Section IV. Assessments of Species and Species Assemblages

Chapter 19. Three-Species Fish Assemblage

By Annika K. Walters, Kirk R. Sherrill, and Jena R. Hickey

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Distribution and Ecology

The bluehead sucker, flannelmouth sucker, and roundtail chub (herein referred to as the three-species assemblage) are imperiled fish species native to the Colorado River Basin. Historically, flannelmouth sucker, bluehead sucker, roundtail chub, along with razorback sucker, were the dominant fish species in medium-to-large reaches of the Upper Green River watershed. Flannelmouth suckers were probably the most abundant sucker species, and roundtail chub was the dominant carnivore (Rees, Ptacek, Carr, and Miller, 2005; Rees, Ptacek, and Miller, 2005). The distribution and abundance of these species have declined substantially however, and they occupy only 45–50 percent of their historical habitat in the Colorado River Basin (Bezzerides and Bestgen, 2002). In the Wyoming Basin, their distributions are limited to the Upper Green River drainage, with bluehead suckers also occurring in the Bear and Snake River drainages. All three members of the three-species assemblage are listed by the Bureau of Land Management (BLM) as sensitive species. The Wyoming Game and Fish Department and Colorado Parks & Wildlife (formerly the Colorado Division of Wildlife) also list them as species of concern and cooperate to manage them as a group. The three-species assemblage is also addressed by a multistate conservation agreement (Karpowitz, 2006).

All species are relatively large-bodied and long-lived. Flannelmouth suckers may grow to 650 millimeters (mm) (25.59 inches [in]), whereas roundtail chub only reach 200–300 mm (7.87–11.81 in) (Rees, Ptacek, Carr, and Miller, 2005; Sweet and others, 2009). Bluehead and flannelmouth suckers can live to more than 20 years of age (Rees, Ptacek, Carr, and Miller, 2005; Ptacek and Miller, 2005), although Sweet and others (2009) consistently found flannelmouth suckers to be longer lived. Bluehead suckers are benthic algivores that forage by scraping rock surfaces, consuming not only algae, but also organic and inorganic debris and occasionally aquatic invertebrates. The omnivorous flannelmouth sucker consumes aquatic invertebrates, organic detritus, algae, and phytoplankton; the larvae consume primarily aquatic invertebrates, crustaceans, and organic/inorganic debris, whereas adult fish consume primarily benthic matter, such as organic debris, algae, and aquatic invertebrates (Rees, Ptacek, Carr, and Miller, 2005). Roundtail chub are also omnivores, foraging on algae, terrestrial and aquatic insects, vegetation, and other fish species (Laske and others, 2011); at least historically, they probably frequently preyed on young bluehead suckers (Ptacek and others, 2005). For unknown reasons, flannelmouth suckers are afflicted with relatively high rates of parasitism and disease (Rees, Ptacek, Carr, and Miller, 2005).

Spawning occurs in the spring and summer. Flannelmouth suckers generally spawn in May and June when water temperatures are between 12–15 degrees Celsius (°C) (53.6–59 degrees Fahrenheit (°F]). Their eggs are deposited on sand and gravel bars, and once they are fertilized, the eggs are adhesive (adhere to the substrate) (Rees, Ptacek, Carr, and Miller, 2005). Bluehead suckers spawn in mid-to-late summer when temperatures are 18–24 °C (64.4–75.2 °F). They deposit their eggs in redds (nests) that they build in shallow water vegetated with reeds (Ptacek and others, 2005). Roundtail chub spawn in spring and early summer after peak runoff when water temperatures are about 18.3 °C (64.94 °F). They deposit their adhesive eggs over gravel (Rees, Ptacek, and Miller, 2005). Knowledge about thermal preferences of sucker species is limited, although bluehead suckers have been found in water temperatures as high as 28 °C

(82.4 °F) (Ptacek and others, 2005). Roundtail chub prefer stream temperatures from 22 to 24 °C (71.6–75.2 °F) but can tolerate higher temperatures (Rees, Ptacek, and Miller, 2005).

Landscape Structure and Dynamics

Flannelmouth suckers primarily inhabit large rivers and are more common in lower drainages, but they also may be found in smaller streams and lakes and reservoirs. Their probability of occurrence is greatest in wide stream reaches with large pools, and within a given reach they tend to occur in the larger, deeper pools (Bower and others, 2008). Bluehead suckers also occupy large rivers, but compared to flannelmouth suckers, they are typically found further upstream in tributaries and headwaters where they inhabit wider stream reaches and larger pools and riffles with rocky substrates (Bower and others, 2008). Roundtail chub are generally found in rivers, but they also occur in six natural lakes in the upper Green River Basin (Laske and others, 2011). In rivers, roundtail chub inhabit relatively wide streams, deep pools, and rocky substrates (Bower and others, 2008), whereas lentic (lake-dwelling) roundtail chub use littoral (edge) and mid-depth benthic habitats (Laske and others, 2011). Adults of the three-species assemblage generally undertake limited movements, but in spring and summer, they may migrate to spawn in small streams where there are gravel riffles free of sediments (Compton and others, 2008). Once they hatch, the larvae can drift long distances (Ptacek and others, 2005; Rees, Ptacek, and Miller, 2005; Sweet and Hubert, 2010) to find suitable larval habitat and (or) disperse.

Ecology and population dynamics of all three fish species are influenced by streamflow dynamics, which also influence their prey and predator populations (Rees, Ptacek, Carr, and Miller, 2005; Rees, Ptacek, and Miller, 2005). Streamflow dynamics include peak flows associated with snowmelt, flash floods associated with significant summer rainfall events, and drought. The timing, location, and extent of these events vary among years. Streamflow dynamics can affect sediment transport and deposition, water quality, and thermal regime, which have strong influences on three-species assemblage ecology (Rees, Ptacek, Carr, and Miller, 2005; Rees, Ptacek, and Miller, 2005).

The dynamics of and contrasts between peak and base flows have implications for different life-history stages of fish. For example, if peak streamflow at the mouths of major tributaries to the Green and Colorado Rivers and receding streamflow in the upper drainages occur at the same time, pooling tends to occur in side channels and backwaters near the tributary-mainstem confluences (Rees, Ptacek, Carr, and Miller, 2005). These pools provide crucial larval habitat. Summer flash floods, however, can wash the larvae downstream into the river mainstems where water temperatures (affected by dams) may be too low for larval survival. Regular flooding, however, is required to maintain the complexity of channel morphology, including backwaters, side channels, eddies, deep pools, and riffles, that provides a range of habitat types required for different life stages. For example, sand and gravel deposits that form bars during high flows, along with deep pools strewn with unembedded boulders, provide spawning habitat for flannelmouth suckers; eddies, backwaters, and pools developed by streamflow dynamics provide crucial larval/juvenal habitats; and peak flows or flash floods can scour away fine sediments that would otherwise embed the rocky and gravely substrates, which are vital for roundtail chub spawning (Rees, Ptacek, Carr, and Miller, 2005; Rees, Ptacek, and Miller, 2005; Ptacek and others, 2005).

Wildfire generally has little direct influence on the dynamics of three-species assemblage habitats. Prior to vegetation regrowth, however, large quantities of sediments can be moved from severely burned areas into streams and rivers during large postfire rainfall events (Moody and others, 2008). In the short term, large postfire sediment loads in streams can reduce fish survival either directly through suffocation or indirectly through loss of suitable spawning habitat and reductions in the food base (Rees, Ptacek, Carr, and Miller, 2005).

Change Agents

Development

Dams

Damming the Green River to create the Fontenelle and Flaming Gorge Reservoirs greatly reduced the availability of three-species assemblage habitat and habitat quality. Moreover, the Green River was treated with rotenone to depress populations of undesirable (nongame) fish species prior to finishing construction of Flaming Gorge Dam (1962) and Fontenelle Dam (1964). The rotenone treatment removed the vast majority of flannelmouth suckers, bluehead suckers, and roundtail chub in the area, although recolonization occurred relatively quickly (Wiley, 2008). More permanently, the dams altered hydrological and thermal regimes, as well as sedimentation dynamics, in the Green River (Wiley, 2008). The loss of habitat due to dam construction was considerable, both due to the conversion of riverine habitats to reservoirs and a transformation below the dams from a warm, turbid, free-flowing river to a clear, cold, regulated river (Wiley, 2008).

Energy and Infrastructure

Within the range of the three-species assemblage, there has been substantial development from road construction and extraction of oil and natural gas, which has led to the modification of streambeds through channelization, sedimentation, and disturbance of riparian habitats (Rees, Ptacek, and Miller, 2005). Dauwalter, Wenger, and others (2011) found that bluehead sucker occurrence decreased with increased land-use intensity, suggesting that local disturbance from roads and oil and gas wells was having negative effects on bluehead sucker distribution. In contrast, flannelmouth sucker occurrence was not associated with differences in land-use intensity (Dauwalter, Wenger, and others, 2011). Roundtail chub responses to road density and energy development are equivocal; their presence was negatively associated with road density, but positively associated with oil and gas well density within 0.5 kilometers (km) (0.31 miles [mi]) of streams. In addition, they were positively associated with road density at the watershed scale (Dauwalter, Wenger, and others, 2011). The positive associations were unexpected but may be artifacts of a positive association between oil and gas infrastructure and preferred roundtail chub habitat (Dauwalter, Wenger, and others, 2011).

Agricultural Activities

Water diversions are a primary agricultural threat to the three-species assemblage; they alter the streamflow regime, create barriers to fish movements, and cause fish mortality due to entrainment in irrigation ditches (Compton and others, 2008; Roberts and Rahel, 2008). Water diversions and the potential for dewatered stream reaches to dry out lead to habitat fragmentation. In turn, fragmentation can isolate fish populations, confine individuals to less desirable habitat conditions, restrict access to spawning habitats, reduce genetic diversity, and ultimately lead to the extirpation of isolated populations (Rees, Ptacek, Carr, and Miller, 2005; Compton and others, 2008). In a study of the three-species assemblage in the Muddy Creek in Wyoming, it was found that the fish could move downstream over small diversions during high flows, but during low flows, the diversions restricted upstream movements (Compton and others, 2008). The probability of occurrence for juvenile bluehead suckers can be lower in areas with a high proportion of dry reaches (Bower and others, 2008). In addition, severe reduction in streamflow can lead to increased temperatures and reduced levels of dissolved oxygen.

