VI. Summary Findings and Applications

This chapter presents REA findings designed to help managers visualize the REA products and how they may be used at various scales (ecoregional, state, field office). The focus of this example is on BLM lands not currently protected, but the models are flexible enough to analyze all areas at the ecoregion, state, or field office scales. This summary presents ways to use the integrity/intactness results with composite species information to provide an overview of key regional issues as an introduction to more local step-down management or planning. Understanding the relationship of these data provides basic ecoregion-level information to begin to identify broad areas of opportunity for development, restoration, conservation, or connectivity that may be examined at multiple scales, both regional and local.

6.1 Using REA Results for Regional Planning

The REA Statement of Work required an assessment of ecological integrity (condition or health). As defined in the Statement of Work, ecological integrity is "the ability of ecological systems to support and maintain a community of organisms that have the species composition, diversity, and functional organization comparable to those of natural habitats within the ecoregion (Karr and Dudley 1981)." The wildlife species selected as core conservation elements for the REA were envisioned to be wide-ranging species that represent other species and multiple habitats and serve as indicators of the condition of the ecoregion. Besides having broad representation, some of the selected indicator species should be habitat specialists that express site fidelity for breeding, nesting, or wintering (to reduce interannual variability in sampling) and also sensitive and responsive to a range of disturbances. The ecoregion-wide scope in these REAs did not lend itself well to accommodate an approach using indicator species. Perhaps reducing the size of the region to more homogeneous subunits such as Environmental Protection Agency (EPA) level IV ecoregions (Woods et al. 2001, Chapman et al 2006) and selecting assemblages or species guilds (e.g., sagebrush obligates) across sites with a range of disturbances within these smaller units would produce a useful biological component to add to the spatial measure of terrestrial ecological integrity developed for this REA.

There are few measurable indicators and metrics available as spatial data for individual species to incorporate into such an effort. For this REA, our present state of knowledge required the use of the condition of vegetation communities, habitats, or landscapes as surrogates for the condition of the species and ecological processes in the region. With BLM approval, the REA focused on landscape intactness, an attribute that could be defensibly supported by existing geospatial datasets and reasonably tracked through time. Although different species may possess different tolerances to regional habitat conditions, species assemblages and natural patterns and processes are typically increasingly compromised by the cumulative effects of the change agents that affect their habitats. Terrestrial and aquatic landscape intactness models served as the foundation against which to assess current and future conservation element status.

This reliance on landscape intactness to represent ecological integrity meant that the presence or absence of a particular species, species rarity, or species richness did not factor into any metric of integrity. High species richness or concentrations of rare or endemic species do not indicate high ecological integrity (Odum 1985, Scott and Helfman 2001). Richness is limited by the partitioning of energy among species (Currie 1991, Hawkins et al. 2003); some of our most valued and intact landscapes support few species (Currie 1991, Hughes et al. 2004). On the other hand, although areas of high species richness or endemism should be evaluated separately from integrity or intactness, they are still important for conservation and management decision making. Much of the BLM's management and planning is species-centric. This chapter examines the use of regional concentrations or hotspots of species and resource values as one avenue to regional planning that identifies regional areas of interest for closer examination at a local scale.

6.1.1 NatureServe Natural Heritage Elements

NatureServe summarized Natural Heritage data for the ecoregion by 5th level HUCs, enumerating all G1–G3 species (Master 1991, Master et al. 2000) and threatened and endangered species occurring within each HUC. The map identifies specific areas that are species-richness hotspots for these sensitive fine-filter elements within the ecoregion (Figure 6-1A). The richness function map layers represent locations from which occurrences have been recorded, rather than where the species currently occurs. The greatest concentration of these species is along the western border of the ecoregion along the boundary with the high elevation Aquarius Plateau, but other concentrations can be observed in the central and northeastern portions of the ecoregion as well. Comparing these species concentrations to the same areas on the terrestrial landscape intactness map shows that many of the HUCs with high concentrations of sensitive species do not coincide with areas of High or Very High landscape intactness (green areas in Figure 6-1B). This is not unexpected when one considers that human activities tend to put species at risk, but it is interesting to see the regional pattern.

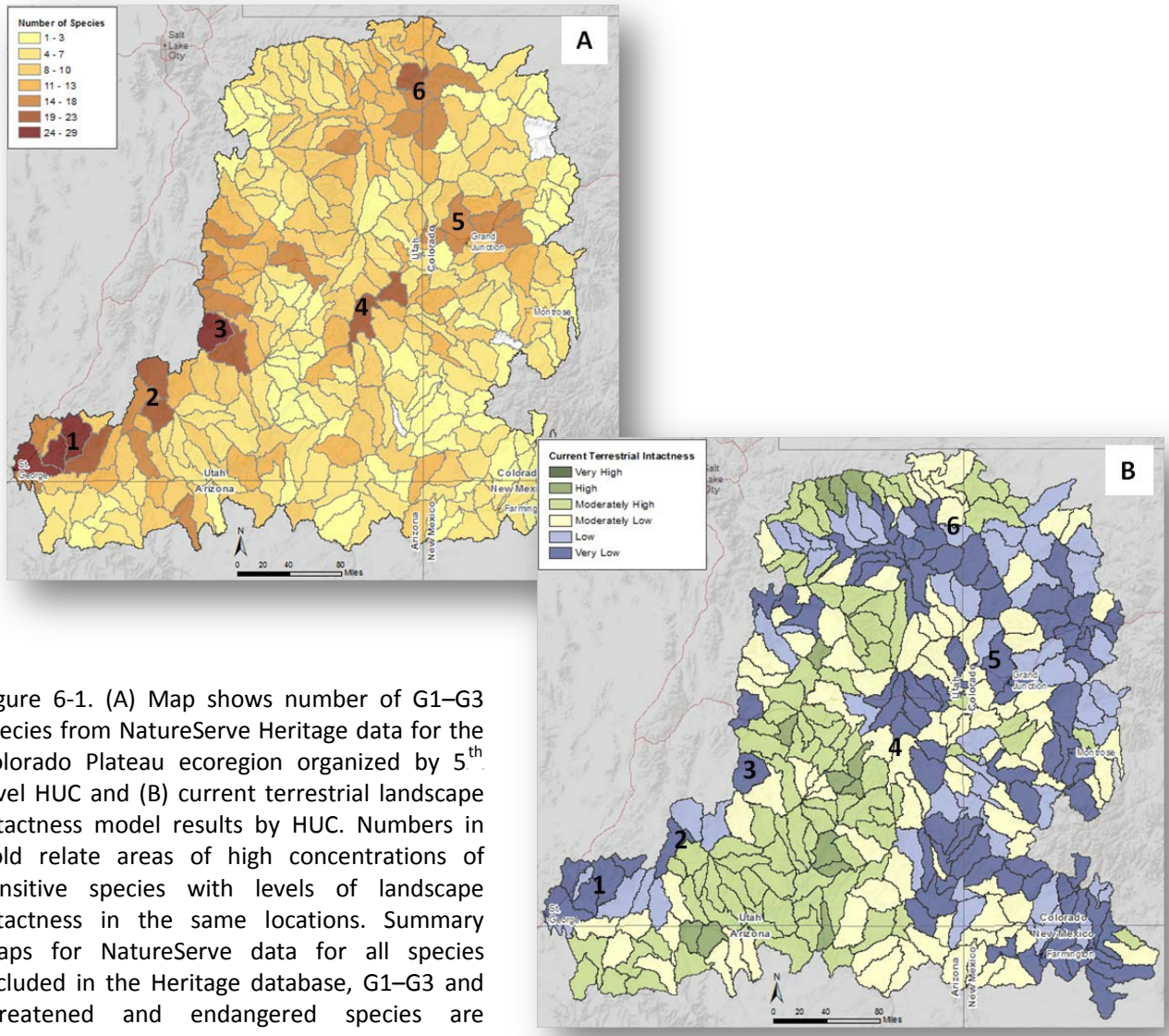


Figure 6-1. (A) Map shows number of G1–G3 species from NatureServe Heritage data for the Colorado Plateau ecoregion organized by 5th level HUC and (B) current terrestrial landscape intactness model results by HUC. Numbers in bold relate areas of high concentrations of sensitive species with levels of landscape intactness in the same locations. Summary maps for NatureServe data for all species included in the Heritage database, G1–G3 and threatened and endangered species are provided in Appendix C.

6.1.2 Concentrations of Conservation Elements

As was done in the previous section for the heritage data, the collection of REA conservation elements (CEs) was combined by HUC to create CE concentrations or hotspots to compare against regional terrestrial landscape intactness. The list of 29 conservation elements included 18 species, 9 ecological systems, and Herd Management Areas (HMAs). The number of conservation elements contained within a single HUC ranged from 11–22. As before, although the map results do not mimic the NatureServe data exactly, the areas with high concentrations of conservation elements (19–22) were located in the lower-scoring intactness landscapes (Figure 6-2A and B) and no HUCs containing the highest CE concentrations were classified as having High or Very High intactness.

