Section III. Assessments of Communities

Chapter 9. Wetlands

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Distribution and Ecology

Compared to other regions of the United States, the Intermountain West has relatively few wetlands due to its arid climate (Hubert, 2004); thus, wetland distribution is largely influenced by proximity to perennial or seasonal water sources, topography, and localized precipitation patterns (Laubhan, 2004). The majority of wetlands in the Wyoming Basin are associated with riverine systems (Wyoming Partners in Flight Riparian Habitat Group, 2003), although the historical distribution and types of wetlands, particularly in the low-elevation basins, are poorly understood because anthropogenic activities have altered a majority of the low-elevation wetlands (Knight, 1994).

The distribution of wetlands in the Wyoming Basin varies widely by elevation (Laubhan, 2004). At lower elevations, most wetlands are clustered along major drainages near the foothills and at low points of closed basins (Laubhan, 2004; Copeland and others, 2010). Basin wetlands include playas, alkali flats, and wetlands associated with riverine systems and floodplains, including marshes, wet meadows, side channels, and oxbows (Knight, 1994; Wyoming Partners in Flight Riparian Habitat Group, 2003; Laubhan, 2004). Most of the input to basin wetlands is indirect and arrives in the form of surface runoff or groundwater discharge originating from higher elevations. Rates of evapotranspiration often exceed water input, allowing salts to accumulate in many of these wetlands. Basin wetlands also typically have well-developed and productive alluvial soils, relatively warm water, and long growing seasons capable of supporting a wide range of biota (Laubhan, 2004). At higher elevations, wetlands are relatively widely distributed, with the majority occurring in montane coniferous forests (Copeland and others, 2010). Alpine/subalpine, montane, and foothill wetlands include snowbeds, tarns, kettles, sedge bogs, fens, seeps and springs, wet meadows, marshes, beaver ponds, and shallow morainal lakes (Laubhan, 2004). High-elevation wetlands typically receive both direct (precipitation) and indirect (snowmelt, groundwater discharge) input, and the rates of evapotranspiration rarely exceed water input; they also tend to have short growing seasons, cold water, and nutrient-poor soils, which limit the biota they can support (Laubhan, 2004).

Wetlands may be classified according to hydroperiod, ranging from permanently to intermittently flooded. Permanent wetlands are generally inundated throughout the year and support obligate hydrophytes. Semi-permanent wetlands are flooded most years throughout the growing seasons, whereas seasonal wetlands are flooded for part (usually early) of the growing season. Temporary wetlands may be flooded briefly in the growing season, and intermittent wetlands are flooded at irregular intervals for variable periods; in both cases the plant communities may include wetland and (or) upland species (Cowardin and others, 1979). Saturated wetlands generally lack surface water but have saturated substrates for extended periods in the growing season. For permanent, semi-permanent, and saturated wetlands, the water table is typically at or above the surface, whereas the water table may be well below the surface of temporary and intermittent types.

The composition and structure of wetland vegetation communities are influenced by many factors, including frequency and duration of inundation/saturation, depth to the water table, soil depth and texture, and length of growing season (Knight, 1994). Wetlands can include trees and shrubs (addressed in Chapter 10—Riparian Forests), but for this chapter, we address permanent to intermittent wetlands dominated by nonwoody, emergent plants and wetlands that may lack vegetation (Cowardin and others, 1979). Vegetation types range from floating (unrooted) to rooted, submergent to emergent, and freshwater obligates to halomorphic species (adapted to alkaline conditions) (Laubhan, 2004). Typically, floating plants, such as duckweeds, occur in permanent wetlands in which the water is too turbid and (or) deep to support rooted plants; exceptions include newly formed wetlands or those in subalpine and alpine locations where conditions do not support the growth of floating plants (Laubhan, 2004). Where light can penetrate the water, there may be rooted submergent and emergent plants, such as common marestail and sago pondweed, and wetland margins may support perennial emergents such as sedges, common spikerush, and broadleaf cattail.

Landscape Structure and Dynamics

The timing, amount, and duration of wetland inundation, as well as the rates and pathways by which water enters, circulates within, and exits a wetland system, define the hydrological regime that shapes wetland structure and dynamics (Baron and others, 2002). Most of the region's precipitation falls as snow at higher elevations, and snowmelt makes a significant input to surface waters and groundwater that discharges into wetlands. At higher elevations, snowmelt, greater water input, and lower rates of evapotranspiration not only tend to prolong hydroperiods of wetlands in those areas, they also promote more stable water levels (Laubhan, 2004). In basins, the warmer, drier climate promotes shorter hydroperiods, and many low-elevation wetlands have dramatic fluctuations in water levels (Gammonley, 2004).

In general, wetlands are very dynamic. Most systems undergo frequent, annual flooding from snowmelt runoff, but some (low-elevation systems in particular) also undergo infrequent but severe flooding, generally associated with significant monsoonal rainfall in mid-to-late summer (Hubert, 2004; Laubhan, 2004). Frequent, small floods tend to recharge or inundate existing wetlands, whereas less frequent, severe floods generally result in stream meandering, channel braiding, and other geofluvial dynamics that create oxbow wetlands and side channels, debris flows and scouring that sets back succession and accretions of sediments that create mudflats and point bars. Some wetland plants require these accretions for successful germination (Hubert, 2004; Knight, 1994; Laubhan, 2004). Beaver activities and log jams can enlarge or create wetlands and alter the successional dynamics of associated vegetation, particularly along mountain streams with otherwise steep gradients (McKinstry and others, 2001). At the other extreme, drought is also a major driver of wetland structure and dynamics. Annual or periodic drought allows oxidization of wetland substrates and release of nutrients, which helps to renew wetland productivity (Wyoming Partners in Flight Riparian Habitat Group, 2003; Wyoming Joint Ventures Steering Committee, 2010). Although fires are not common in wetlands, they also affect wetland dynamics. Fires in riverine wetlands tend to occur in late summer or fall (Knight, 1994), setting back succession and maintaining a more open structure in wetland vegetation. Severe, extensive fires in uplands of a watershed can result in significant flows of debris and sediments with subsequent rainfall, which can result in a cascade of dynamics in downslope wetlands, including sedimentation and altered water chemistry and nutrient cycling (Knight, 1994).

Associated Species of Management Concern

Although wetlands in the Wyoming Basin compose only 1 percent of the total surface area, more than 90 percent of the region's wildlife species use wetlands at some point in their daily or seasonal activities, and nearly 70 percent of the bird species are wetland or riparian obligates (Copeland and others, 2010). The wetlands that tend to support the greatest diversity and density of wildlife are those that occur at lower elevations, in large part due to the longer growing seasons and greater nutrient levels in lower elevation wetlands than in higher elevation wetlands (Wyoming Joint Ventures Steering Committee, 2010). Wetland complexes also tend to support more diversity that single wetlands, and wetland complexes occurring in the Green, Wind, and Big Horn River Basins, and those in the Green River foothills, tend to host more rare species than complexes elsewhere in Wyoming (Copeland and others, 2010). Small, isolated wetlands, however, also contribute significantly to the region's biodiversity and may serve as important stopover sites for migratory waterbirds (Wyoming Joint Ventures Steering Committee, 2010).

Forty-nine of Wyoming's Species of Greatest Conservation Need depend on wetlands for at least some part of their life cycle or daily activities (Wyoming Game and Fish Department, 2005), including white-faced ibis, American white pelican, Black tern, long-billed curlew, northern leopard frog, Columbia spotted frog, Great Basin and plains spadefoots, and fringed myotis. The boreal toad, which has been petitioned for listing under the Federal Endangered Species Act, also depends on Wyoming Basin wetlands (U.S. Fish and Wildlife Service, 2012). Fish species classified as Species of Greatest Conservation Need typically inhabit semi-permanent wetlands or those that are seasonally or intermittently flooded and are connected to permanent wetlands (such as floodplains along riverine systems) (Gammonley, 2004).

Change Agents

Development

Energy and Infrastructure

Energy, mineral, and urban development are considered moderate- to high-level threats to wetlands, and dewatering and channelization are considered significant threats to wetlands of the Wyoming Basin (Wyoming Joint Ventures Steering Committee, 2010). Development drives the additions of water diversions and impoundments (reservoirs) for municipal and industrial use, and it drives levee-building and channelization to protect nearby property from flooding. Reservoirs often inundate significant complexes of wetland and riparian areas, and because most of these impoundments are large enough to have significant wave and ice flow action, new wetlands usually cannot form along their margins. Furthermore, the water levels of most reservoirs are typically too deep and unstable to support the development of wetland soils and biota (Wyoming Joint Ventures Steering Committee, 2010). Levees (especially those built immediately adjacent to the main channel) and channelization preclude or alter the important flooding and geofluvial processes of riverine systems (Gergel and others, 2002). Moreover, many riverine systems are used as corridors for erecting utility lines, fences, and roads that further fragment and degrade the water quality of associated wetlands (Wyoming Joint Ventures Steering Committee, 2010).

