herbicides, biological agents, and mechanical techniques should be followed by reseeding and restoration of native plant species to prevent the reinvasion of weeds (Larson et al. 1994). Controlling fall-germinating annuals can enhance survival of seeded fall-dormant perennials, which will better re-establish if annuals are not already

rooted and competing for moisture when the perennials germinate in spring (R. Hill pers. comm.).

- In cheatgrass-dominated units, managers may have only two options—manage the unit as an annual grassland, or intensively control cheatgrass and reseed. Deferred grazing plans may favor cheatgrass if perennial grasses are not a significant component of the unit. Where cheatgrass dominates, heavy spring grazing before seed production may reduce cheatgrass and prepare a unit for reseeding with desirable perennial grasses (Vallentine and Stevens 1994). The U.S. Bureau of Land Management in Idaho is using the herbicide sulfometuron-methyl (tradename Oust) to control cheatgrass after fires. It is applied in late fall/early winter or in the early spring prior to seeding and rehabilitation efforts (M. Pellant pers. comm.).
- Medusahead control appears particularly difficult. Mechanical means of control often do not work on the soils or topography where medusahead invades; herbicidal sprays may be more effective. There is some indication that a few perennial grass species can eventually establish themselves on medusahead-infested sites (Young 1992).

Farming

Tillage fragments and completely alters sagebrush habitat to the detriment of sagebrush birds. However, even remnant sagebrush patches have value to some species. Certain practices can be adopted to reduce farming's impacts on birds.

- Minimum till and no-till systems maintain vegetative cover through the non-breeding season and provide habitat for small mammals and wintering songbirds. This in turn benefits raptors. The burrowing owl and short-eared owl, and to a lesser extent the ferruginous hawk and prairie falcon, all use agricultural areas during winter for foraging (Young 1987).
- Maintain riparian woodlands, unplowed borders and edges, and vegetated waterways to provide nest and roost sites for raptors and shrikes and foraging habitat for many songbirds. Provide an unplowed buffer of at least 30 m (100 ft) around springs, seeps, wetlands, and riparian habitats. Even small-scale habitat protection can provide important habitat features for many birds during breeding, wintering, and migration.
- Haying often destroys nests of short-eared owls, vesper sparrows, sharp-tailed grouse, and other ground-nesting birds and decreases cover for mammalian prey. If possible, delay haying until ground-nesting birds have fledged. Most will have fledged by late July (Ivey 1995), depending on the area.
- Reduce or eliminate insecticide use to prevent poisoning birds, reducing insect prey, or eliminating beneficial insects (see "Insecticides" above).
- To avoid harm to other wildlife, check that fences meet specifications designed to protect deer and pronghorn. Avoid fencing small, scattered sagebrush patches in agricultural areas as this may encourage, rather than discourage, trespass grazing.
- Sites with unsuitable soils or slopes too steep for farming should be kept in native vegetation as "habitat stepping stones."

Mining and Oil/Gas Development

Mining and oil/gas development should only be a short-term habitat conversion. Land reclamation, initiated concurrently with mining operations, can restore sagebrush habitat for birds (see discussions under "General Sagebrush Habitat Management" and "Habitat Fragmentation").

- Avoid placing mines, oil and gas drill sites, sand or gravel pits, geothermal sites, and roads in or next to sensitive habitats such as grouse lek, breeding, or wintering habitat; raptor nest sites on cliffs and outcrops; or riparian areas, springs, and other wetland habitats.
- The impact of construction and operations on raptor nest sites can be effectively reduced through buffers

and timing restrictions. These will vary based on time of year, type and duration of activities, intervening topography, and other factors. Contact state or federal wildlife agencies for local advice on appropriate buffers and timing.

John Erickson, Wyoming Dept. of Environmental Quality

This shrub reestablishment area at the Skull Point Mine in Wyoming is contoured to blend in with the native habitat. Variation in topography will result in a mosaic similar to what occurs in an unmined area. Sagebrush can be reestablished from wind-blown seeds, seeds stored in topsoil, a seed mix, or transplanting shrubs. This site is about 7 years old.

- Protection of grouse leks from disturbance during the mating season is important for successful reproduction. Ulliman et al. (1998) and the Idaho Sage Grouse Task Force (1997) recommend no developments within 365 m (400 yd) of a lek and avoiding physical, mechanical, and loud noise disturbances within 800 m (0.5 mi) of a lek during the breeding season (March through May for sage grouse, March through June for sharp-tailed grouse) from one hour before sunrise to three hours after sunrise.
- Prepare fire and weed control plans to protect both reclamation and adjacent sagebrush habitat.
- Ponds containing mining wastes should be netted, fenced, or otherwise closed off to exclude birds, bats, and other wildlife attracted to the water.
- Reclaim areas as soon as possible after completion of activities. This reduces the amount of habitat converted at any one time and speeds up the recovery to sagebrush habitat.
- Avoid planting monocultures. Carefully plan for a complex of vegetation that reflects the diversity of plant species and habitats in the surrounding area (Karr 1980). Reseed with local genetic seed stock if available, and avoid using non-native plant species that compete with native species. Big sagebrush will grow from soil-banked seeds, so saving topsoil is an excellent way to reestablish this species. Providing topography similar to the surrounding area will provide microsites that promote a mosaic pattern.
- Grasses and forbs compete with young shrubs, but a mixture of shrubs and herbaceous species can be established at lower seeding rates if they are seeded in separate strips (Richardson et al. 1986.)
- Fencing may be necessary to protect a site from both livestock and wild grazers, such as jackrabbits, until vegetation is well established (Richardson et al. 1986; Romney et al. 1990). However, because of hazards posed by fences, determine their necessity on a case-by-case basis.

Residential and Urban Development

Developments generally eliminate sagebrush habitat entirely by totally converting shrublands to buildings, asphalt, lawns, and landscaped parks. Residential areas also harbor animals that prey on birds or eggs, such as domestic cats, crows, ravens, skunks, and raccoons. However, careful planning can conserve native habitats even within and near developed landscapes. The kinds and abundance of wildlife such areas can support will depend on their size and proximity to other native habitats.

- Large-scale planning should promote and maintain "open space" of native habitats as public parks and commons. Manage land use to maintain these openings as native vegetation communities.
- When designing open space of native habitats, plan for large areas to increase interior habitat, minimize fragmentation, and reduce edges and ecotones between native and non-native habitats. Design open spaces so they connect with surrounding native

habitats. Avoid creating small patches or narrow strips of habitat except as possible corridors between larger habitat patches. Wide habitat corridors are better than narrow ones, but the ideal width is unknown.

- On a local scale, design housing developments, shopping areas, industrial parks, and other developments so that homes and buildings are in clusters and preserve large commons of native vegetation. Design subdivision of ranchlands so that native habitats in each subdivided lot are next to one another, reducing habitat fragmentation. Where possible, locate developments in peripheral areas, not interior portions of sagebrush stands. Use tax incentives, such as conservation easements, to maintain wildlife open space in sagebrush habitat.
- Confine all construction-related disturbance to immediate construction areas to avoid destroying adjacent sagebrush habitat. Restore areas disturbed by construction, using native plant species.
- Use native plant species in landscaping for parks, homes, shopping areas, and other developments. Although not a substitute for native habitat, such plantings can provide foraging opportunities, nest sites for some bird species, and migration stopover habitat.
- Avoid or minimize insecticide and herbicide use on lawns and gardens. As alternatives, landscape with native plants, and encourage birds, bats, and beneficial insects to help control insect pests.
- Residents can help protect native birds by keeping their cats indoors and by not allowing cats and dogs to run free in adjacent sagebrush habitat. Residents should also avoid attracting other predators by covering garbage and not leaving out food for pets.

Concluding Remarks

We have produced this publication out of concern for the birds, other wildlife, and plants of sagebrush country. Now it's up to you to put these recommendations to work, to turn the tide for the wildlife and plants of the sagebrush sea.

> " *. . . We have modified this ocean of sagebrush just as surely as we have transformed tall-grass prairie with the plow. . . . Unlike pristine wilderness, it requires management. . . . The challenge: juggling a billion acres worth of ecologic, economic, and political realities with deftness, wisdom, farsightedness, and tolerance. We should wish ourselves luck.*"

SUMMARY OF BIRD MANAGEMENT GOALS AND RECOMMENDATIONS

Summary of bird management goals and recommended actions to meet those goals for different activities that occur in sagebrush shrublands. For more details and for general recommendations for sagebrush shrublands, sagebrush shrubs, understory grasses and forbs, and biological soil crusts, see the section "How to Help Birds in Sagebrush Habitats."

Activity	Bird Management Goal	Recommended Action
Grazing	Promote growth of native grasses and forbs.	Use proper stocking levels and grazing plans such as rest-rotation two-crop short rotation, or deferred grazing.
	Protect/restore biological soil crusts.	Limit grazing to wet periods and winter months.
	Avoid trampling ground nests.	Reduce stock, time grazing, or rotate pastures to avoid the nesting season.
	Maintain herbaceous nesting cover.	Protect current season's growth through the nesting season and manage for at least 50% of annual vegetative growth to remain. Maintain adequate grass height for grouse nesting cover.
	Restore degraded sagebrush shrublands.	Temporarily remove livestock.
	Reduce cowbird parasitism.	Minimize livestock concentrations; rotate livestock use in alternate years spatially or temporally.
Water developments	Maintain water quality and vegetation in springs, seeps, and riparian areas.	Retain natural water flow.
		Protect and enhance growth of native forbs.
		Use exclosures or non-fencing methods to keep livestock out.
		Limit grazing to the plants' dormant season.
		Develop livestock watering facilities away from sensitive wet areas.
	Reduce bird mortality.	Provide escape ramps or floats.
Insecticides	Reduce bird mortality.	Include birds in integrated pest management programs.
		Avoid insecticide use during grouse brood-rearing season.
		Use insecticide baits and natural pathogens instead of broad-spectrum insecticides.
		Avoid broadcast spraying; use ground applications rather than aerial spraying.
		Restrict use to the minimum application rates on croplands bordering sagebrush shrublands.

