Section IV. Assessments of Species and Species Assemblages

Chapter 17. Juniper Woodlands

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Distribution and Ecology

Five species of junipers occur in the western United States, two of which occur in the Wyoming Basin: Rocky Mountain juniper and Utah juniper. Junipers are short-stature evergreen trees generally found on rocky soils in some of the driest sites that support trees anywhere in the world (Waring, 2011). In the Wyoming Basin, junipers generally occur on hills, escarpments, and rocky terrain in semiarid landscapes at elevations of 1,200–2,400 meters (m) (3,937–7,874 feet [ft]) in the foothill shrublands and woodlands that are located between sagebrush steppe at lower elevations and montane forests at higher elevations. In more arid settings, juniper species generally are dominant in open woodlands characterized by a sparse understory of shrubs, grasses, and forbs, including mountain mahogany, serviceberry, bitterbush, blue grama, bluebunch wheatgrass, and fringed sagewort. In relatively mesic juniper woodlands, limber pine, ponderosa pine, aspen, and Douglas-fir may be co-dominant with junipers (Knight, 1994), and on some landscapes, juniper woodlands may develop into closed-canopy "pygmy forests" with very sparse understories. Throughout most of their range in the western United States, junipers co-occur with pinyon pines (often referred to as pinyon-juniper woodlands), but in the Wyoming Basin, pinyon pines are found only in the southern-most areas. Elsewhere in the Basin, juniper is often associated with limber pine, which is similar to pinyon pine because both pines have large seeds dispersed by animals.

In the Wyoming Basin, Rocky Mountain and Utah junipers have similar ecological requirements and broadly overlapping ranges. Both species are usually found on coarse-textured soils but may also occur on deeper alluvial soils. Rocky Mountain juniper is widely distributed across the Wyoming Basin and generally occurs in ravines or in areas of ample summer precipitation, whereas Utah juniper is found primarily on escarpments in the western portion of the Basin (Knight, 1994). Analysis of packrat middens suggests that Utah juniper colonized southwestern Wyoming during the early Holocene (approximately 9,500–8,000 years [yr] ago), then spread north across the Basin, and may be continuing to colonize areas with suitable climate and soils (Lyford and others, 2003). The size and density of trees varies along gradients in soil moisture and precipitation (Romme and others, 2009). Juniper woodlands can exist as sparsely wooded savannahs or wooded shrublands, but also as denser woodlands with relatively dense overstories of old-growth trees that may persist for centuries (Romme and others, 2009).

Landscape Structure and Dynamics

The structure and distribution of juniper woodlands are shaped by fire, climate, and site-level conditions, the interactions of which result in considerable spatial and temporal variation in juniper woodland dynamics (Romme and others, 2009). Across the full range of juniper woodlands, some stands are experiencing infilling and expansion, whereas widespread mortality resulting from fires, drought, and insect outbreaks has led to a decrease in the spatial extent of juniper woodlands in many areas (Romme and others, 2009). Overall, juniper woodlands were stable or declining across much of the Intermountain West in the 20th century, possibly due to an increase in episodic mortality events from fire, drought, and insect outbreaks (Romme and others, 2009; Arendt and Baker, 2013).

Until recently, it was widely assumed that spreading, low-intensity fires helped to restrict juniper woodlands to areas with rocky soils and low fuel loads (Miller and Rose, 1999; Miller and Tausch, 2001). Newer research, however, indicates that fires were typically high severity, resulting in high levels of tree mortality, and historical fire rotations were often much longer than previously assumed for juniper woodlands (Romme and others, 2009; Shinneman and Baker, 2009). For example, historical fire rotations in pinyon-juniper woodlands at Dinosaur National Monument, Colo., and the surrounding area were estimated to have been 400–600 years (Floyd and others, 2004; Shinneman and Baker 2009; Arendt and Baker, 2013).

It is well established that decadal-scale variation in climate plays a major role in episodic mortality and recruitment of juniper and pinyon pine, but there is considerable uncertainty about how natural dynamics have affected the contemporary distribution and densities of these woodlands in the western United States (Romme and others, 2009). Much of the research addressing the dynamics of juniper woodlands has been conducted in pinyon-juniper systems, and the degree to which these results apply to other juniper systems is unclear. Junipers and pinyon pines vary in their responses to drought. Pinyon pines have shallower roots compared to juniper; consequently, juniper establishment is favored during drought, whereas pinyon pine is favored during periods of above average moisture (Shinneman and Baker, 2009). During prolonged drought periods, 7,500−5,400 before present (B.P.) and from 2,800−1,000 B.P., Utah juniper expanded into central and northern Wyoming, and southern Montana (Lyford and others, 2003). The combined effects of widespread drought, high temperatures, and bark beetle outbreaks led to extensive mortality of pinyon pines across the Four Corners region of the United States at the end of the 20th century (Romme and others, 2009).

Locally, the complex interplay of regional precipitation patterns, elevation, topography, and plant species also can affect juniper woodland dynamics. In the southern Rocky Mountains, where most precipitation falls during the summer monsoon season, one-seeded juniper showed a high potential for expansion; however, the same propensity was not observed for Rocky Mountain juniper in areas of the Colorado Plateau, where most precipitation falls in winter (Jacobs, 2011). In some areas, pinyon-juniper woodlands at lower elevations have expanded more in recent decades than they did at higher elevations. Mortality resulting from drought can be greatest at lower elevations, whereas mortality resulting from fire can be greatest at upper elevations, which can offset recent expansions (Manier and others, 2005; Clifford and others, 2011; Arendt and Baker, 2013; Powell and others, 2013). Juniper woodlands are often restricted to steeper slopes, but expansion can occur on moderate slopes in deeper soils, particularly under favorable climatic conditions (Jacobs, 2011; Arendt and Baker, 2013). Regionally, juniper woodlands occur across broad and localized ecological gradients, and consequently their structure and dynamics cannot be explained by a simple paradigm (Romme and others, 2009).

In the Wyoming Basin, recent widespread expansion of juniper woodlands has not been demonstrated, but studies in the Wyoming Basin ecoregion are limited. A repeat photography study designed to compare recent photographs with historical photographs taken in the early 1900s indicate that Utah juniper has expanded in some areas of Wyoming and Montana, but has remained stable in others (Steve Jackson, Director, Southwest Climate Science Center, U.S. Geological Survey, written commun., October 24, 2013). In Dinosaur National Monument and surrounding areas, pinyon-juniper woodlands declined 3–7 percent overall during the past 90 years, resulting in part from high fire frequency relative to historical conditions (Arendt and Baker, 2013). Locally, however, pinyon-juniper expanded along historical pinyon-juniper-sagebrush ecotones at elevations of 2,000–2,400 m (6,500–7,900 ft). As with much of the Intermountain West, juniper woodland ecotones of the Wyoming Basin appear to be expanding and contracting over a range of spatial and temporal scales.

Associated Species of Management Concern

Juniper woodlands provide crucial ecological resources for many birds and small mammals (Albert and others, 2004), many of which are Wyoming Species of Greatest Conservation Need (Wyoming Game and Fish Department, 2010) and serve as critical winter habitat for elk and mule deer (Alden and Grassy, 1998). Two reptiles of management concern, the midget faded rattlesnake and northern tree lizard, are found in juniper woodlands in the Wyoming Basin. Within the Basin, both species are restricted to a small region in southwestern Wyoming, northeastern Utah, and northwestern Colorado. Many bird species are closely tied to juniper woodlands during all or part of the year, including ash-throated flycatcher, gray flycatcher, juniper titmouse, blue-gray gnatcatcher, Bewick’s Wren, Bullock's oriole, pinyon jay, western scrub-jay, Townsend’s solitaire, Virginia's warbler, and black-throated gray warbler (Lederer, 1977; Paulin and others, 1999; Pavlacky and Anderson, 2001; Gillihan, 2006). In a comparison of forests in the Flaming Gorge National Recreation Area, Wyoming, juniper woodlands ranked second in the percentage of obligate and semiobligate bird species and fourth in overall bird species diversity (Paulin and others, 1999).

A number of mammal species in the Wyoming Basin are also restricted to or rely on juniper woodlands for critical resources; in southwestern Wyoming, juniper woodlands mark the northeastern extent of several small mammal species’ ranges, including those of the cliff chipmunk, pinyon mouse, and canyon mouse (Rompola and Anderson, 2004). Black bears, small mammals, and many bird species are attracted to juniper woodlands in the fall and winter to forage on juniper “berries” (cones). Additionally, the large resource-rich seeds of pinyon and limber pine are a major food resource for wildlife including pinyon jays and Clark’s nutcrackers (see Chapter 16—Five-Needle Pine Forests and Woodlands).

Change Agents

Development

Juniper woodlands are used for a number of human activities, including timber harvest for wood products, energy extraction, livestock grazing, and recreation. Prescribed burns, mechanical treatments, and chemical treatments also are used to manage stand structure of juniper woodlands (Romme and others, 2009). The effects and effectiveness of management activities, such as prescribed fire, depend on past disturbance history, site use, and local conditions (Romme and others, 2009; Arendt and Baker, 2013).

Altered Fire Regimes, Grazing, and Invasive Species

Increases in stand density and expansion of juniper woodlands are often attributed to fire suppression and grazing. Generally, it has been assumed that livestock herbivory and fire suppression after Euro-American settlement reduced fire frequency, thereby facilitating the expansion of juniper woodlands into areas with deeper soils. Because fires were infrequent in juniper woodlands, however, fire exclusion is unlikely to have played a significant role in the recent expansion of juniper woodlands (Romme and others, 2009). Extended fire-free intervals, however, allow juniper seedling survival. Grazing can decrease fine fuels and lead to an increase in shrub cover, and shrubs can serve as nurse plants for tree seedlings (Romme and others, 2009). The degree to which livestock grazing has led directly to increased tree densities and indirectly to decreased fire occurrence is unclear and varies among species, soil types, and climatic patterns (Romme and others, 2009; Jacobs, 2011).