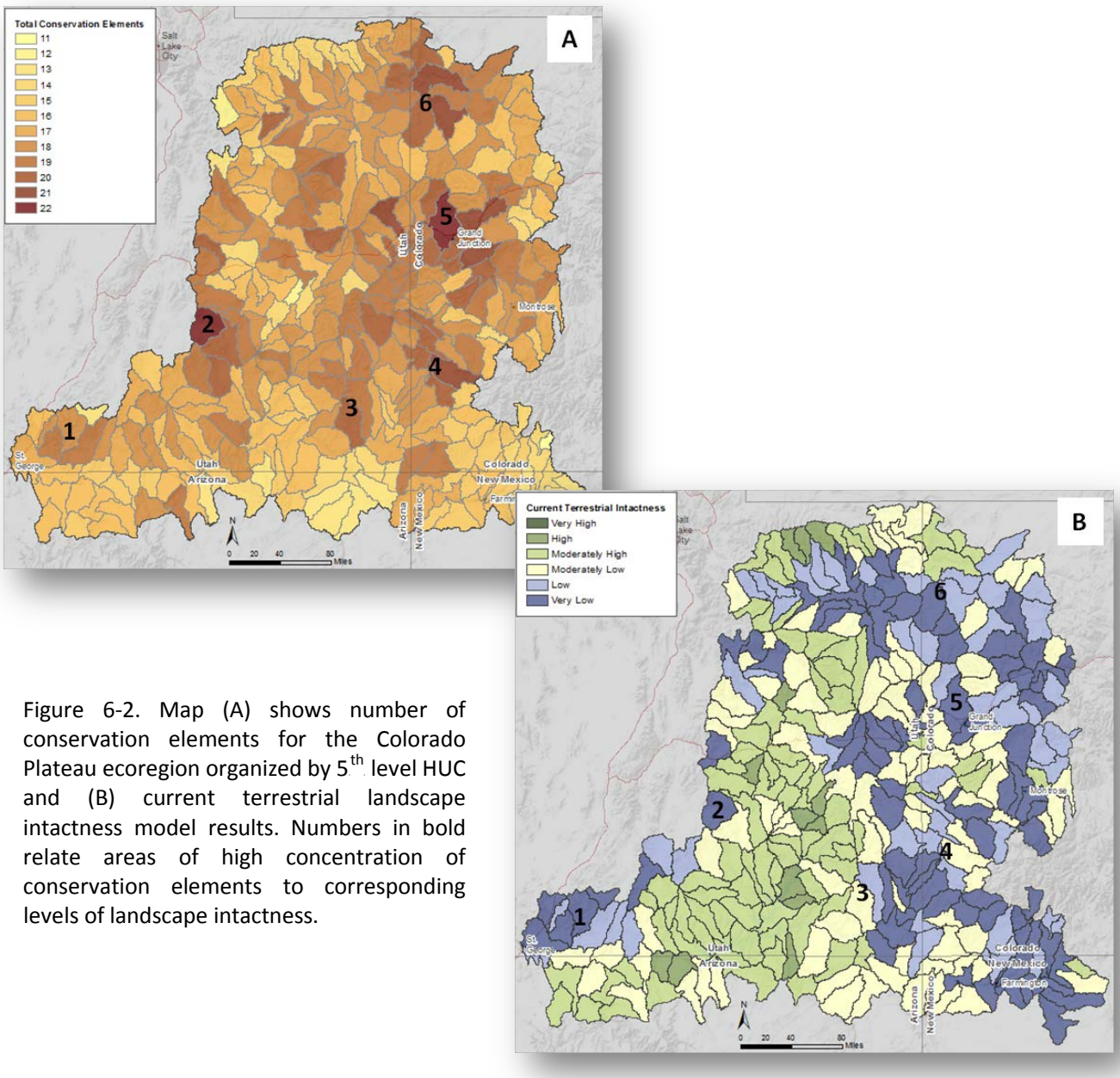


Figure 6-2. Map (A) shows number of conservation elements for the Colorado Plateau ecoregion organized by 5th level HUC and (B) current terrestrial landscape intactness model results. Numbers in bold relate areas of high concentration of conservation elements to corresponding levels of landscape intactness.

Mapping the conservation element composite at the 4 km reporting unit reveals an improvement in spatial detail with the increase in resolution of the reporting unit (Figure 6-4B). The most apparent difference at the 4 km scale is the ability to detect some of the stream networks and with them the contribution of the aquatic conservation elements to the CE concentrations. The 4 km resolution shows a more textured result when mapped and compared to landscape intactness reported by HUC; that is, groups of 4 km grid cells within low scoring HUCs will show a wider range of intactness classes, picking up the complete range (1–18, compared to the 11–22 elements observed using HUCs). The 4 km results are at a scale and detail that more closely matches recognizable topographic changes and areas of management interest. When 4 km results such as these are compared to regional intactness mapped at the 4 km unit (as in Figure 6-5A in Section 6.2.1 below), management may be aimed at grid cells with higher levels of intactness or neighboring grid cells of lower intactness that might be candidates for restoration.

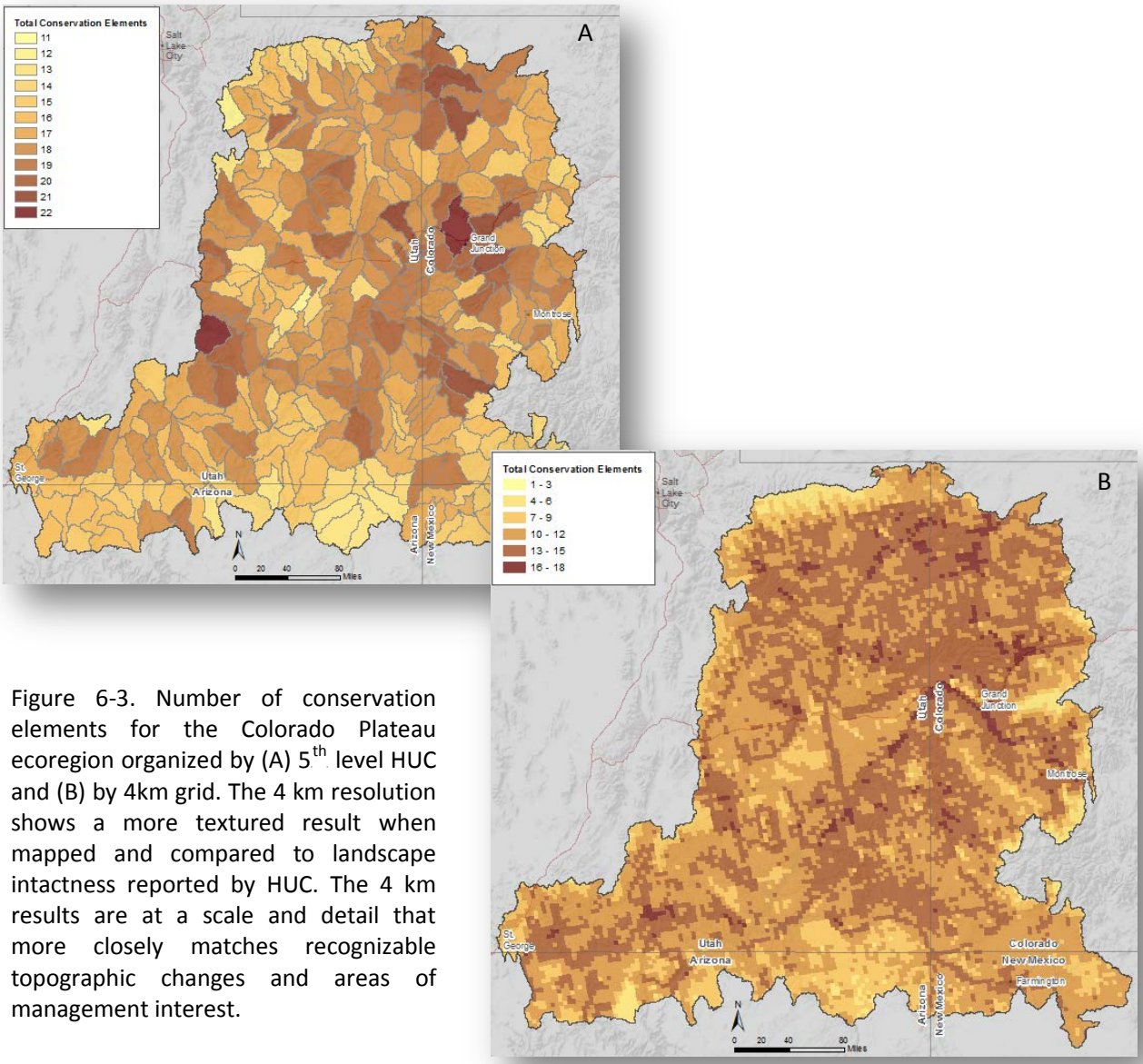


Figure 6-3. Number of conservation elements for the Colorado Plateau ecoregion organized by (A) 5th level HUC and (B) by 4km grid. The 4 km resolution shows a more textured result when mapped and compared to landscape intactness reported by HUC. The 4 km results are at a scale and detail that more closely matches recognizable topographic changes and areas of management interest.

6.2 Regional View of Landscape Intactness: Current and Future Risk to Conservation Elements

6.2.1 Comparing Concentrations of Conservation Elements with Regional Levels of Intactness

Three different maps were considered to represent the concentrations of resource values and to reveal patterns across the region—1) REA conservation elements enumerated by 4 km grid cell (Figure 6-4A); 2) the number of globally critically imperiled and vulnerable species (G1–G3 by 5th level HUC, Figure 6-4B); and 3) the number of USFWS threatened and endangered species recorded by 5th level HUC (Figure 6-4C). Additional areas of interest were added to map 6-4A from maps 6-4B and 6-4C to create one map for purposes of discussion (Figure 6-4D), used when comparing concentrations of conservation elements with intactness maps and maps of future condition found in the following sections. All three maps share areas surrounding Dinosaur National Monument in the northeastern portion of the ecoregion, Castle Valley and the Colorado River corridor between Moab and Canyonlands in the center of the map, and the Zion National Park-Uinkaret Plateau area in the southwestern corner. Maps 6-4A and 6-4B share an area in the vicinity of the Roan Plateau and Colorado National Monument in the northeast. Other concentrations of globally imperiled species in map 6-4B occur along the western boundary in the transition to the Sevier Plateau near Bryce Canyon and Capitol Reef. Finally, a concentration of threatened and endangered species in map 6-4C just south of the Uinta Basin marks an area on the west Tavaputs Plateau straddling the Green River.

To compare these concentrations of conservation elements (CEs) to the condition of surrounding habitats at the 4 km grid scale, areas of moderately high to high intactness have been outlined (in pink) on the intactness map (Figure 6-5A) and the higher concentrations of CEs outlined in royal blue on the map in Figure 6-5B. A comparison of the two maps identifies some broad areas of interest between the two layers, particularly in the north. Area 1 (black numbers in bold in Figure 6-5A) marks the Douglas Mountain area north of Dinosaur National Park; area 2 represents a concentration of threatened and endangered species and REA conservation elements near the Winter Ridge Wilderness Study Area and Green River, western Tavaputs Plateau; and area 3 covers an area common to maps 6-4A and 6-4B near Grand Junction that includes the Roan Cliffs and Roan Plateau. In planning situations, of course, there may be valid reasons for restoring or protecting areas of lower intactness or lower numbers of resource values. Areas 4 and 5 (white numbers, Figure 6-5B) represent areas with high concentrations of CEs that occur in moderate to lower intactness classes. Existing protected areas tend to occur in rugged or high elevation terrain that experiences lower development pressure than lowland areas where heavy resource use makes it more difficult to establish conservation areas. For example, Gunnison sage-grouse is an REA species of concern that is in serious decline, an inhabitant of sagebrush habitats that are more highly developed, privately owned, and difficult to conserve. When Gunnison sage- grouse distribution is compared to designated protected areas (Figure 6-6), one can see that there is little overlap. BLM manages 23% of the species' distribution (101,000 acres); 10% of the species distribution (46,000 ac) is protected by various designations, leaving 67% (295,000 acres) unprotected.

