Section III. Assessments of Communities

Chapter 8. Streams and Rivers

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Key Ecological Attributes

Distribution and Ecology

The Wyoming Basin includes the headwaters of three of the major river systems in the United States. The Upper Snake River is the headwaters to the Columbia River Basin; the Green River is the headwaters to the Upper Colorado River Basin; and the Bighorn, Powder-Tongue, and North Platte Rivers are headwater systems to the Missouri River Basin. In addition, the Bear River is a headwater system for the inland Great Basin that drains into the Great Salt Lake in Utah. The Wyoming Basin also includes the Great Divide Basin, a small closed basin with few permanent streams and no outflow to other external bodies of water (see fig. 1−2).

The distribution and dynamics of streams and rivers in the Wyoming Basin are influenced by precipitation, topography, and soils. The hydrologic regime for most streams and rivers is characterized by substantial seasonal and interannual variability. Most streams and rivers come from snowmelt run-off, which means that generally streamflow peaks in the spring. However, there are groundwater and spring-fed systems as well, the flows of which are more consistent. Streams that hold water throughout the year are referred to as perennial. Rivers are simply large perennial streams, and in this chapter our references to perennial streams include rivers. Due to the arid climate of the Wyoming Basin, however, many streams are intermittent (hold water for just part of the year) or ephemeral (hold water only during and immediately after rain or snowmelt events).

The Wyoming Basin includes both low-elevation mainstem river systems (such as the North Platte, Green, and Bighorn Rivers), which are dominated by a warm- or cool-water fish assemblage, and high-elevation tributary streams, which are dominated by cold-water species (such as trout). Streams and rivers are closely connected to adjacent riparian ecosystems, which were historically dominated by cottonwoods and willow (see Chapter 10—Riparian Forests). Riparian ecosystems play an important role in stream and river health by storing groundwater, attenuating floods, and providing important biogeochemical cycling and water quality functions (Naiman and Décamps, 1997; Theobald and others, 2010).

Landscape Structure and Dynamics

Natural disturbances, including floods and droughts, play an important role in the dynamics of streams and rivers and help maintain ecosystem health and complexity (Poff and others, 1997). Floods and droughts affect streamflow dynamics and influence physical and biological processes in streams and rivers. Streamflow affects the abundance, distribution, and behavior of stream organisms through its effects on water quality and important ecological processes such as dispersal, habitat use, resource acquisition, competition, and predator-prey interactions (Hart and Finelli, 1999). Streamflow also affects connectivity within and among streams and rivers. Historically, the beaver was an important keystone species in streams and rivers, and beaver activities affected temperature, hydrology, and habitat availability, although their numbers have substantially declined across the western United States (Collen and Gibson, 2001).

Wildfire is another important disturbance that can have both positive and negative effects on streams and rivers, depending on fire severity, size, and time since fire. In the short term, wildfires remove above-ground riparian vegetation, which can lead to increased stream temperatures. For example, the mean maximum water temperature increased by as much as 2–6 degrees Celsius (3.6–10.8 degrees Fahrenheit) in severely burned reaches (Sestrich and others, 2011). Additionally the loss of vegetation can lead to postfire flooding and debris flows, which can have negative consequences for some aquatic organisms (Dunham and others, 2007; Cannon and others, 2010). Conversely, the loss of riparian cover can also increase instream productivity due to increased light levels, warmer water temperatures, nutrient pulses, and increased macroinvertebrate drift. In healthy, well-connected stream reaches, rapid recovery and recruitment of aquatic organisms generally occur following wildfires. In degraded, fragmented streams and rivers, however, system resistance and resilience to the direct and indirect effects of fire can be reduced (Dunham and others, 2007).

Associated Species of Management Concern

In the semiarid Intermountain West, streams and rivers are especially important ecologically because both terrestrial and aquatic ecosystems are constrained by water availability (Brown and others, 2008). It is estimated that stream, river, and riparian ecosystems account for 1–2 percent of the land area in the western United States, yet they provide habitat and water to more than half the wildlife species in the region (Theobald and others, 2010). Streams and rivers support a large number of freshwater species, including many imperiled native fish and mussels. In addition, it is estimated that 61 percent of 445 terrestrial species in Wyoming show some preference for riparian habitats, including 73 avian species (Wyoming Game and Fish Department, 2010).

Change Agents

Streams and rivers are subject to numerous anthropogenic stressors (Harding and others, 1998; Allan 2004), including grazing, mining and energy development, water extraction, pollution, and dams. These stressors alter flow and sediment transport. Such alterations have important implications for channel and floodplain structure, water quality, riparian vegetation, and aquatic species (Theobald and others, 2010; Esselman and others, 2011).

Development

In the Wyoming Basin, the natural flow regimes of streams and rivers have been severely disrupted, and with the exception of the Yellowstone and Powder Rivers, most of the major rivers have been dammed. A major contribution to altered streamflow is the extensive system of water diversions throughout the Basin, which reduce both the quantity and seasonal and interannual variability of streamflow. Reduced streamflow can lead to declines in fish abundance (Poff and Zimmerman, 2010) and shifts in community composition (Freeman and Marcinek, 2006).

Energy and Infrastructure

Energy development throughout the Wyoming Basin is of concern due to water use for energy extraction, potential pollution from spills, introduced chemicals or waste water, and increased sediment run-off due to surface disturbance associated with roads, pipelines, and well pads (Entrekin and others, 2011). Although urbanization is relatively limited in the Wyoming Basin, expansion of rural subdivisions generally leads to increased area of impervious surfaces. These surfaces can result in substantial increases in the delivery of water and sediment to streams when rain events occur, but streamflow typically drops rapidly once the rain has stopped. When approximately 10 percent of the surface had become impervious, Booth and Jackson (1997) found that channels became unstable.

Agricultural Activities

Irrigation is the largest use of freshwater in the Wyoming Basin (Hutson and others, 2004), and the Basin contains an extensive network of irrigation diversions. In addition to altering hydrological regimes, water diversions also can form barriers to fish movements, not only due to the diversion structures themselves but also because they dewater stream reaches. Water diversions can also entrain fish in the diversion structures, leading to mortality (Schrank and Rahel, 2004; Moyle and Israel, 2005; Roberts and Rahel, 2008). Nitrogen and phosphorus can run off agricultural and urban lands into aquatic systems, which can lead to eutrophication (Carpenter and others, 1998). Other potential contaminants associated with agriculture include pesticides and herbicides, which can have toxic or chronic sublethal effects on aquatic organisms (Cooper, 1993).

Grazing can alter the amount and structure of riparian vegetation, and trampling can lead to increased erosion and sedimentation (Armour and others, 1991; Belsky and others, 1999). Grazing also can affect stream food webs and the transfer of terrestrial invertebrates into streams (Saunders and Fausch, 2012). The Wyoming Basin's arid climate also results in significant water use for agriculture and livestock.

Invasive Species and Disease

Many species of nonnative fish have been introduced to streams and rivers of the Wyoming Basin, including walleye, bluegill, largemouth bass, rainbow trout, brown trout, and lake trout. In addition, whirling disease is present throughout the area, with negative consequences for trout species (McGinnis and Kerans, 2013). Other nonnative species of concern in streams and rivers of the Wyoming Basin region include New Zealand mudsnail, Asian clam, and curly pondweed. Although there currently are no known occurrences of zebra mussels in the Wyoming Basin, they are present in neighboring regions and the potential for spread to the Basin is of concern. There are also several invasive plant species that occur in riparian zones, including tamarisk and Russian olive (see Chapter 10—Riparian Forests and Shrublands).

Climate Change

The thermal and hydrological regimes of streams and rivers are strongly influenced by climatic variation. The potential for increased summer temperatures, increased winter flooding, and drought projected for some climate scenarios may be particularly problematic for fish and other aquatic organisms (Haak and others, 2010). Historical data indicate that water temperatures have been increasing in many streams and rivers across the western United States (Isaak and others, 2011). An increase in water temperature can lead to shifts in the distribution and even local extirpation of some cold- and cool-water fish (Comte and Grenouillet, 2013). Warmer water temperatures also can reduce water quality by lowering dissolved oxygen levels and could promote the expansion of nonnative fish (Rahel and Olden, 2008). Declining snowpack can lead to shifts in flow regimes (Mote and others, 2005). Changes in the amount and timing of precipitation could increase flooding in winter and spring if more precipitation occurs as rain. Additionally, earlier snowmelt could result in more low-flow events in the summer. There is considerable uncertainty, however, associated with models of projected precipitation (see Chapter 7—Climate Analysis).

Altered Fire Regimes

Warmer temperatures associated with climate change could lead to altered fire regimes in some systems (Westerling and others, 2006), which could affect streams and rivers (see Chapter 5—Wildland Fire).

Rapid Ecoregional Assessment Components Evaluated for Streams and Rivers

A generalized, conceptual model was used to highlight some of the key ecological attributes and Change Agents affecting streams and rivers (fig. 8–1). Key ecological attributes addressed by the Rapid Ecoregional Assessment (REA) include (1) the distribution of streams and rivers, (2) landscape structure (patch size and structural connectivity), and (3) landscape dynamics (fire occurrence and hydrologic regime) (table 8–1). The Change Agents evaluated include development, invasive species, and climate change (table 8–2). Ecological values and risks used to assess the conservation potential for streams and rivers are summarized in table 8–3. Core and Integrated Management Questions and the number of the associated summary maps and graphs are provided in table 8–4.

Methods Overview

The baseline distribution of streams and rivers was derived from the National Hydrology Database for 2010 (see table 8−1). The National Hydrology Database classification of perennial and intermittent/ephemeral streams was used to identify stream hydroperiod (duration of flow). Key ecological attributes were evaluated for baseline conditions and overlays of Change Agents. Riparian vegetation was derived from LANDFIRE (see Chapter 10—Riparian Forests) and summarized using a 270-meter (m) (885.8-feet [ft]) moving window to minimize finer-scale spatial errors in the location of riparian vegetation, and for visualization purposes.

Aquatic Development Index (ADI) scores were derived from catchments coincident with streams and rivers and summarized by hydroperiod. Stream-segment lengths were used as an index of patch size. To evaluate where development may alter flow regime, fragment streams, and decrease structural connectivity, the presence of dams and potential barriers (the number of points of diversion and stream-road crossings in streams and rivers) was summarized by sixth-level watershed. It is important to note that functional connectivity is species specific. To determine where recent fires have occurred, the perimeters of fires since 1980 were compiled from several data sources and area burned was summarized by sixth-level watershed (table 8–1).

To evaluate potential effects of current and projected temperature on hydrological regimes, we relied on data derived from existing macro-scale hydrological Variable Infiltration Capacity (VIC) models. Wegner and others (2010) demonstrated that the VIC model can be used to simulate recent (1978−1997) hydrological characteristics (such as mean summer flow and center time of mass streamflow) for streams and larger rivers. The center time of mass streamflow (referred to herein as center time) is defined as the time when 50 percent of the annual streamflow has occurred and serves as an index of the recent climatic conditions that govern the timing of runoff (Stewart and others, 2004). The VIC models also are used with climate model projections to evaluate potential changes in hydrological characteristics for future climate scenarios. To our knowledge, however, model calibration has not been performed for a semiarid environment such as the Wyoming Basin, which is dominated by intermittent and ephemeral stream types. These modeled streamflow characteristics, therefore, should be interpreted and used with caution and an understanding that these variables have a high level of uncertainty. Mean summer flow and center time were summarized by sixth-level watershed (table 8–1);

the summarized flow data for each watershed were assigned to streams coincident with the watershed. Stream segments predicted to have a mean summer flow of <1 cubic foot per second were considered at risk for drought due to low flow.

