3.0 Affected Environment

3.1 Geologic Setting

3.1.1 Geology

The Navajo Nation lies entirely on the Colorado Plateau, and is composed of a variety of geologic features including canyons, mesas, barren badlands, and expansive flatlands (Foos 1999). The Colorado Plateau covers an area of approximately 130,000 square miles, covering western Colorado, northwestern New Mexico, southeastern Utah, and the northern Arizona. Land surface elevations within this area can range from 5,100 feet above sea level on the western side to over 10,000 feet within some of the mountain ranges found within the project area. The region is rich with geologic history through plateau uplift, deposition, and hydrologic erosion, giving rise to the unique features and landscape of the Southwestern United States. Specifically, the Navajo Nation lies mainly on the Navajo Section of the Colorado Plateau, with some territory on the Grand Canyon and Datil Sections (Rigby 1977).

Major geological formations found on the Navajo Nation include the Chuska and Carizzo Mountains, Defiance Plateau, and the San Juan Basin in the eastern portion of the region (**Figure 3-1**). The Chuska Mountains and the Defiance Plateau are part of the same monocline region, separated by the Black Creek Valley. The uplift is formed from volcanic and sedimentary rocks with geologic layers ranging from the DeChelly Sandstone through the Chuska Sandstone formations with Defiance Plateau lying between 7000 to 8000 ft in elevation and the Chuska Mountains reaching over 10,000 ft in elevation (Harshbarger and Repenning 1954, Peirce et al. 1979). The San Juan Basin located near Farmington is a major coal source thanks to the prominent Fruitland Formation that borders the outlying portions of basin (Fassett 2000). In the western portion, Marble Canyon and Echo Cliffs run down from Navajo Nation border with the Grand Canyon. Marble Canyon and Echo Cliffs run along a tributary of the Colorado River from Lee's Ferry to the Little Colorado River. The canyon is a prominent monocline, exposing cliffs from the Moenkopi and Chinle Formations. Black Mesa, a prominent mesa in the northern center of the region, rises over 8000 ft in elevation as a Cretaceous island formed from folded geologic layers and topped with soils derived from geologic layers ranging from the Dakota formation to Mesaverde sandstone (Nations et al. 2000). In the north, Navajo Mountain is a prominent laccolith, formed from igneous rock intruding into sedimentary substrate layers towering over 10,000ft in elevation. Shiprock, a prominent monadnock located near the town of the same name, is part of a field of the Chuska Volcanic Field, which is collection of similar geologic features that remain from an ancient volcano that previously existed in the area (Crumpler 2015).

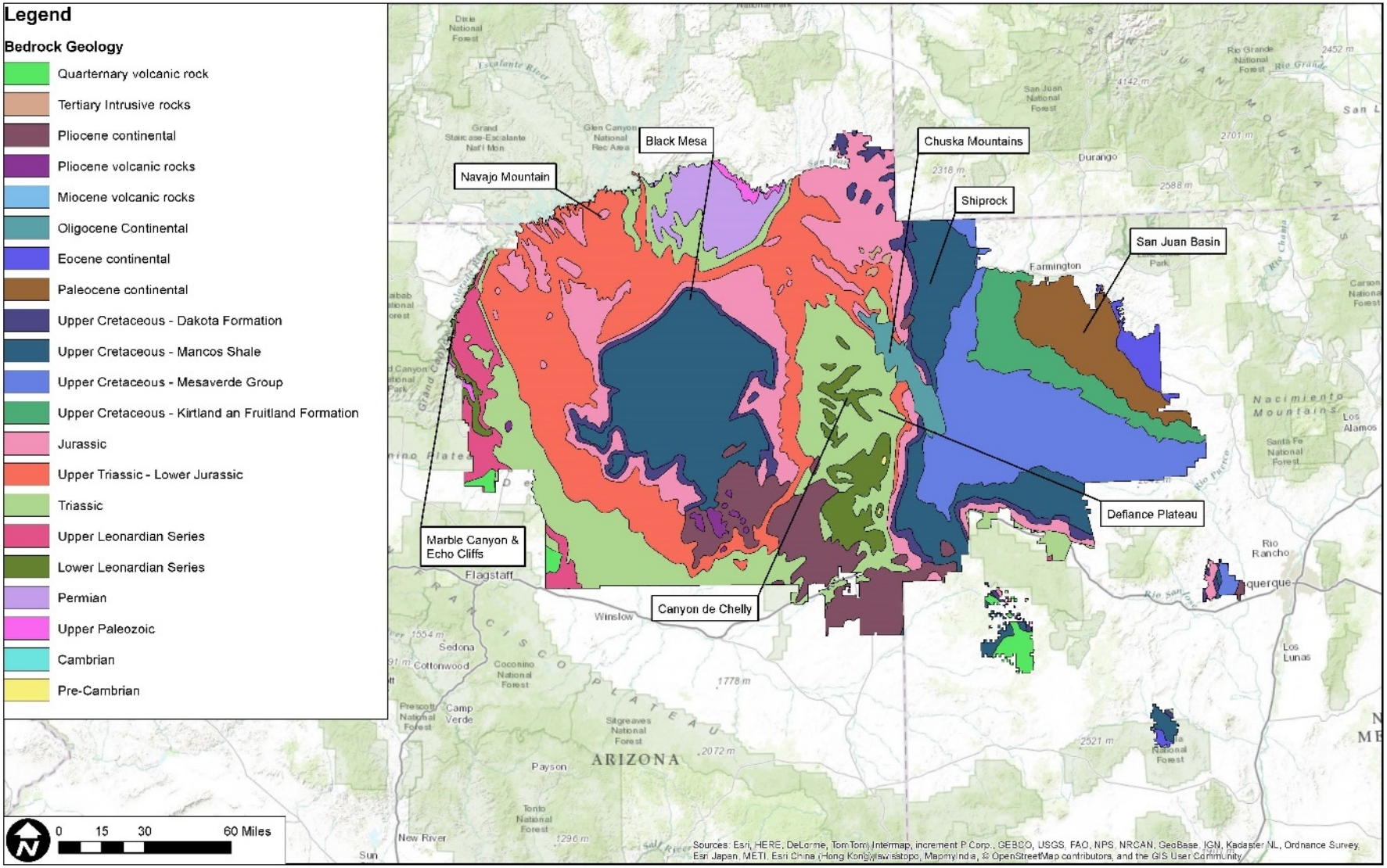

Figure 3-1. Map of bedrock geology for the Navajo Nation. Geologic layers are based on the King and Beikman map for the United States (1974) with modifications to labeling nomenclature to reflect regional stratigraphic layers and group names per USGS mapping efforts

The Navajo Nation is rich with geologic history, allowing geologists to view and study a variety of geologic layers and events that helped shaped this unique landscape (**Figure 3-2**). Bedrock layers for the region can range from Pre-Cambrian gneiss to Quaternary alluvium. Prominent formations within this layer include the Supai formation, Coconino Sandstone, and Kaibab Limestone. Mesozoic rock layers were formed mostly through depositional inputs over time and are mostly composed of sandstone and shale. Key formations within this group of geologic layers include the Moenkopi Formation, the Chinle Formation, the Kayenta Formation, Navajo Sandstone, and the Mesaverde group. Cenozoic rock layers are formed from igneous intrusion, volcanic rock, and gravel. Finally, many portions of the Navajo Nation have significant cover from quaternary deposits, including eolian sand dunes and alluvial deposits (**Figure 3-3**).

Surface geology on the Navajo Nation is also important for understanding the geologic history of the area as well as the vegetation communities and species that are currently present. These components are where much of the existing soils are derived and can provide information on major forces that help shape the landscape of the Navajo Nation today. Much of the region is covered with broad alluvial valleys, where rivers and waterways carried fine grained sediments during the Holocene, which are most apparent near the Colorado and Little Colorado River Valleys, the Black Mesa region, San Juan Basin, and Chaco Canyon (Andrews 1991). While alluvium deposition is still a major source for sedimentation and soil genesis near streams, rivers, and washes, nearly a third of the Navajo Nation is covered with eolian sand, or wind distributed sediments (Muhs and Been 2004, Redsteer et al. 2010). Recent changes in climate have caused drier conditions resulting in decreased vegetative cover and an increase in the transport of eolian sand dunes within the region, facilitating dune formation and migration within the region. Additionally, these changes further encourage the replacement of perennial grasses with annual species, such as Russian thistle, which only provide temporary stabilization of eolian deposits and soils, contributing to increasing dust storms and loss of top soil on the Navajo Nation (Draut et al. 2012).

3.1.2 Mineral Resources

Due to the unique geologic setting of the Navajo Nation, the area has several mineral resources that have been mined and extracted within the area. Mineral deposits are highly linked to the varying geologic layers found within the Navajo Nation. The development of different extraction industries for mineral resources has been rife with controversy on the Navajo Nation, much of it from the results of environmental and public health impacts to surrounding communities.

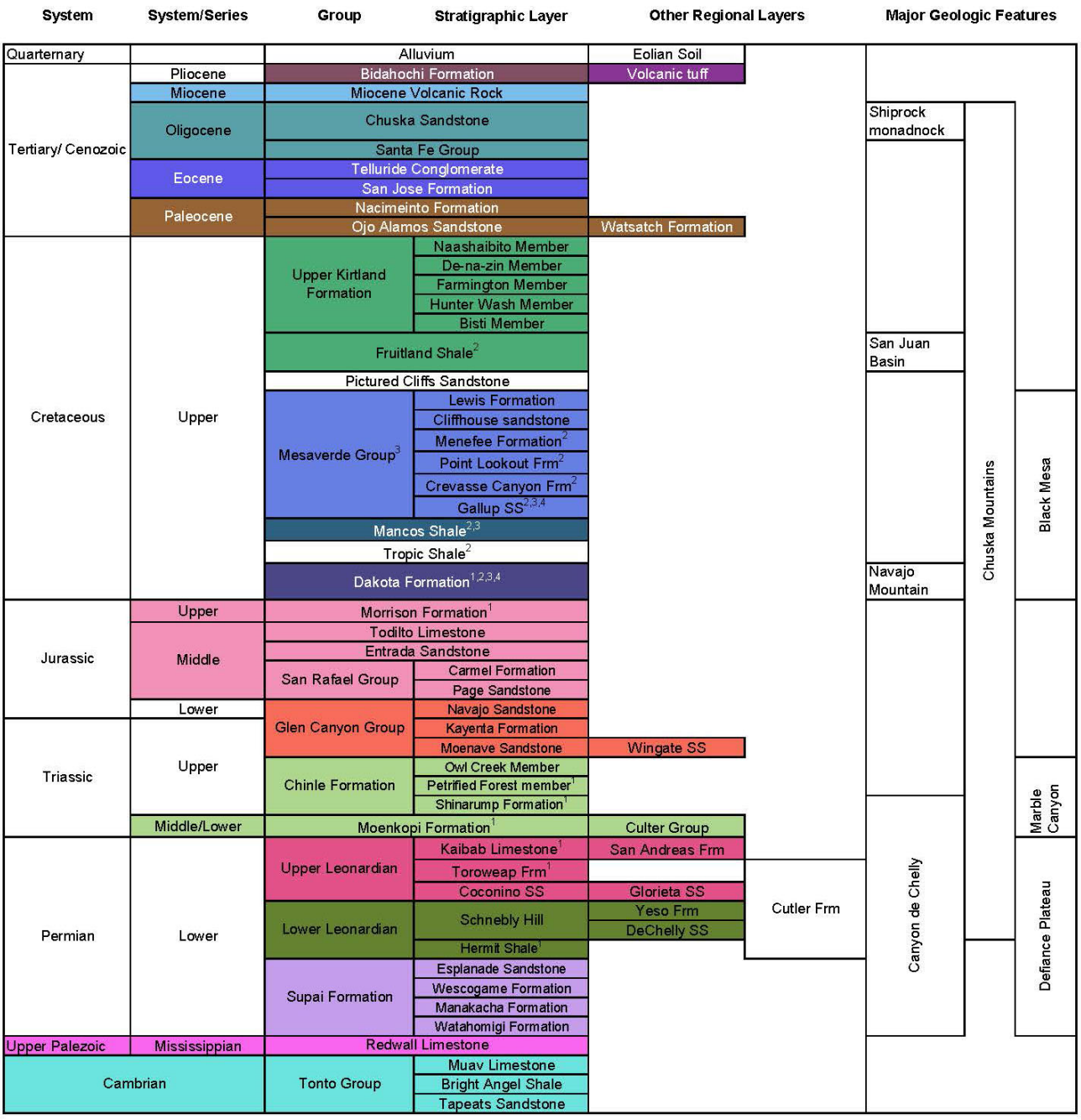

Figure 3-2. A stratigraphic chart of major geologic layers that can occur on the Navajo Nation, with younger layers at the top and older layers at the bottom. This chart is not scaled to for geologic time and the presence of different geologic layers varies across the region. Numbers on the chart denote layers where resources such as [1]uranium, [2]coal, [3]oil, and [4]methane can potentially exist. Colors correspond with the geologic bedrock layers described in Figure 3-1.

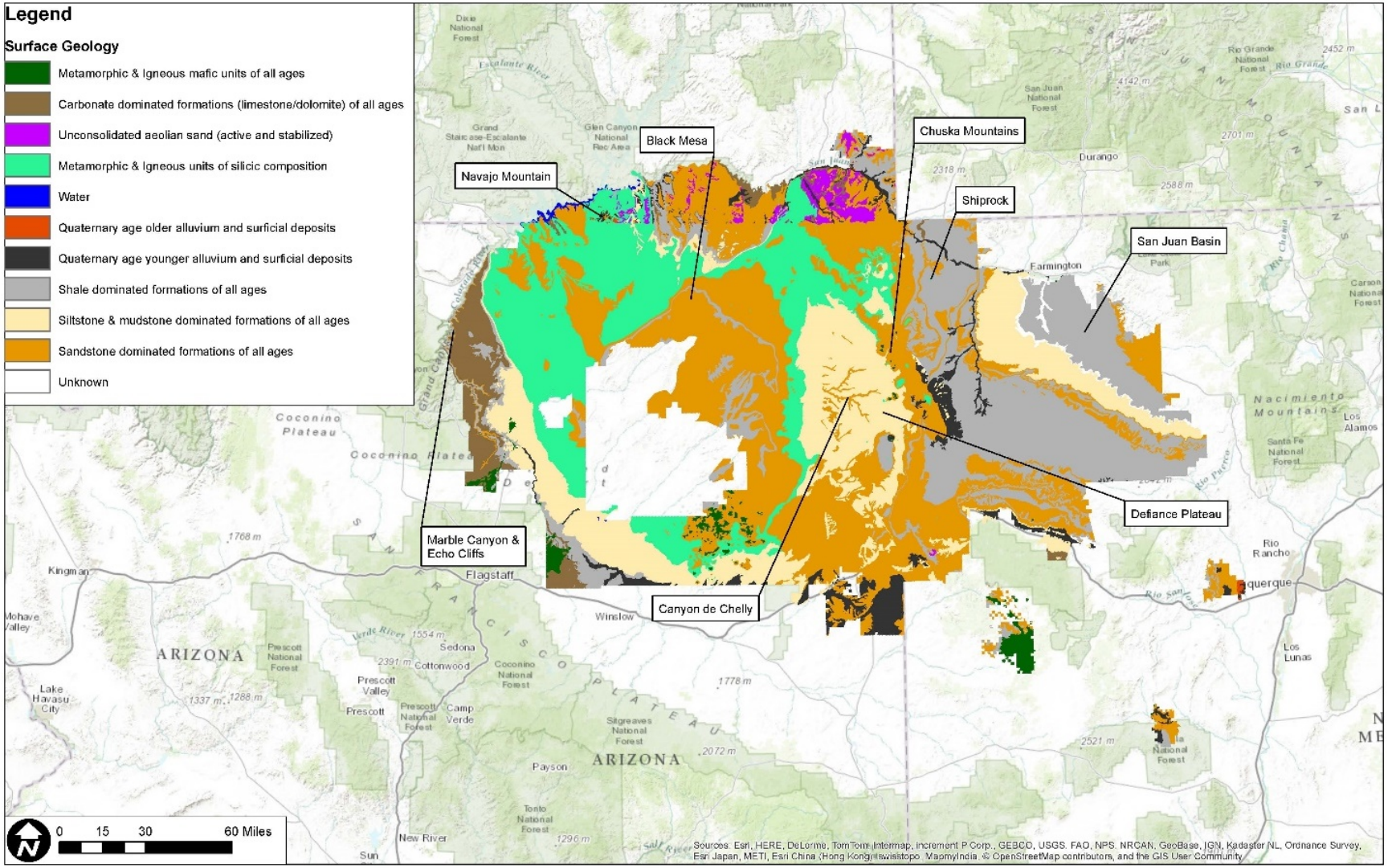

Figure 3-3. Surficial geology of the Navajo Nation as developed by the Southwestern Regional Gap Analysis Project (USGS 2005). Surficial data was compiled from geologic maps from Arizona (Hirschberg and Pitts 2000), New Mexico (Green and Jones 1997), and Utah (Ramsey 1996) to develop a generalized map for the region.

The most famous and controversial of mineral industries was the uranium mining that occurred on the Navajo Nation from the 1940's through the mid-1980's. Sandstone deposits, such as the Shinarump member of the Morrison, Chinle, and Moenkopi Formations, are the geologic layers where uranium is most abundant in the Navajo Nation (Repenning et al. 1969, Chenoweth 1993, Billingsley et al. 2007, TerraSpectra Geomatics 2007). In the 1940's the discovery of uranium deposits in the region and the threat of the Cold War, led to the widespread establishment of uranium mining operations. While mining operations slowed around the mid-1960s and stopped altogether in the mid 1980's, the remains of hundreds of abandoned mines and mine waste has left major impacts on the Navajo people, leaving many communities and workers to deal with the impacts of increased radiation exposure and illness (USEPA 2013). As a result of such actions, the Navajo Nation passed a legal ban on uranium mining through the Diné Natural Resources Protection Act of 2005 (18 N.N.C. §1301)

Uranium mining occurred across the Navajo Nation in six areas, which have been designated by the U.S. Environmental Protection Agency (U.S. EPA) as abandoned uranium mine regions where mining operations were concentrated (**Figure 3-4)**. While similarly named, these mining regions are not related to the Navajo Agencies. On the Western Abandoned Uranium Mining Region, major mining was concentrated in Cameron, although mining operations occurred from Bitter Springs in the North to Grand Falls in the south and as far east as Ward Terrace. The Morale Mine in the Hopi Buttes was the only productive mine in operation in the Southern Abandoned Uranium Mining region. The Central Abandoned Uranium Mining Region had several mines on the east side of Black Mesa, with a few located near Rough Rock. In the North-Central Abandoned Uranium Mining Region, mining occurred in Monument Valley along the Arizona-Utah border with the Whirlwind mine on the San Juan River. For the Northern AUM Region, mining operations were conducted around the Carrizo Mountains with a few straddling the Arizona-New Mexico border and the Cove Mesa mine located further south near the Lukachukai Mountains. In New Mexico, a few mines in the region were also in the Sanostee region. The Eastern Abandoned Uranium Mining Region saw mining operations in the productive Grants Uranium District, stretching from Church Rock in the west to Ambrosia Lake in the east (USEPA 2013). To date, the U.S. EPA has identified over 500 different abandoned mine locations on the Navajo Nation (USEPA 2013).

Clean-up efforts are coordinated and implemented in the region by the U.S. EPA, the Navajo Nation EPA Superfund Program, and the Nuclear Regulatory Commission, with additional funding provided by Anadarko Petroleum and Kerr-McGee Corporation as the result of Department of Justice settlement in 2014 (USEPA 2013, USDOJ 2014). However, the recent increase in demand for uranium oversees has increased pressure on the Navajo Nation to permit uranium mining once again. Several mining companies have purchased mining rights to lands and rights-of-way located on the Navajo Nation and have been seeking approval to conduct mining operations in the area. In the southeastern portion of the Navajo Nation, the

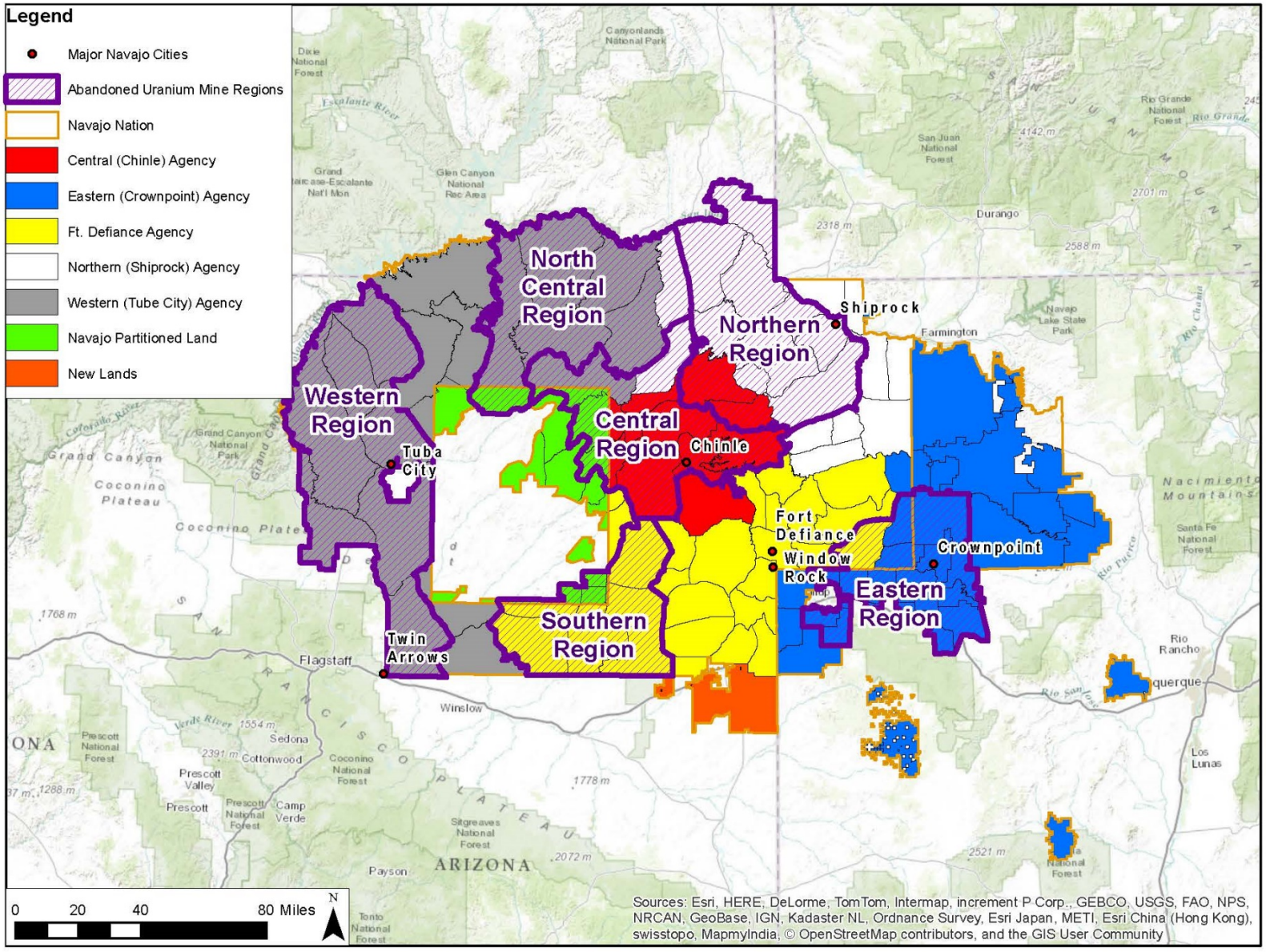

Figure 3-4. U.S. EPA Map showing Abandoned Uranium Mining Regions designated on the Navajo Nation (USEPA 2014).

checkerboard of federal, tribal, state, and private land has raised new questions about mining operations and how they may commence despite the tribal ban.

Coal mining is still a major mineral extraction industry within the Navajo Nation. Coal deposits are located throughout the Navajo Nation, with major coal fields located at Black Mesa and the San Juan Basin. In the San Juan Basin, coal is largely found within the Fruitland formation of the Upper Cretaceous age and is the second largest natural gas and oil producing basin in the conterminous United States (Fassett 2000). Additional deposits are also found in formations associated with the Upper Cretaceous system (Nations et al. 2000, Billingsley et al. 2007, Ridgley et al 2013). Permitted coal mines on the Navajo Nation include the Amcoal, Kayenta Mine, Black Mesa Mine and Pipeline, Navajo Mine, and Burnham Mine (**Table 3-1**). All mining operations on the Navajo Nation are done through surface mining techniques. Only two mines are actively in operation: Navajo Mine and Kayenta Mine. Black Mesa Mine is currently inactive, however Peabody Western Coal Company (a.k.a. Peabody Energy) is seeking to open operations for the mine in the near future. The remaining mines are in the process of reclamation through the Office of Surface Mining (OSMRE 2014).

Table 3-1. Permitted coal mining operations on the Navajo Nation, including legal owner, and operation status as of 2013 (OSMRE 2014).

Name	**Owner**	**Status**
Kayenta Mine	Peabody Western Coal Company	Active
Navajo Mine	Navajo Transitional Energy LLC	Active
Black Mesa Mine	Peabody Western Coal Company	Inactive
McKinley North Mine	Chevron Mining, Inc.	In Reclamation
Amcoal Mine	Amcord, Inc.	In Reclamation
Burnham Mine	Consol Energy	In Reclamation
Black Mesa Pipeline	Peabody Western Coal Company	In Reclamation

On Black Mesa, use of the Navajo Aquifer to transport coal off the reservation led to accusations that mine operations were depleting and contaminating the ground water supply. The pipeline on Black Mesa used water from the aquifer to help break up the extracted coal and transport it to the Mohave Generating Station in Nevada. However, the Mohave Generating Station was closed in 2006 which ceased operation of the pipeline and Black Mesa Mine. Current operations at Kayenta Mine however have continued and recent expansion of the mine to include facilities at Black Mesa Mine are currently proposed, which will supply coal to the Navajo Generating Station in Page, AZ. The Navajo Mine currently is the main provider of coal to the Four Corner's Power Plant and the San Juan Generating Station (OSMRE 2014). The Peabody Western Coal Company is currently a member of the Moenkopi Cooperative Weed Management Area and assists other Cooperative Area members with inventory and identification of weeds, developing and implementing weed control projects, and contributing to project funding (BIA 2010)

Gas and oil extraction is also a major industry on the Navajo Nation. While natural gas exploration does not currently occur on the Navajo Nation, close to 150,000 acres have been identified by the Navajo Nation as potential mineral resource development areas (Landry 2013). For natural gas exploration, fracturing of below ground shale fomations through drilling and injecting a mixture of sand, water, and chemicals to release the gases. Oil exploration requires drilling into deep geologic layers to access reserves of crude oil and then pumping them to the surface. The Navajo Nation Oil and Gas Company currently operates an 87-mile pipeline to transport these resources, delivering the oil and gas to distributors and refiners (NNOGC 2015).

Mining and processing of construction materials, such as crushed stone, sand, and gravel, are also important mining operations conducted on the Navajo Nation. Materials such as red dog ore, humic acid, and soil aggregates are also commonly mined on the Navajo Nation to help provide construction and building materials.

3.2 Paleontological Resources

A variety of paleontological resources exist on the Navajo Nation including vertebrate and invertebrate animal fossils, fossil leaves, palynomorphs, petrified wood, and trace fossils. Some portions of the Navajo Nation are particularly important paleontologically, as some of the best-preserved botanical, mammalian, and reptilian fossils in North America are known to occur in the Triassic, Jurassic, Cretaceous, and Tertiary rock formations that underlie the region. Dinosaurs and other fossils that have made significant contributions to the scientific record have been recovered from the Navajo Nation. Along the eastern and northern boundaries of the Nation in New Mexico, the BLM has designated a number of areas for special management emphasis to preserve important paleontological resources for scientific study and other public benefits. These include the Bisti/De-Na-Zin Wilderness and the Ah-Shi-Sle-Pah Wilderness Study Area (respectively west and southwest of Nageezi, New Mexico). While on BLM land, these areas are surrounded by checkerboard Navajo land. In Arizona the Petrified Forest National Park, well known for its fossilized trees (and to a lesser extent its wide variety of other fossils), is bordered to the north and partially on the east by the Navajo Nation.

However, to date few areas of the Navajo Nation have been systematically surveyed for paleontological resources. One exception is the area around the Four Corners Power Plant and Navajo Mine southwest of Farmington, New Mexico. Ten locations of significant paleontological resources have been confirmed in this area by recent work (OSMRE 2015). Immediately adjacent to or potentially impacted by the action alternatives of this example project are the Lybrook and Betonnie Tsosie fossil areas. The Betonnie Tsosie Fossil Area is a type location for early Paleocene North American land mammals (BLM 2003).

There is no Navajo Nation legislation requiring paleontological resource inventories on their lands. Nevertheless, once paleontological resources are identified they are protected under Nation rules and regulations. Permits for collecting fossils on the Navajo Nation are issued by the Minerals Department (Bradley Nesemeier, Navajo Nation Sr. Geologist, personal

communication, 5/21/15; Wolberg and Reinhard 1997), and are issued only for scientific research or mitigation. The Indian Affairs Manual Part 57, Chapter 7 entitled *Environmental and Cultural Resources Management, Paleontological Resources* established a policy on the specific requirements and responsibility of the BIA for the protection and management of paleontological resources on Indian lands. The policy is specific to imbedded fossils (when a fossil cannot be moved from a location without aid of a tool or instrument) on Indian lands. Before any person excavates or removes an imbedded fossil from Indian lands, BIA must issue a permit. The above-referenced Indian Affairs Manual outlines this procedure. Furthermore, paleontological permits issued by BIA are subject to compliance with the National Environmental Policy Act of 1969; National Historic Preservation Act of 1966 (as amended through 2000), Section 106; Endangered Species Act 1973, Section 7; the Material Act of 1947; and the Federal Land Management Policy Act of 1976 (per the Indian Affairs Manual Part 57, Chapter 7 and Wolberg and Reinhard 1997).

3.3 Soils, Water, and Air

3.3.1 Soil Resources

Soils on the Navajo Nation range from arid, saline soils in low lying deserts and scrublands to productive soils with considerable amounts of organic matter within productive forests. Soils are the result of complex interactions between parent material (geology), climate, topography, organisms and time (Brady & Weil 1999). Soils are classified by the degree of development into distinct layers or horizons and their prevailing physical and chemical properties (Fanning & Fanning 1989). Similar soil types are grouped together into soil orders based on defining characteristics such as organic matter and clay content, amount of mineral weathering, water and temperature regimes, or other characteristics that give soil unique properties (Jenny 1980).

Five soil orders are represented on the Navajo Nation trust lands (**Figure 3-5**). Soils in the area are formed mostly from sandstone, although basalt, limestone, shale, and siltstone are also important sources of parent material. Soil forms are also heavily influenced by the arid to semi-arid climate, predominant vegetative communities, and the distinct topography of the region. Because soils develop under local soil forming factors, they are organized here by soil order. Soil data was obtained from the NRCS web soil survey for Arizona, New Mexico and Nevada to assess major soil orders and coverage on the Navajo Nation (NRCS 2013). Soils are currently inventoried and assessed through a Memorandum of Understanding developed between the BIA and NRCS to complete Order 3 and Order 4 surveys on a regular basis (BIA 2012). Order 3 surveys are more detailed and are typically done around areas proposed for development or construction. Order 4 surveys are less detailed and more applicable to rangelands and farming areas. Soils provide important ecosystem services as well, from water filtration, impacting nutrient exchange from terrestrial ecosystems to surface and groundwater reservoirs, and providing a variety of nutrients to plants and animals. Currently, soil surveys are required for

activities such as farming, infrastructure or land development, and community planning on Navajo Nation.

3.3.1.1 Entisols

Entisols make up the majority of soils on the Navajo Nation, occurring on 61.4% (11.5 million acres). They are young, weakly developed mineral soils that lack significant profile development (soil horizons) and are often found in lower elevation, arid and semi-arid environments supporting desert shrub and sagebrush communities. Entisols can include recent alluvium, sands, soils on steep slopes, and shallow soils. Soil productivity ranges from very low in soil forming in shifting sand or on steep rocky slopes to very high in certain soils formed in recent alluvium. Productivity is often limited by shallow soil depth, low water holding capacity, or inadequate available moisture, but these soils do support rangeland vegetation and may support trees in areas of high precipitation.

3.3.1.2 Aridisols

Aridisols occur on 24.2% (4.5 million acres) of the Navajo Nation. These soils are characterized by an extreme water deficiency. They are light colored soils, are low in organic matter, and may have subsurface accumulations of soluble materials, such as calcium carbonate, silica, gypsum, soluble salts, and exchangeable sodium. Vegetation on these soils include scattered desert shrubs and short bunchgrasses, which are important resources for livestock. Aridisols are generally not very productive without irrigation, and may be prone to salinity buildup. Surface mineral deposits often form physical crusts that impede water infiltration.

3.3.1.3 Alfisols

Alfisols are found on 8.4% (1.5 million acres) of the Navajo Nation. They are characterized by subsurface clay accumulations and nutrient-enriched subsoil. While Alfisols are commonly found in more temperate and humid regions, in the southwest, they can form in low lake terraces and alluvial fans where water is more available. Alfisols commonly have a mixed vegetative cover and are productive for most crops, including commercial timber.

3.3.1.4 Mollisols

Mollisols occur on 4.2% (791,000 acres) of the Navajo Nation. These soils typically support grasslands and are mineral soils with thick, dark-colored surface horizons rich in organic matter from the dense root systems of prairie grasses. They are one of the most productive soils in the southwest, and their high organic matter content helps reduce the risk of groundwater contamination by herbicides. Mollisols extend from upland areas to the prairie grasslands, where they are most abundant. Mollisols support a variety of plant communities including grasslands, chaparral-mountain shrub, and forests. Since they have developed primarily under grassland vegetation, mollisols have been used extensively for livestock grazing.

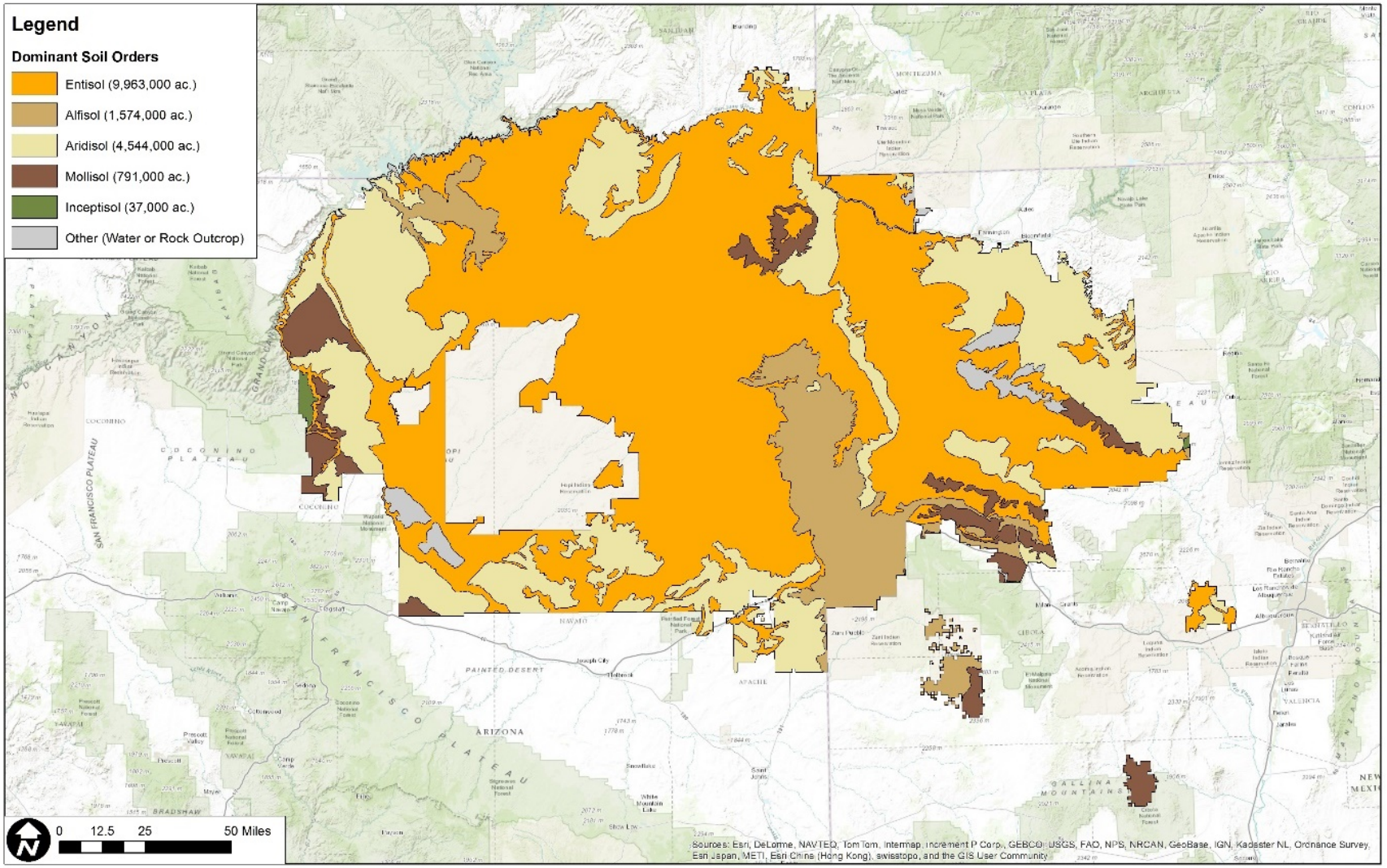

Figure 3-5. Map of dominant soil orders found on the Navajo Nation as reported by the Natural Resource Conservation Service (2013).

