Section III. Assessments of Communities

Chapter 13. Foothill Shrublands and Woodlands

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Key Ecological Attributes

Distribution and Ecology

In the Wyoming Basin, foothill shrublands and woodlands typically occur from elevations of 1,400–2,600 meters (m) (4,594–8,530 feet [ft]) along the perimeters of Wyoming's mountain ranges, creating a narrow zone of ecological transition between the sagebrush steppe and montane communities. Foothill shrublands and woodlands also occur on the slopes of escarpments scattered throughout the Basin, and they may form mosaics of broadleaf shrubs and mixed coniferous-broadleaf woodlands interspersed with grasslands and wind-swept ridges. Overall, the climate of Wyoming's foothill shrublands and woodlands is less extreme than the surrounding communities. On leeward slopes, accumulations of wind-driven snow result in more moisture availability during the growing season than what is typical of the adjacent lowlands, and some foothill locations receive greater summer rainfall than the lowlands. The foothills climate is also cooler than lower-elevation sagebrush steppe and warmer than higher-elevation montane forests (Knight, 1994).

Common shrubs of the foothill shrublands include mountain big sagebrush, mountain mahogany, skunkbush sumac, antelope bitterbush, serviceberry, snowberry, and snowbush ceanothus. Mountain big sagebrush is the most common species and typically occurs at elevations above 2,134 m (7,000 ft) on relatively deep, mesic soils (Beetle and Johnson, 1982). The nitrogen-fixing species, including mountain mahogany, can dominate the ridges with poorly developed soils (Knight, 1994). Most of the other broadleaf shrubs typically occur where soils are relatively deep and mesic, such as draws and other topographic depressions (Knight, 1994).

Foothill woodlands may be composed of conifers, broadleaf species, or both. Ponderosa pine woodlands are restricted to the warmest sites where summer precipitation is plentiful (particularly eastern Wyoming, northeastern Colorado, and the Uinta Mountains in Utah), whereas Douglas-fir is more common on northern slopes and in western Wyoming where winter precipitation is ample. Utah or Rocky Mountain juniper woodlands are typically found on the rocky, shallow soils of arid escarpments adjacent to grasslands (see Chapter 17—Juniper Woodlands, and Chapter 16—Five-Needle Pine Forests and Woodlands). Limber pine, which may co-occur with junipers, is characteristic of wind-swept ridges in northern parts of the Basin, and scattered stands of pinyon pine occur in south-central parts of the Basin. Broadleaf species, such as aspen (see Chapter 15—Aspen Forests and Woodlands) and chokecherry, tend to dominate the sites with relatively deep, mesic soils, particularly snow-accumulation areas, along drainages, and (or) where summer rainfall is relatively plentiful. Gambel oak, which is not very tolerant of drought or late spring frosts, is restricted to the west slope of the Sierra Madre (Knight, 1994).

Foothill shrublands and woodlands are interspersed with grasslands, especially on plateaus and windy slopes where snow accumulation is minimal and soils are deep enough to support grasses but not shrubs (Knight, 1994). Bluebunch wheatgrass is most characteristic of the warmer, drier foothill sites with shallower soils, and Idaho fescue is more typical of the higher-elevation sites (Knight, 1994).

Landscape Structure and Dynamics

Foothill shrublands and woodlands form complex mosaics due to abrupt changes in elevation, aspect-driven microclimates, highly variable topography, variation in the underlying geologic substrates and soil types/depths, fracture lines, and patterns in drainage and snow-accumulation. For example, sharp ecological transitions may be found where resistant bedrock is exposed on foothill ridges and escarpments. Coniferous trees may dominate these sites on suitable substrates (such as marine shales) because water can percolate deeply into the substrata, and the lack of well-developed soils discourages the growth of (and competition from) forbs and grasses. Without the continuity of fine understory fuels, fire is infrequent enough to allow trees to become dominant (Knight, 1994). Variations in geologic substrates often form linear bands across the foothill slopes, which can strongly influence vegetation patterns. For example, aspen stands may form linear bands along the piedmont of granitic mountain ranges where relatively exposed, impermeable granite gives way to more permeable soils of overlying sedimentary layers and run-off provides soil moisture (Knight, 1994). Geologic formations, fractures, and erosional patterns also greatly influence how and where water flows above and below the ground surface, which in turn influences vegetation patterns.

The most important natural drivers of change in foothill shrublands and woodlands are fire, herbivory, and erosion. Overall, historical fire regimes in this community were likely quite variable. Where fire occurred on sites dominated by broadleaf species (most of which can resprout after fire) postfire communities were more likely to resemble prefire communities except where fire intensity was high enough to expose mineral soils. Because fire usually kills sagebrush and junipers, however, fire likely resulted in community shifts at sites dominated by these species, at least initally (Knight, 1994). Snowbush not only resprouts after fire, but the seeds require fire to break dormancy, so the species can quickly invade postfire sites (Knight, 1994). Historically, fire rotations in mountain big sagebrush communities were generally shorter and fires were smaller than they were in Wyoming big sagebrush communities (Bukowski and Baker, 2013). Miller and others (2011) reported that fire rotations in mountain big sagebrush were typically <35 years (yr), but Bukowski and Baker (2013) estimated that the fire rotations were 137−217 yr across the Intermountain West; sample sizes from Wyoming, however, were relatively small and considerable uncertainty remains. Miller and others (2011) also suggested that fire frequency has decreased in mountain big sagebrush, but Bukowski and Baker (2013) found no evidence for this. Finally, the relatively small patches of mountain big sagebrush (as measured by interspersion with other shrublands or woodlands) in the foothill shrublands indicate that fires in these systems were probably small compared to those in sagebrush steppe, where much larger expanses of sagebrush can occur (Bukowski and Baker, 2013).

Browsing ungulates can have notable effects on foothill shrublands and woodlands. Heavy winter use of aspen by elk along migration routes and adjacent to wintering areas are believed to contribute to the decline of foothill aspen stands (Knight, 1994) (see Chapter 15—Aspen Forests and Woodlands). Where overwintering ungulates concentrate due to population booms, heavy snows, or other factors, browse lines may appear in shrublands, but if browsed during dormancy, most deciduous shrubs recover quickly (Knight, 1994). Where juniper and ponderosa woodlands grow adjacent to mountain big sagebrush or grassland, livestock grazing coupled with fire suppression can lead to juniper expansion in these types, particularly where sagebrush plants are available to serve as nurse plants for juniper seedlings (Knight, 1994). The role of fire in the dynamics along the sagebrush-conifer ecotone is unclear. Some authorities have argued that conifer expansion into sagebrush is primarily attributable to fire exclusion, livestock grazing, and favorable climates (Miller and others, 2011), but this does not sufficiently account for sagebrush-juniper dynamics observed across the entire Intermountain West (Bukowski and Baker, 2013). Conifer trees in sagebrush landscapes may have occurred as low-density

woodlands or as naturally occurring ecotones, or conifers may have expanded into sagebrush naturally or had become established after a fire (Romme and others, 2009) (see Chapter 17—Juniper Woodlands).

An important factor influencing the distribution of limber pine in the foothills is the behavior of Clark's nutcrackers. These birds cache the seeds of wingless pine seeds, including those of limber pine, on the snow-free ridges and escarpments for later consumption. Seeds that escape nutcracker retrieval develop into open stands of limber pine on these sites (see Chapter 16—Five-Needle Pine Forests and Woodlands).

Associated Species of Management Concern

Foothill shrublands in Wyoming provide habitat for 17 of Wyoming's Species of Greatest Conservation Need (Wyoming Game and Fish Department, 2010). Furthermore, stands of mountain big sagebrush also provide habitat for three species or species assemblages assessed for the Wyoming Basin Rapid Ecoregional Assessment (REA), including pygmy rabbit, greater sage-grouse, and the sagebrush-obligate songbirds: sagebrush sparrow, Brewer's sparrow, and sage thrasher (see Chapter 27—Pygmy Rabbit, Chapter 23—Greater Sage-Grouse, and Chapter 26—Sagebrush-Obligate Songbirds). The foothill shrublands and woodlands also provide crucial winter habitat for mule deer (see Chapter 28—Mule Deer) and other ungulates; the leeward slopes provide shelter from wind, and on the south-facing and windward slopes, forage is usually accessible throughout the winter, cool-season grasses and browse species in particular (Knight, 1994). The ridges, mesas, buttes, escarpments, and rocky outcrops (particularly on shale substrates) of the Wyoming foothills also harbor communities of rare cushion plants (most of which have a special conservation status) that typically inhabit cracks and crevices of these sites. Examples of these cushion plants include Barneby's clover, stemless beardtongue, Laramie columbine, and precocious milkvetch (Bureau of Land Management, 2013).

Change Agents

Development

Energy and Infrastructure

Energy development in the Wyoming Basin foothill shrublands and woodlands has been occurring in several locations, including the Big Piney LaBarge oil field along the foot of the Wyoming Range in southern Sublette and northeastern Lincoln counties. Wind energy development is also likely to become increasingly prevalent on foothill ridgelines (Wyoming Game and Fish Department, 2010). The infrastructure associated with energy development converts and fragments foothill shrublands and woodlands, and the disturbances associated with energy development affect wildlife, including over-wintering mule deer (Wyoming Game and Fish Department, 2010). Development of ranches, vacation homes, and resorts (including not only the structures, but also the plantings, outbuildings, and roads that accompany them), are converting and fragmenting the foothills as well (Knight, 1994; Wyoming Game and Fish Department, 2010).

