BUREAU OF LAND MANAGEMENT

Rangeland Resource Assessment—2011

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Rangeland Resource Assessment—2011

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Introduction

Rangelands are the largest ecosystem type in the United States, covering 830 million acres in the lower 48 states and 205 million acres in Alaska (The Heinz Center 2008). The Bureau of Land Management (BLM), within the Department of the Interior, manages nearly 194 million acres of rangelands in the lower 48 states and Alaska (USDI–BLM 2013). Rangelands in the United States are diverse, including the prairies of the Midwest and Great Plains, sagebrush shrublands, deserts, mountain meadows, pastures and haylands, and tundra in Alaska. Although rangelands can appear barren and unproductive, rangelands provide us with minerals; food and fiber; huntable and watchable wildlife; clean, fresh water; open space and views; wilderness experiences; and inspiration (The Heinz Center 2008).

Rangelands *are lands on which the climax or potential plant cover is composed of grasses, grasslike plants, forbs, and shrubs managed as a natural ecosystem. Lands with introduced perennial grasses such as crested wheatgrass and managed as rangelands are also considered rangelands. Rangelands include grasslands, savannas, shrublands, deserts, tundra, alpine plant communities, marshes, wet meadows, and oak and pinyon-juniper woodlands.*

Sustained yield *means achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the public lands consistent with multiple use (as defined in the Federal Land Policy and Management Act).*

Congress directed the BLM to manage public lands for multiple uses and the *sustained yield* of renewable resources in the Federal Land Policy and Management Act of 1976 (Public Law 94-579). As a way to determine if the BLM was achieving sustained yield, Congress directed the agency to periodically and systematically inventory the public rangelands, identify current public rangeland conditions and trends, and report this information to Congress and the public. This report meets the requirements of section 201(a) (43 U.S.C. 1711(a)) of the Federal Land Policy and Management Act, as amended, and sections 1901 (b)(1) and 1903(a) of the Public Rangelands Improvement Act (Public Law 95-514).

Purpose and Background

The 2011 rangeland resource assessment (RRA) is a first-of-its-kind report on the *status* and *condition* of renewable resources on federal rangelands managed by the BLM. The BLM based the RRA on a statistical survey of 879 locations across BLM rangelands in 13 western states. Future RRAs will report the trend (change across time) in status and condition of renewable resources on BLM rangelands.

Status *is an amount of a renewable resource at a point in time.*

Condition *is the status of a renewable resource in comparison with a reference value for that renewable resource.*

Several aspects of this assessment make it unique. The 2011 RRA uses a standardized set

An **attribute** is a biological or physical component that provides information about the functional status of the ecological processes (soil development, water and nutrient cycling, and energy flow) on rangelands. Ecological processes are often complex and difficult to measure directly; attributes reduce the complexity of ecological processes to measureable components that show the status of these processes.

An **indicator** is a component of rangeland that has a characteristic (such as presence or absence, amount, or distribution) used to infer the status of productivity of rangeland.

of *attributes* and *indicators* to portray the status and condition of renewable resources on BLM-managed public rangelands. The BLM used standardized field methods and a statistically valid study design to measure attributes and indicators of rangeland status and condition consistently across all rangelands sampled. This consistency allowed the computation of statistically valid estimates of rangeland status and condition and the interpretation of those results across BLM rangelands.

The 2011 BLM RRA is a product of a partnership among the BLM, the United States Department of Agriculture–Natural Resources Conservation Service (NRCS), and the Center for Survey Statistics and Methodology (CSSM) at Iowa State University. The 2011 BLM RRA augments the National Resources Inventory (NRI) RRA, conducted by the NRCS, which estimates the status and condition of rangeland resources and describes trends on nonfederal rangelands. The NRCS conducts the NRI RRA in cooperation with the CSSM, which generates the statistics and survey design methods used in the NRI. The NRCS has conducted on-the-ground NRI sampling on nonfederal rangelands since 2003.

The BLM, NRCS, and CSSM developed this partnership to use funds and the existing workforce efficiently to provide a unified estimate of rangeland status and condition on nonfederal rangelands and BLM-managed public rangelands. The 2011 BLM RRA and the 2011 NRI used the same sampling design and the same trained data collectors. Field methods used in the 2011 BLM RRA were used also in the 2011 NRI. The CSSM provided statistical support for the selection of samples, support for the survey design, and statistical processing and estimates of the attributes and indicators for the 2011 BLM RRA (Nusser et al. 2013).

Rangeland Productivity

The attributes and indicators in this report tell a story about the productivity of BLM rangelands. The productivity of rangelands is the capacity of rangelands to produce commodities and satisfy values (National Research Council 1994). Sustaining rangeland productivity depends on ecological processes such as soil development, water cycling (the capture, storage, and safe release of precipitation), nutrient cycling (movement of nutrients through air, water, soil, and animals), energy flow (conversion of sunlight to plant matter and then animal matter), and the structure and dynamics of plant and animal communities (National Research Council 1994). The status and condition of the attributes and indicators give us a way to determine whether these processes are maintaining their functionality, degrading, or improving. For example, large areas with low soil aggregate stability or abundant bare ground demonstrate high potential for soil erosion, degrading productivity. Likewise, large areas free of invasive plants show that the structure of plant communities may be relatively stable, maintaining productivity. Multiple indicators tell a more complete story than one alone, and thus, any conclusions drawn about rangeland productivity should consider all indicators.

Methods

Sample Design and Selection

The assessment team designed the 2011 BLM RRA to assess the status and condition of renewable resources on BLM rangelands in 13 western states: Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming. The assessment team did not assess the status and condition of renewable resources on BLM-managed public rangelands in Alaska because the NRI RRA did not sample Alaska. NRCS personnel and NRCS-contracted personnel measured attributes and indicators of rangeland status and condition at sample points (i.e., locations) in these 13 western states.

For 2011, the BLM RRA relied on the existing sample design of the NRI. The NRI uses a stratified two-stage design where Public Land Survey System quarter-sections called segments are randomly selected within each township and three sample points are selected within each segment using a restricted randomization procedure that encourages a geographic spread of the points (Nusser et al. 2013).

The sampling universe for the BLM RRA sample was BLM-managed public land in the 13 western states. The BLM provided a geographic information system layer to the CSSM that defined the extent of BLM-managed public land in each state. Segments eligible for sampling were those that had at least one point located on BLM-managed public land within the 13 western states.

The target sample size of the 2011 BLM RRA was 1,070 points on BLM-managed public rangelands, based on the constraints of the number of eligible segments and a sample design constraint of a maximum of 2 points per eligible segment. The CSSM selected a larger sample size of 1,200 points on BLM-managed public lands to try to yield a final sample of 1,070 BLM rangeland points. The CSSM allocated the 1,200 points to the 13 western states in proportion to the number of BLM-managed acres in each state and calculated the number of segments selected from this allocation. States having a small amount of BLM-managed public lands had few to no segments, and states having greater amounts of BLM-managed public lands had a greater number of segments.

Of the three points within each segment, the CSSM selected a maximum of two points. If a segment contained one or two points located on BLM-managed public land, the CSSM selected these points with certainty for the BLM RRA sample. If a segment had three points on BLM-managed public land, then the CSSM randomly selected two of the three points to be included in the sample.

Of the original sample of 1,200 points on BLM-managed public land, NRCS personnel and NRCS-contracted personnel actually sampled 883 points (table 1). The CSSM removed points from the sample that were (1) not on BLM-managed public land; (2) not on rangeland, such as those on roads, in water, or on forest land; and (3) on rangeland but could not be sampled, such as those requiring access across private land where permission was not granted, those in inaccessible terrain, and those on steep slopes that posed a safety hazard for sampling.

Table 1. Number of sample points by state.

State	Number of Sample Points
Arizona	59
California	47
Colorado	29
Idaho	52
Montana	33
Nevada	274
New Mexico	75
North Dakota	0
Oregon	86
South Dakota	1
Utah	118
Washington	3
Wyoming	106
Total	**883**

Data Collection

NRCS personnel and NRCS-contracted personnel collected all data for the 2011 BLM RRA following NRI protocols and the BLM's core terrestrial methods (MacKinnon et al. 2011). Before receiving authorization to collect data, these field personnel received training and performed calibration on the methods for data collection and the attributes and indicators to be measured. Data collection occurred primarily in the summer and fall of 2011 for most states. Data collection occurred from 2011 through the spring of 2012 in Arizona and from December 2011 to October 2012 in California.

The data collectors conducted rangeland health assessments at each sample location using the protocol from Pellant et al. (2005). They completed measurements for the BLM's core terrestrial indicators (MacKinnon et al. 2011) using protocols from Herrick et al. (2009). Each sample location consisted of a 0.4-acre (0.16-hectare) area encompassed by a 150-foot (45.7-meter) diameter circular plot centered on the intersection of two perpendicular 150-foot (45.7-meter) line transects.

The data collectors used the following five methods to measure the rangeland attributes and indicators:

1. Rangeland health assessment protocol (Pellant et al. 2005)
2. Line-point intercept supplemented with plot-area species inventory
3. Canopy gap intercept
4. Height of woody and herbaceous vegetation
5. Soil aggregate stability

Data provided by this suite of methods allows for the calculation of myriad attributes and indicators of rangeland resources. For the BLM RRA, however, the assessment team reported on a limited suite of indicators related to national-scale rangeland resource productivity (table 2) and did not produce an exhaustive set of estimates from all methods. For example, although the data collectors recorded vegetation height data at each sample location, the assessment team did not report height-related indicators in this BLM RRA (but might report them in future RRAs). Descriptions of each method (excluding vegetation height) and the attributes or indicators measured with each method follow.

Table 2. Indicators calculated for the 2011 BLM RRA and the methods used to measure the indicators.

Indicator	Method
Average amount of bare ground on BLM rangelands	Line-point intercept
Proportion of BLM rangelands with at least 20% bare ground	Line-point intercept
Proportion of BLM rangelands with at least 30% bare ground	Line-point intercept
Proportion of BLM rangelands with at least 40% bare ground	Line-point intercept
Proportion of BLM rangelands with at least 50% bare ground	Line-point intercept
Proportion of BLM rangelands where soil aggregate stability is	Soil aggregate stability ranked 4 or less
Proportion of BLM rangelands with at least 20% of the land having intercanopy gaps of at least 2 meters in length	Canopy gap intercept
Proportion of BLM rangelands with nonnative invasive plant species present	Line-point intercept with plot-area species inventory
Proportion of BLM rangelands with abundant nonnative invasive plant species*	Line-point intercept
Proportion of BLM rangelands where biotic integrity shows moderate departure from reference conditions	Rangeland health assessment
Proportion of BLM rangelands where biotic integrity shows moderate-to-extreme or extreme-to-total departure from reference conditions	Rangeland health assessment
Proportion of BLM rangelands where hydrologic function shows moderate departure from reference conditions	Rangeland health assessment
Proportion of BLM rangelands where hydrologic function shows moderate-to-extreme or extreme-to-total departure from reference conditions	Rangeland health assessment
Proportion of BLM rangelands where soil/site stability shows moderate departure from reference conditions	Rangeland health assessment
Proportion of BLM rangelands where soil/site stability shows moderate-to-extreme or extreme-to-total departure from reference conditions	Rangeland health assessment

* ≥25% of foliar intercepts of vegetation are nonnative invasive plant species

Rangeland Health Assessment

Rangeland health assessments characterize three attributes of the ecological processes of rangeland ecosystems: biotic integrity, hydrologic function, and soil/site stability (Pellant et al. 2005). For each rangeland health assessment, the data collectors qualitatively compared 17 biological and physical indicators (table 3) at the sample location to reference conditions for each indicator at that location. Reference conditions are those that occur where the biotic integrity, hydrologic function, and soil/site stability are at their potential under the natural disturbance regime. A detailed reference sheet specific to the type of land, or ecological site, at the sample location describes reference conditions for each indicator. A team of experts uses the best available information to develop the reference sheets contained within the ecological site descriptions.

The data collectors recorded the degree of departure from reference conditions in five rating categories: none to slight, slight to moderate, *moderate*, *moderate to extreme*, and *extreme to total.* They combined departure ratings for

Moderate *departure from reference conditions suggests that the attribute is "at risk" of declining in condition on the rangeland.*

Moderate-to-extreme *departure or extreme-to-total departure suggests that the attribute has declined in condition on the rangeland.*

the 17 indicators to produce composite ratings of departure from reference conditions for each of the three rangeland health attributes:

- Biotic integrity is the capacity of the biotic community to support ecological processes (the water cycle, energy flow, and nutrient cycle) within the normal range of variability expected for the ecological site, to resist a loss in the capacity to support these processes, and to recover this capacity when losses do occur. The biotic community includes plants, animals, and microorganisms occurring both above and below ground (Pellant et al. 2005). Biotic integrity, as measured, is a compilation of the ratings of departure from reference conditions for nine indicators (table 3).

- Hydrologic function is the capacity of an area to capture, store, and safely release water from rainfall, run-on, and snowmelt; to resist a reduction in this capacity; and to recover this capacity when a reduction does occur (Pellant et al. 2005). Hydrologic function, as measured, is a compilation of the ratings of departure from reference conditions for 10 indicators (table 3).

- Soil/site stability is the capacity of an area to limit redistribution and loss of soil resources (including nutrients and organic matter in the soil) by wind and water (Pellant et al. 2005). Soil/site stability, as measured, is a compilation of the ratings of departure from reference conditions for 10 indicators (table 3).

Table 3. Combined assessments of the 17 rangeland health indicators produce ratings of biotic integrity, hydrologic function, and soil/site stability (Pellant et al. 2005).

Rangeland Health Indicator	Description	Biotic Integrity	Hydrologic Function	Soil/Site Stability
Soil surface resistance to erosion	The resistance of the surface of the soil to erosion.	X	X	X
Soil surface loss or degradation	The loss or degradation of the soil surface layer.	X	X	X
Compaction layer	Presence of a near-surface layer of dense soil caused by repeated impacts on or disturbances of the soil surface, and the thickness of this layer.	X	X	X
Functional/ structural groups	Abundance and relative dominance of groups of plant species; groups are based on similarity in characteristics such as height, volume, root structure, type of photosynthesis, or life cycle.	X		
Plant mortality/ decadence	The proportion of dead or decadent (for example, moribund or dying) plants, compared with young or mature plants, in the plant community.	X		
Litter amount	The cover of litter and the depth of litter, which is any dead plant material that is detached from the base of the plant and is in contact with the soil surface.	X	X	
Annual production	The net quantity of aboveground plant material produced within a year.	X		

Table 3. Continued.

Rangeland Health Indicator	Description	Biotic Integrity	Hydrologic Function	Soil/Site Stability
Invasive plants	Plants that are invasive to the sample location, with invasive plants being plants that are not part of, or are a minor component of, the original plant community and that have the potential to become a dominant or codominant species on the sample location if their future establishment and growth are not actively controlled by management actions.	X		
Reproductive capability of perennial plants	The seed production of sexually reproducing plants and tiller or rhizome production of asexually reproducing plants.	X		
Rills	The number and extent of rills, which are small, generally linear erosional water flows across the surface of the soil.		X	X
Gullies	The number of gullies, which are channels cut into the soil by moving water, and the erosion associated with gullies.		X	X
Water flow patterns	The presence of water flow patterns, which is the path that water takes across the soil surface during overland flow caused by rainstorms or snowmelt.		X	X
Pedestals and/or terracettes	The number and height of pedestals and terracettes caused by erosion. Pedestals are rocks or plants that appear elevated as a result of soil loss by wind or water erosion. Terracettes are benches of soil deposition caused by water movement and located behind obstacles.		X	X
Bare ground	The amount and distribution of bare ground, which is exposed mineral or organic soil that is susceptible to raindrop splash erosion.		X	X
Plant community composition and distribution relative to infiltration and runoff	The distribution of the amount and type of vegetation in relation to its ability to control infiltration of water and runoff of water.		X	
Wind-scoured, blowout, and/or depositional areas	The extent of wind-scoured, blowout, and depositional areas caused by accelerated wind erosion of soil.			X
Litter movement	The degree and amount of litter movement caused by erosion by wind or water, with litter being dead plant material that is in contact with the soil surface.			X

The assessment team used the attributes of rangeland health to characterize the condition of renewable resources on BLM rangelands. The data collectors collected rangeland health assessment data on only 828 points because requisite soils data for identifying reference conditions was not available at all sampling locations. The 2011 BLM RRA reported on six indicators derived from the rangeland health assessment protocol (table 2).

Line-Point Intercept with Plot-Area Species Inventory

Line-Point Intercept:

The line-point intercept (LPI) method estimates foliar and basal plant cover as well as the proportion of the plot that is bare ground or otherwise nonvegetated (e.g., rock). The 2011 RRA used LPI to describe the presence and relative abundance of plants and soil features in a plot. At 3-foot (0.9-meter) intervals along each plot transect, the data collectors dropped a long, narrow pin and recorded aerial foliage of vegetation touching the pin by species. They also recorded any plant species intercepted by the pin at the ground surface as well as litter, rock, and the soil surface. For a more detailed description of the LPI technique, see Herrick et al. (2009).

The data collectors used the LPI method to collect data on bare ground and foliar and basal cover of nonnative invasive plant species. The CSSM used these data to calculate the average amount of bare ground on BLM rangelands, the proportion of BLM rangelands with equal to or more than 20%, 30%, 40%, and 50% bare ground, and the proportion of BLM rangelands with abundant nonnative invasive plant species (table 2). The data collectors recorded bare ground for pins that did not hit plants and did not hit rock or gravel. The CSSM calculated bare ground for each plot as the number of pins that hit bare ground at the soil surface, divided by the total number of pin drops along the two transects, and then multiplied by 100. The assessment team considered nonnative invasive plant species abundant when ≥25% of foliar intercepts of vegetation on the line transects in a plot were nonnative invasive plant species.

Plot-Area Species Inventory:

The plot-area species inventory captured the presence of a majority of plant species occurring in the plot. The data collectors searched the entire plot area systematically to identify all plant species encountered. Searches lasted 15 minutes.

The data collectors used LPI supplemented with the plot-area species inventory method to collect data on nonnative invasive plant species. The CSSM used these data to calculate the proportion of rangelands with nonnative invasive plant species present (table 2). The data collectors recorded the presence of nonnative invasive plant species in the plot if at least one nonnative invasive plant species was detected either on the line transects or on the walking search of the plot area. Appendix A lists nonnative invasive plant species included in the search of all plots.

Canopy Gap Intercept

The canopy gap intercept method (Herrick et al. 2009) estimates the proportion of a plot with gaps (i.e., areas without plant cover) of different sizes. An abundance of large canopy gaps can indicate decreased rangeland forage production, low-quality wildlife habitat, and an increased susceptibility to wind erosion. Potential for wind erosion is a function of canopy gap size and vegetation height, and most rangelands with canopy gaps of greater than 2 meters are at high risk for wind erosion (Okin 2008). The data collectors used the canopy gap intercept method on the same transects where they used the LPI method, measuring gaps in vegetation between the boundaries of the plant canopies along both plot transects. The canopy gap intercept method allowed the CSSM to calculate the proportion of BLM rangelands where vegetation gaps of at least 2 meters in length accounted for 20% or more of the length of the line transects (table 2).

Soil Aggregate Stability

Soil aggregate stability measures the ability of soils to hold together despite disturbance. Unstable soils are more susceptible to wind and water erosion (Pellant et al. 2005; Herrick et al. 2001).

The data collectors conducted a rangeland soil aggregate stability test (Herrick et al. 2001) at nine locations within each plot area. They collected surface soil samples at five locations along one transect and at four locations along the other transect. They exposed surface soil samples of about 6 millimeters (0.24 inches) in diameter to rapid wetting with water to determine the length of time it took for the soil sample to dissolve or crumble. The data collectors ranked the soil samples on a scale of 1 to 6. They based the rankings on observations of dissolving or crumbling during the first 5 minutes after immersion in distilled water and the percent of the soil sample remaining on a 1.5-millimeter (0.06-inch) sieve after five dipping cycles at the end of the 5-minute period. The higher the ranking, the greater the stability of the soil aggregate. The soil aggregate stability method allowed the CSSM to compute the average ranking for the nine soil aggregate tests for each plot area and calculate the proportion of BLM rangelands having an average soil aggregate stability ranking of 4 or less (table 2).

Data Summarization

The assessment team summarized the attribute and indicator data by ecoregions as defined by the U.S. Environmental Protection Agency (EPA) *(https://www.epa.gov/eco-research/ecoregions-north-america)*. Ecoregions are areas that contain geographically distinct rangelands (USDI–BLM 2008). Ecoregions in the 2011 RRA were either EPA level II ecoregions, EPA level III ecoregions, or ecoregions created from a combination of EPA level III ecoregions. The ecoregions selected for the 2011 RRA balance the need to report on units that are meaningful for BLM rangelands with the available sample size. Figure 1 identifies the ecoregions and the number of locations sampled within each of them.

Two ecoregions, the Marine West Coast Forest and Mediterranean California, had few to no data collection points. The assessment team could not confidently say that the attribute and indicator estimates from the few points sampled represented conditions across these two ecoregions, so they excluded the ecoregions from the 2011 RRA. Removing the four points sampled in these ecoregions from the 883 total sampled points left 879 points in this RRA. If future data collection efforts include additional sample points, future RRAs may include these ecoregions.

Ecoregions in this 2011 RRA included the Arizona/New Mexico Mountains, Central Basin and Range, Eastern Cold Deserts, Madrean Archipelago, Northern Cold Deserts, South Central Semi-Arid Prairies, Warm Deserts, West Central Semi-Arid Prairies, and Western Cordillera. The CSSM calculated attributes and indicators within each of these ecoregions with statistics of mean (average), standard error (SE), coefficient of variation (CV), and an 80% *confidence interval*. Appendix B contains the attribute and indicator estimates by ecoregion.

What Is a Confidence Interval?

*A **confidence interval** represents the uncertainty associated with an indicator estimate due to sampling. A confidence interval of 80% means that if the sampling and measurements were repeated many times, 80% of the time the true value of the indicator would lie within the interval.*

The width of a confidence interval is determined by the underlying variability of the indicator being estimated as well as the number of samples. Wide-ranging confidence intervals are typically associated with very heterogeneous ecoregions or ecoregions with small sample sizes—both cases where the sampling effort may be insufficient. Narrow confidence intervals are typically associated with ecoregions with larger sample sizes.

The assessment team interpreted the calculated attributes and indicators to describe the status and condition of rangeland resources for each ecoregion. The ecoregion interpretations also highlight any differences between that ecoregion and other ecoregions for each attribute or indicator.

The assessment team determined differences in attributes or indicators across ecoregions or between pairs of ecoregions using an omnibus F test. The results of the omnibus F test showed that the estimates for each attribute or indicator were not all the same across the ecoregions (appendix C). The assessment team also performed pairwise comparisons of attribute and indicator estimates to determine significant differences between ecoregions (appendix D).

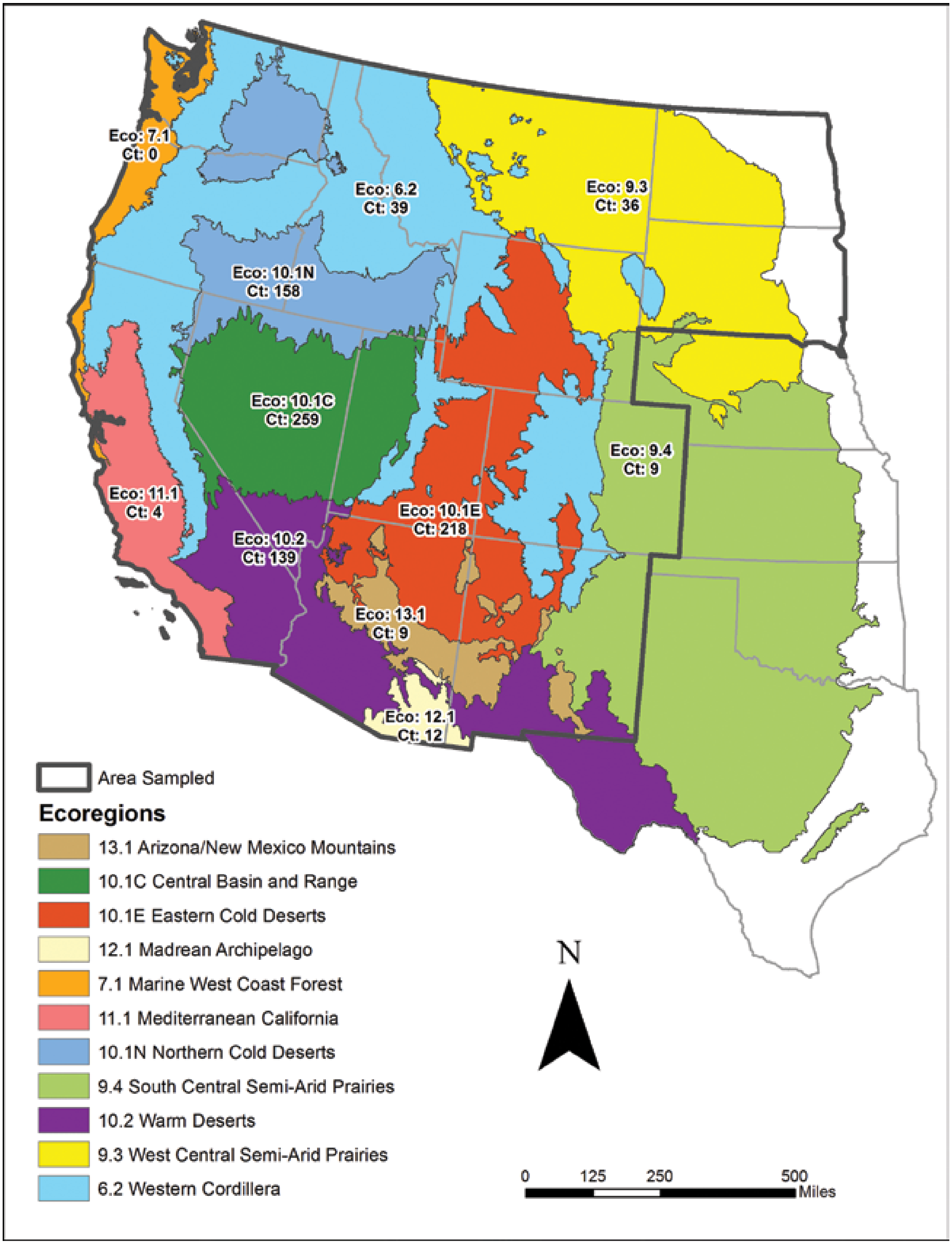

Figure 1. Ecoregions and the number of points sampled in each ecoregion (= ct) for the 2011 BLM RRA.