3.3.1.5 Inceptisols

Inceptisols are the least abundant soil type on the Navajo Nation, covering around 0.2% (37,000 acres) of the project area. They are generally young mineral soils, but have had more time to develop profile characteristics than Entisols. They principally occur in very cool to warm, humid, and subhumid regions and in most physiographic conditions, and often support coniferous and deciduous forests as well as rangeland vegetation. They may form in resistant rock or thin volcanic ash on steep mountain slopes or depressions, on top of mountain peaks, or next to rivers. Productivity is varied and may be high where moisture is adequate.

Other classified areas included in the soil survey data for the Navajo Nation include, water, rock outcrops, and badlands. Areas classified as water (52,000 acres) include major rivers, lakes, and water bodies within the Navajo Nation. Rock outcrops are exposures of bare rock covers 50-75% of the survey surface and may be associated with shallow soils (Boettinger 2009). Badlands are arid land formations composed of soft sedimentary rocks and clay rich soils that have been extensively eroded by wind and water (Boettinger 2009). They are most common in canyons, ravines, and gullies. Visually, badland areas are distinct for the irregular, jagged, and fluted land formation created by erosional processes and geological formations.

Soil quality affects soil function, including how soils sustain plant and animal productivity, influence air and water quality, and impact human health (Soil Quality Institute 2001). A soil's inherited properties (texture, mineral composition, depth) and their dynamic properties (porosity, infiltration, ground cover, and aggregate stability) may be altered with management activities. These properties are important for determining the ability of soil to filter, buffer, degrade, immobilize, and detoxify chemicals applied in a given area.

The management and removal of noxious weeds can result in changes to some of these properties, such as porosity, organic matter composition, biological activity, and erosive potential. These changes can have a positive feedback which can further affect the fate of herbicides at a site. For example, some herbicides can alter the existing soil microbial communities that help breakdown chemicals. Other methods may increase erosion, which can allow herbicides that bind to soil particle to move off-site more easily. Compaction is another concern, especially with the use of heavy machinery, increased foot traffic, and vehicle use.

3.3.2 Watersheds

Portions of five sub-regional watersheds which occur on the Navajo Nation include (acreages represent total watershed acreages): Rio Grande (17.3 million acres), Upper Colorado (8.7 million acres), San Juan (16 million acres), Lower Colorado (19.3 million acres), and Little Colorado (17.3 million acres). Within these major watersheds 30 sub-watersheds that occur on the Navajo Nation and 14 sub-watersheds that are adjacent to the Navajo Nation (**Table 3-2**).

Table 3-2. Watersheds and sub-watersheds that occur on the Navajo Nation, including the USGS Hydrologic Unit Code Number (HUC No.), total acreage of the sub-watersheds, and total acres of subwatersheds occuring on the Navajo Nation.

Sub- Watershed Name	HUC No.	Total Acres	Acres on Navajo Nation	% of Watershed on Navajo Nation
LITTLE COLORADO WATERSHED				
Moenkopi Wash	15020018	1,685,552	1,199,190	71.1
Dinnebito Wash	15020017	475,416	207,895	43.7
Corn-Oraibi Wash	15020012	547,176	305,664	55.9
Lower Little Colorado River	15020016	1,535,259	783,649	51
Polacca Wash	15020013	692,851	324,573	46.8
Upper Puerco River	15020006	1,225,809	1,121,178	91.5
Cottonwood Wash	15020011	1,028,501	896,982	87.2
Jeddito Wash	15020014	665,429	440,772	66.2
Leroux Wash	15020009	516,281	385,579	74.7
Middle Little Colorado River	15020008	1,580,529	326,363	20.6
Lower Puerco River	15020007	715,941	333,537	46.6
Canyon Diablo	15020015	770,708	68,597	8.9
Zuni River	15020004	1,764,468	327,718	18.6
Upper Little Colorado River	15020002	1,032,340	2,216	0.2
LOWER COLORADO WATERSHED				
Lower Colorado-Marble Canyon	15010001	927,155	272,588	29.4
RIO GRANDE WATERSHED				
Rio Puerco	13020204	1,356,949	82,749	6.1
Arroyo Chico	13020205	876,642	338,158	38.6
Rio San Jose	13020207	1,689,289	218,417	12.9
Rio Salado	13020209	900,010	60,563	6.7
North Plains	13020206	729,397	10,480	1.4
SAN JUAN WATERSHED				
Montezuma Creek	14080203	747,121	61,012	8.2
Lower San Juan -Four Corners	14080201	1,283,869	582,240	45.4
Upper San Juan River	14080101	2,206,444	262,308	11.9
Lower San Juan River	14080205	1,502,448	1,009,277	67.2
McElmo Creek	14080202	458,010	40,026	8.7
Mancos River	14080107	513,141	37,971	7.4
Middle San Juan River	14080105	1,241,815	685,612	55.2
Chaco Wash	14080106	2,927,155	2,917,013	99.7
Blanco Canyon	14080103	1,097,855	278,642	25.4
Chinle Wash	14080204	2,664,383	2,664,383	100
UPPER COLORADO WATERSHED				
Lower Lake Powell	14070006	1,910,567	980,449	51.3

The San Juan, Little Colorado, and mainstem of the Colorado River serve as boundaries around the northern, southern, and western portions of the Navajo Nation. Largely ephemeral washes emanating on the reservation, such as Chaco, Rio Puerco, and Pueblo Colorado contribute to the flows of the major river systems (NDWR 2011).

3.3.3 Hydrology

The Navajo Nation resides on the sandstone Colorado Plateau aquifers, which are composed of permeable, moderately to well-consolidated sedimentary rocks, which can range in age from Permian to Tertiary. The entire aquifer covers an area of approximately 110,000 square miles from northern Utah and Colorado down through northeastern Arizona and northwestern New Mexico (**Figure 3-6**, Robson and Banta 1995). These aquifers recharge the numerous lakes, streams, and rivers of the Navajo Nation in addition to mountain run off and high elevation recharge. In terms of water supply on the Navajo Nation, the Mesaverde, Morrison (M), Coconino (C), Navajo (N), and Dakota (D) aquifers in addition to several numerous alluvial aquifers make up the majority of the water resources of the Navajo Nation (NDWR 2011).

The San Juan Structural unit is composed of several formations in New Mexico, including the Mesaverde aquifer and the Morrison Formation (NDWR 2011). The Mesaverde aquifer covers the Black Mesa Basin and a portion of the San Juan Basin on the eastern edge of the Navajo Nation. In the San Juan Basin this aquifer is largely recharged from the Zuni Uplift, the Chuska Mountain, and northern Sandoval County in New Mexico. Water level withdrawals for this aquifer are relatively small and limited to localized areas. Groundwater flow for this aquifer in the San Juan basin generally flows from the margins of the basin to stream valleys. Groundwater typically discharges from the aquifer directly into streams, springs, and seep, such as the Colorado River, the San Juan River, and the Chaco River (Robson and Banta 1995). This set of aquifers provides water to several communities in the eastern portion of the Navajo Nation.

The Coconino aquifer is composed sandstone rocks from the Early Permian formation, such as Coconino, DeChelly, Glorieta, and San Andreas. This aquifer covers the majority of the Navajo Nation as it resides in the lower portion of the Colorado Plateau Aquifer. On the Navajo Nation, most of the recharge of this aquifer comes from the Zuni Uplift along the western edge of the San Juan Basin, and the Mogollon Slope along the Mogollon Rim. The Coconino aquifer discharges mainly into the Colorado River. Near Black Mesa, water flows northwest and discharges near the mouth of the Little Colorado River (Robson and Banta 1995). The Coconino aquifer is a major source of industrial water for non-Indian communities in Arizona.

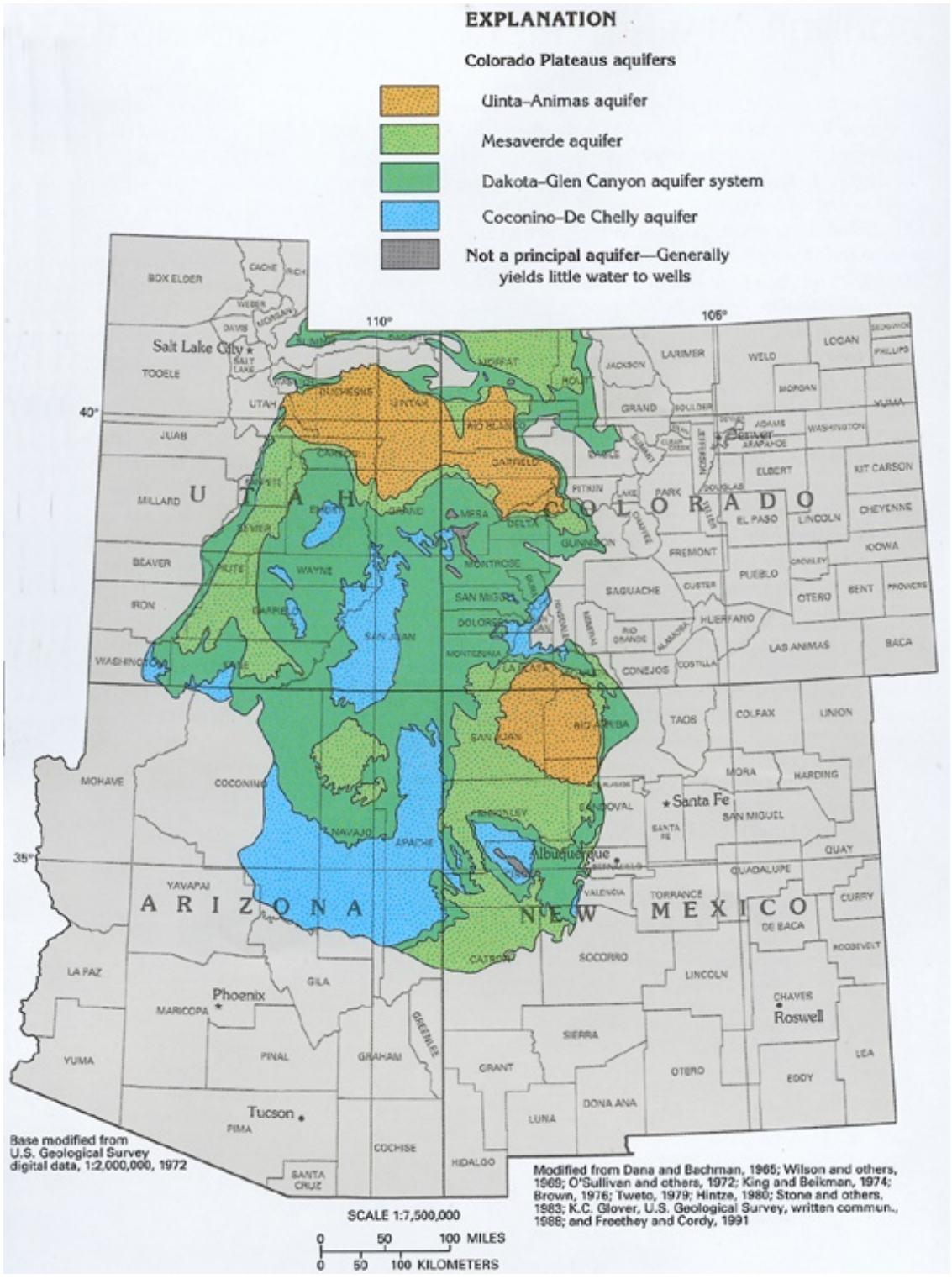

Figure 3-6. Map of three of the four major Colorado Plateau aquifers found on the on Navajo Nation. The Mesaverde (M), Coconino-DeChelly (C), and Dakota-Glen Canyon (D) aquifers are major sources of groundwater on the Navajo Nation. (Map from Robson and Banta 1995). Not depicted is the Navajo Aquifer (N), which lies under the Dakota Aquifer on the Navajo Nation.

The Navajo aquifer is located in northeastern Arizona in the Black Mesa Area and is composed of Navajo Sandstone, Kayenta Formation, and Wingate Sandstone. The aquifer is recharged from areas near Shonto in the southwest, south, southeast, and west along the borders of the aquifer (Lopes and Hoffman 1997). The aquifer discharges mainly as surface flow to the Moenkopi Wash and Laguna Creek (Littin 1999). While water is supplied industrially to Peabody Western Coal Company for commercial purposes, the N-aquifer is an important water source for domestic use in several communities in the western portion of the Navajo Nation (NDWR 2011)

The Dakota aquifer system is composed of confining units of sandstone ranging in age from the Cretaceous to Triassic System, such as the Chinle and Moenkopi Formations. Water in these aquifers is generally considered to be poor unsuitable for development due to their depth and poor water quality. However, in areas, the aquifers are closer to the land surface, they may be an important source for water. The Dakota Canyon aquifer covers much of the northern portion of the Navajo Nation. The Dakota aquifer is recharged from the Uinta Basin in Utah and Colorado and discharges the Colorado River on the border of the Navajo Nation. Ground-water then flows to discharge the Colorado and San Juan Rivers along the Navajo Nation (Robson and Banta 1995).

Water through each of these aquifer portions moves fairly quickly due to channels and fractures within the formations (USBOR 2006). Actual recharge rates for the entire aquifer are currently unknown but it is estimated that the Coconino aquifer could store up to 413 million acre-feet of water (ADWR 1990). Other estimates calculate annual recharge of the aquifer system at 4% of annual precipitation (Kirby 2008).

3.3.4 Water Use

Water for the Navajo Nation comes from groundwater and surface water resources. Groundwater is currently the most heavily utilized water source for the Navajo Nation, supplying water to remote communities through municipal water projects. Groundwater storage for the major aquifers is large enough to meet annual water demand (**Table 3-3**), several aquifers are not easily accessible or readily developed due to depth or water quality (NDWR 2011). Water in these aquifers are used either through the development of wells or through municipal pipelines, which transport the water to Navajo Tribal Utility Authority districts who then provide water to nearby communities.

Table 3-3. Major aquifers of the Navajo Nation and their estimated storage as reported by the Navajo Nation Department of Water Resources (2011).

Aquifer	Total Storage (Million Acre-feet)	Information Source
Coconino	413	ADWR 1994
Navajo	290	USGS 1997a
Dakota	50*	DOI 1993
San Juan Unit	1.18*	NWNMCOG 1994

*Estimated recoverable volume, not total storage

For surface water, the Navajo Nation has several large rivers within the region. The major rivers where the Navajo Nation access water include:

- Colorado River
- Little Colorado River
- San Juan River
- Rio Grande River
- Rio Puerco
- Rio San Jose
- Zuni River
- Bill Williams River
- Verde River
- Tributary Washes

Total domestic water use on the Navajo Nation is approximately 12,000 acre-feet annually. Forty percent of Navajo Nation households haul water for domestic use. The Navajo Nation Department of Water Resources estimates that approximately 30% of households on the Navajo Nation are without direct access to public water and must haul water long distance to provide it for families (USBOR 2006, NDWR 2011). Other major water uses on the Navajo Nation include water for agricultural uses and for commercial industries. Approximately 20,000 acres of small Navajo farms, or dryland farms (see Section 3.6.2 Farming) use approximately 100,000 acre-feet of water annually. The Navajo Indian Irrigation Project irrigates approximately 60,000 acres and diverts approximately 206,000 acre-feet of per year. When completed, the project will irrigate and estimated 110,630 acres of land and diverts 508,000 acre-feet per year. The estimated 300,000 permitted animal units on the Navajo Nation obtain water from approximately 900 windmills and 7,000 stock ponds. Industrial and mining water used in the region is approximately 75,000 acre-feet per year. Black Mesa Mine, operated by the Peabody Coal Company, uses approximately 4,500 acre feet per year (NDWR 2014).

Water development is a major concern on the Navajo Nation, where the Navajo Tribal Utility Authority does not incorporate the costs to address aging and inadequate water infrastructure. Lack of funding and sustained poverty have prevented large-scale changes in water use on the Navajo Nation. Distance, endangered species concerns, and lack of opportunities for infrastructure development has left several water sources unavailable for use by the Navajo people. There are also public health concerns as several water resources available to the Navajo people are either poor in quality or subject to contamination.

Water use is also important for sustaining and developing plant communities as well. Differences in plant composition and community structure can have impacts on how water behaves on the land surface. Plants, such as trees and bushes, can intercept precipitation, reducing or slowing the rate at which water falls from the sky to the earth's surface. How plants grow within an area, may also influence hydrologic conditions on the surface. Some noxious

weeds species, such as tamarisk, develop dense and long root systems that are able to access deep groundwater reservoirs that many native plant species cannot reach. In other instances, some plants have different leaf colorations, which allow them to reflect light and reduce evaporation. This can have the most effect in areas where diverse plant communities are replaced by monocultures of weeds. Such changes in hydrologic relationship between evapotranspiration and plant communities is most important in large areas where weeds will likely have the most impact on water recharge and infiltration.

3.3.5 Surface Water Quality

Assessing and monitoring water quality on the Navajo Nation is the responsibility of the Navajo Nation Environmental Protection Agency (NNEPA) through their Water Quality Program. Under the purview of the U.S. Environmental Protection Agency (U.S. EPA), NNEPA is responsible for developing water quality standards and conducting water quality assessments on all waters of the U.S. found on the Navajo Nation (NNEPA 2013). The water quality standards are regulations in fulfillment of the Navajo Clean Water Act and the U.S. Clean Water Act (CWA) and are established to help protect and maintain the quality of surface waters for multiple uses on the Navajo Nation. The NNEPA uses these standards to assess if waters found within the Navajo Nation are impaired or polluted in a fashion that makes use of the water for various means unsafe. When waters are found to be impaired, it is the responsibility of the NNEPA to document the reasons for the impairment and to submit the information to the U.S. EPA for reporting. NNEPA then goes through necessary restoration protocols to identify reasons for the impairment, establish total maximum daily limits (TMDLs) to help control and reduce pollution and negative impacts, and then work with other agencies and permit holders to eventually delist the waterway. At the writing of this document, however, no water quality assessment reports have been approved

In 2013, the NNEPA revised their surface water quality standards to reflect recent federal changes for measurable water quality indices and to add standards for newly identified impacts. The revised standards include standards for certain pesticides, including atrazine and non-aquatic chemical forms of 2-4 D, and glyphosate. The regulations set numerical standards for these chemicals for Primary and Secondary Human contact uses (such as swimming, ceremonial uses, or boating and fishing) and for use as part of the domestic water supply. Standards have also been set for fish consumption for glyphosate.

In terms of monitoring the waters of the Navajo Nation, NNEPA has not listed any waters as impaired through the U.S. EPA program (Steve Austin, NNEPA, personal communication September 2013). However, a few locations do experience some pollution and acute impairment issues. Cove Wash, in the San Juan watershed near the Chuska Mountains, is currently proposed for U.S. EPA approval for impairment listing due to nutrient loading and sedimentation. Additionally, fish advisories for mercury have been issued for Red Lake near Navajo, NM, in Red Lake Chapter. Morgan Lake, near Fruitland, and after Hogback, the San Juan River have

also experienced higher than normal levels of selenium. For the Navajo Nation, grazing and roadways tend to pose the most significant problems by increasing sedimentation and turbidity within waterways due to the high clay content of soils. The San Juan River near NAPI has also received occasional acute impairments for pesticide contamination from nearby agricultural areas, such as NAPI (Steve Austin, NNEPA, personal communication, September 2013). These locations within the Navajo Nation indicate areas where additional care should be taken to reduce or limit treatments that could reduce overall water quality.

While there are currently no impaired waters listed by the Navajo Nation EPA, there are a number of neighboring waterways that either border or are in close proximity to the Navajo Nation. These areas have the potential to impact waters draining from or into the region. These waters have been evaluated by state water quality departments and listed as impaired with the U.S. EPA. The Navajo Nation EPA works with the state agencies within these watersheds to help address water quality issues along the borders of the region (**Figure 3-7**, **Table 3-5**). Water quality in Arizona is monitored and assessed by the Water Quality Division of the Arizona Department of Environmental Quality. In New Mexico, the Surface Water Quality Bureau through the New Mexico Environment Department is responsible for water quality assessments. For Utah, the Division of Water Quality in the Utah Department of Environmental Quality monitors and assesses water quality for the state.

In Utah, Chance Creek (UT14070006-004), Paria River-3 (UT14070007-005), and Comb Wash (UT17080201-011) have all been listed by the state for biotic impairments (UED 2010). Such impairments could be from nutrient loading or eutrophication of watershed, resulting in imbalances in the biotic communities within these watersheds. While these watersheds are not directly within the Navajo Nation, they do drain into the San Juan and Paria Rivers, which border the region near Lake Powell.

Table 3-4. Pesticides-Cause of Impairment Group for Arizona and New Mexico. Table is compiled from 2008 water assessment data for Arizona and New Mexico with 2012 data for New Mexico included.

State	Cause of Impairment	River and Streams (miles)	Lakes, Reservoirs, and Ponds (Acres)
AZ	Chlordane	98.9	285.0
AZ	DDT	98.9	285.0
AZ	Toxaphene	98.9	285.0
NM	DDT	132.2 (2012)	3,058.7

Source: http://ofmpub.epa.gov/waters10/attains_state.control?p_state=NM&p_cycle=2012#total_assessed_waters and http://iaspub.epa.gov/tmdl_waters10/attains_state.cause_detail?p_state=AZ&p_state_name=Arizona&p_cycle=2008&p_cause_group_name=PESTICIDES.

Additionally, a large portion of Lake Powell, which lies on the border between the Navajo Nation, Utah, and Arizona, has also been listed as impaired by Utah, Arizona, and the U.S. EPA for high levels of mercury found in fish tissues. Fish consumption advisories have been issued by both states recommending limits on the amount of fish consumed from Lake Powell and other bodies of water where fish tissues have mercury levels that exceed the standard limit. The

mercury can come from natural sources, such as volcanic rocks, or from human-caused sources such as industrial mining, agriculture, or atmospheric deposition.

In Arizona, portions of the Colorado River and Paria River near Lake Powell and the Navajo Nation boundary have been listed as impaired (**Table 3-5**, ADEQ 2012). The Colorado River (AZ14070006-001) was listed for high total selenium concentrations, which impacts aquatic life and fishery production. Selenium concentrations can increase through naturally occurring conditions based on dominant soil types, such as Mancos Shale, or from runoff and deposition from coal industrial industries such as coal-fired power plants or petroleum refineries. The Paria River (AZ14070007-123) was listed for suspended sediments and increased *Escherichia coli*, affecting use of the water for domestic water, human contact, and the ability of the waterway to support aquatic life. *E. coli* is used as an indicator of pathogenic microorganisms within bodies of water, which can be introduced from activities such as recreation or grazing near the water. Elevated levels pose a threat to human health. Suspended sediments most commonly affect aquatic organisms within waterways, reducing light for photosynthesis, impairing filtration, and interfering with ingestion and increasing mortality rates over time.

In New Mexico, seven water bodies have been listed for impairment for a variety of different causes (**Table 3-5**, NMED 2012). Within the San Juan Watershed, the San Juan River from Hogback to Cañon Largo (NM-2401-00 and NM-2401-10) was listed as impaired for elevated mercury levels in fish tissues, increased turbidity, increased sedimentation, and *E. coli* contamination. Such impairments have affected the use of the River for recreation, fishery production, and support for aquatic life. Likely reasons for impairment include increased atmospheric deposition, natural sources such as wildlife, hydromodifications, municipal discharge, increased irrigation return flows, and resource extraction. Draining into the San Juan River in New Mexico, the La Plata River, the Animas River, and Navajo Reservoir have also been listed. The La Plata River (NM-2404A_00) was listed for increased temperature and sedimentation, which affect the ability of the water body to support aquatic life. The Animas River (NM-2404_00) was listed for high temperature. The Navajo Reservoir (NM-2406_00) was listed for elevated levels of mercury in fish tissue. In the Rio Puerco watershed, Rio Puerco, Bluewater Creek were listed for water quality impairments. A section of Rio Puerco (NM-2105_20) that borders the Cañoncito Chapter of the Navajo Nation was listed for elevated mercury in fish tissues and *E. coli* impairment. Lastly, Bluewater Creek was listed for impairment due to high temperatures and potential nutrient loading and eutrophication. Bluewater Creek was last assessed in 2012 and portions of the impaired part of the stream are found in Baca and Haystack Chapters of the Navajo Nation.

While impairment can restrict activities in certain waterways, waters designated as exemplary, may also limit the extent of certain impacts. The Bureau of Land Management and the State of Utah are currently considering the Utah portion of the San Juan River for designation as a Tier III – Outstanding water classification through the U.S. EPA. Currently no waters are designated as Outstanding Waters in or near the project area.

Pesticide use is a major concern for water quality standards as they are subject to public scrutiny because of potential impacts on humans and the environment. Negative effects from the use of herbicides are possible in the aquatic environment. Research has indicated that some herbicides disrupt endocrine systems and affect reproduction by interfering with natural hormones in fish and mammals, including humans.

In a comprehensive study of pesticide levels throughout the United States, the National Water-Quality Assessment (NAWQA) Program focused on water quality in more than 50 major river basins and aquifer systems that cover about one-half of the land area of the United States, including a portion of the Rio Grande River Basin, which occurs on the Navajo Nation. Studies of groundwater and surface water indicated that commonly used herbicides and their breakdown products were detected in most surface water sources in North America due to urban and agricultural uses (Fry et al. 2011). Follow-up studies performed additional testing on groundwater sources and showed that the same herbicides were still present but decreasing between 2001 and 2003 (Bexfield 2008). These common herbicides and compounds include triazine herbicides (atrazine, simazine, and prometon), metolachlor, tebuthiuron, and the atrazine breakdown product deethlyatrazine (DEA).

Recent assessments of pesticide concentrations in water from 2008 did indicate that pesticides caused major water impairments in Arizona and New Mexico (**Table 3-4**). The banned substances, such as DDT, chlordane, and toxaphene, were the major contributors to impairments. In Arizona, ADEQ lists pesticides as contributing factors to impairments in the Gila River, the Hassayumpa River, and the Salt River. These rivers are located in southern Arizona and thus will likely not af. In New Mexico, pesticides were listed as contributing impairment factors for the Rio Grande and Brantley Reservoir in 2008, and in 2012, the Pecos River was also added. The sections of the river along the Rio Grande and Pecos Rivers, while not located on the Navajo Nation, are located close to the eastern segments of the Navajo Nation currently managed by Eastern Agency.

The pesticides listed in **Table 3-4** are all banned insecticides showing residual accumulation in Arizona and New Mexico waters. See Appendix B for listing of areas where pesticides are impairing New Mexico near the Navajo Nation. Maps of each of the impaired sites are available on the EPA website at:
http://ofmpub.epa.gov/tmdl_waters10/attains_impaired_waters.control?p_state=NM&p_cycle=2012&p_cause_group_id=885&p_report_type=T for New Mexico

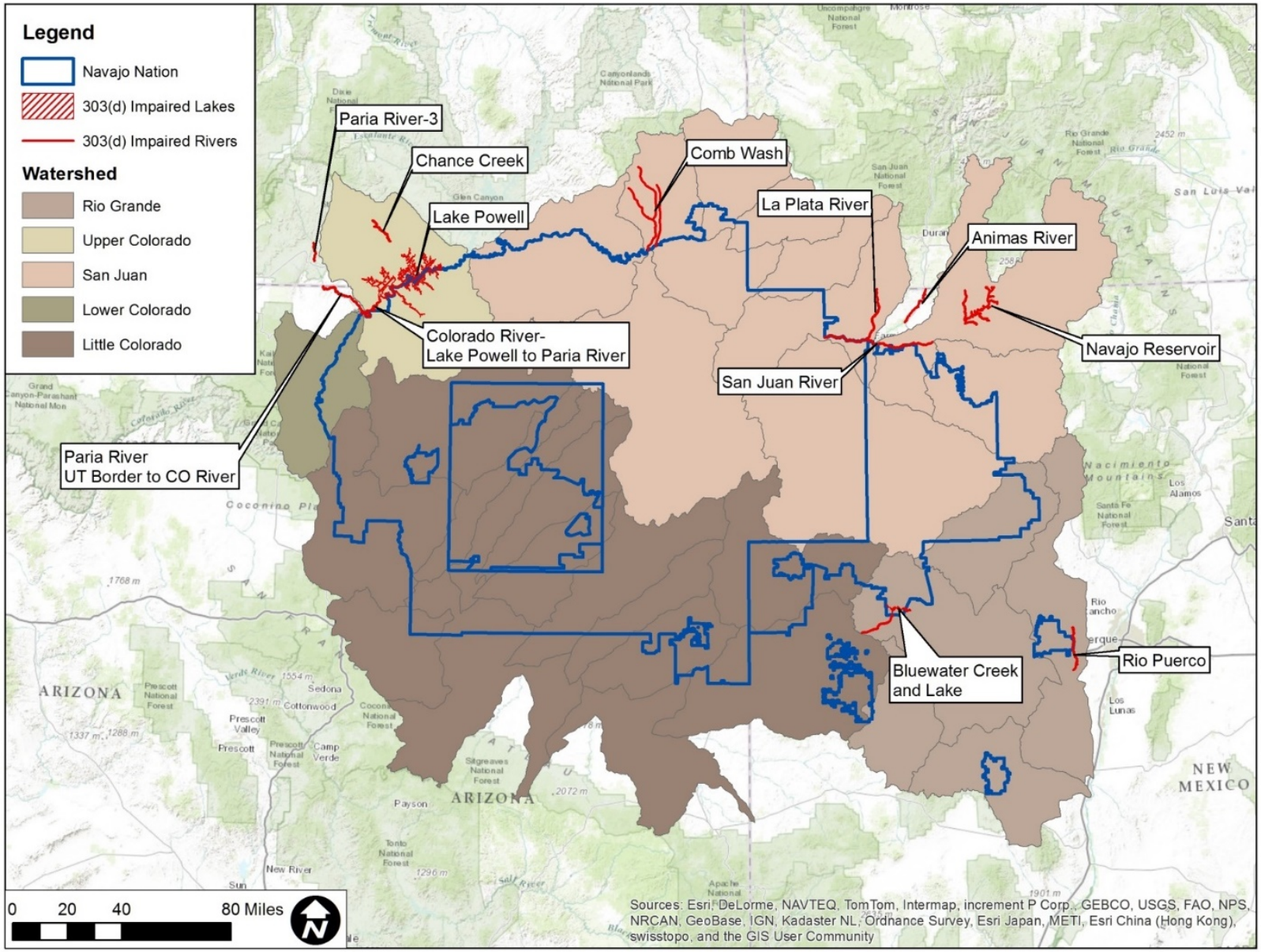

Figure 3-7. Map of impaired waters found on or near the Navajo Nation as listed by state water quality agencies in Utah (2010), Arizona (2010), and New Mexico (2012) and approved by the U.S. EPA.

Table 3-5. Impairments indicated for rivers near or within the Navajo Nation. Information on reasons for impairment were compiled from the latest state water quality assessment reports (ADEQ 2010, NMED 2012, UED 2010) and the U.S. EPA Water Quality Assessment website (www.epa.gov/waters/ir/index.html)

State	Name	AU ID	Class	Size	Cause	Use	Year	Source	Notes
UT	Chance Creek	UT14070006-004	River	16.17 mi	Nutrient/Eutrophication	Cold water aquatic life	2008	Unknown	
UT	Paria River-3	UT14070007-005	River	9.22 mi	Nutrient/Eutrophication	Aquatic wildlife	2008	Unknown	
UT	Comb Wash	UT17080201-011	Stream	31.63 mi	Nutrient/Eutrophication	Warm water aquatic life	2010	Unknown	
UT	Lake Powell	UT14070006-1130	Lake	9770 ac	Mercury in Fish	Fisheries	2010	Atmospheric Deposition, Unknown	
AZ	Lake Powell	AZ14070006-1130	Lake	9770 ac	Mercury in Fish	Fisheries	2010	Atmospheric Deposition, Unknown	
AZ	Colorado River - Lake Powell to Paria River	AZ14070006-001	River	16.3 mi	Total Selenium	Cold water aquatic life	2008	Hydromodification, Natural/Wildlife, Agriculture	Delisted 2012
AZ	Paria River - Utah to Colorado River	AZ14070007-123	River	29.4 mi	Suspended Sediment	Warm water aquatic life	2008	Hydromodification, Natural/Wildlife, Agriculture	
					E. coli	Recreation	2008	Natural/Wildlife, Agriculture	Delisted 2012
NM	Rio Puerco - Rio Grande to Arroyo Chijuilla	NM-2105_20	Stream	147 mi	E. coli	Human Contact, Livestock	2012	Grazing, Irrigation	
					Mercury in Fish	Human Contact	2012	Atmospheric Deposition, Unknown	
NM	Upper San Juan River - Animas to Cañon Largo)	NM-2401_00	River	21.44 mi	E. coli	Human Contact	2010	Hydromodifications, Municipal Discharge, Agriculture	Delisted 2012
					Turbidity	Cold water aquatic life	2012	Unknown	
					Sedimentation	Cold water aquatic life	2012	Natural/Wildlife, Habitat Modifications, Resource Extraction, Unknown	
					Mercury	Aquatic Wildlife Protection	2012	Atmospheric Deposition, Unknown	
NM	San Juan River (Hogback to Animas River)	NM-2401_10	River	32.27	E. Coli	Recreation	2012	Natural/Wildlife, Municipal Discharge, Agriculture	
					Mercury	Fisheries	2012	Atmospheric Deposition, Unknown	
					Sedimentation	Cold water aquatic life	2012	Unknown	
					Turbidity	Cold water aquatic life	2012	Unknown	
NM	Bluewater Creek (Reservoir to Headwaters	NM-2107.A_01	Stream	17.1	Nutrient/Eutrophication	Cold water aquatic life	2012	Non-point source, Unknown	
					Temperature	Cold water aquatic life	2012	Silviculture, Habitat Alterations, Agriculture, Hydromodifications	
NM	La Plata River - San Juan to McDermott Arroyo	NM-2402A_00	Stream	16.77 mi	Dissolved Oxygen	Wildlife protection	2012	Agriculture, Natural/Wildlife, Hydromodification, Habitat Modifications	
					Sedimentation	Cold water aquatic life	2012	Unknown	
NM	Animas River - Estes Arroyo to CO Border	NM-2404_00	River	19.6 mi	Temperature	Cold water aquatic life	2012	Agriculture, Natural/Wildlife, Hydromodification, Habitat Modifications	
NM	Navajo Reservoir	NM-2406_00	Lake	13,15 ac	Mercury in Fish	Fishery Production	2012	Atmospheric Deposition, Unknown	

NNEPA manages the Pesticide Tribal Program for the Navajo Nation to help protect human health and the environment by ensuring pesticides and alternatives are available and can be used according to label directions without causing unreasonable risks. An important function of the Pesticide Program is compliance with the National Pollutant Discharge Elimination System (NPDES) permit program to control water pollution by regulating point sources that discharge pollutants into the waters of the United States. Point sources include structures such as pipes or constructed ditches. The NPDES program also is responsible for the regulation of pesticide contamination under the Pesticide General Permit (PGP) program.

In 2009, the Sixth Circuit Court (National Cotton Council vs. EPA) struck down the EPA's 2006 published Rule [Application of Pesticides to Waters of the United States in Compliance with Federal Insecticide, Fungicide, and Rodenticide Act ((FIFRA) 40 CFR 122)] and mandated that pesticide application to, near or over waters of the United States fall under the Clean Water Act (CWA) and required NPDES Permits. As of October 21, 2011, NPDES permits are required by the U.S. EPA for pesticide application "to, over, or near" waters of the U.S.

To authorize the use of pesticides under this court order, the U.S. EPA developed the Pesticide General Permit program. The PGP has a number of restrictions and stipulations, including an evaluation of options for each pest management area to include:

a. No Action
b. Prevention
c. Mechanical or physical methods
d. Cultural methods
e. Biological control agents
f. Pesticides

The BIA Noxious Weed Program requires weed grant application to evaluate each of these options part of grant criteria. The PGP has other size and discharge limitations. Once finalized, U.S. EPA's Regionally-based Pesticide General Permits will cover pesticide applications in six states, most U.S. territories, Indian county lands, and many federal facilities. Permitting Authority is U.S. EPA Region 9 for the Navajo Nation. The permit program covers pesticide use for mosquitos and other flying insect pest control, weed and algae pest control, animal pest control, and forest canopy pest control. Each BIA Agency and/or cooperating is required to maintain coverage under the U.S. EPA's PGP permit for all pesticides applications near water completed on the Navajo Nation. Each Agency will serve as the Decision-Maker or Operator for the eNOI for reporting and notification purposes.

