Section IV. Assessments of Species and Species Assemblages

Chapter 25. Ferruginous Hawk

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

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Key Ecological Attributes

Distribution and Ecology

The ferruginous hawk is the largest buteo in North America (Bechard and Schmutz, 1995). The species inhabits grasslands, sagebrush and desert shrublands, and deserts from southern Canada southward to northern New Mexico and Arizona, and from eastern Oregon, Washington, and northeastern California eastward to western North and South Dakota and Nebraska (Bechard and Schmutz, 1995). The wintering distribution stretches from northeast Utah, extreme southern Wyoming, and southwestern Nebraska south to western Texas, central Mexico, and northern Baja California.

Since the mid-1980s, ferruginous hawk populations generally have been stable or increasing across most of their breeding range and much of the Wyoming Basin (Bechard and Schmutz, 1995), but declines have been observed in peripheral areas of the species' range and in northern and central Utah (Olendorff, 1993; Stepinsky and others, 2002; Sauer and others, 2011). In 1991, the ferruginous hawk was petitioned for listing under the Endangered Species Act, and although it was denied (U.S. Fish and Wildlife Service, 1992), the U.S. Fish and Wildlife Service currently lists it as a species of management concern in regions 1 and 6 (which includes the Wyoming Basin). In Utah, the ferruginous hawk is listed as threatened and the Bureau of Land Management (BLM) lists it as a Sensitive Species (Travsky and Beauvais, 2005), and in Canada, it is a species of special concern (Commission for Environmental Cooperation, 2005).

Ferruginous hawks breed in open grasslands, sagebrush steppe, saltbush-greasewood shrublands, and along the periphery of piñon-juniper woodlands and other forests (Bechard and Schmutz, 1995). They generally nest on elevated sites including boulders, low cliffs, trees, and large shrubs but will nest on the ground if elevated sites are lacking. In winter, ferruginous hawks generally occur in grasslands, especially where prairie dogs and other small mammals are abundant.

Ferruginous hawks feed almost exclusively on small- to medium-sized mammals. West of the Continental Divide, their primary prey are jackrabbits or cottontail rabbits; east of the Divide their primary prey are ground squirrels, including prairie dogs (Olendorff, 1993). Ferruginous hawks generally hunt from low perches or from perches on the ground near active mammal burrows, but occasionally they hunt from the air. Primary predators of ferruginous hawk eggs and nestlings include golden eagles, falcons, great horned owls, coyotes, and foxes (Jasikoff, 1982).

Landscape Structure and Dynamics

Nesting ferruginous hawks require large areas of relatively flat or rolling terrain vegetated with open grassland or shrubland (Bechard and Schmutz, 1995). Reported mean home range sizes vary considerably (Bechard and Schmutz, 1995; Leary and others, 1998), but home range sizes have not been evaluated in the Wyoming Basin. Ferruginous hawks also require suitable, preferably elevated nest sites, a lack of which may limit occupancy of nesting territories. For example, territory occupancy increased after artificial nesting platforms were erected in territories lacking suitable nesting structures (Bechard and Schmutz, 1995).

Fire can have both positive and negative effects on ferruginous hawks. Because ferruginous hawks avoid woodland and forested habitats (Bechard and Schmutz, 1995), fire and drought can contribute to the open habitat structure they prefer in some areas, although fire may eliminate trees and structures used for nesting (Landers, 1987; Dechant and others, 2002). Within sagebrush shrublands, fire can result in temporary shifts from a sagebrush-dominated to a grassland-dominated system (Knight, 1994), but ferruginous hawks breed in both shrublands and grasslands (Bechard and Schmutz, 1995), so temporary loss of sagebrush may not have much effect on their breeding distributions. Nonetheless, declines of ferruginous hawk populations in Utah have been attributed, in part, to effects of fire destroying nesting structures and the shrub component important to prey species (Olendorff, 1993).

Local populations of ferruginous hawks can exhibit dramatic, short-term fluctuations in response to prey fluctuating availabilities and landscape dynamics that influence populations of ground squirrels, prairie dogs, jackrabbits, and cottontail rabbits (Woffinden and Murphy, 1989; Olendorff, 1993; Ward and Conover, 2013). Fire and drought, in particular, can have strong effects on prey density, either enhancing or reducing populations, depending on context, timing, and species (Lehman and Allendorf, 1989). For example, body condition and densities of Piute ground squirrels, an important prey species for ferruginous hawks in some regions, declined sharply in response to drought and a longer-than-normal winter in the Morley Nelson Snake River Birds of Prey National Conservation Area of Idaho (Van Horne and others, 1997). Previously, it was assumed that during years of low prey availability, ferruginous hawks would abandon established breeding territories and move to areas where prey are more available (Bechard and Schmutz, 1995); however, recent evidence indicates that ferruginous hawks may forgo breeding yet remain on site when prey populations are low (Watson, 2003).

Change Agents

Development

Energy and Infrastructure

Both positive and negative responses of ferruginous hawks to oil and gas development have been observed (Smith and others, 2010; Keough and Conover, 2012). These hawks have a propensity for nesting on elevated structures, including utility and other structures associated with energy development sites (Bechard and Schutz, 1995), and some of their prey species are attracted to potential burrow sites around oil and gas well pads (Smallwood and Thelander, 2005). In the Uinta Basin of Utah, however, ferruginous hawk nesting productivity decreased with increasing proximity to oil and gas wells (Keough, 2006), whereas no such effect was observed in central Wyoming and north-central Montana (Zelenak and Rotella, 1997; Smith and others, 2010). At wind-energy facilities in Wyoming, California, Oregon, and Washington, ferruginous hawk mortalities have been recorded (Johnson and others, 2000; Smallwood and Thelander, 2008; Johnson and Erickson, 2010). The ferruginous hawks' hunting style of perching on or near the ground may increase their vulnerability to being hit by spinning turbine blades (Johnson and others, 2000; Smallwood and others, 2009).

A crucial feature of the landscapes used by nesting ferruginous hawks is a lack of human disturbance, as these large raptors appear to be very sensitive to disturbances within at least a half mile of their nests (Keeley and Bechard, 2011). When disturbance occurs near a nest, the adult birds may flush from the nest or even abandon it (White and Thurow, 1985; Keeley and Bechard, 2011). Experimental disturbance studies indicated that fledging success also may be reduced by disturbance, and if a disturbed nest is abandoned, the nesting territory may remain unoccupied in subsequent nesting seasons (White and Thurow, 1985).

Depending on context, ferruginous hawks also may be sensitive to disturbance associated with roads. There is evidence that these hawks may select nest sites farther from primary roads than other buteos (Bechard and others, 1990). Ferruginous hawk nests within 500 m (1,640.4 ft) of an interstate highway or other well-traveled road were no less productive than other ferruginous hawk nests (Gilmer and Stewart, 1983), and highly productive ferruginous hawk nests were closer to unimproved dirt roads than less productive or unproductive nests (Zelenak and Rotella, 1997), possibly because Richardson's ground squirrels were more abundant along the edges of the unimproved roads. Ferruginous hawks also nested farther from human habitation than other buteos of open country (Bechard and others, 1990). It is possible, however, that ferruginous hawks may acclimate to some levels of disturbance, as hawks nesting in exurban sites flushed from disturbances at shorter distances than hawks nesting in rural sites, and in either case, most ferruginous hawks did not flush from their nests if disturbances were at least 650 meters (m) (2,132 feet [ft]) away (Keeley and Bechard, 2011). Ferruginous hawks also may be less susceptible to disturbance during the nonbreeding season, when home-range size, number of perches used per day, and prey-to-acquisition rates were similar between relatively undisturbed and disturbed areas (Plumpton and Andersen, 1998).

Agricultural Activities

Local declines of ferruginous hawk populations have been attributed to grazing, agricultural cultivation, and control of small mammals including poisoning (Olendorff, 1993); however, effects may depend on activity type, areal extent, and seasonality of agricultural activities. For example, open rangelands are considered suitable habitats for ferruginous hawks (Bechard and Schmutz, 1995). They also may be found in landscapes where <30 percent of the landscape is under cultivation (Schmutz, 1989). Where crested wheatgrass was cultivated in a sagebrush shrubland context, ground squirrel abundance increased after which numbers of ferruginous hawks also increased (Lardy, 1980). Moreover, ferruginous hawk productivity was greater for nests closer to crop fields than for nests farther away, also likely due to greater prey densities along edges of crop fields than in uncultivated areas (Zelenak and Rotella, 1997). Nesting densities may diminish, however, when more than 30 percent of the landscape is under cultivation (Gilmer and Stewart, 1983; Schmutz, 1984, 1989; Olendorf, 1993), possibly due to effects of disturbance on hawks and effects of cultivation practices and habitat fragmentation on their prey.

Altered Fire Regime

Fire suppression can lead to expansion of aspen or juniper woodlands into shrublands and grasslands (Schmutz, 1984; Olendorff, 1993). In turn, woodland expansion can result in loss of ferruginous hawk habitat. In the Wyoming Basin, however, woodland expansion is not a current concern for ferruginous hawks, as fire regimes in their primary habitat types do not appear to have been greatly altered since European settlement (see Chapter 17—Juniper Woodlands). Moreover, ferruginous hawks may readily nest in both recent and older (15 years old) burns in shrub-steppe or sagebrush-cheatgrass habitat (Dechant and others, 2002).

Invasive Species and Disease

Cheatgrass proliferation was suggested as a possible factor in the decline and local extirpation of a ferruginous hawk population in western Utah (Woffinden and Murphy, 1989). Ferruginous hawks, however, have been observed breeding in areas dominated by sagebrush and cheatgrass in eastern Washington (Leary and others, 1998), and therefore, cheatgrass expansion may not pose a threat to ferruginous hawks in all cases. Although a few isolated cases of ferruginous hawks contracting West Nile virus have been reported, the virus does not appear to pose a serious threat to the species throughout its range (Collins and Reynolds, 2005).

Rapid Ecoregional Assessment Components Evaluated for Ferruginous Hawk

A generalized, conceptual model was used to highlight some of the key ecological attributes and Change Agents affecting ferruginous hawks (fig. 25–1). Key ecological attributes addressed by the REA include (1) the distribution of ferruginous hawk habitat, (2) landscape structure (patch sizes and structural connectivity), and (3) landscape dynamics (fire occurence) (table 25–1). The Change Agents evaluated were development and wind energy (table 25–2). Ecological values and risks used to assess the conservation potential of ferruginous hawk habitat by township are summarized in table 25–3. Core and Integrated Management Questions and the associated summary maps and graphs are provided in table 25–4.