Recreation	Reduce impact on bird habitat.	Avoid placing recreation sites near sage grouse and sharp-tailed grouse breeding habitat or raptor nests. Protect springs and wetlands from recreation use. Encourage use of established sites, including keeping vehicles on established trails and roads. Limit the number of roads; reclaim excess roadbeds with native vegetation.
	Reduce bird mortality.	Keep vehicles on established trails and roads to prevent harm to nests and nestlings. Restrict target practice to established shooting and archery ranges.
Prescribed fire and wildfire	Allow reestablishment of sagebrush and native grasses and forbs.	Keep burns to a small scale and patchy distribution. Burn late in early spring or fall to take advantage of native grasses' adaptations to late season fires and to discourage cheatgrass. Reseed burns with native bunchgrass and forb species. Keep cattle off recovering sites until native grasses become established.
	Prevent large-scale wildfires that will result in cheatgrass invasion or will destroy high-value sagebrush sites.	Use green-stripping if needed.
Habitat fragmentation	Maintain large areas of sagebrush for area-sensitive species.	Manage for no *net* loss of sagebrush habitat. Avoid designs and practices that create or increase the amount of edge. Maintain large expanses of sagebrush habitat. Minimize sagebrush conversion to annual grasslands or croplands. Suppress range fires that threaten to eradicate large, continuous areas of sagebrush. Restore sagebrush and perennial bunchgrass communities. Limit the number of roads; rehabilitate old roads.
Invasion of non-native grasses and forbs.	Maintain existing sites that are relatively free from non-native invaders.	Maintain the vigor of native species. Control livestock stocking levels. Avoid large-scale disturbances. Minimize habitat fragmentation.
	Restore native species following weed control.	Reseed native plant species and control fall-germinating annuals. Use heavy spring grazing to reduce cheatgrass and prepare a unit for reseeding with perennial grasses.

Activity	Bird Management Goal	Recommended Action
Farming	Provide prey for raptors.	Use minimum till and no-till systems to maintain vegetative cover through the non-breeding season.
	Maintain nesting and roosting sites for raptors and shrikes and foraging areas for songbirds.	Protect riparian woodlands, unplowed borders and edges, and vegetated waterways.
	Reduce bird mortality.	Delay haying until after ground-nesting birds have fledged.
		Reduce or eliminate insecticide use.
Mining	Protect sensitive wildlife habitats.	Avoid developing near grouse breeding or wintering habitat, raptor nest sites, or riparian and wetland areas.
		Use buffers and timing restrictions to protect raptor nest sites and grouse leks.
	Protect reclamation and adjacent habitat from wildfires and non-native forb and grass invasion.	Prepare fire and weed control plans.
	Reduce wildlife mortality.	Exclude birds, bats, and other wildlife from mining waste ponds and oil pits using netting, fences, or other methods.
	Restore sagebrush habitat.	Reclaim disturbed sites using a diversity of plant species and local genetic stock.
		Avoid using non-native species.
		Protect newly reclaimed sites from livestock and wild grazers.
Residential and urban development	Provide nesting and foraging habitat within and adjacent to developments.	Retain native vegetation in open spaces.
		Use tax incentives to maintain open space.
		Use native plant species in landscaping to provide foraging opportunities, nest sites, and migration stopover habitat.
	Reduce impacts of development on adjacent habitat.	Confine construction-related disturbance to the immediate construction area.
		Restore disturbed areas using native plant species.
	Reduce bird mortality.	Avoid or minimize use of insecticides.
		Landscape with native plants to encourage the presence of birds, bats, and beneficial insects that control pest insects.
		Keep cats indoors and don’t allow cats and dogs to run free in adjacent sagebrush habitat.
		Discourage other predators by covering garbage and reducing other food sources (i.e., pet food).

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APPENDIX I.
BIRDS OF CONCERN IN SAGEBRUSH SHRUBLANDS

Seventeen bird species that breed in sagebrush shrublands score high on the Partners in Flight priority rankings for one or more of eight western states. We are concerned about the future for these species for several reasons. They are vulnerable to changes in sagebrush shrublands caused by human activities, and information from the continent-wide Breeding Bird Survey indicates that their populations are in decline or their population status is unknown. This section presents brief life history accounts for each of these "species of concern." Consult field guides for range maps.

We placed these species into several groups. Not all of the species are sagebrush obligates, i.e., using only sagebrush habitat. They all use sagebrush, but to varying extents. The groups are **Sagebrush Obligates**—sage grouse, sage thrasher, sage sparrow, and Brewer's sparrow; **Shrubland Species**—green-tailed towhee, black-throated sparrow, and lark sparrow; **Shrubland-Grassland Species**—Swainson's hawk, ferruginous hawk, prairie falcon, sharp-tailed grouse, and loggerhead shrike; **Grassland Species**—long-billed curlew, burrowing owl, short-eared owl, and vesper sparrow; and **Primarily Dry Woodland Species**—gray flycatcher. Tables 2 and 3 (pages 12 and 13) summarize habitat components and nesting substrates for these species.

Information Sources: Except where other sources are cited, the following accounts are based on several major compilations of bird life histories: *Birds of the Great Basin* (Ryser 1985*), The Birder's Handbook* (Ehrlich et al. 1988), *Conservation and Management of Neotropical Migrant Birds in the Northern Rockies and Great Plains* (Dobkin 1994), *The Sparrows of the United States and Canada* (Rising 1996), *Atlas of Idaho's Wildlife* (Groves et al. 1997), the Idaho Heritage Program's vertebrate characterization abstracts database, and the *Birds of North America* series (A. Poole and F. Gill, editors).

The information given on species population trends is based on the most current Breeding Bird Survey (BBS) trend estimates from the U.S.G.S. Biological Resources Division. The accounts below include brief trend synopses for each species in those states and physiographic regions having extensive sagebrush shrub-steppe. The most current BBS trend results with complete tables and maps are now published on the Breeding Bird Survey World Wide Web site (Sauer et al. 1996).

Be aware of several things when interpreting BBS data. First, although the BBS got its start in 1966, surveys were not run in the West until 1968. Secondly, the BBS is our best source of long-term population information for North American birds, but it does have some shortcomings. In many western states, survey routes are few and far between, so sample sizes are generally low for western birds—particularly in the Intermountain and Great Basin areas we are concerned with here. Also, many species are not sampled well either because their range is restricted, they occur in low densities, or they are found in habitats that are not well sampled, such as riparian woodlands. In short, BBS trend estimates must be interpreted conservatively, but declining trends should not be ignored.

The "centers of abundance" information for each species in the following accounts is based on *The Summer Atlas of North American Birds* (Price et al. 1995). This atlas maps the patterns of abundance for North American birds using a careful interpretation of BBS relative abundance data.

SAGEBRUSH OBLIGATE SPECIES

Sage Grouse (*Centrocercus urophasianus*)

Breeding Habitat - A sagebrush obligate in nearly every way, the sage grouse is found associated with both tall and short species of sagebrush in foothills, sagebrush shrublands, and mountain slopes. Sage grouse also occur in mosaics of sagebrush, grasslands, and aspen, but not in pinyon-juniper woodlands or in shadscale shrublands. Habitat requirements vary during the year. Summer home ranges may be 3 to 7 km^2 (1 to 2.5 mi^2; Connelly and Markham 1983; Gates 1983), and annual home ranges may be as large as 1500 km^2 (577 mi^2; Connelly unpub. data).

Males display on leks in gatherings of a few to a few hundred birds; leks are used exclusively for display and mating. They are in open areas surrounded by sagebrush or where sagebrush density is low, such as on exposed ridges and knolls.

During early brood-rearing, wet meadows, springs, seeps, and other green areas within gently sloping, sagebrush shrublands (15 to 25% canopy coverage) close to the nest site are important for insect foraging (Idaho Sage Grouse Task Force 1997). As sagebrush areas dry in June and July, sage grouse move to wetter sites with succulent forbs, including wet meadows, irrigated areas, and riparian areas bordered by sagebrush (Connelly et al. 1988). In a Nevada study, broods used meadows with effective cover 7 to 16 cm (3 to 6 in) tall (Klebenow 1982). Broods used upland habitats with big sagebrush ranging from 1 to 25% canopy cover and 15 to 20 cm tall (6 to 8 in; Wallestad 1971; Klebenow 1982).

Nest - The sage grouse nest is a shallow ground depression lined with grass and sage leaves. The hen conceals its nest most often beneath big sagebrush, but sometimes uses other shrubs. Nests under sagebrush are reportedly more successful than those under other plant species (Connelly et al. 1991). For nesting, hens select sagebrush stands with higher canopy cover (15 to 40%) than surrounding stands, and choose one of the tallest shrubs in the stand (36 to 80 cm; 14 to 31 in) with high lateral cover (Roberson 1986; Wakkinen 1990). Grass cover is important for both concealment and for a warmer microclimate (Call and Maser 1985; Gregg et al. 1994). Compared to random sites, sage grouse-selected sites have taller grass cover (>18 cm; 7 in; Gregg et al. 1994; Connelly et al. 1991). A review by Dobkin (1995) indicates good nesting habitat contains 15 to 35% shrub canopy cover and at least 20% herbaceous cover.

Wintering Habitat - Sage grouse may migrate only a short distance, not at all, or as much as 75 km (47 mi) between winter, breeding, and summer habitats (Dalke et al. 1963; Braun et al. 1977; Connelly et al. 1988). Fall movement to winter range can span several months (Connelly et al. 1988). Males and females flock separately. Winter ranges may exceed 140 km^2 (54 mi^2; Robertson 1991). Sage grouse select winter sites based on topography, snow depth, and availability of sagebrush above snow level. They select stands with patches of the highest available canopy cover (10 to 40%) with heights of 25 to 30 cm (10 to 12 in) above the snow (Braun et al. 1977; Call and Maser 1985; Idaho Sage Grouse Task Force 1997). They forage in drainages and on slopes with south and west aspects. Wintering grouse feed almost exclusively on sagebrush, choosing plants containing the most protein. In feeding trials, wintering grouse preferred certain subspecies of big sagebrush—mountain big sagebrush, Wyoming big sagebrush, and basin big sagebrush (Welch et al. 1991). Suitable winter habitat in sagebrush may be the most limiting factor in some areas.