A stronger relationship exists between cheatgrass expansion and increased fire frequencies (Romme and others, 2009). For example, the increased fire occurrence in juniper woodlands of Dinosaur National Monument and City of Rocks National Monument (southern Idaho) was attributed to the expansion of cheatgrass in both locations (Arendt and Baker, 2013; Powell and others, 2013). Roads, energy development, and management actions may influence the expansion of cheatgrass into juniper woodlands. Cheatgrass cover was greater along roads, on the edges of burns, and in seeded areas within burns in pinyon-juniper woodlands on the Uncompahgre Plateau in western Colorado (Getz and Baker, 2008). The greater cheatgrass cover in seeded areas was likely a result of the presence of cheatgrass seeds in the seed mixture used in postfire rehabilitation (Getz and Baker, 2008).

Climate Change

Climate projections, and associated changes in the distribution of bioclimatic conditions suitable for juniper woodlands (classified as Great Basin conifer forests) in the western United States, indicate the potential for northern expansion of juniper woodlands in Wyoming, Idaho, and Montana, but potential contraction in Washington, Nevada, Arizona, and Utah (Rehfeldt and others, 2012). However, the potential for cheatgrass expansion in juniper woodlands under increasing temperatures and carbon dioxide levels could lead to an increase in fire frequency and potential loss of juniper woodlands (Romme and others, 2009; Arendt and Baker, 2013).

Rapid Ecoregional Assessment Components Evaluated for Juniper Woodlands

A generalized, conceptual model was used to highlight some of the key ecological attributes and Change Agents affecting juniper woodlands (fig. 17–1). Key ecological attributes addressed by the Rapid Ecoregional Assessment (REA) include (1) the distribution of juniper woodlands, (2) landscape structure (patch sizes and structural connectivity), and (3) landscape dynamics (fire occurrence and sagebrush-juniper ecotone dynamics) (table 17–1). The Change Agents evaluated include development and climate change (table 17–2). Ecological values and risks used to assess the conservation potential of desert shrublands by township are summarized in table 17–3. Core and Integrated Management Questions and the associated summary maps and graphs are provided in table 17–4.

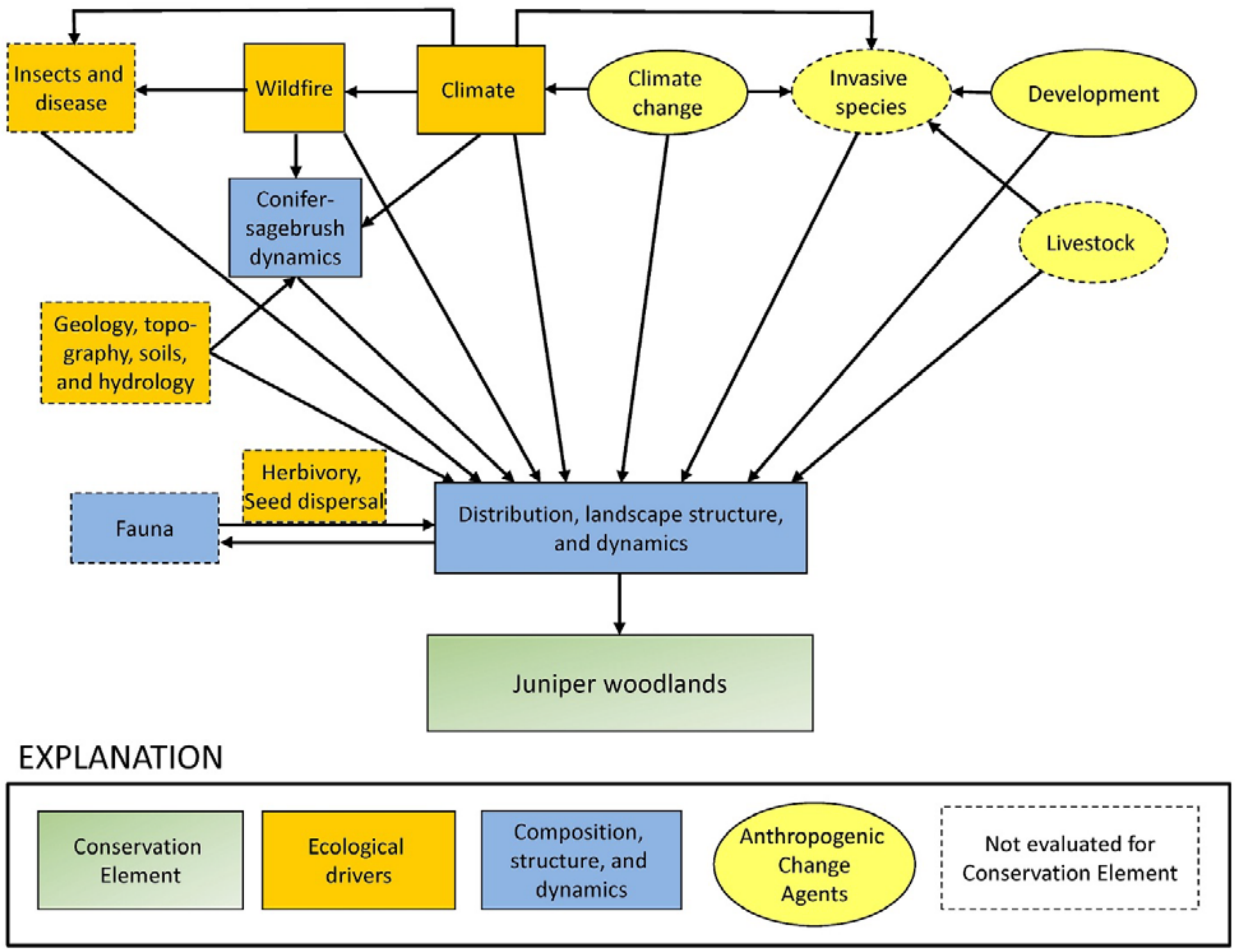

Figure 17−1. General conceptual model for juniper woodlands for the Wyoming Basin Rapid Ecoregional Assessment (REA). Biophysical attributes and ecological processes regulating the occurrence, structure, and dynamics of juniper woodlands are shown in orange rectangles; additional ecological attributes are shown in blue rectangles; and anthropogenic Change Agents that affect key ecological attributes are shown in yellow ovals. The dashed lines indicate the 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 17−1. Key ecological attributes and associated indicators of baseline juniper woodlands[1] for the Wyoming Basin Rapid Ecoregional Assessment.
[km, kilometer; mi, mile; m, meter; ft, foot]

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 distances that provide an index of structural connectivity for baseline patches at local (0.45 km; 0.28 mi), landscape (0.72 km; 0.45 mi), and regional (1.08 km; 0.67 mi) levels
Landscape dynamics	Fire occurrence[3]	Locations of fires and annual area burned since 1980
	Sagebrush-juniper ecotone dynamics[4]	Sagebrush shrublands within 30 m (98 ft) of juniper woodlands

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

[2] 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 and the Appendix.

[3] See Wildland Fire section in the Appendix.

[4] See Chapter 23—Greater Sage-Grouse for an evaluation of the potential for juniper expansion in proximity to sage-grouse leks.

Table 17−2. Anthropogenic Change agents and associated indicators influencing juniper woodlands for the Wyoming Basin Rapid Ecoregional Assessment.
[km^2, square kilometers; mi^2, square miles; km, kilometers; mi, miles]

Change Agents	Variables	Indicators
Development	Terrestrial Development Index[1]	Percent of juniper woodlands in seven development classes using a 16-km^2 (6.18- mi^2) moving window
		Patch-size distribution for juniper 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 (0.63 km; 0.39 mi), landscape (3.33 km; 2.07 mi), and regional (7.38 km; 4.59 mi) levels
Climate change	Projected temperature and precipitation	Potential distribution of juniper woodlands derived from the projected distribution of the bioclimatic envelope in 2030[2]

[1] See Chapter 2—Assessment Framework.

[2] Bioclimatic envelope represents the climatic conditions conducive for juniper woodlands, derived from Rehfeldt and others (2012) using climate scenario I (Canadian Centre for Climate Modeling and Analysis Coupled Global Model, ver. 3, emissions scenario A2).

Table 17−3. Landscape-level ecological values and risks for juniper woodlands. 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	<0.4	0.4–1.4	>1.4	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 juniper woodlands to minimize the effects of extremely small areas and put greater emphasis on large areas (see table A−19 in the Appendix).

[2] See tables 17–1 and 17–2 for description of variables.

Table 17−4. Management Questions addressed for juniper woodlands for the Wyoming Basin Rapid Ecoregional Assessment.