The vast amount of information produced by this REA can and must be examined in multiple ways and at multiple scales. To accompany the spatial mapped results, it will be useful for managers to have tabular summaries of conservation elements and areas in various intactness classes. Table 6-1 shows the results for all lands across the Colorado Plateau. The matrix is organized into six different categories; the colored panels indicate High, Medium, and Low intactness classes (red, blue, and yellow, respectively) from left to right with increasing numbers of conservation elements from top to bottom (darker color tones for the higher concentrations of conservation elements). An accompanying map using the same color scheme is provided in Figure 6-7.

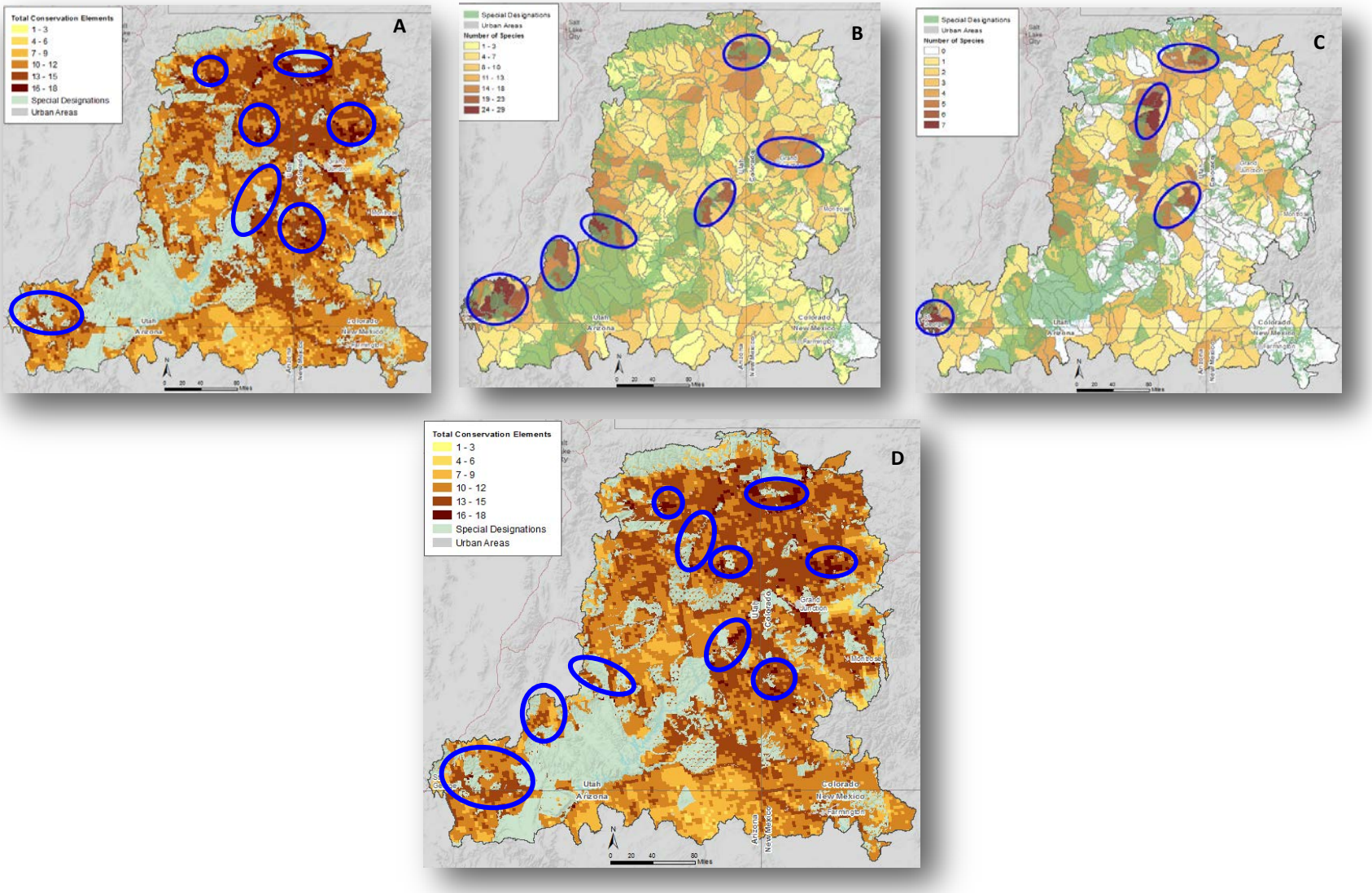


Figure 6-4. Maps of (A) concentrations of conservation elements, (B) globally imperiled species, and (C) USFWS-listed threatened and endangered species with highest concentrations circled; (D) map A with additional areas of interest (represented by 3 additional blue ellipses) added to it from maps B and C. Protected areas are masked out in light green.

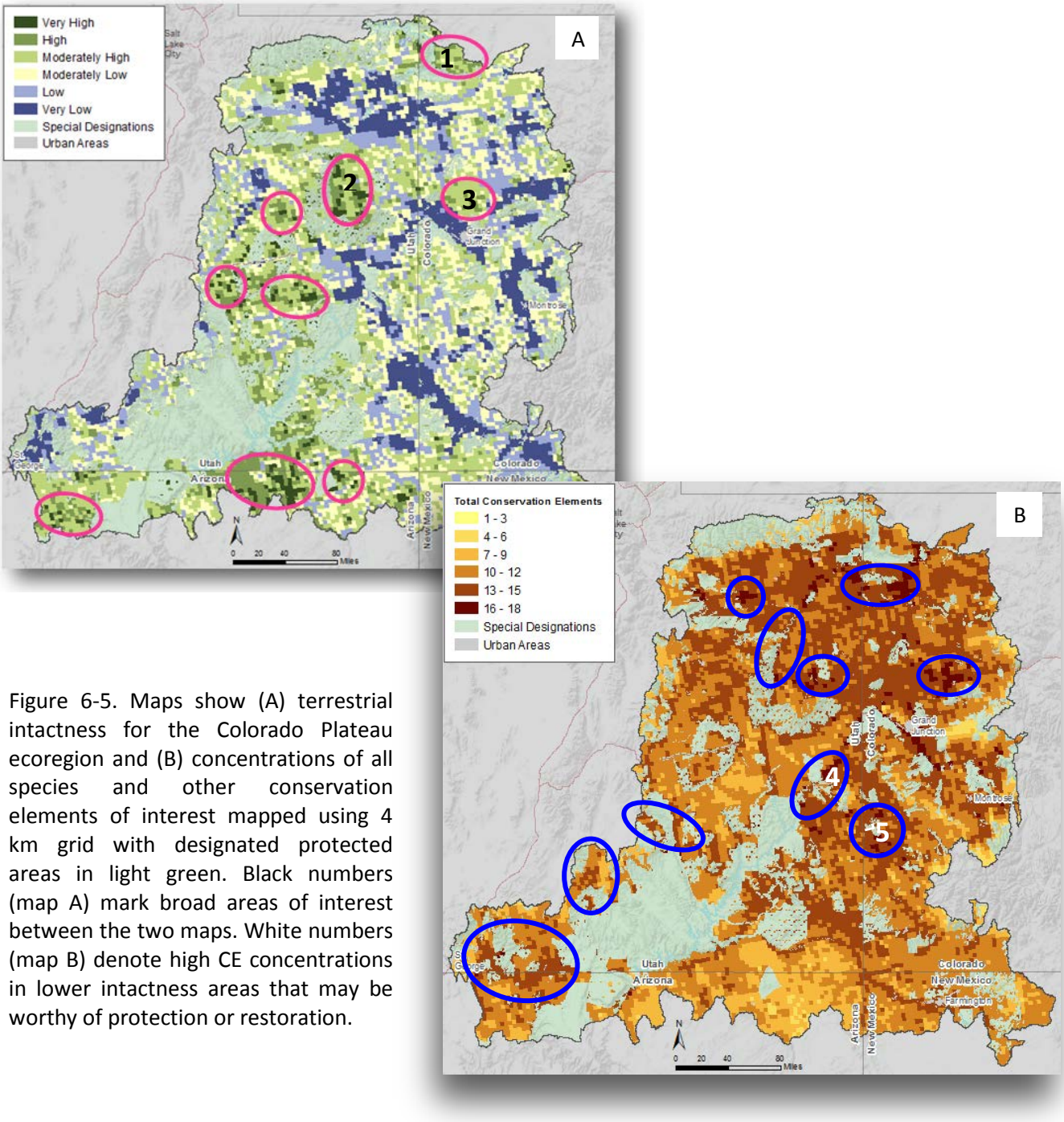


Figure 6-5. Maps show (A) terrestrial intactness for the Colorado Plateau ecoregion and (B) concentrations of all species and other conservation elements of interest mapped using 4 km grid with designated protected areas in light green. Black numbers (map A) mark broad areas of interest between the two maps. White numbers (map B) denote high CE concentrations in lower intactness areas that may be worthy of protection or restoration.

Acres within each category in Table 1 may be viewed in different ways to assess management options and to inform policy decisions. For example, areas in dark red—those locations that contain high concentrations of conservation elements and that demonstrate the highest levels of landscape intactness—can be viewed as places of high potential conflict or high protection value. Future development may be more acceptable in areas in the light yellow category (low intactness and low concentrations of conservation elements) assuming specific issues (protection of a sensitive species) are assessed and properly managed. Areas in dark blue (high concentrations of conservation elements combined with moderate intactness) may be the best locations for restoration to get the greatest return on investment.

