UINTAH BASIN REVISITED

2012-2013

Bioregional Planning Studio Project

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Cover Photo: View of the Green River in eastern Uintah County. Source: Michael Gottfredson

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Preface

Since the Uintah Basin Research Conference in 2007, residents of the area have witnessed a consistent level of land-use development throughout the region. Portions of that growth and development have precipitated the need to develop a landscape-level plan in order to maintain the context of their region and community identity in the coming years. The purpose of this study is to research and develop a process that identifies current and future land-use issues throughout the Uintah Basin. The identification of these issues by various stakeholders will help to provide a framework for future policy decisions.

In pursuit of future policies, it is proposed to identify the most beneficial spatial patterns in the region based upon cultural, ecological, and economic considerations. The interaction and cause and effect relationships that exist between these three elements will identify common areas which support critical landscape services with respect to public health, safety, and welfare. The study will also address the cultural and economic history in the region which will help resolve land-use and policy conflicts between future development and management activities. The identification and understanding of landscape resources, and why and how those resources should clarify land planning and design decisions for stakeholders, will be a major emphasis of this work. Those landscape resources are embedded in a complex pattern of ownership which will challenge the compatibility of new policies (wilderness areas, USFS, National Rec. Area, National Monument, BLM, SITLA, tribal, Utah wildlife reserves, and private lands). In general, landscape-level issues such as extractive energy, residential development, agriculture, and wildlife have received minimal attention in traditional community master plans. Landscape-level concerns like water quality and quantity, public health, air quality, safety, and welfare tend to go unnoticed as part of future development scenarios. These attributes are important in helping to establish the quality of life and the context of the communities within the basin (Uintah, Duchesne, and Daggett Counties) and, as such, will be addressed in the study.

The following bioregional planning study is the result of interest from decision-makers within the Uintah Basin and the thesis project that was completed by Nicholas E. Kenczka in June 2009, *An Alternative Futures Study for the Uintah Basin: Exploring 2030*. With recent developments within the basin, such as the boom of energy extraction and the resulting influx of energy labor, it was deemed advantageous to reflect upon the work that Nicholas Kenczka developed from his thesis.

This study looks to provide decision-makers with different options on how to best assess development within the Uintah Basin in very general terms. It can provide leaders a framework to approach pressing issues that face the people of the Uintah Basin, such as identifying conflicts between development and conservation. By identifying these conflicts, leaders can begin to develop a more detailed approach as to how to address them.

There were several limitations that were encountered when conducting this study. These limitations include the lack of accurate and extensive soils data that is essential when developing land allocation models for development, and the lack of flood data for the basin. In addition to these limitations was the lack of participation of Native Tribes from within the Uintah Basin in the coordination of this work.

Chapter 1

Introduction and Methodology

Introduction

The rising demand for energy resources around the world and the push for "energy independence" in the United States have caused an economic boom in the Uintah Basin of Northern Utah. The rapid expansion of oil and gas industries has provided many jobs and economic benefits to the region. However, new growth and development have not occurred without cost. There have been significant impacts to the social structure of the region's communities as well as the ecological integrity of the surrounding landscape.

Long term economic stability and the protection of the Uintah Basin's environmental and cultural assets will require a concerted effort from local leaders, government officials, and industry representatives to form an integrated plan that transcends traditional jurisdictional boundaries. This bioregional study aims to provide a useful assessment of landscape level ecological resources and cultural aspects of the region to identify how they are likely to be impacted by new development in the future. Critical aspects contributing to the ecological integrity, economic stability, and identity of the region have been discussed and modeled to provide planners and decision-makers with appropriate tools to assess the impact of potential strategies for both conservation and development as the region continues to grow.

The Study Area

The proposed study area includes portions of three larger physiographic provinces and varies in elevation from less than 5000 feet at the center of the basin to a high point of 13,528 feet at King's Peak in the Uintah Mountains. Climate varies widely from semi-arid areas at lower elevations to much cooler and wetter areas at higher elevations of undifferentiated highlands. The majority of the study area is represented by two counties – Uintah and Duchesne – with smaller portions made up of Daggett County and areas within Summit, Wasatch, Utah, Carbon, Emery, and Grand Counties.

The Uintah Basin Study Area

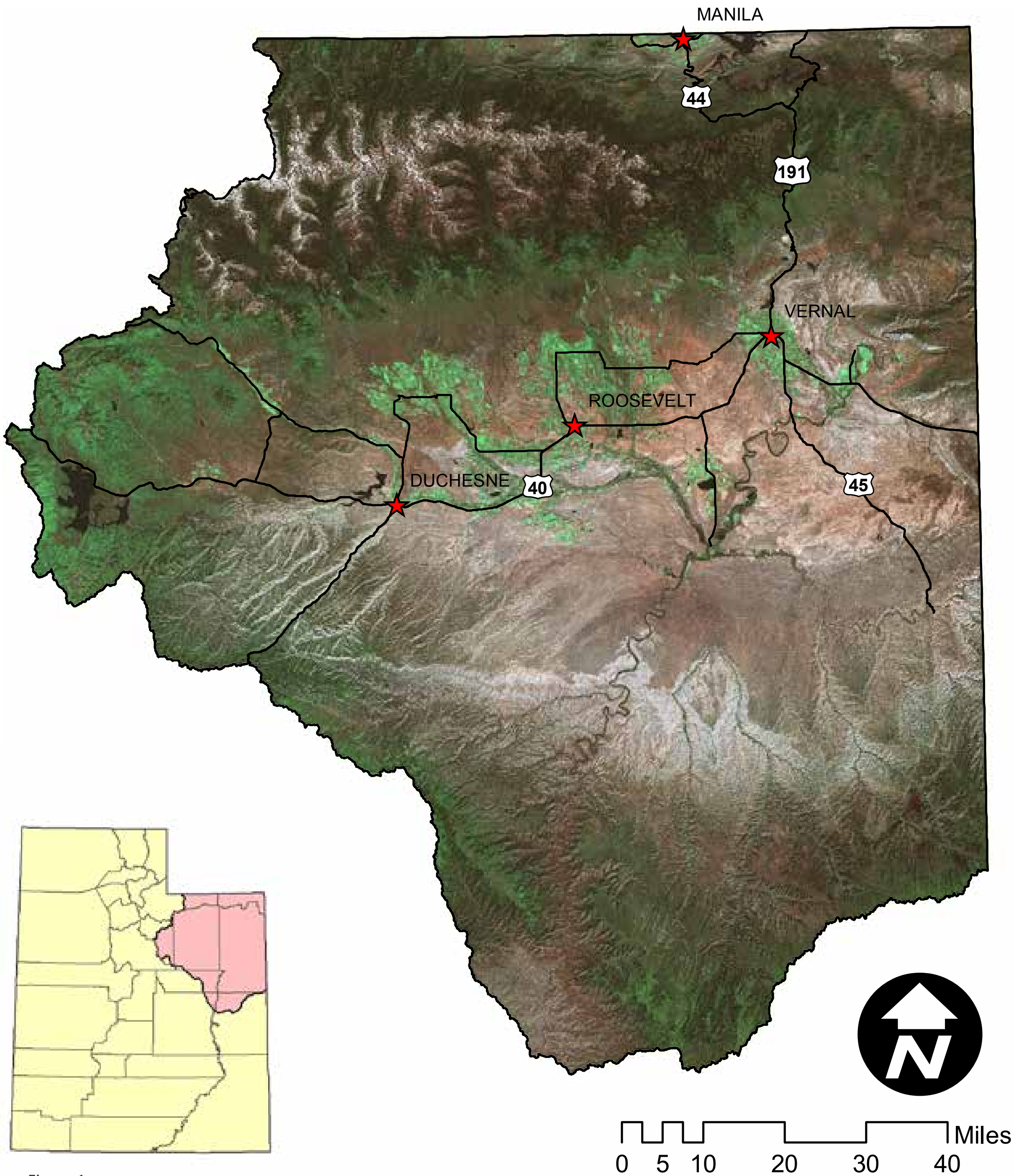
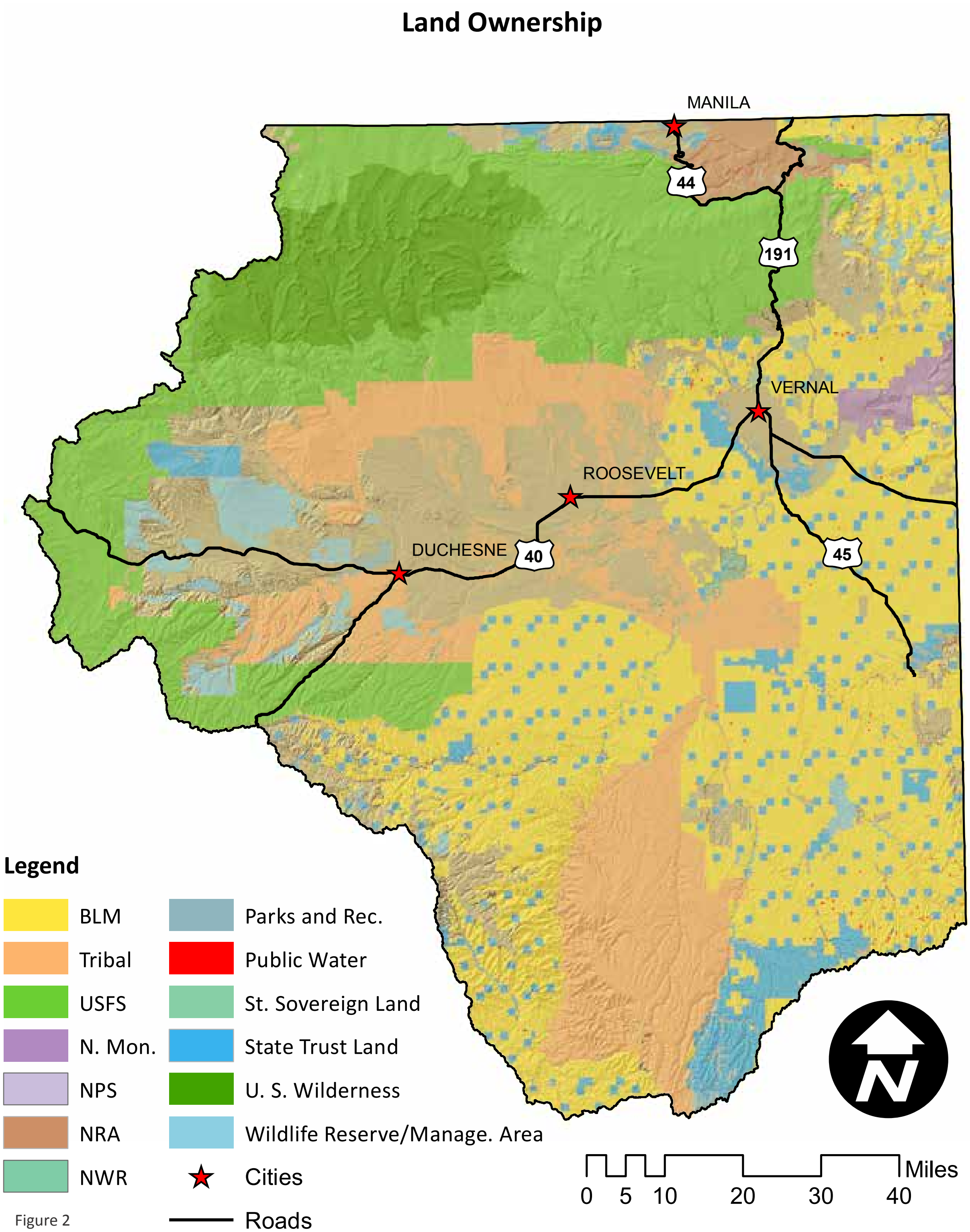


Figure 1



Land Ownership
MANILA
VERNAL
ROOSEVELT
DUCHESNE
44
191
40
45
Legend
BLM
Tribal
USFS
N. Mon.
NPS
NRA
NWR
Parks and Rec.
Public Water
St. Sovereign Land
State Trust Land
U. S. Wilderness
Wildlife Reserve/Manage. Area
Cities
Roads
Miles
0 5 10 20 30 40
N

Figure 2

Methodology

To address complex issues on a regional or landscape scale, it is helpful to develop a suitable methodology to guide the research and analysis through each phase of the overall study. The methodology for this bioregional planning studio project was adapted from that of Professor Richard Toth (Toth, 1974) with some adaptations based on past studio projects and the specific issues and problems identified during the pre-analysis phase of the Uintah Basin Project. A diagram of the methodology used is provided on page 7. While upon first glance it seems to be a very straightforward and almost linear process, the different phases of work are quite fluid. Due to the complexity of addressing multi-faceted issues on a regional scale, several iterations of work are generally completed in each phase of the modeling process in order to obtain appropriate representations.

Pre-Analysis

The primary objective of the Pre-Analysis is to get a "feel" for the region, gain an understanding of the issues and opportunities that may need to be addressed through the course of the project, and to begin to develop a suitable methodology. Several sources of information were explored during this phase. Case studies representing seminal works in large-scale environmental planning, such as *The River Basin* by Ian McHarg as well as more contemporary work such as the *Willamette River Basin Planning Atlas*, were reviewed to establish an appropriate foundation for the type of work being done as well as to identify potential strategies and methodologies to move the project forward. Site visits were made to allow face-to-face meetings with local officials and stakeholders as well as to get an "on the ground" perspective of the region. A significant advantage that we enjoy as part of a large university is access to many extremely knowledgeable and capable individuals with specific professional knowledge of various issues. As needed, we took advantage of these individuals to provide us with much of the scientific information and professional judgment necessary to identify and understand important aspects of the regional landscape. Finally, "project opinion papers" were researched and written to establish an initial inventory of regional issues and opportunities identified throughout this phase of work.

Regional Inventory – Function and Structure

The primary objective of this first phase was to research the structural and functional aspects of the region to gain an understanding of the landscape-level processes that exist is the study area – more simply put, the way that everything works and why. While these aspects were delineated as physical, biological, and social/cultural aspects, careful attention was paid to the relationships between and among them. The primary aspects addressed directly included the region's geology, climate, soils, vegetation, and wildlife as well as human settlement, culture, and impacts.

Assessment Models

Based on the issues identified in the previous phase, as well as the functional and structural aspects of the region identified in the first phase, assessment models were created to spatially represent operationally significant attributes and processes occurring in the study area. This phase of work involved significant data collection and modeling using ArcGIS software. These spatial representations are referred to as "Assessment Models" because one of their primary uses is to assess the impact of any proposed action or planning strategy on the regional resources identified. Additionally, they can also be used as components to create integrated or composite assessment models and combined with allocation models to develop alternative future scenarios.

Allocation Models

Allocation models are spatial representations of potential activities or land uses as they might occur in the landscape. Based upon the suggestions of local officials and stakeholders during site visits and conversations, the allocation models employed in this particular study are very simplified. The primary reason for this simplification was to leave the details of planning and design strategies for specific land uses to local planners and decision-makers. Therefore, the allocation models developed in this study were very general models that represent where residential, commercial, or industrial development on one hand and energy development on the other, could possibly occur in the Uintah Basin without making any value judgments regarding where the research team thought they should specifically occur.

Trade-Off Models

The primary purpose of the trade-off models is to spatially represent areas of landscape where conflicts may exist between land use priorities such as development and conservation. Equally important are areas where no real conflict is likely to exist. These models are useful for planners, developers, and local stakeholders to evaluate the feasibility of potential projects or planning strategies in regard to the resistance that may be present based upon the desirability of a particular piece of landscape for a competing land use priority. While only two trade-off models are presented in this study, the potential exists to use the framework for almost any number of additional combinations of competing land uses.

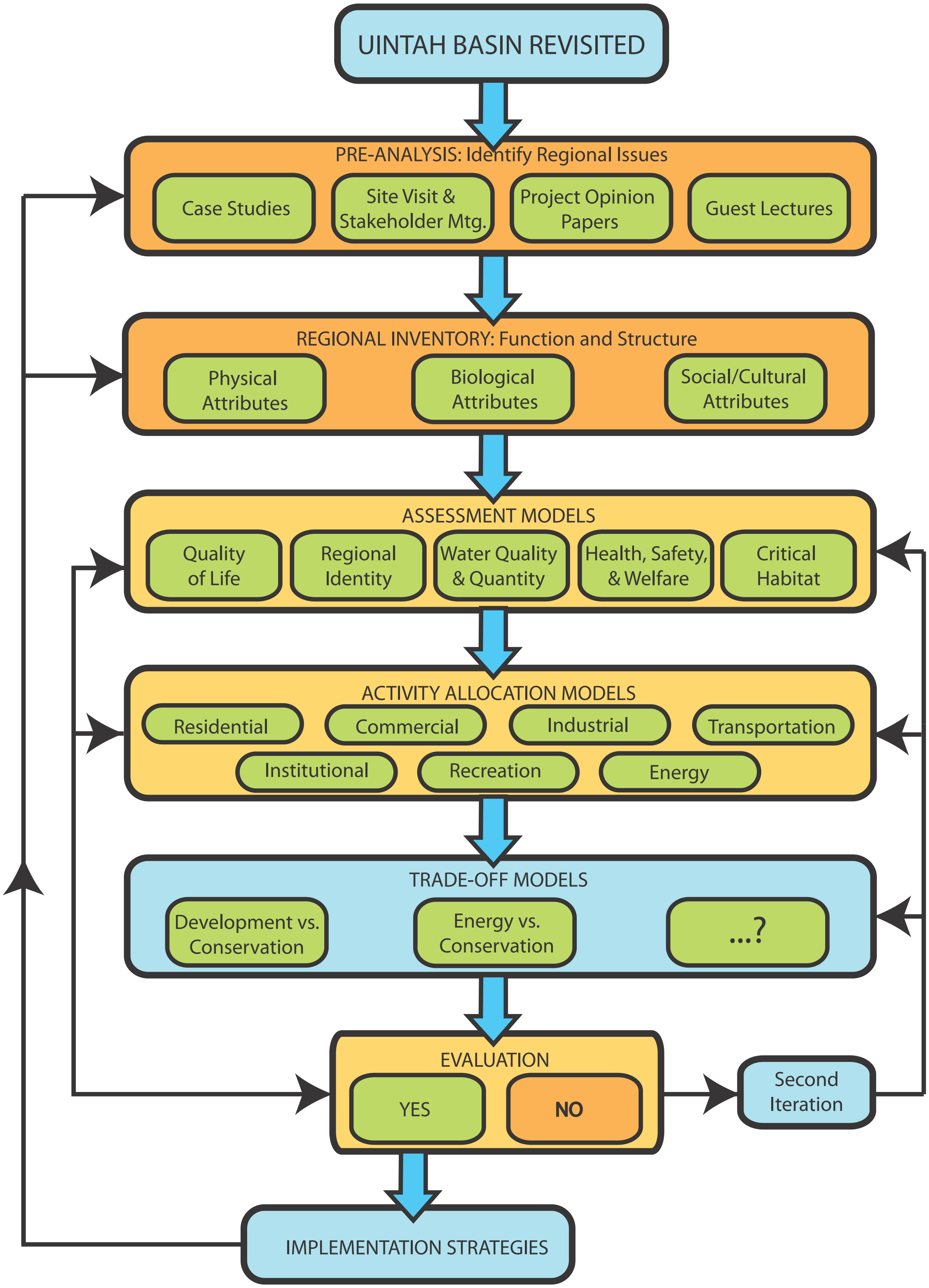
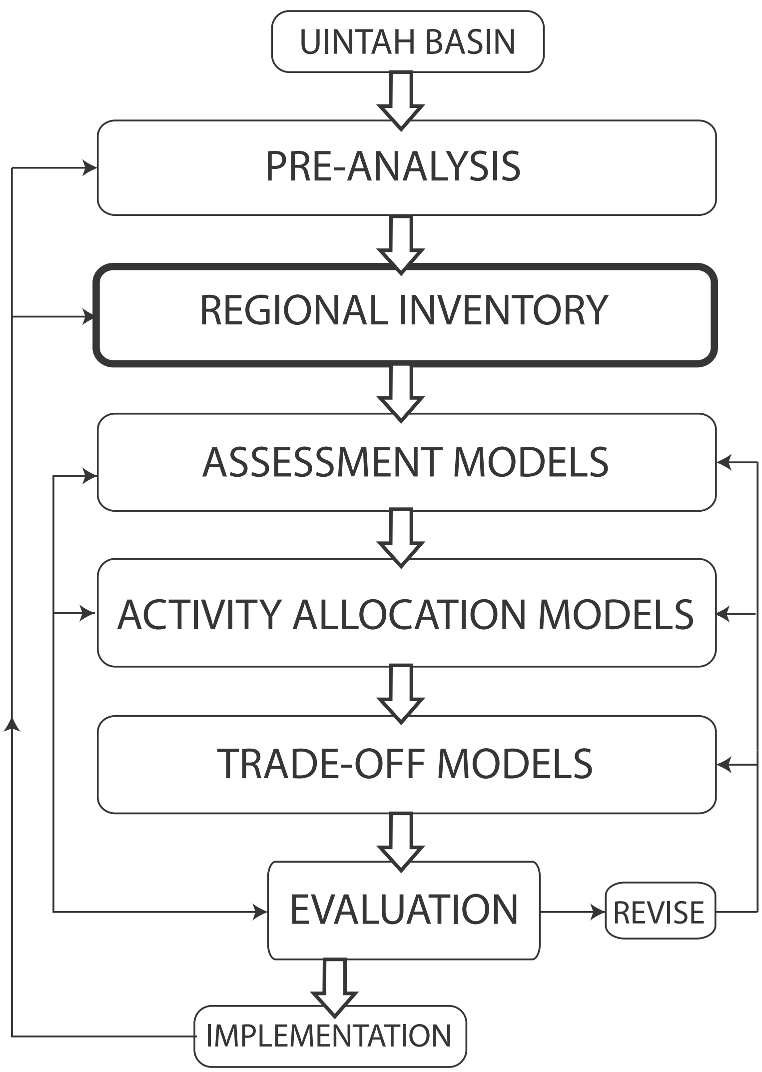

UINTAH BASIN REVISITED
PRE-ANALYSIS: Identify Regional Issues
Case Studies
Site Visit & Stakeholder Mtg.
Project Opinion Papers
Guest Lectures
REGIONAL INVENTORY: Function and Structure
Physical Attributes
Biological Attributes
Social/Cultural Attributes
ASSESSMENT MODELS
Quality of Life
Regional Identity
Water Quality & Quantity
Health, Safety, & Welfare
Critical Habitat
ACTIVITY ALLOCATION MODELS
Residential
Commercial
Industrial
Transportation
Institutional
Recreation
Energy
TRADE-OFF MODELS
Development vs. Conservation
Energy vs. Conservation
...?
EVALUATION
YES
NO
Second Iteration
IMPLEMENTATION STRATEGIES

Figure 3

Chapter 2

Regional Inventory

Summary
The primary objective of this first phase was to research the structural and functional aspects of the region to gain an understanding of the landscape-level processes that exist in the study area – more simply put, the way that everything works and why. See page 5 for more information.



Chapter 2: Regional Inventory

Biophysical Attributes of the Uintah Basin

Geology

The Uintah Basin Study Area contains portions of three larger physiographic provinces: the Middle Rocky Mountains, the Colorado Plateau, and a small portion of the Wyoming Basin. These provinces are defined by prominent rock types, deformation, and erosional characteristics (Fenneman, 1931). As shown in the image to the left, during the Late Jurassic and Early Cretaceous Periods, the study area was part of a large, highly sedimented, fluvial plain between the mountain formations of the Sevier Orogeny and a low-lying inland sea (Blakely & Ranney, 2008); see Figure 1. From the Late Cretaceous to Late Eocene, deposition in northern Utah and northwest Colorado was guided by uplifts, beginning with the Laramide Orogeny. Rising mountains and plateaus pushed upward through a large continuous foreland, segmenting the region into a series of inter-montane basins surrounded by highlands (Fillmore, 2011).

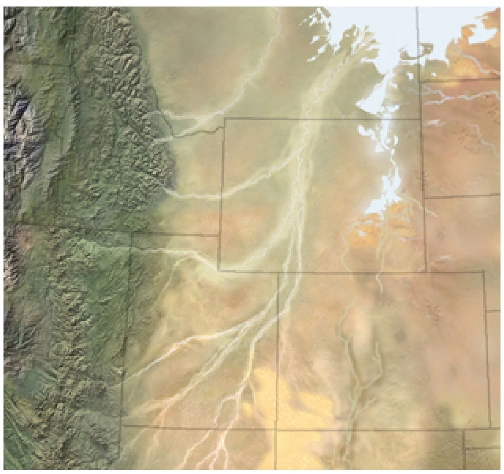


Figure 4: Western U.S. during the Late Jurassic Period (Blakely, 2008)

The Uinta Mountains

The Uinta Mountain Range in the north of the study area is part of the larger Middle Rocky Mountain physiographic province (Fenneman, 1931). The range is about 150 miles long and 30 miles wide (Resource U.B., 1999), contains the highest peaks in Utah, and is the only major east-west trending mountain range in North America (Smith & Cooke, 1985). The mountains were formed by immense, anticlinal uplifts beginning during the Laramide Orogeny and subsequently shaped by geological and climatic forces (Hansen, 1975). Rock formations – primarily sandstone, shale, quartzite, and limestone – vary widely in age and composition. Some formations are estimated to be 2 billion years old (Hansen, 1975). During Pleistocene times, the Uintas were extensively glaciated, and glacial erosion has created the many picturesque examples of horns, arêtes, cirques, and glacial troughs that give the range its character today.

As the source of several important rivers, including the Bear, the Weber, and the Provo, the Uinta Mountains have been critical to the historic and current development of Utah. They are also a major source of water flowing into the Green River, which is the largest tributary that feeds the Colorado River (Fuller, 1994).

Figure 5: Geologic strata along the Green River near Split Mountain recreation area, Uintah County. Source: Michael Gottfredson

Figure 6: Dry Fork Canyon, Ashley National Forest in Autumn. Source: Tyler Allen

The Uintah Basin

The Uintah Basin is a structural basin marking the northern corner of the Colorado Plateau Physiographic Province (Fillmore, 2011). It is bounded by the Uinta and Wasatch Mountain Ranges to the north and west, the Tavaputs Plateau and Book Cliffs to the south, and is connected to Colorado's Piceance Basin via the Douglas Creek Arch to the east. The undulating topography of the central basin has an elevation of approximately 5500 feet with most of the basin rim exceeding 8000 feet (USFS, 2012).

The basin has a synclinal (downward warping) geological structure, characterized by broad asymmetrical folds typical of formations during the Laramide Orogeny (Lehman, 2001), see Figure 7. It has an east-west axis near the base of the Uinta Mountains (USFS, 2012). Strata on the northern flank dip steeply toward the axis of the basin while the southern flank dips more gently (Howells, Longsen, & Hunt, 1987). The basin contains several deep layers of sedimentary rock indicative of the area's history as part of a large alluvial floodplain. For approximately 10 million years, the Uinta Basin was filled by a giant lake known as Lake Uinta. As nearby mountain ranges continued to uplift and erode, the basin acted as a receptacle, collecting sediment that pushed the lake outward across the landscape. From the Late Paleocene to Late Eocene, an estimated 10,000 feet of sediment was deposited into the basin (Fillmore, 2011).

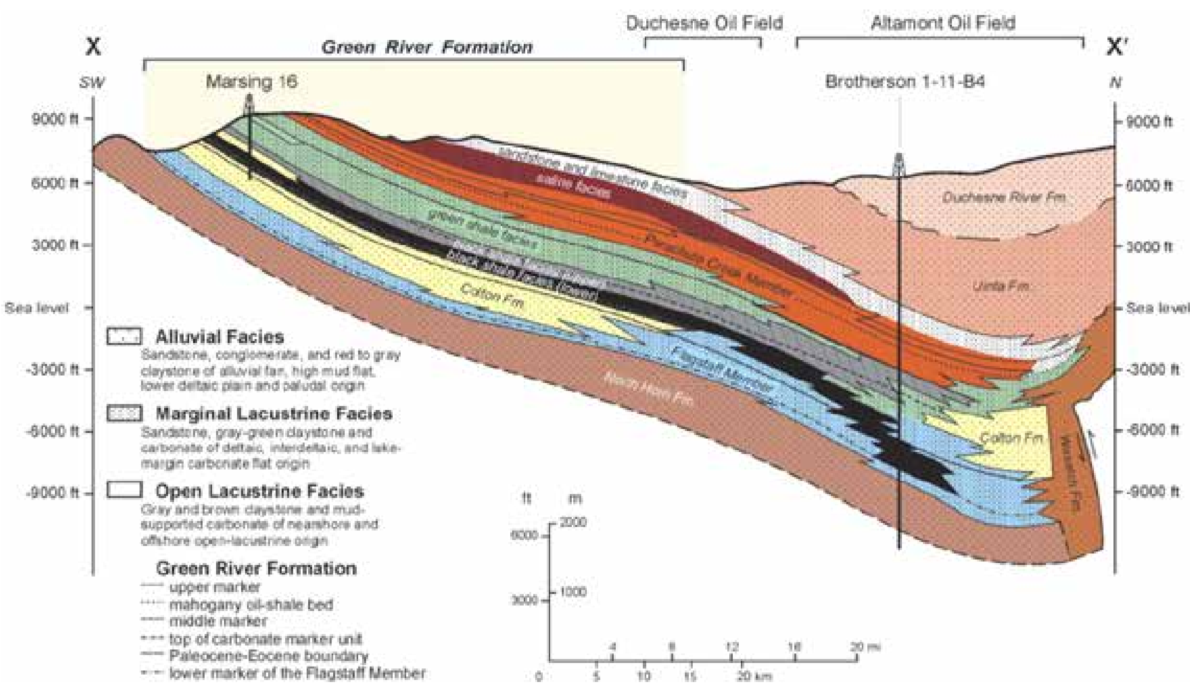


Figure 7: Geologic Cross Section of Uintah Basin. Source: AAPG, Vol. 85, No. 8, page 1338.

The eventual formation of early tertiary rock within the basin resulted in the storage of fossil fuel resources that have driven the economic development in the region for the last several decades. Oil in permeable rock formations such as sandstone or limestone filtrates upward until it is trapped by impermeable rock surfaces, leading to the formation of oil or gas fields. These underground reservoirs of oil and gas along with deposits of oil shale, tar sands, Gilsonite, and other hydrocarbons are found throughout the basin (Chronic, 1990).

Climate

The Modified Köppen classification system – based on the distribution of vegetation as an indicator of temperature and moisture (Oliver & Hidore, 2002) – depicts "Steppe" and "Undifferentiated Highlands" as the two primary climate zones in the study area (Pope & Brough, 1996). These classifications, shown spatially in Figure 8, correlate with the topography, precipitation, temperatures, and geographical context of the region. They highlight the differences as well as the relationship between the two primary physiographic provinces as the Uinta and Wasatch Mountain Ranges guide wind and precipitation patterns across the rest of the study area.

Steppe

The Steppe climatic zone accounts for the largest portion of land area in the Uinta Basin. These areas are found at varying elevations between 4300 and 9300 feet and are characterized by large expanses of sagebrush and mixed grasses. Steppe landscapes are generally described as areas with semiarid regimes where evapotranspiration rates exceed average annual precipitation (Bailey, 1996). Most of the Uinta Basin receives 7 to 12 inches of annual precipitation (USFS, 2012) with fewer than 6 inches in the most arid areas around Ouray (Weather Channel, 2012). Sporadic precipitation, hot summers, and cold winters create very dry soil conditions and a harsh growing environment.

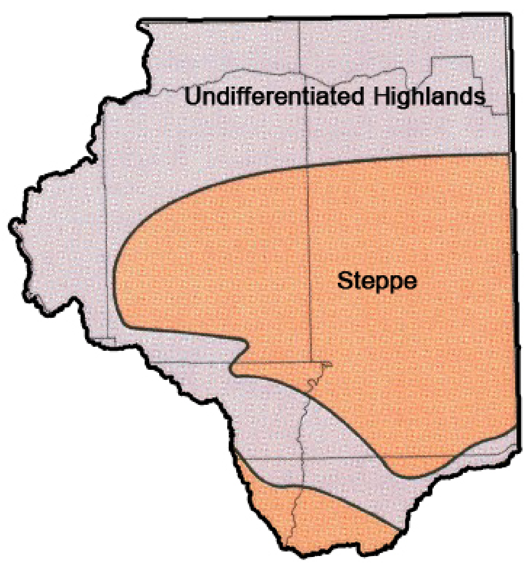


Figure 8: Climatic Zones of the Uinta Basin.
Modified from: earthscienceeducation.org

Undifferentiated Highlands

The undifferentiated highland climatic zone is markedly different. These areas vary widely in both temperature and precipitation due to differences in elevation, localized weather conditions, and geographical context. Undifferentiated highlands generally exist at a range of 8,000 to 13,000 feet in elevation (Woods et al., 2001) and have an average annual precipitation between 20 and 50 inches (Jensen et al., 1990). They experience cold winters, cool summers, and relatively unpredictable weather patterns.