Other agricultural activities, including the effects of grazing on stream and riparian habitats, can negatively affect the three-species assemblage. Grazing and trampling can reduce vegetation, leading to increased erosion and sediment loads, as well as altered thermal regimes in the water (Rees, Ptacek, and Miller, 2005). Streams with extensive grazing have increased water temperatures, decreased cover, increased bank erosion, and decreased preferred spawning substrate due to a higher proportion of fine sediment (Armour and others, 1991). Logging also may lead to degradation of watersheds through road construction, erosion and sedimentation, and disturbance of riparian habitats (Rees, Ptacek, and Miller, 2005), but logging activities in watersheds where the three-species assemblage occurs are limited.

Altered Fire Regime

Fire is thought to have limited direct effects on the three-species assemblage. An increase in the size and severity of fires, however, could affect populations negatively by limiting habitat availability.

Invasive Species

Hybridization between native and nonnative sucker species, especially the white sucker, is one of the greatest risks to populations in Wyoming (McDonald and others, 2008). Bluehead and flannelmouth suckers are hybridizing, as are the introduced white sucker and the longnose and Utah suckers, and at least some of the hybrid offspring are fertile (Gelwicks, and others, 2009). Both native and nonnative suckers prefer similar habitats (large, low-gradient streams), and they do not segregate while spawning; consequently, hybridization is a common occurrence (Quist, and others, 2009). Although there are still some genetically pure flannelmouth and bluehead suckers in the Green River drainage, only two remaining populations are isolated from nonnative suckers: there is one isolated population of flannelmouth sucker in Upper Bitter Creek and one isolated population of bluehead sucker in Ringdahl Reservoir (Gelwicks and others, 2009). Due to hybridization concerns, Muddy Creek, Big Sandy River, and Little Sandy Creek have been designated as priority areas for native fish restoration (Dauwalter, Sanderson, and others, 2011). In these systems, barriers will be constructed, nonnatives will be removed, and native species will be restored (Gelwicks and others, 2009).

In addition to hybridization, many introduced fish species, such as brown trout and burbot, are competitors and predators with the three-species assemblage. The burbot is a voracious predator native to the Wind and Bighorn Rivers in the northern portion of the Wyoming Basin, but it was introduced to the Green River drainage in the early to mid-1990s, where it now poses a considerable threat to the three-species assemblage (Gardunio and others, 2011). Other nonnative species, including white sucker, fathead minnow, redside shiner, and red shiner, compete with juvenile species of the three-species assemblage (Rees, Ptacek, and Miller, 2005).

Climate Change

Fishes living in streams and rivers have adapted to a specific set of hydrologic conditions, and changes in these conditions can lead to reduced fish recruitment (Modde and others, 2001), increased success of invasive species (Ross and others, 2001), and extirpation of locally specialized species (Cross and Moss, 1987). Because fishes of the three-species assemblage can tolerate relatively high water temperatures, they are expected to be resistant to increased temperatures associated with climate change; however, the potential for changes in the hydrologic regimes and decreasing streamflow and water levels in stream habitats is a concern. Reduced steamflows in areas where there are existing water diversions could exacerbate the potential for streams to dry out and isolate fish populations. Reduced streamflow also could result in water users taking a larger proportion of the remaining streamflow, thereby entraining more fish in diversions (Walters and others, 2012).

Rapid Ecoregional Assessment Components Evaluated for the Three-Species Fish Assemblage

A generalized, conceptual model was used to highlight some of the key ecological attributes and change agents affecting the three-species fish assemblage (fig. 19–1). Key ecological attributes addressed by the REA include (1) the distribution of the three-species assemblage, (2) landscape structure (patch size and connectivity) (table 19–1), and (3) landscape dynamics (hydrologic regime and fire occurrence). Change Agents evaluated include development, predation, hybridization risk, and climate change (table 19–2). Ecological values and risks used to assess the conservation potential for the three-species assemblage by fifth-level watershed are summarized in table 19–3. Core and Integrated Management Questions and the number of the associated summary maps and graphs are provided in Table 19–4.

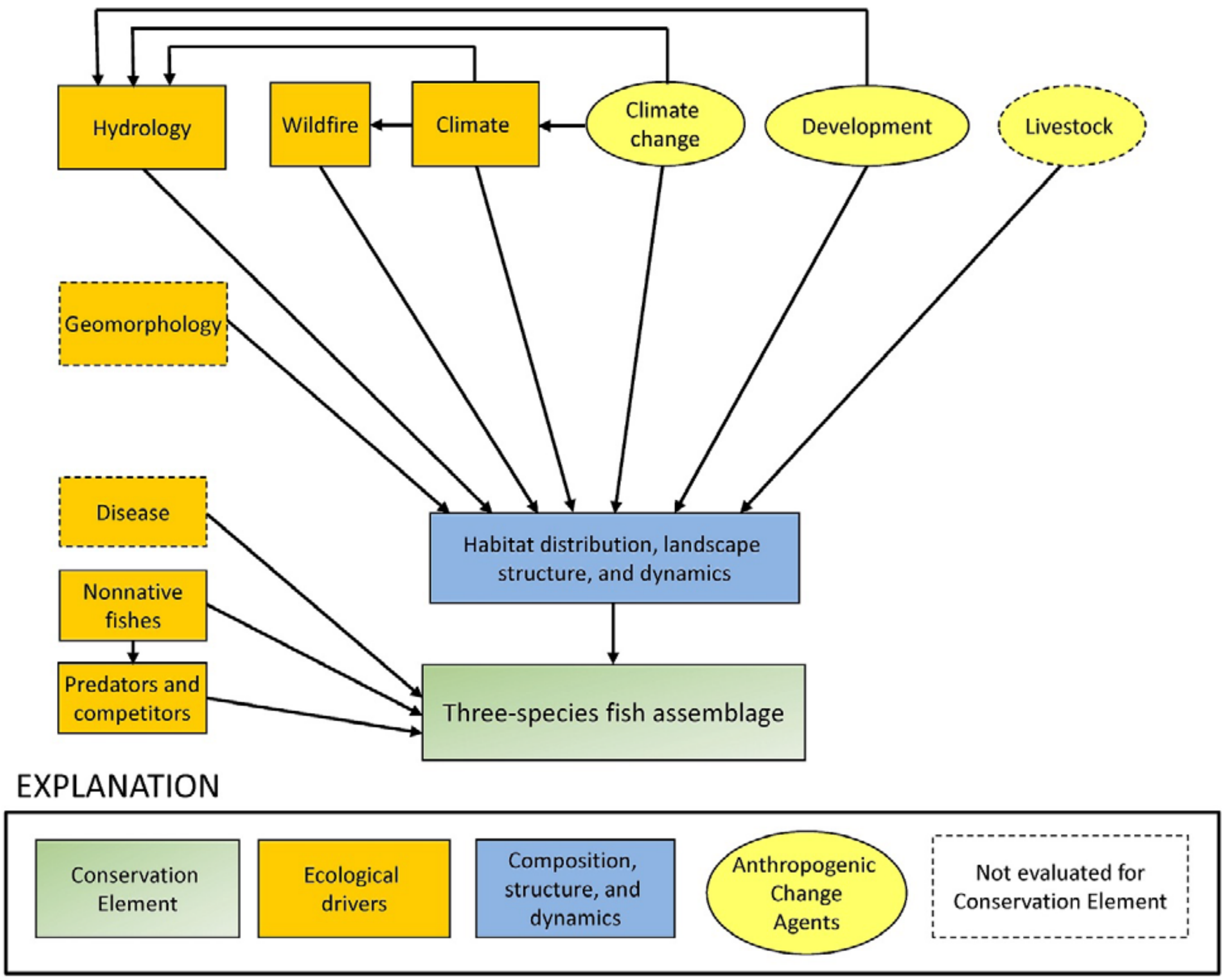

Figure 19–1. Generalized conceptual model of the three-species assemblage habitat for the Wyoming Basin Rapid Ecoregional Assessment (REA). Biophysical attributes and ecological processes regulating the occurrence, structure, and dynamics of the three-species assemblage populations and habitat are shown 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 is a Change Agent that was not evaluated due to lack of regionwide data.

Table 19–1. Key ecological attributes and associated indicators of baseline habitat for the three-species fish assemblage[1] for the Wyoming Basin Rapid Ecoregional Assessment.

Attributes	Variables	Indicators[1]
Amount and distribution	Stream length and area of lakes/reservoirs occupied	Distribution maps of each species and the three-species assemblage derived from occurrence data[2]
Landscape Structure	Patch size	Stream-segment length frequency distribution
Landscape dynamics	Fire occurrence	See Chapter 8—Streams and Rivers
	Hydrological regime	Mean summer flow[3]

[1] Baseline conditions are used as a benchmark to evaluate changes in the amount and landscape structure of three-species assemblage habitat due to Change Agents. Baseline conditions are defined as the current distribution of three-species assemblage habitat derived from occurrence surveys. See Chapter 2—Assessment Framework.

[2] Data provided by Wyoming Game and Fish Department, Utah Natural Heritage Program, and the Colorado Parks & Wildlife.

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

Table 19–2. Anthropogenic Change Agents and associated indicators influencing habitat of the three-species fish assemblage for the Wyoming Basin Rapid Ecoregional Assessment.

Change Agents	Variables	Indicators
Development	Aquatic Development Index (ADI)	Percent of habitat in each of seven development classes[1]
		Frequency distribution of stream-segment lengths that are relatively undeveloped or have low development scores compared to baseline habitat[2]
	Barriers to movement	Number of potential barriers (dams, points of diversion, and stream-road crossings)[3]
Nonnative Fishes[4]	Predation risk	Co-occurrence of burbot with the three-species assemblage
	Hybridization risk	Co-occurrence of the nonnative white sucker with flannelmouth and bluehead suckers
Climate change	Hydrologic regime change[5]	Projected mean summer flow for 2040

[1] See Chapter 2—Assessment Framework.

[2] Relatively undeveloped stream segments have ADI scores <20.

[3] See Chapter 2—Assessment Framework.

[4] White sucker and burbot occurrence data from Wyoming Game and Fish Department.

[5] 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 Wenger and others, 2010]).