Feeding - Sage grouse are restricted to soft foods by lack of a muscular gizzard. In the breeding season, they eat sagebrush and the leaves, flowers, and buds of associated forbs and grasses. They also eat ants and grasshoppers, focusing almost exclusively on grasshoppers during an irruption. In winter, sage grouse feed almost entirely on the evergreen leaves of sagebrush, most often selecting species and shrubs with high protein levels.

Status - Sage grouse were once widespread, ranging across 14 western states and into three Canadian provinces. Sagebrush conversion to agriculture, grazing, and eradication of sagebrush with herbicides eliminated the sage grouse from much of its former range, particularly in the Northwest. Destruction and degradation of springs, seeps, and wet meadows by overgrazing, and hunting and poaching pressure also took their toll. Populations were seriously reduced by the 1930s. The sage grouse was extirpated in parts of its range, and declined by more than 50% of its former population in Washington, Oregon, California, Nevada, and Utah (DeSante and George 1994). Surveys show a steady and significant decline since 1960 in Idaho and Oregon. A recent summary of sage grouse status by Drut (1994) indicates decreasing populations in Washington, Oregon, Montana, and Wyoming, and stable populations in Idaho, Nevada, and Utah. Idaho Sage Grouse Task Force (1997) states that the number of sage grouse in Idaho is at a record low.

Conservation - Grouse benefit from restoration of native forb and perennial bunchgrass communities and from maintenance of patches of tall and dense big sagebrush within sagebrush shrublands. Prevent sagebrush over-dominance by managing for a mosaic of patchy sagebrush with openings of native grasses and forbs across the landscape. Sagebrush stands should have multiple cover and size classes. During the breeding season, nests and broods may be vulnerable to trampling by livestock.

Springs, seeps, and wet meadows within and adjacent to sagebrush stands should be protected from livestock over-grazing to support the native forb and insect diet of young broods. Sage grouse respond positively to light or moderate grazing strategies that maintain grass and forb cover (Klebenow 1982). Avoid land uses that allow invasion of non-native plants, reduce the diversity and abundance of native forbs, eliminate sagebrush, reduce cover within breeding habitats, or reduce soil moisture (J. Connelly pers. comm.). Water developments, such as wildlife guzzlers, may be useful for sage grouse, but should be located in known summer habitats (Connelly and Doughty 1990). Sage grouse can be adversely affected by organophosphate and carbamate pesticides (Blus et al. 1989). Use of these pesticides should be avoided near breeding and brood-rearing habitats (J. Connelly pers. comm.).

Sage Thrasher (*Oreoscoptes montanus*)

Breeding Habitat - A sagebrush obligate, the sage thrasher is almost always associated with sagebrush shrubland communities dominated by big sagebrush (*A. tridentata*), using shrublands for nesting and security cover. It usually breeds between 1300 and 2000 m (3900 to 6500 ft) elevation (Reynolds and Rich 1978), but in the Columbia Basin may nest as low as 700 m (2300 ft) (B. and N. LaFramboise pers. comm.). In the northern Great Basin, tall sagebrush/bunchgrass, juniper/sagebrush/bunchgrass, mountain mahogany/shrub, and aspen/sagebrush/bunchgrass communities are primary breeding and feeding habitats (Maser et al. 1984). The sage thrasher

is positively correlated with shrub cover, bare ground, and measures of horizontal habitat heterogeneity, and negatively correlated with the presence of spiny hopsage, budsage, and grass cover (Rotenberry and Wiens 1980; Wiens and Rotenberry 1981). In an Idaho study, the sage thrasher was more likely to occur in sites with higher sagebrush cover and greater spatial similarity (Knick and Rotenberry 1995). In Oregon, sage thrashers are not found in extensive patches of crested wheatgrass or annual grasses and forbs, but a few will be present once sagebrush covers 2 to 5% of the area (A. Bammann pers. comm.). Breeding densities in the Great Basin are rarely more than 30 individuals per km^2 (78 per mi^2; Wiens and Rotenberry 1981; Rotenberry and Wiens 1989).

Nest - The sage thrasher's selection of a nest site is very specific within sagebrush stands: the tallest, densest clump of shrubs available surrounded by little bare ground. The sage thrasher builds its nest in or beneath a shrub, nearly always sagebrush, with dense foliage overhead and almost invariably a nest-to-shrub crown depth of 0.5 m (1.5 ft). It most often orients the nest to the southeast, presumably for morning warmth, afternoon shading, and protection from prevailing winds (Petersen and Best 1991). Males sing and display from the tops of shrubs, as well as displaying in flight. The sage thrasher is known to eject cowbird eggs from the nest (Rich and Rothstein 1985).

Wintering - The sage thrasher winters in the Southwest and southern California, through Baja, and into central Mexico, where it uses arid and semi-arid scrub, brush, and thickets.

Feeding - An insectivore, the sage thrasher especially favors Mormon crickets and their eggs; consumes grasshoppers, beetles, weevils, ants, and bees; and will also eat small fruits and berries. It forages on the ground between shrubs and gleans food from foliage.

Status - In 1868 at Carson City, Nevada, Ridgway (King 1877 as referenced in Ryser 1985) noted that the sage thrasher was one of the most common species in that area. BBS trend estimates show populations were more or less stable across the West through the 1968 to 1995 survey period; however, sample sizes are generally too low for accurate state and physiographic region trend estimates. Possible declines are evident from 1980 to 1995 in Wyoming, the Colorado Plateau, Great Basin, Snake River Plain, and Columbia Basin. Centers of abundance are in the northern Great Basin, central Nevada, eastern Idaho, southwestern Wyoming, and northern Colorado.

Conservation - A summary of several studies shows varying responses to grazing in sagebrush; the sage thrasher responded positively to grazing in big sage in two studies and negatively in one study (Saab et al. 1995). Long-term responses to grazing are unknown. Maintaining tall sagebrush in dense clumps with significant amounts of other shrubs, grasses, and forbs to minimize bare ground beneath shrub canopies is important for nest habitat. Some bare ground between shrubs may be important for foraging. The sage thrasher reportedly can help control Mormon crickets and other grasshoppers (Knowlton and Harmston 1943). Saab and Rich (1997) found the sage thrasher to be of high management concern in the Columbia River Basin.

Sage Sparrow (*Amphispiza belli*)

Breeding Habitat - The sage sparrow is a sagebrush obligate associated with sagebrush shrublands dominated by big sagebrush with perennial bunchgrasses. It is also sometimes found in shadscale, antelope brush, rabbitbrush, and in black greasewood (the latter in western Colorado; R. Lambeth pers. comm.). The species occurs from sea level up to 2000 m (6500 ft) elevation. Observers have noted that the sage sparrow is not found in all seemingly suitable sagebrush habitats (Rich 1978). Vander Haegan (pers. comm.), in a study in Washington, did not find sage sparrows on patches smaller than about 130 ha (1/2 section), and suggests that they are area-sensitive. On a broad scale, sage sparrows prefer shrublands with tall shrubs and low grass cover, where sagebrush is clumped in a patchy landscape (Petersen and Best 1985a; Wiens et al. 1986). A landscape analysis by Knick and Rotenberry (1995) found sage sparrows most likely to use sites with high sagebrush cover, spatially similar patches, large patch size, low disturbance, and little fragmentation. The species is positively correlated with big sagebrush, shrub cover, bare ground, and above-average shrub height, and negatively correlated with cottonthorn, greasewood, and grass cover (Rotenberry and Wiens 1980; Wiens and Rotenberry 1981; Larson and Bock 1984). In the northern Great Basin, it uses low and tall sagebrush/bunchgrass, juniper/sagebrush, mountain mahogany/shrub, and aspen/sagebrush/bunchgrass communities as primary breeding and feeding habitats (Maser et al. 1984). Breeding densities average between 50 to 200 individuals per km^2 (130 to 520 per mi^2), and territory size averages 1.5 to 3 ha (3.7 to 7.5 ac; Wiens and Rotenberry 1981; Wiens et al. 1985; Rotenberry and Wiens 1989).

Nest - The sage sparrow builds an open cup nest, usually placed within a sagebrush shrub or on the small branches at the periphery, and occasionally on the ground beneath a shrub. Nest placement appears to be related to the density of cover over the nest, as the sage sparrow will nest higher in taller sagebrush (Rich 1980). A study in southwestern Idaho found that sage sparrows preferred living sagebrush from 50 to 70 cm (20 to 28 in) tall and avoided placing nests in the southwest portion of the shrub (Petersen and Best 1985a). The sage sparrow is an

occasional cowbird host. Before European settlement, the species was probably isolated from cowbird parasitism for the most part, but is now vulnerable to parasitism where fragmentation of sagebrush shrublands and land conversion to agriculture provide contact zones between cowbirds and sagebrush breeders (Rich 1978).

Wintering - After breeding, sage sparrows gather in loose flocks and may move to higher elevations before migration. In winter, they retreat from the northern part of their range and overwinter in southern Oregon, Nevada, Utah, and southern Colorado south into northern Mexico. Sage sparrows use arid, open lands with scattered shrubs, including sagebrush grasslands, coastal chaparral, and weedy scrub.

Feeding - The sage sparrow forages on the ground and in shrubs, feeding on insects (weevils, grasshoppers, crickets, caterpillars, ants, lacewings) and seeds (Wiens and Rotenberry 1979).

Status - Throughout the West, the overall long-term trend is stable: populations apparently declined from 1968 to 1979, but have increased since 1980. The species declined in Wyoming from 1980 to 1995, but sample sizes are too small for reliable trend estimates in other states and physiographic regions. Centers of abundance are in southwestern Wyoming, western and northern Great Basin, and the Colorado Plateau. Local declines, small sample sizes, and the species' dependence on big sagebrush habitats make it a species of management concern.

Conservation - Males show strong site fidelity to breeding territories and may persist where sagebrush is partially removed within a territory or for a short term where sagebrush is completely removed (Wiens and Rotenberry 1985; Wiens et al. 1986). With complete removal of sagebrush on a broader scale, sage sparrows steadily decline within two years (Wiens and Rotenberry 1985). In fragmented sagebrush shrubsteppe, they may be vulnerable to cowbird parasitism where habitat alteration brings cowbirds into contact with sagebrush breeders (Rich 1978). The sage sparrow will benefit from maintenance of large, continuous stands of sagebrush habitat. Because it is a ground forager, continuous cheatgrass cover is probably detrimental to its foraging success. Saab and Rich (1997) found the sage sparrow to be of high management concern in the Columbia River Basin.