Agricultural Activities

The primary agricultural activity in foothill shrublands and woodlands is livestock grazing, including ranching operations and "hobby" livestock associated with rural residential developments (Wyoming Game and Fish Department, 2010). With grazing pressure, palatable species tend to decrease

and less palatable species tend to increase (West, 1988; Knight and others, 1994). Grazing seasonality is also important, in that broadleaf shrubs browsed during dormancy are not affected negatively by browsing and quickly resprout new leaders; however, coupled with heavy browsing during the growing season, broadleaf shrubs and trees can be locally extirpated browsing (Knight, 1994; Wyoming Game and Fish Department, 2010). Effects of heavy livestock use include not only damage from foraging, but also from trampling, both of which can alter plant structure and reduce or eliminate recruitment (Knight, 1994; Wyoming Game and Fish Department, 2010) (see Chapter 15—Aspen Forests and Woodlands). Livestock production can include management of vegetation to improve productivity of livestock forage. Sites occupied by mountain big sagebrush have relatively deep, mesic soils that also support quality livestock forage; thus, these sagebrush communities are sometimes altered or eliminated through brush-control treatments to encourage forage species (Beetle and Johnson, 1982). Treatments used for eliminating or controlling shrubland and woodland vegetation to benefit both livestock and wild ungulates include mechanical removal, herbicides, and prescribed mme and others, 2009; Wyoming Game and Fish Department, 2010). The effects and effectiveness of these activities, however, depend on past disturbance history, site use, plant community types, and local conditions (Knight, 1994; Romme and others, 2009; Arendt and Baker, 2013).

Altered Fire Regime

Historical fire regimes in foothill shrublands and woodlands likely varied by elevation, aspect, and soil type. Some of the broadleaf species resprout readily after fire, and a lack of fire can lead to stand senescence and (or) disease, particularly in stands of mountain mahogany, oak, and aspen (Knight, 1994). Likewise, fire suppression can lead to conifer expansion into adjacent shrublands and grasslands (Knight, 1994). Some foothill shrubland species, however, are killed outright by fire, including mountain big sagebrush, which could provide inroads for cheatgrass invasion.

Invasive Species and Diseases

Invasive species with significant potential to alter the structure and community composition of foothill shrublands and woodlands include cheatgrass and smooth brome, alyssum, nonnative spurges, and species of knapweed and starthistle (Colorado Natural Heritage Program, 2005; Wyoming Game and Fish Department, 2010; University of Wyoming Extension, 2013). Invasives compete with native shrub species, reducing their vigor and recruitment (Knight, 1994). Many of these plants commonly invade disturbed areas, including postfire sites, livestock-use areas, and roadways. Cheatgrass is of concern in the foothill shrublands (mountain mahogany in particular) and woodlands, where interactions with fire could generate significant shifts in community composition, particularly in mountain big sagebrush and mountain mahogany (Knight, 1994; Wyoming Game and Fish Department, 2010). Cheatgrass also inhibits the germination and survival of shrub seedlings (Knight, 1994).

Limber pine is one of the five-needle pine species that is highly susceptible to the nonnative white pine blister rust (see Chapter 16—Five-Needle Pine Forests and Woodlands). Coupled with the current severe outbreak of bark beetles, the disease is resulting in high rates of mortality among five-needle pines. Indeed, the whitebark pine has been petitioned for listing under the Endangered Species Act (warranted but precluded). Mortality rates for whitebark pine are of greatest concern in the northern extent of the species' range, although there are "hot-spots" of infection in southwestern Wyoming.

Climate Change

Climate projections and associated changes in the distribution of suitable bioclimatic conditions for foothill shrublands and woodlands in the western U.S. indicate the potential for expansion of grassland communities at the expense of arid woodlands, with upslope shifts in the bioclimatic conditions conducive to shrublands and woodlands (Rehfeldt and others, 2006). Complicating these projections, however, is the potential for cheatgrass expansion in foothill grasslands, mountain big sagebrush, and juniper woodlands with increasing temperatures, which in turn could lead to an increase in fire frequency and potential conversion to nonnative grasslands (Romme and others, 2009; Arendt and Baker, 2013).

Rapid Ecoregional Assessment Components Evaluated for Foothill Shrublands and Woodlands

A generalized, conceptual model was used to highlight some of the key ecological attributes and Change Agents affecting foothills shrublands and woodlands (fig. 13–1). Key ecological attributes addressed by the Rapid Ecoregional Assessment (REA) include (1) the distribution of foothills shrublands and woodlands, (2) landscape structure (size and structural connectivity of patches), and (3) landscape dynamics (fire occurrence and sagebrush-juniper dynamics) (table 13–1). The Change Agents evaluated included development and climate change (table 13–2). Ecological values and risks used to assess the conservation potential of foothills shrublands and woodlands by township are summarized in table 13–3. Core and Integrated Management Questions and the associated summary maps and graphs are provided in table 13–4.

Methods Overview

To map the baseline distribution of foothill shrubland and woodlands, we included LANDFIRE Existing Vegetation Types corresponding to mountain big sagebrush, mountain shrublands (predominantly mountain mahogany and scrub oak), ponderosa pine savannahs, and juniper woodlands. We also included the foothill aspen functional type (see Chapter 15—Aspen Forests and Woodlands) and grassland Existing Vegetation Type cells between 2,600 m (8,530 ft) and 2,900 m (9,514 ft).

We assessed development levels in foothill shrublands and woodlands using the Terrestrial Development Index (TDI) map, and used the resulting output to calculate patch size and structural connectivity metrics. We mapped the structural connectivity of relatively undeveloped areas at three interpatch distances derived from connectivity analysis for this community: local (0.27 km; 0.17 mi), landscape (2.43 km; 1.51 mi), and regional (3.24 km; 2.01mi) levels. Areas that may function as barriers or corridors were derived from development levels and were identified by overlaying relatively undeveloped patches (TDI score $\leq$1 percent) on the TDI map. The perimeters of fires in foothill shrublands and woodlands since 1980 were compiled from several data sources (table 13–1).

Climate change was not directly evaluated for the foothill shrublands and woodlands community because there were no corresponding biomes in Rehfeldt and others (2012). Climate change was evaluated, however, for several species included in the foothill shrublands and woodlands community that either had a species-level distribution model or the species is included different biome (Rehfledt and others, 2012) including (1) mountain big sagebrush (included in sagebrush shrublands; see Chapter 11—Sagebrush Steppe), (2) aspen (see Chapter 15—Aspen Forests and Woodlands), (3) juniper (see Chapter17—Juniper Woodlands), and (4) limber pine (see Chapter 16—Five-Needle Pine Forests and Woodlands).