Current energy development in the Wyoming Basin includes hydraulic fracturing to extract gas from shale, which usually requires at least 2–4 million gallons of water per horizontal well (U.S. Department of Energy, 2009). Although the requisite withdrawals of surface or groundwater are relatively small and temporary compared to those for municipal irrigation uses, it is a concern in arid parts of the country, such as the Wyoming Basin (Freyman, 2014). Oil and gas development can produce contaminated effluents, including fracturing fluids containing petroleum-based chemicals and other contaminants, which, if spilled or inadequately treated at wastewater treatment plants, can be released into surface and groundwater (Kargbo and others, 2010; Papoulias and Velasco, 2013). Playas and other isolated wetlands have been used as holding and (or) evaporation ponds for contaminated effluents from the energy industry (Melcher and Skagen, 2005).

Road development, including roadbeds, culverts, and bridges, associated with both energy and urban/ex-urban development can fragment landscapes and redirect both surface water and groundwater flows (Wyoming Joint Ventures Steering Committee, 2010). Loss of wetland structural connectivity can create barriers to movements of some wetland obligates, particularly fishes, amphibians, and aquatic reptiles (Knutson and others, 1999; Lehtinen and others, 1999). Furthermore, animals are at risk of direct mortality from roads and other exposed sites between wetlands (Ouren and others, 2007; Bouchard and others, 2009). Declines in populations of northern leopard frogs have been associated with urban development (Johnson and others, 2011), and the disturbance associated with roads and other development adjacent to wetlands can reduce the nesting success of wetland birds (Ward and others, 2010).

Wind-energy development near wetlands can cause disturbance and direct mortality when wetland birds or foraging bats collide with turbine blades, transmission lines, and other wind-energy infrastructure (Wyoming Joint Ventures Steering Committee, 2010; Johnson and Stephens, 2011). Trona (soda ash) mining is also an important industry in parts of the Wyoming Basin, and it is unclear whether mining-industry regulations will protect nearby isolated wetlands from being used as evaporation ponds (Wyoming Joint Ventures Steering Committee, 2010). Furthermore, evaporation and retention ponds created by mining and energy-extraction industries could increase populations of insects that serve as disease vectors. Effects of sand and gravel mining on wetlands are mixed, as some activities may create wetlands whereas others may alter or eliminate wetlands (Wyoming Joint Ventures Steering Committee, 2010).

Agricultural Activities

Agricultural activities, including irrigation, growing crops, overuse by livestock, and timber harvesting, also pose threats to wetlands (Wyoming Partners in Flight Riparian Habitat Group, 2003). Dams and reservoirs may permanently inundate riverine wetlands and could shift semi-permanent or temporary wetlands to permanent wetlands or lacustrine (lake) systems. Due to the proximity of reliable water sources, flat terrain, and rich soils along riverine systems, irrigated agricultural lands are common along riverine systems, where irrigation can create or enlarge existing wetlands and can alter hydroperiods, including the timing (seasonality), amount, duration, and regularity of inundation (Knight, 1994). Water diversions and groundwater pumping also frequently dewater wetlands by translocating surface waters and (or) by lowering water tables (Knight, 1994). Intensive livestock grazing in or adjacent to wetlands can reduce wetland vegetation through trampling, which destabilizes soils and accelerates rates of erosion and sedimentation. Intensive grazing has been found to reduce or eliminate nesting habitat for some wetland bird species (Ward and others, 2010) and agricultural practices can lead to excessive inflows of nutrients, contaminants, and sediments in nearby wetlands, all of which may alter wetland functions (Melcher and Skagen, 2005). At all elevations, there are thousands of stock ponds and other artificial wetlands. Logging in montane systems also requires road building that can redirect the flow of surface and groundwater, which can affect not only montane wetland systems but also wetlands downslope in the basins (Wyoming Joint Ventures Steering Committee, 2010).

Invasive Species

Wetlands may be more vulnerable to invasive species than most other communities, in part because anthropogenic activities that regularly affect wetlands, such as water use and pollution, also render them more susceptible to opportunistic species (Zedler and Kercher, 2004). Invasive plants of particular concern include leafy spurge, halogeton, purple loosestrife, and common reed (Wyoming Joint Ventures Steering Committee, 2010). Invasive plants have the capacity to form dense monocultures that compete with native species, and they can alter wetland hydroperiod, water chemistry, and nutrient cycling (Ehrenfled, 2003). For example, halogeton may contribute to build-ups of soil salinity (Harper and others, 1996). Nonnative plants in upland areas, such as cheatgrass in sagebrush systems, can affect soil chemistry in adjacent wetlands (Ehrenfeld, 2003). Introduced animal species also pose a potential problem in wetlands. For example, population declines of northern leopard frogs have been attributed to introductions of bullfrogs in wetlands outside of their range (including parts of the Wyoming Basin) (Johnson and others, 2011).

Climate Change

Drought is a natural driver of wetland dynamics; thus, altering the duration, intensity, and frequency of drought has the potential to alter hydrologic regimes (Wyoming Joint Ventures Steering Committee, 2010). Changes in hydrologic regime could result in altered wetland distribution, structure or type, and dynamics across the Great Plains (Johnson and others, 2005). These changes also could increase the susceptibility of wetlands to invasive species.

Rapid Ecoregional Assessment Components Evaluated for Wetlands

A generalized, conceptual model was used to highlight some of the key ecological attributes and Change Agents affecting wetlands (fig. 9–1). Key ecological attributes addressed by the REA include (1) the amount and distribution of wetlands, (2) landscape structure (wetland size and structural connectivity), and (3) landscape dynamics (hydrologic regime; table 9–1). Development and climate change were evaluated as Change Agents (table 9–2). Ecological values and risks used to assess the conservation potential for wetlands by township are summarized in table 9–3. Core and Integrated Management Questions and the associated summary maps and graphs are provided in table 9–4.

Methods Overview

We mapped the distributions of wetlands using the National Wetlands Inventory (NWI) (Cowardin and others, 1979). We augmented NWI data with Colorado Natural Heritage Program wetland data for Colorado and the Uinta-Wasatch Cache National Forest in Utah where NWI data were limited. We used the following NWI classifications of wetlands: freshwater emergent, freshwater forested, freshwater forested/shrub, freshwater scrub/shrub, freshwater pond, riparian emergent, riparian forested, riparian scrub-shrub, and other freshwater (Cowardin and others, 1979). To calculate wetland area by sixth-level watershed, we standardized wetland area by the area of each watershed, and represented wetland area as a percent of the watershed.

We assessed development levels in wetlands using the Local Aquatic Development Index (ADI) scores rather than the Aquatic Development Index. The Local ADI includes only catchment-level development from the ADI (excluding the upstream catchment inputs). A Local ADI score was generated for each catchment. We first calculated an area-weighted Local ADI score for each wetland, which we used to calculate the mean Local ADI score for each sixth-level watershed. We mapped the structural connectivity of baseline and relatively undeveloped wetlands at three interpatch distances derived from connectivity analysis: for baseline conditions, local, landscape, and regional scales of connectivity were 0.18 kilometers (km) (0.11 miles [mi]), 0.54 km (0.33 mi), and 1.44 km (0.89 mi); for relatively undeveloped areas (Local ADI score <20), local, landscape, and regional scales of connectivity were 0.81 km (0.50 mi), 1.44 km (0.89 mi), and 3.51 km (2.18 mi), respectively.

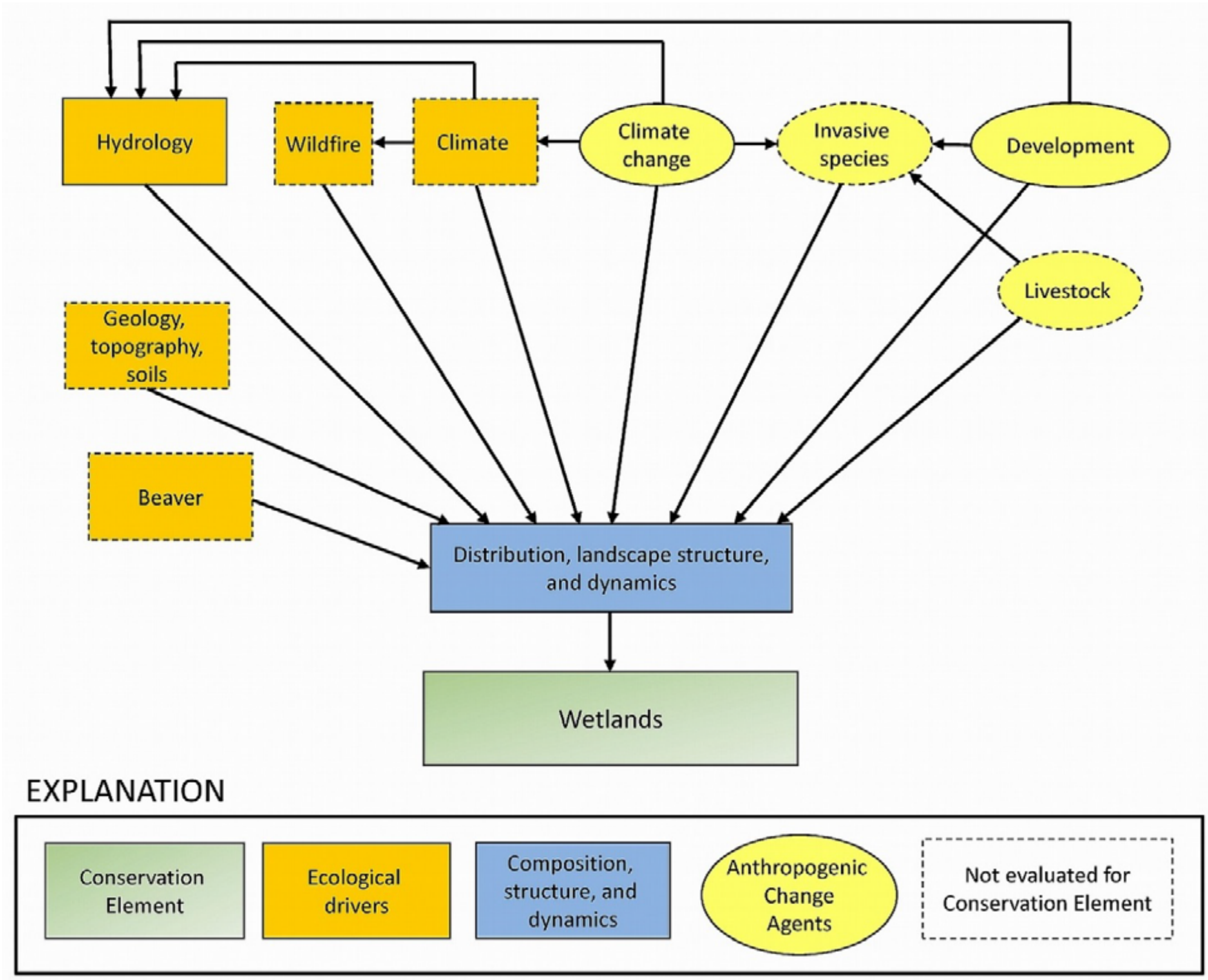

Figure 9−1. Generalized conceptual model of wetlands for the Wyoming Basin Rapid Ecoregional Assessment (REA). Biophysical attributes and ecological processes regulating the occurrence, structure, and dynamics of wetlands are shown in orange rectangles; additional ecological attributes are shown in blue rectangles; and anthropogenic Change Agents that affect key ecological attributes are shown in yellow ovals. The dashed lines indicate components not addressed by the REA. Livestock and invasive plants are Change Agents that were not evaluated due to the lack of regionwide data.

Because many wetlands in developed areas may be artificially created and maintained through agricultural activities like flood irrigation (for example, Lovvorn and Hart [2004]), we estimated the areal percent and distribution of wetlands that were coincident with agriculture. We considered a wetland as potentially created or altered if it was spatially coincident with agriculture.

Landscape-level ecological values (percent wetland area in fifth-level watershed) and risk (ADI score of fifth-level watershed) were compiled into an overall index of conservation potential for each fifth-level watershed (table 9−3). Conservation potential for wetlands 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.

Table 9–1. Key ecological attributes and associated indicators of baseline wetlands[1] for the Wyoming Basin Rapid Ecoregional Assessment.

[km, kilometer; mi, mile]

Attributes	Variables	Indicators
Amount and distribution	Wetland distribution	Distribution derived from National Wetlands Inventory
		Percent of sixth-level watershed classified as wetlands
Landscape structure	Wetland size	Wetland size frequency distribution
	Structural connectivity[2]	Interpatch distances that provide an index structural connectivity for baseline wetlands at local (0.18 km; 0.11 mi), landscape (0.54 km; 0.33 mi) and regional (1.44 km; 0.89 mi) scales
Landscape dynamics	Hydrologic regime	Dominant wetland type by hydroperiod classification[3]

[1] Baseline conditions are used as a benchmark to evaluate changes in the total area and landscape structure of wetlands due to Change Agents. Baseline conditions are defined as the potential current distribution of wetlands derived from National Wetlands Inventory (Cowardin and others, 1979) data without explicit inclusion of Change Agents (see Chapter 2—Assessment Framework and the Appendix).

[2] See Chapter 2—Assessment Framework and the Appendix.

[3] Hydroperiods include permanent, semi-permanent, and temporary.

Table 9–2. Anthropogenic Change Agents and associated indicators influencing wetlands for the Wyoming Basin Rapid Ecoregional Assessment.

[km, kilometer; mi, mile]

Change Agents	Variables	Indicators
Development	Local Aquatic Development Index (ADI)	Percent of wetlands in seven Local ADI classes[1]
		Percent of sixth-level watershed classified as relatively undeveloped wetlands
		Wetland size frequency distribution for wetlands that are relatively undeveloped or have low levels of development compared to baseline wetlands
		Interpatch distances that provide an index structural connectivity for relatively undeveloped wetlands at local (0.81 km; 0.50 mi), landscape (1.44 km; 0.89 mi), and regional (3.5 km; 2.17 mi) scales
	Agriculture	Wetlands coincident with agriculture
Climate change	Hydrologic regime	See Chapter 8—Streams and Rivers

[1] See Chapter 2—Assessment Framework.

Table 9–3. Landscape-level ecological values and risks for wetlands. Ranks were combined into an index of conservation potential for the Wyoming Basin Rapid Ecoregional Assessment.

[<, less than]

		Relative rank			
	Variables[1]	Lowest	Medium	Highest	Description[2]
Values	Area	<1	1–3	>3	Percent of watershed
Risks	Local Aquatic Development Index (ADI)	<20	20–40	>40	Mean Local ADI score 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 9–1 and 9–2 for description of variables.

Table 9–4. Management Questions addressed for wetlands for Wyoming Basin Rapid Ecological Assessment.

Core Management Questions	Results
Where are baseline wetlands, by functional type and hydroperiod, and what is the total area of each?	Figure 9–2, Tables 9–5 and 9–6
Where are the sixth-level watersheds with the greatest wetland area?	Figure 9–3
Where does development pose the greatest threat to wetlands, and where are the relatively undeveloped wetlands?	Figures 9–4 to 9–6
How has development affected the structural connectivity of wetlands relative to baseline conditions?	Figure 9–7
Which wetlands are potentially created or altered by agriculture?	Figure 9–8
Integrated Management Questions	**Results**
How does risk from development vary by land ownership or jurisdiction for wetlands?	Table 9–7, Figure 9–9
Where are the watersheds with the greatest landscape-level ecological values?	Figure 9–10
Where are the watersheds with the greatest landscape-level risks?	Figure 9–10
Where are the watersheds with the greatest conservation potential?	Figure 9–11

Key Findings

Where are baseline wetlands, by functional type and hydroperiod, and what is the total area of each (fig. 9–2; tables 9–5 and 9–6)?

- There are 250,065 wetlands within the Wyoming Basin, totaling 3,431 square kilometers km^2 (1,324.7 square miles [mi^2]). The average wetland size was 1.37 hectares (ha) (3.39 acres).
- Freshwater emergent wetland is the most abundant functional wetland type; together with freshwater ponds and forested/shrub wetlands, freshwater emergent wetlands compose the majority of wetlands in the Wyoming Basin (fig. 9–2, table 9–5). All other wetland types comprise <2.1 percent of total wetland area (table 9–5).
- Most wetlands in the Basin are temporary, composing 84 percent of the total number of wetlands and total wetland area (table 9–6).
- Temporary wetlands are widely distributed throughout the basin, whereas permanent, semi-permanent, and other wetlands are often associated with mountainous areas.

Where are the sixth-level watersheds with the greatest wetland area (fig. 9–3)?

- All but seven watersheds contained wetlands (fig. 9–3*A*). Wetland area (percent) was low in most watersheds averaging 2 percent per sixth-level watershed, with the greatest wetland area representing 49 percent of the watershed area.
- Watersheds with the greatest wetland area occur in the western and southeastern parts of the Wyoming Basin within the Wind River Basin, Upper Green River, Bear River, Laramie Plains, Little Snake River, Uintah Mountains, Shoshone River, and Bighorn River (fig. 9–3*A*).

Where does development pose the greatest threat to wetlands, and where are the relatively undeveloped wetlands? (figs. 9–3 to 9–6)?

- Approximately 16 percent of wetlands in the Wyoming Basin occur in relatively undeveloped areas (Local ADI score <20; figs. 9–4 and 9–5). Many areas with high wetland densities also have high levels of development (figs. 9–3*B* and 9–4).
- Local ADI scores are especially high for wetlands along the Bear River, in the Laramie Plains, and in the northern portion of the Wyoming Basin along the Shoshone and Bighorn rivers (fig. 9–4), whereas only a few isolated watersheds had little to no development (figs. 9–4 and 9–5).
- None of the wetlands larger than 10 km^2 (3.86 mi^2) are relatively undeveloped (fig. 9–6).
- Small wetlands (<1 km^2 [0.39 mi^2]) constitute more than 70 percent of all wetlands, and about half of these are relatively undeveloped (fig. 9–6).

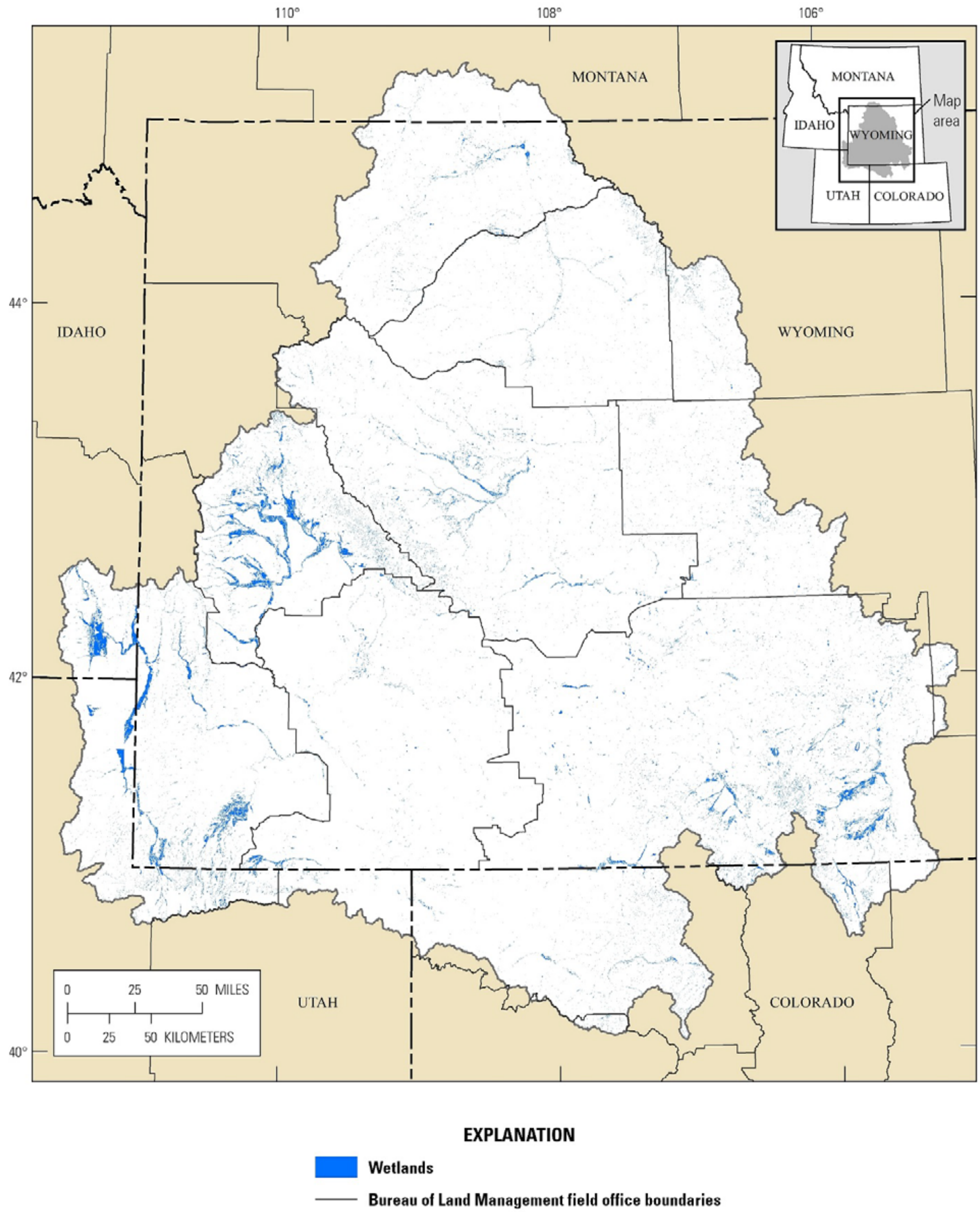

Figure 9−2. Distribution of wetlands in the Wyoming Basin Rapid Ecoregional Assessment project area. Wetlands are defined by the National Wetland Inventory (Cowardin and others, 1979).

Table 9–5. Summary of wetland area, percent of area, and number, by wetland type, in the Wyoming Basin Ecoregional Assessment project area.

[km^2, square kilometer; <, less than]

Wetland type[1]	Area (km^2)	Percent of total wetland area	Number of wetlands	Percent of wetlands
Freshwater emergent wetland[2]	2,554	74	125,074	50
Freshwater forested wetland	1	0	5	<1
Freshwater forested/shrub wetland[3]	625	18	35,211	14
Freshwater scrub-shrub wetland[4]	<1	<1	58	<1
Freshwater pond[5]	169	5	72,041	29
Other freshwater wetland	77	2	16,890	7
Riparian emergent[4]	<1	<1	37	<1
Riparian forested[4]	3	<1	492	<1
Riparian scrub-shrub[4]	2	<1	257	<1

[1] Wetland type from National Wetland Inventory database (Cowardin and others, 1979).

[2] Herbaceous marsh, fen, swale, and wet meadow.

[3] Forested swamp, wetland shrub bog, or wetland.

[4] Forested, shrub, or scrub bog or wetland in the riparian zone near a permanent water-body.

[5] Pond with palustrine aquatic bed or unconsolidated bottom.

Table 9–6. Summary of wetland area and percent, by hydroperiod, in the Wyoming Basin Ecoregional Assessment project area.

[km^2, square kilometer]

Hydroperiod[1]	Area (km^2)	Area (percent)
Permanent	34	1
Semipermanent	224	7
Temporary	2,893	84
Other	280	8

[1] Hydroperiod from National Wetland Inventory database (Cowardin and others, 1979).

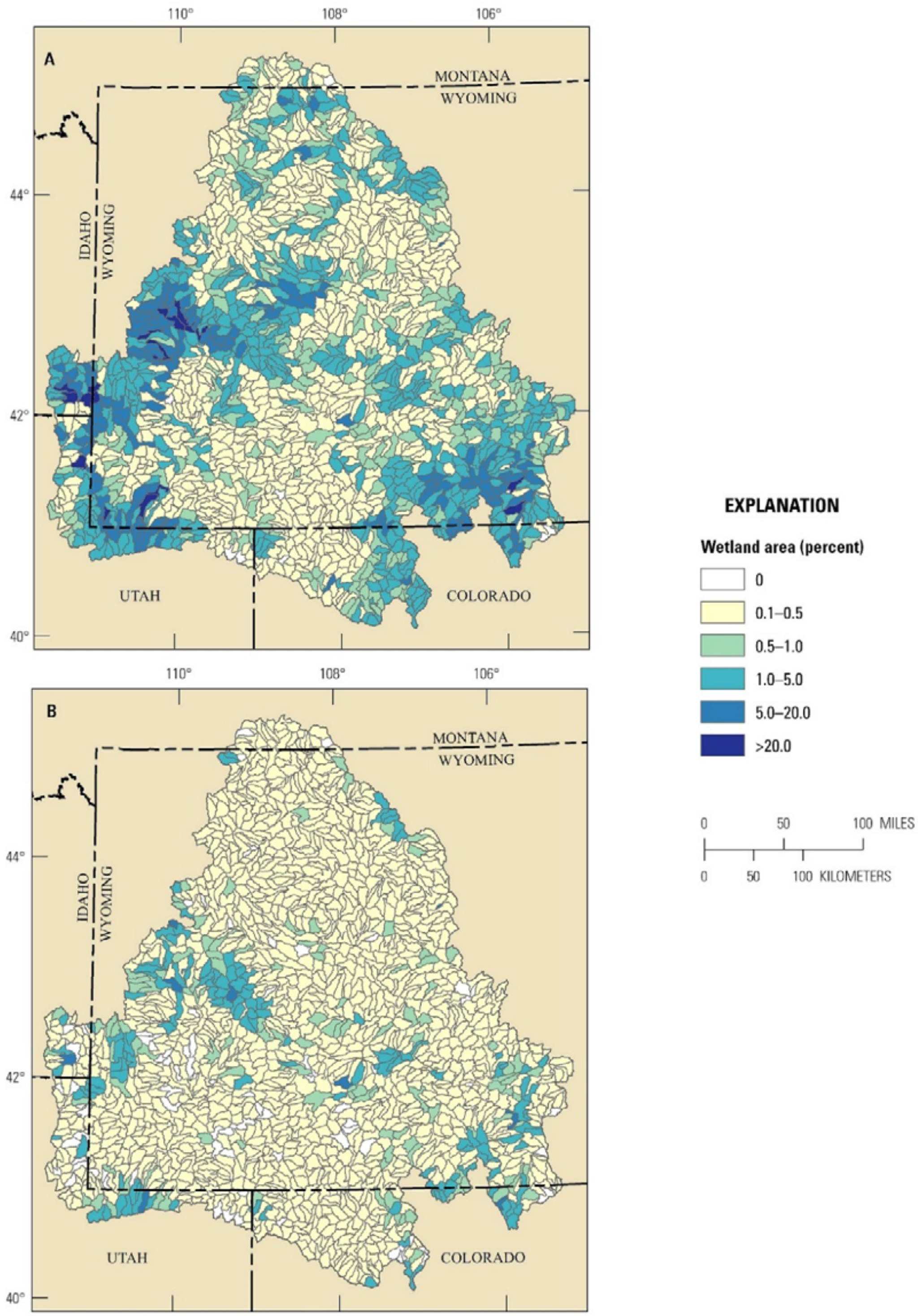

Figure 9−3. Percent of sixth-level watershed area that is classified as wetlands in the Wyoming Basin Rapid Ecoregional Assessment project area for (*A*) baseline and (*B*) relatively undeveloped wetlands. Relatively undeveloped wetlands are defined as wetlands within watersheds with a local Aquatic Development Index score <20.

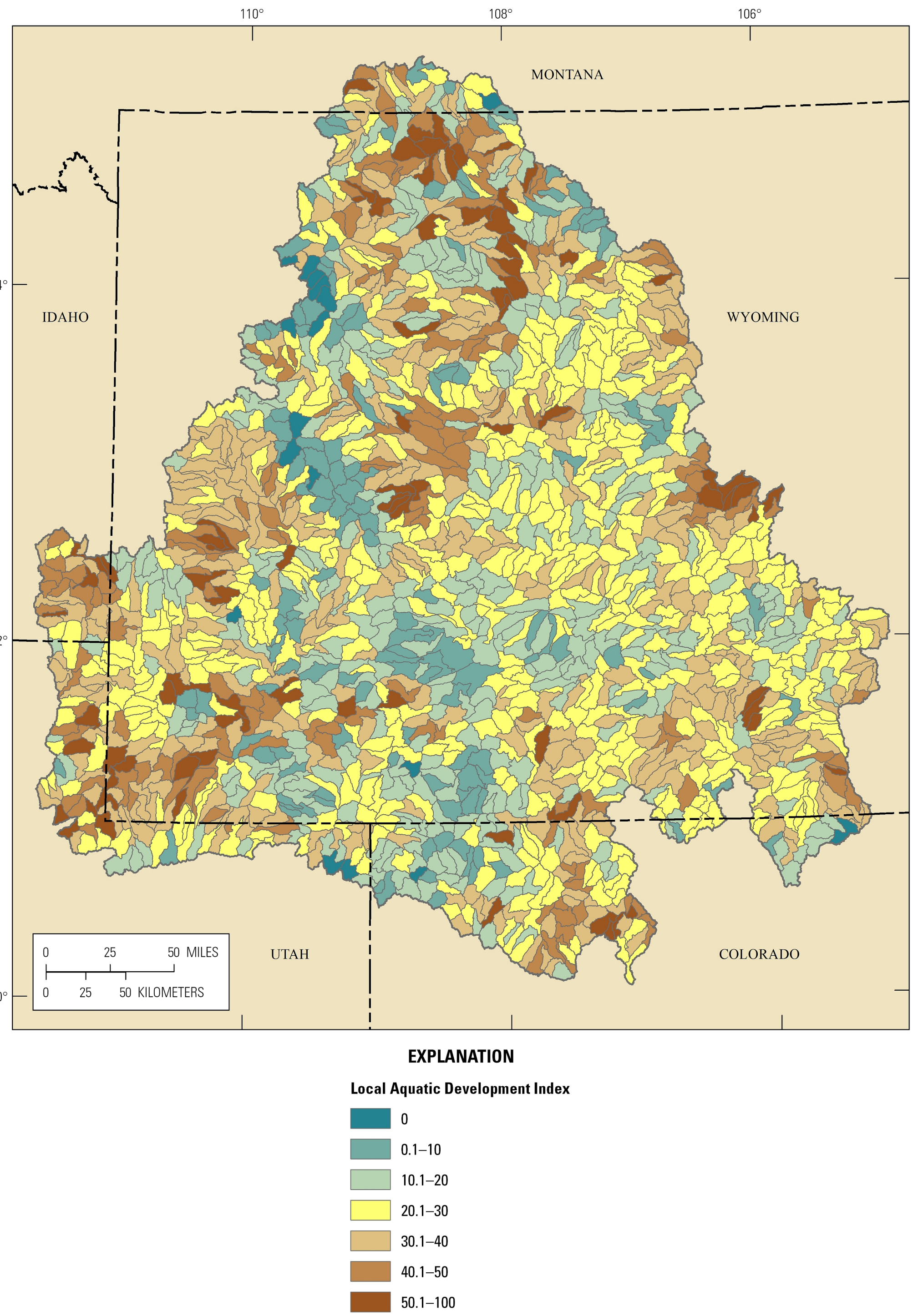

Figure 9–4. Local Aquatic Development Index scores for wetlands, summarized by sixth-level watershed, in the Wyoming Basin Rapid Ecoregional Assessment project area.

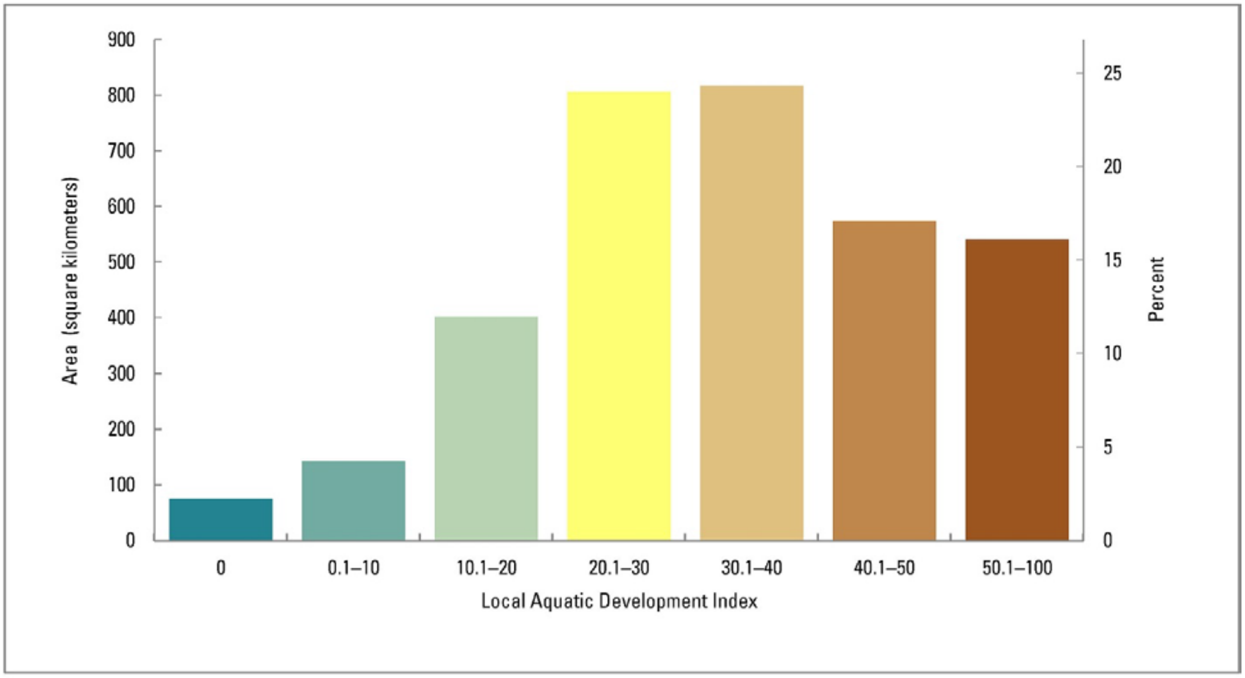

Figure 9−5. Area and percent of baseline wetlands as a function of the Local Aquatic Development Index score in the Wyoming Basin Rapid Ecoregional Assessment project area.

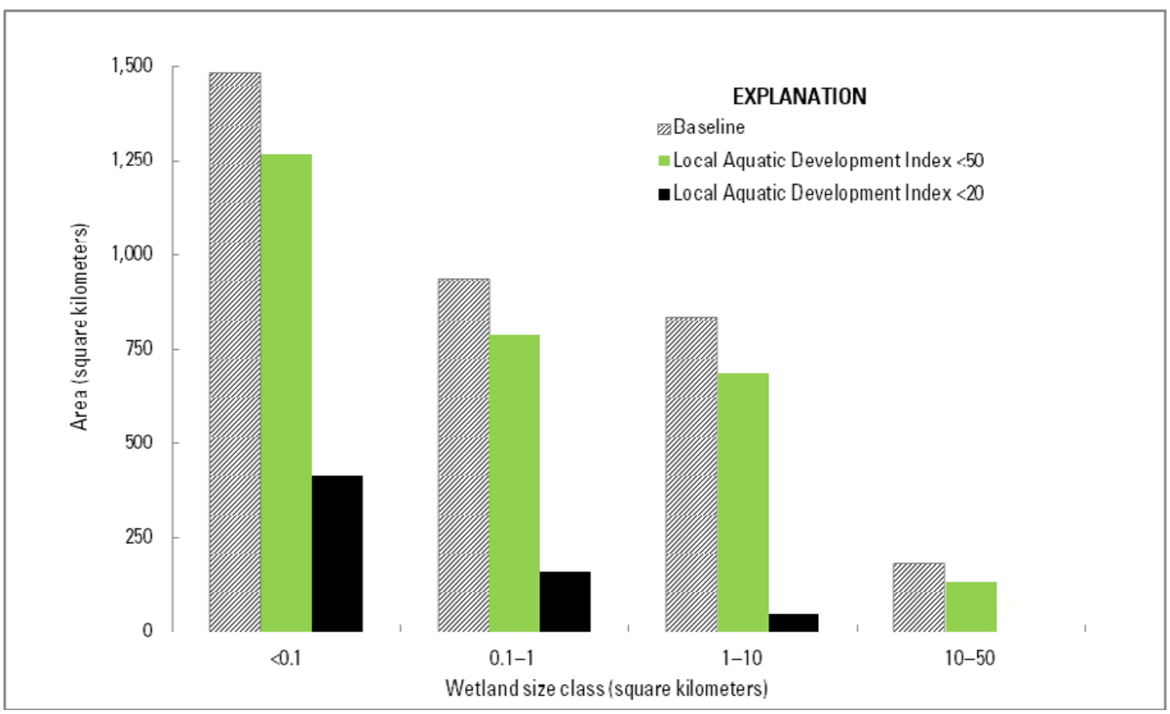

Figure 9−6. Area of wetlands as a function of wetland size for baseline conditions and two development levels: (1) (Local Aquatic Development Index [Local ADI] score <50), and (2) relatively undeveloped wetlands (Local ADI score <20).

How has development affected the structural connectivity of wetlands relative to baseline conditions (fig. 9–7)?

- Wetland structural connectivity is generally high for wetlands in large riverine wetland complexes and at higher elevations, whereas connectivity is low through much of the Wyoming Basin interior (fig. 9–7*A*). Baseline wetlands have regional-scale connectivity at 1.44 km (0.89 mi).
- Structural connectivity of relatively undeveloped wetlands is greatest at higher elevations (fig. 9–7*B*). Regional-scale connectivity for relatively undeveloped wetlands is 3.51 km (2.18 mi).
- The lower structural connectivity of relatively undeveloped wetlands may represent significant dispersal barriers for amphibians, which typically disperse <1 km (0.62 mi) and are sensitive to landscape-scale habitat conditions (Lehtinen and Galatowitsch, 2001; Rittenhouse and Semlitsch, 2007; Semlitsch, 2008; Scherer and others, 2012; Peterson and others, 2013).

Which wetlands are potentially created or altered by agriculture (fig. 9–8)?

- A majority (58 percent) of wetlands in the Wyoming Basin are coincident with agriculture and are potentially altered or created by irrigation (fig. 9–8). Wetland creation associated with agricultural irrigation can be substantial (Lovvorn and Hart, 2004).

How does risk from development vary by land ownership or jurisdiction for wetlands (table 9–7, fig. 9–9)?

- The majority of areas classified as wetlands occur on either private (65 percent) or Forest Service (12 percent) lands (table 9–7).
- The majority of wetlands on private land have medium or high risk from development, whereas the majority of Forest Service wetlands have low risk from development (fig. 9–9).

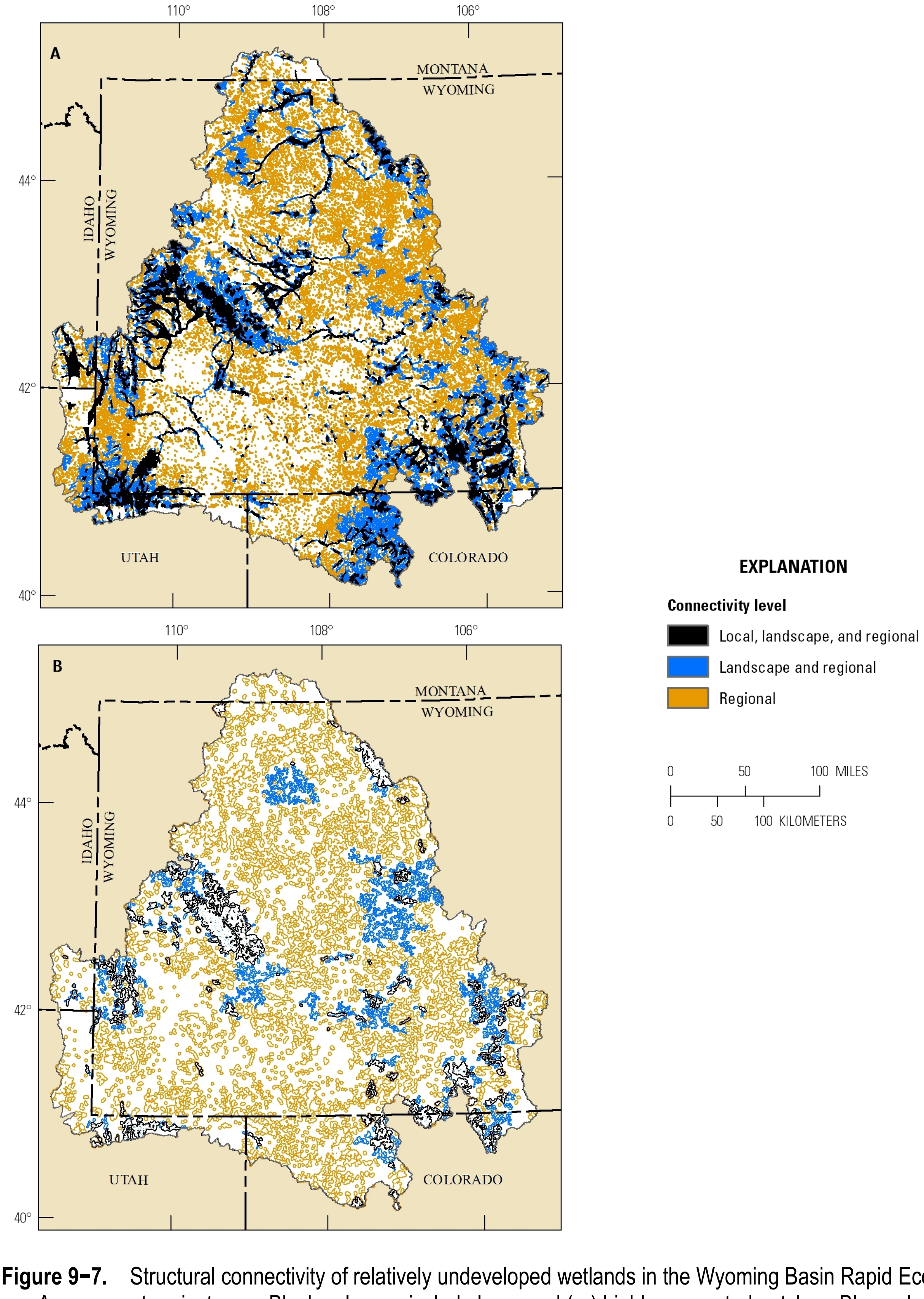

Figure 9–7. Structural connectivity of relatively undeveloped wetlands in the Wyoming Basin Rapid Ecoregional Assessment project area. Black polygons include large and (or) highly connected patches. Blue polygons include patches that contribute to both landscape and regional connectivity. Orange polygons represent isolated clusters of patches surrounded by developed areas or other cover types. (*A*) Baseline conditions; and (*B*) relatively undeveloped wetlands.

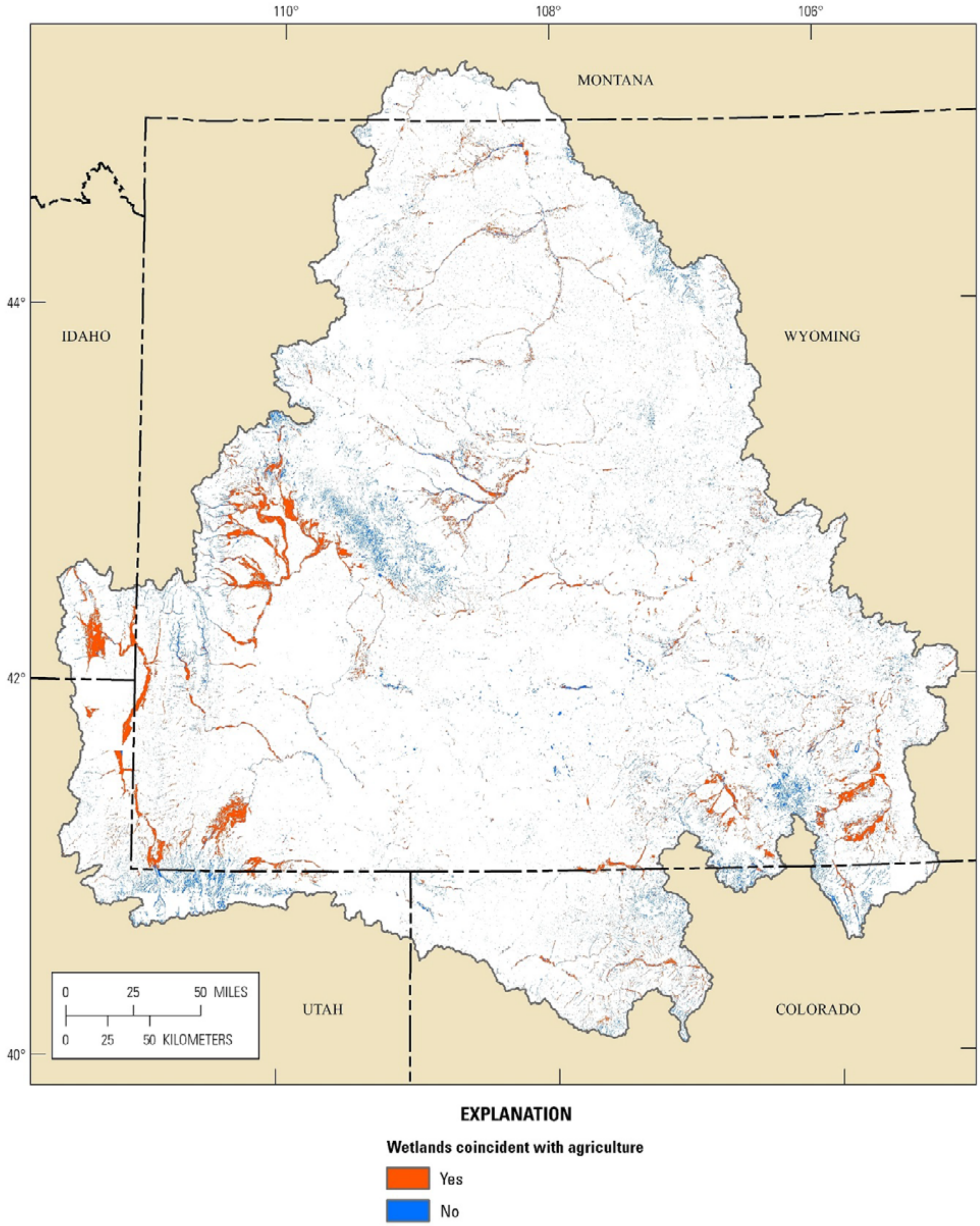

Figure 9–8. Distribution of altered or created wetlands, defined as wetlands coincident with areas of agriculture, in the Wyoming Basin Rapid Ecoregional Assessment project area.

Table 9–7. Number and percent of wetlands, by land ownership or jurisdiction, in the Wyoming Basin Rapid Ecoregional Assessment project area.

[km^2, square kilometer]

Ownership or jurisdiction	Wetland area (km^2)	Percent of habitat
Private	2,193	65.07
Forest Service[1]	408	12.09
Bureau of Land Management	181	5.38
State/County	177	5.24
Other Federal[2]	164	4.86
Tribal	137	4.06
Private conservation	84	2.48
National Park Service	15	0.45

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

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

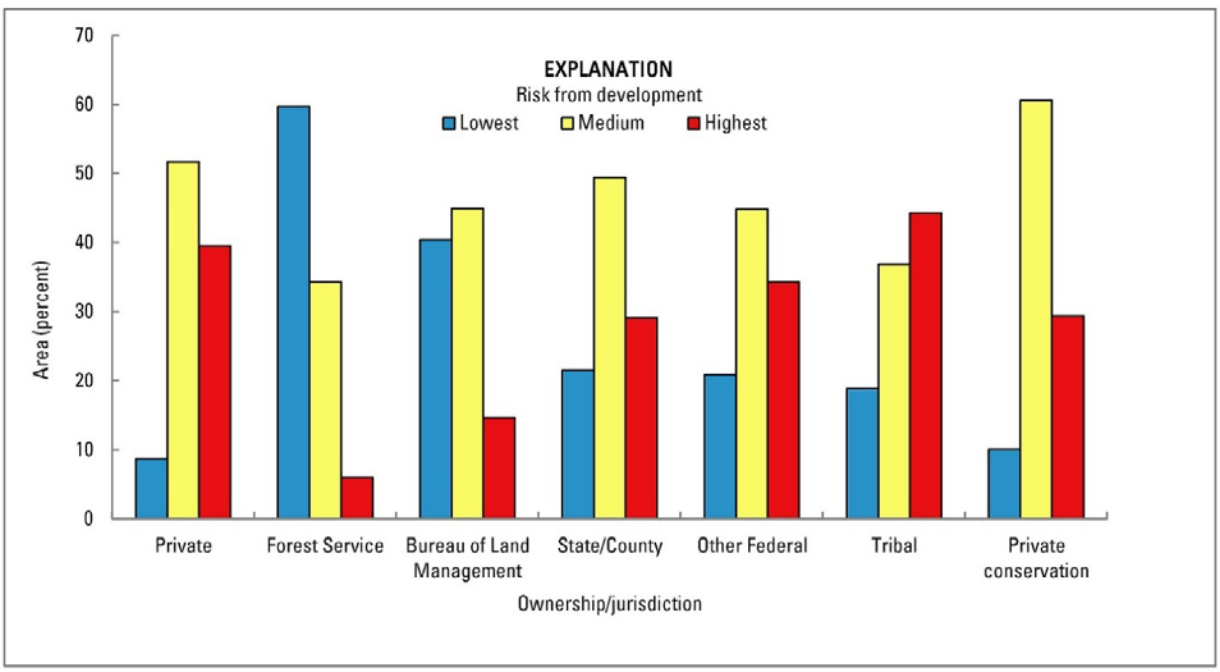

Figure 9−9. Relative ranks of risk from development, by land ownership or jurisdiction, for wetlands in the Wyoming Basin Rapid Ecoregional Assessment project area. Rankings are lowest (Local Aquatic Development Index [ADI] score <20), medium (local ADI score 20−40), and highest (local ADI >40).

Where are the watersheds with the greatest landscape-level ecological values, and where are the watersheds with the greatest landscape-level risks (fig. 9–10)?

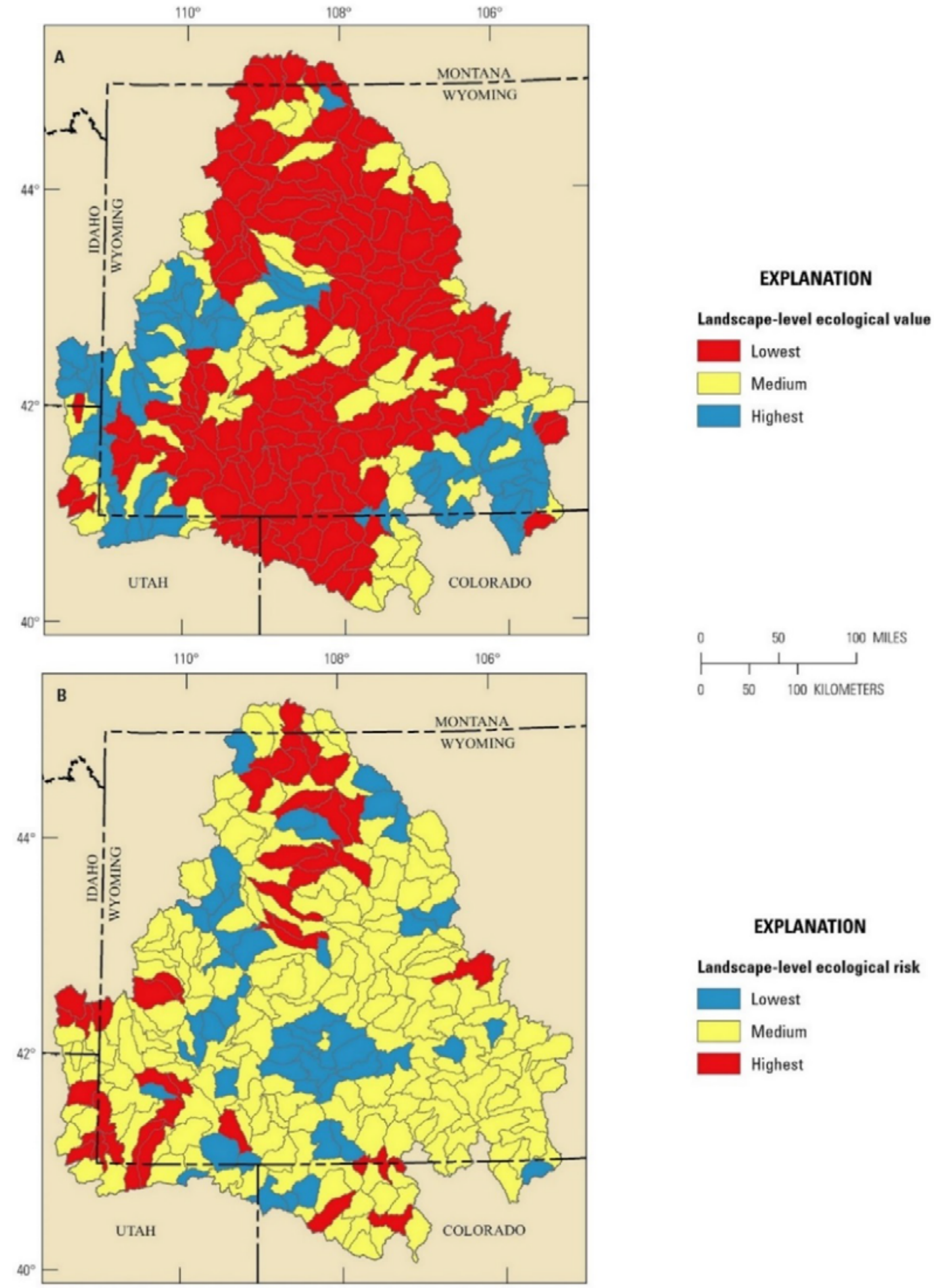

Figure 9–10. Ranks of landscape-level ecological values and risks for wetlands, summarized by fifth-level watershed, in the Wyoming Basin Rapid Ecoregional Assessment project area. (*A*) Landscape-level value based on wetland area and (*B*) landscape-level risk based on Aquatic Development Index (see table 9–3 for overview of methods).

Where are the watersheds with the greatest conservation potential (fig. 9–11)?

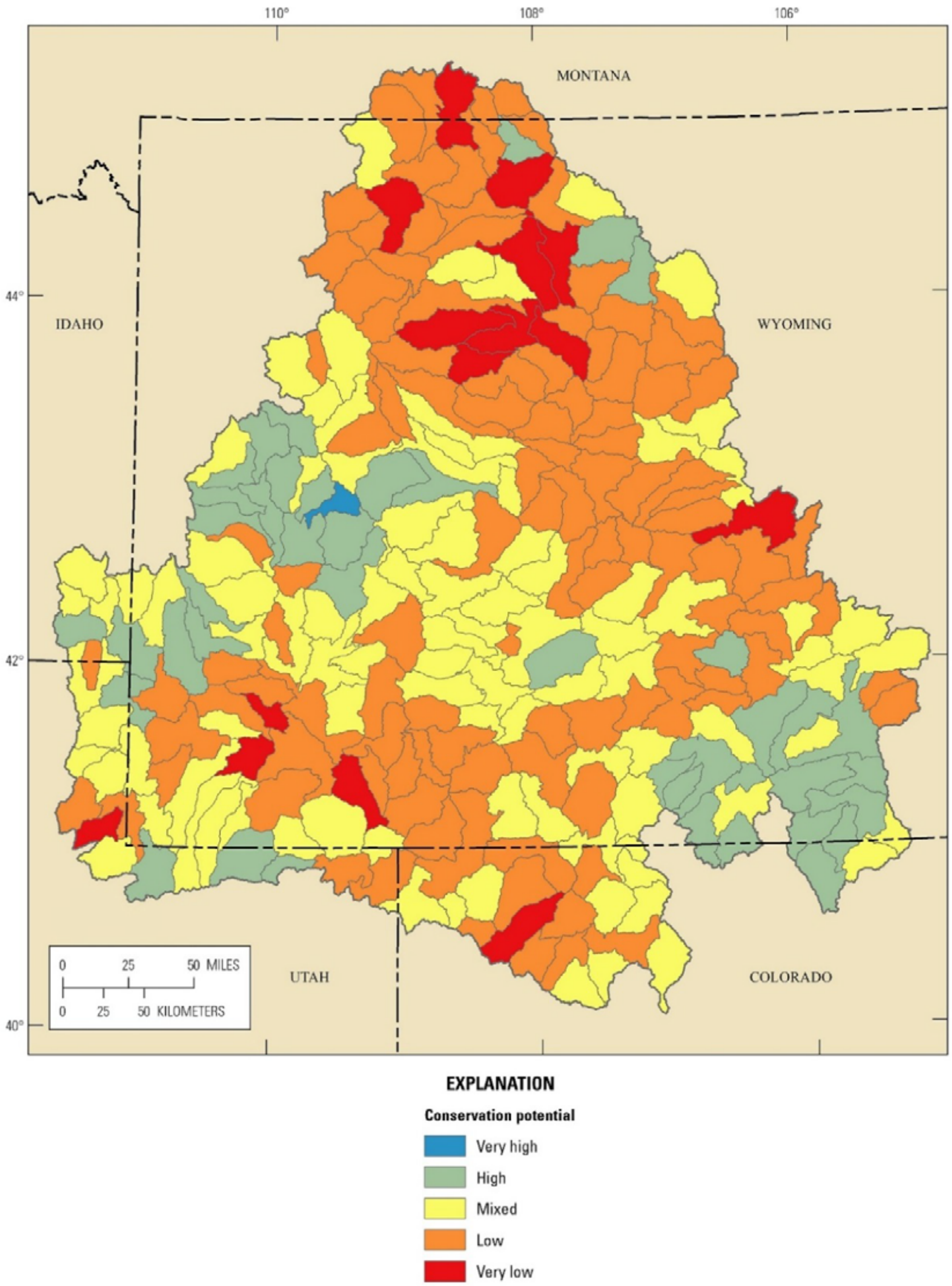

Figure 9−11. Conservation potential of wetlands, summarized by fifth-level watershed, in the Wyoming Basin Rapid Ecoregional Assessment project area. Highest conservation potential identifies watersheds that have the highest landscape-level values and the lowest risks. Lowest conservation potential identifies watersheds 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

Wetlands are unevenly distributed throughout the ecoregion. Overall, wetland area is low in most of the region, with greater amounts present in the Wind River, Upper Green River, Bear River, Laramie Plains, Little Snake River, Uintah Mountains, Shoshone River, and Bighorn River basins (figs. 9–2 and 9–3). Baseline watersheds with large total wetland area are highly connected. Most of the highly connected and less developed wetland complexes occur in higher elevations (the Uintah and Wind River Ranges) or along rivers.

Moderate to high development levels may exist in watersheds with high densities of wetlands, which reflects the fact that many wetlands in developed areas are artificially created or altered by irrigation (Lovvorn and Hart, 2004). More than half of the existing wetlands are being used for agriculture in the Wyoming Basin. In the Laramie River Basin (in southeast Wyoming), 65 percent of surface and subsurface inflows to wetlands come directly from irrigation, thereby changing natural wetland hydrology and substantially increasing total wetland density (Peck and Lovvorn, 2001).

The loss of structural connectivity as a result of development may be especially detrimental to amphibians; those with small dispersal ranges may become vulnerable if their immediate habitat is altered, whereas those with greater dispersal capabilities may experience mortality events when moving through unfavorable terrain (Cushman, 2006). Multiple studies suggest that most amphibian species are generally limited to dispersal distances of <1 km (0.62 mi) (Lehtinen and Galatowitsch, 2001; Rittenhouse and Semlitsch, 2007; Semlitsch, 2008; Peterson and others, 2013). The structural connectivity of baseline wetlands at the landscape level corresponds to amphibians dispersing <0.5 km (0.31 mi); however, structural connectivity of relatively undeveloped areas often greatly exceeds 1 km (0.62 mi) (fig. 9–10), which may exceed the typical dispersal capabilities of many amphibian species and thereby could inhibit dispersal. The consequences of changes in connectivity for dispersing amphibians depends, in part, on their dispersal abilities, sensitivity to disturbance, and the availability of suitable refugia in an arid environment like the Wyoming Basin. Conservation potential was greatest at higher elevations, where wetland densities are greater and development levels are lower than they are at lower elevations. Many watersheds in the Bighorn Basin are at high risk from development.

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