3.3.6 Well Management

The Navajo Nation utilizes a series of wells throughout the project area to provide water to rural communities. Ground water supplies drinking water to close to 97% of the Navajo Nation's public drinking water system (NNEPA 2001). Ground water is also commonly utilized for

livestock agricultural needs, and industrial uses. Due to the lack of sufficient surface water supplies, access to clean water from underground aquifers is a necessity for the many in the Navajo Nation. The alluvial aquifers, for example, located away from the San Juan River, are more at risk to drought and contamination conditions.

Regulation of these wells is governed by several Navajo Nation programs. Construction of wells to provide drinking water is done by the Navajo Tribal Utility Authority (NTUA). Permitting and regulation of well drilling and water use is managed by the Navajo Nation Water Code Administration. The NNEPA Public Water Systems Supervision Program (PWSSP) is responsible for monitoring water quality and has a wellhead and source water protection programs to protect from contamination. Drinking water is monitored for contaminants based on the Navajo Nation Primary Drinking Water Regulations, which were amended in 2013. Of the contaminants tested for in drinking water sources, some herbicides are also included due to health concerns related. Specifically, contamination of drinking water supplied by 2,4-D, atrazine, glyphosate, and picloram monitoring and reported to the public if they exceed specified limits.

The main aquifers used for supplying drinking water are often accessed by use of wells, which are vulnerable to contamination. Contamination of wells can occur from the infiltration of chemicals or elements from natural sources such as arsenic or selenium. Of greater concern, however, is contamination from human-related activities. Runoff and ground water infiltration from rangelands, illegal dumping grounds, chemical spills from mining waste or pesticide containers, waste storage lagoons, sewage, and septic systems can all introduce harmful contaminates to well systems. Contaminated water from these incidents can enter the source waters that eventually supply public water wells, putting communities at risk for a variety of health issues.

For these reasons, wellheads and source waters are protected through the PWSPP Source Water Assessment and Protection Program, which establishes a protection zones around wells, wellfields, springs, and surface water to protect potential source waters from contamination. To do this, wells are surveyed and a protection zone is established to limit contamination from microbial and chemical contaminates. While the buffer zone, ½ mile, is the same for all wells, identification and documentation for all wells is still being completed by the NNEPA. Coordination with the Navajo EPA PWSSP can help identify the location of some wells and the wellhead protection zones associated with each in a given area (NNEPA 2001).

Water quality on the Navajo Nation is a major concern as more than 30% of the population does not have access to safe and adequate drinking water (USBOR 2006). In 2011, the Indian Health Service estimated that over 7,000 homes on the Navajo Nation did not have access to potable water, leaving many households to rely on nearby wells (IHS 2011). Prior to the implementation of the Safe Drinking Water Act, many Navajos obtained their drinking water supply from livestock wells, making them more at risk of using contaminated water. While watering points

have been set up at border towns and Chapters, where the water haulers can obtain safe drinking water, some residents still obtain water from unregulated wells. Additionally, homes with NTUA connections are discouraged from the water hauling and from withdrawing water from the hose, especially water used for drinking and livestock uses. Water quality studies of wells on Indian lands indicate that land use practices, including the presence of livestock near wells or unregulated pesticide use, may increase the risk of well water contamination (McGinnis and David 2001). Many of the wells on the Navajo Nation may be outdated as damaged or shallow wells may allow contaminants to seep into drinking water supplies. Geologic studies of the area have indicated that a majority of the Navajo Nation exhibits geologic conditions that increase the risk for groundwater contamination from contaminants such as pesticides (**Figure 3-8**, Blanchard 2002). Factors that contributed to contamination sensitivity included presence of bedrock recharge areas, presence of unconsolidated deposits on the surface, annual precipitation rate, ground water elevation, soils with high sand composition and low organic matter content, proximity to floodplains, and land surface slope.

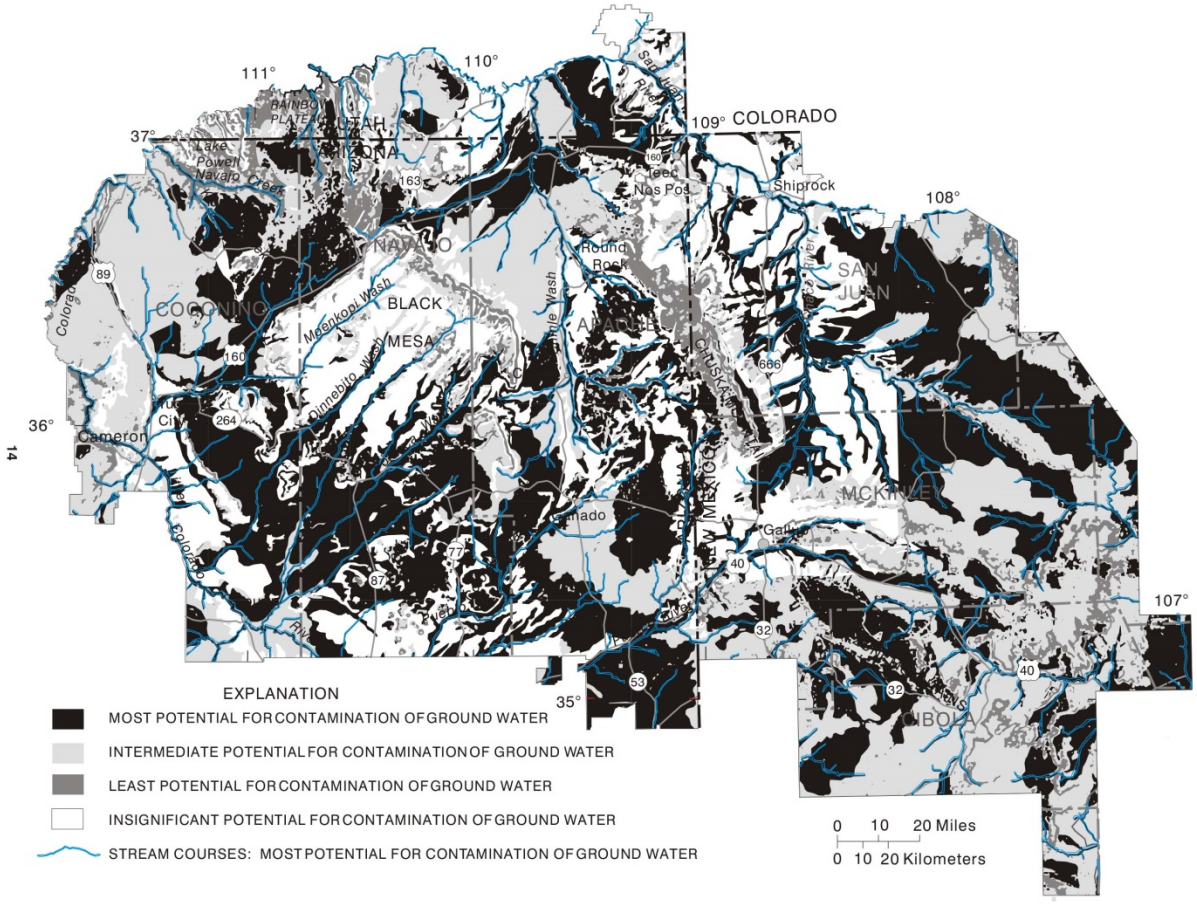

Figure 3-8. Map created by Bureau of Reclamation showing potential for ground water contamination on the Navajo Nation. The study developed the model based on areal geology, precipitation, slope, and soils (Blanchard 2002).

The problem with groundwater contamination is most pronounced for unregulated wells, such as abandoned wells, livestock wells, or windmill-powered wells found on the Navajo Nation. Abandoned wells are those that have been sealed off or filled to prevent it from being used as a source of water. If a well is abandoned, the Navajo Nation requires that it be done in compliance either Arizona, Utah, or New Mexico well abandonment regulations and requirements. Livestock wells are used throughout the Navajo Nation, but are not monitored for safe drinking water quality standards. Livestock wells can be shallow (20-50' in depth) or deep (1,500' or greater). Shallow livestock wells can be easily contaminated by livestock waste and run off since the trough is located next to the well where it is often surrounded by animal waste. Volatile organic chemicals, such as automotive oil, lubricant, or anti-freeze have also been known to contaminate wells. While livestock wells are intended for livestock use only, contamination of this water source can still pose health risks to communities, especially women, children, and those with compromised immune systems. Finally windmill powered wells are those used to pump water from underground aquifers and not regulated by PWSSP, and thus not tested for contamination. Often these unregulated wells can be affected by uranium, arsenic, and *E. coli* contamination (Garvin et al. 2010). Such wells are often located in rural, poor communities where the cost of installing better drinking water infrastructure is major barrier.

Due to the heavy reliance of many remote communities on wells and groundwater supplies, contamination of wells and groundwater water sources could result in significant public health issues. Regular monitoring, notification, and testing are needed to maintain safe drinking water standards, which is managed by the Navajo Nation EPA.

3.3.7 Air Resources

Air quality standards are set by the Navajo Nation EPA in collaboration with the U.S. EPA to enforce both the U.S. Clean Air Act (as passed in 1955) and the Navajo Nation Clean Air Act (as passed in 2004). Both pieces of legislation outline a list of pollutants and criteria that are part of the National Ambient Air Quality Standards (NAAQS). Currently all areas of the Navajo Nation are designated as being in attainment for pollutants assessed under the NAAQS. Air emissions are regulated by the Navajo EPA through the Navajo Air Quality Control Program (NAQCP) (NNEPA 2009).

For the Navajo Nation, six criteria pollutants are monitored by the Navajo Nation EPA as they pose a significant threat to public health and the environment. These pollutants include sulfur dioxide (SO_2), nitrogen dioxide (NO_2), hydrogen sulfide (H_2S), ozone (O_3) and particulate matter ($PM_{2.5}$ and PM_{10}). The Navajo Nation Air Quality Control Program monitors these pollutants from five stations located throughout the Navajo Nation (**Figure 3-9**). Data collected by the NAQCP is submitted to the U.S. EPA Air Quality System database to help monitor trends and compliance to the NAAQS. Federal Air Quality regulations also include standards for lead and carbon monoxide. These pollutants are not measured by the Navajo Nation EPA as there are no areas or facilities that produce enough of these emissions to impact human health.

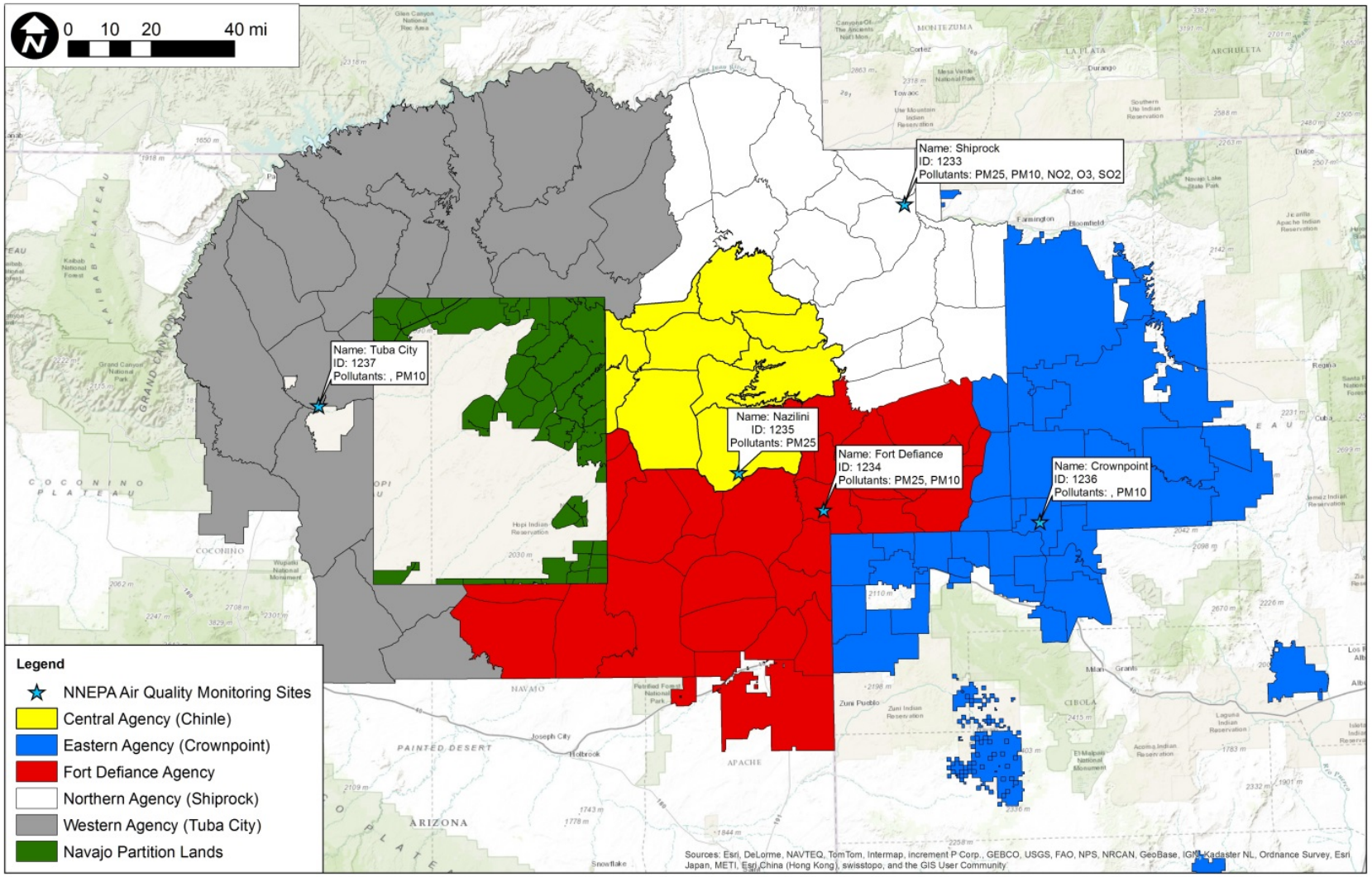

Figure 3-9. Navajo Nation Environmental Protection Agency Air Quality Monitoring Stations and pollutants. Data courtesy of the U.S. EPA AirData program.

Ambient air quality on the Navajo Nation is generally good. However, certain communities and areas do experience unhealthful or poor air quality on occasion. Since 2011, the Navajo Nation has experienced 11 days where the air quality index was measured at "Unhealthy for Sensitive Groups" or above (AIRNOW 2015). There have been two days where air quality was measured at "Unhealthful." The first day was March 22, 2012 and was due to high ozone levels centered near Flagstaff, AZ. The second day was June 28, 2013 resulting from high particulate matter ($PM_{2.5}$) coming from near the New Mexico, Colorado border (www.airnow.gov). The air quality conditions for that day only affected the northeastern edge of the Navajo Nation and then dissipated during the following days. Day where air aulity is considered poor mostly happen in specific areas and are not widespread across the region.

Often, the index values rise due to emissions being transported to the Navajo Nation from other urban areas such as Phoenix, Arizona or Albuquerque, New Mexico. Pollutants that tend to contribute to air pollution on the Navajo Nation are particulate matter ($PM_{2.5}$ and PM_{10}), carbon monoxide, and nitrogen oxides (NNEPA 2009). Sources of air pollution related to particulate matter include fires, dust storms, and emissions from power generation at nearby power plants, specifically the Four Corners Power Plant and the Navajo Generating Station located off the Navajo Nation. Ozone pollution is commonly the result of increased emissions from industrial processes or fossil fuel burning combined with increased sunlight and high temperatures. To assess air quality in relation to health concerns, the U.S. EPA uses a system known as the air quality index (AQI), which is an indicator of when air pollutants have reached unsafe levels for an area, resulting in increased concern for those with sensitivities to air pollutants and for the general public (**Table 3-6**).

Table 3-6. Air Quality Index categories used to assess health concerns related to air quality conditions. Information courtesy of the U.S. EPA.

Air Quality Index Values	Level of Health Concern	Symbolic Color
0-50	Good	Green
51-100	Moderate	Yellow
101-150	Unhealthful for Sensitive Groups	Orange
151-200	Unhealthy	Red
201-300	Very Unhealthy	Purple
301-500	Hazardous	Maroon

Besides monitoring daily air quality, NAQCP is also responsible for inventorying emissions on the Navajo Nation among major point sources and area emissions sources. Point sources are major emissions contributors who have obtained a Title V permit and include mining operations, power plants, and fuel processing operations. Areas sources are other emissions sources where a permit is not required, but activities can contribute to area emissions. Area sources include activities such as wildfires, prescribed burning, agriculture, road dust, road paving and maintenance, and manufacturing.

According to a 2009 Navajo Nation emissions inventory, carbon monoxide, NO_x, and fine particulate matter (PM_{10} and $PM_{2.5}$) account for a majority of emissions measured on the Navajo Nation (**Table 3-7**). Point sources are the main source for NO_x emission, with the Four Corners Power Plant and the Navajo Generating Station contributing around 93% of emissions. Wildfire, prescribed fires, residential wood burning, and dust from unpaved and paved roads are the main contributors to area source emissions (NNEPA 2009)

Table 3-7. Emission inventory for major air pollutants measured on the Navajo Nation as reported by the NNEPA (NNEPA 2009).

Emission Category	Point Source Emissions (T/yr)	Area Source Emissions (T/yr)	Total Emissions (tons/yr)	% of 2005	Major Contributor(s)
CO	7,525.5	115,045.9	122,571.4	29.5	
NH_3	300.5	1,476.9	1,777.4	0.4	
NO_x	80,918.4	2,119.7	83.038.1	20.0	Four Corners Power Plant, Navajo Generating Station
$PM_{2.5}$	3,730.6	21,512.9	25,243.5	6.1	
PM_{10}	8,907.1	109,814.3	118,721.4	28.6	
PM-CON	3,420.6	-	3,420.6	0.8	
SO_2	16,610.4	561.6	17,172.0	4.1	Four Corners Power Plant, Navajo Generating Station
VOC	906.9	42,772.4	43,679.3	10.5	
TOTAL	**122,320.0**	**293,303.7**	**415,623.7**	**-**	

Many resources and values are affected by air pollution. The ability to appreciate scenic vistas is dependent on good visibility. Human-made pollution also injures various species of trees and other plants, can acidify streams and lakes, and can leach nutrients from soils. Air pollution can cause or increase respiratory symptoms for residents. The harmful effects of air pollution on the visual and recreation experience could cause impacts and economic losses on Navajo lands and surrounding communities.

While ambient air quality within the Navajo Nation is good, there are concerns about indoor air quality and its impacts on residents and human health. A recent study found that the use of coal within households increased indoor air pollution in many households (Bunnell et al. 2010). The combustion of coal within houses for energy production and heating was found to be significantly higher than the emissions of local coal-powered plants such as the Four Corners Generating Station and the Navajo Generating Station.

3.4 Vegetation

3.4.1 Terrestrial Ecosystems

The Navajo Nation resides on over 25,000 square miles with elevations ranging from close to 5,100 ft to just over 10,000 ft above sea level. The size and elevation range of the Navajo Nation results in a wide variety of plant communities. Vegetation on the Navajo Nation is based on broad classifications outlined in the National Land Cover Dataset developed for the United

States by the U.S. Geological Survey in collaboration with several federal agencies. Due to the size of the Navajo Nation land base, this land cover classification system was chosen due to its broad nature. The Southwestern Regional GAP data (USGS, 2005) was also used to provide more specific descriptions of the major plant species found within the land cover classes of the Navajo Nation. Land Cover classes found on the Navajo Nation are outlined in **Table 3-8** and shown in **Figure 3-10**. Descriptions of each class are outlined below.

Table 3-8. Land Cover classes found on the Navajo Nation per the National Land Cover Dataset (Fry et al. 2011)

Class	Estimated Acres	% of Navajo Nation
Open Water	144,111	<0.01
Developed, Open Space	296,670	0.2
Developed, Low Intensity	63,478	<0.01
Developed, Medium Intensity	14,335	<0.001
Developed, High Intensity	1,234	<0.0001
Barren Land	3,040,525	17.6
Deciduous Forest	16,533	<0.001
Evergreen Forest	7,994,883	46.4
Mixed Forest	312	0
Shrub/Scrub	3,913,516	22.7
Grassland/Herbaceous	1,316,151	7.6
Pasture/Hay	72,276	<0.01
Cultivated Crops	167,250	1.0
Woody Wetlands	148,772	0.9
Emergent Herbaceous Wetlands	47,871	0.3

Water

Open Water – Open water areas are classified based on presence of water year round with less than 25% cover of vegetation or soils. On the Navajo Nation, these areas include perennial rivers, streams, lakes, and channels. Open water comprises 0.8% of land cover on the Navajo Nation.

Developed Land

Developed, Open Space – These are areas with a mixture of some constructed materials, but mostly vegetation in the form of short grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes. Developed, Open Space land cover comprises approximately 1.7% of land cover on the Navajo Nation. This land cover classification is commonly used to describe roadways within the region.

Developed, Low Intensity – These include areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% of the total cover. These areas most commonly include single family housing units. Developed, Low Intensity land cover comprises 0.3% of the land cover of the Navajo Nation. Low Intensity areas are commonly homesite lease sites and rural housing areas.

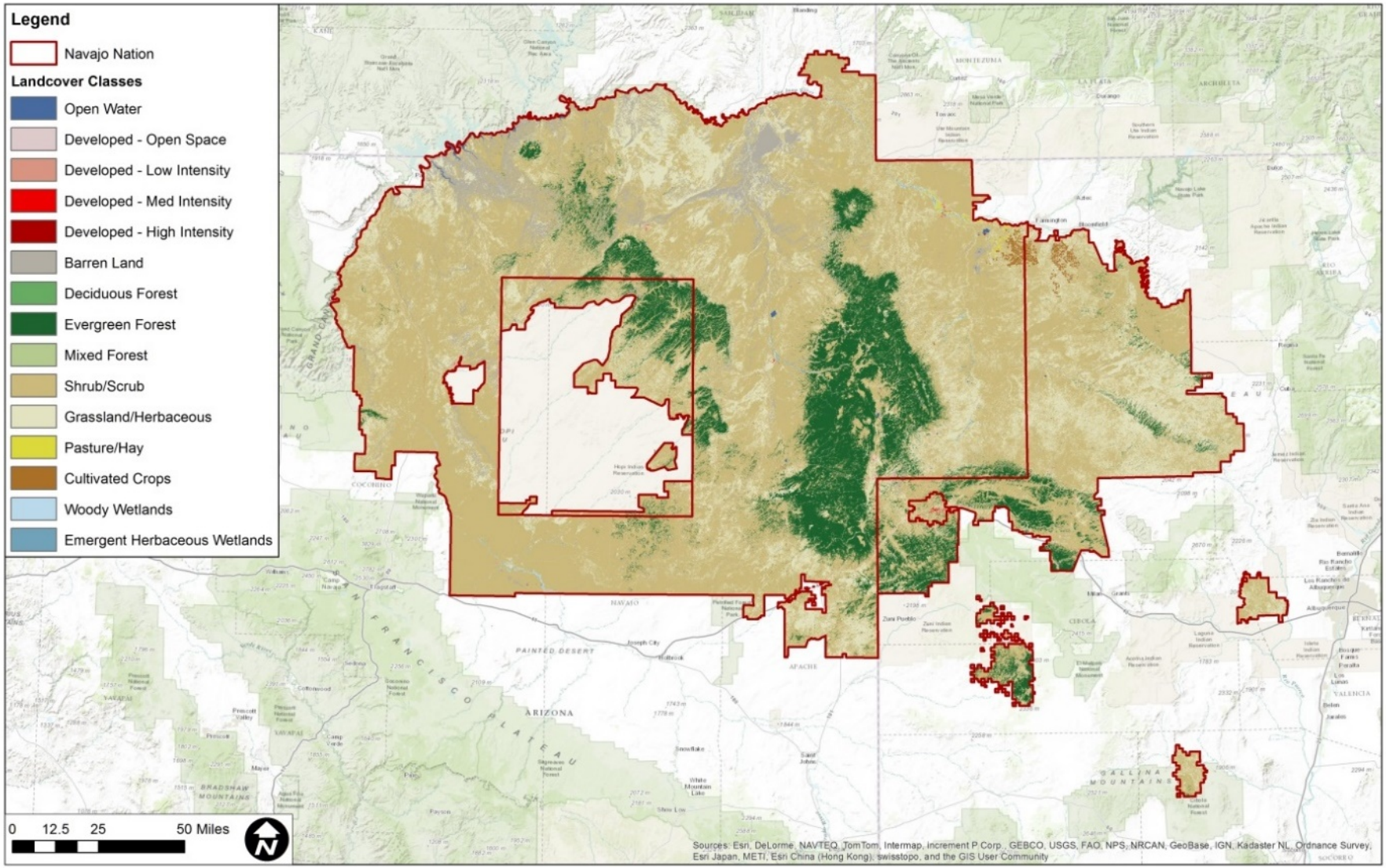

Figure 3-10. Landcover classes for the Navajo Nation as reported by the U.S.G.S National Land Cover Dataset (Fry et al. 2011).

Developed, Medium Intensity – These include areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79% of the total cover. On the Navajo Nation, Developed, Low Intensity areas comprise less than 0.1% of the region. Areas classified as Medium Intensity are often low density residential areas.

Developed, High Intensity – Highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrials areas. Impervious surfaces account for 80% to 100% of the total cover. Developed, High Intensity areas comprise less than 0.01% of the Navajo Nation and are commonly associated with Community Development Areas.

Barren Land

Barren Land (Rock/Clay/Sand) – Barren land on the Navajo Nation is characterized by barren and sparsely vegetated landscapes, with generally less than 10% plant cover. Barren land composes 17.6% of the Navajo Nation. Canyons and tablelands are included in this classification, which are characterized by steep cliff faces, narrow canyons, and open tablelands of predominantly sedimentary rocks, such as sandstone, shale, and limestone. Sand dunes are also included and are characterized by shifting sandy substrates which form patchy or open grasslands, shrublands, or steppes. Vegetation, if present, is usually very open with scattered trees and shrubs and a sparse herbaceous layer. Specific land cover classes found within the Barren Lands on the Navajo Nation include:

- Colorado Plateau Mixed Bedrock and Canyon and Tableland (2.1 million acres)
- Inter-Mountain Basins Shale Badland (250,000 acres)
- Inter-Mountain Basins Active and Stabilized Dune (145,500 acres)
- Rocky Mountain Cliff and Canyon (27,000 acres)

Forests

Deciduous Forest – These are areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to season change. Due to the arid nature of the Colorado Plateau, deciduous forests only compose around 1% of land cover of the Navajo Nation. Deciduous forests in this region are characterized by upland forests dominated by stands of aspen trees (*Populus tremuloides*), with complex shrub and herbaceous understories. Distribution of these forests is limited by water availability, length of growing season, and low temperature. Specific land cover classes found within the Deciduous Forests on the Navajo Nation include:

- Rocky Mountain Aspen Forest and Woodland (35,000 acres)

Evergreen Forest – Evergreen forests are dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage. On the Navajo Nation, Evergreen forests

compose 46.4% of the land cover, making it the most abundant land cover class. Evergreen forests include ponderosa pine (*Pinus ponderosa*) forests and woodlands, alpine and subalpine mixed conifer forests, and pinyon juniper woodlands. Specific land cover classes found within the Evergreen Forests on the Navajo Nation include:

- Colorado Plateau Pinyon-Juniper Woodland (4.7 million ac)
- Rocky Mountain Ponderosa Pine Woodland (533,000 ac)
- Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland (15,400 ac)
- Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland (8,000 ac)
- Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland (4,000 ac)
- Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland (2,700 ac)

Mixed Forest – Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover. This forest type is very uncommon on the Navajo Nation as they only compose around 300 estimated acres of the region.

Shrubland

Shrub/Scrub – Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions. Shrub/Scrub comprises 22.7% of the Navajo Nation, making it the second largest land cover class. On the Navajo Nation, Shrub/Scrub typically occur along plains and foothills between mountain ranges in association with grasslands. GAP land cover classes found in the Shrub/Scrub land cover on the Navajo Nation include:

- Inter-Mountain Basins Mixed Salt Desert Scrub
- Inter-Mountain Basins Big Sagebrush Shrubland
- Colorado Plateau Mixed Lowe Sagebrush Shrubland
- Rocky Mountain Gambel-Oak Mixed Montane Shrubland

Herbaceous

Grassland/Herbaceous - Grasslands are dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling. Grasslands make us 7.6% of land cover on the Navajo Nation. Most grasslands on the Navajo Nation are found in arid areas with well-drained soils and are dominated by perennial bunchgrasses and can be found in associated with open shrub layers. Specific land cover classes found within the Grasslands of the Navajo Nation include:

- Inter-Mountain Basins Semi-Desert Shrub Steppe
- Inter-Mountain Basins Semi-Desert Grassland
- Inter-Mountain Basins Juniper Savanna

Planted/Cultivated

Pasture/Hay – Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for great than 20% of total vegetation. Pasture/Hay comprise approximately 0.4% of the Navajo Nation and include many range management units near and along river ways and portions of the NAPI-NIIP agricultural fields.

Cultivated Crops – Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled. On the Navajo Nation, Cultivated Crops comprise 1% of land cover and primarily describe NAPI/NIIP agricultural lands.

Wetlands

Woody Wetlands - Areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water. Woody Wetlands comprise close to 1% of the Navajo Nation and are commonly found near drainages and stream terraces within the floodplain. Woody plant species dominate such areas, which are subject to annual or episodic flooding, such as cottonwood, willow, and ash trees are common. Tamarisk and Russian olive are commonly GAP land cover classes found within Woody Wetlands on the Navajo Nation include:

- Inter-Mountain Basins Greasewood Flat
- Rocky Mountain Lower Montane Riparian Woodland and Shrubland

Emergent Herbaceous Wetlands – Herbaceous Wetlands are areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water. Typically, tall grasses and sparse shrubs are found in these areas. Emergent Herbaceous Wetlands comprise close to 0.3% of land cover on the Navajo Nation. GAP land cover classes found in Emergent Herbaceous Wetlands on the Navajo Nation include:

- Rocky Mountain Alpine-Montane Wet Meadow
- North American Arid West Emergent Marsh

3.4.2 Wetlands

Because of the arid climate of the southwestern United States, many perennial streams and standing bodies of water are restricted on the Navajo Nation. Major rivers, such as the San Juan River, the Colorado River, and the Little Colorado River are found on the borders of the Navajo Nation. The remainder of the project area mainly supports ephemeral streams and drainages. These conditions restrict where wetland vegetation can be found to areas where water is available throughout much of the year. Most wetlands are found near the San Juan and Little

Colorado River drainages, the Chuska Mountains, and at the bottom of ephemeral and intermittent washes (Ecosphere 2009).

Monocultures of tamarisk (*Tamarix* spp.) and mixed tamarisk stands are the most common riparian vegetation communities found within the ephemeral washes on the Navajo Nation. Species commonly intermixed with tamarisk include the exotic Russian olive (*Eleagnus angustifolia*), native cottonwood (*Populus* sp.), and native coyote willow (*Salix exigua*). Similar to trends in the rest of the Southwest, native riparian vegetation is being displaced by exotic tamarisk and Russian olive. Seeps and springs are found throughout the project area and provide important habitat for a variety of plants and animals, including several endangered and threatened species (Ecosphere 2009). In the arid southwest, riparian vegetation communities are important as places of high biodiversity and their support for a variety of plant and animal species, especially for migratory birds.

Emergent wetlands, however, are rare on the Navajo Nation due to a lack of standing water. However, some of these vegetation communities can be found along stock ponds, in backwater areas of the San Juan, and along the crest of the Chuska Mountains. Emergent wetlands are wetland communities dominated by rushes (*Juncus* spp.), sedges (*Carex* spp.), cattails (*Typha* spp.), and bulrush (*Scirpus* spp.). The emergent wetlands in the Chuska Mountains are unique due to their high diversity of plant species, and are dependent on seasonal snowmelt and summer monsoons (Ecosphere 2009).

As part of the U.S. EPA Wetlands Program to restore and protect wetlands, the Navajo Nation EPA conducted wetland mapping to inventory wetlands, lakes, rivers, and streams (**Table 3-9**).

Table 3-9. Delineated wetlands as reported by the Navajo Nation EPA based on the Cowardin Classification Code (Ecosphere 2009).

Wetland Type	Total Estimated Acres
Lakes (>2 meters deep)	51,200
Lakes (<2 meters deep)	656
San Juan River	5,624
Intermittent Rivers	1,383
Ephemeral streambeds	12,867
Vegetated ephemeral streambeds	1,783
Emergent wetlands	1,755
Riparian woodlands	12
Riparian shrublands	36,790
Natural ponds	315
Stock ponds (w/water)	1,576
Dry natural ponds	485
Dry stock ponds	760

The study indicated that the San Juan River is the primary perennial river on the Navajo Nation and drains many of the washes on the northern portion of the project area. The river also has a wide floodplain and a shallow ground water table. The Little Colorado River is intermittent and drains the White Mountains in central Arizona. It also has a wide floodplain and an active river

channel. Most flows on the Little Colorado River occur in late spring/early summer from seasonal snowmelt, and the river is subject to flash flooding during the summer monsoons (Ecosphere 2009). Both exhibit characteristics that support riparian shrublands and woodlands. Approximately 16,796 acres of riparian shrublands are found on the San Juan River and 14,690 acres are found on the Little Colorado River. These river corridors help support close to 86% of riparian shrublands found on the Navajo Nation. However, the perennial water supply of the San Juan River creates conditions that support emergent wetlands along the river channel. The San Juan River supports approximately 400 acres of emergent wetlands (Ecosphere 2009). This represents about 23% of emergent wetlands found on the Navajo Nation.

Water resources on the Chuska Mountains also help support a significant number of wetlands communities. These wetlands are supported by seasonal snowmelt and seasonal monsoonal events. Additionally, the crest of the Chuska Mountains is flat in some areas, creating depressions that support numerous wetlands. Overall, 1,075 acres of emergent wetlands are found in the Chuska Mountains. This represents about 72% of all emergent wetlands for the Navajo Nation (Ecosphere 2009).

3.4.3 Noxious Weeds

The expansion of noxious weed species within the Navajo Nation has resulted in ecological and economic impacts for the Navajo people. These plants are widely dispersed over the project area. Currently, just over 24,000 acres of weeds have been mapped on the Navajo Nation by the BIA and other affiliated programs (**Table 3-10**, **Table 3-11**). However, mapping efforts have only focused on areas reported to the BIA by land users interested in eradication and control. The actual coverage of weeds identified for control under the Navajo Nation Integrated Weed Management Plan is unknown, but anticipated to be much greater and the BIA is currently performing weed mapping efforts throughout the Navajo Nation. The Plan calls for the BIA to implement comprehensive mapping efforts to provide more current data on weed coverage and diversity. Mapping of weed populations on the Navajo Nation is currently being completed at the time this document was prepared. However, funding is limited and will limit the scope of weed mapping activities, which means that many weed populations may go undetected before ecological impacts are detected by land users, land managers, and federal agencies. The species identified as priority weed species within the plan have been identified through previous weed mapping efforts implemented by the BIA and by the Southwest Exotic Plant Information Clearinghouse managed by the U.S.G.S Colorado Plateau Research Station.

Table 3-10. Current mapped weed infestations by BIA Navajo Regional Office Agencies. The acres documented below represent the most current weed mapping efforts and are likely to change in the future due to the dynamic nature of weed populations.

Agency	Total Acres	Demonstration Weed Project Acres	Acres of Weeds Mapped
Western	5,214,108	2645	38,391.94
Eastern	2,267,541	1900	292.42
Fort Defiance	3,349,982	2642	4,464.52
Northern	2,695,089	80	5,292.59
Central	1,389,504	120	10,143.38
NPL	910,834	In Progress	1,510.11
New Lands			
ADOT	-	650	97.13
Other Roads	-	-	121.94
Total	**15,827,058**	**8037**	**60,411.06**

Table 3-11. Acres of weed by species mapped on the Navajo Nation. This information includes weed mapping data compiled by the BIA and estimated acres from the Southwest Exotic Plant Mapping Program (SWEMP) to determine the coverage of the target weed species. Weed acres documented in the table below represent the most current weed documentation at the time of this writing and are expected to change due to the dynamic nature of weed populations.

Common Name	PLANT Code	Acres Mapped
Tamarisk	TAMAR2	10,377.36
Russian olive	ELAN	4,254.35
Field Bindweed	COAR4	361.71
Russian knapweed	ACRE3	691.88
Camelthorn	ALMA13	1,918.58
Halogeton	HAGL	1,372.55
Scotch thistle	ONAC	24.43
Musk thistle	CANU4	123.5
Diffuse knapweed	CEDI3	6.85
Johnsongrass	SOHA	3.22
Ravenna grass	SARA3	0.1
Yellow starthistle	CESO3	0.2
Tree of Heaven	AIAL	0.75
Blue mustard	CHTE2	0.05
Bull thistle	CIVU	485.75
Canada thistle	CIAR4	0.2
Dalmatian toadflax	LIDA	98.47
Perennial pepperweed	LELA2	0.11
Tall whitetop	CADR	1.19
Siberian elm	ULPU	0.39
Cheatgrass	BRTE	711.21
Puncturevine	TRTE	60.5
Ripgut brome	BRDI3	0.5
Smooth brome	BRIN2	0.75
Bald brome	BRRA2	0.05
Red brome	BRRU2	38.18
Spreading wallflower	ERRE4	0.1
Horehound	MAVU	0.3
California burclover	MEPO3	0.5
Russian thistle	SAKA	28,460.64
Field brome	BRAR5	0.3
Kochia	BASC5	77.67

TOTAL	49,071.89

Additional reporting and documented observations of weed infestations from annual BIA weed reports indicate that approximately 110,000 acres of the Navajo Nation have been impacted by exotic weed species. While, only accounting for 0.7% of the Navajo Nation land base, many of these infestations are in areas in use by local residents for grazing, farming, travel, or water use. There are several thousand undocumented acres that have not been documented or reported by by the BIA Noxious Weed Program.