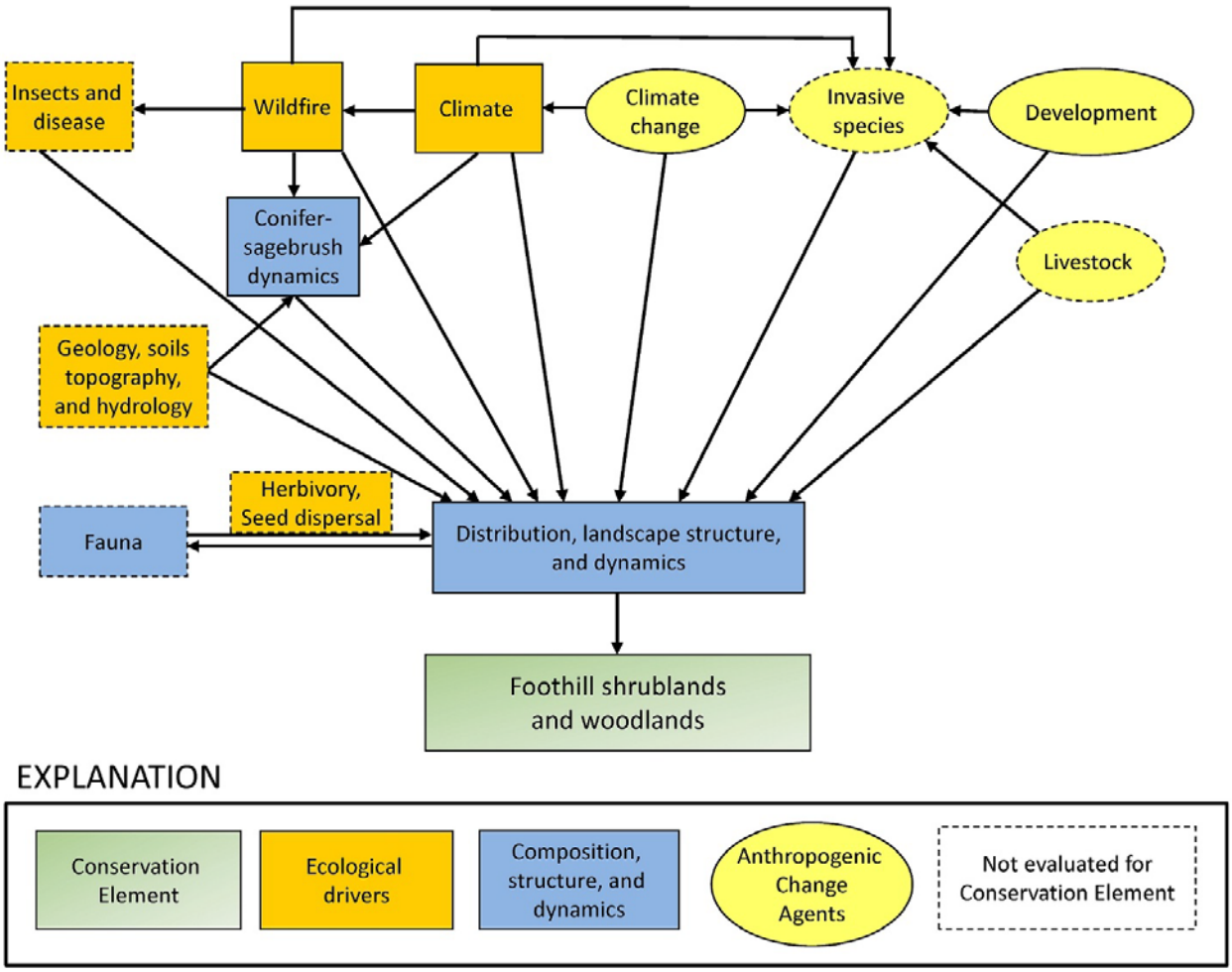

Figure 13−1. Generalized conceptual model of foothill shrublands and woodlands for the Wyoming Basin Rapid Ecoregional Assessment (REA). Biophysical attributes and ecological processes regulating the occurrence, structure, and dynamics of foothill shrublands and woodlands are shown in orange rectangles; 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 ecological drivers not addressed by the REA. Livestock herbivory and invasive plants are Change Agents that were not addressed for foothill shrublands and woodlands due to the lack of regionwide data.

Landscape-level ecological values (area of foothills shrublands and woodlands) and risks (TDI score) were compiled into an overall index of conservation potential for each township (table 13–3). See Chapter 2—Assessment Framework and the Appendix for additional details on the methods. 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.

Table 13−1. Key ecological attributes of baseline foothill shrublands and woodlands[1] for the Wyoming Basin Rapid Ecoregional Assessment.

[km, kilometer; mi, mile]

Attributes	Variables	Indicators
Amount and distribution	Total area	Distribution derived from LANDFIRE[1]
Landscape structure	Patch size	Patch-size frequency distribution
	Structural connectivity[2]	Interpatch distance that provides an index of structural connectivity for baseline patches at local, landscape, and regional levels (0.27 km; 0.17 mi)
Landscape dynamics	Fire occurrence[3]	Locations of fires and annual area burned since 1980
	Sagebrush-juniper ecotone dynamics	See Chapter 17—Juniper Woodlands

[1] Baseline conditions are used as a benchmark to evaluate changes in the total area and landscape structure of foothill shrublands and woodlands due to Change Agents. Baseline conditions are defined as the potential current distribution of foothill shrublands and woodlands derived from LANDFIRE Existing Vegetation Types without explicit inclusion of Change Agents (see Chapter 2—Assessment Framework and the Appendix).

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

[3] See Wildland Fire section in the Appendix.

Table 13−2. Anthropogenic Change Agents and associated indicators influencing foothill shrublands and woodlands 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 foothill shrublands and woodlands in seven development classes using a 16-km^2 (6.18-mi^2) moving window
		Patch-size frequency distribution for foothill shrublands and woodlands that are relatively undeveloped or have low development scores compared to baseline conditions
		Interpatch distances that provide an index of structural connectivity for relatively undeveloped patches at local (0.27 km; 0.17 mi), landscape (2.43 km; 1.51 mi), and regional (3.24 km; 2.01mi) levels
Climate change	Projected temperature and precipitation	See Chapter 15—Aspen Forests and Woodlands, Chapter 17—Juniper Woodlands, and Chapter 11—Sagebrush Steppe

[1] See Chapter 2—Assessment Framework.

Table 13−3. Landscape-level ecological values and risks for foothill shrublands and woodlands. Ranks were combined into an index of conservation potential for the Wyoming Basin Rapid Ecoregional Assessment.

[>, greater than]

	Variables[1]	Relative rank: Lowest	Medium	Highest	Description[2]
Values	Area	<11	11–34	>34	Percent of township classified as juniper woodlands
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 each Conservation Element to minimize the effects of extremely small areas and put greater emphasis on conservation potential of large areas (see table A-19 in the Appendix).

[2] See tables 13–1 and 13–2 for description of variables.

Table 13−4. Management Questions addressed for foothill shrublands and woodlands for the Wyoming Basin Rapid Ecoregional Assessment.

Core Management Questions	Results
Where are baseline foothill shrublands and woodlands, and what is the total area?	Figure 13–2
Where does development pose the greatest threat to baseline foothill shrublands and woodlands, and where are the relatively undeveloped areas?	Figures 13–3 and 13–4
How has development fragmented baseline foothill shrublands and woodlands, and where are the large, relatively undeveloped patches?	Figures 13–5 and 13–6
How has development affected structural connectivity of foothill shrublands and woodlands relative to baseline conditions?	Figure 13–7
Where are potential barriers and corridors that may affect animal movements among relatively undeveloped foothill shrubland and woodland patches?	Figure 13–8
Where have recent fires occurred in baseline foothill shrublands and woodlands, and what is the total area burned per year?	Figures 13–9 and 13–10
What is the potential distribution of foothill shrublands and woodlands in 2030?	See Chapter 15—Aspen Forests and Woodlands, Chapter 17—Juniper Woodlands, and Chapter 11—Sagebrush Steppe
Integrated Management Questions	**Results**
How does risk from development vary by land ownership or jurisdiction for foothill shrublands and woodlands?	Table 13–5, figure 13–11
Where are the townships with the greatest landscape-level ecological values?	Figure 13–12
Where are the townships with the greatest landscape-level risks?	Figure 13–12
Where are the townships with the greatest conservation potential?	Figure 13–13

Key Findings for Management Questions

Where are baseline foothill shrublands and woodlands, and what is the total area (fig. 13–2)?

- Foothill shrublands and woodlands occupy a small portion of the Wyoming Basin, comprising 28,492 square kilometers (km^2) (11,000 square miles [mi^2]) and covering 16 percent of the project area.

Where does development pose the greatest threat to baseline foothill shrublands and woodlands, and where are the relatively undeveloped areas (figs. 13–3 and 13–4)?

- Disturbance occurs throughout foothill shrublands and woodlands of the Wyoming Basin, but areas in the Bighorn, Absaroka, and Uinta Mountains have low levels of development (fig. 13–3).

- Only 27.1 percent of foothill shrublands and woodlands is relatively undeveloped (TDI score ≤1 percent), and approximately 24 percent has TDI scores >5 percent, indicating high levels of development (fig. 13–4).

How has development fragmented baseline foothill shrublands and woodlands, and where are the large, relatively undeveloped patches (figs. 13–5 to 13–6)?

- Distribution of baseline foothill shrubland and woodland patch size is bimodal; approximately 35 percent occurs in patches <10 km^2 (3.9 mi^2) and 39 percent in patches 100–1,000 km^2 (38.6–386.1 mi^2). There are few large patches of foothill shrublands and woodlands; only 8.8 percent occurs in patches >1,000 km^2 (386.1 mi^2) (fig. 13–5).

- Development has effectively fragmented foothill shrublands and woodlands into smaller patches relative to baseline conditions. All relatively undeveloped foothill shrublands and woodlands occur in patches <1,000 km^2 (386.1 mi^2).

- The largest relatively undeveloped patches are in the Bighorn and Absaroka Mountains (fig. 13–6).

How has development affected structural connectivity of foothill shrublands and woodlands relative to baseline conditions (fig. 13–7)?

- Baseline foothill shrublands and woodlands are well connected across the ecoregion, with local, landscape, and regional structural connectivity occurring at an interpatch distance of 0.27 km (0.17 mi).

- Development has diminished the structural connectivity of foothill shrublands and woodlands at the landscape and regional levels. Relatively undeveloped areas are somewhat fragmented; landscape-level connectivity is 2.43 km (1.51 mi) and regional-level connectivity is 3.24 km (2.01 mi).

- Areas with high local and landscape connectivity may facilitate dispersal and seasonal movements of organisms, whereas foothill shrublands and woodlands with only regional connectivity may have value as stepping stones across developed or otherwise unsuitable habitat.