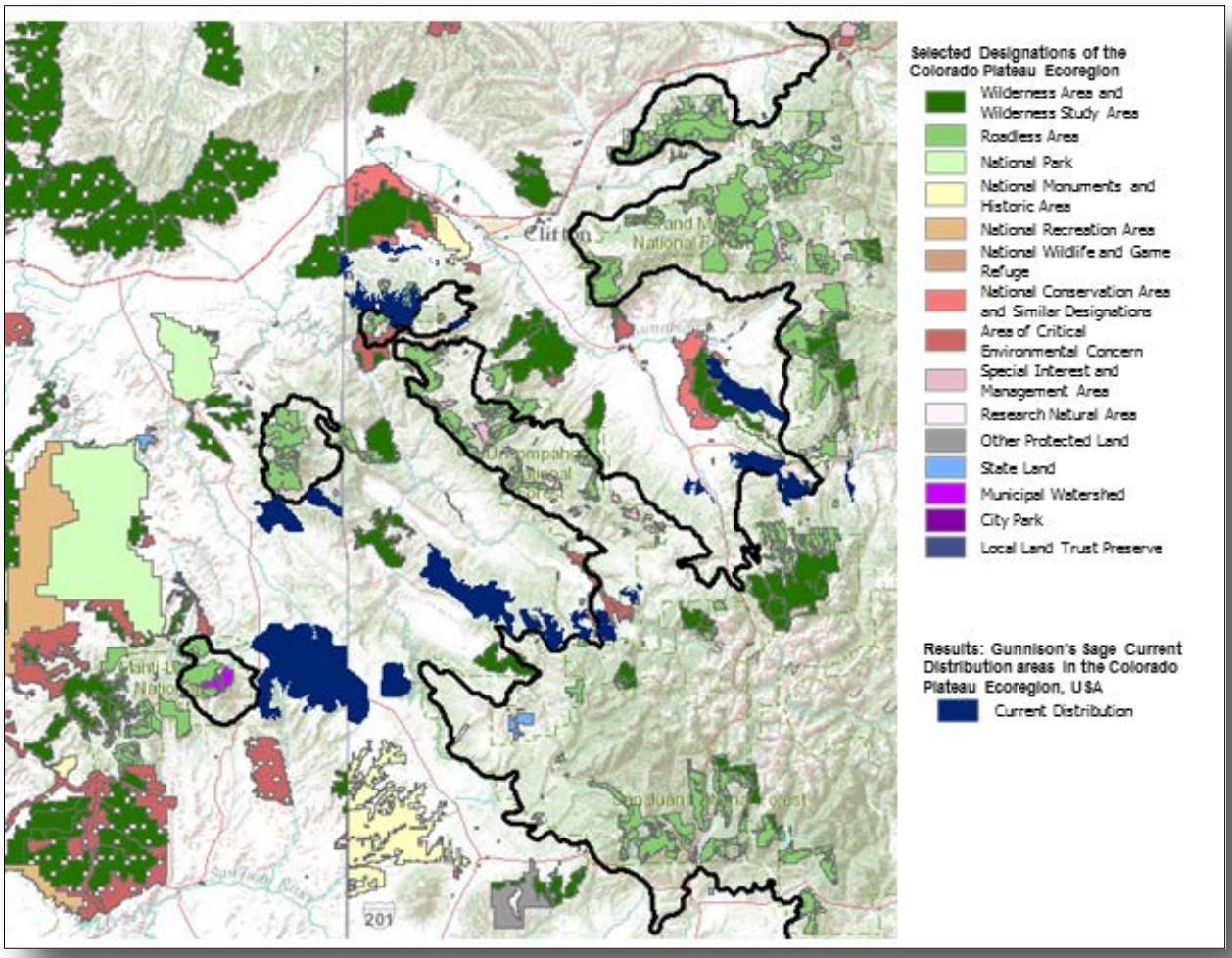


Figure 6-6. Map shows classes of designated protected areas in various colors with the distribution of Gunnison's sage-grouse in dark blue. There is little overlap of protected areas with the distribution of this threatened, though not yet federally listed, species except just north of Black Canyon of the Gunnison (tri-colored area near eastern boundary).

Table 6-1 is one example of how the matrix table could be organized. Depending on the circumstances and issues to be addressed, managers could organize the same data in different ways (Figure 6-8). The standard model presented here (Figure 6-8A) could be changed by increasing (Figure 6-8B) or decreasing (not shown) the threshold for conservation element concentrations. A simpler grid could be applied to the data using a 4 panel instead of a 6 panel organization (Figure 6-8C). Finally, the number of categories could be increased based on the range of conservation element concentrations or number of management options (Figure 6-8D). Managers could also take into account rare species information by adding the heritage findings (the globally imperiled or threatened and endangered species shown in Figures 6-1B and C) to the list of conservation elements and incorporating them into the matrix diagram. In addition to creating a useful matrix table, one could improve the approach by grouping species into guilds, ranking species by sensitivity to disturbance, working at various scales (both regional and local) or working within relatively homogeneous landscape areas (such as EPA level IV ecoregions).

AREA IN ACRES FOR ALL COLORADO PLATEAU LANDS BY NUMBER OF CONSERVATION ELEMENTS AND INTACTNESS CLASSES

NUMBER OF CONSERVATION ELEMENTS	Very High	High	Moderately High	Moderately Low	Low	Very Low	Totals
0							
1							
2		325					**325**
3	2	1,044		39	867	15	**1,966**
4	308	2,634	197	1,082	1,244	18	**5,483**
5	41,932	78,555	101,008	95,350	50,978	3,954	**371,777**
6	72,732	188,071	233,112	130,455	67,398	1,902	**693,670**
7	75,490	173,751	462,173	310,476	202,505	32,823	**1,257,219**
8	82,251	264,931	659,448	455,730	243,903	68,004	**1,774,268**
9	207,748	461,112	1,008,241	694,964	485,681	130,156	**2,987,903**
10	179,732	841,176	1,536,486	1,116,386	772,118	361,426	**4,807,325**
11	218,433	1,147,886	1,863,389	1,326,415	1,068,169	787,067	**6,411,359**
12	262,209	1,620,275	2,485,117	1,774,932	1,256,474	1,212,609	**8,611,617**
13	268,180	1,503,916	2,546,286	1,851,837	1,186,985	1,184,497	**8,541,701**
14	170,005	905,374	1,730,262	1,220,270	924,792	727,319	**5,678,021**
15	43,490	418,739	654,945	498,003	403,267	379,546	**2,397,989**
16	7,907	154,190	249,077	166,051	159,265	185,819	**922,310**
17	3,954	63,258	71,165	55,350	39,536	47,443	**280,706**
18		7,907	23,722	7,907	7,907	11,861	**59,304**
Totals	**1,634,374**	**7,833,144**	**13,624,628**	**9,705,248**	**6,871,091**	**5,134,459**	**44,802,943**

Table 6-1 lists all lands for all ownerships across the Colorado Plateau with the number of conservation elements on the y-axis and columns for area of lands in 6 intactness classes. The colored panels indicate High, Moderate, and Low intactness classes (red, blue, and yellow, respectively) from left to right and lower and higher numbers of conservation elements (CEs) from top to bottom (lighter and darker colors).

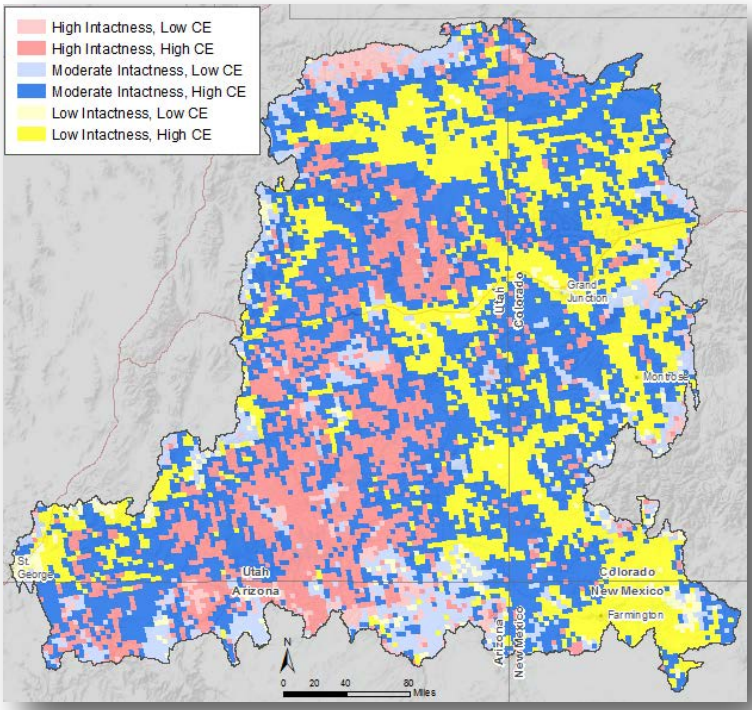


Figure 6-7. Map to accompany Table 6-1 showing 6 classes of intactness by number of CEs. Colors in map match color panels in Table 6-1.

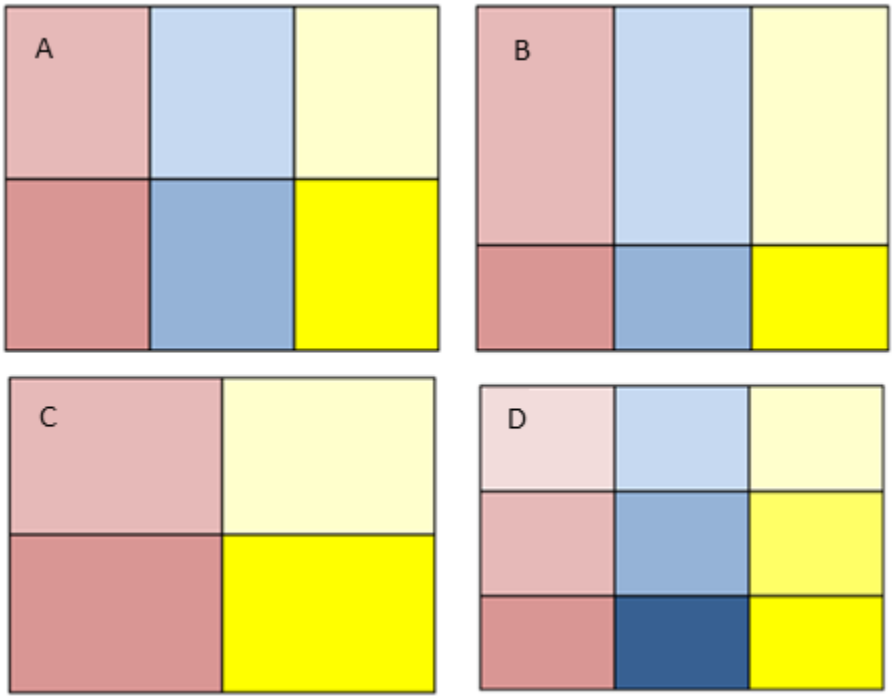


Figure 6-8. Different options for organizing data (area information in acres as presented in Table 6-1) comparing concentrations of conservation elements (y-axis) and groupings of classes of relative landscape intactness (x-axis). Colors correspond to different categories for the combinations and match colors in Table 6-1.

Using the example provided by Table 6-1 and its associated map (Figure 6-7), the analysis was rerun, this time excluding all specially designated lands and urban areas. The resulting matrix table (Table 6-2) and companion map (Figure 6-9) emphasize land areas in play across multiple ownerships and reduces the amount of land area from the "all lands" view by approximately 28 percent.