3.4.3.1 Species Descriptions

The following are description and characteristics of the weeds found within the project area that have been prioritized for management and control on the Navajo Nation. As defined in the weed management plan, weeds are exotic, invasive, aggressive, competitive, and persistent. Locations for known weed infestations are from recent BIA weed mapping efforts and the Southwestern Exotic Plant Mapping Program (SWEMP)

Leafy spurge (*Euphorbia esula*) is a noxious weed from Eurasian reproducing from adventitious root buds and seeds. Roots of this species form extensive underground systems that can extend over 30 feet into the soil, and laterally as well. Seeds, forcefully expelled, can travel up to 15 feet from the original plant. These factors make the species very difficult to control. The milky latex found in leafy spurge causes lesions around the eyes and mouth when eaten by cattle (USFS 2005). Commonly invades grasslands and has the potential to invade riparian areas, shrublands, and savannas. Currently no populations have been documented, but some are known to occur near Mormon Lake in the Flagstaff, Arizona area.

African rue *(Peganum hermala*) is a small bright green succulent perennial herb with a bushy growth habitat. The plant dies back to its roots in the winter and initiates new growth in late March and early April. African rue is known to contain four poisonous alkaloids and is toxic to cattle, sheep, and horses. The toxins include loss of appetite, trembling, and a loss of coordination. Severe poisoning can result in hemorrhaging in the heart and liver. The seeds are the most toxic part of the plant, with the leaves being somewhat less toxic (USFS 2005). African rue commonly invades disturbed or barren areas with moist soils. Populations have been detected near Navajo Bridge at a business site lease in the Western Navajo Region.

Tree of Heaven (*Ailantus altissima*) is a deciduous tree from China that can grow up to 90 feet tall. It can reproduce from seed or from root sprouts that create an extensive root system forming dense colonies that out-compete native trees like box elder. Tree of Heaven also produces chemicals that prevent the establishment of other plant species nearby. Roots systems are extensive and have been known to damage sewers and foundations of nearby structures (PCA 2009). Tree of Heaven commonly invades disturbed areas and can grow in forest openings and common areas. It does not establish well in wetlands or shaded areas. Populations have been found in the Shiprock area in the Northern Navajo Region.

Fountaingrass (*Pennisetum setaceum*) is an attractive perennial grass with a densely clumped growth form and erect stems that can grow up to 4 feet high. The small flowers are grouped in pink or purple, bristly, upright inflorescences 6-15 inches long. Fountain grass is a highly aggressive and fire-adapted colonizer that can out-compete native plants and emerges quickly after burning. The seeds are long-lived and disperse easily by wind or water, allowing them to disperse great distances (USFS 2005).

Squarrose knapweed (*Centaurea virgate*) is a long-lived perennial forb that grows to a height of 12-18 inches with small pink to purple flowers. The plant can remain as a rosette for several years if conditions are poor before growing into a flowering stem. Squarrose knapweed can invade rangelands with shallow soils and is adapted to harsh climates. Flower heads have burs on them that allow them to cling easily to passing animals, vehicles, and clothing (USFS 2012).

Blue mustard (*Chorispora tenella* (Pall.) DC) is a winter annual native to Eurasia that grows in late fall or early winter. It overwinters as a rosette and resumes growth in the spring. It spreads and grows via seeds in disturbed areas and sites. If eaten by milk cattle, it can produce off-flavor milk. If grown in agricultural fields, blue mustard has been known to reduce the overall yield of grain crops (Lyons et al. 2006). Populations of blue mustard have been detected just outside of Chinle, AZ.

Ravenna grass (*Saccharum ravennae*) is a bunch grass with long flowing cane-like stalks that can reach heights over 12 feet and with a basal area several feet in diameter. Often planted as an ornamental, Ravenna grass escapes easily due to its lightweight seeds that can disperse in wind and waters. It establishes quickly in disturbed areas and is highly competitive in riparian areas. It can form dense monocultures, growing out from beneath established vegetation. Established stands also increase the risk of fires along riparian zones and anchor soils normally subject to shifting (PDCNR 2013). Ravenna grass has been detected along the San Juan River near Glen Canyon National Recreation Area and outside of Lake Powell. Small populations have also been detected on the Hopi Reservation and inside Grand Canyon National Park.

Yellow starthistle (*Centaurea solstitialis*) is an annual introduced from Europe, which grows 2 to 3 feet tall. The roots grow at least 3 feet deep, and it seeds prolifically. Horses grazing large quantities of this plant are susceptible to "chewing disease," a neurological disorder preventing the horse from swallowing. There is no cure for chewing disease; it is fatal (USFS 2005). Yellow starthistle has been detected along roadsides on BIA-27 north of Ganado Lake, and on Interstate 40 outside of Window Rock.

Bull thistle (*Cirsium vulgare*) is a stout biennial thistle with purple flowers from Eurasia. It invades disturbed sites including slash piles, old log desks, and roadsides. Regeneration is solely from short-lived seed. It can out-compete native vegetation and reduce overall site productivity and stocking levels where grown (USFS 2005). Bull thistle has been detected in numerous locations within the Navajo Nation, mostly along roads and highways.

Canada thistle (*Cirsium arvense*) is a colony-forming perennial thistle. It has extensive underground roots, which are capable of producing new plants. It can also reproduce from seeds. Canada thistle can reduce forage consumption in rangelands and reduce crop yields in agricultural lands (USFS 2005). Canada thistle has been detected on some rangelands and along roads near Window Rock and Leupp.

Dalmatian toadflax (*Linaria dalmatica*) is an introduced ornamental, perennial weed from the Dalmatian region of Eastern Europe. It can grow up to 3 feet tall, and reproduces from both seed and underground rootstalks. One plant can produce up to one-half million seeds, as well as lateral roots up to 10 feet from the plant (King County 2011). Dalmatian toadflax can crowd out native plants and reduce forage on rangelands. Dalmatian toadflax commonly occurs along roadsides in the southwestern United States and has been detected in Western and Fort Defiance Agencies jurisdictions.

Musk thistle (*Carduus nutans*) is a biennial member of the sunflower family. Flowers are showy purple red disks that "not" at a 90° angle. In one growing season a single plant can produce over 100,000 seeds. Therefore, it can increase from a single plant to a rather large infestation within 2 or 3 years. The seeds can remain viable in the soil for roughly 15 years, which necessitates intensive monitoring of sites and repeated treatments (USFS 2012). Musk thistle has been found throughout the Navajo Nation along roadsides, farm fields, and rangelands.

Perennial pepperweed (*Lepidum latifolium*) is a long-lived perennial native to Eurasia which can grow in a variety of areas; including floodplains, pastures, riparian areas, and near residential structures. Pepperweed can grow from 2 to 4 feet tall from seeds or its perennial root system. Overtime, it can form dense thickets that crowd out other plant species (UC-IPM 2004). Populations of perennial pepperweed have been detected within Marble Canyon and at NAPI/NIIP lands on the Navajo Nation.

Scotch thistle (*Onopordum acanthium*) is a large biennial thistle, native to Europe. Characteristics of this species include broad, spiny stems with vertical ribs, large, spiny leaves with dense hairs and violet to reddish flowers. The plant can create an impenetrable thicket. Seeds are viable for 6 years. This species grows in disturbed habitats along roadsides and in waste areas (USFS 2014). Scotch thistle is found throughout the Navajo Nation along roadsides and in some riparian washes and farms.

Spotted knapweed (*Centaurea maculosa*) is a biennial or short-lived perennial from central Europe, growing 1 to 3 feet tall. If allowed to spread, it forms a monoculture and reduces desirable plant populations. This species inhibits other plants from growing near it (USFS 2005). Populations are common along roads and near the Shonto Boarding School.

Tall Whitetop (*Cardaria draba*) is a deep-rooted perennial in the mustard family, native to Russia. It often grows up to 2 feet tall, with roots going 12-30 feet deep. It can produce 50

shoots in a square yard. One plant can spread 12 feet in its first year. It is toxic to cattle. It reproduces by seed and by root segments. Whitetop is found on alkaline, disturbed soils and is highly competitive once it becomes established (USFS 2005). Tall whitetop has been detected on the Navajo Nation along roadsides and washes in the eastern Chuska Mountains.

Sahara mustard (*Brassica tournefortii)* is a fast-growing, drought tolerant, winter annual that grows in disturbed and sandy soils. The basal rosette can grow to a span of 3 feet with an overall height of about 2 feet. The small yellow flowers are self-pollinating, creating thousands of seeds. Dried plants break off like a tumbleweed, spreading seeds long distances. Areas invaded by Sahara mustard have an increased risk of fire, lowered biodiversity, and lower forage quality of rangelands (USFS 2014).

Uruguyan pampas grass (*Cortaderia selloana*) is a quick growing bunch grass that can grow along roadsides, steep cliffs, river banks, and open disturbed areas. A single plant can produce millions of seeds which can travel via wind for several miles. The grass is tolerant of intense sunlight, drought, and frost and can live over a decade. The grass can displace native place, lowering biodiversity and reducing habitat quality. The leaves, which are extremely sharp, can also cause physical harm to wildlife, livestock, and humans (DiTomaso 2013).

Yellow nutsedge (*Cyperus esculentus*) is a warm season perennial sedge native with a fibrous root system and scaly rhizomes. The nutsedge reproduces by seeds and tubers, which form at the end of rhizomes, making it difficult to control. The tubers develop rapidly and can persist in the soil for many years, forming dense colonies and crowding native vegetation. Yellow nutsedge can grow in a variety of soil types, and prefers wet or moist soils, but can tolerate dry sites once established (UC IPM 2014).

Sulphur cinquefoil (*Potentilla recta* L.) is a Mediterranean perennial forb that can grow up to 3 feet tall, which can reproduce via seeds or new root shoots. It commonly invades grasslands and shrub-dominated areas, especially disturbed sites or waste areas. The plants are unpalatable and largely avoided by animals due to the high tannin content. Sulphur cinquefoil can quickly dominate grazing areas, out-competing native forage grasses (King County 2005).

Common Mediterranean grass (*Schismus barbatus*) is a cool-season annual grass native to Africa. It is an erect to semi-prostrate grass that can reach heights of up to 8 in. It often forms large, dense mats. In North America this species is found on dry slopes, bajadas, desert mesas, river bottoms or valley bottoms, and is locally abundant in mountain ranges between 100 and 4,000 ft. in elevation. This grass can from dense stands during years of favorable winter precipitation, outcompeting native species. It is one of the primary species fueling desert wildfires in the Mojave Desert, threatening species diversity in ecosystems that have not evolved with fire (USFS 2005).

Tamarisk (*Tamarix spp.,* including hybrids) is similar to the more widespread *T. ramossisima* described below. Athel tamarisk is a slower growing species of tamarisk that has been used as

an ornamental and for erosion control. This species is found in more isolated populations but poses concern due to its ability to hybridize with other similar species. Impacts of such hybridization are not yet well understood, but include concerns regarding increased spread and utilization of previously uninhabitable ecosystems.

Camelthorn (*Alhagi maurorum*) is a native of Eurasia and is considered one of the most difficult to eradicate, and therefore, could result in serious economic impacts. It is an aggressive perennial that sends thick rhizomes out 36 feet or more from the parent plant. Seeds may be viable for years, although reproduction is mostly vegetative. It can grow through pavement, and the thorns can flatten car tires (USFS 2005). Camelthorn has caused numerous problems on the Navajo Nation, where it grows quickly along roadside, along washes and streams, and near communities. Heavy infestations are detected near Shiprock, Tuba City, Chinle Wash, the San Juan River Basin, and along the Little Colorado River.

Halogeton (*Halogeton glomeratus*) favors disturbed sites and can reach a height of 18 inches or more. The species has numerous upright stems that branch from the base. The leaves are small, fleshy, and tubular and end in a needle-like spine. Halogeton is not extremely competitive but invades disturbed and overgrazed areas. It produces oxalates, which are toxic to livestock (NRCS 2008). Halogeton is found in heavy populations along roads and disturbed areas such as on Black Mesa near coal mine operations. On the Navajo Nation, halogeton is widespread.

Siberian elm (*Ulmus pumila*) is widely grown in many areas of the southwestern United States as a shade tree. However, it is not appropriate in wildland settings which it can out-compete native tree species in riparian zones and other sensitive areas. The trees reproduce through winged seeds that can be transported long distances on the wind or by vehicles to new locations. The abundant production of seeds makes this species difficult to control (USFS 2005). Siberian elm has been detected in isolated populations on the Navajo Nation along roadsides, homesite leases, and business site lease areas.

Tamarisk (*Tamarisk ramossisima)* is found in riparian areas throughout the West. It was originally introduced as an ornamental and for erosion control. It out-competes native riparian trees by forming deep root systems that can access underground water not available to native species and by growing in dense monocultures. The foliage of tamarisk can add salt deposits to the soil, inhibiting growth of other species. The species can also increase the risk of fire in riparian ecosystems by increasing flammable fuels (USFS 2005). Tamarisk is widespread on the Navajo Nation in riparian areas and washes where it has altered stream flow, decreased habitat quality, and increased fire risk. Some populations are also impacted by the release of the tamarisk leaf beetle (*Diorhabda spp.*), defoliating large stands and increasing fuel loads and fire risk in impacted washes and riparian areas. Tamarisk is common along washes, roadsides, homesite leases, and business site lease areas.

Diffuse knapweed (*Centaurea diffusa*) is an annual or short-live perennial form the Mediterranean region, growing 1 to 2 feet tall with a long single taproot. It reproduces from seed, which can remain viable for 12 years. Dead plants break off at the ground level and tumble around, spreading seed in the wind. Knapweed can increase erosion and sedimentation and decrease habitat and forage quality. It produces chemical compounds that inhibit other species (even other knapweeds) from growing around it (USFS 2005). Diffuse knapweed is widespread has been found largely along roadsides, mining areas, and in community areas on the Navajo Nation.

Russian knapweed (*Acroptilon repens*) is a deep-rooted perennial that reproduces from weed and vegetative root buds. These buds develop into adventitious roots enabling the species to colonize large areas quickly. Russian knapweed produces compounds that suppress growth in native plants, allowing it to form dense monocultures. In 2 years, the roots can grow 10 feet deep and 10 to 12 feet in diameter (USFS 2005). Russian knapweed is found throughout the Navajo Nation on farms, rangeland, near waterways, and along roadsides.

Russian olive (*Elaeagnus angustifolia*) is a woody species forming large shrubs to medium-sized trees. Until recently, this species was promoted for windbreaks and erosion control. It has been planted extensively in areas through the southwestern United States and can invade riparian areas where it eventually replaces native tree species (USFS 2005). Russian olive has invaded several major washes and riparian areas within the Navajo Nation including Long Canyon, Shonto Wash, Colorado Pueblo Wash, Fruitland, and streams and tributaries around Shiprock.

Johnsongrass (*Sorghum halepense*) is a coarse, clumping perennial grass native to the Mediterranean region. It can spread rapidly through seed and underground rhizomes. It poses problems on disturbed sites and agricultural land, where it can hybridize with crops such as sorghum. Under certain conditions, the leaves can produce a toxin which can poison livestock if ingested (UC IPM 2014b).

Cheatgrass (*Bromus tectorum*) is an erect winter and spring annual grass from Europe, which can grow to a height of 2 feet. The plant is a prolific seed producer and the density of the species has more to do with available sites (bare soil) for germination than the number of seeds produced. The presence of cheatgrass has increased the fire frequency in areas where it invades, often in forests, near residential areas, and in open fields (USFS 2005). Cheatgrass invasions are a widespread problem throughout the southwestern United Stated and populations are found throughout the Navajo Nation. Cheatgrass is a known invader on rangelands and along hiking and horse trails.

Field bindweed (*Convolvulus arvernsis*) is a hardy perennial originally from Eurasia which can spread quickly and climb other upright plants. It spreads vegetatively, producing extensive rhizomes and rootstock, although it can also spread via seeds. Seeds have a long dormancy period, lasting up to 60 years in the soil. It is drought tolerant and can out-compete native and

desirable vegetation. Bindweed roots also have the ability to penetrate through fabric, plastic, and other barriers (UC IPM 2011). Field bindweed is widespread on the Navajo Nation, affecting rangelands, farmlands, and roadsides.

Jointed goatgrass (*Aegilops cylindrical*) is a tall winter annual grass from Eurasia known to cause serious problems in agricultural fields, especially grains. It can grow between 15-30 inches tall and is very similar visually and genetically to winter wheat, which allows it to hybridize and reduce overall crop yields (USFS 2012).

Puncturevine (*Tribulus terrestris*) is a summer broadleaf annual from southern Europe, that forms ground covering dense mats 2 to 5 feet in diameter. When its yellow flowers are pollinated, seedpods form with flat spiny burrs which can stick on passing animals, tires, and shows. A prolific seeder, a single plant can produce thousands of seeds, which can persist in the ground for up to 20 years. Puncturevine also has a deep taproot, allowing it to out-compete other plants for water and nutrients. Puncturevine is harmful to animals both from injury caused by ingesting the seed burrs and toxins produced by the plant. The toxins are particularly harmful to sheet and can contribute to nitrate poisoning in sheep and cattle (UC IPM 2006). Puncturevine is widespread on the Navajo Nation, along roadsides, fields, disturbed sites, and near watering holes and windmills.

Rescuegrass *(Bromus catharticus*) is an annual, cool-season bunchgrass native to South America. This grass is used as forage in much of the southern U.S., however, it is considered weedy throughout much of the U.S. and Mexico. It is well adapted to warm climates and can resist extreme cold. It is found along roadsides, ditch banks, lawns, gardens and in small grained winter crops. It has been shown to outcompete native vegetation, particularly in riparian areas. Seeds have barbed awns that adhere to clothing, and animal fur; they may be carried by wind, water, or by small rodents (Halvorson and Guertin 2003b).

Ripgut brome (*Bromus diandrus*) is a C3 annual grass that is native to Africa, temperate Asia, and parts of Europe. It is adapted to Mediterranean climates and can be found along roadsides, field borders, disturbed areas, and native rangelands. This grass poses a significant threat to wildlands, particularly in California, where it replaces native bunchgrasses. Seeds have barbed awns that adhere to clothing, and animal fur; they may be carried by wind, water, or by small rodents (Halvorson and Guertin 2003b). Ripgut brome has currently only been detected east of Chinle near Canyon de Chelly.

Smooth brome (*Bromus inermis*) is a leafy, sod-forming, perennial cool-season grass that spreads by rhizomes. It is best adapted to cooler climates but is drought tolerant and cold resistant. It is established throughout most of the U.S. It is considered desirable for forage and hay production, however, it can become highly invasive and outcompete more desirable plants. Spread is through both seeds and rhizomes (Bush 2006) Populations of smooth brome have been detected in the Chuska Mountains north of Long Lake and along Hwy-134.

Bald brome (*Bromus racemosus*) is an exotic Eurasian grass that grows in agricultural fields, pastures, and disturbed areas. Like cheatgrass, bald brome can be grazed by livestock when young but dries up as it matures, increasing fire risk in areas where it invades (Gibbs 1973). Bald Brome has been detected in Canyon de Chelly.

Red brome (*Bromus rubens*) early emerging annual grass that is native to the Mediterranean region. It actively grows for only about 4 to 6 weeks. Mature foliage and seed heads have a distinctly reddish color. This noxious weed prefers open spaces within shrub and grassland communities. As the grass matures, red brome provides a fine-fuel source that decomposes slowly and greatly increases the fire potential, intensity, and burn speed. It alters the fire pattern in many plant communities and has been especially harmful to desert plants that are not fire adapted such as blackbrush (*Coleogyne ramosissima*). Its sharp awns can injure wildlife and livestock, reduce available forage, diminish recreational opportunities, degrade wildlife diversity and habitat, and decrease land values. Seeds have barbed awns that adhere to clothing, and animal fur; they may be carried by wind, water, or by small rodents (USFS 2012). Red brome has been detected on the Utah side of Lake Powell, near Antelope Pass, along Hwy 160 outside of Tuba City, and in the western portion of Canyon de Chelly.

Spreading wallflower (*Erysimum repandum*) is a winter branching annual with narrow toothed margin basal leaves that grows approximately 1-2 feet tall. The basal leaves form a low rosette spanning 6 inches across on average. The plant also has a deep, stouted tap root. They are commonly found among winter annual crops, along roadsides, and in disturbed sites (Hilty 2012). Spreading wallflower has been detected in Canyon de Chelly.

Horehound (*Marrubium vulgare*) is a perennial herb in the mint family (Lamiaceae) with square stems; leaves are covered by dense white hairs. It colonized fields, lawns, and other open/disturbed areas. It establishes on infertile soils and is often the first colonizer on recently eroded areas. It is considered a naturalized species in the United States (Halvorson and Guertin 2003). Horehound has been detected near Ganado, east of Luckachukai on BIA-13, and east of South Sheba Crater.

California burclover (*Medicago polymorpha*), while it can be used as forage for livestock, has prickly fruits that can get caught on wool and animal fur. Introduced from southern Europe, burclover is a shallow-rooted annual legume with prostrate stems that spread outward 6 to 30 inches from the base. Burclover has a tendency to spread quickly on poor and disturbed soils, where it can out-compete native vegetation (UC IPM 2014c). Burclover has been detected in Canyon de Chelly in Canyon del Muerto.

Russian thistle (*Salsola kali)* is a warm-season, C4, annual herb that grows between ½ and four feet in height and is native to Eurasia. It is densely branched and globe-shaped, forming a taproot. It occurs in many plant communities, and is common in disturbed grasslands and desert communities, being prevalent in the semiarid regions of the western United States. It is found on

sites such as roadsides, railroad right-of-ways, trails, along streams and lakes, and dry plains, cultivated and irrigated fields, abandoned fields, waste places, and overgrazed ranges/pastures. One this plant matures, it breaks off at the base and becomes a tumbleweed, distributing its seeds across the landscape. *Salsola* tumbleweeds persist for years, collecting along waterways and fence lines, and posing a fire hazard. Ignited tumbleweeds have also been known to carry fire across fire breaks, spreading fire to unburned areas. *Salsola* competes with native species and crops and has also been reported to inhibit the movement of desert tortoises when it forms monocultures (Halvorson and Guertin 2003a).

Field brome (*Bromus arvensis*) is a winter annual grass that produces a dense, low leafy growth in the fall. It is commonly planted as a winter cover crop, but can become invasive displacing more desirable vegetation in certain habitats. It does well on medium textured soils that are moderately to well-drained. It can be found throughout the U.S. Spread is through seed (USFS 2012). This species is also sometimes known as Japanese brome.

Kochia (*Bassia scoparia*) is an annual plant identified by erect, highly branched stems that can grow up to 7 feet tall. Kochia is efficient at using water and adapted to variable environment, thriving in low rainfall regions. It can be found in grasslands, pastures, prairies, roadsides, floodplains, riparian areas and agricultural fields. This plant reduces crop yields, contaminates crops and outcompetes native vegetation by competing for resources and releasing allelopathic chemicals into the soil. If consumed in large quantities, it can be toxic to livestock. Kochia produces copious amounts of seed; plants break off at the base and are blown as tumbleweeds, spreading seeds as they move across the landscape (Rumph and Schat 2009).

3.4.4 Plants – Endangered, Threatened, Candidate, and Sensitive Species

The project area contains populations for 39 that have been listed for protection; 8 species are federally listed and 31 additional tribally listed through the Navajo Department of Fish and Wildlife (**Table 3-12**). Of the federally listed species, 3 plant species are endangered, 4 species are threatened, and there is a conservation agreement (CA) in place for Gooding's Onion precluded the need for listing the species. For tribally listed species, 5 species are listed as critically endangered (G2), 14 are listed as endangered (G3), and 20 plants are listed as sensitive or of concern (G4). Listing of species for the Navajo Nation is based on species populations solely within the Navajo Nation Information on habitat for all listed plant species is managed by the Navajo Department of Fish and Wildlife.

Table 3-12. Species of concern found on the Navajo Nation as designated by the U.S. Fish and Wildlife Service and the Navajo Department of Fish and Wildlife.

Common Name	Scientific Name	Federal Status[+]	Tribal Status[++]	Location
Brady pincushion cactus	*Pediocactus bradyi*	E	G2	AZ
Fickeisen plains cactus	*Pediocactus peeblesianus var. fickeiseniae*	E	G3	AZ
Mancos milkvetch	*Astragalus humillimus*	E	G2	AZ, NM
Mesa Verde cactus	*Sclerocactus mesae-verdae*	T	G2	AZ, NM
Navajo sedge	*Carex specuicola*	T	G3	AZ, UT
Welsh's milkweed	*Asclepias welshii*	T	G3	AZ, UT
Zuni fleabane	*Erigeron rhizomatus*	T	G2	AZ, NM
Goodding's onion	*Allium gooddingii*	CA	G3	AZ, NM
Cutler's milkvetch	*Astragalus cutleri*	-	G2	UT
Marble Canyon milkvetch	*Astragalus cremnophylax* var. *hevroni*	-	G3	AZ
Cronquist milkvetch	*Astragalus cronquistii*	-	G3	UT
Naturita milkvetch	*Astragalus naturitensis*	-	G3	NM
Acoma fleabane	*Erigeron acomanus*	-	G3	NM
Round dunebroom	*Errazurizia rotundata*	-	G3	AZ
Navajo bladderpod	*Lesquerella navajoensis*	-	G3	AZ, NM
Navajo penstemon	*Penstemon navajoa*	-	G3	UT
Alcove rock daisy	*Perityle specuicola*	-	G3	UT
Alcove bog-orchid	*Platanthera zothecina*	-	G3	AZ, UT
Alcove death camas	*Zigadenus vaginatus*	-	G3	AZ, UT
Aztec gilia	*Aliciella Formosa*	-	G4	NM
Peebles blue-star	*Amsonia peeblesii*	-	G4	AZ
San Juan milkweed	*Asclepias sanjuanensis*	-	G4	NM
Beath's milkvetch	*Astragalus beathii*	-	G4	AZ
Heil's milkvetch	*Astragalus heilii*	-	G4	NM
Navajo saltbush	*Atriplex garrettii var. navajoensis*	-	G4	AZ
Atwood's Camissonia	*Camissonia atwoodii*	-	G4	UT
Rydberg's thistle	*Cirsium rydbergii*	-	G4	AZ, UT
Yellow lady's slipper	*Cypripedium parviflorum var. pubescens*	-	G4	NM
Utah bladder-fern	*Cytsopteris utahensis*	-	G4	AZ, NM
Grand Canyon Goldenweed	*Ericameria arizonica*	-	G4	AZ
Sivinski's fleabane	*Erigeron sivinskii*	-	G4	AZ, NM
Sarah's buckwheat	*Eriogonum lachnogynum var. sarahiae*	-	G4	AZ, NM
Bluff phacelia	*Phacelia indecora*	-	G4	UT
Cave primrose	*Primula specuicola*	-	G4	AZ, UT
Marble Canyon dalea	*Psorothamnus arborescens var. pubescens*	-	G4	AZ
Parish's Alkali grass	*PuccinellIa parishii*	-	G4	AZ, NM
Arizona rose sage	*Salvia pachyphylla ssp. eremopictus*	-	G4	AZ
Brack hardwall cactus	*Sclerocactus cloverae brackii*	-	G4	NM
Welsh' American-aster	*Symphyotrichum welshii*	-	G4	AZ, UT

[+]E=endangered, T=threatened, CA=conservation agreement (precluded listing)

[++]G2=critically endangered, G3=endangered, G4=sensitive

3.4.4.1 Species Descriptions

Federally Listed Species

Brady Pincushion Cactus (*Pediocactus bradyi)* is a small, semiglobose cactus, ranging from a 2.5 to 5 cm in diameter. Suitable habitat consists of Kaibab limestone chips overlaying soils derived from Moenkopi shale and sandstone. It is typically found on gently sloping benches and terraces with sparse vegetation from mid-March to late April. Populations are known from 3340 – 5200 ft. in elevation. The species is known only from Coconino County, within the vicinity of the Marble Canyon rim. On the Navajo Nation it is found south of Lee's Ferry on the east side of the Colorado River, south to the vicinity of Sheep Springs Wash. There is potential for the species to exist from Lee's Ferry south and west to the Echo Cliffs, along tributary canyons of the Colorado River, south to Shinumu Wash (NNDFW 2008).

Fickeisen Plains Cactus (*Pediocactus pebblesianus ssp. fickeiseniae)* is a spherical, usually solitary cactus with stems ranging from 2.5-6.0 cm tall. It is best surveyed from late March to late April. Suitable habitat consists of soils overlain by Kaibab limestone in Navajoan desert or Great Plains grassland, as well as canyon rims and flat terraces along washes, typically with limestone chips scattered across the surface. Populations are known to occur between 4000 and 6000 ft. in elevation. This species is known from Arizona in Coconino County from House Rock Valley and Gray Mountain to the Little Colorado and Colorado Rivers. On the Navajo Nation, this cactus can be found between Gray Mountain and Bitter Springs at elevations between 4,000 and 6,000 ft. There is potential for the species to occur between Marble Canyon and Gray Mountain (NNDFW 2008)

Mancos Milk-vetch (*Astragalus humillimus*) is a small, mat forming, perennial shrub with persistent spiny leaf stalks. It is best surveyed during the flowering period from April to early May, but can be identified by an expert year round. The species forms highly localized populations from 4 – 20 acres in size, typically found on large, nearly flat sheets of exfoliating whitish-tan colored sandstone, in small depressions and sand filled cracks on or near ledges and mesa tops. It can be found on the Navajo Nation in San Juan County, New Mexico on Palmer Mesa east to the Hogback area and south of the San Juan River, to a hogback east of Little Water. There is potential for the species to exist throughout the Four Corners area on all slickrock formations consisting of Point Lookout and Cliffhouse Sandstone, and possibly other related features (NNDFW 2008)

Mesa Verde Cactus (*Schlerocactus mesae-verdae)* consists of mostly solitary stems, though it can be found in clusters; stems are oval to depressed-globose, 3 – 11 cm long, and up to 10 cm in diameter. It can only be surveyed during the flowering and fruiting period from April through May. Suitable habitat can be surveyed year round and consists of salt-desert scrub communities, typically in the Fruitland and Mancos shale formations, but also in the Menefee Formation overlaying Mancos shale. It is most frequently found on the tops of hills or benches and along slopes, between 4900 to 5500 ft. elevation. Appropriate Mesa Verde cactus habitat must have an

underlying layer of clay soils that can be overlain with either igneous or sedimentary gravel. On the Navajo Nation, it is found from the Colorado border south to near Naschitti, New Mexico. There is potential for the species to exist on the Navajo Nation only within its known distribution to the north, south, and west. The eastern limits are still unclear (NNDFW 2008).

Navajo Sedge (*Carex specuicola)* is a perennial grass-like plant with a dried persistent leaf base. Positive identification of the plant is only possible during the flowering/fruiting season, from late June through September; however, suitable habitat can be identified year round. This sedge is typically found in seeps and hanging gardens on vertical sandstone cliffs and alcoves, from 4600 ft. to 7200 ft. in elevation. On the Navajo Reservation it has been documented from the Navajo Creek drainage in Coconino County; east to the Tsegi Canyon Watershed in Navajo County; south to Rock Point, Mexican Water, and Canyon de Chelly National Monument in Apache County, Arizona. It is also known from Chinle Creek in San Juan County, Utah. Within the Navajo Nation, there is potential for the species to occur in northern Arizona and southeastern Utah, especially in hanging gardens of the San Juan River drainage and Lake Powell (NNDFW 2008)

Welsh's Milkweed (*Asclepias welshii*) is an herbaceous perennial herb with large oval soft woolly leaves and globular clusters of cream colored flowers that are rose-tinged in the middle. It is best surveyed from June through September. Suitable habitat consists of active sand dunes derived from Navajo sandstone in sagebrush, juniper, and ponderosa pine communities. On the Navajo Nation, the species can be found in Coconino County, north of Tuba City and south of Monument Valley in Navajo County and Apache County. There is potential for the species to exist on all active sand dunes between Page and Tuba City, east to the Chinle Creek drainage (NNDFW 2008)

Zuni/Rhizome Fleabane (*Erigeron rhizomatus)* is an herbaceous perennial herb with creeping rhizomes, 25 – 45 cm tall. It is distinguished from other fleabane species by its rhizomatous habit, nearly hairless leaves and very few hairs on the stems and leaves. It is best surveyed during its flowering period between May and June, but can be identified by an expert through July and possibly August. Suitable habitat can be identified year round and consists of fine textured clay hillsides of mid to high elevation between ca. 7000 and 8300 ft. in elevation. It is known from clays derived from the Chinle Formation in the Zuni and Chuska Mountains, and to similar clays of the Baca Formation in the Datil and Sawtooth ranges in New Mexico. On the Navajo Nation, it has been recorded on the slopes of the Chuska Mountains from Lukachukai and west of Red Valley in Apache County, Arizona south to Navajo in McKinley County, New Mexico. There is potential for the species to occur on the Navajo Nation in the Chuska Mountains and in suitable habitat in the pinion-juniper associations between Lupton in Apache County, Arizona and Prewitt in McKinley County, New Mexico (NNDFW 2008).

Goodding's Onion (*Allium gooddingii)* is an herbaceous perennial with an elongate bulb terminating in a thick iris-like rhizome. It is best surveyed from mid-July through August. Its

habitat generally consists of spruce-fir forests and mixed conifer forests in the Chuska Mountains and also under Gambel oak thickets interspersed with aspen, dogwood, and Douglas fir. It is most often found in moist, shady canyon bottoms and north-facing slopes, often along streams, from 6400 – 9400 ft. in elevation. On the Navajo Nation, it is found in Canyon de Chelly, the Chuska Mountains in Apache County, Arizona and McKinley County and San Juan Counties in New Mexico. There is potential for the species to occur throughout the Chuska Mountains and the Defiance Plateau (NNDFW 2008).

Navajo Listed Species

Cutler's Milk-vetch (*Astragalus cutleri)* is a short-lived perennial, often flowering as an annual, growing 10-35 cm tall. Because this is primarily an annual plant, it can only be located during its flowering/fruiting period, which is April through early June. Its habitat consists of warm desert shrub communities on sandy, seleniferous soils with level to moderate slopes on the Shinarump and Chinle Formations, from ca. 3800 ft. in elevation. Within the Navajo Nation, it is found in Copper and Nokia Canyons; however, there is potential for the species to occur in canyons adjacent to Copper and Nokia Canyons, where there is suitable habitat (NNDFW 2008).

Marble Canyon Milk-vetch (*Astragalus cremnophylax var. hevroni)* is a dwarf, evergreen, perennial herb, which forms a matt less than 1.5 cm high. It is best surveyed from April to May, but can be identified year round by an experienced botanist. Suitable habitat can be identified year round. Habitat consists of crevices and depressions with shallow soils on Kaibab Limestone and on rimrock benches at the edge of Marble Canyon. The plants are associated with Great Basin desert scrub communities at ca. 5000 ft. in elevation. The species is only known from the rim of Marble Canyon near Shinumo Wash. Specifically, it is known from the east rim of Marble Canyon from the Little Colorado River Gorge to Navajo Bridge (NNDFW 2008)

Cronquist Milk-vetch (*Astragalus cronquistii)* is a perennial plant that sprouts from a taproot and underground root crown. It must be surveyed from May to June, when seedpods are present. Suitable habitat can be identified year round. Habitat consists of salt desert shrub and blackbrush communities on sandy or gravelly soils derived from the Cutler and Morrison Formations or Mancos Shale, from 4750 to 5800 ft. in elevation. On the Navajo Nation, is it reported from south of Bluff, Aneth, and near the Utah border with Colorado. There is potential for the species to occur on the Navajo Nation in southeastern Utah (NNDFW 2008).

Naturita Milk-vetch (*Astragalus naturitensis)* is a low-growing perennial best surveyed from late April through May when seed pods are present. Habitat consists of sand filled pockets on sandstone slickrock and rimrock pavement along canyons in the pinyon-juniper zone. Known populations occur between 5000—7000 ft. in elevation. On the Navajo Nation, the species has been reported from the Hogback in San Juan County to the Pinetree Canyon area in McKinley County in Utah. Within the Navajo Nation there is suitable habitat for the species north of I-40 in McKinley County to the Hogback in San Juan County (NNDFW 2008).

Acoma Fleabane (*Erigeron acomanus)* is a mat-forming perennial which sprouts from a taproot. It is best surveyed from June to August, though suitable habitat can be identified year round. Suitable habitat consists of sandy slopes beneath sandstone cliffs of the Entrada Sandstone Formation in pinion-juniper woodland communities. Populations are known from ca. 7000 ft. in elevation. On the Navajo Nation, it is documented north of Thoreau and north of Prewitt; however, there is potential for the species to exist north of I-40 in McKinley County (NNDFW 2008).