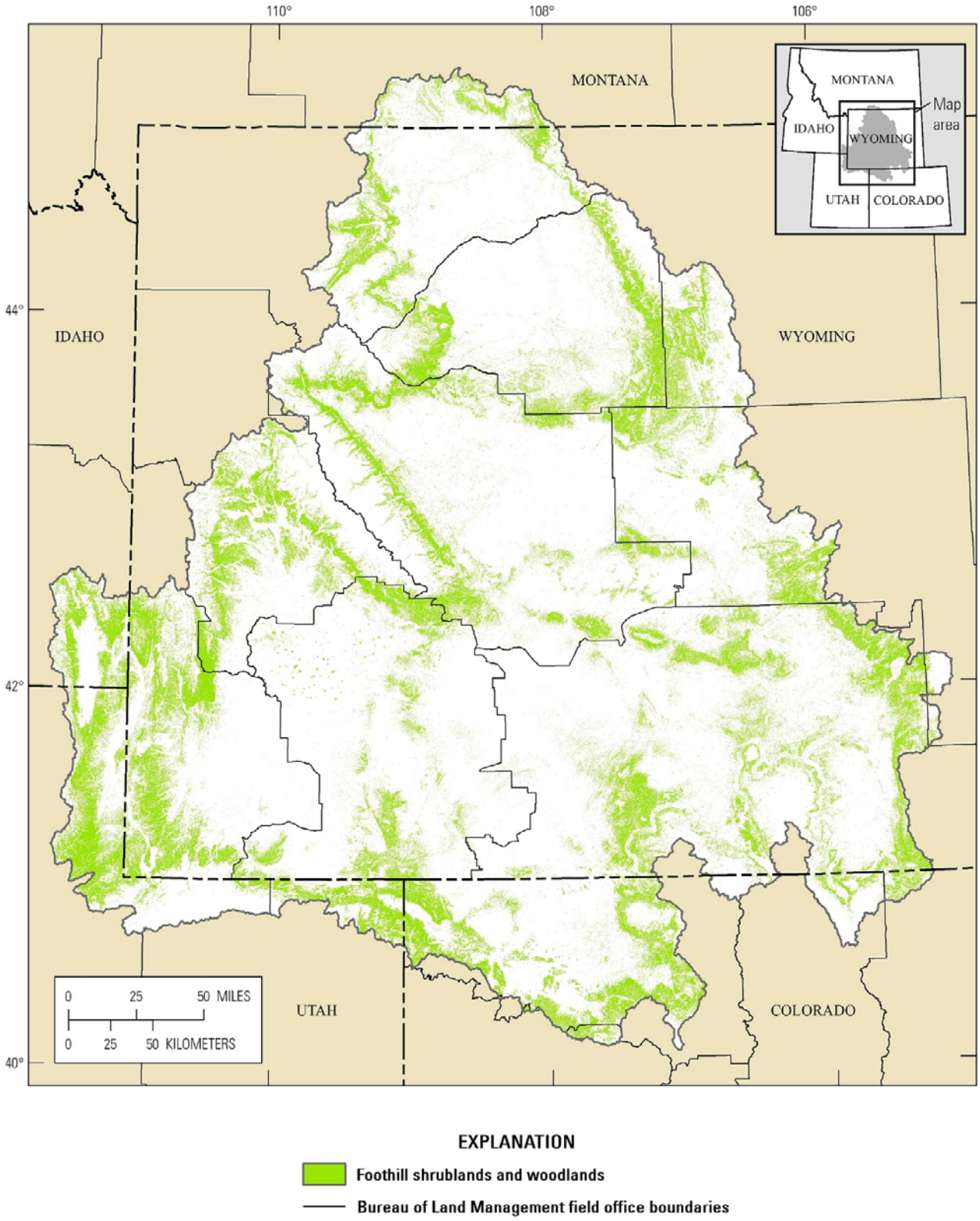

Figure 13−2. Distribution of baseline foothill shrublands and woodlands in the Wyoming Basin Rapid Ecoregional Assessment project area.

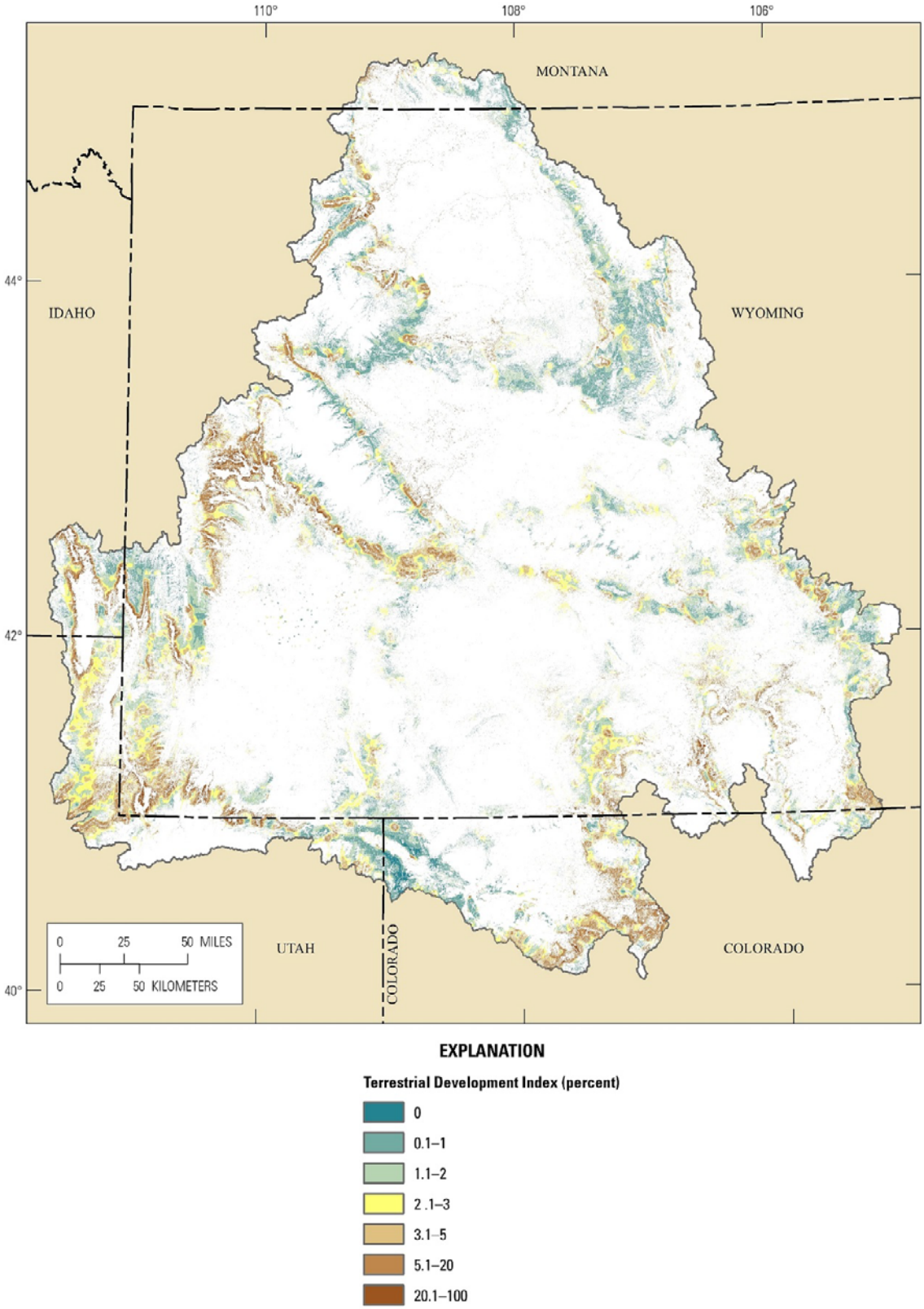

Figure 13−3. Terrestrial Development Index scores for baseline foothill shrublands and woodlands in the Wyoming Basin Rapid Ecoregional Assessment project area.

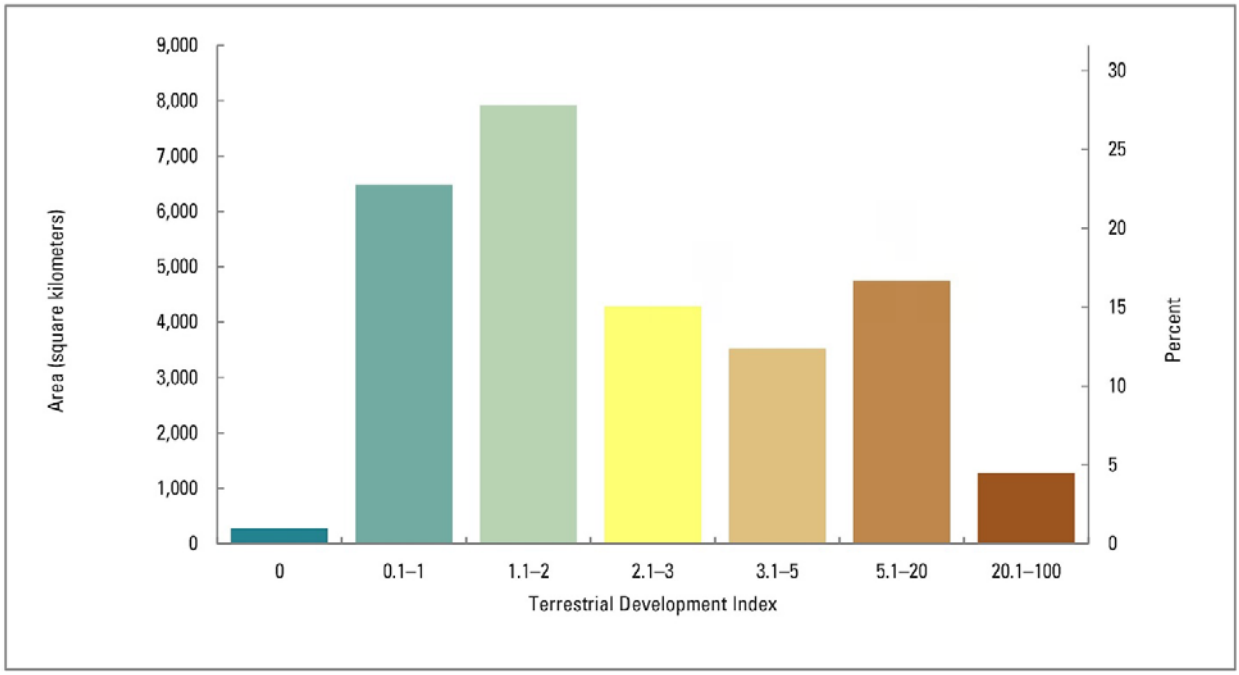

Figure 13−4. Area and percent of baseline foothill shrublands and woodlands as a function of the Terrestrial Development Index in the Wyoming Basin Rapid Ecoregional Assessment project area.