Core Management Questions	**Results**
Where are baseline juniper woodlands, and what is the total area?	Figure 17–2
Where does development pose the greatest threat to baseline juniper woodlands, and where are the relatively undeveloped areas?	Figures 17–3 and 17–4
How has development fragmented baseline juniper woodlands, and where are the large, relatively undeveloped patches?	Figures 17–5 and 17–6
Where are baseline juniper woodlands with high structural connectivity, and which woodlands function as stepping stones?	Figure 17–7
Where are potential barriers and corridors that may affect animal movements among baseline juniper woodland patches?	Figure 17–8
Where are the sagebrush-juniper ecotones with potential for juniper expansion?	Figure 17–9
Where have recent fires occurred in baseline juniper woodlands, and what is the total area burned per year?	Figure 17–10
What is the potential distribution of juniper woodlands in 2030?	Figure 17–11
Integrated Management Questions	**Results**
How does risk from development vary by land ownership or jurisdiction for juniper woodlands?	Table 17–5, Figure 17–12
Where are the townships with the greatest landscape-level ecological values?	Figure 17–13
Where are the townships with the greatest landscape-level risks?	Figure 17–13
Where are the townships with the greatest conservation potential?	Figure 17–14

Methods Overview

To map the baseline distribution of juniper woodlands, we included all juniper, pinyon-juniper, and limber-pine juniper LANDFIRE Existing Vegetation Types (EVTs). We assessed development levels in juniper woodlands using the Terrestrial Development (TDI) map, and then used the resulting output to calculate patch size and structural connectivity metrics. We mapped the structural connectivity of baseline distribution at three interpatch distances derived from connectivity analysis: local (0.45 km; 0.28 mi), landscape (0.72 km; 0.45 mi), and regional (1.08 km; 0.67 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 juniper woodlands since 1980 were compiled from several data sources to assess fire frequency and extent (table 17–1).

To evaluate the potential for expansion of juniper woodlands into adjacent sagebrush shrublands (includes basin, Wyoming, and mountain big sagebrush), we assumed that expansion potential would be greatest along ecotones between juniper woodlands and sagebrush shrublands. Potential ecotones included cells where juniper woodlands were adjacent to sagebrush shrublands; the proportion of sagebrush shrublands within a 30-m (98.4-ft) buffer was used as an index of the potential for juniper expansion.

To evaluate the potential changes in the distribution of juniper woodlands as a consequence of climate change, we used the bioclimatic envelope model developed by Rehfeldt and others (2012) for juniper woodlands (which includes pinyon pine and juniper) using climate scenario I (Canadian Centre for Climate Modeling and Analysis Coupled Global Model, version 3 [CCCM3], emissions scenario A2) in 2030. Current and projected bioclimatic envelopes were used to identify areas where juniper woodlands had the potential to increase, decline, or remain the same. We then overlaid the resulting map with the baseline juniper woodlands map to identify existing areas that have the potential to change using climate scenario I.

Landscape-level ecological values (area of juniper woodlands) and risk (TDI score) were compiled into an overall index of conservation potential for each township (table 17–3). 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 Appendix for additional details on source data and methods.

Key Findings for Management Questions

Where are baseline juniper woodlands, and what is the total area (fig. 17–2)?

- Juniper woodlands are sparsely distributed throughout the Wyoming Basin, occupying 4,815 km^2 (1,859 mi^2) or 1.6 percent of the ecoregion.
- The largest juniper woodland complexes occur in the southern portion of the Basin at the base of the Uinta Mountains in northeastern Utah and northwestern Colorado, and the southern extent of the Bighorn Basin (fig. 17–2).

Where does development pose the greatest threat to juniper woodlands (figs. 17–3 and 17–4)?

- Juniper woodlands have relatively low development levels compared to other communities within the Wyoming Basin. Relatively undeveloped areas (TDI scores ≤1 percent) represent 34 percent of juniper woodlands. Only 9 percent of the juniper woodlands have TDI scores >5 percent, indicating high development levels (fig. 17–3).
- The largest patches of juniper woodlands occur in areas with low development in the southern portion of the Wyoming Basin and along the Granite Mountains (fig. 17–4).

How has development fragmented baseline juniper woodlands, and where are the large, relatively undeveloped patches (figs. 17–5 and 17–6)?

- Most of the area occupied by baseline juniper woodlands in the Wyoming Basin occur as numerous small patches <1 km^2 (0.39 mi^2). The total area of large patches exceeding 100 km^2 (38.3 mi^2) is only 10 percent (figs. 17–5 and 17–6).
- Unlike most species and communities, development levels are greater for smaller juniper woodlands patches than they are for larger ones. The total area of small patches that are relatively undeveloped is one third of the total area of small baseline patches. The area of baseline and relatively undeveloped woodlands of patches larger than 100 km^2 is similar, indicating the relatively low development scores for large juniper woodlands (fig. 17–5).

Where are baseline juniper woodlands with high structural connectivity, and which woodlands function as stepping stones (fig. 17–7)?

- Juniper woodlands are typically small and isolated; this leads to relatively large interpatch distances. Regional connectivity baseline juniper woodlands occurs at interpatch distance of 1.08 km (0.67 mi) and 7.38 km (4.59 mi) for relatively undeveloped patches.

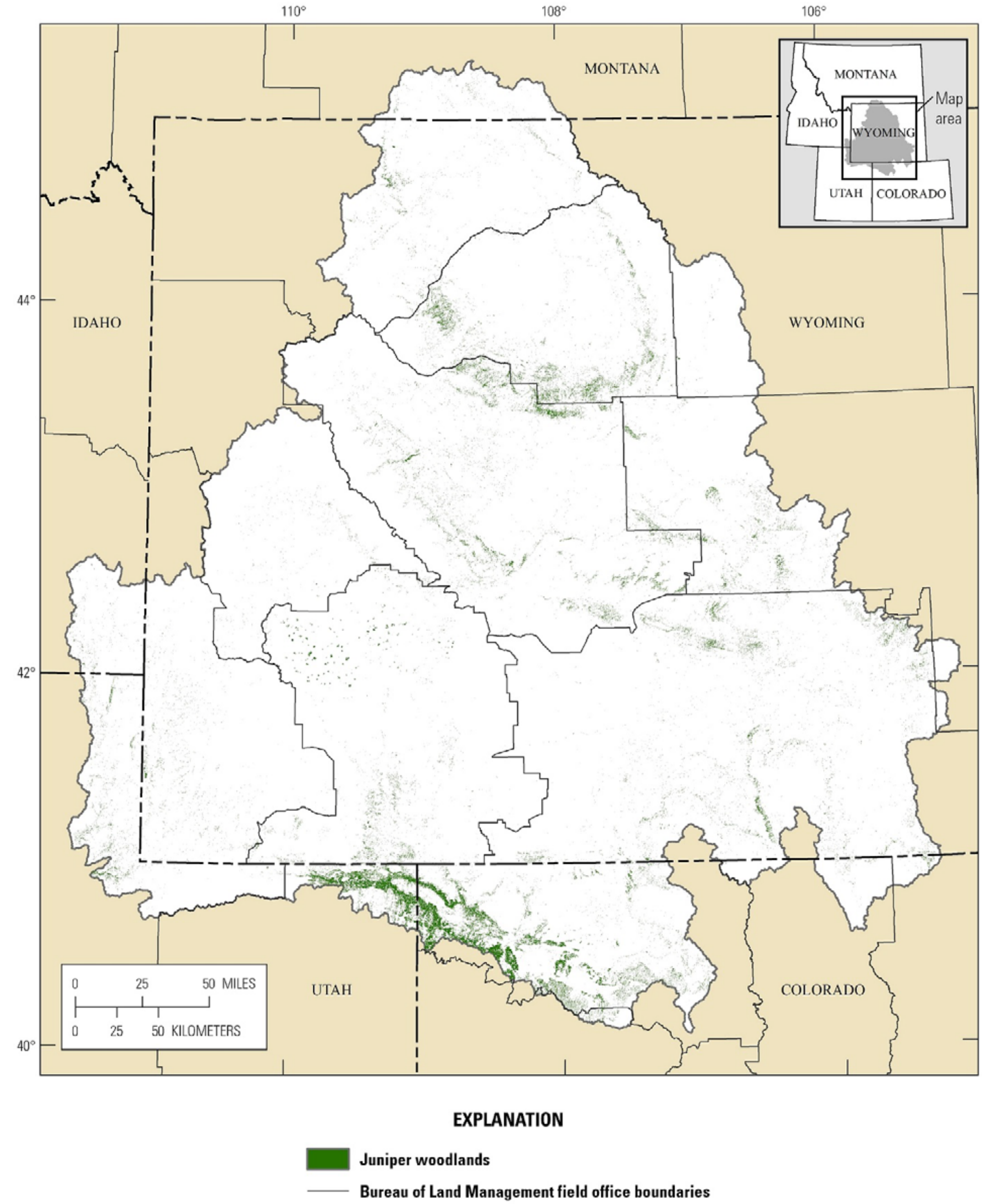

Figure 17−2. Distribution of baseline juniper woodlands in the Wyoming Basin Rapid Ecoregional Assessment project area.