Methods Overview

We developed a general habitat model for ferruginous hawks using MaxEnt software (Phillips and others, 2006). Values of vegetation and abiotic variables at 598 mapped ferruginous hawk locations (nests and observations of individual birds) since 1990 were derived from data sources in table 25–1. Variables with the greatest weight included topographic relief, elevation, the average temperature of the warmest quarter, and slope. The map of potential ferruginous hawk habitat was derived from MaxEnt parameter values that included 95 percent of the locations (omission rate of 5 percent). The distribution map was used to quantify key ecological attributes (table 25–1) and Change Agents (table 25–2) for baseline ferruginous hawk habitat within the region.

We assessed development levels in ferruginous hawk habitat using the TDI map and then used the resulting output to calculate patch size and structural connectivity metrics. We mapped the structural connectivity of relatively undeveloped habitat (TDI score ≤1 percent) at three interpatch distances derived from connectivity analysis: local (1.26 kilometers [km]; 0.78 miles [mi]), landscape (3.69 km; 2.29 mi), and regional (5.04 km; 3.13 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 ferruginous hawk habitat since 1980 were compiled from several data sources to assess fire frequency and extent (table 25–1). To evaluate risks to ferruginous hawks posed by wind energy, we identified areas with existing and high potential for wind-energy development that were coincident with baseline ferruginous hawk habitat (see Chapter 4—Development).

Landscape-level ecological values (area of habitat) and risk (TDI score) were compiled into an overall index of conservation potential for each township (table 25–3). Conservation potential was summarized by township based on overall landscape-level values and risks (table 25–3). 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.

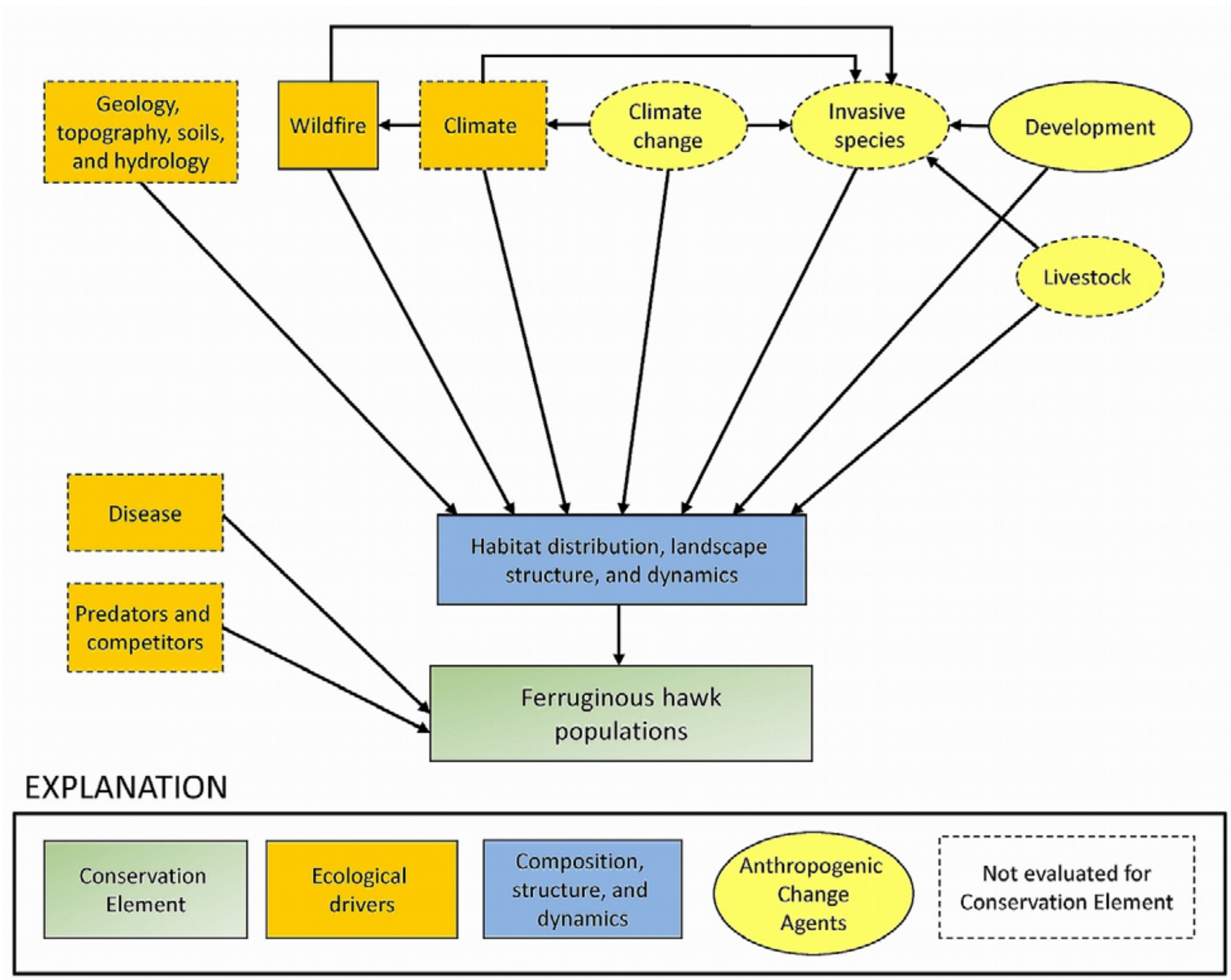

Figure 25–1. Generalized conceptual model of ferruginous hawk habitat for the Wyoming Basin Rapid Ecoregional Assessment (REA). Biophysical attributes and ecological processes regulating the occurrence, structure, and dynamics of ferruginous hawk populations and habitat are shown in orange rectangles; additional ecological attributes are shown in blue rectangles; and key 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 addressed due to the lack of regionwide data.

Table 25–1. Key ecological attributes and associated indicators of baseline ferruginous hawk habitat[1] evaluated for the Wyoming Basin Rapid Ecoregional Assessment.

[km, kilometer; mi, mile]

Attribute	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, landscape, and regional levels (0.09 km; 0.06 mi)
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 ferruginous hawk habitat derived from abiotic and biotic variables without explicit inclusion of Change Agents (see Chapter 2—Assessment Framework).

[2] Habitat modeled using MaxEnt; occurrence data (locations of individuals and nests) from Colorado Natural Heritage Program, Idaho Fish and Wildlife Information System, Montana Natural Heritage Program, Rocky Mountain Bird Observatory, Utah Natural Heritage Program, and the Wyoming Natural Diversity Database; 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 25–2. Anthropogenic Change Agents and associated indicators influencing ferruginous hawk habitat for the Wyoming Basin Rapid Ecoregional Assessment.

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

Change Agent	Variables	Indicators
Development	Terrestrial Development Index[1]	Percent of ferruginous hawk habitat in seven development classes using a 16 km^2 (6.18 mi^2) moving window
		Patch-size frequency distribution of ferruginous hawk habitat that is relatively undeveloped or has low development scores compared to baseline habitat[1]
		Interpatch distances that provide an index of structural connectivity for relatively undeveloped patches at local (1.26 km; 0.78 mi), landscape (3.69 km; 2.3 mi), and regional (5.04 km; 3.13 mi) levels
	Wind energy[2]	Location of existing wind-energy sites and wind-energy potential within ferruginous hawk habitat

[1] See Chapter 2—Assessment Framework.

[2] See Chapter 4—Development.

Table 25–3. Landscape-level ecological values and risks for ferruginous hawk 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	<24	24−65	>65	Percent of township modeled as ferruginous hawk 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 ferruginous hawk habitat 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 25–1 and 25–2 for description of variables.

Table 25–4. Management Questions addressed for ferruginous hawks for the Wyoming Basin Rapid Ecoregional Assessment.

Core Management Questions	Results
Where is baseline ferruginous hawk habitat, and what is the total area?	Figure 25–2
Where does development pose the greatest threat to baseline ferruginous hawk habitat, and where are the relatively undeveloped areas?	Figures 25–3 and 25–4
How has development fragmented baseline ferruginous hawk habitat, and where are the large, relatively undeveloped patches?	Figures 25–5 and 25–6
How has development affected structural connectivity of ferruginous hawk habitat relative to baseline conditions?	Figure 25–7
Where are potential barriers and corridors that may affect animal movements among relatively undeveloped habitat patches?	Figure 25–8
Where are existing wind-energy facilities, and where are areas with high wind-energy potential in baseline ferruginous hawk habitat?	Figure 25–9
Where have recent fires occurred in baseline ferruginous hawk habitat, and what is the total area burned per year?	Figures 25–10 and 25–11
Integrated Management Questions	**Results**
How does risk from development vary by land ownership or jurisdiction for ferruginous hawk habitat?	Table 25–5, Figure 25–12
Where are the townships with the greatest landscape-level ecological values?	Figure 25–13
Where are the townships with the greatest landscape-level risks?	Figure 25–13
Where are the townships with the greatest conservation potential?	Figure 25–14

Key Findings for Management Questions

Where is baseline ferruginous hawk habitat, and what is the total area (fig. 25–2)?

- Baseline ferruginous hawk habitat totals 54,908 square kilometers (km^2) (21,200 square miles [mi^2]) or 30.1 percent of the Wyoming Basin.
- Baseline habitat is widely distributed throughout lower elevations in the Wyoming Basin with the exception of the Bighorn Basin.

Where does development pose the greatest threat to baseline ferruginous hawk habitat, and where are the relatively undeveloped areas (figs. 25–3 and 25–4)?

- Development is widely distributed across ferruginous hawk habitat within the Wyoming Basin (fig. 25–3).
- Approximately 23 percent of ferruginous hawk habitat in the Basin is relatively undeveloped (TDI score ≤1 percent) and 29 percent had high levels of development as indicated by TDI scores of >5 percent (fig. 25–4).

How has development fragmented baseline ferruginous hawk habitat, and where are the large, relatively undeveloped patches (figs. 25–5 and 25–6)?