Extrapolation of Sample Data to BLM Rangelands

The 2011 RRA reports on rangeland resource status and condition based on a sample of 879 locations. The 879 locations in the sample are representative of rangeland resources on about 150 million acres of BLM lands across the ecoregions (table 4).

Table 4. The number of points sampled and the acres of BLM rangelands within each ecoregion.

Ecoregion	Number of Sample Points	Acres of BLM Rangelands*
Arizona/New Mexico Mountains	9	1,147,998
Central Basin and Range	259	42,027,281
Eastern Cold Deserts	218	34,546,049
Madrean Archipelago	12	1,094,849
Northern Cold Deserts	158	25,903,037
South Central Semi-Arid Prairies	9	1,623,357
Warm Deserts	139	28,328,632
West Central Semi-Arid Prairies	36	7,756,129
Western Cordillera	39	7,696,398
Total	879	150,123,730

* Acres of BLM rangelands estimated by the CSSM (Nusser et al. 2013).

Rangeland Resources Status and Condition

Arizona/New Mexico Mountains Ecoregion

Overview

The Arizona/New Mexico Mountains ecoregion is an EPA level III ecoregion (figure 2). The climate is variable, but generally characterized by warm to hot summers and mild winters. Mean annual temperatures vary with elevation, ranging from 19 °C in lower southern valleys to 3 °C at high elevations. More than half the precipitation occurs with thunderstorms in July, August, and September. The remaining precipitation occurs from December through March with frontal storms from the Pacific. Mean annual precipitation is 477 mm, ranging from 270 mm at lower elevations to more than 1,000 mm on higher peaks. Steep foothills, mountains, and high plateaus characterize the terrain. Chaparral shrublands dominate the vegetation in the lowlands. At middle elevations, pinyon-juniper woodlands are common, and higher elevations have evergreen forests (Wiken et al. 2011).

Figure 2. Agua Fria National Monument, Arizona, within the Arizona/New Mexico Mountains ecoregion (BLM photo).

Status and Condition

Results of this RRA represent a bird's-eye view of the status and condition of BLM rangelands within each ecoregion in 2011. Status is the amount of a renewable resource at a point in time. Condition is the status of a renewable resource in comparison against a reference value. The assessment team reported all indicators using an 80% confidence interval. An 80% confidence interval means that there is an 80% chance that the true population mean lies within that range. Average conditions for an attribute or an indicator in this ecoregion will fall within this range. For more information, see "Data Summarization." Differences in climate, vegetation type, physiography, and similar broad-scale factors likely drive differences in ecoregion status (e.g., bare ground). Differences in management factors likely drive differences in condition (e.g., rangeland health attributes).

Figure 3 shows the means and 80% confidence intervals for each indicator. Within the Arizona/New Mexico Mountains ecoregion, average bare ground on BLM rangelands was between 10% and 33%. Bare ground refers to bare mineral soil with no vegetation, rocks, litter, or other cover above it. Greater amounts of bare ground suggest an increased risk of soil erosion (Smith and Wischmeier 1962, Morgan 1986, Benkobi et al. 1993, Blackburn and Pierson 1994, Pierson et al. 1994, Gutierrez and Hernandez 1996, and Cerda 1999 in Pellant et al. 2005). Between 18% and 89% of the rangelands here had at least 20% bare ground. Some rangelands had at least 30% bare ground, but the sample size was not large enough to confidently estimate the proportion of BLM rangelands. No BLM rangelands sampled in this ecoregion had at least 40% bare ground.

Soil stability and occurrence of large canopy gaps are notable indicators of the status of the Arizona/New Mexico Mountains ecoregion. Most soils in this ecoregion had low aggregate stability, suggesting high erosion potential. Between 89% and 100% of BLM rangelands had soils that are susceptible to breaking apart and eroding from wind and water. Only the Madrean Archipelago and Warm Deserts ecoregions had as much rangeland with unstable soils as the Arizona/New Mexico Mountains ecoregion (figure 4). Between 29% and 92% of the rangelands in the Arizona/New Mexico Mountains ecoregion had large gaps (≥2 meters) between plant canopies that comprised more than 20% of the soil surface. The "openness" of the vegetation suggests that BLM rangelands in this ecoregion may be more vulnerable to soil erosion by water and wind. Most rangelands with canopy gaps of greater than 2 meters are at high risk for wind erosion (Okin 2008).

Nonnative invasive plant species had colonized an estimated 6% to 100% of BLM rangelands in the Arizona/New Mexico Mountains ecoregion. Some BLM rangelands had abundant nonnative invasive plants, but the sample size was not large enough to confidently estimate the proportion of BLM rangelands. Nonnative invasive plant species often outcompete native plant species for growing space, causing a decline in abundance of native plant species. This decline in turn causes changes in wildlife habitat availability, wildfire frequency and severity, and susceptibility of soil to erosion.

An estimated 19% to 52% of the rangelands in the Arizona/New Mexico Mountains ecoregion were at risk of declining biotic integrity relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that these rangelands and their associated plant, animal, and microorganism communities may be starting to have trouble cycling water and nutrients, capturing energy from sunlight, and sustaining other ecological processes. More rangelands are at risk of declining biotic integrity here than on nearly all remaining BLM rangelands (figure 5). Some BLM rangelands had diminished biotic integrity relative to reference conditions (rating of moderate-to-extreme or extreme-to-total departure), but the sample size was not large enough to confidently estimate the proportion.

Some BLM rangelands in the Arizona/New Mexico Mountains ecoregion were at risk of declining hydrologic function relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005), but the sample size was not large enough to confidently estimate the proportion. Likewise, some BLM rangelands sampled in this ecoregion had diminished hydrologic function relative to reference conditions (moderate-to-extreme or extreme-to-total departure). The sample size was not large enough to confidently estimate the proportion of rangelands.

No BLM rangelands sampled in the Arizona/New Mexico Mountains ecoregion were at risk of declining soil and site stability relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). Some BLM rangelands sampled in this ecoregion had diminished soil and site stability relative to reference conditions (moderate-to-extreme or extreme-to-total departure), but the sample size was not large enough to confidently estimate the proportion of rangelands.

Implications for Productivity

Rangeland health assessments showed that declining biotic integrity was a primary threat to productivity in the Arizona/New Mexico Mountains, with at least one-fifth of the ecoregion at risk of decline. In addition, low soil aggregate stability and large intercanopy gaps present on large proportions of the rangelands suggest further declines in soil and site stability and hydrologic function and, thus, future productivity.

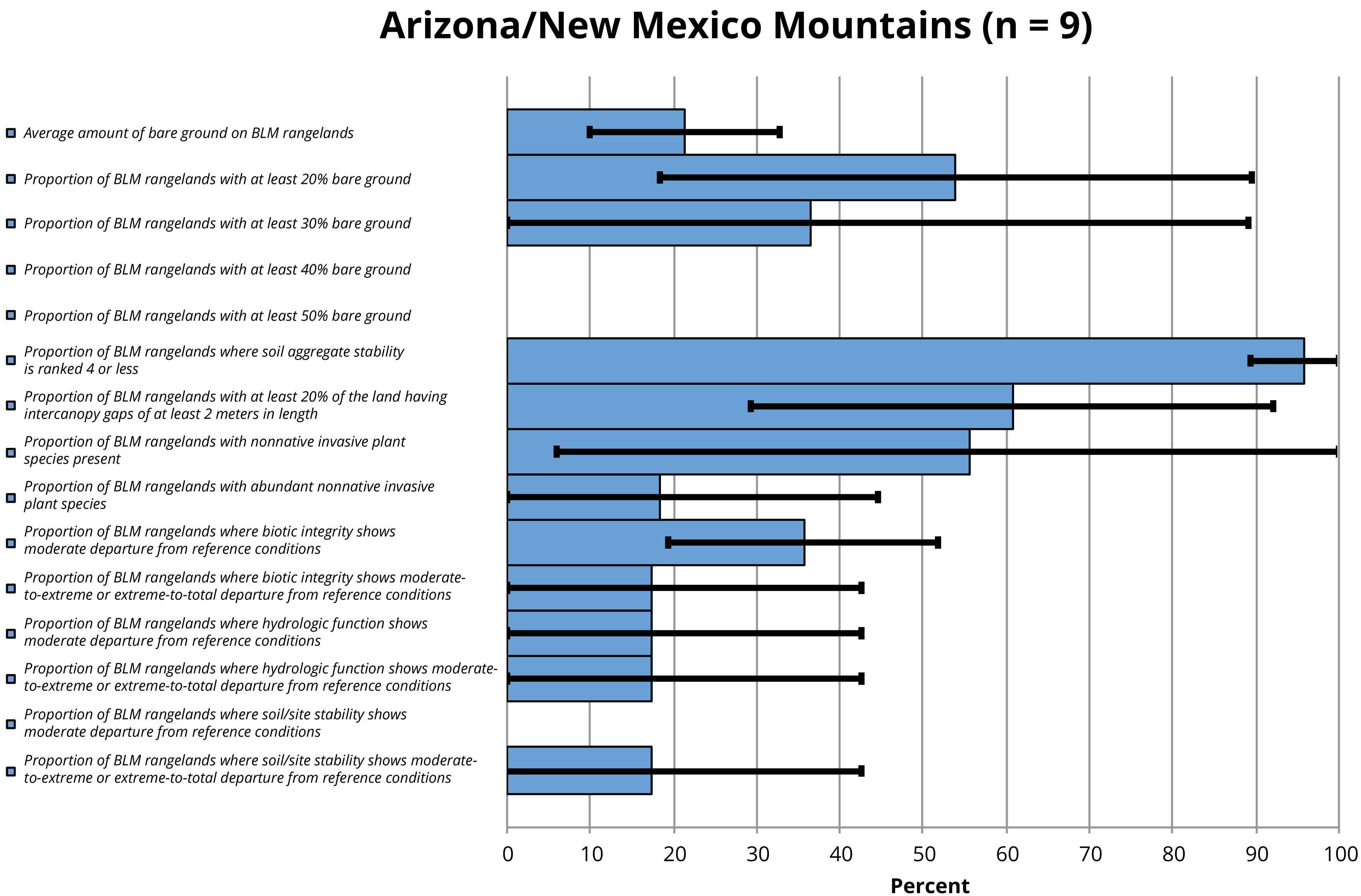

Figure 3. Mean and 80% confidence interval for attributes and indicators in the Arizona/New Mexico Mountains ecoregion.

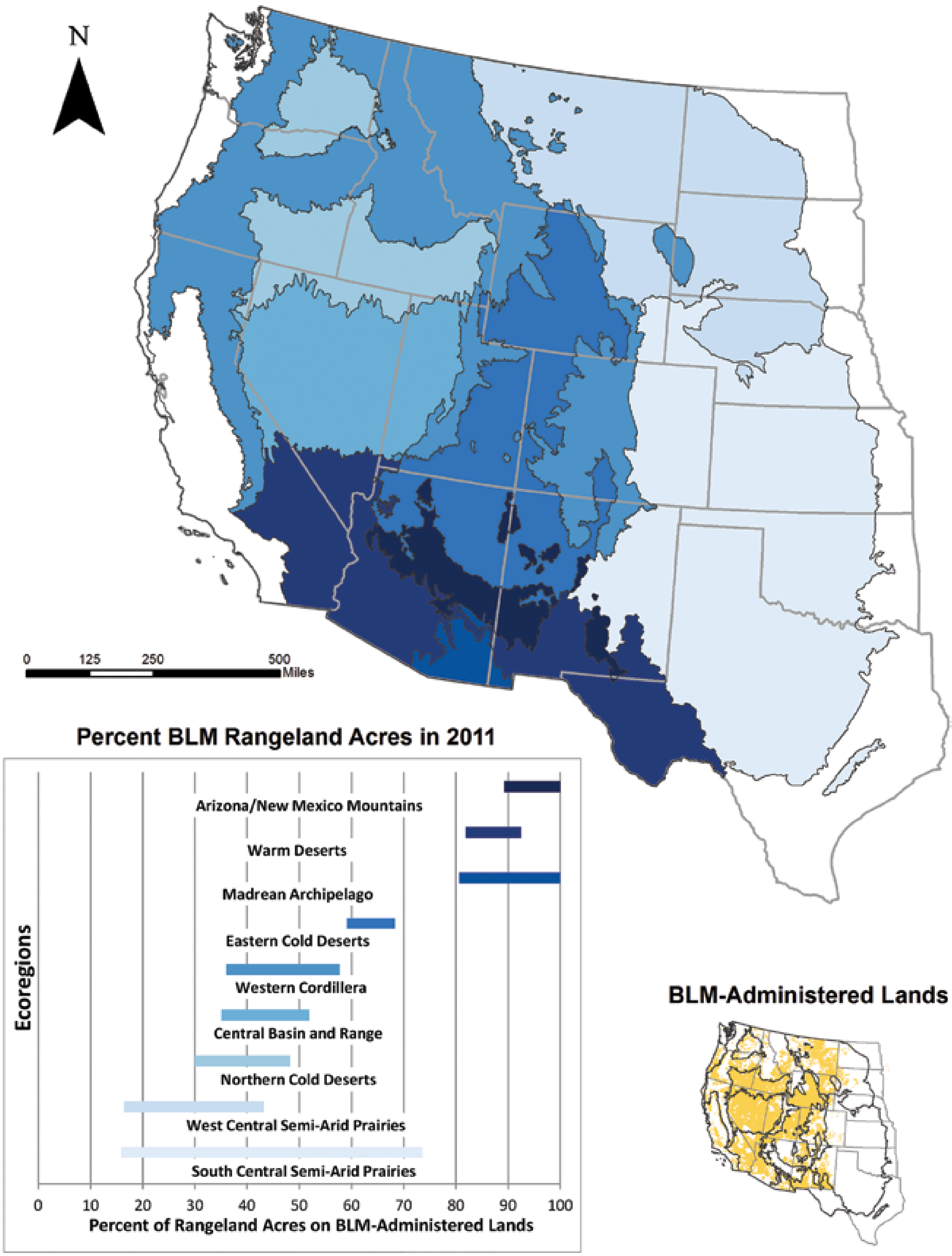

Figure 4. Proportion of BLM rangelands where soil aggregate stability is ranked 4 or less (80% confidence interval) within ecoregions.

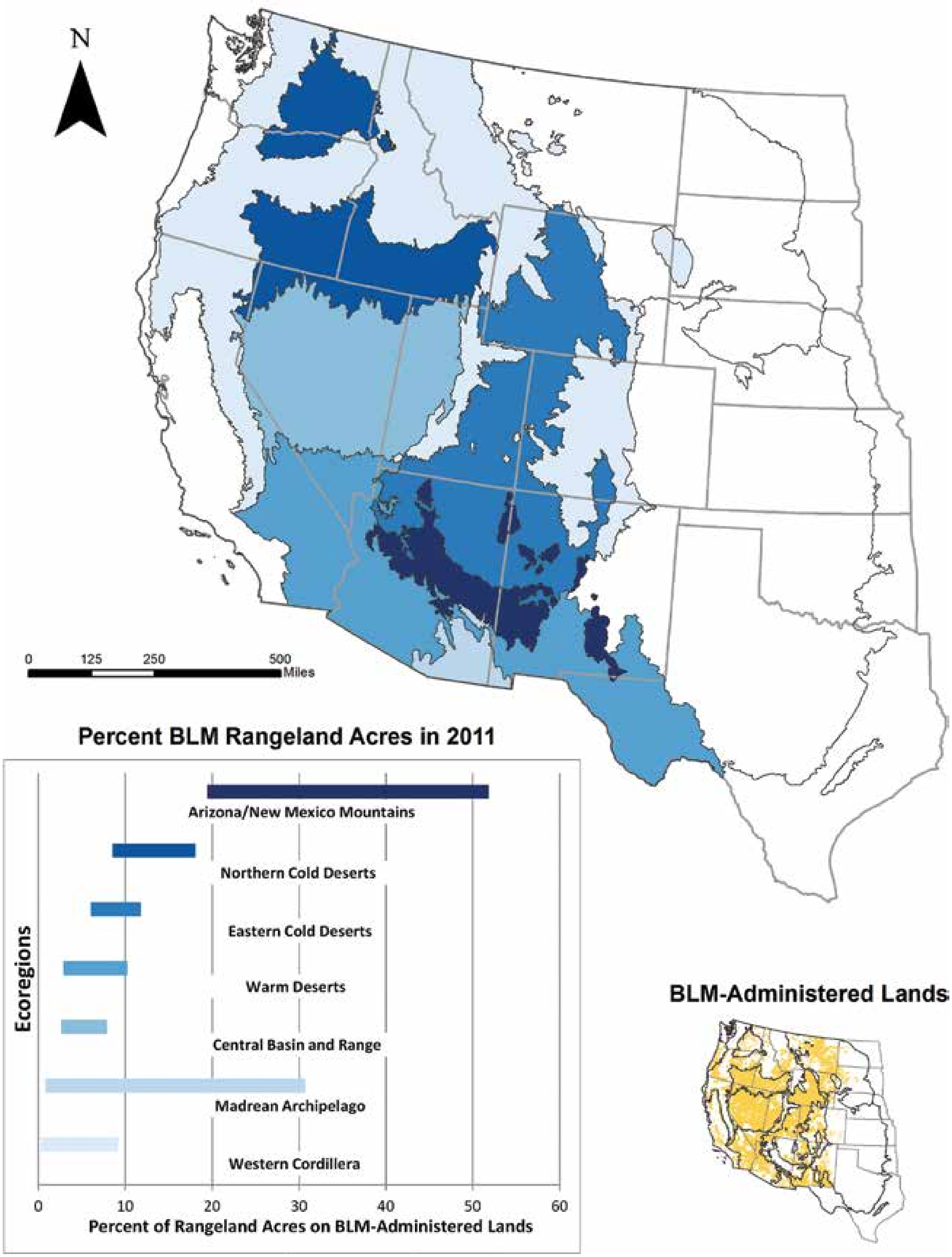

Figure 5. Proportion of BLM rangelands where biotic integrity shows moderate departure from reference conditions (80% confidence interval) within ecoregions.

Central Basin and Range Ecoregion

Overview

The Central Basin and Range ecoregion is an EPA level III ecoregion (figure 6). Hot summers and mild winters are typical in this ecoregion. Mean annual temperatures vary with elevation, ranging from 14 °C in lowlands to 2 °C in the mountains. Mean annual precipitation is 277 mm, ranging from 4 mm to more than 1,000 mm. Most of the rainfall occurs in the summer. Broad basins and valleys interrupted by mountain ranges characterize the terrain. Basin vegetation is shrub-dominated with primarily cool-season native grasses. Mountain vegetation ranges from shrublands at lower elevations to forests at higher elevations (Wiken et al. 2011).

Status and Condition

Results of this RRA represent a bird's-eye view of the status and condition of BLM rangelands within each ecoregion in 2011. Status is an amount of a renewable resource at a point in time. Condition is the status of a renewable resource in comparison against a reference value. The assessment team reported all indicators using an 80% confidence interval. An 80% confidence interval means that there is an 80% chance that the true population mean lies within that range. Average conditions for an attribute or an indicator in this ecoregion will fall within this range. For more information, see "Data Summarization." Differences in climate, vegetation type, physiography, and similar broad-scale factors likely drive differences in ecoregion status (e.g., bare ground). Differences in management factors likely drive differences in condition (e.g., rangeland health attributes).

Figure 6. Black Rock Desert–High Rock Canyon Emigrant Trails National Conservation Area, north of Gerlach, Nevada, within the Central Basin and Range ecoregion (BLM photo).

Figure 7 shows the means and 80% confidence intervals for each indicator. Within the Central Basin and Range ecoregion, average bare ground on BLM rangelands was between 16% and 25%. Bare ground refers to bare mineral soil with no vegetation, rocks, litter, or other cover above it. Greater amounts of bare ground suggest an increased risk of soil erosion (Smith and Wischmeier 1962, Morgan 1986, Benkobi et al. 1993, Blackburn and Pierson 1994, Pierson et al. 1994, Gutierrez and Hernandez 1996, and Cerda 1999 in Pellant et al. 2005). A large proportion of BLM rangelands, between 30% and 46%, had at least 20% bare ground, and only 8% to 20% of BLM rangelands had at least 40% bare ground.

BLM rangelands in the Central Basin and Range had less bare ground than BLM rangelands in the Eastern Cold Deserts and Warm Deserts ecoregions (figure 8). Likewise, a smaller proportion of BLM rangelands in this ecoregion had large amounts of bare ground (i.e., at least 20%, 30%, or 40% bare ground) than in the Eastern Cold Deserts and Warm Deserts (figures 9, 10, and 11). BLM rangelands in the Central Basin and Range had greater amounts of bare ground than BLM rangelands in the West Central Semi-Arid Prairies (figure 8). More of the BLM rangelands here had large amounts of bare ground (at least 40% or 50% bare ground on average) than in the Northern Cold Deserts (figures 11 and 12).

Many soils in the Central Basin and Range had low soil aggregate stability, suggesting high erosion potential. Between 35% and 52% of BLM rangelands had soils that are susceptible to breaking apart and eroding from wind and water. However, the proportion of BLM rangelands with unstable soils was less than in the Arizona/New Mexico Mountains, Eastern Cold Deserts, Madrean Archipelago, and Warm Deserts (figure 4).

Between 52% and 66% of BLM rangelands in the Central Basin and Range ecoregion had large gaps (≥2 meters) between plant canopies that comprised more than 20% of the soil surface. This greater "openness" of the vegetation suggests that BLM rangelands in this ecoregion may be more vulnerable to soil erosion by water and wind. Most rangelands with canopy gaps of greater than 2 meters are at high risk for wind erosion (Okin 2008). Large gaps between plant canopies were more prevalent on BLM rangelands in the Central Basin and Range than in the Eastern Cold Deserts, Northern Cold Deserts, and West Central Semi-Arid Prairies, but less prevalent than in the Warm Deserts (figure 13).

The presence and abundance of nonnative invasive plant species is a notable indicator of the condition of BLM rangelands in the Central Basin and Range ecoregion. Nonnative invasive plant species had colonized a large proportion of BLM rangelands in this ecoregion, on average between 66% and 80%. Between 34% and 52% of BLM rangelands had abundant nonnative invasive plants. Nonnative invasive plant species often outcompete native plant species for growing space, causing declines in abundance of native plant species. This decline in turn causes changes in wildlife habitat availability, wildfire frequency and severity, and susceptibility of soil to erosion. The Central Basin and Range ecoregion had a greater proportion of BLM rangelands colonized by nonnative invasive plant species than the Eastern Cold Deserts, South Central Semi-Arid Prairies, Warm Deserts, West Central Semi-Arid Prairies, and Western Cordillera (figure 14). The Central Basin and Range also had a greater proportion of BLM rangelands with abundant nonnative invasive plant species than the Eastern Cold Deserts, Warm Deserts, and Western Cordillera (figure 15).

An estimated 3% to 8% of the BLM rangelands in the Central Basin and Range ecoregion were at risk of declining biotic integrity relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that these rangelands and their associated plant, animal, and microorganism communities may be starting to have trouble cycling water and nutrients, capturing energy from sunlight, and sustaining other ecological processes. Some BLM rangelands in this ecoregion had diminished biotic integrity relative to reference conditions (moderate-to-extreme or extreme-to-total departure), but the proportion could not be confidently estimated attributable to insufficient sample size.

An estimated 1% to 5% of BLM rangelands in the Central Basin and Range ecoregion were at risk of declining hydrologic function relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that the soils and vegetation on these rangelands may be starting to have trouble capturing, storing, and safely releasing water. A lower proportion of rangelands were at risk of declining hydrologic function in Central Basin and Range than in the Eastern Cold Deserts, Warm Deserts, and West Central Semi-Arid Prairies (figure 16). No BLM rangelands sampled in this ecoregion had diminished hydrologic function relative to reference conditions (moderate-to-extreme or extreme-to-total departure).

An estimated 0.4% to 3% of BLM rangelands in the Central Basin and Range ecoregion were at risk of declining soil and site stability relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that excessive amounts of soil may be eroding by wind and water on these rangelands. No BLM rangelands sampled in this ecoregion had diminished soil and site stability relative to reference conditions (moderate-to-extreme or extreme-to-total departure).

Implications for Productivity

Rangeland health assessments showed that less than 10% of the Central Basin and Range ecoregion was at risk of declining productivity, with biotic integrity at risk of the largest declines. However, abundant nonnative invasive plant species and frequent large plant canopy gaps represent potential threats to biotic integrity, soil and site stability, and hydrologic function and, thus, future productivity.

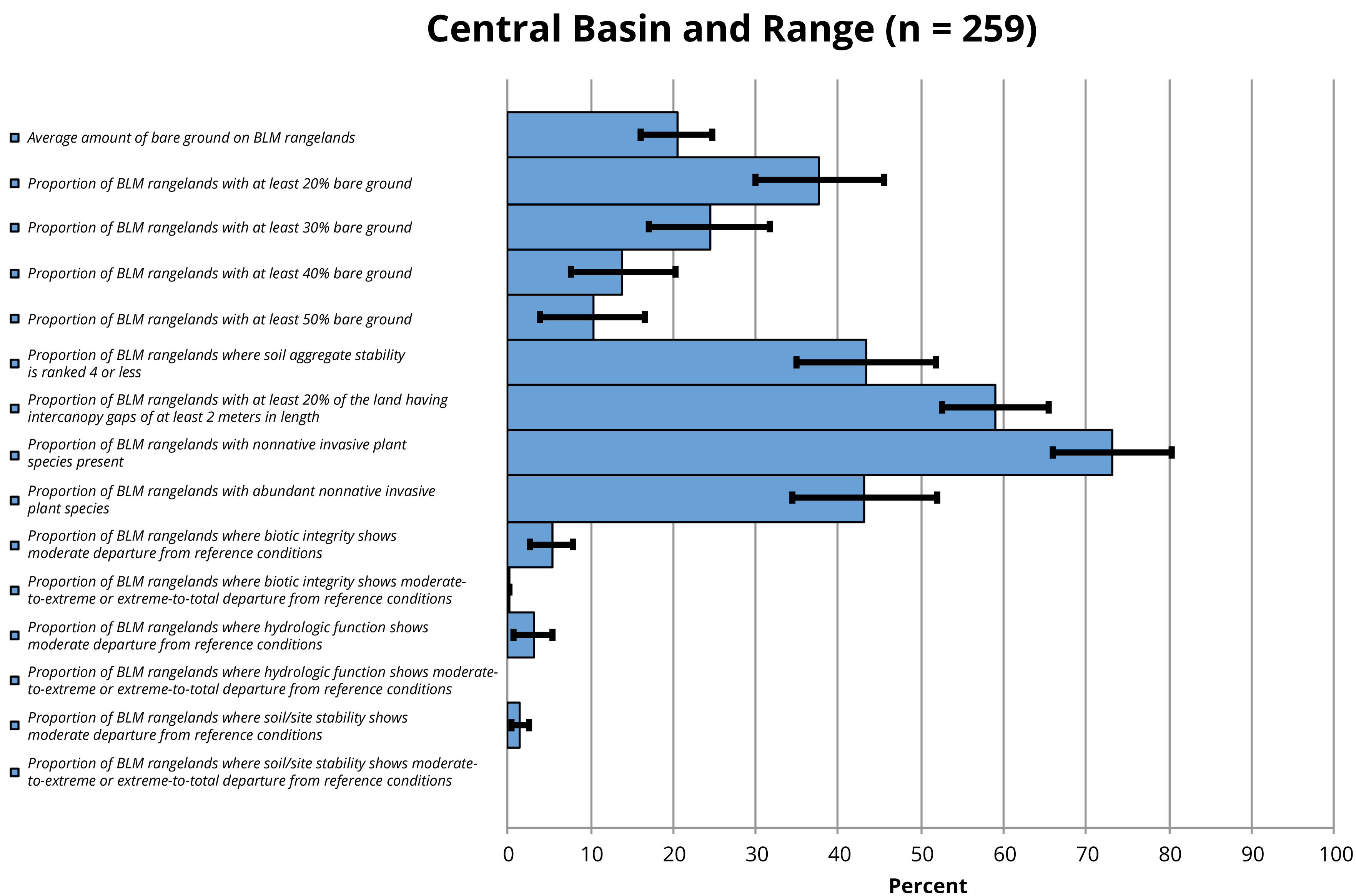

Figure 7. Mean and 80% confidence interval for attributes and indicators in the Central Basin and Range ecoregion.

