Section IV. Assessments of Species and Species Assemblages

Chapter 26. Sagebrush-Obligate Songbirds

By Natasha B. Carr, Cynthia P. Melcher, Kirk R. Sherrill, and Gordon Reese

Contents

Figures

Tables

Key Ecological Attributes

Distribution and Ecology

The Brewer's sparrow, sagebrush sparrow (formerly sage sparrow), and sage thrasher compose the assemblage of sagebrush obligate-songbirds (SOS). All three are listed as Wyoming Species of Greatest Conservation Need (Wyoming Game and Fish Department, 2010) due to habitat loss, degradation, and fragmentation. The breeding distributions of SOS occur primarily in sagebrush shrublands of the Wyoming and Great Basins, Snake River Plains, and the Columbia Plateau (Martin and Carlson, 1998; Reynolds and others, 1999; Rotenberry and others, 1999). The SOS are migratory and also share similar nonbreeding distributions, which extend southward from extreme southwestern U.S. to southern Baja California, northwestern Sonora, and throughout the Mexican Central Plateau.

As a group, the three species are generally referred to as sagebrush-obligates, although they may occur in nonsagebrush shrublands. The SOS generally nest in habitats dominated by big sagebrush, but they also nest in other species of sagebrush, bitterbush, green rabbitbrush, black greasewood, and other desert shrubland species (Martin and Carlson, 1998; Paige and Ritter, 1999; Reynolds and others, 1999; Rotenberry and others, 1999). The three species respond somewhat differently, however, to vegetation and patch structure, including differences at landscape, patch, territory, and nest-site scales (Martin and Carlson, 1998; Reynolds and others, 1999; Rotenberry and others, 1999; Chalfoun and Martin, 2007).

Brewer's sparrows breed in relatively dense sagebrush with minimal grass cover (Rotenberry and others, 1999). They also nest in large openings of conifer-dominated woodlands or forests. At the territory scale, Brewer's sparrows use patches with greater foliar cover and denser, taller shrubs than those found in the surrounding habitat (Chalfoun and Martin, 2009). Shrubs selected as nest sites are taller and denser than others in the patch, which provides concealment from nest predators and provides singing perches used by territorial males (Wiens and others, 1987; Rotenberry and others, 1999).

Sagebrush sparrows generally breed in more open shrublands than Brewer's sparrows, typically where the shrubs are relatively evenly spaced (Martin and Carlson, 1998). Although they are closely tied to sagebrush shrublands, they also nest in desert shrublands lacking sagebrush. Nest concealment and microclimate seem to play interactive roles in nest-site selection, as nests on the ground are generally in dense bunchgrasses under shrubs, and shrubs used for nesting are usually taller and denser than surrounding shrubs (Martin and Carlson, 1998).

Like Brewer's sparrows, sage thrashers prefer relatively dense shrublands, and their densities increase with increasing sagebrush cover, total shrub cover, and shrub patch size. Their densities decline, however, with increasing landscape homogeneity, with reductions of sagebrush cover to <10 percent, and with increasing grass cover (Reynolds and others, 1999; Vander Haegen and others, 2000). Densities also correlate positively with loamy, shallow soils, but not with sandy soils, indicating potential direct and indirect influences of soils on habitat structure and (or) associated prey populations. As with the other two SOS species, at the nest-site scale sage thrashers select shrubs that are taller than nearby shrubs and have wider crowns.

Brewer's sparrows forage primarily in tall shrubs, whereas the other two SOS species usually forage on the ground (Rotenberry and others, 1999). All three species are omnivorous, but the proportion of arthropods to seeds or other plant materials consumed varies by species and season. Brewer's and sagebrush sparrows (and presumably sage thrashers) will drink free water

if available; however, they can exist without free water (Martin and Carlson, 1998; Rotenberry and others, 1999).

Primary predators of SOS adults, nestlings, and eggs include loggerhead shrikes and ground squirrels, but they are also preyed on by falcons, corvids, weasels, and snakes. Overall, nest predation is the primary cause of nesting failure among SOS species (Martin and Carlson, 1998; Reynolds and others, 1999; Rotenberry and others, 1999). When populations of ground squirrels are high, nest predation on SOS eggs and nestlings has been observed to increase accordingly. All three SOS species are also susceptible to brood parasitism by brown-headed cowbirds, but the species vary in their responses to cowbird eggs. Sage thrashers eject cowbird eggs from their nests; sagebrush sparrows may either accept or abandon parasitized nests; and Brewer's sparrows generally abandon parasitized nests (Martin and Carlson, 1998; Reynolds and others, 1999; Rotenberry and others, 1999). Reported rates of parasitism among Brewer's sparrows are as high as 52 percent (Rotenberry and others, 1999).

Landscape Structure and Dynamics

Landscapes that support the greatest densities of breeding SOS include large tracts of mature big sagebrush characterized by a high percentage of shrub (foliar) cover with low-stem density; high density of potential nest sites; somewhat heterogeneous vertical and horizontal structure and shrub age; relatively little bare ground; and a scattered component of perennial bunchgrasses and forbs (Martin and Carlson, 1998; Paige and Ritter, 1999; Reynolds and others, 1999; Rotenberry and others, 1999; Chalfoun and Martin, 2007). The sagebrush sparrow also avoids patch edges and is considered area sensitive (Hansley and Beauvais, 2004).

The spatial configuration and long-term dynamics of historical sagebrush shrublands were influenced by fires (see Chapter 11—Sagebrush Steppe for a discussion of fire). Historically, fires in sagebrush shrublands were infrequent but extensive (Bukowski and Baker, 2013). The responses of SOS species to fire likely depend on burn size and time since fire. In the short-term, fire removes shrub cover, leading to a decrease in density and nesting success of Brewer's sparrows (Rotenberry and others, 1999). It may take many decades for sagebrush, and consequently SOS populations, to recover from large fires. Prior to Euro-American settlement, however, the broad expanse of sagebrush shrublands likely helped to buffer SOS populations from infrequent habitat losses during extensive fire years.

Change Agents

Development

Energy and Infrastructure

The SOS species appear to differ in their responses to energy development. In southwestern Wyoming, abundance of Brewer's and sagebrush sparrows decreased with increasing gas well density (Gilbert and Chalfoun, 2011). This effect is stronger in developing fields, where levels of human activities are typically greater than they are in older fields. In contrast, sage thrasher abundance did not decrease with increasing gas well density, although it is unclear whether this was due to strong breeding site fidelity or a greater tolerance to the direct and indirect effects of energy development (Gilbert and Chalfoun, 2011). Preliminary results from an associated study in the same region indicate that nest survival of all three species also

decreases with increasing habitat loss from natural gas development, whereas the densities of rodents that are the most common nest predators (mice, chipmunks, and ground squirrels) increase with increasing natural gas development (Anna Chalfoun, Research Wildlife Ecologist, University of Wyoming Cooperative Extension Unit; unpub. data, March 2013). In southwestern Wyoming, densities of Brewer's and sagebrush sparrows also decreased within 100 meters (m) (328.1 feet [ft]) of roads associated with energy development (Ingelfinger and Anderson, 2004), and densities were negatively related to traffic volume. However, traffic volume alone did not fully account for the decreases; thus, it is suspected that noise levels and edge effects associated with the energy-development roads also negatively affected these birds (Ingelfinger and Anderson, 2004).

The effects of wind turbines in sagebrush steppe on breeding densities or productivity of SOS are poorly understood. Songbirds in general frequently collide with tall objects, including wind turbines, power lines, and communications towers (Manville, 2005; Drewitt and Langston, 2008), but the conditions that promote collisions are still debated. Low cloud ceilings at night tend to force migrating birds to lower altitudes, where birds are more likely to encounter and become disoriented by the light emitted from aviation warning lights (Poot and others, 2008; Gehring and others, 2009). Wind-energy facilities also create a "barrier effect" that restricts animal movements (see http://www.fws.gov/windenergy/docs/Barrier_Effect.pdf), and birds have been found to avoid these facilities by up to 1 kilometer (km) (0.62 miles [mi]), particularly in open habitats such as grasslands and shrublands (Pitman and others, 2005; Pearce-Higgins and others, 2009).

Agricultural Activities

Agricultural conversion from sagebrush steppe to cropland causes direct loss and fragmentation of SOS habitat (Knick and others, 2003). Agricultural conversion, its associated infrastructure (such as above-ground irrigation equipment), and fragmentation also create or provide movement corridors, lookout perches, and foraging areas for SOS nest predators and cowbirds, thus increasing nesting failure and (or) reducing productivity among SOS in nearby sagebrush habitats (Knick and others, 2003).

Overgrazing by livestock and trampling can reduce the grass and forb components of the sagebrush system, alter composition of plant communities and associated arthropod fauna consumed by SOS, and it can result in trampled nests (Knick and others, 2003). Brewer's sparrow exhibits a neutral or negative reponse to grazing (Saab and others, 1995). Cowbird parasitism is also promoted when sagebrush habitats are supplanted by grasses, especially in proximity to feedlots, watering sites, and other animal-concentrating infrastructure associated with the livestock industry (Knick and others, 2003).

Altered Fire Regime and Invasive Species

Recent evidence indicates that current fire regimes in the Wyoming Basin appear to be fairly similar to historical regimes, although previous authors have suggested that the number of fires and total area burned have increased in the last 30 years in the Basin (Miller and others, 2011; Bukowski and Baker, 2013; see Chapter 11—Sagebrush Steppe). The presence of invasive grasses can increase fire frequency, size, and intensity, as well as alter the composition and structure of sagebrush understory in habitats used by SOS. Sagebrush sparrows have been found to abandon previously occupied habitats once they were supplanted by cheatgrass (Martin and

Carlson, 1998), and sage thrashers are no longer found in sagebrush habitats supplanted by cheatgrass (Reynolds and others, 1999).