Although BLM managers will be pursuing a landscape approach to management that stresses cooperative planning across agencies and ownerships, they will also want to examine REA results for BLM lands only (Figure 6-10, maps of intactness and concentrations of conservation elements with designated lands excluded; maps are the same as those in Figure 6-5A and 6-5B but for BLM lands only). Table 6-3 and companion map (Figure 6-11) present the land area information (for BLM lands only outside of designated lands) with the number of conservation elements on the y-axis and, across the table, six columns with acreage totals of area of BLM lands in the various intactness classes.

AREA IN ACRES FOR ALL LANDS MINUS DESIGNATED SITES AND URBAN AREAS

NUMBER OF CONSERVATION ELEMENTS	Very High	High	Moderately High	Moderately Low	Low	Very Low	Totals
0							
1							
2		122					**122**
3				39	798	15	**852**
4	26	126	197	592	1,099	18	**2,057**
5	6,359	4,190	36,343	33,790	27,398	3,954	**112,034**
6	9,544	26,932	133,560	101,880	57,198	646	**329,759**
7	38,928	98,061	299,887	223,372	165,249	19,282	**844,779**
8	41,916	136,620	397,361	369,330	211,830	48,166	**1,205,223**
9	143,779	337,058	822,095	596,874	379,410	111,317	**2,390,531**
10	98,300	533,111	1,136,860	916,274	647,323	334,184	**3,666,053**
11	116,486	585,514	1,298,366	1,119,992	916,874	713,744	**4,750,976**
12	126,932	709,864	1,648,555	1,484,415	1,110,455	1,118,341	**6,198,563**
13	103,747	668,880	1,757,000	1,577,248	1,057,591	1,098,130	**6,262,596**
14	52,918	319,149	1,112,105	1,008,368	838,234	666,643	**3,997,417**
15	8,891	114,230	380,216	414,642	367,666	361,540	**1,647,185**
16	3,954	31,811	113,629	142,211	150,540	171,455	**613,599**
17		9,116	33,357	34,424	34,039	39,112	**150,048**
18		75	18,172	7,880	7,774	4,528	**38,429**
Totals	**751,780**	**3,574,858**	**9,187,701**	**8,031,330**	**5,973,479**	**4,691,074**	**32,210,222**

Table 6-2 lists all lands minus areas of designated sites and urban lands across the Colorado Plateau with the number of conservation elements on the y-axis and six columns for area of lands in various intactness classes with acreage totals.

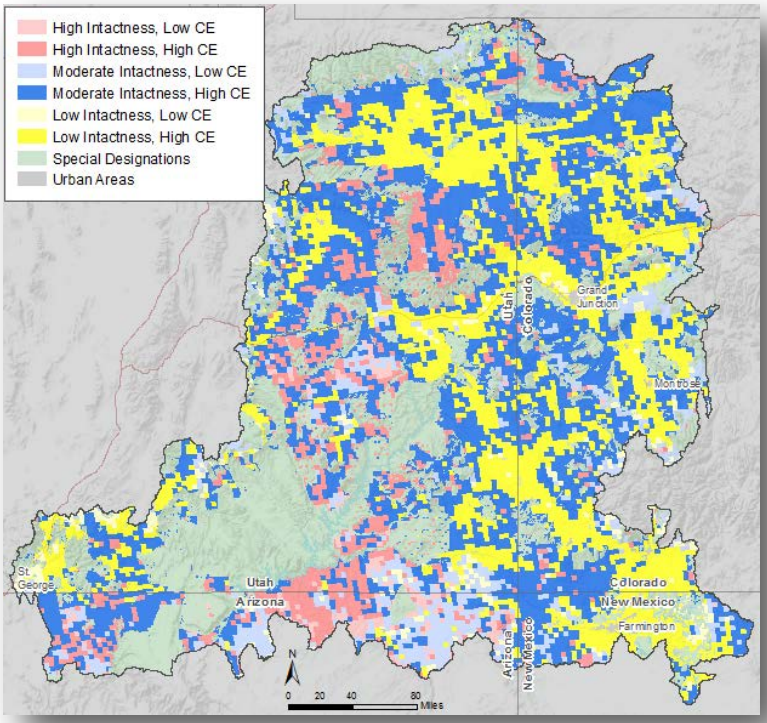
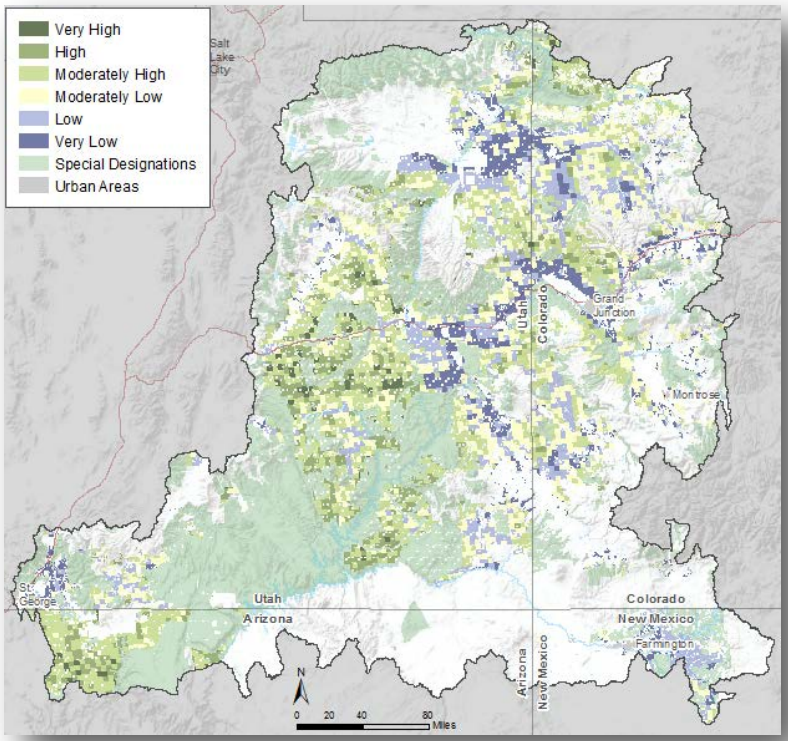


Figure 6-9. Map to accompany Table 6-2 showing 6 classes of intactness by high or low number of CEs. Colors in map match color panels in Table 6-2.



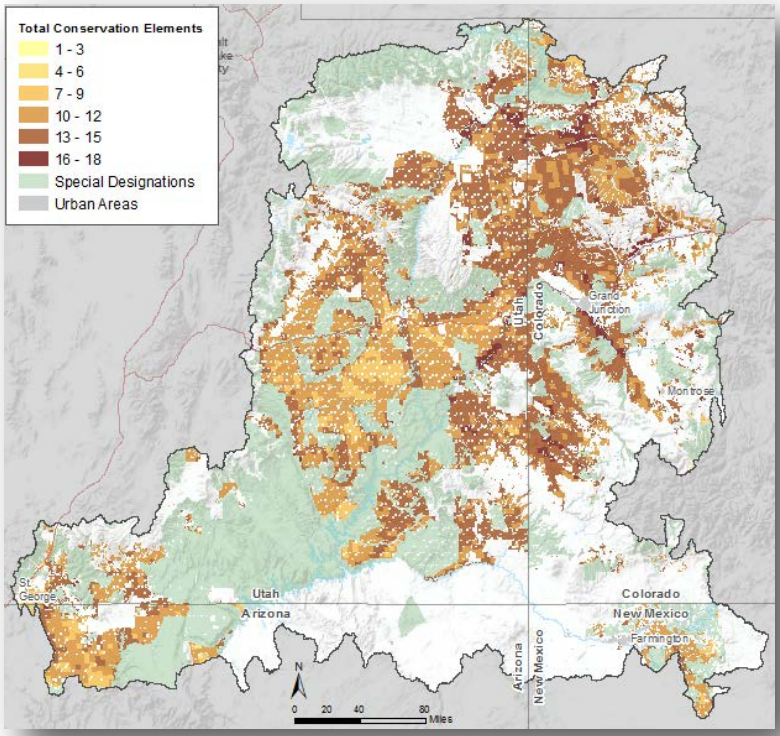


Figure 6-10. Top: Map of intactness for BLM lands outside of designated areas (light green). Bottom: Map of concentrations of conservation elements for BLM lands outside of designated areas (light green). These maps reproduce Figure 6-2A and B for BLM lands only.

AREA IN ACRES FOR BLM LANDS MINUS DESIGNATED AND URBAN AREAS

NUMBER OF CONSERVATION ELEMENTS	Very High	High	Moderately High	Moderately Low	Low	Very Low	Totals
4	7		197				**204**
5			1,151	1,374	1,913	10	**4,448**
6	59	2,646	4,348	1,794	3,357	91	**12,295**
7	8,192	13,291	20,011	11,652	20,337	859	**74,341**
8	24,067	42,906	84,095	14,025	24,991	5,153	**195,239**
9	23,452	88,286	261,824	68,049	51,423	18,581	**511,615**
10	27,006	202,761	375,175	222,689	133,158	86,081	**1,046,870**
11	51,942	278,677	536,640	383,509	308,140	187,473	**1,746,382**
12	37,733	334,219	857,830	678,580	497,175	302,426	**2,707,963**
13	40,041	364,065	996,388	797,590	536,856	336,634	**3,071,573**
14	17,732	192,241	654,400	576,989	470,881	256,826	**2,169,069**
15	1,842	49,516	239,021	243,921	186,167	166,667	**887,134**
16		12,864	71,744	98,806	56,650	73,244	**313,308**
17		2,076	24,439	25,264	14,961	16,933	**83,672**
18		2	12,112	6,480	7,316	2,349	**28,260**
Totals	**232,071**	**1,583,550**	**4,139,375**	**3,130,723**	**2,313,326**	**1,453,328**	**12,852,373**

Table 6-3 lists all BLM lands minus areas of designated and urban lands for the Colorado Plateau with the number of conservation elements on the y-axis and six columns of area of lands in the various intactness classes with acreage totals.