Brewer's Sparrow (*Spizella breweri*)

Breeding Habitat - Considered a sagebrush obligate, the widespread Brewer's sparrow is tightly associated with sagebrush shrublands that have abundant, scattered shrubs and short grass. It can also be found in mountain mahogany, rabbitbrush, pinyon-juniper, or bunchgrass grasslands (Rising 1996). In studies of sagebrush shrubland habitat components, Brewer's sparrows are positively correlated with sagebrush, shrub cover, above-average vegetation height, bare ground, and measures of horizontal habitat heterogeneity, and are negatively correlated with grass cover, spiny hopsage, and budsage (Rotenberry and Wiens 1980; Wiens and Rotenberry 1981; Larson and Bock 1984). The negative correlation with grass cover indicates that they prefer areas dominated by shrubs compared to areas dominated by grass. Brewer's sparrows will avoid burned sagebrush shrublands in favor of unburned sagebrush (Bock and Bock 1987), and an Idaho study found Brewer's sparrows more likely to occur in sites with high shrub cover and large patch size (Knick and Rotenberry 1995). In pinyon-juniper, the species is associated with large openings (Sedgwick 1987). Sagebrush provides perch sites for singing males (Wiens et al. 1987).

The Brewer's sparrow will breed in high densities. Where it occurs, it is usually the most abundant bird species (R. Lambeth pers. comm. citing Reynolds 1981; Rotenberry and Wiens 1989). Breeding territories measured in Washington, Oregon, and Nevada averaged between 0.63 and 1.25 ha (1.5 to 3 ac) and contracted as population density increased, but did not vary in relation to habitat variables measured (Wiens et al. 1985). In the Great Basin, densities average 150 to 300 individuals per km^2 (390 to 780 per mi^2), but can exceed 500 per km^2 (1295 per mi^2; Wiens and Rotenberry 1981; Rotenberry and Wiens 1989). In Oregon, clutch size increased in wetter years, possibly indicating an ability to adjust reproductive investment with variations in climate and presumably prey productivity (Rotenberry and Wiens 1989, 1991). However, ground squirrels (an important nest predator and the prey of other predators) also increase with increased precipitation but show a two-year lag, complicating the relationship between climate and nest success (Rotenberry and Wiens 1989).

Nest - The Brewer's sparrow builds an open cup nest in a shrub, preferring large, living sagebrush. In an Idaho study, the species selected taller shrubs, averaging 69 cm tall (27 in) and ranging from 42 to 104 cm tall (16.5 to 41 in). Shrubs less than 50 cm tall (19.5 in) were rarely used (Petersen and Best 1985b). Brewer's sparrows construct their nests low in the shrub, from a few cm to 1 m (3 ft) from the ground, and on the finest branches of new growth at the shrub's edge (Rich 1980). Concealment and cover provided by living sagebrush foliage are important (Petersen and Best 1985b). Because Brewer's sparrows are occasional cowbird hosts, their populations are vulnerable to parasitism where land conversion to

agriculture and the fragmentation of sagebrush shrublands provide contact zones between cowbirds and sagebrush breeders (Rich 1978).

Wintering - The Brewer's sparrow winters from the Southwest through Baja into central Mexico where it uses low, arid vegetation, including desert scrub and creosote bush. Outside the breeding season it is usually seen in large, vocal flocks, often with other sparrows.

Feeding – This sparrow forages chiefly in foliage but also on the ground, feeding on alfalfa weevils, aphids, beet leafhoppers, caterpillars, beetles, spiders, grasshoppers, and the seeds of grasses and forbs.

Status - Historically, the Brewer's sparrow may have been the most abundant bird in the Intermountain West. The BBS trend estimates indicate, however, that the Brewer's sparrow is declining steadily and significantly across the West, with sharp declines since 1980. State trends show declines in California, Colorado, Idaho, Montana, Oregon, and Wyoming and apparently an increase in Utah. Sample sizes in Nevada and Washington are too low for reliable trend estimates in those states. Since 1980, there is a steep, significant decline in the Columbia Plateau, and also declines in the Wyoming Basin and Basin and Range physiographic regions. Centers of abundance are in the Wyoming Basin, Snake River Plain, and Great Basin, particularly southeastern Oregon and central Nevada.

Conservation - Many details of the species' biology and ecology are unknown. Brewer's sparrows are sensitive to sagebrush control, declining with the loss of shrubs and shifting their diet from insects to seeds with changes in food availability. Because they return to the same breeding territories each year, there can be a time-lag in their response to major habitat changes (Wiens and Rotenberry 1985). In the first year following sagebrush control by herbicides, Brewer's sparrow numbers declined by more than 50% (Best 1972; Schroeder and Sturges 1975; Kerley and Anderson 1995), and in the years following, they abandoned the habitat completely as the sagebrush died out (Schroeder and Sturges 1975). Castrale (1982) found similar reductions in Brewer's sparrow numbers on burned plots. In a Wyoming study, 22 years after spraying and 9 years after burning, numbers were less than 50% of the species' abundance in untreated continuous sagebrush (Kerley and Anderson 1995). Where sagebrush is not completely eliminated, Brewer's sparrows may persist (Best 1972; Castrale 1982), but the long-term effects of partial shrub reduction need further study. In short, Brewer's sparrows will thrive best where sagebrush is maintained in tall, clumped, and vigorous stands. Cowbird parasitism is also a concern in areas with fragmentation and cattle. Saab and Rich (1997) found the Brewer's sparrow to be of high management concern in the Columbia River Basin.

SHRUBLAND SPECIES

Green-tailed Towhee (*Pipilo chlorurus*)

Breeding Habitat - The green-tailed towhee is found on mountain slopes, plateaus, and the higher valleys of the arid West, associated with dense shrubs about 0.5 to 1.5 m (1.6 to 5 ft) high. It prefers the ecotones between sagebrush and other shrub habitats, such as mountain mahogany (Knopf et al. 1990). This towhee occurs in dry sagebrush thickets, brushy slopes, riparian scrub in canyons and ravines, and in shrubby openings in woodlands. In pinyon-juniper, it is associated with sagebrush-dominated openings with high shrub species richness (Sedgwick 1987). In the northern Great Basin, the green-tailed towhee uses tall sagebrush/bunchgrass, squaw apple/bunchgrass, mountain mahogany/bunchgrass, mountain mahogany/pinegrass, and aspen/sagebrush/bunchgrass communities as primary breeding and feeding habitat (Maser et al. 1984). In Montana, it is found principally in sagebrush habitats and also higher-elevation, shrubby second-growth (Hutto 1995). The species occurs up to 2400 m (8000 ft) elevation in the Great Basin and 3000 m (10,000 ft) in Arizona (Rising 1996).

Nest - The green-tailed towhee builds a large, open cup nest on the ground beneath dense shrubs, or close to the ground in a low shrub, often in sagebrush. It also uses shrubs as security cover, making an escape by running across the ground when approached. It is an uncommon cowbird host.

Wintering - This towhee winters from the Southwest and southern California to southern Baja and central Mexico. In winter, it may be found at lower elevations in dry brush and occasionally urban areas.

Feeding - Insects, berries, and particularly the seeds of grasses and forbs are the towhee's mainstay. It feeds by raking through leaf-litter with both feet, usually beneath dense shrubs.

Status - The western BBS trend is relatively stable, showing a slight decline overall from 1968 to 1995, but a small increase since 1980. Trends show declines in Wyoming, Colorado, Oregon, and California, and sample sizes are too small in many other states and physiographic regions for reliable trend estimates. Centers of abundance are in eastern California, southern Oregon, the Snake River Plain, and the southern Rockies from Wyoming into

New Mexico. High trend uncertainty in many areas, in addition to local declines, the species' preference for dense shrubs, and a lack of information on the species' breeding biology make the green-tailed towhee a species of management concern.

Conservation - No quantitative information is available on the green-tailed towhee's biology, ecology, or sensitivity to management activities. The species should benefit from maintenance of dense shrub stands on mountain slopes and in ravines. It may be harmed by sagebrush control or heavy grazing that removes the grass and forb groundcover that provides a food base. Cowbird parasitism is also a concern in areas with fragmentation and cattle.

Black-throated Sparrow (*Amphispiza bilineata*)

Breeding Habitat - A true desert bird, the black-throated sparrow frequents the arid, hot desert valleys of the West, occurring in areas with sparse xeric shrubs. It is not closely associated with particular plant communities. It uses desert scrub and thorny brush (ocotillo, cactus, cat-claw, mesquite), saltbush, greasewood, canotia, creosote bush, sagebrush, antelope brush, rabbitbrush, and arid shrublands with juniper. In Idaho, it uses open shrublands of tall sagebrush, spiny hopsage, and horsebrush, and areas where shrub height exceeds 50 cm (20 in). Wiens and Rotenberry (1981) found black-throated sparrows in sites with greater shrub cover, maximum vegetation height, shrub species diversity, and bird species diversity compared to other sites. The species was also positively correlated with the presence of dead woody vegetation. In northeastern Washington, the black-throated sparrow is closely associated with steep, sandy/rock slopes with hopsage/buckwheat/sage and some grasses (M. Denny pers. comm.). The black-throated sparrow is usually found below 1500 m (5000 ft) elevation in the northern part of its range and up to 2100 m (7000 ft) farther south (Rising 1996).

Nest - The black-throated sparrow builds an open cup nest on the ground at the base of a cactus, shrub, or grass tuft, or occasionally in a low shrub, 15 to 45 cm (6 to 18 in) above the ground. It is sometimes parasitized by cowbirds.

Wintering - The black-throated sparrow winters from the Mojave desert southward through Baja and into northwestern and central Mexico. Apart from desert scrub, it may also frequent riparian areas, grasslands, and weedy fields (Rising 1996).

Feeding - In the dry season, the black-throated sparrow feeds chiefly on seeds, adding insects and new shoots of grass and forbs in wetter months. Young are fed insects. This sparrow will visit water holes in the dry season, but once rains begin, gets its water from green vegetation and insects.