Climate Change

Changes in precipitation could affect SOS, but projections of precipitation are highly variable among climate models (see Chapter 7—Climate Analysis). If winter precipitation increases throughout the sagebrush steppe, as some models project (Karl and others, 2009), Brewer's sparrow productivity could increase. Overall, measures of Brewer's sparrow productivity, such as clutch and brood size and fledging success, were strongly affected by variation in prior winter weather, and the number of Brewer's sparrow fledglings per nest correlated positively with precipitation levels in the previous winter (Rotenberry and others, 1999). Less is known about the effects of climate trends or variability on the productivity of other SOS or potential effects of climate change on the nonbreeding habitats used by SOS.

Rapid Ecoregional Assessment Components Evaluated for Sagebrush-Obligate Songbirds

A generalized, conceptual model was used to highlight some of the key ecological attributes and Change Agents affecting s (fig. 26–1). Key ecological attributes addressed by the REA include (1) the distribution of baseline sagebrush-obligate songbird habitat, (2) landscape structure (patch sizes and structural connectivity), and (3) landscape dynamics (fire occurrence; table 26–1). The Change Agents evaluated include development and climate change (table 26–2). Ecological values and risks used to assess the conservation potential for SOS habitat by township are summarized in table 26–3. Core and Integrated Management Questions and the associated summary maps and graphs are provided in table 26–4.

Methods Overview

We developed general habitat models for each species using occupancy data collected between 2009 and 2012 in Wyoming as part of the Integrated Monitoring in Bird Conservation Regions program (White and others, 2012). A suite of occupancy models with different environmental covariates were evaluated using program MARK (White and Burnham, 1999), and the top model for each species was used to model their breeding distribution. The map of potential habitat used parameter threshold values that included 90 percent of the locations (omission rate of 10 percent). This omission rate minimized commission errors derived from a comparison with independent datasets from Idaho Fish and Game, Montana Natural Heritage Program, Utah Natural Heritage Program, and Wyoming Natural Diversity Database. The sagebrush-obligate songbird distribution map was derived from the occurrence of at least one species to quantify attributes of breeding habitat (hereafter habitat).

We assessed development levels in SOS habitat using the Terrestrial Development Index (TDI) map, and then used the resulting output to calculate patch size and connectivity metrics. We mapped the structural connectivity of relatively undeveloped habitat at three interpatch distances derived from connectivity analysis: local (2.07 km; 1.29 mi), landscape (3.15 km; 1.96 mi), and regional (3.69 km; 2.29 mi) levels. We used development levels to identify areas that may function as barriers or corridors by overlaying relatively undeveloped habitat patches on the TDI map. The perimeters of fires in SOS habitat since 1980 were compiled from several data sources to assess fire frequency and extent (table 26–1).

Landscape-level ecological values (area of habitat) and risk (TDI score) were compiled into an overall index of conservation potential for each township (table 26–3). Conservation potential was summarized by township based on overall landscape-level values and risks (table 26–3). Landscape-level values and risks, and conservation potential rankings are intended to provide a synthetic overview of the geospatial datasets developed to address Core Management Questions in the REA. Because rankings are very sensitive to the input data used and the criteria used to develop the ranking thresholds, they are not intended as stand-alone maps. Rather, they are best used as an initial screening tool to compare regional rankings in conjunction with the geospatial data for Core Management Questions and information on local conditions that cannot be determined from regional REA maps. See Chapter 2—Assessment Framework and the Appendix for additional details on the methods.

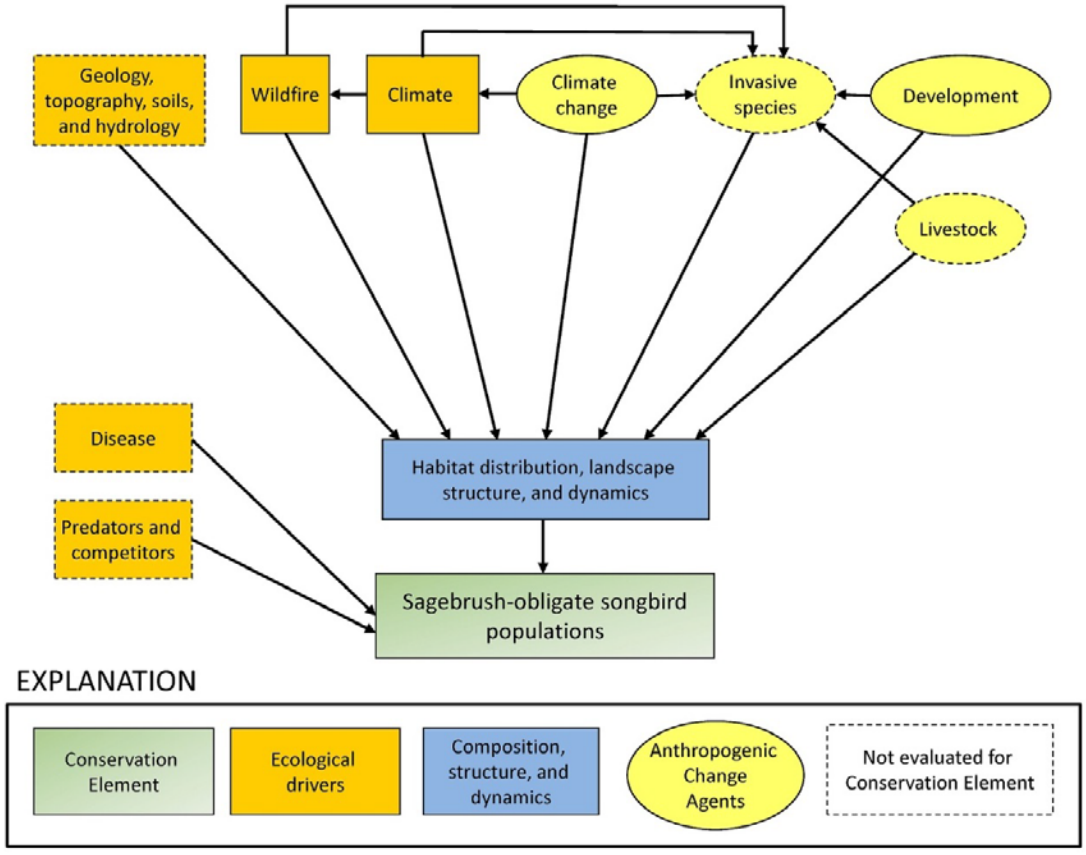

Figure 26–1. Generalized conceptual model of sagebrush-obligate songbird (SOS) habitat for the Wyoming Basin Rapid Ecoregional Assessment (REA). Biophysical attributes and ecological processes regulating the occurrence, structure, and dynamics of SOS populations and habitat are shown in orange rectangles; additional ecological attributes are shown in blue rectangles; and anthropogenic Change Agents that affect key ecological attributes are shown in yellow ovals. The dashed lines indicate components not addressed by the REA. Livestock and invasive plants are Change Agents that were not evaluated due to the lack of regionwide data.

Table 26–1. Key ecological attributes and associated indicators of baseline sagebrush-obligate songbird breeding habitat[1] for the Wyoming Basin Rapid Ecoregional Assessment.

[km, kilometer; mi, mile]

Attributes	Variables	Indicators
Amount and distribution of habitat	Total area	Habitat distribution derived from vegetation and abiotic variables[2]
Landscape structure	Patch size	Patch-size frequency distribution
	Structural connectivity[3]	Interpatch distances that provide an index of structural connectivity for baseline patches at local (0.09 km; 0.62 mi), and landscape and regional (0.27 km; 0.17 mi) levels
Landscape dynamics	Fire occurrence[4]	Locations of fires and annual area burned since 1980

[1] Baseline conditions are used as a benchmark to evaluate changes in the amount and landscape structure of habitat due to Change Agents. Baseline conditions are defined as the potential current distribution of sagebrush-obligate songbird habitat derived from abiotic and biotic variables without explicit inclusion of Change Agents (see Chapter 2—Assessment Framework).

[2] Habitat modeled using species occupancy; occupancy data from Rocky Mountain Bird Observatory and U.S. Geological Survey; habitat variables derived from SAGEMAP (Hanser and others, 2011) and Homer and others (2012).

[3] Structural connectivity refers to the proximity of patches at local, landscape, and regional levels but does not reflect species-specific measures of connectivity. See Chapter 2—Assessment Framework.

[4] See Wildland Fire section in the Appendix.

Table 26–2. Anthropogenic Change Agents and associated indicators influencing sagebrush-obligate songbird habitat for the Wyoming Basin Rapid Ecoregional Assessment.

[km^2, square kilometer; mi^2, square mile; km, kilometer; mi, mile]

Change Agents	Variables	Indicators
Development	Terrestrial Development Index[1]	Percent of sagebrush-obligate songbird habitat in seven development classes using a 16-km^2 (6.18-mi^2) moving window
		Patch-size frequency distribution for sagebrush-obligate songbird habitat that is relatively undeveloped or has low development scores compared to baseline habitat
		Interpatch distances that provide an index of patch structural connectivity for relatively undeveloped patches at local (2.07 km; 1.29 mi), landscape (3.15 km; 1.96 mi), and regional (3.69 km; 2.29 mi) levels
Climate change	Potential changes in sagebrush shrublands	See Chapter 11—Sagebrush Steppe

[1] See Chapter 2—Assessment Framework.

Table 26–3. Landscape-level ecological values and risks for sagebrush-obligate songbird habitat. Ranks were combined into an index of conservation potential for the Wyoming Basin Rapid Ecoregional Assessment.

		Relative rank			
	Variables[1]	Lowest	Medium	Highest	Description[2]
Values	Area	<49	49–92	>92	Percent of township modeled as sagebrush-obligate songbird habitat
Risks	Terrestrial Development Index (TDI)	<1	1–3	>3	Mean TDI score by township

[1] Township was used as the analysis unit for conservation potential on the basis of input from the Bureau of Land Management. A minimum area threshold of total area per township was established for sagebrush-obligate songbird habitat to minimize the effects of extremely small areas and put greater emphasis on large areas (see table A–19 in Appendix).