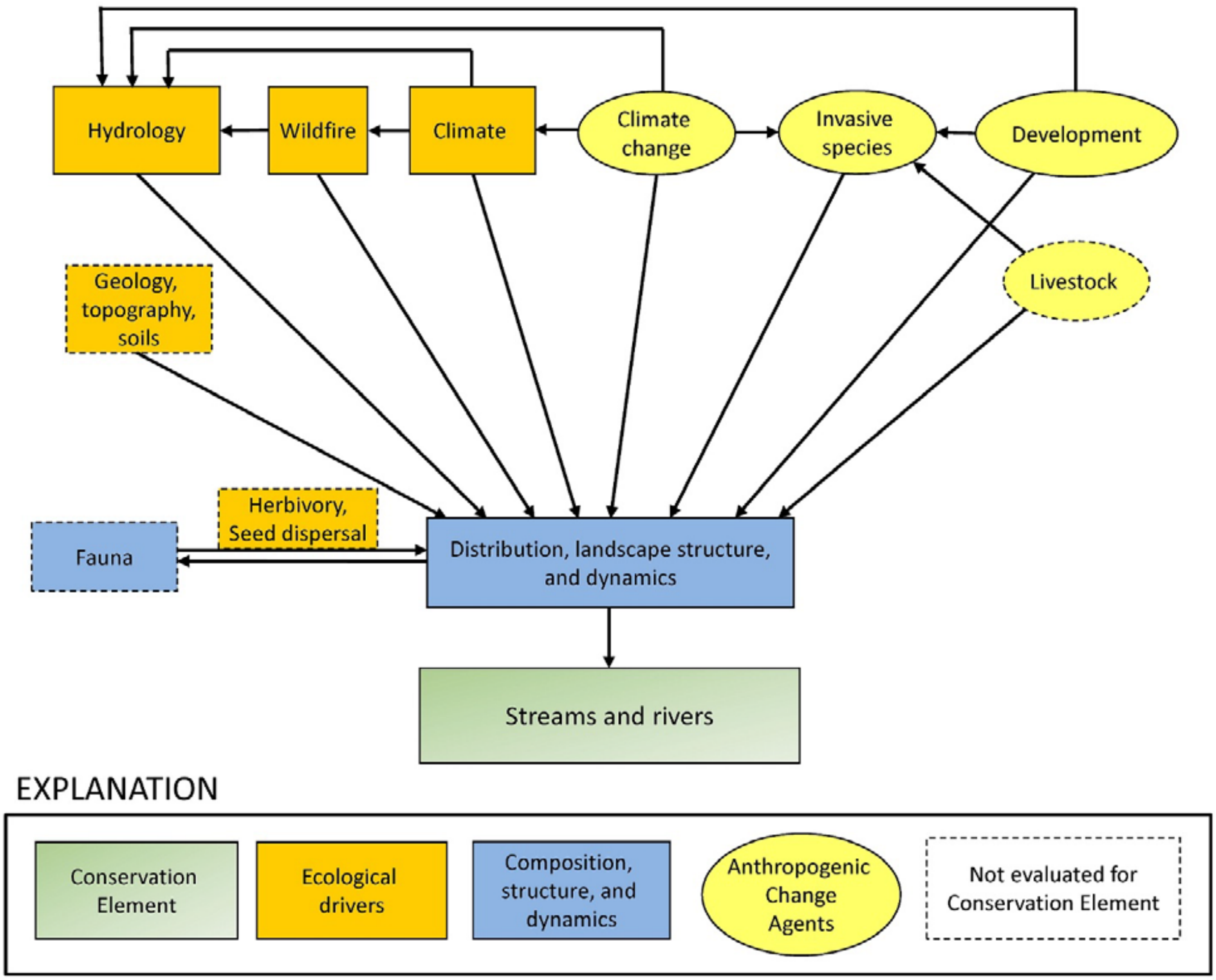

Figure 8–1. Generalized conceptual model of streams and rivers for the Wyoming Basin Rapid Ecoregional Assessment (REA). Biophysical attributes and ecological processes regulating the structure and dynamics of streams and rivers are shown in orange rectangles, additional ecological attributes are shown 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 species are Change Agents that were not evaluated due to lack of regionwide data.

Table 8–1. Key ecological attributes and associated indicators of baseline streams and rivers[1] for the Wyoming Basin Rapid Ecoregional Assessment.

Attributes	Variables	Indicators
Amount and distribution	Total length	Distribution derived from National Hydrography Dataset[1]
Landscape structure	Patch size	Total length of perennial and ephemeral/intermittent stream segments by sixth-level watershed
	Presence of riparian vegetation[2]	Percent of woody riparian vegetation (within 270 meters of perennial streams)
Landscape dynamics	Fire occurrence	Proportion of sixth-level watershed burned since 1980[3]
	Hydrologic regime	Mean summer flow and center time of mass streamflow[4]

[1] Baseline conditions are used as a benchmark to evaluate changes in the amount and landscape structure of streams and rivers due to Change Agents. Baseline conditions are defined as the current distribution of streams and rivers derived from data obtained from National Hydrography Dataset, at http://nhd.usgs.gov/index.html .

[2] Presence of riparian vegetation derived from LANDFIRE (see Chapter 10—Riparian Forests)

[3] See Wildland Fire section in the Appendix.

[4] U.S. Department of Agriculture Forest Service data from http://www.fs.fed.us/rm/boise/AWAE/projects/modeled_stream_flow_metrics.shtml (see Wenger and others, 2010).

Table 8–2. Anthropogenic Change Agents and associated indicators influencing streams and rivers for the Wyoming Basin Rapid Ecoregional Assessment.

Change Agents	Variables	Indicators[1]
Development	Aquatic Development Index (ADI)[2]	Percent of streams and rivers in seven development classes
		Length of perennial and intermittent/ephemeral streams and rivers that are relatively undeveloped or have low development compared to baseline
	Barriers affecting patch size and structural connectivity	Number of dams and potential barriers (points of diversion within 30 meters and stream/road crossings)[3]
Invasive species	Presence and expansion risk of tamarisk and Russian olive	See Chapter 10—Riparian Forests
Climate change	Hydrologic regime change[4]	Projected mean summer flow and center time of mass streamflow in 2040

[1] All analyses were completed for perennial and intermittent/ephemeral streams separately.

[2] See Chapter 2—Assessment Framework for Aquatic Development Index methods summarized by catchment and by sixth-level watershed.

[3] U.S. Army Corps of Engineers, National Hydrography Dataset, TIGER, and O'Donnell and others (2014).

[4] U.S. Department of Agriculture Forest Service (derived from climate models Geophysical Fluid Dynamics Laboratory Climate Model, ver. 2.1; and European Center Hamburg Model, ver. 5). (http://www.fs.fed.us/rm/boise/AWAE/projects/modeled_stream_flow_metrics.shtml [see Wegner and others, 2010]).

Table 8–3. Landscape-level ecological values and risks for streams and rivers. Ranks were combined into an index of conservation potential for the Wyoming Basin Rapid Ecoregional Assessment.

[<, less than; >, greater than]

	Variables[1]	Relative rank			Description[2]
		Lowest	Medium	Highest	
Values	Perennial stream density	<0.13	0.13−0.34	>0.34	The ratio of perennial stream length to the area of watershed
	Ephemeral/ intermittent stream density	<1.12	1.12−1.56	>1.56	The ratio of ephemeral/intermittent stream length to the area of watershed
Risks	Aquatic Development Index (ADI)	<20	20−40	>40	Mean ADI score by watershed
	Number of dams	0	1−2	>2	Number of dams by watershed

[1] Fifth-level watershed was used as the analysis unit for conservation potential on the basis of input from Bureau of Land Management (see table A−19 in the Appendix).

[2] See tables 8–1 and 8–2 for description of variables.

Table 8–4. Management questions evaluated for streams and rivers for Wyoming Basin Rapid Ecoregional Assessment.

Core Management Questions	Results
What are the amount and distribution of streams and rivers?	Figures 8–2 and 8–3
Where is woody riparian vegetation present along perennial streams?	Figure 8–4
Where does development pose the greatest threat to streams and rivers, and where are the large, relatively undeveloped areas?	Figures 8–5 to 8–8
How has development fragmented streams and rivers, altered flow, and decreased structural connectivity?	Figure 8–9
Where are streams and rivers with a high proportion of nonnative riparian vegetation?	Chapter 10—Riparian Forests and Shrublands
Which watersheds have had the most area burned by recent fires?	Figure 8–10
Where are streams and rivers currently at risk from low summer flows?	Figure 8–11
Where could streams and rivers be at risk from projected shifts in hydrological regimes in 2040?	Figures 8–12 and 8–13
Integrated Management Questions	**Results**
How does risk from development vary by land ownership or jurisdiction for streams and rivers?	Table 8–5, Figure 8–14
Where are the watersheds with the greatest landscape-level ecological values?	Figure 8–15
Where are the watersheds with the greatest landscape-level risks?	Figure 8–16
Where are the watersheds with the greatest conservation potential?	Figure 8–17

Landscape-level ecological values (length of perennial and ephemeral/intermittent streams) and risk (ADI score, number of dams) were compiled into an overall index of conservation potential for each fifth-level watershed (table 8–3). Conservation potential for streams and rivers was summarized by fifth-level watershed based on overall landscape-level values and risks. 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.

Key Findings for Management Questions

What are the amount and distribution of streams and rivers (figs. 8–2 to 8–3)?

- The Wyoming Basin contains approximately 286,000 kilometers (km) (177,712.16 miles [mi]) of streams and rivers, 85 percent of which are intermittent or ephemeral (fig. 8–2).
- Seventeen percent of sixth-level watersheds contain only ephemeral and intermittent streams. These are found primarily in the most arid portions of the ecoregion, such as the Great Divide Basin (fig. 8–3).
- The large river systems include the mainstems of the Wind, Bighorn, North Platte, and Upper Green Rivers. High densities of lower-order perennial streams are found in mountain headwaters.

Where is woody riparian vegetation present along perennial streams (fig.8–4)?

- The large mainstem rivers have the highest percentage of woody riparian vegetation, with the exception of the North Platte River, which has a relatively low percentage of riparian vegetation (fig. 8–4).