- Development has effectively fragmented ferruginous hawk habitat into smaller patches relative to baseline conditions. All relatively undeveloped habitat (TDI score ≤ percent) occurs in patches <5,000 km^2 (1,930 mi^2). In contrast, over 50 percent of baseline habitat occurred in patches >5,000 km^2 (fig. 25–5).
- The largest relatively undeveloped habitat patch is located northeast of Rock Springs, Wyoming (fig. 25–6).

How has development affected structural connectivity of ferruginous hawk habitat relative to baseline conditions (fig. 25–7)?

- Baseline ferruginous hawk habitat was highly connected, with local-, landscape-, and regional-scale connectivity occurring at a 0.09-km (0.62-mi) interpatch distance.
- Development has greatly diminished the structural connectivity of ferruginous hawk habitat. Relatively undeveloped habitat is highly fragmented and local-scale connectivity (1.26 km [0.78mi]) is much greater than for baseline condition. Interpatch distances for landscape- (3.69 km [2.29 mi]) and regional-scale connectivity (5.04 km [3.13 mi]) for relatively undeveloped habitat is at least tenfold greater than baseline conditions.
- Patches of highly connected, relatively undeveloped habitat (local, landscape, and regional connectivity) are concentrated in the central and southern portion of the Basin.
- Ferruginous hawk habitat in the northern and southeastern portions of the Basin has limited landscape and regional connectivity, which could increase vulnerability to habitat loss and fragmentation in these areas.
- Structural connectivity for wide-ranging species like ferruginous hawks may be less important than it is for less mobile species, but collectively smaller patch sizes and diminished connectivity may decrease habitat quality. In addition, the hawks may avoid areas with high development levels and human or vehicle disturbance or suffer from high mortality levels due to collisions along roads with high traffic volumes.

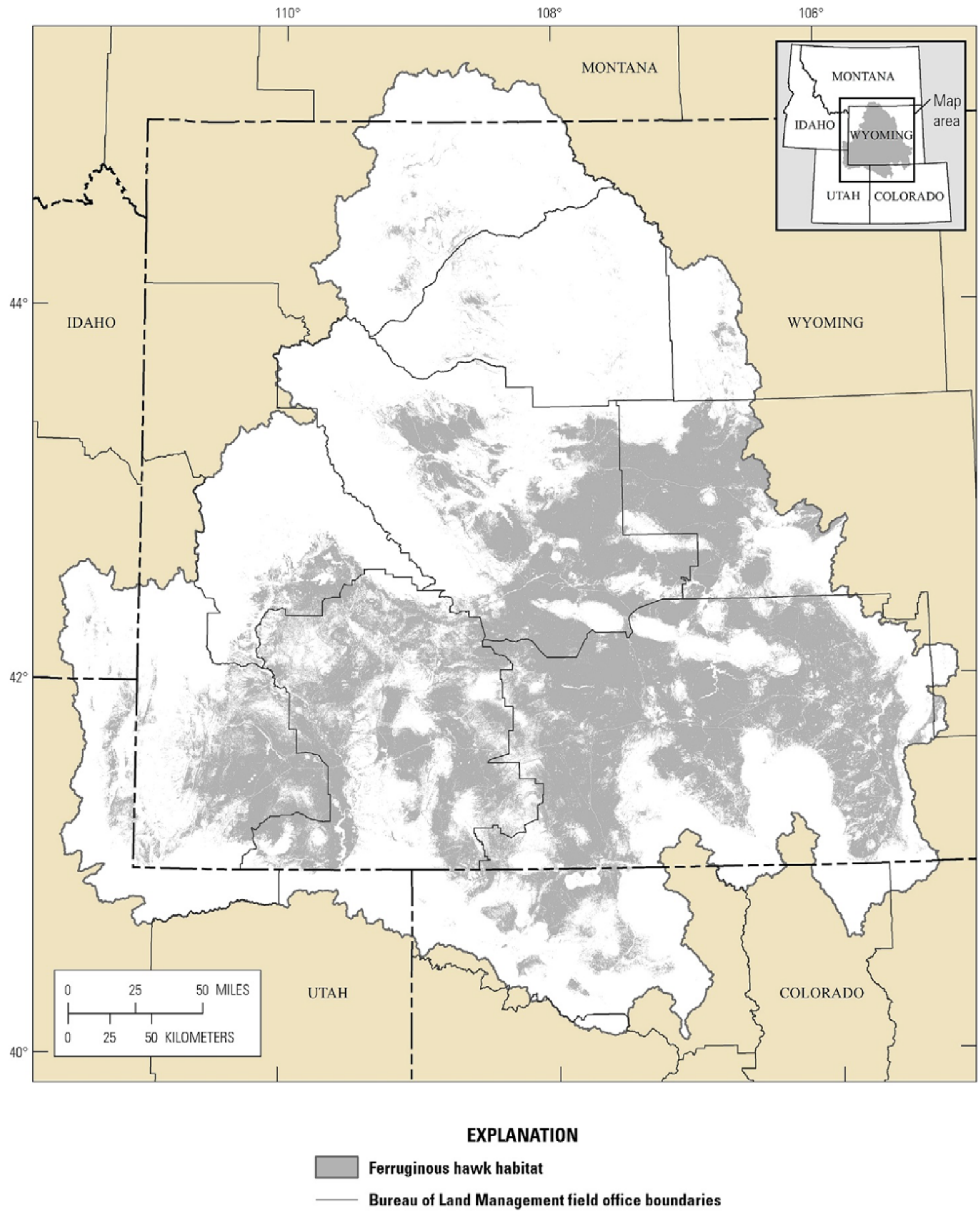

Figure 25–2. Distribution of baseline ferruginous hawk habitat in the Wyoming Basin Rapid Ecoregional Assessment project area.

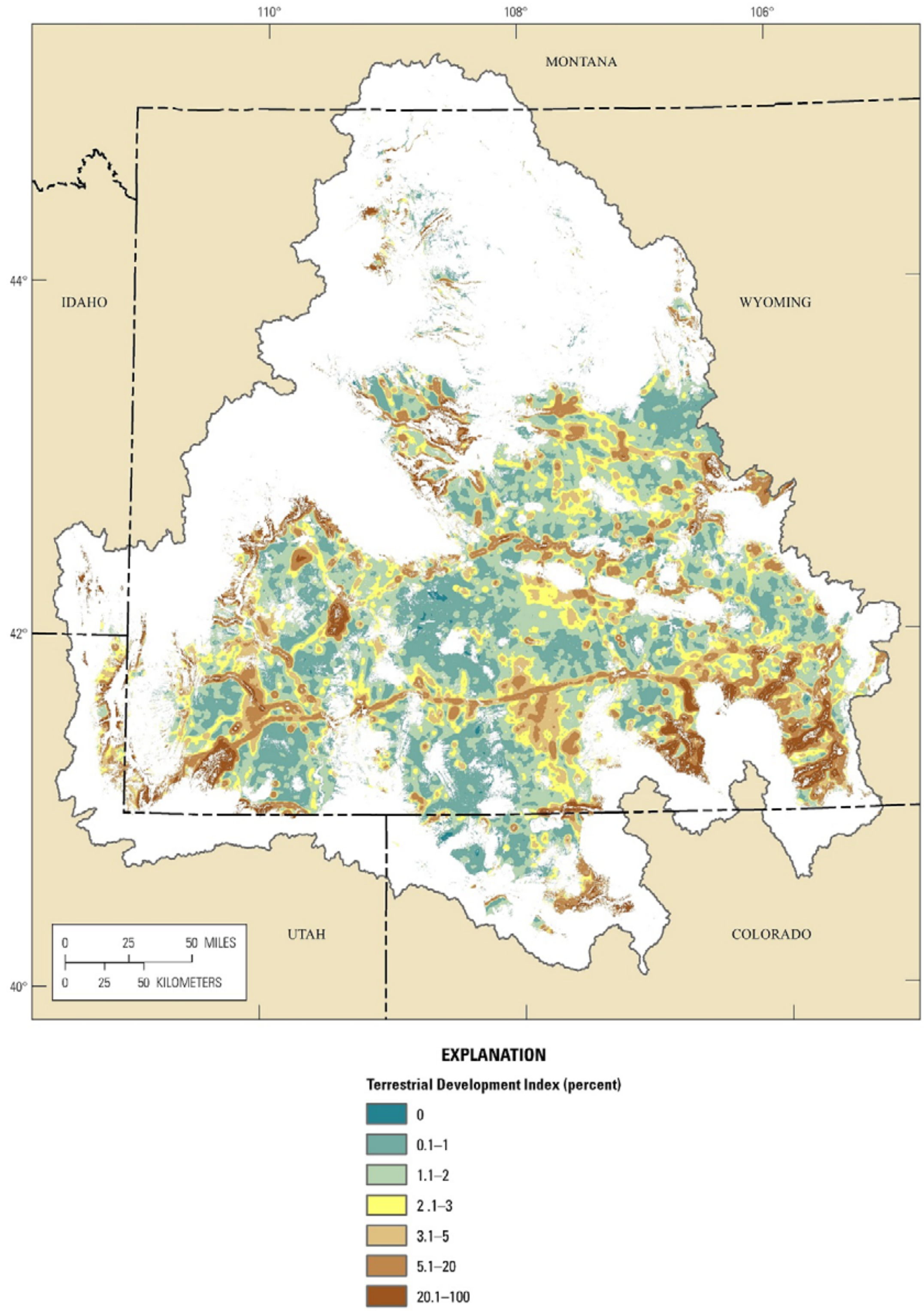

Figure 25–3. Terrestrial Development Index scores for baseline ferruginous hawk habitat in the Wyoming Basin Rapid Ecoregional Assessment project area.