Table 19–3. Landscape-level ecological values and risks for three-species fish assemblage distribution. Ranks were combined into an index of conservation potential for the Wyoming Basin Rapid Ecoregional Assessment.

[km, kilometer)

	Variables[1]	Relative rank: Lowest	Relative rank: Medium	Relative rank: Highest	Description[2]
Values	Mean stream-segment length (km)	<31	31–66	>66	Mean length of stream segments occupied by the three-species assemblage by watershed
	Number of stream segments	0	1	2–3	Count of number of stream segments occupied by the three-species assemblage by watershed
	Number of lakes	0	1	2–3	Count of number of lakes/reservoirs occupied by the three-species assemblage by watershed
Risks	Aquatic Development Index (ADI)	<20	20–40	>40	Mean ADI score by watershed
	Hybridization and predation risk	<20	20–80	>80	Percent of catchments with co-occurrence of burbot and (or) white sucker and the three three-species assemblage 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 19–1 and 19–2 for description of variables.

Table 19–4. Management questions evaluated for the three-species fish assemblage for Wyoming Basin Rapid Ecoregional Assessment.

Core Management Questions	Results
Where is baseline habitat for the three-species assemblage, and what is the total amount occupied per species?	Figure 19–2
Where does development pose the greatest threat to baseline three-species assemblage habitat, and where are the relatively undeveloped habitats?	Figures 19–3 to 19–6
Where do dams, diversions, and road crossings pose potential barriers to three-species assemblage movements, and where are watersheds with the highest structural connectivity?	Figure 19–7
Where are three-species assemblage populations at risk of hybridization and competition or predation from nonnative species?	Figure 19–8
Where could the three-species assemblage be at risk from projected shifts in hydrological regime in 2040?	Figures 19–9 and 19–10
Integrated Management Questions	**Results**
How does development risk vary by land ownership or jurisdiction for three-species assemblage habitat?	Table 19–5, Figure 19–11
Where are the watersheds with the greatest landscape-level ecological values?	Figure 19–12
Where are the watersheds with the greatest landscape-level risks?	Figure 19–13
Where are the watersheds with the greatest conservation potential?	Figure 19–14

Methods Overview

To map the distribution of the three-species assemblage, we compiled occurrence information from the Wyoming Game and Fish Department (streams, rivers, and lakes and reservoirs), Utah Natural Heritage Program (point locations), and the Colorado Parks and Wildlife (sixth-level watersheds). Due to the variety in the data types available, we summarized occurrence information by sixth-level watershed. The resulting distribution map was used to quantify baseline conditions for each species and the three-species assemblage overall (fig. 19–2). In addition, we mapped the intersection of point locations with rivers in Utah and adjacent occupied watersheds in Colorado, which we assumed represented occurrence along the full reach of the river within occupied watersheds. Aquatic Development Index (ADI) scores were derived from catchments coincident with three-species assemblage habitat. We used the length of occupied stream segments, as classified by occurrence data, as an index of habitat patch size. Stream segments were defined by natural and anthropogenic barriers (dams) that restrict bidirectional movements among three-species assemblage populations. To incorporate other potential barrier types, we summarized the number of diversions and stream-road crossings for occupied segments, by sixth-level watershed.

We evaluated potential risks, including competition, predation, and hybridization, from nonnative fish on the basis of their co-occurrence with three-species assemblage species. Competition and predation risk were derived from co-occurrence of burbot with the three-species assemblage. Hybridization risk was derived from co-occurrence of white sucker with bluehead and flannelmouth suckers (see table 19–2 for data sources on nonnative species).

To evaluate potential effects of current and projected hydrological regimes, we relied on data derived from existing macroscale hydrological Variable Infiltration Capacity (VIC) models. Wenger and others (2010) demonstrated that the VIC model can be used to simulate recent (1978-1997) hydrological characteristics (such as center time of streamflow) for streams and larger rivers. 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.

Current and projected mean summer flow values were summarized for sixth-level watersheds; projected flows were available only in 2040 (table 19–2). The summarized flow data for each watershed were assigned to occupied stream segments. Occupied stream segments predicted to have a mean summer flow near or at 0 cubic feet per second (ft^3/s) were considered at risk due to low flow (calculated for the period beginning the first day after June 1 when flow falls below the mean annual flow through September 30).

Landscape-level ecological values (amount of three-species assemblage habitat) and risk (ADI score and risk from nonnative species) were compiled into an overall index of conservation potential for each fifth-level watershed (table 19–3). To account for different spatial patterns of habitat (mainstem, headwater, and lakes and reservoirs), we combined area ranks using stream-segment length and number of populations (derived from counts of occupied stream segments and lakes/reservoirs) into an overall area rank (table 19–3). See Chapter 2—Assessment Framework and Appendix for additional details on methods.

Key Findings for Management Questions

Where is baseline habitat for the three-species assemblage, and what is the total amount occupied per species (fig. 19–2)?

- The bluehead sucker occurs in the Green, Bear, and Little Snake River drainages in the southwestern portion of the Basin. The flannelmouth sucker distribution broadly overlaps that of the bluehead sucker, but flannelmouth suckers do not occur in the Bear River watershed, and they are more widely distributed, occupying more watersheds. The roundtail chub has a more restricted distribution than the other two species within the Green and Little Snake River drainages.
- Total stream and river habitat identified in the Basin is 1,810 km (1,125 mi) for the bluehead sucker; 2,314 km (1,438 mi) for the flannelmouth sucker; and 1,062 km (660 mi) for the roundtail chub. Total identified lake and reservoir habitat for the bluehead sucker is 1.8 square kilometers (km^2) (0.7 square miles [mi^2]), 237 km^2 (92 mi^2) for the flannelmouth sucker, and 48 km^2 (19 mi^2) for the roundtail chub.

Where does development pose the greatest threat to baseline habitat for the three-species assemblage, and where are the relatively undeveloped habitats (figs. 19–3 to 19–6)?

- Most of the habitat occupied by the three-species assemblage has moderate or high levels of development (fig. 19–3).
- Only 4 percent of river and stream habitat and 29 percent of lake and reservoir habitat is relatively undeveloped (ADI score <20) (fig. 19–4).
- The longest stream segment occupied by the three-species assemblage is 738 km (458.57 mi) (figs. 19–5 and 19–6). All relatively undeveloped stream segments (ADI score <20) are <50 km (31.07 mi). Only 5 percent of stream segments with low development scores (ADI score <30) are >50 km.
- The longest stream segments of baseline habitat occur in the Black's Fork, Muddy Creek, and Ham's Fork drainages (fig. 19–6). Relatively undeveloped stream segments are short, widely scattered, and restricted to smaller creeks and two portions of the mainstem of the Green River in Colorado. No relatively undeveloped stream segments occur in the Little Snake River drainage.

Where do dams, diversions, and road crossings pose potential barriers to three-species assemblage movements, and where are watersheds with the highest structural connectivity (fig. 19–7)?

- The number of potential barriers to movement for three-species assemblage habitat is considerable in most watersheds. Only 25 percent of all watersheds lacked any potential barriers. Watersheds with high densities of potential barriers (>50) are scattered across the distribution of the three-species assemblage, and 32 percent of watersheds had >10 potential barriers in three fish habitat.
- A number of watersheds with a low number of potential barriers occur in the Flaming Gorge Reservoir, where habitat has been altered by the presence of the dam. In addition, the reservoir may decrease structural connectivity among tributaries downstream of the dam.

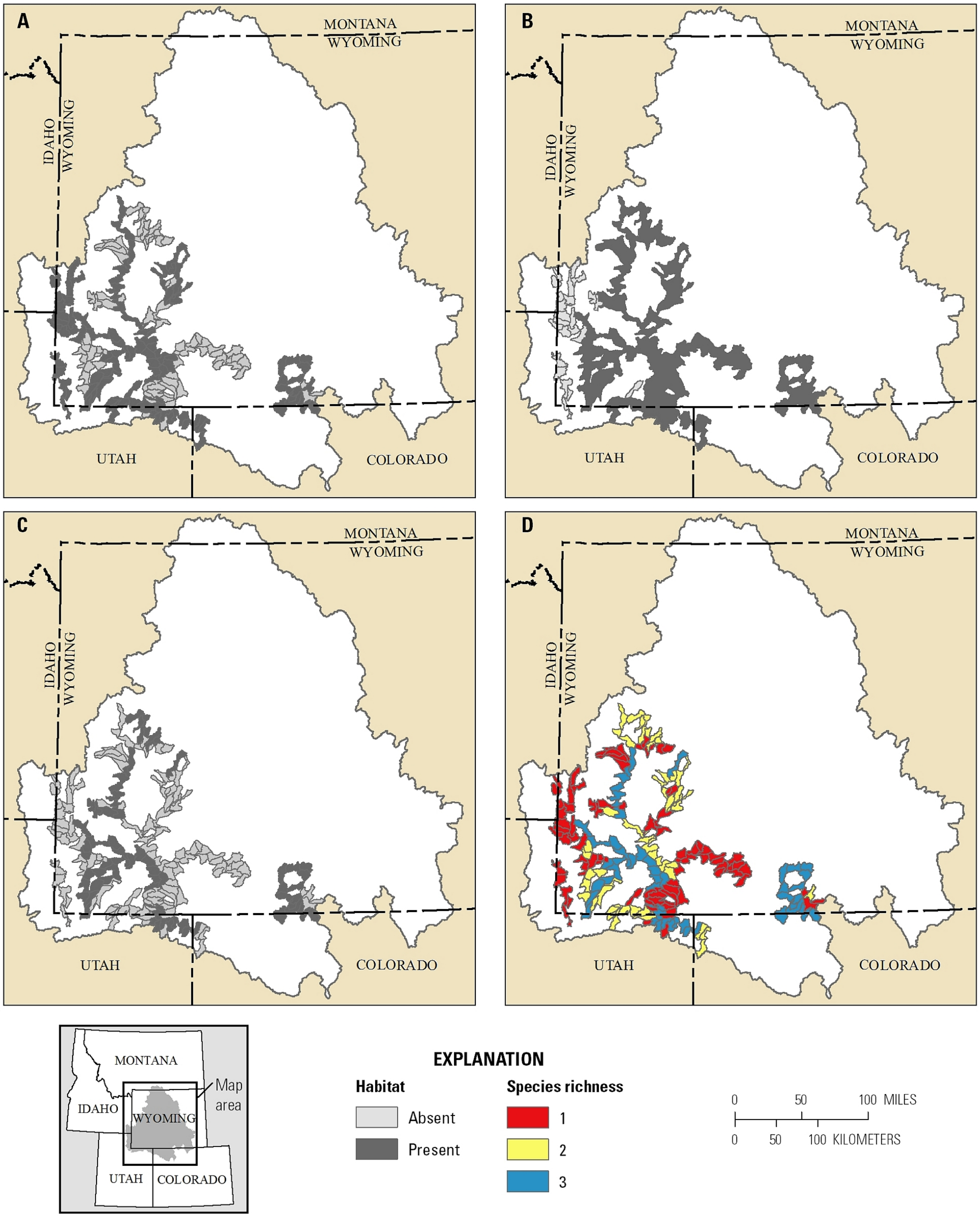

Figure 19–2. Baseline distribution of (*A*) bluehead sucker, (*B*) flannelmouth sucker, (*C*) roundtail chub derived from occurrence in sixth-level watershed, and (*D*) number of species in the three-species fish assemblage, summarized by sixth-level watershed, in the Wyoming Basin Rapid Ecoregional Assessment project area.