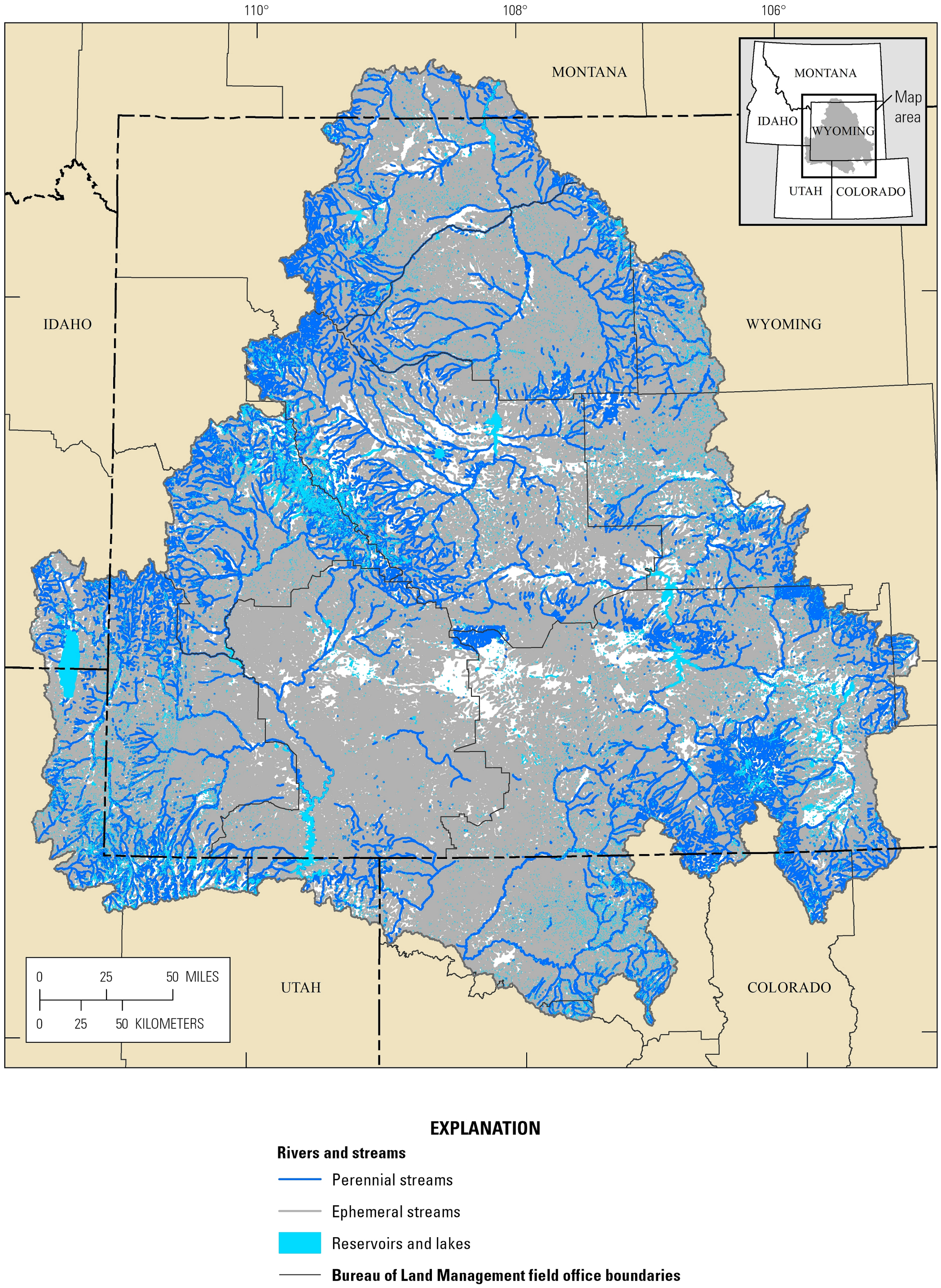

Figure 8–2. Distribution of perennial and ephemeral/intermittent streams (rivers are large perennial streams) in the Wyoming Basin Rapid Ecoregional Assessment project area.

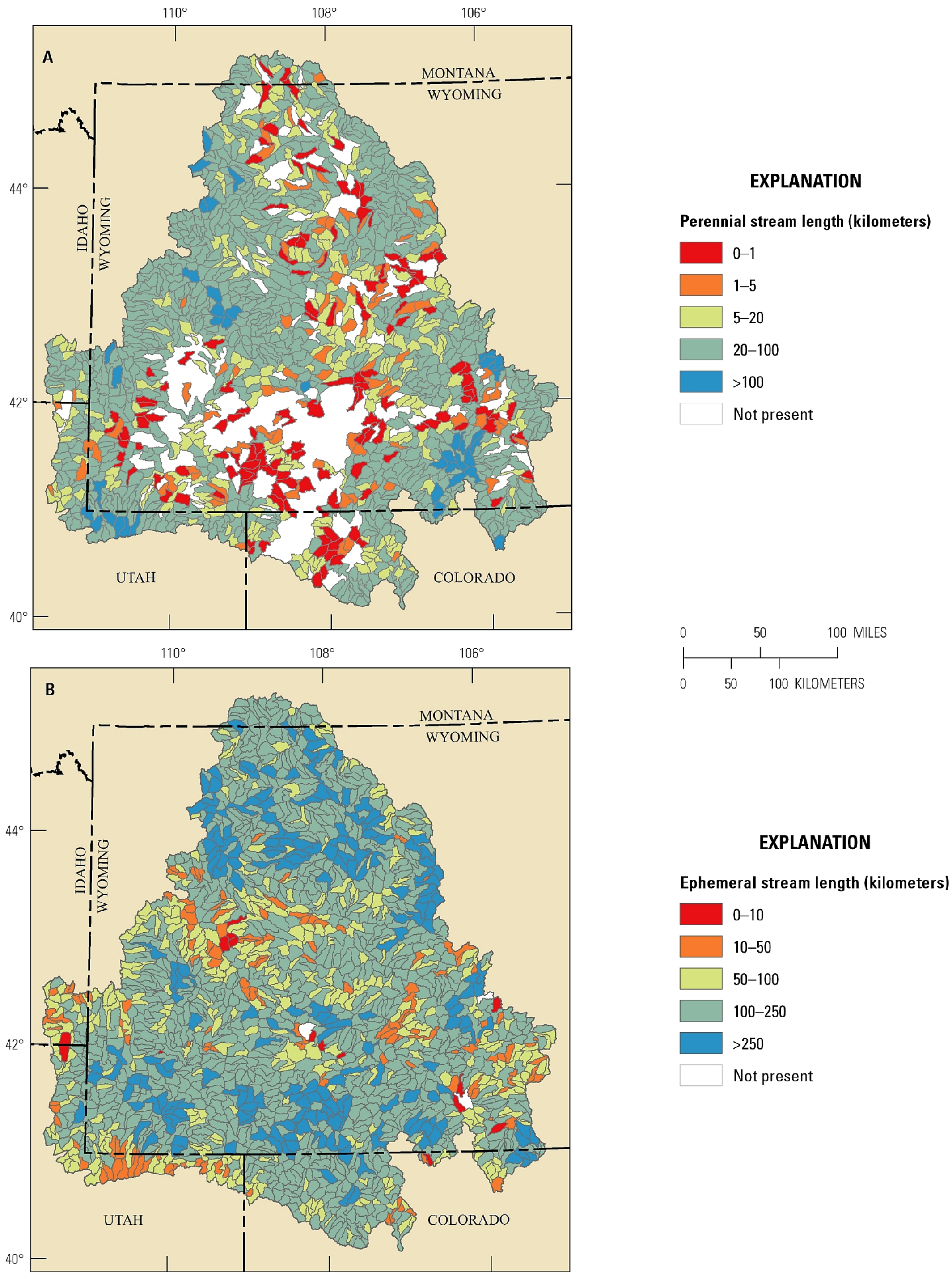

Figure 8–3. Total length of baseline streams and rivers by sixth-level watershed: (*A*) perennial streams and (*B*) intermittent and ephemeral streams.

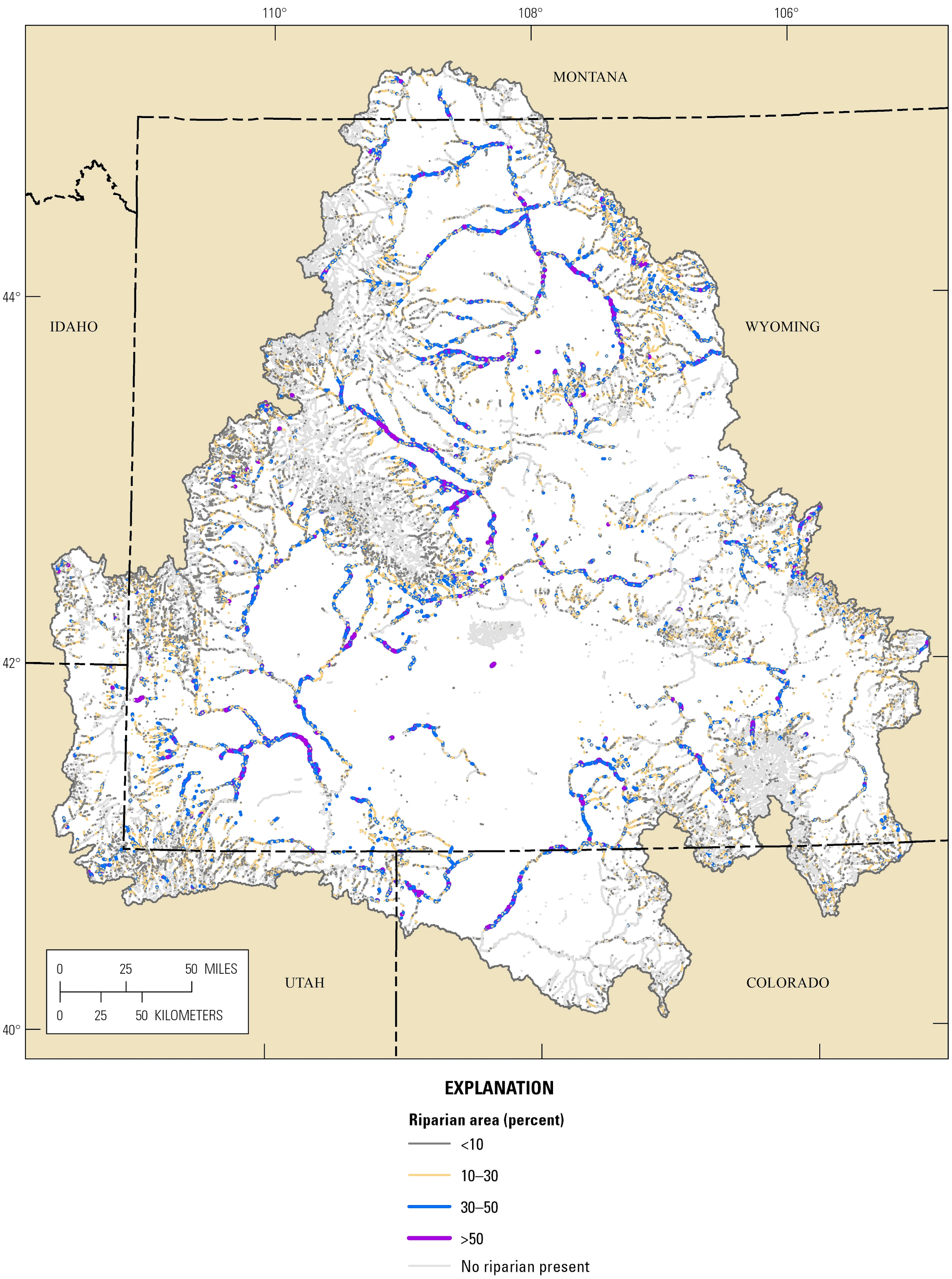

Figure 8–4. Distribution of riparian forests and shrublands along perennial streams in the Wyoming Basin Rapid Ecoregional Assessment project area. Percent of riparian vegetation summarized by 270-meter (886.83-feet) radius moving window.