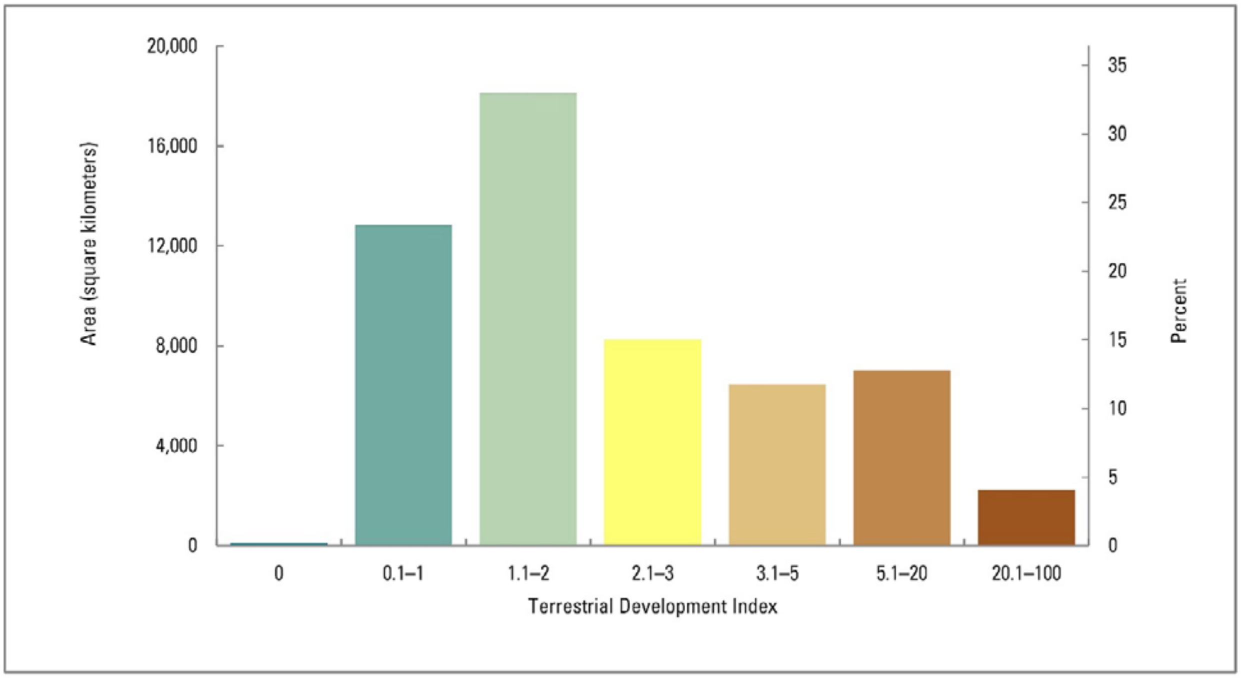

Figure 25–4. Area and percent of baseline ferruginous hawk habitat as a function of the Terrestrial Development Index in the Wyoming Basin Rapid Ecoregional Assessment project area.

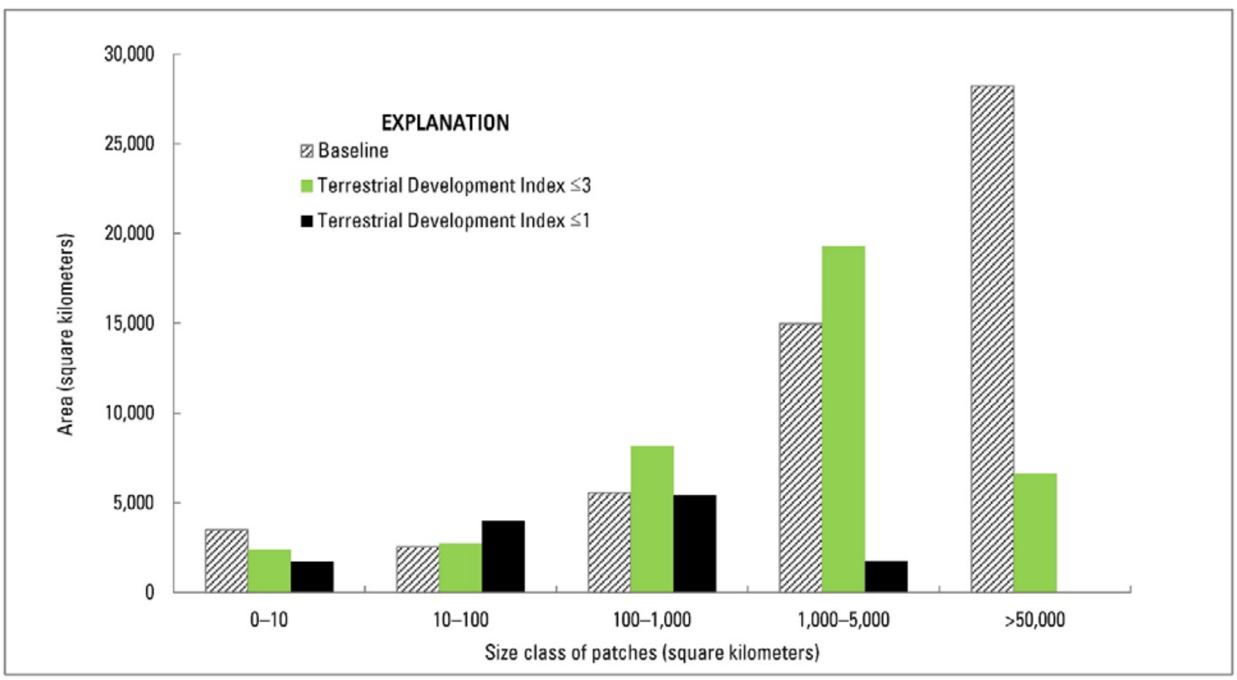

Figure 25–5. Area of ferruginous hawk habitat as a function of patch size for baseline conditions and for two development levels: (1) Terrestrial Development Index (TDI) score≤3 percent and (2) TDI score ≤1 percent (relatively undeveloped areas) in the Wyoming Basin Rapid Ecoregional Assessment project area.

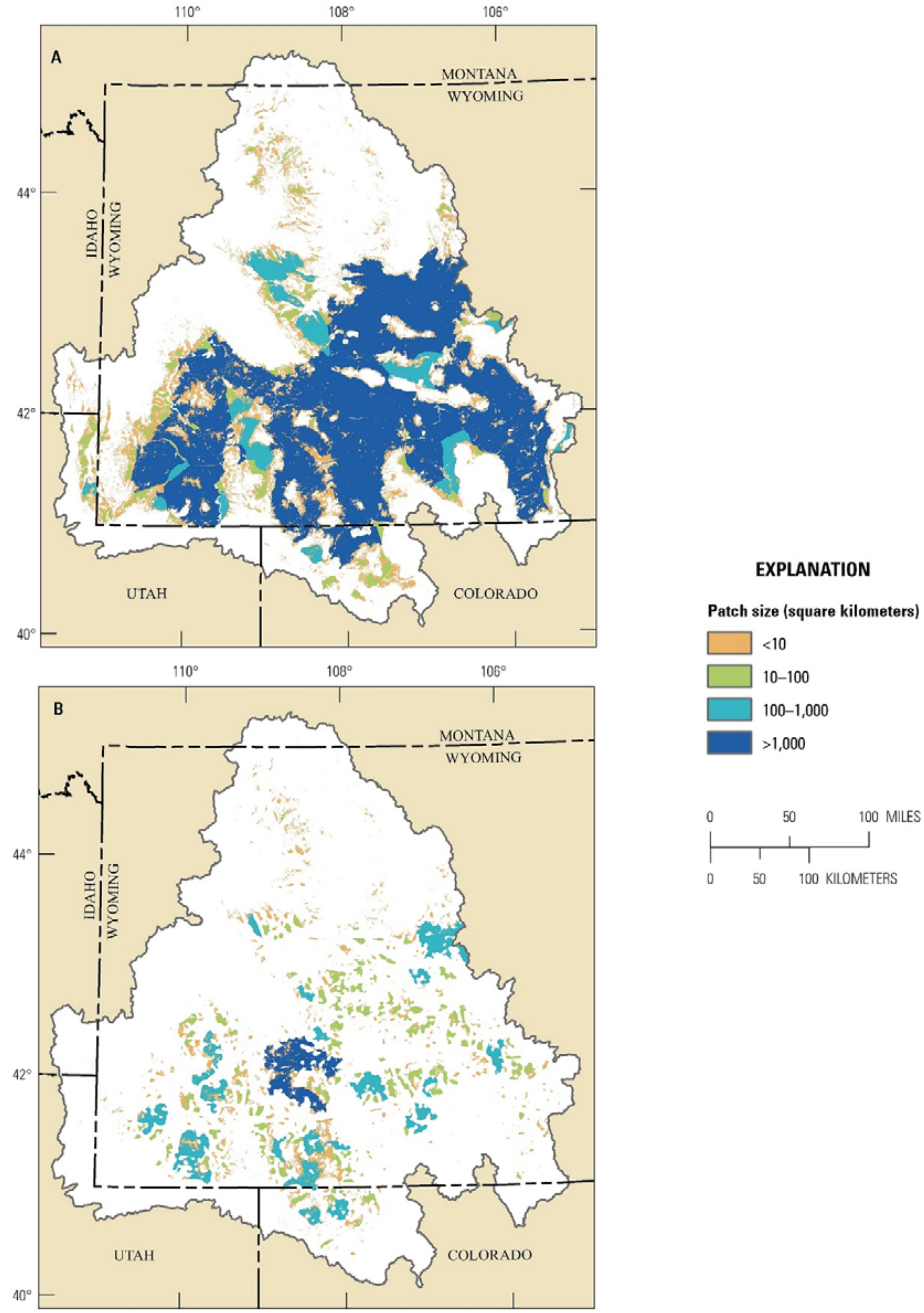

Figure 25–6. Patch sizes of ferruginous hawk habitat in the Wyoming Basin Rapid Ecoregional Assessment project area for (*A*) baseline conditions and (*B)* relatively undeveloped areas (Terrestrial Development Index score ≤1 percent).