Hydrology

As in most arid to semi-arid regions, hydrologic processes and water resources play an integral role in all forms of development throughout the Uintah Basin. The availability of water resources was the primary driver of European settlement patterns, and water diversions for irrigation date back to the early 1900s (UDWR, 1999). The quantity and quality of both surface and groundwater resources is critical to the current and future well-being of the region.

Surface Water

The study area can be divided into two primary drainages, the north and south slope of the Uinta Mountains (UDWR, 1999). The primary hydrologic feature is the Green River, which collects water from both slopes to form the largest tributary of the Colorado River. Other major rivers include the Strawberry, Uinta, Duchesne, and White, with a number of smaller creeks that drain directly into the Green River (USFS, 2012).

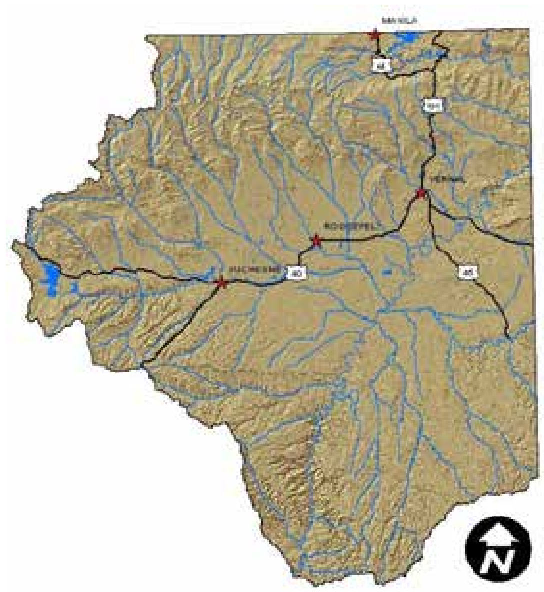


Figure 9: Uintah Basin Hydrology
Data Source: Utah AGRC

Figure 9 shows the basic surface water hydrology of the Uintah Basin (an enlarged map is also included as Appendix F at the end of this report.). The Green River enters the region through Split Mountain and Dinosaur National Park on the Utah/Colorado border and cuts a wandering line from northeast to southwest through the basin. The Duchesne River meets the Green River near the center of the basin, collecting water from both the Wasatch Mountains via the Strawberry River, and the south slope of the Uinta Mountains via the Lake Fork and Uinta Rivers. The White River coming from the east meets the Green River almost opposite the Duchesne. Beyond the center of the basin, the Green River continues its flow against the north facing topography of the Books Cliffs and Tavaputs Plateau. It exits the basin through 5,000-foot deep Desolation Canyon and continues south toward its eventual confluence with the Colorado River.

Primary water uses in the study area include agricultural irrigation, municipal, and industrial uses. Irrigation currently places the highest demand on surface water resources. Due to the contrast between semi-arid conditions of steppe-land and wetter conditions of the highlands, water collection and storage is critical for lower elevation areas where the vast majority of human settlement has taken place. The Uintah Basin has 82 active reservoirs and lakes used for water storage (UDWR, 1999). The largest are Starvation, Steinaker, and Strawberry Reservoirs, but most water collected by Strawberry is diverted to serve Utah County in the Bonneville Basin.

Surface water in the upper watersheds is generally of good quality but deteriorates as it moves downstream. There are approximately 3,445 perennial stream miles within the Uintah Basin Study Area. The Utah Department of Water Quality made an assessment of 3,013.6 miles of these streams for its 2008 report to the EPA. According to that report, there are 2,378 miles (78.9%) listed as fully supporting designated beneficial uses and 635.0 miles (21.1%) that are not supporting at least one designated use. (UDWQ, 2008). The major sources of impairment were agricultural activities, habitat modification, and hydrological modification that caused impacts to water quality in the form of total dissolved solids, temperature, and significant habitat alterations (UDWQ, 2008). For a general map of the hydrology of the Uintah Basin, see Figure 9 on the previous page.

Groundwater

Groundwater hydrology in the Uintah Basin is primarily influenced by its geologic structure (Howells et al., 1987). The most significant aquifer recharge areas are found at the northern edge of the basin, while less significant recharge occurs in the Eocene and Oligocene formations at the basin interior (USFS, 2012). The general pattern of groundwater flow is centripetal, with water flowing toward the center of the basin from primary recharge areas at the margins.

Unconsolidated, valley-fill materials have traditionally been the best groundwater resource for other areas in Utah but are very limited in the Uintah Basin. The only extensive, unconsolidated aquifers are found in the Duchesne-Myton-Pleasant Valley area and in the plain east of Neola. The only other unconsolidated aquifers occur in the bottoms of mountain canyons, stream valleys, or as discontinuous caps on terraces (UDWR, 1999). The general lack of unconsolidated aquifers in the basin make consolidated or bedrock aquifers the only potential groundwater source for most areas.

Recharge to consolidated bedrock aquifers occurs through several processes including the infiltration of precipitation, the leakage of groundwater from other formations, the seepage from streams where the water table is lower than the streambed, the inflow of groundwater that originates outside of the basin, and through the infiltration of irrigation water. Especially for unconfined alluvial aquifers, irrigation and return flow are important sources of recharge. Evidence that this occurs, at least locally, is the observation that the water level in alluvial wells responds to the application of water during the irrigation season (UDWR, 1999).

The quality of groundwater in the Uintah Basin aquifers ranges from fresh to briny. The freshest water is found in the Precambrian formations of the Uinta Mountains, and the chemistry of the water changes as it moves from higher elevation recharge areas toward the central part of the basin. For each aquifer, groundwater becomes more saline as it moves down gradient and dissolves soluble minerals (Schlotthauer, Nance, & Olds, 1981). Initial water infiltration is usually of the calcium-magnesium bicarbonate type. As it descends into deeper regions of the aquifer, it becomes a sodium bicarbonate, then changes to a sodium sulfate, and finally becomes dominated by sodium chloride. This process, characteristic of most deep groundwater basins, is enhanced by the presence of unusual salts in some formations of the Uinta Basin (Schlotthauer Nance & Olds, 1981; Holmes, 1985).

The groundwater resources present in the Uintah Basin have been developed as springs and wells that support public water supplies, irrigation, and livestock watering (UDWR, 1999). However, this development has been relatively minor for several reasons: 1) The early development of surface water has been adequate for most needs; 2) the consolidated aquifers, generally, have hydraulic properties that preclude large-scale groundwater development; 3) the quality of groundwater in many areas is unsuitable for most uses; and 4) the economics of drilling and pumping water from deeply buried aquifers is currently prohibitive. (UDWQ, 1997).

Soils

Soils have been a significant factor in the structure of the natural environment as well as the cultural history of the Uintah Basin. The distribution of suitable soils for grazing and agriculture has shaped historical land use throughout the region almost as much as the availability of water resources (Kenczka, 2009).

The Natural Resources Conservation Service (NRCS) uses a classification system of 12 soil orders. According to the NRCS, five of these orders occur within the Uintah Basin study area. They include: alfisols, aridisols, entisols, inceptisols, and mollisols. The distribution of these soil orders in the Uintah Basin is shown in Figure 10.

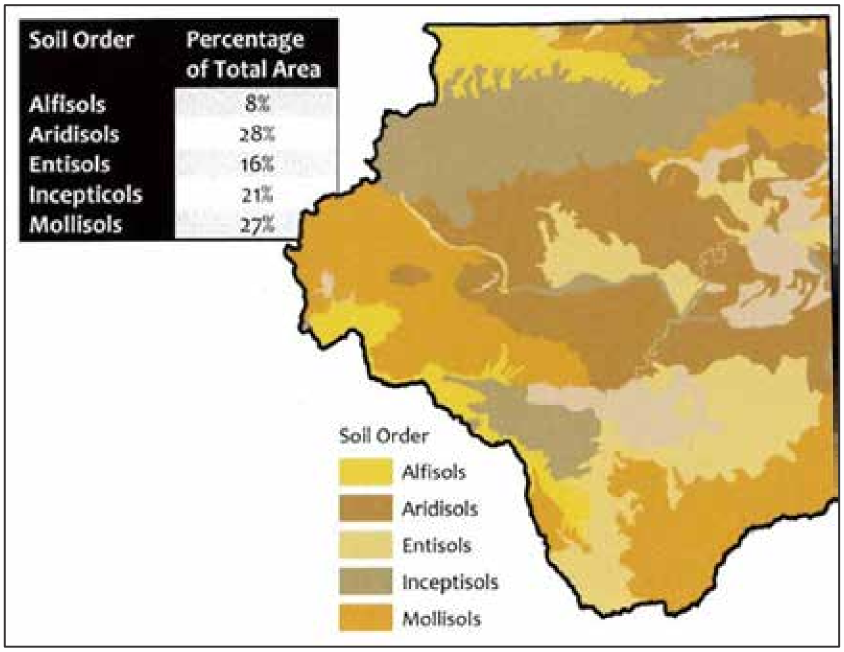


Figure 10: Soil Orders within the Uintah Basin,
Source: Kenczka, 2009

Alfisols: These soils are formed in humid environments "under native deciduous forests" (Kenczka, 2009). They have a clay rich horizon and high natural fertility. They have a fine-loamy texture that responds well to agricultural and rangeland uses. Alfisols make up the smallest proportion of soil orders within the basin (Kenczka, 2009).

Aridisols: These are the most widely distributed soils throughout the region. They were formed long ago when a period of wet conditions quickly transitioned into a dry desert-like environment. These soils have fine, coarse, and loamy textural qualities with high salinity that makes them largely unsuitable for agricultural purposes (Kenczka, 2009).

Entisols: These soils also occur in areas throughout the basin. They are a more recently formed class of soils with widely varying characteristics. Due to their diversity, they have a wide ranging suitability for land use that depends on the local soil conditions (Kenczka, 2009).

Inceptisols: These are often referred to as young soils and are located in more mountainous regions around the perimeter of the basin. Their texture ranges from sandy to loamy and their productivity is largely dependent on geographical context and sub-order development. Current land uses associated with these soils include recreation and forestry (Kenczka, 2009).

Mollisols: These soils are the second largest soil order within the basin. They are generally soft, dark-colored soils with a loamy texture. They are found primarily within grassland and prairie areas of the basin. They contain high levels of rich organic matter that make them highly productive for agricultural uses (Kenczka,2009).

Vegetation

There are three distinct classifications used to represent vegetative regimes in the study area: riparian zones, range and intermountain basins, and montane forests. For a more comprehensive, spatial representation of vegetation in the Uintah Basin, refer to Appendix B on pages 114 and 115 of this report.

Riparian Zones

Riparian zones make up a relatively small portion of the basin but provide a high level of vegetative diversity. The structural distinction among vegetation types within these zones takes various forms including marshes, meadows, shrub lands, and trees. Riparian zones can be broken down into three sub-categories: lowland riparian, highland riparian, and wetlands.

> *Lowland riparian areas:* These areas consist of slow-moving rivers with still marshes and wetland areas. Cottonwood, salt cedar, and willows are dominant in this area.
>
> *Highland riparian areas:* These areas are found at higher elevations with steep stream gradients and cool temperatures. Flora includes birch, dogwood, cottonwood and willows.
>
> *Wetlands:* These are areas that are saturated with surface water (Kenczka, 2009). Predominant flora includes cattail, bulrush, and sedges (UDWR, 2005) with variations due to elevation, soil type, sinuosity, and precipitation.

In general, riparian areas are fragile environments that show little resilience to human disturbance and are generally in a continual state of decline (UDWR, 2005).

Range and Intermountain Basin

These areas make up the largest proportion of land in the Uintah Basin and are critical for providing habitat to support several threatened or endangered species (UDWR, 2005). The two sub-categories of range and intermountain basin are shrub-steppe and mountain foothill shrub-lands (Gorrell et al., 2005).

> *Sagebrush shrub-steppe* areas receive little precipitation and include species such as big sagebrush, black sagebrush, and silver sagebrush that have persisted under harsh conditions (Woods et al., 2001). Bluebunch wheatgrass, Indian ricegrass, cheatgrass, rabbitbrush, and juniper are also prevalent within this ecosystem (Kenczka, 2009).

Mountain foothill shrub land is characterized by rocky formations. It receives more precipitation than shrub-steppe areas, creating suitable conditions for mountain mahogany, cliff rose, chokecherry, gambel oak, and Manzanita (Woods et al., 2001).

Montane Forests

Areas of montane forest are found at elevations of 8,000 to 13,000 feet and consist of a wide range of forest types (Woods et al., 2001). Like other vegetative classifications, topography, elevation, aspect, and climate dictate the variation of vegetative species in these areas. Pinyon-juniper, douglas-fir, and ponderosa pine forests are found at lower elevations because they require less water and withstand warmer temperatures. Mid-elevation forests include lodge pole pine and aspen. Aspen groves are generally found on north-facing slopes where cooler temperatures occur (Kenczka, 2009).

Wildlife

The occurrence of various forms of wildlife in the study area is closely related to the vegetation described in the previous section. The three classifications used to represent vegetative regimes will also be used to identify areas of wildlife habitat. Some of the major areas currently protected and managed as migratory, wintering, or breeding habitat in the Uintah Basin include lands managed by the Utah Department of Natural Resources, U.S. Forest Service, the Bureau of Land Management (BLM), and the U.S. Fish and Wildlife Service.

Riparian Habitat

Riparian ecosystems provide a rich and diverse set of habitat types (Kenczka, 2009) that, in turn, support a diverse mixture of terrestrial vertebrate and aquatic wildlife species (USFWS, 2012) Lowland riparian areas provide "critical" habitat for many sensitive aquatic s pecies that require very specific conditions of both water quality and quantity (Kenczka, 2009). Sensitive species found in these areas include the Colorado pikeminnow, humpback chub, bonytail, and razorback sucker (USFWS, 2002). Wetland areas also provide critical habitat for many migrating avian species, including the whooping crane, bobolink, American avocet, and black-necked stilt.

Range and Intermountain Basin Habitat

These areas are rugged and generally offer little vegetative cover or water. However, they do support several critical wildlife functions ranging from food to shelter from predators (Kenczka, 2009). Two notable bird species that have become especially adapted to these areas are the Gunnison and greater-sage grouse (Rawley & Bailey, 1988). The pygmy rabbit, Utah prairie-dog, and white-tailed prairie-dog represent some of the small mammals commonly found in sagebrush steppe areas (Kenczka, 2009). The region is also important as winter habitat for mule deer populations.

It should be noted that these areas generally suffer the most impact from overgrazing, energy development, wildland fire, and invasive species (UDWR, 2005).

Montane Habitat

Large ungulates are more commonly found in the montane habitat. The forests provide a wide variety of habitat functions such as shelter and protection from predators. Species in this area include mule deer, elk, moose, black bear, and cougar. These areas also provide critical corridors between the Colorado Plateau and the Green River Basin in Wyoming. Major concerns for wildlife in this region include the suppression of natural fire regimes, land development, improper grazing practices, and recreational activities that impact the landscape and ecosystem (Kenczka, 2009).

Social and Economic Attributes of the Uintah Basin

History and Culture

The Uintah Basin has a rich history of indigenous culture and European settlement that has shaped the social structure and historical trends that persist in the region today. Understanding the history and culture that have shaped the region is crucial to establish relationships with regional stakeholders and create plans for future land-use and development.

Archaeological evidence suggests that the Fremont culture was one of the earliest indigenous populations in the basin, relying heavily on agriculture and small game hunting (Eichman, 2008). Around the 1800s, the area was occupied by a small, peaceful, band of Ute Indians called the Uinta-ats (Barton, 1998). The Uinta-ats were forced out of their traditional lands by mounted Comanche but later re-established themselves after acquiring horses of their own (Burton, 1996).

The first known white-Europeans to enter the Uintah Basin were members of the Dominguez-Escalante expedition from Santa Fe, New Mexico. The expedition paved the way for many trappers, traders, and hunters who made important historical contributions to the basin. Some of the more prominent trappers and explorers to pass through the basin included Etienne Provost, Antoine Robidoux, William Becknell, William Heddest, William Huddard, and William H. Ashley, who established the first American fur-trading rendezvous in the basin (Burton, 1996).
The 1860s brought increased activity to the basin. Upon hearing that the Pony Express was interested in establishing a route between Denver and Salt Lake City, Brigham Young called for Mormon missionaries to begin settling the basin. In 1864, an executive order from President

Lincoln established the first Indian Reservation in the Uintah Basin (Powell, 1994). The competition for resources in the basin was now underway. As animosity and resentment built among Native American tribes, Mormon settlers, and the federal government, a second reservation was established to include the Uncompaghre Utes from western Colorado. Eventually the two reservations were consolidated to form the Uintah-Ouray Indian Reservation.

The Uintah-Ouray Reservation has experienced continual pressure from outside forces throughout its history. The discovery of Gilsonite led to the removal of 7,000 acres of land along what is known as "The Strip" (Barton, 1998). As more LDS settlers continued to arrive during the late 1800s, grazing and agricultural activities became more prevalent along the rivers and floodplains of the basin. Lands within the Uintah-Ouray Indian Reservation were opened to homesteaders and mining activities in the late 1800s, bringing further change to the area. Many of the prosperous communities that were established during this period developed into the more prominent towns that persist throughout the Uintah Basin today (Eichman, 2008).

The establishment of the Ashley National Forest in 1908 and the continual push to develop the natural resources of the basin spurred the growth and progress of many communities. By 1920, Uintah, Duchesne, and Daggett Counties had been established. Farming, ranching, timber harvesting, and mining were all essential components of the regional economy and continue to play an important role in the identity of the region today (Eichman, 2008). Oil resources were developed, and commercial oil production began in the 1940s (Russel, 2008). Construction began on the Flaming Gorge Dam in 1958, and the first power generation at the Flaming Gorge Dam began in 1963 (USBR, 2012). For a current land-use map of the Uintah Basin, see page 4.

The Current State of the Uintah Basin

The boom and bust cycles experienced throughout the history of the Uintah Basin are common to areas dependent on the development of natural resources (Putz, Finken, & Goreham, 2011). The rich mineral resources that attracted many original settlers to the basin continue to have a substantial influence in the region today. Cycles of boom, bust, recovery, and disruption continue to affect the social, economic, and environmental well-being of the Uintah Basin – notice the fluctuations seen in recent energy production sales within the state of Utah in Figure 11. This trend will likely continue for as long as the communities of the Uintah Basin rely so heavily (and directly) on the extraction of natural resources for their economic growth and development.

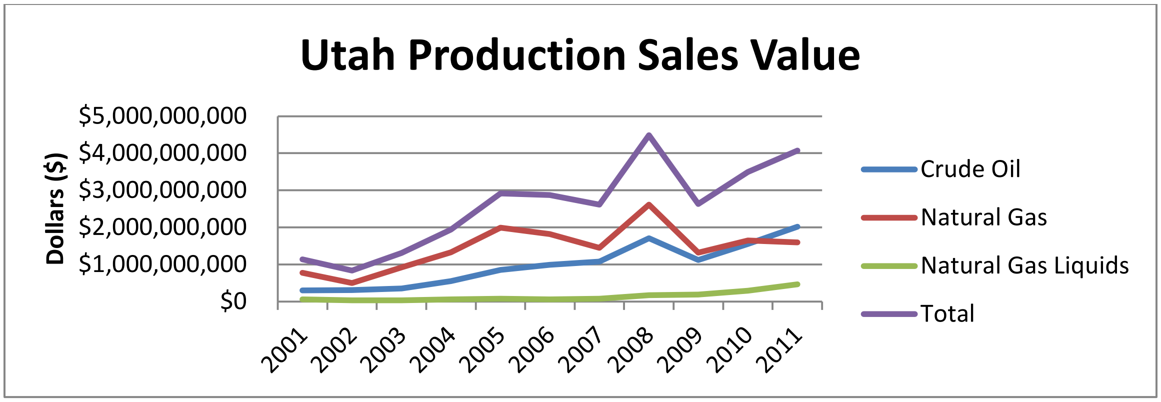


Figure 11: Utah Oil and Gas Sales Value Data Source: http://oilgas.ogm.utah.gov/Statistics/ on 11 July 2013

As the region has developed, the economy has diversified from its traditional base in agriculture and mining but continues to be based in the extraction of natural resources. The nature of these primary industries has made the Uintah Basin susceptible to boom and bust cycles since the first white-Europeans arrived in the area – fur trading in the early 1800s, mining activities and the opening of Indian reservations for settlement in the late 1800s, the establishment of public lands and further development in the early 1900s, and the commercial extraction of crude oil resources since the 1940s.

The increasing demand for domestic energy resources in the United States has created a new rush for oil and gas exploration, bringing another economic boom to the Uintah Basin; Appendix A includes graphs representing increases in the number of drilling permits as well as overall oil and gas production in Uintah and Duchesne Counties. While there is a limited amount of tourism, the extraction of energy resources and the billions of dollars being invested by oil and gas industries are the primary economic drivers in the region. The modern economic vitality of both Uintah and Duchesne Counties closely tracks the price of oil on the international market (Uintah County Economic Development, 2012). The unemployment rate, while averaging between 5-6% when seasonally adjusted, has ranged from less than 2% to well over 10% within the last few years (Workforce Services, 2012).

Regional Challenges

Utah is ranked 12th in the country in crude oil production and 9th in natural gas (UDEQ, 2012). The rapidly developing oil and gas industry in the Uintah Basin has provided many jobs and boosted the local economy. However, it has also brought a range of concerns that must be resolved to maintain the social, economic, and environmental integrity of the region. Rapid population growth, reported by attendees of a stakeholder meeting in Vernal, is quickly changing the demographics of the Uintah Basin. It will be difficult to maintain a strong regional identity amidst such rapid and extensive new development.

Population Growth

New workers moving into the region to service oil and gas industries are dramatically changing the demographic and social structure of communities in the Uintah Basin.

Figure 12: Semi-permanent RV Camp in the Uintah basin.
Source: Matt Coombs

These workers, whether temporary or permanent, have basic needs that must be met in the community. Problems related to sufficient and appropriate housing were both observed during the site visit and reported by nearly all attendees of the first stakeholder meeting; refer to Figure 12, which shows a semi-permanent RV camp that seems to be typical worker housing in many areas of the basin. These problems not only affect oil and gas workers but have reportedly spilled over to affect teachers, police officers, and others who provide important services to the community. Housing developers have been hesitant to invest in the Uintah Basin because of their experience with the region's economic boom and bust cycles in the past. There are some private homes for sale, but many new residents have trouble qualifying for loans and must seek to rent rather than buy housing.

The growing population is certainly placing increased demands on community services and infrastructure. However, it is equally important to recognize the impact growing populations will have on the natural resources and environment of the surrounding area. More people equates to more automobiles contributing to traffic and air quality problems. The growing demand for recreation opportunities will place additional stress on resources such as those of the Uinta-Wasatch-Cache and Ashley National Forests. Increasing demands for culinary and industrial water will prompt the need to develop additional water sources and/or pull water resources away from agriculture, as has already been seen in many areas of the world (Scheierling, 2011).

Economic Stability

As discussed previously, the economy of the Uintah Basin has been susceptible to boom and bust cycles throughout most of its history. Approximately half of all economic activity in the Uintah Basin is generated or derived from the oil and gas industry and fluctuations in the prices of these commodities have major effects on the regional economy. Low unemployment rates and high wages, despite the relatively bleak national economy, have caused rapid population growth due to an influx of workers and families moving to the Uintah Basin in search of jobs.

Unfortunately, very little evidence has been found to suggest that the economy will not continue its historical pattern. There will always be a demand for energy resources, but oil and gas prices will continue to fluctuate. Over time, new technology may reduce employment rates in these industries, and government regulations related to environmental quality, endangered species, and other factors can have a significant impact on the feasibility of extracting energy resources in the Uintah Basin study area. All of these factors and more create uncertainty and risk in the regional economy. One significant indicator of concern is that outside investors (housing developers, service providers, etc.) remain hesitant to invest in the area because of past experiences with the boom and bust cycles of the Uintah Basin and have not been convinced that this pattern has changed. This hesitancy has contributed to housing shortages and placed increased pressure on local services, including public health and education.

Without substantial evidence to the contrary, local officials and planners must recognize the possibility of a regional economic downturn and plan accordingly. There must be a concerted effort among regional stakeholders to create a strategic plan that takes advantage of the current economic boom to create a more diverse, resilient economic core in the region.

Landscape Fragmentation

The rapid development of oil and gas resources is having an extreme impact on the landscape in the Uintah Basin. Vast networks of dirt and gravel roads connecting oil and gas facilities have shattered any semblance of natural patches or corridors throughout the landscape (see Figure 13).

This fragmentation has the potential to interrupt important migration routes

Figure 13: Patterns of Oil and Gas Wells Southeast of Vernal

and habitat areas that many species of wildlife, including controversial species such as the sage grouse, rely upon for their survival. The dust and vehicle emissions generated along these roads alone can also have a significant environmental impact. The introduction and propagation of invasive plant species is another serious concern. As an example, cheatgrass is crowding out many areas of native vegetation, reducing habitat value and increasing the risk and intensity of wildland fires.

Environment – Air and Water

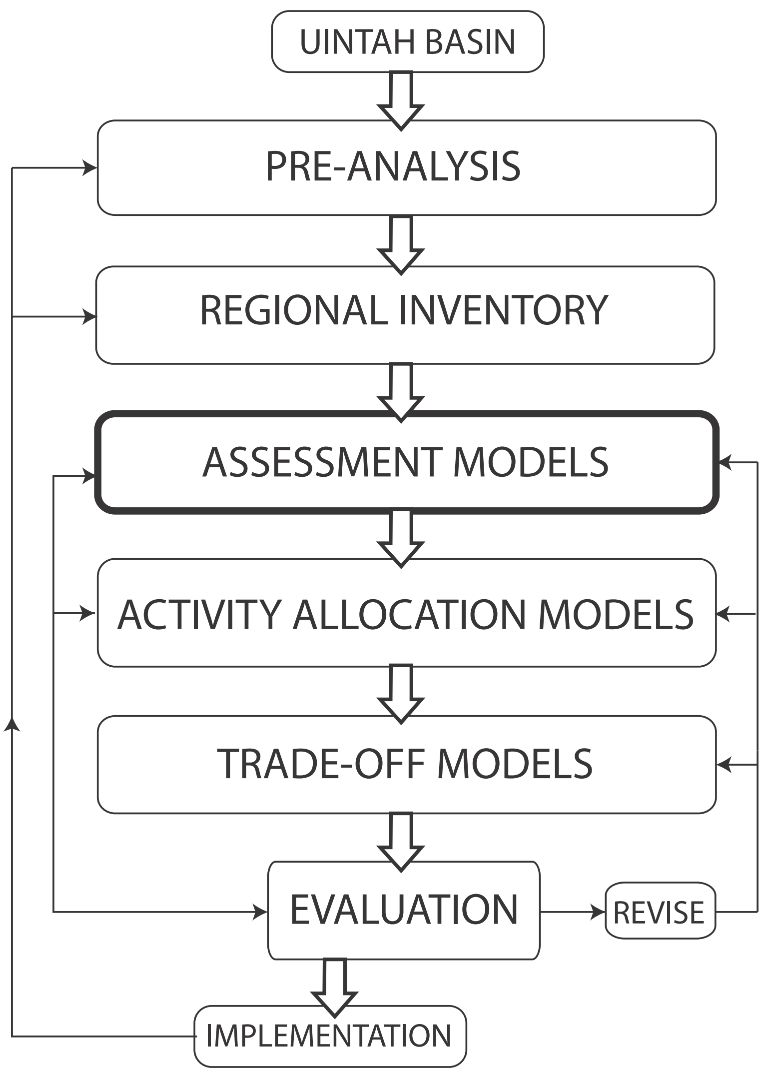
The Uintah Basin has a very low population density compared to most areas of the country, but winter ozone levels are often among the worst in the United States. According to officials, winter ozone levels reached 139 parts per billion in 2011, which is almost double the federal health standard (Utah DEQ, 2012). The physiographic characteristics of the region certainly exacerbates air quality issues during inversions, but energy development and associated activities are likely contributing to increased emissions in the region.

The Environmental Protection Agency has named the oil and gas industry "the largest industrial source of emissions of volatile organic compounds," a primary contributor to the formation of ground-level ozone (EPA, 2012). Ozone exposure is linked to a wide range of health effects, including asthma, increased emergency room and hospital visits, and even premature death (EPA, 2012). Air quality problems in the Uintah Basin are threatening public health and safety and, if the Environmental Protection Agency is employed to take further action regulating air quality in the region, it may have significant consequences for economic growth as well.

Despite the semi-arid climate and low annual rainfall throughout most of the Uintah Basin, water resources have historically supported the development of communities and agricultural activities. However, population growth and the expansion of oil and gas industries are significantly increasing the demand on water resources. In order to be economically feasible, all gas wells in the area must employ fracturing processes that use over one million gallons of water per gas well each time the process is completed. Established oil and gas wells pull huge amounts of water to the surface from deep within the earth, but the geology of the region makes the water so saline that it is generally unsuitable to be used even for the hydraulic fracturing of other wells. These activities create two distinct problems affecting both water quantity and quality: where to obtain clean water to meet increasing industrial and residential demands and how to dispose of poor quality water "produced" by oil and gas wells.

Assessment Models

Summary
Assessment models were created to spatially represent operationally significant attributes and processes occurring in the study area. This phase of work involved significant data collection and modeling using ArcGIS software. See page 6 for more information.



Health, Safety, & Welfare Assessment Models

The purpose of this section is to identify important concerns that may pose a risk to public health, safety, and welfare in the Uintah Basin study area. Five different models are presented representing areas of the landscape where there may be a significant level of risk associated with earthquake damage, landslides, wildfire, contamination of drinking water, or structural damage in flood-prone wetland areas. Additionally, a composite model has been developed showing three tiers of risk exposure based on the inclusion of different levels of threat from the hazards identified. These models are explained in more detail in the following sections.

Earthquake Risk

Earthquakes represent one of the Earth's most devastating natural hazards. As development in Utah and the Uintah Basin continues to expand into seismic zones, the potential impact of earthquakes is growing in importance. Most earthquakes generate multiple hazards and have a pronounced impact when they strike near populated areas. A fault is a fracture or zone of fractures in the Earth's crust, where blocks of crust have moved relative to one another; an earthquake is the result of such a movement. Folds are curves or bends in rock layers.

Direct effects include fault displacement or rupture, tectonic lift and/or subsidence, and ground-shaking. Induced effects include various types of ground failure such as liquefaction and landslides (Toth et al., 2006). Structures in close proximity to fault zones will be vulnerable to considerable structural damage and collapse. "Not only are buildings and homes endangered by these hazards, but water tanks, dams, roads, bridges, railways, airports, and utility corridors carrying electricity, water, sewage, natural gas, petroleum, and telephone service" (UGS, 1996). Earthquake damages can be minimized by constructing buildings away from fault traces (Bolt, 1999) and establishing easements that require varying setbacks from active faults (Berlin, 1980).

Future earthquakes are most likely to occur where earthquakes have produced faults in the geologically recent past. The Quaternary Faults and Fold Database contains information compiled by the Earthquake Hazards Program of the U.S. Geological Survey (USGS). The database describes faults and folds that are believed to be sources of earthquakes greater than magnitude 6 in the past 1,600,000 years. This database is intended to be an archive of historical (less than 150 years) and ancient earthquake sources which can be used in seismic-hazard analyses and developing design provisions for structures and utilities (National Atlas, 2013).

Under the advice of the Utah Geological Survey (UGS), to mitigate some risk associated with quaternary fault rupture, all faults are mapped with a 500 foot buffer (McDonald 2010). Any future development proposed within this buffer warrants discussion with the UGS and, potentially, a more detailed study by a qualified engineer (Profazier, 2010).

Earthquake Risk

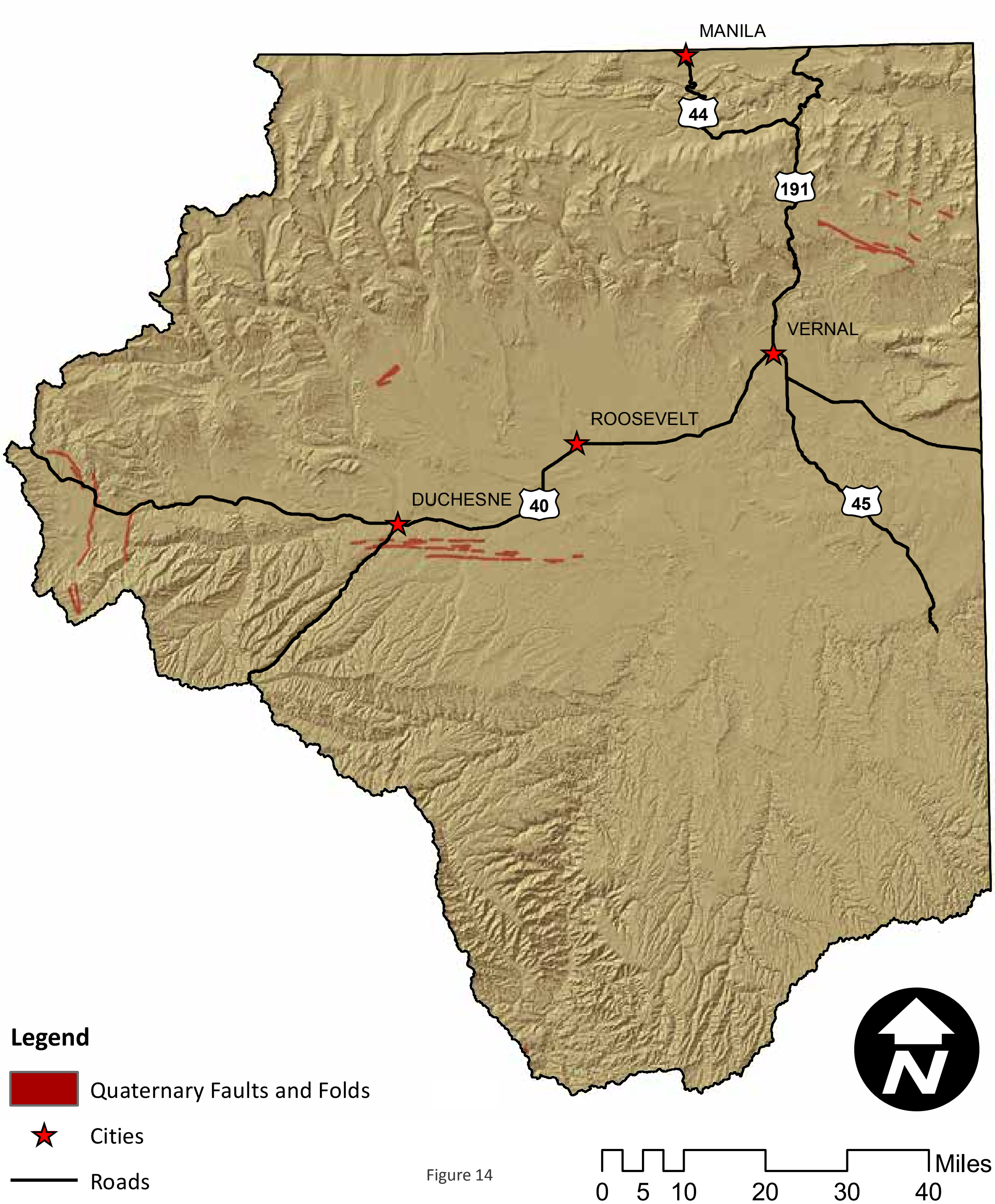


Figure 14

Landslide Susceptibility

Landslides are downslope movements of rock or soil under the influence of gravity that may pose a risk to life and property. Landslides have caused significant economic loss in Utah. As development continues to expand into landslide prone areas, the exposure to landslide hazards and potential for damage to private property and public infrastructure is increasing throughout the state. The landslide susceptibility mapping utilized in this study was originally completed as part of a statewide study by the Utah Geological Survey in 2007. We used the data and susceptibility categories from that study to re-create the landslide susceptibility maps for the Uintah Basin Study Area. Correspondingly, much of the explanation of the mapping and susceptibility categories is taken directly from that study.

The map on the following page is a spatial representation of landslide prone areas in the Uintah Basin. It is important to note that “low” and “very low” susceptibility do not indicate that landslides cannot occur in these areas. Human activities can reduce stability, alter groundwater levels, and trigger landslides on any slope. Additionally, this map is not intended to determine slope stability for an individual structure or site. Rather, it is meant for use in regional planning to determine where landslide hazards may exist and where more detailed studies are needed.

Landslide Susceptibility Categories

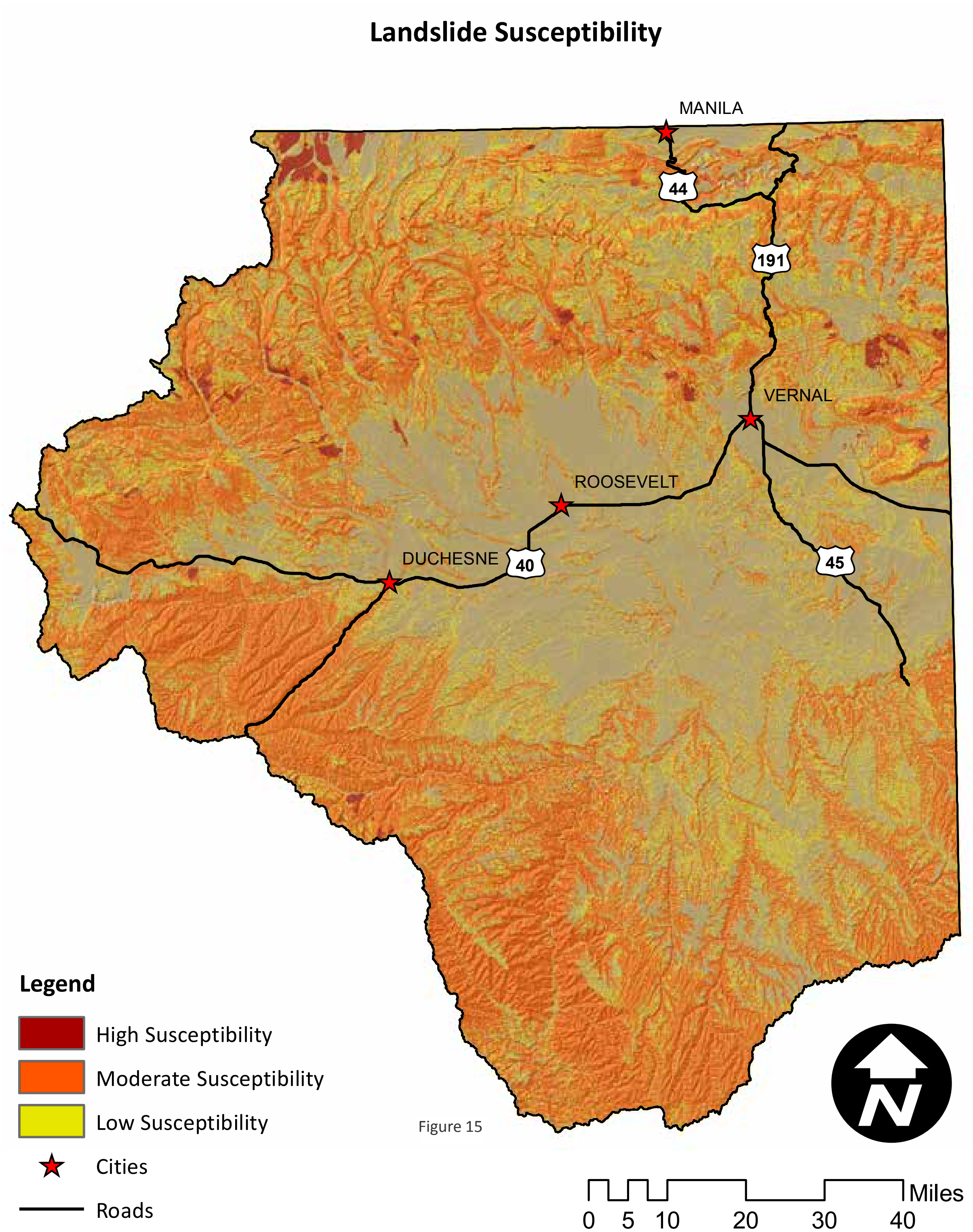
Two steps are used to assign susceptibility categories. The first step assigns areas of high susceptibility. Observations of landslide movement in Utah show that nearly all historically active landslides are re-activations of pre-existing landslides and, thus, these mapped landslides have the greatest potential for movement. The second step used statistical techniques to assign slope angle thresholds distinguishing areas of moderate, low, and very low landslide susceptibility. A brief explanation of each of these categories is provided in the table below.

High Susceptibility: Areas of existing shallow and deep landslides are shown as red on the map. Slope and geologic unit were not included as criteria in this category.

Moderate Susceptibility: Areas that have slopes prone to landslides based on observed landslide slope angles are shown as orange on the map. The category includes slopes greater than 12% (7 deg.) to greater than 32% (18 deg.), depending on the geologic unit present.

Low Susceptiblity: Areas that have slopes that may produce landslides are shown as yellow on the map. This category includes slopes from 9-12% (5-7 deg.) as the lower threshold ranging to to 23-32% (13-18 deg.), for the upper threshold depending on the geologic unit present.

Very Low Susceptibility: Areas that are unlikely to produce landslides are not assigned any particular color, but generally show up as tan on the map. This category includes slopes less than 9% (5 deg.) to less than 12% (7 deg.), depending on the geologic unit.


Landslide Susceptibility
MANILA
44
191
VERNAL
ROOSEVELT
DUCHESNE
40
45
Legend
High Susceptibility
Moderate Susceptibility
Low Susceptibility
Cities
Roads
N
Miles
0 5 10 20 30 40
Figure 15

Wildfire Risk

Wildfires pose a variety of hazards to property, infrastructure, ecological damage, and loss of life (Fire, 2008); see Figure 16. Due to the continual dry summers and geographical context of the Uintah Basin studyarea, wildfires have historically been prevalent and caused severe damage, especially in the last two to three decades.

Several existing communities throughout the study area have been designated as “at risk” for wildfire damage (Fire, 2008). Further development in areas near high risk fuel types will increase the risk of fire damage as well as the costs associated with fire-fighting and fire mitigation. In addition to the direct impact of wildfire, post-fire hazards related to slope stability and watershed health also pose significant risks (UBAG, 2004). There are three general classes of wildfire with different characteristics and varying levels of severity and threat. These classes are surface fires, ground fires, and crown fires (Budget U.G., 2005).

While the best method to reduce residents’ exposure to fire hazards is to place structures away from fire prone areas, there are mitigation strategies that have been developed to help protect communities and residences in some fire prone areas. Most of these strategies are based on reducing the ignition potential of structures by reducing potential fuels in designated zones surrounding structures (NFPA, 2013).

Wildfire data for the Uintah Basin was obtained from the Landfire National Dataset. The Fire Regime Groups (FRG) presented are intended to characterize the presumed historical fire regimes within specific landscapes based on the interactions between vegetation dynamics, fire behavior and spread, fire effects, and spatial context (Landfire, 2013)

Figure 16: Wildfire in in Central Utah (David Jolley 2007, used under the Creative Commons Attribution- ShareAlike 3.0 License)

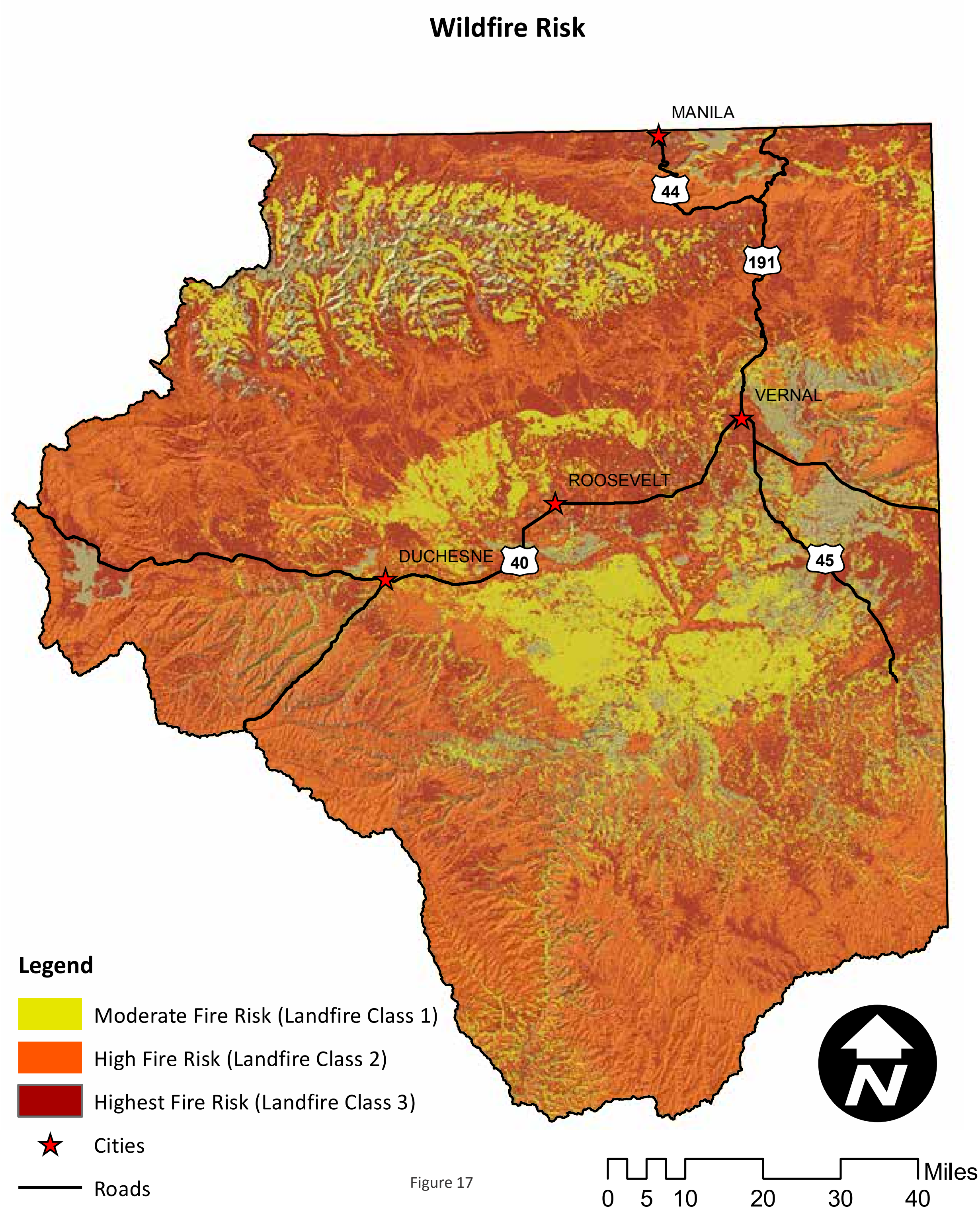

Wildfire Risk
MANILA
44
191
VERNAL
ROOSEVELT
DUCHESNE
40
45
Legend
Moderate Fire Risk (Landfire Class 1)
High Fire Risk (Landfire Class 2)
Highest Fire Risk (Landfire Class 3)
Cities
Roads
N
0 5 10 20 30 40
Miles

Figure 17

Culinary Water Protection

Drinking water supplies are a very fragile and important resource. Nearly 97% of the world's water is salty or undrinkable, and an additional 2% is locked away in ice caps and glaciers, leaving only 1% of the world's water as a potential drinking water source. There is no "new" water. Whether the source is a stream, river, lake, spring, or well, we are using the same water the dinosaurs used millions of years ago (EPA, 2009).

As development increases, there are more activities that potentially contaminate our drinking water. Improper disposal of chemicals, animal and human waste, waste injected underground, and even naturally occurring substances can contaminate culinary water supplies (EPA, 2009).

Common Sources of Pollution

Naturally Occurring: microorganisms (wildlife and soils), radionuclides (underlying rock), nitrates and nitrites (nitrogen compounds in the soil), heavy metals (underground rocks containing arsenic, cadmium, chromium, lead, and selenium), and fluoride (EPA, 2009).

Human Activities: bacteria and nitrates (human and animal waste), heavy metals (mining, construction, old orchards), fertilizers and pesticides (anywhere crops or lawns are maintained), industrial products and waste (local factories, industrial plants, gas stations, dry cleaners, underground storage tanks, and landfills), household waste (solvents, motor oil, paint), lead and copper (plumbing materials), water treatment chemicals (wastewater plants) (EPA, 2009).

The drinking water source data used for this model were provided by the Utah Division of Drinking Water Quality. While the data was incorporated into the health, safety, and welfare models, the Division of Drinking Water does consider this information sensitive, so it will not be published in this report. Information on drinking water sources and source protection zones can be obtained through a formal Government Records and Management Act (GRAMA) request to the Utah Division of Drinking Water.

The data used represent both ground and surface water sources. There are six different zones for groundwater sources and four different zones for surface water sources.

Groundwater

Drinking Water Source Protection (DWSP) zones are established protection zones for community water systems as well as for new water sources in transient, non-community systems such as campgrounds and recreational areas. The four zones are:

DWSP Zone 1: 100-foot radius from wellhead or margin of the spring collection area

DWSP Zone 2: 250-day groundwater travel time to wellhead or margin of spring collection areas, the boundary of the aquifer(s) which supplies water to the groundwater source, or the groundwater divide, whichever is closer.

DWSP Zone 3: 3 year groundwater time of travel

DWSP Zone 4: 15 year groundwater time of travel

Source Water Assessment Zones (SWAZ) are zones for existing water sources used for transient, non-community water systems such as campgrounds or highway rest stops. These zones have been delineated as part of the Source Water Assessment Program. The delineation of the protection zones assumes average aquifer characteristics and uses the local topography to estimate the groundwater flow direction. Local aquifer conditions and/or geology are not taken into consideration, but the Division of Drinking Water (DDW) considers the hydro-geologic values used to be conservative.

SWAZ Zone 2: Represents a 250-day groundwater time of travel

SWAZ Zone 4: Represents a 10-year groundwater time of travel

Surface Water

Surface Water Zone 1A: Streams, rivers, and canals

The area on both sides of the source, 1/2 mile from each side as measured from the high water mark and to 100 feet downstream from the point of diversion (POD) to 15 miles upstream, the limits of the watershed, or the state line – whichever comes first. If a natural stream or river is diverted into an uncovered canal or aqueduct to deliver water into a system or treatment facility, the entire canal is considered part of zone 1 and the 15-mile measurement upstream will apply to the stream or river that contributes water to the system.

Surface Water Zone 1B: Reservoirs or lakes

The area 1/2 mile from the high water mark of the source. Any stream or river contributing to the lake/reservoir for a distance of 15 miles upstream and a 1/2 mile buffer on both sides of the source. If the lake/reservoir is diverted into an open canal or aqueduct to deliver water to a system or treatment facility, the entire canal is considered part of zone 1 and the 15-mile measurement upstream will apply to the reservoir and tributaries contributing water to the system.

Surface Water Zone 2: The area from the end of zone 1 and an additional 50 miles upstream (or to the limits of the watershed or the state line, whichever comes first), and a 1,000 foot buffer on each side of the source.

Surface Water Zone 3: The area from the end of zone 2 to the limits of the watershed or to the state line, whichever comes first, and a 500-foot buffer on each side of the source.

Surface Water Zone 4: The remainder of the watershed (up to the state line) that contributes to the source but does not fall within the boundaries of zones 1 through 3.

The aforementioned protection zones have been aggregated into 3 tiers - as outlined in Table 1 below – to represent three potential levels of protection. Tier 1 is the least restrictive and includes only the most essential areas, while tier 3 offers the most extensive protection.

Groundwater Assessment - Source Water Protection		
Tier Levels	Components	Data source
Tier 1 - Essential Groundwater Protection	Drinking Water Source Protection Zone 1 Drinking Water Source Protection Zone 2 Source Water Assessment Zone 2 Surface Water Zone 1 (A & B) Surface Water Zone 2	Utah Department of Environmental Quality
Tier 2 - Essential and Moderate Protection	All Tier 1 Areas Drinking Water Source Protection Zone 3 Surface Water Zone 2	Utah Department of Environmental Quality
Tier 3 - Extensive Protection	All Tier 1 and 2 Areas Drinking Water Source Protection Zone 4 Source Water Assessment Zone 4 Surface Water Zone 3	Utah Department of Environmental Quality

Table 1: Groundwater Assessment Tiers

Culinary Water Protection

Due to the sensitive nature of water source data, we are not able to publish the location of water sources. This data can be obtained by submitting a GRAMA request to the Utah Division of Drinking Water.

Figure 18

Wetlands

Wetlands are a critical component of the landscape for many reasons. Federal, state, and local programs usually focus on wetland protection due to their ecological role. However, wetlands are also important for health, safety, and welfare because they are prone to natural hazards. Wetlands can be defined as transitional lands between terrestrial and aquatic systems where water is usually at or near the surface or land is covered by shallow water (Toth et al, 2006). Wetlands occur in many hydrologic conditions and perform valuable functions for humans by regulating the hydrologic cycle and improving water quality by filtering nutrients, sediment and contaminants before they reach aquatic systems (Toth et al., 2006).

Flooding and Erosion

Particularly in the Uintah Basin where flood mapping is not yet available for many areas, wetlands are an indicator of areas subject to flooding. Structures in wetlands can directly suffer damage and also increase hazards to other areas by blocking flood flows and increasing runoff (Kusler, 2009). Freshwater wetlands can affect both the depth and velocity of downstream flooding and erosion in several ways. They reduce water velocity by providing temporary floodwater storage and facilitating the conveyance of water from upstream to downstream points. They also reduce erosion by helping to trap sediment and bind the soil (Kusler, 2009).

Soil Instability

Wetland soils are often saturated and may have high organic content. Increased hydrostatic pressure in saturated soils can cause basements to crack or collapse. Soils with high organic content can compress if drained or buried and result in cracked foundations. In cold climates, secondary roads constructed over saturated soils may develop ice heaves (Kusler, 2009).

Subsidence

High organic content can cause subsidence when wetland soils are drained or exposed to air. Houses, roads, and fill materials in wetland areas can also compact other materials and cause them to sink or settle. Foundations crack and water enters (Kusler, 2009)

Earthquakes and Liquefaction

Soil liquefaction refers a phenomenon in which saturated or partially saturated soils substantially lose strength and stiffness in response to an applied stress - usually earthquake shaking - causing the soil to take on the characteristics of a liquid. Some wetland soils, particularly saturated soils in filled wetlands, experience liquefaction during earthquakes. This liquefaction greatly exacerbates damage to structures, roads, and pipelines. Even in non-saturated areas, soft soils and sediment in wetlands can amplify earthquake waves.

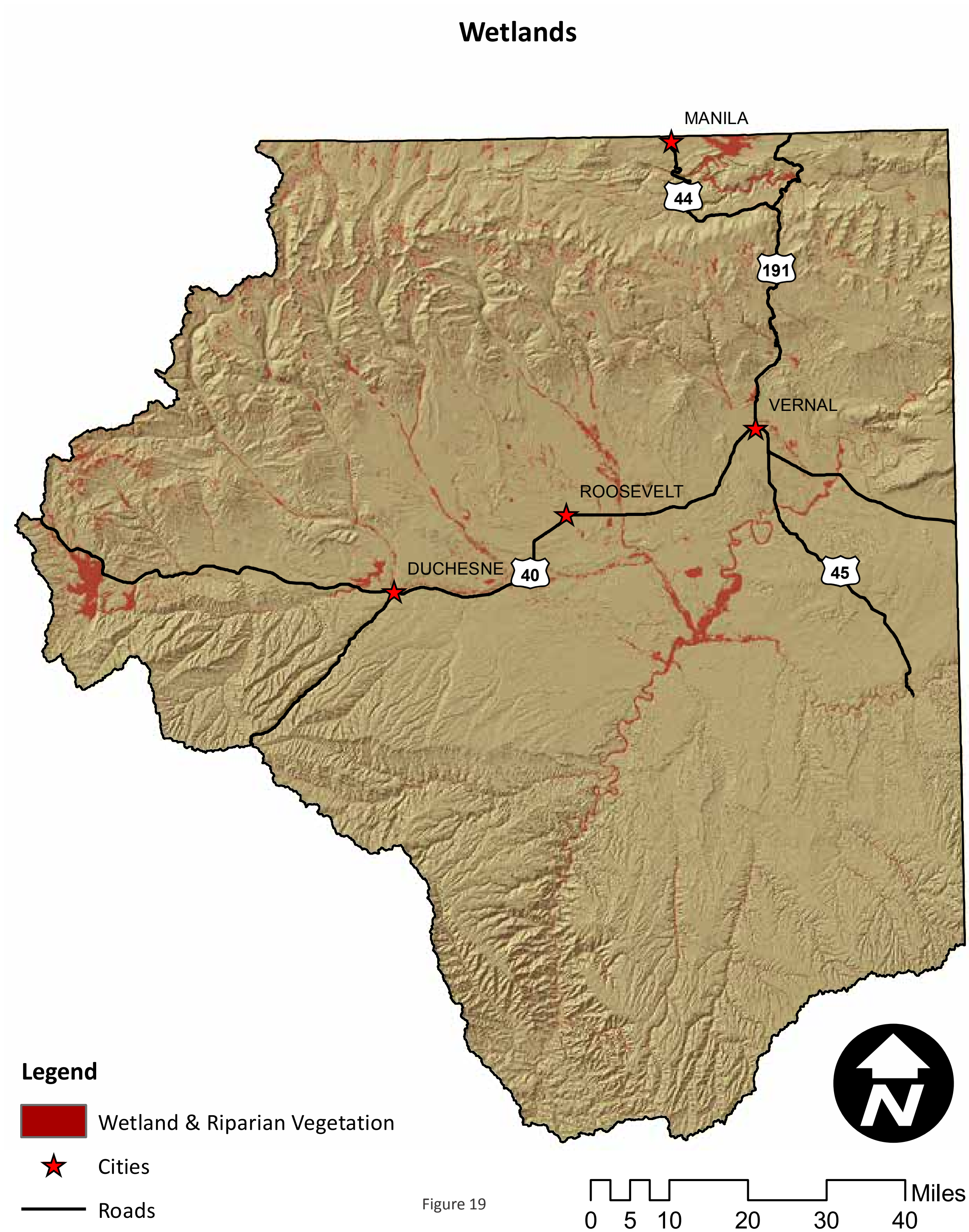

Wetlands
MANILA
44
191
VERNAL
ROOSEVELT
DUCHESNE
40
45
Legend
Wetland & Riparian Vegetation
Cities
Roads
N
0 5 10 20 30 40 Miles

Figure 19

Public Health, Safety, & Welfare Model

The public health, safety, and welfare model is a composite model that identifies areas of landscape that are critically important to the general welfare of people in the Uintah Basin study area. The purpose of this model is to provide stakeholders and decision-makers with information regarding areas that, if developed, could pose a threat to public health, safety, and welfare. As the population of the Uintah Basin continues to grow, development is occurring in or near many of these areas. Planners, developers, and residents alike should be made aware of the potential consequences of developing in these areas. Appropriate uses for these areas may include open space and recreational resources.

The criteria for this model are the same as those hazards mapped and presented individually in the preceding pages. They include landslide susceptibility, quaternary faults and folds, wildfire regimes, drinking water sources, and wetlands. One significant limitation is the lack of floodplain data for most of the study area.

The highest risk areas, shown in red, are where three or more of these hazards pose a risk to the health, safety, and welfare of the population. “High” risk areas are where 2 factors overlap, and “moderate” risk areas are those where at least one potential hazard is present.

In order to provide flexibility in the range of choices available to planners and officials, three tiers of this model were developed by using different thresholds for individual hazards. The criteria used for each tier are listed above the legend of each model presented. The tier 1 model represents only the most critical areas and is, therefore, the least restrictive to development but presents a higher level of risk to public health, safety, and welfare. The tier 2 model represents a balance. The tier 3 model is the most restrictive to development but best illustrates the relative risk to public health, safety, and welfare for the land throughout the Uintah Basin.

It is important to note that the hazards mapped in this study are not exclusive and that other potential hazards may be present. This model is simply a spatial representation of risk based on the best available data we found for the study area. Additionally, this model is intended for use at the regional level and is not meant to determine the suitability of any particular site for any particular use. Moderate risk can be very significant, and more detailed analysis should be conducted at the site and project scale before any development is approved.

Health, Safety & Welfare - Tier 1

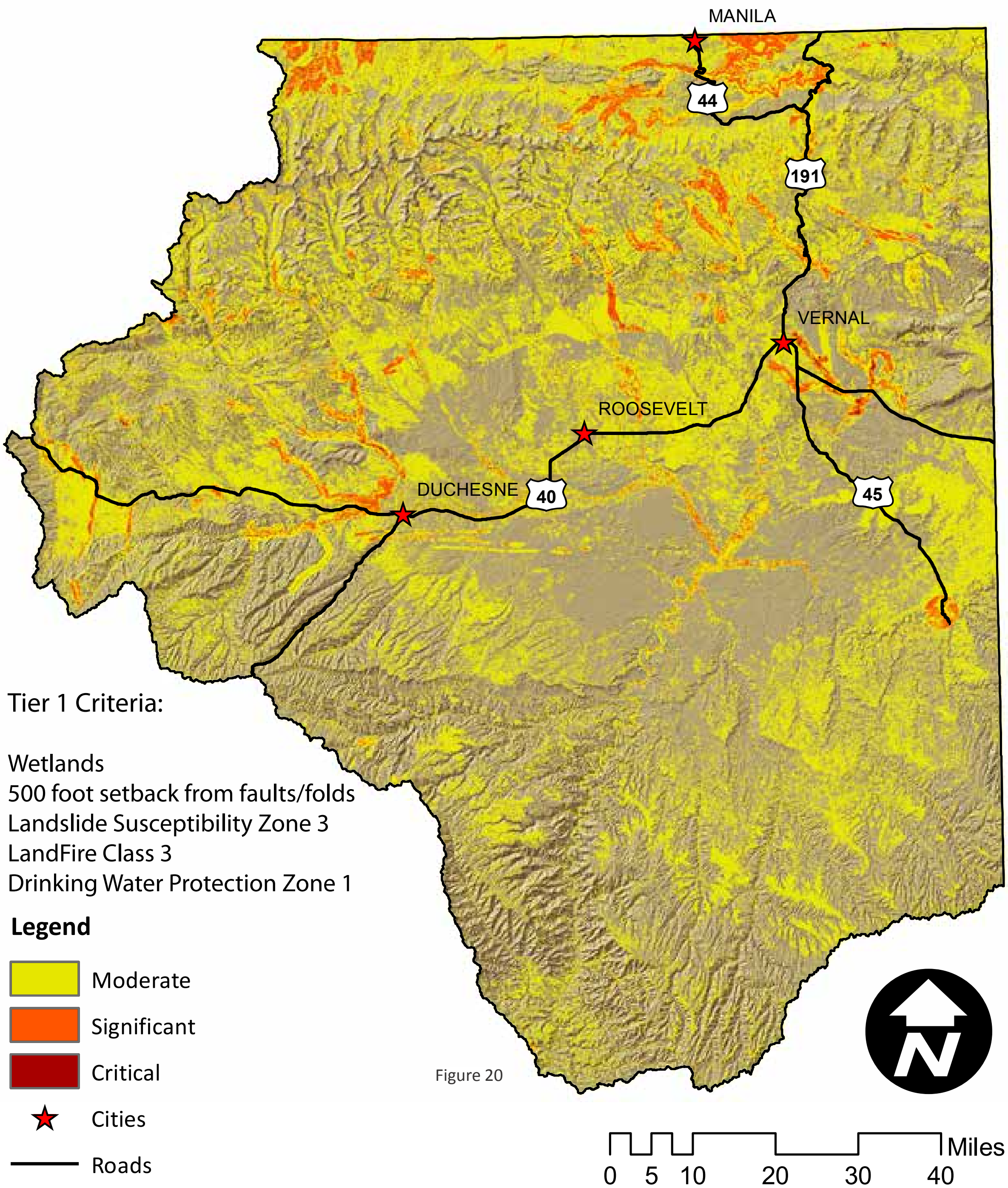


Figure 20

Health, Safety & Welfare - Tier 2

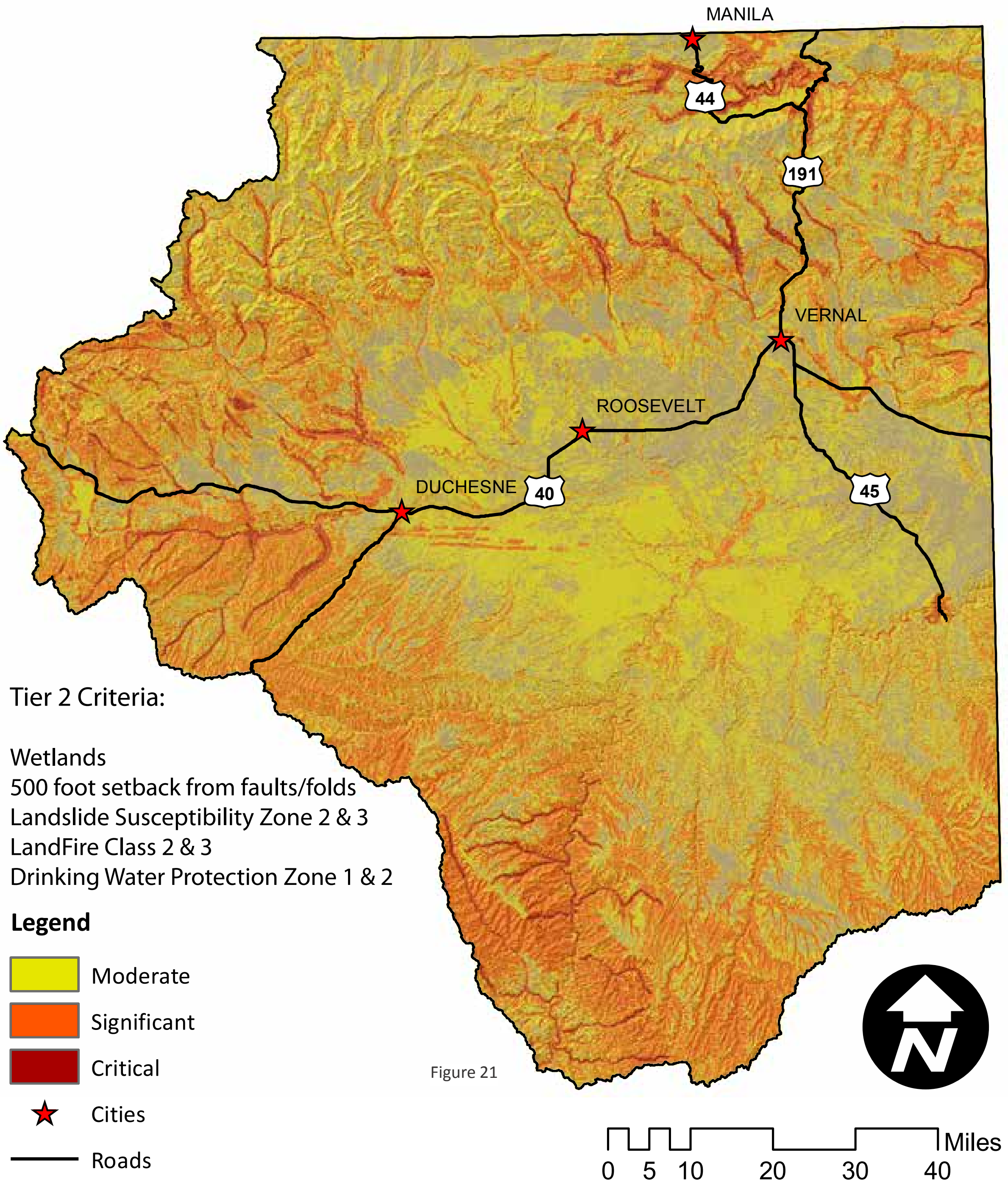


Figure 21

Health, Safety & Welfare - Tier 3

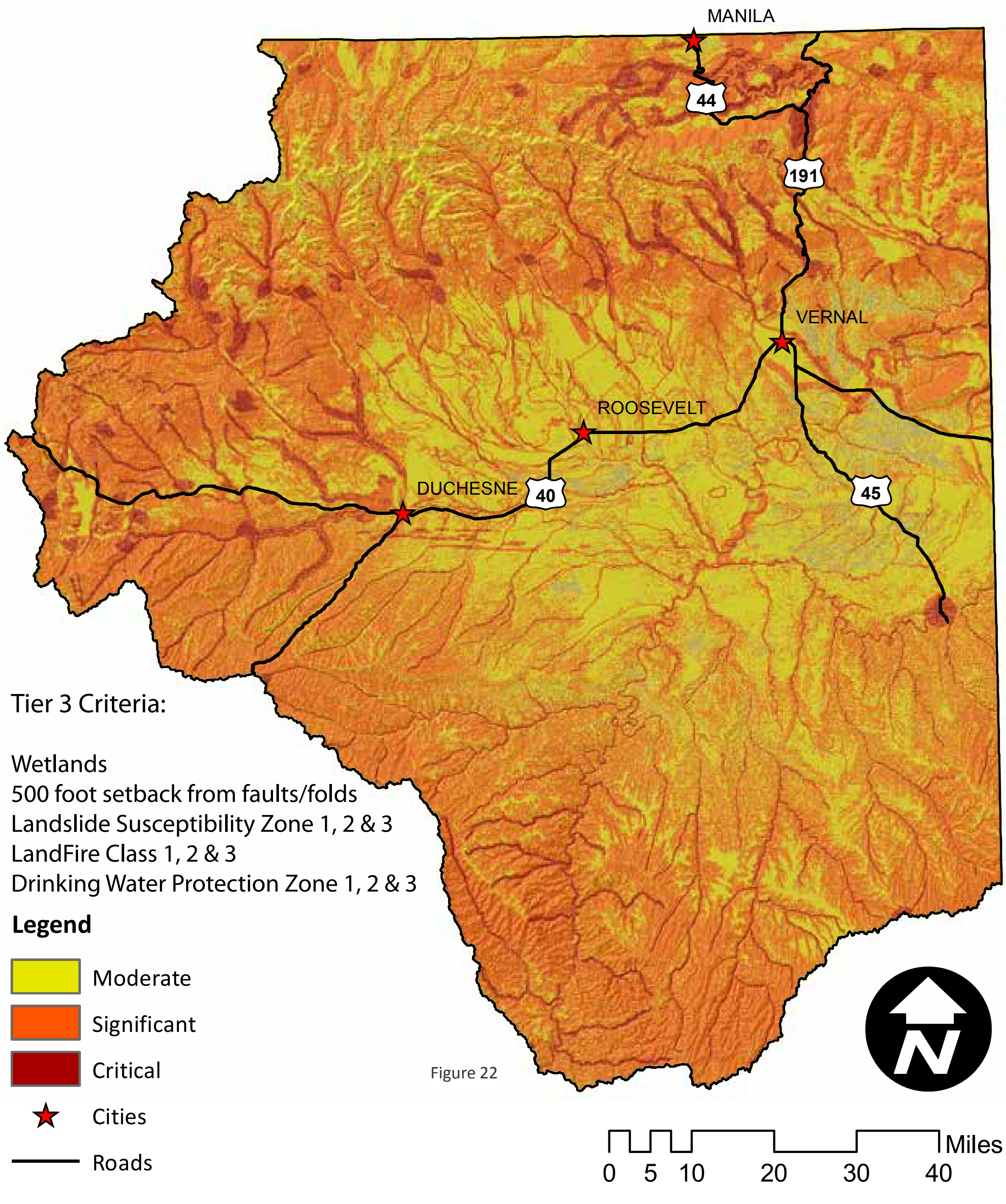


Figure 22

The assessment models in this section represent areas of important habitat criteria for various species of wildlife, agricultural lands, and wetland areas in the Uintah Basin. These are areas that stakeholders may want to consider protecting through the creation of conservation plans. The final composite model at the end this section represents particularly rich areas of potential habitat – those supporting a high diversity of species – where conservation efforts may have the biggest impact.

Wildlife

The variety of ecosystems across the Uintah Basin study area creates a rich diversity of habitat for various wildlife and aquatic species. The protection of wildlife habitat improves the functionality of ecosystems that contribute both aesthetic and amenity values to the region. In addition to maintaining critical ecosystems, wildlife often boosts recreational activities such as hunting, fishing, wildlife-watching, and hiking (Budget, U.G., 2005). Outdoor recreation is a significant factor in the quality of life and economy of the Uintah Basin in the future.

In 2000, Bill Riebsame, from the University of Colorado, presented "Life in the New West: Human and Wild." During that presentation, Riebsame said the American West was "experiencing rapid demographic, economic, and cultural change," and was growing faster than any other region in the United States. Most of the growth is occurring in what he called "exburbs," or non-metropolitan areas next to larger towns or cities. Exburbs have about one house per 10-40 acres and will likely be the areas creating the highest negative impact to wildlife habitat and management in the future. (UDWR, 2013; Travis, 2007).

Three wildlife habitat models are presented to represent federally designated threatened and endangered species, other major wildlife species, and sage grouse habitat separately before integrating them into the composite conservation model.

Threatened and Endangered Species

Spatial data for habitat supporting various designated threatened, endangered, and sensitive species was obtained through the Utah Fish and Wildlife Service. Due to the sensitivity of this information, data is only available at the township level and appears as a very coarse block pattern. However, the data does establish a pattern of the relative concentration of threatened and endangered species throughout the Uintah Basin. Areas are classified as being of high, medium, or low concentration based on the diversity of threatened and endangered species present.

Threatened & Endangered Species

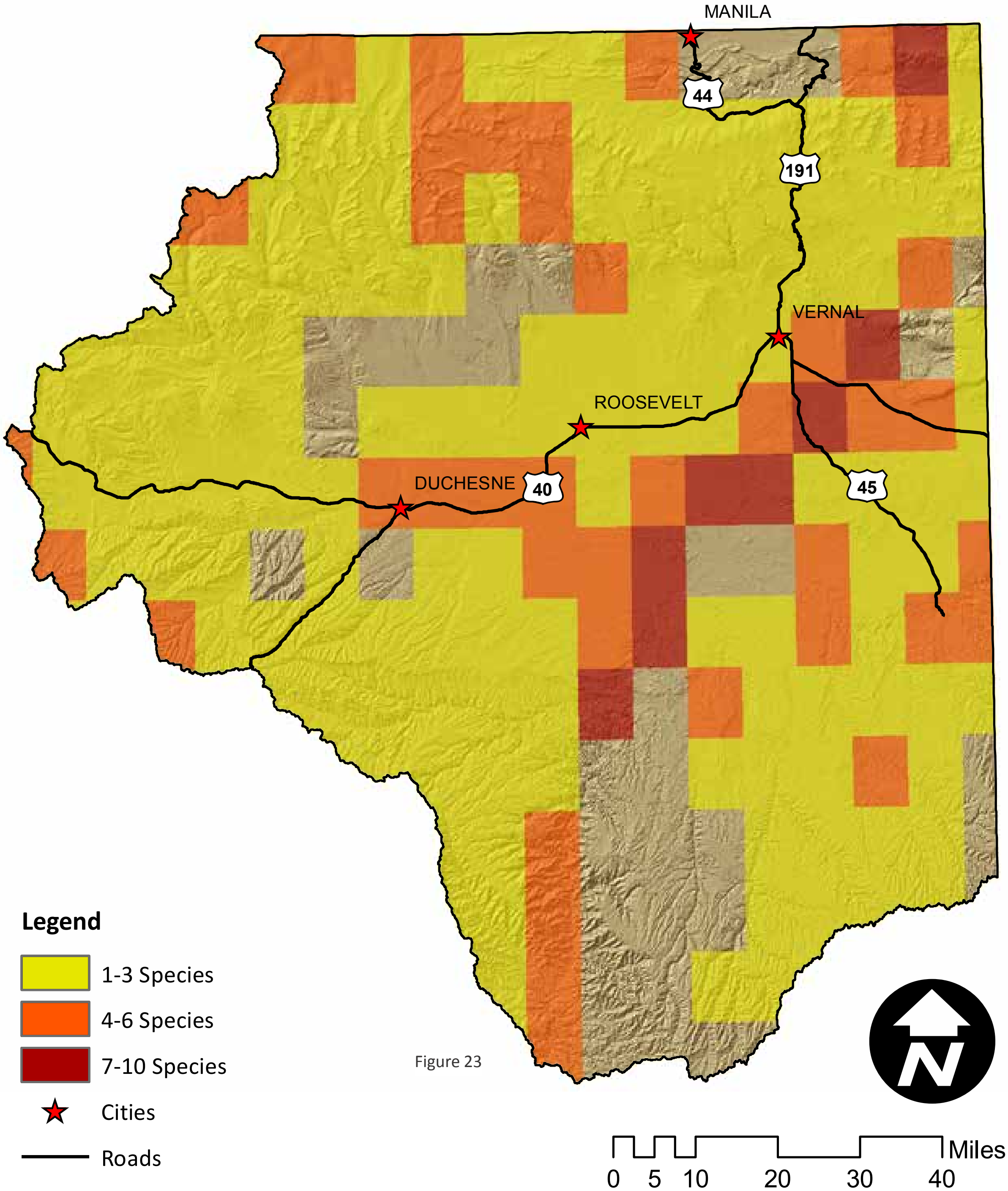


Figure 23

Major Wildlife Habitat

In addition to threatened and endangered species, there are a number of other important wildlife species present in the Uintah Basin. Spatial Data representing important habitat areas for fourteen different species was gathered from the Utah Fish and Wildlife Service. Many of the species listed below are both important components of the ecosystem as well as species that are important for the recreational value they provide to the region in terms of hunting and wildlife watching.

The habitat areas were first modeled separately and then aggregated to represent areas that support a wide variety of important species throughout the study area. To be consistent with the classification of Threatened and Endangered Species occurrence, major wildlife habitat areas were classified as being of high, medium, or low species richness based on the diversity of species they support.

The major wildlife species used for this assessment were:

- Black Bear (Figure 24)
- Blue Grouse
- California Quail
- Chukar (Figure 25)
- Moose
- Mountain Goat
- Mule Deer (Figure 26)
- Pronghorn
- Rocky Mountain Bighorn
- Rocky Mountain Elk
- Ruffed Grouse
- Snowshoe Hare
- White Tailed Ptarmigan
- Wild Turkey

Figure 24 : Black Bear. Source: Greg Hume, Wikipedia Commons.

Figure 25 : Chukar partridge. Source: mdf, Wikipedia Commons.

Figure 26 : Mule deer. Source: Yanthin S. Krishnappa, Wikipedia Commons.

Major Wildlife Habitat

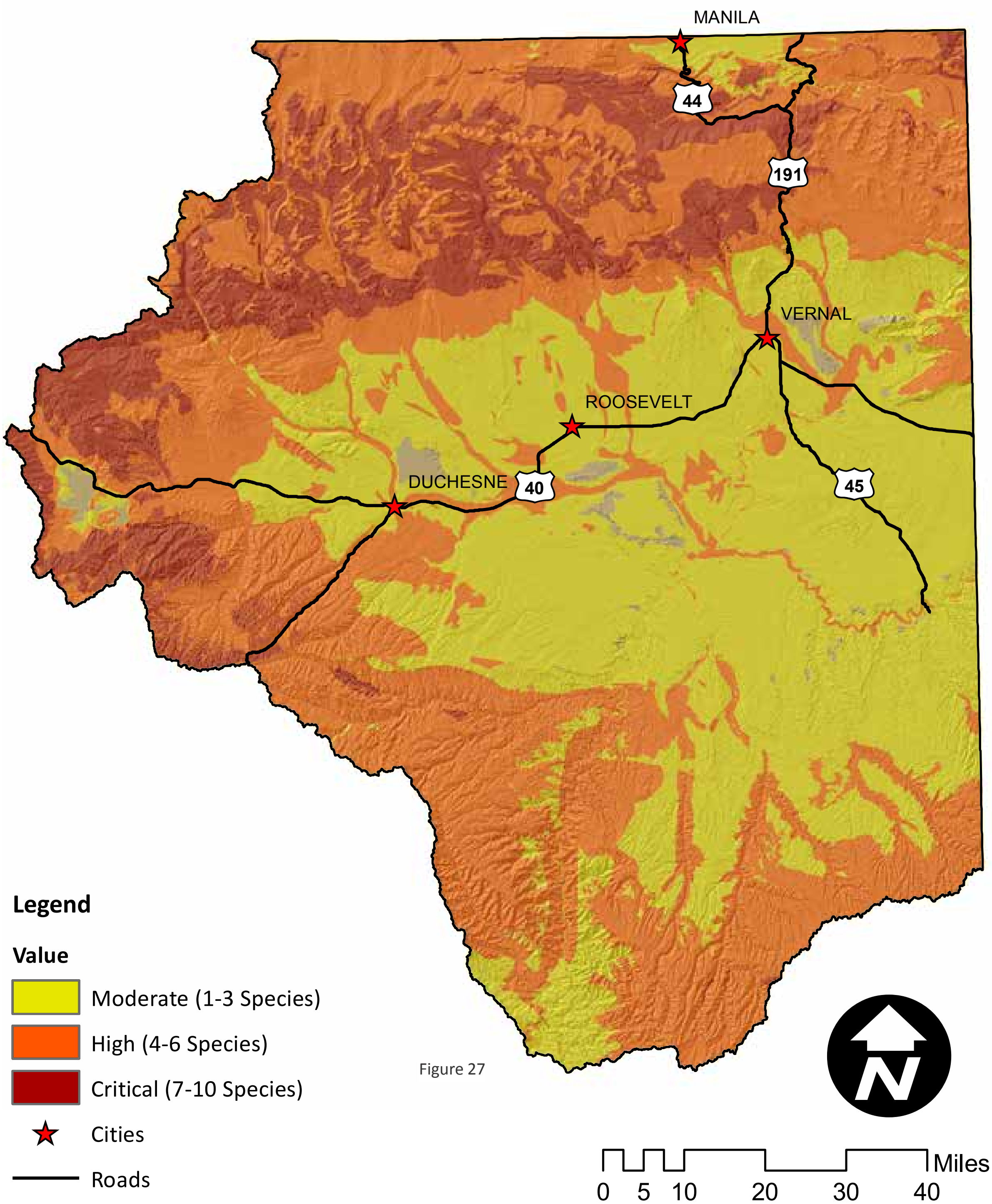


Figure 27

Sage Grouse

Issues surrounding the protection and potential listing of the Greater Sage Grouse as a federally endangered species have been controversial throughout the intermountain west and, likewise, in the Uintah Basin. The most recent assessment by the U.S. Fish and Wildlife Service (FWS) in March of 2010 found that the listing of the greater sage grouse was warranted on a range-wide basis, but that further action was precluded by higher ESA priorities of the FWS. The FWS is bound by a court decree to review the decision by the end of 2015 (UDWR, 2013).

In response to concerns regarding the greater sage grouse, the state of Utah created a working group on sage grouse to develop Utah's Conservation Plan for Greater Sage Grouse. "This plan is designed to protect high-quality habitat, enhance impaired habitat and restore converted habitat to support, in Utah, a portion of the range-wide population of greater sage-grouse (*Centrocercus urophasianus*) necessary to eliminate threats to the species and negate the need for the listing of the species under the provisions of the federal Endangered Species Act (ESA)" (UDWR, 2013).

Due to the heightened concerns surrounding greater sage grouse and the impact that such a listing could have on the economic development and growth in the Uintah Basin Study Area, the species has been given increased importance in the modeling for this study. Essentially, by isolating sage grouse habitat as a separate input to the integrated wildlife model, the species is given as much importance as both the occurrence of other major wildlife species as well as currently designated threatened and endangered species.

The spatial data for mapping important sage grouse habitat represents the same areas identified in the *Utah Sage Grouse Management Plan* and was provided by Professor Terry Messmer. The sage grouse management areas included in the mapping do not represent all sage grouse habitat but are targeted toward "the best opportunity for focused conservation efforts for the species" (UDWR, 2013).

Figure 28: Greater Sage Grouse. Source: Pacific Southwest Region U.S. Fish and Wildlife Service, Wikipedia Commons.

Sage Grouse Management Areas

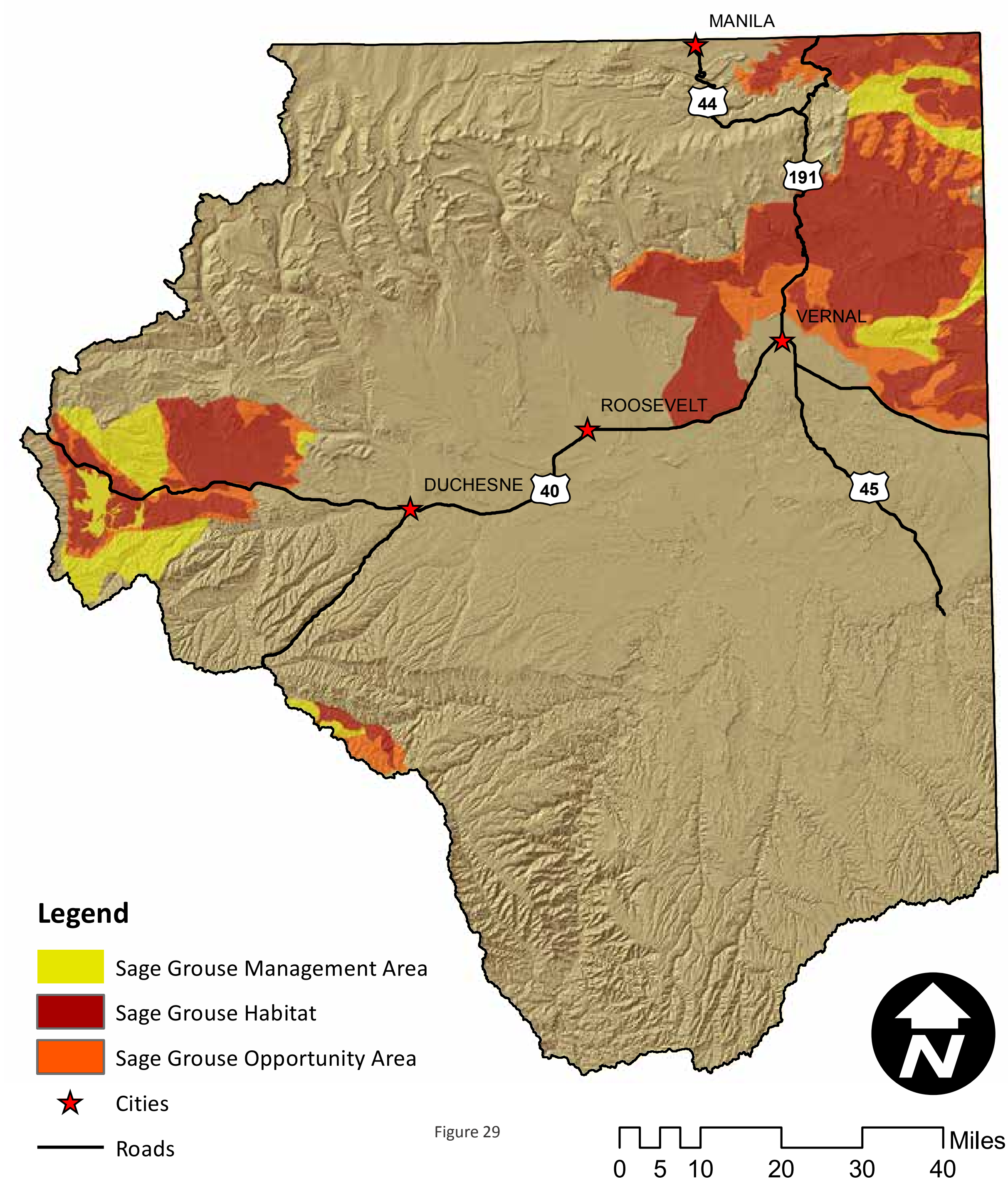


Figure 29

Agriculture

Historically, agriculture has been an important component of human settlement and expansion in the Uintah Basin. In addition to food and livestock forage, agricultural lands provide a host of other benefits to the region. These lands are valuable open space resources that enhance aesthetic views, provide wildlife habitat and migration corridors, and are a key element of the historical and cultural history and identity of the region (see Figure 30). As growth and development increase throughout the state of Utah and especially in the Uintah Basin, significant acreages of agricultural lands are being lost to encroaching commercial and residential development.

While agricultural lands generate less revenue per acre than residential or commercial land uses, they require very few public resources and little infrastructure, making them net generators of public revenues. A recent study by the American Farmland Trust showed that in every community included, working lands provided a fiscal surplus to the community. On the other hand, residential development is nearly always a net loser, costing the public more funds than it generates back into the budget (Farmland Information Center, 2007). Moreover, this effect is amplified by the low density residential development characteristic of the recent development in the intermountain west (Travis, 2007) and much of the new development in the Uintah Basin. It is not just inevitable population growth, but wasteful land use and planning that are putting agricultural lands at risk. From 1982 to 2007, the U.S. population grew by 30 percent. During the same time period, developed land increased 57 percent (American Farmland Trust, 2013).

The agricultural lands assessment model is based on data from the water-related land use database. The categories utilized include irrigated agricultural lands, non-irrigated agricultural lands, and sub-irrigated agricultural lands.

Figure 30: Agricultural lands along the Green River. Source: Tyler Allen

Agricultural Lands

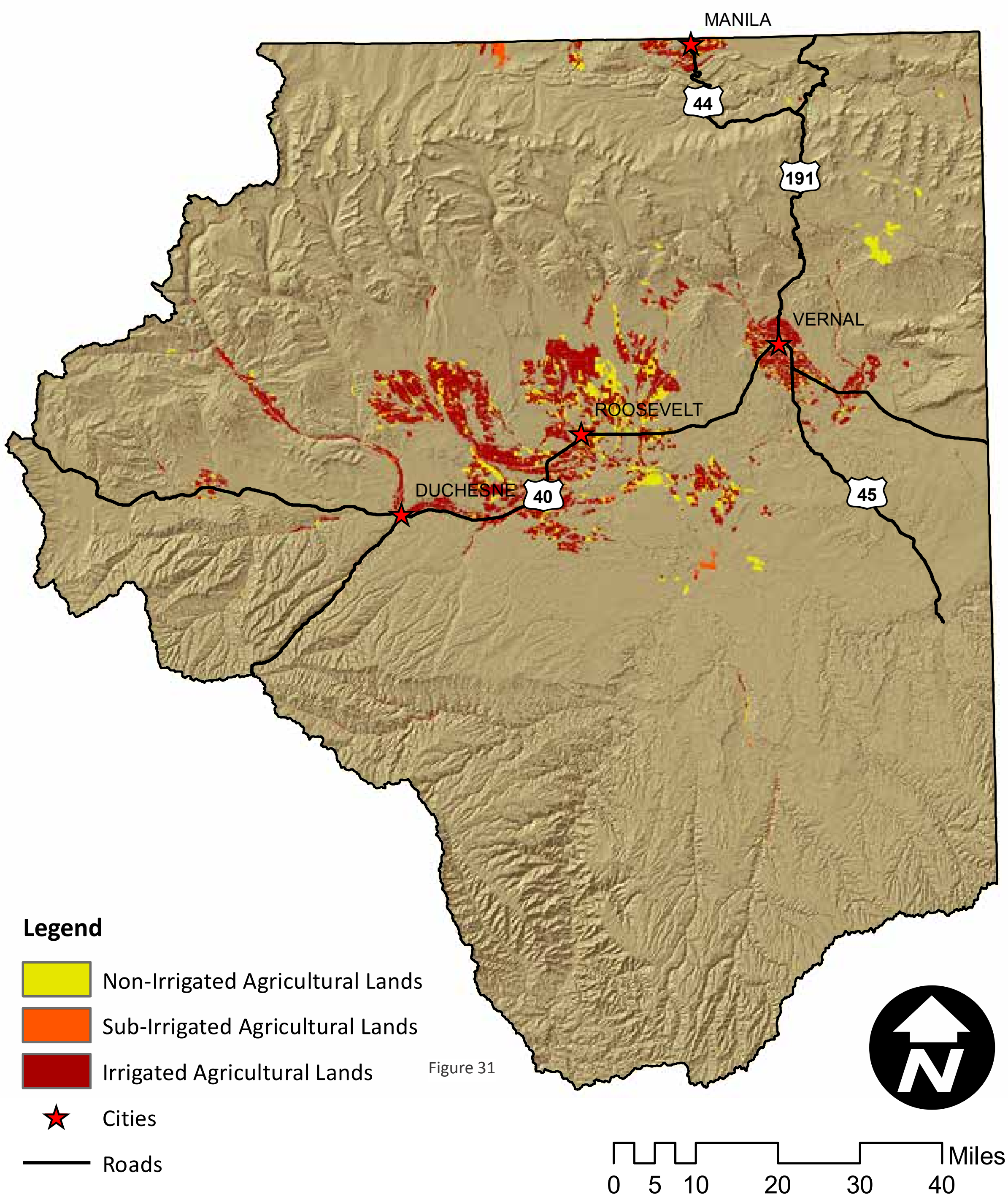


Figure 31

Surface Water & Wetland/Riparian Vegetation

Surface water in the Uintah Basin is, spatially, a small component of the landscape, but it is a critical resource for the overall quality of life throughout the region. It supports agricultural activities in the form of irrigation and enables residential, commercial, and industrial development as well as provides critical wildlife habitat and an abundance of recreational opportunities. It is also an important aesthetic feature in many areas that contributes to the sense of identity within the region. Without careful planning and adequate protection, these resources are at danger of impairment due to the degradation of both water quality and quantity.

Relevant features employed in the surface water assessment model include tributaries, streams, rivers, ponds, lakes, and reservoirs. Wetland and riparian vegetation has also been included because of the important function of these areas to filter and remove the sediment and pollutants that threaten the quality of the resource.

Figure 32: Canadian geese along the Green River.
Source: Tyler Allen

Figure 33: Waterfowl at Ouray National Wildlife Refuge.
Source: Michael Gottfredson

Figure 34: Example of wetlands, Ouray National Wildlife
Source: Matt Coombs

Figure 35: Steineker Reservoir, Uintah County.
Source: Matt Coombs

Wetland & Riparian Vegetation

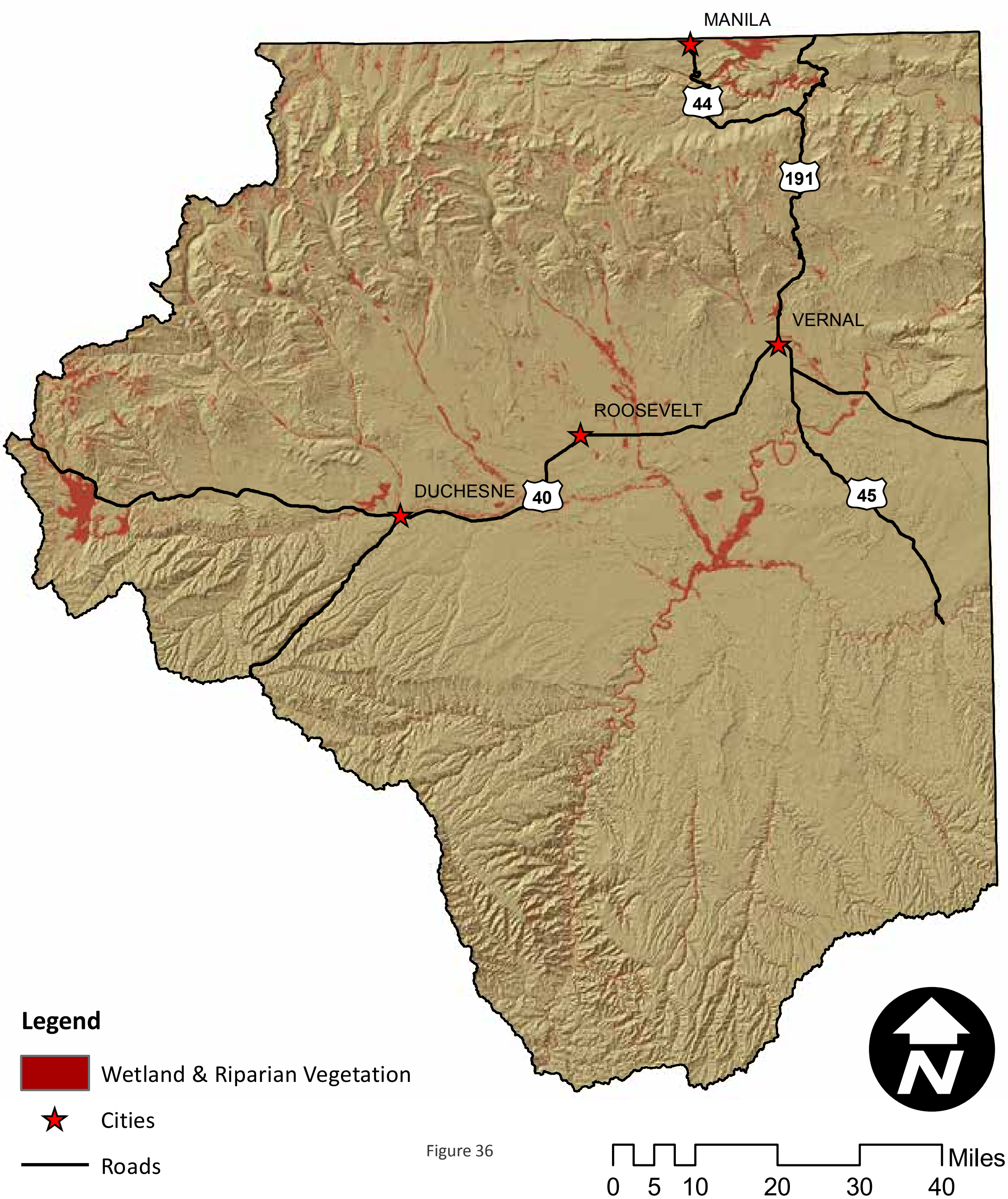


Figure 36

Composite Conservation Model

The final conservation model was created by aggregating the wildlife habitat, agriculture, and surface water models into a single spatial representation of areas that may be considered in future conservation decisions. Three classifications are provided based on the overlap of the three different conservation values. Areas in yellow are of moderate importance, areas in orange have significant importance, and the dark red areas are the most critical areas for conservation in the study area.

Figure 37: Valley near Deep Creek, Uintah County. Source: Michael Gottfredson

Figure 38: Red Fleet Buttes in Winter, along the State Highway 191 corridor. Source: Matt Coombs

Composite Conservation Model

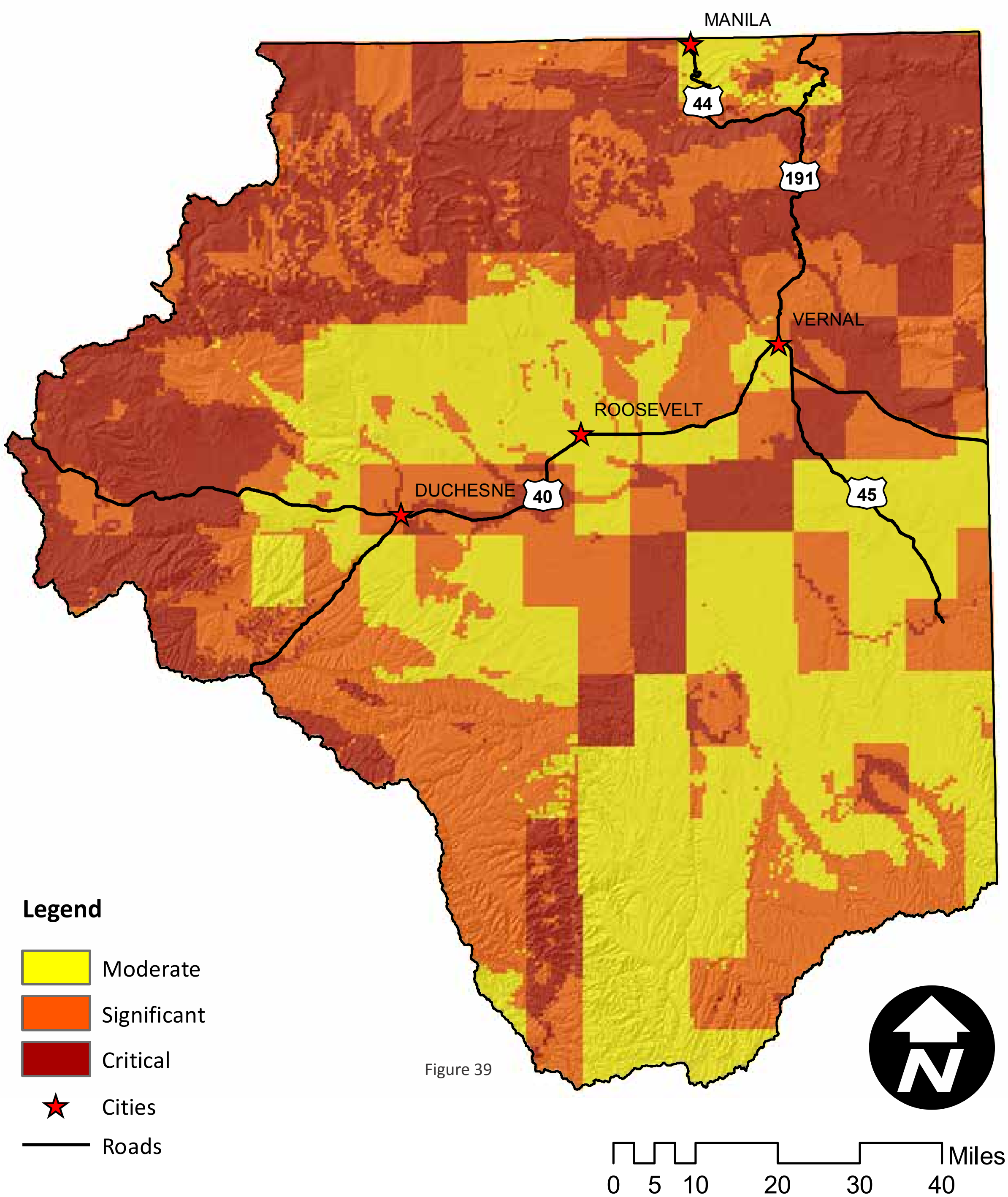


Figure 39

Regional Identity Overview

The term regional identity has been defined in various ways by different disciplines and professions. For the purposes of this study, regional identity refers to the collective attributes of a region that make it stand out as unique in the minds of the people who inhabit and experience it. These attributes can include natural phenomena such as landforms, wildlife, and water bodies. They can also include historical and cultural attributes such as settlement patterns, agricultural landscapes, recreational resources, or the economic context of the region.

While regional identity is relational by nature and impressions of a region vary based upon the people who experience it (Cross, 2001), there are general attributes that are broadly accepted as having a strong influence as defining factors that affect regional identity. One stated priority of the Uintah County General Plan is to maintain and enforce land use ordinances that complement the county's rural lifestyle and local character. The purpose of this assessment model is to provide a spatial representation of key attributes that contribute to the sense of place or identity of the Uintah Basin. By understanding where these features occur in the landscape, planners and decision-makers will be able to better evaluate how new development or other types of projects may impact the regional identity of the Uintah Basin.

The attributes identified for this study, presented and mapped on the following pages, include cultural resources such as agricultural lands and historic sites, recreational opportunities, wildlife, vegetation, water bodies and natural areas. In addition to mapping these features, two view-shed analyses were developed and are presented to illustrate highly visible areas of the basin and are ultimately combined with the Bureau of Land Management's assessment of visual quality on lands they currently administer.

Figure 40: Winter in Ashley National Forest, along State Highway 191. Source: Michael Gottfredson

Figure 41: Exhibit at the Quarry Exhibit Hall, Dinosaur National Monument. Source: Michael Gottfredson

Figure 42: Native American petroglyphs at the Sadie McConkie Ranch. Source: Michael Gottfredson

Cultural Resources

The cultural resources assessment model includes three primary components: urban cores, historic sites, and agricultural lands. While this is certainly not an exhaustive list of cultural attributes in the Uintah Basin, it does represent some of the key features for which reliable data exists.

Urban Cores

Cities and incorporated towns represent important nodes within the network of human settlement and activity of the Uintah Basin. These areas are where most of the commerce, public gatherings, and events take place. Consequently, they are also where most social and cultural interaction occurs.

Historic Sites

Places of historical importance in the Uintah Basin were derived from data based on the National Register of Historic Places. These sites include districts, sites, buildings, structures, and objects significant in American history, architecture, archeology, engineering, and culture. National Register properties have significance to the history of their community, state, or the nation (NRHP, 2013). Figures 43 and 44 are examples of historic sites from the National Register.

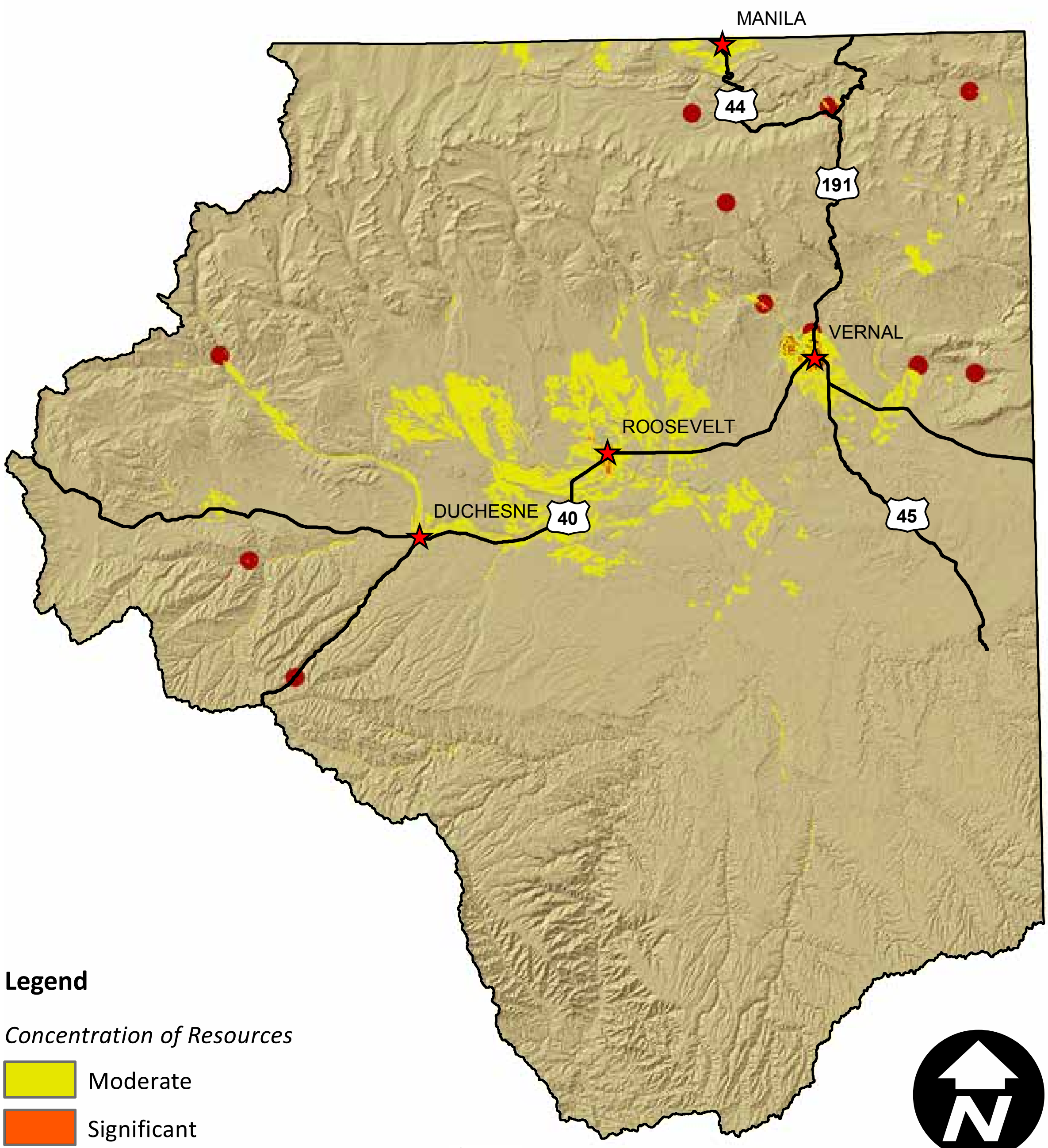
Agricultural Lands

The Uintah Basin, like many areas of the west, has a strong history related to agricultural and livestock industries that have made significant impressions on the landscape. The agrarian character of some areas in the Uintah Basin represents this history and adds to its aesthetic appeal. Residents of the Uintah Basin have identified agriculture as an important attribute of the Uintah Basin landscape (Uintah County, 2011).

Figure 43: The Bank of Vernal Building.
Source: Ntsimp, Wikipedia Commons.

Figure 44: The Quarry Exhibit Hall.
Source: www.nps.gov/archive/gosp/tour/dinosaur.jpg, Wikipedia Commons.

Cultural Resources



Legend

Concentration of Resources

- Moderate
- Significant
- Historic Places
- Cities
- Roads

Figure 45

Miles
0 5 10 20 30 40

Natural Areas

Natural landscapes perform several valuable ecological functions that benefit humans. They are also a key component of the regional identity for many areas, such as the Uintah Basin, where features such as mountain ranges, plateaus, rivers, and lakes are prominent in the landscape. The natural landscape of the Uintah Basin has been identified by decision-makers as an important feature to protect, preserve, and manage.

Most of the natural areas in the Uintah Basin are managed by public state or federal agencies and given different designations accordingly. The lands included in this model are provided in the list below along with the agency responsible for their administration.

National Park Service:	Dinosaur National Park
U.S. Forest Service:	Ashley National Forest (see Figure 46) Wasatch Cache National Forest Uinta National Forest High Uinta Wilderness Area Flaming Gorge National Recreation Area
U.S. Fish and Wildlife Service:	Ouray National Wildlife Refuge
Bureau of Land Management:	Areas of Critical Environmental Concern Wilderness Study Areas
UT Dept. of Natural Resources:	State Wildlife Reserves State Wildlife Management Areas

Figure 46: Ashley National Forest. Source: Tyler Allen

Natural Areas

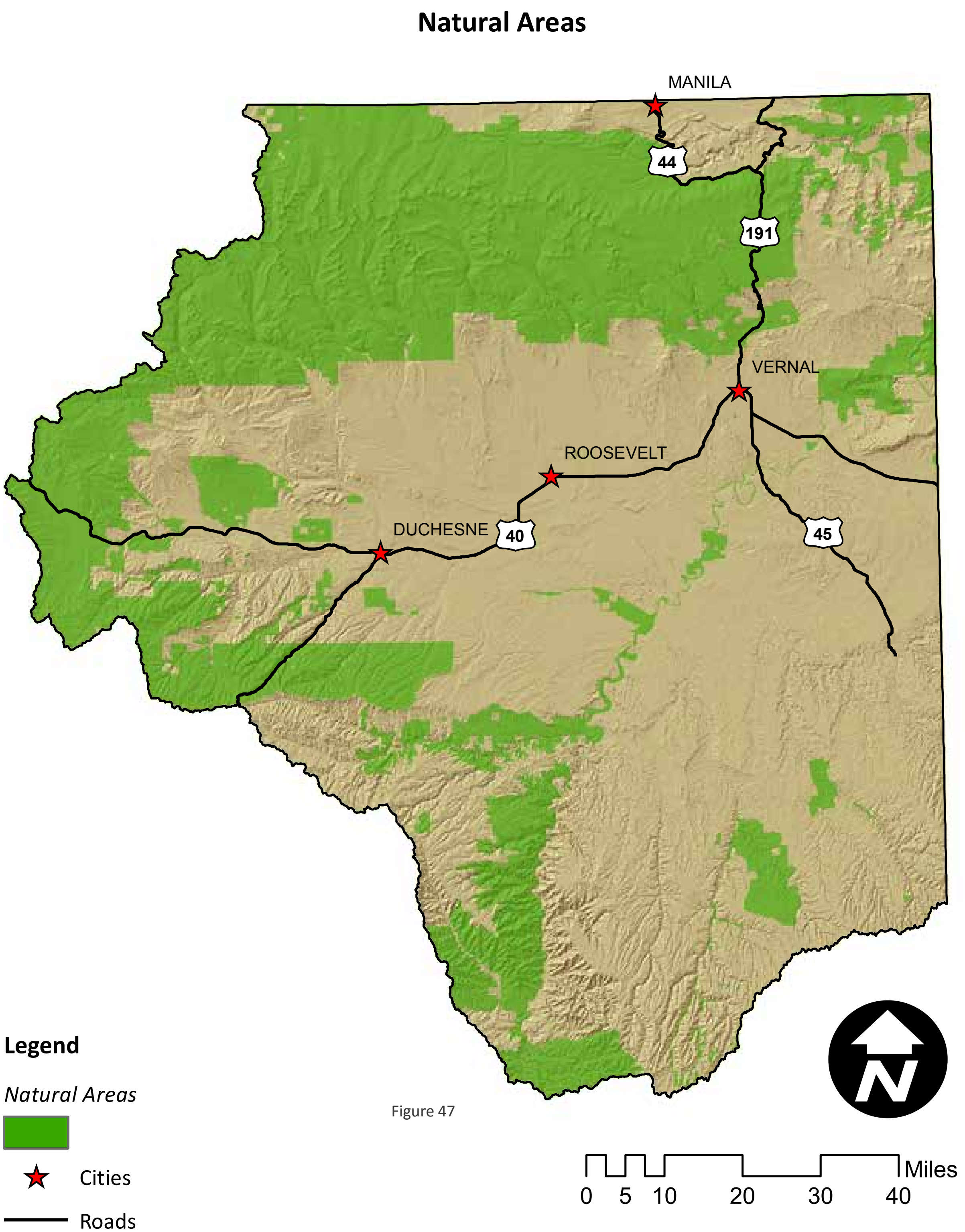


Figure 47

Public Recreational Resources

Outdoor recreation facilitates a strong relationship between people and the features of the surrounding landscape. Recreational opportunities were identified by local stakeholders as an important part of the quality of life in the Uintah Basin and a resource that should be protected and enhanced as more people are visiting and moving into the region. There are abundant opportunities for outdoor recreation on public lands in the Uintah Basin Study Area. The purpose of this model is to represent, spatially, where many of these opportunities exist. This information is meant to facilitate the preservation of the resources that support those activities as well as help to identify areas where further opportunities may exist.

The areas included in this model were:

Forest Service Trails
Forest Service Recreation Sites
Major Peaks
Destination Resorts
State Parks
BLM Special Recreation Management Areas
Public Campgrounds (USFS and BLM)
Off Highway Vehicle Areas (BLM)
Biking Trails (BLM)
City and Local Parks
Golf Courses
Boating Facilities
Sports Parks
Fairgrounds

Recreation Resources

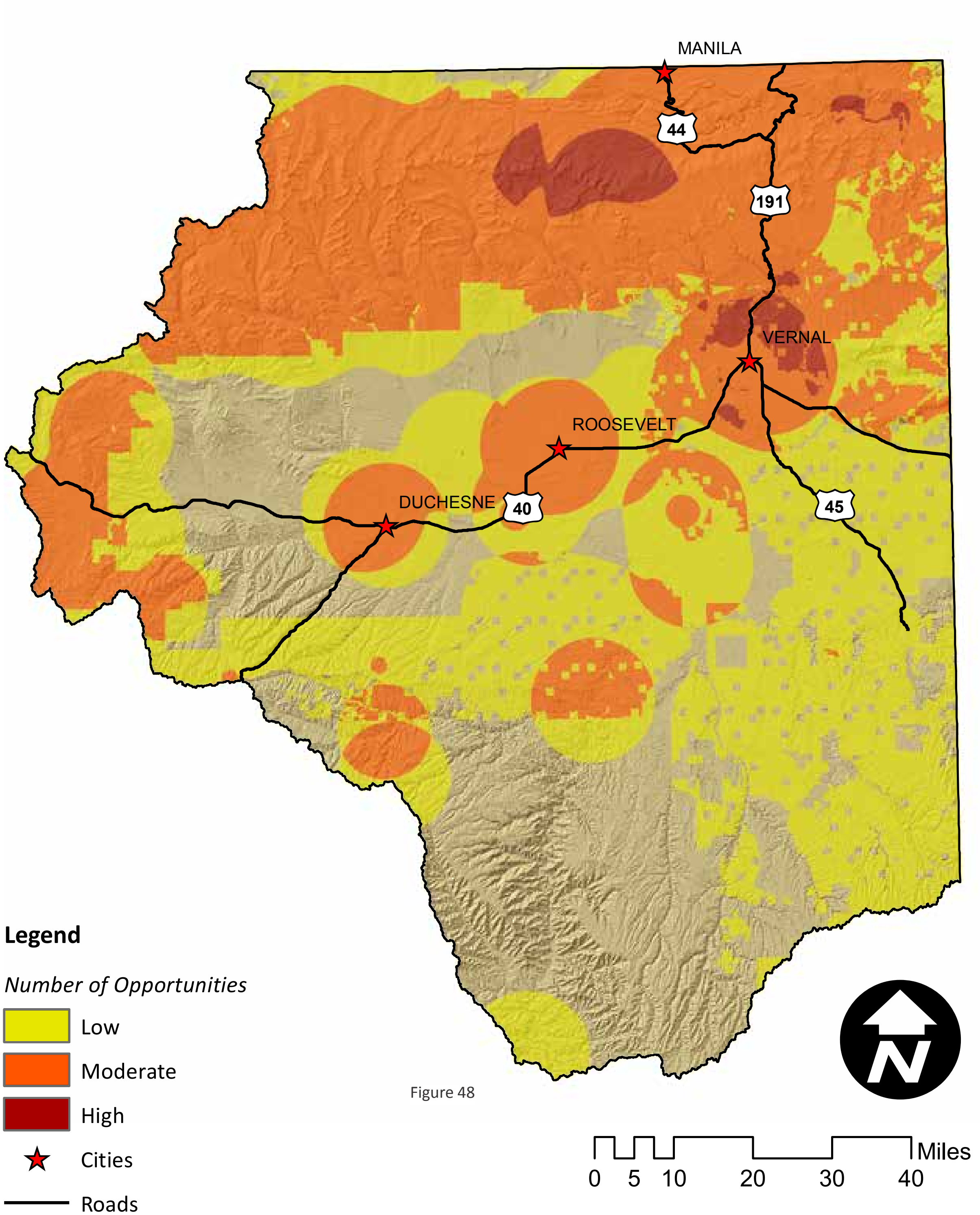


Figure 48

Surface Water and Riparian Areas

Surface water and riparian areas are not only important for their ecological functions and value to public water supplies, they are also important factors in the identity of a region. Particularly in more arid regions of the country, water bodies and riparian areas stand out in contrast to the surrounding landscape. People are naturally attracted to water for a variety of reasons including recreation opportunities and even more spiritual aspects such as the calming influence of still water or the sense of connectivity provided by flowing streams throughout the landscape (Litton & Tetlow, 1974). Evidence of this attraction is illustrated by the consistently higher value of property adjacent or in close proximity to water resources throughout the country (EPA, 2010).

In addition to recreation and economic values of water, the aesthetic value of water contributes to the identity and quality of life of a bioregion. Litton categorizes the aesthetic value of water by its unity, variety, and vividness.

Unity: This category is defined as that concern and expression whereby parts are joined together into a coherent and single harmonious unit. (Litton & Tetlow, 1974). This means that elements such as movement, substance, reflectiveness, and color all add to the unity that water can bring to a bioregion.

Variety: This category is represented by richness or diversity, and is linked to the ecological factors of water as well as the aesthetic (Litton & Tetlow, 1974). Variety represents a paradox when considered with unity. For example, the elements of movement, substance, reflectiveness, color, and even stream course alignments, can all be unique and rich when considered across a bioregion, even though it is a unifying factor as well (Litton & Tetlow, 1974).

Vividness: Vividness is the quality "which gives distinction or produces a strong visual impression (Litton & Tetlow, 1974). Making use of variety, vividness grows out of the combining together of different things, such as contrast and similarity. The presence of vividness may often indicate the presence of features, whether of water, landform, or trees. (pg. 112)

The model on the following page represents major surface water resources including lakes, reservoirs, ponds, major rivers, wetlands, and riparian areas in the Uintah Basin. Small tributaries and seasonal streams were excluded from this model, but they may be important attributes to consider when working at a smaller scale to preserve or enhance the sense of place and identity in smaller areas of landscape.

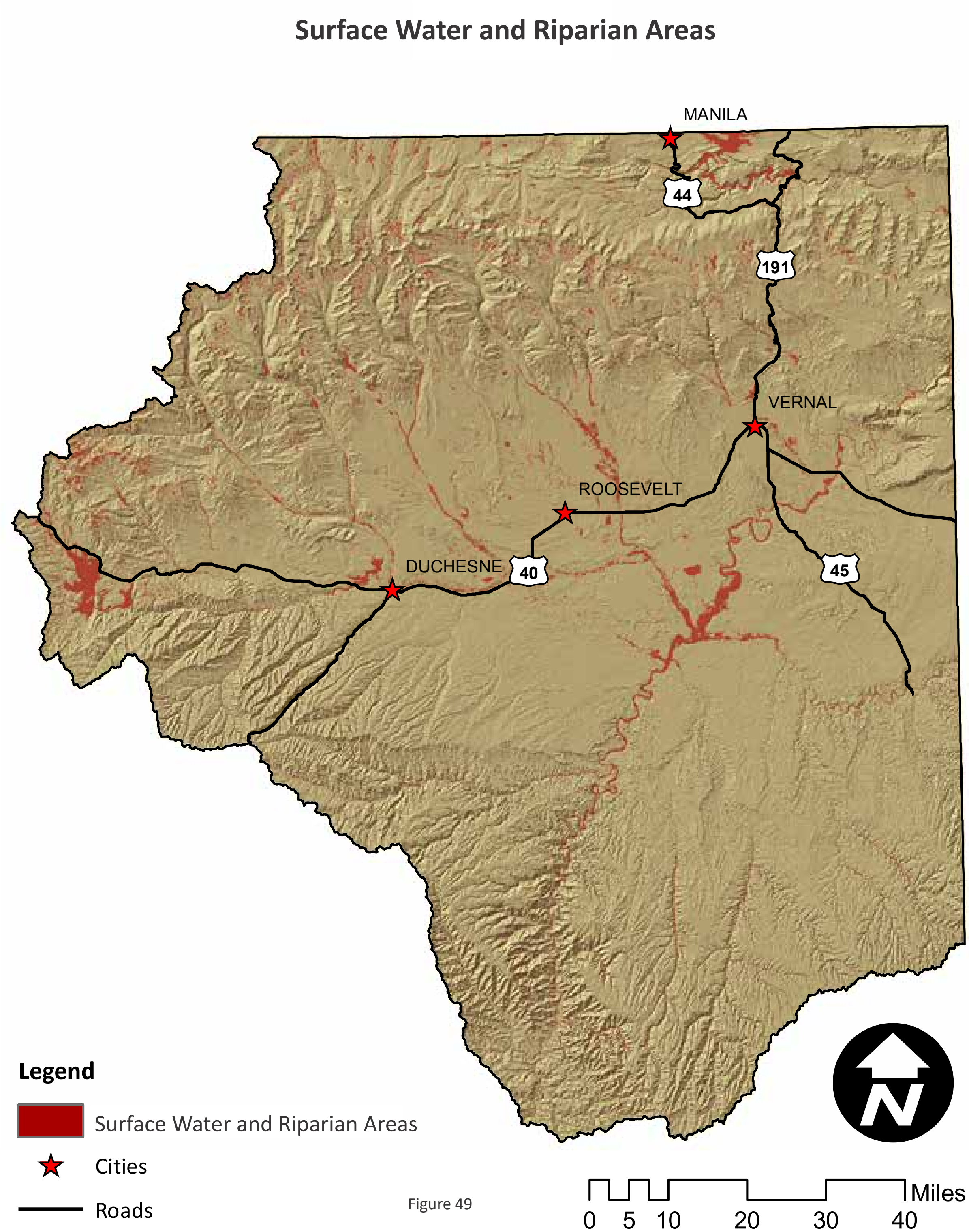

Surface Water and Riparian Areas
MANILA
44
191
VERNAL
ROOSEVELT
DUCHESNE
40
45
Legend
Surface Water and Riparian Areas
Cities
Roads
Miles
0 5 10 20 30 40

Figure 49

Vegetation

Though perhaps too often ignored, the dominant vegetation types often contribute significantly to regional identity – especially in the case of forested areas. In order to best represent the pattern of dominant vegetation types contributing to the regional identity of the Uintah Basin, we extracted the data for six different species from the southwest regional GAP Land Cover database (see Appendix B).

The selected species that we felt were most representative of the Uintah Basin based on their land cover area are:

Utah Juniper	*Juniperus osteosperma*	see Figure 50
Rocky Mountain Maple	*Acer glabrum*	see Figure 51
Quaking Aspen	*Populus tremuloides*	see Figure 52
Indian Rice Grass	*Orysopsis hymenoides*	see Figure 53
Lodgepole Pine	*Pinus contorta*	see Figure 54
Big Sagebrush	*Artemisia tridentate*	see Figure 55

Figure 50: Utah Juniper. Source: Fcb981, Wikipedia Commons

Figure 51: Rocky Mountain Maple. Source: Walter Siegmund, Wikipedia Commons

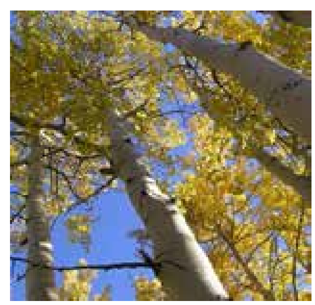


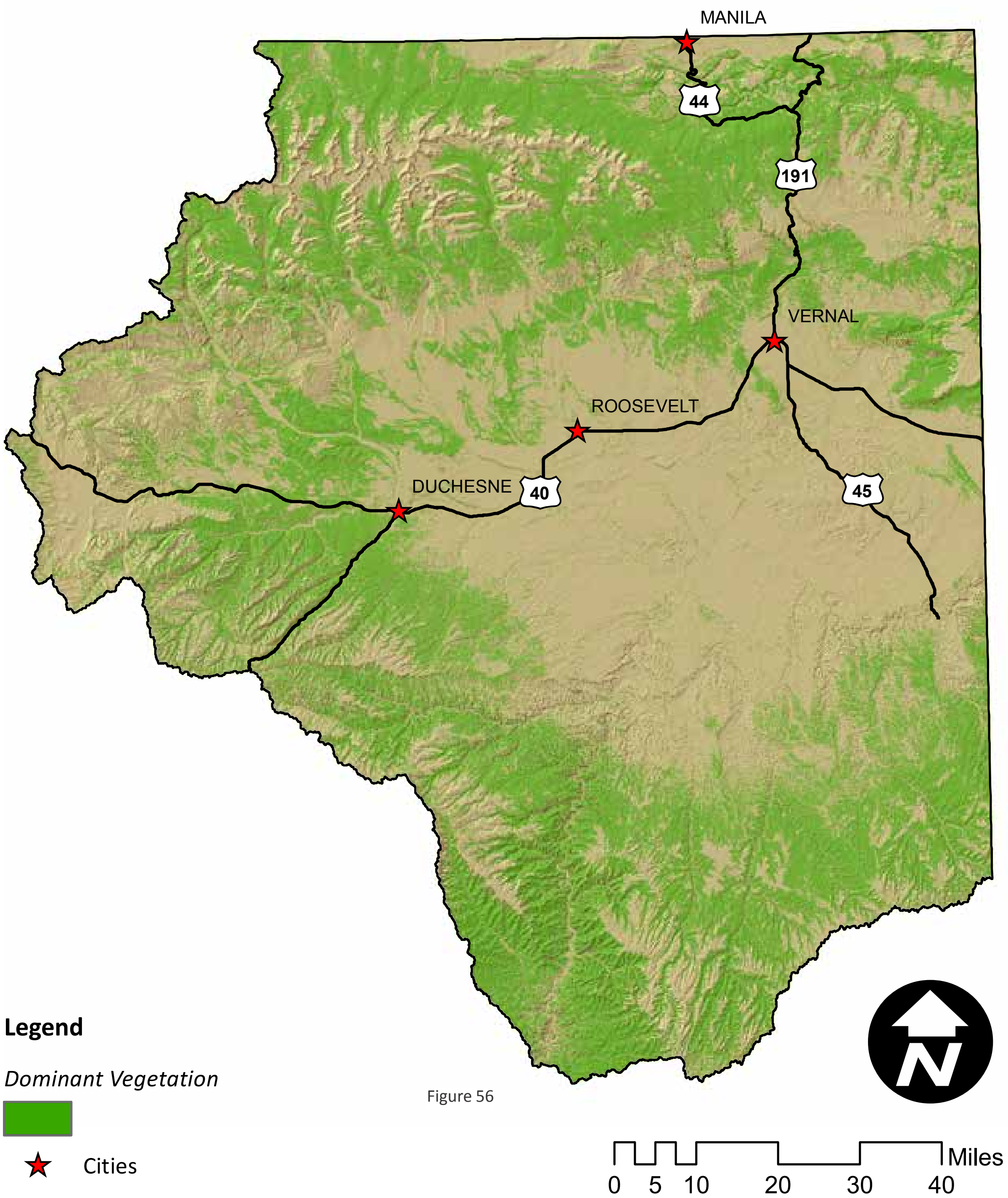
Figure 52: Quaking Aspen. Source: Scott Catron, Wikipedia Commons

Figure 53: Indian Ricegrass. Source: SkepticVK, Wikipedia Commons

Figure 54: Lodgepole Pine. Source: Tyler Allen

Figure 55: Big sagebrush. Source: Famartin, Wikipedia Commons

Vegetation



Legend

Dominant Vegetation

Cities

Roads

Figure 56

Visual Resources

Visual resources are an important component of the quality of life and identity of any geographic area. As people inhabit or experience a place, their primary sensory interaction with that place is visual. Points, lines, plains, shapes, colors, and textures created by topography, vegetation, structures, roadways, etc. define views to and from areas of the landscape. While visual quality is largely subjective to the viewer, it is possible to identify areas that are highly visible in a region and, thus, most likely to create an impression on people.

As discussed previously, many people, both residents and tourists, form connections to the surrounding landscape through outdoor recreational activities. Therefore, the first viewshed model identifies areas that are visible from major recreation areas in the Uintah Basin.

The second viewshed attempts to capture key areas that are visible to people as they travel throughout the basin. The viewshed analysis was done from selected points along major transportation corridors – specifically Highways 40 and 191 and State Roads 44 and 45.

The third visual resource model is somewhat different than the first two. This model represents areas of varying visual quality as identified through the Bureau of Land Management's Visual Resource Management (VRM) system. This system is used to identify visual quality priorities and evaluate the potential visual impact of proposed projects. Areas are classified into four different classes that define the amount of acceptable change to the landscape.

Class I: Areas where the existing character of the landscape should be preserved. The level of change should be *very low* and must not attract attention.

Class II: The objective is to retain the existing character of these landscapes. The level of change to the characteristic landscape should be *low*.

Class III: The objective is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be *moderate*.

Class IV: Areas that provide opportunities for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be *high*.

It is important to note that this third visual assessment model applies only to lands administered by the Bureau of Land Management.

Visual Resources

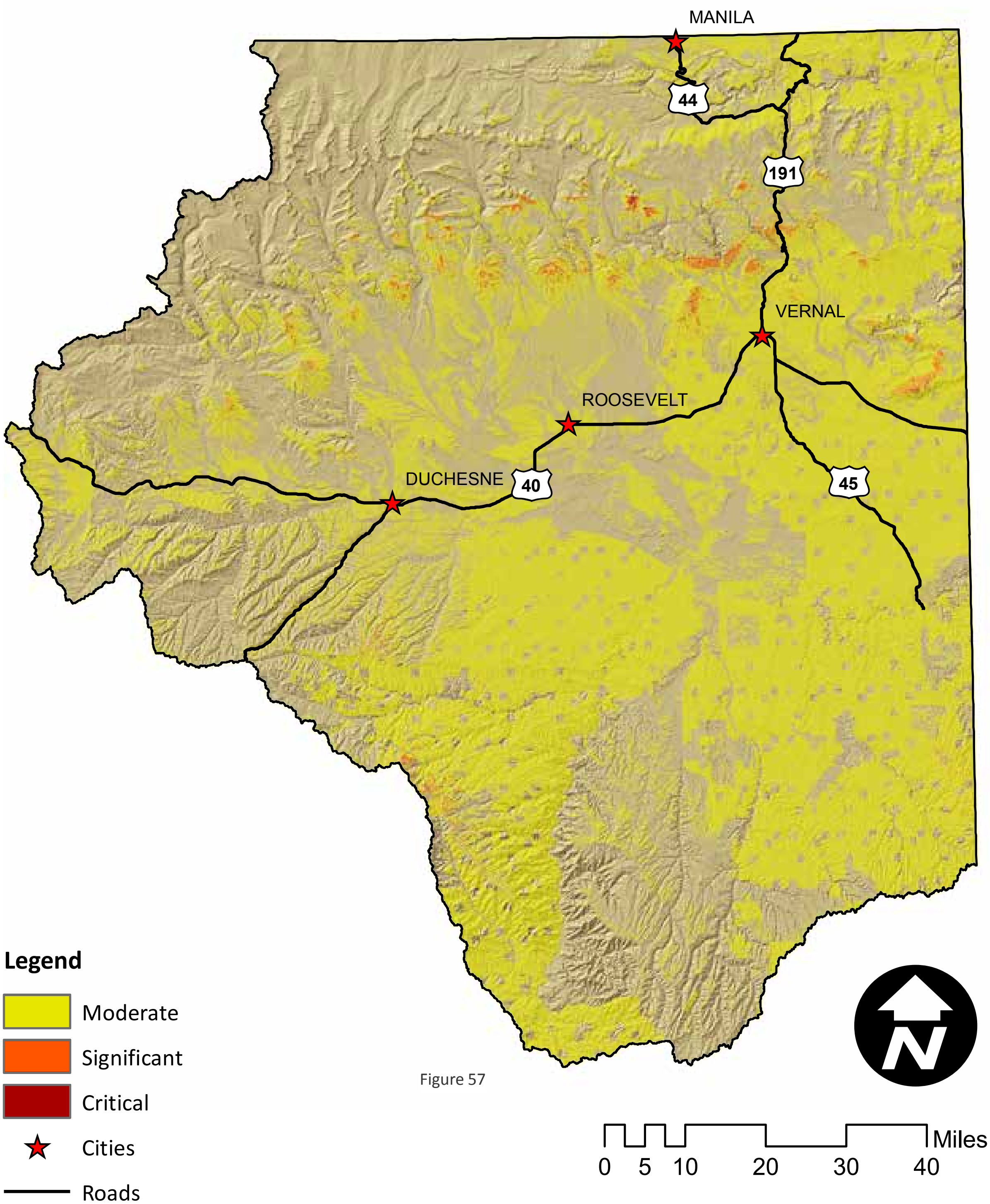


Figure 57

Wildlife

The occurrence of wildlife species throughout the landscape can also be an important component of regional identity. Many people who visit wildlife refuges and natural forest areas are attracted to those regions for wildlife viewing opportunities. In addition, hunting both large and small game are activities that have become especially important as cultural traditions in many areas throughout the intermountain west. Hunting and fishing are very popular activities in the Uintah and Wasatch mountain ranges, the Book Cliffs, and other areas where good habitat for game species exist. These activities are an important part of the quality of life for both residents and visitors of the Uintah Basin and provide significant opportunities for people to form connections with the regional landscape.

The model presented on the following page is the same as the model presented in the conservation section of this report. The model is based on potential habitat identified through the Southwest Regional GAP data and the Utah Division of Wildlife Resources. Land areas are classified as providing a high, medium, or low diversity of habitat types represented, respectively, by the red, orange, and yellow areas of the map.

The major wildlife species included in this model were:

- Black Bear
- Blue Grouse
- California Quail
- Chukar
- Moose
- Mountain Goat
- Mule Deer
- Pronghorn
- Rocky Mountain Bighorn
- Rocky Mountain Elk
- Ruffed Grouse
- Snowshoe Hare
- White Tailed Ptarmigan
- Wild Turkey

Major Wildlife Habitat

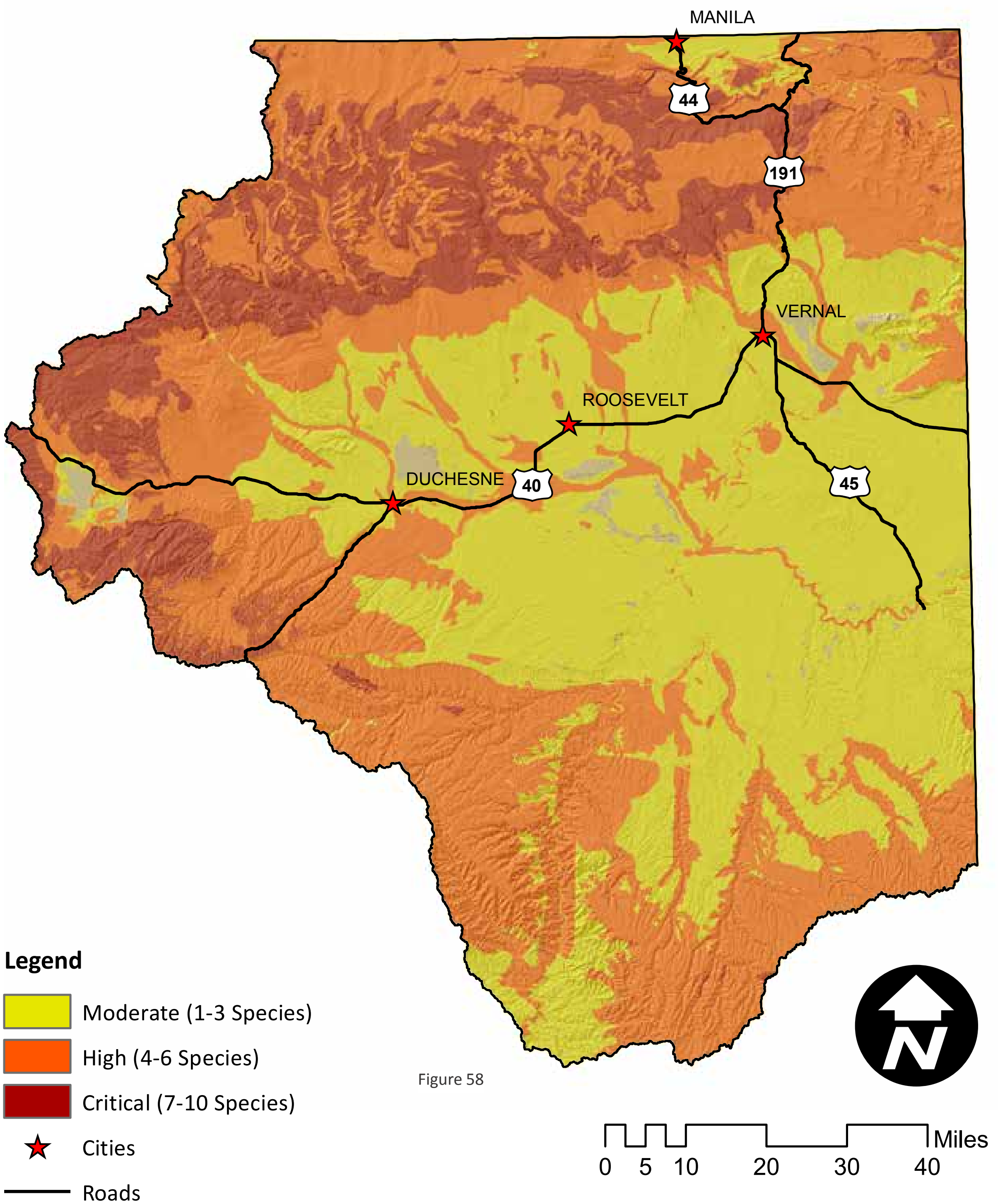


Figure 58

Composite Regional Identity Model

This composite regional identity assessment model was created to represent areas of the Uintah Basin where several factors coexist in the landscape to create rich areas that are critical to the regional identity of the study area. This composite model was compiled from the same data that has been presented in the preceding pages of the report, including:

Cultural Resources
Natural Areas
Major Wildlife Habitat
Vegetation
Surface Water and Riparian Areas
Recreational Resources
Visual Resources

These data layers from the previous models were combined using ArcGIS and classified into three groups representing the relative richness of different areas across the landscape as shown on the Regional Identity Assessment Map on the next page. This model can be used by officials and decision makers to determine how potential planning strategies or proposed actions may affect the regional identity of the Uintah Basin Study Area.

As mentioned previously, county plans include the preservation of rural character as a priority for land use planning (Uintah County, 2011). To preserve this regional character, careful attention should be paid to potential land uses and activities that affect the areas of significant or abundant identity resources, represented as orange and red areas on the map.

Figure 59: Split Mountain Boat Ramp, Green River. Source: Tyler Allen

Regional Identity

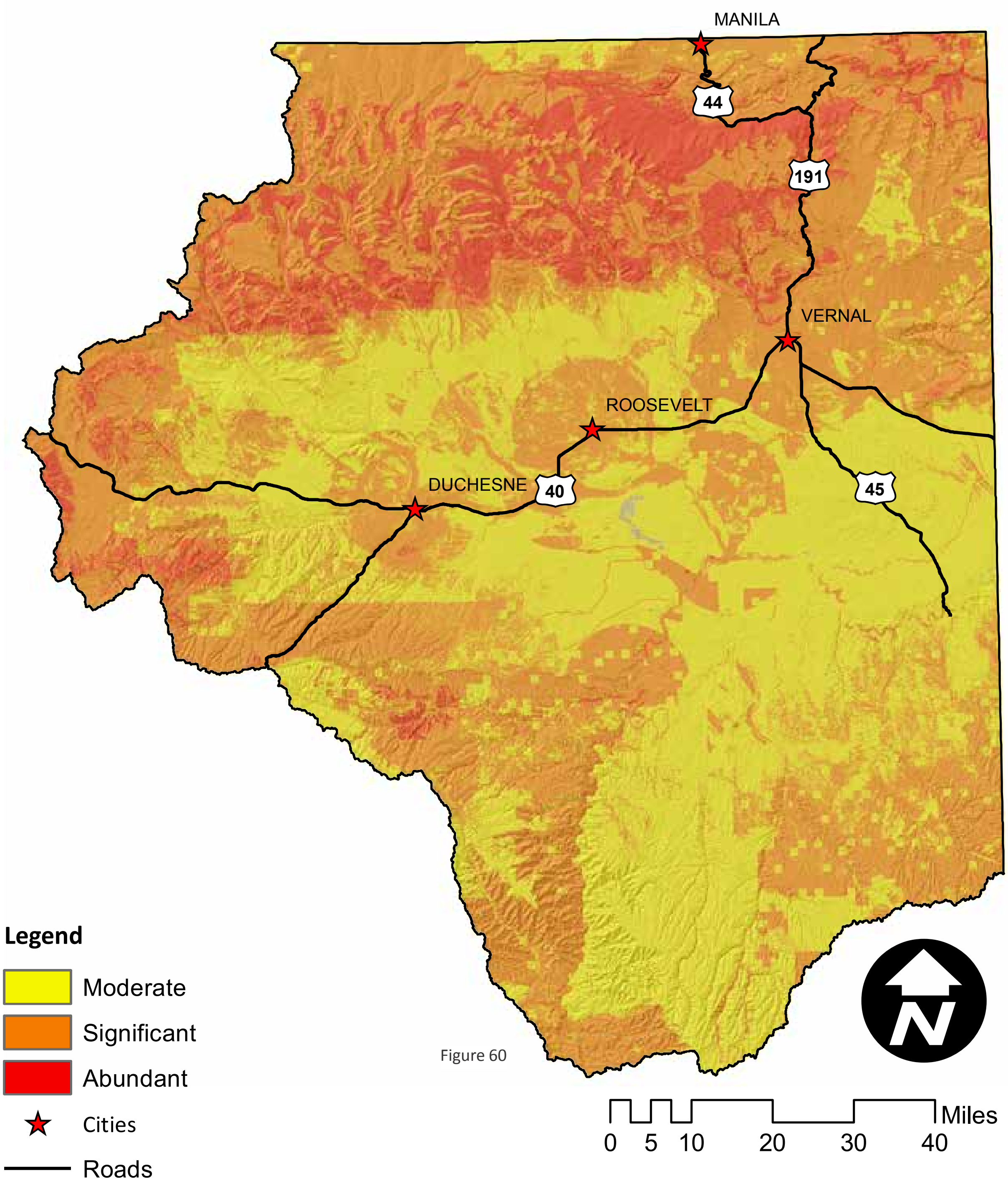
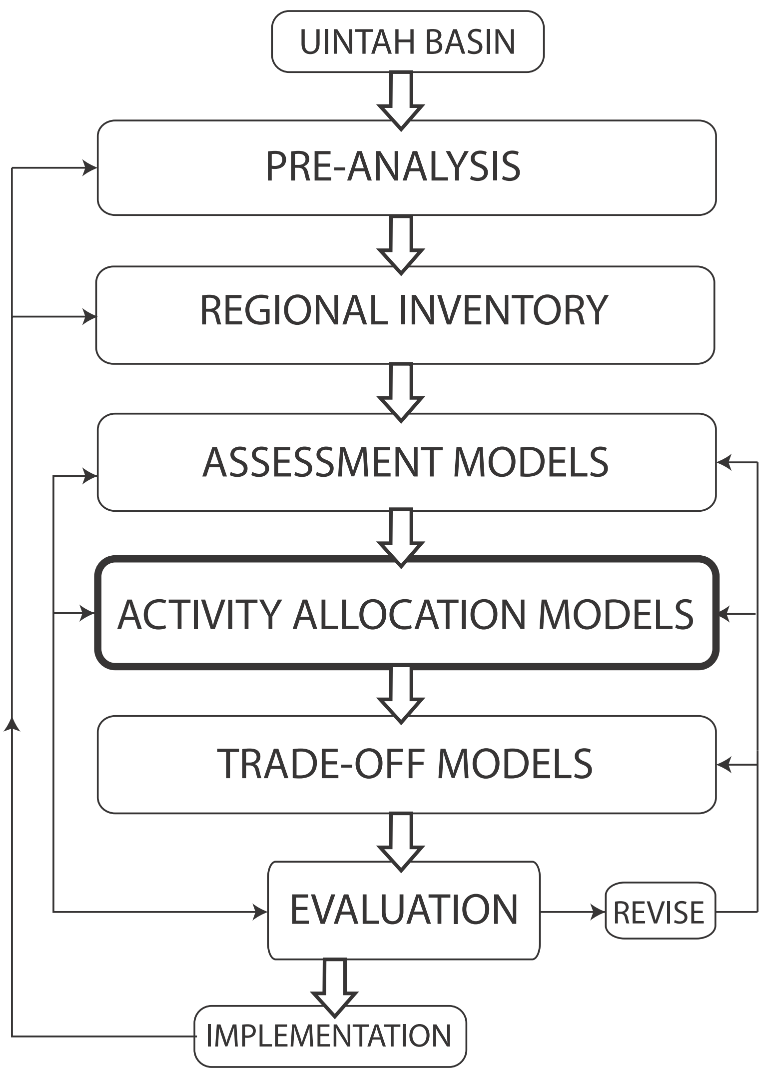


Figure 60

Allocation Models



Summary
Allocation models are spatial representations of potential activities or land uses as they might occur in the landscape. These models developed in this study were very general models that represent where residential, commercial, or industrial development on one hand and energy development on the other could possibly occur in the Uintah Basin. See page 6 for more information.

General Development Model

While past studies in the bioregional planning studio have created and employed more sophisticated models to predict development pressure or desirability, the model in this study used only two very basic criteria. Based upon stakeholder meetings and the recommendation of officials in the Uintah Basin, we decided to create a model that loosely represents areas that may be developed. This model leaves most of the details and the majority of planning efforts regarding commercial, residential (see Figure 61), and industrial development to local officials and planners.

Only two criteria were used to create the general development model. The first criteria is that development will only occur on either private land or state lands administered by the School and Institutional Trust Lands Administration (SITLA) since those lands can be sold at auction for the purposes of development. While it is possible in rare cases to exchange or purchase land from federal agencies, that potential is usually very limited and the quantity of available private and SITLA land in the Uintah Basin makes such purchases or exchanges unnecessary. It is also important to note that we have not included tribal lands in the model because we have not had the opportunity to involve tribal governments or representatives in this study.

The second criteria simply restricts developable land to those areas with less than 20% slope. Land areas with steeper slopes, while also posing a potential risk to the health and safety of the population, are generally much more difficult and costly to develop in a responsible manner. Again, we feel that the availability of more suitable land in the Uintah Basin makes the development of steeper slopes unnecessary at this time.

Figure 61: Recent Residential Development, Vernal. Source: Michael Gottfredson

Commericial, Residential, & Industrial Development

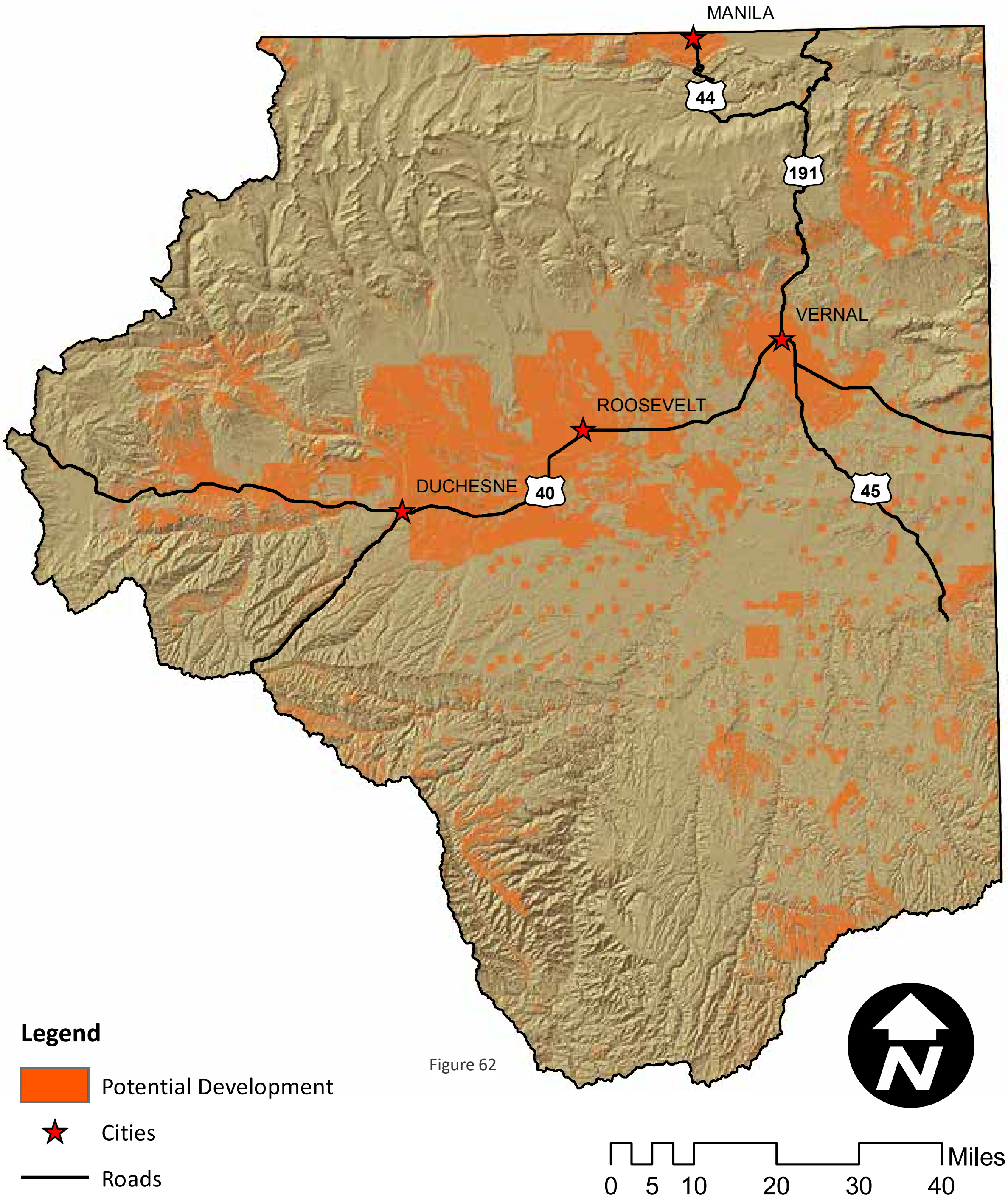


Figure 62

Energy Development

Energy extraction will continue to play a prominent role in the Uintah Basin. For the purposes of this study, oil and natural gas are the primary energy resources included in our assessment model because of their current significance in the Uintah Basin. It should be noted, however, that other energy resources such as tar sands, oil shale, solar, and wind, as well as mineral deposits such as phosphates, are also likely to become factors regarding land use in the Uintah Basin and take on increased importance in the future. Some examples of energy extraction are provided in Figures 68 and 69 on page 83.

The data presented in the first model represent producing oil and gas wells in the Uintah Basin Study Area (Figure 64). As can be seen, the majority of oil production is concentrated around the Highway 40 Corridor. The higher concentration of wells south of Highway 40 may be due to the accessibility of public (specifically BLM and SITLA) lands for drilling rather than the presence of oil resources. Drilling for gas, on the other hand, is concentrated to the southeast of the oil fields, primarily between the Green River and State Road 45.

In order to better show the concentration of energy extraction activities, ArcGIS software was used to calculate the number of oil and gas wells per square mile in the Uintah Basin. The concentration of oil wells is shown in Figure 65 and the concentration of gas wells is provided in Figure 66 on page 81.

The final model that will be used later in the study to represent the allocation of extractive energy development is presented on page 82 (Figure 67). This model is based on the location of oil and gas fields as identified by the Utah Department of Natural Resources Division of Oil, Gas and Mining.

Figure 63: Worker s Servicing Energy Infrastructure near Bonanza, UT. Source: Michael Gottfredson

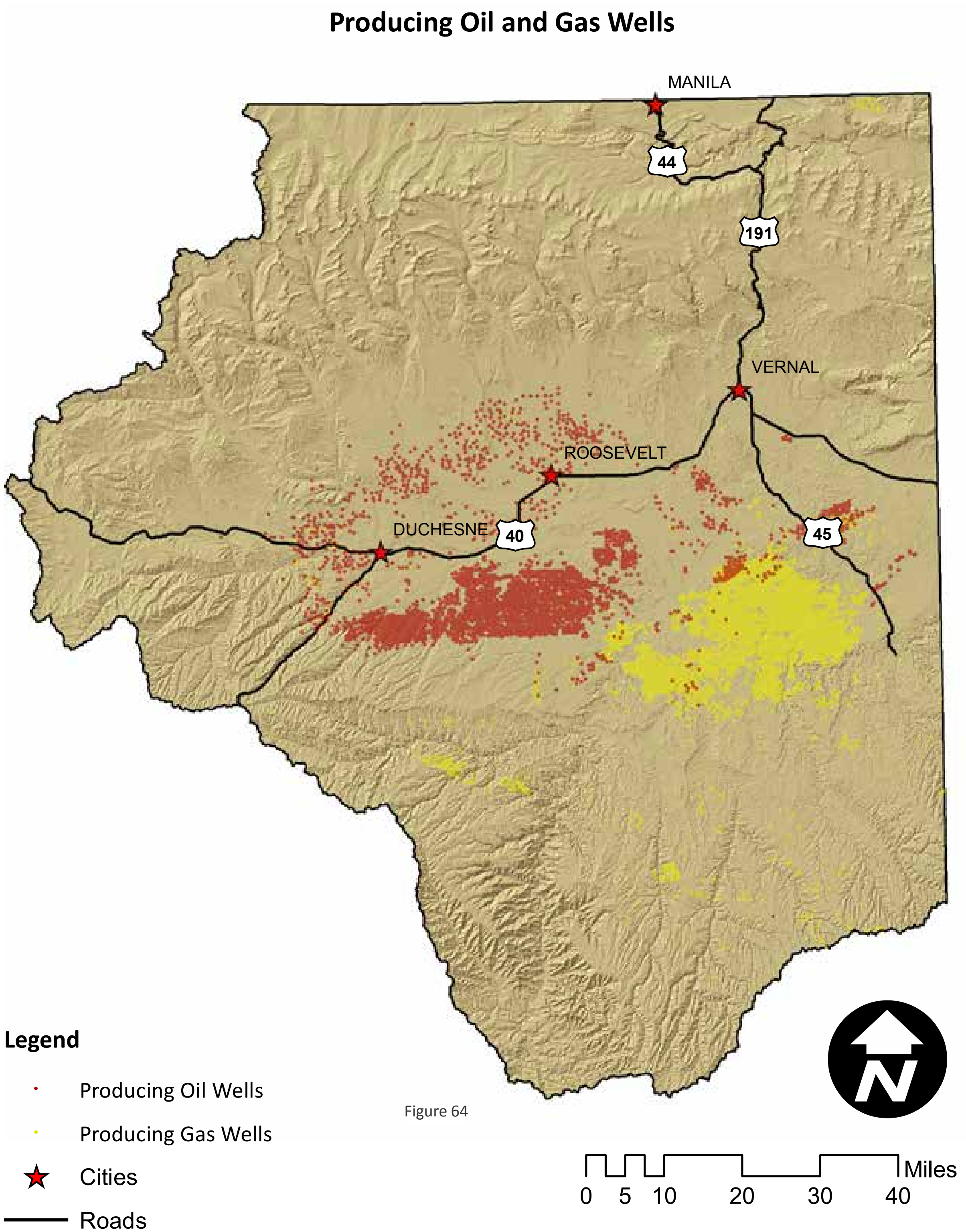
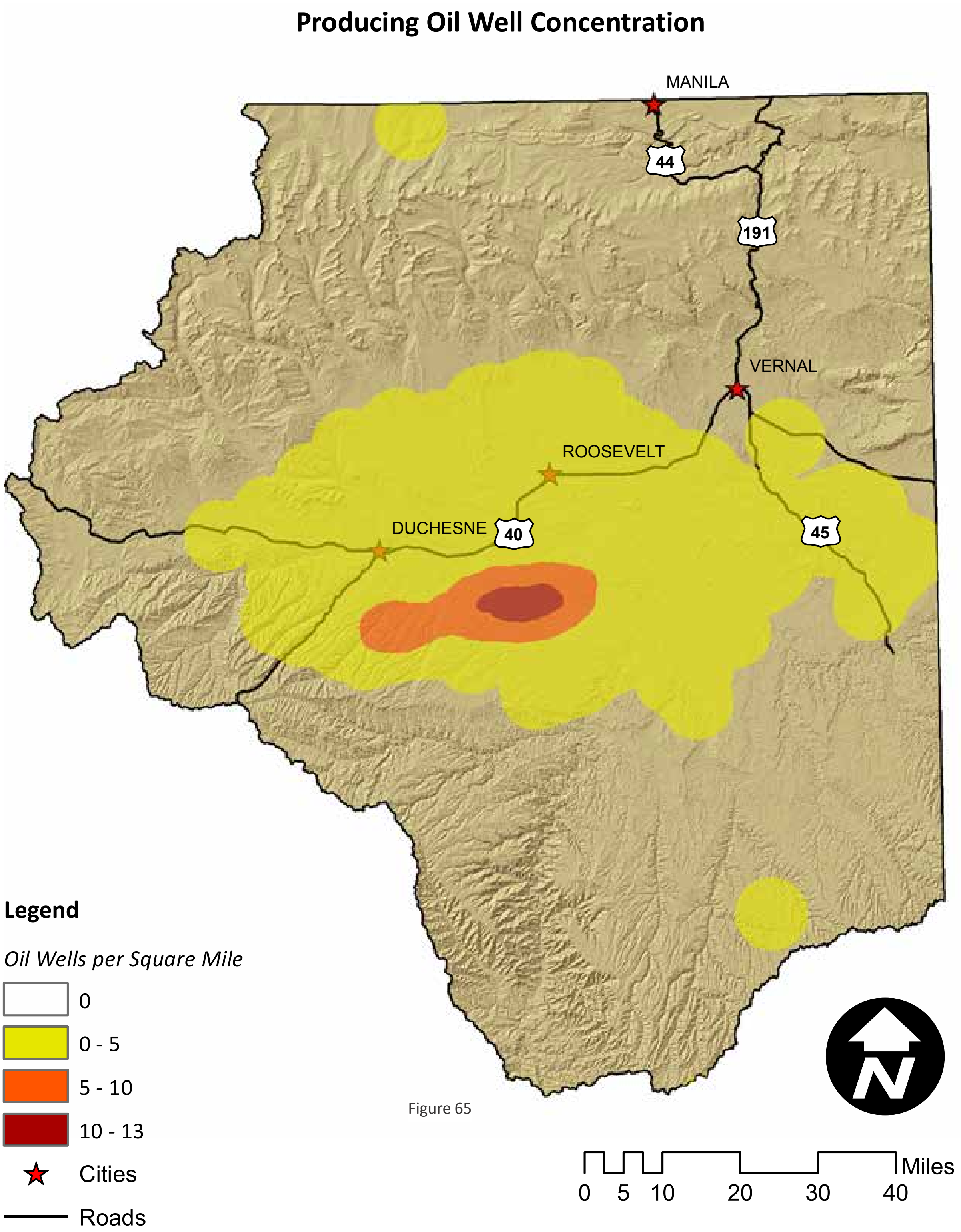

Producing Oil and Gas Wells
MANILA
44
191
VERNAL
ROOSEVELT
DUCHESNE
40
45
Legend
Producing Oil Wells
Producing Gas Wells
Cities
Roads
Miles
0 5 10 20 30 40
N

Figure 64


Producing Oil Well Concentration
MANILA
44
191
VERNAL
ROOSEVELT
DUCHESNE
40
45
Legend
Oil Wells per Square Mile
0
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5 - 10
10 - 13
Cities
Roads
N
Miles
0 5 10 20 30 40

Figure 65

Producing Natural Gas Well Concentration

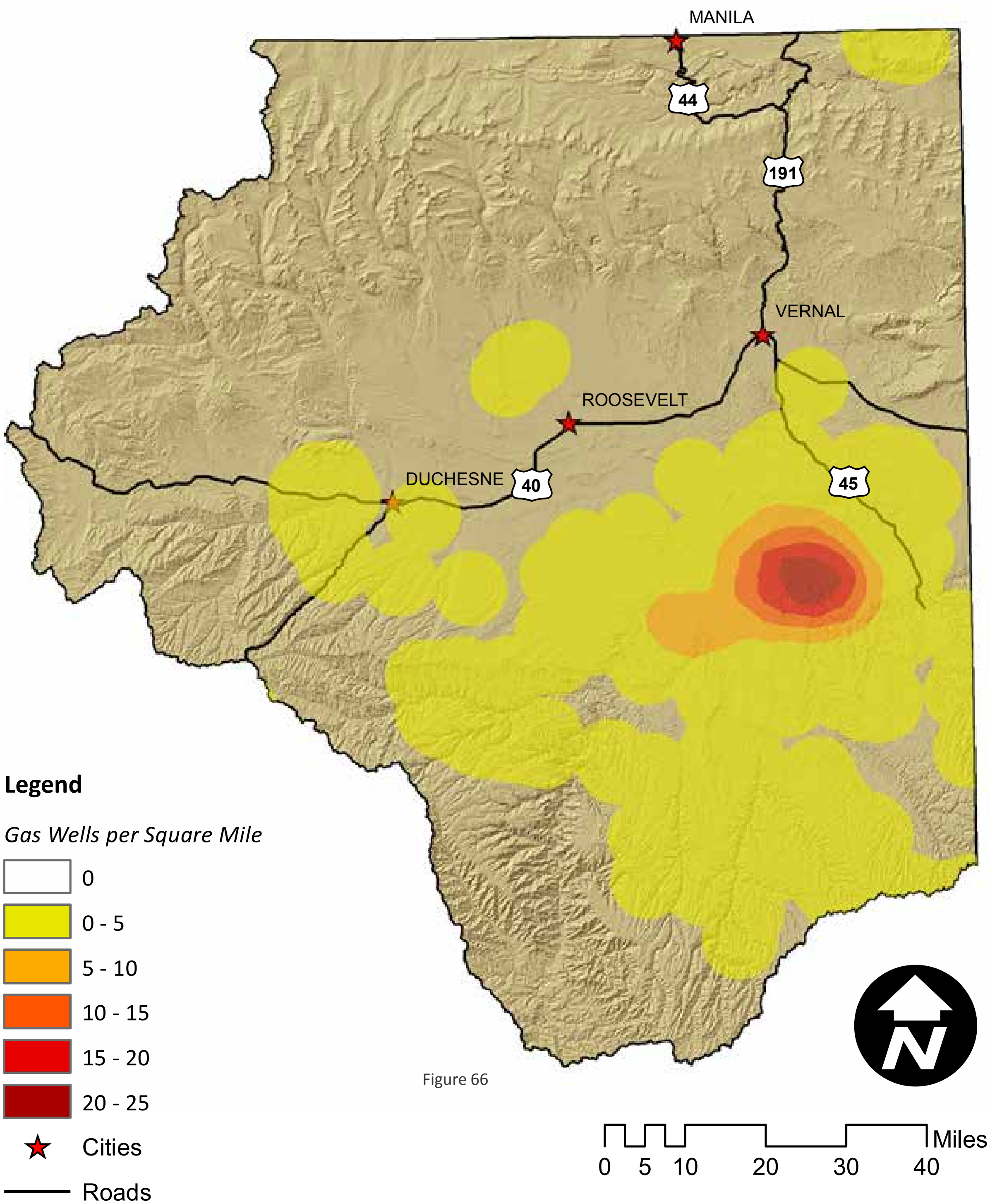


Figure 66

Energy Development Model

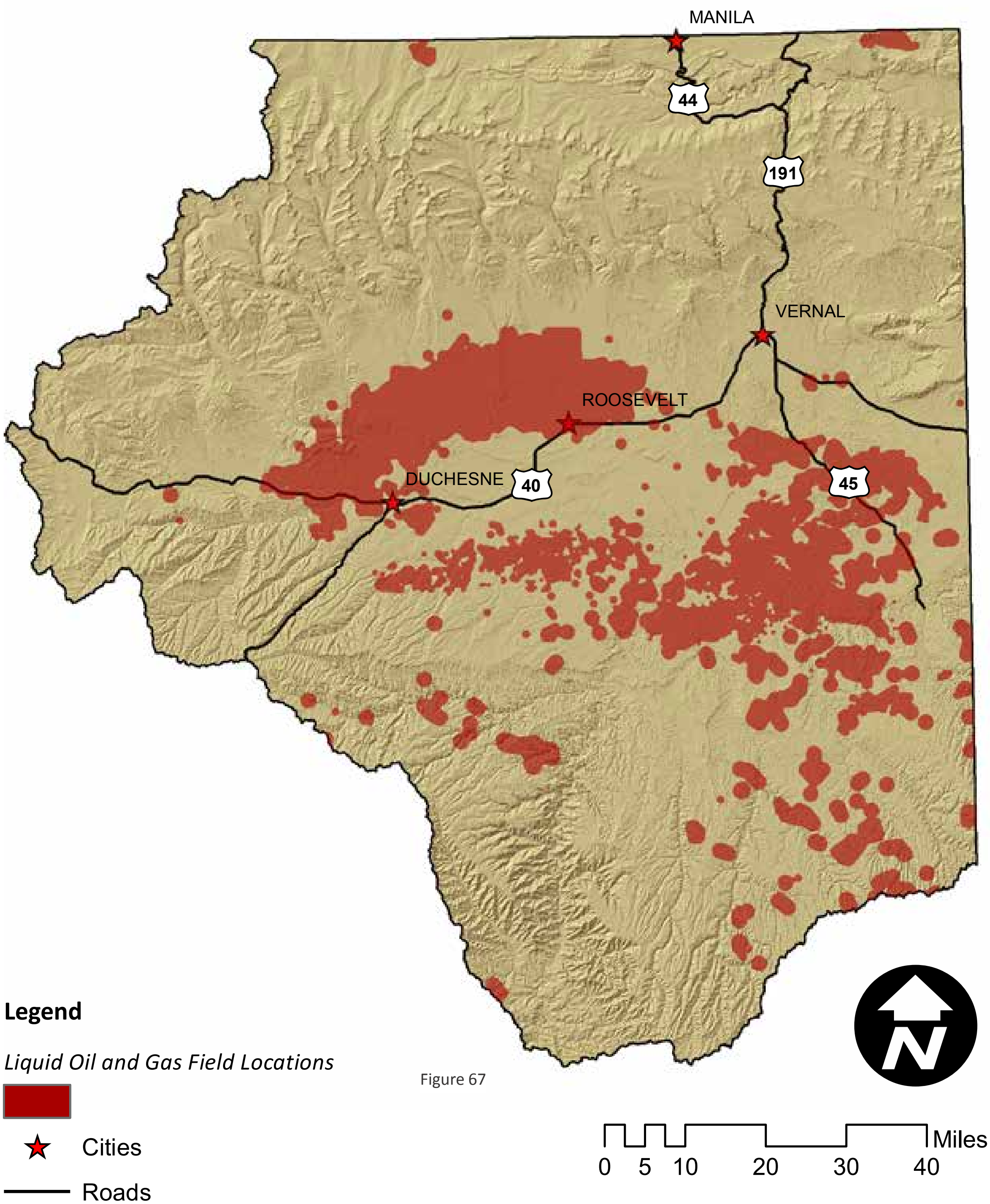


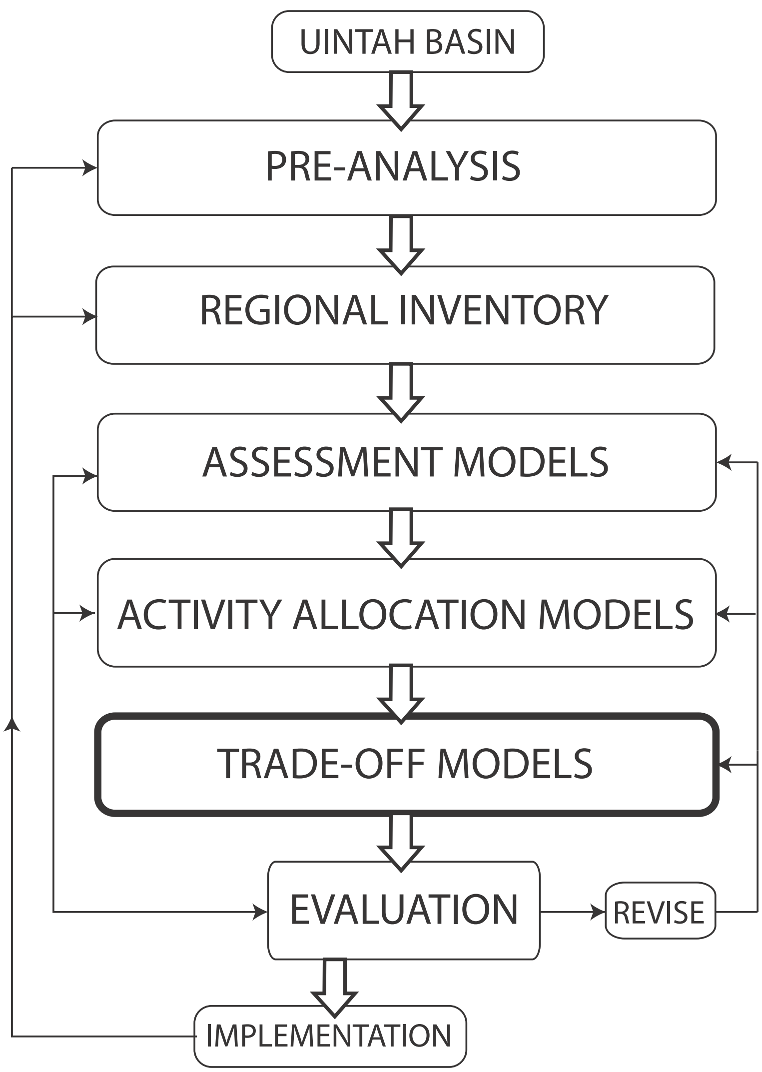
Figure 67

Figure 68: Hydraulic fracturing in the Uintah Basin. Source: Michael Gottfredson

Figure 69: Seven Natural Gas Well Heads on One Pad, Suggesting Directional Drilling, in the Uintah Basin. Source: Michael Gottfredson

Chapter 5

Trade-Off Models



Summary
The primary purpose of the trade-off models is to spatially represent areas of landscape where conflicts may exist between land use priorities such as development and conservation. See page 6 for more information.

Development vs. Conservation Trade-Off Models

This trade-off model provides a spatial representation of where potential areas for development occur in relation to areas with high conservation value. The primary purpose of the models presented in this section is to identify areas of potential conflict between conservation and development as well as to identify those areas where land uses are not as likely to be in conflict.

The models contain four classifications for lands within the Uintah Basin Study Area: "conservation," "development," "conflict," and "land bank." Placing the values of each priority model (conservation and development) along each axis of the diagram below (Figure 70)– also used as the legend for the trade-off models on the following pages – it is possible to see how these different classifications are derived.

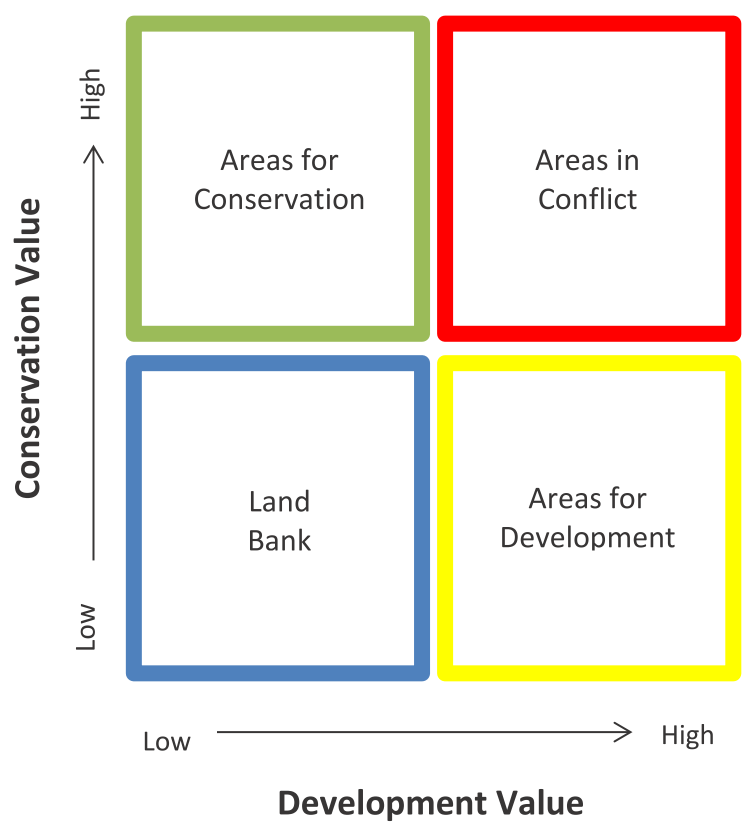


Figure 70: Development vs. Conservation Trade-Off Diagram

The upper left quadrant - shown in green on both the diagram and the map – represents areas with a high conservation value and a low potential for development. These areas are high quality landscapes that should be included in conservation plans.

The upper right quadrant shows areas that have both a high conservation value and high potential for development. These areas are where conflict between conservation and development is most likely to occur and may require the most attention from planners to make more detailed assessments and develop strategies that balance demands for development with the important ecological values and functions of these landscapes.

The lower right quadrant of the diagram represents areas with minimal conservation value but a high potential for development. These areas, shown in yellow, are where future residential and commercial development should occur. As noted in Chapter 4 of this report, the development models employed in this study are very simplified and loose. Therefore more detailed models for traditional commercial, residential, and industrial development as well as energy development should be developed – preferably in accordance with smart growth principles and/or the best management practices for oil and gas that are provided in the concluding sections of this report.

Finally, the lower left quadrant is referred to as the land bank because, under current conditions, these areas have relatively low value in terms of either conservation or development. As emphasized in other sections, planning should be a dynamic and recurring process, and these areas should be re-evaluated as conditions change in the future.

Because the requirements for potential commercial, residential, and industrial land uses are very different than the requirements for energy development, two different models have been included on the following pages. The first model uses the general development allocation model from Chapter 5 and plots it against the conservation assessment model from Chapter 4. The second model uses the energy development allocation model (also in Chapter 5) against the same conservation assessment model.

While we selected development and conservation as the most important land uses to include in this report, it is important to note that this same basic framework can be used to identify conflicts between any two competing land uses. For example, energy development could also be plotted against the regional identity assessment model, a more refined residential development model, or even against the model representing sage grouse habitat on page 49.

General Development/ Conservation Trade-Off

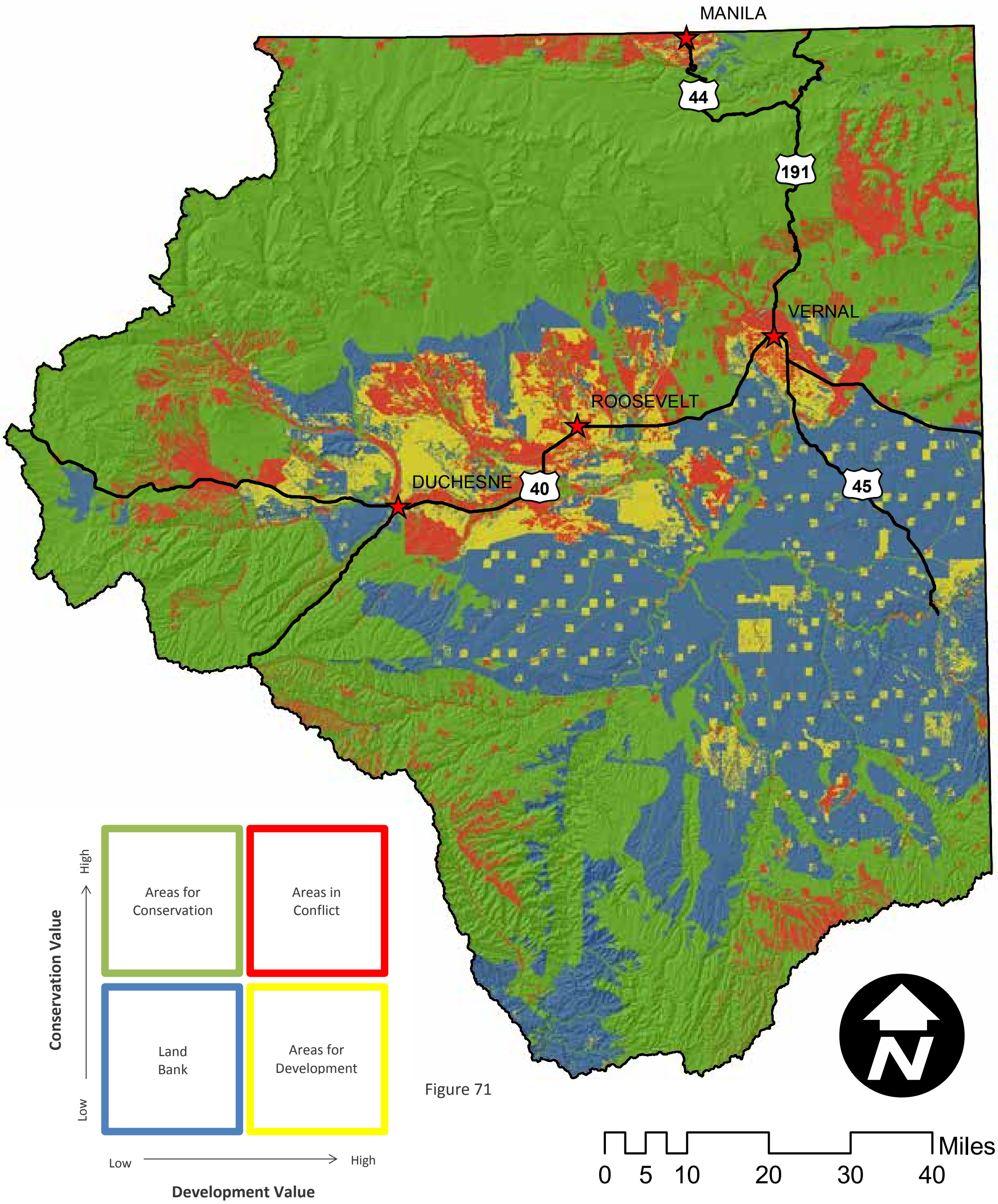


Figure 71

Energy Development/ Conservation Trade-Off

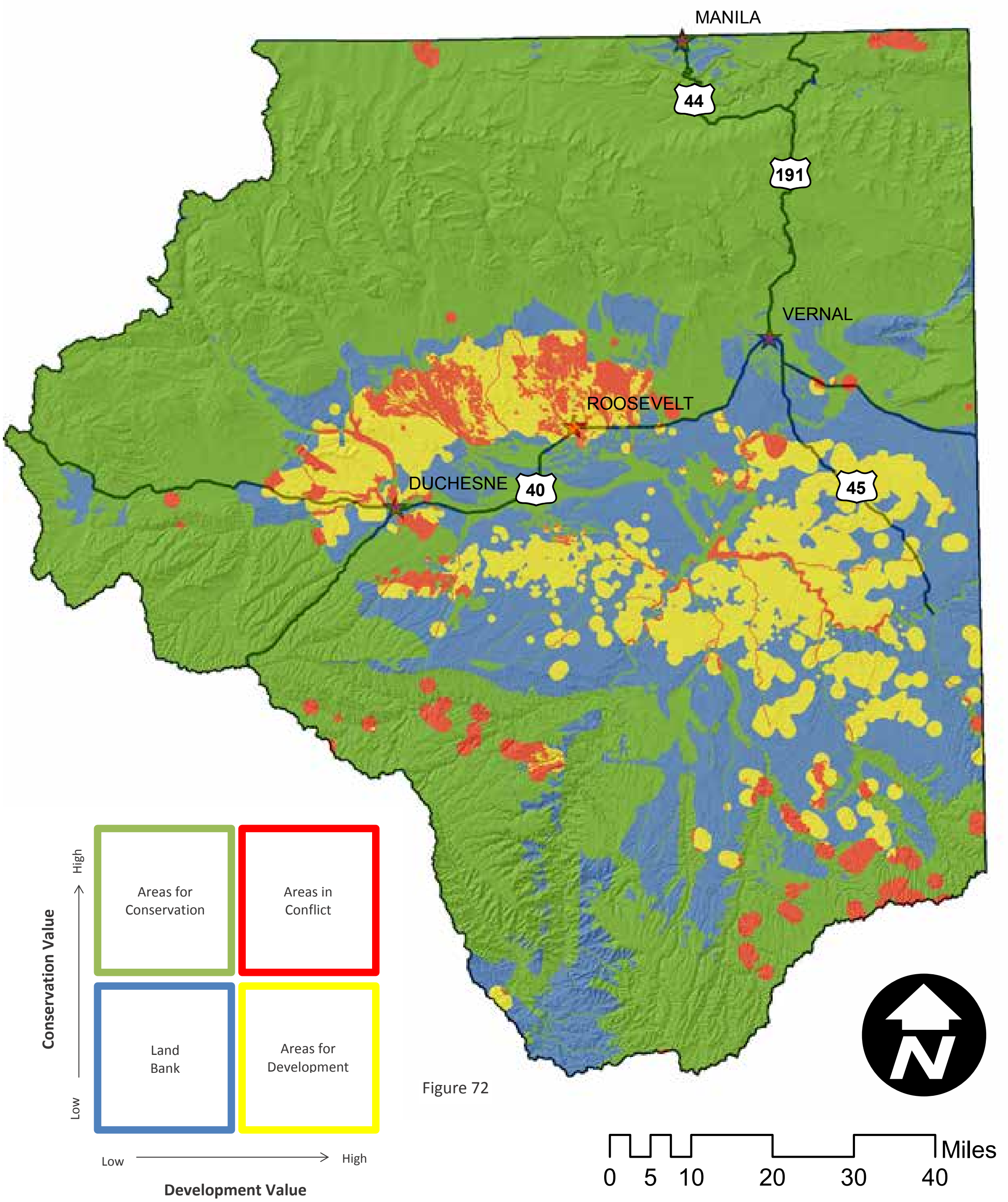
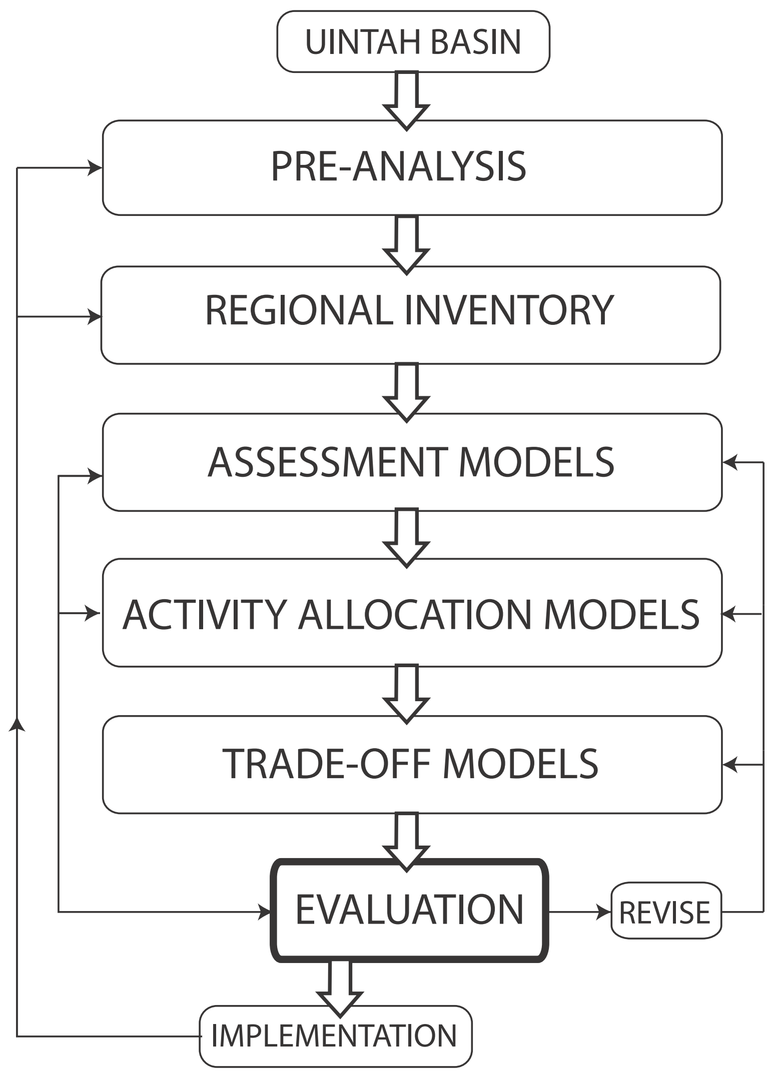


Figure 72

Conclusions and Recommendations



Conclusions and Recommendations

This bioregional study has provided a series of assessment models that can be used to guide future planning decisions for the Uintah Basin Study Area. Decisions such as the level of acceptable risk to health, safety, and welfare, the emphasis that will be given to the conservation of environmental attributes, and the aggressiveness of development strategies will, ultimately, be made by local officials and planners. Consequently, we have attempted to provide assessment models that represent a menu of choices that can be made by presenting three different tiers in the case of health, safety, and welfare and providing areas of moderate, significant, and critical importance in the rest of the assessment models.

In past bioregional planning studies, alternative futures have been developed that represent different planning strategies. Some examples, specifically for the Uintah Basin, are available in Nick Kenczka's *Alternative Futures for the Uintah Basin.* The assessment models in this report can be employed by local planners or officials using a method such as the one outlined in Figure 73 below. Each line in this Planning Strategy Matrix represents a different planning objective that could be proposed by planners through adopting different levels (or tiers) of each assessment model for incorporation into a comprehensive plan. Each box represents a different choice regarding the level of importance that each attribute is given in the development of the proposed plan, and the pros and cons of those choices can be examined. A more comprehensive explanation of this methodology can be found in *The Development of Alternative Future Growth Scenarios for the California Mojave Desert* (Toth et al., 2002).

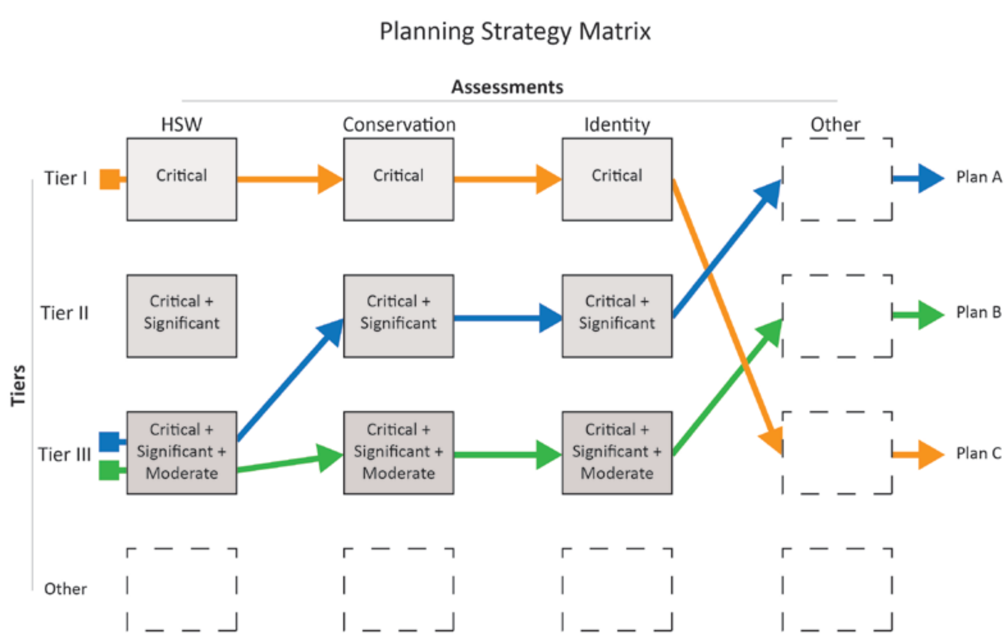


Figure 73: Planning Strategy Matrix

For example, the green line shows a planning strategy that emphasizes conservation and quality of life and thus includes the more restrictive options regarding conservation and health, safety, and welfare. The orange line represents a planning strategy that emphasizes growth and development, selecting lower levels of emphasis for conservation. The blue line represents a balanced approach involving aspects of both by selecting a less restrictive conservation model with higher restrictions to development associated with public health, safety, and welfare. It is very important to point out that any combination is possible, including the development of additional assessment models or potential future scenarios.

HSW Assessment Model

Our first recommendation regarding the future development of the Uintah Basin is to employ the models included in the Health, Safety, and Welfare section of this final report. Keeping people out of harm's way should take priority over conservation or economic goals. Decision makers are encouraged to develop appropriate policies that guide development out of high-risk areas and to create procedures that require detailed analysis of hazards and, when possible, proven mitigation strategies at the project- and site- scale when any type of development is proposed in these areas. For example, if the current development pattern continues, more homes will likely be placed in areas with significant risk for damage from wildfires. If decision-makers elect to develop in these areas despite the risk, they should consult resources such as guidelines for "FireWise" communities included in Appendix C and consider making such considerations a requirement for development in those areas.

Trade-Off Models

The diagram and associated map developed for the Trade-Off models are a simple way to illustrate where there may be conflict between any prospective land uses that are incorporated into that framework. The two models presented in that section should be useful for identifying, in a general sense, which lands should be considered for inclusion in more detailed open space or development plans.

Also very important are the areas shown in red where these two uses may be in conflict. Our recommendation is to further develop strategies for commercial, residential, industrial, and energy development that restrict the areas where these uses are in conflict with areas of high value for conservation. Simply put, guide development toward the yellow areas shown on the maps. In the case that the benefits of developing in the conflict areas shown in red are determined to outweigh the environmental costs, or when there is not sufficient political will to preserve these areas, planners should develop strategies and design requirements that minimize the impact of the development on the environmental resources present in those areas.

Figure 74. King's Peak in the High Uintas WIlderness Area. This wilderness area along with other public lands offer important recreation opportunities that can bolster tourism in the UIntah Basin and add considerably to important quality of life issues.
Source: Hkw2, Wikipedia Commons

Smart Growth

Regional identity is also a big factor in the Uintah Basin, and many longer-term residents make strong associations with the surrounding landscape. It is also crucial for the development of recreational activities that might help bolster the economy via tourism. Maintaining a sense of identity amidst the rapid population growth and development that is expected to continue in the Uintah Basin will be a significant challenge. In order to help preserve that identity as well as to guide development toward the appropriate areas represented in the trade-off models, we recommend that planners and decision makers develop strategies according to the smart growth principles included in Appendix D.

Best Management Practices for Energy Development

Energy development has been a significant factor in the historical development of this region and will continue to drive growth in the future. It's a vital part of the economy. There have been strategies developed to reduce some of the consequences of energy development on landscape resources. Specifically, the Bureau of Land Management, in cooperation with energy industry representatives, has developed "Best Management Practices" for reducing and mitigating the impact of oil and gas development on environmental resources. These efforts should be continued and adopted for energy development occurring on federal lands but should also be extended to development on private and state-owned lands, especially in areas where important energy and conservation values are in conflict. Appendix E includes Best Management Practices General Information.

Visioning Process

Throughout the course of this study, we had the opportunity to talk with several public officials, land managers, and private citizens. One important note we took from these discussions is that there doesn't seem to be a cohesive vision of what people living and working in the study area really value. There is no shared vision for what this area could or should be trying to achieve. Without having a better idea of what the public values and expects in the surrounding landscape – how they want it to look and feel or what amenities they want it to support – it will be difficult to create more detailed conservation and development plans because the objectives will be unclear or directly in conflict with each other.

To this end, it would be beneficial to consult with an outside entity to conduct a comprehensive basin-wide visioning process for the Uintah Basin Study Area. While such a process will not make people agree and cannot capture the vision of all residents, it may provide valuable insight into shared values and common themes that may help to guide the future development of the Uintah Basin. The combination of that shared vision and an assessment of critical social and environmental attributes such as those presented in this report would greatly enhance the effectiveness of policy-makers in working toward a desirable future for the Uintah Basin.

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Geospatial Data References

Category	***Data Element***	***Source***	***Data Type***
Boundary	State, Counties, Municipalities, Cities	Utah AGRC	Vector
Boundary	Watershed Boundaries	Utah Division of Water Quality	Vector
Climate	Climate Zones	Koppen-Geiger Climate Classification	Vector
Conservation	1999 Wilderness Inventory, Revised	BLM Geographic Information- Utah BLM On-line Data	Vector
Conservation	BLM Wilderness	BLM Geographic Information- Utah BLM On-line Data	Vector
Conservation	National Conservation Area	BLM Geographic Information- Utah BLM On-line Data	Vector
Conservation	Wilderness Study Area (WSA)	BLM Geographic Information- Utah BLM On-line Data	Vector
Conservation	Wilderness Suitability Determinations	BLM Geographic Information- Utah BLM On-line Data	Vector
Cultural	City Names/ Places	Utah AGRC	Vector
Cultural	Historic Places	National Register of Historic Places	Vector
Cultural	Land Ownership	Utah AGRC	Vector
Energy	Oil and Gas Fields	Utah AGRC & Utah DNR-OGM	Vector

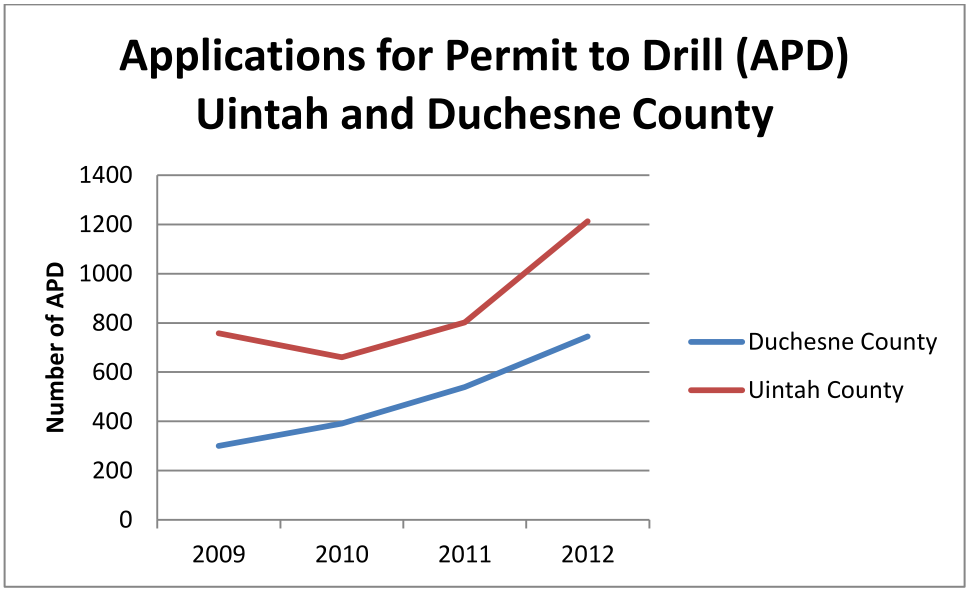
Category	***Data Element***	***Source***	***Data Type***
Energy	Oil and Gas Wells	Utah AGRC & Utah DNR-OGM	Vector
Geology	Landslide Susceptibility	Utah Geological Survey	Vector
Geology	Quaternary Faults and Folds	U.S. Geological Survey	Raster
Geology	Soils	USDA Soil Data Mart	Vector
Hydrology	Drinking Water Zones	Utah Division of Drinking Water	Vector
Hydrology	Lakes, Reservoirs, and Ponds	Utah AGRC	Vector
Hydrology	River and Streams	Utah AGRC	Vector
Hydrology	Springs	Utah AGRC	Vector
Hydrology	Watershed Boundaries	National Hydrography Dataset	Vector
Imagery	Landsat 5 Natural Color Composite	Intermountain Region Digital Image Archive Center	Raster
Infrastructure	Education	Utah AGRC	Vector
Infrastructure	Fire Stations	Utah AGRC	Vector

Category	*Data Element*	*Source*	*Data Type*
Infrastructure	Law Enforcement	Utah AGRC	Vector
Infrastructure	Medical Facilities	Utah AGRC	Vector
Infrastructure	Roads	Utah AGRC	Vector
Land Cover	Dominant Vegetation	Utah Division of Wildlife Resources	Vector
Land Cover	Fire Regime Groups	LandFire	Raster
Land Cover	Southwest Regional GAP	RS/GIS Laboratory, Utah State University	Raster
Land Cover	Water Related Land Use - Agriculture	Utah AGRC	Vector
Land Cover	Wetland and Riparian Vegetation, GAP	RS/GIS Laboratory, Utah State University	Raster
Recreation	BLM Off Highway Vehicle Areas	BLM Geographic Information- Utah BLM On-line Data	Vector
Recreation	BLM Public Campgrounds and Trails	BLM Geographic Information- Utah BLM On-line Data	Vector
Recreation	BLM Special Recreation Management Areas	BLM Geographic Information- Utah BLM On-line Data	Vector
Recreation	Boating Facilities	Utah AGRC and Utah Department of Natural Resources	Vector

Category	***Data Element***	***Source***	***Data Type***
Recreation	Forest Service Recreation Areas	Ashley National Forest Geospatial Data	Vector
Recreation	Golf Courses	Utah AGRC	Vector
Recreation	Local, City, Sport Parks and Fairgrounds	Utah AGRC	Vector
Topography	National Elevation Dataset - 10 meter	Utah AGRC	Raster
Visual	BLM Visual Resource Management	BLM Geographic Information- Utah BLM On-line Data	Vector
Wildlife	Major Wildlife Habitats	Utah Division of Wildlife Resources	Vector
Wildlife	Sage Grouse Management Areas	Sage Grouse Working Group - Professor Messmer	Raster
Wildlife	Threatened, Endangered and Sensitive Species	Utah Division of Wildlife Resources	Raster

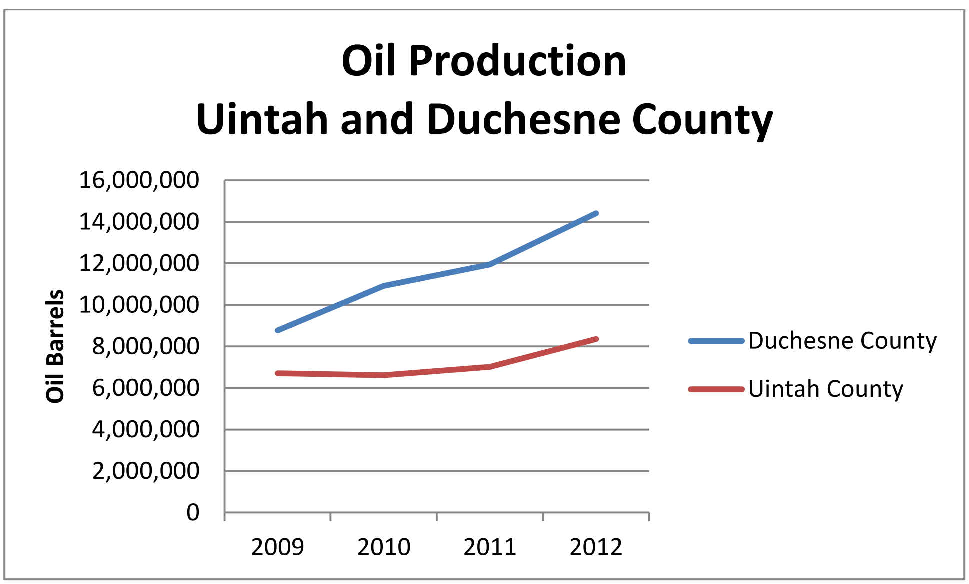
Appendix A:
Oil and Natural Gas Industry in the Uintah Basin

Applications for Permit to Drill



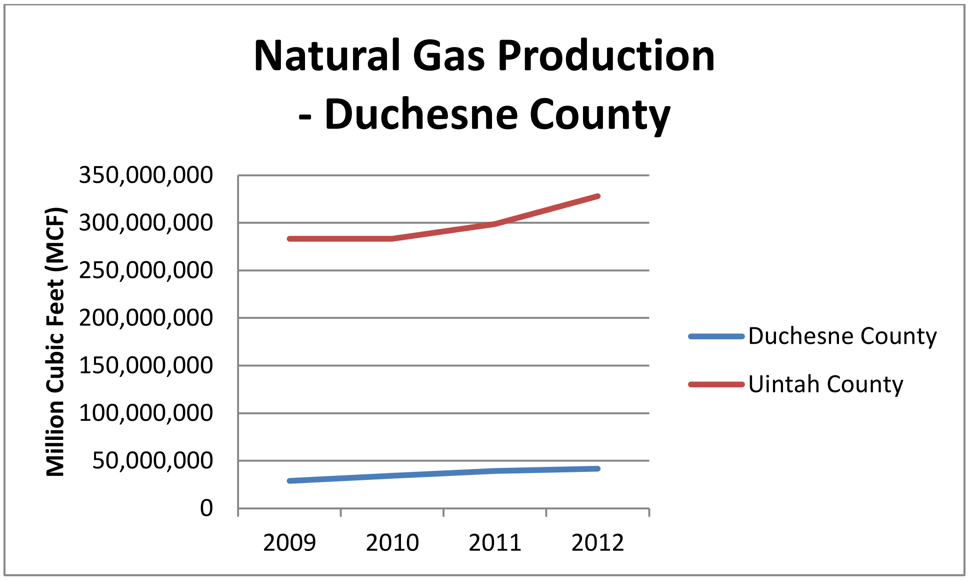
Retrieved from http://oilgas.ogm.utah.gov/Statistics/APD_county.cfm on 9 July 2013

Oil Production Uintah and Duchesne Counties



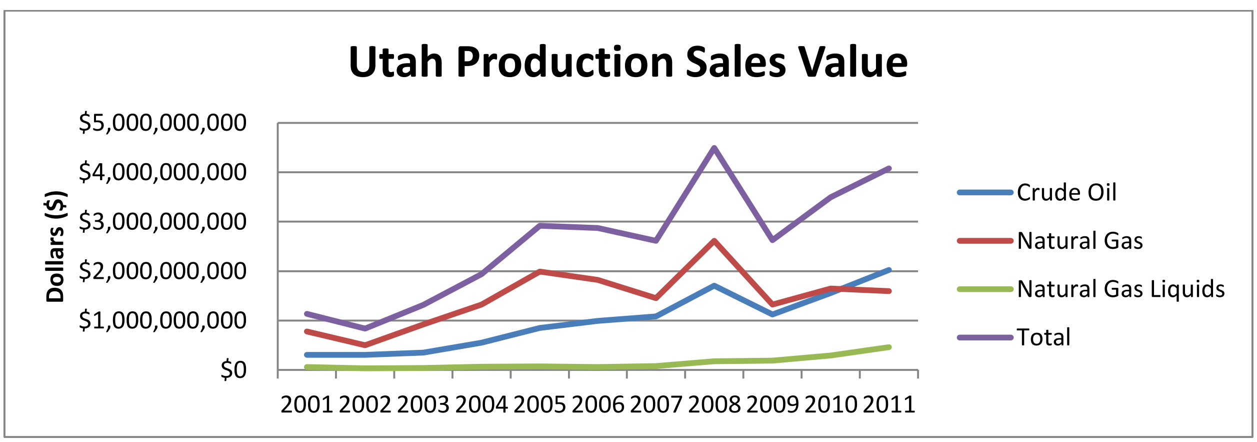
Oil volumes are reported in Barrels (1 Barrel = 42 U.S. Gallons).
Retrieved from http://oilgas.ogm.utah.gov/Statistics/ on 11 July 2013

Natural Gas Production Uintah and Duchesne Counties



Gas volumes are reported in MCF (1 MCF = 1,000 cubic feet).
Retrieved from http://oilgas.ogm.utah.gov/Statistics/ on 11 July 2013

Utah Production Sales Value



Retrieved from http://oilgas.ogm.utah.gov/Statistics/ on 11 July 2013

Appendix B:
Southwest Regional GAP Analysis Land Cover Key

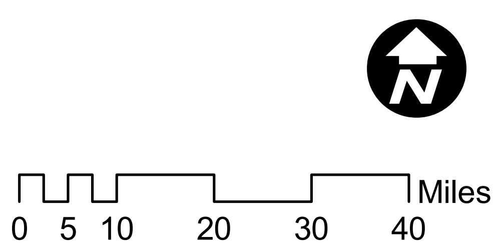
Legend

- Cities
- Roads
- UB_Boundary

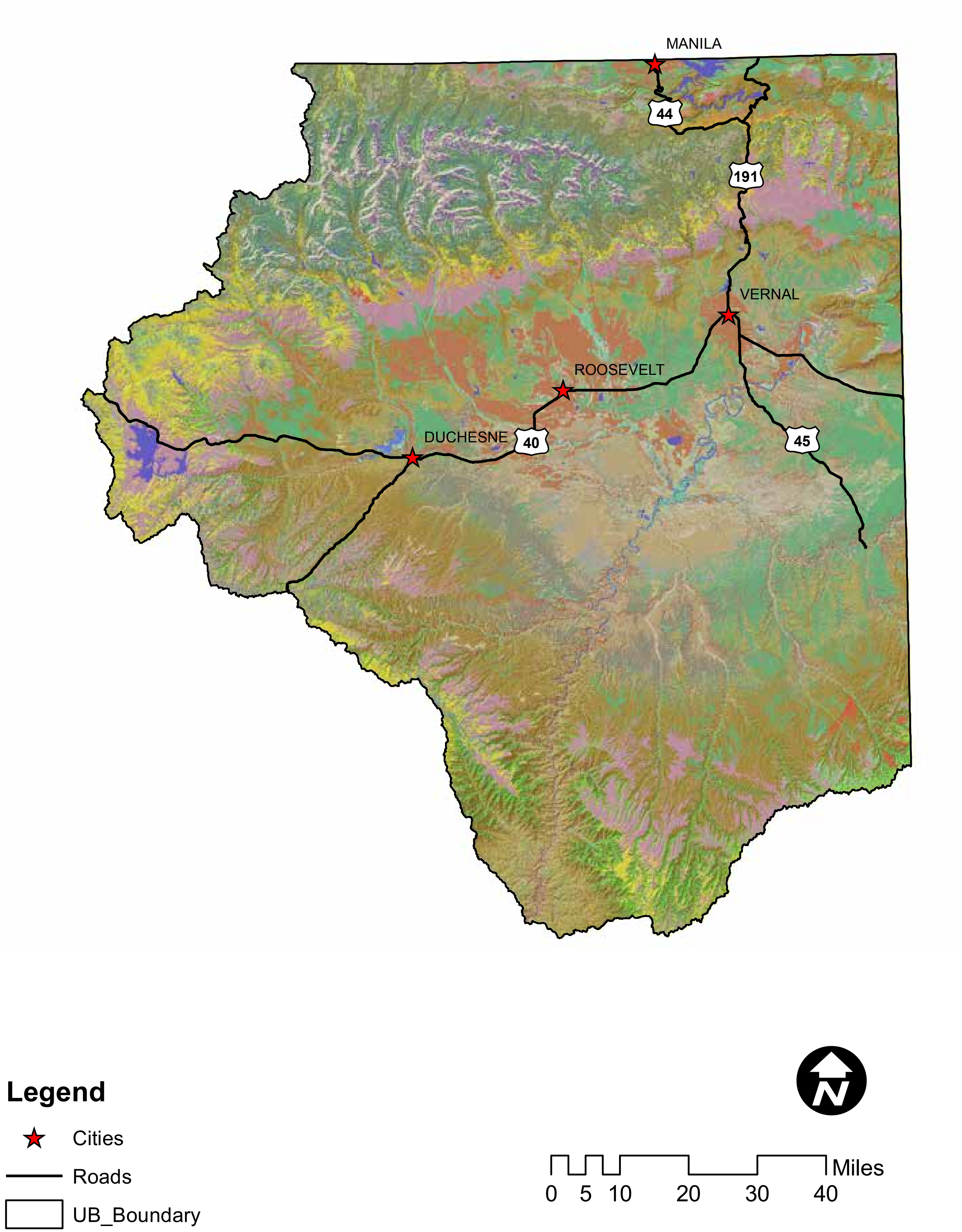
GAPUB

DESCRIPTION

- Agriculture
- Colorado Plateau Blackbrush-Mormon-tea Shrubland
- Colorado Plateau Mixed Bedrock Canyon and Tableland
- Colorado Plateau Mixed Low Sagebrush Shrubland
- Colorado Plateau Pinyon-Juniper Shrubland
- Colorado Plateau Pinyon-Juniper Woodland
- Developed, Medium - High Intensity
- Developed, Open Space - Low Intensity
- Disturbed, Oil well
- Inter-Mountain Basins Big Sagebrush Shrubland
- Inter-Mountain Basins Big Sagebrush Steppe
- Inter-Mountain Basins Greasewood Flat
- Inter-Mountain Basins Mat Saltbush Shrubland
- Inter-Mountain Basins Mixed Salt Desert Scrub
- Inter-Mountain Basins Montane Sagebrush Steppe
- Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland
- Inter-Mountain Basins Playa
- Inter-Mountain Basins Semi-Desert Grassland
- Inter-Mountain Basins Semi-Desert Shrub Steppe
- Inter-Mountain Basins Shale Badland
- Inter-Mountain West Aspen-Mixed Conifer Forest and Woodland Complex
- Invasive Annual and Biennial Forbland
- Invasive Annual Grassland
- Invasive Perennial Grassland
- Invasive Southwest Riparian Woodland and Shrubland
- North American Alpine Ice Field
- North American Arid West Emergent Marsh
- Open Water
- Recently Burned
- Recently Chained Pinyon-Juniper Areas
- Recently Logged Areas
- Recently Mined or Quarried
- Rocky Mountain Alpine Bedrock and Scree
- Rocky Mountain Alpine Dwarf-Shrubland
- Rocky Mountain Alpine Fell-Field
- Rocky Mountain Alpine-Montane Wet Meadow
- Rocky Mountain Aspen Forest and Woodland
- Rocky Mountain Bigtooth Maple Ravine Woodland
- Rocky Mountain Cliff and Canyon
- Rocky Mountain Dry Tundra
- Rocky Mountain Gambel Oak-Mixed Montane Shrubland
- Rocky Mountain Lodgepole Pine Forest
- Rocky Mountain Lower Montane Riparian Woodland and Shrubland
- Rocky Mountain Lower Montane-Foothill Shrubland
- Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland
- Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland
- Rocky Mountain Ponderosa Pine Woodland
- Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
- Rocky Mountain Subalpine Mesic Meadow
- Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland
- Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
- Rocky Mountain Subalpine-Montane Riparian Shrubland
- Southern Rocky Mountain Montane-Subalpine Grassland
- Wyoming Basins Low Sagebrush Shrubland



Southwest Regional GAP Analysis Land Cover



A guide to Firewise principles

THE FIREWISE COMMUNITIES PROGRAM provides homeowners with simple and easy steps to help reduce a home's wildfire risk by preparing ahead of a wildfire. These steps are rooted in principles based on solid fire science research into how homes ignite. The research comes from the world's leading fire experts whose experiments, models and data collection are based on some of the country's worst wildland fire disasters.

Below are Firewise principles and tips that serve as a guide for residents:

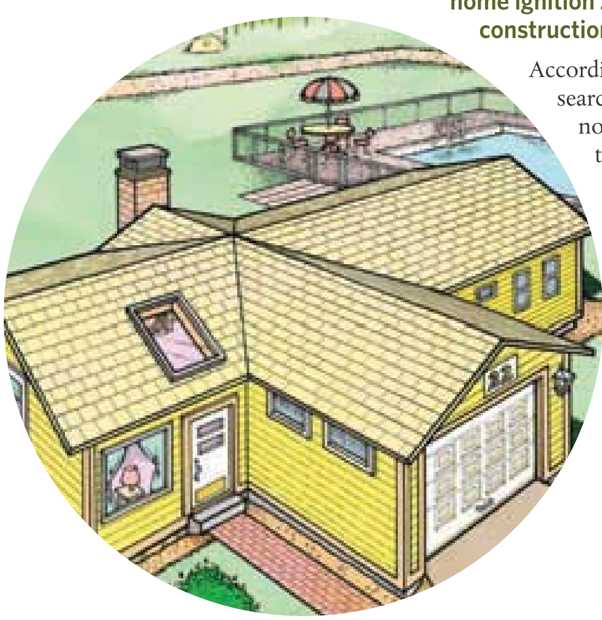
When it comes to wildfire risk, it is not a geographical location, but a set of conditions that determine the home's ignition potential in any community.

Wildfire behavior is influenced by three main factors: topography (lie of the land), weather (wind speed, relative humidity and ambient temperature) and fuel (vegetation and man-made structures). In the event of extreme wildfire behavior, extreme weather conditions are normally present, like extended drought, high winds, low humidity and high temperatures, coupled with excess fuel build up including the accumulation of live and dead vegetation material. Additionally, the inherent lie of the land influences the intensity and spread a fire takes. Fires tend to move upslope, and the steeper the slope the faster it moves.

Of these three factors, **fuel** is the one we can influence.

Debris like dead leaves and pine needles left on decks, in gutters and strewn across lawns can ignite from flying embers. Fire moving along the ground's surface can "ladder" into shrubs and low hanging tree limbs to create longer flames and more heat. If your home has flammable features or vulnerable openings, it can also serve as fuel for the fire, and become part of a disastrous chain of ignitions to other surrounding homes and structures.

A home's ignition risk is determined by its immediate surroundings or its "home ignition zone" and the home's construction materials.



According to fire science research and case studies, it's not where a home is located that necessarily determines ignition risk, but the landscape around it, often referred to as the "home ignition zone." The home ignition zone is defined as the home and its immediate surroundings up to 200 feet (60 m).

The Firewise Communities Program provides tips for reducing wildfire risk based on the home ignition zone concept:

Home Zone: Harden your home against wildfire. This includes fences, decks, porches and other attachments. From the point of view of a fire, if it's attached to the house it is a part of the house. Non-flammable or low flammability construction materials—especially for roofs, siding and windows—are recommended for new homes or retrofits. Keep any flammables, including plantings and mulch out of the area within 5 feet of your home's perimeter.

Zone 1: This well-irrigated area encircles the structure for at least 30 feet on all sides including decks and fences, and provides space for fire suppression equipment in the event of an emergency. Lawns should be well maintained and mowed. Plantings should be limited to carefully-spaced low flammability species. In particularly fire prone areas, non-flammable mulch should be considered.

Zone 2: This area encircles 30 – 100 feet from the home. Low flammability plant materials should be used here. Plants should be low-growing and the irrigation system should extend into this section. Shrubs and trees should be limbed up and spaced to prevent crowns of trees from touching.

Zone 3: This area encompasses 100 – 200 feet from the home. Place low-growing plants and well-spaced trees in this area, remembering to keep the volume of vegetation (fuel) low.

Zone 4: This furthest zone from the structure is a natural area. Selectively prune and thin all plants and remove highly flammable vegetation.

Homeowners can and must take primary responsibility for wildfire safety action around the home.

There are not enough fire fighting resources to protect every house during severe wildfires, and with shrinking budgets it means we need to do more with less. Fire fighters are trained to safely and efficiently suppress wildland fires, but their effectiveness is reduced when they must sweep decks, move wood piles and patio furniture while trying to fight a fire. According to fire science research, individual efforts do make a difference even in the face of a catastrophic wildfire.

The following steps are outlined by the Firewise program to reduce home ignition risk, based on this principle:

- Prune low hanging limbs to reduce ladder fuels
- Clean roofs and gutters of pine needles and dead leaves
- Keep flammable plants and mulches at least 5 feet away from your home's perimeter
- Use low-growing, well pruned and fire-resistive plants around home
- Screen or box-in areas below patios and decks with wire screening no larger than 1/8-inch mesh
- Sweep decks and porches clear of fallen leaves
- Move woodpiles away from the home during non-winter months
- Bring doormats and furniture cushions inside when an area is threatened by a wildfire
- Close garage doors when leaving your home in the event of an evacuation

We all have a role to play in protecting ourselves and others.

Your home ignition zone extends up to 200 feet—and it's quite common to have neighbors whose home ignition zone overlaps yours. Buildings closer than 100 feet apart can ignite one another if they are in flames. In addition, many communities have commonly owned property, including natural or wooded areas that can pose fire risks to all. This means that to be most effective, neighbors need to work together and with their local fire service to achieve greater wildfire safety.

Together, community residents can work with agencies and elected officials to accomplish the following:

- Ensure that homes and neighborhoods have legible/clearly marked street names and numbers
- Create "two ways out" of the neighborhood for safe evacuation during a wildfire emergency
- Create phone trees to alert residents about an impending fire
- Review any existing community rules or regulations on vegetation management and construction materials to see if they are "Firewise-friendly"
- Use the "Ready, Set, Go!" program with the fire department to educate neighbors
- Use the Firewise Communities/USA® Recognition Program to create and implement an ongoing action plan that will also earn the neighborhood national recognition for their efforts

LEARN MORE about how to keep families safe and reduce homeowners' risk for wildfire damage at www.firewise.org.

ADDITIONALLY, complimentary brochures, booklets, pamphlets, videos and much more can be found on the information and resources page of the website and ordered online through the Firewise catalog.

Appendix D

Smart Growth Principles

- Mix land uses
- Take advantage of compact building design
- Create a range of housing opportunities and choices
- Create walkable neighborhoods
- Foster distinctive, attractive communities with a strong sense of place
- Preserve open space, farmland, natural beauty, and critical environmental areas
- Strengthen and direct development towards existing communities
- Provide a variety of transportation choices
- Make development decisions predictable, fair, and cost effective
- Encourage community and stakeholder collaboration in development decisions

*Taken Directly from "This is Smart Growth" available online at: http://www.epa.gov/smartgrowth/pdf/2009_11_tisg.pdf

What Is Smart Growth?

Health, schools, taxes, traffic, the environment, economic growth, fairness, opportunity—many of the things we care about—are all affected by development decisions. From the length of our daily commute to the price of a new home to the safety of our neighborhoods—what, where, and how we build have major impacts on our personal lives, our communities, and our nation.

Growth presents a tremendous opportunity for progress. Communities around the country are looking for ways to get the most out of new development and to maximize their investments. Frustrated by development that requires residents to drive long distances between jobs and homes, many communities are challenging rules that make it impossible to put workplaces, homes, and services closer together. Many communities are questioning the fiscal wisdom of neglecting existing infrastructure while expanding new sewers, roads, and services into the fringe. And in many communities where development has improved daily life, the economy, and the environment, smart growth principles (see facing page) have been key to that success.

When communities choose smart growth strategies, they can create new neighborhoods and maintain existing ones that are attractive, convenient, safe, and healthy. They can foster design that encourages social, civic, and physical activity. They can protect the environment while stimulating economic growth. Most of all, we can create more choices for residents, workers, visitors, children, families, single people, and older adults—choices in where to live, how to get around, and how to interact with the people around them. When communities do this kind of planning, they preserve the best of their past while creating a bright future for generations to come.

If you've heard the term *smart growth* and want to know what it actually looks like, this publication is a good starting point. If you're already familiar with smart growth ideas, this publication can help you educate others. It contains many examples of how smart growth principles have been applied in cities, suburbs, small towns, and rural areas; some of these examples may look much like your own community.

Thirty-six national organizations that work on community design and development, environmental protection, and public health have endorsed this booklet. These organizations have many resources, some of which are listed in the *Resources* section, to help you learn more about smart growth techniques and apply them in your community.

Growth is smart when it gives us great communities, with more choices and personal freedom, good return on public investment, greater opportunity across the community, a thriving natural environment, and a legacy we can be proud to leave our children and grandchildren.

This is smart growth.

*Taken Directly from "This is Smart Growth" available online at: http://www.epa.gov/smartgrowth/pdf/2009_11_tisg.pdf

Appendix E

*Taken directly from BLM Website at: http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas

BMP General Information

What are Best Management Practices?

The U.S. Bureau of Land Management (BLM) manages many outstanding resources, including important wildlife habitat, scenic western landscapes, flowing streams and rivers, recreational opportunities, and oil and natural gas production. As oil and gas development and production continues across much of the rural West, it is important the BLM take precautions to ensure development on the public lands is conducted in a manner that prevents or lessens its impact on Public Lands resources.

The BLM continues to improve the way it manages oil and gas development on the Public Lands. Part of that improvement includes the use of Best Management Practices (BMPs) to lessen the effects of oil and gas development on the environment. The oil and gas industry and the BLM are constantly developing and improving BMPs. The BLM has collected a sampling of these BMPs and included them on this website.

Visual Resources

(*To the Right:* Dark Green Pumping unit partially screened with trees)

Many BMPs focus on reducing the visual or physical "footprint" of development. The theory is, the less vegetation that is disturbed, the less harm will come to wildlife habitat and the scenic beauty our western landscapes offer.

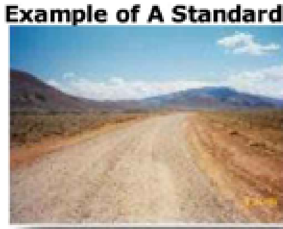
The choice of color is perhaps the most common and simplest BMP for reducing visual contrast. By selecting colors that help oil and gas equipment blend into the background, we lessen the visual intrusion on the landscape.

Road Building

An Example of a two-track Road

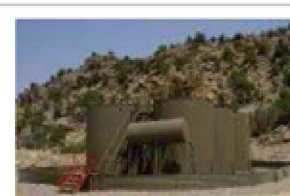
BMPs reduce the amount of area disturbed for development.
In some cases, two-track roads are used to lessen disturbance...

An Example of A Standard Road



...rather than standard roads which disturb more habitat and create more visual contrast.

Reducing Human Activity in Wildlife Habitat



(To the Right: Centralized tank battery*)*

BMPs can also reduce the footprint of human activity and its harmful effects on wildlife populations. Placing produced oil, water, or condensate tanks in centralized locations, away from important wildlife areas, can greatly reduce the amount of truck traffic in wildlife habitat. Centralizing tank batteries eliminates the need to drive large tanker trucks to each well and reduces the need to maintain large roads in support of the trucks.

Reclamation

(*To the Right:* Interim reclamation on coalbed natural gas access road)

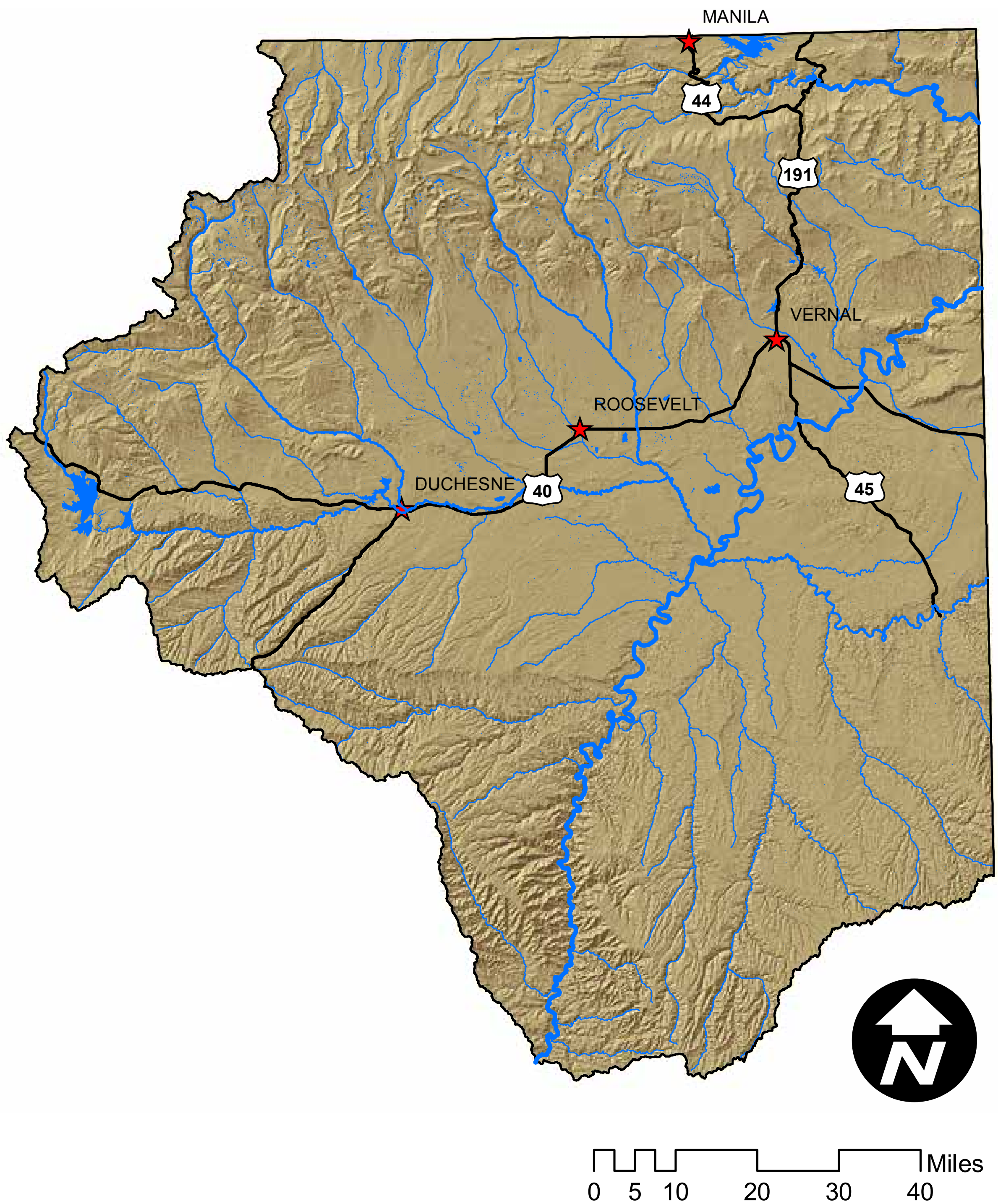
"Interim Reclamation" is used to restore vegetation, and scenic and habitat resources while a well continues to produce energy. With interim reclamation, all areas not needed for the production of oil and gas are reclaimed, that is, reshaped, covered with topsoil, and reseeded with native plants.

When the well no longer produces oil and gas, final reclamation begins. The well is sealed (plugged) with cement to protect freshwater aquifers. The entire well location and access road are reshaped as closely as possible to the original contour, covered with topsoil, and reseeded. Over a period of years the site will regrow native vegetation, eventually making it very difficult to find the well location.

(*To the Right:* A restored well location)

The continued support and use of BMPs will help to ensure a sustainable oil and gas exploration, development, and production program that is conducted in a manner that minimizes harm to the environment while serving the Nation's energy needs.

Appendix E:
Uintah Basin Hydrology- Surface Water



A. L-R: Professor Toth, Matt Coombs, and Tyler Allen at Dinosaur National Monument; **B.** L-R: Matt Coombs, Michael Gottfredson, Professor Toth at Split Mountain on the Green River, Uintah County; **C.** L-R: Paul Hacking, Cheri McCurdy, Irene Hansen, and Seth Lyman at a stakeholder meeting; **D.** L-R: Matt Coombs, Professor Toth at Split Mountain on the Green River, Uintah County; **E.** Matt Coombs, Professor Toth, and Randy Anderson at a natural gas pad in Uintah County; **F.** L-R: Matt Coombs, Tyler Allen, and Michael Gottfredson at Dinosaur National Monument.