Round Dunebroom (*Errazurizia rotundata)* is a low, woody shrub reaching up to 30 cm in height. It is best surveyed from mid-April through September. This species can occur on several types of outcrops, ranging from sandy soils in sandstone, gravelly soils in calcareous outcrops, to deep, alluvial cinders in sandstone breaks. Generally, this plant is found in exposed habitats in the semi-arid environment of the Great Basin desert scrub. On the Navajo Nation, populations are known from sandy pockets between outcroppings of Moenave Sandstone, between 4600 and 5200 ft. in elevation. On the Navajo Nation this species has been found between Moenave and Willow Springs; however, suitable habitat exists between Gap, Arizona and Petrified Forest National Monument (NNDFW 2008).

Navajo Bladderpod (*Lesquerella navajoensis)* is a cushion-forming herbaceous perennial which grows from a thick taproot. Surveys for this plant should take place during the flowering period from May to early June. Suitable habitat primarily consists of windward, windswept mesa rims and nearby habitat with little vegetative cover and high insolation. It is also found at the base and slopes of small hills of the Chinle Formation; typically, this plant is only found in a combination of Todilto Limestone overlaying Entrada Sandstone or Chinle outcrops in pinion-juniper communities. On the Navajo Nation, it is found in New Mexico on mesa rims northwest of Thoreau and Continental Divide, in the Chuska Mountains at Todilto Park; in Arizona it is known from the Red Valley area to Wheatfields Lake. There is potential for the species to occur anywhere there are Todilto and Chinle outcroppings northeast and northwest of Thoreau and in the Chuska Mountians within McKinley and San Juan Counties in New Mexico. It is possible the species occurs in the Chuska and Carrizo Mountains in Apache County, Arizona as well (NNDFW 2008).

Navajo Penstemon (*Penstemon navajoa)* is a short-lived perennial herb that grows between 20 and 45 cm tall. It is best surveyed from early July to early August, to ensure positive identification. Habitat consists of rocky, open places in ponderosa pine, aspen, and Douglas-fir communities ranging from 7,000 to 10,300 ft. in elevation. This plant is known only from the upper slopes of Navajo Mountain and upper Dark Canyon in San Juan County, Utah. There is potential for the species to occur on the upper slopes of Navajo Mountain and, potentially, on the upper elevations of Skeleton Mesa (NNDFW 2008).

Alcove Rock Daisy (*Perityle specuicola)* is a perennial herb reaching 50 – 70 cm in height. Identification of this plant is only possible from late July through September. Habitat consists of

hanging garden communities between 3690 and 4000 ft. in elevation. On the Navajo Nation, it is only known from one site on the San Juan River downstream from Goosenecks State Park; however, there is potential for the species to occur anywhere there are hanging gardens in the San Juan River drainages (NNDFW 2008).

Alcove Bog-orchid (*Platanthera zothecina)* is a perennial orchid with erect stems 15 to 60 cm tall. It must be surveyed during the flowering period, between July and August, for positive identification. Suitable habitat consists of seeps, hanging gardens, and moist stream areas within desert shrub, pinion-juniper, and ponderosa pine/mixed conifer communities. Known populations occur between 4000 and 7200 ft. in elevation. Within the Navajo Nation, the plant has been documented in the headwaters of Oljeto Wash, Tsegi Canyon watershed, hanging gardens surrounding Navajo Mountain, and Chinle Wash drainages. There is potential for the species to occur in appropriate habitat within the Navajo Nation in northern Arizona and San Juan County, Utah (NNDFW 2008).

Alcove Death Camas (*Zigadenus vaginatus)* is a stout perennial that sprouts from rhizomes. It is best surveyed from mid-July through August. Suitable habitat can be identified year round. Habitat consists of hanging gardens, seeps, and alcoves, primarily on Navajo Sandstone. It is endemic to the Colorado Plateau in southern Utah and northern Arizona. On the Navajo Nation, it is known from hanging gardens in sandstone canyons surrounding Navajo Mountain in Coconino County, Arizona and San Juan County, Utah. There is a disjunct population in Canyon de Chelly National Monument (NNDFW 2008).

Aztec Gilia (*Aliciella formosa)* is an herbaceous perennial distinguished by entire leaves and woody bases on older plants. It must be surveyed during the flowering/fruiting period from late April to June. It is endemic to soils of the Nacimiento Formation in salt-desert scrub communities ranging from 5,000 6,400 ft. in elevation. On the Navajo Nation, it has been recorded in Kutz Canyon south of Bloomfield, New Mexico. There is potential for the species to exist south of Farmington and Bloomfield where the Nacimiento Formation occurs (NNDFW 2008).

Peebles Blue-star (*Amsonia peeblesii)* is an herbaceous perennial with several erect stems 40-90 cm tall and flowers with white or light blue corollas. For positive identification it is best surveyed during the flowering and fruiting period from mid-May through July. Habitat consists of plains grassland, Great Basin shrub-grassland, and Great Basin desert scrub communities ranging in elevation from 4000 to 5620 ft. in elevation. Substrate types range from strongly alkaline sedimentary conglomerates to volcanic cinders. On the Navajo Nation, it has been observed in Coconino County from Grand Falls to Gray Mountain and north to Cedar Ridge, also west of Highway 89 between Camron and Cedar Ridge. There is potential for the species to exist from Marble Canyon south to the boundary with Gray Mountain and east to the Holbrook vicinity (NNDFW 2008).

San Juan Milkweed (*Asclepias sanjuanensis)* is a perennial herb, 4-8 cm tall, which forms a woody taproot. It is distinguished from other milkweeds in its range by its greenish white petals. It is best surveyed from April through June. Habitat consists of primarily sandy or sandy loam soils in pinion-juniper woodlands and Great Basin grassland communities. Known populations occur from 5000 to 6200 ft. in elevation, often in disturbed sites. On the Navajo Nation, it is recorded from east of Highway 666 south of the San Juan River, and just south of the San Juan County line. There is potential for the species to occur on the Navajo Nation within suitable habitat throughout San Juan and McKinley Counties in New Mexico (NNDFW 2008).

Beath Milk-vetch (*Astragalus beathii)* is a malodorous perennial which grows up to 60 cm high and often prostrate. It is only possible to survey for this plant during the flowering/fruiting period from late March to early May and possibly into June. Habitat consists of sandy flats, red clay knolls, and gullied washes in badlands. Substrates are selenium-bearing soils derived from Moenkopi sandstone shale from 4000 to 4800ft in elevation. It has been recorded north of Gray Mountain and west and southwest of Cameron. There is potential for the species to occur from Gray Mountain north to the Navajo Bridge, where Moenkopi shale is present (NNDFW 2008).

Heil's Milk-vetch (*Astragalus heilii)* is a tufted, low perennial best surveyed from mid-May through June. The species' habitat consists of rocky ledges of the Mesa Verde Group in pinion-juniper communities at ca. 7200 ft. On the Navajo Nation, it is only documented from its type locality near Borrego Pass (NNDFW 2008).

Navajo Saltbush (*Atriplex garrettii var. navajoensis)* is a deciduous shrub growing up to 1.5 m in height. It is best surveyed from August through November. The species' habitat consists of salt desert shrub communities between 3000 and 4000ft. in elevation. It grows on Moenkopi Shale, often overlain with a Kaibab Limestone. On the Navajo Nation, it is located on the east side of Marble Canyon from Lee's Backbone to Jackass Canyon; however, there is potential for the species to exist on the east side of Marble canyon and Glen Canyon from Glen Canyon Dam south and west to the Echo Cliffs and along tributary canyons of the Colorado River, south to Shinumo Wash (NNDFW 2008).

Atwood's Camissonia (*Camissonia atwoodii)* is a winter annual herb that sprouts from a taproot. Surveys must occur during the flowering months from September to November for positive identification. The species' habitat consists of salt desert shrub communities growing on clay soils of the Tropic Shale and Carmel Formations. Known populations occur between 4060 and 5000 ft. in elevation. The species is endemic to the Last Chance drainage in Kane County, Utah. It has not been reported on the Navajo Nation; however, there is appropriate habitat along shores and drainages of Lake Powell (NNDFW 2008).

Rydberg's Thistle (*Cirsium rydbergii)* is a perennial herb ranging from 100 cm to 300 cm in height. It is best surveyed during the flowering and fruiting season from late spring through September and October. Suitable habitat consists of hanging gardens, seeps, and sometimes

stream banks below hanging gardens, between 3300-6500 ft. in elevation. On the Navajo Nation, the species occurs in southern San Juan County, Utah and in Coconino and Apache Counties in Arizona (NNDFW 2008).

Yellow Lady's Slipper (*Cypripedium parviflorum var. pubescens)* is a perennial, erect orchid which forms clumps with several stems. It is best surveyed during the flowering/fruiting season from late May through June. Suitable habitat consists of moderate shade along stream banks, mountain meadows, and mesic places in ponderosa pine, mixed conifer, and aspen forest communities. On the Navajo Nation, it is known only above 7000 ft. in elevation. On the Navajo Nation there is only one historic record of the plant near Toadlena in San Juan County, New Mexico. There is potential for the species to occur in the Chuska Mountains (NNDFW 2008).

Utah Bladder-fern (*Cystopteris utahensis)* is a fern consisting of creeping stems. The best time to survey is from June through August; however, the plant can be identified anytime there are fertile fronds. Habitat consists of seeps, cracks, and ledges on cliffs formed from calcareous substrates including sandstone, limestone, and dacite. Populations are known from 4200 to 8800 ft. in elevation. On the Navajo Nation, it is only found within Canyon de Chelly National Monument (NNDFW 2008).

Grand Canyon Goldenweed (*Ericameria arizonica)* is a small shrub ranging from 20 – 50 cm in height. It is best surveyed from September through November. Suitable habitat consists of rocky ledges and cracks, usually on Kaibab limestone, from 5500 to 6000 ft. in elevation. On the Navajo Nation it is found along the rim of the western Little Colorado River Gorge. There is potential for the species to exist on limestone benches and ledges in the vicinity of the Little Colorado River Gorge and Marble Canyon on the Navajo Nation (NNDFW 2008).

Sivinski's Fleabane (*Erigeron sivinskii)* is a perennial herb that sprouts from a thick taproot. For positive identification of this species, surveys must occur during the flowering and fruiting period from May through June. Habitat consists of steep, barren, shale slopes of the Chinle Formation, in pinion-juniper woodland and Great Basin desert scrub communities. Known populations occur from 6100 to 7400 ft. in elevation. On the Navajo Nation, the plant is found on east and west facing slopes of the Carrizo and Chuska Mountians, the Cove area, the Round Rock area, and north of Navajo in San Juan County, New Mexico and Apache County, Arizona. Elsewhere on the Navajo Nation, there is potential for the species to exist north of I-40 in New Mexico and in the Chuska Mountains (NNDFW 2008).

Sarah's Buckwheat (*Eriogonum lachnogynum var. sarahiae)* is a perennial herb reaching 10 cm in height which grows in dense clusters and mounds. It is best surveyed from May through July. Suitable habitat consists of windswept mesa tops in pinion – juniper communities between 5900-7500 ft. in elevation. This species is endemic to the Owl Rock Member of the Chinle Formation, topped by Todilto limestone. Only a few plants have been recorded on the Navajo Nation in the

vicinity of Red Valley, north of Red Lake. There is potential for the species to exist in the Chuska Mountains between Lupton, Arizona and Prewitt, New Mexico (NNDFW 2008).

Bluff Phacelia (*Phacelia indecora)* is a 3-14 cm tall annual with spreading stems. It must be surveyed in May or June for positive identification. Suitable habitat consists of salt desert communities between 3600 ft. and 4500 ft. in elevation. This species is endemic to San Juan County, Utah, and has not been documented on the Navajo Nation; however, there is potential for it to occur within the San Juan River drainage (NNDFW 2008).

Cave Primrose (*Primula specuicola)* is a perennial herb that forms basal rosettes and grows to a height of 30 cm. It is best surveyed during the flowering season from March through April, but can be identified by an expert year round. Suitable habitat consists of hanging gardens and occasionally stream sides in Entrada and Navajo Sandstone Formations between 3500 and 7200 ft. in elevation. In the Grand Canyon it is known from seeps in Kaibab and Redwall limestone. On the Navajo Nation, it has been documented in the Chinle Wash area and in canyons surrounding Navajo Mountain. There is potential for the species to occur in any of the hanging gardens in the Chinle Wash drainage and in canyons north and south of Navajo Mountain (NNDFW 2008).

Marble Canyon Dalea (*Psorothamnus arborescens var. pubescens)* is a shrub ranging from 40 – 100 cm tall with small indigo flowers, linear leaflets, and distinctive seed ponds with large round discrete blister glands. It is best surveyed during the flowering and fruiting season in May and June. Suitable habitat consists of mixed desert shrub communities growing on soils derived from the Moenkopi Formation between 3400 – and 4900 ft. in elevation. On the Navajo Nation, it has been recorded in the Navajo Springs area south of Navajo Bridge. Within the Navajo Nation, there is potential for the species to occur from Lees' Backbone to Bitter Springs (NNDFW 2008).

Parish's Alkali Grass (*Puccinella parishii)* is a many-stemmed annual grass growing 5 – 28 cm tall. For positive identification, this species must be surveyed from mid-April to early June. Suitable habitat includes alkali seeps, springs, and seasonally wet areas such as washes. Populations are known to occur between 5000 and 7200 ft. in elevation. Within the Navajo Nation, this species has been documented in Utah in San Juan County northeast of Beclabito and in the vicinity of Two Grey Hills. There is potential for the species to exist anywhere on the Navajo Nation in alkali seeps, springs, or seasonally wet areas (NNDFW 2008).

Arizona Rose Sage (*Salvia pachyphylla ssp. eremopictus)* is a many-branched spreading shrub growing 35-50 cm tall with showy, bright violet flowers. It is best surveyed in the flowering period from mid-July to October, but can be identified by an experienced individual year round. Habitat consists of desert shrub lands and pinion-juniper communities on basalt or soils derived from the Chinle Formation, between 5500 and 6500 ft. in elevation. On the Navajo Nation, it is often found along the base of volcanic plugs, mesa tops, and slopes. It has been found north of

Dilkon in Navajo County. There is potential for the species to occur along the southern boundary of the Navajo- Hopi Reservation to the southern boundary of the Navajo Nation, between just north of Winslow and Petrified Forest National Park (NNDFW 2008).

Brack Hardwall Cactus (*Sclerocactus cloveriae brackii)* is a mostly solitary cactus with elongate, cylindrical stems 3 – 8 cm long. Positive identification is only possible during the flowering and fruiting period from late April to mid-June. Suitable habitat consists of desert scrub and scattered juniper communities growing on sandy, clay hills of the Nacimiento Formation. Populations occur between 5000 and 6000 ft. in elevation. On the Navajo Nation, it can be found in San Juan County south of the San Juan River (NNDFW 2008).

Welsh's American-aster (*Symphyotrichum welshii)* is an herbaceous perennial growing 30 – 100 cm tall. It is best surveyed during the flowering period from August to October. Suitable habitat consists of wet meadows, seeps, springs, and hanging gardens between 4300 and 8000 ft. in elevation. On the Navajo Nation, it is only known from one population in the Tsegi watershed in northern Navajo County. Within the Navajo Nation there is potential for it to occur in northern Coconino and Navajo Counties (NNDFW 2008).

3.4.5 Plants with Cultural and Traditional Significance

The Navajo people use plants for a variety of different traditional and cultural purposes, including for traditional religious ceremonies, their medicinal properties, healing rituals, food, construction, arts and crafts, and making dyes and paints. Plants are seen as sacred to the Navajo, and collection of plants requires careful consideration regarding the location where plants are collected, the amount present at the site, and how the plants will be used. Where plants or herbs are gathered may have special significance for different ceremonies or traditions for different communities and families. The importance of gathering places may differ depending on individuals, communities, medicine people, and ceremonialists (Martin 2002). During collection, a portion of the plant usually remains at a site to allow for future use. Prayers or songs are also sometimes said during collections in gratitude for their use.

The use of specific plants by traditional healers and users can vary from person to person. Different specialists have their preferences for different species, parts, and uses for particular plants. Several ethnobotanical studies have been conducted on the Navajo Nation to identify cultural and traditionally important plants (Franciscan Fathers 1929, Young 1940, Wyman and Harris 1941, Steggerda and Eckardt 1941, Elmore 1944, Mayes and Rominger 1994, AERA 2000, Rainey and Adams 2004). Over 450 different species have been identified, with several plants identified for similar uses. The Navajo Historic Preservation Department's Traditional Culture Program also maintains a list of traditional plants and gathering sites used by the Navajo. Plant collection by Navajos for cultural uses does not require a permit. Below is a list of some of the species and genera of plants that have been identified as having cultural significance to the Navajo people for medicinal, ceremonial, or practical uses. This list was compiled by looking at a compendium of ethnographic documentation of various plants used by the Navajo and looking

at known uses (Rainey and Adams 2004). If available, the Navajo name is also given as described by either the Arizona Ethnobotanical Research Association (2001) or in the Navajo Nation Range Management Handbook (Parrill and Blacksheep 1981). In the Navajo naming system, plants can have up to three different names. Names can indicate physical characteristics, the plant's ceremonial use, and/or a sacred name, which is not commonly known (Parrill and Blacksheep 1981). A few of the species have been highlighted because (a) they are also priority weed species, (b) they may look similar to priority weed species but may be native to the region, or (c) may be similar to in the same family as federal or tribal species of concern.

Some noxious priority weed species are used for ceremonial and medicinal purposes. These species do not fit into the Navajo mythology in which plants originally within or on the Navajos' sacred mountains are mentioned in Navajo stories nor do they have specific uses in Navajo culture (Mayes and Lacy 1989). However, many noxious weed species have been adapted to use for ceremonial and medicinal purposes in place of plants that they physically or medicinally resemble. The Navajo have several plants that serve the same medicinal or ceremonial purpose so that there is always a plant locally available throughout the year when needed (Elmore 1944).

Amaranth (*Amaranthus spp.*) – Naazkaadii – or pigweed is a genus of annual or biennial plants with catkin-like flowers. The seeds are commonly gathered and used to make flour for breads or porridges. Species such as *A. albus,* and *A. blitoides* are introduced to the southwestern United States. Other species such as *A. palmeri* and *A. retroflexus*, however, are native to the area and used for similar purposes. *A. albus* has been noted for its use as smoking agent during ceremonies such as the Coyote Chant (Franciscan Fathers 1929). *A. blitoides* has been documented as a medicine to treat itching (Wyman and Harris 1941).

Giant Reed (*Arundo donax*) is a species of cane grass that is common within riparian areas in the Southwest. Elmore has document Navajo use to make prayer-sticks and whistles for ceremonies such as the Night Chant and the Lightning Chant (1944). However, giant reed has been identified as a non-native noxious species which naturally displaces other native species once established. Though it is not currently listed as a priority weed species for this project action, it is listed as target weed species by the U.S. Forest Service (USFS 2005) and is on the noxious plant watch list for New Mexico (Ashigh et al. 2010).

Sagebrush (*Artemisia spp.*) – Ts'ah ch7l – is a genus of widely used woody herbaceous shrubs common to dry flatlands in the action area. Commonly used varieties include Bigelow sagebrush (*A. bigelovii*, Ts'ah[ib1h7), tarragon (*A. dracunculus*), pasture sage (*A. frigida*), big sagebrush (*A. tridentata*, Ts'ahtsoh*)*, and white sagebrush (*A. ludoviciana*). In terms of ceremonial uses, the plant is used in a variety of medicines and practices including in the construction of sweathouses, liniments, as wands, to make charcoal for Blackening ceremonies, and as a burnt offering to the Dieties (Wyman & Harris 1941, Elmore 1944, Hocking 1956). Sagebrush also holds significance as a life medicine, where different varieties are mixed to treat everything from headaches and colds to child labor and boils (Wyman and Harris 1941, Elmore 1944). Other

uses include boiling the leaves to make yellow to green dyes for textiles and as a toilet paper (Young 1940, Elmore 1944).

Saltbush (*Atriplex spp.*) - K'ei'[ich77'its'00z – is a widely distributed genus of woody herbaceous shrubs that can retain salt in their leaves. The Navajo and other Native American groups make sure of the plant as a medicine for treating skin irrigations, boils, and warts (Wyman and Harris 1941, Elmore 1944, Hocking 1956). Use of species, such as *A. canescens* (D7w0zhii[b477), have included use of seeds for flours and puddings (Hocking 1956), twigs and flowers for making yellow dyes (Young 1940, Elmore 1944), and wood for firewood (Bailey 1940).

Mountain mahogany (*Cercocarpus montanus*) – Ts4'1sdaazii – is a native flowering shrub native to chaparral and semi-desert habitats. Ceremonially, the wood is used in the construction of sweathouses for the Mountain Chant Ceremony and to make prayersticks (Elmore 1944). The root bark can be missed with other plants, such as juniper or cactus species to make red, orange, or brown dyes (Young 1940). Roots, leaves, and bark can also be made into different medicines to treat stomach issues (Wyman and Harris 1941, Elmore 1944).

Goosefoot (*Chenopodium spp.*) – T['oh [igsii – is a genus of herbaceous plants, many species of which are commonly used as a food sources. For example, the leaves and stems from white goosefoot (*C. album*, T['ohdein1[gai) can be eaten as greens when young and tender, while the seeds can be dried and ground into a flour. Clammy goosefoot (*C. graveolens,* Ch'il lich77'l) has ceremonial significance as the leaves can be used to make a liniment as part of the Mountain Chant Ceremony (Franciscan Fathers 1929). Some varieties of goosefoot, such as *C. album*, are considered noxious in some southern states but have not been identified for management within the Southwest.

Rabbitbrush (*Chrysothamnus spp.*) – Ch'ildiily4siit'00z – is a genus of shrubs common to the western United States. Ceremonially, they have been used to make implements for ceremonies such as the War Dance, burned for smoke in the Coyote Chant Ceremony, and as a way to ward off evil spells (Elmore 1944). The plants can also be used medicinally to treat chickenpox and measles (Elmore 1944). Flowers and twigs have also been used to help create yellow dyes (Young 1940, Wyman and Harris 1941, Elmore 1944). Rubber rabbitbrush (*C. nauseosus*) and yellow rabbitbrush (*C. viscidiflorus*) are the most commonly used species. Rabbitbrush is sometimes managed as an aggressive native on grazing land, where it can encroach and outcompete valuable native grasses.

Thistles *(Cirsium spp.*) – Ch'ildeen7n7 – are a genus of herbaceous plants commonly known for their erect stems and prickly leaves. There are several species of native thistles that are native to the region. Rydberg's thistle (*C. rydbergii*) is protected by the Navajo Nation Department of Fish and Wildlife as a G4 species. Native New Mexico thistle (*C. neomexicanum*) or the naturalized spear thistle (*C. lanceolatum)* have been used in the creation of Navajo Life medicines (Elmore

1944). However, many native thistle species are similar in appearance to target weed species such as *C. arvense* or *C. vulgare*. Care should be taken to discern between native thistle species and non-native noxious species

Rocky Mountain Beeplant (*Cleome serrulata*) – Waa' – is an annual flowering plant, native to the western United States. The plants are commonly used as food, with the leaves and shoots being cooked into edible greens, which are good sources of vitamin A and calcium (Elmore 1944). Seeds can also be ground and stored as flour during the winter. The plant can also be used to make greenish-yellow dyes for wool rugs and blankets by boiling the plant (Young 1940). The plants are important ecologically for attracting pollinators such as birds and insects.

Larkspurs (*Delphinium spp.)* – T1d7d77ndoot['izh – are a genus of flowers native to North America and known for their stalks of brilliant showy flowers. All parts of the plants are known to be highly toxic to humans and livestock, so their cultural use is ceremonial in nature (Warnock 1993). Several accounts note the importance of blue pollen, which is collected from delphinium flowers (Wyman and Harris 1941, Elmore 1944). The pollen is symbolic of the Navajo creation story and is used to bless items during different ceremonies including the Night Chant.

Mormon tea (*Ephedra spp.)* – T['ohozihii – is a genus of evergreen shrubs found in semi-desert shrublands. Several different varieties of ephedra are used by the Navajo for medicinal purposes and as food. The fruit can be eaten while the stems, which are high in caffeine and ephedrine, can be boiled and made into a tea. The plant is used medicinally either as tea to treat stomachaches, kidney issues, congestion, or venereal diseases (Wyman and Harris 1941, Elmore 1944, Lynch 1986). The leaves and twigs of the plant have also been boiled to help create tan dyes (Curtin 1984, Lynch 1986).

New Mexico Olive (*Forestiera neomexicana*) – Ma'i'th1 – grows as either a tall deciduous large shrub or tree in the southwestern United States, commonly found in canyons, rocky slopes, and desert flats. The wood of the plant can be used to make prayer-sticks used in the Night Chant or hoops for ceremonies such as the Evil Way (Wyman and Harris 1941, Elmore 1944). Parts of the plant can also be used to make a light gray dye (Young 1940), to make arrows, or in the construction of saddles (Elmore 1944).

Common sunflower (*Helianthus annuus)* – Ni'd7yilii – is a widespread native flowering plant with bright yellow flowers. Navajo are known to use the seeds to make flours for dumplings, bread, and cakes or to extract oils for cooking (Steggerda and Eckardt 1941). Stems have been used in ceremonies as flutes, to conceal arrows, or as prayer-sticks (Wyman and Harris 1941, Elmore 1944). Medicinally, parts of the plant are sometimes used to make ceremonial liniments or to treat warts (Wyman and Harris 1941, Elmore 1944).

Juniper (*Juniperus spp.*) – Gad – is a genus of evergreen trees found in higher elevation desert ecoregions. Juniper trees have a wide variety of uses for the Navajo people. Bark from the tree can be woven with yucca fibers for blankets or curtains (Elmore 1944). The wood can also be

used as tinder in ceremonies such as the Night Chant, or to make prayer-sticks. Besides ceremonial uses, the wood is also used in the construction of shelters, carved into spoons or figurines, or used as fuel. The berries can be ground into flours, roasted whole, or eaten raw (Lynch 1986). Species commonly used include one-seed juniper (*J. monosperma*), western juniper (*J. occidentalis*), and Rocky Mountain juniper (*J. scopulorum*). Juniper, while native to the region, is sometimes removed or treated as a weed to prevent its encroachment on neighboring grasslands and grazing areas.

Stoneseed (*Lithospermum spp.*) – Az1'ha'che4'ni'tso – is a genus of herbaceous flowering plants found in open woods, dry prairies, and disturbed areas, mostly in the eastern portion of the Navajo Nation. Roots of the plant can be used to make Navajo Life medicine (Wyman and Harris 1944). Narrowleaf stoneseed (*L. angustifolium*) is known for its use in the Knife Chant Ceremony (Franciscan Fathers 1929). The roots of the plant were also sometimes chewed to treat coughs and colds (Hocking 1956).

Wolfberry (*Lycium pallidum.*) – Haasch'44hd11 – is a genus of flowering shrubs, which grow in many kinds of desert habitats and are valued for their edible berries. Branches from wolfberry shrubs can be used ceremonially by the Navajo to make hoops for the Evil Way Ceremony (Wyman and Harris 1944). While the berries are used as a food source, it is also noted for its used as a sacrifice to the Dieties for various ceremonies (Elmore 1944).

Horehound (*Marrubium vulgare*) –Azee'ndoot'eezh7 [ib1h7g77 – is a noxious herbaceous perennial plant, which is member of the mint family. Horehound is widely used as a medicine used to treat fevers, coughs, and indigestion, and is commonly used today in a variety of medicinal uses (Wyman and Harris 1941, Elmore 1944, Zeid et al. 2011). Ceremonially, it has also been documented as part of the liniment for the Female Shooting Life Chant Ceremony (Elmore 1944) and as cold infusion for additional chant lotions (Wyman and Harris 1941). The plant has also been identified as a target weed species for this plan due to its ability to invade and persist on disturbed rangelands.

Burclover (*Medicago spp.*) – T['oh waa'7 – is a genus of flowering plants, which includes alfalfa. Ceremonially, different varieties of burclover may be used in the preparation of chant lotions (Wyman and Harris 1941). While also serving as feed for livestock, the introduced alfalfa (*M. satvia*) can also be used to make blue or green dyes for textiles. Of concern is the noxious California burclover (*M. polymorpha*), which has been identified as a target weed species because the prickly fruits can reduce the quality of sheep wool and the quality of rangeland and farm fields. While most varieties of burclover have been introduced in the southwestern United States, differentiation between the noxious species and commonly cultivated naturalized species is necessary.

Coyote tobacco (*Nicotiana attenuata)* – Dzi[n1t'oh – is an annual herb native to western North America, which can grow in a variety of habitats. The plant is widely used for medicinal and

ceremonial purposes for both the Navajo, and the neighboring Hopi and Zuni communities. Smoke from the plant is used for both medicinal purposes and ceremonial rituals. Blown in the face, it is thought to help treat fainting (Wyman and Harris 1941). It can be mixed and burned with other plants as part of the Blessing Way Ceremony (Wyman and Harris 1941). Ethnobotanical studies have also documented it use in prayer-sticks for the Night Chant (Elmore 1944) and as a smoking agent during the Evil Way Ceremony (Wyman and Harris 1941). Because it can grow in disturbed sites, it can sometimes grow in association with target weed species identified for control and management. Care should be taken to avoid impacts to this plant due to its cultural significance.

Penstemons (*Penstemon spp.*) – Ts4d7d44h – are a genus of herbaceous flowering plants that are widely distributed and known for their showy straight flowers. The Navajo may use penstemons for various medicinal uses, such as a treatment for burns, toothaches, childbirth, or rattlesnake bites (Wyman and Harris 1941, Elmore 1944). Ceremonially, penstemons can also be incorporated into herbal infusions to ward off witchcraft or as a Life Medicine. Varieties that have been documented for medicinal and ceremonial uses include gilia beardtongue (*P. ambiguus* Torr., Na'ashj4'ii ch'il), Torrey's penstemon (*P. barbatus ssp. torreyi*), and mountain meadow penstemon (*P. oliganthus*). The Navajo penstemon (*P. navajoa*) is listed as tribally protected species as a Group 3 plant, so care should be taken to identify and avoid this plant where possible.

Common Reed (*Phragmites spp.*) – T[oh'k1 – is a reed that commonly grows in washes, canyons, and riparian corridors. Common reed is noted for use in a variety of Navajo religious ceremonies, including as frames for the Mountain Chant and as prayer-sticks for the Night Chant and Mountain Chant Ceremonies (Elmore 1944). Reeds are also used for making arrows and sometimes for medicinal purposes as well (Wyman and Harris 1941, Elmore 1944). While not identified as a target weed species for the Navajo Nation Integrated Weed Management Plan, common reed (*P. australis)* some subspecies of common reed are considered exotic and invasive. Recent studies have also indicated that the introduced subspecies (*P. australis spp. australis*) can hybridize with native reed species (*P. australis spp. americanus*), increasing the potential for aggressive hybrid offspring (Meyerson et al. 2010). This has led some agencies, such as the National Park Service at Wupatki National Monument to implement special measures to protect the native subspecies from hybridization (NPS 2009).

Pine (*Pinus spp.*) is a genus of evergreen trees common in high elevation mountain ecoregions within the Navajo Nation. The bark of the tree can be used in the construction of hogans and summer shelters, while pine needles have been noted for use in medicinal remedies used on patients during War Chant and Mountain Chant ceremonies (Elmore 1944). The wood can be used for fuel, making cradles, arrows, or waterproof jars (Franciscan Fathers 1929, Elmore 1944). Pinyon pine (*P. edulis,* Ch1'o[) is noted for its use in ceremonies such as the Witch Chant, the Mountain Chant, and the War Dance (Franciscan Fathers 1929, Elmore 1944). The pinyon nuts are also an important source of food, as they can be roasted, dried, and ground for a

variety of uses (Bailey 1940, Elmore 1944, Lynch 1986). Limber pine (*P. flexilis*) with its flexible twigs are sometimes used to make arrows and bows (Elmore 1944). Ponderosa pine (*P. ponderosa*, Nd7shch77) is noted for its use in ceremonies such as the Evil Way and the Night Chant, where it can be used to make arrows, medicine, or charcoal (Wyman and Harris 1941, Elmore 1944). Pine stands are associated with a wide variety of sensitive animal and plant species such as the Navajo penstemon (*Penstemon navajoa*). The Mexican spotted owl (*Stirex occidentalis*) prefers habitat in mixed conifer stands and pinyon pine-juniper woodlands.

Cottonwoods/Aspen (*Populus spp.)* – Ts'iisbit'aa'niteel7 – is a genus of deciduous trees that can be found in high elevation mountains and in riparian areas. Cottonwood trees are used for the construction of shelters and are sometimes carved into ceremonial figurines, ceremonial prayer-sticks tinderboxes, cradleboards, or looms used for weaving (Franciscan Fathers 1929, Elmore 1944). Commonly used varieties include quaking aspen (*P. tremuloides*), Rocky Mountain cottonwood (*P. wislizeni*), and narrowleaf cottonwood (*P. angustifolia*). Some cottonwood galleries do serve as habitat for a variety of sensitive bird species, including the federally endangered southwestern willow flycatcher (*Empidonax traillii extimus)* and threatened western yellow-billed cuckoo (*Coccyzus americanus*).

Cherry/Plum (*Prunus spp.*) - Didz4d7k'0zh7/Didz4 – is a genus of large shrubs or small trees that bear stone fruits. The fruits (plums, cherries, apricots) from plants in the genus are collected by many Native American groups in the area as a food source. Different varieties are commonly used in ceremonies as staffs, prayer-sticks, or hoops. The Navajo sometimes use the roots to make red to purple dyes for textiles (Young 1940, Elmore 1944). Different parts of the plant are also sometimes used for a variety of medicinal purposes including the treatment of stomach issues, sore throats, and fevers (Plumb 2009). Western chokecherry (*P. virginiana var. demissa*) is noted for its use in medicines and as prayer-sticks as part of the Shooting, Night, and Mountain Top Chants (Elmore 1944). Black chokecherry (*P. virginiana var. melanocarpa*) is noted for use as medicine and as use in making staffs and hoops for the Evil Way, Mountain Top, and Beauty Way Ceremonies (Bailey 1940, Wyman and Harris 1941). Plants within this genus are also important for providing forage, shelter, and cover for wildlife.

Douglas-fir (*Pseudotsuga menziesii)* is a native high-elevation evergreen tree which commonly grows in stands above 8000ft. Douglas-fir grows in mixed conifer stands, which can also serve as habitat for a number of sensitive species such as Gooding's onion (*Allium gooddingii*), the Northern saw-whet owl (*Aegolius acadicus*), and the American three-toed woodpecker (*Picoides dorsalis*). Wood from the tree is used in a variety of different ceremonies. Different parts are used to make garments and arrows for the Evil Way Ceremony (Wyman and Harris 1941) and for use in the Shooting Chant (Elmore 1944).

Oak (*Quercus spp.*) – Ts4ch'ilnit['z7 – is a genus of deciduous trees and woody shrubs that are native to high elevation mountains and riparian areas. The Navajo use the branches to make a variety of tools, from games to clubs to drills to farming implements (Elmore 1944). Acorns

from the trees can be boiled, ground, or roasted as a food sources (Franciscan Father 1929, Bailey 1940, Elmore 1944). Scrub oak (*Q. pungens*) branches are documented for making hoops for unraveling ceremonies, while the sap can be used to seal arrows or as chewing gum (Elmore 1944). Wavyleaf oak (*Q. undulata)* is sometimes mixed with other plants to create the medicine for the Shooting Chant Ceremony (Elmore 1944).

Lemon sumac (*Rhus aromatica*) is a woody shrub with red hairy berries or drupes and leaves that give off a citrus fragrance when crushed. It grows in high elevation forested areas in open or disturbed areas, such as rocky woodlands, valley bottoms, or slopes. The Navajo collect the fruit, which can be made into a jelly for preservation (Bailey 1940). Pollen from the plants is noted in the use of Navajo religious ceremonies (Franciscan Fathers 1929). The branches are also noted for use as arrows and in basketweaving (Franciscan Fathers 1929). Native Americans may also use the plant to treat diarrhea, burns, colds, toothaches, and for reproductive health (Kartesz and Meacham 1999). The bushes also serve as an important food source for wildlife, attracting a wide variety of birds and ungulates.

Skunkbush/Three-leaf sumac (*Rhus trilobata*) – Ch'il[ichiin – is a native woody shrub that grows in oak woodlands and wetlands in the Navajo Nation. Drupes from the plant are used to make liniments and medicines for a variety of ceremonies, including the War Dance and the Mountain Top Chant (Elmore 1944). The wood and branches are sometimes used to make square hoops, prayer-sticks, and masks for ceremonies such as the Night Chant and the Mountain Chant (Elmore 1944). The shrub also serves as a source of food as the drupes can be eaten fresh from the plant, used to make a lemonade, or ground and used as a thickening agent in a variety of recipes (Elmore 1944, Lynch 1986).