[2] See tables 26–1 and 26–2 for description of variables.

Table 26–4. Management Questions addressed for sagebrush-obligate songbirds for the Wyoming Basin Rapid Ecoregional Assessment.

Core Management Questions	Results
Where is baseline sagebrush-obligate songbird habitat, and what is the total area?	Figure 26–2
Where does development pose the greatest threat to baseline sagebrush-obligate songbird habitat, and where are the relatively undeveloped areas?	Figures 26–3 and 26–4
How has development fragmented baseline sagebrush-obligate songbird habitat, and where are the large, relatively undeveloped patches?	Figures 26–5 and 26–6
How has development affected structural connectivity of sagebrush-obligate songbird habitat relative to baseline conditions?	Figure 26–7
Where are potential barriers and corridors that may affect animal movements among relatively undeveloped habitat patches?	Figure 26–8
Where have recent fires occurred in sagebrush-obligate songbird habitat, and what is the total area burned per year?	Figures 26–9 and 26–10
Integrated Management Questions	**Results**
How does risk from development vary by land ownership or jurisdiction for sagebrush-obligate songbird habitat?	Figure 26–11
Where are the townships with the greatest landscape-level ecological values?	Figure 26–12
Where are the townships with the greatest landscape-level risks?	Figure 26–12
Where are the townships with the greatest conservation potential?	Figure 26–13

Key Findings for Management Questions

Where is baseline and sagebrush-obligate songbird habitat, and what is the total area (fig. 26–2)?

- Baseline habitat total for (*A*) Brewer's sparrow is 97,141 square kilometers (km^2) (37,506.35 square miles [mi^2]) or 54.5 percent of the project area; (*B*) sagebrush sparrow is 72,645 km^2 (28,048.39 mi^2) or 40.7 percent of the project area; and (*C*) sage thrasher is 89,429 km^2 (34,528.73 mi^2) or 50.1 percent of the project area.
- Total baseline habitat for all three SOS species combined is 103,537 km^2 (39,975.86 mi^2) or 58 percent of the project area and there is a close correspondence in the modeled distributions of SOS species.
- There is a high degree of overlap among species in areas where sagebrush shrublands are dominant (fig. 26−2*D*). In the Bighorn Basin and along the ecoregion perimeter, where the distribution of sagebrush is more heterogeneous, the number of SOS species is predicted to be lower as the species may respond differently to spatial heterogeneity at those scales.

Where does development pose the greatest threat to baseline sagebrush-obligate songbird habitat, and where are the relatively undeveloped areas (figs. 26–3 and 26–4)?

- The TDI scores for baseline SOS habitat are similar to those for sagebrush shrublands overall (see Chapter 11—Sagebrush Steppe). Only 23.8 percent of baseline habitat is classified as relatively undeveloped (TDI score ≤1 percent) (figs. 26–3 and 26–4).
- Approximately 20 percent of SOS habitat in the Basin has high levels of development as indicated by TDI scores >5 percent (fig. 26–4).

How has development fragmented baseline sagebrush-obligate songbird habitat, and where are the large, relatively undeveloped patches (figs. 26–5 and 26–6)?

- Development has effectively fragmented SOS habitat into smaller patches relative to baseline conditions. All patches of relatively undeveloped SOS habitat are <5,000 km^2 (1,930.51 mi^2), whereas half of baseline SOS habitat occurs within patches >5,000 km^2 (figs. 26–5 and 26–6).
- Several large areas of relatively undeveloped habitat >1,000 km^2 (386.1 mi^2) remain, all of which are located in the southern portion of the Basin (fig. 26–6). Most of the relatively undeveloped habitat occurred in numerous isolated patches.

How has development affected structural connectivity of sagebrush-obligate songbird habitat relative to baseline conditions (fig. 26–7)?

- Baseline SOS habitat is highly connected, with local-scale connectivity occurring at a 0.09-km (0.62-mi) interpatch distance, and landscape- and regional-scale connectivity occurring at a 0.27 km (0.1 mi) interpatch distance (fig. 26–7).
- Development has greatly diminished the structural connectivity of SOS habitat. Relatively undeveloped habitat is highly fragmented, and local-scale connectivity (2.07 km [1.29 mi]) is double that of baseline conditions. Interpatch distances for landscape- (3.15 km [1.96 mi]) and regional-scale connectivity (3.69 km [2.29 mi]) for relatively undeveloped habitat are more than an order of magnitude greater than for baseline conditions.

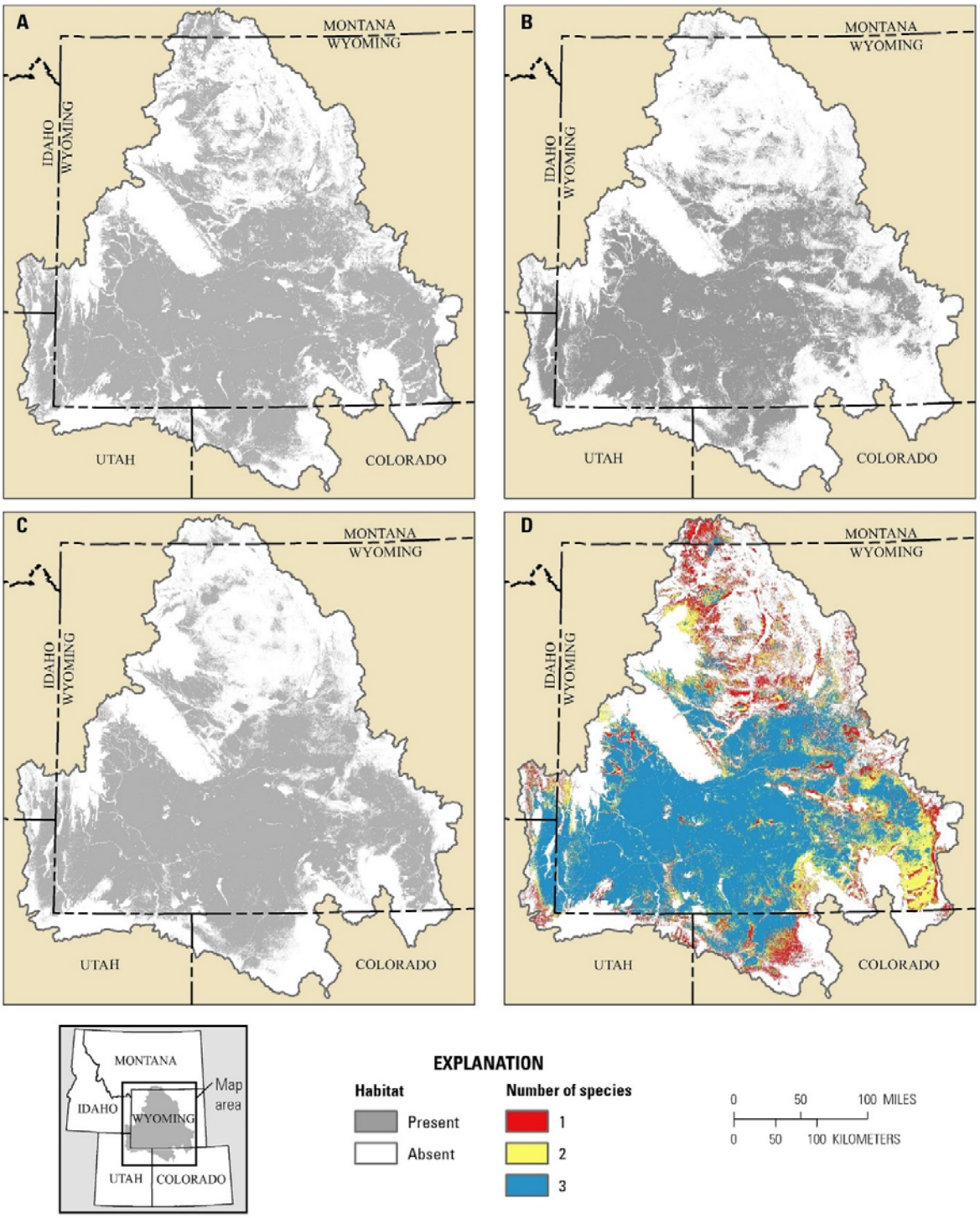

Figure 26–2. Distribution of baseline sagebrush-obligate songbird habitat in the Wyoming Basin Rapid Ecoregional Assessment project area derived from occupancy models for (*A*) Brewer's sparrow, (*B*) sagebrush sparrow, and (*C*) sage thrasher. (*D*) Number of sagebrush-obligate songbird species, derived from distribution maps *A*−*C*, is also illustrated.