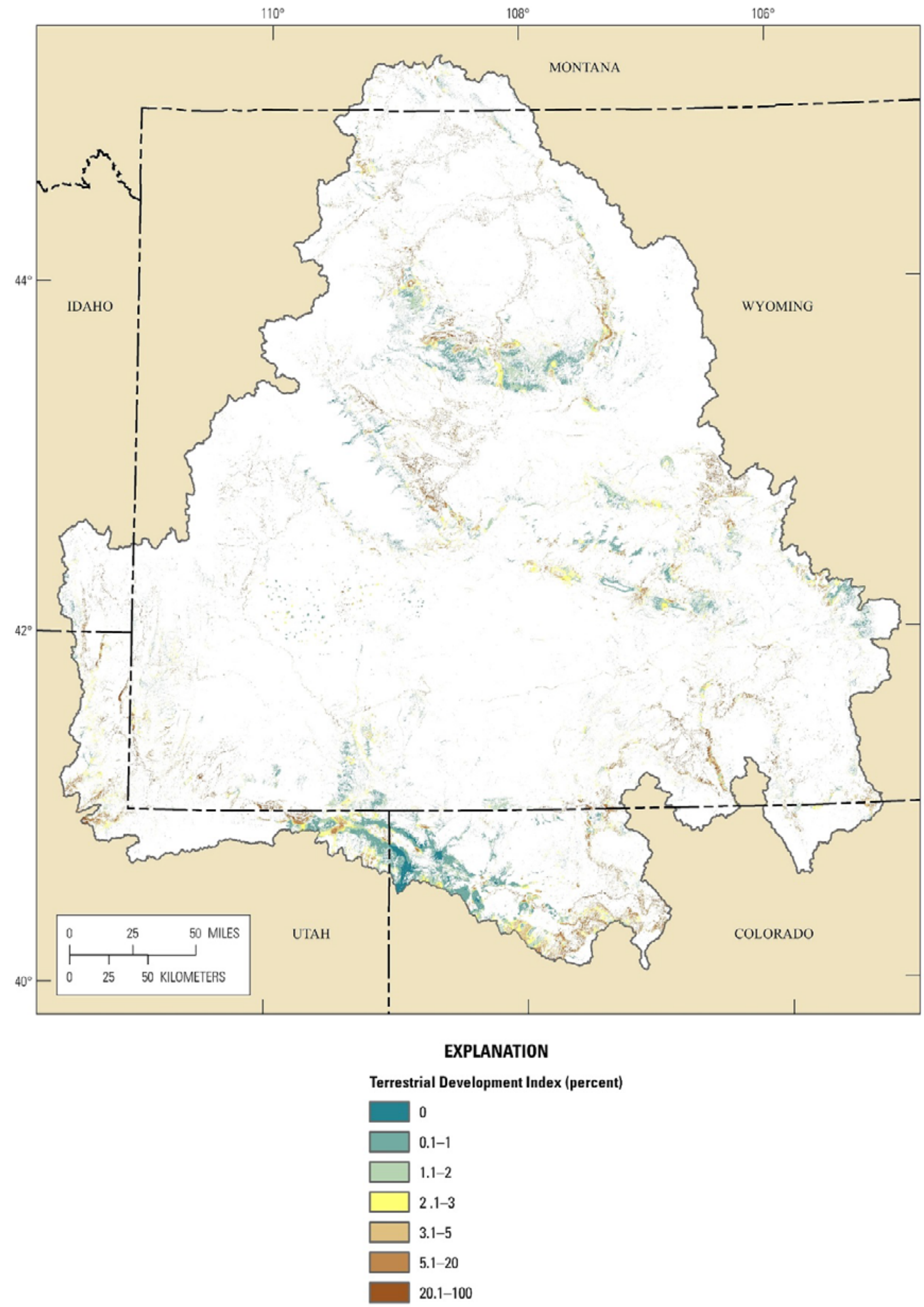

Figure 17−3. Terrestrial Development Index scores for juniper woodlands in the Wyoming Basin Rapid Ecoregional Assessment project area.

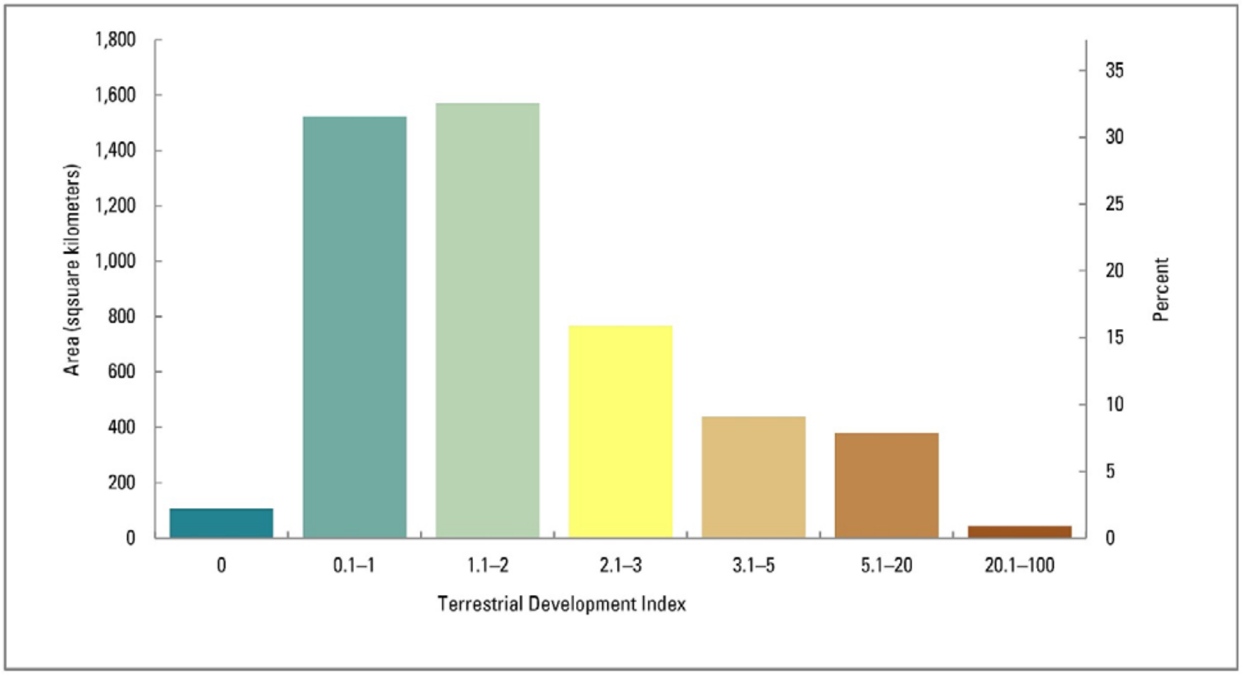

Figure 17−4. Area and percent of baseline juniper woodlands as a function of the Terrestrial Development Index in the Wyoming Basin Rapid Ecoregional Assessment project area.

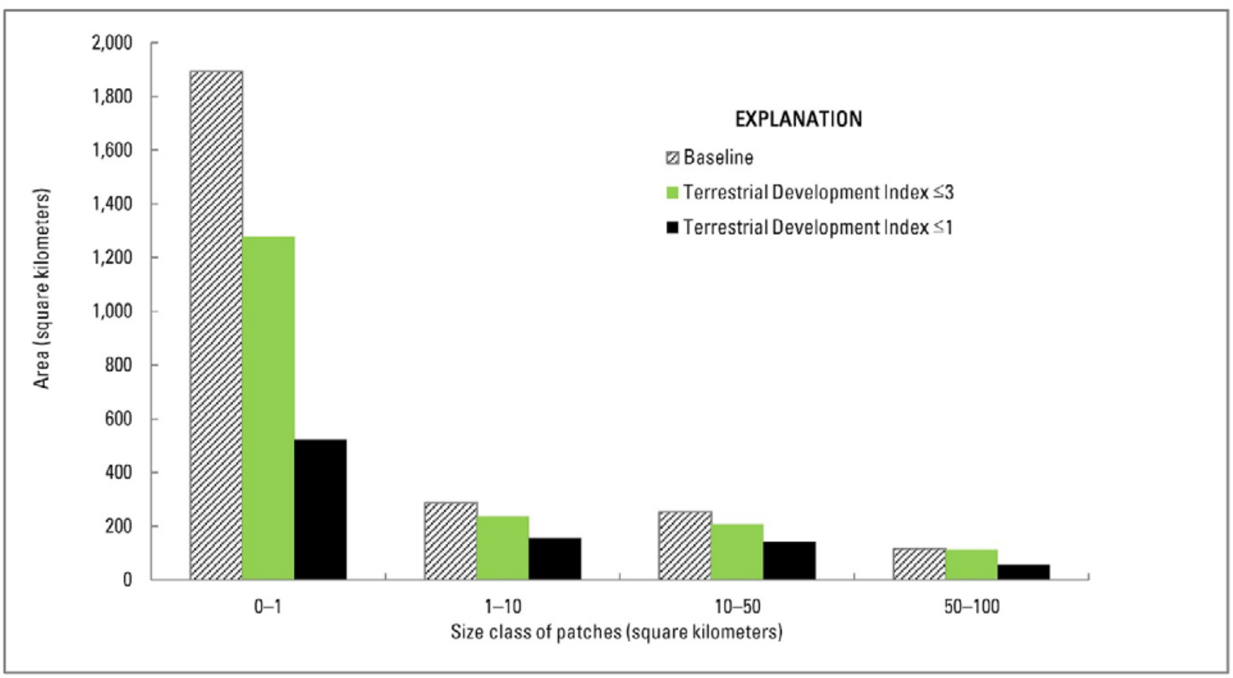

Figure 17−5. Area of juniper woodlands as a function of patch size for baseline conditions and two development levels: (1) Terrestrial Development Index (TDI) score <u><</u>3 percent, and (2) TDI score <u><</u>1 percent (relatively undeveloped areas) in the Wyoming Basin Rapid Ecoregional Assessment project area.