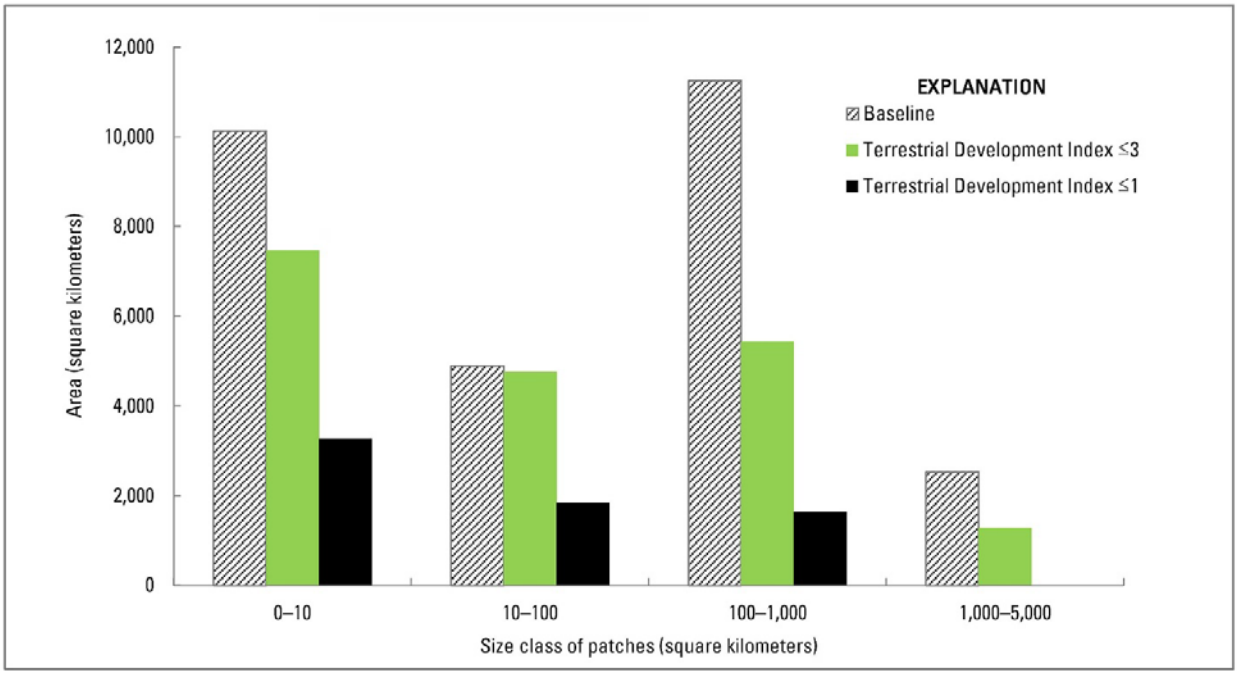

Figure 13−5. Area of foothill shrublands and woodlands as a function patch size for baseline conditions and two levels of development: (1) Terrestrial Development Index (TDI) score ≤3 percent, and (2) relatively undeveloped areas (TDI score ≤1 percent) in the Wyoming Basin Rapid Ecoregional Assessment project area.

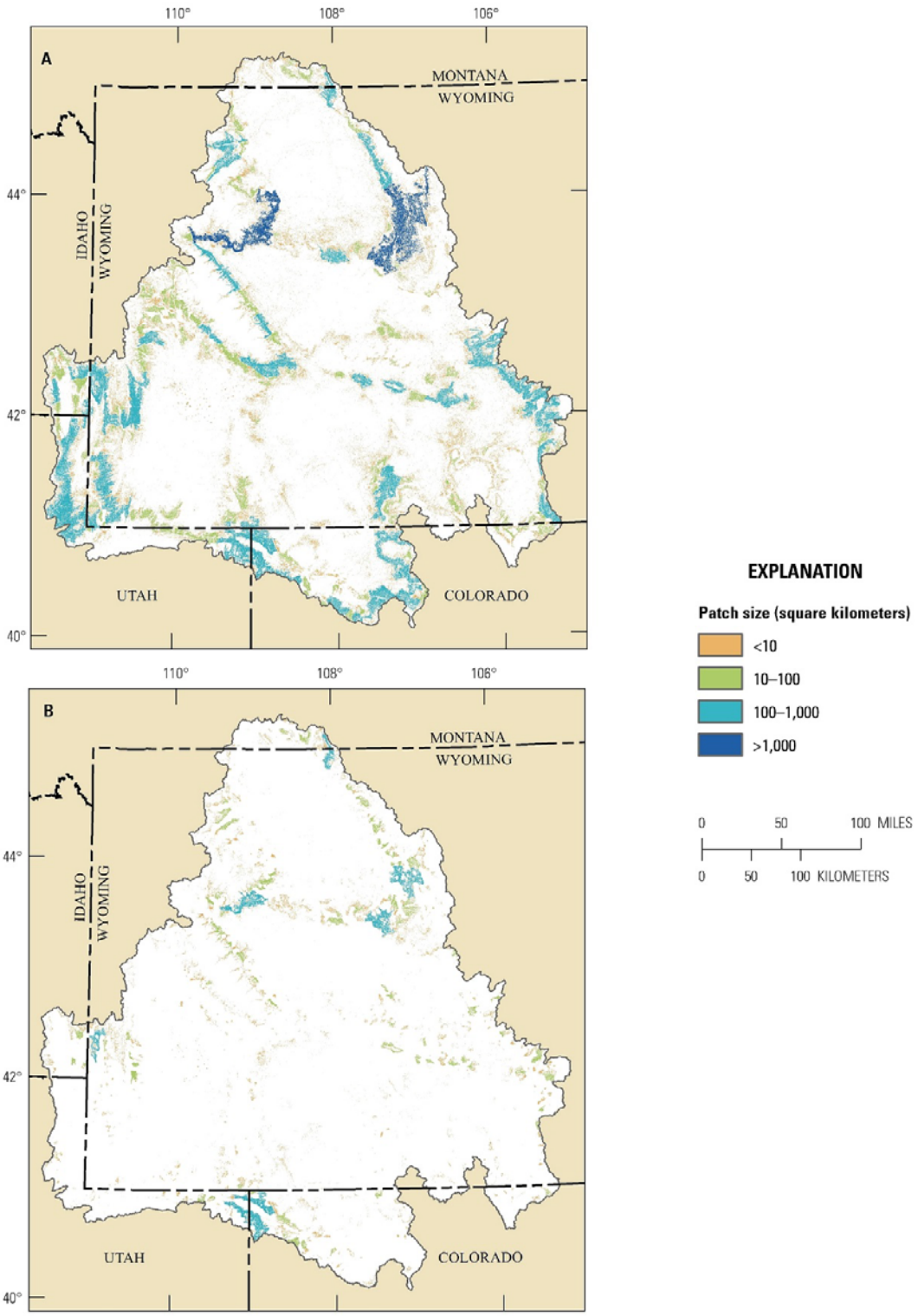

Figure 13−6. Patch sizes of foothill shrublands and woodlands in the Wyoming Basin Rapid Ecoregional Assessment project area for (*A*) baseline conditions and (*B*) relatively undeveloped areas (Terrestrial Development Index score ≤1 percent).