Status - DeSante and George (1994) indicate that populations in Nevada have declined by more than 50%. Long-term BBS trends, from 1968 to 1995, show a significant decline survey-wide and a slight decline in the West overall; however, trends appear more stable since 1980. The species is poorly sampled in many parts of its range. From 1968 to 1995, trend estimates show significant increases in Nevada and New Mexico, an increase in the Basin and Range region, and declines in Arizona, California, and Utah. Centers of abundance are in Nevada, Utah, southern California, and the desert Southwest. The black-throated sparrow is of management concern due to local declines and uncertainty of its status in many areas.

Conservation - The details of the black-throated sparrow's biology and ecology are largely unknown. The species responded positively to moderate grazing in a semi-desert habitat in Arizona (Bock et al. 1984), and a Utah study in shadscale showed a mixed response to heavy grazing (Medin 1986). Elsewhere, quantitative studies of the species' response to management activities are lacking. Their ground nests may be vulnerable to trampling. The black-throated sparrow would benefit from good perennial grass cover to conceal its nest. Cowbird parasitism is also a concern where there are cattle.

Lark Sparrow (*Chondestes grammacus*)

Breeding Habitat - The lark sparrow is found in lower-elevation shrublands and savannah of valleys and foothills; in open, dry woodlands and woodland margins (cottonwood riparian, oak savannah, pinyon-juniper, and ponderosa pine with bunchgrasses); and in grasslands or farmlands with scattered shrubs. It uses shrubs, small trees, and fence posts as song perches and as lookouts. In Montana, it is associated with grassland and sagebrush habitats, and less frequently with cottonwood and aspen (Hutto 1995).

Nest - The lark sparrow builds an open cup nest, usually on the ground in a slight depression or low in a shrub, sometimes in a rocky crevice. It often places its nest at the base of vegetation (bunchgrass, cactus, thistle, sagebrush, or rabbitbrush) or up to 3 m (10 ft) high in a shrub or tree (sagebrush, cottonwood, sycamore, mesquite, or live oak). The lark sparrow will reuse the nests of other species, and territoriality disappears with the onset of

incubation. It is a frequent cowbird host.

Wintering - This sparrow winters from southern California and southern Arizona through Baja to central Mexico. In migration and winter, it is usually seen in flocks and frequents agricultural fields, suburban gardens, oak woodlands, chaparral, and mesquite and acacia interspersed with grassland.

Feeding - The lark sparrow forages on the ground for insects (especially grasshoppers) and the seeds of grasses and forbs. It often forages in flocks even in the breeding season.

Status - Long- and short-term BBS trend estimates show significant declines across the West and survey-wide from 1968 to 1995 and from 1980 to 1995. In the 1980 to 1995 period, estimates show significant declines in Colorado and the Intermountain Grasslands and Columbia Plateau physiographic regions, and possible declines in California, New Mexico, and Wyoming. Sample sizes are too low for reliable estimates for Arizona, Washington, and Idaho. Centers of abundance are well-distributed throughout the Great Plains, Great Basin, Colorado Plateau, and western California. Widespread declines make us concerned about this species.

Conservation - In semidesert habitats of Arizona, Bock et al. (1984) found that moderate grazing can have a positive effect on populations depending on the overall habitat condition. Elsewhere, quantitative information on the lark sparrow's sensitivity to management activities is lacking. The lark sparrow would benefit from good perennial grass cover to conceal its nest. Reducing or eliminating pesticide spraying and grasshopper control may increase its prey base.

SHRUBLAND AND GRASSLAND SPECIES

Swainson's Hawk (*Buteo swainsoni*)

Breeding Habitat - The Swainson's hawk is found in sagebrush shrublands, prairies, and cultivated land (e.g., hay, alfalfa, and grain fields) with scattered trees. Open sagebrush/bunchgrass, juniper/sagebrush/bunchgrass, aspen/grassland, and aspen/sagebrush/bunchgrass communities are important as breeding and feeding habitat in the northern Great Basin (Maser et al. 1984). Tall trees (riparian, juniper, aspen, and shelterbelts) next to open fields are used for nest and roost sites. However, the increase in perch sites in most shrublands (telephone poles, fence posts, and trees) favors the red-tailed hawk over the Swainson's hawk (Houston and Bechard 1983). Nesting density varies from 0.1 to 1.6 nests per 10 km^2 (0.3 to 4 per mi^2) throughout their range.

Nest - The Swainson's hawk constructs its nest of large twigs in isolated trees or in riparian zones adjacent to open country. The nest is often in a deciduous tree, sometimes in a conifer or shrub. In the Great Basin, nests are often in juniper and not necessarily associated with riparian zones. In a treeless area, the nest may be placed on a cliff ledge or on the ground.

Wintering - During migration, Swainson's hawks will roost in large fields. Highly migratory, the species mostly winters from south of the United States to South America. Swainson's hawks from throughout North America winter in concentrations of hundreds to thousands in the Pampas of Argentina, where they forage on locust and grasshopper outbreaks and roost in woodlands and shelterbelts.

Feeding - Swainson's hawks feed in low vegetation in openings of low sagebrush, other shrubs, woodlands, and wet meadows (Maser et al. 1984). Bechard (1982) found that they used cultivated fields after and during harvesting, taking advantage of reduced plant cover. Locusts, grasshoppers, and crickets are favorite prey, but the Swainson's hawk also takes small mammals (rabbits, prairie dogs, ground squirrels, mice, voles), birds, amphibians, snakes, and beetles. Early observers reported the Swainson's hawk feeding heavily on grasshoppers, and also taking other insects and small vertebrates (see May 1935). Woodbridge (pers. comm.) suggests the species evolved to follow outbreaks of locusts and grasshoppers; however, eradication of North American locusts and widespread grasshopper control have shifted the hawk's diet to small mammals in many areas.

Status - According to historical accounts, the Swainson's hawk was once the most common hawk in suitable habitat. In the West, it has been in decline since the early part of the century and is now a rare breeder in the Great Basin (Ryser 1985; Harlow and Bloom 1989). A long-term decrease in productivity has also been documented in Saskatchewan (Houston 1993). Although BBS data show stable to increasing trends across the West from 1968 to 1995, and across the United States since 1980, these estimates seem to be driven by increases in Montana and Texas. BBS trends for many other areas are less certain due to small sample sizes. Populations in Colorado and Wyoming have declined steadily since 1968, and the central Great Plains show sharp declines since 1980. Relative abundances are low throughout the hawk's breeding range. Declines may be associated with loss of native bunchgrass prairies and perennial grasslands for breeding, foraging, and wintering habitat; widespread pesticide application on wintering grounds; and habitat changes that favor red-tailed hawks (Harlow and Bloom

1989). Organophosphate pesticide applications on wintering grounds have inadvertently killed thousands of roosting hawks in recent years (Woodbridge et al. 1995; England et al. 1997).

Conservation - This hawk is tolerant of agricultural lands interspersed with grasslands and sagebrush shrublands. Foraging habitat may be limiting, and the hawk should benefit from maintenance of native grass and forb habitats for rodent and insect prey. In sagebrush shrublands, provide foraging habitat by managing for native, perennial bunchgrasses in openings or intermixed with open sagebrush and preventing dominance by sagebrush or non-native annual grasses (Harlow and Bloom 1989). Maintain scattered trees and woodlands for nesting.

Ferruginous Hawk (*Buteo regalis*)

Breeding Habitat - The ferruginous hawk is found in flat or rolling landscapes in sagebrush shrublands and other arid shrublands, dry open prairie grasslands, and badlands of western North America. Its optimal habitat is extensive ungrazed or lightly grazed prairie or sagebrush shrublands with nesting sites that command a view (Gilmer and Stewart 1983).

Nest - The ferruginous hawk prefers to nest in a tree (deciduous or conifer, often juniper) or on rimrock or a cliff ledge with a view. It will also nest on an outcrop, shrub, hillside, haystack, or elevated ground. In Wyoming, nests were observed in junipers, but were most often found in sagebrush shrublands on spires and outcrops (S. Ritter unpub. data). In western Colorado, ferruginous hawks nest in lone or small clumps of junipers at the desert edge or on rock outcrops on hillsides (R. Lambeth, pers. comm.). This hawk builds a large nest of heavy sticks and debris and will reuse a nest site and nest from year to year. It will also use artificial nest platforms.

Wintering - This species winters from the southwestern United States to Baja California and central Mexico, although a few winter on the breeding grounds.

Feeding - Small mammals (chiefly ground squirrels and pocket gophers east of the Continental Divide, and jackrabbits or cottontails west of the Divide) are the mainstay of this hawk's diet (Bechard and Schmutz 1995). It will also feed on songbirds, ducks, grouse, snakes, lizards, and large insects. The ferruginous hawk's breeding density and productivity apparently track the abundance of its major prey (Bechard and Schmutz 1995).

Status - Ferruginous hawk populations suffered large declines in this century due to severe persecution, loss of native prairie habitats, and reduced prey availability, including elimination of prairie dog towns and ground squirrel colonies (Harlow and Bloom 1989). Breeding Bird Survey data show overall stable to increasing population trends across the West since 1968 and especially since 1980. However these estimates are driven by apparent increases in Montana and Colorado, and estimates for other states are less certain due to small sample sizes. The species remains rare throughout its range, and relative abundances on BBS routes are low.

Conservation - Breeding productivity apparently varies with prey availability, and especially with jackrabbit abundance in the Great Basin. Maintaining habitats for prey base, especially rodents (e.g., prairie dogs) and lagomorphs, and protection of elevated nest sites (trees and rock outcrops) should benefit the ferruginous hawk. Nest abandonment has been linked to mining developments (Bechard and Schmutz 1995). For recommendations on protecting ferruginous hawk nest sites from disturbance, see White and Thurow (1985) and Olendorff (1993). Recreational facilities such as trails should be routed away from and screened from view of known nest sites.

Prairie Falcon (*Falco mexicanus*)

Breeding Habitat - Most associated with prairie grasslands and sagebrush shrublands, the prairie falcon can be found in many open habitats from prairies and arid valleys to dry alpine tundra. Availability of cliff nest sites and a prey base of small mammals and birds are important factors. The highest known nesting density in North America is in southwest Idaho, where average home range size is 49 to 73 km^2 (20 to 29 mi^2).