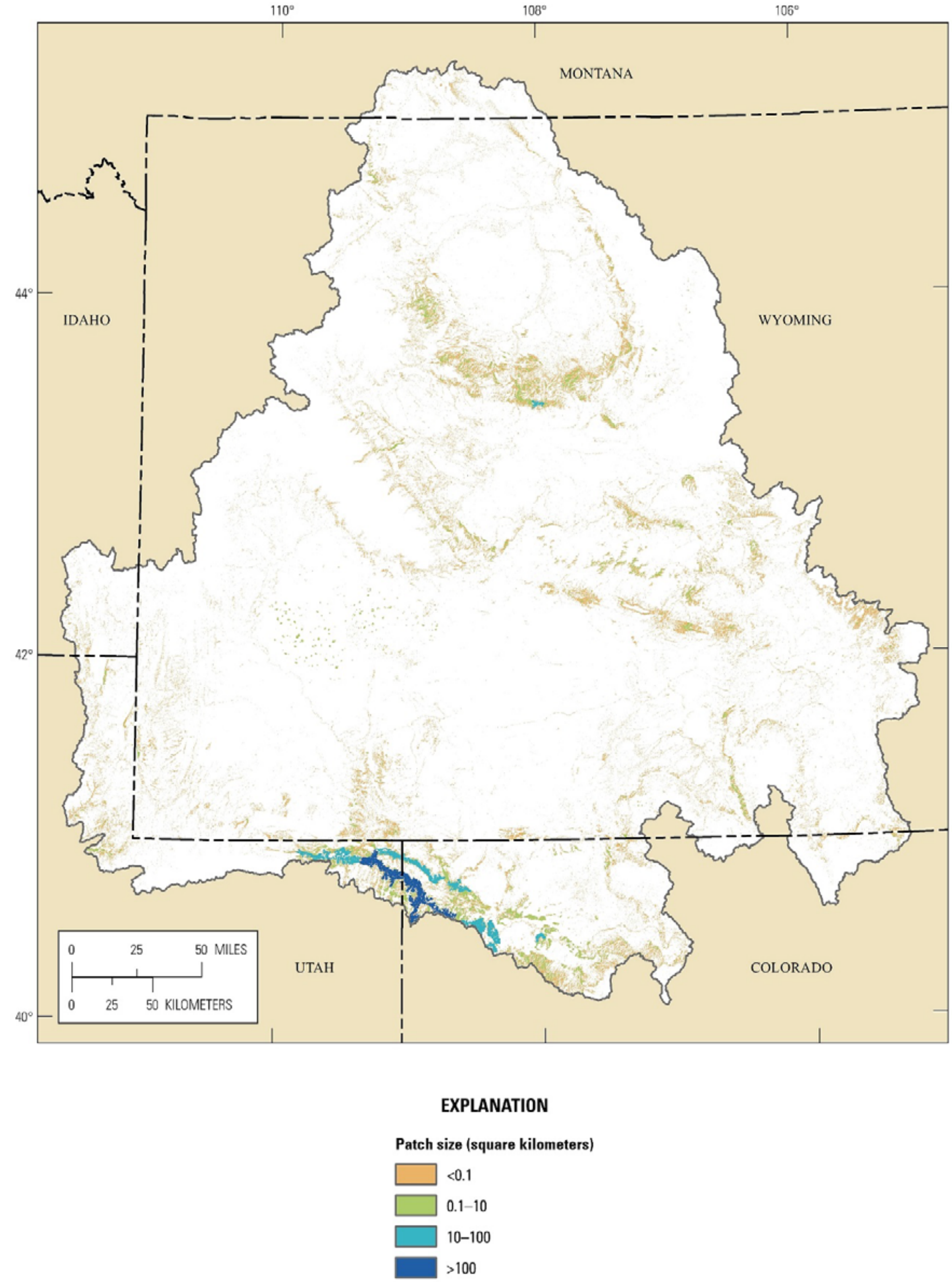

Figure 17−6. Patch sizes of baseline juniper woodlands in the Wyoming Basin Rapid Ecoregional Assessment project area.

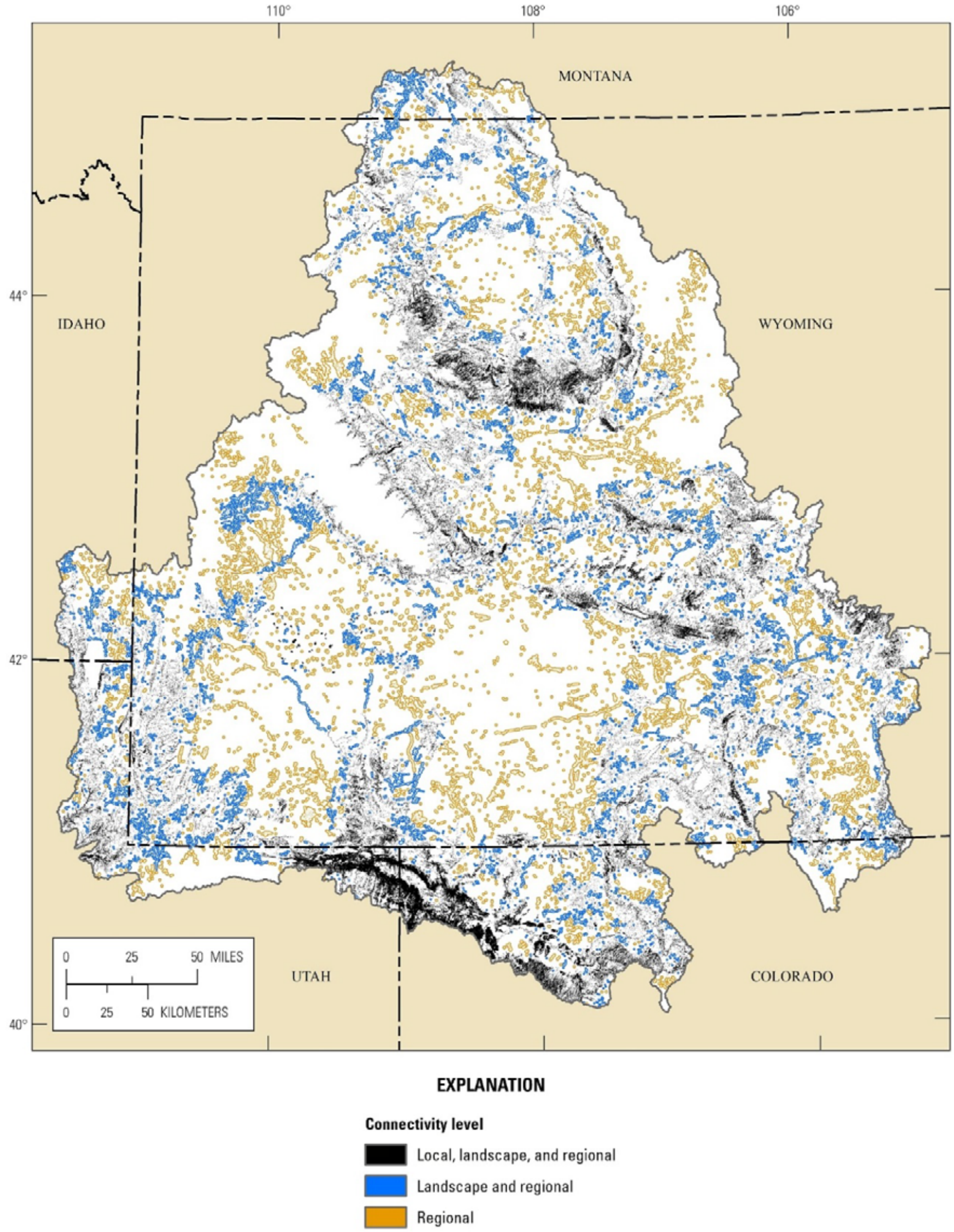

Figure 17−7. Structural connectivity of baseline juniper woodlands in the Wyoming Basin Rapid Ecoregional Assessment project area. Black polygons include large and highly connected patches. Blue polygons include patches that contribute to both landscape and regional connectivity. Orange polygons represent isolated clusters of patches surrounded by developed areas or other cover types.

Where are potential barriers and corridors that may affect animal movements among baseline juniper woodland patches (fig. 17–8)?