Willow (*Salix spp.*) is a genus of deciduous trees that are commonly found near riparian areas. Different studies have documented several uses for willow trees by the Navajo. Branches can be used to more arrows, lances, baskets, or cradle canopies (Elmore 1944). Ceremonially, the branches can be made into ceremonial hoops, wands, or prayersticks or woven into emblems, like those used to signify the Four Winds in the Mountain Chant Ceremony (Elmore 1944). Elmore also documented the use of willow sap, which is painted on patients during the War Chant (1944). Ethnobotanical studies have noted the used of varieties such as red willow (*S. laevigata*), peachleaf willow (*S. amygaloides*), sandbar willow (*S. exigua*, K'ei'[ib1h7), Gooding's willow (*S. gooddingii*), and Bebb's willow (*S. bebbiana*). Stands of willow are also an important component of riparian habitat for migratory birds within the region. Endangered species such as the southwestern willow flycatcher and the yellow-billed cuckoo are associated with mature willow stands.

Greasewood (*Sacrobatus vermiculatus*) – D7w0zhiishjiin – is a woody semi-evergreen shrub that commonly grows in desert lowlands. The plant has a wide variety of medicinal and ceremonial uses for the Navajo. Elmore has documented that the plants are used in medicine for the Coyote Chant and carved into figurines used in the Beauty and Lightning Chant Ceremonies

(1944). Others have noted use of twigs for knitting needles and in bird snares, as arrow shafts, and for digging sticks or cooking implements (Franciscan Fathers 1929). The wood is also used as firewood (Elmore 1944, Welsh et al. 2003). The plant makes poor grazing forage due to the high concentration of sodium and potassium oxalates. However, it does provide important cover for livestock and wildlife (Benson et al. 2009).

Poison Ivy and Poison Oak (*Toxicodendron rydbergii, T. diversilobum*) – K'ishishjiin – are woody shrubs found in chaparral, riparian, and woodland areas. They are widely known for producing the oily toxin, urushiol, which causes skin irrigation and dermatitis. Some Navajos occasionally made use of the toxic qualities of these plants to make poisoned arrows (Wyman and Harris 1941).

Yucca (*Yucca spp.*) – Ts1'1szi' – is a genus of perennial shrubs and trees known for their rosettes of tough, evergreen leaves and large showy panicles of flowers. They are found in desert environments within the region. Yucca has a wide range of documented uses for the Navajo. The fibers of the thick leaves can be used to weave a wide variety of items including clothing, mats, blankets, baskets, and moccasins. The fibers can also be used to make paintbrushes for painting ceremonial items. Ceremonially, they have been noted for use in making loops and knots for the War Dance Blackening Ceremony, into whips and lashes to represent the Whipping God, and incorporated into ceremonial masks for the Night Chant Ceremony (Elmore 1944). Roots of the plant can be pounded to create soap (Elmore 1944, Lynch 1986). Fruits from the banana yucca (*Y. baccata*) and soapweed yucca (*Y. glauca*) can also be harvested and eaten raw, or roasted, or made into a syrup (Franciscan Fathers 1929, Steggerda and Eckardt 1941, Lynch 1986).

Maize/Corn (*Zea mays*) – T1d7d77n – is widely prized by the Navajo for a variety of purposes and as staple in the Navajo diet; so much so that it is commonly depicted in religious artwork. It has been known to symbolize food, fertility, and life itself for the Navajo (Griffen-Pierce 1992). Different parts of the plant can have different uses. Husks can be used to roll cigarettes (Elmore 1944). The ears are sometimes used to help soften leather before dying or as tinder for fuel (Elmore 1944). Elmore has noted that ears of corn with straight rows of kernels are sometimes selected for use in a variety of ceremonies (1944). Maize can be made into cakes and offered during various ceremonies such as the Night Chant, the Nubility Ceremony, or the Wind Chant (Franciscan Fathers 1929). It can also be made into a mush or dough to carve animal figurines used in ceremonies such as the Mountain Chant, the Bead Chant, or the Coyote Chant (Elmore 1944). Pollen from the plant is also commonly used in rituals to bless items such as masks, paintings, or dances (Elmore 1944). Much of the corn found on the Navajo Nation is cultivated on farms and agricultural lands.

Tamarisk (*Tamarix spp.*) – K'ei'[ich77its'00z – is a priority noxious weed species that is used as medicine and for heald sticks for weaving. The Navajo use tamarisk as a medicine by soaking in water and drinking for several illnesses or as a substitute for juniper for a smoke treatment

(Mayes and Lacy 1989). Although tamarisk does not fit into Navajo mythology, it is used in place of juniper, because of its resemblance.

Russian thistle (*Salsola kali*) – Ch'ildeen7n7 – is a priority noxious weed species that is highly adaptable to all plant communities. This species was used to treat influenza and smallpox. A lotion was made out of the plant's ashes and it was used as an internal medication (Mayes and Lacy 1989). It is used as a blackening in the Enemy Way and Evil Way (Mayes and Lacy 1989). It is also one of the plants used as a liniment in the Bead Chant (Elmore 1944). The young Russian thistle plants can be fermented and made into a dull olive green dye. Navajos used to eat the seeds when food was scarce; however, it is now only eaten by cattle (Mayes and Lacy 1989).

Puncture vine (*Tribulus terrestris*) – Ch'ilhoshi'-Naakaibihosh – is a priority noxious weed species that thrives in disturbed and cultivated areas. This is one of the plants used as ceremonial tobacco in the Evil Way and Bead Way (Elmore 1944, Mayes and Lacy 1989). It is also used as a medicine in other ceremonies and a blackening in the Evil Way (Mayes and Lacy 1989).

Cheatgrass (*Bromus tectorum*) – Shi'yin1ldzid7 – is a priority noxious weed species that is found ubiquitously across the Navajo Nation. It is used by the God Impersonators in the Night Way chant, a blackening in the Evil Way and Hand Trembling Way, and as a medicine in the Night Way and Plume Way (Mayes and Lacy 1989). The Navajo Name for this plant "Yé'iibe'ets'os" means "God's Plume" and the Plume Way is named after this species (Mayes and Lacy 1989).

Field Bindweed (*Convolvulus arvensis*) is a priority noxious weed species that is found on disturbed soils. This species is used as a medicine for spider bites (Macy and Lacy 1989).

3.5 Wildlife

3.5.1 Terrestrial and Aquatic Wildlife Species – Endangered, Threatened, Proposed, Candidate, and Sensitive Species.

There are 7 federally listed species and 34 additional tribally listed species. Of the federally listed species, 5 are endangered, one is threatened, and one is potentially threatened. Listing of species for the Navajo Nation is based on species populations solely within the Navajo Nation. Of the tribally listed species, two are listed as extirpated from the Navajo Nation (G1), 5 are listed as critically endangered (G2), 7 are listed as endangered (G3), and 20 are listed as sensitive (G4). Information on habitat for all listed plant species is managed by the Navajo Department of Fish and Wildlife.

Table 3-13. Terrestrial and aquatic animal species of concern found on the Navajo Nation as designated by the U.S. Fish and Wildlife Service and the Navajo Nation Department of Fish and Wildlife.

Common Name	Species Name	Federal Status[+]	Tribal Status[++]	Range
Black-footed ferret	*Mustela nigripes*	E	G2	AZ, NM, UT
California condor	*Gymnogyps californianus*	E	G4	AZ, NM, UT
Kanab ambersnail	*Oxyloma haydeni kanabensis*	E	G4	AZ
Mexican spotted owl	*Strix occidentalis lucida*	T	G3	AZ, NM, UT
Mexican gray wolf	*Canis lupus baileyi*	E	G1	AZ, NM
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	G2	AZ, NM, UT
Western yellow-billed cuckoo	*Coccyzus americanus*	T	G2	AZ, NM, UT
Northern river otter	*Lontra candensis*	-	G1	NM
Bald Eagle*	*Haliaeetus leucocephalus*	D	G2	AZ, NM, UT
Northern Leopard frog	*Lithobates pipiens*	-	G2	AZ, NM, UT
Pronghorn	*Antilocapra americana*	-	G3	AZ, NM, UT
Bighorn sheep	*Ovis canadensis*	-	G3	AZ, NM, UT
Golden Eagle*	*Aquila chrysaetos*	-	G3	AZ, NM, UT
Ferruginous Hawk*	*Buteo regalis*	-	G3	AZ, NM, UT
American dipper	*Cinclus mexicanus*	-	G3	AZ, NM, UT
Western seep fritillary	*Speyeris nokomis*	-	G3	AZ, NM, UT
Townsend's big-eared bat	*Corynorhius townsendii*	-	G4	AZ, NM
Chisel-toothed kangaroo rat	*Dipodomys microps*	-	G4	AZ, UT
Banner-tailed kangaroo rat	*Dipodomys spectabilis*	-	G4	AZ, NM, UT
Navajo Mountain vole	*Microtus mogollonensis*	-	G4	AZ, NM, UT
Wupatki pocket mouse	*Perognathus amplus cineis*	-	G4	AZ
Kit fox	*Vulpes macrotis*	-	G4	AZ, NM, UT
Northern goshawk	*Accipter gentilis*	-	G4	AZ, NM, UT
Clark's grebe	*Aechmophorus clarkii*	-	G4	AZ, NM, UT
Northern saw-whet owl	*Aegolius acadicus*	-	G4	AZ, NM, UT
Burrowing owl	*Athene cunicularia*	-	G4	AZ, NM, UT
Belted kingfisher	*Ceryle alcyon*	-	G4	AZ, NM
Mountain plover	*Charadrius montanus*	-	G4	AZ, NM, UT
Dusky grouse	*Dendragapus obscurus*	-	G4	AZ, NM, UT
Yellow warbler	*Dendroica petechia*	-	G4	AZ, NM, UT
Hammond's flycatcher	*Empidonax hammondii*	-	G4	AZ, NM, UT
Peregrine falcon	*Falco peregrinus*	-	G4	AZ, NM, UT
Northern Pygmy owl	*Glaucidium gnoma*	-	G4	AZ, NM, UT
Flammulated owl	*Otus flammeolus*	-	G4	AZ, NM, UT
Band-tailed pigeon	*Patagioenas fasciata*	-	G4	AZ, NM, UT
American three-toed woodpecker	*Picoides dorsalis*	-	G4	AZ, NM, UT
Sora	*Porzana carolina*	-	G4	AZ, NM, UT
Tree swallow	*Tachycineta bicolor*	-	G4	AZ, NM, UT
Gray vireo	*Vireo vicinior*	-	G4	AZ, NM, UT
Milk snake	*Lampropeltis triangulum*	-	G4	AZ, NM, UT
Chuckwalla	*Sauromalus ater*	-	G4	AZ, UT
Rocky Mountainsnail	*Oreohelix strigosa*	-	G4	AZ, NM, UT
Yavapai Mountainsnail	*Oreohelis yavapai*	-	G4	AZ, NM, UT

[+]E=endangered, T=threatened, PT=proposed threatened, D=delisted

[++]G1=extirpated, G2=critically endangered, G3=endangered, G4=sensitive

3.5.1.1 Species Descriptions

Federally Listed Species

Black-footed ferret (*Mustela nigripes*) inhabits medium to large active prairie dog towns (>80 ha, and ≥20 burrows/ha) or complex of towns (two or more towns within seven km). Prairie dogs are their main food source, and burrows are used for denning and rearing young. The species' historic range extended from the Canadian Great Plains to the U.S. Inter-mountain region and the Southwest. On the Navajo Nation, prairie dogs occupy extensive areas in low- to mid-elevation (1200-2000 m) plains, desert grassland, and desert scrub habitats, and are recognized by clusters of burrows (10-15 cm dia.) with associated dirt mounds (approx. 60 cm dia., 10-20 cm height). Navajo Nation historic records for the species include Mexican Springs, Keams Canyon, Oraibi, and Howell Mesa. Currently, there are no known wild ferrets on the Navajo Nation except for those associated with the Arizona Game & Fish Department's re-introduction efforts on the Tribal Ranch lands of Big Boquillas in Aubrey Valley, Coconino Co.; however, there are likely un-surveyed prairie dog colonies of sufficient size elsewhere on the reservation that could support ferrets (NNDFW 2008).

California condor (*Gymnogyps californianus*) feeds on carrion, eating two to three pounds per day. Habitat consists of mountainous terrain at low and moderate elevations, especially rocky and brushy areas with cliffs available for nest sites. The California condor forages in grasslands, oak savanna, mountain plateaus, ridges, and canyons. They roost in snags or tall open branched trees near important foraging grounds. In 1996, the U.S. Fish and Wildlife Service (USFWS) designated the planned reintroduced population in northern Arizona and southern Utah as a nonessential experimental population; the California condor is listed as Endangered elsewhere in U.S. The northern Arizona population was reintroduced adjacent to the Navajo Nation at Vermilion Cliffs and now use much of Marble and Grand Canyons for foraging and breeding, and to a smaller extent the western Navajo Nation for foraging. Condors are now breeding in the wild in northern Arizona, but not yet on the Navajo Nation; roosting on the Navajo Nation is mostly restricted to Marble Canyon (NNDFW 2008).

Kanab ambersnail (*Oxyloma kanabense*) is restricted to perennially wet soil surfaces or shallow standing water and decaying plant matter associated with springs and seep-fed marshes near sandstone or limestone cliffs. Vegetative cover is necessary: cattails, monkeyflower, or watercress are present at the two known locations, but wetland grasses and sedges may suffice. Only two populations are known, one near Kanab in Kane County, Utah and the other at Vasey's Paradise in Grand Canyon National Park (75.3 km downstream of Glen Canyon Dam). Potential for the species is likely restricted to the western Navajo Nation; including tributaries of the Colorado and Little Colorado Rivers, springs on Echo Cliffs, and creeks north and west of Navajo Mountain

Mexican spotted owl (*Strix occidentalis lucida*) uses three distinct types of habitat: 1) mid-aged to mature mixed-conifer stands dominated by Douglas fir, typically on mountain slopes with

moderate to dense canopies and multiple canopy layers; 2) steep-walled narrow canyons, or side and hanging canyons in wide canyons, often with riparian vegetation and cool microclimates; and 3) moderately sloped drainages with Douglas fir in pinyon-juniper woodland (*e.g.* Black Mesa). The species is not known to nest in ponderosa pine-oak forests on the Navajo Nation, but will use a variety of habitats, including pinyon-juniper and clearings when foraging. On the Navajo Nation, Mexican Spotted Owls are known to occur within, or adjacent to, the Chuska Mountain Range, Defiance Plateau, Canyon de Chelly, Black Mesa, and the extensive canyonlands to the north. Numerous other potential areas exist that have yet to be surveyed (NNDFW 2008).

Mexican gray wolf (*Canis lupus baileyi*) is the smallest, southernmost occurring, rarest, and most genetically distinct subspecies of gray wolf in North America. It once occurred in the mountainous regions of the Southwest from central Mexico throughout portions of Texas, New Mexico, and Arizona, including areas within the Navajo Nation. Predator control programs at the turn of the century all but exterminated the Mexican wolf from the wild. The last five Mexican wolves remaining in the wild were captured Mexico from 1977 – 1980 (USFWS 2006). These captured wolves were used to create a captive-breeding program. In 1997 the USFWS received approval from the US Department of Interior to restore Mexican wolves to the wild in Arizona and New Mexico. Wolves were initially released into the "primary recovery zone" on the Apache National Forest, with release efforts continuing on an annual basis. The White Mountain Apache Tribe has also become a formal partner in the recovery effort, and has released wolves on its lands. Released wolves are allowed to disperse within the "Blue Range Wolf Recovery Area", consisting of the Apache National Forest and the Gila National Forest. A non-essential experimental population area extends in a broad swath across central Arizona and southern and central New Mexico, with its northern limit defined by Interstate 40 (USFWS 2006). Wolves within this area are subject to special management including removal for depredation on livestock. At the end of 2012 the population estimate for released wolves was 75, with the northernmost pack located approximately 25 miles east of Show Low, Arizona (USFWS 2012). Wolves are a wide ranging animal and potential exists for the species to expand onto Navajo lands. However, the Navajo Nation does not foresee participation in the Mexican Wolf Recovery Program in the near future.

Southwestern willow flycatcher (*Empidonax traillii extimus*) nests in dense riparian vegetation near surface water or saturated soil; either in monotypic or mixed stands of native (e.g. willow) and/or exotic (e.g. tamarisk or Russian olive) riparian tree species. Vegetation is typically ≥3 m high and dense (i.e. a thicket) with a closed canopy; although, the understory may be dispersed or clumped (especially when vegetation consists of tamarisk or Russian olive). Nesting habitat greatly varies in size and shape and may be as small at 0.8 ha, but does not include linear riparian zones <10 m wide. Migrant flycatchers may use unsuitable breeding riparian and non-riparian areas in early spring. The Flycatchers' breeding range includes Arizona, New Mexico, southwestern Colorado, and southern portions of California, Nevada, and Utah. Breeding may

occur at any elevation (except possibly above 2600 m) throughout the Navajo Nation where appropriate habitat exists. Breeding is known to occur along the San Juan and Colorado Rivers. Migrant flycatchers have been found in less dense or abundant riparian habitat across the Navajo Nation (NNDFW 2008).

Yellow-billed Cuckoo (*Coccyzus americanus*) nests within close proximity to water in mature riparian woodlands with dense understories that are preferably ≥17 ha with a minimum of 3 ha of closed-canopy broad-leaved forest. Cuckoos will also nest in orchards adjacent to river bottoms. Preferred riparian woodlands and nest substrate consists of willow, cottonwood, alder, mesquite, hackberry, soapberry, and cultivated fruit trees. The cuckoos' breeding range includes all of the eastern United States and formerly throughout most western U.S. states and northern Mexico (extirpated from British Columbia, Washington, Oregon, and Nevada). Currently, the western U.S. cuckoo population (which includes the Navajo Nation) is comprised of rare local breeders in disjunct riparian habitats of major river valleys. Breeding may occur at all elevations throughout the Navajo Nation, but currently is only known from several sections of the San Juan River. Potential for breeding may also occur along the Little Colorado and Colorado rivers, within Canyon de Chelly, Chinle Valley, and other canyons or streams with appropriate habitat. The cuckoo winters in Central and South America; migratory habitat for the Navajo Nation is unknown (NNDFW 2008).

Navajo Listed Species

Northern River Otter (*Lontra canadensis*) can occupy almost every kind of aquatic habitat, including marine coasts, lakes, marshes, reservoirs, and streams (Boyle 2006). They inhabit water bodies and riparian areas within a broad range of ecosystems from semi-desert shrubland to montane and subalpine forest. The primary habitat requirement for river otters is permanent water with abundant fish or crustacean prey and relatively high water quality. The physical habitat attribute most important to river otters, besides water, is riparian vegetation, which provides cover when they are feeding, denning, or moving on land (Boyle 2006). River otters formerly occupied most major drainages in Canada and the continental United States. Population centers (Boyle 2006). River otters historically occurred in the Colorado and Gila rivers and their major tributaries, but the species' current distribution is uncertain. Channelization, bank-armoring, marshland draining, and other kinds of habitat destruction were major factors in the species' population declines. Evidence suggests that a few populations persisted at least into the 1960s with the potential for small isolated populations still in existence today. Some populations have recently been identified along the San Juan River in New Mexico near the Navajo Nation boundary. A Louisiana subspecies (*L. c. lataxina*) was successfully introduced into central Arizona (Verde River drainage) between 1981 and 1983, however the success of the introduction is unclear and there is the potential for this subspecies to swamp the genetic diversity of native populations (Boyle 2006 and AZGFD 1996). There is potential for the Navajo Department of

Fish and Wildlife to change the current listing of the Northern river otter from extirpated to highly endangered (Chad Smith, NNDFW, personal communication).

Bald Eagle (*Haliaeetus leucocephalus*) typically nests within trees in forested areas, especially mature and old-growth stands, adjacent (usually <2 km) to large bodies of water with suitable forage of waterfowl and fish; bald eagles rarely use cliff faces adjacent to large bodies of water. Eagles winter roost in large trees in forests, river bottoms, or near canyon rims, usually within a few miles of ponds, lakes, and rivers with adequate prey. Ponds and lakes are used until completely iced-over and prey availability is reduced. The species breed across North America, from the Gulf of Mexico to the Arctic; most nesting in the Southwest is limited to the Salt, Verde, Animas, and Gila Rivers. There are few nesting records on the Navajo Nation, and migrants use various lakes, including (but not limited to): Wheatfields, Tsaile, Many Farms, Morgan, Red, Black Lakes, and various lakes in the Chuska Mountains. Wintering eagles occur along the San Juan and Colorado Rivers (NNDFW 2008).

Northern Leopard Frogs (*Lithobates pipiens*) breed in wetlands, usually with permanent water and aquatic vegetation (especially cattails), ranging from irrigation ditches and small streams to rivers, and small ponds and marshes to lakes or reservoirs. The leopard frogs' range includes most of Canada and the northeastern U.S., southwest to NV, central Arizona, and New Mexico. On the Navajo Nation, historic records include the Chuska Mountains; Little Colorado, Colorado, and San Juan Rivers; Navajo and Chinle Creeks; Canyon de Chelly; and near Tuba City, Cameron, Thoreau, and Newcomb. Most of these populations are now extirpated. Potential for the species exists throughout the Navajo Nation where appropriate habitat is present (NNDFW 2008).

Pronghorns (*Antilocapra americana*) are found in grasslands or desert scrub areas with rolling or dissected hills or small mesas, and usually with scattered shrubs and trees (typically juniper and sagebrush). The pronghorns' range includes most of the western U.S. and south-central Canada. Occupied range on the Navajo Nation includes the New Lands area, the southwestern portion north of Flagstaff, and checkerboard lands in New Mexico. Navajo Nation Department of Fish and Wildlife (NNDFW) do occasionally permit special hunts of pronghorn within NNDFW Big Game Management Unit 16, which covers the New Lands area. The Navajo Nation G3 designation does not apply within this area. These special hunts are conducted only for Navajo tribal members only and are done to help with specific management goals (NNDFW 2008).

Bighorn Sheep (*Ovis canadensis*) are found year-round in arid, precipitous terrain with rocky slopes, ridges, cliffs, and rugged canyons; vegetation is typically composed of low shrubs, grasses, and forbs. The range of the subspecies *O. c. nelsoni* extends from California to Texas and south to northern Mexico. The species' present range on the Navajo Nation includes the San Juan River in Utah and possibly along the Little Colorado River, with rare sightings along Marble Canyon. There is potential for the species to exist throughout the deep canyon reaches of

the San Juan, Colorado, and Little Colorado Rivers. There has been at least documented case of a ram dying from an infection related to eat cheatgrass. In this instance, the grass awn became lodged, in the ram's throat (Jeff Cole, NNDFW, personal communication July 24, 2015). Game hunts for bighorn sheep are permitted on some years depending on wildlife management needs (NNDFW 2008). These are done for research and management purposes and are permitted within NNDFW Management Unit 11, across the Arizona-Utah border. NNDFW also makes three permits available to the public via auction through Safari International, Grand Slam/Ovis, and the Wild Sheep Foundation.

Golden Eagles (*Aquila chrysaetos*) nest on steep cliffs, typically ≥ 30 m in height, although shorter cliffs (≥ 10 m) are infrequently used. Nesting cliffs are normally directly adjacent to foraging habitat consisting of desert grasslands or desert scrub, with only sparse shrubs, that provide habitat for their primary prey: cottontail and jackrabbits. Nests are usually constructed in the middle to upper parts of cliffs on sheltered ledges, potholes, or small caves, which provide protection from the elements. The eagles' breeding range extends throughout Canada and the western U.S. from South Dakota south to western Texas and northern Mexico, and west to the Pacific Coast. Nesting occurs at nearly all elevations across the Navajo Nation, and on nearly all types of cliff substrates including sandstone, limestone, and those of volcanic origin (NNDFW 2008).

Ferruginous Hawk (*Buteo regalis*) nests in badlands, flat or rolling desert grasslands, and desert scrub. Most nests on the Navajo Nation are on clay or rock pinnacles, small buttes, or short cliffs (< 30 m high); fewer are placed in top of juniper trees or on the ground; there is one record of a nest on the cross-arm of a transmission-line tower. Habitat surrounding nest sites must support populations of their preferred prey items: cottontails, jackrabbits, prairie dogs, ground squirrels, and gophers. The Hawks' breeding range extends from North Dakota and northern Texas, west to Washington and Nevada, including northern New Mexico and Arizona, and into southern Canada. Winter range extends from Colorado and southern Nevada south into Mexico and west to northern California. The Navajo Nation is used by Ferruginous Hawks year-round; most hawks (>90%) breed and winter in northwestern New Mexico, but also occur in Chinle Valley and Dilkon area (NNDFW 2008).

American Dipper (*Cinclus mexicanus*) nests near clear, unpolluted streams usually ≤ 15 m in width and ≤ 2 m in depth, with a variety of riffles, pools, and waterfalls with substrates of rocks, sand, and rubble; in-stream and streamside boulders are necessary for perches. Nests are placed on ledges, or in crevices, on stream bank structures of small cliffs, large rocks, fallen logs and tree roots. Streams used in winter may be larger and deeper, because lack of ice is a major selection factor. Dippers are resident throughout Alaska and western Canada, and in isolated populations in most western states and Mexico, from the eastern Rocky Mountains to the Pacific Coast. They are present on the Navajo Nation on the east and west faces of the Chuska Mountains, upper Canyon de Chelly, the Little Colorado River, and upper Piute Canyon near

Navajo Mountain. Potential for the species exists anywhere perennial streams have the proper habitat parameters (NNDFW 2008).

Western Seep Fritillary (*Speyeria nokomis*) inhabits perennially wet meadows associated with seeps, springs, and streams, which vary in size from 0.1 ha to >1.2 ha. Habitat must be relatively open, dominated by grasses, and with few shrubs. Violets (*Viola nephrophylla*), found in wet soils in shady areas beneath shrubs or within stream banks, are a necessary component of habitat and serve as the host plant for larvae. There is the potential for the fritillary to be found on rangeland and farmland where violets, thistles, and other nectar producing plants grow. The species' range extends across eastern Utah, western Colorado, northern Arizona, and New Mexico. On the Navajo Nation, it is known from <10 populations in the Chuska Mountains and Defiance Plateau: Tsaile, Wheatfields, Whiskey Creeks, and two springs near Washington Pass; however, potential exists throughout the Chuska Mountains and the Defiance Plateau where appropriate habitat is present (NNDFW 2008).

Townsend's Big-eared Bat (*Corynorhinus townsendii*) roosts, raises young, and hibernates primarily in sandstone or limestone caves, lava tubes, mine tunnels, and other man-made structures. The bats use a variety of habitats for foraging, including coniferous forests and pinyon-juniper woodlands, deciduous riparian woodlands, and desert lands. During spring and summer, females form maternity colonies of < 100 adults in warm parts of mines and caves; males are solitary. During winter, they hibernate singly or in small groups in colder parts of mines and caves, near entrances and in well-ventilated areas. The species' range includes most of the western U.S. states from southern British Columbia southeast to South Dakota and west to the Pacific Coast, south through Texas and California and throughout most of inland Mexico. Only two roost caves are known on the Navajo Nation: near Shiprock and Page. Distribution is likely limited to areas with suitable roost sites. The species is reportedly common elsewhere in coniferous forests, but has not yet been documented from the Chuska Mountains or the Defiance Plateau (NNDFW 2008).

Chisel-toothed Kangaroo Rat (*Dipodomys microps*) constructs burrow systems with multiple entrances on a discrete raised mound (2-4 m in diameter) in Great Basin desert scrub habitat with open sandy areas and vegetation dominated by sparse grasses, shadscale, four-wing saltbush, or blackbrush. Preferred areas have surface soils with a rock or gravel component, and are relatively undisturbed by cattle grazing. The species is found throughout most of Nevada and extends into southeast Oregon, eastern California, western Utah, and northwest Arizona. The subspecies *D. m. leucotis* is limited to Marble Canyon and House Rock Valley of Coconino County, Arizona, and is only known on the Navajo Nation near the Navajo Bridge of Marble Canyon; potential range is likely restricted to the upper Marble Canyon area (NNDFW 2008).

Banner-tailed Kangaroo Rat (*Dipodomys spectabilis*) constructs elaborate and distinctive burrow systems, usually with 3-12 burrow openings on a discrete and raised (≤1.2 m tall) mound (1.5-4.5 m diameter), in Great Basin desert grassland or desertscrub, preferring areas with

heavier soils than other *Dipodomys*. Presence of grasses is necessary, but habitats at the extremes of vegetation density and height are avoided. Burrow openings are invariable larger than necessary for the size of the animal. The species' range includes most of New Mexico, southeast Arizona, western Texas, and northern Mexico, with small populations of the subspecies, *D.s .baileyi*, in northern Arizona. Its occupied range on the Navajo Nation includes small remnant populations just west of Chinle and possibly near Navajo Mountain, with patches of desert lands in New Mexico also being occupied. Potential range includes all desert lands east of the Chuska Mountains, northeast of Black Mesa in Apache Co., Arizona, and San Juan Co., Utah. Designation as G4 only applies to populations occurring in Arizona and Utah (NNDFW 2008).

Navajo Mountain Vole (*Microtus mogollonensis*) typically occupies dry, grassy vegetation in conifer forests, with variations including dense prostrate shrub patches in ponderosa pine forests (Navajo Mountain); monotypic sagebrush stands, thick grasses in greasewood/desert-olive stands and juniper stands, shrubby tamarisk thickets and chained pinyon and juniper woodlands (Black Mesa); and clear-cut pine flats with regenerating grasses and scattered oak (Chuska Mountains). Ground cover vegetation is necessary. The range of *M. mogollonensis* includes Arizona, New Mexico and Mexico with small populations in southern Utah, Colorado, and Texas. *M. m. navahos'* range extends from Williams, Arizona to Mesa Verde, Colorado, including four locations on the Navajo Nation: Navajo Mountain, Black Mesa, Defiance Plateau, and the Chuska Mountains (NNDFW 2008).

Wupatki (Arizona) Pocket Mouse (*Perognathus amplus cineris*) occupies Great Basin desert scrub habitat, usually with sparse ground cover of greasewood, snakeweed, rabbitbrush, ephedra, shortgrass, and possibly, short junipers. The species' range includes the southwestern half of Arizona and extreme northwestern Mexico. *P. a. cineris* occupies a smaller disjunct range including a narrow swath of the western Navajo Nation from the northern Echo Cliffs south to Wupatki National Monument near Flagstaff, AZ. Potential range on the Navajo Nation likely extends from the Colorado River (Marble Canyon) east to Kaibito Plateau and south through Cameron to the Leupp area (NNDFW 2008).

Kit Fox (*Vulpes macrotis*) inhabits dens excavated in desert scrub or desert grasslands with soft, alluvial or siltly-clay soils, and often with sparse saltbush, shadscale, greasewood, sagebrush, and grasses. Dens have 2-25 keyhole-shaped entrances (average of 3) that are 20-25 cm (8-10 inches) in height and < 20 cm wide. The species' historic range included desert land areas of southern Oregon and Idaho; south through Nevada, Utah, and California to the Baja Peninsula; and southeast through Arizona, New Mexico, and western Texas to northern-central Mexico. The foxes' current range is reduced in size, but not well documented. It is known from the Navajo Nation east of the Chuska Mountains and Chinle Valley in Arizona and Utah; however, potential exists within all desert lands on the Navajo Nation (NNDFW 2008).

Northern Goshawk (*Accipiter gentilis*) typically nests in drainages, canyon bottoms, or north-facing forested slopes with ponderosa pine stands composed of large mature trees and high (60-

90%) canopy closure. They also inhabit mixed-species, spruce-fir, and aspen stands. A variety of forest types, ages, and successional stages often surround nest sites and are used extensively by recently fledged young. The Goshawks' breeding range includes most of Canada, Alaska, the northeastern U.S, northern Mexico, and most the western states including Utah, western Colorado, New Mexico, and eastern Arizona. On the Navajo Nation, goshawks occupy the Chuska Mountain Range, Defiance Plateau, and Black Mesa. There is potential for Goshawks to occur throughout the Navajo Nation where appropriate habitat exists (NNDFW 2008).

Clark's Grebe (*Aechmophorus clarkia*) nests on fresh-water lakes and marshes with extensive areas of open water bordered by emergent vegetation. Clark's Grebe uses lakes and occasionally small ponds during migration. Its breeding range includes most of the western U.S. and Canada and east to the Great Lakes. The Grebe winters along the Pacific Coast of the U.S., northern Mexico, and inland on open waters from California east to southern Texas. The species has only been documented at Morgan Lake, but there is potential for the species on open waters throughout the Navajo Nation (NNDFW 2008).

Northern Saw-whet Owl (*Aegolius acadicus*) nests in tree cavities in relatively open ponderosa pine, Douglas-fir, or mixed conifer forests; they may also nest in old-growth riparian woodlands. The Owls' wintering habitat is variable, but dense vegetation is critical. The Northern Saw-whet Owl's breeding range includes most of the northern and western U.S., Canada, and central Mexico. There is no documented breeding on the Navajo Nation, but potential exists in forests and wooded canyons of the Chuska Mountains, Defiance Plateau, Black Mesa, and Navajo Mountain (NNDFW 2008).

Burrowing Owl (*Athene cunicularia*) nests in ground burrows (often deserted prairie-dog burrows), typically in dry, open grasslands or desert scrub. However, grasslands with sparse junipers may also be used on the Navajo Nation; presence of a suitable nest burrow is critical. The Owls' breeding range covers a wide distribution across western North America, generally from south-central Canada and the Dakotas, south through Texas, to central Mexico, and west to California, Oregon, and Washington. The Owl's winter range includes most of Texas, and southern parts of New Mexico, Arizona, and California, south through Mexico to the northern parts of Central America. Potential range on Navajo Nation includes all low-elevation desert lands to elevations where juniper habitat is found (NNDFW 2008).

Belted Kingfisher (*Ceryle alcyon*) nests in burrows in earthen banks, usually near major water sources (streams, rivers, ponds and lakes), with adequate prey of small fish and other aquatic animals. Important components of aquatic habitat for the species include clear water, riffles, and lack of overgrown vegetation. Small lakes, ponds, coves, and shallow bays of larger lakes are preferred lentic habitats. The kingfishers' breeding range includes most of the US and Canada, but is a local, occasional breeder in Arizona and New Mexico. On the Navajo Nation, the species is known from the Chuska Mountains (Tsaile and Asaayi Creeks), Morgan Lake, and the Little

Colorado River. There is potential for the species to occur throughout the Navajo Nation where appropriate habitat exists (NNDFW 2008).

Mountain Plover (*Charadrius montanus*) typically nests in flat (≤ 2 degree slope) to slightly rolling expanses of grassland, semi-desert, or badlands, in areas with short, sparse vegetation, including large bare areas (often ≥ ⅓ of total area), and landcover that is typically disturbed (e.g. grazed). The plover may also nest in plowed or fallow cultivated fields. Nests consist of a scrape in dirt, often next to a grass clump or old cow manure pile. Migration habitat is similar to breeding habitat. The Plover's breeding range includes most of Montana, Wyoming, eastern Colorado, central to northern New Mexico, and the panhandle areas of Oklahoma and Texas. Wintering range includes central California; southern parts of Arizona, New Mexico, Texas; and northern Mexico. Known breeding areas on the Navajo Nation occur only in New Mexico. Grasslands between the Chuska Mountains, Black Mesa, and southwest of Black Mesa to Little Colorado River are potential habitat (NNDFW 2008).

Dusky (or Blue) Grouse (*Dendragapus obscures*) nests primarily in mixed-conifer stands with relatively open tree canopies, but possibly in nearly all montane forest habitats, especially those dominated by Douglas-fir with varying amounts of aspen, and possibly ponderosa pine. Winter habitat is nearly exclusively montane conifer forests composed of fir or spruce, and occasionally pinyon pine. The Dusky Grouse is resident to all major mountain ranges of the western U.S. and Canada, from Arizona and New Mexico to British Columbia. On the Navajo Nation, they are known only from the Chuska Mountains, with potential habitat occurring at all elevations, but the greatest potential is in high-elevation pine and fir forests, especially during winter (NNDFW 2008).

Yellow Warbler (*Dendroica petechia*) can be found in the western US, where it nests primarily in wet deciduous thickets, especially those dominated by willows, and in disturbed and early successional habitats. Migration habitats are mainly semi-open scrub or shrublands and second-growth forests, often associated with wetlands. The Warbler's breeding range includes most of Canada, the U.S., and interior Mexico, but its populations are fragmented and local in the Southwest, where it is mostly absent from southern and eastern California, Nevada, western Utah, northern and western Arizona, New Mexico, and Texas. The Warbler winters from coastal Mexico to South America. There are no current breeding records for the Navajo Nation, but potential exists where suitable habitat is present, especially areas of the San Juan River and its tributaries (NNDFW 2008).

Hammond's Flycatcher (*Empidonax hammondii*) breeds in nearly all high-elevation (2,000-3,000 m) forest types, including monotypic Douglas-fir, ponderosa pine, aspen, as well as mixed-conifer and aspen/conifer types; stands are typically dense old-growth with cool micro-climates. Migration habitat is less restrictive, but preferentially includes mid-elevation forests and riparian habitats. The Flycatcher's breeding range extends from central Alaska and western Canada south to central California, and northern Arizona and New Mexico. The species winters in southeastern

Arizona, Mexico, and Central America. On the Navajo Nation, it's only known nesting site occurs in the Chuska Mountains; however, there is potential on Black Mesa and Navajo Mountain (NNDFW 2008).