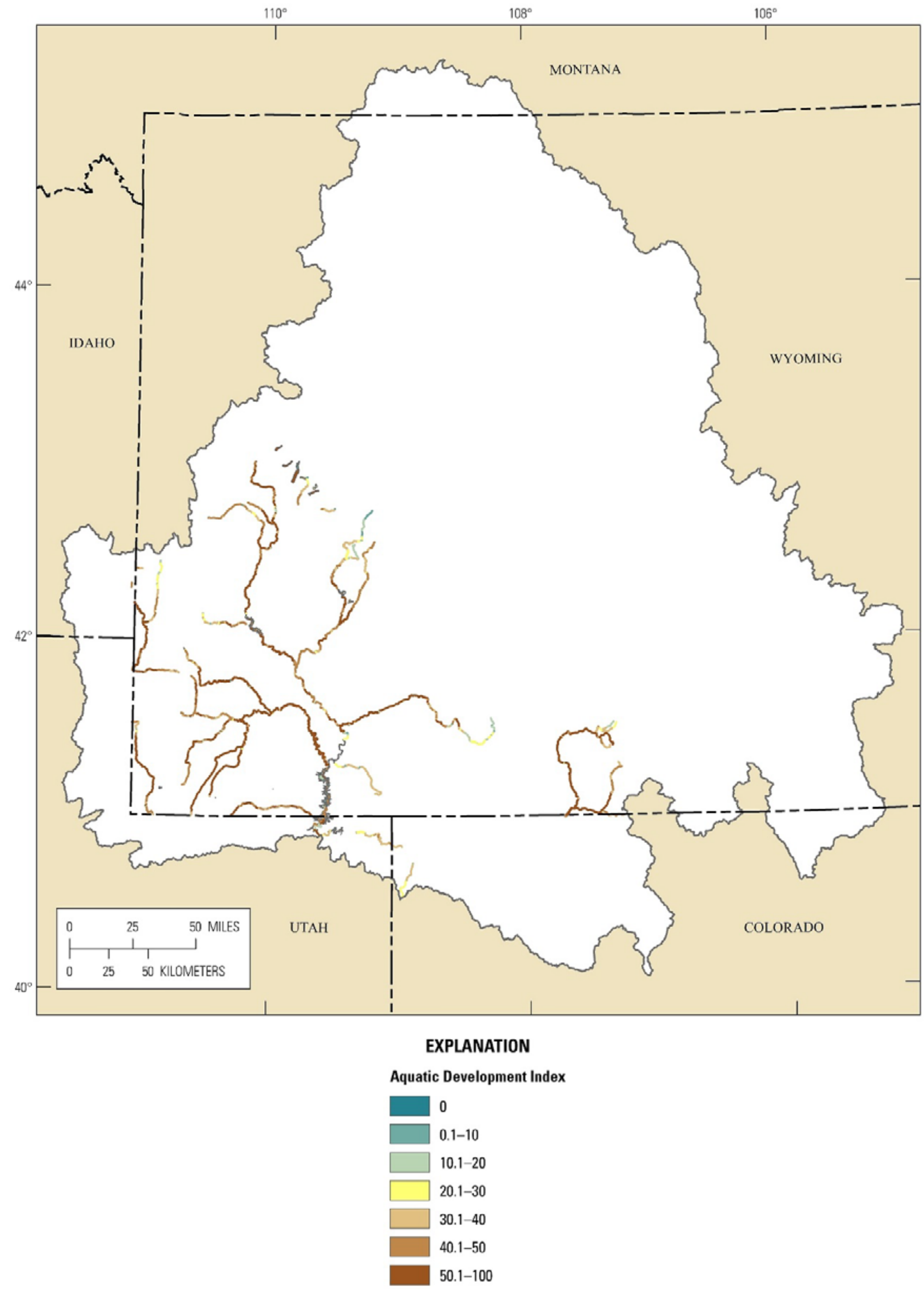

Figure 19–3. Aquatic Development Index scores for the three-species fish assemblage habitat in the Wyoming Basin Rapid Ecoregional Assessment project area.

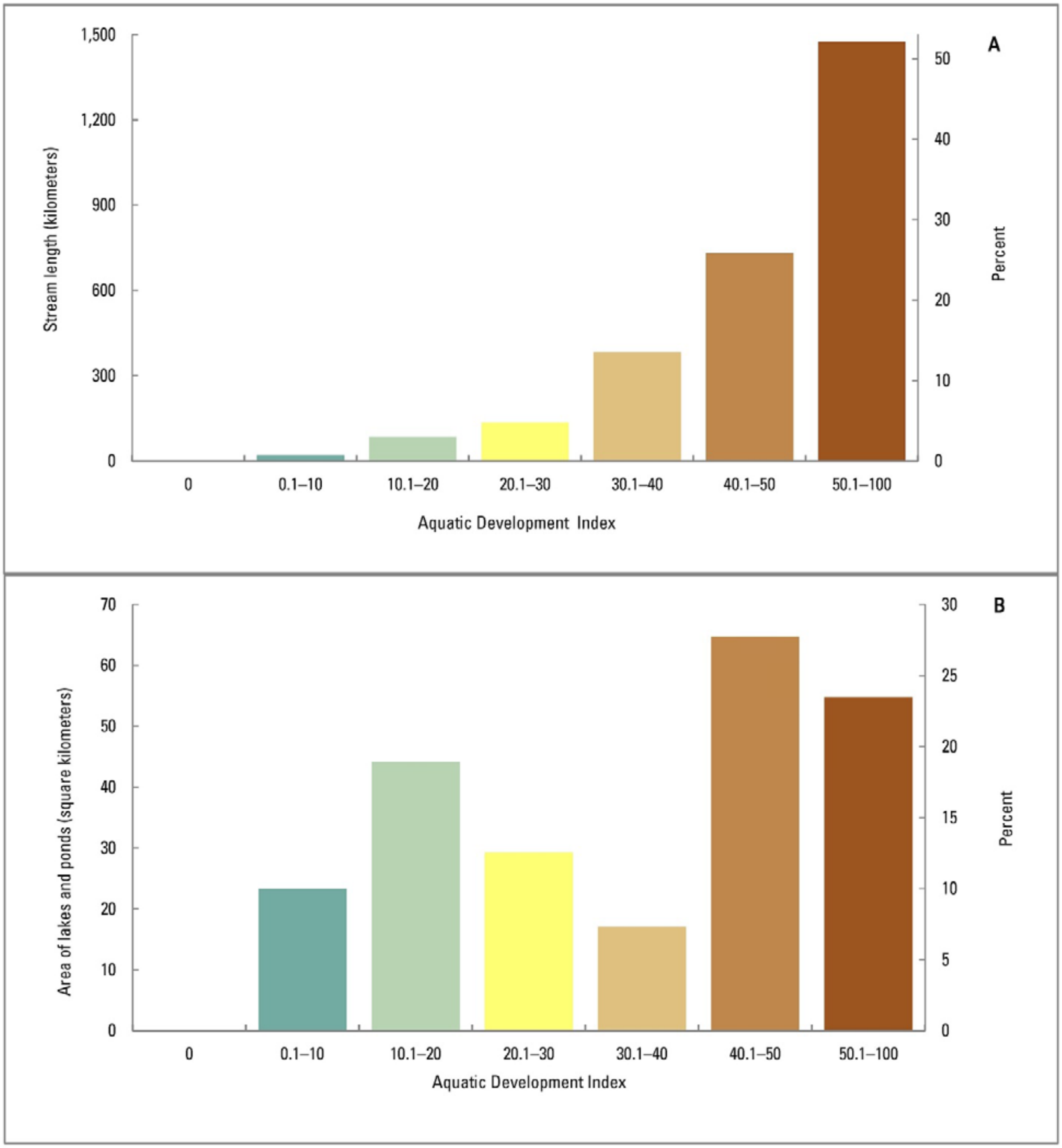

Figure 19–4. The total size of three-species fish assemblage habitat as a function of the Aquatic Development Index in the Wyoming Basin Rapid Ecoregional Assessment project area for (*A*) streams and (*B*) lakes/reservoirs and ponds.