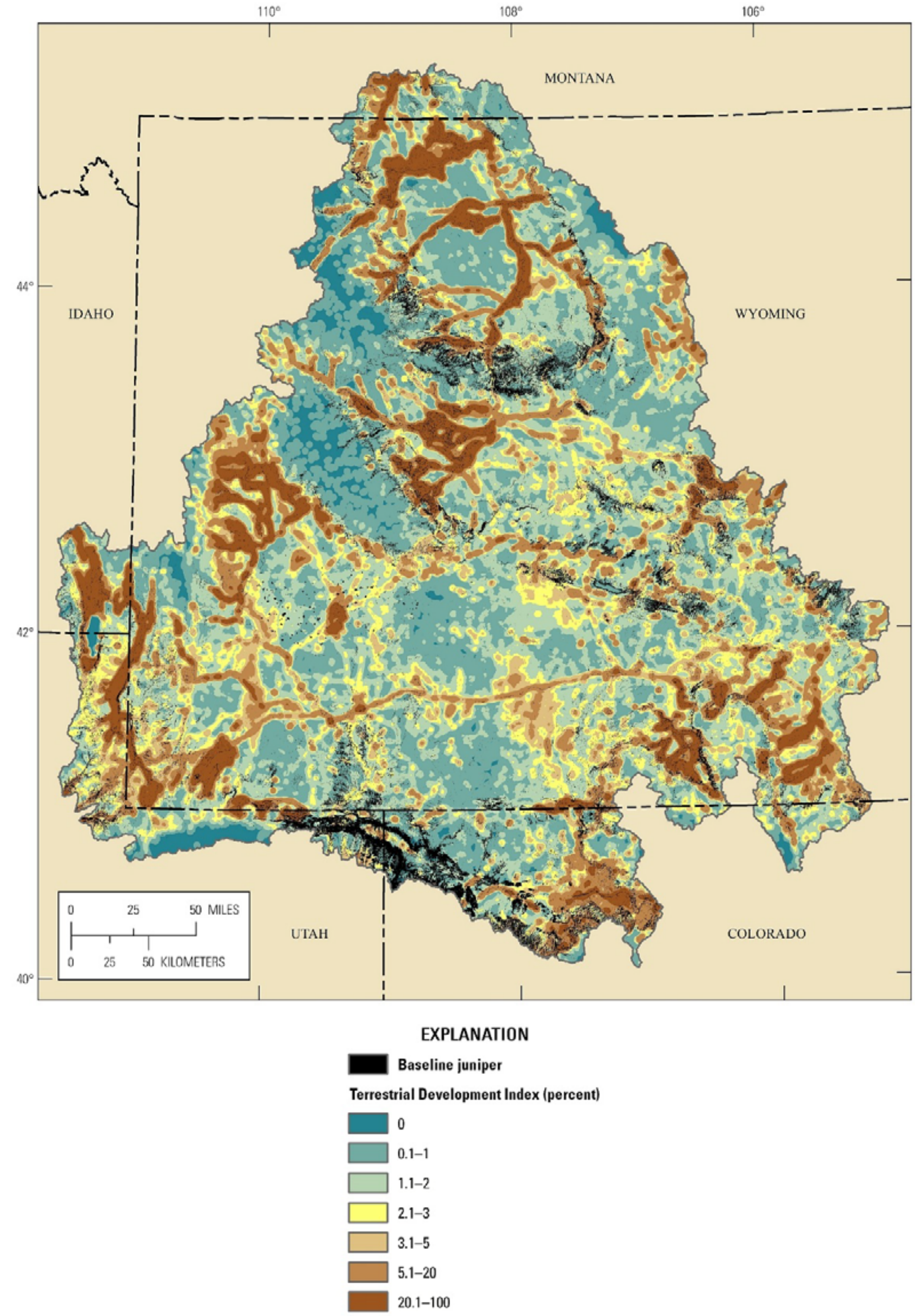

Figure 17−8. Potential barriers and corridors as a function of the Terrestrial Development Index (TDI) score for lands surrounding baseline juniper woodlands. Higher TDI scores (for example, >5 percent) represent potential barriers to movement among relatively undeveloped patches. Lower TDI scores (for example, <2 percent) represent potential corridors for movements among patches.

Where are the sagebrush-juniper ecotones with potential for juniper expansion (fig. 17–9)?

- Across the entire Wyoming Basin, 42 percent of all juniper woodland cells are >30 m (98.4 ft) from sagebrush shrublands. Much of this area falls in the large pinyon-juniper forests in Utah and Colorado.
- Because of the small size of many juniper woodland patches in the Basin, sagebrush and juniper woodlands form heterogeneous mosaics.
- Twenty-four percent of juniper woodland cells had >50 percent cover of sagebrush shrublands within 30 m, which may represent ecotones with potential for juniper expansion. However, other factors, including climate variation, topography, elevation, grazing, and fire occurrence contribute to the dynamics of juniper woodland-sagebrush shrubland ecotones.
- See also Chapter 23—Greater Sage-Grouse for potential juniper expansion in the vicinity of leks.

Where have recent fires occurred in baseline juniper woodlands, and what is the total area burned per year (fig. 17–10)?

- Recent fires have burned an average of 8.15 km^2 (3.1 mi^2) or <0.2 percent of juniper woodlands in the Wyoming Basin per year.
- The largest fire year occurred in 2000, when 89 km^2 (34.4 mi^2) or 2 percent of juniper woodlands in the Basin burned.
- The largest fires occurred in the southern portion of the Wyoming Basin.
- In 1992 and 1995, the total area burned by prescribed fire exceeded that burned by wildfire.
- Using the fire extent in juniper woodlands in the Wyoming Basin since 1980, the estimated fire-rotation interval is approximately 352 yr, which is similar to the historic fire occurrence for the region (Floyd and others, 2004; Shinneman and Baker, 2009).

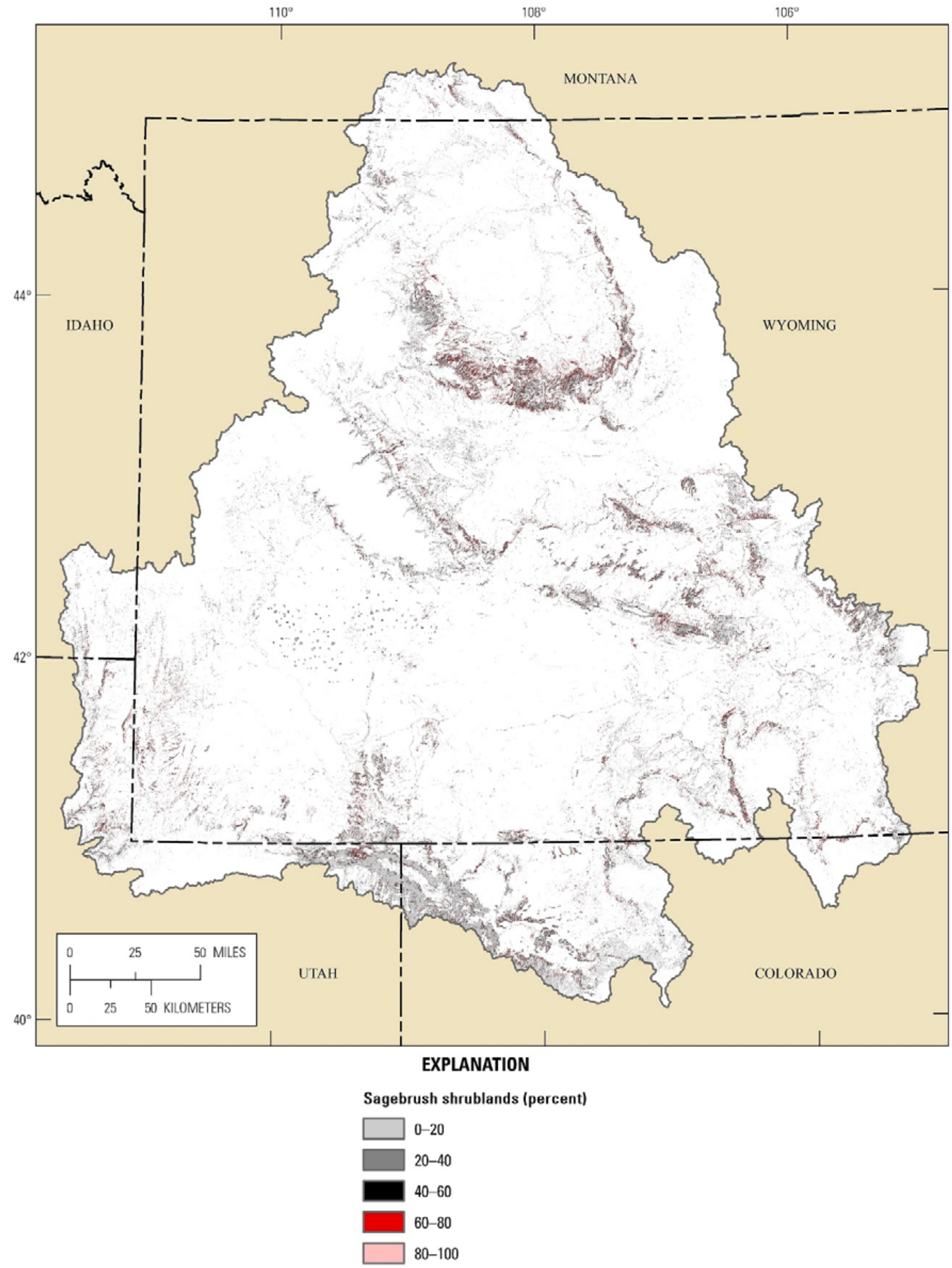

Figure 17−9. Sagebrush-juniper ecotones in the Wyoming Basin Rapid Ecoregional Assessment project area. Ecotones are indicated by juniper woodlands cells with a higher percent of sagebrush shrublands within 30 meters (98.4 feet).

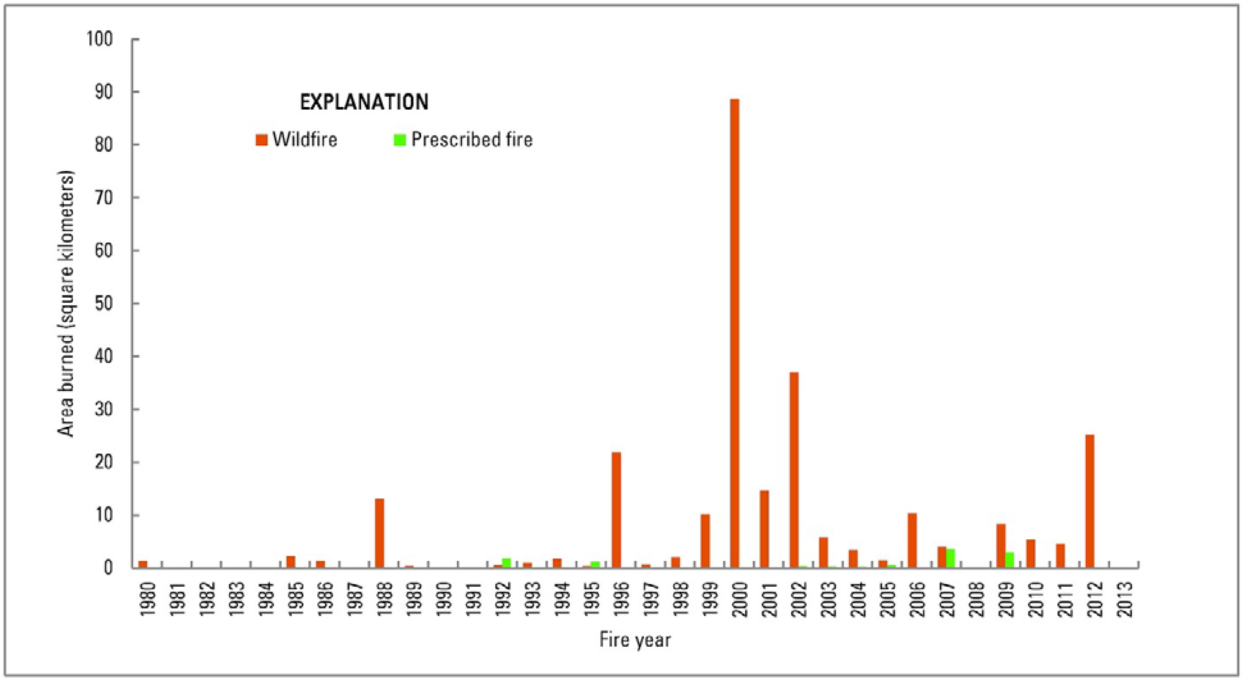

Figure 17−10. Annual area burned by wildfires and prescribed fires in baseline juniper woodlands since 1980 in the Wyoming Basin Rapid Ecoregional Assessment project area.

What is the potential distribution of juniper woodlands in 2030 (fig. 17–11)?

- The distribution of bioclimatic conditions conducive for juniper woodlands is projected to greatly expand by 2030 for climate scenario I (fig. 17−11*A*).
- Large areas that currently support juniper woodlands, especially in Colorado, are projected to have the potential for decline by 2030 (fig. 17−11*B*) for climate scenarios. Figure 2−18 includes additional climate scenarios and time periods.

How does risk from development vary by land ownership or jurisdiction for juniper woodlands (table 17–5, fig. 17–12)?

- Most juniper woodlands in the Wyoming Basin are located on Bureau of Land Management (BLM) and private lands (table 17–5).
- BLM lands have a relatively high proportion (49 percent) of juniper woodlands with low levels of development, whereas private lands have a high proportion (45 percent) of juniper woodlands with the greatest development levels (fig. 17–12).

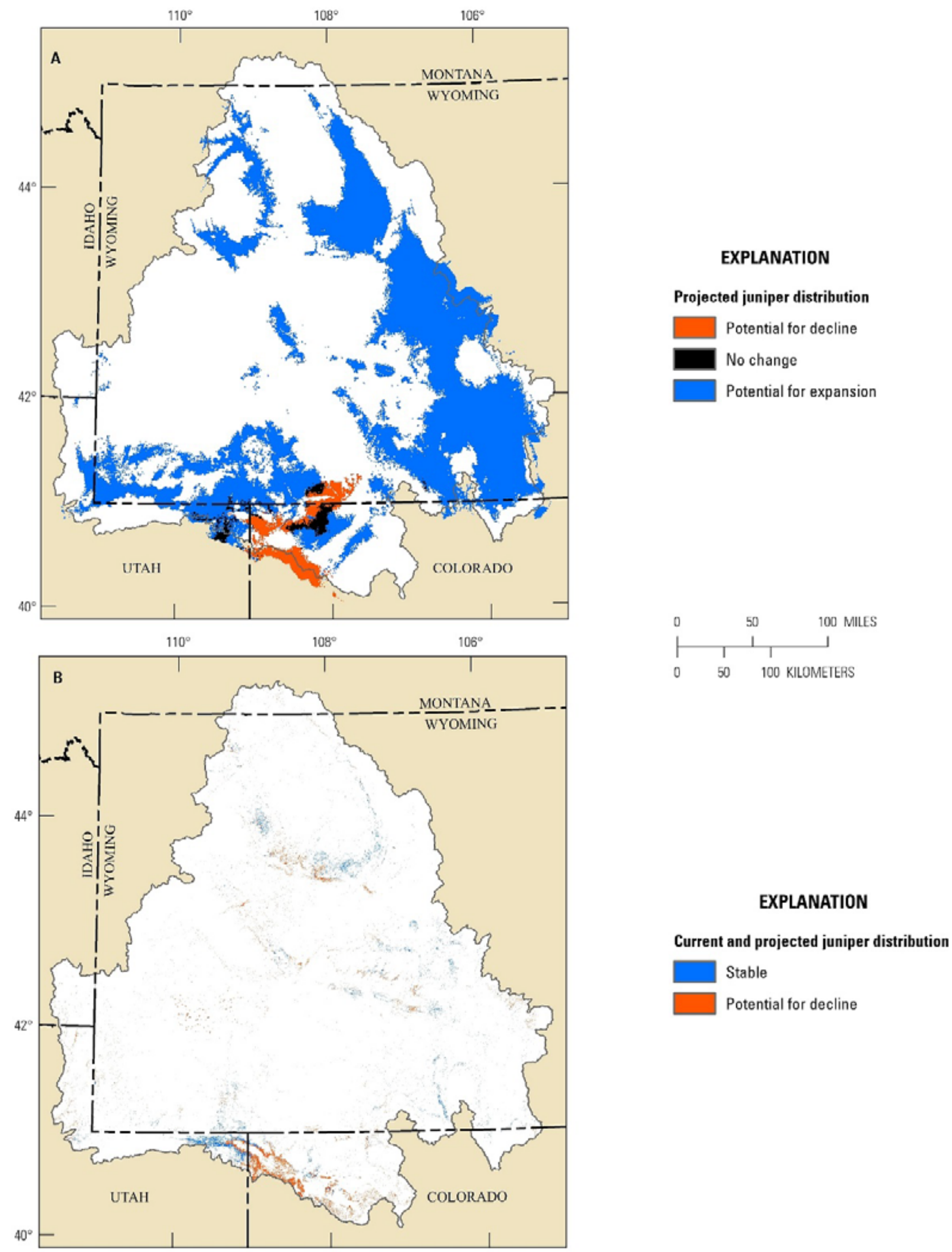

Figure 17−11. Potential effects of climate change on juniper woodlands in the Wyoming Basin Rapid Ecoregional Assessment project area. (*A*) Projected changes in the bioclimatic envelope for juniper woodlands derived from Rehfeldt and others (2012) for climate scenario I in 2030. Orange indicates areas with potential for decline because current and projected envelope distributions do not coincide. Black indicates areas not expected to change because the current and projected envelope distributions overlap. Blue indicates potential for expansion into areas that are outside the current envelope distribution. (*B*) Potential changes in baseline juniper woodlands derived from overlap with the projected bioclimatic envelope distribution for juniper woodlands (as represented in *A*).

Table 17−5. Area and percent of juniper woodlands by land ownership or jurisdiction in the Wyoming Basin Rapid Ecoregional Assessment project area.

[km^2, square kilometers]

Ownership or jurisdiction	Area (km^2)	Percent of Area
Bureau of Land Management	1,389	48.7
Private	767	26.9
Forest Service[1]	220	7.7
State/County	200	7.0
Tribal	154	5.4
Other Federal[2]	94	3.3
Private conservation	24	0.9

[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.

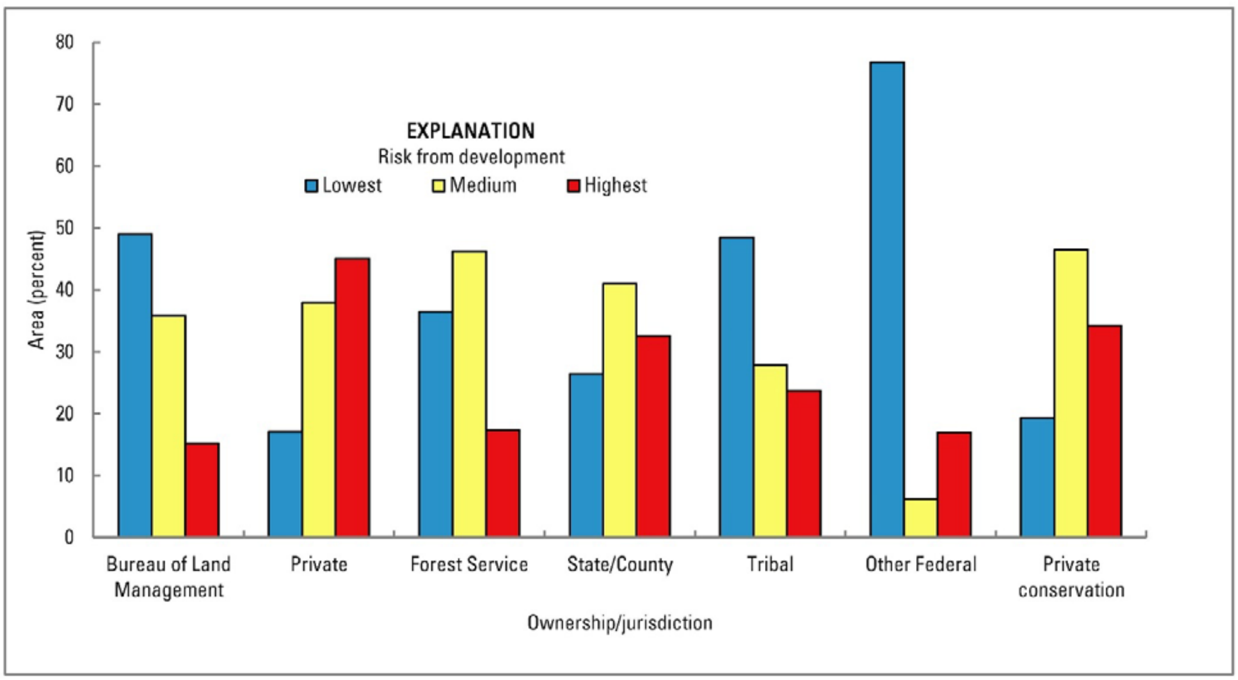

Figure 17−12. Relative ranks of risk from development, by land ownership or jurisdiction, for juniper woodlands in the Wyoming Basin Rapid Ecoregional Assessment project area. Rankings are lowest (Terrestrial Development Index [TDI] score <1 percent), medium (TDI score 1−3 percent), and highest (TDI score >3 percent). [Forest Service, U.S. Department of Agriculture Forest Service]

Where are the townships with the greatest landscape-level ecological values and greatest landscape-level risks (fig. 17–13)?

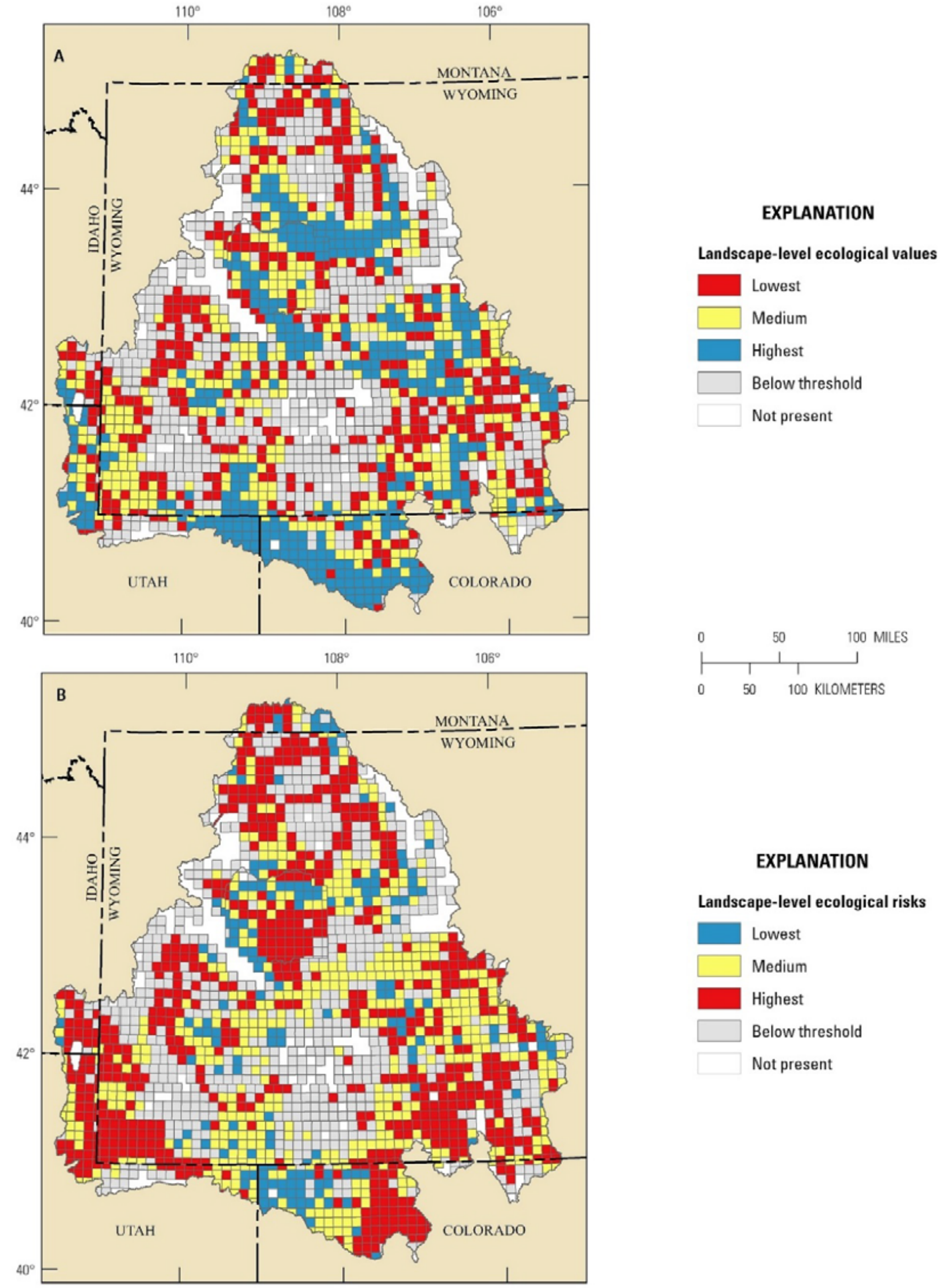

Figure 17−13. Ranks of landscape-level ecological values and risks for juniper woodlands, summarized by township, in the Wyoming Basin Rapid Ecoregional Assessment project area. (*A*) Landscape-level values based on area and (*B*) landscape-level risks based on Terrestrial Development Index (see table 17–3 for overview of methods).

Where are the townships with the greatest conservation potential (fig. 17–14, table 17–5)?

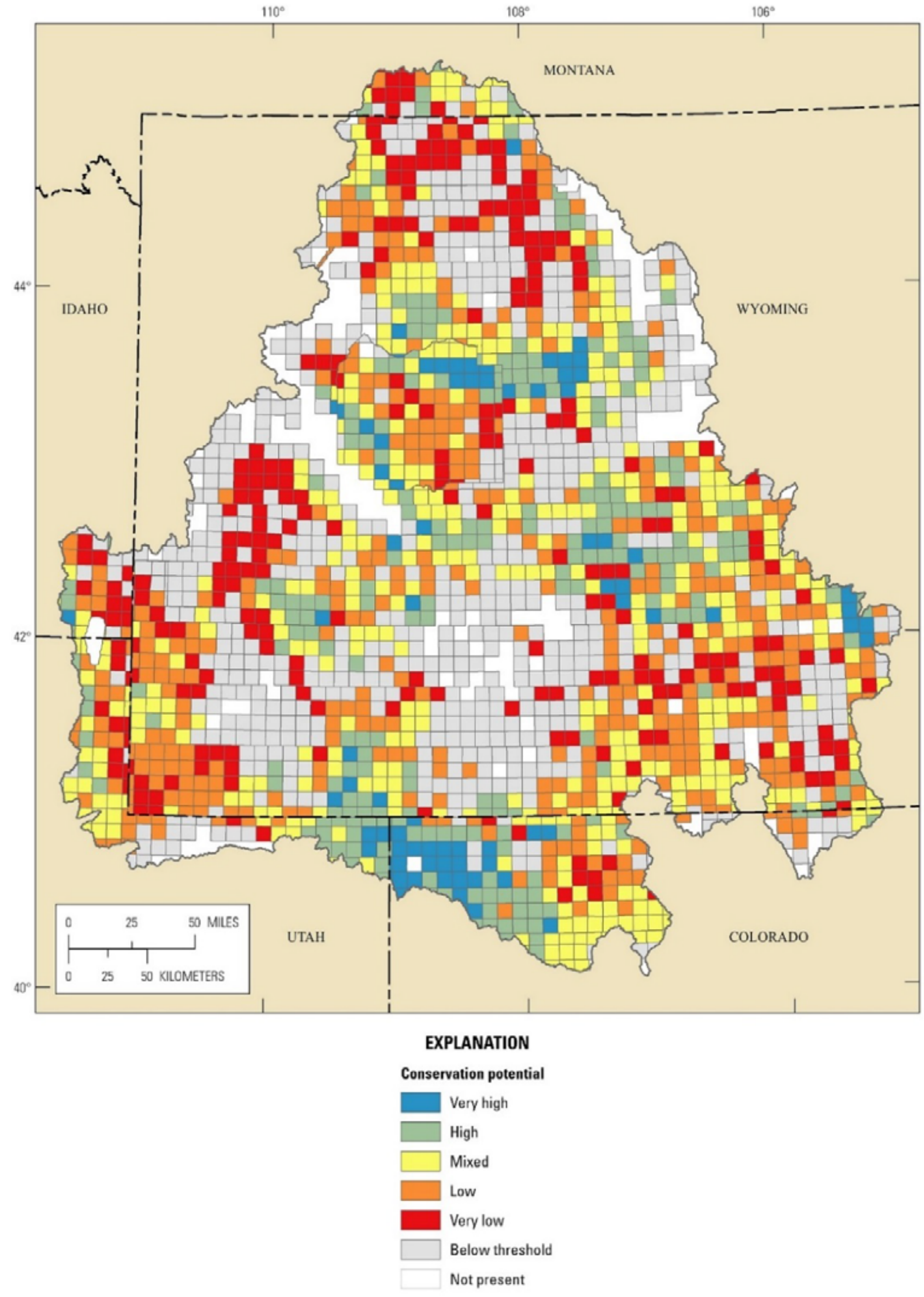

Figure 17−14. Conservation potential of juniper woodlands, summarized by township, in the Wyoming Basin Rapid Ecoregional Assessment project area. Highest conservation potential identifies areas that have the highest landscape-level values and the lowest risks. Lowest conservation potential identifies 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

Juniper woodlands occupy a limited area of the Wyoming Basin, but they provide crucial habitats for a number of species. Most juniper woodlands are small and widely dispersed across the ecoregion. The numerous small patches can function as vital stepping stones connecting larger juniper woodland complexes across the Basin. Many of the small patches, however, had high levels of development, resulting in decreased structural connectivity among relatively undeveloped juniper woodland complexes, which could pose problems for species that rely on juniper woodlands for food and cover. The Bureau of Land Management (BLM) has a significant responsibility for juniper woodlands in the Wyoming Basin, as almost half of the woodlands fall under BLM jurisdiction, and those woodlands have relatively low development scores.

The relatively small size of juniper woodland patches in a matrix of sagebrush shrublands leads to a high proportion of juniper woodland edges. Over decades and centuries, the patch edges, or ecotones, between juniper woodlands and sagebrush shrublands can expand and contract in response to climate variability and time since fire. The degree to which the current distribution of juniper woodlands in the Wyoming Basin is a consequence of fire suppression and grazing or the result of longer term ecotone dynamics could not be determined for this REA and represents a critical information gap. Over the past several decades, however, the occurrence of fires in juniper woodlands of the Wyoming Basin appears consistent with the historical fire regime in which fire-return intervals can exceed several centuries. Consequently, fire suppression does not appear to have played a major role in juniper woodland expansion in this ecoregion. Climate-change scenarios indicate that conditions for juniper woodlands could expand by 2030 throughout much of the Wyoming Basin; in Colorado, however, where pinyon pine reaches the northern limits of its distribution, climate scenarios indicate a potential for declines in large stands of pinyon-juniper woodlands.

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