Nest - The prairie falcon nests in a shallow scrape on protected ledges of cliffs and outcrops. Nest sites are usually in crevices or cavities beneath protective overhangs on sheer cliffs. Most eyries face south or east and overlook open habitats. This falcon will re-use old nest sites as well as find new sites within a territory. It will also use man-made holes on otherwise unsuitable cliffs.

Wintering - The species mostly winters from southern Canada to Baja California and northern Mexico, often at lower elevations than during breeding season. In fall and winter, prairie falcons wander and may congregate locally, possibly following the occurrence of horned larks, a principle prey species.

Feeding - This falcon preys on small birds (especially horned larks, western meadowlarks, and mourning doves) and small mammals, including ground squirrels

and rabbits. Reptiles and insects make up a small portion of its diet. It will flush prey by flying low over the ground, will stoop on flying birds from above, or hunt from a tall perch.

Status - BBS data are slim because the prairie falcon is not well sampled by the survey. Overall, BBS data show a significant decline across the West since 1968; the declining trend has been somewhat less steep since 1980. Sample sizes are too small for reliable state or physiographic region trend estimates and the falcon's abundance across the West is low. A 1987 assessment of status based on state wildlife agency listings and Audubon Christmas Bird Counts indicated that prairie falcon populations were stable (Platt and Enderson 1989). Although widespread, the prairie falcon is of concern primarily due to a high concern ranking in Idaho, where the species reaches its greatest recorded breeding density.

Conservation - In Montana, Leedy (1972) found that eggshell thinning from organochloride pesticide poisoning was associated with expanding alfalfa production. In Idaho, the species showed a negative response to moderate grazing in big sagebrush/bluebunch wheatgrass (Reynolds and Trost 1981). Prairie falcons should benefit from protection of cliff nest sites and maintaining habitat for grassland and sagebrush shrubland birds and small mammals. Activities on the cliff tops above eyries are much more disturbing to nesting falcons than below the eyries at cliff bottoms (R. Lambeth pers. comm.). For drilling and construction activities, a buffer zone of 1 km (0.6 mi) around active nest sites is recommended to avoid nest abandonment (Suter and Jones 1981).

Columbian Sharp-tailed Grouse (*Tympanuchus phasianellus columbianus*)

Breeding Habitat - Columbian sharp-tailed grouse are associated with prairie grasslands and sagebrush-grasslands. In Idaho, Saab and Marks (1992) found that sharp-tails selected big sage habitat types during summer. They use areas dominated by perennial bunchgrasses like bluebunch wheatgrass or Idaho fescue (having a high percentage of leaves to stems) and where the shrub layer, if present, is dominated by big sagebrush and/or antelope bitterbrush (Ulliman et al. 1998). They use grasslands having few shrubs to sagebrush/grass areas having shrub cover up to 40%. The common denominator appears to be the amount of cover provided by the vegetation, whether herbaceous, shrub, or a combination. Brood sites are similar to nest sites, but they are usually close to broad-leaved brush patches or shrubby riparian zones. Sharp-tails will also nest and raise broods in cultivated fields (e.g., irrigated pasture, alfalfa hay, grain stubble, dryland seedings; Ulliman et al. 1998). They need habitat with moderate vegetative cover, high plant diversity, and high structural diversity. They are predominately associated with flat to rolling terrain during the breeding season. A self-sustaining population of sharp-tailed grouse needs thousands of hectares (acres).

Males display on leks, usually in open areas such as a small knoll, bench, or ridge top. Their mating displays, or dancing, occur from March through June, peaking in April. Leks contain as few as two males to as many as 30 or more, but average about 12 males (Ulliman et al. 1998). The females come to the lek to mate, then return to the surrounding grassland or shrubland to nest. Most nest and brood locations are within 2 km (1.2 mi) of the lek where the hen mated (Ulliman et al. 1998).

Nest - Sharp-tailed grouse nest on the ground in shallow depressions lined with grass, leaves, and other vegetative materials. They nest in sites with an overhead canopy of vegetation, provided either by grasses or shrubs.

Wintering - Tall, broad-leaved mountain shrub and riparian cover types are critical components of winter habitat for sharp-tailed grouse (Saab and Marks 1992). They often move to higher elevations to get into moister sites that support greater amounts of these types of shrubs (Ulliman et al. 1998). However, in mild winters, they often stay in the open grasslands and shrubland communities that they used for nesting and brood-rearing. Suitable winter sites need to be no more than 6.4 km (4 mi) from leks to be useful to sharp-tails (Ulliman et al. 1998). They form mixed-sex winter flocks of 10 to 35 birds, occasionally up to 100.

Feeding - Sharp-tailed grouse feed on leaves, buds, flowers, seeds, and fruit. The young in their first two to three weeks eat mostly insects. In the winter, they eat the buds of broad-leaved trees and shrubs. In Idaho, the fruits of hawthorn and snowberry are favored, as are the buds of chokecherry and serviceberry (Ulliman et al. 1998). Alfalfa, wheat, and barley fields can provide important food resources, but they must be located near permanent cover that provides nesting, brood-rearing, and winter habitat (Ulliman et al. 1998).

Status - The subspecies Columbian sharp-tailed grouse has undergone a significant rangewide decline; it currently occupies less than 10% of its former range (Ulliman et al. 1998). Historically, Columbian sharp-tailed grouse ranged in suitable habitats from British Columbia south through eastern Washington and Oregon; Idaho; western Montana, Wyoming, and Colorado; and northern Utah, Nevada, and California (Fig. 1 in Ulliman et al. 1998). Many remaining populations are small and widely separated from other populations. Idaho has the best remaining populations, with 75% of the remaining birds; the subspecies has been extirpated from Oregon, California, and Nevada and is nearly gone in Montana (Ulliman et al. 1998). The conversion of native grassland and shrub/

grass communities to unsuitable land uses has been primarily responsible for the reduction in Columbian sharp-tailed grouse populations (Ulliman et al. 1998). Much of the remaining historical habitat that has not been converted to other uses has been degraded by fire (too much in some areas, not enough in other areas), invasion of non-native annual vegetation, and excessive grazing by livestock (Ulliman et al. 1998).

Conservation - The federal Conservation Reserve Program (CRP) has restored many thousands of hectares of nesting and brood-rearing habitat for Columbian sharp-tailed grouse and has resulted in a large increase in the abundance of this species in Idaho (Ulliman et al. 1998). The CRP, however, sets aside lands for only 10-15 years, with option for an extension, so these lands are likely to either be placed back into crop production or used for livestock grazing in the future. Maintaining or restoring grasslands and sagebrush-grasslands to good to excellent ecological condition (i.e., late seral condition) will benefit sharp-tailed grouse. Retaining a residual cover of perennial grasses and forbs of at least 20 cm (8 in) in nesting habitat will provide sufficient nesting cover. Grazing of key winter shrubs should be no more than 35% use (Ulliman et al. 1998). Sharp-tailed grouse require thousands of hectares (acres) to support a self-sustaining population; large blocks of agriculture are not conducive to sharp-tail occupancy (Ulliman et al. 1998).

Protection of dancing grounds or leks from disturbance during the mating season is important for successful reproduction. Ulliman et al. (1998) recommend no developments within 365 m (400 yd) of a lek and avoiding physical, mechanical, and loud noise disturbances within 800 m (0.5 mi) of a lek during the breeding season (March through June) from one hour before sunrise to three hours after sunrise.

Loggerhead Shrike (*Lanius ludovicianus*)

Breeding Habitat - The loggerhead shrike is found in open country wherever there is low vegetation for foraging and scattered shrubs and trees for nesting and roosting, often around ecotones between open cover types. Hunting perches are an important component of the habitat. The loggerhead shrike occurs in sagebrush shrublands, arid scrub, prairies, mountain meadows, desert shrublands, juniper and pinyon-juniper, mountain mahogany, riparian areas, and shelterbelts (Yosef 1996). In the northern Great Basin, greasewood/grass, tall sagebrush/bunchgrass, mountain mahogany/shrub, juniper/sagebrush/bunchgrass, and riparian communities are primary habitats (Maser et al. 1984). Wiens and Rotenberry (1981) found loggerhead shrikes uncommon in sagebrush shrublands and associated with areas of broken topography.

Nest - The loggerhead shrike builds an open cup nest in a shrub or tree with dense foliage for protective cover, often preferring thorny vegetation, and sometimes in a brush pile or vine tangle. It sometimes uses the same nest, and often the same shrub or tree, from past years (Yosef 1996). In a study in southwestern Idaho, nests were constructed deep within shrubs 1 to 2 m tall (3 to 6 ft) and were found in sagebrush (65%), antelope bitterbrush (20%), and greasewood (12%). The study found that nests in this sagebrush shrubland were invariably placed low to the ground, averaging 79 cm (31 in; range 33 to 160 cm, 13 to 63 in) regardless of shrub height, and the authors suggest this may be representative of nest heights in arid western shrublands (Woods and Cade 1996).

Wintering - Northern populations retreat from the breeding grounds, and the species winters throughout the southern tier of North America, including the Great Basin and Colorado Plateau, California, the Southwestern states, and south through Mexico (Yosef 1996).

Feeding - The shrike hunts where vegetation is scattered and bare ground is exposed, hunting from perches within 2 m (6 ft) of the ground. It feeds chiefly on insects (beetles and grasshoppers) but also small birds, small mammals (ground squirrels, mice, and voles), and lizards (Yosef 1996). Shrikes adjust their diet to the availability of prey, taking more vertebrates in winter, migratory birds during spring migration, rodents in mid-summer, and grasshoppers once the larger instars become abundant. Shrikes prefer to forage where substrate vegetation is low (1 to 25 cm; 0.4 to 9 in) and hunt on patchy, open ground or swoop on prey in shrubs. Young, inexperienced shrikes prefer to hunt on bare ground where their success in capturing prey is higher (Leu 1995).

Status - Once abundant, the loggerhead shrike has declined sharply since the mid-20th century in much of the East and Midwest. Shrikes were often shot in the past, but sharp declines coincide with the use of organochloride pesticides (e.g., DDE and dieldrin) from the 1940s through the 1970s. BBS data show nearly universal declines across the continent, and populations in the West have declined significantly since 1968. Data show significant declines in the Great Basin, Columbia Basin, and Colorado Plateau from 1968 to 1995. Western centers of abundance are in the Southwest and California. Declines are thought to be linked to pesticide contamination, habitat loss, and winter survival problems, but are not well understood.