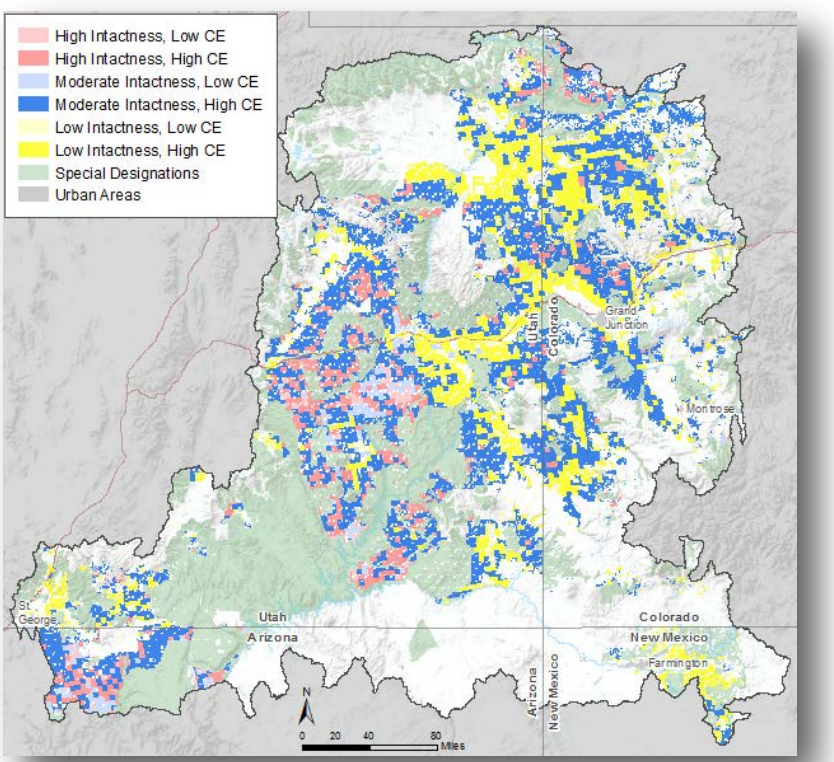


Figure 6-11. Map to accompany Table 6-3 showing 6 classes of intactness by high or low number of CEs for BLM lands only. Colors match color panels in Table 6-3.

6.2.2 Exposure of CE Concentrations to Change Agents

6.2.2.1 Current and Near-Term Future (2025) Development

The relationship of region-wide concentrations of conservation elements and three development scenarios are presented in Figure 6-12A–D. The current and near-term development models appear very similar (Figures 6-12A and 6-12B), with changes occurring mostly in the Uinta Basin and Grand Valley from oil and gas development and the spread of invasive species. The near-term future development (2025) model was built from the logic model presented in Section 5.1, which contains four major development components—energy, agriculture, urban and roads, and recreational development. Little predictive data were available for future projections; the REA relied on data for projected near-term oil and gas development (Copeland et al. 2009), the spread of invasives, and urban expansion (Theobald 2010). The only projected near-term renewable energy development was a small area of potential wind development in the southwest corner slightly outside the ecoregion boundary (Figure 6-12B). The third map, maximum potential energy development (Figure 6-12C), is more speculative—that is, not based on actual plans for development—with a longer term time frame; the results there are shown in three classes. Potential oil and gas development data included numerous sources—oil and gas potential data (Copeland et al. 2009), BLM oil and gas leases, allowable leasing footprints for tar sand and oil shale extraction, and Department of Energy producing oil and gas fields, mapped by buffering existing active wells by 1.4 km. Two data sources comprised potential wind development—Utah BLM wind energy priority Areas and National Renewable Energy Laboratory (NREL) wind power density classes 3 and above at 50 m high. Solar resource potential (>5.5 kW/m^2) was obtained from NREL as well. Summarized at 4km resolution, the final composite map for all energy components covered a large area of the ecoregion in the northern and eastern portions.

Just as the status of individual conservation elements was determined relative to current and near-term future development (2025) in Chapters 4 and 5, concentrations of CEs and high resource values can be identified that are at risk from current, near-term, and longer term potential energy development (Figure 6-12A–D). Urban expansion and renewable energy are not high-ranking development issues in the Colorado Plateau ecoregion—traditional oil and gas is the top terrestrial development issue in the region. The high concentrations of conservation elements (circled in royal blue in Figures 6-12A–D) are most at risk for change from near-term future development (2025) in the Uinta Basin, Farmington, St. George, and Grand Junction areas. Development pressures in the Uinta Basin and Grand Valley affect many of the core REA conservation elements: sagebrush obligates, particularly greater sage-grouse, and species associated with white-tailed prairie dog colonies such as black footed ferret, burrowing owl, golden eagle, and ferruginous hawk. See more detailed results for the distribution and status of each of these species in Appendix C.

Circled areas of concentrations of CEs in the central portion of the region are at less risk for change from development (Figure 6-12A–D)—particularly areas previously discussed marked 2, 4, and 5 in Figure 6-2A and B. Although it is difficult to see the changes between the current and the near-term development map (Figure 6-12A and B), the Very High development class grew by 2%, and both High and Moderately High classes gained approximately .5%; in all, the development footprint increased by about 1.5 million acres for the near-term 2025 scenario.

Summary tables for future energy development (both near-term [2025] and maximum potential [longer term] energy development) accompany the mapped results (Tables 6-4 and 6-5). Areas in acres for both categories of land area were assessed using the intersection of the additional area of future energy developments, the 4 km intactness surface, and the total concentration of conservation elements per 4 km grid cell.

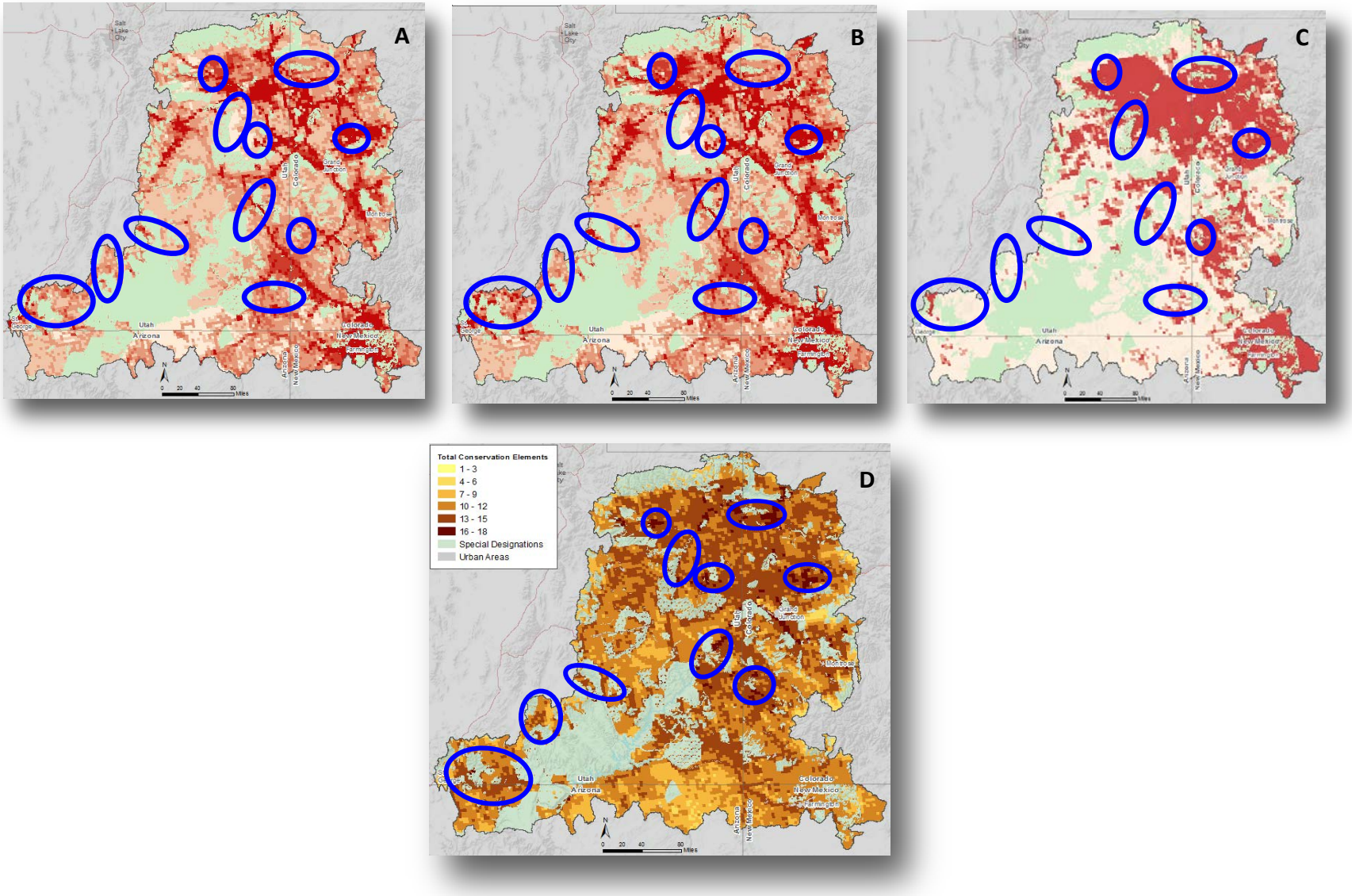


Figure 6-12. Maps arranged to compare patterns show (A) current development footprint in the Colorado Plateau ecoregion, (B) near-term future (2025) development, (C) longer term maximum potential energy development, and (D) concentrations of conservation elements with highest concentrations circled in royal blue in each map. Designated sites are masked out in light green on all maps.

AREA IN ACRES OF LAND SURFACE AFFECTED BY NEAR-TERM (2025) ENERGY DEVELOPMENT BY NUMBER OF CONSERVATION ELEMENTS AND INTACTNESS CLASS

# of CONSERVATION ELEMENTS	Very High	High	Moderately High	Moderately Low	Low	Very Low	Totals
9					1,832		1,832
10			742	5,715	2,528	4,060	13,045
11		409	691	4,218		9,989	15,307
12		230	5,023	6,256	862	26,213	38,585
13		2,880	4,180	1,453	14	14,732	23,259
14				1,776	655	2,054	4,485
15				422	136	2,061	2,620
16				414	499		914
17				26			26
Totals	0	3,519	10,636	20,281	6,526	59,110	100,072

Table 6-4. Land area in acres in various intactness classes and number of conservation elements affected by near-term (2025) energy development. It is useful to know that there is little acreage in the Very High and High categories affected by near-term energy development. Closer inspection may reveal if acreage in the High category should be off-limits to development. It is also useful to note that most of the land area affected by possible near-term energy development contains high concentrations of conservation elements.