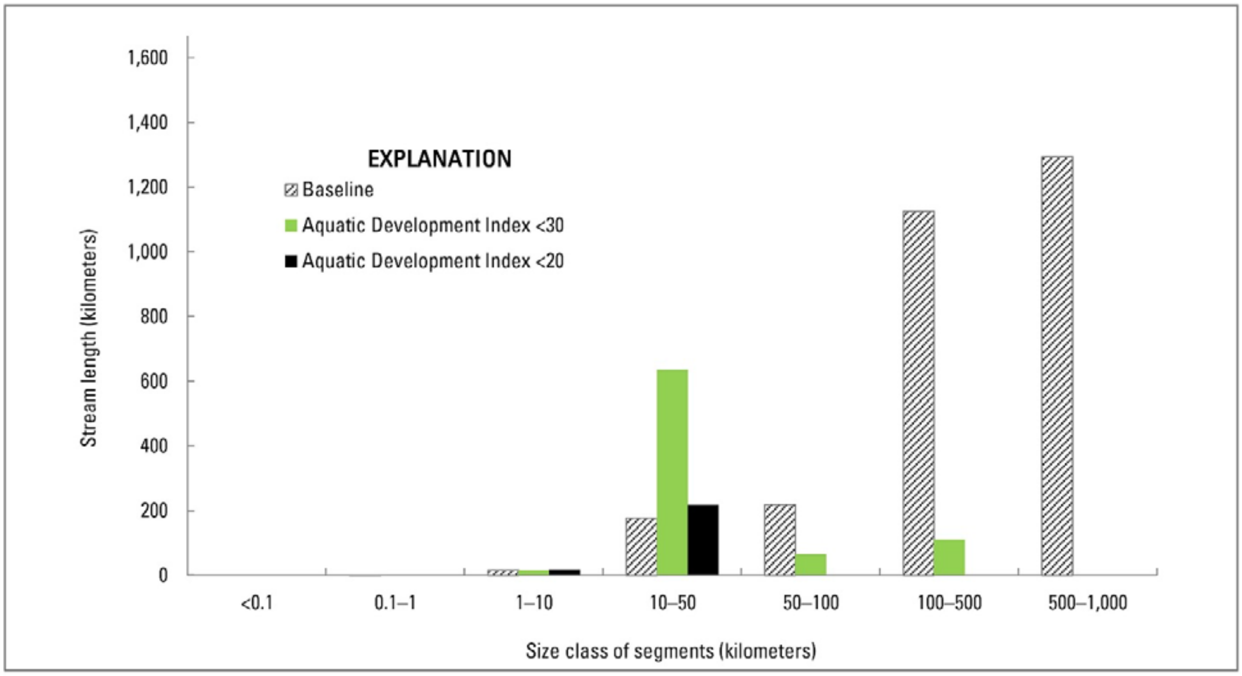

Figure 19–5. Amount of three-species fish assemblage habitat as a function of stream-segment size for baseline conditions and two development levels: (1) Aquatic Development Index (ADI) score <30, and (2) ADI score <20 (relatively undeveloped habitat) in the Wyoming Basin Rapid Ecoregional Assessment project area.

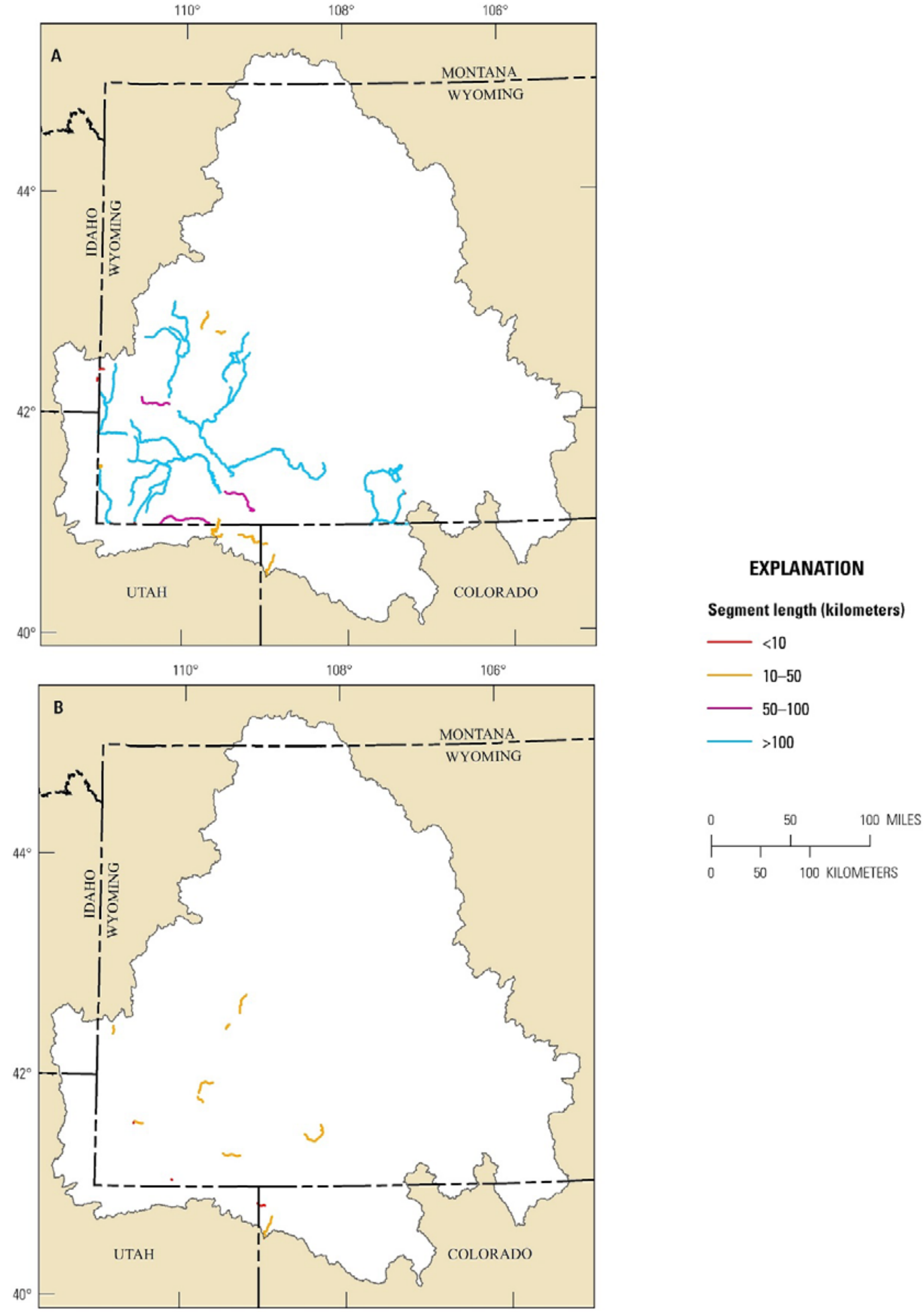

Figure 19–6. Stream-segment lengths of three-species fish assemblage habitat for the Wyoming Basin Rapid Ecoregional Assessment project area for (*A*) baseline conditions and (*B*) relatively undeveloped areas (Aquatic Development Index scores <20).

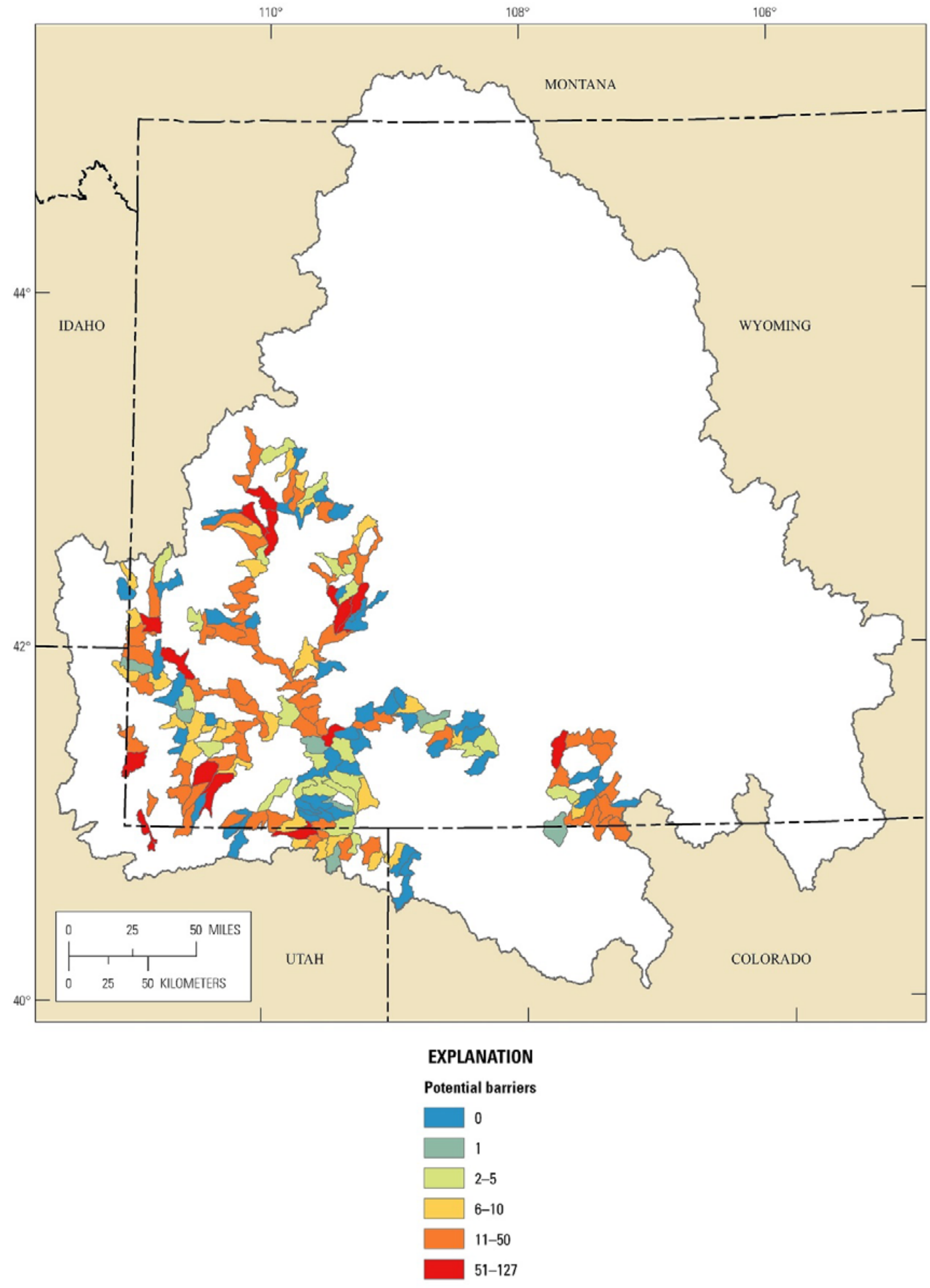

Figure 19–7. Potential barriers to three-species fish assemblage movements, summarized by sixth-level watershed, in the Wyoming Basin Ecoregional Assessment project area. Number of potential barriers includes dams, points of diversion, and stream-road crossings of occupied streams.