Conservation - Agricultural conversion of sagebrush shrublands and prairies, urbanization, strip-mining, and hedgerow destruction have reduced suitable habitat. In the Canadian prairies, steep declines in shrike numbers coincided with grasshopper control using dieldrin, and declines may be connected more to reduction in prey base than to direct effects of chemicals on reproduction, but the full effects of pesticide contamina-

tion are not known (Yosef 1996). In a Nevada study, loggerhead shrikes responded positively to grazing in shadscale and low sage habitats (Page et al. 1978). They showed no response to grazing in big sage/bluebunch wheatgrass in Idaho (Reynolds and Trost 1980) or in shadscale in Utah (Medin 1986). The shrike would benefit from elimination of pesticides and maintenance of a diverse vegetative structure. Long-term heavy grazing may ultimately reduce prey habitat and degrade the vegetation structure for nesting and roosting. Light to moderate grazing may provide open foraging habitat.

GRASSLAND SPECIES

Long-billed Curlew (*Numenius americanus*)

Breeding Habitat - Although a shorebird, the long-billed curlew is not associated with water during the breeding season. It breeds in shortgrass uplands, grazed mixed-grass prairie, meadows, arid scrub prairies, and short, open sagebrush. For nesting, curlews prefer open areas with a wide view. They will nest in recently-grazed areas of short vegetation, desert, dry prairies, sagebrush shrublands, grasslands, and moist meadows.

Nest - The curlew nests in an open scrape on the ground, usually on a well-drained site with gravelly soils, in a grassy hollow, or on a small slope. It often places the nest near a rock, manure pile, or other object, and lines the scrape with grass, weeds, and bits of cow chips. An Idaho study in grazed cheatgrass found that curlews preferred to nest in areas with short vegetation (10 to 20 cm; 4 to 8 in) and wide visibility, and required a 300- to 500-m (327 to 5445 yd) buffer zone around a territory that is unoccupied by other curlews. Territories averaged 14 ha (35 ac; Bicak et al. 1982). In Wyoming, nests in sagebrush shrublands were in areas where the sagebrush was short (<0.3 m or 1 ft) and open (S. Ritter unpub. data). In Utah, nests were in vegetation from 4.5 to 6 cm tall (1.8 to 2.5 in) in small clumps of live and dead vegetation near patches of barren ground (Paton and Dalton 1994). Nest predators include magpies, gulls, raptors, and many medium-sized mammals. The precocial chicks feed themselves from hatching, and remain in dry grasslands until they are able to fly, feeding on items picked from the ground.

Wintering - Long-billed curlews use beaches and mudflats during migration. They migrate to coastal and grassland habitats in California, Mexico, and Central America, and winter in flocks on tidal flats, inland grassland, and agricultural fields.

Feeding - Adults pick items from the soil or probe into wet sand and mud, feeding on insects (grasshoppers, beetles, caterpillars, larvae) and other invertebrates, especially worms, crustaceans, mollusks, small amphibians, and the eggs and nestlings of small birds. The long-billed curlew will also consume berries before fall migration.

Status - Long-billed curlew populations were decimated by uncontrolled hunting in the 19th and early 20th centuries. Protected populations in the arctic recovered, but pesticide poisoning and widespread agricultural conversion of grassland habitats in the central and western states have not permitted the same population recovery. The species is not well sampled on the BBS, so sample sizes are small, but trend estimates show a long-term significant decline across the continent, particularly in the western Great Plains. West of the Rockies, the species was stable to increasing over the 1968 to 1995 survey period, with a significant increase in the Columbia Basin. Because curlews can be inconspicuous during breeding, relative abundances along survey routes are low. Centers of abundance are in western Montana and the Snake River Plain, the Columbia Basin, western Utah and eastern Nevada, the Staked Plains of New Mexico and Texas, and High Plains of Colorado and Wyoming.

Conservation - Long-billed curlews generally respond positively to grazing prior to the onset of nesting to create short-grass habitat (Ryder 1980; Bicak et al. 1982; Medin and Clary 1990). A study in the northern plains, however, showed no response to heavy or moderate grazing in mixed-grass habitats (Kantrud and Kologiski 1982), and Reynolds and Trost (1981) found a negative response to moderate grazing in big sage/bluebunch wheatgrass. During the breeding season, nests and nestlings are vulnerable to livestock trampling. Curlews may respond positively to burning that creates openings of short grass (A. Bammann pers. comm.). The species should benefit from wetland protection, protection from trampling during nesting, and maintenance of open areas of short to mixed-grass uplands. In Washington, curlews nested on Conservation Reserve Program lands that had been in the program for 5 years (M. Denny pers. comm.).

Burrowing Owl (*Athene cunicularia)*

Breeding Habitat - The burrowing owl is found in open, treeless country, including dry prairies, grasslands, meadows, open sagebrush shrublands, and agricultural lands, but not in mountain meadows. Where free from direct harassment, it will also use outlying areas of airports, golf courses, road rights-of-way, and vacant lots. The presence of abandoned small mammal burrows in grazed, level grasslands for nest and roost sites is of primary importance (Haug et al. 1993), and this owl is frequently associated with prairie dog and ground squirrel colonies.

Nest - The burrowing owl nests in abandoned burrows of small mammals, especially prairie dogs, ground squirrels, marmots, and badgers. Burrowing owls in the West do not excavate their own burrows although owls in Florida have been known to do so. The owls prefer areas with a high density of burrows that may provide escape for young owls, and often nest in loose colonies. Owls maintain burrows throughout the nesting season and will return to the same burrow the following year. Badgers are a major nest predator. Other predators are domestic cats and dogs, opossums, weasels, and skunks (Haug et al. 1993). Burrowing owls will also use human-made structures such as culverts, overflow pipes, and artificial nest burrows.

Wintering - The burrowing owl migrates from the northernmost areas of its breeding range in the Great Plains and Great Basin to winter in the Southwest, Mexico, and Central America.

Feeding - Active both night and day, the burrowing owl hunts mostly at dawn, dusk, and at night. It is an opportunistic predator and feeds on insects, small mammals (kangaroo rats and voles), small birds, and other small vertebrates. It hunts from a perch, from low flight, or by stalking prey on the ground, and forages in short grass, including mowed or grazed pastures.

Status - Prairie dog and ground squirrel control efforts and agricultural conversion reduced the prey base and nesting habitat for the burrowing owl in many parts of its range. The species is listed as endangered in Minnesota and Iowa and threatened in Canada, and is of concern throughout much of the West. Populations in Canada are in sharp decline (Haug et al. 1993). Populations are down by more than 50% in California, Nevada, Colorado, and New Mexico and have also declined in Idaho, Montana, and Arizona (DeSante and George 1994). The BBS does not adequately sample burrowing owls for state-level trend estimates. Estimates for the West as a whole show a significant increase from 1968 to 1995, with a steeper increase since 1980, probably driven by an apparent increase in California in recent years. The overall estimate for the Rocky Mountain and Great Plains states shows a decline since 1968, but a more stable trend since 1980. Trends in the Southwest show a steep and significant decline since 1980.

Conservation - Protection of burrowing mammal populations is of primary importance to maintaining the burrowing owl's nest habitat. Agricultural conversion of grasslands and pastures and the control of small mammal populations eliminate the owl's breeding habitat. Predators, pesticides, shooting, and vehicle collisions also take a heavy toll on the birds. A summary of grazing studies shows mixed responses to grazing in sagebrush and grassland habitats (Saab et al. 1995). Owls will use well-grazed, early successional grasslands that emulate prairie dog towns (MacCracken et al. 1985). Burrowing owls will benefit from management that maintains zones free of herbicides and pesticides within a 600-m (655-yd) radius of burrows and that provides uncultivated plots of dense grasses and forbs within owl home ranges to support rodent and insect prey (Rich 1986; Haug and Oliphant 1990).

Short-eared Owl (*Asio flammeus*)

Breeding Habitat - Widely distributed across North America, the short-eared owl uses prairies, grasslands, meadows, marshes, and open sagebrush shrublands. It nests most often in grassland, but also in stubble fields, hay fields, and Conservation Reserve Program fields. It is strongly associated with ungrazed and undisturbed native grasslands and wetlands that support dense small mammal populations (Duebbert and Lokemoen 1977; Kantrud and Higgins 1992). This owl roosts singly or communally on the ground, in a low shrub, or in a conifer.

Nest - The short-eared owl nests in a depression on the ground in concealing cover, typically on a dry site such as a slight ridge, knoll, or mound. In Montana, of 28 recorded nests, 85% were surrounded by grasses and 90% were in vegetation less than 0.5 m (1.6 ft) high (Holt and Leasure 1993).

Wintering - Northern populations are migratory, wintering from southern Canada to southern Baja, and south through Mexico. Short-eared owls use grain stubble-fields, hay meadows, and pastures and will roost in dense conifers to escape heavy snow cover. Roosts within the northern breeding range are often communal.

Feeding - This owl hunts day or night, though in winter usually at dawn and dusk, and probably in synchrony with prey activity. Voles are the owl's primary prey throughout North America, but it will also take other rodents, grassland birds (killdeer, western meadowlark, and horned lark), and large insects. It seeks out areas with

high rodent densities, causing local irruptions in short-eared owl numbers during the breeding season, migration, and winter.

Status - Wetland destruction, grassland conversion, and overgrazing of grasslands and shrubsteppe are believed to have caused significant declines across the West. Agricultural harvesting destroys nests laid in croplands. Populations have declined by more than 50% in California and New Mexico (DeSante and George 1994). Because the short-eared owl is an irruptive and nomadic bird, the BBS population trend data are scarce. The 30-year trend estimate for the West as a whole shows a steep decline, chiefly in the period from 1968 to 1979. There is also a significant overall decline survey-wide, but sample sizes are too low for accurate trend estimates for states and physiographic regions. Relative abundances are low throughout the species' range.