Where does development pose the greatest threat to streams and rivers, and where are the large, relatively undeveloped areas (figs. 8–5 to 8–8)?

- For the Wyoming Basin area, development levels are relatively high throughout areas where streams and rivers occur. Most relatively undeveloped perennial streams are located in mountain headwater regions, such as the Wind River and Absaroka Mountains (figs. 1–1 and 8–5).
- A total of 22 percent of streams and rivers are relatively undeveloped (ADI score <20) and 24 percent are found in areas with very high development levels, as indicated by ADI scores of >50 (fig. 8–6).
- Highly developed areas include the Bear River drainage, the mainstem of the Wind and Bighorn Rivers, the Upper Green watershed, and some parts of the North Platte watershed (figs. 1–2 and 8–5).
- Overall, intermittent and ephemeral streams have lower development levels compared to most perennial streams. A total of 43.5 percent of intermittent and ephemeral streams are relatively undeveloped and 8.3 percent had ADI scores of >50 (fig. 8–6).
- A majority of baseline perennial stream segments are longer than 100 km (62.1 mi), whereas relatively undeveloped segments are generally much shorter than baseline segments (fig. 8–7).
- Watersheds with the longest stream segments are primarily headwater systems. When only relatively undeveloped areas are considered, the Wind River and Absaroka Mountains are the two main areas that still contain longer stream sections (fig. 8–8).

Where has development fragmented streams and rivers, altered flows, and decreased structural connectivity (fig. 8–9)?

- Potential barriers, such as water-diversion structures and road crossings, can affect streamflow and impede movements of organisms. Almost all sixth-level watersheds contain at least one potential barrier, but many contain more than 20.
- The Upper Green watershed near Pinedale and portions of the Bear River and the North Platte Basins contain a large number of sixth-level watersheds with more than 50 potential barriers.

Which watersheds have had the most area burned by recent fires (fig.8–10)?

- Most of the recent wildfires occurred in forested regions of the Wyoming Basin.
- Watersheds with >25 percent burned area are generally at higher elevations.

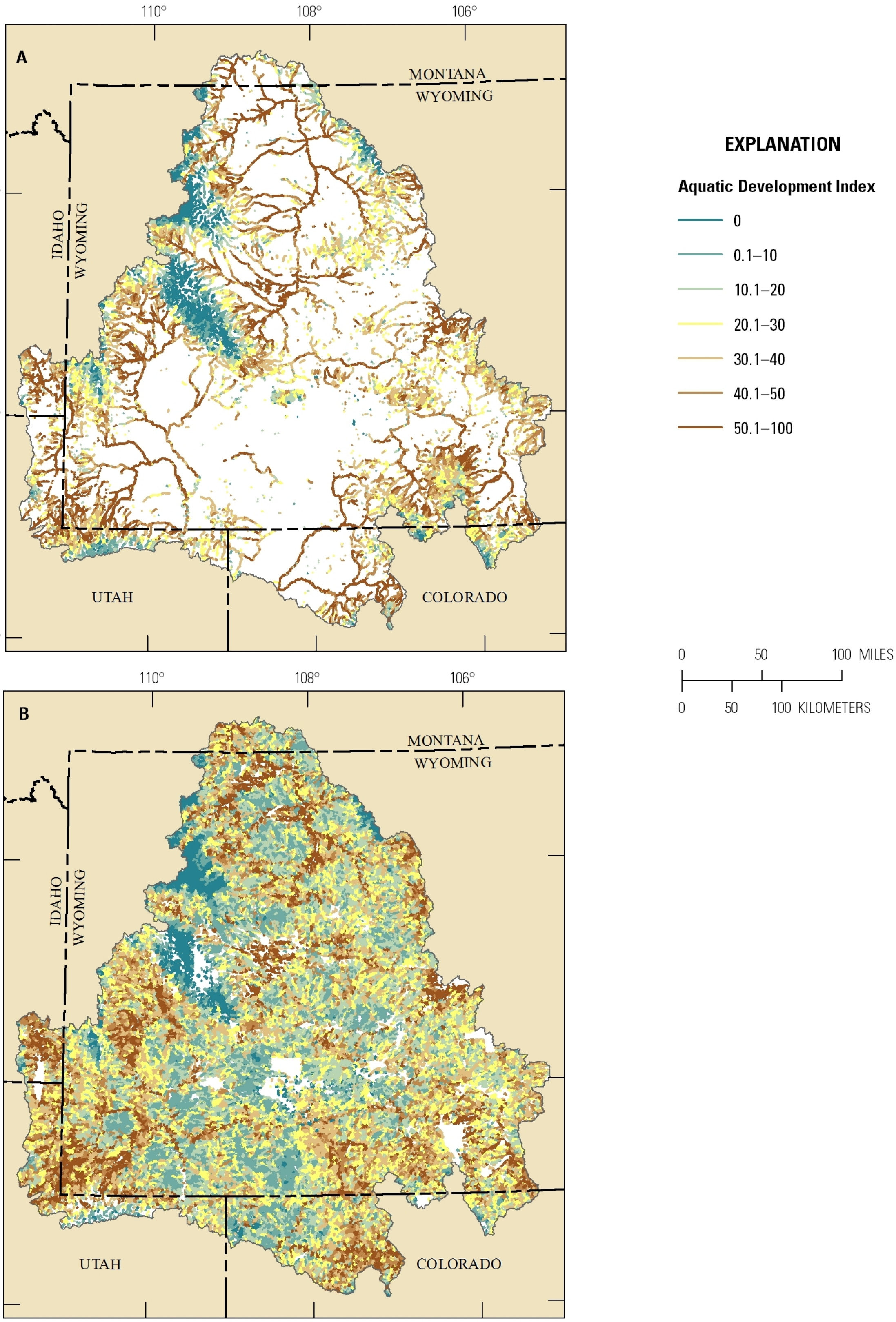

Figure 8–5. Aquatic Development Index scores for (*A*) perennial streams and (*B*) intermittent and ephemeral streams in the Wyoming Basin Rapid Ecoregional Assessment project area.

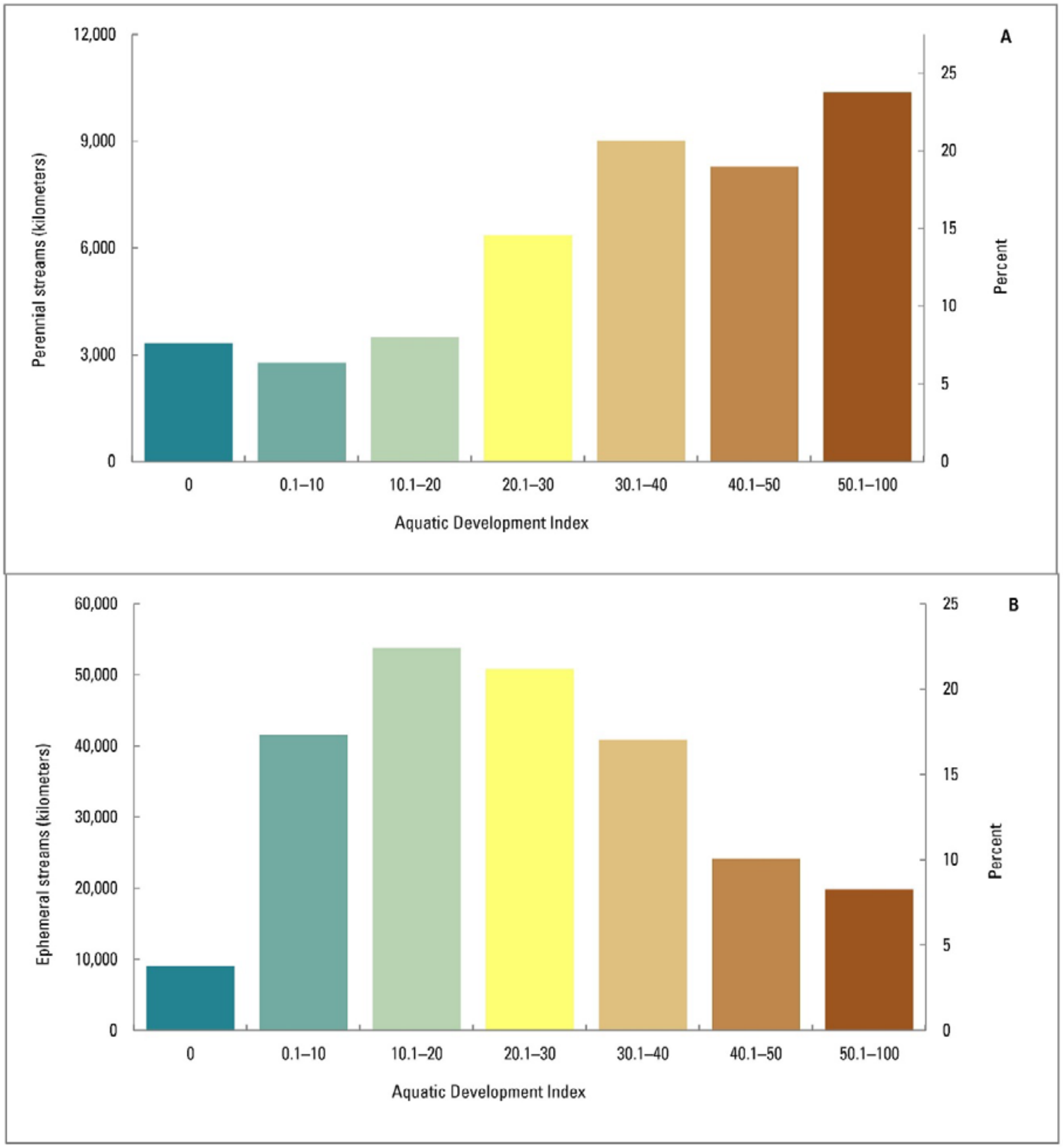

Figure 8–6. Total length and percent of (*A*) perennial streams and (*B*) intermittent and ephemeral streams as a function of the Aquatic Development Index score in the Wyoming Basin Rapid Ecoregional Assessment project area.