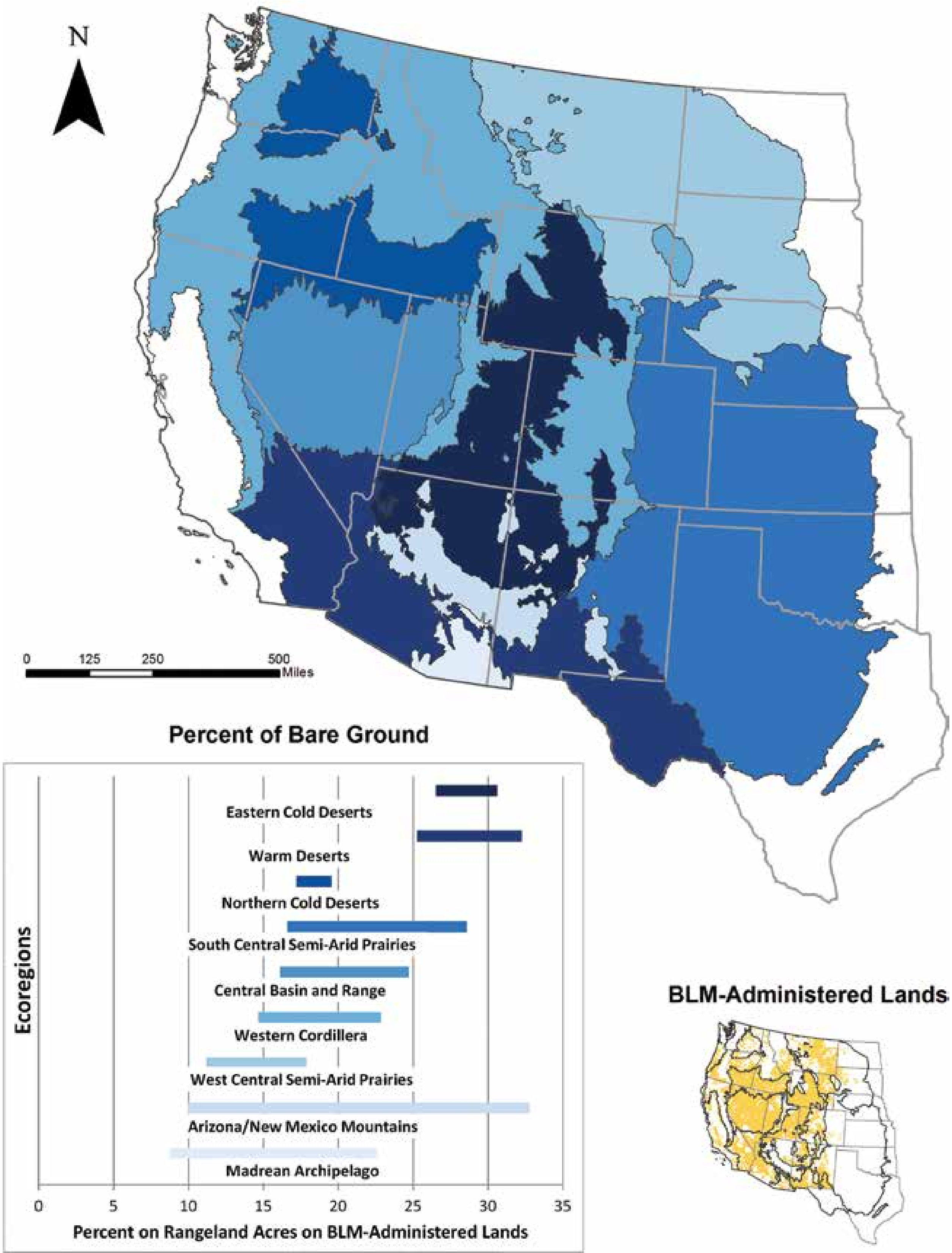

Figure 8. Average amount of bare ground (80% confidence interval) on BLM rangelands within ecoregions.

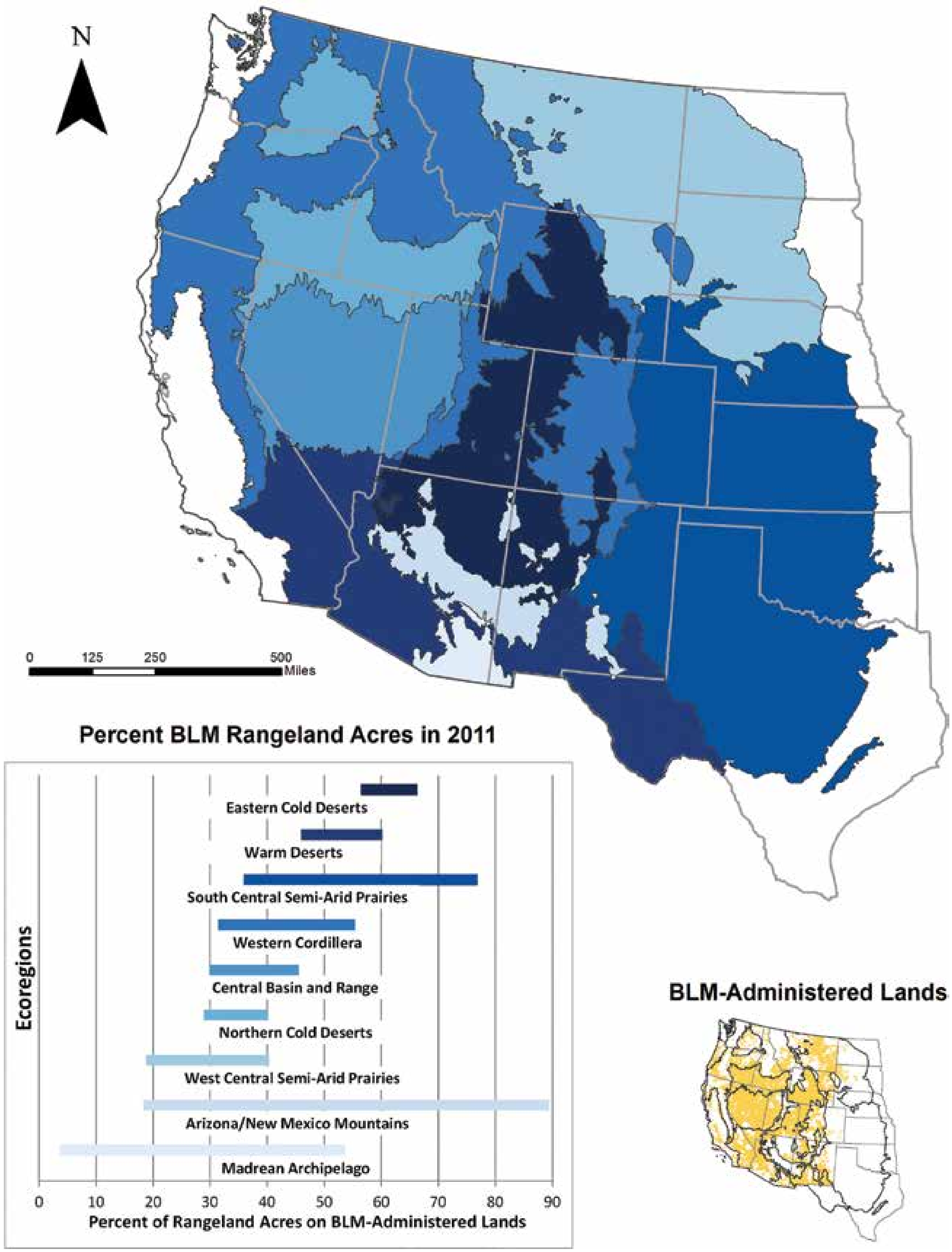

Figure 9. Proportion of BLM rangelands with at least 20% bare ground (80% confidence interval) within ecoregions.

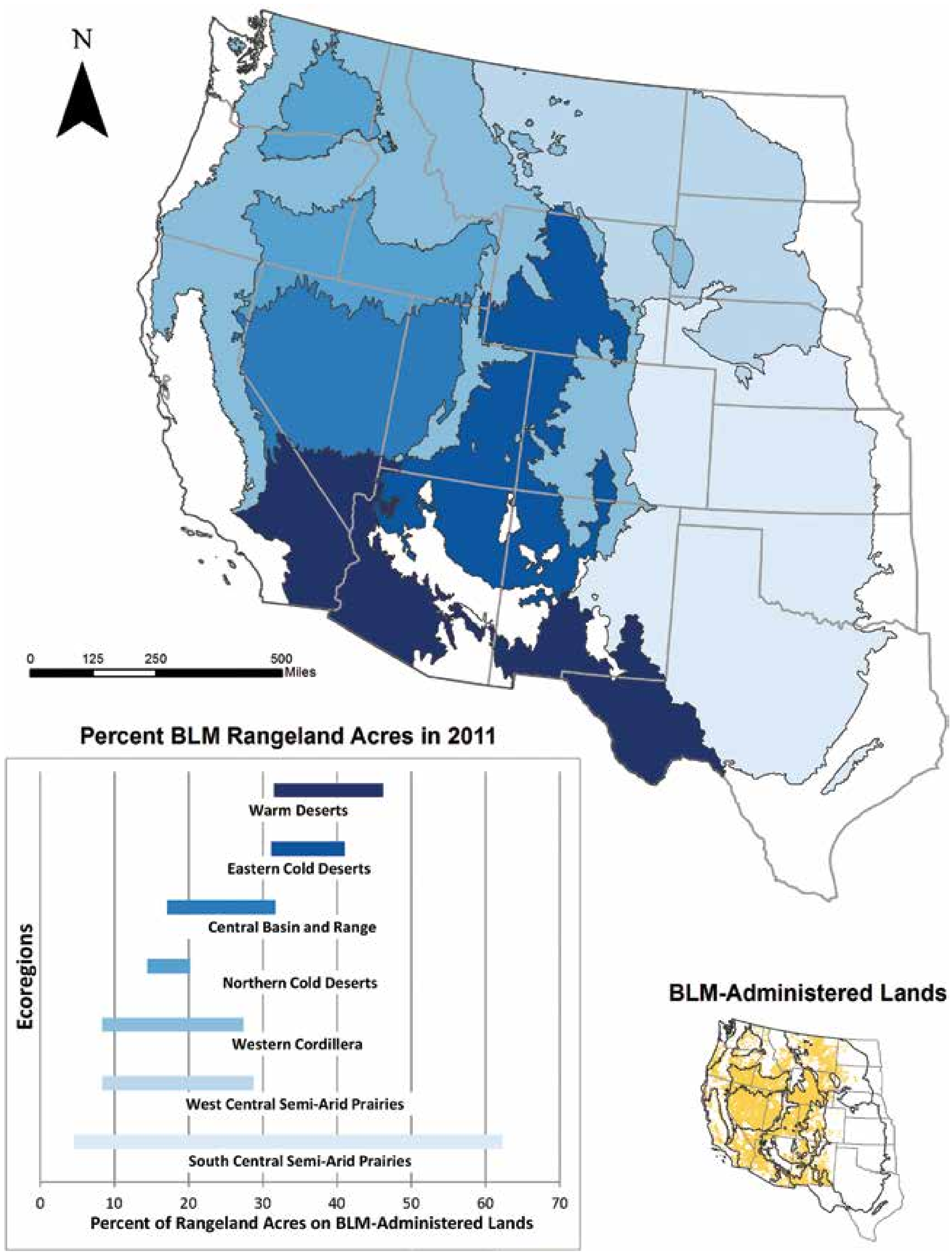

Figure 10. Proportion of BLM rangelands with at least 30% bare ground (80% confidence interval) within ecoregions.

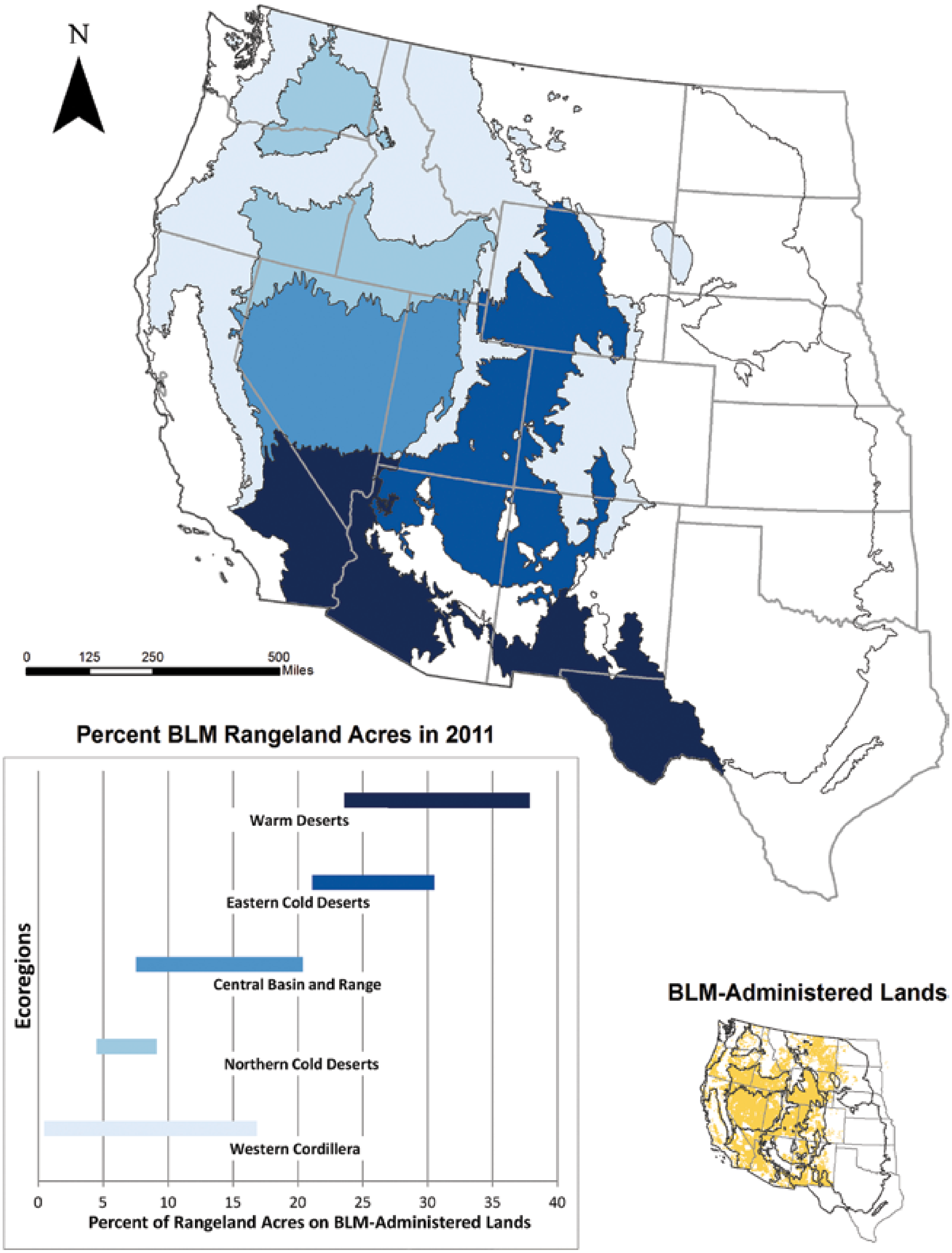

Figure 11. Proportion of BLM rangelands with at least 40% bare ground (80% confidence interval) within ecoregions.

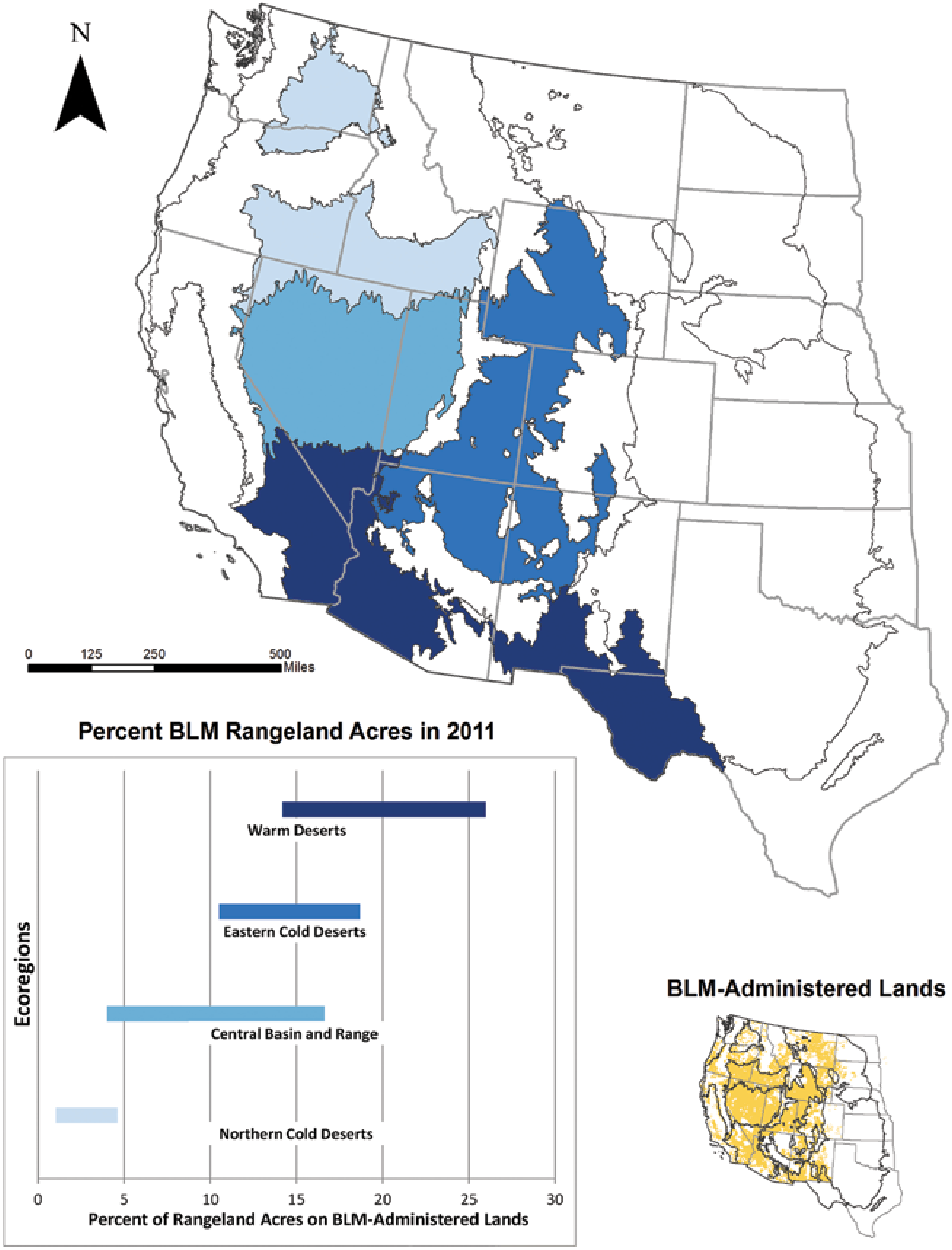

Figure 12. Proportion of BLM rangelands with at least 50% bare ground (80% confidence interval) within ecoregions.

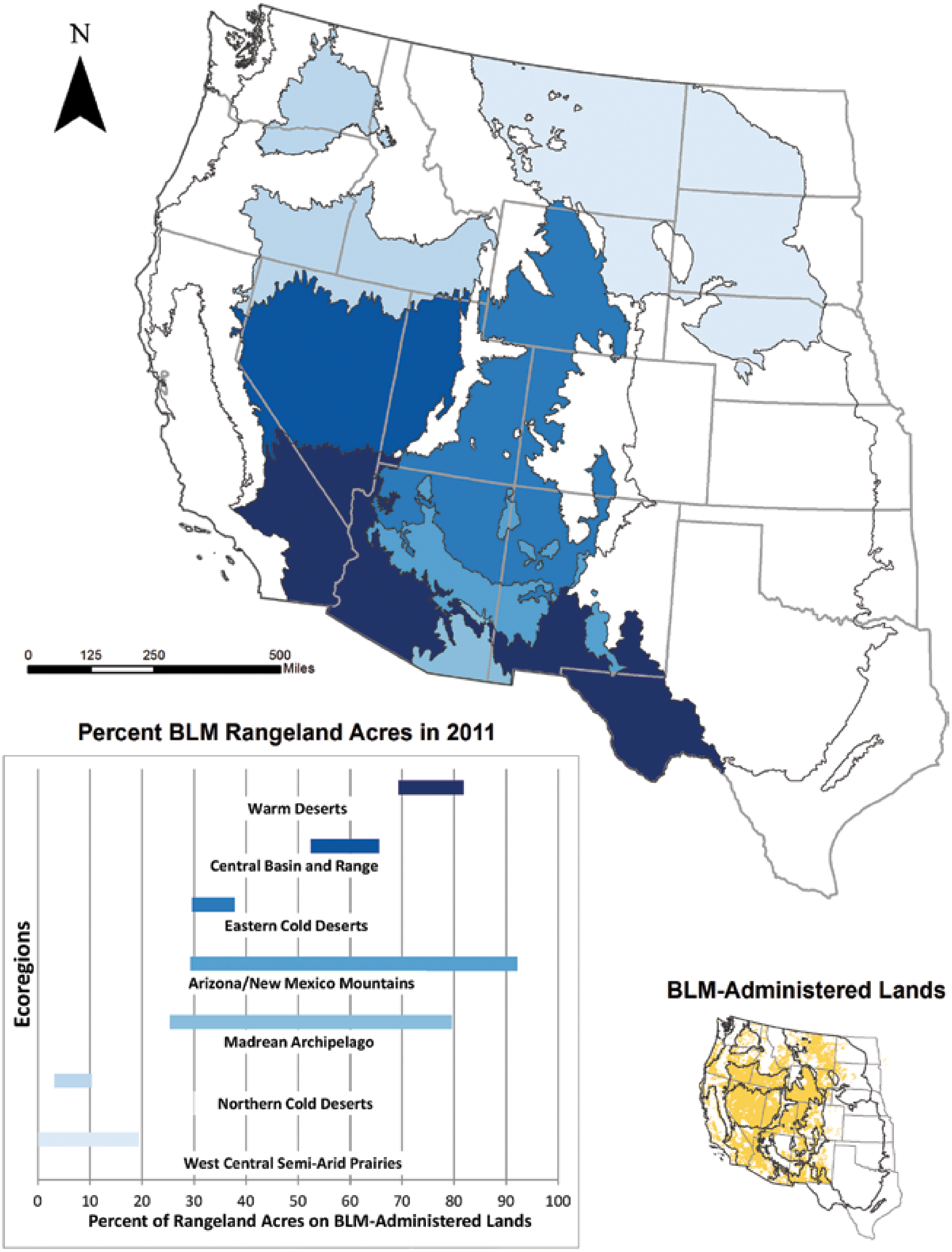

Figure 13. Proportion of BLM rangelands with at least 20% of the land having intercanopy gaps of at least 2 meters in length (80% confidence interval) within ecoregions.

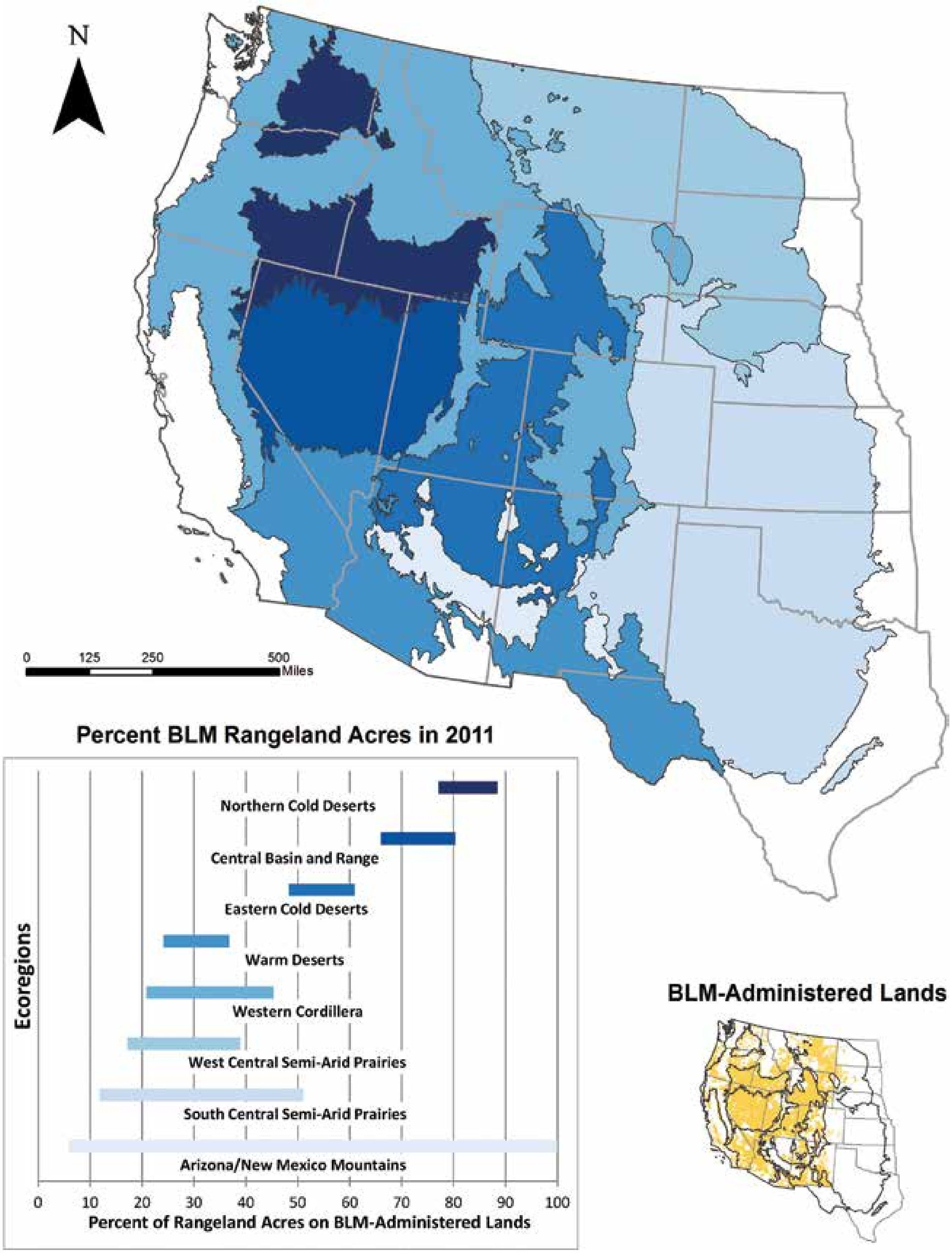

Figure 14. Proportion of BLM rangelands with nonnative invasive plant species present (80% confidence interval) within ecoregions.