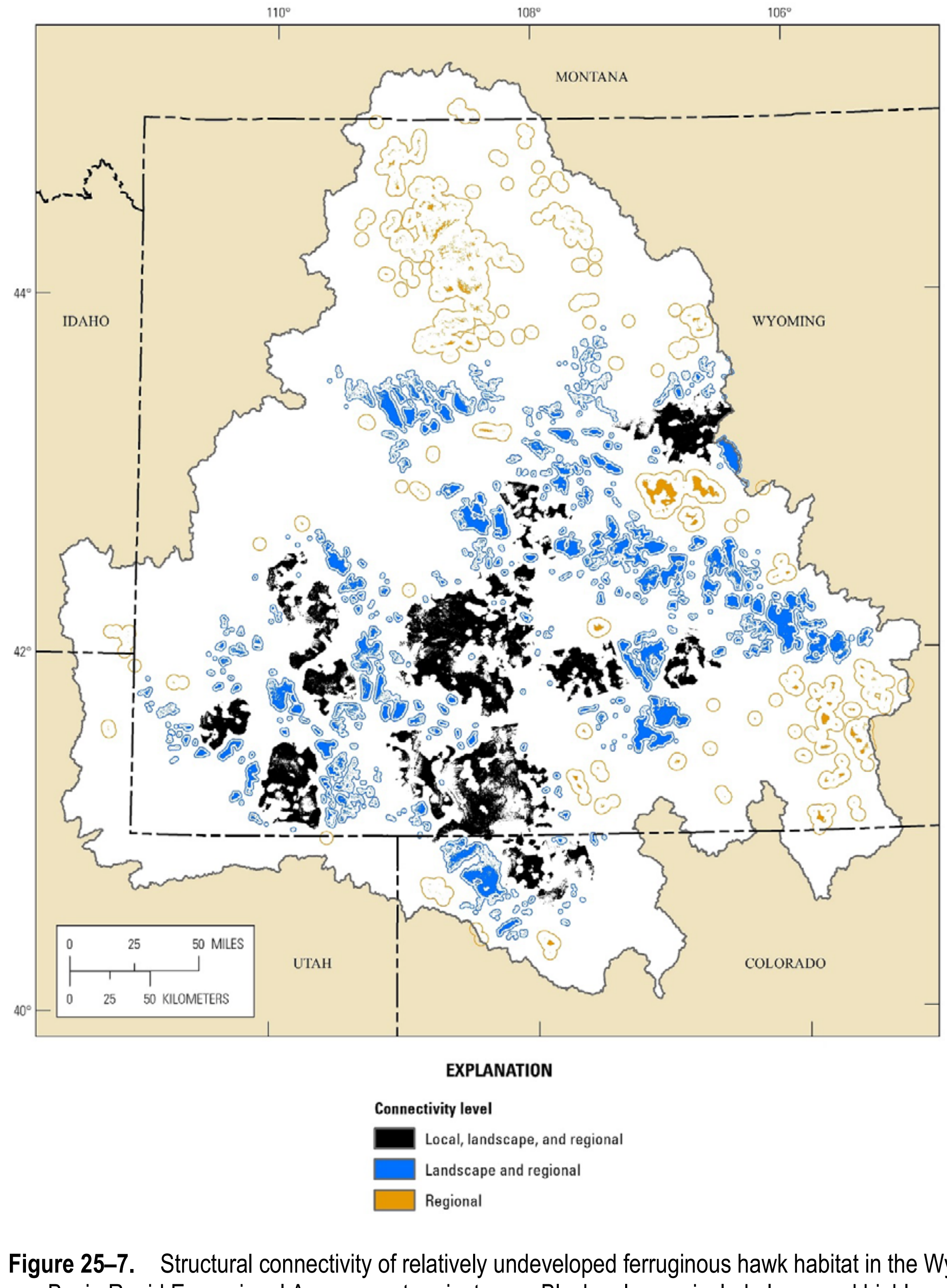

Figure 25–7. Structural connectivity of relatively undeveloped ferruginous hawk habitat in the Wyoming Basin Rapid Ecoregional Assessment project area. Black polygons include large and highly connected habitat patches. Blue polygons include habitat patches that contribute to both landscape and regional 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. 25–8)?

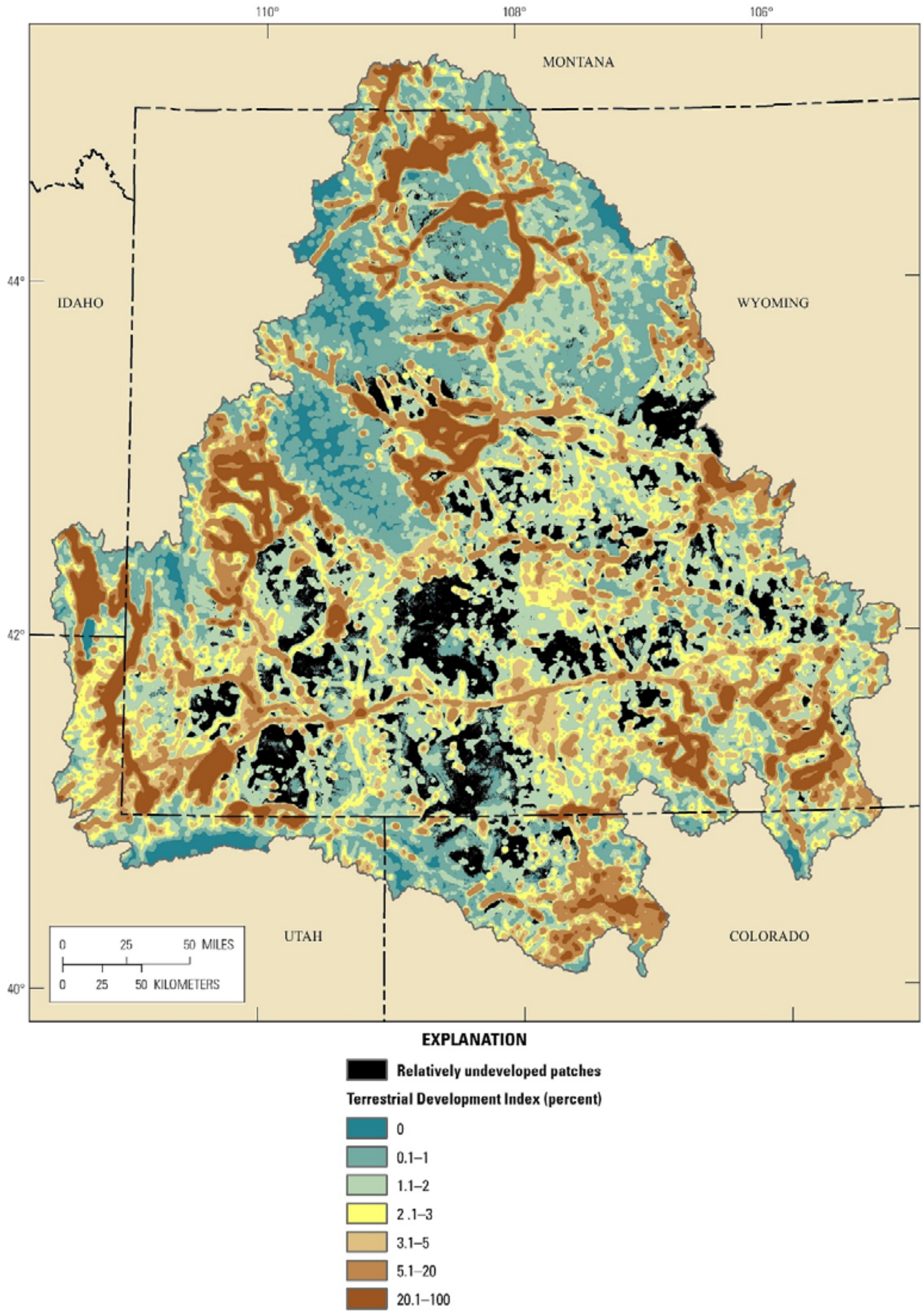

Figure 25–8. Potential barriers and corridors as a function of Terrestrial Development Index (TDI) score for lands surrounding relatively undeveloped ferruginous hawk habitat. Higher TDI scores (for example, >5 percent) represent potential barriers to movement among relatively undeveloped habitat patches. Lower TDI scores (for example, <2 percent) represent potential corridors for movements among patches.

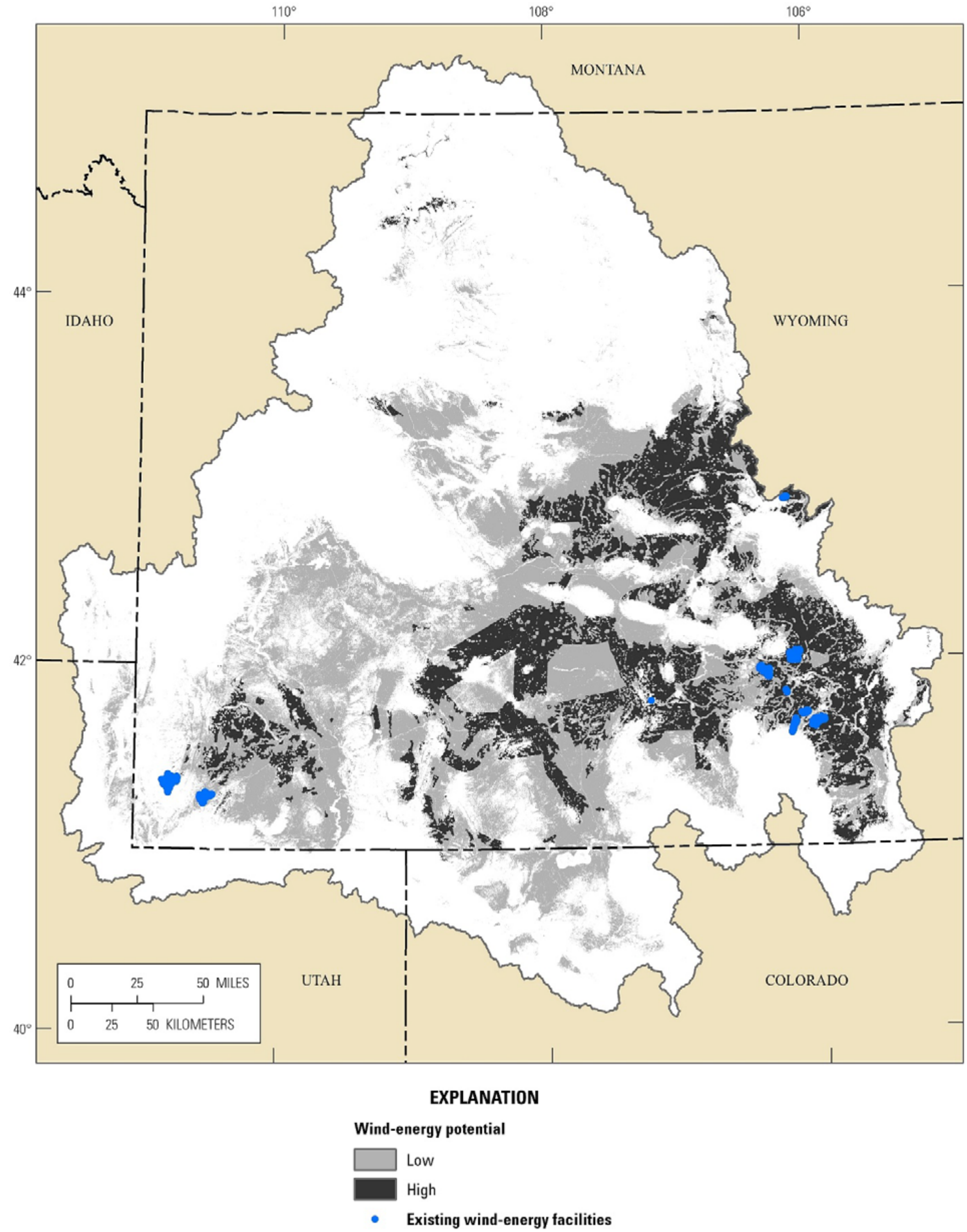

Figure 25–9. Potential for wind-energy development and existing wind-energy facilities within baseline ferruginous hawk habitat in the Wyoming Basin Rapid Ecoregional assessment project area.

Where are existing wind-energy facilities, and where are areas with high wind-energy potential in baseline ferruginous hawk habitat (fig. 25–9)?

- Although most existing wind-energy facilities fall within or near ferruginous hawk habitat, they are restricted to a few areas.
- Regions with high potential for wind-energy development are found throughout 29 percent of ferruginous hawk habitat.

Where have recent fires occurred in baseline ferruginous hawk habitat, and what is the total area burned per year (figs. 25–10 and 25–11)?

- Typically only a small fraction of ferruginous hawk habitat has burned each year since 1980. Cumulatively, <1 percent (463 km^2 [178.77 mi^2]) of ferruginous hawk habitat has burned since 1980 (figs. 25–10 and 25–11).
- In most years, fires are small and burn only a small portion of ferruginous hawk habitat, with most of the area burned by fires occurring in large fires occurring in 2000 and 2008 (fig. 25–10).

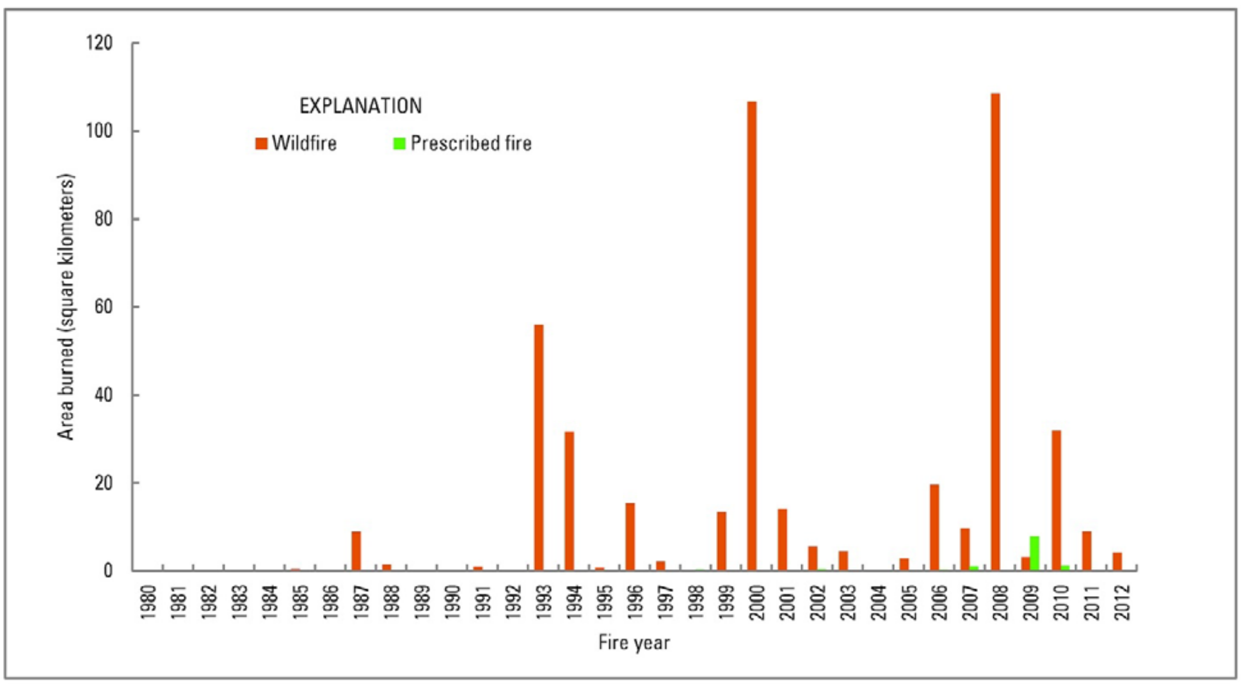

Figure 25–10. Annual area burned by wildfires and prescribed fires in baseline ferruginous hawk habitat since 1980 in the Wyoming Basin Rapid Ecoregional Assessment project area.

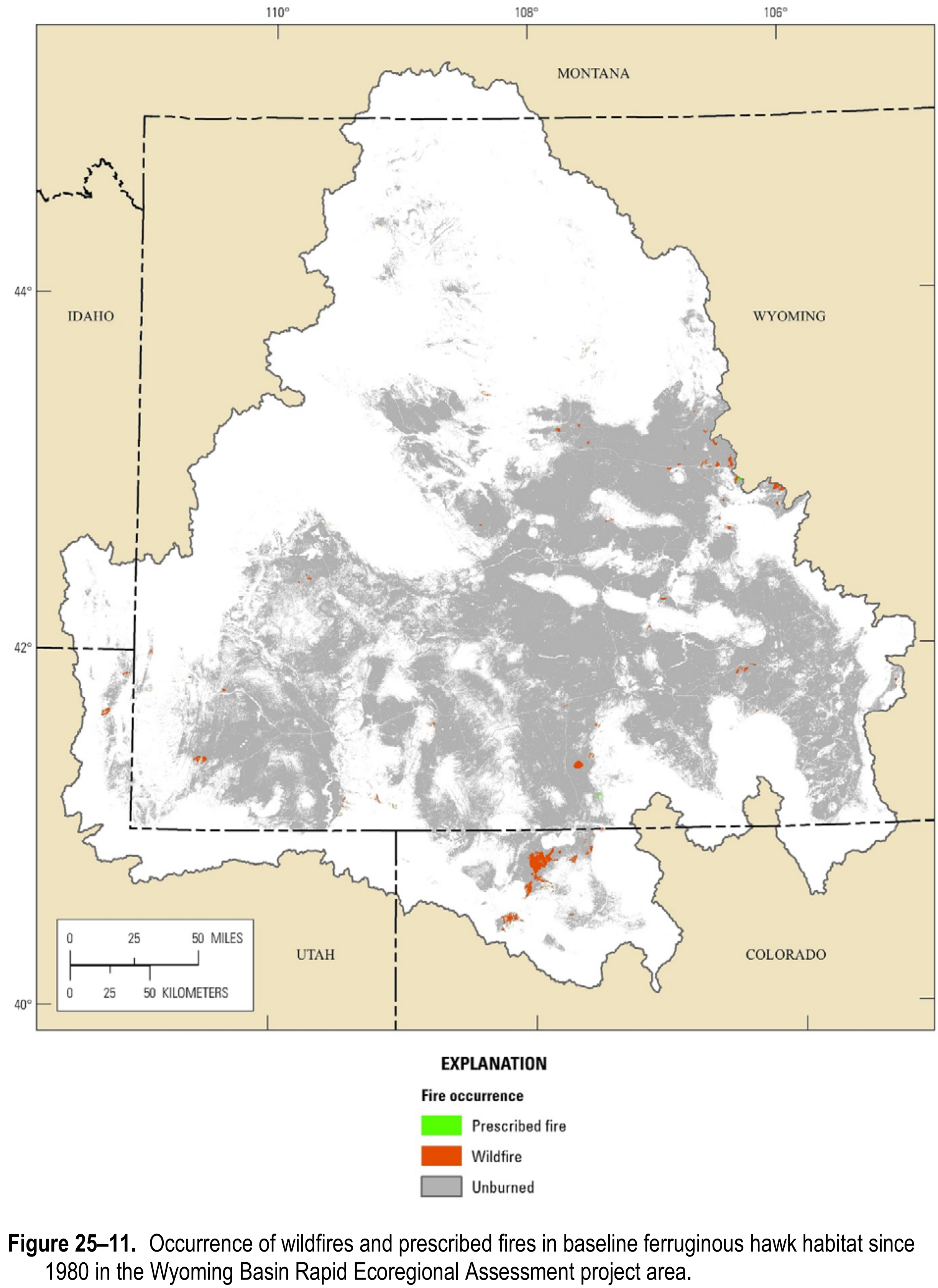

Figure 25–11. Occurrence of wildfires and prescribed fires in baseline ferruginous hawk habitat since 1980 in the Wyoming Basin Rapid Ecoregional Assessment project area.

How does risk from development vary by land ownership or jurisdiction for ferruginous hawk habitat (table 25–5, fig. 25–12)?

- The majority of the potential ferruginous hawk habitat in the Wyoming Basin occurs on BLM lands and another third is under private ownership, collectively accounting for 88 percent of their habitat (table 25–5).
- Risk from development is the lowest on BLM lands compared to most other public and private lands (fig. 25–12).