AREA IN ACRES OF LAND SURFACE AFFECTED BY POTENTIAL ENERGY DEVELOPMENT BY NUMBER OF CONSERVATION ELEMENTS AND INTACTNESS CLASS

NUMBER OF CONSERVATION ELEMENTS	Very High	High	Moderately High	Moderately Low	Low	Very Low	Totals
0							
2		179					**179**
3	2	617			349	15	**982**
4	184	690	6	584	219	18	**1,701**
5	9,199	12,169	11,841	14,986	7,496	1,098	**56,788**
6	10,887	26,895	41,840	24,672	17,898		**122,191**
7	12,193	24,712	70,496	69,281	35,161	2,286	**214,129**
8	13,620	47,741	114,439	85,012	58,191	15,830	**334,834**
9	17,113	49,894	225,466	176,711	242,293	20,343	**731,820**
10	18,213	88,546	356,938	342,981	396,093	204,058	**1,406,829**
11	29,595	139,184	448,881	528,942	599,121	375,095	**2,120,819**
12	34,332	246,484	655,276	705,143	700,515	668,596	**3,010,346**
13	33,835	248,098	902,613	885,330	641,888	656,360	**3,368,124**
14	26,133	190,674	630,215	620,558	518,868	431,410	**2,417,858**
15	11,651	111,519	281,143	280,884	265,114	266,312	**1,216,622**
16	37	32,191	77,931	102,911	92,450	129,744	**435,265**
17	101	8,096	26,654	35,252	26,390	19,599	**116,092**
18		1,136	12,759	6,579	6,741	4,287	**31,502**
Totals	**217,095**	**1,228,824**	**3,856,500**	**3,879,825**	**3,608,788**	**2,795,051**	**15,586,082**

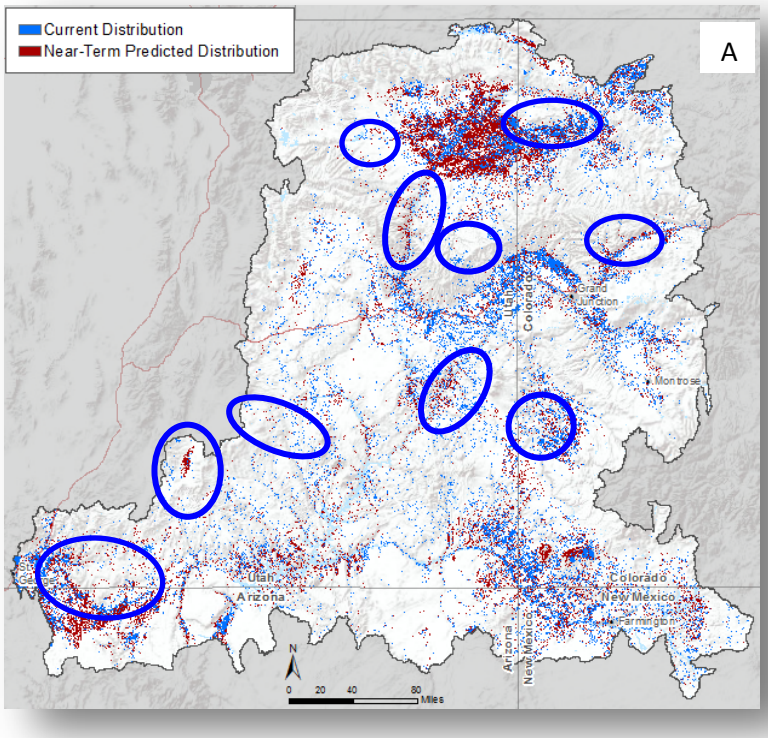
Table 6-5. Land area in various intactness classes and number of conservation elements affected by maximum potential development. Longer term maximum potential energy development occurs in all classes and concentrations of conservation elements.

6.2.2.2 Current and Future Risk from the Spread of Invasive Species

Urban area and invasive projections were updated for the near-term future (2025) terrestrial landscape intactness model (see logic model Section 5.3). The change in urban area relative to concentrations of conservation elements was covered in the previous development section (6.2.2.1). The only other future projection data available for near-term future terrestrial intactness was that for the spread of invasive species. Invasives species projection data was added to current invasives data (LANDFIRE and NatureServe invasives classes, a predictive model of tamarisk distribution [Jarnevich et al. 2011], and historic tamarisk polyline data). Projections of invasive spread were based on LANDFIRE succession class data, which included all invasive species, and US Geological Survey data on early seasonal invasives (J. Hansen, T. Arundel, and R. Kokaly, model created in 2011 for this REA). The near-term change attributed to the spread of invasives shows the most impacts in the Uinta Basin, the southwestern corner of the ecoregion, and the San Juan River basin-Farmington region (Figure 6-13A). About half of the CE concentrations are located in dense areas of invasives, particularly in the northeastern, central, and southwestern portions of the ecoregion.

6.2.2.3 Future Risk from Climate Change

The MAPSS climate results were used to predict changes in temperature, precipitation, potential evapotranspiration, and runoff; a number of the key findings from these analyses were selected to assemble into an overall relative climate change map showing different levels of climate change potential that could then be used to assess relative impacts on the specific conservation elements (Section 5.4). The fuzzy model inputs included potential for summer temperature change and potential for winter temperature change averaged into a single factor, potential for runoff change from MAPSS modeling, potential for precipitation change, and potential for vegetation change, again from MAPSS modeling. Direction of the change was not important—only degree of departure from historic measures. Areas most likely to show the most extensive changes were those that either were predicted to change in their vegetation type or as a combination of all the other factors (temperature, precipitation, and runoff). Results were mapped in five separate classes: Very High, High, Moderate, Moderately Low and Low for the potential for an area to be affected by climate change as defined in the fuzzy logic model (Figure 6-14A). Individual species and vegetation communities' response to climate were presented in Section 5.4 as histograms. Histograms and maps for the exposure to climate change of all conservation elements (distributions overlaid with the climate change potential map) may also be viewed in Appendices B and C. Of the vegetation communities, those showing the most area under High climate exposure include the shrublands (especially big sagebrush and blackbrush-Mormon-tea communities) and pinyon-juniper woodland. This pattern is apparent when the dark brown high-climate-change exposure areas in Figure 6-14A are compared with the vegetation community landcover maps (Section 4.2.2). The areas of Very High exposure in the south and central portions of the ecoregion occur in concentrations of pinyon-juniper and big sagebrush. On the other hand, these same vegetation communities, pinyon-juniper and sagebrush, experience Moderately Low exposure to climate change farther north in the Uinta Basin. When the climate change map is compared to the concentrations of conservation elements in Figure 6-14B, the potential for climate-related change is projected to be moderate for the circled areas in the higher elevations surrounding the Uinta Basin and along the western edge of the ecoregion. The two circled areas on the eastern side of the region in the Grand Junction and Dolores River areas and the group of conservation elements along the Utah/Arizona border in the southwestern portion of the ecoregion have the highest exposure to climate change.



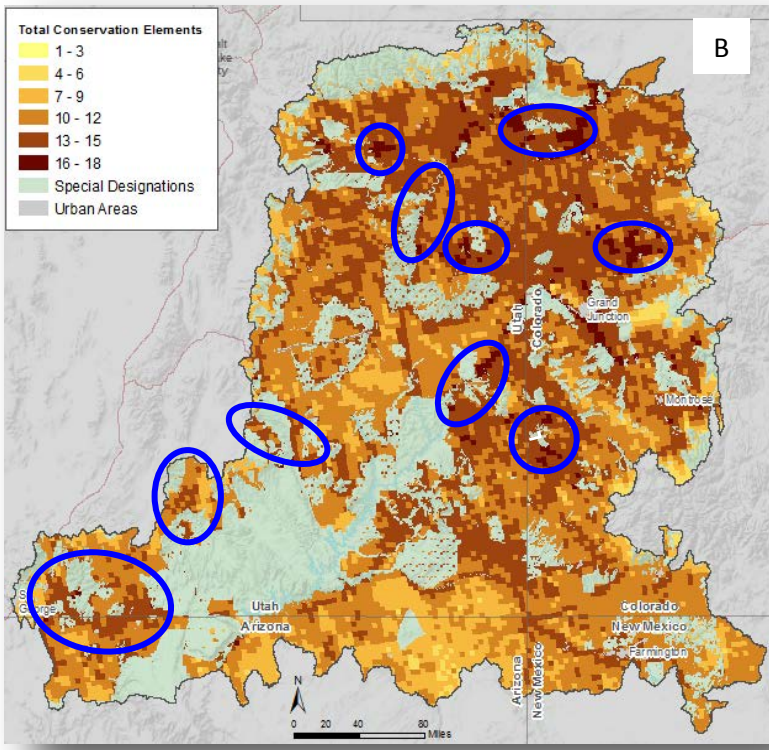
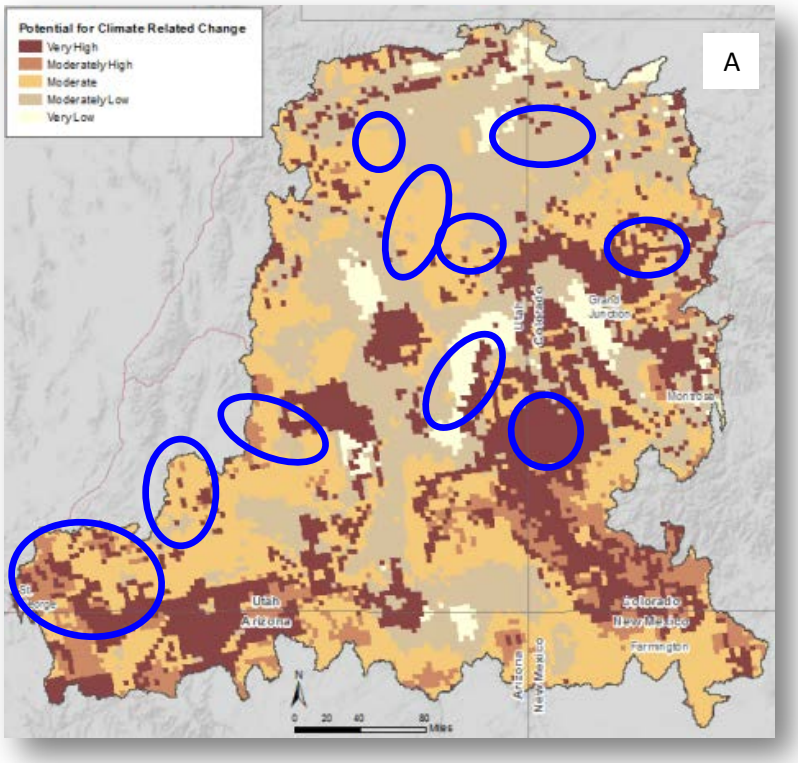


Figure 6-13. Maps for (A) current (in blue) and near-term future (2025, in red) predicted distribution of invasive species, and (B) concentrations of conservation elements with designated sites shown in green.