Peregrine Falcon (*Falco peregrines*) nests on steep cliffs (>30 m tall and typically ≥ 45 m in height) in scrapes or on sheltered ledges or potholes. Foraging habitat quality is an important factor for the species; often, but not always, extensive wetland and/or forest habitat is within the falcon's hunting range of ≤ 12 km. Variability in topographic features, such as elevation and slope, may also indicate the availability of prey for Peregrine Falcons. The species breeds throughout much of the U.S., Canada, and Mexico. Breeding occurs across the Navajo Nation where appropriate habitat exists, including, but not limited to, the Chuska Mountain Range; Canyon de Chelly; Black Mesa north to Glen Canyon; the Dilkon-buttes region; and the canyon reaches of the San Juan, Colorado, and Little Colorado Rivers (NNDFW 2008).

Northern Pygmy Owl (*Glaucidium gnoma*) nests in tree cavities, often near openings (e.g. meadows, lakes, and ponds), in a variety of montane forest habitats and possibly wooded canyons. Montane habitats include coniferous (spruce, fir, and ponderosa pine), mixed conifer-hardwood forests with oak and aspen, hardwood bottomlands, and occasionally aspen stands. Owls may migrate to lower elevations and use woodlands or prairie foothills as wintering habitat. The Owl's breeding range includes most of western North America from southeast Alaska and British Columbia, south through central parts of the Four-Corner states, and through central Mexico to northern Central America. On the Navajo Nation, they are known from the Chuska Mountain Range and Tsegi Canyon; however, there is potential throughout forested areas and canyon lands on the Navajo Nation (NNDFW 2008).

Flammulated Owl (*Otus flammeolus*) nests in tree cavities in open conifer (usually ponderosa pine) or aspen forests, often with a brushy understory of dense saplings or oak shrubs; areas with old-growth are preferred. Owls roost within dense stands with large-diameter trees or regeneration. Nest and roost habitats need a high abundance and diversity of nocturnal arthropods for prey. The species winters in lower elevation habitats, especially riparian areas. The Flammulated Owl's breeding range includes most mountain ranges of the western US, southern British Columbia, and Mexico. On the Navajo Nation, it is known from the Chuska Mountain Range, Defiance Plateau, and Black Mesa. Potential exists throughout forested areas of the Navajo Nation (NNDFW 2008).

Band-tailed Pigeon (*Patagioenas fasciata*) nests primarily in montane conifer or mixed-species forests dominated by pines and oaks between 1,600-2,700 m in elevation (5,250-8,850 ft). The species prefers pine-Douglas-fir forests and spruce-fir with abundant berry-producing shrubs in Colorado, northern Arizona, and New Mexico. In southern Utah, the species prefers Gambel's oak-dominated communities. Migratory habitat is generally the same as that used for nesting. Two distinct breeding ranges exist; the first range extend along the Pacific Coast from northern Washington to southern California and the second ranges from central Utah and Colorado south

through Arizona, New Mexico, central Mexico, and throughout most Central American countries. The species winters in central and southern California, and throughout its breeding range south of the U.S.-Mexico border. It is known from the Chuska Mountains on the Navajo Nation; however, there is potential for the species on the Defiance Plateau and possibly Black Mesa and Navajo Mountain (NNDFW 2008).

American Three-toed Woodpecker (*Picoides dorsalis*) nests and winters primarily in spruce, fir, aspen, or mixed-conifer forests (and possibly adjacent ponderosa pine habitats) above 2,400 m (8,000 feet) in elevation; ideal conditions have mature or old-growth stands, fire-killed trees, 42-52 snags per 40 ha (100 acres), and/or large numbers of bark-boring beetles. Nests are placed 1½-15 m high in a stump or dead/dying conifer or aspen. The specie's breeding range extends throughout Alaska and Canada to the northeastern U.S., and south through most western states to eastern Nevada, central Arizona, and southern New Mexico. On the Navajo Nation, the species is only known from the Chuska Mountains and has low potential to exist within habitats on Black Mesa and Navajo Mountain (NNDFW 2008).

Sora (*Porzana carolina*) nests in wetlands with shallow to intermediate-depth water and fine-leaved emergent vegetation (typically cattails, sedges, burreeds, and bulrushes); floating and submerged vegetation increases habitat quality. Wetlands with heavy snow, ice, or high water until early May are unusable for nesting. Migration habitat is typically wetlands with tall dense vegetation and shorter seed-producing plants, but occasionally may include upland habitats (e.g. fields and pastures). The Sora's breeding range includes most of Canada, the northern and western US, south to central Arizona and New Mexico. The species winters in the extreme southern US, Mexico, and Central America. It is known from various ponds and lakes on the Navajo Nation, including several in the Chuska Mountains, Morgan Lake, and near Tuba City. Potential for the species exists within suitable wetlands throughout the Navajo Nation (NNDFW 2008).

Tree Swallows (*Tachycineta bicolor*) breed in the existing cavities of a variety of tree species (coniferous and deciduous), and often use snags in open fields near water, especially marshes and wooded ponds. The Tree Swallows' breeding range includes most of central and northern North America, but is a local breeder in Arizona and New Mexico. The species winters in the extreme southern US, Mexico, and Central America. On the Navajo Nation, it is known from the Chuska Mountains; but, potential occurs throughout forested areas of Navajo Nation (NNDFW 2008).

Gray Vireo (*Vireo vicinior*) prefers habitat consisting of mixed pinyon-juniper, juniper-sagebrush associations, and possibly in dry brushland and oak scrub woodlands. Continuous shrub cover, 0.5 – 2 m in height, is an important component of breeding habitat in California and Texas, and possibly on the Navajo Nation. Nests studied in Colorado were typically 2 m above the ground in 3 m tall junipers. The species is also known to nest in pinyon pine, sagebrush, sumac, mountain mahogany, and oak species were observed. The species is often separated from

other *Vireo* species by elevation preferences. The species' breeding range includes mostly montane regions and adjacent scrubland in the southwestern U.S., from south-central New Mexico north to northwestern Colorado, southwest to southern Nevada, and to southeastern Arizona. Local breeding occurs in southern California and southwestern Texas. The species winters mostly in south-central Arizona; Sonora, Mexico; the Baja Peninsula; and also in southwestern Texas. The species distribution on the Navajo Nation is relatively unknown; however, potential occurs throughout pinyon-juniper woodlands on the Navajo Nation (NNDFW 2008).

Milk Snake (*Lampropeltis triangulum*) is a secretive species that uses rocks, logs, stumps, boards, and other surface objects as cover within a variety of habitats including river valleys, desert scrub, grasslands, pinyon-juniper, and coniferous forests. Most specimens from New Mexico were found in high foothill grasslands and coniferous forests. The species' range extends from southeastern Canada and all of eastern U.S., west to Montana, central Colorado, and New Mexico, and south through Mexico to Ecuador. There are also distinct populations in Utah and Arizona. Currently no records exist for the Navajo Nation, but the species has been found in bordering areas (Farmington, Cameron, Bluff, Wupatki National Monument, and Petrified Forest National Park), and there is potential throughout all elevations and habitats of the Navajo Nation (NNDFW 2008).

Chuckwalla (*Sauromalus ater*) habitat consists of low desert lands (especially with volcanic alluvia and lava flows or desert hardpan) and rocky canyons (especially with large boulders). Chuckwallas also use the margins of grass-oak woodlands in southern Utah. The specie's range includes southern California and Nevada, south through the Baja Peninsula and northwestern Mexico, and east through western Arizona, including the canyons of the Colorado River in northern Arizona and south-central Utah. Its known range on the Navajo Nation is not well understood, but likely includes deep canyons and adjacent desert lands of the Little Colorado River, the Marble Canyon area (including Echo Cliffs) of the Colorado River, and the San Juan River in Utah (NNDFW 2008).

Rocky Mountainsnail (*Oreohelix strigosa*) is known to occur in leaf-litter or within/near rocks and rock outcrops within steep-sloped, northern-aspect coniferous forests. Steep-walled canyons and areas that maintain moist soils are also potential habitat. Within most of the species' U.S. range, it is restricted to limestone outcrops or under vegetation on limestone slopes where the presence of limestone is critical; sandstone seems to provide adequate substrate, especially on the Navajo Nation. Plant community composition is of little importance in determining potential habitat; however, a cool, moist microclimate and leaf mold are critical. The species mostly occurs in a swath through the western states of Washington, Idaho, and Montana; south through Utah, Colorado to the northern third of Arizona; and New Mexico. A subspecies on the Navajo Nation (*O. s. depressa*) occurs in the southern half of its U.S. range. One historic record exists from the south slope of Navajo Mountain, but presently the species is known from only a few

locations in the Chuska Mountains. There is potential for the species to exist throughout forested areas and possibly canyon lands on the Navajo Nation (NNDFW 2008).

Yavapai Mountainsnail (*Oreohelix yavapai*) is only known extant to occur on the Navajo Nation on steep-sloped, northern-aspect coniferous forest with dense mossy groundcover over an exposed rock/boulder substrate. Cool and moist microclimate and dense moss are likely key habitat components. Potential habitats include steep forested slopes with leaf-litter and/or exposed rocks and rock outcrops, steep-walled canyons, and others areas that maintain a cool microclimate and moist soils. The species mostly occurs in Arizona, New Mexico, and southern Utah, with smaller distributions in Wyoming and Montana. Historic records indicate the presence of two subspecies on the Navajo Nation (*O. y. clutei* and *O. y. cummingsi*) from on, and around, Navajo Mountain, but presently the species is only known from one location in Canyon de Chelly National Monument (subspecies unknown). There is potential for the species to exist throughout forested areas and possibly canyon lands on the Navajo Nation (NNDFW 2008).

3.5.2 Fish Species – Endangered, Threatened, Proposed, Candidate, and Sensitive Species

The project area contains populations or suitable habitat for 5 federally listed fish species and 1 additional tribally listed species (**Table 3-14**). Of the federal species, there are three listed as endangered, one listed as potentially endangered, and one listed as a candidate species. The tribally listed fish species is considered sensitive (G4). Information on suitable habitat for all listed fish species is managed by the Navajo Department of Fish and Wildlife.

Table 3-14. Fish species of concern found on the Navajo Nation as designated by the U.S. Fish and Wildlife Service and the Navajo Nation Department of Fish and Wildlife.

Common Name	Scientific Name	Federal Status[+]	Tribal Status[++]	Location
Colorado Pikeminnow	*Ptychocheilus lucius*	E	G2	AZ, NM, UT
Humpback chub	*Gila cypha*	E	G2	AZ, UT
Razorback sucker	*Xyrauchen texanus*	E	G2	AZ, NM, UT
Zuni bluehead sucker	*Catostomus discorbolus yarrow*	E	G4*	AZ, NM
Roundtail chub	*Gila robusta*	C	G2	AZ, NM
Mottled sculpin	*Cottus bairdii*	-	G4	NM

[+]E=endangered, PE=proposed endangered, C= candidate.

[++]G2=critically endangered, G3=endangered, G4=sensitive

*All subspecies of bluehead sucker are currently listed by Navajo Nation Department of Fish and Wildlife. Genetic testing is underway to determine the location populations of the subspecies Zuni from other populations found on the Navajo Nation.

3.5.2.1 Species Descriptions

Federally Listed Species

Colorado Pikeminnow (*Ptychocheilus lucius*) adults use backwaters and flooded riparian areas during spring runoff, and migrate large distances (15-64 km in the San Juan River to spawn in riffle-run areas with cobble/gravel substrates. Post-spawning adults primarily use run habitats,

with eddies and slackwater also being important. Young-of-year (<120 mm length) use warm backwaters along shorelines. Deeper backwater areas (>1 m deep at confluences with the main channel) are the preferred habitat of young fish into the subadult stage (>3 yrs. age and 200- 400 mm length). Irrigation canals and ponds connected to the San Juan River may be potential habitat. Currently, the species is restricted to the Upper Colorado River from Wyoming to New Mexico. On the Navajo Nation it has been documented throughout the San Juan River, from Shiprock to Lake Powell; the mouth of the Mancos River is used during the spring runoff period. The majority of adults use the stretch from 11 km downstream of Shiprock (RM142) to just downstream of Four Corners (RM117), and spawn in 'The Mixer Area' (RM131-132); young-of-year have primarily been found within the lower 26 km of the San Juan River, upstream from Lake Powell (NNDFW 2008). Critical habitat occurring on or adjacent to the Navajo Nation includes the San Juan River.

Humpback Chub (*Gila cypha*) use a variety of habitats including pools, riffles, and eddies; they seem to prefer whitewater reaches with deep swirling eddies and the turbulent waters near boulders and submerged rocks. First-year chubs (<65 mm in length) are found in shallow waters along edges of deeper waters. Spawning in the Lower Colorado River is thought to occur over gravel beds in swift water. Humpback chub are endemic to the Colorado River and a few of its narrow, canyon-bound tributaries in Arizona, Utah and Colorado. The largest population is found at the confluence of the Little Colorado and Colorado Rivers; nearly all successful spawning downstream of the Glen Canyon Dam and occurs within the lower 14 km of the Little Colorado River (NNDFW 2008). Critical habitat occurring on or adjacent to the Navajo Nation includes the Colorado River in Grand Canyon National Park.

Razorback Sucker (*Xyrauchen texanus*) is found in the mainstream portion of major rivers in the southwestern United States. Pre- and post-spawning suckers mostly use low-flow areas including backwaters over sand and silt substrate, deep eddies, and impoundments, but shallow to deep runs over sandbars and seasonally-flooded shorelines are also important. Spawning occurs in areas with shallow swift riffles over gravel or cobble substrate, and they may also use backwater habitats. Young-of-year use warm flooded bottomlands and backwaters. Irrigation canals and ponds connected to the San Juan River may be potential habitat. The species is restricted to the Colorado River and a few of its warm-water tributaries, and is regularly found only in Lake Mohave, the upper Green River in Utah, and the lower Yampa River in Colorado. It is rare along the main stem of the Colorado River in Marble Canyon, the mouth of the Little Colorado River, the San Juan arm of Lake Powell, and upstream within the San Juan River. The only occurrences recorded for the San Juan River are from Bluff, Utah in 1976; two adult and 100-150 young were found in an irrigation pond connected to the river by a man-made canal, and in 1988 one adult was captured in the main channel (NNDFW 2008). Critical habitat occurring on or adjacent to the Navajo Nation includes the San Juan River.

Zuni Bluehead Sucker (*Catostomus discobolus*) typically inhabit small desert stream systems including isolated headwater springs, small headwater springs, and mainstem river habitats

(Gilbert and Carman 2011) with clean, hard substrate, hard substrate, flowing water, and abundant riparian vegetation. Zuni bluehead suckers occupy habitat with abundant shade in pools, runs and riffles with water velocities ranging from 0-0.35 m/sec (1.15 ft/sec) or less and ranging in depth from 0.2 – 2.0 m (7.9-78.7 in) (Hanson 1980, Propst and Hobbes 1996, Gilbert and Carmon 2011). Water temperatures in sucker habitat vary from -3.2- 24.1 °C (Gilbert and Carmen 2011). The Zuni bluehead sucker is a benthic forager (eating food from the stream bottom) that scrapes algae, insects and other organic and inorganic material from the surface of rocks (NMDGF 2004). Zuni bluehead sucker spawn from early April to early June when water temperatures are 6 to 15 °C (43 to 59°F) peaking around 10°C (50°F) (Propst 1999, Propst et al. 2001). Excessive sedimentation is the primary threat to water quality for the Zuni bluehead sucker, due to its effects on reproduction and food resources (USFWS 2014). Introduced species, particularly green sunfish, northern crayfish, fathead minnows and other fish-eating fish, are a threat to the Zuni bluehead sucker. This species is known from the following locations on the Navajo Nation: Black Soil Wash, Kinlichee Creek, Scattered Willow Wash, and Red Clay Wash.

Roundtail Chub (*Gila robusta*) adults inhabit permanent water in cool to warm-water, mid-elevation streams, typically using pools and eddies, adjacent to rapids and boulders. They are often found near cover (e.g. rocks and plant roots) and in pools behind irrigation diversions. Juveniles prefer the margins of flowing water and backwater areas. Spawning occurs over gravel bottoms in runs and pools with ≥25 cm water depth. Roundtail chub are native to large streams and intermediate-sized rivers of the Colorado River System from Wyoming to Arizona and New Mexico. On the Navajo Nation, the roundtail chub has been extirpated from the Colorado River (Grand Canyon), but is extant in the San Juan and Mancos Rivers. Roundtail chubs have rarely been encountered in recent surveys; however, they have been found from Shiprock to near Lake Powell, with most occurrences located between Shiprock and Aneth (RM 107- 140) (NNDFW 2008).

Navajo Listed Species

Mottled Sculpin (*Cottus bairdi*) prefers stream sections with coarse gravel and small-to-large rock substrates; usually riffle areas are preferred, regardless of water depth. Adults rarely use areas with slow current and silt substrate; young typically use areas with little or no current, and may hide within the silt of slow-water shorelines. Spawning occurs within shallow, scooped-out depressions under large rocks, as eggs are adhered to the underside of rocks; water velocity is not criteria for spawning sites. Males attend eggs until hatching. The sculpin's range includes most of the eastern U.S. and Canada, and is also present in the northwestern U.S. and a few tributaries of the Colorado River. On the Navajo Nation, the species is only known from the New Mexico portion of the San Juan River; however, potential also exists in the Utah portion of the river and its perennial tributaries (NNDFW 2008).

3.5.3 Migratory Birds

Some neotropical migratory birds (NTMBs), which typically breed in the United States and winter in Central and South America, are a concern due to reported declines in numbers. Numerous species of NTMBs use various habitats within the Navajo nation for breeding, rearing young, or migrating at various times of the year. Riparian habitats and canyonlands in good ecological condition, supporting deciduous woody vegetation, have been identified as important habitat for many of these bird species.

To address the topic of migratory birds, this analysis will assess the impacts to tribally listed bird species. These include species listed as G2, G3, and G4 by the Navajo Department of Fish and Wildlife. Indications for these species are made in Chapter 4.

3.6 Agriculture

Agriculture is an important part of the Navajo Nation, both economically and culturally. Use of the land for the propagation of crops and livestock production has been a key element of Navajo society, economy, and development. Livestock ownership and agriculture are rooted in the Navajo identity as symbols of resourcefulness, prosperity, and social status. In terms of economy, the practice of farming and raising livestock is an essential way of life for many Navajo. These activities help provide food and wool for many families and are a vital part of their artistic culture and economy through activities such as fiber production, jewelry making, weaving, and art trading. For this project, agricultural activities will be examined based on crop production, livestock grazing and management, and commercial agricultural operations including the Navajo Agricultural Products Industry and the Navajo Indian Irrigation Project. Management of agricultural activities on the Navajo Nation is managed tribally by the Navajo Nation Department of Agriculture (NNDA) and federally by the Bureau of Indian Affairs Division of Natural Resources. Because the land is held in trust by the Bureau of Indian Affairs, permits must be obtained for grazing and farming through the BIA with tribal government approval.

NNDA provides administrative, guidance, and support services to the Navajo Nation for all grazing and farming land use. The entire Navajo Nation is divided into different land management units, which are further subdivided into Districts (**Figure 3-11**). Each Land Management District has a corresponding District Grazing Committee to address farming and grazing needs. For Eastern Navajo Agency, instead of Grazing Committees, agricultural activities are managed by the Eastern Land Board and Farm Boards. District Grazing Committees (25 CFR 167, 3 NNC §3) provide guidance, coordination, and technical assistance to those holding grazing and agricultural land use permits for each Land Management District. Farm Boards are established specifically to address irrigated farmlands. The Eastern Land Board provides grazing management to the communities that are part of Eastern Navajo Agency and for off-reservation land. All members of these boards are currently elected officials.

3.6.1 Livestock/Grazing

The raising of livestock is not only an important economic activity on the Navajo Nation, it is also a vital cultural one as well. Sheep, cattle, goats, and horses became an integral part of Navajo life after the Spanish introduced rangeland management to the area starting in the fifteenth century (Underhill 1956). The Navajo adopted the practice of ancient pastoralism, moving their animals to different ecological zones over the seasons, making it sustainable in the arid climate (Weisiger 2004). Livestock rearing soon became a prominent feature of Navajo culture. Economically, the practice gave rise of the production of Navajo textiles and animals could be used to sell meat and dairy products. The animals also became symbols of wealth for the Navajo, equating the size of a herd with a family's prosperity.

Sheep hold a prominent role within Navajo culture as a source for wool and meat. As the main source of wool, sheep are essential for the creation of Navajo textiles, including weavings, blankets, and clothing. Meat from sheep is also commonly used for ceremonial purposes and gatherings (Witherspoon 1972). Goats are also important as a source of food for the Navajo. While goats may hold little value on the market, the Navajo often used goats for the provision of milk, cheese, and meat. Cattle are also raised by the Navajo, both for the provision of milk and meat. While horses were introduced by the Spanish, they are believed to have been sacred in many Navajo stories and legends. After the introduction of the horse by Spanish settlers, Navajo started raising them for several different purposes. The horses became a part of cattle ranching practices, were used as a method of travel, and occassionally as a food source. Some believe that horse provides restorative and medicinal properties. Since their introduction, feral horses are common on the Navajo Nation and are occasionally rounded up for sale to address issues of overgrazing, drought impacts, and increased erosion.

Both the Bureau of Indian Affairs (BIA) and the Navajo Nation Department of Agriculture (NNDA) have jurisdiction over the approval and management of grazing permits for the Navajo Nation. The grazing permit system was established in 1937, and is regulated based on existing tribal grazing regulations, which were approved and adopted by the tribe in 1956. The BIA officially recognizes grazing permits assigned to designated Range Units or Range Management Units on the Navajo Nation (**Table 3-15**, **Figure 3-12**). District Grazing Committees and the Bureau of Indian Affairs are also responsible for a variety of grazing related tasks such as range inventories, rangeland planning, rangeland improvements, and rangeland protection. The BIA offers these services to permit holders when requested and in collaboration with the District Grazing Committee. Currently, enforcement of grazing regulations is assumed by the Tribe through the District Grazing Committees (or the Eastern Land Board for grazing districts in Eastern Agency and off reservation lands).

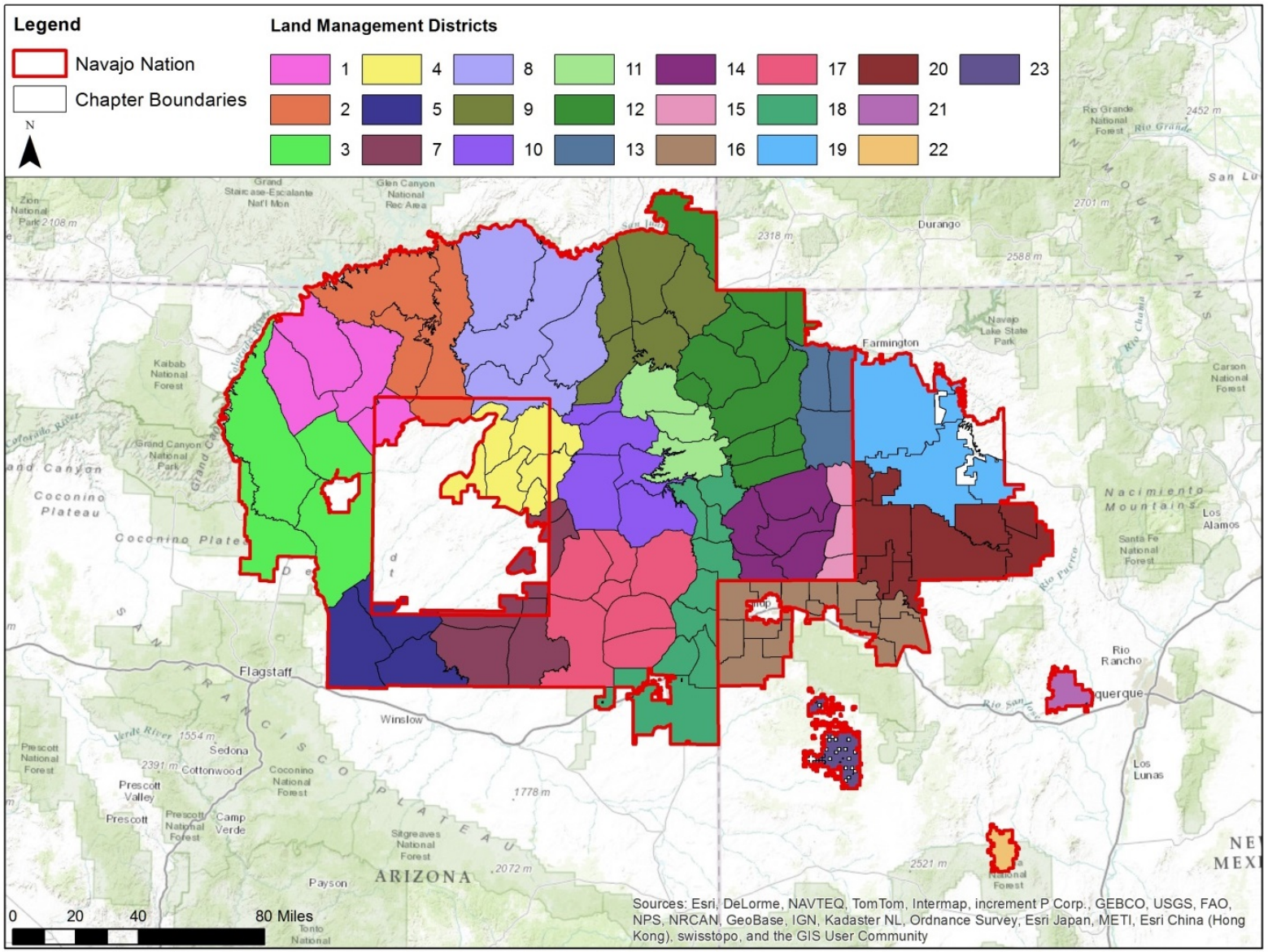

Figure 3-11. Map of the Land Management Districts for the Navajo Nation. Grazing and farming are managed based on these districts.

Table 3-15. Navajo Grazing permits for 2012 as reported by the BIA Navajo Regional Office Government Performance and Results Act (GPRA) Coordinator. Data compiled on January 10, 2014.

Agency	Land Management District	# of Grazing Permits
Central (CNA)	4	82
	10	936
	11	456
Eastern (ENA)	15	189
	16	460
	19	113
	20	340
Fort Defiance	7	608
	14	735
	17	1,426
	18	958
Northern (NNA)	9	595
	12	1,199
	13	210
Western (WNA)	1	532
	2	364
	3	664
	5	354
	8	705
TOTAL		**10,926**

Table 3-16. Tally count data from 2010 for livestock on the Navajo Nation. Tally count data does not indicate the total number of animals on the Navajo Nation, but rather provides information on fluctuations in livestock populations for each Agency. The tally count data can represent anywhere from 30-60% of the population of livestock on designated rangeland and does not take into account feral populations. Tally counts are performed by the Navajo Nation Department of Agriculture at the request of the grazing permit holder. All animals are presentated in sheep units (SU), as numbered on the grazing permit (1 cow = 4 SU, 1 horse = 5 SU, 1 llama = 3 SU. Sheep and goats each equal 1 SU).

Agency	Approved Grazing Permits	No. of SUYL Permitted	2010 Tally Count					
			Sheep	Cow SU	Horse SU	Goats	Llama SU	Total SUYL
Western Navajo	2,619	137,142	8,323	29,192	5,430	4,059	30	47,034
Northern Navajo	2,004	86,429	4,880	12,096	3,965	3,049	90	24,062
Central/Chinle Navajo	1,474	54,009	2,310	7,504	2,825	1,100	-	13,739
Fort Defiance	3,727	169,688	4,708	11,704	4,185	1,560	21	22,178
Eastern Navajo	1,102	57,678	924	-	170	117	-	1,211
New Lands[+]	n/a	4,346	231	2,948	120	84	2	3,865
Navajo Partitioned Land*	-	-	3,405	3,599	1,343	2,970	12	27,522

* All permits for the Navajo Partitioned Lands were suspended until further notice.

[+]New Lands tally count data is for 2013 as provided by the Office of Navajo and Hopi Indian Relocation.

In addition to management of grazing permits, the Navajo Nation Department of Agriculture also maintains several tribally owned ranches (**Figure 3-13**). These ranches are for use by Navajo grazing permit holders who wish to hold cattle on these areas, such as during deferment periods on customary use areas.

Many in the southwest have called for reforms to grazing management on the Navajo Nation due to its ecological impacts. Overgrazing in the southwest has been linked to a loss of top soil, reduction in vegetative cover, loss of grassland biodiversity, impacts to animal species of concern, and the establishment of noxious species (Fleischner 1994; Jones 2001). Many of these issues are major problems on the Navajo Nation, where overgrazing and a lack of proper grazing management have degraded many rangelands. While tally count data from 2010 (**Table 3-16**) may not indicate overgrazing due to larger than permitted herd sizes, such data does not take into account changes in carrying capacity or the presence of feral animals in permitted grazing areas. Additionally, tally counts are only performed at the request of the permitee and on average only represent 30-60% of these permittees for a given agency, leaving an incomplete picture of grazing use on the Navajo Nation. However, recent vegetation surveys for many of the Land Management Districts indicate that the state of many grazing areas on the Navajo Nation are significantly deteriorating or degraded (BIA 2007-2007b, 2008, 2012a, 2013, 2013a, 2014a, 2014b). The decline in available forage is largely tied to prolonged drought, the spread of invasive weeds, continuous heavy grazing pressure, and a loss of soil resources through heavy erosion.

Overall, grazing is also a vital part of the Navajo economy, culture, and identity. However, management of Navajo rangelands has been difficult to manage. When permits were first issued in the 1940s for grazing, each grazing district had a set number of animal units to divide between the permits. These initial permits, though, did not take the carrying capacity of each assigned customary use area into consideration when assigning animal units for each permit holder. For many areas, the number of permitted animals allowed on a site is much higher than the amount of forage available, leading to a decline in rangeland quality. Prolonged drought further strained forage production, limiting the growth of many desirable forage species. Unsustainable grazing practices implemented by other cattle management companies and settlers in the region also introduced practices that further degraded rangelands in the region, such as overloading pastures, introducing certain types of fencing, and preventing access of wildlife to areas (Abruzzi 1995). Such land management practices encouraged the spread of noxious species and created conditions that favor their continued spread and the replacement of more desirable and palatable forage grasses. Recovery of ecosystems impacted by overgrazing can be slow due to the arid environment, where water and nutrient inputs can be limited (Jones 2001).

Currently, the Navajo Nation Tribal Council is considering reforms to their grazing management regulations through the proposed Navajo Grazing Act. The act would reform the permitting process, provide greater enforcement for grazing related disputes, institute a grazing fee system, and provide comprehensive management of grazing. Better enforcement and more sustainable grazing practices would help address many of the negative impacts grazing has had on the Navajo Nation, while continuing to support it as a traditional practice.

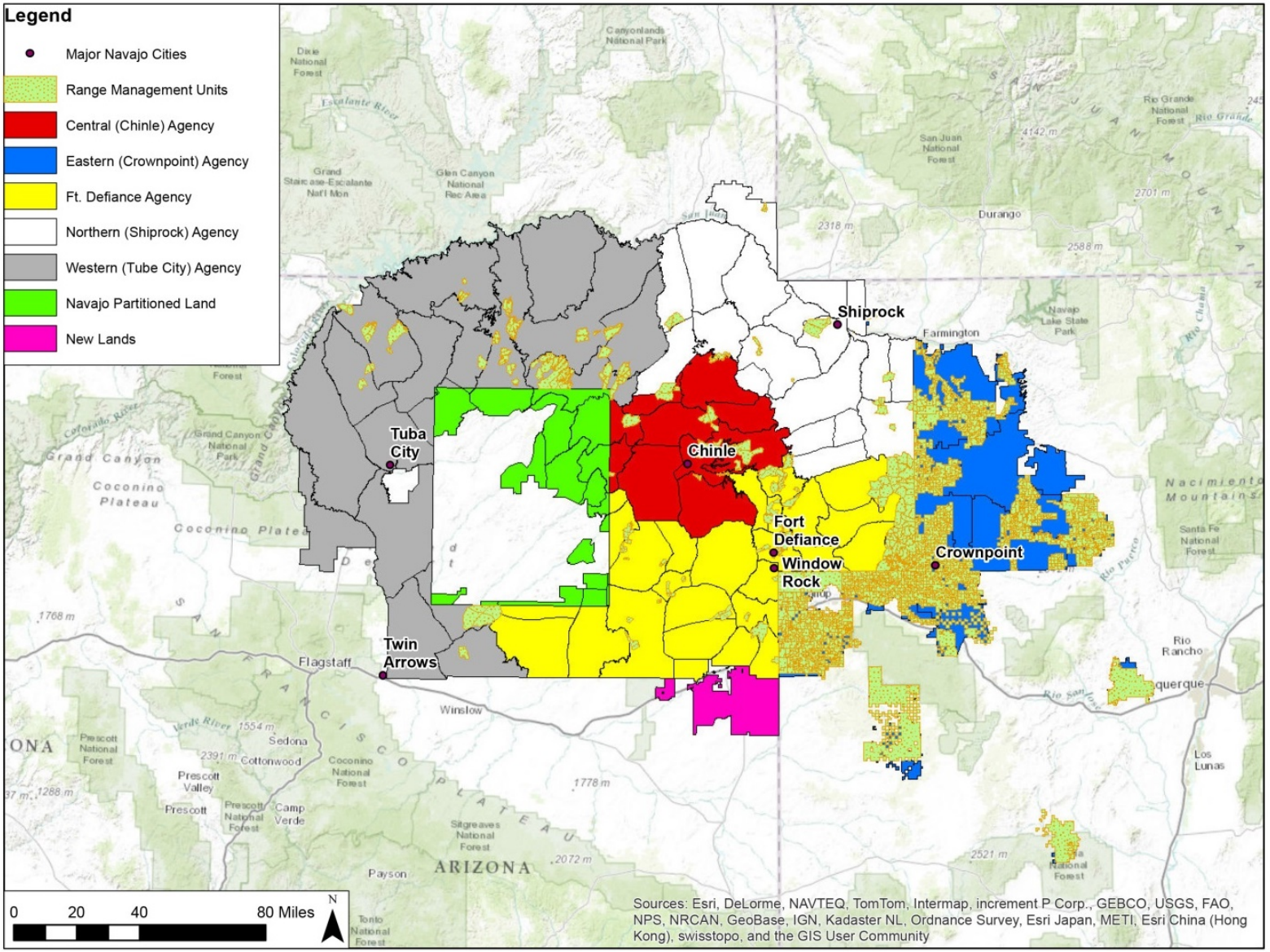

Figure 3-12. Map depicting range management units (RMUs) on the Navajo Nation in relation to the Regional Navajo Agencies.

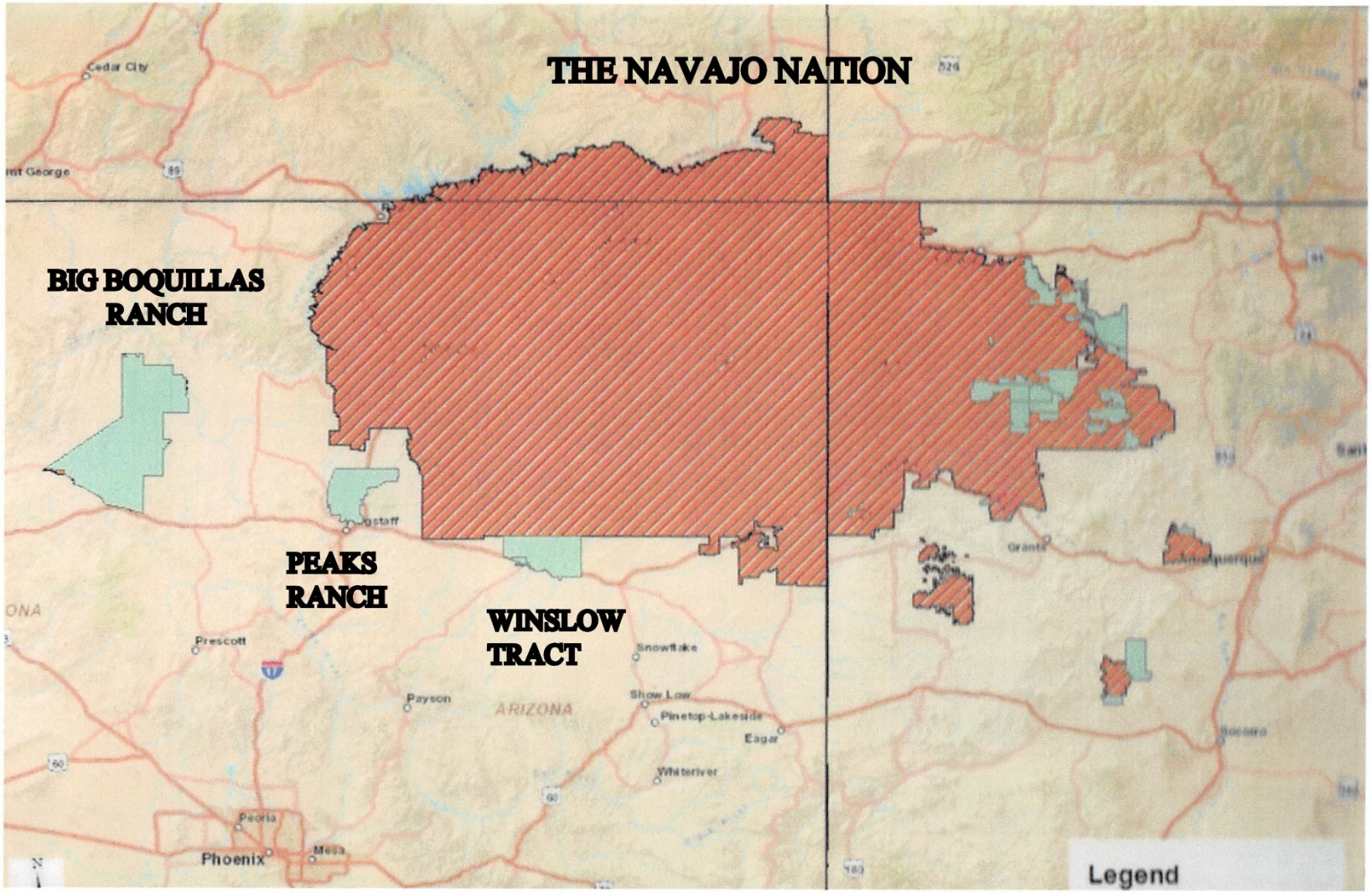

Figure 3-13. Map of Tribal Ranch Properties owned by the Navajo Nation. (Provided by the Navajo Nation Department of Agriculture).