Table 25–5. Area and percent of ferruginous hawk habitat 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
Bureau of Land Management	29,629	54.0
Private	18,590	33.9
State/County	3,510	6.4
Tribal	1,632	3.0
Other Federal[1]	1,342	2.4
Private conservation	213	0.4

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

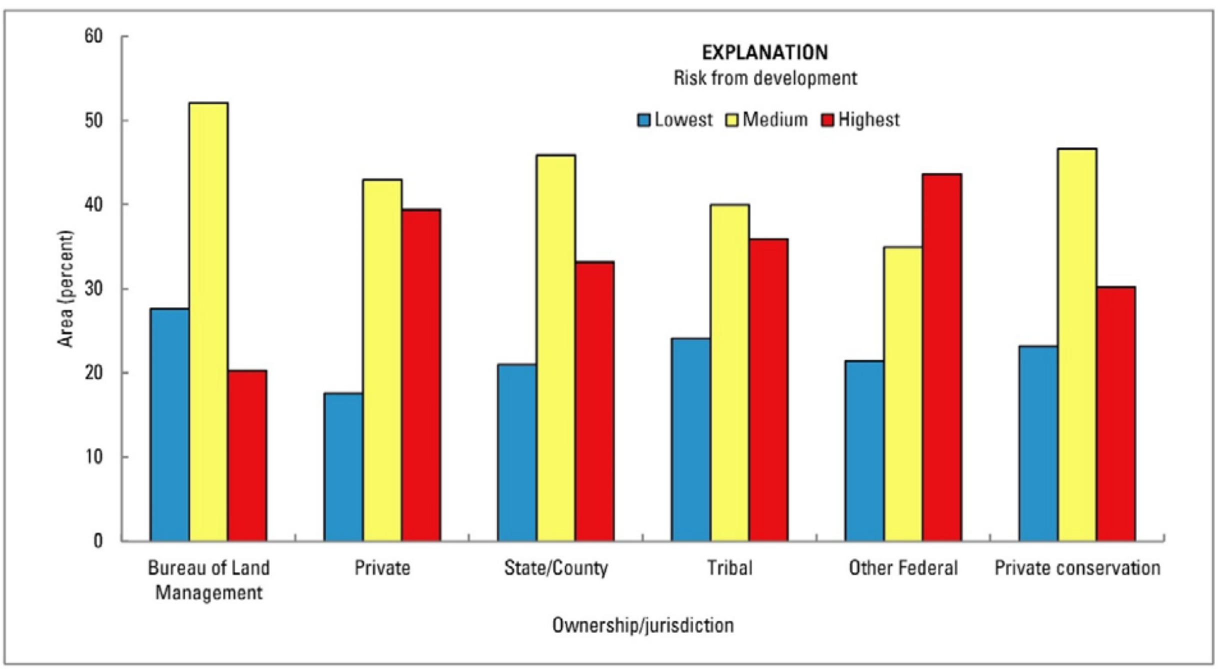

Figure 25–12. Relative ranks of risk from existing development, by land ownership or jurisdiction, for ferruginous hawk habitat in the Wyoming Basin Rapid Ecoregional Assessment project area. Rankings are lowest (Terrestrial Development Index [TDI] score <1 percent), medium (TDI score between 1 and 3 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. 25–13)?

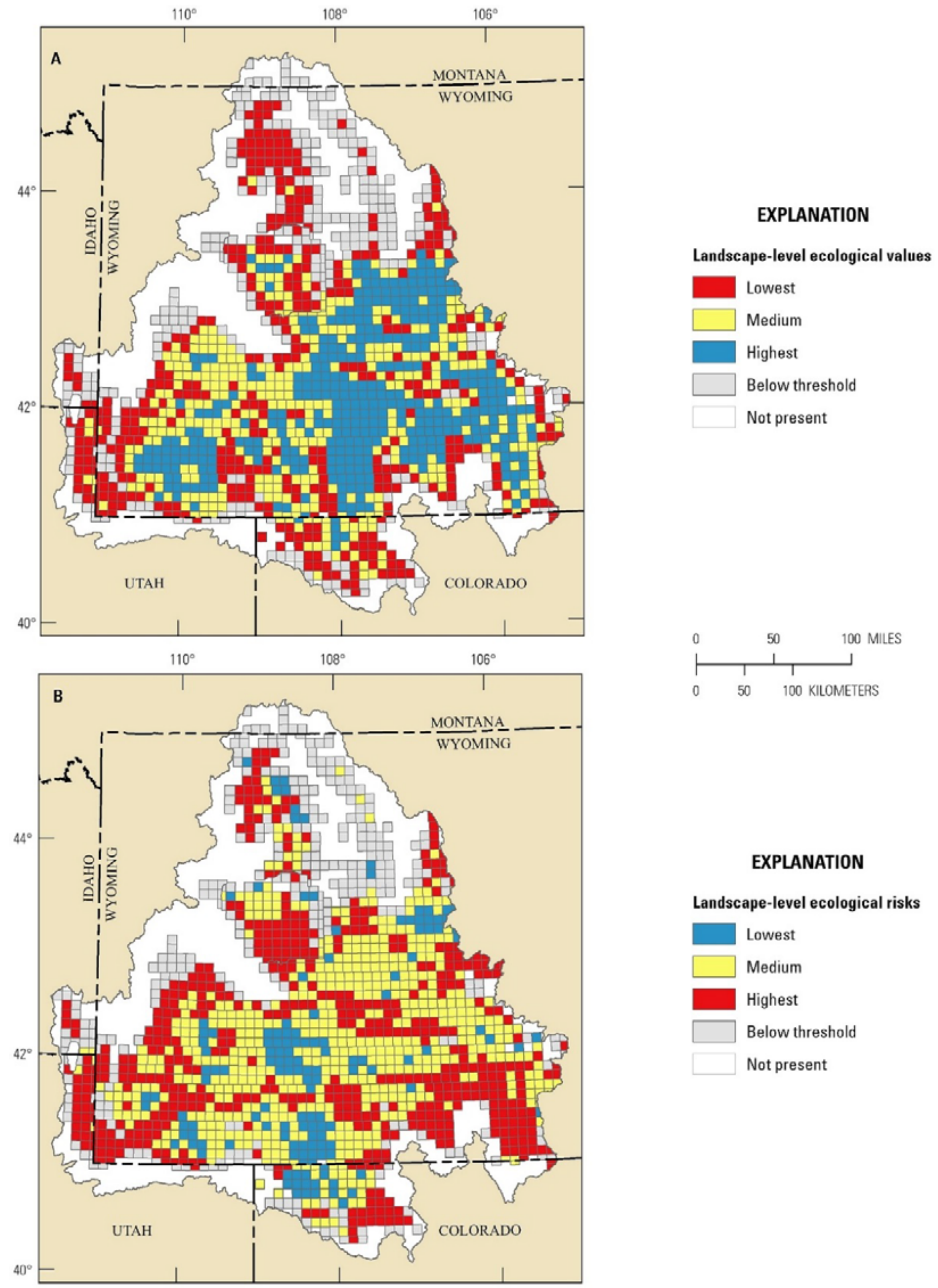

Figure 25–13. Ranks of landscape-level ecological values and risks for ferruginous hawk habitat, summarized by township, in the Wyoming Basin Rapid Ecoregional Assessment project area. (*A*) Landscape-level values based on habitat area and (*B*) Landscape-level risks based on Terrestrial Development Index (see table 25–3 for overview of methods).

Where are the townships with the greatest conservation potential (fig. 25–14)?

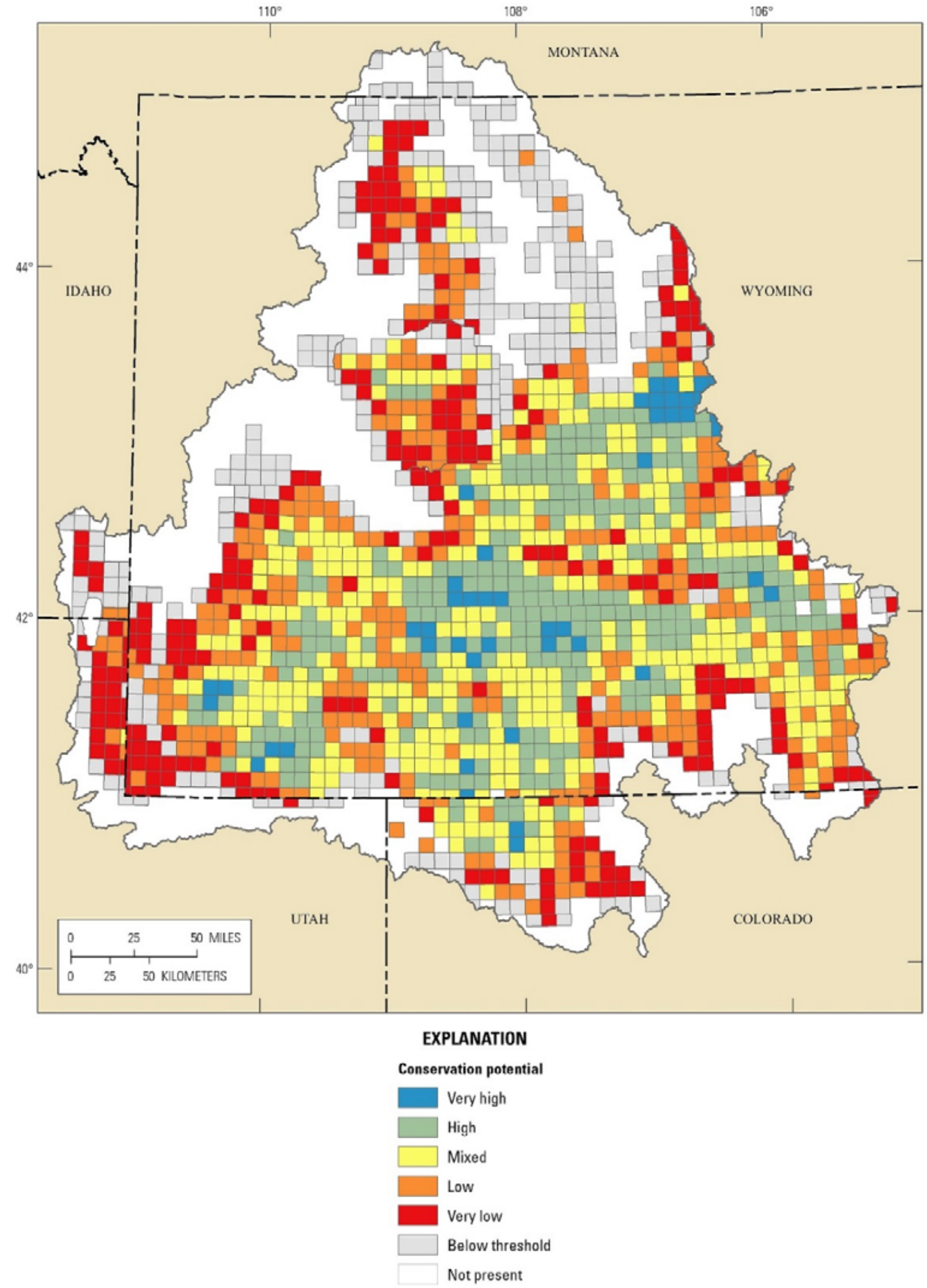

Figure 25–14. Conservation potential of ferruginous hawk habitat, summarized by township, in the Wyoming Basin Rapid Ecoregional Assessment project area. Highest conservation potential identifies areas that have the highest landscape-level values and the lowest risks. Lowest conservation potential identifies 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

Ferruginous hawk habitat is widely distributed throughout much of central and southern Wyoming and adjacent areas of Idaho, Utah, and Colorado. Agricultural conversion, roads, and energy development have cumulatively led to habitat loss, increased fragmentation, and decreased structural connectivity of ferruginous hawk habitat. Ferruginous hawks, however, may respond differently to different types of development. They are more sensitive to disturbance at their nest sites than other buteos; therefore, development that results in high levels of human activity may lead to a reduction in nesting productivity. In addition, ferruginous hawks are vulnerable to mortality from wind turbines and a large proportion of their habitat within the Basin occurs in regions with high wind-development potential. The majority of the ferruginous hawk habitat in the Basin is managed by the Bureau of Land Management.