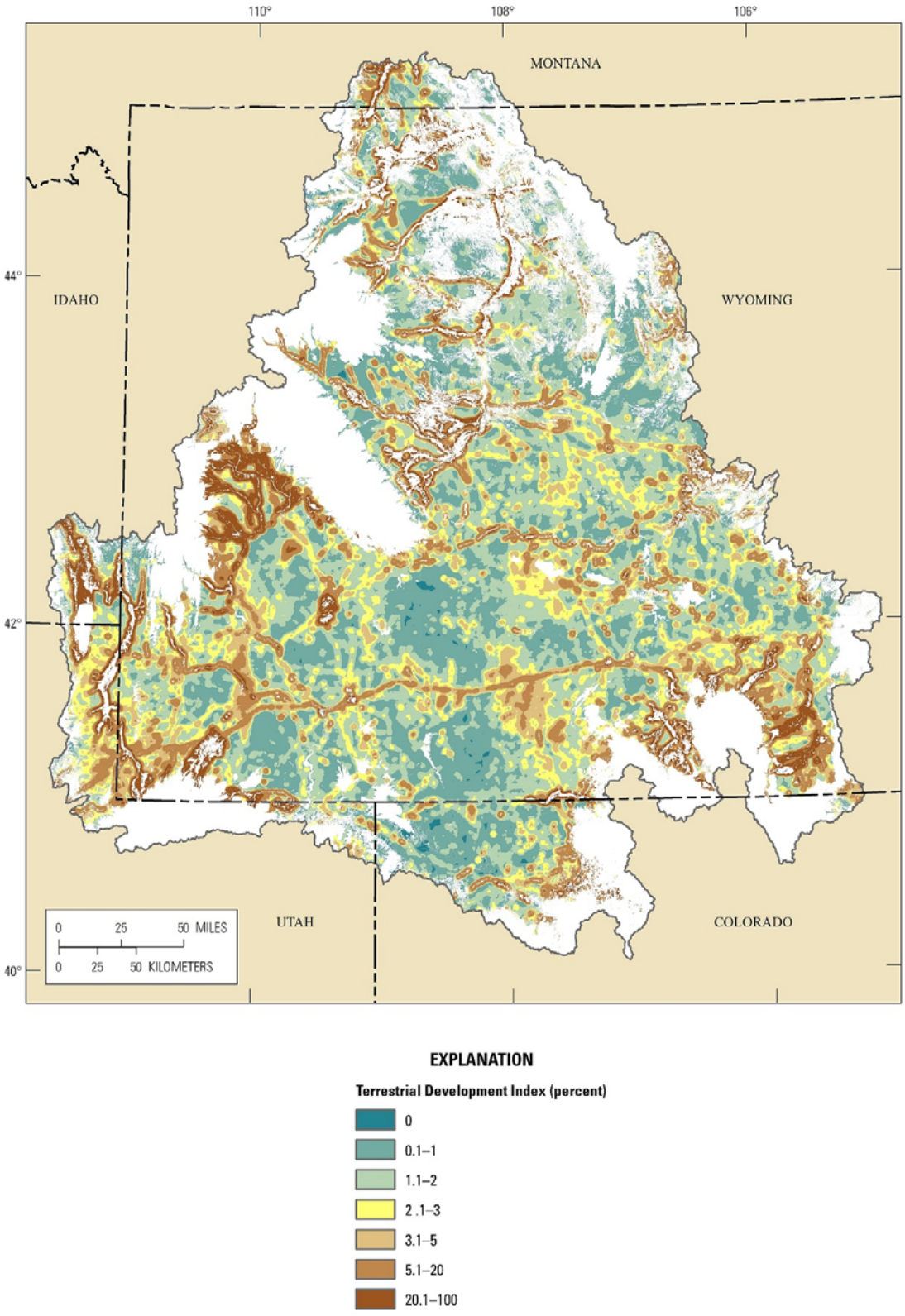

Figure 26–3. Terrestrial Development Index scores for sagebrush-obligate songbird habitat in the Wyoming Basin Rapid Ecoregional Assessment project area.

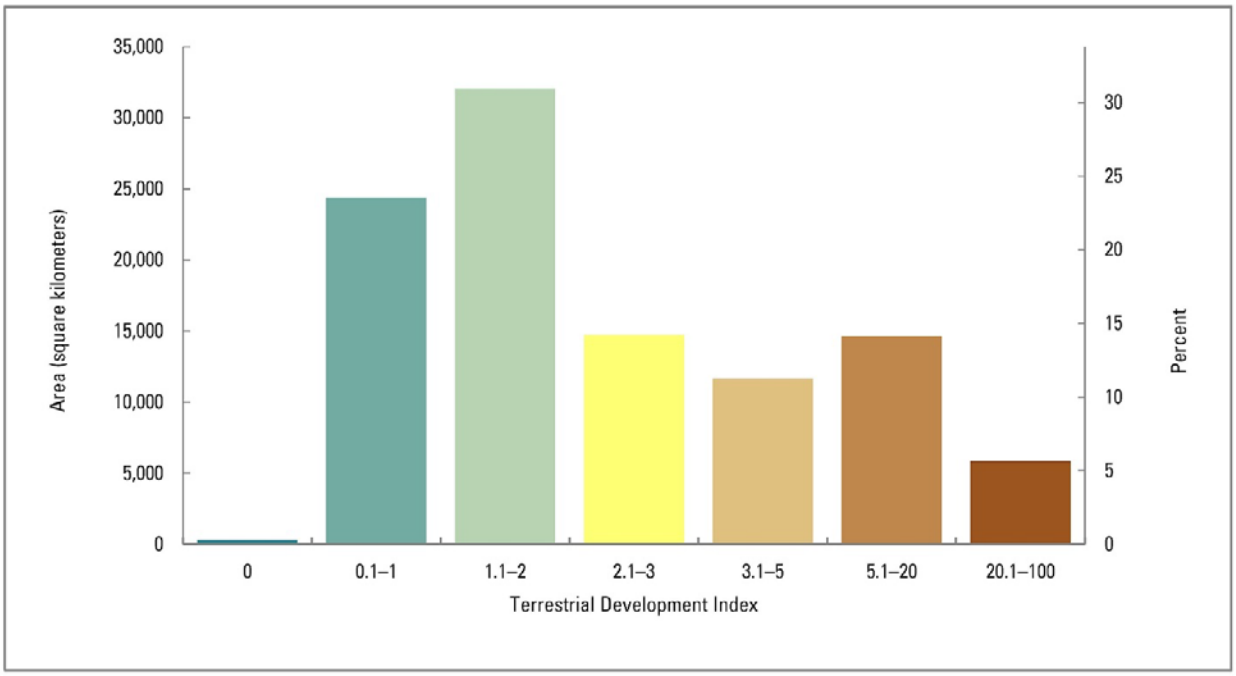

Figure 26–4. Area and percent of sagebrush-obligate songbird habitat as a function of the Terrestrial Development Index in the Wyoming Basin Rapid Ecoregional Assessment project area.

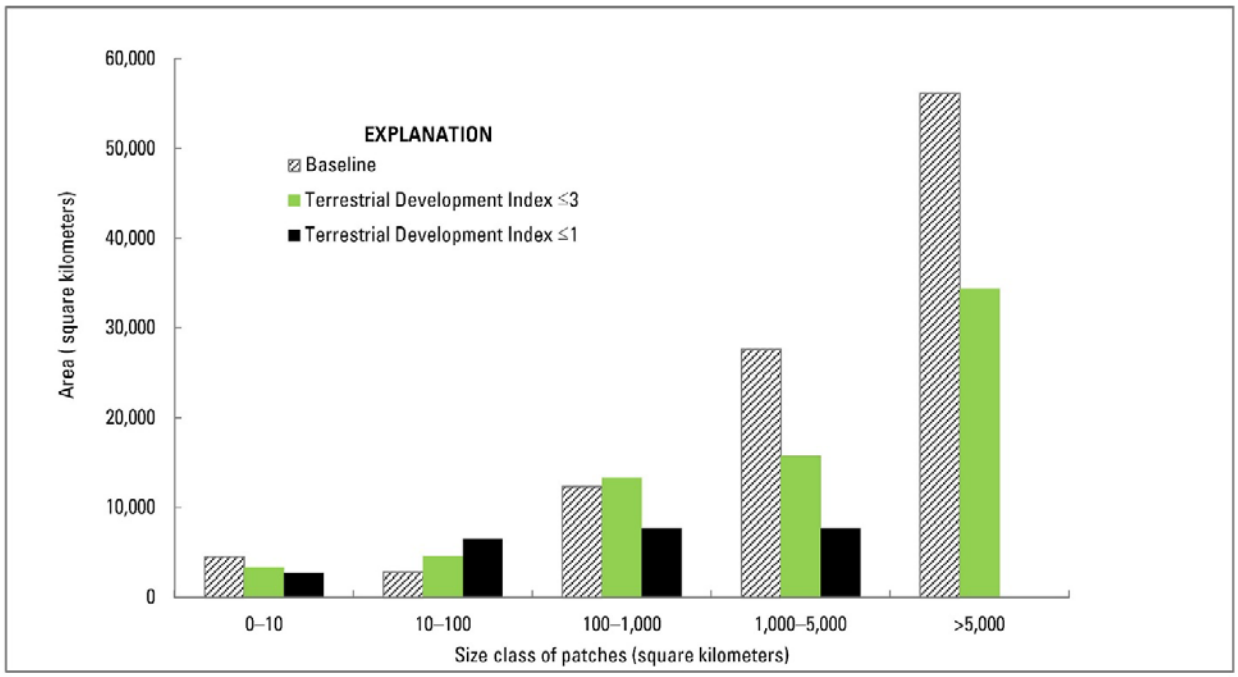

Figure 26–5. Patch sizes of sagebrush-obligate songbird habitat as a function of patch size for baseline conditions and for two development levels: (1) Terrestrial Development Index (TDI) score <3 percent, and (2) TDI score ≤1 percent (relatively undeveloped areas) in the Wyoming Basin Rapid Ecoregional Assessment project area.