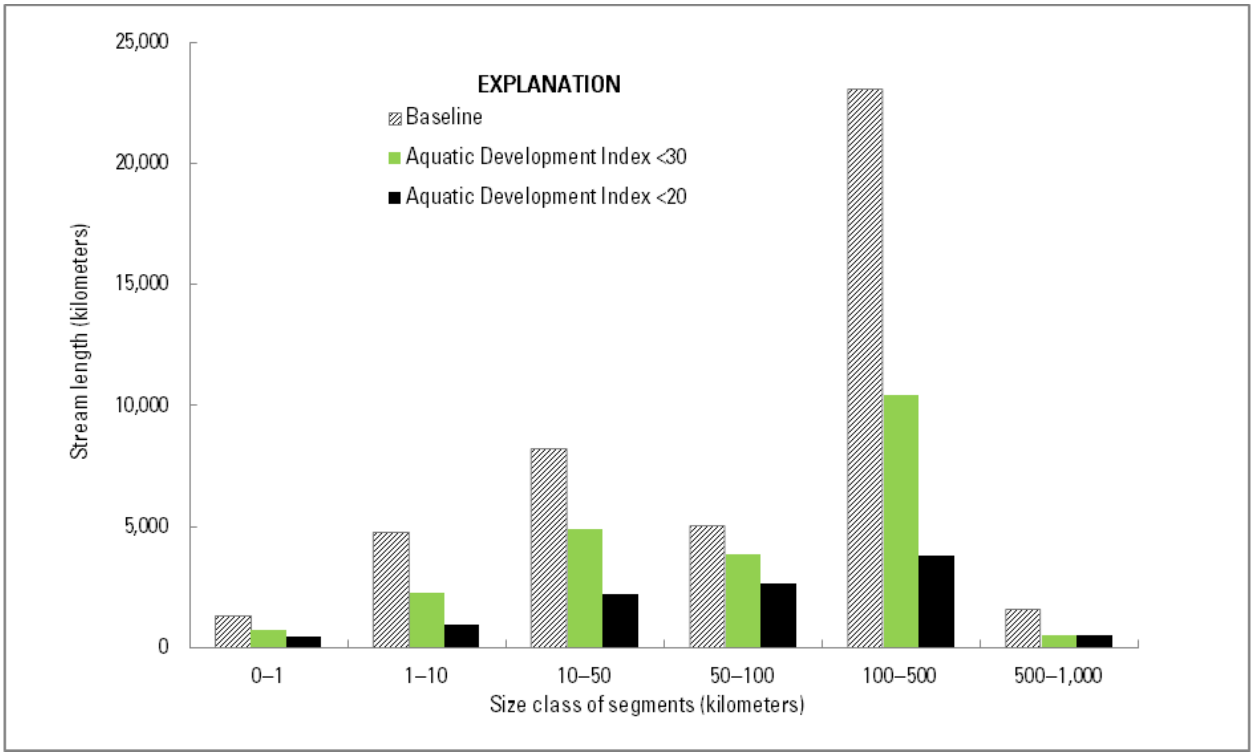

Figure 8–7. Total stream length as a function of stream-segment size for baseline conditions and two development levels: (1) Aquatic Development Index (ADI) score <30 and (2) ADI score <20 (relatively undeveloped) in the Wyoming Basin Rapid Ecoregional Assessment project area.

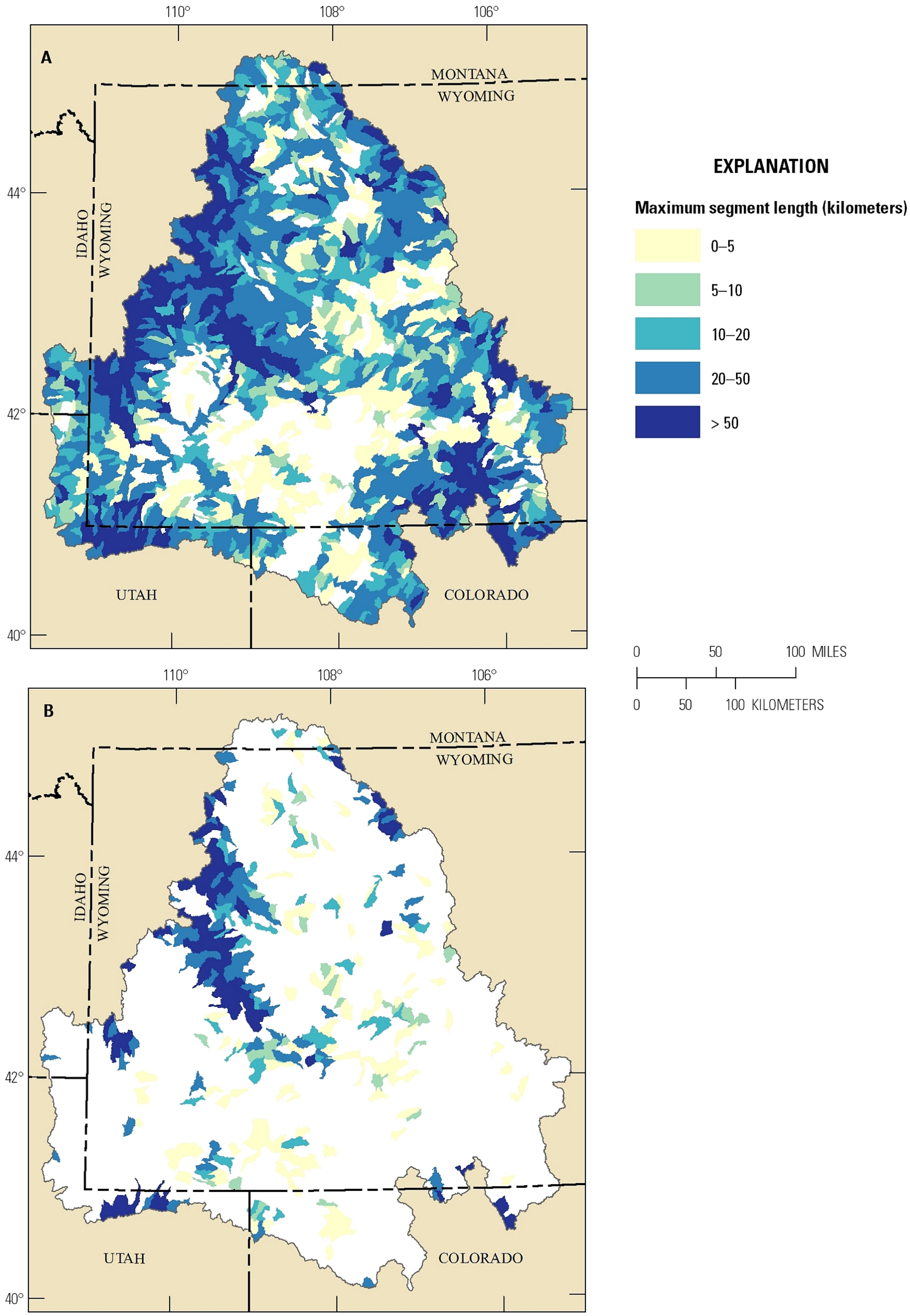

Figure 8–8. Maximum stream-segment length for (*A*) baseline and (*B*) relatively undeveloped perennial streams in the Wyoming Basin Rapid Ecoregional Assessment project area, summarized by sixth-level watershed. Relatively undeveloped habitat has an Aquatic Development Index score <20.

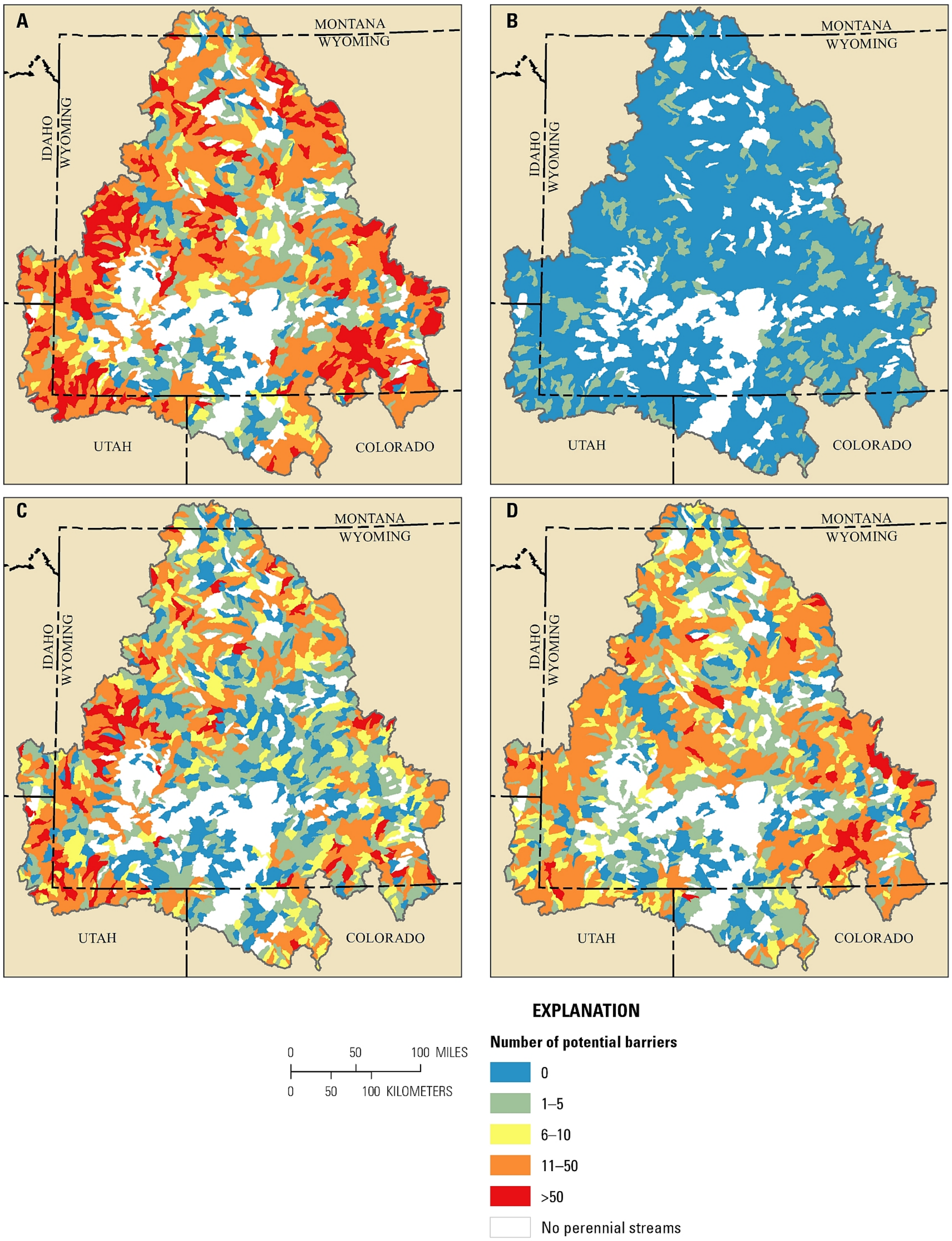

Figure 8–9. Potential barriers in perennial streams, summarized by sixth-level watershed. (*A*) All potential barriers; (*B*) number of dams; (*C*) points of diversion; and (*D*) stream/road crossings.