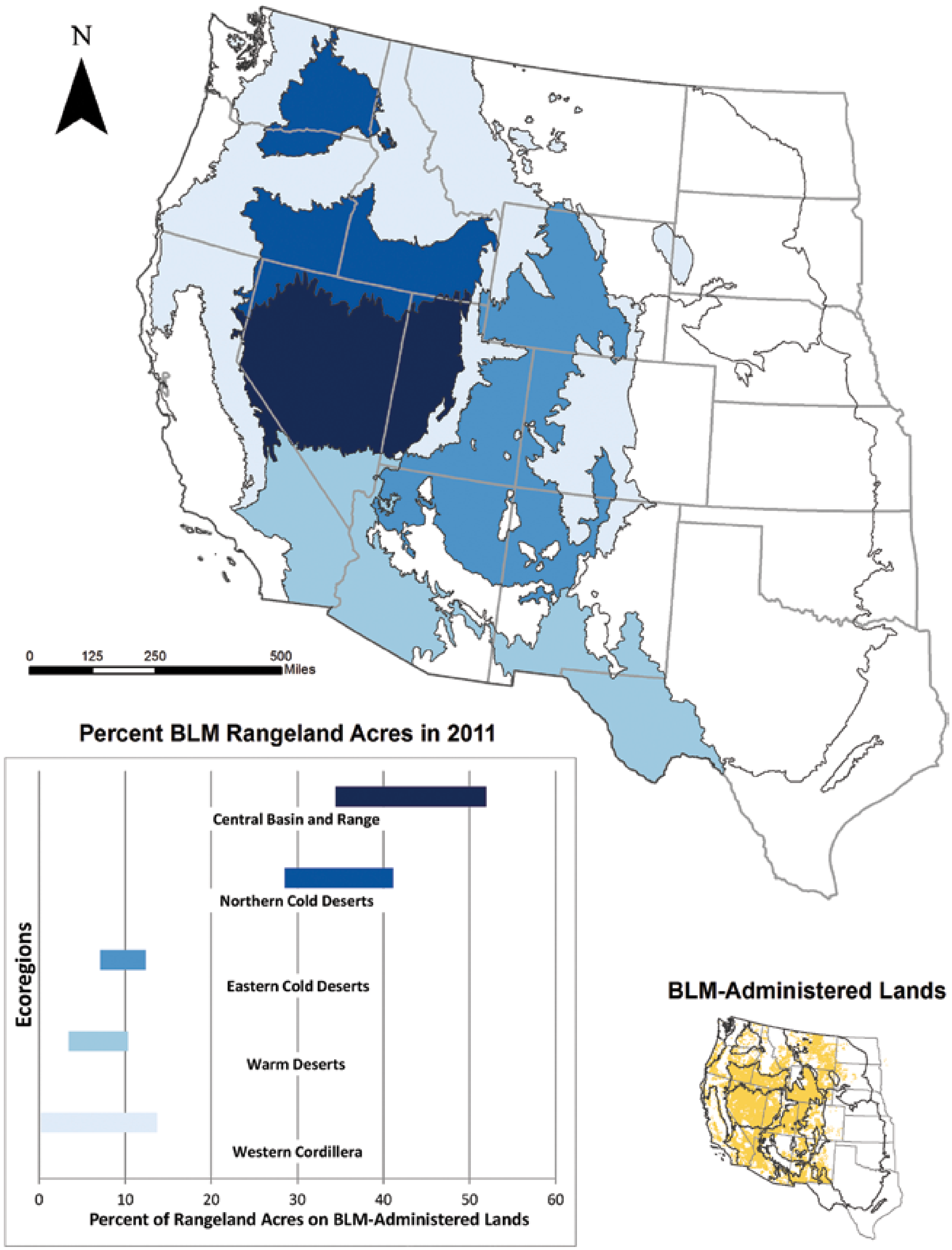

Figure 15. Proportion of BLM rangelands with abundant nonnative invasive plant species (80% confidence interval) within ecoregions.

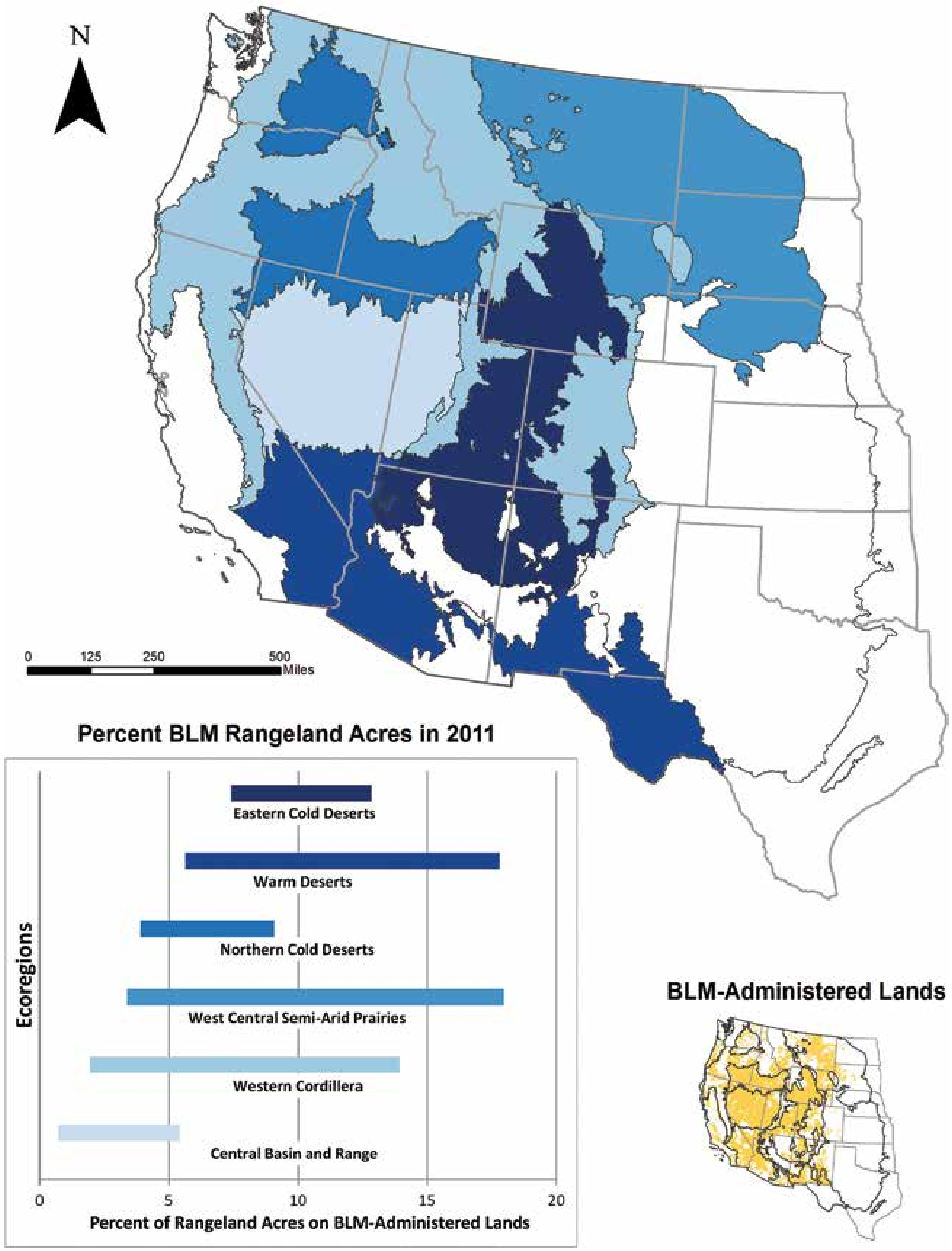

Figure 16. Proportion of BLM rangelands where hydrologic function shows moderate departure from reference conditions (80% confidence interval) within ecoregions.

Eastern Cold Deserts Ecoregion

Overview

The Eastern Cold Deserts ecoregion is composed of three EPA level III ecoregions: Wyoming Basins, Colorado Plateaus, and Arizona/New Mexico Plateau (figure 17). Warm to hot summers and cold winters are typical in the Eastern Cold Deserts ecoregion. Mean annual temperatures get slightly warmer as you move from north to south, ranging from 0 °C to 8 °C in the Wyoming Basins, 5 °C to 15 °C in the Colorado Plateau, and 5 °C to 16 °C in the Arizona/New Mexico Plateau. Mean annual precipitation averages 290 to 300 mm across all three subregions, with lows around 130 mm and highs up to 800 mm at higher elevations. Plains, plateaus, mesas, steep canyons and valleys are characteristic landforms. Grasslands and shrublands are the most common vegetation types. Some woodlands occur at higher elevations. Grasslands are more common in the northern and southern areas of the ecoregion (Wiken et al. 2011).

Status and Condition

Results of this RRA represent a bird's-eye view of the status and condition of BLM rangelands within each ecoregion in 2011. Status is an amount of a renewable resource at a point in time. Condition is the status of a renewable resource in comparison against a reference value. The assessment team reported all indicators using an 80% confidence interval. An 80% confidence interval means that there is an 80% chance that the true population mean lies within that range. Average conditions for an attribute or an indicator in this ecoregion will fall within this range. For more information, see "Data Summarization." Differences in climate, vegetation type, physiography,

Figure 17. Head of Sinbad, San Rafael Swell, Utah, within the Eastern Cold Deserts ecoregion (BLM photo).

and similar broad-scale factors likely drive differences in ecoregion status (e.g., bare ground). Differences in management factors likely drive differences in condition (e.g., rangeland health attributes).

Figure 18 shows the means and 80% confidence intervals for each indicator. Within the Eastern Cold Deserts ecoregion, average bare ground on BLM rangelands was between 27% and 31%. Bare ground refers to bare mineral soil with no vegetation, rocks, litter, or other cover above it. Greater amounts of bare ground suggest an increased risk of soil erosion (Smith and Wischmeier 1962, Morgan 1986, Benkobi et al. 1993, Blackburn and Pierson 1994, Pierson et al. 1994, Gutierrez and Hernandez 1996, and Cerda 1999 in Pellant et al. 2005). Bare ground was widespread on BLM rangelands in this ecoregion, with between 56% and 66% of the rangelands having at least 20% bare ground. Bare ground was more widespread in the Eastern Cold Deserts than on nearly all other BLM rangelands. Only rangelands in the Warm Deserts, South Central Semi-Arid Prairies, and Arizona/New Mexico Mountains had as much or more bare ground than the Eastern Cold Deserts (figure 8).

Many soils in the Eastern Cold Deserts had low soil aggregate stability, suggesting high erosion potential. Between 59% and 68% of BLM rangelands had soils that are susceptible to breaking apart and eroding from wind and water. Only rangelands in the Arizona/New Mexico Mountains, Madrean Archipelago, and Warm Deserts had more rangelands with erodible soils than the Eastern Cold Deserts (figure 4).

Between 30% and 38% of BLM rangelands in the Eastern Cold Deserts had large gaps (≥2 meters) between plant canopies that comprised more than 20% of the surface. This "openness" of the vegetation suggests that BLM rangelands in this ecoregion may be more vulnerable to soil erosion by water and wind. Most rangelands with canopy gaps of greater than 2 meters are at high risk for wind erosion (Okin 2008). Large gaps between plant canopies were more prevalent in the Eastern Cold Deserts than in the Northern Cold Deserts and West Central Semi-Arid Prairies. However, large gaps were less prevalent here than on BLM rangelands in the Central Basin and Range and Warm Deserts (figure 13).

Nonnative invasive plant species had colonized a large proportion of BLM rangelands in the Eastern Cold Deserts, between 48% and 61%. However, a relatively small proportion of these rangelands, between 7% and 12%, had abundant nonnative invasive plant species. Only BLM rangelands in the Central Basin and Range and Northern Cold Deserts had greater presence and abundance of nonnative invasive plant species than those in the Eastern Cold Deserts (figures 14 and 15).

An estimated 6% to 12% of BLM rangelands in the Eastern Cold Deserts ecoregion were at risk of declining biotic integrity relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that these rangelands and their associated plant, animal, and microorganism communities may be starting to have trouble cycling water and nutrients, capturing energy from sunlight, and sustaining other ecological processes. Biotic integrity had declined on between 1% and 3% of BLM rangelands in the Eastern Cold Deserts relative to reference conditions (moderate-to-extreme or extreme-to-total departure). This finding suggests that these rangelands may have lost some capacity to cycle water and nutrients, capture sunlight, and sustain other ecological processes. Only BLM rangelands in the Warm Deserts had lost more biotic integrity than those in the Eastern Cold Deserts (figure 19).

An estimated 7% to 13% of BLM rangelands in the Eastern Cold Deserts ecoregion were at risk of declining hydrologic function relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that soils and vegetation on these rangelands may be starting to have trouble capturing, storing, and safely releasing water. Hydrologic function had declined relative to reference conditions on between 1% and 4% of the rangelands (moderate-to-extreme or extreme-to-total departure). This finding suggests that soils and vegetation on these rangelands may have lost some capacity to capture, store, and safely release water. Only BLM rangelands in the Warm Deserts had lost more hydrologic function than those in the Eastern Cold Deserts (figure 20).

An estimated 6% to 11% of BLM rangelands in the Eastern Cold Deserts ecoregion were at risk of declining soil and site stability relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that excessive amounts of soil may be eroding by wind and water on these rangelands. Soil and site stability had declined relative to reference conditions on between 1% and 4% of the BLM rangelands (moderate-to-extreme or extreme-to-total departure). This finding suggests that excessive amounts of soil may have been lost on these rangelands. Only rangelands in the Warm Deserts have lost more soil and site stability than those in the Eastern Cold Deserts (figure 21).

Implications for Productivity

Rangeland health assessments showed that up to one-tenth of the Eastern Cold Deserts ecoregion was at risk of declining productivity attributable to declines in all three attributes of rangeland health: soil and site stability, hydrologic function, and biotic integrity. Only the Warm Deserts ecoregion exceeded the proportion of rangelands with declines in health. Large amounts of bare ground, unstable soils, and broad colonization of nonnative invasive plant species represent threats to rangeland health and, thus, future productivity.

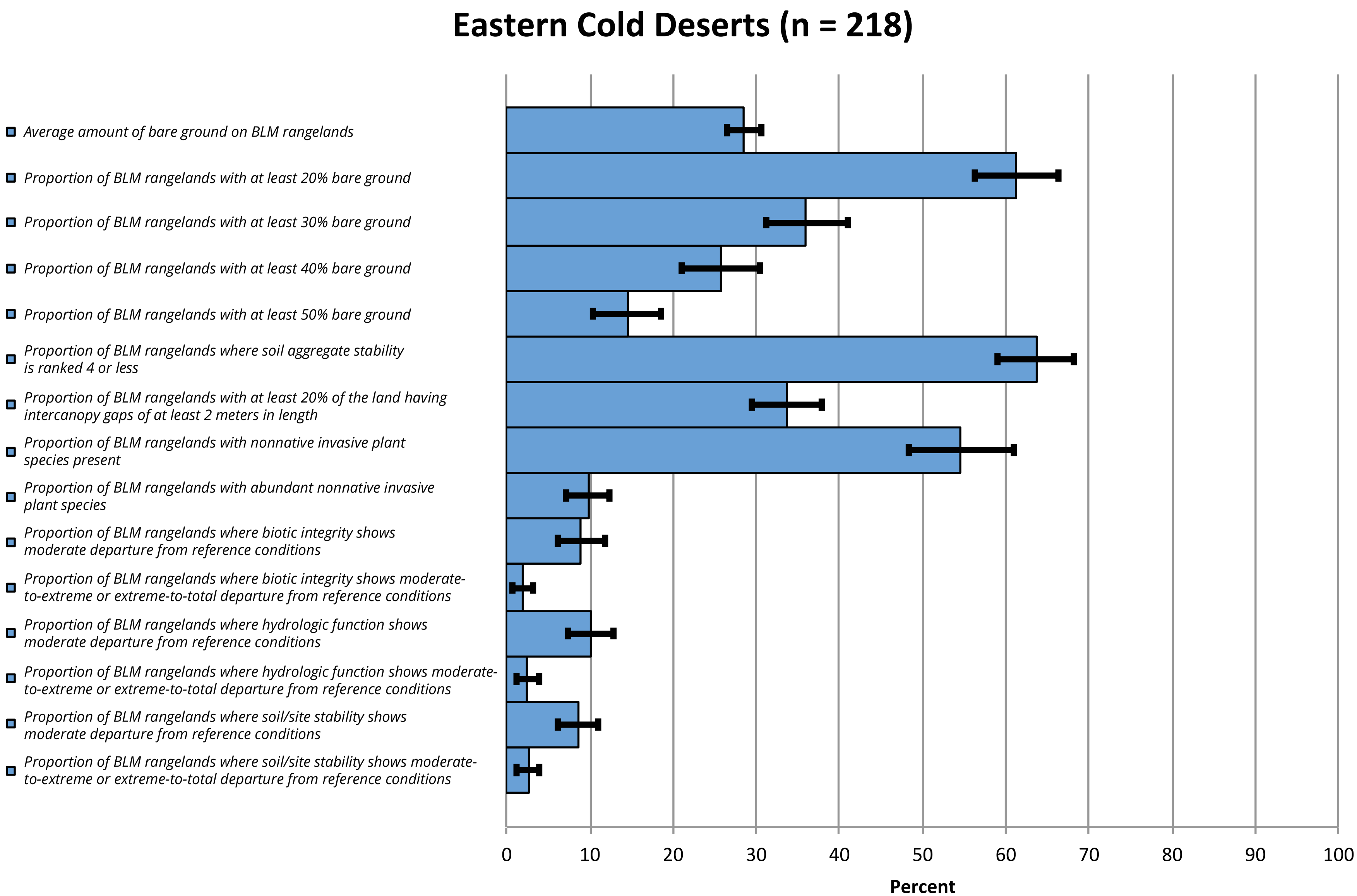

Figure 18. Mean and 80% confidence interval for attributes and indicators in the Eastern Cold Deserts ecoregion.

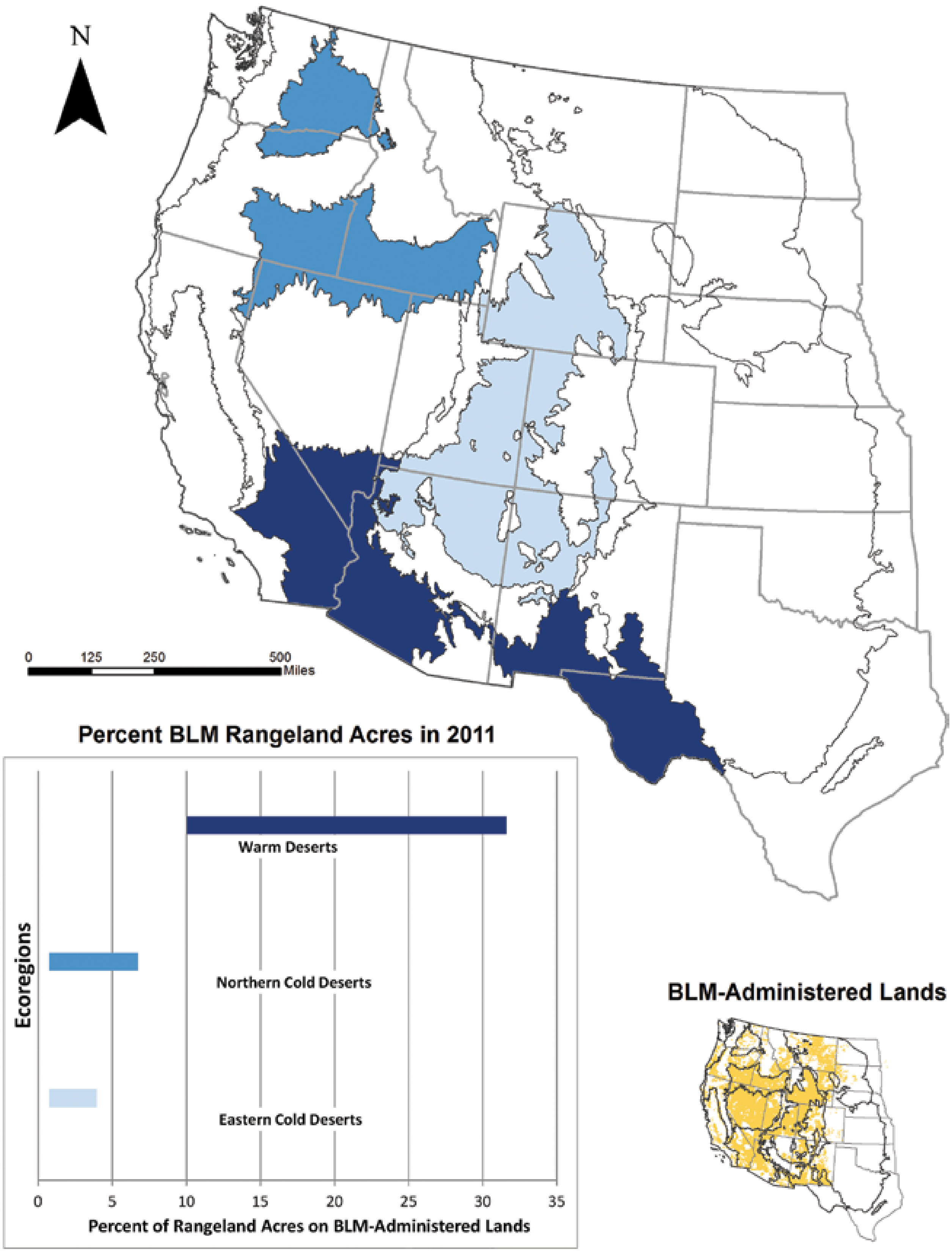

Figure 19. Proportion of BLM rangelands where biotic integrity shows moderate-to-extreme or extreme-to-total departure from reference conditions (80% confidence interval) within ecoregions.

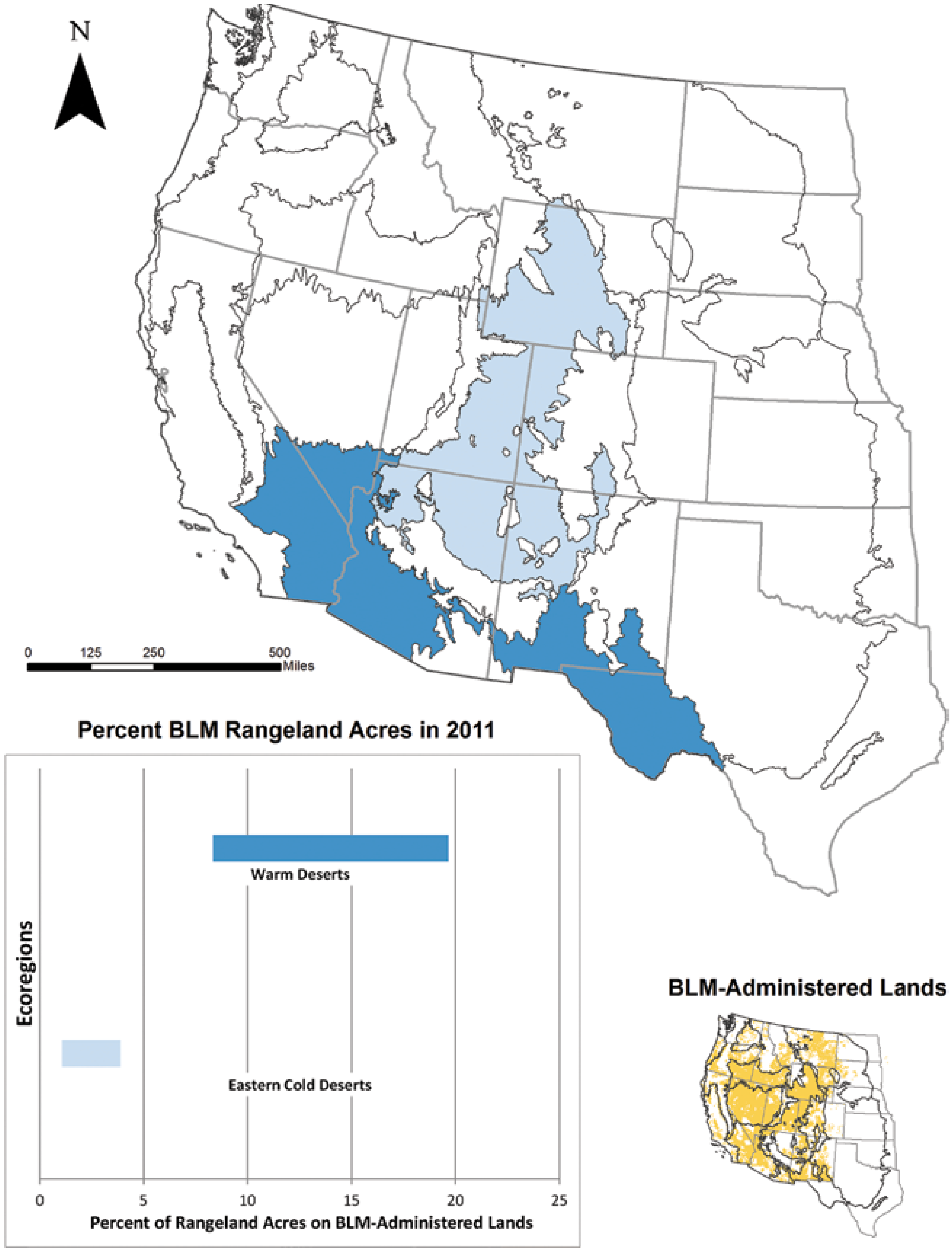

Figure 20. Proportion of BLM rangelands where hydrologic function shows moderate-to-extreme or extreme-to-total departure from reference conditions (80% confidence interval) within ecoregions.

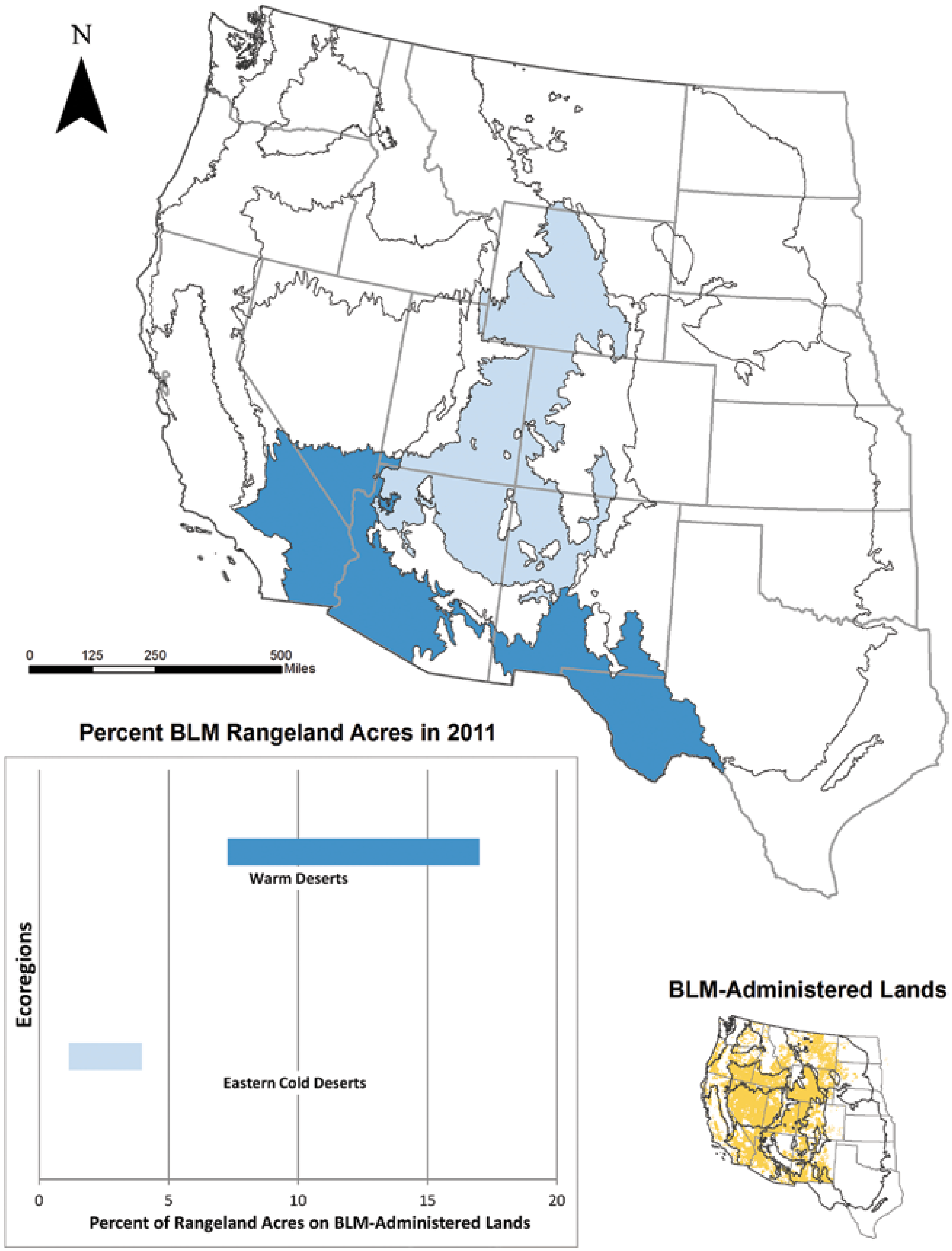

Figure 21. Proportion of BLM rangelands where soil/site stability shows moderate-to-extreme or extreme-to-total departure from reference conditions (80% confidence interval) within ecoregions.

Madrean Archipelago Ecoregion

Overview

The Madrean Archipelago is an EPA level III ecoregion characterized by hot summers and mild winters (figure 22). Mean annual temperature ranges from 7 °C to 19 °C, making this ecoregion among the warmest of all ecoregions in the RRA. Mean annual precipitation is 421 mm, but ranges with elevation from 260 to 950 mm. Much of the precipitation occurs as rain during thunderstorms from July to September. The terrain consists of mountain ranges and intermountain basins. Vegetation varies with elevation, from shrublands and warm season grasslands at low elevations, to oak-juniper woodlands on mountain slopes, to ponderosa pine forests at high elevations (Wiken et al. 2011).

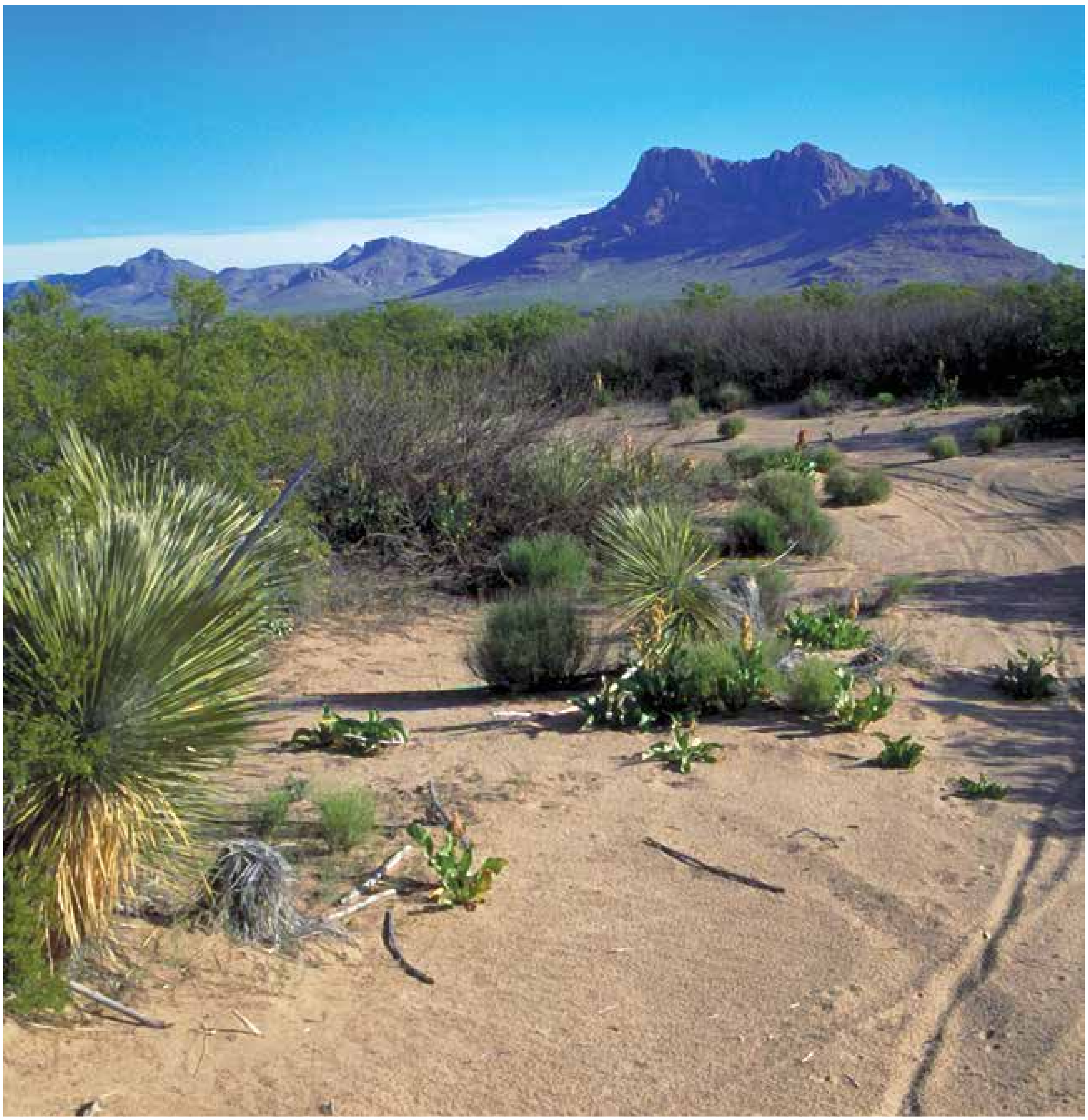

Figure 22. Sandy lowland wash near Safford, Arizona, within the Madrean Archipelago ecoregion (BLM photo).

Status and Condition

Results of this RRA represent a bird's-eye view of the status and condition of BLM rangelands within each ecoregion in 2011. Status is an amount of a renewable resource at a point in time. Condition is the status of a renewable resource in comparison against a reference value. The assessment team reported all indicators using an 80% confidence interval. An 80% confidence interval means that there is an 80% chance that the true population mean lies within that range. Average conditions for an attribute or an indicator in this ecoregion will fall within this range. For more information, see "Data Summarization." Differences in climate, vegetation type, physiography, and similar broad-scale factors likely drive differences in ecoregion status (e.g., bare ground). Differences in management factors likely drive differences in condition (e.g., rangeland health attributes).

Figure 23 shows the means and 80% confidence intervals for each indicator. Within the Madrean Archipelago ecoregion, average bare ground on BLM rangelands was between 9% and 23%. Bare ground refers to bare mineral soil with no vegetation, rocks, litter, or other cover above it. Greater amounts of bare ground suggest an increased risk of soil erosion (Smith and Wischmeier 1962, Morgan 1986, Benkobi et al. 1993, Blackburn and Pierson 1994, Pierson et al. 1994, Gutierrez and Hernandez 1996, and Cerda 1999 in Pellant et al. 2005). An estimated 4% to 54% of BLM rangelands in the Madrean Archipelago had at least 20% bare ground. Some BLM rangelands had at least 30%, 40%, and 50% bare ground, but the sample size was not sufficient to confidently estimate the proportion of BLM rangelands. There was less bare ground on BLM rangelands in the Madrean Archipelago than in the Eastern Cold Deserts and Warm Deserts (figure 8).

Most BLM rangelands in the Madrean Archipelago ecoregion had low soil aggregate stability, suggesting high erosion potential. Between 81% and 100% of BLM rangelands had soils that were susceptible to breaking apart and eroding from wind and water. Only rangelands in the Arizona/New Mexico Mountains and Warm Deserts had as high a proportion of unstable soils as those in the Madrean Archipelago (figure 4).

Between 25% and 80% of BLM rangelands in the Madrean Archipelago ecoregion had large gaps (≥2 meters) between plant canopies that comprised more than 20% of the surface. This greater "openness" of the vegetation suggests that BLM rangelands in this ecoregion may be more vulnerable to soil erosion by water and wind. Most rangelands with canopy gaps of greater than 2 meters are at high risk for wind erosion (Okin 2008). Large gaps between plant canopies were more prevalent in the Madrean Archipelago than in the Northern Cold Deserts and West Central Semi-Arid Prairies (figure 13).

Nonnative invasive plant species had colonized some BLM rangelands in the Madrean Archipelago ecoregion, but the sample size was not large enough to confidently estimate the proportion of BLM rangelands. None of the sampled BLM rangelands had abundant nonnative invasive plants. Nonnative invasive plant species often outcompete native plant species for growing space, causing a decline in abundance of native plant species. This decline in turn causes changes in wildlife habitat availability, wildfire frequency and severity, and susceptibility of soil to erosion.

An estimated 1% to 31% of BLM rangelands in the Madrean Archipelago were at risk of declining biotic integrity relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that these rangelands and their associated plant, animal, and microorganism communities may be starting to have trouble cycling water and nutrients, capturing energy from sunlight, and sustaining other ecological processes. None of the BLM rangelands sampled in the Madrean Archipelago ecoregion had diminished biotic integrity relative to reference conditions (moderate-to-extreme or extreme-to-total departure). Some BLM rangelands in the Madrean Archipelago ecoregion were at risk of declining hydrologic function relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005), but the sample size was not large enough to confidently estimate the proportion of rangelands. Likewise, some BLM rangelands sampled in this ecoregion had diminished hydrologic function relative to reference conditions (moderate-to-extreme or extreme-to-total departure), but the sample size was not large enough to confidently estimate the proportion of rangelands.

Some BLM rangelands in the Madrean Archipelago ecoregion were at risk of declining soil and site stability relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005), but the sample size was not large enough to confidently estimate the proportion of rangelands. Likewise, some BLM rangelands sampled in this ecoregion had diminished soil and site stability relative to reference conditions (moderate-to-extreme or extreme-to-total departure), but the sample size was not large enough to confidently estimate the proportion of rangelands.

Implications for Productivity

Rangeland health assessments showed that the Madrean Archipelago was at risk of declining productivity primarily attributable to declines in biotic integrity. However, the risk of declining productivity was less here than in nearly all other ecoregions. Low soil aggregate stability present on large proportions of the rangelands represents a potential threat to soil and site stability and hydrologic function and, thus, future productivity.

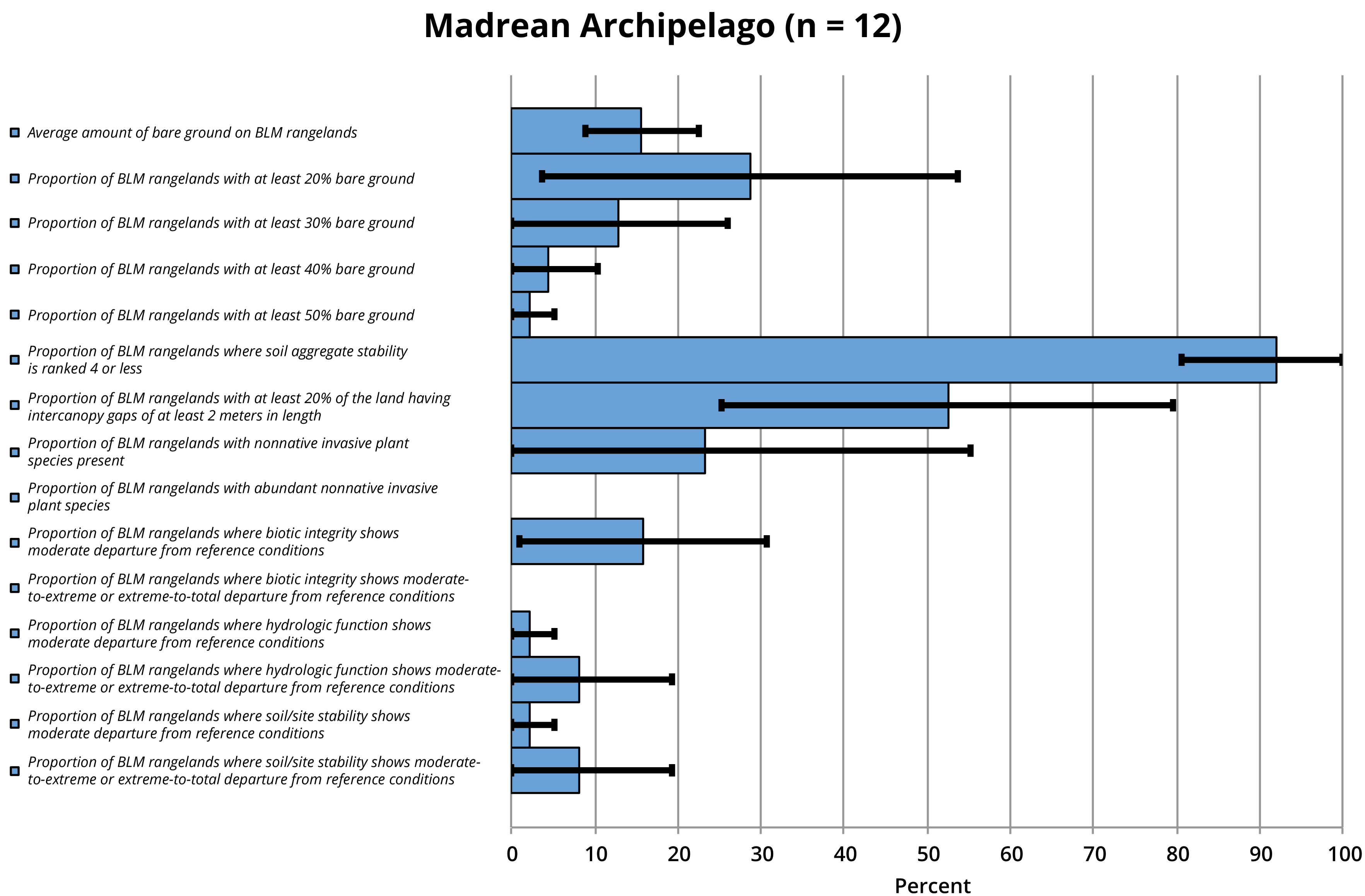

Figure 23. Mean and 80% confidence interval for attributes and indicators in the Madrean Archipelago ecoregion.

Northern Cold Deserts Ecoregion

Overview

The Northern Cold Deserts ecoregion is composed of three EPA level III ecoregions: Columbia Plateau, Snake River Plain, and Northern Basin and Range (figure 24). Warm to hot summers and cold winters are typical in this ecoregion. Mean annual temperatures are very similar across the three subregions, ranging from 7 °C to 12 °C in the Columbia Plateau, 6 °C to 10 °C in the Snake River Plain, and 5 °C to 9 °C in the Northern Great Basin. Mean annual precipitation is also similar, but slightly lower in the Snake River Plain (316 mm) than the Columbia Plateau (334 mm) and Northern Great Basin (351 mm). Annual precipitation ranges from 110 mm at low elevations and in rain shadows to more than 1,000 mm at high elevations. Topography consists of plains (including lava plains), valleys, low hills, and tablelands, sometimes interrupted by mountain ranges. Vegetation is primarily sagebrush shrublands and cool-season grasslands. Aspen and conifer forests occur at higher elevations (Wiken et al. 2011).

Status and Condition

Results of this RRA represent a bird's-eye view of the status and condition of BLM rangelands within each ecoregion in 2011. Status is an amount of a renewable resource at a point in time. Condition is the status of a renewable resource in comparison against a reference value. The assessment team reported all indicators using an 80% confidence interval. An 80% confidence interval means that there is an 80% chance that the true population mean lies within that range. Average conditions for an attribute or an indicator in this ecoregion will fall within this range. For more information, see "Data Summarization." Differences in climate, vegetation

Figure 24. **Northwest of Frenchglen, Oregon, near Fish Lake, within the Northern Cold Deserts ecoregion (BLM photo).**

type, physiography, and similar broad-scale factors likely drive differences in ecoregion status (e.g., bare ground). Differences in management factors likely drive differences in condition (e.g., rangeland health attributes).

Figure 25 shows the means and 80% confidence intervals for each indicator. Within the Northern Cold Deserts ecoregion, average bare ground on BLM rangelands was between 17% and 20%. Bare ground refers to bare mineral soil with no vegetation, rocks, litter, or other cover above it. Greater amounts of bare ground suggest an increased risk of soil erosion (Smith and Wischmeier 1962, Morgan 1986, Benkobi et al. 1993, Blackburn and Pierson 1994, Pierson et al. 1994, Gutierrez and Hernandez 1996, and Cerda 1999 in Pellant et al. 2005). There is less bare ground on BLM rangelands here than in the Eastern Cold Deserts and Warm Deserts (figure 8). A smaller proportion of BLM rangelands in the Northern Cold Deserts had large amounts of bare ground (at least 30%, 40%, or 50% bare ground) than in the Central Basin and Range, Eastern Cold Deserts, and Warm Deserts (figures 10, 11, and 12). There was more bare ground on BLM rangelands here than on those in the West Central Semi-Arid Prairies (figure 8).

Many soils in the Northern Cold Deserts had low soil aggregate stability, suggesting high erosion potential. Between 30% and 48% of BLM rangelands had soils that were susceptible to breaking apart and eroding from wind and water. However, the proportion of BLM rangelands with unstable soils was less than in the Arizona/New Mexico Mountains, Eastern Cold Deserts, Madrean Archipelago, and Warm Deserts (figure 4).

Between 3% and 10% of BLM rangelands in the Northern Cold Deserts ecoregion had large gaps (≥2 meters) between plant canopies that comprised more than 20% of the soil surface. Less "open" vegetation suggests that BLM rangelands in this ecoregion may be less vulnerable to soil erosion by water and wind. Most rangelands with canopy gaps of greater than 2 meters are at high risk for wind erosion (Okin 2008). Large gaps between plant canopies were less prevalent in the Northern Cold Deserts than in the Arizona/New Mexico Mountains, Central Basin and Range, Eastern Cold Deserts, Madrean Archipelago, and Warm Deserts (figure 13).

The presence and abundance of nonnative invasive plant species are notable indicators of the condition of BLM rangelands in the Northern Cold Deserts. Nonnative invasive plant species had colonized nearly all of the rangelands, on average between 77% and 88%. Between 29% and 41% of BLM rangelands had abundant nonnative invasive plants. Nonnative invasive plant species often outcompete native plant species for growing space, causing a decline in abundance of native plant species. This decline in turn causes changes in wildlife habitat availability, wildfire frequency and severity, and susceptibility of soil to erosion. Nonnative invasive plant species are pervasive on BLM rangelands here. Only BLM rangelands in the Central Basin and Range had as high a proportion of colonization and abundance of nonnative invasive plant species as those in the Northern Cold Deserts (figures 14 and 15).

An estimated 8% to 18% of the rangelands in the Northern Cold Deserts ecoregion were at risk of declining biotic integrity relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that these rangelands and their associated plant, animal, and microorganism communities may be starting to have trouble cycling water and nutrients, capturing energy from sunlight, and sustaining other ecological processes. Biotic integrity had declined relative to reference conditions on between 1% and 6% of BLM rangelands (moderate-to-extreme or extreme-to-total departure). This finding suggests that these rangelands may have lost some capacity to cycle water and nutrients, capture sunlight, and sustain other ecological processes. Only rangelands in the Warm Deserts had lost more biotic integrity than in the Northern Cold Deserts (figure 19).

An estimated 4% to 9% of BLM rangelands in the Northern Cold Deserts were at risk of declining hydrologic function relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that soils and vegetation on these rangelands may be starting to have trouble capturing, storing, and safely releasing water. Some BLM rangelands in this ecoregion had diminished hydrologic function relative to reference conditions (moderate-to-extreme or extreme-to-total departure), but the sample size was not large enough to confidently estimate the proportion of rangelands. An estimated 2% to 6% of BLM rangelands in the Northern Cold Deserts ecoregion were at risk of declining soil and site stability relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that excessive amounts of soil may be eroding by wind and water on those rangelands. Only rangelands in the Warm Deserts, Eastern Cold Deserts, and South Central Semi-Arid Prairies had greater risk of declining soil and site stability than in the Northern Cold Deserts (figure 26). Some BLM rangelands in this ecoregion had diminished soil and site stability relative to reference conditions (moderate-to-extreme or extreme-to-total departure), but the sample size was not large enough to confidently estimate the proportion of rangelands.

Implications for Productivity

Rangeland health assessments showed that up to one-fifth of the Northern Cold Deserts ecoregion was at risk of declining productivity attributable to biotic integrity. This risk was greater here than in all ecoregions except the Warm Deserts and Eastern Cold Deserts. Abundant nonnative invasive plant species represent a potential threat to biotic integrity and, thus, future productivity.

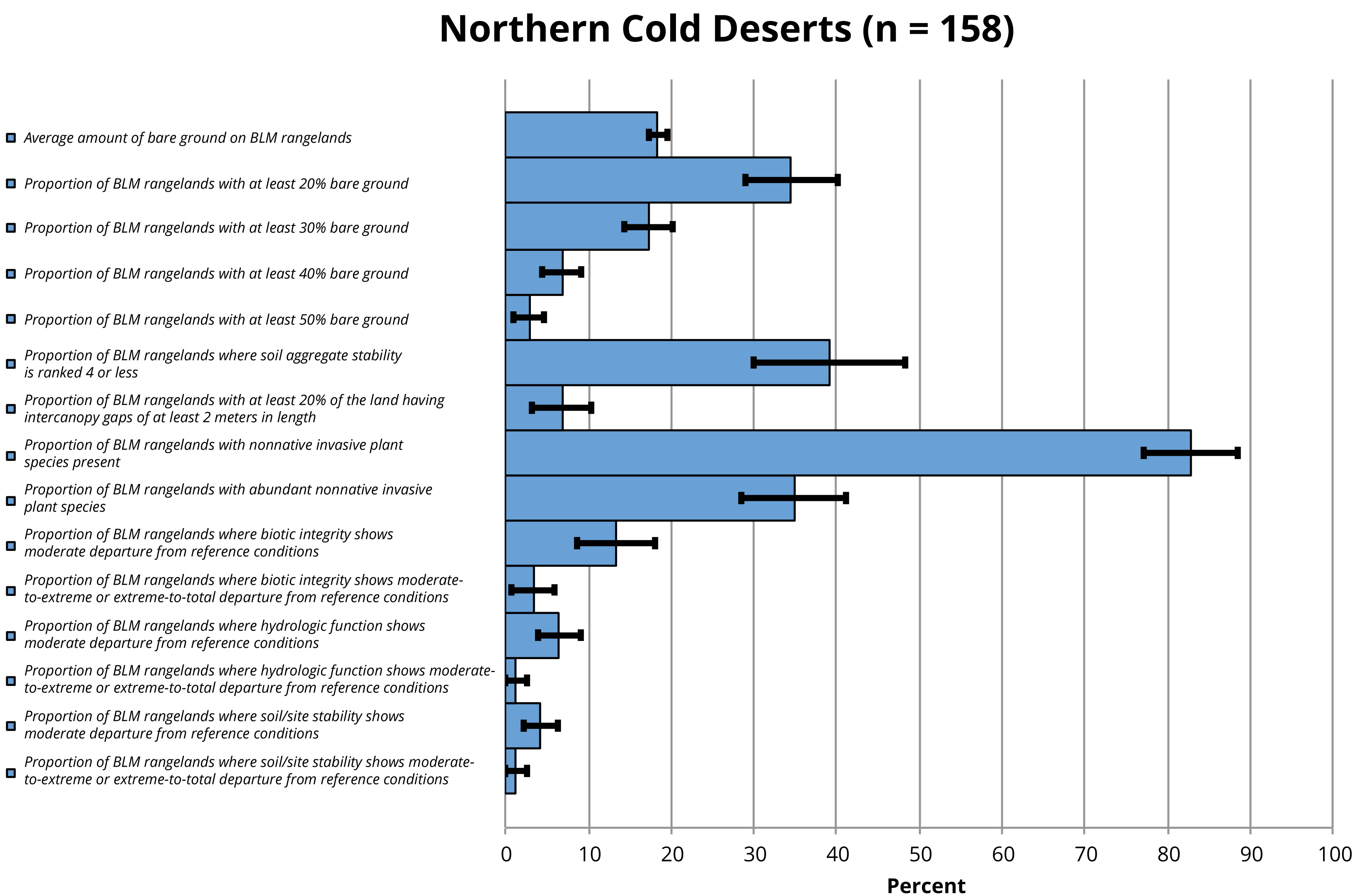

Figure 25. Mean and 80% confidence interval for attributes and indicators in the Northern Cold Deserts ecoregion

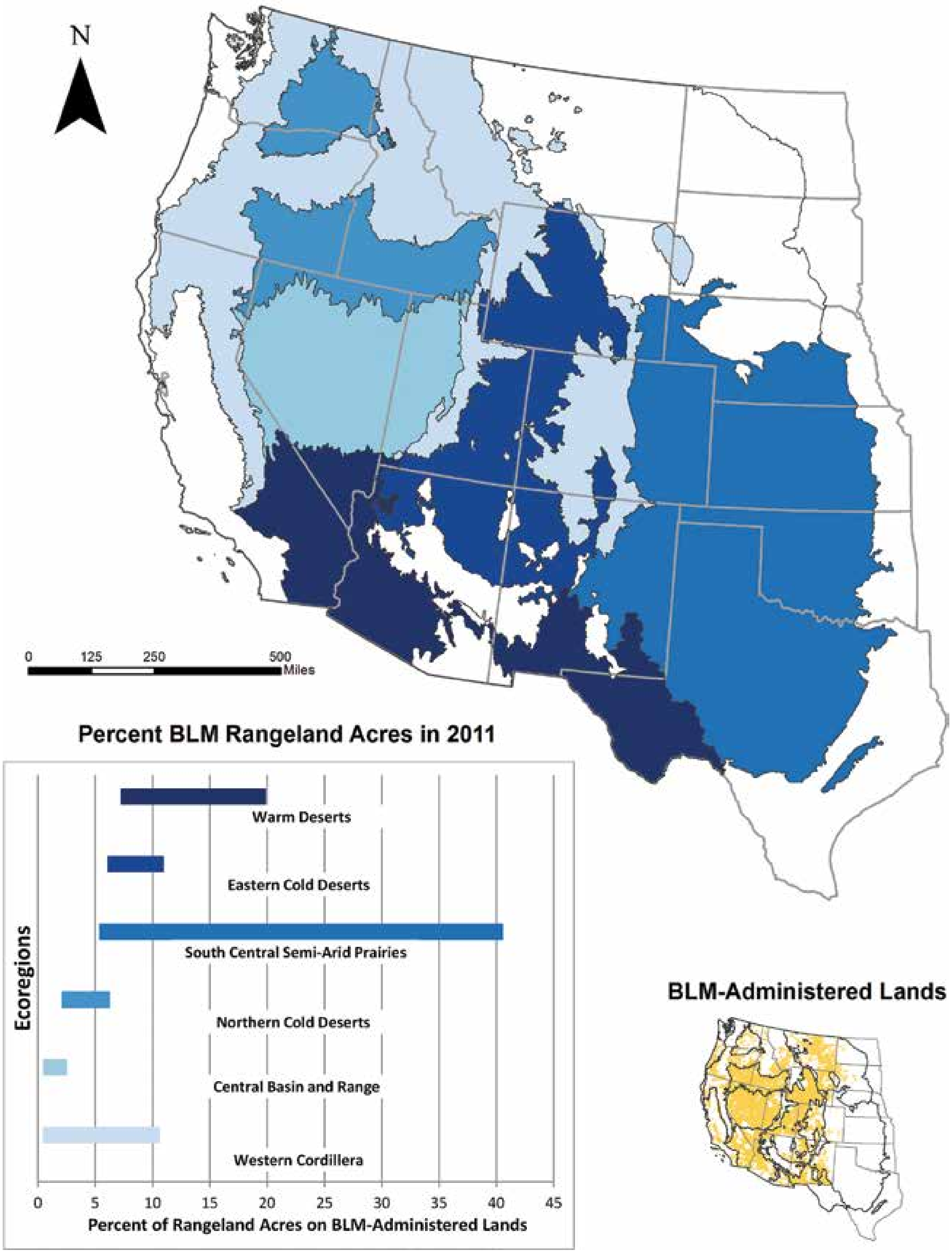

Figure 26. Proportion of BLM rangelands where soil/site stability shows moderate departure from reference conditions (80% confidence interval) within ecoregions.

South Central Semi-Arid Prairies Ecoregion

Overview

The South Central Semi-Arid Prairies ecoregion is an EPA level II ecoregion (figure 27). Hot summers and cool to cold winters are typical in this ecoregion. Mean annual temperatures range from 8 °C to 21 °C, among the warmest of all ecoregions in the RRA. Mean annual precipitation ranges from 255 to 1,170 mm. Landforms consist of smooth as well as irregular plains and tablelands. Shortgrass prairie dominates the vegetation in the north, blended with mesquite juniper and oak woodlands further south Wiken et al. (2011).

Status and Condition

Results of this RRA represent a bird's-eye view of the status and condition of BLM rangelands within each ecoregion in 2011. Status is an amount of a renewable resource at a point in time. Condition is the status of a renewable resource in comparison against a reference value. The assessment team reported all indicators using an 80% confidence interval. An 80% confidence interval means that there is an 80% chance that the true population mean lies within that range. Average conditions for an attribute or an indicator in this ecoregion will fall within this range. For more information, see "Data Summarization." Differences in climate, vegetation type, physiography, and similar broad-scale factors likely drive differences in ecoregion status (e.g., bare ground). Differences in management factors likely drive differences in condition (e.g., rangeland health attributes).

Figure 28 shows the means and 80% confidence intervals for each indicator. Within the South Central Semi-Arid Prairies ecoregion, average bare ground

Figure 27. Shortgrass prairie at the U.S. Department of Agriculture–Agricultural Research Service, Central Plains Experimental Range near Nunn, Colorado, within the South Central Semi-Arid Prairies ecoregion (photo by Emily Kachergis).

on BLM rangelands was between 17% and 29%. Bare ground refers to bare mineral soil with no vegetation, rocks, litter, or other cover above it. Greater amounts of bare ground suggest an increased risk of soil erosion (Smith and Wischmeier 1962, Morgan 1986, Benkobi et al. 1993, Blackburn and Pierson 1994, Pierson et al. 1994, Gutierrez and Hernandez 1996, and Cerda 1999 in Pellant et al. 2005). BLM rangelands here had greater amounts of bare ground than those in the West Central Semi-Arid Prairies (figure 8). No BLM rangelands sampled in the South Central Semi-Arid Prairies had extreme amounts (at least 40% or 50%) of bare ground.

Some soils in the South Central Semi-Arid Prairies had low soil aggregate stability, suggesting high erosion potential. Between 16% and 74% of BLM rangelands had soils that were susceptible to breaking apart and eroding from wind and water. A smaller proportion of rangelands here have unstable soils than in the Arizona/New Mexico Mountains, Madrean Archipelago, and Warm Deserts (figure 4).

Some BLM rangelands in the South Central Semi-Arid Prairies ecoregion had large gaps (≥2 meters) between plant canopies that comprised more than 20% of the surface. However, the sample size was not sufficient to confidently estimate the proportion of rangelands.

Nonnative invasive plant species had colonized an estimated 12% to 51% of BLM rangelands in the South Central Semi-Arid Prairies. Nonnative invasive plant species often outcompete native plant species for growing space, causing a decline in abundance of native plant species. This decline in turn causes changes in wildlife habitat availability, wildfire frequency and severity, and susceptibility of soil to erosion. Nonnative invasive plant species had colonized a smaller proportion of rangelands here than in the Central Basin and Range, Eastern Cold Deserts, and Northern Cold Deserts (figure 14). Some BLM rangelands in the South Central Semi-Arid Prairies ecoregion had abundant nonnative invasive plant species, but the sample size was not sufficient to confidently estimate the proportion of rangelands.

Some BLM rangelands in the South Central Semi-Arid Prairies ecoregion were at risk of declining biotic integrity relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005), but the sample size was not large enough to confidently estimate the proportion of rangelands. No BLM rangelands sampled had diminished biotic integrity relative to reference conditions (rating of moderate-to-extreme or extreme-to-total departure).

Some BLM rangelands in the South Central Semi-Arid Prairies ecoregion were at risk of declining hydrologic function relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005), but the sample size was not large enough to confidently estimate the proportion of rangelands. No BLM rangelands sampled in this ecoregion had diminished hydrologic function relative to reference conditions (moderate-to-extreme or extreme-to-total departure).

An estimated 5% to 41% of BLM rangelands in the South Central Semi-Arid Prairies ecoregion were at risk of declining soil and site stability relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that excessive amounts of soil may be eroding by wind and water on these rangelands. No BLM rangelands sampled in this ecoregion had diminished soil and site stability relative to reference conditions (moderate-to-extreme or extreme-to-total departure).

Implications for Productivity

Rangeland health assessments showed that soil and site stability was a primary threat to productivity in the South Central Semi-Arid Prairies ecoregion. In contrast, relatively low proportions of rangelands with declines in the other rangeland health attributes, or with prevalence of other indicators such as large plant canopy gaps and colonization by nonnative species, suggested that this ecoregion may be less at risk for declining productivity than other ecoregions.

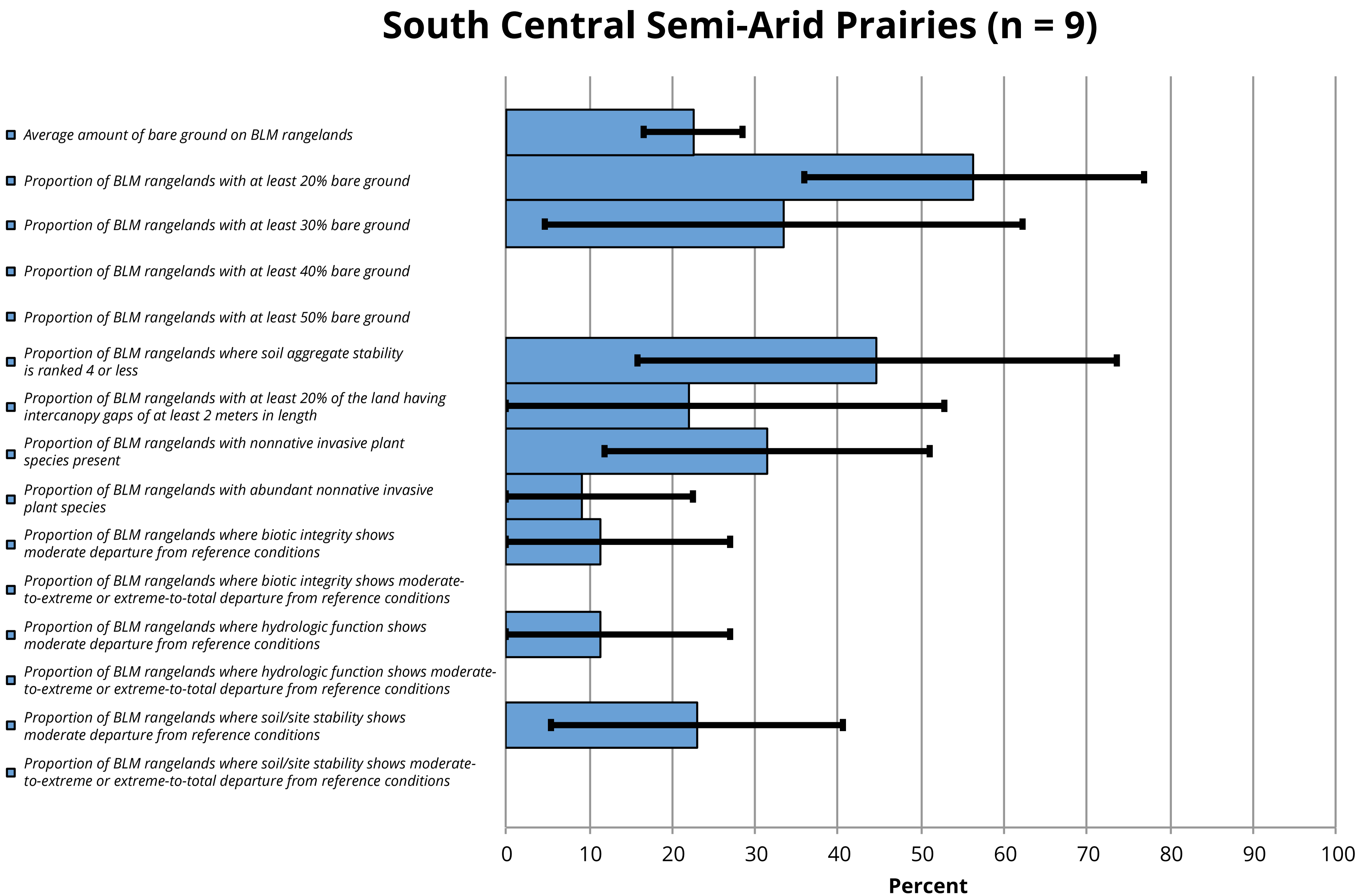

Figure 28. Mean and 80% confidence interval for attributes and indicators in the South Central Semi-Arid Prairies ecoregion.

Warm Deserts Ecoregion

Overview

The Warm Deserts ecoregion is an EPA level II ecoregion (figure 29). Hot summers and mild winters are typical in this ecoregion. Mean annual temperatures range from 5 °C to 25 °C. Mean annual precipitation is generally low, but ranges from 50 mm to over 900 mm on high mountain peaks. The Warm Deserts ecoregion is the warmest and driest of all ecoregions in the RRA. Dominant landforms are open plains interspersed with low to high mountain ranges. Vegetation consists of shrublands mixed with grasslands (Wiken et al. 2011).

Status and Condition

Results of this RRA represent a bird's-eye view of the status and condition of BLM rangelands within each ecoregion in 2011. Status is an amount of a renewable resource at a point in time. Condition is the status of a renewable resource in comparison against a reference value. The assessment team reported all indicators using an 80% confidence interval. An 80% confidence interval means that there is an 80% chance that the true population mean lies within that range. Average conditions for an attribute or an indicator in this ecoregion will fall within this range. For more information, see "Data Summarization." Differences in climate, vegetation type, physiography, and similar broad-scale factors likely drive differences in ecoregion status (e.g., bare ground). Differences in management factors likely drive differences in condition (e.g., rangeland health attributes).

Figure 30 shows the means and 80% confidence intervals for each indicator. Within the Warm Deserts

Figure 29. California desert, within the Warm Deserts ecoregion (BLM photo).

ecoregion, average bare ground on BLM rangelands was between 25% and 32%. Bare ground refers to bare mineral soil with no vegetation, rocks, litter, or other cover above it. Greater amounts of bare ground suggest an increased risk of soil erosion (Smith and Wischmeier 1962, Morgan 1986, Benkobi et al. 1993, Blackburn and Pierson 1994, Pierson et al. 1994, Gutierrez and Hernandez 1996, and Cerda 1999 in Pellant et al. 2005). Large amounts of bare ground occurred on a significant proportion of BLM rangelands in the Warm Deserts, with between 46% and 60% of the rangelands having at least 20% bare ground. Bare ground was more prevalent here than on most other BLM rangelands. Only rangelands in the Eastern Cold Deserts, Arizona/New Mexico Mountains, and South Central Semi-Arid Prairies had as much bare ground as those in the Warm Deserts (figure 8).

Many soils in the Warm Deserts had low soil aggregate stability, suggesting high erosion potential. Between 82% and 93% of BLM rangelands had soils that were susceptible to breaking apart and eroding from wind and water. Only rangelands in the Arizona/New Mexico Mountains and Madrean Archipelago had as high a proportion of rangelands with erodible soils as the Warm Deserts (figure 4).

Between 69% and 82% of BLM rangelands in the Warm Deserts have large gaps between plant canopies (≥2 meters) that comprised at least 20% of the soil surface. This greater "openness" of the vegetation suggests that BLM rangelands in this ecoregion may be more vulnerable to soil erosion by water and wind. Most rangelands with canopy gaps of greater than 2 meters are at high risk for wind erosion (Okin 2008). Only rangelands in the Arizona/New Mexico Mountains and Madrean Archipelago had large gaps between plant canopies as prevalent as those in the Warm Deserts (figure 13).

Nonnative invasive plant species had colonized between 24% and 37% of BLM rangelands in the Warm Deserts ecoregion, but only a small proportion of these rangelands had abundant nonnative invasive plant species. Nonnative invasive plant species often outcompete native plant species for growing space, causing a decline in abundance of native plant species. This decline in turn causes changes in wildlife habitat availability, wildfire frequency and severity, and susceptibility of soil to erosion. Nonnative invasive plant species had colonized or were abundant on a smaller proportion of BLM rangelands in the Warm Deserts than in the Central Basin and Range and Northern Cold Deserts (figures 14 and 15).

An estimated 3% to 10% of BLM rangelands in the Warm Deserts were at risk of declining biotic integrity relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that these rangelands and their associated plant, animal, and microorganism communities may be starting to have trouble cycling water and nutrients, capturing energy from sunlight, and sustaining other ecological processes. Biotic integrity had declined relative to reference conditions on an estimated 10% to 22% of BLM rangelands (moderate-to-extreme or extreme-to-total departure). This finding suggests that these rangelands may have lost some capacity to cycle water and nutrients, capture energy, and sustain other ecological processes. A larger proportion of BLM rangelands had diminished biotic integrity in the Warm Deserts than in any other ecoregion (figure 19).

An estimated 6% to 18% of BLM rangelands in the Warm Deserts ecoregion were at risk of declining hydrologic function relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that soils and vegetation on these rangelands may be starting to have trouble capturing, storing, and safely releasing water. Hydrologic function had declined relative to reference conditions on an estimated 8% to 20% of the rangelands (moderate-to-extreme or extreme-to-total departure). This finding suggests that soils and vegetation on these rangelands may have lost some capacity to capture, store, and safely release water.

A larger proportion of BLM rangelands had diminished hydrologic function in the Warm Deserts than in any other ecoregion (figure 20).

An estimated 7% to 20% of BLM rangelands in the Warm Deserts were at risk of declining soil and site stability relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that excessive amounts of soil may be eroding by wind and water on these rangelands. Soil and site stability had declined relative to reference conditions on an estimated 7% to 17% of BLM rangelands (moderate-to-extreme or extreme-to-total departure). This finding suggests that excessive amounts of soil may have been lost on these rangelands. A larger proportion of rangelands had diminished soil and site stability in the Warm Deserts ecoregion than in any other ecoregion (figure 21).

Implications for Productivity

Rangeland health assessments showed that up to one-fifth of the Warm Deserts ecoregion was at risk of declining productivity attributable to declines in all three attributes of rangeland health: soil and site stability, hydrologic function, and biotic integrity. This ecoregion has a greater proportion of rangelands with declines in health and, thus, productivity than any other ecoregion. Large amounts of bare ground, unstable soils, and large gaps between plant canopies represent threats to rangeland health and, thus, future productivity.

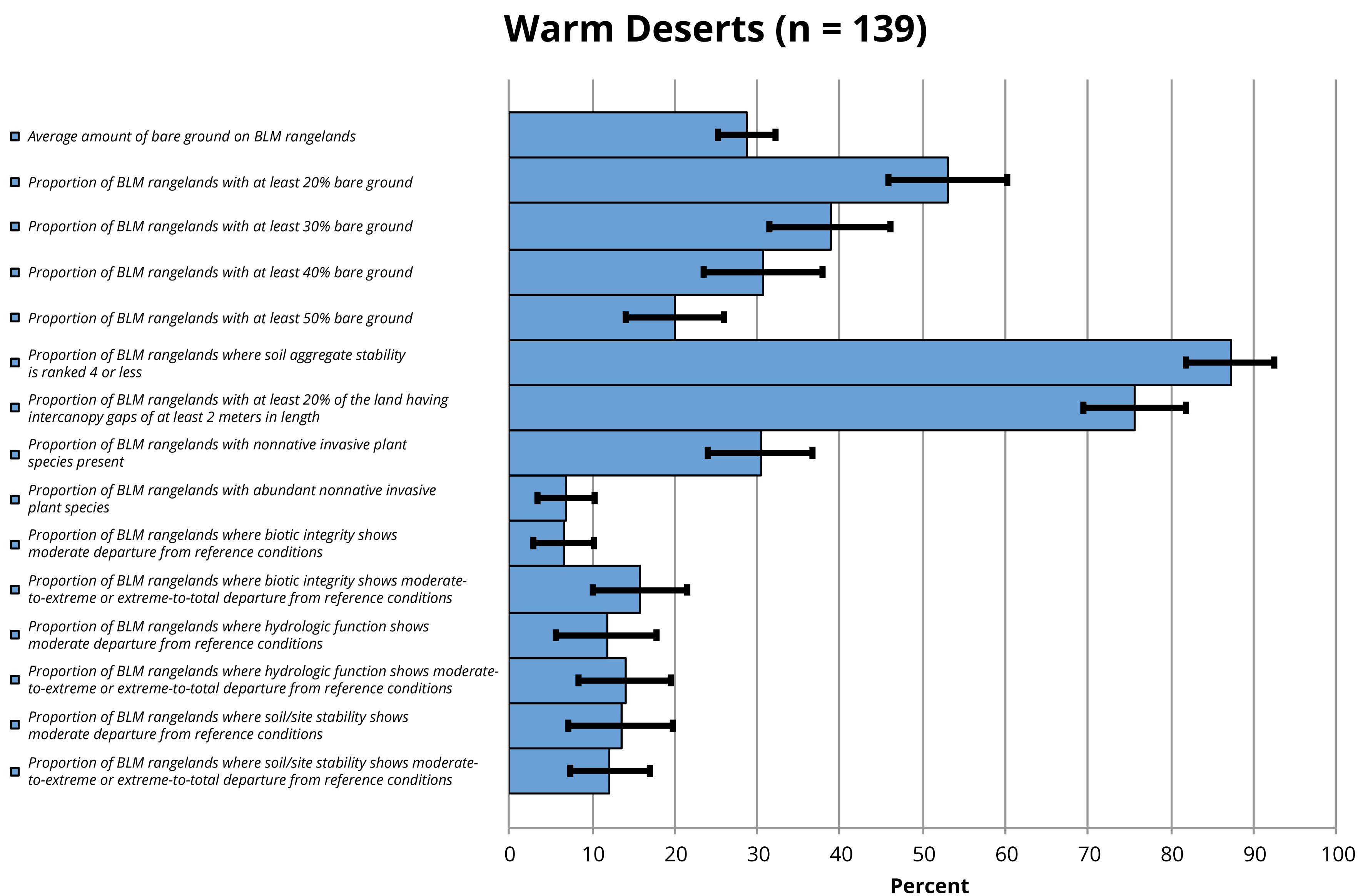

Figure 30. Mean and 80% confidence interval for attributes and indicators in the Warm Deserts ecoregion.

West Central Semi-Arid Prairies Ecoregion

Overview

The West Central Semi-Arid Prairies ecoregion is an EPA level II ecoregion (figure 31). Warm to hot summers and cold winters are typical in this ecoregion. Mean annual temperatures range from 2 °C to 9 °C, among the coolest of all ecoregions in the RRA. Mean annual precipitation varies from 250 mm to 580 mm. Irregular plains, tablelands, and low hills characterize the terrain. Native vegetation is grassland with a mix of short and mid-height grasses (Wiken et al. 2011).

Status and Condition

Results of this RRA represent a bird's-eye view of the status and condition of BLM rangelands within each ecoregion in 2011. Status is an amount of a renewable resource at a point in time. Condition is the status of a renewable resource in comparison against a reference value. The assessment team reported all indicators using an 80% confidence interval. An 80% confidence interval means that there is an 80% chance that the true population mean lies within that range. Average conditions for an attribute or an indicator in this ecoregion will fall within this range. For more information, see "Data Summarization." Differences in climate, vegetation type, physiography, and similar broad-scale factors likely drive differences in ecoregion status (e.g., bare ground). Differences in management factors likely drive differences in condition (e.g., rangeland health attributes).

Figure 32 shows the means and 80% confidence intervals for each indicator. Within the West Central Semi-Arid Prairies ecoregion, average bare ground on BLM rangelands was between 11% and 18%. Bare ground refers to bare mineral soil with no vegetation, rocks, litter, or other cover above it. Greater amounts of bare ground suggest an increased risk of soil erosion (Smith and Wischmeier 1962, Morgan 1986, Benkobi et al. 1993, Blackburn and Pierson 1994, Pierson et al. 1994, Gutierrez and Hernandez 1996, and Cerda 1999 in Pellant et al. 2005). Bare ground

Figure 31. **Mixed-grass prairie near Battle Creek, Montana, within the West Central Semi-Arid Prairies ecoregion (BLM photo).**

was less in the West Central Semi-Arid Prairies than in Central Basin and Range, Eastern Cold Deserts, Northern Cold Deserts, South Central Semi-Arid Prairies, and Warm Deserts (figure 8).

Some soils in the West Central Semi-Arid Prairies had low soil aggregate stability, suggesting high erosion potential. Between 16% and 43% of BLM rangelands had soils that are susceptible to breaking apart and eroding from wind and water. A smaller proportion of BLM rangelands in the West Central Semi-Arid Prairies had unstable soils than in the Arizona/New Mexico Mountains, Eastern Cold Deserts, Madrean Archipelago, and Warm Deserts (figure 4).

Between a trace (less than 1%) to 19% of BLM rangelands in the West Central Semi-Arid Prairies had large gaps between plant canopies (≥2 meters) that comprise more than 20% of the surface. The greater the "openness" of the vegetation, the more vulnerable BLM rangelands in this ecoregion are to soil erosion by water and wind. Most rangelands with canopy gaps of greater than 2 meters are at high risk for wind erosion (Okin 2008). Large gaps between plant canopies were less prevalent in the West Central Semi-Arid Prairies than in the Arizona/New Mexico Mountains, Central Basin and Range, Eastern Cold Deserts, Madrean Archipelago, and Warm Deserts (figure 13).

Nonnative invasive plant species had colonized between 17% to 39% of BLM rangelands in the West Central Semi-Arid Prairies ecoregion, but no rangelands were sampled that had abundant nonnative invasive plant species. Nonnative invasive plant species often outcompete native plant species for growing space, causing a decline in abundance of native plant species. This decline in turn causes changes in wildlife habitat availability, wildfire frequency and severity, and susceptibility of soil to erosion. Nonnative invasive plant species had colonized a smaller proportion of rangelands in the West Central Semi-Arid Prairies than in the Central Basin and Range, Eastern Cold Deserts, and Northern Cold Deserts (figure 14).

Some BLM rangelands in the West Central Semi-Arid Prairies ecoregion were at risk of declining biotic integrity relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005), but the sample size was not large enough to confidently estimate the proportion of rangelands. No BLM rangelands sampled had diminished biotic integrity relative to reference conditions (rating of moderate-to-extreme or extreme-to-total departure).

An estimated 3% to 18% of BLM rangelands in the West Central Semi-Arid Prairies were at risk of declining hydrologic function relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that soils and vegetation on these rangelands may be starting to have trouble capturing, storing, and safely releasing water. No rangelands sampled had diminished hydrologic function relative to reference conditions (moderate-to-extreme or extreme-to-total departure).

Some BLM rangelands in the West Central Semi-Arid Prairies ecoregion were at risk of declining soil and site stability relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005), but the sample size was not large enough to confidently estimate the proportion of rangelands. No BLM rangelands sampled in this ecoregion had diminished soil and site stability relative to reference conditions (moderate-to-extreme or extreme-to-total departure).

Implications for Productivity

Rangeland health assessments showed that declines in hydrologic function were a primary threat to productivity in the West Central Semi-Arid Prairies ecoregion. In contrast, relatively low proportions of rangelands where other rangeland health attributes were at risk, or with prevalence of other indicators such as large plant canopy gaps and unstable soils, suggest that this ecoregion may be less at risk for declining productivity than other ecoregions.

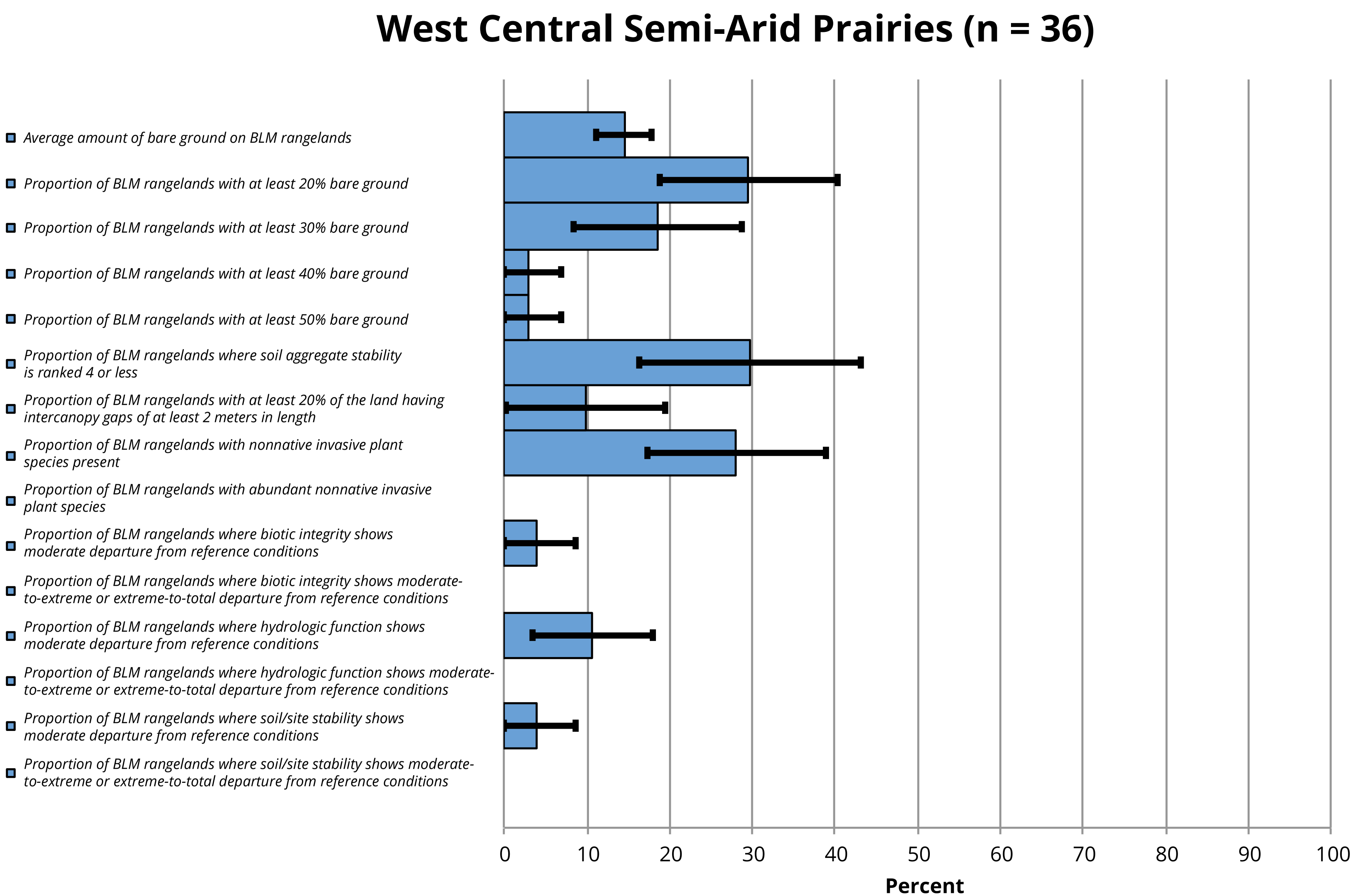

Figure 32. Mean and 80% confidence interval for attributes and indicators in the West Central Semi-Arid Prairies ecoregion.

Western Cordillera Ecoregion

Overview

The Western Cordillera ecoregion is an EPA level II ecoregion (figure 33). Warm to hot summers and cold winters are typical in this ecoregion. Mean annual temperatures range from -5 °C to 17 °C. Precipitation varies with elevation and latitude, ranging from 150 to 6,000 mm per year. This is the coolest and wettest ecoregion in the RRA. The terrain is primarily high mountains interspersed with high-elevation broad valleys. Vegetation at low elevations consists of shrublands and grasslands. Conifer and aspen forests occur at higher elevations (Wiken et al. 2011).

Status and Condition

Results of this RRA represent a bird's-eye view of the status and condition of BLM rangelands within each ecoregion in 2011. Status is an amount of a renewable resource at a point in time. Condition is the status of a renewable resource in comparison against a reference value. The assessment team reported all indicators using an 80% confidence interval. An 80% confidence interval means that there is an 80% chance that the true population mean lies within that range. Average conditions for an attribute or an indicator in this ecoregion will fall within this range. For more information, see "Data Summarization." Differences in climate, vegetation

Figure 33. Northeast of Crested Butte, Colorado, within the Western Cordillera ecoregion (photo by Emily Kachergis).

type, physiography, and similar broad-scale factors likely drive differences in ecoregion status (e.g., bare ground). Differences in management factors likely drive differences in condition (e.g., rangeland health attributes).

Figure 34 shows the means and 80% confidence intervals for each indicator. In the Western Cordillera ecoregion, average bare ground on BLM rangelands was between 15% and 23%. Bare ground refers to bare mineral soil with no vegetation, rocks, litter, or other cover above it. Greater amounts of bare ground suggest an increased risk of soil erosion (Smith and Wischmeier 1962, Morgan 1986, Benkobi et al. 1993, Blackburn and Pierson 1994, Pierson et al. 1994, Gutierrez and Hernandez 1996, and Cerda 1999 in Pellant et al. 2005). Bare ground occurred in smaller amounts on Western Cordillera rangelands than on the rangelands in the Eastern Cold Deserts and Warm Deserts (figure 8). Likewise, a smaller proportion of BLM rangelands here had large amounts of bare ground (at least 30% or 40% bare ground) than in the Eastern Cold Deserts and Warm Deserts (figures 10 and 11). An estimated 8% to 27% of BLM rangelands in the Western Cordillera had at least 30% bare ground, and trace (less than 1%) to 17% of BLM rangelands here had at least 40% bare ground.

Many soils in the Western Cordillera ecoregion had low soil aggregate stability, suggesting high erosion potential. Between 36% and 58% of BLM rangelands had soils that are susceptible to breaking apart and eroding from wind and water. However, the proportion of BLM rangelands with unstable soils was less than in the Arizona/New Mexico Mountains, Eastern Cold Deserts, Madrean Archipelago, and Warm Deserts (figure 4).

Some BLM rangelands in the Western Cordillera ecoregion had large gaps between plant canopies (≥2 meters) that comprised more than 20% of the soil surface. However, the sample size was not sufficient to confidently estimate the proportion of rangelands.

Nonnative invasive plant species had colonized an estimated 21% to 45% of BLM rangelands in the Western Cordillera ecoregion. However, a small proportion of these rangelands, between a trace (less than 1%) and 14%, had abundant nonnative invasive plant species. Nonnative invasive plant species often outcompete native plant species for growing space, causing a decline in abundance of native plant species. This decline in turn causes changes in wildlife habitat availability, wildfire frequency and severity, and susceptibility of soil to erosion. Nonnative invasive plant species colonized a smaller proportion of rangelands, and were less abundant, in the Western Cordillera than in the Central Basin and Range and Northern Cold Deserts (figures 14 and 15).

An estimated trace (less than 1%) to 9% of BLM rangelands in the Western Cordillera ecoregion were at risk of declining biotic integrity relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that these rangelands and their associated plant, animal, and microorganism communities may be starting to have trouble cycling water and nutrients, capturing energy from sunlight, and sustaining other ecological processes. No BLM rangelands sampled in the Western Cordillera had diminished biotic integrity relative to reference conditions (moderate-to-extreme or extreme-to-total departure).

An estimated 2% to 14% of BLM rangelands in the Western Cordillera are at risk of declining hydrologic function relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that the soils and vegetation on these rangelands may be starting to have trouble capturing, storing, and safely releasing water. Some BLM rangelands in this ecoregion had diminished hydrologic function relative to reference conditions (moderate-to-extreme or extreme-to-total departure), but the sample size was not sufficient to confidently estimate the proportion of rangelands.

An estimated trace (less than 1%) to 11% of BLM rangelands in the Western Cordillera were at risk of declining soil and site stability relative to reference conditions based on a qualitative rating of moderate departure (Pellant et al. 2005). This finding suggests that excessive amounts of soil may be eroding by wind and water on these rangelands. Some BLM rangelands in this ecoregion had diminished soil and site stability relative to reference conditions (moderate-to-extreme or extreme-to-total departure), but the sample size was not sufficient to confidently estimate the proportion of rangelands.

Implications for Productivity

Rangeland health assessments showed that up to one-tenth of the Western Cordillera ecoregion was at risk of declining productivity attributable to declines in all three rangeland health attributes: biotic integrity, hydrologic function, and soil and site stability. However, relatively low proportions of rangelands with prevalence of indicators such as bare ground and colonization by nonnative invasive plants suggest that this ecoregion may be less at risk for declining productivity than other ecoregions.

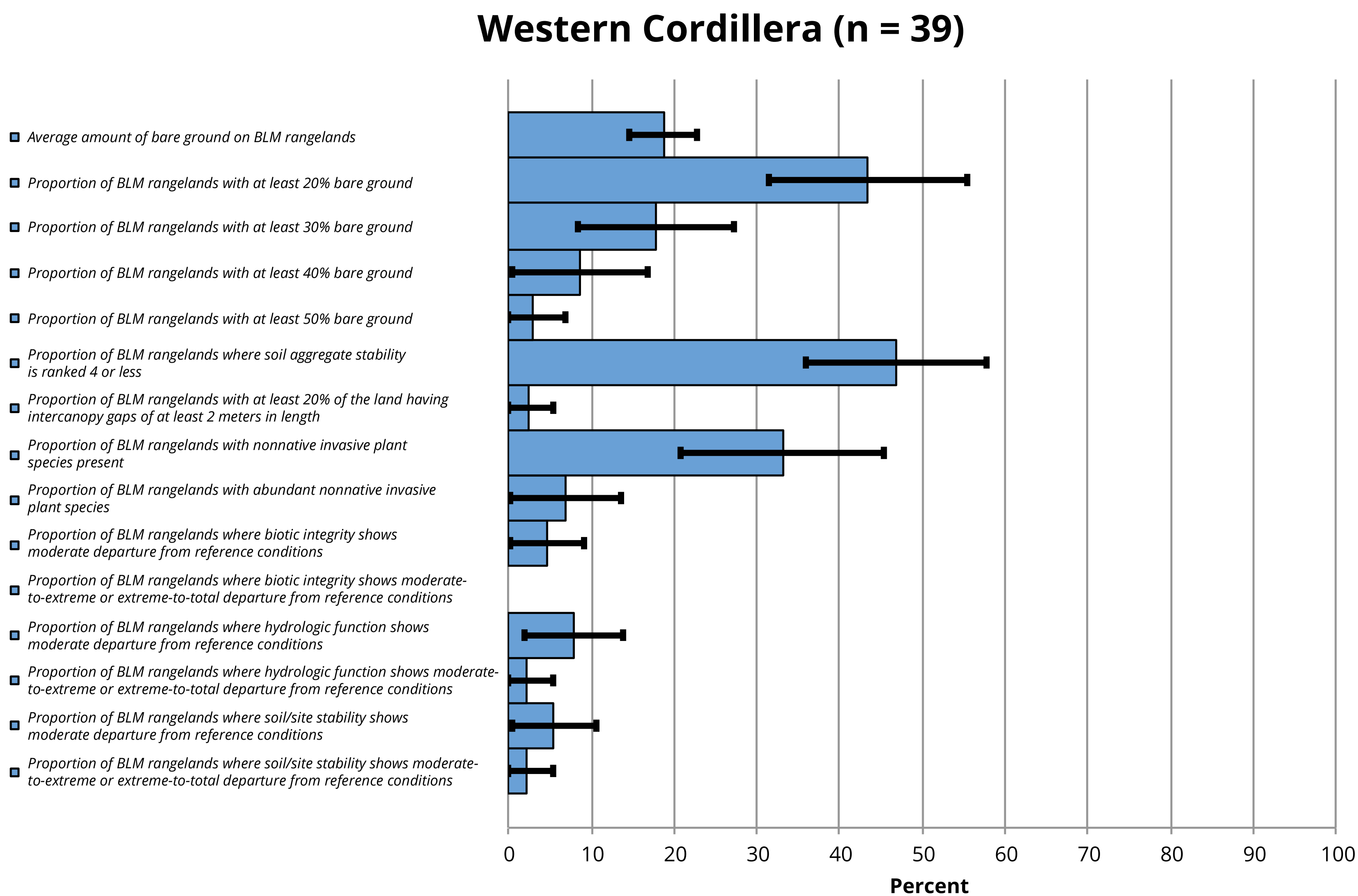

Figure 34. Mean and 80% confidence interval for attributes and indicators in the Western Cordillera ecoregion.

Conclusion

This first-of-its kind BLM RRA provides a snapshot of renewable resource status and condition on BLM rangelands. Indicators and attributes reported relate to ecological processes responsible for sustaining the productivity of BLM rangelands or the capacity of rangelands to produce commodities and satisfy values (National Research Council 1994). This report fulfills Congress's direction in the Federal Land Policy and Management Act and the Public Rangelands Improvement Act to periodically and systematically inventory the public rangelands, identify current conditions, and report that information to Congress and the public.

Results from 2011 show that status and condition, and thus productivity, vary in different ecoregions on BLM rangelands. Generally, the Warm Deserts, Eastern Cold Deserts, and Northern Cold Deserts ecoregions exhibited the largest risks to and declines in productivity. In contrast, the Madrean Archipelago, West Central Semi-Arid Prairies, and South Central Semi-Arid Prairies had lower risks to and declines in productivity. However, every ecoregion had some rangelands with declines in productivity.

The variability in status and condition in each ecoregion can inform a targeted approach to land use, management, and restoration focused on sustaining ecological processes within that ecoregion. For example, efforts towards nonnative invasive plant species control may be most justified in the most invaded ecoregions, the Central Basin and Range and Northern Cold Deserts. Likewise, efforts to improve soil stability may have the most benefit in the Warm Deserts, Arizona/New Mexico Mountains, and the Madrean Archipelago, where soils were the least stable.

The information from the RRA helps the BLM better understand its rangelands via remote sensing and provides contextual information for local monitoring results. Subsequent RRAs will report on trend or changes in renewable resource status and condition over time.

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Appendix A: List of Nonnative Invasive Plant Species

The BLM recognizes the following list of species compiled from legally declared noxious weed species lists in the western states and invasive plant species recognized by the Weed Science Society of America.

PLANTS symbol[1]	Scientific Name
ABTH	*Abutilon theophrasti*
ACPA8	*Acacia paradoxa*
ACNO7	*Acaena novae-zelandiae*
ACPA14	*Acaena pallida*
ACBR5	*Achnatherum brachychaetum*
ACRE3	*Acroptilon repens*
AECY	*Aegilops cylindrica*
AEGE	*Aegilops geniculata*
AETR	*Aegilops triuncialis*
AEIN6	*Aeginetia indica*
AERU	*Aeschynomene rudis*
AGAD2	*Ageratina adenophora*
AIAL	*Ailanthus altissima*
ALMA12	*Alhagi maurorum*
ALPE4	*Alliaria petiolata*
ALNE3	*Allium neapolitanum*
ALPA20	*Allium paniculatum*
ALVI	*Allium vineale*
ALMY	*Alopecurus myosuroides*
ALPH	*Alternanthera philoxeroides*
ALSE4	*Alternanthera sessilis*
AMAR4	*Ammophila arenaria*
ANAR16	*Anchusa arvensis*
ANOF	*Anchusa officinalis*
ANAR6	*Anthemis arvensis*
ANCO2	*Anthemis cotula*
ANSY	*Anthriscus sylvestris*
ARSE8	*Araujia sericifera*
ARMI2	*Arctium minus*
ARCA45	*Arctotheca calendula*
ARAB3	*Artemisia absinthium*
ARDO4	*Arundo donax*
ASFI2	*Asphodelus fistulosus*
AVST	*Avena sterilis*
BAHY	*Bassia hyssopifolia*
BASC5	*Bassia scoparia*
BRSY	*Brachypodium sylvaticum*
BRNI	*Brassica nigra*
BRTO	*Brassica tournefortii*
BRAR5	*Bromus arvensis*
BRDI3	*Bromus diandrus*
BRRU2	*Bromus rubens*
BRTE	*Bromus tectorum*
BRAL4	*Bryonia alba*
BUDA2	*Buddleja davidii*
BUUM	*Butomus umbellatus*
CAGI	*Caesalpinia gilliesii*
CACH42	*Cardaria chalepensis*
CADR	*Cardaria draba*
CAPU6	*Cardaria pubescens*
CAAC	*Carduus acanthoides*
CANU4	*Carduus nutans*
CAPY2	*Carduus pycnocephalus*
CATE2	*Carduus tenuiflorus*
CACH38	*Carpobrotus chilensis*
CAED3	*Carpobrotus edulis*

PLANTS symbol[1]	Scientific Name
CALA20	*Carthamus lanatus*
CAOX6	*Carthamus oxyacanthus*
CACA19	*Carum carvi*
CECA2	*Centaurea calcitrapa*
CECY2	*Centaurea cyanus*
CEDI3	*Centaurea diffusa*
CEIB	*Centaurea iberica*
CEJA	*Centaurea jacea*
CEMA9	*Centaurea macrocephala*
CEME2	*Centaurea melitensis*
CEMO	*Centaurea montana*
CENI2	*Centaurea nigra*
CENI3	*Centaurea nigrescens*
CESO3	*Centaurea solstitialis*
CESTM	*Centaurea stoebe ssp. micranthos*
CESU	*Centaurea sulphurea*
CETR12	*Centaurea trichocephala*
CEVIS2	*Centaurea virgata ssp. squarrosa*
CHMI	*Chaenorhinum minus*
CHJU	*Chondrilla juncea*
CHTE2	*Chorispora tenella*
CIIN	*Cichorium intybus*
CIAR4	*Cirsium arvense*
CIVU	*Cirsium vulgare*
CLOR	*Clematis orientalis*
CLVI6	*Clematis vitalba*
COBE2	*Commelina benghalensis*
COMA2	*Conium maculatum*
COAR4	*Convolvulus arvensis*
COSQ	*Coronopus squamatus*
COJU2	*Cortaderia jubata*
COSE4	*Cortaderia selloana*
CRSE2	*Crepis setosa*
CRVU2	*Crupina vulgaris*
CUMY	*Cucumis myriocarpus*
CUAP2	*Cuscuta approximata*
CURE	*Cuscuta reflexa*
CYCA	*Cynara cardunculus*
CYDA	*Cynodon dactylon*
CYPL2	*Cynodon plectostachyus*
CYTR	*Cynodon transvaalensis*
CYOF	*Cynoglossum officinale*
CYRO	*Cyperus rotundus*
CYSC4	*Cytisus scoparius*
CYST7	*Cytisus striatus*
DACA6	*Daucus carota*
DEOD	*Delairea odorata*
DIPU	*Digitalis purpurea*
DIFU2	*Dipsacus fullonum*
DILA4	*Dipsacus laciniatus*
DISA9	*Dipsacus sativus*
ECPL	*Echium plantagineum*
ECVU	*Echium vulgare*
EGDE	*Egeria densa*
EHCA	*Ehrharta calycina*
EICR	*Eichhornia crassipes*
ELAN	*Elaeagnus angustifolia*
ELRE4	*Elymus repens*
EMAU	*Emex australis*
EMSP	*Emex spinosa*
EPHI	*Epilobium hirsutum*
ERLE	*Eragrostis lehmanniana*
ERGL8	*Erechtites glomerata*
ERCI6	*Erodium cicutarium*
EUCY2	*Euphorbia cyparissias*
EUES	*Euphorbia esula*
EUESU	*Euphorbia esula var. uralensis*
EUMY2	*Euphorbia myrsinites*
EUOB4	*Euphorbia oblongata*
EUSE12	*Euphorbia serrata*
EUTE10	*Euphorbia terracina*
FICA	*Ficus carica*
FOVU	*Foeniculum vulgare*
GAOF	*Galega officinalis*
GATE2	*Galeopsis tetrahit*
GAPA2	*Galinsoga parviflora*
GEMO2	*Genista monspessulana*
GYPA	*Gypsophila paniculata*
HAHA8	*Halimodendron halodendron*
HAGL	*Halogeton glomeratus*
HEHE	*Hedera helix*
HEMA17	*Heracleum mantegazzianum*
HEMA3	*Hesperis matronalis*
HITR	*Hibiscus trionum*

PLANTS symbol[1]	Scientific Name
HIFL3	*Hieracium × floribundum*
HIAU	*Hieracium aurantiacum*
HICA10	*Hieracium caespitosum*
HIPI	*Hieracium pilosella*
HIPI2	*Hieracium piloselloides*
HYVE3	*Hydrilla verticillata*
HYMO6	*Hydrocharis morsus-ranae*
HYNI	*Hyoscyamus niger*
HYPE	*Hypericum perforatum*
HYRA3	*Hypochaeris radicata*
IMGL	*Impatiens glandulifera*
IPAQ	*Ipomoea aquatica*
IPHE	*Ipomoea hederacea*
IPPU2	*Ipomoea purpurea*
IRPS	*Iris pseudacorus*
ISTI	*Isatis tinctoria*
KNAR	*Knautia arvensis*
LALA4	*Lathyrus latifolius*
LELA2	*Lepidium latifolium*
LEHO7	*Lepyrodiclis holosteoides*
LEVU	*Leucanthemum vulgare*
LIDAD	*Linaria dalmatica ssp. dalmatica*
LIGE	*Linaria genistifolia*
LIVU2	*Linaria vulgaris*
LUGRH	*Ludwigia grandiflora ssp. hexapetala*
LYFE4	*Lycium ferocissimum*
LYVU	*Lysimachia vulgaris*
LYSA2	*Lythrum salicaria*
LYVI3	*Lythrum virgatum*
MAVU	*Marrubium vulgare*
MEPO3	*Medicago polymorpha*
MENO2	*Mesembryanthemum nodiflorum*
MIVE3	*Milium vernale*
MOVA	*Monochoria vaginalis*
MUKE	*Murdannia keisak*
MYAQ2	*Myriophyllum aquaticum*
MYSP2	*Myriophyllum spicatum*
NAST3	*Nardus stricta*
NYPE	*Nymphoides peltata*
ONAL5	*Ononis alopecuroides*
ONAC	*Onopordum acanthium*
ONTA	*Onopordum tauricum*

PLANTS symbol[1]	Scientific Name
ORMI	*Orobanche minor*
ORRA	*Orobanche ramosa*
ORRU	*Oryza rufipogon*
OTAL	*Ottelia alismoides*
PAAN4	*Panicum antidotale*
PAMI2	*Panicum miliaceum*
PARE3	*Panicum repens*
PEHA	*Peganum harmala*
PECI	*Pennisetum ciliare*
PECL2	*Pennisetum clandestinum*
PEMA80	*Pennisetum macrourum*
PEPO14	*Pennisetum polystachion*
PESE3	*Pennisetum setaceum*
POCU6	*Polygonum cuspidatum*
POPO5	*Polygonum polystachyum*
POSA4	*Polygonum sachalinense*
POOL	*Portulaca oleracea*
PORE5	*Potentilla recta*
PRST3	*Prosopis strombulifera*
PUMOL	*Pueraria montana var. lobata*
REMO2	*Retama monosperma*
ROAU	*Rorippa austriaca*
ROSY	*Rorippa sylvestris*
ROMU	*Rosa multiflora*
ROCO6	*Rottboellia cochinchinensis*
RUAR9	*Rubus armeniacus*
SACO8	*Salsola collina*
SAPA8	*Salsola paulsenii*
SATR12	*Salsola tragus*
SAVE6	*Salsola vermiculata*
SAAE	*Salvia aethiopis*
SAPR2	*Salvia pratensis*
SASC2	*Salvia sclarea*
SAMO5	*Salvinia molesta*
SAOF4	*Saponaria officinalis*
SCTE	*Schinus terebinthifolius*
SCAR	*Schismus arabicus*
SCBA	*Schismus barbatus*
SCHI	*Scolymus hispanicus*
SECE	*Secale cereale*
SEJA	*Senecio jacobaea*
SESQ	*Senecio squalidus*

PLANTS symbol[1]	Scientific Name
SEFA	*Setaria faberi*
SILAA3	*Silene latifolia ssp. alba*
SIMA3	*Silybum marianum*
SOCA19	*Solanum cardiophyllum*
SODU	*Solanum dulcamara*
SOLA	*Solanum lanceolatum*
SOMA	*Solanum marginatum*
SOSE2	*Soliva sessilis*
SOAR2	*Sonchus arvensis*
SOBI2	*Sorghum bicolor*
SOHA	*Sorghum halepense*
SPAN5	*Spartina anglica*
SPDE2	*Spartina densiflora*
SPJU2	*Spartium junceum*
SPSA3	*Sphaerophysa salsula*
SYAS	*Symphytum asperum*
TACA8	*Taeniatherum caput-medusae*
TAMI3	*Tagetes minuta*
TAAF	*Tamarix africana*
TAAP	*Tamarix aphylla*
TAAR6	*Tamarix aralensis*
TACA9	*Tamarix canariensis*
TACH2	*Tamarix chinensis*
TAGA	*Tamarix gallica*
TAPA4	*Tamarix parviflora*
TAVU	*Tanacetum vulgare*
THPA7	*Thymelaea passerina*
TOAR	*Torilis arvensis*
TRTE	*Tribulus terrestris*
TRPE21	*Tripleurospermum perforata*
TUFA	*Tussilago farfara*
ULEU	*Ulex europaeus*
ULPU	*Ulmus pumila*
URPA	*Urochloa panicoides*
VEBL	*Verbascum blattaria*
VETH	*Verbascum thapsus*
VIAL2	*Viscum album*
XASP2	*Xanthium spinosum*
ZYFA	*Zygophyllum fabago*

[1] The symbol for the nonnative invasive plant species found in the U.S. Department of Agriculture PLANTS database at *http://plants.usda.gov/java/*.