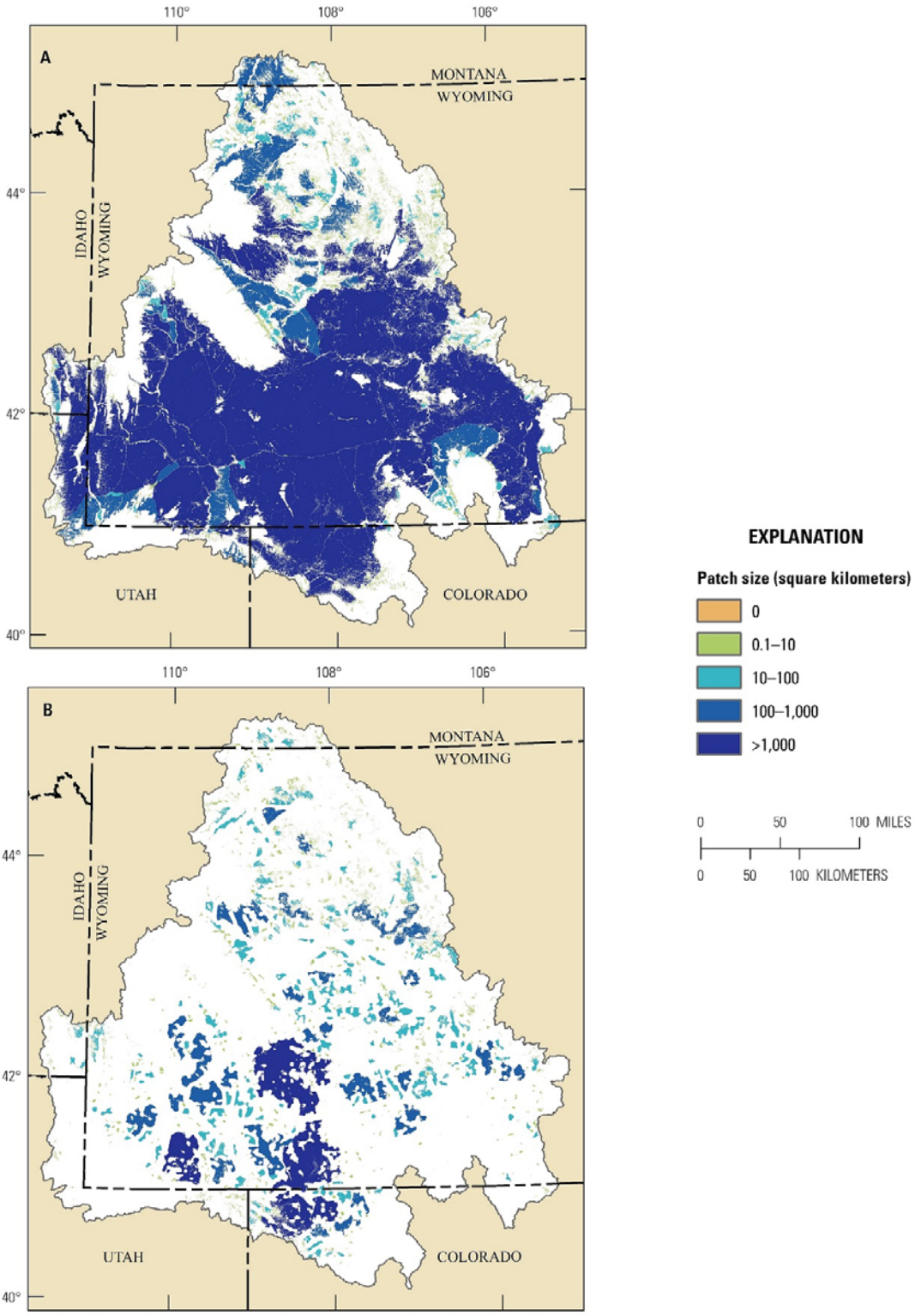

Figure 26–6. Patch sizes of sagebrush-obligate songbird habitat in the Wyoming Basin Rapid Ecoregional Assessment project area for (*A*) baseline conditions and (*B*) relatively undeveloped areas (Terrestrial Development Index score ≤1 percent).

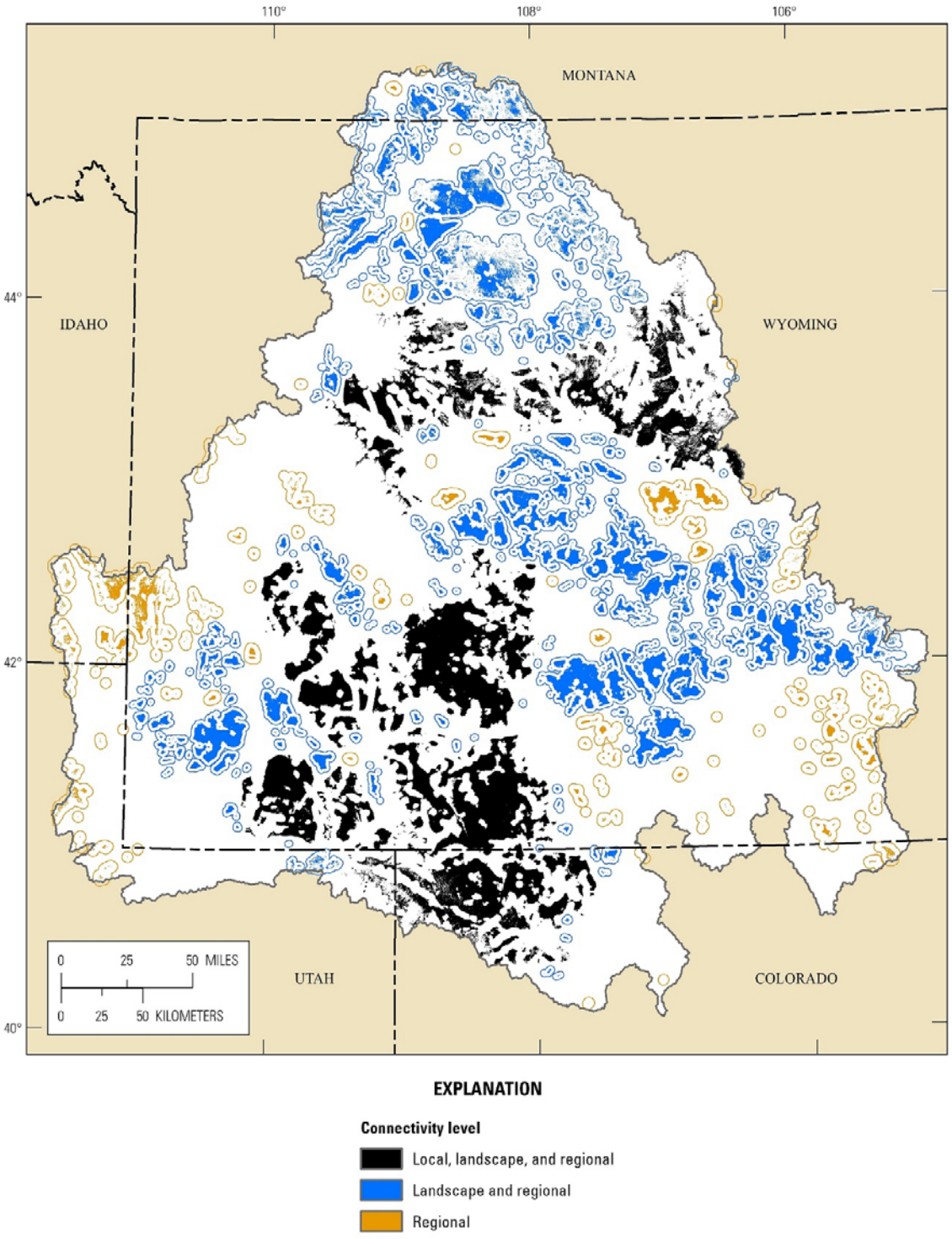

Figure 26–7. Structural connectivity of relatively undeveloped sagebrush-obligate songbird habitat in the Wyoming Basin Rapid Ecoregional Assessment project area. Black polygons include large and highly connected habitat patches. Blue polygons include habitat patches that contribute to both landscape and regional connectivity. Orange polygons represent isolated clusters of patches surrounded by developed areas or other cover types.

Where are potential barriers and corridors that may affect animal movements among relatively undeveloped habitat patches (fig. 26–8)?

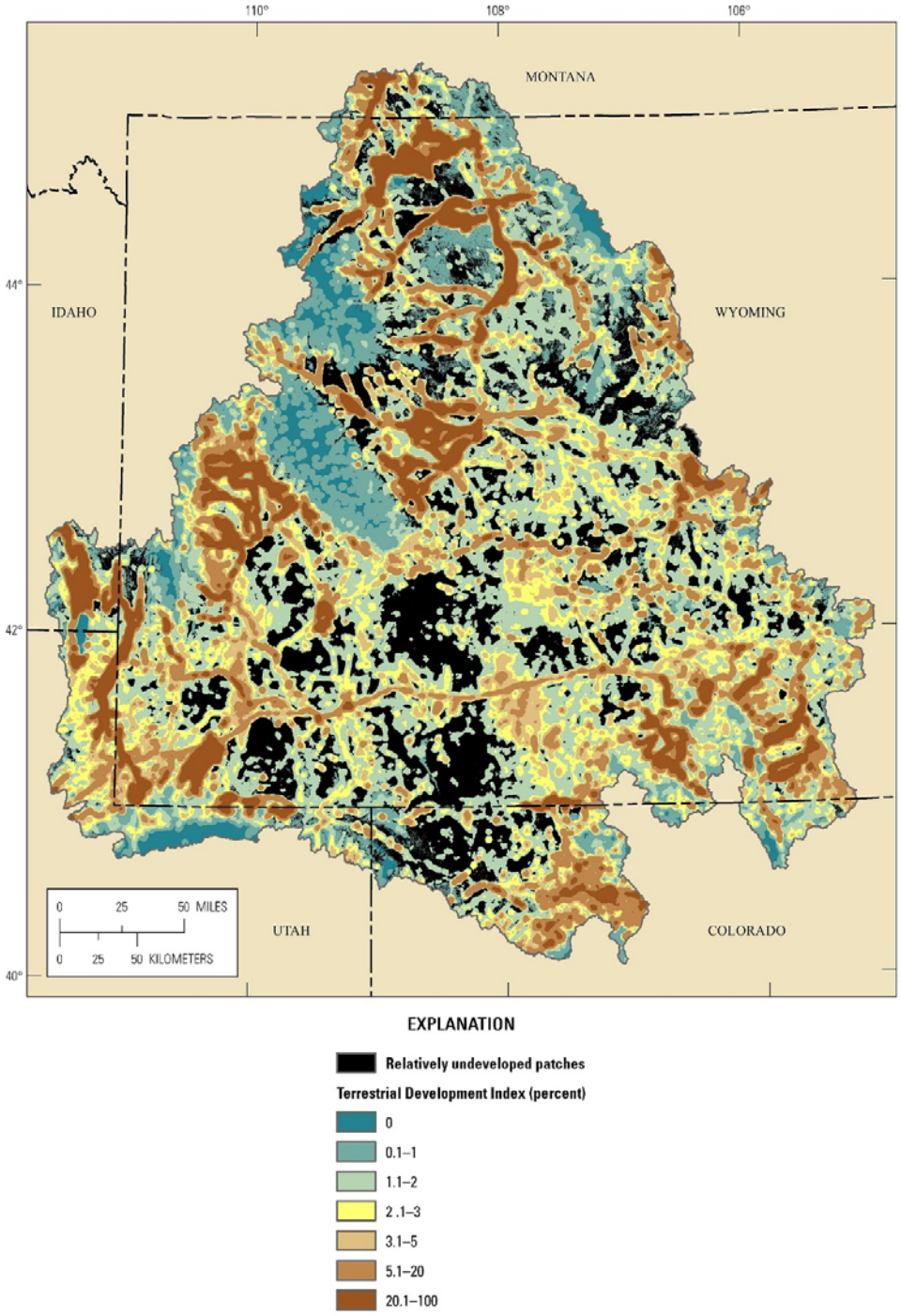

Figure 26–8. Potential barriers and corridors as a function of Terrestrial Development Index (TDI) score for lands surrounding relatively undeveloped sagebrush-obligate songbird habitat. Higher TDI scores (for example, >5 percent) represent potential barriers to movement among relatively undeveloped habitat patches. Lower TDI scores (for example, <2 percent) represent potential corridors for movements among patches.