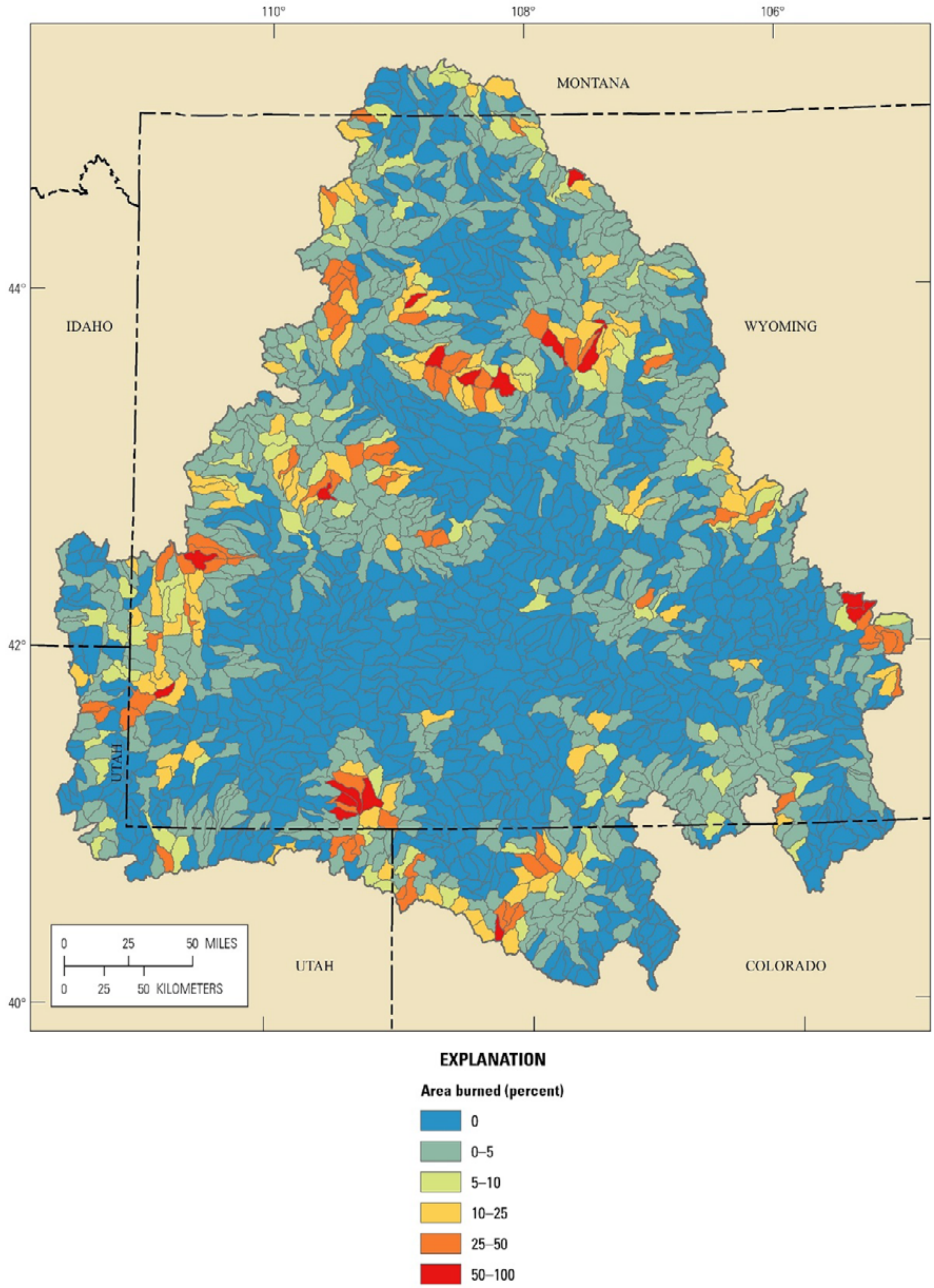

Figure 8–10. Percent of watershed burned by recent (since 1980) wildfires and prescribed fires in the Wyoming Basin Rapid Ecoregional Assessment project area.

Where are streams currently at risk from low summer flows (fig. 8–11)?

- The majority of streams and rivers have mean summer flows >0 but <3 ft^3/s.

Where could streams and rivers be at risk from projected shifts in hydrological regimes in 2040 (figs. 8–12 and 8–13)?

- Increased winter precipitation falling as rain and earlier spring snowmelt can lead to earlier peaks in spring flows. The timing of peak spring flows is projected to shift earlier in many watersheds for some climate scenarios, especially in the southwestern portion of the Wyoming Basin and near Craig, Colorado, indicating these areas could be at greater risk from drought during summer months (figs. 8–12 and 8–13).
- Recent and projected mean summer flows in 2040 are generally similar across the Wyoming Basin (fig. 8–13).
- Because of uncertainty associated with potential changes to hydrological regimes derived from projected climate scenarios, these patterns are best used to identify potential regional-scale vulnerabilities.

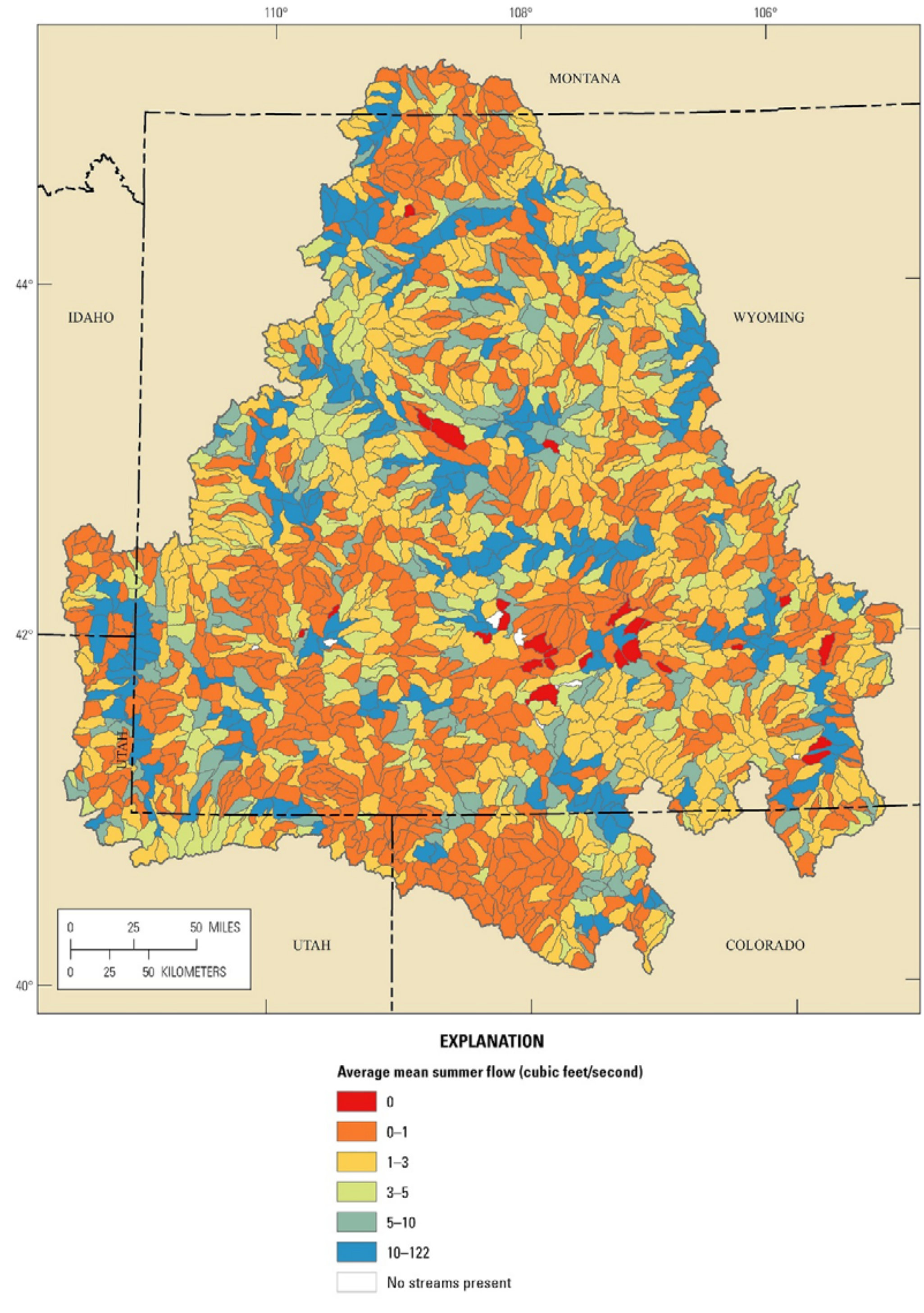

Figure 8–11. Mean summer flow (cubic foot per second) for baseline streams and rivers in the Wyoming Basin Rapid Ecoregional Assessment project area. Mean summer flow summarized by sixth-level watershed; flows near or at zero indicate potential for reaches to dry out during summer months.

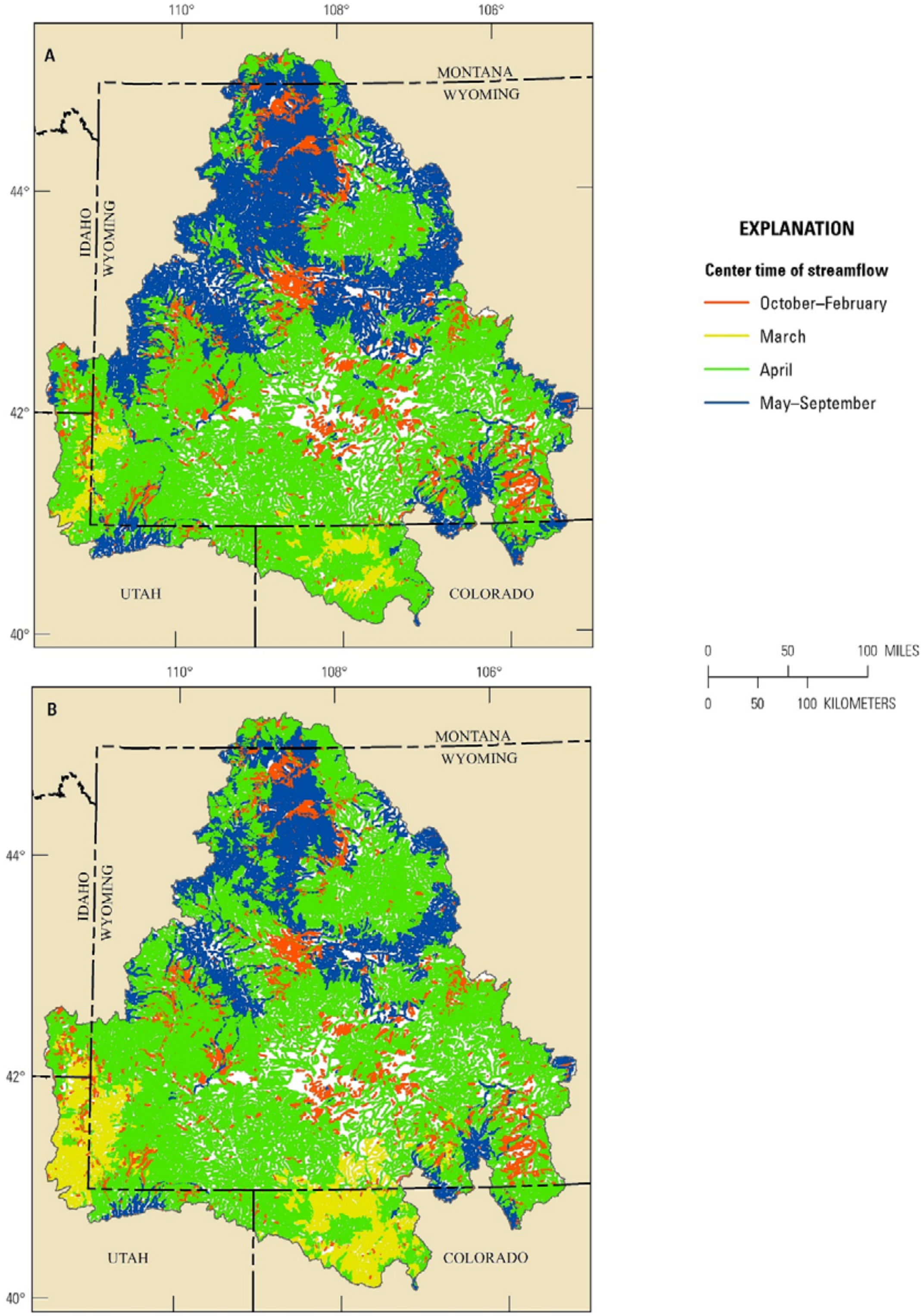

Figure 8–12. Center time of mass streamflow (the time when 50 percent of the yearly streamflow has occurred), for (*A*) current conditions and (*B*) projected in 2040 in the Wyoming Basin Rapid Ecoregional Assessment project area.

