SPECIES ASSESSMENT FOR SAGE THRASHER (*OREOSCOPTES MONTANUS*) IN WYOMING

prepared by

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Summary

The sage thrasher (*Oreoscoptes montanus*), a sagebrush-steppe obligate that relies on large expanses of sagebrush-steppe for successful breeding, is recognized by Canada and several U.S. state agencies as a sensitive species that is apparently at risk based on loss or alteration of breeding habitat and decreasing population trends. In this context, habitat alteration refers to modification of any component of the required habitat mosaic, (e.g., presence and quality of tall big sagebrush (*Artemesia* spp.), adequate cover, and increased vertical and horizontal heterogeneity) that might directly decrease suitability for nesting habitat.

Primary threats to *O. montanus* habitat are agricultural field cultivation, domestic grazing, invasion of exotic plant species, change in fire frequency, fragmentation from oil and gas development, and increased recreational use.

To maintain populations of sage thrasher, it is important to protect and maintain extensive, intact shrubsteppe habitats and rehabilitate sagebrush habitats that have been lost, fragmented, or degraded. In addition, it is essential to understand the impacts of habitat alteration on local and range wide *O. montanus* populations. More specific issues of conservation concern are discussed later in this assessment. Fulfilling the information needs listed at the end of this document will clarify population status and contribute to refining these conservation goals.

Introduction

This assessment addresses the biology, ecology, and conservation status of the sage thrasher (*Oreoscoptes montanus*) throughout its current range, with particular attention given to that portion occurring within and near Wyoming. Our goal is to provide a summary of published information and expert interpretation of this information that can be used by the Bureau of Land Management (BLM) to develop management plans. *O. montanus* was selected for assessment

because it occurs on the Wyoming BLM sensitive species list as a result of only being associated with one habitat (big sagebrush steppe) and the concern for degradation of this breeding habitat in Wyoming.

Relatively little demographics are known about most *O. montanus* populations and very few specifics of this species and its habitat are available for Wyoming. Therefore, this assessment attempts to summarize information documented throughout its North American range, and provide an objective and informed overview in order to relate this information to *O. montanus* in Wyoming. Primary literature was the main source used, supplemented by various agency reports.

As with all pieces of literature synthesized from disparate data, this assessment has some limitations. Since most data presented comes from specific studies with restricted research areas, interpolation and extrapolation of this data must be done with caution. It seems that aspects of *O. montanus* biology, ecology, and conservation may vary over the geographic extent of its range, with most studies focusing on its breeding range. Therefore, the information in this assessment should not be taken as definitive of *O. montanus* in any particular area. Rather, it should be used as a guide to the range of biological parameters and behaviors possible for *O. montanus*, which can then help direct specific investigation to clarify the status of local populations in Wyoming as a prelude to major management action.

Natural History

Morphological Description

Sage thrashers (Figure 1) are a medium sized (39.6-50.3 g; 20-23 cm) passerine (similar in shape with a robin [*Turdus migratorius*], but smaller) with a relatively short, straight bill (11.1-13.3 mm) and short tail (84-95 mm). Males are slightly larger than females, but are otherwise alike in terms of plumage (Pyle et al. 1987; Cannings 1995; Reynolds et al. 1999). General adult

plumage is characterized by a drab, brownish-gray back, with slightly darker feather centers, which form indistinct streaking, especially on crown, and well-defined dark brown-and-white streaking on the breast (Lukas 1999; Reynolds et al. 1999). A dim, whitish supercilium, a pale line behind ear coverts, and a whitish malar region bordered by black streaks at the throat create a pattern on the head that accents the lemon-yellow to amber-colored eyes. The bill is black with a gray lower mandible that is a dull, pale yellow to pink on the basal half. The wings are slightly darker brown than the back, and have two narrow white wings bars which are especially evident in the fall. The tail feathers are darker yet. Distinguishable characteristics of the tail include: white patches in the corners (outer retrices), with off-white underparts that are boldly streaked with dark brown spots; and, undertail-coverts that are buff-colored and unmarked. Adult plumage is similar throughout most of the year, with the exceptions of late summer and the fall. In late summer, the generally well-defined streaking on the breast and white bars on the wings are greatly dulled when plumage is worn. When plumage is fresh in the fall after a prebasic molt following the breeding cycle, the evident streaking on the breast and white wing bars return and the flanks appear more cinnamon in color. Juvenile plumage is similar to adults, but generally has paler, less-evident streaking on underparts (Pyle et al. 1987; Cassidy et al. 1990; Udvardy and Farrand 1998; Reynolds et al. 1999; Ehlphick et al. 2001). Eggs are subelliptical, bluish to bluish-green, with large, reddish-to-brown, well-defined spots (figure 1c; Reynolds et al. 1999; Elphick et al. 2001).

Oreoscoptes montanus can be distinguished from other thrashers by the length of the "culmen" (11.0-13.5mm), or distance between the anterior end of the nostril and the tip of the bill, and the wing formula (see Figure 2; Pyle et al. 1987). Also, *O. montanus* can be distinguished from other similar species, (e.g., Bendire's thrasher [*Toxostoma bendirei*] and the gray thrasher [*Toxostoma cinereum*]) by a combination of color, plumage pattern, bill curvature, and size. For example, Bendire's thrasher is darker than *O. montanus*, appearing brown above and buffy below (versus

gray above and white below), and the gray thrasher is larger, with a distinctly curved, longer bill (versus straight, short bill; Reynolds et al. 1999).

Sage thrashers can also be distinguished from other thrashers by its song and courtship behavior (see Breeding Behavior). Typically singing peaks at the onset of the breeding season, is mainly done by males (Elphick et al. 2001). Its song consists of a continuous, soft warble of mellow, rolling or churring whistles with a changeable tempo and very little pitch change (Figure 3). It is often delivered at a lower volume than other members of the Mimidae family from perches on top of big sagebrush (*Artemisia tridentata* spp.; see Figure 1b), in higher perches of juniper (*Juniperus* spp.), from the ground when it is very windy, and during display flights (Udvardy and Farrand 1998; Reynolds et al. 1999; Sibley 2000). *Oreoscoptes montanus* can be distinguished from the more common brown thrasher (*Toxostoma rufum*) whose song contains broken-up phrases (Udvardy and Farrand 1998), and from Bendire's thrasher whose song is less clear and more husky (Sibley 2000). Other familiar calls of *O. montanus* include a "sweet, high wheeurr" and a low "chup" call (Reynolds et al. 1999; Sibley 2000).

If disturbed, sage thrashers will often run with tails cocked up rather than fly (Stephens 1985; Reynolds et al. 1999).

Taxonomy and Distribution

Oreoscoptes montanus is a member of the Mimidae family, or the "mimic thrushes", in the order Passeriformes, (Sibley 2000; Elphick et al. 2001). There are currently no recognized subspecies of *O. montanus*, although northern populations have longer tails than populations in the southern range, indicating some morphological differences between populations (Reynolds et al. 1999). The sage thrasher is the only species in the *Oreoscoptes* genus (Sibley 2000), and analyses

of hybridization indicate that they are more closely related to mockingbirds than to "true" thrashers (Sibley and Ahlquist 1984).

Oreoscoptes montanus is a migrating species that occurs throughout western North America in suitable shrubsteppe habitat (Figure 4). Its summer breeding range incorporates isolated areas in Canada (south-central British Columbia, extreme southwest Saskatchewan, and extreme southeast Alberta) and large portions of most western States (Washington and Oregon east of the Cascades, central Idaho, southern Montana, southeastern California, Nevada, northern Arizona and New Mexico, western Oklahoma, western and southern Colorado, Utah, and Wyoming). *O. montanus* winters primarily in the southwestern U.S. (southern California, southern Nevada, central and southern Arizona, central and southern New Mexico, and the western half of Texas) and Mexico (Baja California Norte, Baja California Sur, and central interior portions of Mexico; Udvardy and Farrand 1998; Reynolds et al. 1999). There have been reports of *O. montanus* in Minnesota (Mattsson 1985; Shively 1986; Hoffman and Hoffman 1987; Coin 1988), Iowa (Moore 1986), Delaware (Wilson 1986), Manitoba (Horn and Christie 1985), and several other states (see Sibley 2000), but these are not consistent. There are no records for this species outside the Americas.

Sage thrashers breed in the summertime throughout Wyoming in sagebrush steppe habitats, but they typically winter outside Wyoming. Current and historical records indicate that sage thrashers were/are present in all counties in Wyoming (Figure 5; Knight 1902; McCreary 1937; Oakleaf et al. 1982; Dorn and Dorn 1990). During the summer, *O. montanus* can be commonly found at Hutton Lake Refuge (Albany County), the valley bottom south of Fossil Butte (Lincoln County), below Fontenelle Dam (Lincoln County), the north side of Pathfinder Reservoir (Natrona County), and 10-15 miles north of Saratoga (Dorn and Dorn 1990).

Habitat Requirements

General

Indicative of their common name, sage thrashers are considered a sagebrush obligate species (Braun et al. 1976; Dobler et al. 1996). They occupy shrubsteppe habitats dominated by sagebrush (*Artemesia* spp.), arid to semi-arid shrubs and grasslands, and pinyon-juniper (*Pinus* - *Juniperus*) woodlands (Braun et al. 1976; Medin 1990; Smith et al. 1997; Reynolds et al. 1999). Research suggests that they do best in less disturbed communities that approach climax conditions (Vander Haegen et al. 2000); however, whether *O. montanus* are adversely affected by habitat fragmentation seems to be unresolved (Knick and Rotenberry 1995; Vander Haegen et al. 2002; Nicholoff 2003). *Oreoscoptes montanus* may only use sagebrush-steppe habitat that is flat or on gently rolling hills (e.g., not on steep slopes; Siegel and DeSante 1999). The physiognomy of the habitat seems to be an important selection factor (see Landscape Context below).

Breeding

Breeding occurs in sagebrush steppe habitats, typically dominated by big sagebrush (Artemesia tridentata), between 1,300m – 2,000m in elevation (Figure 6a; Bent 1948; Reynolds and Rich 1978; Wiens and Rotenberry 1981). Nest sites most commonly occur deep within or under big sagebrush (three subspecies: A. t. tridentata, A. t. wyomingensis, A. t. vaseyana; Petersen and Best 1991; Reynolds et al. 1999) and three-tip sagebrush (A. tripartita; Reynolds et al. 1999), and occasionally are found in low sagebrush (A. nova; see Reynolds et al. 1999), black greasewood (Gilman 1907), rabbitbrush (Chrysothamnus spp.), bitterbrush (see Reynolds et al. 1999), horsebrush (Tetradymia canescens; Linsdale 1938), and juniper (Juniperus osteosperma; Castrale 1982). Bushes selected for nest-sites are usually: 1) taller than 0.70m (Rich 1980a; Petersen and Best 1991), 2) contain 75-100% living foliage, 3) have branches and foliage within 0.3m of the ground, and 4) have a slightly greater percent coverage of sagebrush, rabbitbrush,

forbs, grasses, and litter within 5m of nest sites than surrounding areas (Petersen and Best 1991). Petersen and Best (1991) reported that shrubs of this size (0.70m) comprised only 7% of available shrubs, suggesting that O. montanus select for healthy, mature sagebrush. This study also showed that sage thrashers nesting in southeastern Idaho were in denser stands of sagebrush (although not significant) resulting in less bare ground than the surrounding area. This microhabitat is typical of other reported studies (Reynolds and Rich 1978; Rich 1978, 1980a; Reynolds 1981; Rotenberry and Wiens 1989), and presumably makes the nests less conspicuous and less accessible to predators.

Nonbreeding

Non-breeding habitat includes habitat used during spring and fall migration and habitat used during winter months. The few populations that inhabit areas suitable for year-round use (i.e., do not completely migrate), probably use habitat similar to that described above in "breeding" habitat; however, few studies have focused on these populations.

Oreoscoptes montanus do not appear to be as selective for habitat used during fall and spring migrations. They have been documented using sagebrush plains, arid shrub, grassland with scattered bushes, and open pinyon-juniper woodland, primarily in arid or semi-arid regions. *Oreoscoptes montanus* are rarely observed using habitat around towns (AOU 1983; Reynolds et al. 1999).

In their winter range (southwestern U.S. and Mexico), sage thrashers use a variety of habitats, including arid and semi-arid scrub, brush, and thicket habitats (AOU 1983; NatureServe 2004). Information on habitat used during the winter months is lacking.

Foraging

Oreoscoptes montanus require relatively open understory for foraging. Foraging sites are typically located close to nest-sites during breeding months (Petersen and Best 1991; Reynolds et al. 1999), but because nest sites are usually in microhabitats with a dense understory they are not synonymous. This suggests that a fine-scale habitat mosaic may be needed to support productive nests (see Area Requirements and Landscape Context, below). During late summer and fall, *O. montanus* forage often in berry and fruit farmlands adjacent to sagebrush habitats (Bent 1948; Reynolds et al. 1999).

Area Requirements

Oreoscoptes montanus typically occupy territories where all their needs are met for mating, nesting, feeding, and cover, ranging in size from 0.39ha – 1.86ha. For example, mean territory sizes from studies in Idaho reported in 1976, an average of 0.96ha ± 0.12 ha (range 0.64ha – 1.64ha, n = 7; Reynolds and Rich 1978) and 1.14ha ± 0.36ha (n = 11; Reynolds 1981), and in 1977, an average of 1.86ha ± 0.38ha (n = 8; Reynolds 1981). Differences in territory size between the two years is speculated to be a result of widespread drought (1977), the presence of a known predator (loggerhead shrike) in 1977, and/or localized and normal annual population fluctuations for the species (Reynolds 1981). To persist, nesting populations require patches of sagebrush steppe of at least 100 ha (Casey 2000; Nicholoff 2003).

Densities of *O. montanus* fluctuate depending on habitat quality and availability, but are usually well under one individual per hectare, even in good habitat. For example, sage thrasher densities recorded from surveys in Washington (Stephens 1985; Dobler et al. 1996) and Nevada (Medin 1992) range from 0.12 – 0.725 individuals/ha. In the Great Basin, Wiens and Rotenberry (1981) documented densities ranging between 0.01 – 0.31 individuals/ha throughout the various

shrubsteppe habitats. In Idaho, Rich (1980a) reported a nest density of about 1 nest/1.25 ha, and Reynolds and Rich (1978) reported distances between nests of 64m to 84m. In two successive years (1976 and 1977), Reynolds (1981) reported densities of 0.88 and 0.54 individuals/ha, respectively.

Landscape Context

Size and spatial distribution of sagebrush appears to be an important variable in selecting habitat, providing critical resources within proximity of each other, such as food, nest-sites, and cover from predators, weather, and sunlight (Rotenberry and Weins 1980; Petersen and Best 1991; Knick and Rotenberry 1995). Sage thrasher populations are found to be positively correlated with specific landscape characteristics, such as structure (e.g., presence of "robust" woody plants like big sagebrush), increasing horizontal and vertical heterogeneity, and high horizontal patchiness. *Oreoscoptes montanus* populations seem to be negatively correlated with grass cover and spiny shrubs (e.g., hopsage and budsage; Rotenberry and Wiens 1980; Wiens and Rotenberry 1981; Dobler et al. 1996). Occurrence of *O. montanus* is greater in shrubsteppe located on loamy and shallow soils than on sandy soils (Vander Haegen et al. 2000), and in continuous patches of similar habitat at least 100ha in size (Knick and Rotenberry 1995).