Where have recent fires occurred in sagebrush-obligate songbird habitat, and what is the total area burned per year (figs. 26–9 and 26–10)?

- Cumulatively, 2.4 percent (2,529 km^2 [976.45 mi^2]) of SOS habitat has burned since 1980 (figs. 26–9 and 26–10).
- In most years, fires are small and burn only a small portion of SOS habitat, with most of the area burned by a large fire occurring in 2000 (fig. 26–9; see Chapter 5—Wildland Fire for more comprehensive discussion of fire).

How does risk from development vary by land ownership or jurisdiction for sagebrush-obligate songbird habitat (table 26–5, fig. 26–11)?

- Approximately half of baseline SOS habitat occurred on BLM lands and another third is privately owned (table 26–5).
- Baseline SOS habitat on BLM and private lands have a lower proportion of highly developed land than all other land ownerships (fig. 26–11).
- Private, conserved lands have relatively high levels of development.

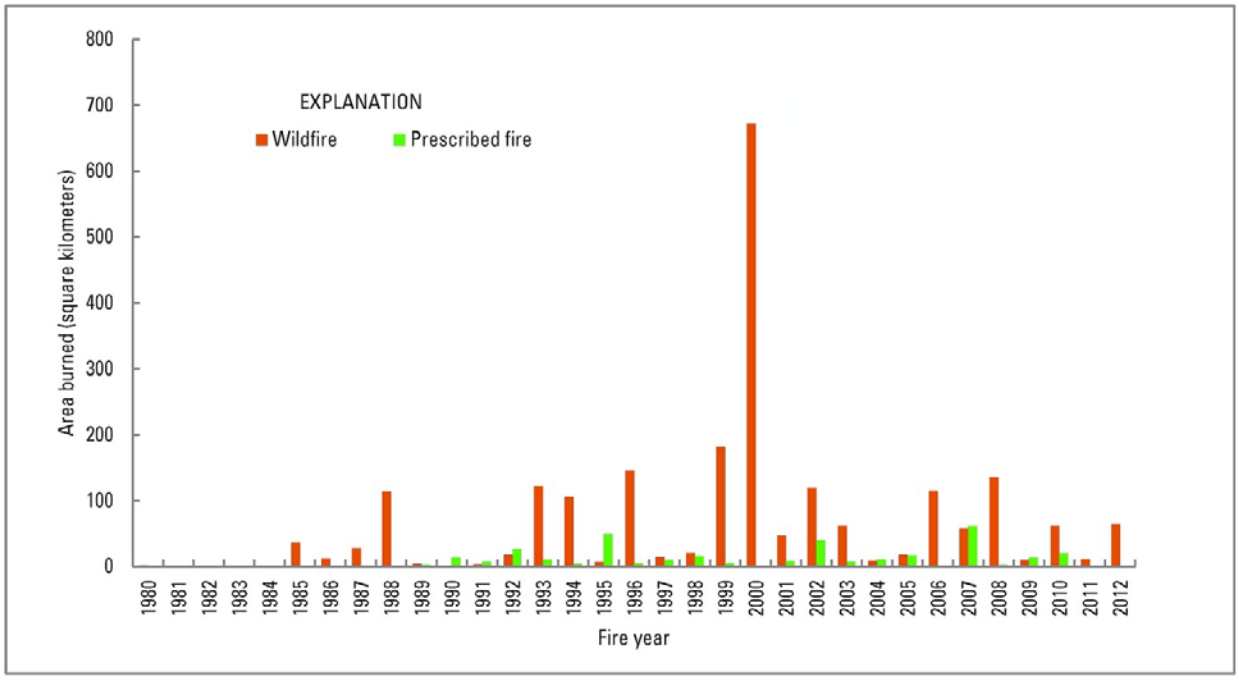

Figure 26–9. Annual area burned by wildfires and prescribed fires in baseline sagebrush-obligate songbird habitat since 1980 in the Wyoming Basin project area.

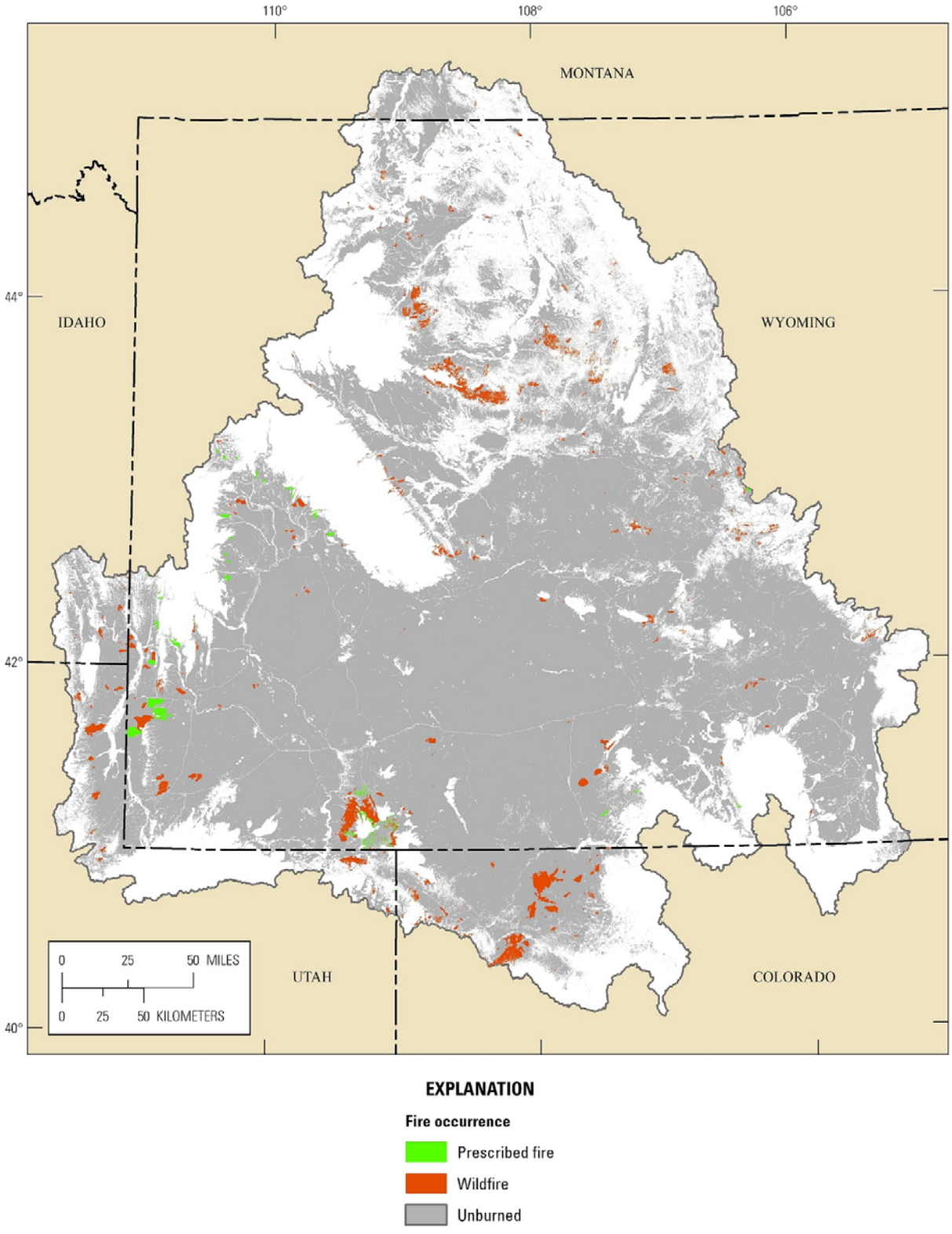

Figure 26–10. Occurrence of wildfires and prescribed fires in baseline sagebrush-obligate songbird habitat since 1980 in the Wyoming Basin Rapid Ecoregional Assessment project area.

Table 26–5. Area and percent of sagebrush-obligate songbird habitat by ownership or jurisdiction in the Wyoming Basin Rapid Ecoregional Assessment project area.

[km^2, square kilometer]

Ownership or jurisdiction	Area (km^2)	Percent of area
Bureau of Land Management	53,548	51.7
Private	34,543	33.4
State/County	6,893	6.7
Tribal	4,401	4.3
Other Federal[1]	2,432	2.3
Forest Service[2]	1,049	1.0
Private conservation	617	0.6

[1] National Park Service, Department of Defense, Department of Energy, Bureau of Reclamation, and U.S. Fish and Wildlife Service.

[2] U.S. Department of Agriculture Forest Service.

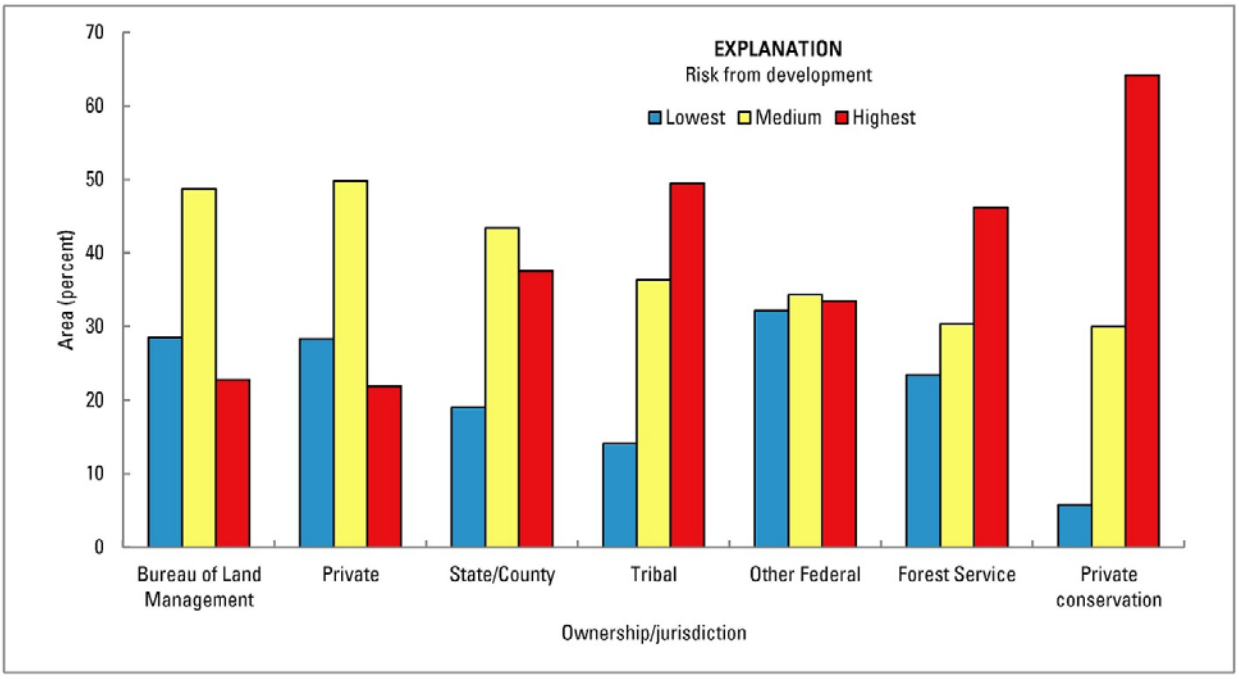

Figure 26–11. Relative ranks of risk from development, by land ownership or jurisdiction, for sagebrush-obligate songbird habitat in the Wyoming Basin Rapid Ecoregional Assessment project area. Rankings are lowest (Terrestrial Development Index [TDI] score <1 percent), medium (TDI score 1−3 percent), and highest (TDI score >3 percent). [Forest Service, U.S. Department of Agriculture Forest Service]

Where are the townships with the greatest landscape-level ecological values, and where are the townships with the greatest landscape-level risks (fig. 26–12)?

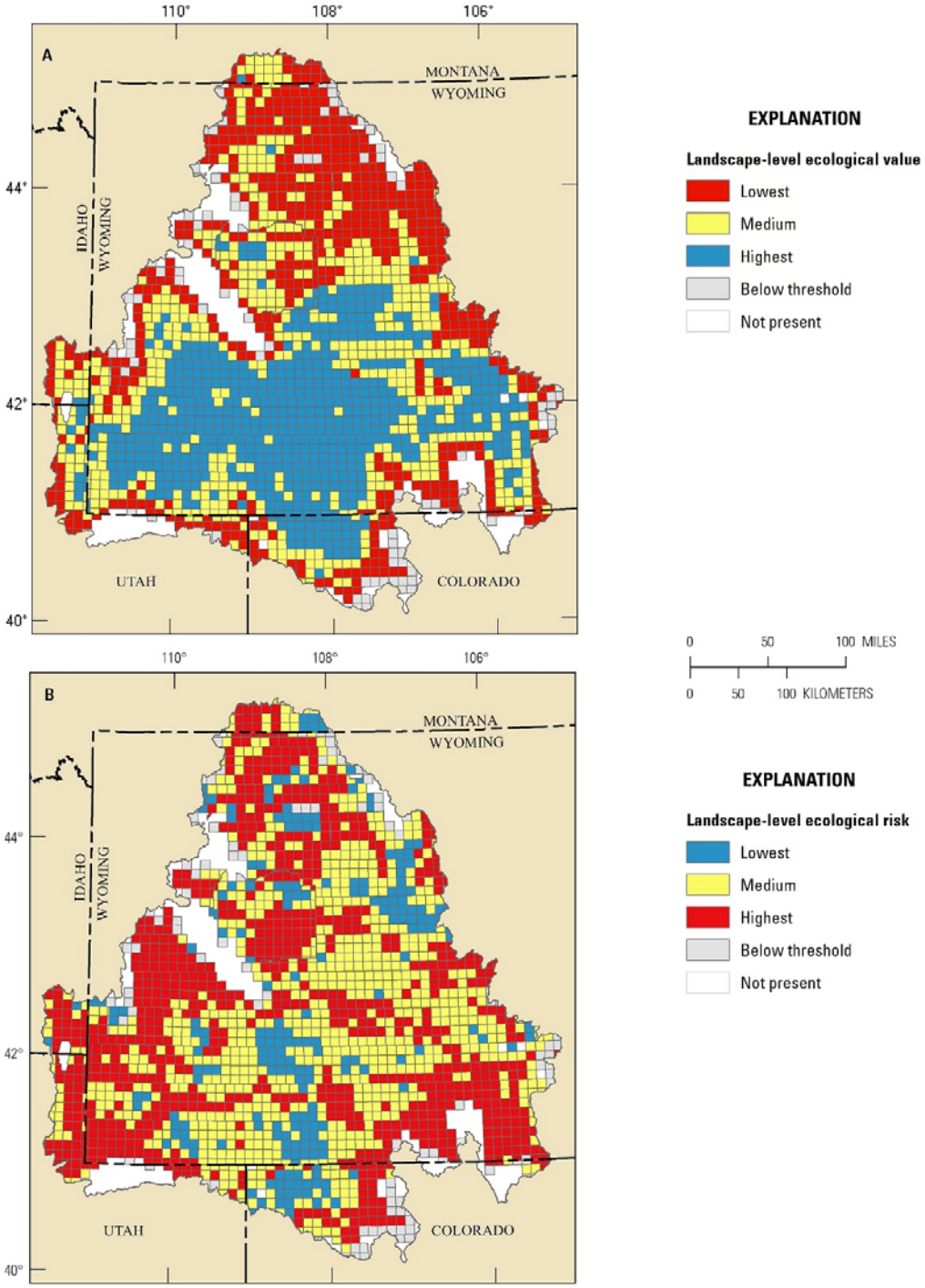

Figure 26–12. Ranks of landscape-level ecological values and risks for sagebrush-obligate songbird habitat, summarized by township, in the Wyoming Basin Rapid Ecoregional Assessment project area. (*A*) Landscape-level values based on habitat area and (*B*) landscape-level risks based on Terrestrial Development Index (see table 26–3 for overview of methods).

Where are the townships with the greatest conservation potential (fig. 26–13)?

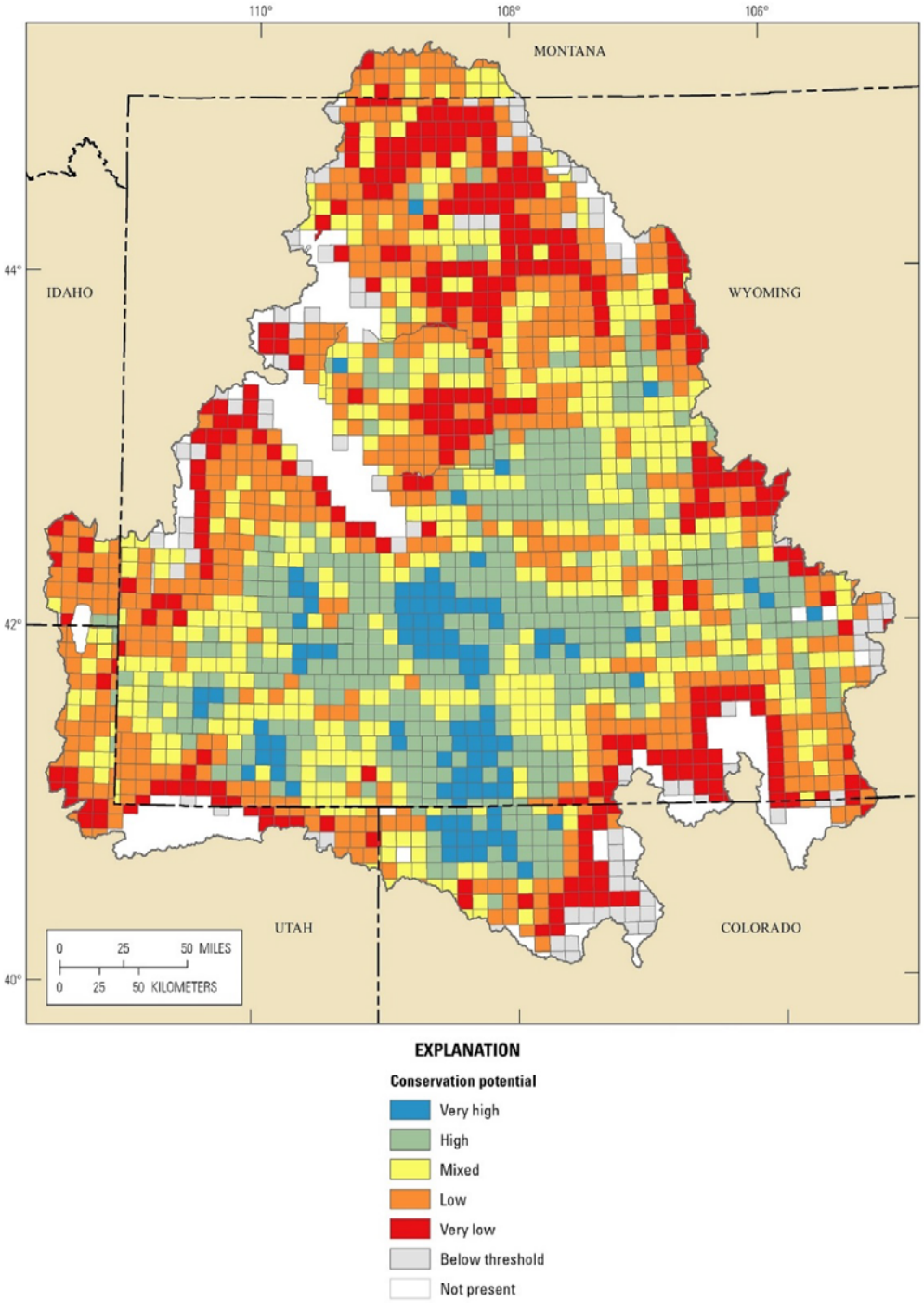

Figure 26–13. Conservation potential of sagebrush-obligate songbird habitat, summarized by township, in the Wyoming Basin Rapid Ecoregional Assessment project area. Highest conservation potential identifies areas that have the highest landscape-level values and the lowest risks. Lowest conservation potential identifies areas with the lowest landscape-level values and the highest risks. Ranks of conservation potential are not intended as stand-alone summaries and are best interpreted in conjunction with the geospatial datasets used to address Core Management Questions.

Summary

Total baseline habitat for all three SOS species combined is 103,537 square kilometers (km^2) (39,975.9 square miles [mi^2]) or 58 percent of the project area, and there is a close correspondence in the distributions of sagebrush-obligate songbird (SOS) species. A total of 23 percent of their habitat is relatively undeveloped, whereas 20 percent has high levels of development as indicated by Terrestrial Development Index (TDI) scores >5 percent. Sagebrush-obligate songbird habitat is highly connected in baseline conditions, especially in the southern half of the Wyoming Baseline, but development has effectively fragmented and reduced the structural connectivity of habitat for all three species. The largest patches of relatively undeveloped SOS habitat are found northeast and southwest of Rock Springs. Previous research in Wyoming indicates that Brewer's and sagebrush sparrows may be more sensitive to energy development than sage thrasher (Gilbert and Chalfoun, 2011).

All three species are listed as Wyoming Species of Greatest Conservation Need (Wyoming Game and Fish Department, 2010) due to habitat loss, degradation, and fragmentation. The majority of the modeled SOS habitat in the Wyoming Basin is managed by the Bureau of Land Management or is on private lands, and risk from development is similar for both types of land. Some of the townships with the highest conservation potential for SOS habitat occur within areas that may function as strongholds for sagebrush shrublands under projections of climate change.

References Cited

Bukowski, B.E., and W.L. Baker, 2013, Historical fire regimes, reconstructed from land-survey data, led to complexity and fluctuation in sagebrush landscapes: Ecological Applications, v. 23, p. 546–654.

Chalfoun, A.D., and Martin, T.E., 2007, Assessments of habitat preferences and quality depend on spatial scale and metrics of fitness: Journal of Applied Ecology, v. 44, no. 5, p. 983–992.

Chalfoun, A.D., and Martin, T.E., 2009, Habitat structure mediates predation risk for sedentary prey: Experimental tests of alternative hypotheses: The Journal of Animal Ecology, v. 78, no. 3, p. 497–503.

Drewitt, A.L., and Langston, R.H.W., 2008, Collision effects of wind-power generators and other obstacles on birds: Annals of the New York Academy of Sciences, v. 1,134, no. June, p. 233–266.

Gehring, Joelle, Kerlinger, Paul, and Manville, A.M., II, 2009, Communication towers, lights, and birds: Successful methods of reducing the frequency of avian collisions: Ecological Applications, v. 19, no. 2, p. 505–514.

Gilbert, M.M., and Chalfoun, A.D., 2011, Energy development affects populations of sagebrush songbirds in Wyoming: Journal of Wildlife Management, v. 75, no. 4, p. 816–824.

Hanser, S.E., Leu, M., Knick, S.T., and Aldridge, C.L., eds., 2011, Sagebrush ecosystem conservation and management—Ecoregional assessment tools and models for the Wyoming Basins: Lawrence, Kans., Allen Press, 409 p.

Hansley, P.L., and Beauvais, G.P., 2004, Species assessment for sage sparrow (*Amphispiza belli*) in Wyoming: Cheyenne, Wyo., Wyoming Natural Diversity Database.

Homer, C., Aldridge, C.L., Meyer, D.K., and Schell, S.J., 2012, Multi-scale remote sensing sagebrush characterization with regression trees over Wyoming, USA—Laying a foundation for monitoring: International Journal of Applied Earth Observation and Geoinformation, v. 14, p. 233−244.

Ingelfinger, Franz, and Anderson, Stanley, 2004, Passerine response to roads associate with natural gas extraction in a sagebrush steppe habitats: Western North American Naturalist, v. 64, no. 3, p. 385–395.

Karl, T.R., Melillo, J.M., and Peterson, T.C., eds., 2009, Global climate change impacts in the United States: New York, N.Y., Cambridge University Press.

Knick, S.T., Dobkin, D.S., Rotenberry, J.T., Schroeder, M.A., Matthew, W., Haegen, V., and van Riper, C.R., III, 2003, Teetering on the edge or too late? Conservation and research issues for avifauna of sagebrush habitats: Condor, v. 104, no. 4, p. 611–634.

Manville, A.M., 2005, Bird strikes and electrocutions at power lines, communication towers, and wind turbines: State of the art and state of the science—Next steps toward mitigation, in Ralph, C.J. and Rich, T.D., eds., Bird Conservation Implementation and Integration in the Americas— Proceedings of the Third International Partners in Flight Conference, March 20–24, 2002, Asilomar, Calif., volume 1 and 2: U.S. Department of Agriculture Forest Service, Pacific Southwest Research Station, Gen. Tech. Rep. PSW–GTR–191, p. 1051–1064.

Martin, J.W., and Carlson, B.A., 1998, Sage sparrow (*Amphispiza belli*), in Poole, A., ed., The Birds of North America, no. 326: Ithaca, N.Y., Cornell Lab of Ornithology, p. 1–20.

Miller, R.F., Knick, S.T., Pyke, D.A., Meinke, C.A., Hanser, S.E., Wisdom, M.J., Hild, A.L., 2011, Characteristics of sagebrush habitat and limitations to long-term conservation, *in* Knick, S.T., and Connelly, J.W., eds., Greater sage-grouse—Ecology and conservation of a landscape species and its habitats: Berkeley, Calif., University of California Press, Studies in Avian Biology, v. 38, p. 145–184.

Paige, Christine, and Ritter, S.A., 1999, Birds in a sagebrush sea—Managing sagebrush habitats for bird communities: Boise, Ida., Partners in Flight Western Working Group, 47 p.

Pearce-Higgins, J.W., Stephen, L., Langston, Rowena H. W., Bainbridge, I.P., and Bullman, Rhys, 2009, The distribution of breeding birds around upland wind farms: Journal of Applied Ecology, v. 46, p. 1323–1331.

Pitman, J.C., Hagen, C.A., Robel, R.J., Loughin, T.M., and Applegate, R.D., 2005, Location and success of lesser prairie-chicken nests in relation to vegetation and human disturbance: Journal of Wildlife Management, v. 69, no. 3, p. 1259–1269.

Poot, H., Ens, B.J., De Vries, H., Donners, M.A.H., Wernand, M.R., and Marquenie, J.M., 2008, Green light for nocturnally migrating birds: Ecology and Society, v. 13, no. 2, p. 47.

Reynolds, T.D., Rich, T.D., and Stephens, D.A., 1999, Sage thrasher (*Oreoscoptes montanus*), in Poole, A., ed., The Birds of North America, no. 463: Ithaca, N.Y., Cornell Lab of Ornithology, p. 1–24.

Rotenberry, J.T., Patten, M.A., and Preston, K.L., 1999, Brewer's sparrow (*Spizella breweri*), in Poole, A., ed., The Birds of North America, no. 390: Ithaca, N.Y., Cornell Lab of Ornithology, p. 1–24.

Saab, V.A., Bock, C.E., Rich, T.D., and Dobkin, D.S., 1995, Livestock grazing effects in western North America, *in* Martin, T.E., and Finch, D.M., eds., Ecology and management of neotropical migratory birds: New York, N.Y., Oxford University Press, p. 311–353.

Vander Haegen, W.M., Dobler, F.C., and Pierce, D.J., 2000, Shrubsteppe bird response to habitat and landscape variables in eastern Washington, USA: Conservation Biology, v. 14, p. 1145–1160.

White, G.C., and Burnham, K.P., 1999, Program MARK—Survival estimation from populations of marked animals: Bird Study, v. 46 Supplement, p. 120–138.

White, C. M., Van Lanen, N.J., Pavlacky, D.C., Jr., Blakesley, J.A., Sparks, R.A., Fogg, J.A., McLaren, M.F., Birek J.J., and Hanni, D.J., 2012, Integrated monitoring in Bird Conservation Regions (IMBCR): 2011 Annual Report: Brighton, Colo., Rocky Mountain Bird Observatory, 103 p.

Wiens, J.A., Horne, B., and Rotenberry, J.T., 1987, Temporal and spatial variations in the behavior of shrubsteppe birds: Oecologia, v. 73, no. 1, p. 60–70.

Wyoming Game and Fish Department, 2010, State Wildlife Action Plan: Cheyenne, Wyo., Wyoming Game and Fish Department.