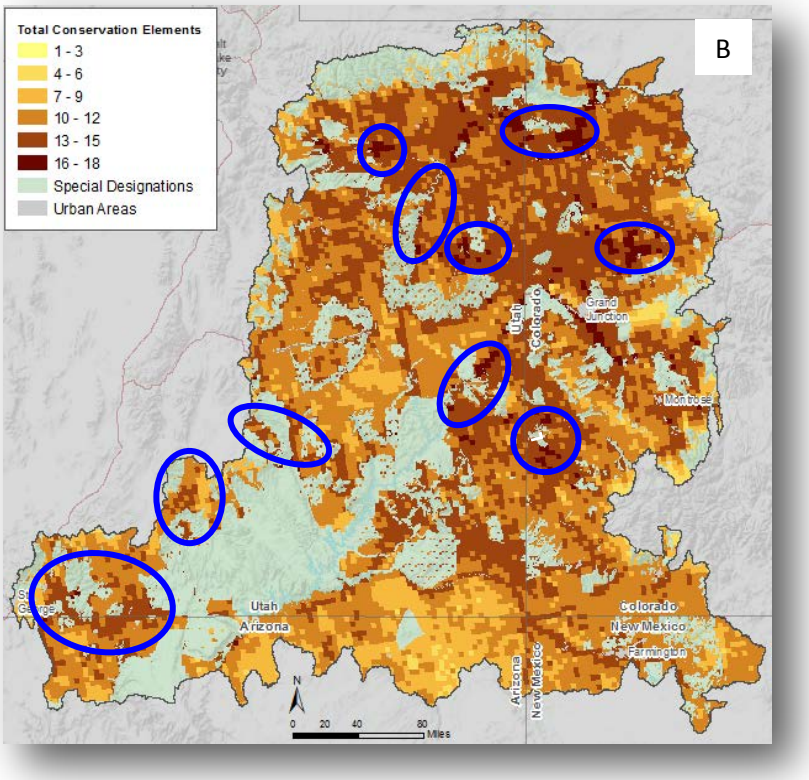


Figure 6-14. (A) Map of relative climate change potential in five classes with areas depicting concentrations of CEs circled; (B) concentrations of conservation elements. Designated sites masked out in green on map (B).

6.3 Conclusion

The examples presented in this chapter offer a few of the many ways this wealth of REA data and maps may be examined depending on project objectives, area of interest, species of concern, and present or future time frames. All that is required of the user is an understanding of the relatively coarse resolution of the results and an ability to translate the results between scales, from regional to local. Application of the results of the current and near-term future intactness models and conservation element status determinations also depend on an understanding of the limitations of a rapid ecoregional assessment of this kind. The effort is fundamentally limited by available spatial data and ecological thresholds so important to tailoring the logic models. These aspects are only likely to improve in the future as the geospatial technology and science evolve.

This REA will serve as a baseline for future efforts in the Colorado Plateau ecoregion. This REA effort provided the opportunity to inventory available information, to collect and archive an atlas of useful spatial data, and to produce hundreds of mapped products. Users may find information about access to the data at http://www.blm.gov/wo/st/en/prog/more/climatechange.html. The models are well documented and are flexible enough to be modified and improved with the addition of new data. Using the baseline current scenario, the REA components are designed for periodic updating to track the ecological status of Colorado Plateau conservation elements as they respond to landscape change and adaptive management in the coming years.

6.4 References Cited

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Photo: Petroglyphs, BLM

Glossary and Acronym List

Adaptive Management: Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of previously employed practices.

ArcGRID: A raster GIS file format developed by Esri**.** The grid defines geographic space as an array of equally-sized square grid points arranged in rows and columns. Each grid point stores a numeric value that represents a geographic attribute for that unit of space. Each grid cell is referenced by its xy coordinate location.

Areas of Critical Environmental Concern (ACEC): Areas within the public lands where special management attention is required to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources or other natural systems or processes.

Assessment Management Team (AMT): A group of BLM managers that provides overall direction and guidance to the REA and makes decisions regarding ecoregional goals, resources of concern, conservation elements, change agents, management questions, tools, methodologies, models, and output work products.

C_3: A plant in which carbon dioxide is first fixed into a compound containing three carbon atoms before completing the photosynthesis cycle.

C_4: A plant in which carbon dioxide is first fixed into a compound containing four carbon atoms before entering the photosynthesis cycle.

C**hange Agent:** An environmental phenomenon or human activity that can alter or influence the future status of resource condition. Some change agents (e.g., roads) are the result of direct human actions or influence. Others (e.g., climate change, wildland fire, and invasive species) may involve natural phenomena or be partially or indirectly related to human activities.

Coarse Filter: A focus of ecoregional analysis that is based upon conserving resource elements that occur at coarse scales, such as ecosystems, rather than upon finer scale elements, such as specific species. The concept behind a coarse filter approach is that preserving coarse-scale conservation elements will also preserve elements occurring at finer spatial scales.

Conceptual models: Conceptual models graphically depict the interactions between a conservation element, the biophysical attributes of its environment, and the change agents that drive ecosystem character. The boxes and arrows that make up the conceptual model represent the state of knowledge about the subject and its relationships to these attributes. Conceptual models are also supported and referenced by scientific literature.

Conservation Element: A renewable resource object of high conservation interest.

Development: A type of change (change agent) resulting from urbanization, industrialization, transportation, mineral extraction, water development, or other human activities that occupy or fragment the landscape or that develop renewable or non-renewable resources.

Ecological Integrity: The ability of an ecological system to support and maintain a community of organisms that have the species composition, diversity, and functional organization comparable to those of natural habitats within the ecoregion.

Ecoregion: An ecological region or ecoregion is defined as an area with relative homogeneity in ecosystems. Ecoregions depict areas within which the mosaic of ecosystem components (biotic and abiotic as well as terrestrial and aquatic) differs from those of adjacent regions.

Ecoregional Direction: Ecoregional direction uses the information from the Rapid Ecoregional Assessments and stakeholders to develop a broad scale management strategy for an ecoregion's BLM-managed lands.

Fine Filter: A focus of ecoregional analysis that is based upon conserving resource elements that occur at a fine scale, such as specific species. A fine-filter approach is often used in conjunction with a coarse-filter approach (i.e., a coarse filter/fine-filter framework) because coarse filters do not capture every management concerns, such as management of endemic species.

Geographic Information System (GIS): A computer system designed to collect, manage, manipulate, analyze, and display spatially referenced data and associated attributes.

Habitat: A place where an animal or plant normally lives for a substantial part of its life, often characterized by dominant plant forms and/or physical characteristics.

Hydrologic Unit: An identified area of surface drainage within the U.S. system for cataloging drainage areas. The drainage areas are delineated to nest in a multilevel, hierarchical arrangement.

Intactness: Intactness may be mapped as a quantifiable estimate of naturalness according to the level of anthropogenic influence based on available spatial data. Intactness considers an assemblage of spatially explicit indicators that helps define the condition of the natural landscape.

Invasive Species: Species that are not part of (if exotic non-natives) or are a minor component of (if native), an original community that have the potential to become a dominant or co-dominant species if their future establishment and growth are not actively controlled by management interventions, or that are classified as exotic or noxious under state or federal law.

Landscape Species: Landscape species use large, ecologically diverse areas. The species often have significant impacts on the structure and function of natural ecosystems.

Logic Model: A logic model is a cognitive map that presents spatial data components and their logical relationships to explain the process used to evaluate a complex topic. Logic models are constructed in a hierarchical fashion relying on symbols, colors, labels, and the physical arrangement of components to communicate how a series of spatial datasets are assembled and analyzed to answer a particular question.

Management Questions: Questions from decision-makers that usually identify problems and request how to fix or solve those problems.

Model: Any representation, whether verbal, diagrammatic, or mathematical, of an object or phenomenon. Natural resource models typically characterize resource systems in terms of their status and change through time

Native Species: Species that historically occurred or currently occur in a particular ecosystem that were not introduced.

Population: Individuals of the same species that live, interact, and migrate through the same niche and habitat.

Process Models: Process models are diagrams that map out data sources, GIS analyses, and workflow. Process models present the spatial analysis details and allow for repeatability of the same or similar model in the future

Rapid Ecoregional Assessment (REA): The methodology used by the BLM to assemble and synthesize regional-scale resource information, which provides the fundamental knowledge base for devising regional resource goals and priorities on a relatively short time frame (less than 2 years).

Status: The condition of a criterion (biological or socio-economic resource values or conditions) within a geographic area (e.g., watershed, grid). A rating (e.g., low, medium, or high) or ranking (numeric) is assigned to specific criteria to describe status.

Step-Down: A step-down is any action related to regionally-defined goals and priorities discussed in the REA that are acted upon through actions by specific State and/or Field Offices. These step-down actions can be additional inventory, a finer-grained analysis, or a specific management activity.

Acronyms

AM	Arbuscular Mycorrhizal
AMT	Assessment Management Team
AUC	Area Under the Curve
ArcGIS	Arc Geographic Information System
BpS	Biophysical Setting
BLM	Bureau of Land Management
CO_2	Carbon Dioxide
CE	Conservation Element
DEM	Digital Elevation Model
ECHAM5	European Centre Hamburg, Version 5
EMDS	Ecosystem Management Decision Support
EPA	Environmental Protection Agency
ENSO	El Nino Southern Oscillation
EVT	Existing Vegetation Type (LANDFIRE)
FGDC	Federal Geographic Data Committee
FRAGSTATS	Fragmentation Statistics software
FRCC	Fire Regime Condition Classification
G-1, G-3	Globally Imperiled-Globally Vulnerable
GCM	Global Circulation Model
GFDL	Geophysical Fluid Dynamics Laboratory

GENMOM	GENesis-Modular Ocean Model
GIS	Geographical Information System
HMAs	Herd Management Areas
HUC	Hydrologic Unit Classification
IPCC AR4	Intergovernmental Panel on Climate Change Fourth Assessment Report
LAI	Leaf Area Index
LANDFIRE	LANDscape FIRE and Resource Management Planning Tools Project
MAPSS	Mapped Atmosphere Plant Soil System
MaxEnt	Maximum Entropy model
MQ	Management Question
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NetCDF	Network Common Data Form
NHD	National Hydrography Dataset
NREL	National Renewable Energy Laboratory
OHV	Off-Highway Vehicles
PET	Potential Evapotranspiration
PFT	Plant Functional Type
PRISM	Parameter-elevation Regressions on Independent Slopes Model
REA	Rapid Ecoregional Assessment
RegCM3	Regional Climate Model Version 3
RMP	Resource Management Plan
SSURGO	Soil Survey Geographic database
STATSGO	State Soil Geographic
SOW	Statement of Work
SW ReGAP	Southwest Regional Gap Analysis Project
TNC	The Nature Conservancy
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey