Physiography of Utah

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The state of Utah is centrally located in the Intermountain West, spanning the ranges of 109° West and 114° West longitude and 37° North and 42° North latitude. The state is approximately 84,868 square miles in size and has 29 counties, with San Juan, Tooele, Millard, and Box Elder counties being the largest. Elevations in Utah range from 2,178 feet at Beaver Dam Wash in the southwestern corner of the state to 13,528 feet at the summit of King's Peak in the Uinta Mountains (Figure 3.1). The Uinta Mountains have several peaks that exceed 13,000 feet; the La Sal, Tushar, and Deep Creek Mountains have peaks that exceed 12,000 feet; and the Wasatch Mountains have numerous peaks that exceed 11,000 feet. The highest peak in the Wasatch Mountains is Mount Nebo at 11,877 feet (Fisher, 1994).

Three primary physiographic regions, each with unique topographic, geologic, and geomorphic characteristics, extend into Utah. They include the Colorado Plateau, the Basin and Range, and the Middle Rocky Mountains. Additionally, small portions of the Columbia Plateau and the Wyoming Basin extend into Utah. The three primary regions substantially differ, yielding diverse, dynamic, and impressive landscapes. Processes of erosion dominate the Colorado Plateau; sedimentation dominates the Basin and Range; and faulting, folding, and glaciation dominate the Middle Rocky Mountains (Atwood, 1994).

COLORADO PLATEAU

The Colorado Plateau is a broad area of regional uplift that covers southern and eastern Utah, western Colorado, northwestern New Mexico, and northern Arizona. The region is characterized by a variety of landforms composed of flat-lying sedimentary rocks. Beginning nearly 10 million years ago, the geologic formations were uplifted and the erosive power of water sculpted outstanding plateaus, buttes, mesas, deeply incised canyons, and river gorges that presently range from 5,000 to 11,000 feet in elevation (Milligan, 2000; Bauman, 1994). The Colorado Plateau holds some of the most spectacular landscapes, including Canyonlands, Arches, Capitol Reef, Zion, Grand Canyon, Natural Bridges, Kodochrome Basin, and Glen Canyon National Recreation Area, and it has one of the largest deposits of hydrocarbons, such as coal, oil, and tar sands, in North America (Bauman, 1994).

The Colorado Plateau is divided into six subprovinces, including the High Plateaus, Uinta Basin, Canyonlands, Navajo, Grand Canyon, and Datil sections. In Utah, the High Plateaus, Uinta Basin, and Canyonlands sections dominate. Additionally, isolated mountains of the Southern Rockies, including the La Sal and Abajo Mountains, protrude from the dry expanses of the Colorado Plateau in Utah.

The High Plateaus are a series of gently rolling plateaus consisting of nearly horizontal sedimentary formations, which in some areas are surfaced by lava flows and glacial deposits. The individual plateaus, such as the Awapa, Aquarius, and Paunsaugunt Plateaus, are separated by north-south trending faults and valleys. The valley margins are often defined by colorful topography, such as that found in Bryce Canyon and Cedar Breaks. The southern margin of the section is defined by a series of impressive cliffs collectively known as the Grand Staircase. They include the Chocolate Cliffs, Vermillion Cliffs, White Cliffs, Gray Cliffs, Pink Cliffs, and Black Cliffs (Murphy, 1989).

The Uinta Basin is located in the northeast corner of the state and south of the Uinta Mountains. The southern rim of the basin is formed by the Tavaputs Plateau, Roan Cliffs, and Book Cliffs; and the western rim is formed by the Wasatch Mountains. Elevations at the top of the Roan Cliffs at the southern rim are over 9,000 feet, while the basin floor near Vernal is approximately 5,000 feet (Fuller, 1994). Although the central portion of the Uinta Basin is gently rolling, there are areas of deeply incised ravines. The Green River and its tributaries have eroded many spectacular canyons, such as Desolation Canyon (Murphy, 1989).

The Canyonlands section of the Colorado Plateau is located in the southeastern quarter of the state. The Kaiparowits Plateau in south-central Utah is the transitional zone between the Canyonlands and High Plateaus sections to the west, while the Book Cliffs and Roan Cliffs form the transitional zone between the Canyonlands and Uinta Basin sections to the north. Mancos shale lowlands, a region of fairly level topography, have developed at the base of the Book Cliffs and High Plateaus. The Canyonlands section has been profoundly sculptured by the Colorado River and its tributaries, resulting in deep, sheer-walled canyons, plateaus, mesas, buttes, and badlands. Delicate rock forms, such as tall pinnacles, deep alcoves, natural

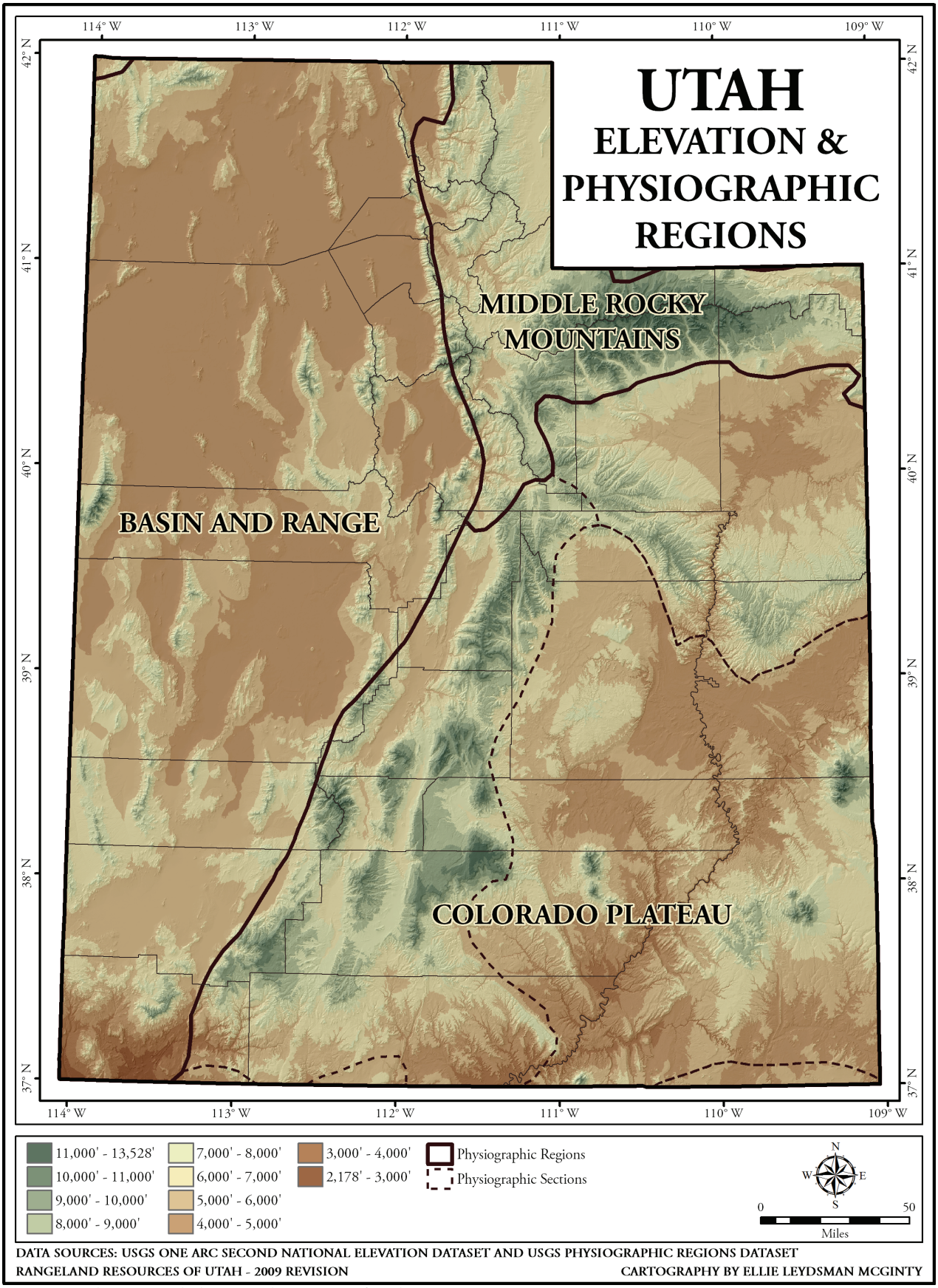

Figure 3.1. Elevation and physiographic regions of Utah.

bridges, and arches, are abundant. These features, when combined with outstanding colors, produce some of the most rugged and scenic topography in the United States (Murphy, 1989).

Although the Colorado Plateau region is characterized by a variety of landforms composed of flat-lying sedimentary rocks, the Canyonlands section has some exceptions. Within the Canyonlands section, a series of steep, rugged, and isolated mountains occur. The Abajo and La Sal Mountains, an isolated subset of the Southern Rockies, as well as the Henry Mountains, are highlands formed by igneous intrusions. The Waterpocket Fold and the San Rafael Swell were formed from the arching and folding of geologic substrates (Milligan, 2000; Murphy, 1989).

BASIN AND RANGE

The Basin and Range region is a large province that includes a large portion of the southwestern United States and northwestern Mexico. The region is bound by the Sierra Nevada Mountains and the Cascade Range on the west, the Columbia Plateau on the north, and the Rocky Mountains and Colorado Plateau on the east. The region is characterized by numerous north-south oriented, fault-tilted mountain ranges that are separated by intervening, broad, sediment-filled basins. Two additional landforms are typical of the Basin and Range region, including playas and alluvial fans. Playas are undrained mud or salt flats that are composed of layers of sediments. Alluvial fans are erosional deposits of sand and gravel that typically occur at canyon mouths (Peterson, 1994). Many of the basins within the region were also modified by shorelines and sediments of inland lakes that intermittently covered the valley floors. The most notable of these was Lake Bonneville (Milligan, 2000).

The Basin and Range is subdivided into five regions, including the Great Basin, Sonoran Desert, Salton Trough, Mexican Highland, and Sacramento sections. The Great Basin section, the northern part of the Basin and Range region, is the only one to occur in Utah. The Great Basin is a large arid region of the western United States that covers most of Nevada and nearly half of Utah, as well as parts of California, Idaho, and Oregon. The region extends from the Sierra Nevada Mountains to the Wasatch Mountains, and is most commonly defined as an endorheic, or internally-drained, basin. As with the Basin and Range region, mountain ranges within the Great Basin were formed by faulting and subsequent erosion. In some areas, the mountain ranges have been so extensively reduced by erosion, and buried by the deposition of material, that only small remnants are visible above coalescing alluvial fans (Murphy, 1989).

A large portion of the Great Basin in Utah is called the Bonneville Basin. The Bonneville Basin and associated Bonneville Salt Flats were formed through the recession and evaporation of the Pleistocene-era Lake Bonneville (Hallaran, 1994). The lowest elevation within the Great Basin occurs within the Bonneville Basin and is covered by the Great Salt Lake. The surface of the Great Salt Lake is approximately 4,200 feet. The elevations of other major features in the Great Basin include the Sevier Basin at approximately 4,700 feet and the Escalante Basin at approximately 4,900 feet (Fisher, 1994).

MIDDLE ROCKY MOUNTAINS

The Middle Rocky Mountains are located in Montana, Wyoming, Idaho, and Utah, and are bound by the Basin and Range and Columbia Plateau to the west and by the Wyoming Basin and Colorado Plateau to the east. In Utah, the Middle Rocky Mountains are located in north and northeastern Utah and consist of the north-south trending Wasatch Range and the east-west trending Uinta Mountains. The region is characterized by mountainous terrain, stream valleys, alluvial basins, sharp ridge lines, U-shaped valleys, glacial lakes, and glacial moraines. Since settlement, the Middle Rocky Mountain region has been valuable to the state of Utah for water, timber, mineral, and recreation resources (Milligan, 2000; Fisher, 1994).

The Wasatch Mountains are located in northern and north-central Utah, and extend from the Bear River Range on the Utah-Idaho border in the north to Salt Creek Canyon near Nephi in the south. The Wasatch Mountains are the transition zone between the Basin and Range region to the west and Colorado Plateau to the south and southeast. The mountains consist of fault-block ranges that are structurally similar to the mountains in the Basin and Range (Fisher, 1994). The western flanks of the ranges are steep and relatively straight as a result of displacement along the extensive and active Wasatch Fault. During the Pleistocene, higher elevations of the Wasatch Mountains were covered in glaciers, and as the climate warmed, glacial erosion created many features, including cirques and moraines (Murphy, 1989). During the time of extensive glaciation, the recession of Lake Bonneville formed a series of benches along the western mountain fronts, creating the Bonneville, Provo, and Gilbert shorelines (Atwood, 1994).

The Uinta Mountains are located in the northeastern portion of Utah and consist of a single range of peaks extending in a general east-west orientation. The range is approximately 30 miles wide and 150 miles long and extends from Heber Valley on the west to Cross Mountains in Colorado on the east (Fuller, 1994). The range is bordered by the Uinta Basin to the south and the Wyoming Basin to the north. The mountains gradually rise above the plateaus to the north and south, and reach their maximum elevations in the central portion (Atwood, 1909). Unlike the fault-block mountains of the Basin and Range and the Wasatch Mountains, the Uinta Range is a folded anticline. The broad, massive range was created by anticlinal uplifting, with sedimentary units outcropping on the flanks. Glacial features, such as horns, arêtes, cirques, and glacial troughs, dominate the present landscape. The deposition of ice and glacial-melt water filled many U-shaped valleys with moraine (glacial debris), lined them with lateral moraines, and left terminal moraines that have often formed natural dams, creating over a thousand small lakes (Murphy, 1989).

PHYSIOGRAPHIC REGIONS VERSUS ECOREGIONS

The physiographic regions of the western United States were initially defined by Nevin M. Fenneman in 1931. A revision of Fenneman's three-tiered classification of the United States was published by the United States Geological Survey in 1946 that delineated eight major divisions, 25 physiographic provinces, or regions, and 86 sections within the coterminous United States. Physiographic, or geomorphic, regions were defined based on terrain texture, rock type, and geologic structure and history. The revised map produced by the United States Geological Survey was automated from Fenneman's 1:7,000,000-scale map (USGS, 2009).

Beginning in 1976, more detailed and holistic regional classifications were being developed. Robert G. Bailey developed Bailey's ecoregions for the United States Forest Service in response to increased involvement by public land management agencies in regional and long-range planning. Bailey divided North America into a hierarchy of domains, divisions, provinces, and sections based on topography, climate, and vegetation (Bailey, 1995).

In 1987, James M. Omernik compiled a national ecological classification, recognizing the importance of considering physical and biotic characteristics. Omernik, in cooperation with the United States Environmental Protection Agency, has developed national datasets of ecological regions, or ecoregions, in the United States to improve environmental resource research, assessment, monitoring, and management. Omernik's ecoregions denote areas of general similarity and incorporate physiography, geology, vegetation, climate, soils, land use, wildlife, and hydrology (US EPA, 2009). A Roman numeral scheme has been adopted for four levels of ecological regions. Level I is the coarsest level, dividing North America into 15 ecological regions. Level II divides the continent into 52 regions. Level III divides the continental United States into 104 ecoregions. Level IV ecological regions are further subdivisions of Level III ecoregions, and they are still being delineated in some areas of the United States. In Utah, there are seven Level III ecoregions and 37 Level IV ecoregions (Figure 3.2; Table 1 in Appendix B; reference section on Vegetation of Utah).

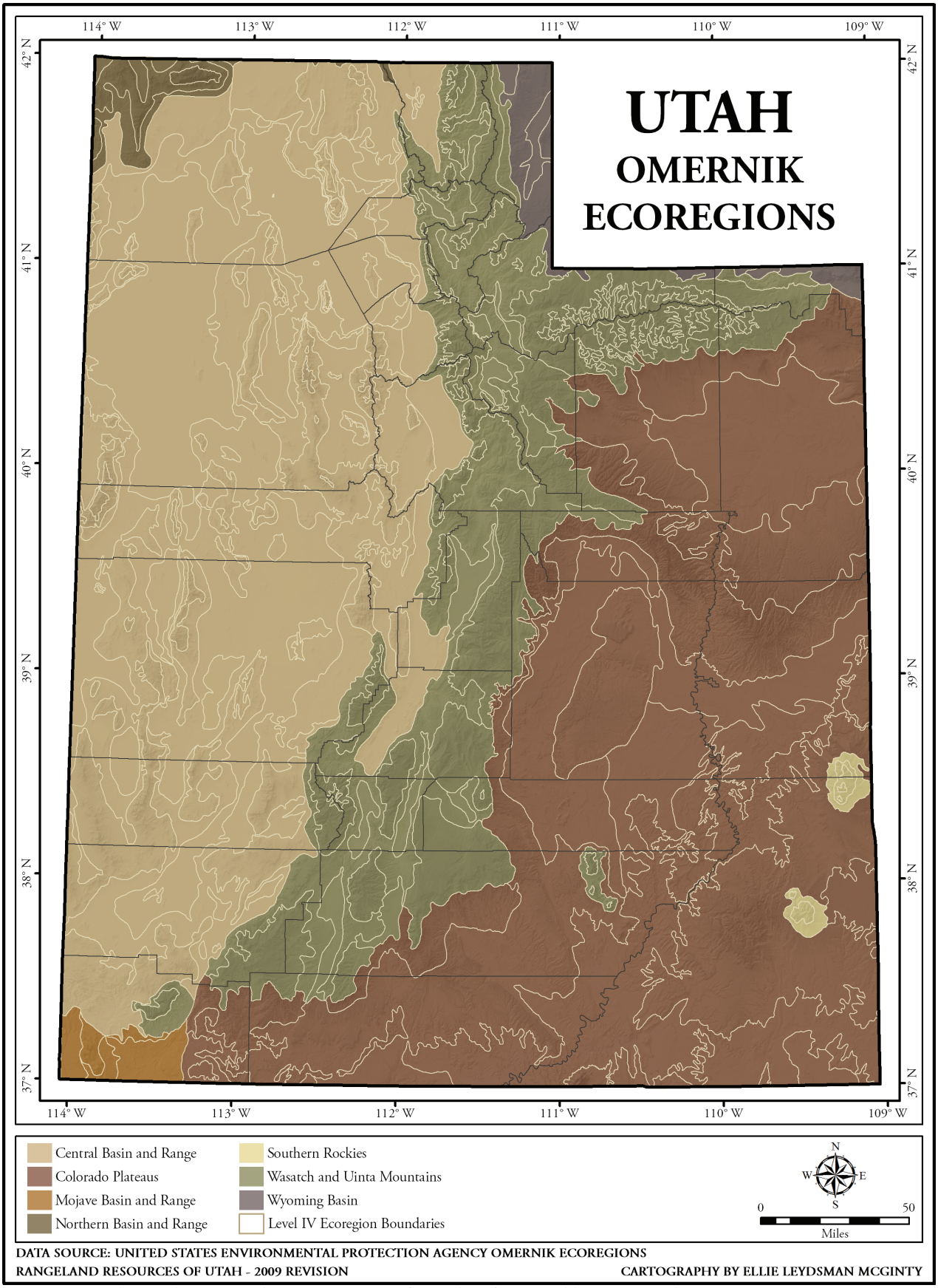

Figure 3.2. Level III and IV Omernik (EPA) Ecoregions for Utah (reference Table 1 in Appendix B).