Appendix B: Attributes and Indicators Measured and Associated Statistics for Each Ecoregion

Attribute and indicator statistics with a single asterisk denote that there is an 80% chance that the actual percent of BLM rangeland acres in the ecoregion ranged between values that included zero. In such situations, the actual percent of BLM rangeland acres could not confidently be stated to differ from zero. Attribute and indicator statistics with a double asterisk denote that the attribute or indicator was not detected on BLM rangelands within the ecoregion.

Attribute or Indicator	Statistics	Ecoregion								
		Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archi-pelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Average amount of bare ground on BLM rangelands	Average percent on BLM rangeland acres	21.38	20.42	28.57	15.68	18.39	22.59	28.75	14.53	18.75
	SE	8.92	3.37	1.59	5.38	0.92	4.67	2.72	2.61	3.20
	CV	0.42	0.16	0.06	0.34	0.05	0.21	0.10	0.18	0.17
	80% confidence interval	9.94-32.81	16.10-24.73	26.53-30.61	8.78-22.58	17.21-19.57	16.60-28.57	25.27-32.24	11.19-17.87	14.65-22.85
Proportion of BLM rangelands with at least 20% bare ground	Average percent of BLM rangeland acres	53.88	37.74	61.34	28.66	34.54	56.38	53.07	29.55	43.40
	SE	27.81	6.08	3.88	19.52	4.41	16.03	5.57	8.40	9.37
	CV	0.52	0.16	0.06	0.68	0.13	0.28	0.10	0.28	0.22
	80% confidence interval	18.24-89.52	29.95-45.54	56.36-66.32	3.64-53.67	28.89-40.20	35.83-76.92	45.93-60.21	18.79-40.31	31.39-55.42
Proportion of BLM rangelands with at least 30% bare ground	Average percent of BLM rangeland acres	36.53*	24.40	36.04	12.89*	17.30	33.41	38.85	18.55	17.86
	SE	41.05	5.69	3.87	10.29	2.25	22.52	5.72	7.97	7.41
	CV	1.12	0.23	0.11	0.80	0.13	0.67	0.15	0.43	0.42
	80% confidence interval	0-89.13	17.11-31.69	31.08-41.01	0-26.07	14.42-20.18	4.55-62.28	31.51-46.18	8.33-28.76	8.36-27.35

Attribute or Indicator	Statistics	Ecoregion								
		Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archi-pelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Proportion of BLM rangelands with at least 40% bare ground	Average percent of BLM rangeland acres	**	13.95	25.79	4.28*	6.80	**	30.73	2.90*	8.65
	SE		5.02	3.68	4.78	1.81		5.58	3.09	6.39
	CV		0.36	0.14	1.12	0.27		0.18	1.07	0.74
	80% confidence interval		7.52-20.38	21.08-30.50	0-10.41	4.48-9.13		23.57-37.88	0-6.87	0.46-16.84
Proportion of BLM rangelands with at least 50% bare ground	Average percent of BLM rangeland acres	**	10.31	14.57	2.14*	2.82	**	20.07	2.90*	2.94*
	SE		4.92	3.19	2.39	1.41		4.59	3.09	3.05
	CV		0.48	0.22	1.12	0.50		0.23	1.07	1.04
	80% confidence interval		4.01-16.62	10.48-18.66	0-5.20	1.02-4.62		14.18-25.96	0-6.87	0-6.86
Proportion of BLM rangelands where soil aggregate stability is ranked 4 or less	Average percent of BLM rangeland acres	95.93	43.47	63.70	91.96	39.12	44.72	87.22	29.81	46.87
	SE	5.19	6.59	3.58	8.86	7.15	22.52	4.14	10.45	8.50
	CV	0.05	0.15	0.06	0.10	0.18	0.50	0.05	0.35	0.18
	80% confidence interval	89.27-100	35.03-51.92	59.11-68.28	80.61-100	29.96-48.28	15.86-73.58	81.91-92.53	16.42-43.20	35.98-57.77

Attribute or Indicator	Statistics	Ecoregion								
		Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archi-pelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Proportion of BLM rangelands with at least 20% of the land having intercanopy gaps of at least 2 meters in length	Average percent of BLM rangeland acres	60.73	59.01	33.71	52.44	6.76	22.11*	75.60	9.75	2.36*
	SE	24.54	5.13	3.23	21.16	2.79	23.96	4.89	7.56	2.43
	CV	0.40	0.09	0.10	0.40	0.41	1.08	0.06	0.78	1.03
	80% confidence interval	29.28-92.18	52.44-65.57	29.57-37.86	25.32-79.56	3.18-10.33	0-52.82	69.34-81.86	0.06-19.45	0-5.48
Proportion of BLM rangelands with nonnative invasive plant species present	Average percent of BLM rangeland acres	55.49	73.16	54.62	23.20*	82.80	31.43	30.43	28.08	33.10
	SE	38.68	5.60	4.95	24.97	4.43	15.29	4.93	8.44	9.58
	CV	0.70	0.08	0.09	1.08	0.05	0.49	0.16	0.30	0.29
	80% confidence interval	5.92-100	65.98-80.34	48.28-60.96	0-55.20	77.12-88.48	11.83-51.03	24.11-36.75	17.26-38.91	20.83-45.38
Proportion of BLM rangelands with abundant nonnative invasive plant species	Average percent of BLM rangeland acres	18.26*	43.18	9.76	**	34.83	9.07*	6.86	**	6.89
	SE	20.52	6.84	2.07		4.93	10.48	2.70		5.28
	CV	1.12	0.16	0.21		0.14	1.16	0.39		0.77
	80% confidence interval	0-44.57	34.41-51.95	7.11-12.41		28.52-41.14	0-22.50	3.40-10.32		0.12-13.67

Attribute or Indicator	Statistics	Ecoregion								
		Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archi-pelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Proportion of BLM rangelands where biotic integrity shows moderate departure from reference conditions	Average percent of BLM rangeland acres	35.61	5.27	8.93	15.77	13.29	11.30*	6.57	3.79*	4.72
	SE	12.62	2.08	2.26	11.64	3.74	12.23	2.86	3.83	3.49
	CV	0.35	0.40	0.25	0.74	0.28	1.08	0.44	1.01	0.74
	80% confidence interval	19.44-51.79	2.60-7.93	6.04-11.82	0.85-30.69	8.50-18.08	0-26.98	2.89-10.24	0-8.70	0.25-9.20
Proportion of BLM rangelands where biotic integrity shows moderate-to-extreme or extreme-to-total departure from reference conditions	Average percent of BLM rangeland acres	17.35*	0.10*	1.96	**	3.38	**	15.80	**	**
	SE	19.69	0.11	0.96		2.05		4.52		
	CV	1.14	1.05	0.49		0.61		0.29		
	80% confidence interval	0-42.58	0-0.24	0.73-3.19		0.75-6.01		10.01-21.60		

Attribute or Indicator	Statistics	Ecoregion								
		Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archi-pelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Proportion of BLM rangelands where hydrologic function shows moderate departure from reference conditions	Average percent of BLM rangeland acres	17.35*	3.08	10.13	2.14*	6.49	11.30*	11.73	10.67	7.95
	SE	19.69	1.83	2.11	2.39	2.02	12.23	4.75	5.69	4.68
	CV	1.14	0.59	0.21	1.12	0.31	1.08	0.40	0.53	0.59
	80% confidence interval	0-42.58	0.73-5.42	7.42-12.83	0-5.20	3.90-9.07	0-26.98	5.64-17.81	3.38-17.96	1.95-13.94
Proportion of BLM rangelands where hydrologic function shows moderate-to-extreme or extreme-to-total departure from reference conditions	Average percent of BLM rangeland acres	17.35*	**	2.49	8.04*	1.12*	**	13.99	**	2.29*
	SE	19.69		1.10	8.86	1.13		4.42		2.41
	CV	1.14		0.44	1.10	1.00		0.32		1.05
	80% confidence interval	0-42.58		1.07-3.90	0-19.39	0-2.57		8.32-19.66		0-5.38

Attribute or Indicator	Statistics	Ecoregion								
		Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archi-pelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Proportion of BLM rangelands where soil/ site stability shows moderate departure from reference conditions	Average percent of BLM rangeland acres	**	1.50	8.54	2.14*	4.19	22.96	13.57	3.79*	5.51
	SE		0.83	1.91	2.39	1.65	13.74	4.95	3.83	4.01
	CV		0.55	0.22	1.12	0.39	0.60	0.36	1.01	0.73
	80% confidence interval		0.44-2.56	6.09-10.99	0-5.20	2.07-6.30	5.35-40.57	7.23-19.91	0-8.70	0.37-10.65
Proportion of BLM rangelands where soil/ site stability shows moderate-to-extreme or extreme-to-total departure from reference conditions	Average percent of BLM rangeland acres	17.35*	**	2.55	8.04*	1.12*	**	12.14	**	2.29*
	SE	19.69		1.10	8.86	1.13		3.79		2.41
	CV	1.14		0.43	1.10	1.00		0.31		1.05
	80% confidence interval	0-42.58		1.15-3.96	0-19.39	0-2.57		7.28-17.00		0-5.38

Appendix C: Overall Comparison of Attribute and Indicator Estimates Across Ecoregions

Results of the omnibus F-test, which tests whether the estimates for an attribute or indicator across different ecoregions are the same or are not all the same.

Attribute or Indicator	F Statistic	P-value	Degrees of Freedom	Number of Ecoregions Compared
Average amount of bare ground on BLM rangelands	69.77	0.0000	(8, 20)	9
Proportion of BLM rangelands with at least 20% bare ground	27.56	0.0000	(8, 20)	9
Proportion of BLM rangelands with at least 30% bare ground	48.41	0.0000	(6, 22)	7
Proportion of BLM rangelands with at least 40% bare ground	51.05	0.0000	(4, 24)	5
Proportion of BLM rangelands with at least 50% bare ground	36.43	0.0000	(3, 25)	4
Proportion of BLM rangelands where soil aggregate stability is ranked 4 or less	163.34	0.0000	(8, 20)	9
Proportion of BLM rangelands with at least 20% of the land having intercanopy gaps of at least 2 meters in length	296.28	0.0000	(6, 22)	7
Proportion of BLM rangelands with nonnative invasive plant species present	148.06	0.0000	(7, 21)	8
Proportion of BLM rangelands with abundant nonnative invasive plant species	49.19	0.0000	(4, 24)	5
Proportion of BLM rangelands where biotic integrity shows moderate departure from reference condition	8.67	0.0001	(6, 22)	7
Proportion of BLM rangelands where biotic integrity shows moderate-to-extreme or extreme-to-total departure from reference conditions	9.35	0.0009	(2, 26)	3
Proportion of BLM rangelands where hydrologic function shows moderate departure from reference conditions	14.24	0.0000	(5, 23)	6
Proportion of BLM rangelands where hydrologic function shows moderate-to-extreme or extreme-to-total departure from reference conditions	6.03	0.0208	(1, 27)	2
Proportion of BLM rangelands where soil/site stability shows moderate departure from reference conditions	35.83	0.0000	(5, 23)	6
Proportion of BLM rangelands where soil/site stability shows moderate-to-extreme or extreme-to-total departure from reference conditions	5.48	0.0269	(1, 27)	2

Appendix D: Pairwise Comparisons Across Ecoregions for Each Attribute or Indicator

These comparisons show whether estimates are significantly different or not for each pair of ecoregions. Values in tables are F statistics.

Indicator: Average amount of bare ground on BLM rangelands

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		0.01	0.63	0.30	0.11	0.02	0.59	0.57	0.08
Central Basin and Range			6.69*	0.49	0.45	0.14	3.81*	2.72*	0.11
Eastern Cold Deserts				5.10*	38.02*	1.47	0.00	23.26*	6.35*
Madrean Archipelago					0.24	0.95	3.97*	0.04	0.17
Northern Cold Deserts						0.74	14.94*	2.03*	0.01
South Central Semi-Arid Prairies							1.44	1.83*	0.57
Warm Deserts								12.59*	5.98*
West Central Semi-Arid Prairies									0.96
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; α = 0.8) = 1.73.

Indicator: Proportion of BLM rangelands with at least 20% bare ground

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		0.32	0.08	0.59	0.47	0.01	0.00	0.75	0.13
Central Basin and Range			11.51*	0.16	0.59	1.36	3.52*	0.86	0.23
Eastern Cold Deserts				2.72*	21.26*	0.09	1.58	9.97*	2.55*
Madrean Archipelago					0.08	0.98	1.27	0.00	0.38
Northern Cold Deserts						1.53	7.35*	0.36	0.62
South Central Semi-Arid Prairies							0.04	1.92*	0.59
Warm Deserts								6.11*	0.87
West Central Semi-Arid Prairies									1.37
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; α = 0.8) = 1.73.

Indicator: Proportion of BLM rangelands with at least 30% bare ground

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		**	**	**	**	**	**	**	**
Central Basin and Range			3.27*	**	1.84*	0.14	4.11*	0.40	0.43
Eastern Cold Deserts				**	19.40*	0.01	0.14	3.78*	3.62*
Madrean Archipelago					**	**	**	**	**
Northern Cold Deserts						0.50	14.22*	0.02	0.01
South Central Semi-Arid Prairies							0.05	0.34	0.50
Warm Deserts								4.52*	5.32*
West Central Semi-Arid Prairies									0.00
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; α = 0.8) = 1.73.

** Pairwise comparisons were not conducted with the Arizona/New Mexico Mountains ecoregion and the Madrean Archipelago ecoregion because the indicator estimates for these ecoregions could not confidently be stated to differ from zero.

Indicator: Proportion of BLM rangelands with at least 40% bare ground

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		***	***	**	***	***	***	**	***
Central Basin and Range			3.74*	**	1.92*	***	5.91*	**	0.37
Eastern Cold Deserts				**	24.39*	***	0.54	**	4.30*
Madrean Archipelago					**	**	**	**	**
Northern Cold Deserts						***	19.71*	**	0.09
South Central Semi-Arid Prairies							***	**	***
Warm Deserts								**	6.53*
West Central Semi-Arid Prairies									**
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; $\alpha = 0.8$) = 1.73.

** Pairwise comparisons were not conducted with the Madrean Archipelago ecoregion and the West Central Semi-Arid Prairies ecoregion because the indicator estimates for these ecoregions could not confidently be stated to differ from zero.

*** Pairwise comparisons were not conducted with the Arizona/New Mexico Mountains ecoregion and the South Central Semi-Arid Prairies ecoregion, because the indicator was not detected on BLM rangelands within these ecoregions.

Indicator: Proportion of BLM rangelands with at least 50% bare ground

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		***	***	**	***	***	***	**	**
Central Basin and Range			0.58	**	2.06*	***	2.25*	**	**
Eastern Cold Deserts				**	14.36*	***	0.89	**	**
Madrean Archipelago					**	**	**	**	**
Northern Cold Deserts						***	15.31*	**	**
South Central Semi-Arid Prairies							***	**	**
Warm Deserts								**	**
West Central Semi-Arid Prairies									**
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; $\alpha = 0.8$) = 1.73.

** Pairwise comparisons were not conducted with the Madrean Archipelago ecoregion, the West Central Semi-Arid Prairies ecoregion, and the Western Cordillera ecoregion because the indicator estimates for these ecoregions could not confidently be stated to differ from zero.

*** Pairwise comparisons were not conducted with the Arizona/New Mexico Mountains ecoregion and the South Central Semi-Arid Prairies ecoregion because the indicator was not detected on BLM rangelands within these ecoregions.

Indicator: Proportion of BLM rangelands where soil aggregate stability is ranked 4 or less

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		37.42*	23.66*	0.15	40.47*	4.68*	1.35	36.07*	27.24*
Central Basin and Range			7.39*	18.83*	0.14	0.00	49.84*	1.21	0.11
Eastern Cold Deserts				7.60*	8.31*	0.68	17.20*	9.64*	3.81*
Madrean Archipelago					23.64*	3.94*	0.20	19.90*	12.56*
Northern Cold Deserts						0.05	27.19*	0.53	0.51
South Central Semi-Arid Prairies							3.06*	0.34	0.01
Warm Deserts								22.35*	18.15*
West Central Semi-Arid Prairies									1.35
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; α = 0.8) = 1.73.

Indicator: Proportion of BLM rangelands with at least 20% of the land having intercanopy gaps of at least 2 meters in length

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		0.00	1.14	0.08	4.66*	**	0.30	3.82*	**
Central Basin and Range			19.04*	0.09	90.24*	**	4.93*	31.51*	**
Eastern Cold Deserts				0.82	49.41*	**	56.91*	11.00*	**
Madrean Archipelago					4.49*	**	1.11	3.58*	**
Northern Cold Deserts						**	171.28*	0.17	**
South Central Semi-Arid Prairies							**	**	**
Warm Deserts								52.98*	**
West Central Semi-Arid Prairies									**
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; α = 0.8) = 1.73.

** Pairwise comparisons were not conducted with the South Central Semi-Arid Prairies ecoregion and the Western Cordillera ecoregion because the indicator estimates for these ecoregions could not confidently be stated to differ from zero.

Indicator: Proportion of BLM rangelands with nonnative invasive plant species present

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		0.21	0.00	**	0.49	0.27	0.41	0.64	0.32
Central Basin and Range			6.89*	**	1.71	5.76*	23.48*	19.83*	20.99*
Eastern Cold Deserts				**	15.24*	2.15*	15.04*	6.68*	3.34*
Madrean Archipelago					**	**	**	**	**
Northern Cold Deserts						11.65*	55.32*	30.31*	24.75*
South Central Semi-Arid Prairies							0.00	0.03	0.01
Warm Deserts								0.05	0.05
West Central Semi-Arid Prairies									0.14
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; α = 0.8) = 1.73.

** Pairwise comparisons were not conducted with the Madrean Archipelago ecoregion because the indicator estimate for this ecoregion could not confidently be stated to differ from zero.

Indicator: Proportion of BLM rangelands with abundant nonnative invasive plant species

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		**	**	**	**	**	**	**	**
Central Basin and Range			20.31*	***	0.83	**	19.23*	***	14.27*
Eastern Cold Deserts				***	21.47*	**	0.93	***	0.24
Madrean Archipelago					***	**	***	***	***
Northern Cold Deserts						**	28.97*	***	16.79*
South Central Semi-Arid Prairies							**	**	**
Warm Deserts								***	0.00
West Central Semi-Arid Prairies									***
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; $\alpha = 0.8$) = 1.73.

** Pairwise comparisons were not conducted with the Arizona/New Mexico Mountains ecoregion and the South Central Semi-Arid Prairies ecoregion because the indicator estimates for these ecoregions could not confidently be stated to differ from zero.

*** Pairwise comparisons were not conducted with the Madrean Archipelago ecoregion and the West Central Semi-Arid Prairies ecoregion because the indicator was not detected on BLM rangelands within these ecoregions.

Attribute: Proportion of BLM rangelands where biotic integrity shows moderate departure from reference conditions

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		5.80*	4.35*	1.55	2.86*	**	4.74*	**	5.61*
Central Basin and Range			1.19	0.79	2.58*	**	0.17	**	0.02
Eastern Cold Deserts				0.31	1.21	**	0.42	**	1.06
Madrean Archipelago					0.04	**	0.50	**	0.84
Northern Cold Deserts						**	1.71	**	2.41*
South Central Semi-Arid Prairies							**	**	**
Warm Deserts								**	0.16
West Central Semi-Arid Prairies									**
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; α = 0.8) = 1.73.

** Pairwise comparisons were not conducted with the South Central Semi-Arid Prairies ecoregion and the West Central Semi-Arid Prairies ecoregion because the attribute estimates for these ecoregions could not confidently be stated to differ from zero.

Attribute: Proportion of BLM rangelands where biotic integrity shows moderate-to-extreme or extreme-to-total departure from reference conditions

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		**	**	**	**	**	**	**	**
Central Basin and Range			**	**	**	**	**	**	**
Eastern Cold Deserts				***	0.31	***	9.15*	***	***
Madrean Archipelago					***	***	***	***	***
Northern Cold Deserts						***	5.83*	***	***
South Central Semi-Arid Prairies							***	***	***
Warm Deserts								***	***
West Central Semi-Arid Prairies									***
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; α = 0.8) = 1.73.

** Pairwise comparisons were not conducted with the Arizona/New Mexico Mountains ecoregion and the Central Basin and Range ecoregion because the attribute estimates for these ecoregions could not confidently be stated to differ from zero.

*** Pairwise comparisons were not conducted with the Madrean Archipelago ecoregion, the South Central Semi-Arid Prairies ecoregion, the West Central Semi-Arid Prairies ecoregion, and the Western Cordillera ecoregion because the attribute was not detected on BLM rangelands within these ecoregions.

Attribute: Proportion of BLM rangelands where hydrologic function shows moderate departure from reference conditions

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		**	**	**	**	**	**	**	**
Central Basin and Range			5.25*	**	1.40	**	2.96*	2.37*	0.89
Eastern Cold Deserts				**	1.15	**	0.09	0.01	0.17
Madrean Archipelago					**	**	**	**	**
Northern Cold Deserts						**	0.92	0.45	0.07
South Central Semi-Arid Prairies							**	**	**
Warm Deserts								0.02	0.41
West Central Semi-Arid Prairies									0.13
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; $\alpha = 0.8$) = 1.73.

** Pairwise comparisons were not conducted with the Arizona/New Mexico Mountains ecoregion, the Madrean Archipelago ecoregion, and the South Central Semi-Arid Prairies ecoregion because the attribute estimates for these ecoregions could not confidently be stated to differ from zero.

Attribute: Proportion of BLM rangelands where hydrologic function shows moderate-to-extreme or extreme-to-total departure from reference conditions

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		**	**	**	**	**	**	**	**
Central Basin and Range			***	**	**	***	***	***	**
Eastern Cold Deserts				**	**	***	6.03*	***	**
Madrean Archipelago					**	**	**	**	**
Northern Cold Deserts						**	**	**	**
South Central Semi-Arid Prairies							***	***	**
Warm Deserts								***	**
West Central Semi-Arid Prairies									**
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; $\alpha = 0.8$) = 1.73.

** Pairwise comparisons were not conducted with the Arizona/New Mexico Mountains ecoregion, the Madrean Archipelago ecoregion, the Northern Cold Deserts ecoregion, and the Western Cordillera ecoregion because the attribute estimates for these ecoregions could not confidently be stated to differ from zero.

*** Pairwise comparisons were not conducted with the Central Basin and Range ecoregion, the South Central Semi-Arid Prairies ecoregion, and the West Central Semi-Arid Prairies ecoregion because the attribute was not detected on BLM rangelands within these ecoregions.

Attribute: Proportion of BLM rangelands where soil/site stability shows moderate departure from reference conditions

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		***	***	**	***	***	***	**	***
Central Basin and Range			11.17*	**	3.01*	2.48*	5.75*	**	0.94
Eastern Cold Deserts				**	2.96*	0.98	0.93	**	0.44
Madrean Archipelago					**	**	**	**	**
Northern Cold Deserts						1.76*	2.57*	**	0.08
South Central Semi-Arid Prairies							0.44	**	1.58
Warm Deserts								**	2.02*
West Central Semi-Arid Prairies									**
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; $\alpha = 0.8$) = 1.73.

** Pairwise comparisons were not conducted with the Madrean Archipelago ecoregion and the West Central Semi-Arid Prairies ecoregion because the attribute estimates for these ecoregions could not confidently be stated to differ from zero.

*** Pairwise comparisons were not conducted with the Arizona/New Mexico Mountains ecoregion because the attribute was not detected on BLM rangelands within this ecoregion.

Attribute: Proportion of BLM rangelands where soil/site stability shows moderate-to-extreme or extreme-to-total departure from reference conditions

Ecoregion	Arizona/ New Mexico Mountains	Central Basin and Range	Eastern Cold Deserts	Madrean Archipelago	Northern Cold Deserts	South Central Semi-Arid Prairies	Warm Deserts	West Central Semi-Arid Prairies	Western Cordillera
Arizona/ New Mexico Mountains		**	**	**	**	**	**	**	**
Central Basin and Range			***	**	**	***	***	***	**
Eastern Cold Deserts				**	**	***	5.48*	***	**
Madrean Archipelago					**	**	**	**	**
Northern Cold Deserts						**	**	**	**
South Central Semi-Arid Prairies							***	***	**
Warm Deserts								***	**
West Central Semi-Arid Prairies									**
Western Cordillera									

* Statistically significant at 80% confidence level; F critical value (degrees of freedom (df) 1, 27; α = 0.8) = 1.73.

** Pairwise comparisons were not conducted with the Arizona/New Mexico Mountains ecoregion, the Madrean Archipelago ecoregion, the Northern Cold Deserts ecoregion, and the Western Cordillera ecoregion because the attribute estimates for these ecoregions could not confidently be stated to differ from zero.

*** Pairwise comparisons were not conducted with the Central Basin and Range ecoregion, the South Central Semi-Arid Prairies ecoregion, and the West Central Semi-Arid Prairies ecoregion because the attribute was not detected on BLM rangelands within these ecoregions.