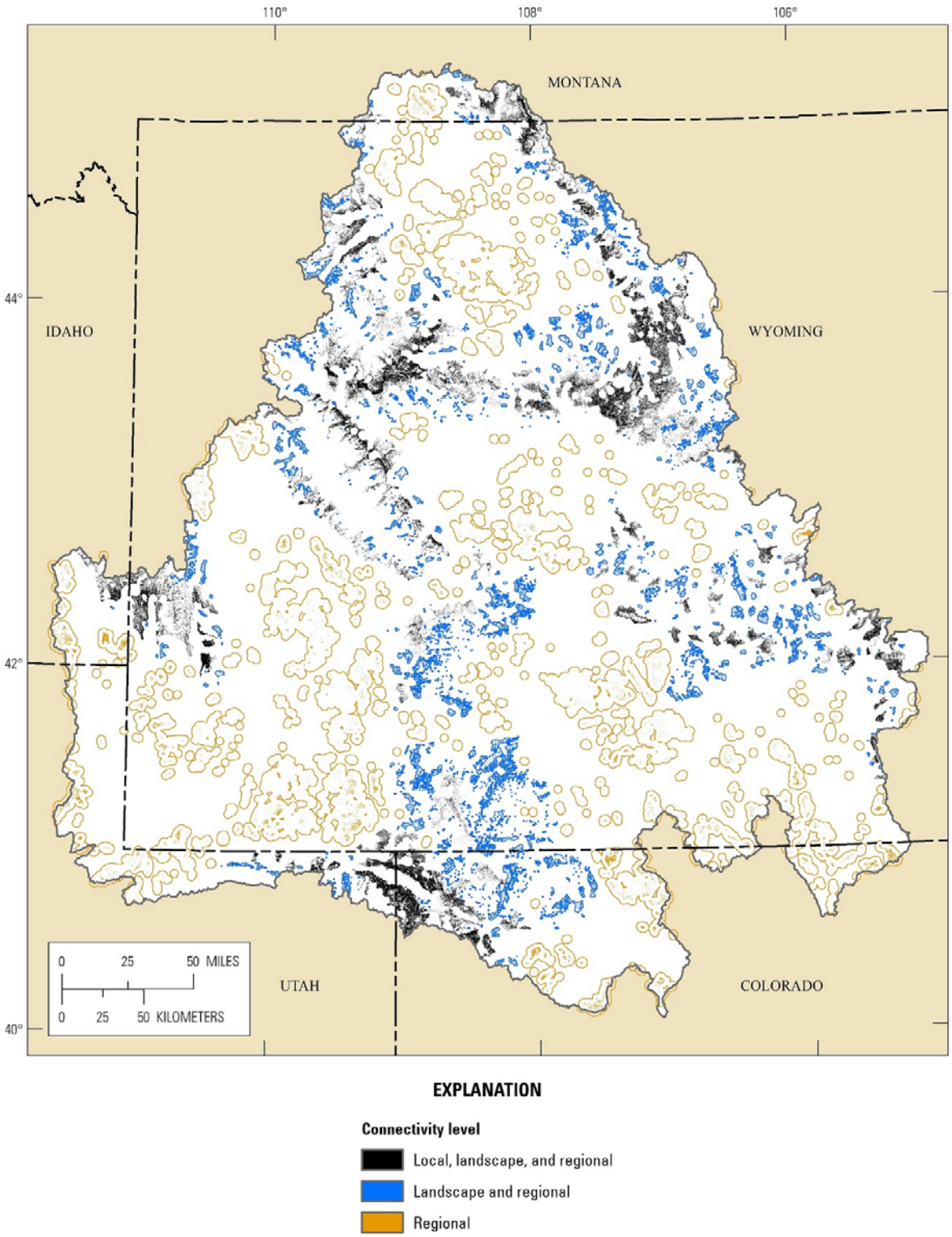

Figure 13−7. Structural connectivity of relatively undeveloped patches of foothill shrublands and woodlands in the Wyoming Basin Rapid Ecoregional Assessment project area. Black polygons include large and highly connected patches. Blue polygons include patches that contribute to both landscape and regional 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 foothill shrubland and woodland patches (fig. 13–8)?

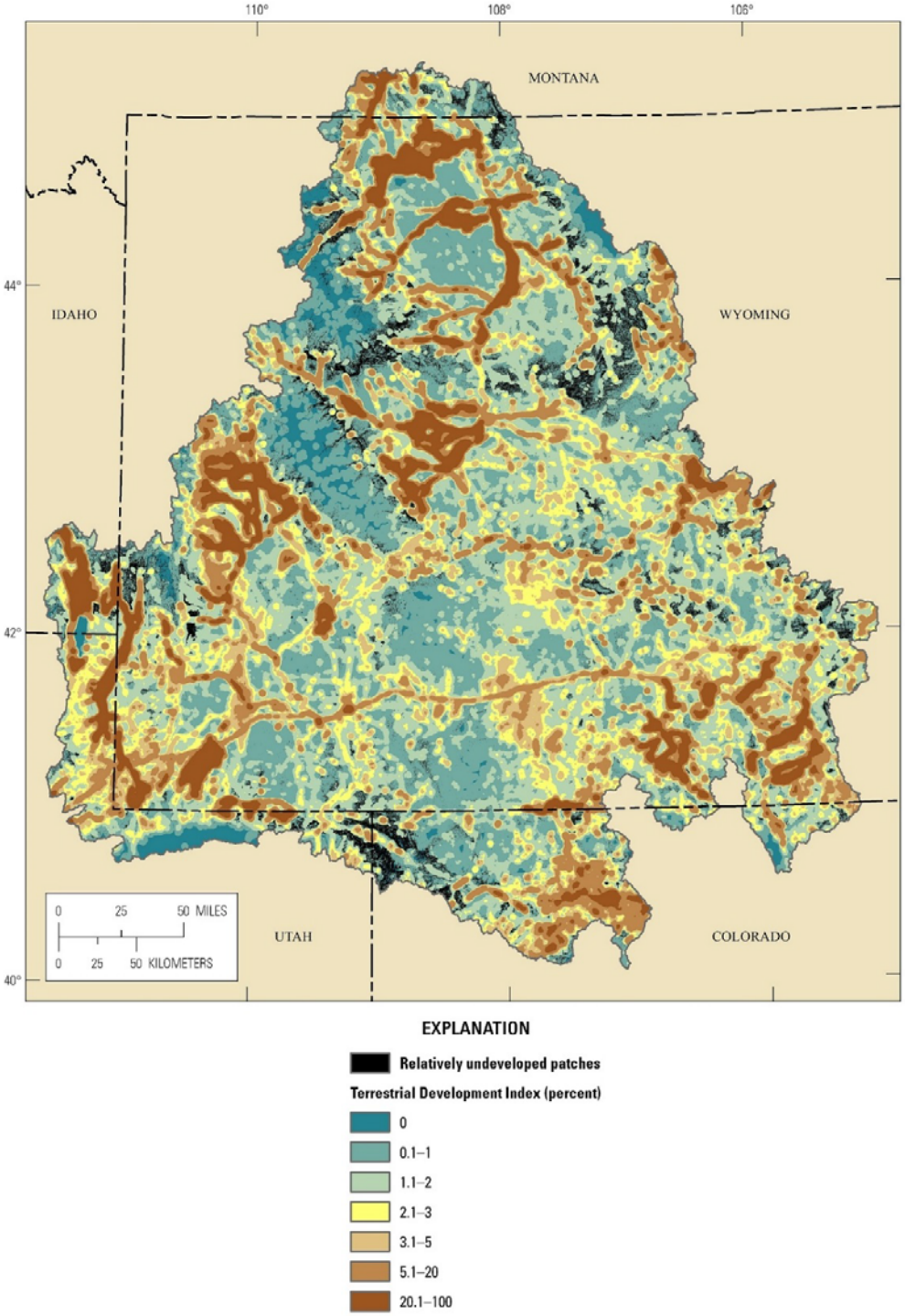

Figure 13−8. Potential barriers and corridors as a function of the Terrestrial Development Index (TDI) score for lands surrounding relatively undeveloped foothill shrublands and woodlands. Higher TDI scores (for example, >5 percent) represent potential barriers to movement among relatively undeveloped patches. Lower TDI scores (for example, <2 percent) represent potential corridors for movements among patches.

Where have recent fires occurred in baseline foothill shrublands and woodlands, and what is the total area burned per year (figs. 13–9 and 13–10)?

- Typically only a small fraction of foothill shrublands and woodlands has burned each year since 1980. Cumulatively, the area of foothill shrublands and woodlands that has burned since 1980 is 1,412 square kilometers (km^2) (545.2 square miles [mi^2]) (5.0 percent).
- In most years, fires were small and burned only a small portion of foothill shrublands and woodlands, with most of the area burned by fires occurring in 2000 and 2012 (fig. 13–9).
- Fires in foothill shrublands and woodlands are distributed throughout the Basin but very little has burned in the southeastern portion since 1980 (fig. 13–10).

How does risk from development vary by land ownership or jurisdiction for foothill shrublands and woodlands (table 13–5, fig. 13–11)?

- The majority of foothill shrublands and woodlands are in private ownership or jurisdiction or fall under Bureau of Land Management jurisdiction (table 13–5).
- Compared to other land ownerships/jurisdictions, tribal and other Federal lands encompass the greatest proportion of foothill shrublands and woodlands with low risk from development (fig. 13–11).