Movement and Activity Patterns

Dispersal

No information on the distance of natal dispersal (i.e., movement of an individual from the area where it was hatched to an area where it will attempt to breed; Elphick et al. 2001) is available. However, it is known that nestlings fledge (disperse) approximately 8 – 14 days after hatching (Killpack 1970; Reynolds 1981; Howe 1992; Reynolds et al. 1999). Two reports from Reynolds et al. (1999) indicate that breeding dispersal (i.e., the movement of adults between

different breeding locations; Elphick et al. 2001) was 20m and 55m from the first nest to site of the second nest. Reynolds (1981) reported a first nesting occurring between 4 – 22 May, and a second nesting between 12 June and 14 July. Therefore, breeding dispersal may occur from the end of May through early June. It is unknown if individuals return to the same nest sites or if the young return to their natal sites to breed (see Habitat Specificity and Fidelity).

Migration

Generally in birds, seasonal activity is coordinated by photosynthetic cues from the environment that are received by light receptors in the brain. For example, lengthening daylight in the spring triggers a series of hormone changes that results in production of testosterone in the males and estrogen in the females. These changes in hormone levels not only orchestrate the timing of reproductive activities, but migration, as well. Then again in late summer when daylight hours begin to shorten, birds enter a photorefactory period (when their hormonal systems cease to respond) that causes hormone production to wane-off, which then triggers preparation for migration (see Foraging Variation above; Elphick et al. 2001). Since migration is dependent on daylight hours, timing of migration (complete migration – see below) is then also dependent on geographical location (i.e., latitude). As a result, approximate dates of spring and fall migration within *O. montanus* populations vary dependent on breeding and wintering range (see Table 1), and even then, may be unpredictable in terms of timing and distance. However, *O. montanus* typically arrive early in the season their breeding grounds and also depart early relative to other sagebrush species (Lukas 1999; Reynolds et al. 1999).

Sage thrasher migration occurs during the day and usually only constitutes short distances (Reynolds et al. 1999). Migration of northern breeding populations is complete, in that they travel entirely from breeding grounds to more insect-productive wintering grounds, generally in the high

deserts of the southwestern United States and adjacent areas in northern Mexico. On the other hand, populations that inhabit the southern range of *O. montanus* during breeding months can be considered facultative migrants, either traveling varying distances to concentrate in areas of abundant foraging resources (e.g., berries) if available, or remaining at summer breeding grounds (Reynolds et al. 1999; Elphick et al. 2001).

Daily Activity

Little data has been reported concerning the daily activity of *O. montanus;* however, activities most likely include such events as foraging, preening feathers, and singing. Activity will vary somewhat during breeding and nonbreeding seasons (e.g., singing, nest-building, brooding, etc.). *Oreoscoptes montanus* are often depicted as "shy" birds, preferring to run and forage on the ground or fly low and direct between dense shrubs (Lukas 1999). If disturbed or frightened, *O. montanus* will run with its tail up (Reynolds et al. 1999). Sage thrashers will routinely begin singing 45 minutes before sunrise, and some will sing all night, particularly under a full moon. During mating season, males typically sing throughout the day, perched on top of big sagebrush or juniper. Singing is limited or ceased once eggs are laid (Lukas 1999; Reynolds et al. 1999). Both adults (male and female) are responsible for feeding the nestlings, and do so with approximately equal frequency. Foraging occurs most often on the ground within close proximity of the nest. The adults generally will not fly to-and-from the nest (rather run on the ground), so as not to attract predators. Adults also practice impeccable nest sanitation and will either eat the fecal sac or carry the sacs away from the nest (Gooding 1970 in Reynolds et al. 1999).

Reproduction and Survivorship

Breeding Behavior

Visually conspicuous wing displays and flight patterns are often associated with courtship among bird species (Elphick et al. 2001). *Oreoscoptes montanus* has distinctive courtship behaviors that are displayed by males during the early and middle stages of the breeding season (Rich 1980b), and presumably cease upon nest-building and egg-laying. The courtship display typically begins with a male vocalizing and flying in undulating circles or sinuous zig-zags low over sagebrush (most likely its territory). The heights of these circles fluctuate from 8m above the ground to below the tops of sagebrush. The undulating flight is then followed by a bilateral wing display upon perching. The bilateral wing display consists of the male raising one or both wings and fluttering them for several seconds while continuing to sing (Rich 1980b; Reynolds et al. 1999). These displays may end in a male landing next to a non-displaying female and copulating without vocalizing (Gooding 1970 in Reynolds et al. 1999). It is also thought that these same displays may be used secondarily for territory establishment and maintenance (Rich 1980b; Reynolds et al. 1999).

Sage thrashers are socially monogamous, with a male and female partnering for the duration of one breeding cycle (no information is available that suggests mated pairs remain together for life). In addition, it is possible that *O. montanus* pairs are also genetically monogamous, in which the male and female together are the sole genetic parents of all the young, since no extra-pair copulations have been documented or reported (Reynolds et al. 1999; Elphick et al. 2001). Both sexes share the responsibility of nest-building, as well as incubating the eggs and feeding the young (Reynolds and Rich 1978; Reynolds 1981).

Nest-Building

Nest-building begins one to two weeks after arriving at breeding grounds (Gooding 1970 in Reynolds et al. 1999). Both sexes participate in building a bulky, large nest approximately 0.20m in diameter and 0.10m deep (Rich 1980a; Rich and Rothstein 1985), with an average inside top diameter of 0.11m, and average nest cup depth of 0.05m for first nests (Rich 1978), and 0.08m for second nests (Killpack 1970; Rich 1978). Nests are constructed from dry twigs of sagebrush and greasewood, and are lined with grasses, rootlets, sage bark, horse hair, goat hair, sheep's wool, and/or rabbit fur (Gilman 1907; Reynolds et al. 1999). It has been documented that *O. montanus* may also construct "shading platforms" above nests for protection from the mid-day sun, when shade obtained from the sagebrush canopy is not adequate to maintain suitable microclimate within the nest. These have been reported to be built in a distinct arch formation from dry twigs (Gilman 1907; Rich 1985).

Placement of nests is critical to the survival of most birds (Rich 1985; Petersen and Best 1991), and facilitates reduction of predation risk and regulation of microclimate (Petersen and Best 1991). For example, *O. montanus* build nests within or under sagebrush shrubs in relatively dense microhabitats. This placement, along with the materials used to build the nest, make the nests less conspicuous and less accessible to predators (Rotenberry and Wiens 1989). In addition, nest placement and structure protects eggs/fledglings from direct sunlight and regulates temperature within the nest. For example, Rich (1978) reported that during May (possibly the first brood/nest), nests were built on the ground beneath sagebrush and close to the trunk. These nests averaged a height of 0.03m from bottom of the nest to the ground, benefiting from the warmer temperature at ground level, and utilizing the sagebrush cover to reduce heat loss to the night sky. From June through July (possibly the second brood/nest) when average daily temperatures are higher, nests were placed off the ground (~0.23m) in main branches of sagebrush (supporting the weight of the

large nest), and were constructed with deeper nest cups (0.08m vs. 0.05m – see above). The location off the ground allowed for air circulation around the nest to aid with convective heat loss, and the deeper cups helped protect the eggs/fledglings from direct exposure to the sun. Whether nests are placed on the ground or within the sagebrush, there is no significant difference between heights of the sagebrush above the nests (e.g., sagebrush height above all nests are 0.66m ± 0.16m). Therefore, *O. montanus* must select sagebrush for the amount of cover it offers from the top down (Reynolds and Rich 1978). Petersen and Best (1991) determined that most sage thrasher nests were placed with an easterly aspect, providing exposure to solar heating in the morning and protection from heating in the afternoon.

Breeding Phenology

Increasing periods of daylight in the spring stimulates photo-sensitive brain receptors in birds to initiate a series of hormonal changes, which result in the production of testosterone in males and estrogen and other hormones in females. These hormonal changes coordinate migration and reproductive activities (Elphick et al. 2001). Males arrive at breeding grounds about a week or more prior to females to establish and defend territories through undulating flight and song. Pair formation and subsequent copulation begins approximately one week after the females arrive (March-April in Central Rocky Mountains), and then both male and female *O. montanus* begin nest building (usually within 1-2 weeks of arrival at the breeding location). Eggs are generally laid one per day, or sometimes two per day (Reynolds et al. 1999). Incubation begins on the day before the last egg is laid (Killpack 1970) by both the male and female (Bent 1948; Gooding 1970 in Reynolds et al. 1999; Howe et al. 1996). The incubation period varies depending on location: 13-17 days in southeast Idaho (Reynolds 1981), 11-14 days in southern Idaho, and 11-13 days in Oregon (Reynolds et al. 1999). After incubation, altricial young (8.5% of adult weight; Killpack 1970) emerge from shells either on the same day or as long as over a three-day period in the same

clutch. Adults carry the shells out of the nest and dispose of them (Reynolds et al. 1999). Brooding ranges from 11 to 13 days, and during this time, both parents will feed and brood young. Fledging, or growth of "flight" feathers, begins on the fourth or fifth day. Fledglings depart the nest at 87 percent of adult weight (Killpack 1970), 11-14 days after hatching (Reynolds 1981). Adults generally lay one brood annually, but may raise a second brood after fledglings leave the nest (Bent 1948; Reynolds and Rich 1978; Ehrlich et al. 1988; Howe et al. 2000; Elphick et al. 2001). Dates for mating, egg-laying, and brooding vary depending on geographical location and climate (e.g., mid-April through early August; see Reynolds et al. 1999).

Fecundity and Survivorship

Oreoscoptes montanus will begin breeding as second-year birds (first year after hatching; Reynolds et al. 1999). The clutch sizes for *O. montanus* vary significantly from year-to-year as a result of fluctuations in annual precipitation (Rotenberry and Wiens 1989). Typically, sage thrashers will have four to five eggs per clutch, with a possible range of one to seven eggs (Gilman 1907; Reynolds and Rich 1978; Reynolds et al. 1999). The first clutches tend to be slightly larger than second clutches ($\bar{x}$ = 3.8 and 3.2 respectively, n = 21; Reynolds and Rich 1978). Reynolds and Rich (1978) reported a nesting success (number of nests producing ≥ 1 fledgling) of 68% in Idaho. The mean number of young per successful nest was 2.6. There is no data available on the lifespan or survivorship for sage thrashers. However, it can be speculated that because nests are conspicuous, predation on eggs and especially nestlings may limit productivity (Reynolds et al. 1999). Reynolds (1981) reported a significantly greater loss of nestlings than eggs, but reason of the losses was not mentioned.

Population Demographics

Limiting Factors

The main limiting factor that influences population growth and range expansion for sage thrashers is the availability of suitable sagebrush-steppe habitat. Sagebrush-steppe habitats are altered by conversion for agriculture or ranching activities, gas and oil extraction, urban growth, and increased recreation. See Extrinsic Threats for more detail.

Metapopulation Dynamics and Genetic Concerns

No studies have been conducted regarding metapopulation dynamics or genetic differentiation among *O. montanus.* This would be a good area for future research, since sagebrush-steppe ecosystems are becoming fragmented at alarming rates and possibly limiting potential nesting and breeding sites for *O. montanus*, as well as distribution and dispersal potential.

Food Habits

Diet

During the breeding season, *O. montanus* are primarily insectivorous (Wiens and Rotenberry 1979; Rotenberry 1980; Howe et al. 2000), with a small proportion of their diet consisting of plant materials, berries, and other small fruits when available (Knowlton and Harmston 1942; Reynolds et al. 1999). Sage thrashers have a strong preference for ground-dwelling insects such as ants (Formicidae; 35.9-61.5% of diet) and beetles (Coleoptera; 27.3-48.0% of diet) in Washington (Stephens 1985), and grasshoppers (Acridomorpha), crickets (Orthoptera), ants, and true bugs (Hemipterans) in Utah (Knowlton and Harmston 1942). The small amount of data available for nestling diets indicates that it is similar to that of the adults, with the exception of increased percentages of moth (Lepidoptera) larvae being fed to the nestlings (Reynolds et al. 1999; see

Howe et al. 2000). Winter food includes arthropods, fruits, mistletoe, and other berries (Rosenberg et al. 1991; Reynolds et al. 1999).

Foraging Strategy

Oreoscoptes montanus forage diurnally and almost exclusively on the ground; however, they occasionally forage within shrub canopy (Stephens 1985, 1994; Reynolds et al. 1999). It has been speculated that *O. montanus* get their common name (sage thrasher) from the "thrashing" behavior associated with "stirring-up" insects (Elphick et al. 2001). For example, La Rivers (1941) documented *O. montanus* "digging" crickets up from wasp burrows. Sage thrashers have been observed foraging alone (breeding season) and in groups, often after the breeding season (Bent 1948; Reynolds et al. 1999). *Oreoscoptes montanus* will gather in small flocks to feed in the open on berries, directly picking berries from the bush and/or breaking the skin and sipping the juice (Bent 1948; Elphick et al. 2001). It has been suggested that *O. montanus* are opportunistic foragers (see below; Stephens 1994; Reynolds et al. 1999).

Foraging Variation

Oreoscoptes montanus insectivorous diet is diverse and strongly correlated with prey availability (Stephens 1994; Reynolds et al. 1999). A study conducted in Idaho demonstrated that free-ranging *O. montanus* switched their diets to a more abundant food item (e.g., cicadas) when previously consumed insects (e.g., crickets) had been reduced through insecticide application (see Howe et al. 2000). This practice of "diet-switching" was also seen in Washington, with *O. montanus* consuming more abundant insects when availabilities shifted throughout the season (Stephens 1994). *Oreoscoptes montanus* will also include more berries and fruits in their diet when availability increases (Reynolds et al. 1999).

It can be assumed that prior to activities that require enormous amounts of energy (e.g., migration, territorial defense, breeding, nest building, and molting), *O. montanus* alter foraging habits (e.g., amount of time spent foraging, types of food consumed). For example, prior to migration, birds forage more often in order to accumulate about 15 to 25 percent of body fat (in comparison to body weight). In the Great Basin, *O. montanus* flock together to feed openly on fruiting shrubs in preparation for migration, after the young have dispersed (Lukas 1999). Also, activities involved with reproduction (e.g., display, territorial behavior, courtship, copulation, nest-building, egg development, incubation, and brooding) may increase a bird's day-time energy requirements by as much as 200 to 300 percent. Annual molt is also quite expensive metabolically, since it requires a lot of protein and minerals for feather synthesis, increasing energy demands by 10 to 15 percent in warm climates and as much as 25 percent in colder climates (Elphick et al. 2001).

Community Ecology

Knowlton and Harmston (1942) reported that *O. montanus* is a desirable resident of wheat and alfalfa fields because of its consumption of grasshoppers during outbreaks, and ants that are common range and field pests (e.g., harvester ant). Therefore, sage thrashers may represent major predators of undesirable insects and could play an important role in "pest" control.

Competitors and Predators

Resource limitation and competition usually play a major role in determining species coexistence and community structure (Diamond 1978; Wiens and Rotenberry 1979). However, within shrubsteppe habitats, competition may not play a large role in structuring the community. For example, food resources are abundant in shrubsteppe habitats (Wiens 1984), and therefore inter- or intra-species competition for these resources (e.g., arthropods) is rare (Rotenberry 1980; Howe et al. 2000). Even in years of low insect abundance or chemical reduction of specific

insects, competition would not significantly affect population stability or viability, because of the opportunistic (generalist) and flexible feeding habits of *O. montanus*, as well as other co-occurring, sagebrush obligate species (e.g., sage sparrow and Brewer's sparrow; see Rotenberry 1980, Reynolds et al. 1999, and Howe et al. 2000). One resource that may limit the size of a population is the availability of suitable nesting habitat (e.g., mature big sagebrush); however, this specific issue has not been researched for *O. montanus*. There have been reports of male *O. montanus* displacing Brewer's sparrows (*Spizella breweri*) and sage sparrows (*Amphispiza belli*) when establishing breeding territories in the spring, suggesting possible interspecific competition for nest-sites (Reynolds et al. 1999). If inter- or intraspecific competition does exist for nest-sites, it may become more apparent as increasing amounts of sagebrush steppe are converted to other habitats through agricultural practices, altered fire regimes, and introduction of invasive species (e.g., cheatgrass; see Extrinsic Threats). Other sagebrush obligates that would be competing for the same nest-sites could be Brewer's sparrow, sage sparrows, and greater sage-grouse (Nicholoff 2003).

Oreoscoptes montanus population stability can be vulnerable to mammalian predators (canids, mustelids, sciurids), snakes, and birds (laniids, corvids), which have been documented taking eggs and young from nests. Research on the reproductive biology of sage thrashers indicates that nestlings are targeted more often than eggs (Reynolds and Rich 1978, Rotenberry and Wiens 1989). Rotenberry and Wiens (1989) reported that the primary predator on nestlings were Townsend's ground squirrels (*Spermophilus townsendii*), however gopher snakes were responsible for taking all fledglings during a single predation event. Snakes may target nestlings more than eggs because of the increased activity by adults, activity within the nest by young, and scent of the young (Vander Haegen et al. 2002). This may be somewhat true with sage thrashers; however, adults practice incessant nest sanitation to reduce scent of the young (Bent 1948; Rich and

Rothstein 1985). Reynolds (1979) reported that loggerhead shrikes were observed taking one or two chicks per day from an *O. montanus* nest until all nestlings were gone, resulting in a significant impact on the nest success. Tracks of coyotes (*Canis latrans*) have been reported leaving damaged *O. montanus* nests, but no observations have been recorded (Killpack 1970). Vander Haegen et al. (2002) reported that ravens, magpies, chipmunks, and mice were responsible for most predatory events on artificial sage thrasher-like nests. Surprisingly, *O. montanus* were also reported visiting several of these artificial nests, and in a few instances, displaced the quail (*Coturinix coturinix*) eggs from the nests (only one showed signs of peck holes). The authors concluded that sage thrashers visited the nests more out of curiosity than predatory intentions.

Parasites and Disease

Blow fly larvae (*Protocalliphora braueri*) have been documented parasitizing sage thrasher nestlings (Howe 1991, 1992); however, this parasite did not have a significant affect on size or weight of nestlings, and may only affect nest success if combined with other factors (Howe 1992). For example, Howe (1992), along with Sabrosky et al. (1989 in Howe 1992), suggest that the larvae do not cause direct mortality of sage thrasher fledglings, but may weaken the young birds so much that other factors (e.g., cold, wet weather) cause death.

Nest parasitism by brown-headed cowbirds (*Molothrus ater*) does impact the reproductive success of some shrubsteppe bird species, such as Brewer's sparrow (*Spizella brewerii*), Sage sparrow (*Amphispiza belli*), and Vesper sparrow (*Pooecetes gramineus*), but does not successfully parasitize *O. montanus* nests (Rich and Rothstein 1985; Vander Haegen and Walker 1999), and therefore breeding success of *O. montanus* should not be affected. After observing 95 *O. montanus* nests in eastern Washington, Vander Haegen and Walker (1999) did not find any brown-headed cowbird eggs within the nests. Rich and Rothstein (1985) suggest that brown-

headed cowbirds may regularly parasitize *O. montanus* nests, however *O. montanus* ejected pseudo cowbird eggs placed within their nests almost every time, and in a timely fashion. They speculated that the size difference of the egg, and not the color, was motivation to eject the eggs. *Oreoscoptes montanus* may be responsible for the parasitism of other sagebrush-inhabiting bird nests (see Vander Haegen et al. 2002).

No known documentation of diseases affecting *O. montanus* has been found. However, with the recent (2003) discovery of West Nile virus lethally affecting sage grouse (*Centrocercus urophasianus*) (19 in Wyoming, 3 in Montana, and 5 in Alberta, Canada; Stone 2004), the possibility exists that West Nile could have a negative affect on sage thrasher populations.

Symbiotic and Mutualistic Interactions

There are no documented symbiotic or mutalistic interactions between *O. montanus* and other Avian or non-Avian species. *Oreoscoptes montanus* are often associated with Brewer's sparrow, sage sparrow, lark sparrow, western meadowlark, and black-throated sparrow (Neel 1999).

Conservation

Conservation Status

Federal Endangered Species Act

Oreoscoptes montanus is not currently listed or being considered for listing under the United States Endangered Species Act (ESA). In Canada, however, *O. montanus* has been listed as endangered under the Species at Risk Act of 2004 (SARA). This listing is based on a species assessment prepared by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), which proposed *O. montanus* receive an "endangered species" listing based on declining populations as a result of habitat loss. SARA provides measures to protect and recover a listed species (CWS 2004). The sage thrasher (including its eggs and nests) are protected in

Canada and the United States from hunting and collecting under the federal Migratory Birds Convention of 1994 (Canning 1995).

Bureau of Land Management

The State Offices of the Bureau of Land Management (BLM) in Idaho (Watch List), Montana, Nevada, Washington, and Wyoming list *O. montanus* on their sensitive species lists. According to the BLM Manual 6840, this designation is meant to provide protection of *O. montanus* and the habitat on which they depend. Therefore the BLM is responsible for reviewing programs and activities on BLM land to determine their potential effect on *O. montanus* (USDOI BLM Wyoming 2002; Keinath et al. 2003).

Forest Service

The range of *O. montanus* encompasses portions of 7 forest service regions, including the central part of The Northern Region (R1), the western half of The Rocky Mountain Region (R2), The Southwestern Region (R3), The Intermountain Region (R4), The Pacific Southwest Region (R5), eastern half of the Pacific Northwest Region (R6), and western part of the Southern Region (R8). Currently these regions do not include *O. montanus* on their sensitive species list.

State Wildlife Agencies

The Wyoming Game and Fish Department (WGFD) has developed a matrix of habitat and population variables to determine the conservation priority of all native, breeding bird and mammal species in the state. Seven classes of Native Species Status (NSS) are recognized, with NSS1 representing critically imperiled species and NSS7 representing stable or increasing species. Classes 1, 2, 3, and 4 are considered to be high priorities for conservation attention. The WGFD assigns *O. montanus* a special concern rank of NSS4. The NSS4 rank is based on WGFD estimates that *O. montanus* populations in Wyoming are declining and/or habitat is vulnerable but

no loss has occurred, and the species is not considered sensitive to human disturbance (Oakleaf et al. 2002; Keinath et al. 2003). Other state wildlife agencies also recognize *O. montanus* as a special management concern, including: Nebraska (Species of Concern), Nevada (Species of Concern), and Washington (State Candidate Species).

Natural Heritage Ranks

The Natural Heritage Network assigns range-wide and state-level ranks to species based on established evaluation criteria. *Oreoscoptes montanus* merits a global rank of G5, which means that rangewide it is deemed by Heritage scientists to be Apparently Secure. This is based on a synthesis of state ranks and biological evidence that suggests it is "widespread in western North America [with] well over 100 occurrences; abundance is apparently low; protected at a minimum of three locations; appears to be moderately threatened" (NatureServe 2004).

Eighteen western states and provinces have assigned a State Rank to *O. montanus*, and five have ranked it as S2 (imperiled) or S1 (critically imperiled). In general, state ranks are assigned based on the assessed risk of extinction within a state, where S1 species are deemed critically imperiled and S5 species are deemed demonstrably secure. These assessments are based on biological information on population status, natural history, and threats at the state level. Specific State Ranks are as follows: Arizona (S5), California (S5), Colorado (S5), Idaho (S5B), Kansas (SNA), Montana (S3B), Nebraska (S1), Nevada (S5B), New Mexico (S4B,S5N), Oregon (S4), South Dakota (S2B), Texas (S3N), Utah (S4,S5B), Washington (S3B), Wyoming (S3B), Alberta (S1B), British Columbia (S1B), and Saskatchewan (S1B). SB and SN designations refer to breeding and nonbreeding status population, respectively, and are generally used for species whose conservation concerns vary with season (e.g., migratory animals). "A" indicates that *O.*

montanus appears irregularly or infrequently in that particular state (e.g., accidental or a vagrant; NatureServe 2004; Keinath et al. 2003; WYNDD 2004).

The Wyoming Natural Diversity Database (WYNDD) gives *O. montanus* a contribution rank of medium. The medium rank indicates that the breeding population of *O. montanus* within Wyoming borders contributes to the rangewide persistence of this species, but is no more critical than populations in other states. Wyoming may offer more security to the *O. montanus* population relative to other areas in its "wide continental distribution" (Keinath et al. 2003; WYNDD 2004), because of the apparent stability of essential habitat.

Partners In Flight Priority List

Oreoscoptes montanus is considered a Partners In Flight "priority species" in several states, including Idaho (22), Montana (19), Utah (29), and Wyoming (19) (Casey 2000; Ritter 2000; Parrish et al. 2002; WY BLM 2002; Nicholoff 2003). This indicates a species of moderately high vulnerability, and with declining or uncertain population trend in the physiographic area or state for which there is relatively high responsibility.

Biological Conservation Issues

Abundance and Abundance Trends

Oreoscoptes montanus has a relatively large breeding range across the western portion of North America, and can be fairly abundant where suitable nesting habitat (e.g., dense patches of big sagebrush) is available (see Figure 7). For example, Wiens and Rotenberry (1981) observed *O. montanus* in 86% of the surveys conducted throughout the Great Basin, which offers large and increasing patches of dense, big sagebrush, especially in higher elevations (Mozingo 1987). In Wyoming, *O. montanus* appear to be fairly common throughout the state during the breeding season (Knight 1902; McCreary 1937; Oakleaf et al. 1982; Dorn and Dorn 1990). Faulkner and

Giroir (2002) reported a density of 3.1 (range: 1.9 – 5.1) per count station (n=358 counts) in Wyoming.

However, recent conversion of shrubsteppe habitat for agriculture and grazing has eliminated breeding areas and caused localized extinctions or population declines throughout the range of this species. For example, in Washington, over half of the native shrubsteppe communities have been converted to agricultural lands (Vander Haegen et al. 2000), which has possibly contributed to the significant decreasing trend of *O. montanus* in the Columbia Plateau (see Population Trend; Sauer et al. 2004). Also, in British Columbia, areas that once documented breeding pairs of *O. montanus* (~30 pairs in 1932) no longer report sage thrasher breeding pairs, most likely as a result of shrubsteppe conversion for agriculture and housing (Cannings 1995).

Even when sagebrush habitat is not wholly destroyed, populations of *O. montanus* may be declining where habitat becomes unsuitable for breeding, since local abundance is dependent on habitat characteristics coupled with survival, productivity, and dispersal (Reynolds et al. 1999; Knick et al. 2003). For example, Vander Haegen et al. (2002) recently determined that nest success of *O. montanus* decreased in more fragmented landscapes, possibly resulting from increased predation, decreased nesting habitat, and/or lack of suitable, continuous habitat. Reduction in nest success as a result of habitat alteration may be one reason a decline in sage thrasher abundance has been noted in regions with extensive habitat alteration and fragmentation (e.g., Washington, Oregon, Idaho; Cannings 1995; Reynolds et al. 1999; Sauer et al. 2004). In areas with less habitat modification, (e.g., Wyoming, Montana), evidence from breeding bird surveys suggests that *O. montanus* populations are relatively stable (Sauer et al. 2004).

Breeding bird surveys (BBS; Sauer et al. 2004) dating back to 1966 have been used to determine the trends in *O. montanus* populations. BBS from 1980 to 2003 showed an overall

significant change for *O. montanus* in U.S. breeding range of -1.4% per year, based on 301 survey routes. Significant declines were also detected during the same period for FWS Region 2 (Arizona, New Mexico, Oklahoma, Texas) of -7.3% per year (n=15), FWS Region 1 (Oregon, Washington, Idaho, Nevada, California) of -1.7% per year (n=113), intermountain grassland (primarily in northern Arizona, western Utah, and northern New Mexico) of -5.6% per year (n=34), Columbia Plateau (Washington, Oregon, and northern California) of -1.4% per year (n=57), and the following states: Nevada (-2.5%/year; n=20), New Mexico (-6.9%/year; n=9), and Utah (-3.9%/year; n=60). With the exception of the Columbia Plateau and Nevada, the areas in which declines were significant are near the edge of *O. montanus* breeding range (see Figure 6a), and mostly represent sub-optimal nesting habitat. The effects of various stresses (e.g., weather, habitat fragmentation, and predation) are often greater in marginal habitat than prime, core habitat and likely account for differences in local or regional population trends (Reynolds et al. 1999). Increases in annual change from 1980 – 2003 were detected in Colorado (+0.8%; n=28), Wyoming (+0.2%; n=70), the southern Rockies (+6.5%; n=14), Pitt-Klamath Plateau (+0.3%; n=11), and the Wyoming Basin (+0.4%; n=52). However, none of these increases were significant (Sauer et al. 2004). Nicholoff (2003) states that there does not appear to be a declining trend for *O. montanus* in Wyoming, as they have been detected on 83 BBS routes, with 57 of those routes being witnessed a minimum of three years.

Population Connectivity and Habitat Trends

Agricultural practices, mining, oil, gas, and coal bed methane development, urbanization, invasive plants, fire, and expansion of road networks have fragmented or completely eliminated sagebrush steppe from extensive areas (Braun et al. 1976; Petersen and Best 1987; Reynolds et al. 1999). It has been estimated that 50% - 60% of native sagebrush steppe has been completely converted to nonnative annual grasslands, or has an exotic annual grass component in the

understory (West 2000 in Knick et al. 2003). Consequently, these converted sites probably no longer support breeding populations of *O. montanus.* For example, within the Interior Columbia River Basin, sagebrush and bunchgrass cover types have experienced greater losses (30.5% decrease in area) than any other habitat type (Ritter 2000) and will probably continue to decline with the cumulative impacts of present land uses. This habitat conversion/loss could possibly be the reason a significant negative change in *O. montanus* abundance (-1.4%) has been noted through breeding bird surveys over the past 20+ years (Sauer et al. 2004). In addition, Cannings (1995) credits the conversion of sagebrush-steppe habitat to agricultural land in British Columbia to the reduction or elimination of breeding pairs now observed (30+ pairs versus <10 pairs). Noss et al. (1995), citing others, reported that 2 to 2.3 million ha of sagebrush-steppe in the western Snake River basin has been converted to exotic annual vegetation, primarily cheatgrass and medusahead. Hironaka et al. (1983) reported that more than 99% of the subspecies basin big sagebrush type in the Snake River Plain has been converted to agriculture. Noss et al. (1995) listed the subspecies basin big sagebrush type and ungrazed sagebrush steppe in the Intermountain West as critically endangered ecosystem types in the United States. The invasion of nonnative cheatgrass (*Bromus tectorum*) is most likely the greatest single threat to sagebrush-steppe habitats and the future of sage thrasher populations (see Invasive Species below; Reynolds et al. 1999). Sagebrush habitats in Wyoming are relatively intact compared to other states within *O. montanus* range (Budd 2003), but could experience more sagebrush-steppe conversion, fragmentation, or invasion of exotic species as more oil and gas projects are established in these habitats.

The extent to which populations of sage thrasher are becoming isolated due to this fragmentation is not clear, since mobility, site fidelity, and regional response is not known. These issues need to be addressed, especially since required breeding habitat (e.g., sagebrush-steppe) is becoming more fragmented.

Range Context

Throughout its range one major hurdle in conservation of *O. montanus* and its habitat, as well as other avian species, is land ownership. Sagebrush-steppe occurs on public and private lands, and therefore, so does *O. montanus*. In the western United States, 72% (52% BLM and less than 3% in national parks and wilderness areas) of sagebrush land is managed by federal and state agencies and 28% is privately owned (see Table 2; Knick et al. 2003). For management of *O. montanus*, this means that the majority of the sagebrush habitat is being managed for multiple-use (e.g., BLM) with a very small area (<3%) receiving permanent protection from conversion of land cover. Only 28% of the sagebrush lands are privately owned, and therefore, future of sagebrush ecosystems will be affected primarily by use of public lands and policies of the management agencies (Raphael et al. 2001 in Knick et al. 2003). In Wyoming federal, state, and tribal agencies manage approximately 62% of the sagebrush steppe habitat, and approximately 38% is privately owned (Merrill et al. 1996).

Extrinsic Threats

Oreoscoptes montanus require large, contiguous stands of tall big sagebrush interspersed with native bunchgrasses and forbs for the sustainability of populations (see Habitat). Studies have shown that the primary threat to sage thrasher populations is habitat loss, modification, and fragmentation due to invasion of nonnative plant species, agricultural practices, fire, urban and natural resource development, and increased recreational activity. Other events that could negatively affect *O. montanus* populations are natural, such as predation and weather conditions. The following section identifies and outlines possible extrinsic threats to *O. montanus* populations in Wyoming and throughout its range.

Invasive Species

The invasion of nonnative grasses and forbs is most likely the largest threat to sagebrush steppe habitats (Ritter 2000), and thus directly, the biggest threat facing *O. montanus* populations (e.g., reduction or destruction of vital breeding habitat). Invasive species can cause ecological problems by producing changes in ecosystem processes, such as altering natural fire regimes and native plant species succession (Brooks and Pyke 2000). Invasive species become established through such activities as excessive grazing (domestic and/or wild), increased fire frequency, and increased recreational vehicle use (Zouhar 2003). Common exotic plant species invading breeding sagebrush-steppe habitats are: cheatgrass (*Bromus tectorum*), yellow starthistle (*Centaurea solstitialis*), spotted knapweed (*C. biebersteinii*), tamarisk (*Tamarix ramosissima*), medusahead wildrye (*Taeniatherum caput-me-dusae*), and rush skeleton-weed (*Chondrilla juncea*; Knick et al. 2003).

The most threatening invasive annual grass species to sagebrush-steppe habitat is cheatgrass. In areas where cheatgrass has become established (especially Idaho, Nevada, and Oregon), changes in vegetative composition has occurred as a result of a change in fire regime and plant species succession. Cheatgrass provides a greater fuel load and horizontal continuity of finer fuels than are usually found in patchy sagebrush, and thus increases the fire regime and fire intensity within sagebrush-steppe habitats from 10 – 70 years to < 10 years. In addition, cheatgrass is a great post-fire competitor of native grass species (Zouhar 2003). Reestablishment of big sagebrush (only from seed) usually takes at least a decade, and therefore the increased fire regime associated with cheatgrass prevents successful reestablishment of sagebrush and converts it into annual grasslands (Knick and Rotenberry 1995; Howard 1999; Tirmenstein 1999; Johnson 2000). As a result, shrub cover is reduced and the patchy patterns formerly characteristic of sagebrush dominated landscapes, which are selected by *O. montanus* for breeding and nesting sites, are

eliminated (Telfer 2000). Cheatgrass occurs in more mesic and cooler sagebrush types (e.g., mountain big sagebrush), but does not dominate these ecosystems. As a result, Wyoming has not had as big a problem with cheatgrass invasion as surrounding states (Knight 1994; Zouhar 2003).

Agricultural Practices

Diversity in plant species, plant communities, and structure is important for maintaining healthy wildlife populations, and is a key factor for *O. montanus* nest-site selection (see Habitat). Influences of range management practices and livestock grazing can have negative and/or positive impacts on sage thrasher habitat depending on the plant community, timing, and duration.

Negative impacts of livestock grazing can be direct (removing and/or trampling vegetation) or indirect (changing the vegetative structure; Holechek et al. 1989; Zouhar 2003). For example, Anderson and Holte (1981) reported that on overgrazed sites in Wyoming and Idaho, cover of Wyoming big sagebrush and its associated bunchgrasses decreased. When grazing ceased, however, the coverage of these species increased significantly, possibly increasing *O. montanus* nest-sites, as well. On the other hand, livestock grazing can have positive effects by opening up dense stands of sagebrush to make them more compatible for *O. montanus* nest-sites and foraging (Holechek et al. 1989), increasing big sagebrush cover (Ellison 1960 in Knight 1994), and/or reducing the accumulations of cheatgrass and thus lessening the fire hazard on a site (Zouhar 2003). However, it must be noted that grazing does alter the vegetative structure of sagebrush shrublands and promotes the invasion of exotic species, such as cheatgrass (Zouhar 2003). Grazing is a large impact to sagebrush-steppe habitats, occurring on 96% of available sagebrush (Short 1986).

Several rangeland practices have been used to reduce sagebrush and promote better forage sites for livestock, such as reseeding with more palatable, nutrient-rich grasses. Crested

wheatgrass (*Agropyron cristatum*), a nonnative perennial bunchgrass, has been planted extensively in the West for livestock forage, often in areas previously dominated by big sagebrush. Extensive seedings of crested wheatgrass replace diverse native vegetation and create a monoculture of one species over huge areas. This monoculture is not beneficial to *O. montanus* populations which require a structurally and species diverse habitat for breeding (see Habitat; Reynolds and Trost 1981; Holechek et al. 1989). For example, Reynolds and Trost (1981) demonstrated a significant reduction in the number of sage thrasher nests after sagebrush-steppe was planted with crested wheatgrass. Other rangeland practices used to reduce sagebrush are: burning, chaining, diskng, plowing, and spraying with chemicals (e.g., teuthiron; Reynolds and Trost 1981; Knight 1994), and could result in the reduction or extirpation of local sage thrasher populations (see Castrale 1982). In Wyoming, where big sagebrush was removed by chemical means, it regained its pretreatment cover in 17 years on stands where grazing was not controlled (Johnson 1969).

Pesticides are also used in agricultural practices to reduce the number of insects that could negatively impact forage species. Use of pesticides can be particularly insidious to birds, because even small amounts can result in high concentration of pesticides in available prey (e.g., arthropods), and result in the bioaccumulation of the chemicals as they pass up through the food chain. The results of bioaccumulation can include eggshell thinning (which reduces hatching success), deformed hatchlings, disruption of reproductive hormones, and even the deaths of adult birds (Elphick et al. 2001). One of the most frequently used insecticides in the western U.S. is malathion, an organophosphate. Malathion primarily targets grasshoppers and mosquitoes, protecting crops and domestic livestock, and can have “moderate to slight acute oral toxicity” to avian species (Smith 1987 in Howe et al. 1996; Howe et al. 2000). During a short-term study in Idaho, malathion was applied to experimental shrubsteppe plots, resulting in a significant reduction of prey abundance. Direct mortality of adult *O. montanus* was not detected from

malathion application, and *O. montanus* nestling growth and survival was not severely affected from reduction of prey abundance (Howe et al. 1996, 2000). Negative effects may not have been detectable since *O. montanus* is an opportunistic feeder (Stephens 1994), exploiting other available food sources (Howe et al. 1996). Also, since shrubsteppe habitat is known to have "superabundant" food during *O. montanus* breeding seasons (Wiens 1984), applications of insecticides may affect *O. montanus* fledgling recruitment only in years of naturally reduced insect abundance (Howe et al. 1996).

Fire

Plant communities are composed of some species that are tolerant to fire and others that are not. Sagebrush steppe, which *O. montanus* use almost exclusively for breeding habitat, is significantly affected by fire. A fire may kill most of the big sagebrush, creating grasslands until big sagebrush can reestablish. Return of big sagebrush could take decades, because it is a mid- to late-seral stage species, and only reestablishes from seedbanks or seeds from adjacent areas (Knight 1994; Howard 1999; Tirmenstein 1999; Johnson 2000). Major disturbances such as fire can reduce community complexity and may have devastating effects on habitat structure essential for *O. montanus* (see Landscape Context). Also, rangeland management practices that have suppressed wildfires have contributed to a dense community of sagebrush that is unsuitable for *O. montanus* breeding sites, as well as increases the potential for extensive and intense wildfires.

Prior to human settlement, fire-return intervals were estimated to range between 20 and 100 years and was compatible to the time it took (more than 50 years) for big sagebrush to reestablish to a climax (e.g., tall, dense) community (Knight 1994; Howard 1999; Telfer 2000). In addition, the intermittent, horizontal landscape context of shrubsteppe ecosystems had great potential for remnant islands of sagebrush to be left intact (Knight 1994), providing structures required, and perhaps preferred, by *O. montanus* for nesting and foraging (Huff and Smith 2000; Vander

Haegen et al. 2000), as well as seed sources for reestablishment. This fire regime changed when humans became established in these arid regions, suppressing fires and reducing fuel load through livestock grazing. These practices allowed pinyon-juniper woodlands to encroach and establish in areas previously dominated by sagebrush (Brooks and Pyke 2000; Miller and Tausch 2000), increasing the susceptibility to high intensity crown fires, which in turn were followed by increased dominance of invasive plant species (e.g., cheatgrass – see above; Brooks and Pyke 2000). The invasive species have increased the biomass and continuity of fine fuels, allowing fire to spread across the landscape where it was previously restricted to isolated patches (Brooks and Pyke 2000), and has increased the fire regime to three to five years in some areas (see Whisenant 1990 in Brooks and Pyke 2000; Howard 1999; Johnson 2000). This quick return of fire can be devastating to shrubsteppe ecosystems dominated by big sagebrush, not allowing enough time for big sagebrush to reestablish (Vander Haegen et al. 2000; Howard 1999).

Prescribed burning has been used to eliminate dense stands of sagebrush and create better forage for livestock (Holecheck et al. 1989). If burns are conducted in the spring, it can also serve to reduce the amount of cheatgrass (Knight 1994). In the short term, prescribed burns can be negative by removing shrub canopy cover. However, there can be some positive long term effects of fire if the burn is relatively cool and openings in dense sagebrush stands are created, constructing the habitat mosaic preferred by *O. montanus*. Petersen and Best (1987) demonstrated that *O. montanus* are most likely not affected by prescribed burning practices (short term), as their populations remained stable on burned and unburned sites. However, Kerley and Anderson (1995) did not observe *O. montanus* on burned sites (short term).

Urban and Natural Resource Development

Road and powerlines associated with urbanization and natural resource development fragment sagebrush-steppe habitat (Knick et al. 2003). In addition, these structures promote the spread of

invasive plant species and easier access of potential nest predators (e.g., corvids and ravens; Vander Haegen et al. 2002; Knick et al. 2003; Ingelfinger and Anderson 2004). Sagebrush habitats are also altered at the operation sites of energy development and natural resource extraction. Natural resource development may be extremely detrimental to sage thrasher populations in Wyoming, since existing oil and gas wells are primarily located in sagebrush-dominated landscapes (see Figure 8; Knick et al. 2003). Whether fragmentation as a result of development or other practices negatively affect *O. montanus* populations is debatable (see Sensitivity to Disturbance and Natural Predation below). More site-specific research across *O. montanus* breeding range is needed.

Ingelfinger and Anderson (2004) showed that abundance of sagebrush obligate species (e.g., Brewer's sparrows and sage sparrows) decreased approximately 50% in close proximity (<100m vs. >100m) of road construction associated with natural gas extraction and field development. It is unknown if this same response would be seen with *O. montanus,* since the authors did not detect a significant difference between research sites. However, it must be noted that sage thrasher abundance was low (e.g., 5% and 4%, consecutively), most likely as a result of average sagebrush height within the study sites (0.28m – not tall enough for sagebrush nest-sites).

Recreation

Hunting and off-road vehicle use in sagebrush-steppe habitats can negatively impact nest-sites through direct or indirect disturbance, as well as serve as a vector (e.g., shoes or tires) for invasive plant introduction (Ritter 2000). One example of indirect disturbance is the destruction of biological soil crust (also known as cryptobiotic crust), which is an important component of sagebrush shrublands. The crust stabilizes soils from wind and water erosion, and contributes to soil productivity by enhancing nutrient levels. In addition, well-established crust communities help prevent the invasion of cheatgrass (see above), as well as reduce the spread of fire because

they do not provide much fuel (Knight 1994). Increased activities in sagebrush habitats can negatively affect the abundance of cryptobiotic crust, and in turn, negatively affect sage thrasher breeding habitat.

Stochastic Factors (e.g., weather events)

Abiotic factors such as weather, fire, and hydrology can influence population size and dynamics, either by directly impacting *O. montanus*, or indirectly by affecting the food supply or habitat availability.

Natural Predation

Predation is usually directed toward nestlings, and rarely eggs within the nest (Reynolds and Rich 1978; Rotenberry and Wiens 1989). This is mostly a consequence of the nests being more conspicuous when nestlings are present (e.g., increased noise levels and smell). Potential predators of sage thrasher nests are: gopher snakes (*Pituophis melanoleucus*), long-tailed weasels (*Mustela frenata*), common ravens (*Corvus corax*), loggerhead shrikes (*Lanius ludovicianus*), Townsend's ground squirrels (*Spermophilus townsendi*), and chipmunks (*Euamias* spp.; Rotenberry and Wiens 1989).

Rotenberry and Wiens (1989) reported that predation on sage thrasher nests adversely affected reproductive success and seemed to vary temporally. For example, in years with more precipitation, the proportion of nests that were depredated increased (see Rotenberry and Wiens 1989). Vander Haegen et al. (2002) also reported that predation rate by corvids on artificial nest sites (eggs only) increased in fragmented landscapes, perhaps attributing to the recent declines in some shrubsteppe birds as a result of lower nest success. This may be a result of corvids utilizing open agricultural fields more often, as they do in recently burned, seral sagebrush communities. In early- to mid-seral communities of Wyoming big sagebrush when sagebrush cover is minimal

(e.g., after fires), depredation by Townsend's ground squirrels and raptors could increase since these species depend on seral sages of big sagebrush (Howard 1999).

Intrinsic Vulnerability

Habitat Specificity and Fidelity

Oreoscoptes montanus are sagebrush obligates and seem to be quite selective in sites used for nesting and breeding habitat. Habitat used is generally in good condition on sandy and loamy soils and provides tall (0.6m – 0.9 m), dense big sagebrush for nesting, adequate shrub cover (11% - 44%), and vertical and horizontal heterogeneity (see Habitat section). If these site characteristics are absent, it is largely unknown how it would affect *O. montanus* populations, since nests are found significantly more in the site characteristics listed above.

It is unknown whether or not sage thrashers are dependant on specific sagebrush-steppe habitats (e.g., do they return to the same sites). From 1955 to 1996, of 660 sage thrashers that were banded in North America, no bands were returned and no encounters of *O. montanus* with bands were reported (Reynolds et al. 1999). Therefore, it is also unknown what affect the loss or modifications to sagebrush-steppe habitats will have on sage thrasher site-fidelity, if any. Wiens and Rotenberry (1985) conducted a short term study (3 years) that investigated the abundance of *O. montanus* after a drastic alteration of sagebrush steppe habitat (chemical application, removal, and crested wheatgrass introduction) and did not see a significant decline in abundance. Speculation leaned toward possible site fidelity or overall increasing trends (across its range) in *O. monantus* abundance; however, the authors concluded that long term studies needed to be conducted to answer these uncertainties.

Territoriality and Area Requirements

A few researchers have reported the average territory size and area requirements within sagebrush steppe for breeding populations (see Area Requirements above). Although these reports

are subjective and variable, the overall consensus for area requirements to support successful breeding populations (~30 – 40 individuals) is a section of big sagebrush greater than 100ha (Wiens and Rotenberry 1981; Medin 1992; Casey 2000; Nicholoff 2003). In support of these reports, Knick and Rotenberry (1995) found that site occupancy increased as shrub patch size increased. Agricultural practices and oil and gas development projects that degrade and fragment sagebrush-steppe habitats may adversely affect nest success if shrubsteppe sections less than 100ha are created; but more information is needed. Possibly more important than size of habitat available for sage thrasher viability, is the composition and structure of vegetation within these patches (see above).

Susceptibility to Disease

No information is available on the susceptibility of *O. montanus* to diseases. However, sage thrashers do occupy the same habitat as greater sage-grouse, which have been recently affected by West Nile virus in Wyoming, Montana, and Alberta, resulting in 28 documented deaths in 2003 (Stone 2004). The susceptibility of *O. montanus* to West Nile virus is unknown.

Dispersal Capability

No information has been reported on the natal dispersal capabilities of *O. montanus*. In Wyoming it can be assumed that young-of-the-year migrate south to wintering grounds; however, it is unknown where they winter and if they return to the same region for breeding the following year.

Reproductive Capacity

Little information is available on the success of *O. montanus* nests across its breeding range. Typically, sage thrashers will have four to five eggs per clutch, with a possible range of one to seven eggs (Gilman 1907; Reynolds and Rich 1978; Reynolds et al. 1999). Rotenberry and Wiens (1989) showed that the amount of annual precipitation significantly affected the number of eggs

produced in a clutch. In Idaho, 46% of the eggs laid produced a fledged young (Reynolds and Rich 1978).

Predation on nestlings plays a major role in determining the reproductive success of *O. montanus* (Rotenberry and Wiens 1989). Parasitism by brown-headed cowbirds most likely does not affect *O. montanus* breeding success, since research has demonstrated that sage thrashers reject brown-headed cowbird eggs placed in their nest (Rich and Rothstein 1985; Canning 1995; Vander Haegen and Walker 1999).

Sensitivity to Disturbance

There appears to be little or no adverse affects of nestlings to research handling. Researchers were able to handle and inspect nestlings without adult abandonment or significant mortality to nestlings. The only observation was that nestlings handled sometimes left the nest earlier than those nestlings not handled; however these dates were within the normal range of reported fledgling dates (Killpack 1970; Rotenberry and Wiens 1989). In addition, continual nest observation may have little to no adverse affects on nest success. For example in Idaho, Reynolds and Rich (1978) reported nest abandonment for only two of the fifty-eight nests during incubation for both research sites over a two-year period.

No reports have specifically addressed the affects of wildland fire on *O. montanus* populations. It can be assumed, however, that if fires occur during the nesting periods (May through July), nests could be lost since they are built within or under big sagebrush. This would directly affect nesting success for that population and year. Sensitivity to gradual disturbances, such as exotic species invasion and domestic livestock grazing are probably negligible (see Reynolds and Trost 1981, Petersen and Best 1987, and Canning 1995).

Several studies have focused on the affects of sagebrush-steppe modifications on a suite of sagebrush obligate species, including *O. montanus*. These studies have presented variable, often contradictory conclusions on the impacts of habitat alteration on sage thrasher populations. For example, Braun et al. (1976) stated that sage thrashers were in no danger of elimination after degradation of sagebrush-steppe, Petersen and Best (1987) showed that sage thrashers were found more often (although not significantly) on prescribed burn sites and therefore concluded that they were unaffected by habitat alteration, and Vander Haegen (unpublished data in Vander Haegen et al. 2000) noted that nesting sage thrashers did not seem to be inhibited by small shrubsteppe fragments in an agricultural matrix. On the other hand, Castrale (1982) concluded that sage thrashers are eliminated with the loss of large shrubs by plowing, chaining, and burning, Knick and Rotenberry (1995) suggested that fragmentation of shrub-steppe habitat appears to significantly affect sage thrashers, and Vander Haegen et al. (2000) suggest that sage thrashers do best in communities that approach climax communities. None of these authors reported affects of nesting success from habitat alterations, only presence/absence data. Therefore degree of population vulnerability is largely unknown. More specific data needs to be collected in order to understand the ramifications of habitat alteration.

Genetic Factors

No information on genetic studies has been located specific for *O. montanus* populations. With the reduction of suitable breeding habitat, sage thrasher populations could decrease and become more isolated, possibly limiting genetic variability throughout the metapopulation.

Population Viability Analyses

There is no known population viability analysis (PVA) specific for *O. montanus*, however conducting a PVA would be helpful to determine how environmental and demographic factors could affect survival of a population. A PVA was conducted for the cactus wren

(*Campylorhynchus brunneicapillus*). That PVA suggested that small sizes of subpopulations coupled with habitat fragmentation may constrain the long-term viability of the metapopulation (Ogden Environmental and Energy Services 1992).

Protected Areas

Public lands (e.g., National Parks, Forest Service, BLM, and State) serve as a means to protect and/or enhance sagebrush-steppe habitat, despite large-scale loss on private lands. For example, the U.S. Department of Energy's (DOE) Hanford Site provides some of the largest contiguous expanses of sagebrush communities in Washington, which has been restricted from public access and free from agricultural uses for over four decades, and now serves as a refugium for numerous plant and animals, including *O. montanus* (Gray and Rickard 1989). Other efforts by state and federal agencies are focusing on identification and long-term protection of sagebrush-steppe sites, including habitat restoration and private land acquisition or exchange in order to block up remaining sagebrush habitat. A more recent challenge by state agencies is the promotion of conservation action on private lands (Reynolds et al. 1999).

Conservation Action

Existing or Future Conservation Plans

Recently several western states have completed bird conservation plans, coordinating efforts with Partners in Flight. These plans provide management and conservation guidance for the numerous species within state boundaries, with particular focus on federally listed, neotropical migratory, and state designated sensitive bird species. The following are completed bird conservation plans within *O. montanus* range: Wyoming Bird Conservation Plan (Nicholoff 2003), Idaho Bird Conservation Plan (Ritter 2000), Colorado Land Bird Conservation Plan (Beidleman 2000), Montana Bird Conservation Plan (Casey 2000), Nevada Bird Conservation

Plan (Neel 1999), Utah Avian Conservation Strategy (Parrish et al. 2002), Columbia Plateau Bird Conservation Plan (Oregon, Washington, Idaho, and Nevada) (OR/WAPIF; 1999), Draft Land Bird Conservation Plan for the State of New Mexico (NMPIF 2003), and Sierra Nevada (California) Bird Conservation Plan (Siegel and DeSante 1999). The completed plans differ greatly in their level of detail and the strength of their management recommendations, but most provide general guidance and also offer recommendations pertaining to specific species relevant to their habitat use. Since the largest conservation concern for *O. montanus* is the lost of suitable habitat, the core of all plans is the preservation of shrubsteppe ecosystems, specifically big sagebrush, in order to maintain or increase sage thrasher numbers. The Idaho plan suggests using sage grouse as an umbrella species by 2007 to effectively manage for all sage brush obligate species, including declining populations of *O. montanus* (Ritter 2000; Sauer et al. 2004).

The Wyoming Conservation Bird Plan (Nicholoff 2003) approaches the conservation of priority bird species by assigning one or more habitat types to each species based on habitat descriptions specific to each species (see Cerovski et al. 2003). It then groups birds with the same habitat types together, allowing specific habitat conservation management actions to be directed toward a "suite" of species with the same habitat requirements, rather than just a particular species.

Other plans that promote the conservation of *O. montanus* habitat via an umbrella species, sagebrush management plan, invasive species reduction plan, and/or fire management plans are: the Wyoming Greater Sage-Grouse Conservation Plan (Budd 2003) and the Federal Wildland Fire Management Policy (Glickman and Babbit 1995).

Conservation Elements

There have been several studies investigating implications of environmental change on a suite of sagebrush-obligate passerine species, including *O. montanus*. From these studies, the following four conservation elements are recognized for *O. montanus*, and many other sagebrush obligate species. Specific approaches that have been proposed to address these conservation elements are provided in the following section of Acting on Conservation Elements.

Protection of breeding habitat

Oreoscoptes montanus are sagebrush obligates, especially during the breeding season, and appear to be quite selective in the structure of the sagebrush-steppe used (e.g., tall, mature shrubs). Loss and destruction of this habitat is the most alarming factor facing the sustainability of *O. montanus* populations across its range and should be avoided at all costs. Some studies have indicated that fragmentation and habitat-altering disturbances do not seem to adversely affect nest success of *O. montanus*, however, sagebrush-steppe should be managed to maintain or increase potential nesting/breeding sites.

Protection of migration corridors and winter range

Very little information exists on the habitat used by *O. montanus* during spring and fall migration and while over-wintering. Since loss of winter habitat could negatively affect *O. montanus* populations, it is very important to determine habitats selected and used. In addition, *O. montanus* winter range does incorporate sections of northern Mexico, and potential exposure to harmful pesticides and herbicides that have been banned in the U.S. and Canada could occur. Therefore, implementing plans to reduce the use of pesticides in Mexico should be pursued.

Maintenance of a landscape mosaic

Oreoscoptes montanus select breeding sites with 1) dense, tall shrubs that provide cover, structure, and support for nests, 2) horizontal and vertical heterogeneity, 3) horizontal patchiness that provides foraging opportunities for *O. montanus*. Ideal patches to maintain a breeding population of *O. montanus* containing these qualities should be at least a continuous 100ha. Fragmentation and/or degradation of this landscape mosaic from agricultural practices, gas and oil development, and conversion of sagebrush composition from nonnative species threaten the persistence of breeding populations.

Restoration and preservation of sagebrush-steppe habitat

The largest threat facing sagebrush obligate species, such as *O. montanus*, is the loss of suitable breeding habitat. Sagebrush-steppe habitat has been greatly altered across *O. montanus* range by a century of settlement, oil and gas development, urban development, livestock grazing, agriculture, nonnative plant species invasion, and changes in wildfire regimes. Decades of wildfire suppression and livestock grazing have caused many areas of sagebrush-steppe to become more densely packed, and unfavorable to *O. montanus*. On the other hand, sagebrush-steppe habitat has also been converted to agricultural lands, areas of monoculture and little structural diversity, and grasslands, which are also not suitable for *O. montanus* habitat. Land management can help restore native sagebrush habitats and reverse the declines of sagebrush-dependent species. All bird conservation plans that specifically address management actions for *O. montanus* and/or other sagebrush obligate species recommend stabilizing or increasing existing sagebrush-steppe habitats through restoration and preservation. In addition, natural resources agencies list conservation and restoration of sagebrush lands as one of their top priorities (BLM 2002). This action is of great importance because if any sagebrush obligate species is federally listed as endangered or threatened (e.g., greater sage-grouse), there would be major ramifications for use

and management of large areas (e.g., sagebrush habitat) of the western United States (see Range Context; Knick et al. 2003).

Acting on Conservation Elements

A handful of states have drafted conservation plans (see Existing Conservation Plans) that provide suggestions of management practices for a suite of sagebrush obligate bird species, including *O. montanus*. In addition, studies have focused specifically on *O. montanus,* or included *O. montanus* with a grouping of other sagebrush species, which have provided insight into affects of disturbances on suitable nesting and breeding habitat. The following are some basic management guidelines tied to each of the above noted Conservation Elements that have been suggested for conservation of *O. montanus* and similar sagebrush obligate species (e.g., greater sage-grouse and Brewer's sparrow). It is important that these management suggestions are scrutinized, because they are based on habitats found across *O. montanus* range, and do not necessarily relate directly to situations in Wyoming.

Protection of breeding habitat

Oreoscoptes montanus most often select breeding habitat based on structure of shrubs available (e.g., at least 0.5m in height for ground nests, 0.7m in height for "within shrub" nests) that are moderately dense horizontally across the landscape with a variety of natural grasses and forbs in the understory dispersed in patches so that bare ground is available for easy foraging. Suitable nesting and breeding habitat throughout Wyoming should be identified through satellite images and ground-truthed for quality of habitat. The best suitable habitat, with a large presence of natural forbs and grasses and tall big sagebrush shrubs, should be surveyed over several summers for presence of *O. montanus* breeding pairs (See Inventory and Monitoring). Where there are nest-sites (either current use or evidence of past use), this area should not be modified

and shrubs should be managed to maintain or increase continuous groups (at least 100ha) of dense, tall big sagebrush shrubs in medium to climax stages of growth, and prevent invasion of nonnative plant species or remove these species. If studies in Idaho, Washington, and the Great Basin are applicable to Wyoming, patches of sagebrush-steppe should contain at least 1 – 2 tall, dense shrubs per hectare providing at least 11% cover to maintain viable breeding populations (e.g., Reynolds and Rich 1978; Reynolds 1981; Wiens and Rotenberry 1981; Stephens 1985; Medin 1992; Dobler et al. 1996). *Oreoscoptes montanus* may not be affected by fragmentation of habitat (although more long-term research is needed; see Vander Haegen et al. 2002); however, they may be affected by disturbance associated with roads (e.g., noise). Therefore, large (>100ha) patches of suitable nesting habitat should be left intact at least 200m from constructed or existing roads associated with oil and gas projects or urban development to avoid disturbance of potential nesting sites (see Ingelfinger and Anderson 2004). Chemical alteration of dense patches of sagebrush may favorably influence nest-site availability, decreasing density and providing sagebrush shrubs in a variety of growth stages (e.g., seral to climax). In addition, it appears that nesting success is not significantly affected in areas that chemical alteration of sagebrush has occurred (short term or long term; Kerley and Anderson 1995; Nicholoff 2003). Altering dense patches of sagebrush through prescribed burns, on the other hand, may adversely affect *O. montanus* by removing too much suitable habitat (e.g., shrub cover) and not leaving enough nesting shrubs, as well as may increase the probability of nonnative plant species invasion (e.g., cheatgrass) that could permanently alter the landscape. Therefore if prescribed burns are used to reduce shrub density, they should be "patchy" to leave remnant patches (at least 100ha) of mature, dense sagebrush (also a "wind-dispersed seed-source), in areas without large cheatgrass populations, and be assisted with regeneration of natural forbs and grasses through reseeding (see below; Kerley and Anderson 1995; Knight 1994; Howard 1999; Nicholoff 2003). To reduce or eliminate trampling of ground

nests, eggs, and/or nestlings from grazing livestock, stock level should be reduced, grazing time should be changed, and/or pastures should be rotated during breeding months (April through July).

Protection of migration corridors and winter range

Since it is hard to manage for habitat that is not clearly defined, the first step in preserving habitat used during spring and fall migration and for winter range is to determine which habitats are most commonly used by *O. montanus*. These habitats are most likely coupled with available forage (e.g., berries). This information may be obtained from Christmas Bird Counts (winter range), as well as sightings documented from published and unpublished reports (winter range and/or migration corridors). Once these sites are identified, efforts should be taken to prevent reduction or destruction of these habitats. Also, it is known that *O. montanus* occupy sagebrush-steppe habitats during the summer/breeding months, and therefore this habitat may also be used more often during migration and winter months. As a result, status of sagebrush and invasion by grasslands in wintering range (e.g., New Mexico, Arizona, Texas, southern California, and Mexico) should be explored. Pesticide and herbicide use during winter months should be investigated. If these chemicals are being used to reduce berry and/or forage crop damage from insects, research should be conducted to determine the affects on *O. montanus*, since ingestion of some chemicals may decrease breeding success in subsequent years.

Maintenance of a landscape mosaic

Habitat objectives for *O. montanus* should focus on maintaining large blocks of unfragmented stands of sagebrush habitat composed of a mosaic of open (5%) to moderate (25%) shrub cover of various ages and heights for nest-sites surrounding areas with short vegetation that are important for foraging, nesting, and perching sites. In order to maintain such a landscape mosaic, large-scale fires should be prevented, prescribed burns should be limited to small-scale fires during the non-

breeding season, conversion of shrublands to nonnative grasslands or croplands should be minimized, and road construction or other developments should be discouraged, especially if it would reduce sagebrush-steppe habitat to patch sizes less than 20 hectares (see Nicholoff 2003). In addition, measures should be taken to protect shrub-steppe habitat from invasion of nonnative plant species that can change the composition of this landscape mosaic (e.g., cheatgrass and crested wheatgrass; see below). Protection of intact, suitable habitat could be achieved through acquisition of conservation easements or through management agreements (Casey 2000).

Restoration and preservation of sagebrush-steppe habitat

Reclaiming sagebrush habitat that has been invaded with exotic grass species (e.g., cheatgrass), converted to grasslands through agricultural practices, or fragmented with urban and oil and gas development, as well as preserving remaining sagebrush-steppe habitats, has become a top priority of rangeland managers, since sagebrush-steppe ecosystems are a vital component to the survival of several sagebrush obligate species, including *O. montanus*. These tasks can be daunting and expensive. Below are suggestions that may help direct management objectives to preserve and rehabilitate various components associated with sagebrush-steppe ecosystems. When reviewing these suggestions, keep in mind that *O. montanus* require breeding habitat that provides a diverse, structural vegetative composition with tall sagebrush shrubs and open areas of native forbs and grasses (see Habitat).

The invasion of nonnative grass species is a major threat to the remaining sagebrush-steppe habitats, and controlling these invasive plant species is the most difficult and perplexing problem facing range managers, because once the nonnative grasses and forbs (e.g., cheatgrass and medusahead) become established, the ecology of sagebrush habitat is changed. In cheatgrass-dominated habitats, intensive control of cheatgrass through heavy spring grazing or prescribed

burning before cheatgrass seed production occurs may be the only option. However, these control methods must be followed by reseeding and restoration of native plant species to prevent the reinvasion of weeds (Nicholoff 2003). It must be noted that reseeding a site with native grasses and forbs can be expensive and difficult to obtain enough seed for a large areas (Ritter 2000). Green-stripping (placing fuelbreaks of fire-resistant vegetation at strategic locations on the landscape) has been suggested to slow the spread or reduce the size of wildfires in areas where nonnative plant invasion is a critical concern or where high-value sagebrush sites exist (Nicholoff 2003). A more practical and less expensive route is to manage cheatgrass-dominated landscapes as grasslands and turn the focus to protecting and improving existing sagebrush habitats (Ritter 2000; Nicholoff 2003). In sagebrush stands that contain a healthy community of native grasses and forbs, nonnative plant species invasion can be mitigated by maintaining the vigor of native species by controlling livestock grazing, avoiding large-scale soil disturbances, and minimizing habitat fragmentation (e.g., road construction associated with development). Wildfire suppression in areas prone to cheatgrass invasion is the best management prescription (Nicholoff 2003).

To maintain or establish perennial bunchgrasses and native forbs associated with healthy, intact sagebrush ecosystems, 1) avoid grazing during the growing season (e.g., spring/summer), 2) thin sagebrush stands chemically and reseed with native species while temporarily eliminating or reducing livestock grazing, 3) maintain native forb diversity by allowing growth to continue through spring and summer, and maintain the current season's growth through mid-July and manage for 50% cover or more of the annual vegetative growth to remain through the following nesting season (Nicholoff 2003).

Soil crusts are associated with healthy sagebrush-steppe ecosystems and are thought to promote soil development and productivity in sagebrush habitats. In order to minimize

disturbances to these crusts and restore areas with soil crust damage, 1) exclosures or nonfence methods should be employed to prevent livestock/wildlife trampling, 2) inoculation of disturbed soils with material from surrounding biological crusts could be used to hasten recovery time (often > 10 years naturally), and 3) use of established sites (e.g., trails) and roads for recreational use should be encouraged (Nicholoff 2003).

Inventory and Monitoring

Recent bird conservation plans suggest monitoring sagebrush-steppe habitat conditions, rather than conducting actual bird population surveys for specific species. Monitoring the conditions of sagebrush-steppe habitat is important since *O. montanus*, as well as a handful of other avian, are sagebrush obligates, and if this habitat was degraded or eliminated, most likely local extinctions would occur. However, given that *O. montanus* population response to general habitat conditions, as well as alterations of habitat is poorly understood, it is also important to not only monitor habitat components but population trend and status in Wyoming, as well. Detailed accounts of avian monitoring techniques are presented in several sources (Ralph et al. 1993; Buckland et al. 2001) and are presented in general detail below. Included with this general outline, are suggestions taken from the recently instituted Wyoming Bird Monitoring Program (WBM) that is being conducted by the Rocky Mountain Bird Observatory to determine population trends and/or status for all breeding birds regularly occurring in Wyoming and not included in monitoring programs under special programs (e.g., threatened or endangered species) (RMBO; Leukering et al. 2001).

Multiple sites and site types – Standardized population monitoring programs, in addition to Breeding Bird Surveys and Christmas Bird counts, should be used across *O. montanus* range. Annual Breeding Bird Surveys and Christmas Bird Counts are effective in determining the

presence of *O. montanus* in sagebrush-steppe habitats, but are not systematic enough to provide meaningful population size or trends, particularly at smaller spatial scales. Monitoring plans ideally should include breeding habitat in significant natural condition (e.g., regular fire regime, native forb and grass understory), in various stages of altered condition (e.g., nonnative species establishment, fragmentation, burn sites, livestock grazing), and in completely converted sagebrush-steppe habitat (e.g., grasslands or agricultural lands) in order to understand habitat utilization in Wyoming, as well as the influence of disturbance on *O. montanus* populations and abundance. Knick et al. (2003) recommend that long-term study sites be established across a gradient of habitat conditions within occupied *O. montanus* range to collect information on population trends, reproductive success, adult and juvenile survival, adult return rates (e.g., site fidelity), and patterns of juvenile dispersal. The WBM suggests conducting 30 transects per each habitat in order to detect changes in population (increases are more easily detected than decreases; Leukering et al. 2001).

Multiple visits – In order to determine population trends, several years of data collected from the same site must be gathered since individual years are the data points in trend data (Faulkner and Giroir 2002). In addition, it has been suggested that subsequent years may have fluctuating *O. montanus* densities as a result of stochastic events (e.g., changes in climate, wildfires) and/or anthropogenic disturbances, and therefore one year versus another would not provide an accurate view of the population status or trend at a particular site.

Population monitoring – Population monitoring is used to determine population trends and status and is the foundation for avian conservation. Leukering et al. (2001) suggests using point transect monitoring to derive a population index for *O. montanus*. With this sampling scheme, 30-fifteen point transects (250m between points) should be conducted diurnally at randomly selected

starting points within selected sagebrush-steppe habitats. Count durations at each point should be five minutes. The data collected could then be put into the program DISTANCE (see Thomas et al. 1998) to determine population density for each sampling unit (each transect). Prior attempts to monitor sage thrasher via banding have been unsuccessful. For example, between 1955 and 1996, 660 *O. montanus* were banded with no bands returned and no encounters reported (Reynolds et al. 1999). The use of radio-transmitters to track *O. montanus* between wintering and breeding grounds would not work since battery life and detection capabilities are too short. However, stable isotope techniques may serve as tools to link wintering populations to breeding populations and habitat (Knick et al. 2003).

Habitat monitoring – Since breeding populations of *O. montanus* are completely associated with sagebrush-steppe ecosystems, it is important to track the quality, extent, succession, and status of suitable nesting habitat. Short-term studies can be used to determine annual habitat associations. Long-term studies (with permanently established plots) can be used to follow *O. montanus* population trends and habitat-use in association with change in vegetative structure and composition (e.g., succession, natural disturbances, or invasion of exotic species).

Transects are particularly useful in sampling large areas. Basic transects incorporated with daubenmeyer plots can be used to establish the vegetative community and visual estimates of basal cover within a sample plot (e.g., Daubenmire Canopy Coverage Method). Another transect method, line-intercept method, is useful for determining the cover of overstory species (e.g., big sagebrush) and mean shrub height. The point-centered quarter method, often conducted along a transect line, is useful to determine density of sagebrush. Other methods that could be used to determine density of sagebrush are the nearest individual, nearest neighbor, and random pairs (more details for these procedures mentioned can be found in Gurevitch et al. 2002). Exclosures

are also important tools to use to establish trends, especially when concerned with impacts of grazing on sagebrush-steppe habiat (Holecheck et al. 1989).

Captive Propagation and Reintroduction

No captive propagation or reintroduction of *O. montanus* has been attempted, nor is such action recommended. Conservation efforts would be more profitable if spent preserving and restoring habitat.

Information Needs

Rangewide Needs

The primary concern associated with *O. montanus* populations is the degradation and loss of breeding and nesting habitat. With agricultural, urban, and oil and gas development, fragmentation of sagebrush habitat has become more extensive, and affects of fragmentation on the productivity and survival of sage thrashers is largely unknown. In addition, little is known about the impacts of livestock grazing, wildland fires, nonnative species invasion, and habitat conversion on breeding success of *O. montanus.* Therefore, in-depth, long-term (> 1-2 years) studies should be conducted to determine the responses of *O. montanus* to these issues. Along with these studies, more detailed assessments should be done to determine the territory requirements and quality (including species composition) of big sagebrush habitat needed to maintain viable breeding populations across its range. This knowledge will help direct management objectives and habitat rehabilitation programs. Components of winter range habitat may also be affecting the survival of *O. montanus*, as well as conservation efforts focused on the breeding populations. However, little is known about winter habitat use. Therefore, more information is needed to determine the requirements, conditions, and possible threats to *O. montanus* and its winter-range.

Long-term population dynamics (e.g., survival, productivity, area fidelity, and dispersal) and core life history data (e.g., longevity) are lacking for *O. montanus.* Obtaining a better understanding of these factors will help determine the metapopulation structure of *O. montanus*.

Wyoming Needs

There is an overall lack of data for *O. montanus* in Wyoming. Most data (although limited) is from Idaho, Washington, and the Great Basin. Therefore, steps should be taken to gather baseline data on the quantity and quality of big sagebrush habitat used in Wyoming by *O. montanus*, as well as conduct comprehensive surveys to establish demographics and an estimated population. This data can then be used to generate management objectives for maintaining adequate patches of sagebrush steppe, and in turn, assist in maintaining or increasing the breeding population of *O. montanus* in Wyoming, as well as other sagebrush obligate species. In addition, monitoring the affects habitat alterations have on *O. montanus* population and demographics will allow detected changes to predict trends in sagebrush ecosystems, since research has demonstrated that *O. montanus* is sensitive to multiscale habitat changes (see Knick and Rotenberry 2000; Knick et al. 2003).

Tables and Figures

Table 1: Reported migration dates of *O. montanus*.

Source	Migration Dates		Comments	Location
	Arrival	Departure		
Rosenberg et al. 1991	mid-Jan	early April	common spring transient; usually in flocks	Colorado River Valley
Rosenberg et al. 1991	early Sept - Dec	nr	rare fall transient	Colorado River Valley
Garrett and Dunn 1981[a]	late Jan	early June	transient; peak is mid-March	southern California
Littlefield 1972[a]	late March	nr	breeding?	eastern Oregon
Burleigh 1972[a], Bergeron et al. 1992[a]	late March	nr	breeding?	eastern Washington
Burleigh 1972[a], Bergeron et al. 1992[a]	early April	nr	breeding?	southern Idaho
Burleigh 1972[a], Bergeron et al. 1992[a]	late April	nr	breeding?	central Montana
Reynolds et al. 1999	mid-March - mid-April	nr	breeding?	southeastern Idaho
Rogers 1988[a]	late February	nr	breeding?; earliest dates	Oregon
Bailey and Niedrach 1965[a]	early February	nr	breeding?; earliest dates	Idaho
Bailey and Niedrach 1965[a]	mid-March	nr	breeding?; earliest dates	Colorado
Bent 1948	mid-April	nr	breeding?; earliest dates	Utah
Bent 1948	late March	nr	breeding?; earliest dates	Wyoming
Reynolds et al. 1999	nr	August - Sept	southward migration	central Washington
Cannings 1992??	nr	late September	southward migration	Canada
Bailey 1928[a]	nr	mid September	southward migration	Idaho
Bailey 1928[a]	nr	early October	southward migration	Wyoming
Bailey 1928[a]	nr	mid October	southward migration	Oregon
Bailey 1928[a]	nr	late October/late November	southward migration	Colorado
Hubbard 1978[a]	nr	mid Novermber	southward migration	Utah
Hubbard 1978[a]	July	nr	fall migratory transient	New Mexico
Reynolds et al. 1999	early September	nr	fall migratory transient	southern New Mexico
Reynolds et al. 1999	early October	nr	fall migratory transient	Texas
Small 1994[a]	mid-Aug - mid-Nov	nr	fall migratory transient/ winter resident	California

nr = not reported ; [a] = Citations in Reynolds et al. 1999

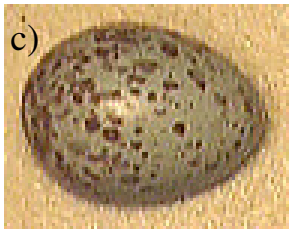
Table 2: Sagebrush area and management responsibility by ecogregions in the western U.S. that contain sagebrush cover of >1% of the total land area. Table was extracted from Knick et al. (2003).

Ecoregion	Sagebrush area (ha)[a] (% of total area)	Management responsibility (% of sagebrush area)			
		Private	BLM	Other federal agencies[b]	State
Wyoming Basin	7 366 521 (55)	30	56	8	7
Columbia Plateau	14 064 004 (48)	23	60	12	5
Great Basin	8 844 892 (30)	13	70	17	1
Utah High Plains	816 128 (18)	27	31	33	9
Utah-Wyoming Rocky Mts.	1 825 576 (17)	34	16	43	6
Middle Rockies	3 389 493 (16)	34	36	24	6
Modoc Plateau	589 075 (10)	24	28	43	5
Southern Rocky Mts.	1 389 004 (9)	51	28	15	6
Northern Great Plains Steppe	3 290 725 (5)	67	21	4	8
Colorado Plateau	841 092 (4)	20	60	11	8
Okanogan	288 010 (3)	55	6	25	14
Sierra Nevada	71 916 (1)	35	7	54	3
Remaining ecogregions	82 486 (<1)	80	<1	15	6
Totals	43 099 867 (14)	28	52	15	5

[a]: sagebrush communities include: Wyoming and basin big sagebrush, black sagebrush, low sagebrush, low sagebrush-mountain big sagebrush, low sagebrush- Wyoming big sagebush, mountain big sagebrush, scabland sagebrush, threetip sagebrush, Wyoming big sagebrush, and Wyoming big sagebrush-squaw apple.

[b]: other federal agencies include: Fish and Wildlife Service, Bureau of Indian Affairs, National Park Service, Department of Energy, Department of Agriculture, and Department of Defense.

Figure 1: Photographs of *O. montanus* showing a) the distinguishing streaked breast and short bill (photograph taken by Brian Small; Lukas 1999) and b) an adult sage thrasher perched and "singing" on top of sagebrush (photograph taken by F.C. and Janice Bergquist; Madson 2004). c) Egg photograph from the Provincial Museum of Alberta, Copyright © 1998, http://www.pma.edmonton.ab.ca – note the subelliptical shape. d) Sibley (2000) illustrates various stages of both adult and juvenile sage thrashers.



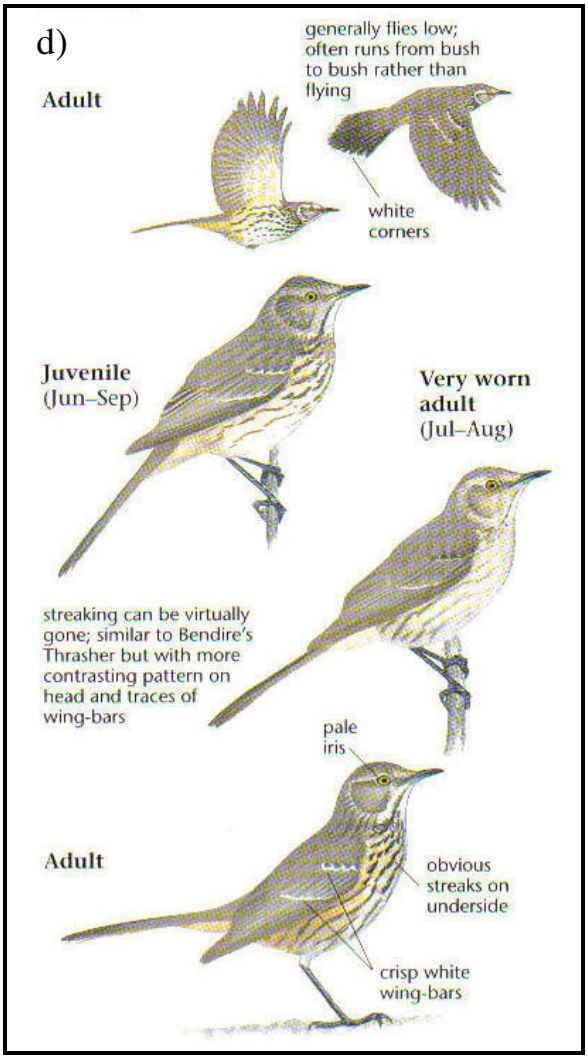


Figure 2: Wing formula of *Oreoscoptes montanus*. The 9th primary is ≥ the 5th primary. The 10th primary is 6-10mm > the primary coverts (Pyle et al. 1987).

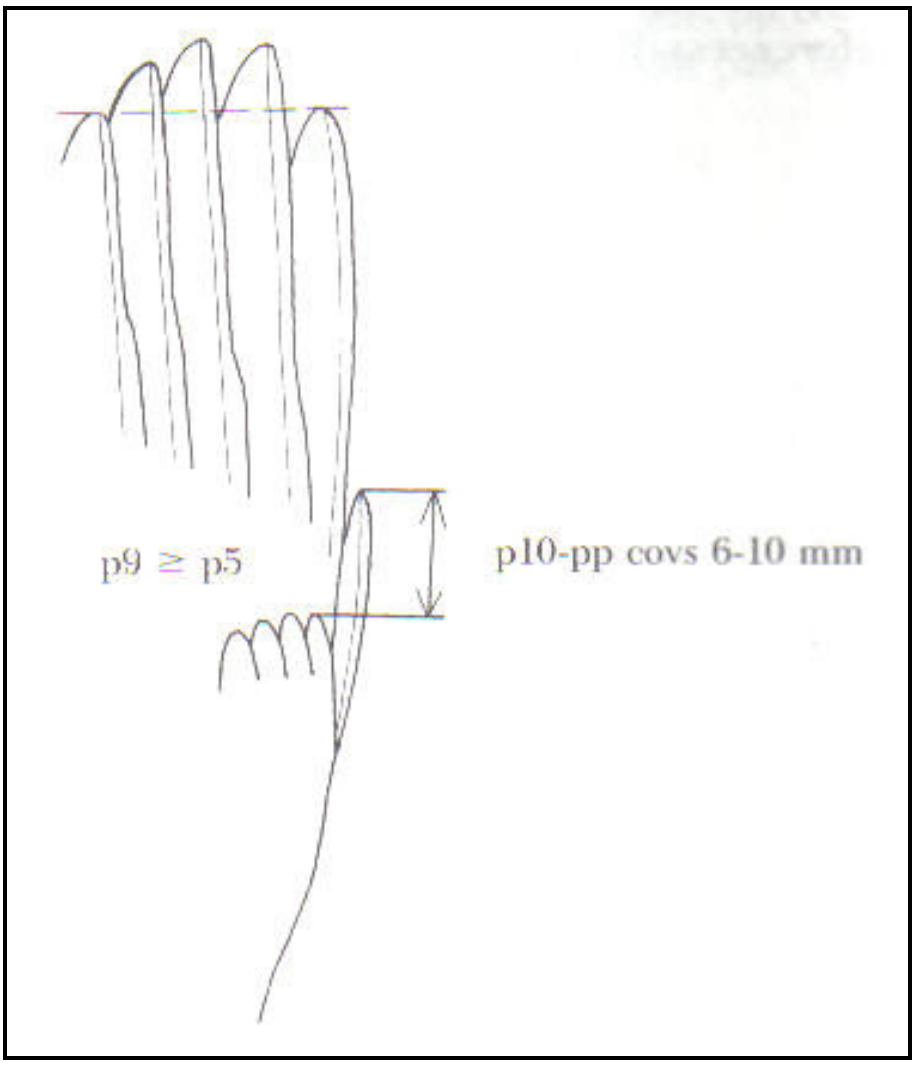


Figure 3: Sonogram of one song bout from a sage thrasher (unknown sex and age) recorded on the Crooked River National Grassland near Remond, Oregon by Geoffrey A Keller (Cornell Library of Natural Sounds no. 44874; Reynolds et al. 1999).

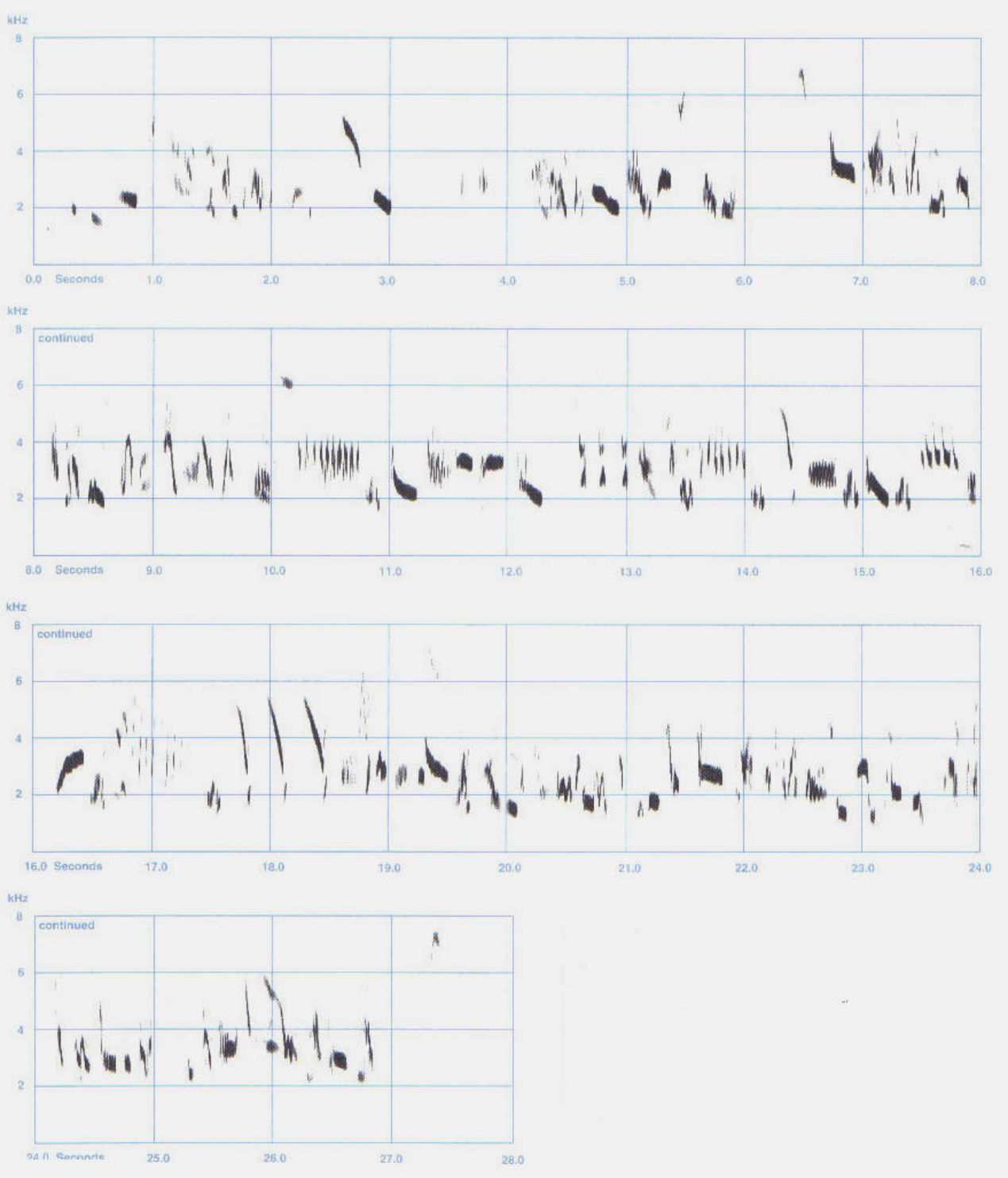


Figure 4: North American range of *Oreoscoptes montanus*. Red indicates approximate range of summer/breeding grounds and blue indicates wintering/nonbreeding grounds. The yellow represents migratory/passage grounds (NatureServe 2004) or possible range of year-round residents (Cassidy et al. 1990).

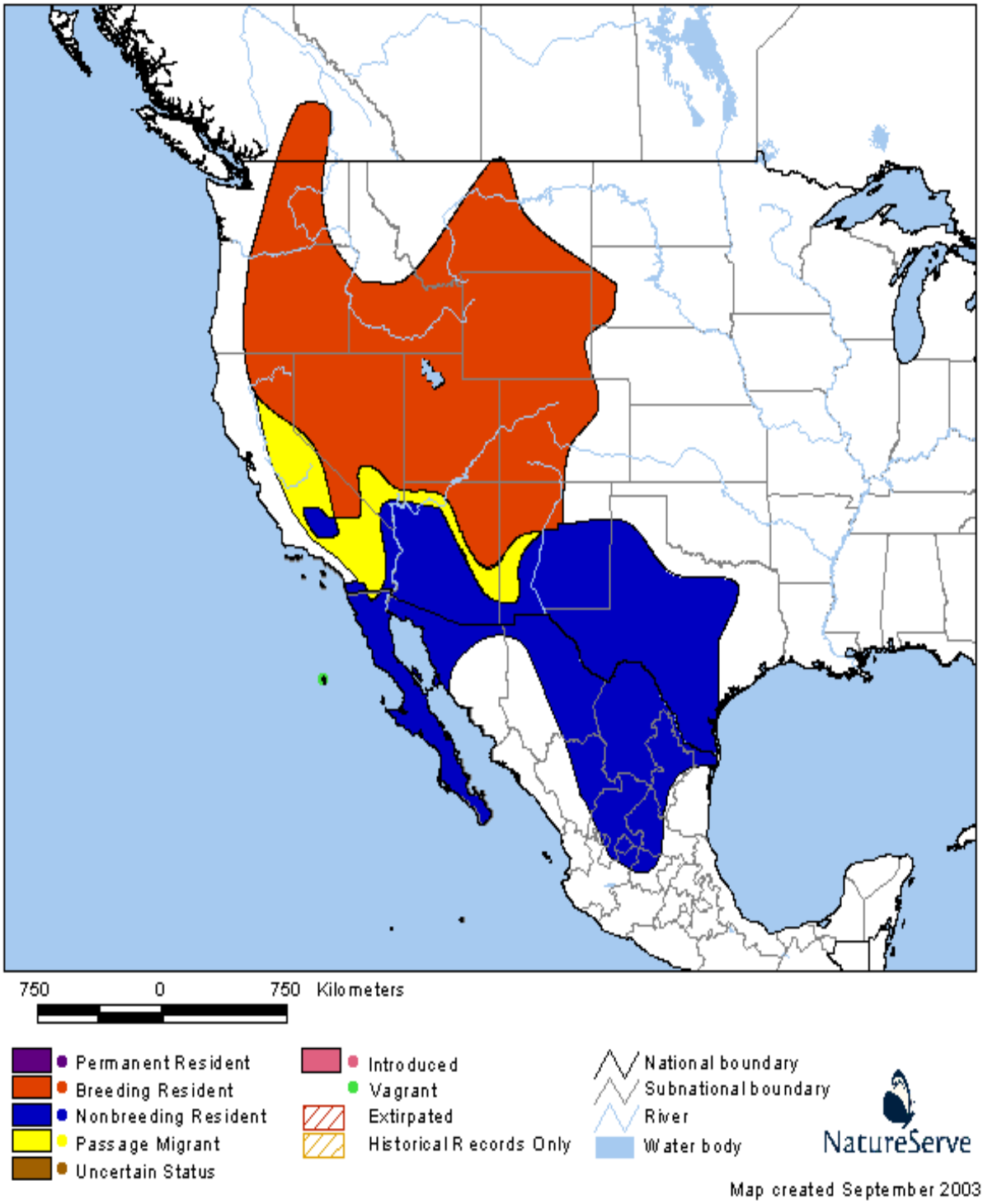
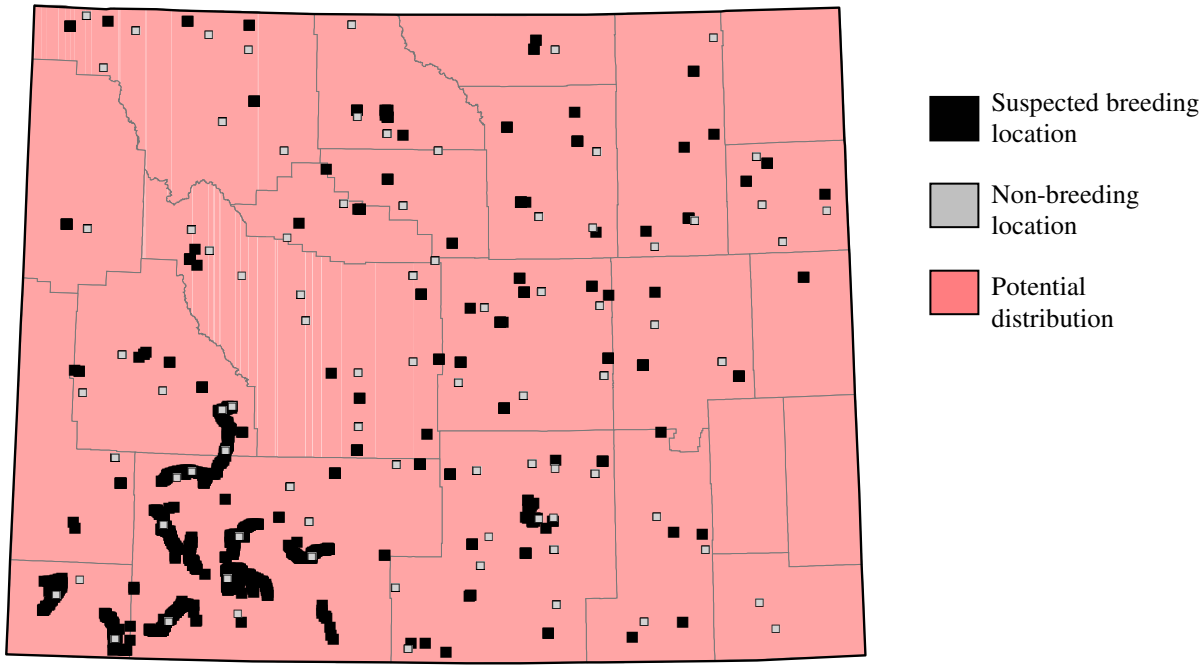


Figure 5: Wyoming Distribution Map.

A) Current (since 1982) suspected breeding vs. non-breeding locations



B) Historic (before 1982) suspected breeding vs. non-breeding locations

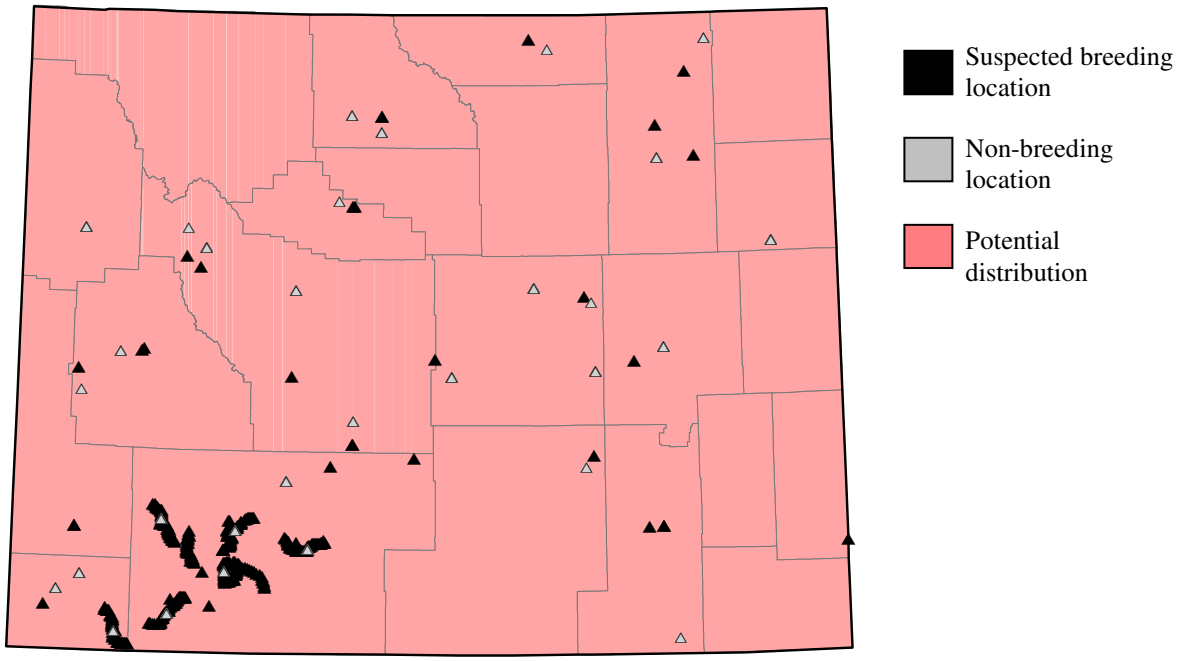


Figure 6: Distribution of *O. montanus* throughout its breeding and nonbreeding range. a) Breeding Bird Survey results throughout western North America. b) North America Christmas Bird Counts. Both maps were downloaded from the Nature Conservancy website (gis.tnc.org; Paige 1999).

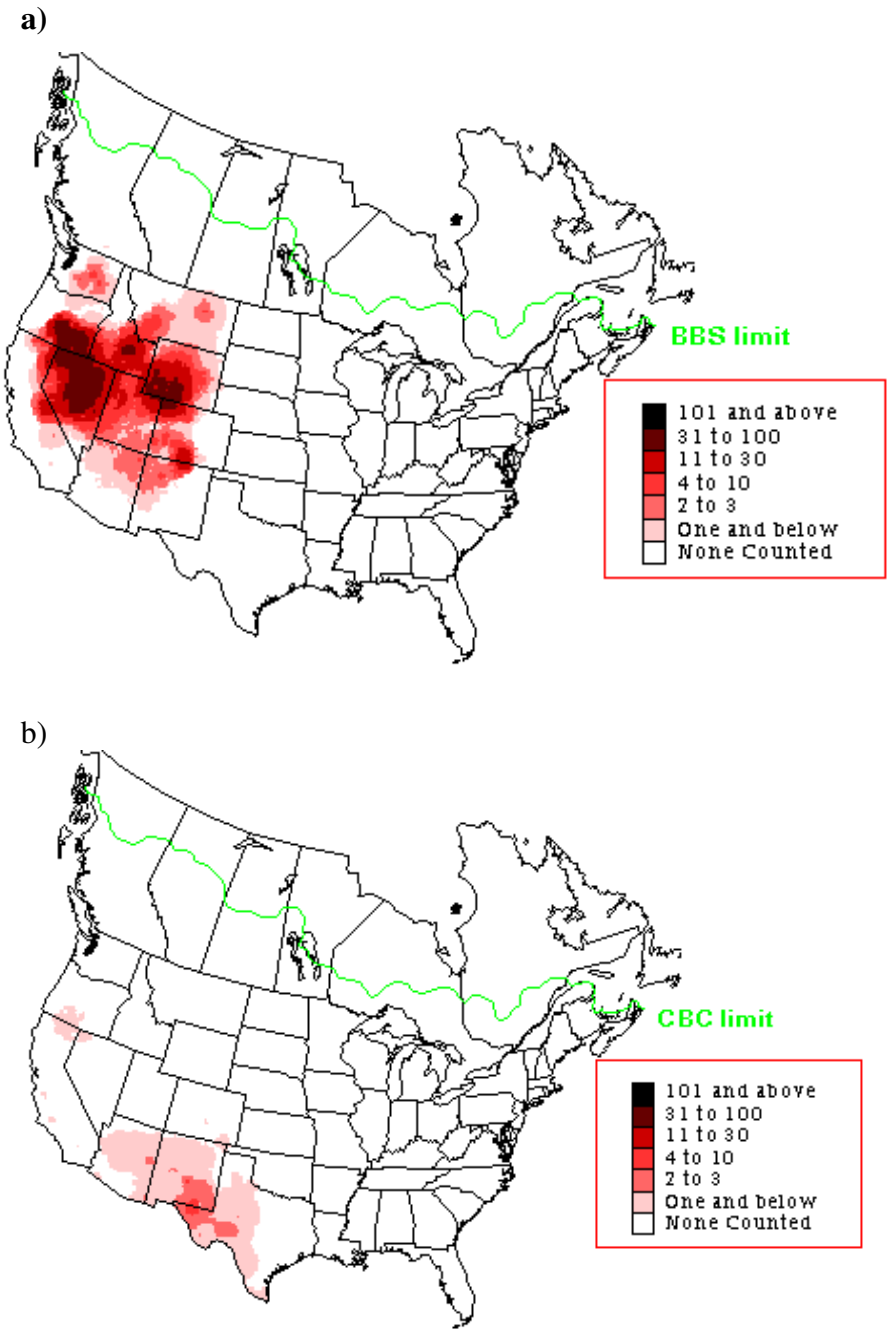
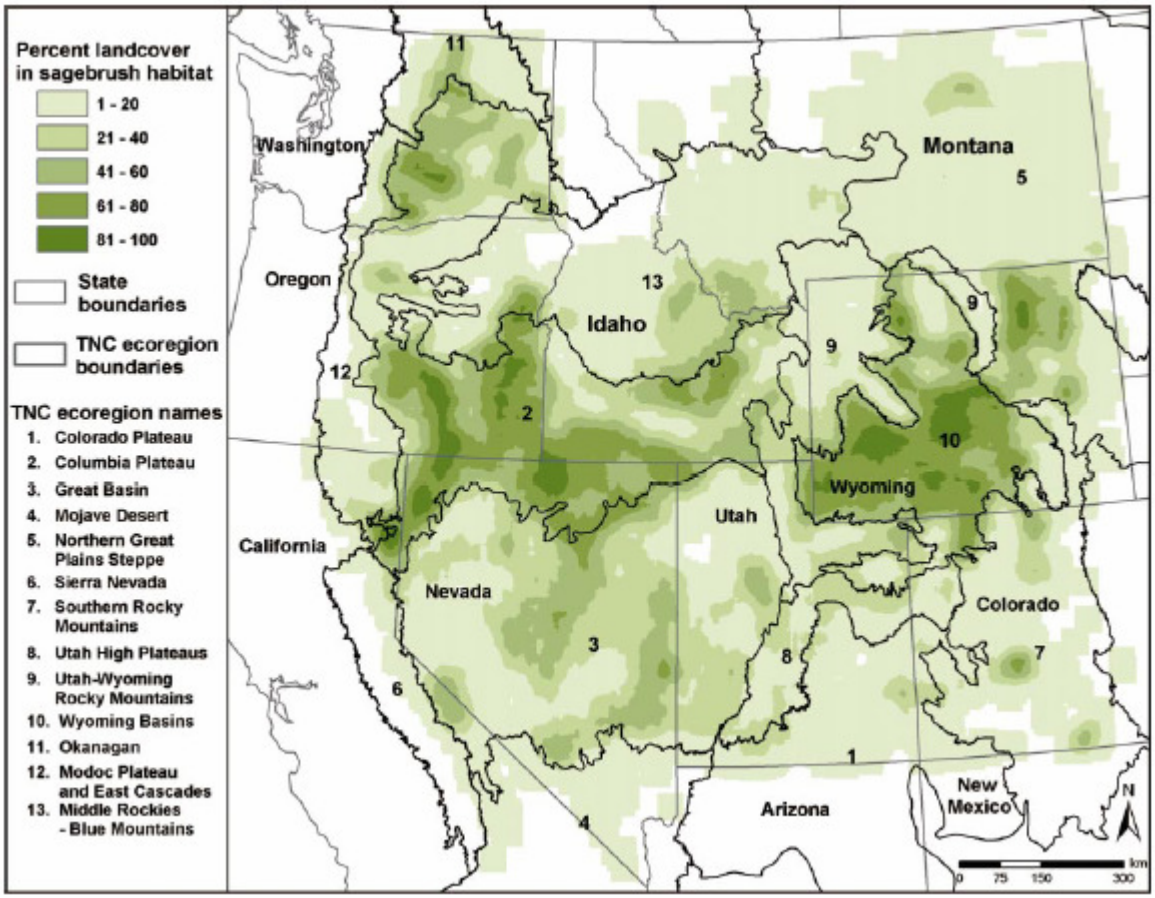


Figure 7: a) Distribution of tall sagebrush (basin big sagebrush, Wyoming big sagebrush, mountain big sagebrush, and silver sagebrush) throughout the western United States, and potential habitats occupied by *O. montanus* (Knick et al. 2003). Only ecoregions with .1% of their land surface dominated by sagebrush are shown. The photographs are of typical b) big sagebrush (*Artemesia* spp.) and c) shrubsteppe habitats occupied by sage thrasher.

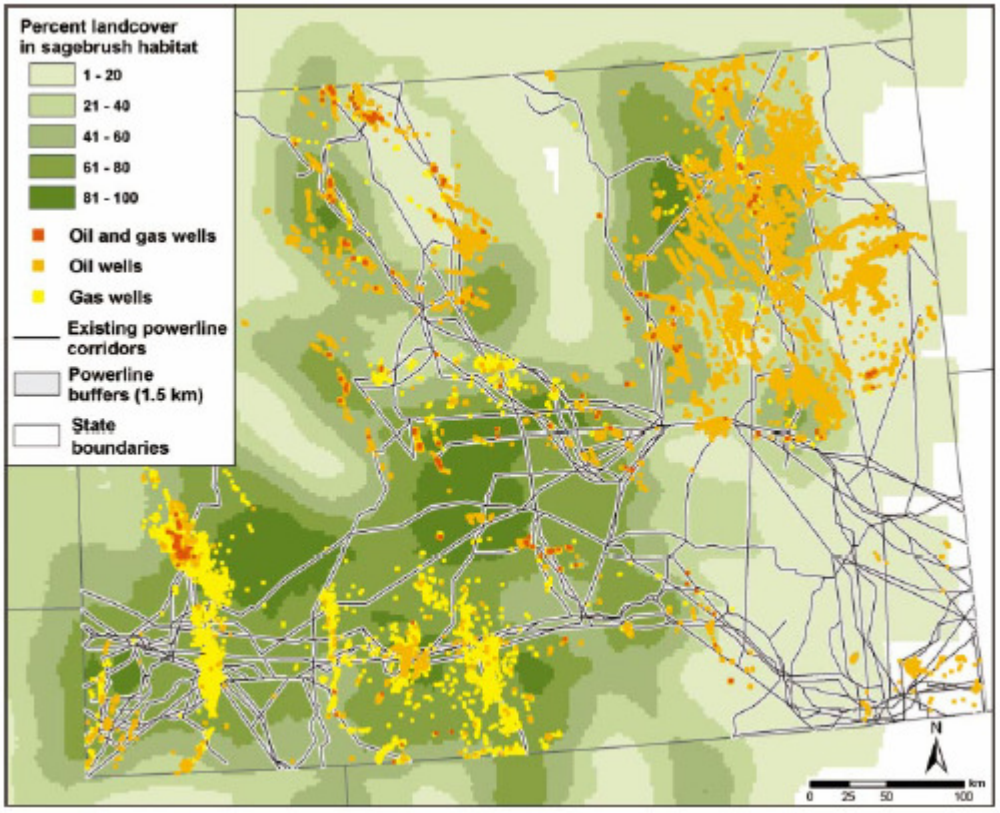
a)



b)

c)

Figure 8: Existing oil and gas developments in Wyoming relative to sagebrush steppe distribution (Knick et al. 2003). Buffers around powerlines reflect the increased predation risk by raptors and corvids.



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