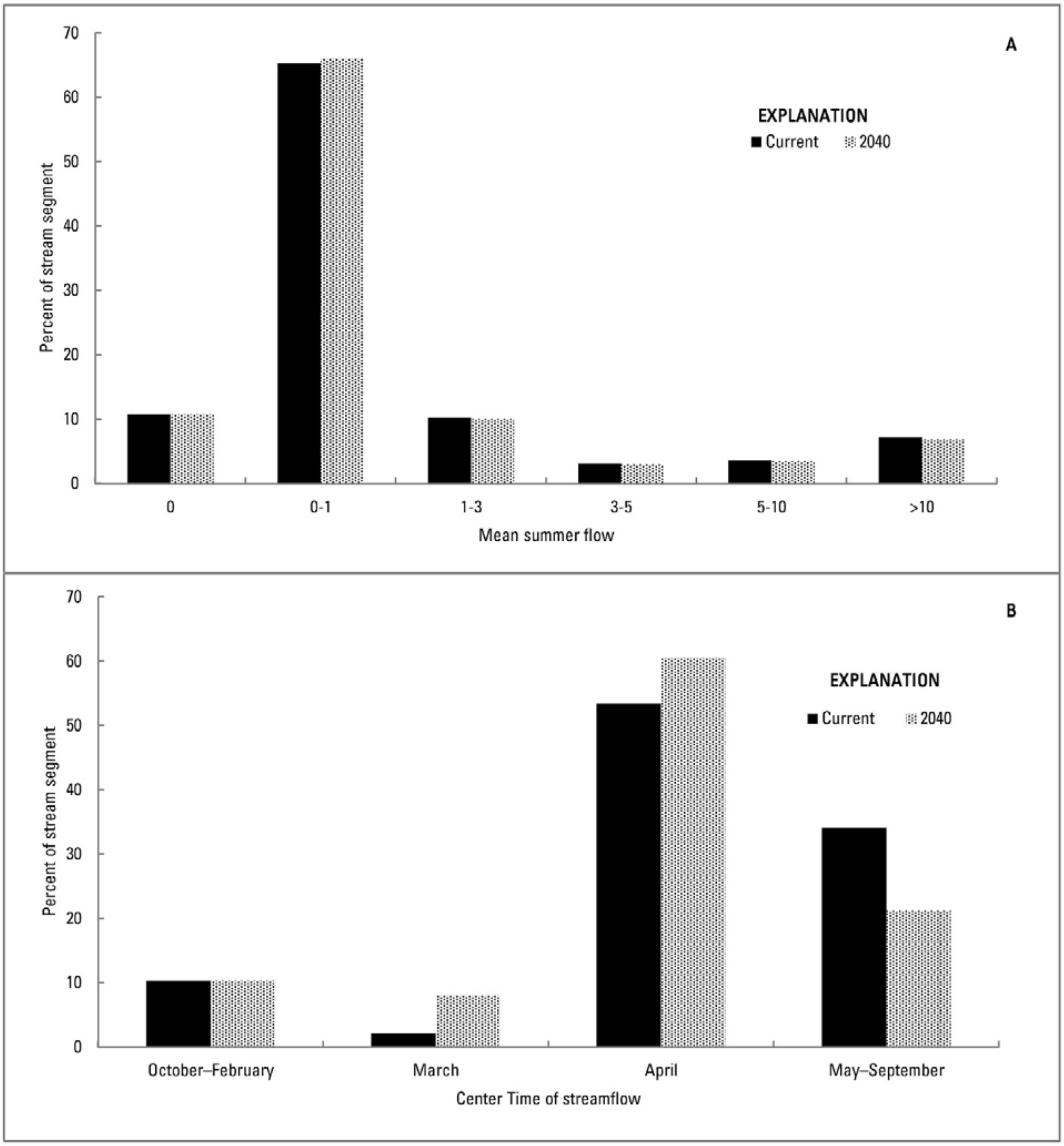

Figure 8–13. Potential effects of climate change on hydrological regime for streams and rivers for current conditions and projected in 2040 in the Wyoming Basin Rapid Ecoregional Assessment project area: (*A*) mean streamflow (cubic feet per second) during summer and (*B*) center time of mass streamflow (derived from figs. 8–11 and 8–12).

How does risk from development vary by land ownership or jurisdiction for streams and rivers (table 8–5, fig. 8–14)?

Table 8–5. Total length and percent of streams and rivers, by ownership or jurisdiction, in the Wyoming Basin Rapid Ecoregional Assessment project area.

[km, kilometer]

Ownership or jurisdiction	Stream length (km)	Percent of habitat
Bureau of Land Management	112,275	39.23
Private	96,608	33.76
Forest Service[1]	40,883	14.29
State/County	19,023	6.65
Tribal	9,651	3.37
Other Federal[2]	4,529	1.58
Private conservation	2,189	0.77
National Park Service	694	0.24
Other	315	0.11

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

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

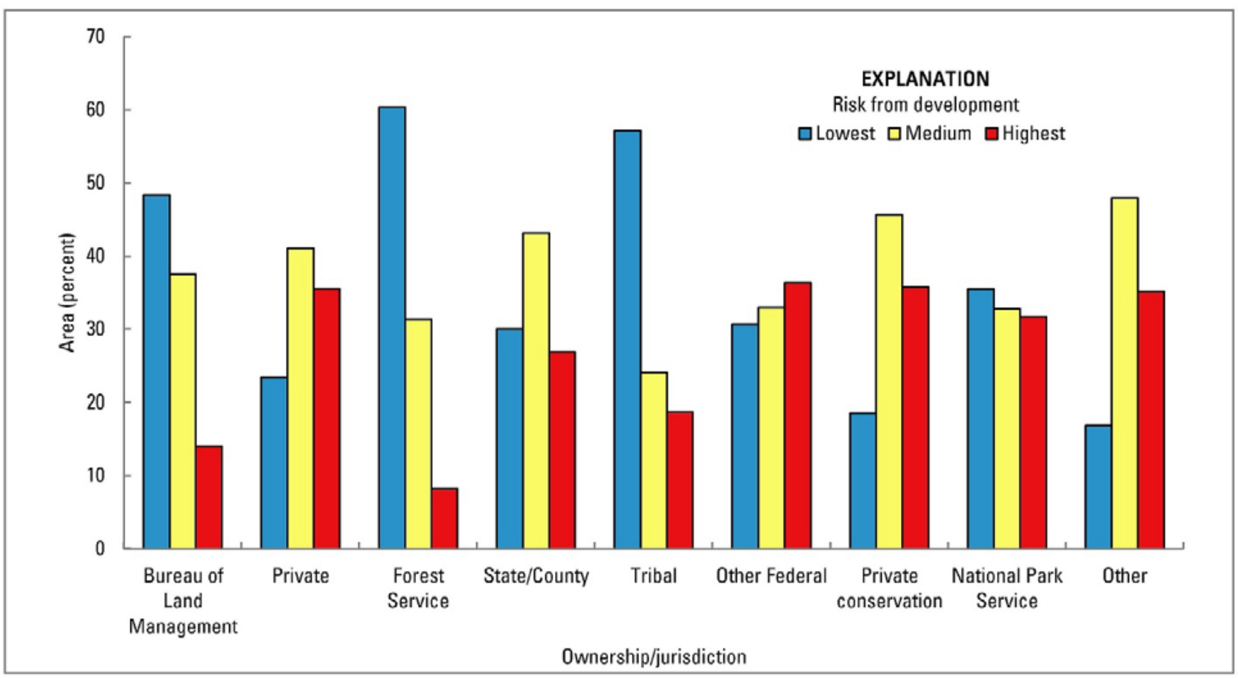

Figure 8–14. Relative ranks of risk from development, by land ownership or jurisdiction, for streams and rivers in the Wyoming Basin Rapid Ecoregional Assessment project area. Rankings are lowest (Aquatic Development Index [ADI] score <20), medium (ADI score 20−40), and highest (ADI score >40).

Where are the watersheds with the greatest landscape-level ecological values (fig. 8–15)?