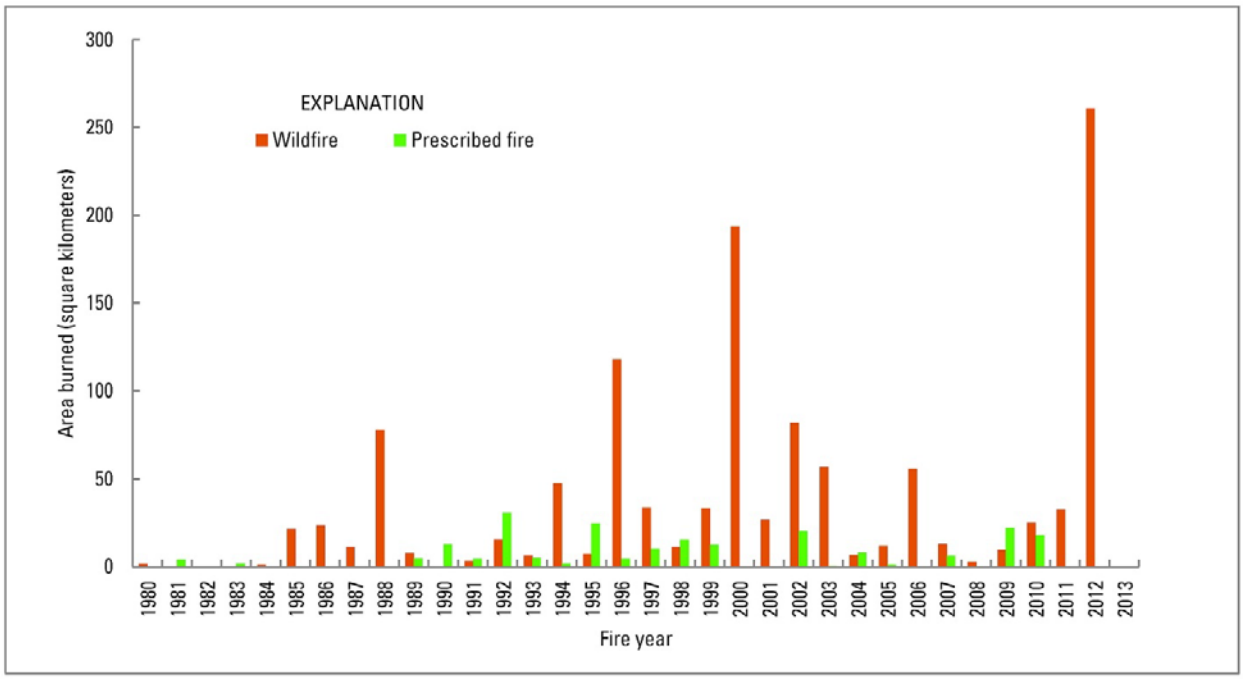

Figure 13−9. Annual area burned by wildfires and prescribed fires in baseline foothill shrublands and woodlands since 1980 in the Wyoming Basin Rapid Ecoregional Assessment project area.

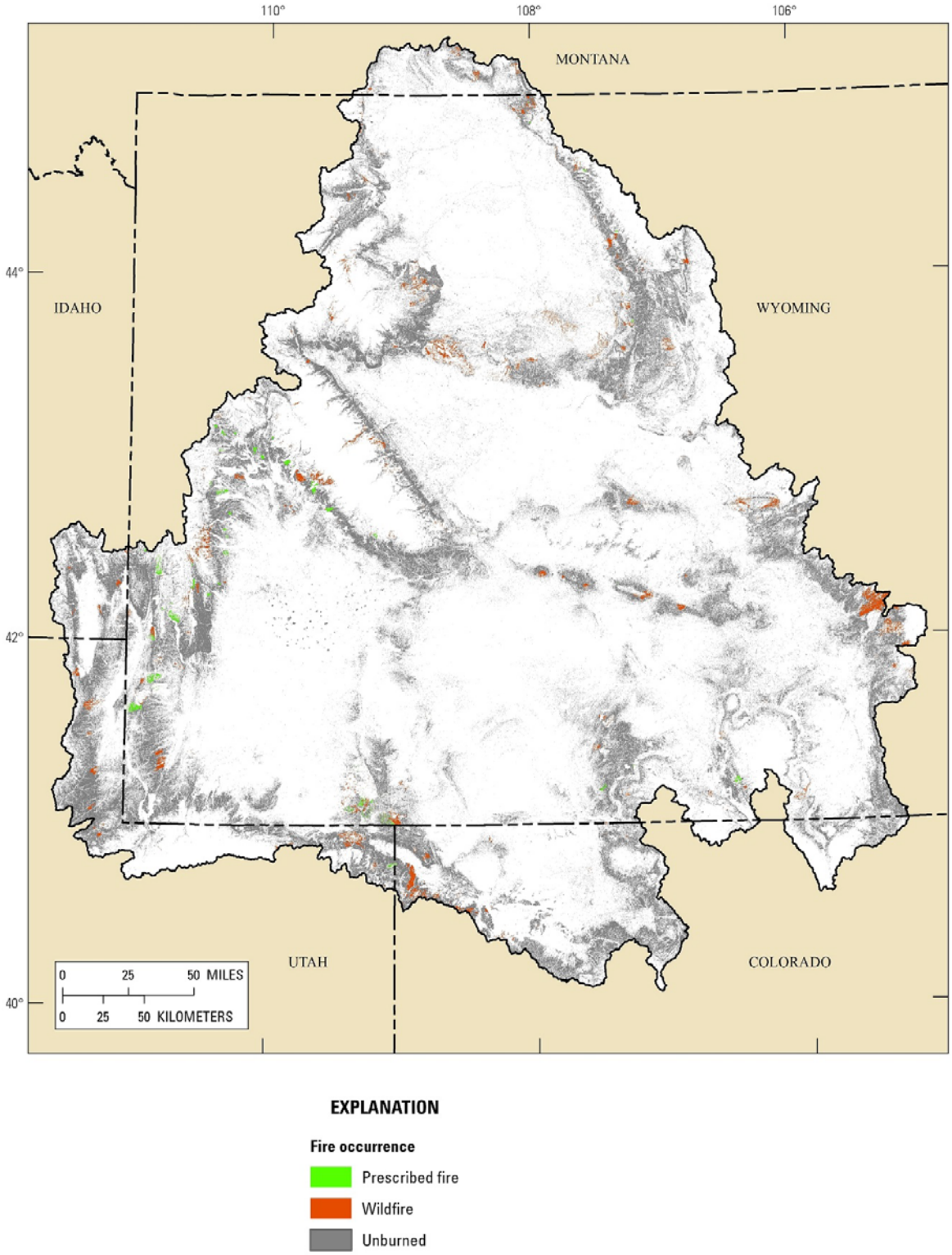

Figure 13−10. Occurrence of wildfires and prescribed fires in baseline foothill shrublands and woodlands since 1980 in the Wyoming Basin Rapid Ecoregional Assessment project area.

Table 13−5. Area and percent of foothill shrublands and woodlands by land 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
Private	11,292	39.6
Bureau of Land Management	10,210	35.8
State/County	2,683	9.4
Forest Service[1]	2,592	9.1
Tribal	1,156	4.1
Private conservation	239	1.1
Other Federal[2]	193	0.7

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

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

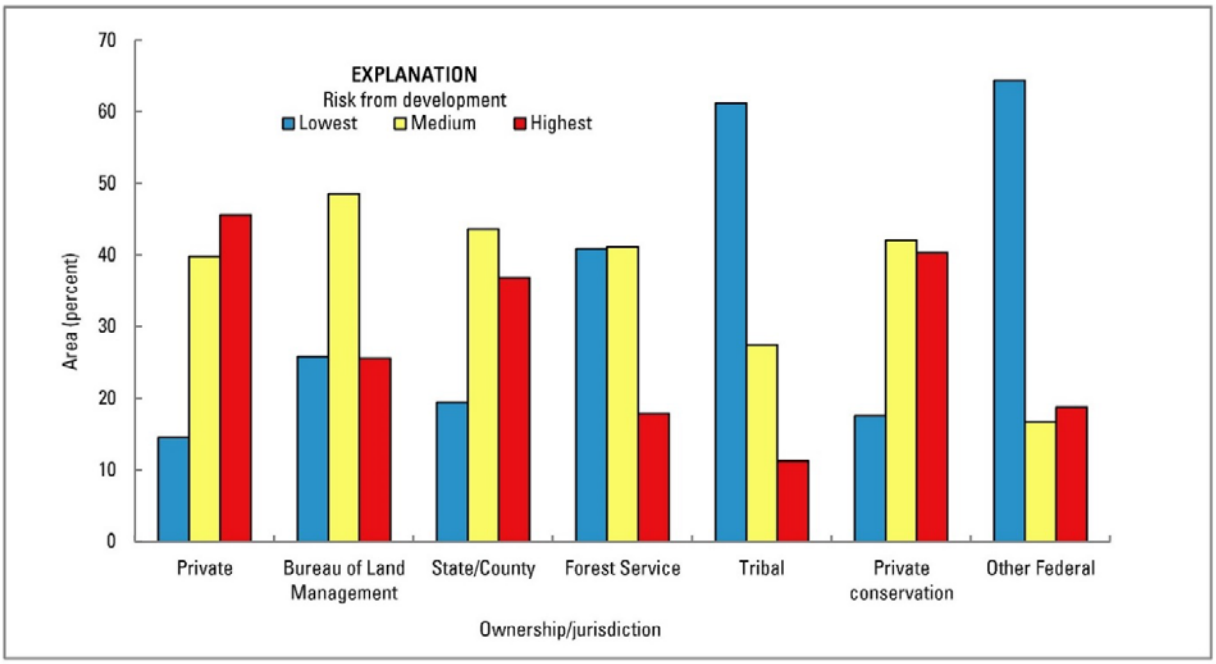

Figure 13−11. Relative ranks of risk from development, by land ownership or jurisdiction, for foothill shrublands and woodlands in the Wyoming Basin Rapid Ecoregional Assessment project area. Rankings are lowest (Terrestrial Development Index [TDI] score <1 percent), medium (TDI score 1−3 percent), and highest (TDI score >3 percent).

Where are the townships with the greatest landscape-level ecological values, and where are the townships with the greatest landscape-level risks (fig. 13–12)?