Conservation - Highly dependent on vole populations, the short-eared owl irrupts locally when vole densities are high. In general, it responds negatively to moderate and heavy grazing in mixed grass and big sagebrush habitats (Saab et al. 1995). Maintaining large, continuous grasslands and wetlands with dense vegetation to support a prey base, and grasses 0.5 m (1.6 ft) high or less, provides breeding and foraging habitat. Short-eared owls benefit from habitat management for waterfowl, particularly nest cover protection, and the burning and management of grasslands for nesting and prey habitat (Holt and Leasure 1993).

Vesper Sparrow (*Pooecetes gramineus*)

Breeding Habitat - A bird of short grasslands, the vesper sparrow breeds throughout North America. In the Great Basin, it is found in sagebrush-grass habitats of higher valleys and mountains, where shrubs are low and scattered and grass-cover is thin. It also occurs in mountain meadows, pinyon-juniper, prairie edges, abandoned fields, Conservation Reserve Program fields, and shelterbelt margins—wherever there is sparse grassland with song perches. In Montana, the vesper sparrow is associated with sagebrush, grassland, and agricultural habitats (Hutto 1995). It can be found in the early seral stages of woodlands (Hejl and Woods 1991) or in pinyon-juniper openings with small, dense shrubs (Sedgwick 1987). Populations will increase after prescribed burns in ponderosa pine and pine-grassland savannah (Bock and Bock 1983). Male vesper sparrows frequently use sagebrush and juniper as song perches (Castrale 1983).

Nest - This sparrow builds an open cup nest on the ground, well-hidden in an excavated depression at the base of vegetation. It is a common host to cowbirds.

Wintering - The vesper sparrow winters in the southern United States, from California, central Nevada and Arizona, south through Baja and into central Mexico. It uses grassy or weedy pastures and fields, prairies, old burns, brushy borders of fields, desert scrub, and woodland openings.

Feeding - The vesper sparrow forages on the ground, and both insects and the seeds of grasses and forbs are important in its diet. A study in western North Dakota found that grasshoppers composed 67% of its diet, yet its nest success was not affected where grasshoppers were experimentally reduced, as nesting birds compensated by foraging farther from the nest. In this study, predation of nestlings played a large role in nest failure (Adams et al. 1994).

Status - In the 19th century, the vesper sparrow expanded its range in the Northeast following the clearing of forests for agriculture, then decreased again in this century as farmlands disappeared. A Montana study found vesper sparrows and Brewer's sparrows to be the two most abundant species in a sagebrush-steppe study site (Feist 1968). Although Brewer's sparrows are common in grassland habitats, the BBS trend estimates for 1968 to 1995 show long-term declines in the West and survey-wide. Declines are significant in the Basin and Range, Dissected Rockies, and Columbia Plateau physiographic regions, particularly since 1980. Washington, California, and Colorado are the only western states that show stable to increasing trends, and in Arizona and Nevada sample sizes are too low for statewide estimates. DeSante and George (1994) list Washington and Oregon as states where vesper sparrow populations have notably declined. Centers of abundance in the West are scattered throughout the Columbia Basin, northern and eastern Great Basin, Snake River Plain, Colorado Plateau, and western Great Plains. The species' association with native grasslands and its widespread population declines make it a species of management concern.

Conservation - In an overview of several studies, the vesper sparrow shows inconsistent responses to grazing in several grassland types; a negative response to heavy grazing in sagebrush/grasslands; and a positive response to heavy grazing in greasewood/wild rye and shadscale/Indian ricegrass habitats (Saab et al. 1995). In the sagebrush shrublands, it benefits from maintenance of open habitats with scattered shrubs and good bunchgrass cover for nest concealment. Widespread use of pesticides and grasshopper control may be detrimental to the vesper sparrow's prey base.

Gray Flycatcher (*Empidonax wrightii*)

Breeding Habitat - Restricted to the arid west, the gray flycatcher is a common breeding migrant of the Great Basin, principally associated with juniper woodlands (Ryser 1985). In the Great Basin's western reaches, the species nests in mature big sagebrush where the sagebrush is luxuriant and reaches small tree size. Arid open woodlands (such as juniper, pinyon-juniper, and oak-pine), aspen, tall sagebrush/bunchgrass, and mountain mahogany communities are important breeding and feeding habitat. Riparian woodlands are also important for feeding (Maser et al. 1984).

Nest - The gray flycatcher constructs a cup nest in a juniper or other low tree or sagebrush, usually within 1 to 4 m (3 to 12 ft) of the ground. Ryser (1985) notes that it may place its nest in or under the same tree as a Swainson's hawk nest in a passive nesting association, taking advantage of the hawk's defense of its own nest site from snakes, crows, and ravens.

Wintering - Arid scrub, riparian woodlands, and mesquite are important to the gray flycatcher during migration. The species winters from the Southwestern United States to southern Baja and central Mexico in desert sagebrush shrublands, savannahs, and gallery forests (Rappole et al. 1983).

Feeding - An insectivore, the gray flycatcher feeds on beetles, grasshoppers, moths, and other small insects. It "fly-catches" close to the ground, sallying out from perches on tops of shrubs and trees. It also catches and gleans insects from the ground and low plants.

Status - The BBS data show a significant positive trend in the West overall from 1968 to 1995, particularly since 1980. The species is poorly sampled by the BBS, however, and sample sizes are too low for accurate state or physiographic region trend estimates, although relative abundances are high on survey routes reporting gray flycatchers. Centers of abundance are in eastern Oregon, the Snake River Plain, and Columbia Basin. The species' association with old-growth juniper and mature big sagebrush stands, plus trend uncertainties for local populations, make the gray flycatcher a species of management concern.

Conservation - A summary of grazing studies indicates mixed responses to grazing in sagebrush habitats—a positive response in shadscale/Indian ricegrass and Nevada bluegrass/sedge, but a negative response in big sagebrush/bluebunch wheatgrass (Saab et al. 1995). The gray flycatcher will probably benefit from maintenance of tall, mature big sagebrush/bunchgrass communities and of mature juniper and pinyon-juniper stands as primary nesting and feeding habitats. Reducing or eliminating pesticides may increase its prey base.

APPENDIX II.
SCIENTIFIC NAMES OF OTHER SPECIES

The major woody sagebrush taxa (genus *Artemisia*) found in the sagebrush-shrubland region and other plant and animal species mentioned in the main text (*Artemisia* taxa after Kartesz 1994; some subspecies not represented).

Scientific Name	English Name
LOW SAGEBRUSHES	
Artemisia arbuscula	low sagebrush
ssp. longiloba	alkali sagebrush
A. bigelovii	Bigelow sagebrush
A. cana	silver sagebrush
A. frigida	fringed sage
A. nova	black sagebrush
A. pygmaea	pygmy sagebrush
A. rigida	stiff sagebrush
A. spinescens	budsage
TALL SAGEBRUSHES	
A. filifolia	sand sagebrush
A. rothrockii	Rothrock sagewort
A. tridentata	big sagebrush
ssp. *tridentata*	basin big sagebrush
ssp. *wyomingensis*	Wyoming big sagebrush
ssp. *vaseyana*	mountain big sagebrush
ssp. *xericencis*	xeric sagebrush
ssp. *spiciformis*	subalpine big sagebrush
A. tripartita	threetip sagebrush
OTHER SHRUBS	
Chrysothamnus spp.	rabbitbrush
Purshia tridentata	antelope bitterbrush, antelope brush
Sarcobatus vermiculatus	greasewood
Atriplex confertifolia	shadscale
Ephedra viridis	Mormon tea
Eurotia lanata	winter fat
Grayia spinosa (*Atriplex spinosa*)	spiny hopsage
Amelanchier spp.	serviceberry
Cercocarpus ledifolius	curlleaf mountain-mahogany
Prunus spp.	wild cherry, chokecherry
Symphoricarpos spp.	snowberry
Tetradymia spinosa	cottonthorn, horsebrush
Crataegus spp.	hawthorn
GRASSES	
Pseudoroegneria spicata (*Agropyron spicatum*)	bluebunch wheatgrass
Agropyron cristatum	crested wheatgrass
Pascopyrum smithii (*Agropyron smithii*)	western wheatgrass
Bromus tectorum	cheatgrass
Festuca idahoensis	Idaho fescue
Oryzopsis hymenoides	Indian ricegrass
Poa secunda (*Poa sandbergii*)	Sandberg's bluegrass
GRASSES *continued*	
Elymus elymoides (*Sitanion hystrix*)	bottlebrush squirreltail
Stipa thurberiana	Thurber needlegrass
S. comata	needle-and-thread
Nassella viridula (*Stipa viridula*)	green needlegrass
Taeniatherum caput-medusae ssp. *asperum*	Medusahead (wildrye)
FORBS	
Achillea millefolium	common yarrow
Agoseris spp.	mountain-dandelion
Astragalus spp.	milk-vetch
Balsamorhiza sagittata	balsamroot
Crepis alnifolia	hawksbeard
Eriogonum spp.	fleabane or buckwheat
Gutierrezia sarothrae	snakeweed
Lactuca serriola	prickly lettuce
Melilotus spp.	sweet-clover
Phlox spp.	phlox
Taraxacum officinale	common dandelion
Tragopogon dubius	yellow salsify
Trifolium spp.	clover
BIRDS	
Molothrus ater	brown-headed cowbird
See also Appendix I.	
MAMMALS	
Bison bison	bison
Antilocapra americana	pronghorn
Odocoileus hemionus	mule deer
Cervus elaphus	elk
Sylvilagus idahoensis	pygmy rabbit
S. audubonii	desert cottontail
S. nuttallii	Nuttall's cottontail
Lepus californicus	black-tailed jackrabbit
L. townsendii	white-tailed jackrabbit
Lagurus curtatus	sagebrush vole
Cynomys ludovicianus	blacktail prairie dog
C. gunnisoni	whitetail prairie dog
Ammospermophilus leucurus	white-tailed antelope ground squirrel
Spermophilus lateralis	golden-mantled ground squirrel
Taxidea taxus	badger
REPTILES	
Sceloporus graciosus	sagebrush lizard

Western Working Group of Partners in Flight

is part of an international coalition called Partners in Flight. This coalition includes government agencies, conservation groups, academic institutions, private businesses, and other citizens who share a common vision: to keep bird populations and their habitats healthy. These individuals and groups are dedicated to voluntary actions that will help preserve the magnificent diversity of birds throughout the Western Hemisphere.