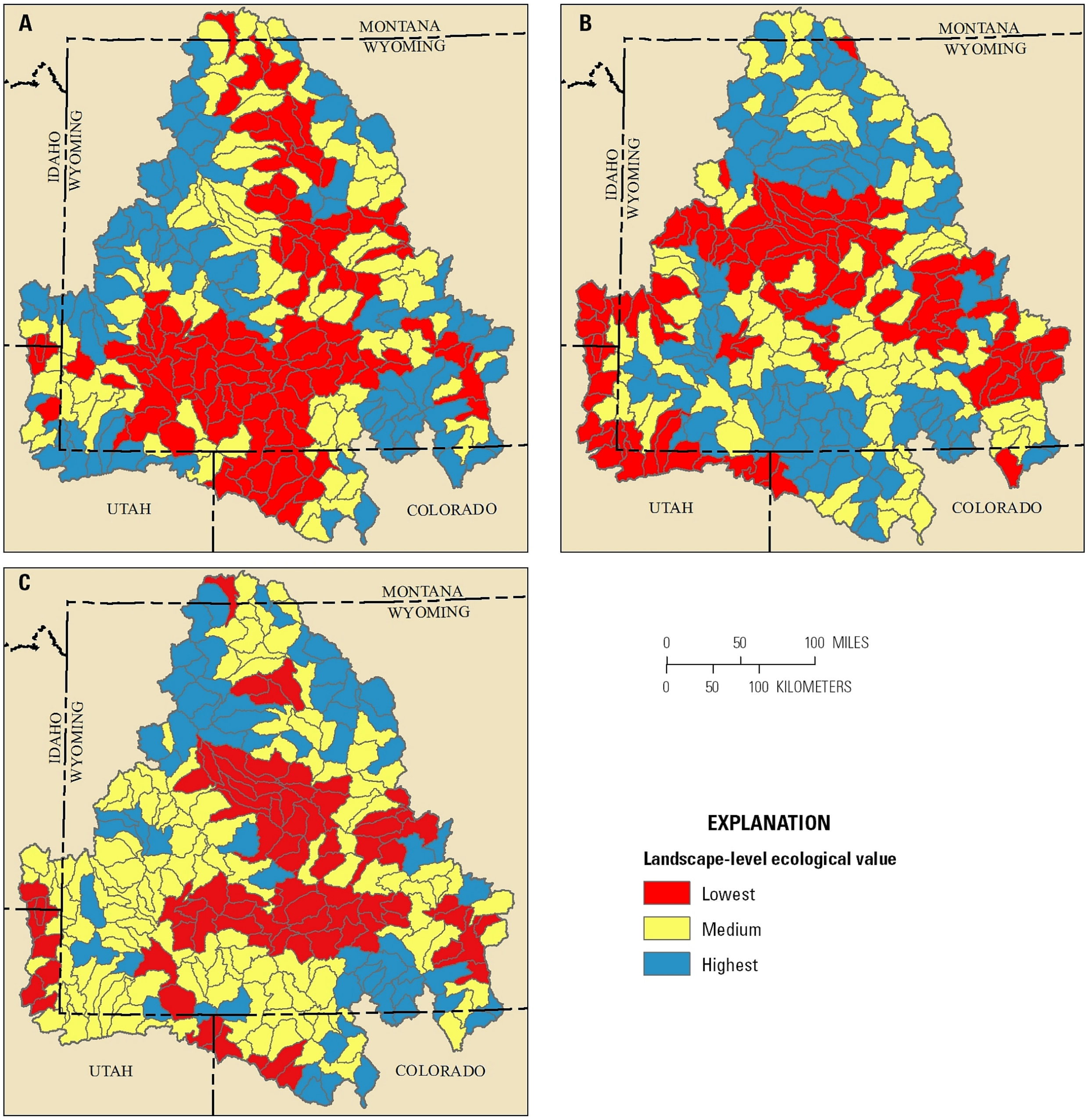

Figure 8–15. Ranks of landscape-level ecological values for streams and rivers, summarized by fifth-level watershed, in the Wyoming Basin Rapid Ecoregional Assessment project area. Landscape-level values based on (*A*) length of perennial streams; (*B*) length of ephemeral and intermittent streams; and (*C*) overall values (see table 8–3 for overview of methods).

Where are the watersheds with the greatest landscape-level risks (fig. 8–16)?

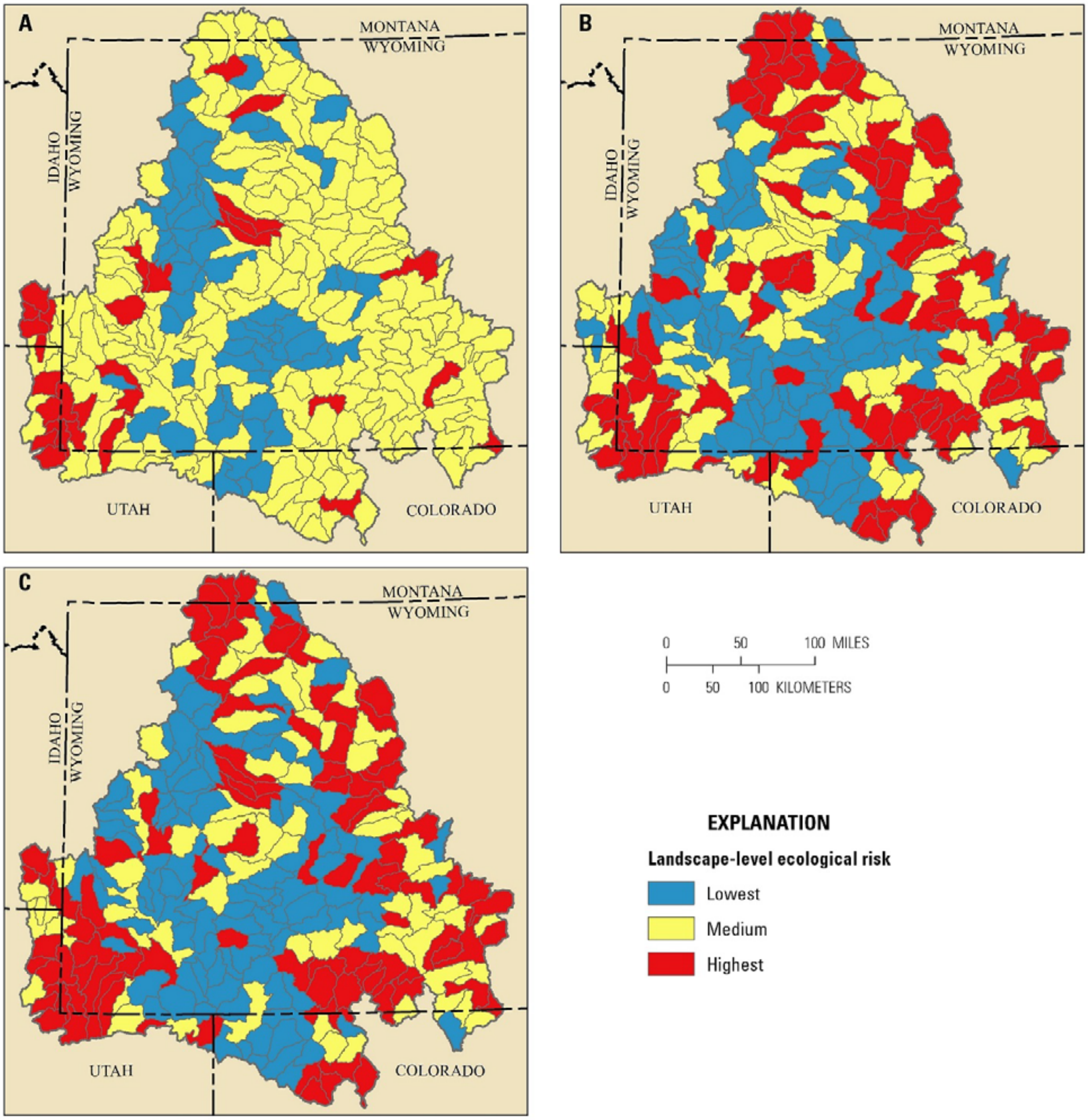

Figure 8–16. Ranks of landscape-level ecological risks for streams and rivers, summarized by fifth-level watershed, in the Wyoming Basin Rapid Ecoregional Assessment project area. Landscape-level risks based on (*A*) Aquatic Development Index, (*B*) number of dams, and (*C*) overall risks.

Where are the watersheds with the greatest conservation potential (fig. 8–17)?

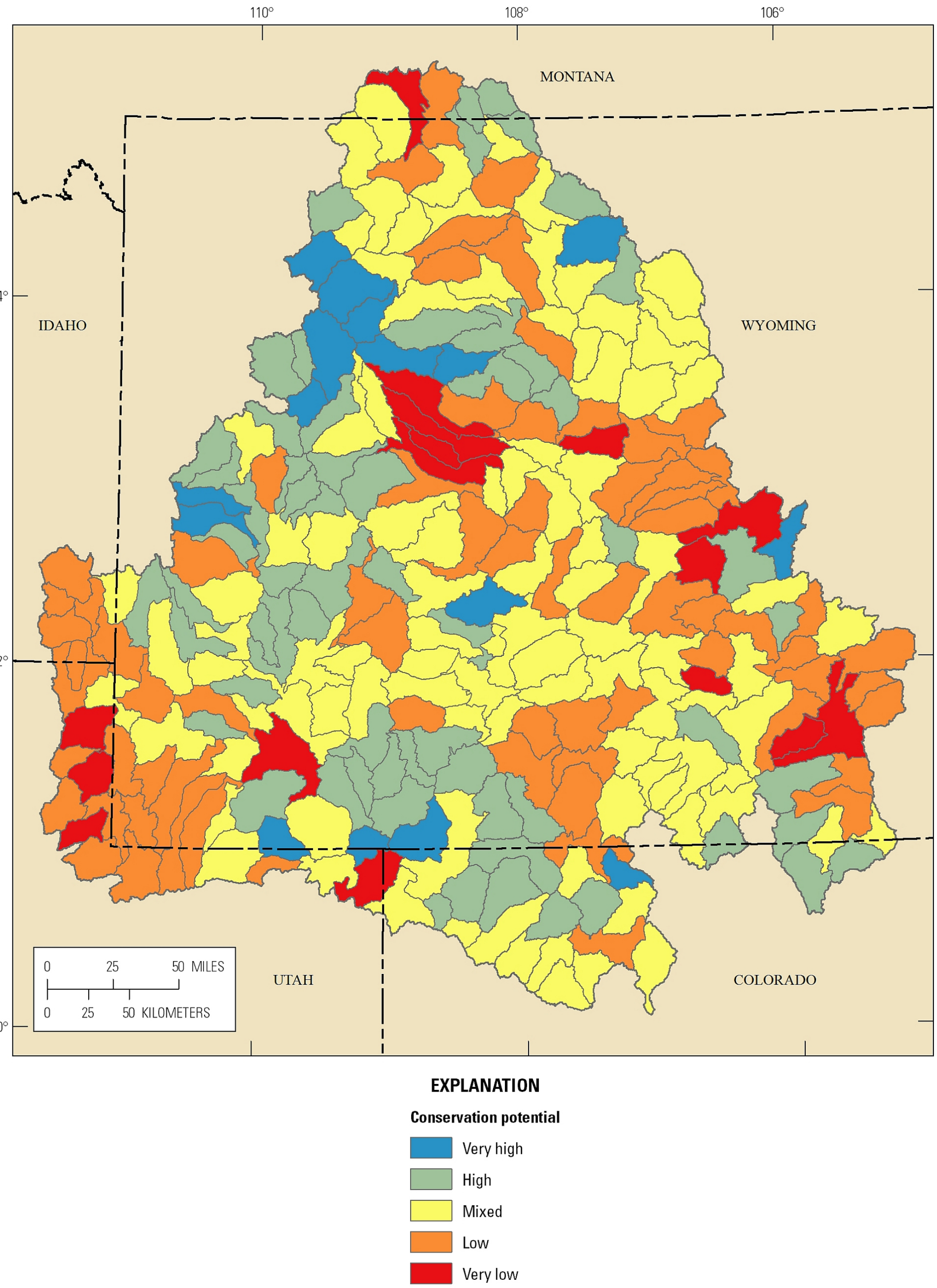

Figure 8–17. Conservation potential of streams and rivers, summarized by fifth-level watershed, in the Wyoming Basin Rapid Ecoregional Assessment project area. Highest conservation potential identifies areas that have the highest landscape-level values and the lowest risks. Lowest conservation potential 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

In the Wyoming Basin, streams, rivers, and associated riparian habitats account for just 2.3 percent of the landscape, yet they have a disproportionately large influence on many species, both aquatic and terrestrial. Most of these streams and rivers flow through sagebrush steppe, the dominant community in the Wyoming Basin, and are intermittent or ephemeral in nature. There are three large perennial river systems in the Wyoming Basin: the Wind/Bighorn, the Green, and the North Platte Rivers.

Development poses threats to the hydrology, structural connectivity, and integrity of streams and rivers throughout the Wyoming Basin, especially for perennial systems. The major sources of development are roads and agricultural activities. Many watersheds have a high number and extensive distribution of potential barriers due to roads and water diversions. Due to the semiarid nature of this ecoregion, many streams are intermittent in nature and (or) have very low mean flows, which makes them especially vulnerable to dewatering from diversions and projected climate change.

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