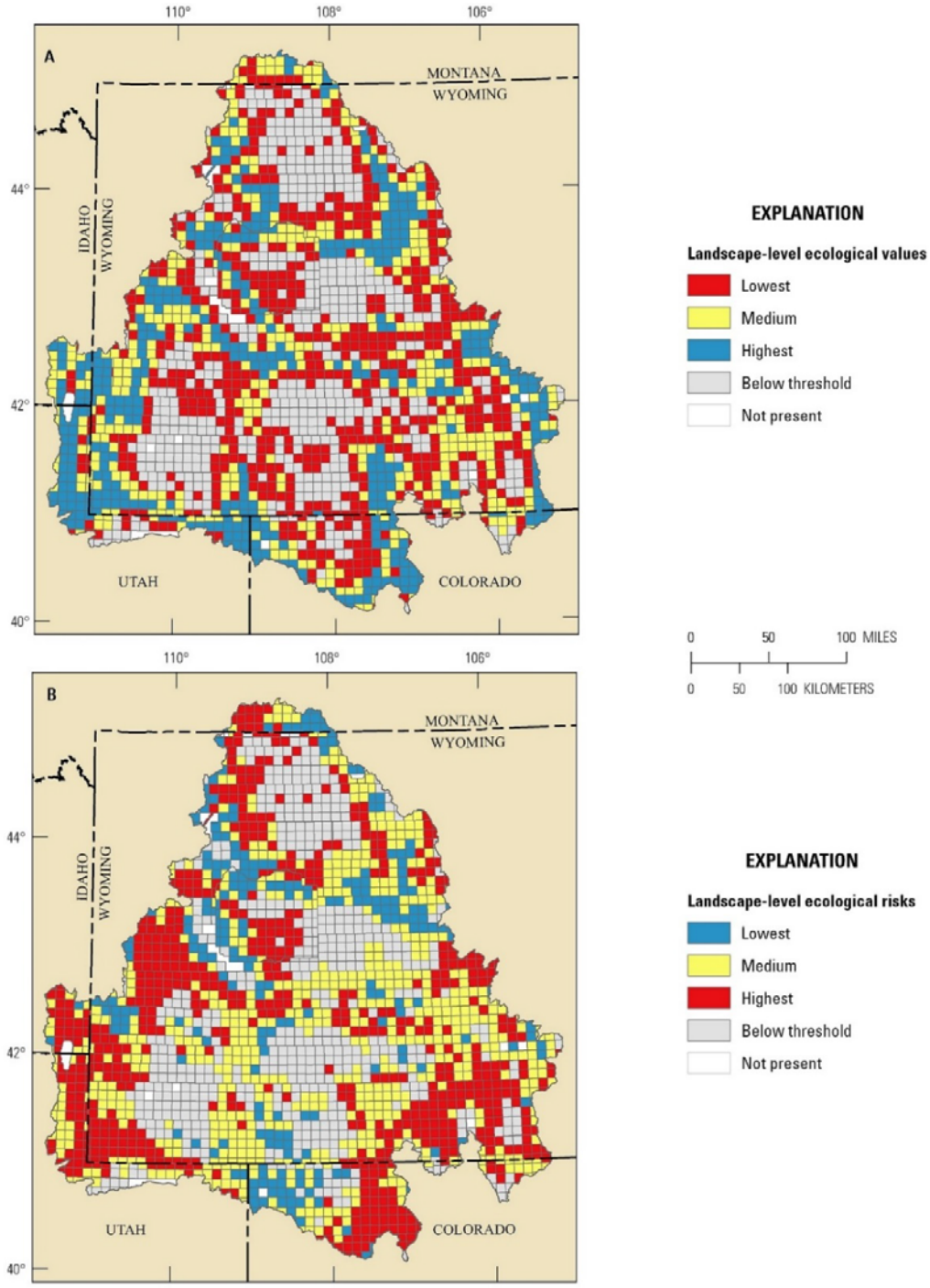

Figure 13−12. Ranks of landscape-level ecological values and risks for foothill shrublands and woodlands, summarized by township, in the Wyoming Basin Rapid Ecoregional Assessment project area. (*A*) Landscape-level values based on area and (*B*) landscape-level risks based on Terrestrial Development Index (see table 13–3 for overview of methods).

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

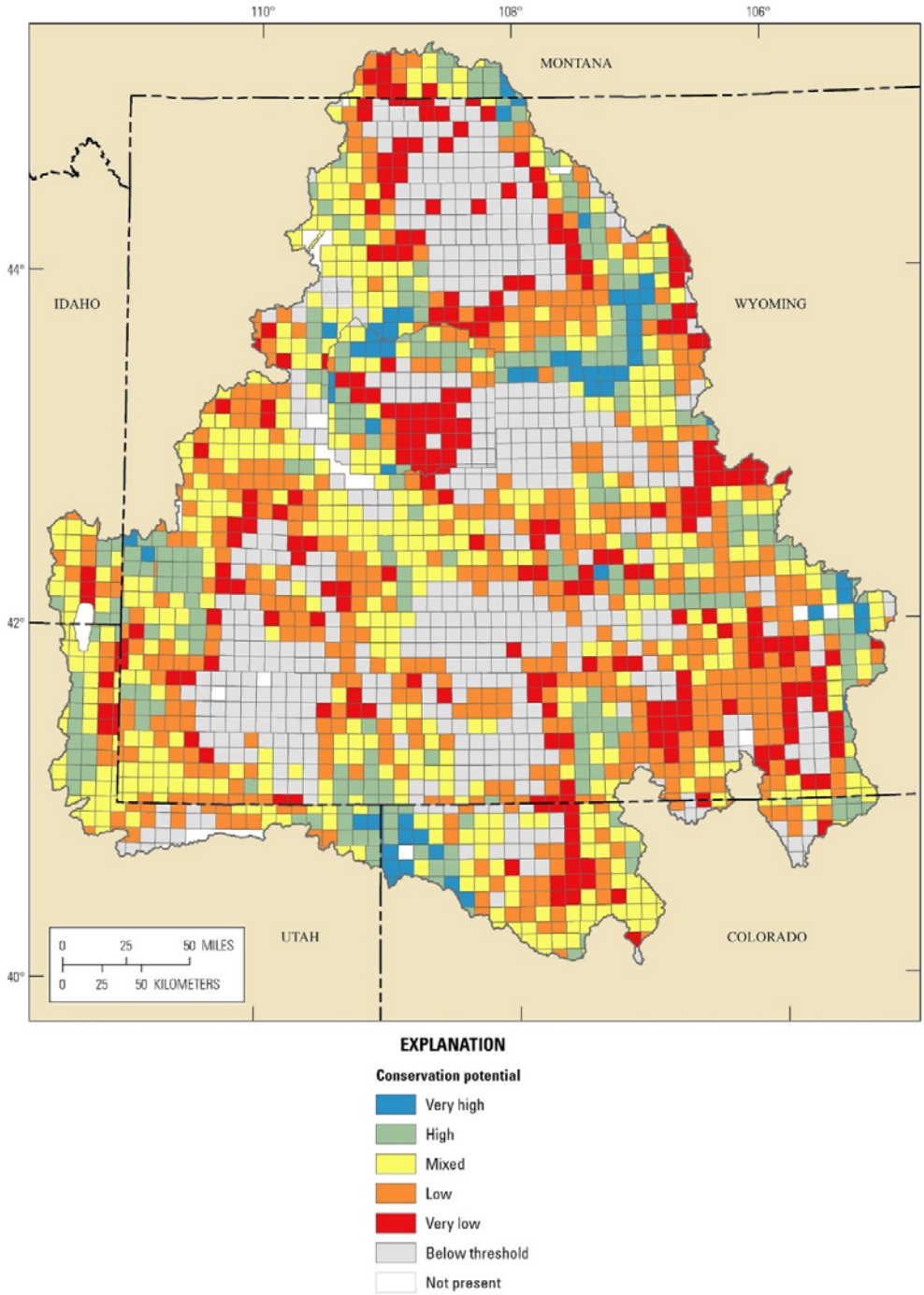

Figure 13−13. Conservation potential of foothill shrublands and woodlands, summarized by township, in the Wyoming Basin Rapid Ecoregional Assessment project area. Highest conservation potential identifies areas that have the highest landscape-level values and the lowest risks. Lowest conservation potential 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

Foothill shrublands and woodlands are associated with lower elevations of all of the mountain ranges in the Basin and account for 16 percent of the Wyoming Basin. Development is pervasive, as 27 percent of the foothill shrublands and woodlands remain relatively undeveloped. Much of the foothill shrublands and woodlands that remain relatively undeveloped occur in scattered patches, all of which are <1,000 km^2 (386.1 mi^2). The largest relatively undeveloped patches occur in the Bighorn, Absaroka, and Uinta Mountains. Foothill shrublands and woodlands were once well connected within the Basin, but development (including roads, energy, and agriculture) has fragmented and decreased their structural connectivity. On the basis of current rates of development, particularly energy development, foothill shrublands and woodlands are expected to undergo further fragmentation, loss, and degradation. Because this community provides crucial winter range for mule deer and habitat for sagebrush-obligate species, including greater sage-grouse, sagebrush-obligate songbirds, and pygmy rabbits (all of which are assessed in this REA), the high development rates can effect numerous species that occur in this community. Plant species assessed for this Rapid Ecoregional Assessment, including aspen and limber pine (five-needle pine assemblage), which are the major tree species in this community, also face threats (including sudden aspen decline and white pine blister rust), which could alter the structure and functions of foothill shrubland and woodlands. The potential risk from invasive plant species, such as cheatgrass, could further compound these problems.

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