Where are three-species assemblage populations at risk of hybridization and competition or predation from nonnative species (fig. 19–8)?

- Burbot are restricted to the larger creeks and rivers within the Green River drainage, but white suckers are in most of the drainages occupied by the three-species assemblage.
- There is extensive overlap between distributions of native bluehead and flannelmouth suckers and nonnative white suckers; thus, the potential for hybridization is high throughout the Basin. The upper portions of the Bear River, Smith's fork, and Bitter Creek are the only regions with contiguous three-species assemblage habitat where white sucker are absent, although they may still have Utah and longnose suckers.

Where could the three-species assemblage be at risk from projected shifts in hydrological regime in 2040? (fig. 19–9 and 19–10)?

- Streams with a mean summer flow at or near 0 ft^3/s indicate the potential for reaches to dry out which can decrease habitat connectivity and increase fish mortality especially during drought years. Reaches with a mean summer flow of <1 ft^3/s are present in the mainstem of the Green River, Black's Fork, and in several small tributary sections (fig. 19–9).
- There is little difference between current and projected mean summer flow in 2040 (fig. 19–10).

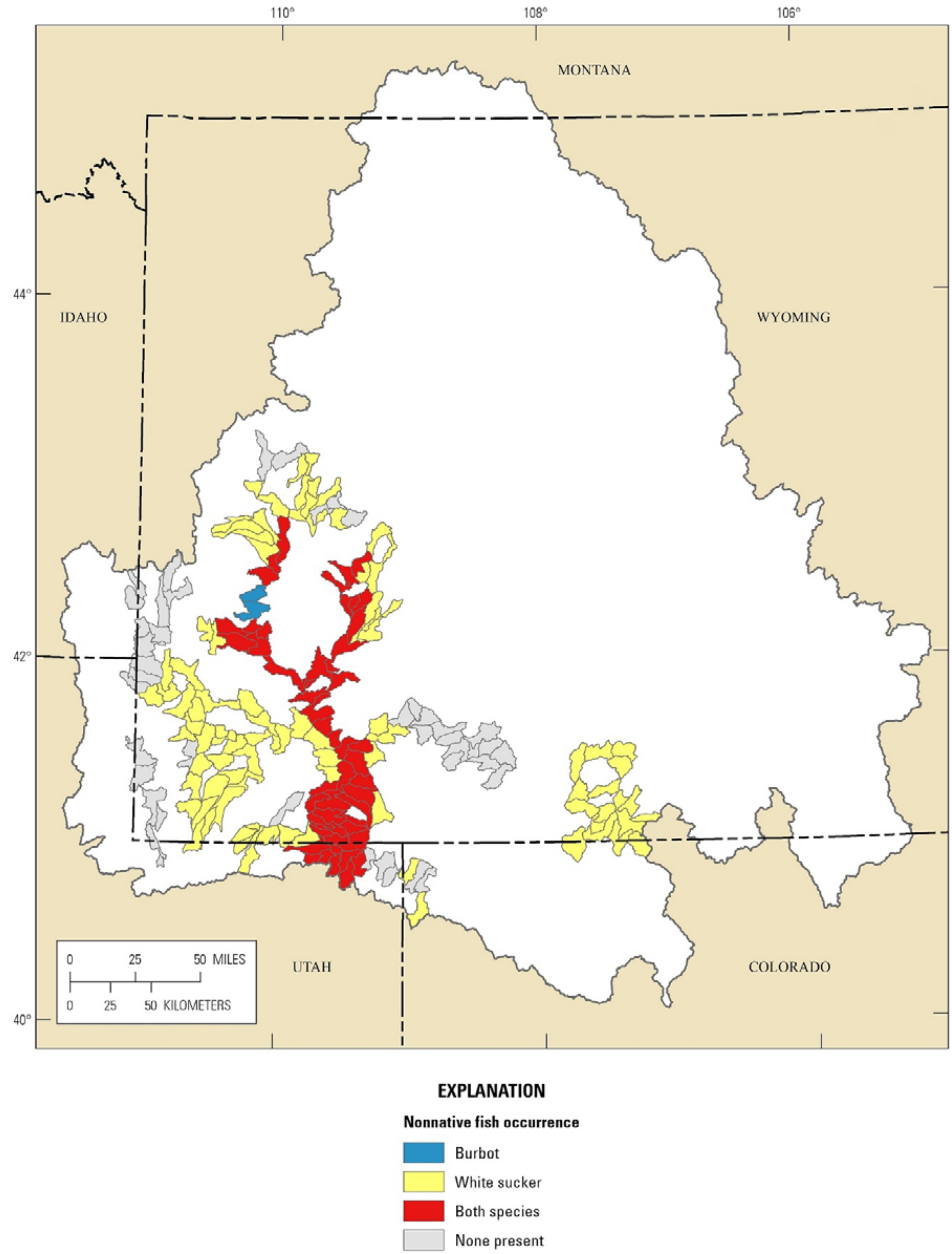

Figure 19–8. Potential risk from competition, predation, and hybridization derived from the co-occurrence of burbot and white sucker with the three-species fish assemblage in the Wyoming Basin Ecoregional Assessment project area. Burbot is a potential competitor and predator of all three species, whereas the white sucker can hybridize with both native suckers.

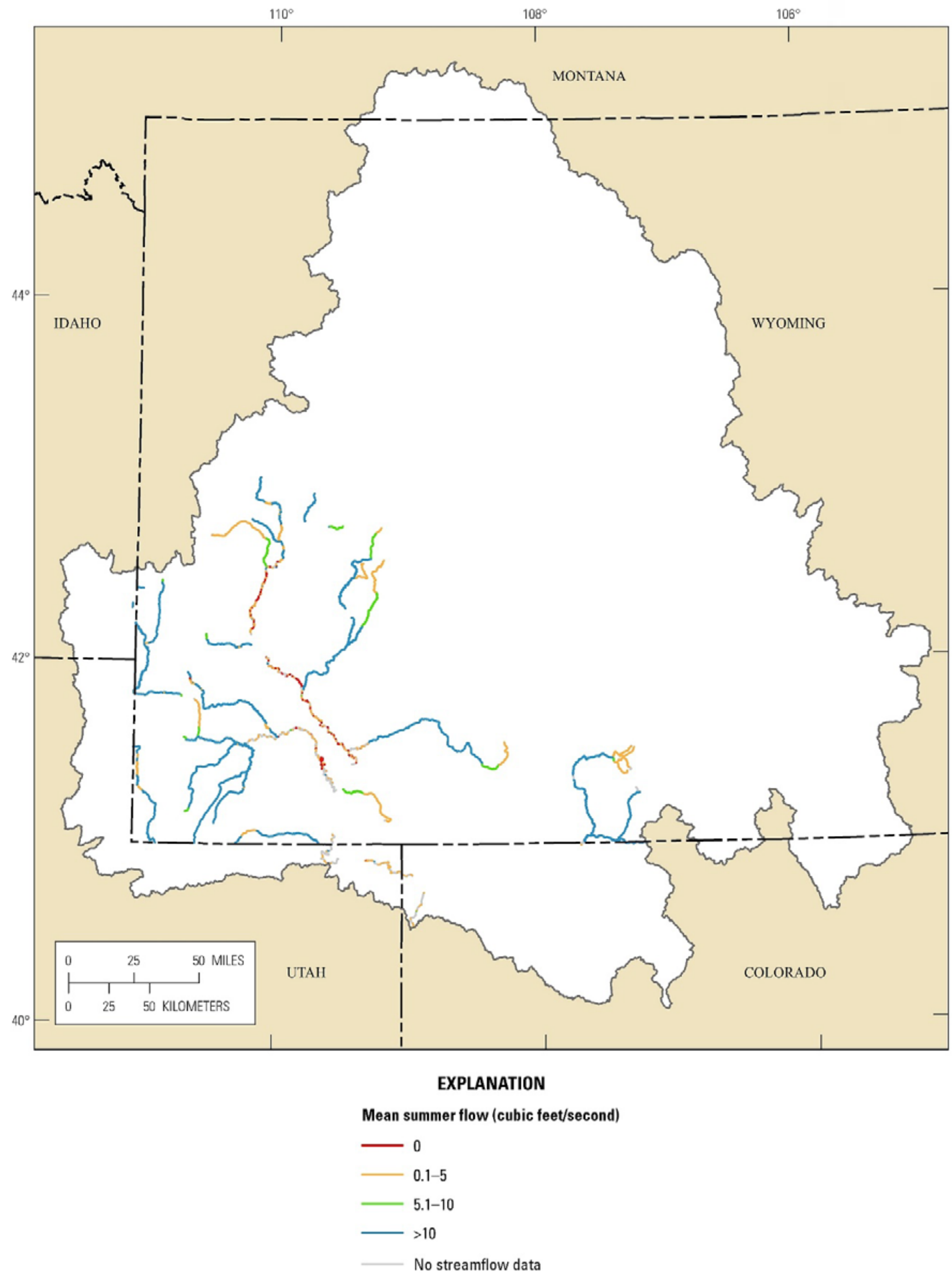

Figure 19–9. Current mean summer flow (cubic feet per second) in three-species fish assemblage habitat in the Wyoming Basin Rapid Ecoregional Assessment project area. Mean summer flow near or at zero indicates potential for reaches to dry out during summer months.

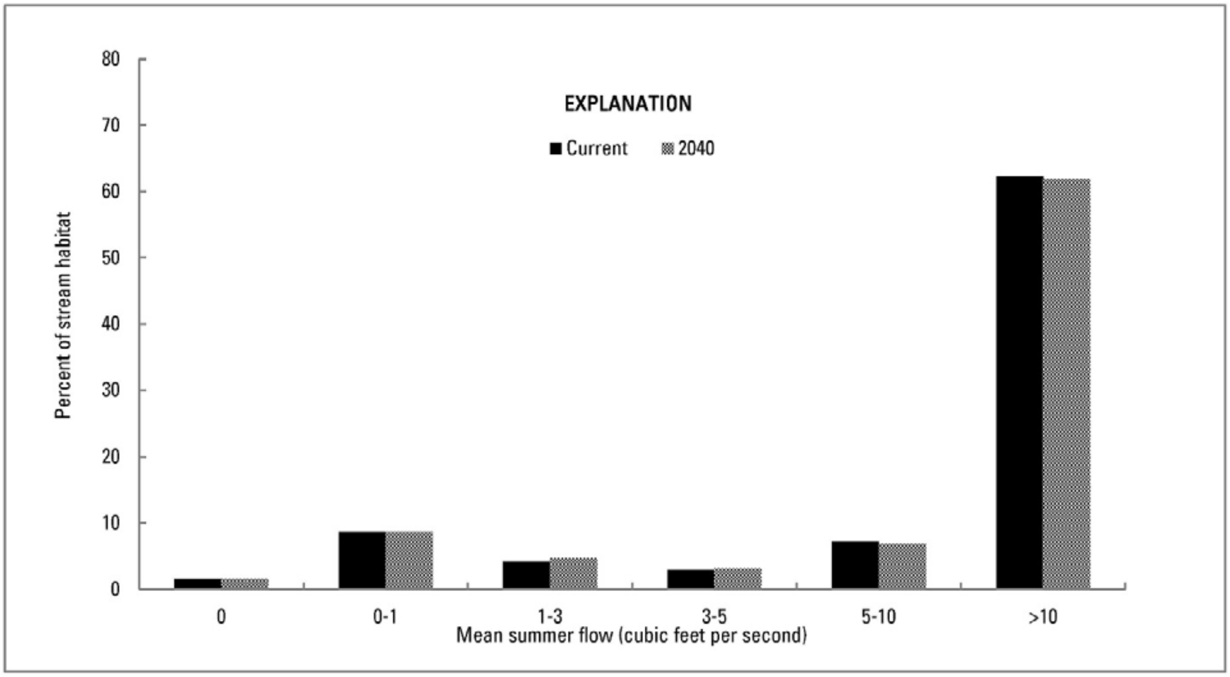

Figure 19–10. Mean summer flow in stream habitats for the three-species fish assemblage for current conditions and projected in 2040 in the Wyoming Basin Rapid Ecoregional Assessment project area. Y-axis values represent percent of combined total (kilometers) of all stream segments in the Wyoming Basin Rapid Ecological Assessment Project Area known to be inhabited by three-species assemblage.

How does development risk vary by land ownership or jurisdiction for three-species assemblage habitat (table 19–5, fig. 19–11)?

- The two major types of land ownership or jurisdiction associated with three-species assemblage habitat are private (59 percent) and BLM (20 percent) (table 19–5). Private lands primarily have high risk from development, whereas risk from development on BLM lands is primarily high and medium (fig. 19–11). The U.S. Department of Agriculture Forest Service had the greatest percent of land at low risk from development, but this only accounts for 1.72 percent of the habitat.

Table 19–5. Length and percent of three-species fish assemblage habitat by land ownership or jurisdiction in the Wyoming Basin Rapid Ecoregional Assessment project area.

[km, kilometer]

Ownership or jurisdiction	Stream length (km)	Percent of habitat
Private	1,627	59.13
Bureau of Land Management	553	20.10
Other Federal[1]	237	8.63
State/County	203	7.36
Forest Service[2]	47	1.72
Private conservation	43	1.58
National Park Service	31	1.11

[1] Bureau of Reclamation, and U.S. Fish and Wildlife Service.

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

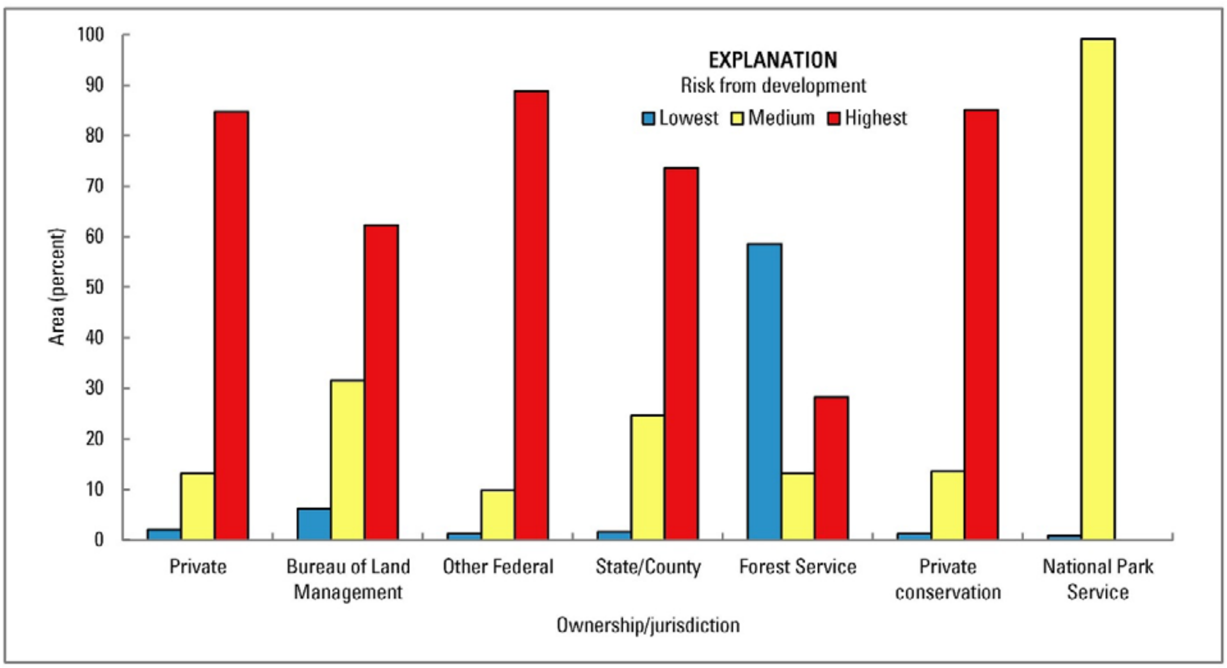

Figure 19–11. Relative ranks of risk from development, by land ownership, for streams occupied by the three-species fish assemblage in the Wyoming Basin Rapid Ecoregional Assessment project area. Rankings are lowest (Aquatic Development Index [ADI] score <20), medium (ADI score 20−40), and highest (ADI score >40). [Forest Service, U.S. Department of Agriculture Forest Service]

Where are the watersheds with the greatest landscape-level ecological values (fig. 19–12)?

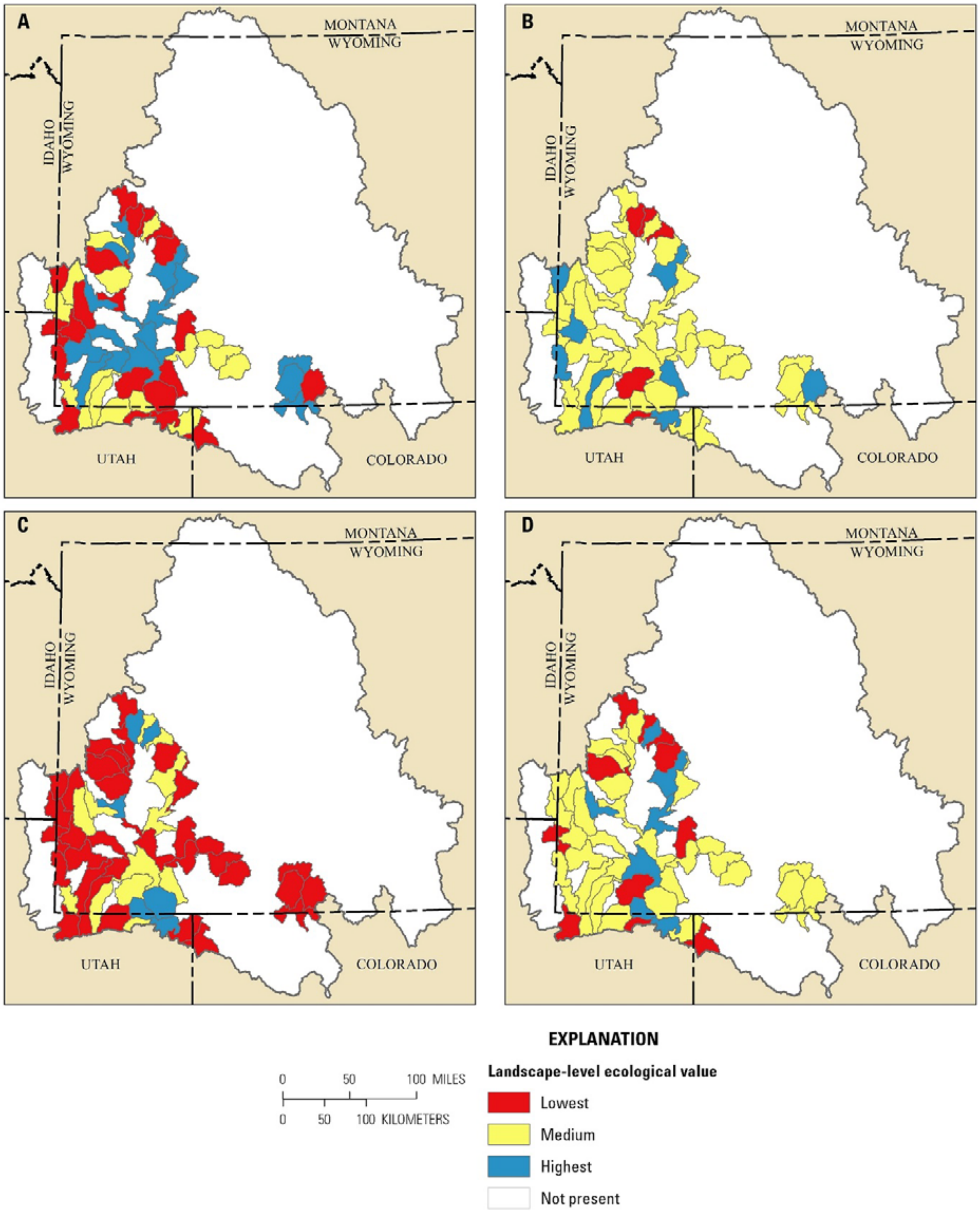

Figure 19–12. Ranks of landscape-level ecological values for three-species fish assemblage habitat, summarized by fifth-level watershed, in the Wyoming Basin Rapid Ecoregional Assessment project area. Landscape-level values based on (*A*) mean occupied segment length (kilometer), (*B*) stream-segment count, (*C*) lake/reservoir count, and (*D*) overall values based on the maximum score for the contributing variables (see table 19−3 for overview of methods).

Where are the watersheds with the greatest landscape-level risks (fig. 19–13)?

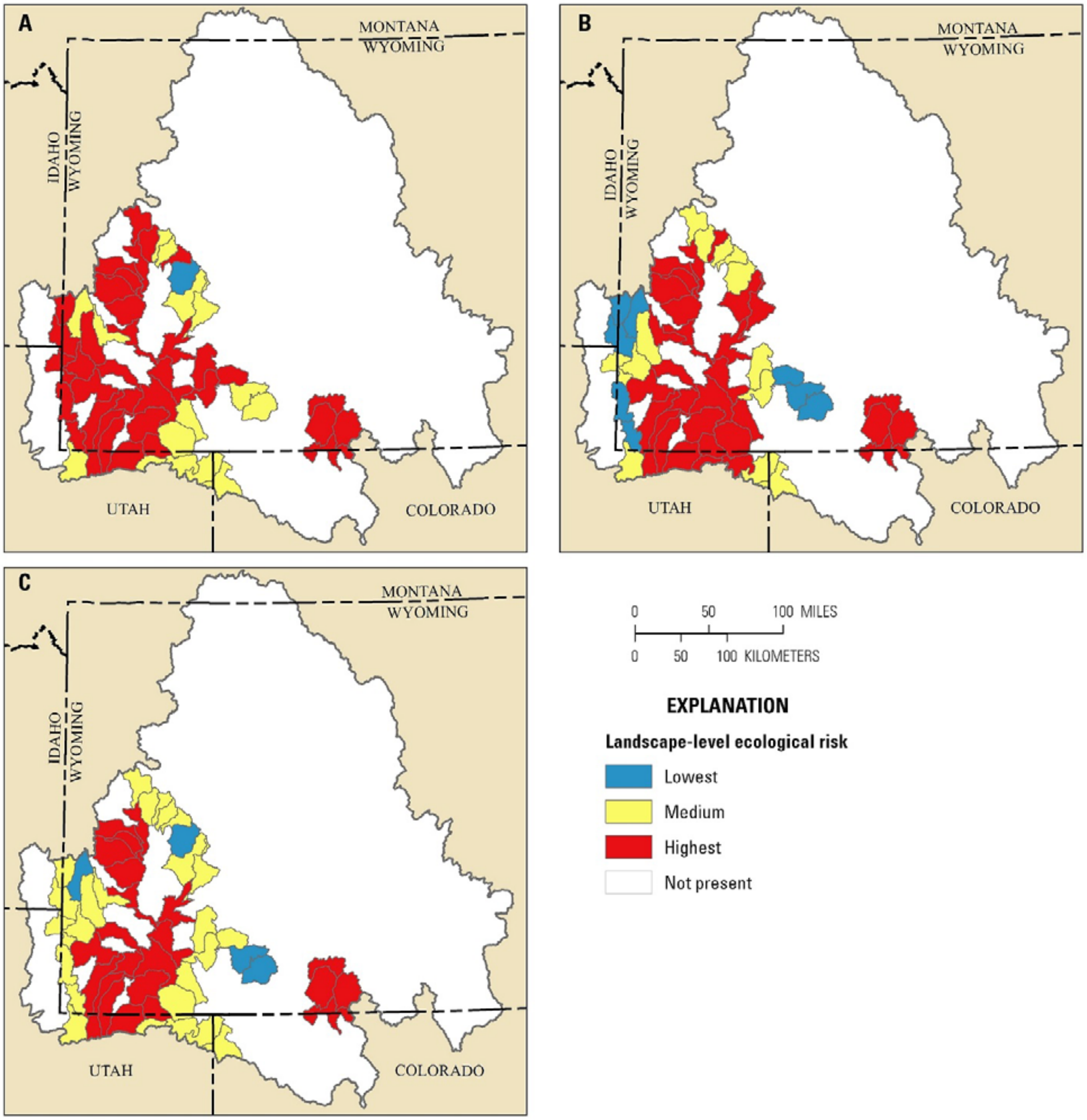

Figure 19–13. Ranks of landscape-level ecological risks for three-species fish assemblage habitat, summarized by fifth-level watershed, in the Wyoming Basin Rapid Ecoregional Assessment project area. Landscape-level risks based on (*A*) Aquatic Development Index, (*B*) presence of nonnative fish, and (*C*) overall risks (see table 19−3 for overview of methods).

Where are the watersheds with the greatest conservation potential (fig. 19–14)?

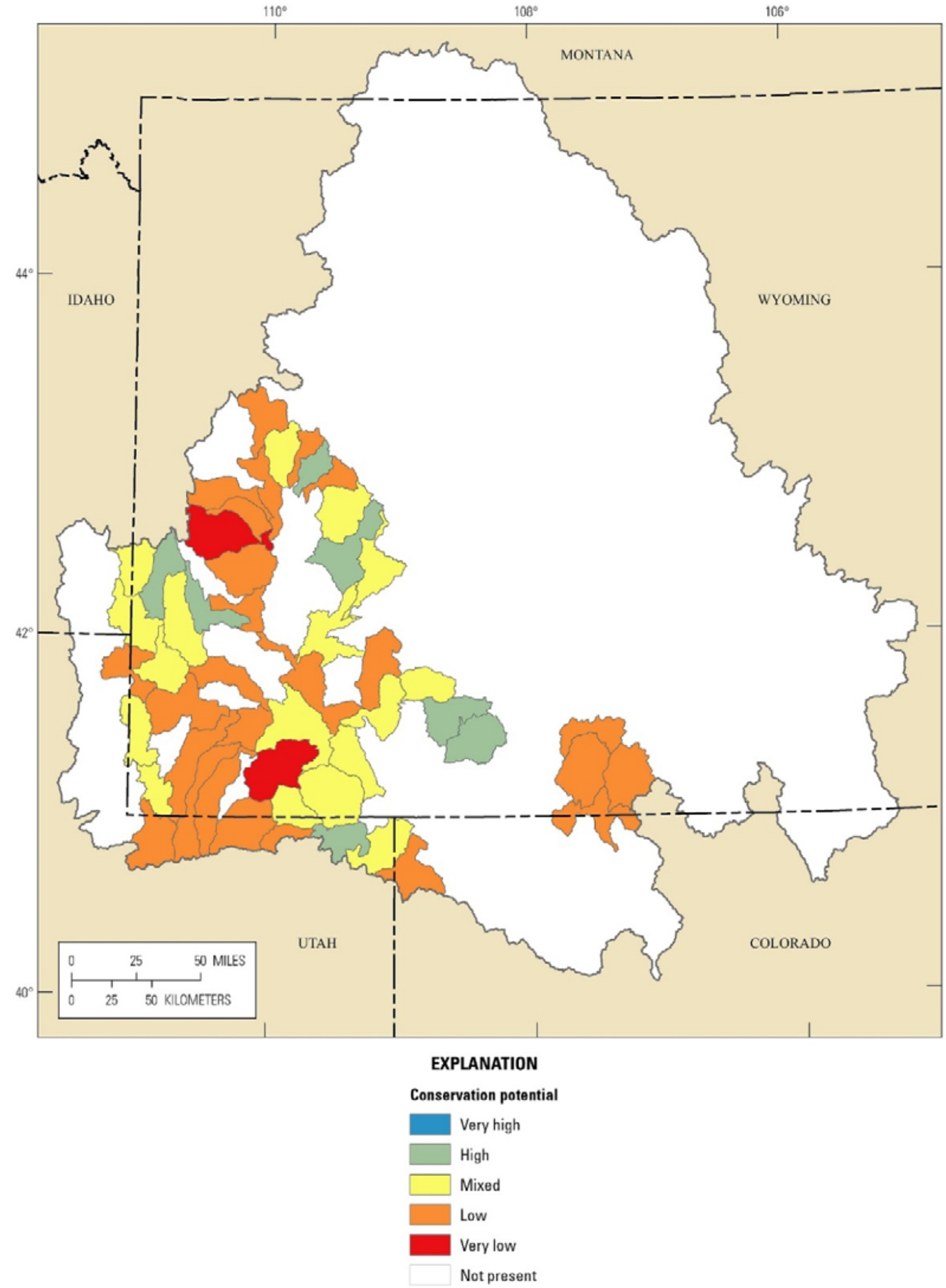

Figure 19–14. Conservation potential of three-species fish assemblage habitat, summarized by fifth-level watershed, in the Wyoming Basin Rapid Ecoregional Assessment project area. Highest conservation potential identifies watersheds that have the highest landscape-level values and the lowest risks. Lowest conservation potential identifies watersheds with relatively low 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

The three fish species that make up this assemblage (bluehead and flannelmouth suckers, and roundtail chub) form the foundation of the native fish community of the Colorado River drainage. The distributions of all three species within the Wyoming Basin are limited, and most of the habitat has high levels of development. Relatively undeveloped habitat for the three-species assemblage is restricted to short, highly disconnected segments in small creeks and a short portion of the mainstem of the Green River. Fragmentation of habitat by dams poses significant threats to the viability of the populations of all three species, and additional barriers posed by water diversions can further increase isolation of remaining populations (Compton and others, 2008).

Two introduced fish species, the burbot and white sucker, widely co-occur with the three species and pose significant risks to the assemblage in many watersheds. Burbot, which are both predators and competitors, are largely limited to the mainstems of the Green, New Fork, and Big Sandy rivers. The brown trout is another potentially significant predator. White suckers broadly overlap the distribution of both bluehead and flannelmouth suckers and have hybridized with both of the native species across much of their range in the Basin. The Utah and longnose suckers also will hybridize with bluehead and flannelmouth suckers.

The results of this assessment complement the identification of native fish conservation areas by Daulwalter and others (2011), who used distribution models for the three species and cutthroat trout, and they included a broader set of risk factors than we addressed here. Our approach did not include cutthroat trout, which are typically found in headwater habitats outside of the range of the three fish species. In addition, our ranks of conservation potential were derived from known locations of the three-species assemblage and a more focused set of values and risks. Consequently, our rankings of conservation potential for the three-species fish assemblage provide a different perspective. The difference among approaches illustrates how identification of watersheds with high conservation potential is very sensitive to the risk factors considered.

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