References Cited

Bechard, M.J., and Schmutz, J.K., 1995, Ferruginous Hawk (*Buteo regalis*), *in* Poole, A., ed., The Birds of North America Online, no. 172: Ithaca, N.Y., Cornell Lab of Ornithology.

Bechard, M.J., Knight, R.L., Smith, D.G., and Fitzner, R.E., 1990, Nest sites and habitats of sympatric hawks (*Buteo* spp.) in Washington: Journal of Field Ornithology, v. 61, p. 159–170.

Collins, C.P., and Reynolds, T.D., 2005, Ferruginous Hawk (*Buteo regalis*)—A technical conservation assessment: Rigby, Idaho, TREC Inc., 63 p., at http://www.fs.fed.us/r2/projects/scp/assessments/ferruginoushawk.pdf.

Commission for Environmental Cooperation, 2005, Ferruginous hawk (*Buteo regalis*) North American conservation action plan: Montreal, Canada, Commission for Environmental Cooperation, 55 p., at http://www3.cec.org/islandora/en/item/2263-ferruginous-hawk-north-american-conservation-action-plan-en.pdf.

Dechant, J.A., Sondreal, M.L., Johnson, D.H., Igl, L.D., Goldade, C.M., Zimmerman, A.L., and Euliss, B.R., 2002, Effects of management practices on grassland birds—Ferruginous hawk (ver. 12Dec2003): Jamestown, N. Dak., Northern Prairie Wildlife Research Center, 23 p., at http://digitalcommons.unl.edu/usgsnpwrc/149.

Gilmer, D.S., and Stewart, R.E., 1983, Ferruginous hawk populations and habitat use in North Dakota: Journal of Wildlife Management, v. 47, p. 146–157.

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.

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.

Jasikoff, T.M., 1982, Habitat suitability index models—Ferruginous hawk, 82/10: Washington, D.C., U.S. Fish and Wildlife Service, 18 p.

Johnson, G.D., and Erickson, W.P., 2010, Avian, bat and habitat cumulative impacts associated with wind energy development in the Columbia Plateau Ecoregion of eastern Washington and Oregon: Cheyenne, Wyo., Western EcoSystems Technology, Inc., 38 p.

Johnson, G.D., Young, D.P., Jr., Derby, C.E., Erickson, W.P., Strickland, M.D., and Kern, J.W., 2000, Wildlife monitoring studies, SeaWest Windpower Plant, Carbon County, Wyoming, 1995–1999, final report: Cheyenne, Wyo., Western EcoSystems Technology, Inc., 195 p.

Keeley, W.H., and Bechard, M.J., 2011, Flushing distances of ferruginous hawks nesting in rural and exurban New Mexico: Journal of Wildlife Management, v. 75, p. 1034–1039.

Keough, H.L., 2006, Factors influencing breeding ferruginous hawks (*Buteo regalis*) in the Uintah Basin, Utah: Logan, Utah, Utah State University, Ph.D. dissertation, 143 p.

Keough, H.L., and Conover, M.R., 2012, Breeding-site selection by ferruginous hawks within Utah's Uintah Basin: Journal of Raptor Research, v. 46, p. 378–388.

Knight, D.H., 1994, Mountains and plains—The ecology of Wyoming landscapes: New Haven, Conn., Yale University Press, 338 p.

Landers, J.L., 1987, Prescribed burning for managing wildlife in southeastern pine forests, *in* Dickson, J.G., and Maughan, O.E., eds., Managing southern forests for wildlife and fish—General Technical Report SO–65: New Orleans, La., U.S. Department of Agriculture Forest Service, Southern Forest Experiment Station, p. 19–27.

Lardy, M.E., 1980, Raptor inventory and ferruginous hawk breeding biology: Moscow, Ida., University of Idaho, M.S. thesis.

Leary, A.W., Mazaika, Rosemary, and Bechard, M.J., 1998, Factors affecting the sizes of ferruginous hawk home ranges: Wilson Bulletin, v. 110, no. 2, p. 198–205.

Lehman, R.N., and Allendorf, J.W., 1989, The effects of fire, fire exclusion and fire management on raptor habitats in the western United States, *in* Giron, B.A., ed., Proceedings of the Western Raptor Management Symposium and Workshop, October 26–28, 1987, Boise, Ida.: Washington, D.C., National Wildlife Federation, Scientific and Technical Series no. 12., p. 236–244.

Olendorff, R.R., 1993, Status, biology, and management of ferruginous hawks—A review: Boise, Idaho, Bureau of Land Management, Raptor Research and Technical Assistance Center, 84 p.

Phillips, S.J., Anderson, R.P., and Schapire, R.E., 2006, Maximum entropy modeling of species geographic distributions: Ecological Modelling, v. 190, p. 231–259.

Plumpton, D.L., and Andersen, D.E., 1998, Anthropogenic effects on winter behavior of ferruginous hawks: Journal of Wildlife Management, v. 62, p. 340–346.

Sauer, J.R., Hines, J.E., Fallon, J.E., Pardieck, K.L., Ziolkowski, D.J., Jr., and Link, W.A., 2011, The North American breeding bird survey, results and analysis, 1966–2010—ver. 12.07.2011: Laurel, Md., U.S. Geological Survey, Patuxent Wildlife Research Center, at http://www.mbr-pwrc.usgs.gov/bbs/bbs2010.html.

Schmutz, J.K., 1984, Ferruginous hawk and Swainson's hawk abundance and distribution in relation to land use in southeastern Alberta: Journal of Wildlife Management, v. 48, p. 1180–1187.

Schmutz, J.K., 1989, Hawk occupancy of disturbed grasslands in relation to models of habitat selection: Condor, v. 91, p. 362–371.

Smallwood, K.S., and Thelander, C.G., 2005, Bird mortality at the Altamont Pass Wind Resource Area, March 1998–September 2001: Ojai, Calif., BioResource Consultants, 396 p., at http://www.nrel.gov/wind/pdfs/36973.pdf.

Smallwood, K.S., and Thelander, Carl, 2008, Bird mortality in the Altamont Pass Wind Resource Area, California: Journal of Wildlife Management, v. 72, no. 1, p. 215–223.

Smallwood, K.S., Rugge, Lourdes, and Morrison, M.L., 2009, Influence of behavior on bird mortality in wind energy developments: Journal of Wildlife Management, v. 73, no. 7, p. 1082–1098.

Smith, J.P., Slater, S.J., and Neal, M.C., 2010, An assessment of the effects of oil and gas field activities on nesting raptors in the Rawlins, Wyoming and Price: Bureau of Land Management, BLM Technical Note 433, 63 p., at http://www.blm.gov/pgdata/etc/medialib/blm/wo/blm_library/tech_notes.Par.76658.File.dat/TN_433.pdf.

Stepinsky, D.P., Erickson, G.L., Iwaasa, Jamie, and Taylor, Brad, 2002, An evaluation of the ferruginous hawk population in Alberta based on recent trend data: Edmonton, Alberta, Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species Risk Report No. 52, 16 p., at http://esrd.alberta.ca/fish-wildlife/species-at-risk/species-at-risk-publications-web-resources/birds/documents/SAR052-EvaluationFerruginousHawkPopulationAlberta-Mar2002.pdf.

Travsky, Amber, and Beauvais, G.P., 2005, Species assessment for the ferruginous hawk (*Buteo regalis*) in Wyoming: Cheyenne, Wyo., Report prepared for Bureau of Land Management Wyoming State Office, 39 p., at http://www.blm.gov/pgdata/etc/medialib/blm/wy/wildlife/animal-assessmnts.Par.1082.File.dat/FerruginousHawk.pdf.

U.S. Fish and Wildlife Service, 1992, Endangered and threatened wildlife and plants; notice of finding on petition to list the ferruginous hawk: Federal Register, v. 57, no. 161, p. 37507–37513.

Van Horne, B., Olson, G.S., Schooley, R.L., Corn, J.G., and Burnham, K.P., 1997, Effects of drought and prolonged winter on Townsend's ground squirrel demography in shrubsteppe habitats: Ecological Monographs, v. 67, no. 3, p. 295–315.

Ward, J.M., and Conover, M.R., 2013, Survival of juvenile ferruginous hawks in Utah: Journal of Raptor Research, v. 47, no. 1, p. 3140.

Watson, J.W., 2003, Migration and winter ranges of ferruginous hawks from Washington, final report: Olympia, Wash., Washington Department of Fish and Wildlife, 51 p.

White, C.M., and Thurow, T.L., 1985, Reproduction of ferruginous hawks exposed to controlled disturbance: Condor, v. 87, p. 14–22.

Woffinden, N.D., and Murphy, J.R., 1989, Decline of a ferruginous hawk population—A 20-year summary: Journal of Wildlife Management, v. 53, p. 1127—1132.

Zelenak, J.R., and Rotella, J.J., 1997, Nest success and productivity of ferruginous hawks in northern Montana: Canadian Journal of Zoology, v. 75, p. 1035–1041.