3.6.2 Farming

Farming has been an important part of Navajo culture since before the arrival of Spanish settlers, who observed their ability to farm in the arid climate of the Southwest (Weisiger 2004). When the Navajo Indian Reservation was established through the Treaty of 1868, the Navajo were encouraged to continue farming through federal subsidy programs that provided the Navajo with seeds, farming equipment, and consumables. The Navajo were encouraged to farm crops with marketable value such as corn, wheat, peaches, hay, and beans. The tradition of farming on the Navajo Nation supports not only the economic interests of members, but also provides a connection between community and the natural world.

Farming is managed by the Navajo Nation Department of Agriculture and the BIA through an agricultural land use permit system. Agricultural permits are required when at least one acre of a land use area is to be used for farming purposes. At the writing of this document, there were close to 6,000 agricultural permits that tribal members can use for small family farms (**Table 3-17**). Of these, 946 are designated for irrigated farming areas in Northern Navajo Agency at Cudai (52 permits), Hogback (543 permits), and Upper Fruitland (351 permits). The rest of the permits cover small dryland farming operations. Dryland farming operations require the construction of water delivery systems or horticultural techniques to either transport water to the farming plots or utilize precipitation to irrigate crops. These farms provide permit holders with commercial and subsistence crops on smaller plots of land and are smaller operations than the large-scale commercial Navajo Agricultural Products Industry near Farmington or the irrigated farming areas. The crops from these farm plots are used by permittes to help subsidize their current food needs for their households, family and friends. Some may sell some of their stores for a modest profit, providing additional income for their household.

Table 3-17. Agricultural Land use permits for 2012 as reported by the BIA Navajo Nation GPRA Coordinator. Data compiled January 2014.

Agency	Land Management District	# of Agricultural Land Use Permits
CNA	4	12
	10	1,235
	11	859
ENA	15	7
	16	23
	19	-
	20	4
FDA	7	15
	14	464
	17	293
	18	270
NNA	9	301
	12	916
	13	7
Irrigated areas	Cudai	52
	Hogback	543
	Upper Fruitland	351

Agency	Land Management District	# of Agricultural Land Use Permits
WNA	1	105
	2	68
	3	206
	5	51
	8	40
TOTAL		**5822**

All farm plots are plowed and planted between April and early June, with cultivation and harvesting occurring during the summer and fall months. Dryland farms are typically dependent on water from seasonal rainfall, groundwater, or floodwater from ephemeral streams (Joynes 1985). Irrigated farming must take place within designated areas located next to perennial water sources with access to water rights. These farms are managed by Farm Boards (3 N.N.C §61-69) who help promote irrigated farming practices and efforts.

There are some concerns with the impacts of farming on the environment. Dryland farming usually involves some alteration of the surrounding area to help transport water to farm plots. Such modifications can exacerbate erosion and arroyo development, leading to drastic changes in water tables and channelization of streams (Jayne 1985). Farming also introduces regular disturbance to the landscape, which can encourage the introduction and spread of weeds. Finally, farming on the Navajo Nation has been heavily linked with ongoing water use rights issues for the Navajo Nation.

3.6.3 Navajo Agricultural Products Industry – Navajo Indian Irrigation Project

In 1970, the Navajo Tribal Council passed Resolution No. CMY-40-67, which established the Navajo Agricultural Products Industry, or NAPI. NAPI is a tribal agricultural enterprise which produces a variety of crops for commercial sale (**Figure 3-14**). The project is located in the northeastern section of the Navajo Nation across the Northern and Eastern Navajo Agency border. NAPI also has a managing stake in the Navajo Indian Irrigation project (NIIP) and serves as the native enterprise tasked with operating NIIP. NIIP is a water diversion project that transports water from the San Juan River to the Rio Grande Basin. The project is also essential for transporting water to over 110,000 acres of NAPI farmland on the Navajo Nation, in fulfillment of the Treaty of 1868. Currently, NAPI manages the operation and maintenance of NIIP under a contract with the BIA while the Bureau of Reclamation serves as the main contractor responsible for planning, design, and construction of NIIP. NIIP is only about 70% completed with the need for ongoing construction and design to irrigate the remaining 30,000-40,000 acres that are not currently in production.

Major crops produced by NAPI include alfalfa, beans, corn, potatoes, and wheat. But they also produce a variety of other crops as outlined in **Table 3-18**. All agricultural products produced by NAPI are marketed under the Navajo Pride brand. They also produce flour, animal feed, and traditional Navajo plants that can be used for their healing and ceremonial uses. Currently, NAPI has between 60,000 and 70,000 acres in production.

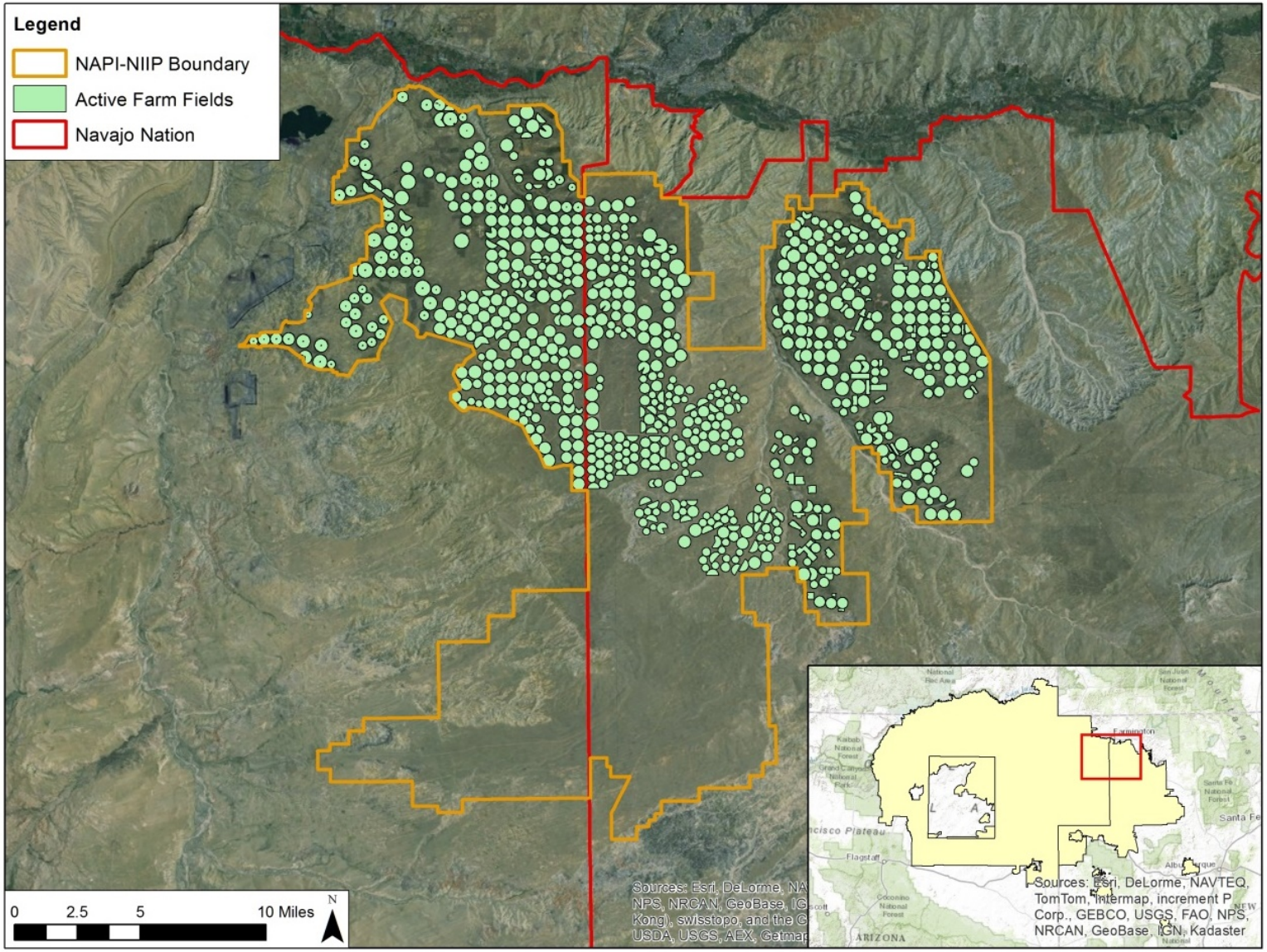

Figure 3-14. Map of the NAPI-NIIP project area with active fields in green. The project is located across the Northern and Eastern Navajo Agency borders.

Table 3-18. Estimated acres for various crops grown by NAPI as reported by USDA for 2013.

Crop	Estimated Acres
Alfalfa	19370
Corn	16530
Dry Beans	10290
Winter Wheat	10080
Potatoes	5060
Pop or Orn Corn	4380
Pumpkins	1230
Rye	60
Sorghum	60
Barley	50
Other Hay/Non-Alfalfa	30
Oats	10

As with most large-scale agriculture enterprises, there are environmental and economic impacts tied with the operation of NAPI-NIIP. In terms of water use, water designated for the irrigated croplands is supplied directly from NIIP, which can currently transport around 206,000 acre-feet per year with the potential to transport up to 508,000 acre-feet per year when completed (NDWR 2014). Fertilizer and pesticide use, selenium leaching, drainage, erosion, and sedimentation are major concerns for NAPI lands. NAPI-NIIP has been working with Navajo EPA to develop monitoring and remediation projects to address potential negative impacts from runoff or discharge related to the irrigation system (Trujillo 2006).

Several of the target weed species are currently found on the NAPI agricultural lands. In total, approximately 1,340 acres of the surrounding rangelands are currently infested with species including salt cedar, Canada thistle, knapweeds, musk thistle, and perennial pepperweed. While weeds currently impact a small portion of the land managed by NAPI-NIIP, these weeds can spread quickly reducing forage value and wildlife habitat quality. Their presence also creates the potential for weeds to start infesting active agricultural fields, where they can alter field productivity and overall crop yields. Lastly, with how tightly water is managed for this agricultural operation, weeds represent a major factor that could alter water use for the site. To manage and control the spread of these weeds, NAPI-NIIP makes a NAPI-NIIP has been working on cooperation with the BIA Northern Navajo Agency, NRCS, and the New Mexico Agricultural Extension Agency to address weed management in the area. Noxious weed species impact the overall agricultural productivity of active agricultural operations and decreases the value of non-operational areas for a variety of services such as for animal forage and wildlife habitat.

While a majority of the lands operated by NAPI are actively managed, the 30,000-40,000 acres not currently developed are also colonized by many of the target weed species. These areas are also adjacent to BLM lands managed by the Farmington Field Office, where an active vegetation management is implemented. Many of the weeds on these fallow NAPI fields pose an increased risk for BLM managers who are unable to address weed management for infestations that occur along their borders with tribal trust lands.

3.7 Public Health

3.7.1 Background

Widespread noxious weed invasive and their management do pose some risks to public health. Many weed species are known to cause allergic reactions in some individuals, which can manifest as hay fever, hives, itchy eyes and throat, or swelling. Other species produce harmful substances that can irritate the skin when encountered. For example, leafy spurge produces a latex substance that can irritate the skin and can range in severity from minor itching to severe burns (Modi et al 2009). The degree to which an individual person negatively reacts to a plant varies widely. Some people may have no reaction at all to the plant. Others may only have reactions when in direct contact, such as when they pull a weed or touch the parts of a plant where the allergen is present. Others may be especially sensitive to the allergen or plant and may experience a reaction when they are nearby to the plant in question. In such individuals, the risks for negative reactions can be greater as their allergic response can vary greatly and may even include the risk of anaphylacsis, which can result in death if not treated immediately. Thus, while some noxious weeds may not pose a significant risk to most of the general populations, there are individuals that can have severely negative reactions to some species, which raises concerns.

Additionally, the management of noxious weeds can also pose some health risks to the general public and to those actively engaged in their treatments. Some treatment methods, such as mechanical removal, can increase the presence of dust in and near treatment areas. This could aggravate respiratory conditions for some people. Other individuals may have allergies to livestock that may be considered for use during cultural treatments that use targeted grazing. For those implementing the treatments, the use of mechanical tools or equipment can increase the risk of personal injury if the tools are not used properly or with caution. Pulling weeds can cause skin irritations or allergic reactions in some individuals. However, the treatment methods that have the potential to affect the most people are those that utilize chemical herbicides to treat weed populations.

Use of herbicides and other pesticides on the Navajo Nation has increased steadily over the past 20 years in an effort to control weeds and other unwanted pests from impacting roads, rights of way, homes, farm land, and range land. How much of an increase is hard to quantify as many pesticides sold to the general public are not restricted and thus to do not carry the same reporting requirements that professional pesticide applications may carry. Herbicides, such as Round-Up® (glyphosate), Weed-be-Gone® (2,4-D), Spectricide (dicamba, fluazifop-p-butyl, diquat), and Trimec® (2,4-D, mecoprop-p, and dicamba) are regularly sold over-the-counter without any means for tribes, states, or the federal government to determine how much is purchased or used and where it is being applied. While most land management agencies require the use of herbicide to be reported under FIFRA, use of these chemicals by private land users or other land

managers can not be accounted for in BIA records. Such undocumented use increases the risk of exposure for the general public.

3.7.2 Public Health Concerns

People can have various responses to chemicals. Felsot (2001) noted that there is a portion of the population that is hypersensitive and/or allergic to any one or more of a variety of substances. Allergic and hypersensitive reactions occur by a different mechanism than toxicity. An allergic reaction is the system overproducing antibodies to a specific foreign substance, which are often proteins. In the case of toxicity, it is the chemical itself that is affecting the body. Hypersensitive responses are unusual non-toxic overreactions likely associated with irritations to certain tissues in the nose or skin. Typical allergic or hypersensitive symptoms include a runny nose, watery eyes, swelling, and/or hives (Felsot 2001).

Toxic reactions result when chemical doses become high enough to interfere with the normal physiological functions of cells and tissues (Felsot 2001). The toxicity of a chemical is related to the dose needed to result in damage or negative reactions to that chemical. For some organisms or chemical, only small doses or concentrations are needed to result in damage, while for other chemicals toxic effects are only observed when large concentration of a chemical are experienced. Thus, toxicity varies between chemical concentrations. In terms of allergic or hypersensitive reations, what may have no apparent effect on one person may have grave consequences for another person, even in small quantities. For some people, their liver or kidneys have less capacity to eliminate toxins, either because of genetics or injury. Some peoples' neurological or immune systems are especially susceptible (Munson 2004). Chemical sensitivity is defined as an adverse reaction to ambient doses of toxic chemicals, at levels that are generally accepted as sub-toxic, in our air, food, and water (Rea 1994).

Populations recognized as being particularly susceptibility to the toxic effects of herbicides include (Munson 2004):

- Infants, children, and fetuses, whose developing brains, nervous and immune systems are subject to developmental disabilities caused by herbicides, and whose detoxification systems are not fully developed, according to the U.S. National Research Council;
- People with respiratory conditions such as asthma, emphysema, reactive airways disease, or lung damage (such as from pneumonia, valley fever, lung cancer, or injury);
- People with certain neurological conditions such as Parkinson's and Parkinsonism, epilepsy, and other neurological conditions;
- People with liver function impairments, such as porphyria and porphyrinopathies, including those that are chemically induced; hepatitis; cirrhosis, low levels of liver enzymes, or other dysfunction of the detoxification pathways due to genetics, liver damage, or use of certain prescription medications;

- People with kidney function impairments (e.g. dialysis patients);
- People with heart problems;
- Those with impaired or suppressed immune systems (e.g., people receiving cancer chemotherapy, transplant patients, those with HIV/AIDS, autoimmune disorders, and other immune imbalances);
- People with multiple chemical sensitivity (MCS) (Calabrese 1978);
- Native Americans who have a greater chance of developing chemical sensitivities (Voorhees 1999)
- Pesticide applicators, farm workers, and landscape workers;
- People who are homeless; and
- People on some medications that may interact with herbicides, or which may reduce the person's ability to eliminate toxins.

Risk factors range from sex, phase of life, and genetic predisposition to disease and organ system damage or impairment. Some vulnerabilities are temporary, and others are permanent. The degree to which the use of chemicals will affect public health depends on how prevalent such risk factors occur within the general population on the Navajo Nation.

Based on 2010 U.S. Census data, children account of 37.4 percent of all tribal members and the elderly 9.5 percent on the Navajo Nation. The birth rate on the Navajo Nation (2.1%) is also significantly higher than the rest of the United States (1.5%) (IHS 2008). Rates of incidence are higher for the Navajo population than the general U.S. population for health concerns including deaths from diabetes, cervical cancer, alcohol related diseases, tuberculosis, pneumonia/influenza, and teen birthrates (**Table 3-19**) (NDOH 2004).

Table 3-19. Statistics on major health concerns for the Navajo Nation as reported by Indian Health Services (2008) and the Navajo Department of Health (2004).

Cause of Death	Navajo Nation Rate	U.S. Rate
Heart Disease	103.2	130.5
Diabetes	35.6	13.5
Cervical Cancer	4.6	2.5
Breast Cancer	11.5	19.4
Alcohol-related	49.8	6.3
Tuberculosis	2.4	0.3
Pneumonia/Influenza	30.8	12.9

Health impacts from abandoned uranium mining operations are also a major public health concern for many on the Navajo Nation. Navajo miners and residents in nearby communities have experienced increases in lung cancer, bone cancer, and impaired kidney function as a result of exposure (USEPA 2013). These impacts are largely due to a lack of adequate reclamation of abandoned sites, allowing radioactive materials to continue to contaminate the soil, water, and air

of affected communities. There is potential for such communities to be more sensitive to other health-related impacts from land management activities, such as weed treatments. Currently, the rate of chemical sensitivity is unknown among Native American populations, and specifically among the Navajo population.

Potential reactions to herbicide exposure include allergic reactions, dizziness, cardiovascular irregularities, flu-like symptoms, asthma, chronic exhaustion, headaches, mental confusion, and seizures (Felsot 2001, AZTAP 1996). Such reactions can also be the result of exposure to substances such as antibiotics, cleaning supplies, natural gas, paint and new building materials. Currently, there is no way to test for or treat people who suffer from chemical sensitivities as the actual mechanisms that cause the reactions are unknown. Most people who suffer from it manage their potential risk by preventing exposures. This includes living in communities that are not impacted to a great degree by chemical use and living in specially built homes.

3.7.3 Access to Vital Services

Individuals with compromised health from chemical exposure may have a difficult time accessing vital services due to the remote nature of many communities on the Navajo Nation. This is mostly like the case where herbicides are used to treat weeds near riparian corridor or along some roads and rights-of-way. Reactions to herbicides can be reduced by either avoiding treatment areas or implementing non-chemical treatment methods.

It is estimated that just over 170,000 Navajo people live on the Navajo Nation (USCB 2010). With a landbase of over 17 million acres, the population density of the Navajo Nation is less than 7 people per square mile. The Indian Health Service currently manages 6 hospitals, 7 healthcare centers, and 15 health stations on the Navajo Nation (**Figure 3-15**, IHS 2014). Additional health facilities are also located off the Navajo Nation in Flagstaff, Arizona, Albuquerque, New Mexico, on the Hopi Indian Reservation, and near Blanding, Utah. These statistics indicate that many that live on the Navajo Nation may not live in close proximity to medical care or communities with additional public services. This would require many to drive or walk long distances if a medical emergency were to arise.

People with chemical sensistivies may be are concerned about existing or proposed herbicide treatments along roads and in remote locations because 1) people with chemical sensitivities would not be able to access vital services like medical facilities or shopping areas and 2) the ability of these individuals to use or travel into priority areas would be severely curtailed. **Table 3-20** lists the acres of weed infestations based on current mapping data from the BIA. Many of the projects identified by BIA Weed Coordinators are those that occur in remote locations (i.e. lands used for farming or grazing, riparian areas, and roads). These indicate that the majority of the projects identified by the BIA for weed control may have the potential to affect those with chemical sensitivities that may live and/or work in remote locations. Navajos with chemical sensitivities may depend on activities such as grazing or farming for their livelihood. Such residents may be exposed to higher levels of chemicals than those living further away.

Land managers and federal agencies are concerned about the treatment of weeds along Federal and State routes and tribal roads because they serve as conduits for the dispersal of many weed species (Roche and Roche 1999). Weed seeds and plant parts are moved along road systems by vehicles and people, allowing the establishment of plants into previous uninfested areas (Gelbard and Belnap 2003, USFS 1998).

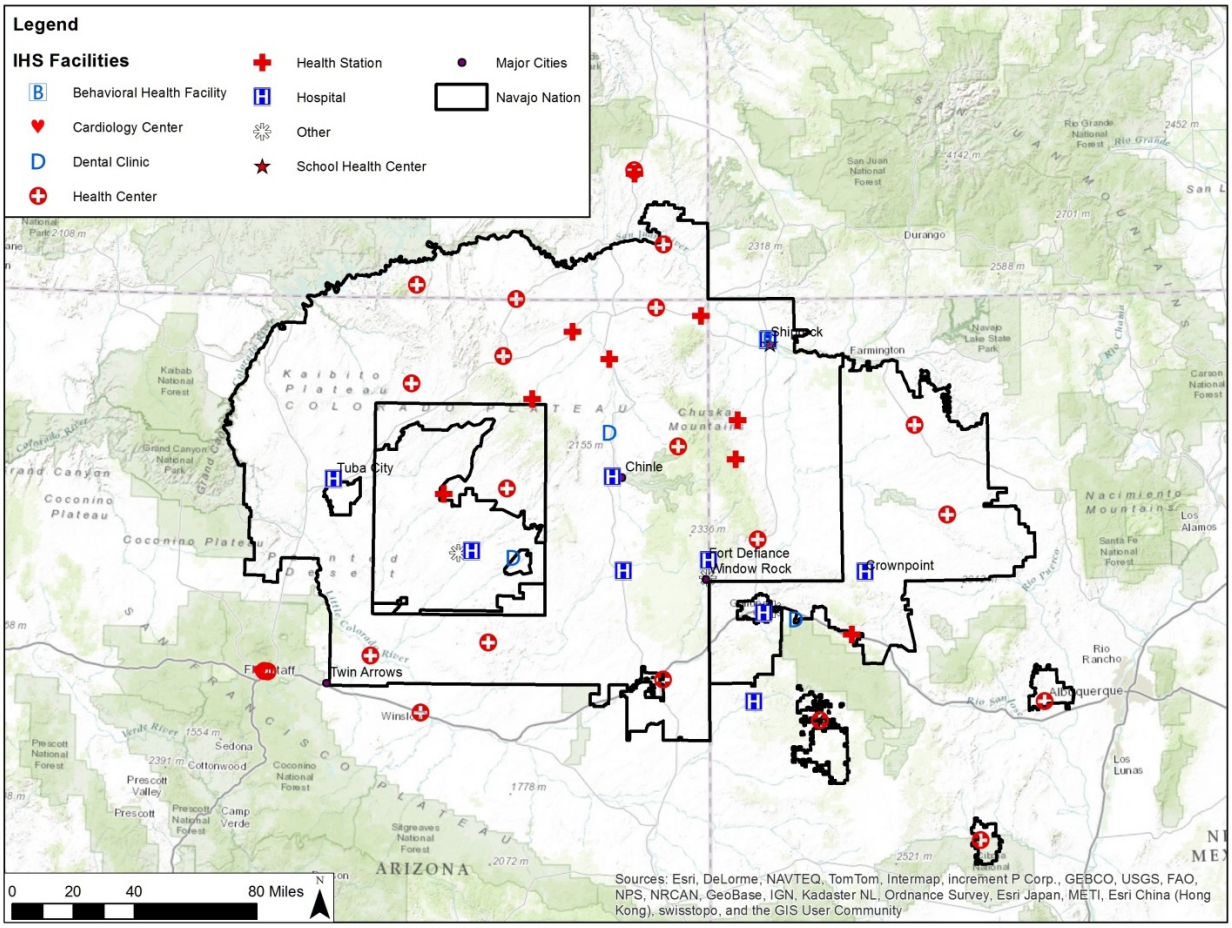

Figure 3-15. Health care facilities operated on or near the Navajo Nation as recorded by Navajo Area Indian Health Service (2014).

Table 3-20. Acres of weeds identified for treatment and through current weed mapping efforts by BIA Navajo Regional Office Weed Coordinators. These numbers are limited only to weeds mapped for projects planned by the BIA and do not represent the full extent of weed infestations on the Navajo Nation. The Project Acres are estimated from Demonstration Site data identified in the Integrated Weed Plan. Some areas still need weed acres mapped as part of the site-specific planning needs. Other areas have had their weeds mapped but have not been identified for treatment as of the writing of this document.

Priority Type	Project Acres Identified	Mapped Weeds (ac)
Agriculture (Rangeland and Farmland)	84,086.79	9,113.41
Riparian	7,157.88	12,868.62
Roads	650	331.0
Community Development Areas	11,046	203
Rights of Way	N/A	N/A

3.8 Socioeconomics

The Navajo Nation is the largest tribal population within the United States with just over 173,000 people living within the area. Major economic industries on the Navajo Nation are service-based jobs, government, tourism, and retail. Internal sources of income include royalties and profits from mining operations and income from various taxes. The Navajo Nation also receives external income from federal, state, and private grants to support many services provided to the Navajo people. While employment on the Navajo Nation has remained steady for the past 10 years (NDED 2010), high unemployment (above 20%) is also fairly steady (AZFTF 2010). Major employers include the Navajo Nation tribal government, private mining companies operating on the Navajo Nation, federal government agencies (i.e. BIA, IHS, etc.), and Navajo private industries (i.e. NTUA, NAPI, etc).

3.8.1 Employment and Income

The Navajo Division of Economic Development (NDED) attributes many of the economic issues found on the Navajo Nation to high unemployment rates, lack of employment opportunities, lack of infrastructure such as roads and economic development centers, and low levels of education (NDED 2010). Measures of the economic status of residents of the Navajo Nation include household income, per capita income, poverty rates, and unemployment rates. The median household income for the Navajo Nation ($27,389) is roughly half that of the US as a whole ($53, 046) (AZRPI 2012; USCB 2014). Similarly, per capita income for the Navajo Nation ($10,695) is less than half the per capita income of the US as a whole ($28, 051) (AZRPI 2012; USCB 2014). The poverty rate for the Navajo Nation is 38%, more than twice that of the US and Arizona (15%), with more than one-third (38%) of Navajo Nation tribal members are classified as severely poor (AZRPI 2012, USCB 2014). The unemployment rate is high for the Navajo Nation compared to the US as a whole, pointing to the lack of employment opportunities on the Navajo Nation. The most recent unemployment rate (2012) for the Navajo Nation is 44.25% (Beatrice Watchman, NDED, pers. comm. June 17th, 2014). The average unemployment rate for the US in 2012, by comparison, was 8.1%.

The American Community Survey 2006 -2010 five-year estimate provides percentages for various industry sectors within the Navajo Nation (**Table 3-21**). The top five industries on the Navajo Nation are 1) education, health care, and social assistance; 2) construction; 3) public administration; 4) tourism; and 5) retail (USCB 2012). According to the NDED (2010), the largest sector of the Navajo Nation economy is the service sector, including schools, hospital, and lodging, which has 272 employers (33.3% of all the employers in the Navajo Nation). In recent years, the Navajo Nation has also developed several casinos to provide additional revenue. Navajo Nation Gaming Enterprises (NNGE) currently manage four properties: Fire Rock, Twin Arrows, Flowing Water, and Northern Edge. Since 2004, NNGE has created over 1,300 jobs with additional plans to expand amenities on their current properties (Landry 2013).

Table 3-21. American Community Survey Statistics for 2006-2010 for Employment Industries within the Navajo Nation (USCB 2012).

Industry Sector	Persons Employed	Industry Percentage
Civilian employed population 16 years and over	44,757	NA
Agriculture, forestry, fishing and hunting, and mining	1,847	4.1%
Construction	5,021	11.2%
Manufacturing	1,803	4.0%
Wholesale trade	472	1.1%
Retail trade	4,449	9.9%
Transportation and warehousing, and utilities	2,428	5.4%
Information	243	0.5%
Finance and insurance, and real estate and rental and leasing	933	2.1%
Professional, scientific, and management, and administrative and waste management services	908	2.0%
Educational services, and health care and social assistance	16,189	36.2%
Arts, entertainment, and recreation, and accommodation and food services	4,472	10.0%
Other services, except public administration	1,272	2.8%
Public administration	4,720	10.5%

The government sector, including all Chapter houses and Navajo government offices, had the second largest number of employers at 236 (28.9% of all the employers in the Navajo Nation). Some of the largest employers in the private sector include Four Corners Power Plant, Frontier Communications Corporation, Navajo Generating Station, Navajo Mine, Peabody Energy Mines, Pittsburg & Midway Coal Mining Co., Raytheon Missile Systems, and Tooh Dineh Industries (NDED 2010). In addition to private industry, there are 13 tribally owned enterprises that employ people on the Nation; some of these include Diné Power Authority, Navajo Arts and Crafts Enterprise, Navajo Agricultural Products Industries (NAPI), Navajo Broadcast Enterprise, and Navajo Housing Authority (NDED 2010).

The NDED (2010) states that "Federal, state, private and other funds, mostly in the form of grants are the primary external sources of revenues on the Navajo Nation. Weed management activities would likely draw from these sources of funding and could potentially provide much needed additional employment opportunities for tribal members.

From 2005 through 2015, the BIA Noxious Weed Program has provided over $5.5 million in funding for weed projects on the Navajo Nation for direct project costs. BIA Funds for weed projects are used to help pay for equipment, staff, materials (such as herbicide), contractors, and administrative costs. Estimates for the total cost of weed projects, however, are hard to determine as in-kind matches in the form of donations or services from cooperators and land users are often estimated. The division of costs for a given project largely depends on the size of the project area, the methods employed, and the timeline for the project. Matching funds for projects, such as in-kind services, have come from the land user, non-profit organizations, or grant funding from federal, state, tribal, or other local sources. In-kind services include donated

time from land users, volunteers, Navajo Nation tribal agencies, other federal agencies, provision of supplies for project implementation, and development of tribal support for projects are included for projects.

3.8.2 Demographic Profile

The information in this section relies heavily of the "Demographic Analysis of the Navajo Nation Using 2010 Census and 2010 American Community Survey Estimates" report prepared by the Arizona Rural Policy Institute (AZRPI) in 2012. The statistics reported in the following paragraphs were calculated using the most recent data available through the 2010 Census and the 2010 American Community Survey. The Navajo Nation experienced a 3.9% decrease in population between the 2000 and 2010 census, decreasing from a total population of 180,462 in 2000 to 173,667 in 2010. Gender distribution remains relatively equal across the Nation with females representing 50.9% of the population and males representing 49.1%. In terms of age structure, a large proportion (33%) of the population is under 18 years of age. Older individuals, those over the age of 65, account for 10% of the population, while those aged 18 to 65 accounts for 57% of the population. The median age for individuals in the Navajo Nation is 28.5 years old. This age structure has implications for the available work force and the poverty level in Navajo Country; principally, a large proportion of the population remains too young to earn income, but may bring economic gains in the future. It is not surprising that the Navajo Nation reports 96% of its population as American Indian or Alaskan Native, while 2% identifies as white and the remaining 2% identifies as "more than one race."

3.8.3 Lifestyle and Cultural Values

The Navajo Nation is the largest population of any American Indian group and occupies the largest reservation in the United States-one of the few that made up of ancestral lands. The Navajo lifestyle and Navajo cultural values maintain close connections to the landscape through herding, farming, and religious and cultural traditions. Because of this close connection to the landscape, the Navajo lifestyle and culture can be impacted by noxious weeds.

Herding and farming remain important practices to many Navajo families. Traditionally, different types of agriculture were adopted across the Navajo homeland. Many families continue to raise sheep, goats, horses, cattle, and llamas in customary use areas that were used by their families for generations on the Navajo Nation. Family farms are also wide-spread with over 10,000 Navajo and Hopi farmers and 500 native-operated farms across the two reservations (Yurth 2009). In addition to family-based agricultural activities, the Navajo Agricultural Products Industry located near Farmington, NM also generates over $30 million annually. Agricultural weeds cause considerable damage to crops, reducing yields for both subsistence and industrial farms.

3.8.4 Community Infrastructure

3.8.4.1 Utilities

Utilities on the Navajo Nation are mainly managed and operated by the Navajo Tribal Utility Authority (NTUA) with technical assistance from Indian Health Service Navajo Area. NTUA is responsible to supplying electricity, natural gas, water, and waste water treatment services to residents and business on the Navajo Nation. To provide services, NTUA is responsible for installing and maintaining transmission lines, which includes lines above and below ground. Gas, water, wastewater, and some electricity transmission lines do require underground installations. The Authority is divided into 5 districts with offices located in Shiprock, NM, Crownpoint, NM, Nageezi, NM, Kayenta, AZ, Red Mesa, AZ, Tuba City, AZ, Dilkon, AZ, Chinle, AZ, and their main headquarters in Fort Defiance, AZ.

Table 3-22. Estimated miles of service lines managed by Navajo Tribal Utility Authority on the Navajo Nation. Source: personal communication with Delbert Smith, NTUA.

Utility	Subtype	Miles
Electricity	Primary Overhead Lines	7385.7
	Secondary Overhead Lines	11308.5
	Primary Underground Lines	58.8
	Secondary Underground Lines	30.9
Gas	Main Lines	451.2
	Service Lines	94
Water	Main Lines	6102.1
	Service Lines	478.7
Sewer	Main Lines	353.7
	Service Lines	0.6

To provide electricity to customers, NTUA purchases resources from the Colorado River Storage Project (CRSP), Western Area Power Administration (Western), the Tucson Electric Power Company (TEP), Rocky Mountain Power, and Continental Divide Electric Cooperative, Inc., (CDEC). To assist in the transmission of power and energy, NTUA has agreements with Western, Public Service Company of New Mexico (PNM), Arizona Public Service Company (APS), and TEP to deliver power to a variety of substations on the Navajo Nation. Once delivered, power and energy are distributed to customers to facilities owned and operated by NTUA (**Table 3-22**). Primary lines deliver power to communities, while secondary and underground lines deliver services to individual residences and businesses. In addition to providing services to members of the Navajo Nation, NTUA also has agreements with 13 neighboring tribes to supply power and electricity as part of the Firm Electric Services Contract with Western (NTUA 2012). While Navajo EPA and Navajo Water Management Branch are responsible for monitoring water sources and water quality for a variety of uses. Installation and management of water lines is the responsibility of Indian Health Services, with NTUA contracted to construct and install lines on the Navajo Nation. IHS manages the lines which provide drinking water and remove and treat wastewater from residences and businesses. They also perform annual testing of their water systems for each of their districts. This includes testing of water storage areas, treatment facilities, and transmission lines.

Even though NTUA is the main utility provider for the Navajo Nation, other utility companies also maintain and manage utility resources in the region. Other companies such as APS and PNM do not provide utility services on the Navajo Nation, but they do maintain service lines that run through the area. These lines are often used to transmit power from generating stations to their main service areas.

3.8.4.2 Transportation Networks

Transportation on the Navajo Nation is managed by several different agencies (**Table 3-23**). Roads provide the main routes for travel by car, bus, or foot. Maintenance of roadways across the Navajo Nation is the responsibility of several state, federal, and tribal agencies. Arizona, New Mexico, and Utah Departments of Transportation manage and maintain state and federal roads found on the Navajo Nation, including U.S. highways and Interstates. The BIA maintains a network of roads on the Navajo Nation as part of the Tribal Transportation Program. Under this program, the BIA operates and maintains a network of roads to provide tribal members with access to medical, educational, commercial, and recreational services and opportunities (25 CFR 170). The BIA Roads Maintenance Program is responsible to maintain, repair, and restore roads, which includes weed control and pavement maintenance. Additionally, the Navajo Division of Transportation's Department of Roads maintain roadways in the region in cooperation with the BIA and county road programs. Many of the roads maintained under NDOT's program provide access for communities, businesses, tribal government, and rural areas to larger roadways. Many of the roads managed by NDOT are unpaved and dirt roads. Their roads program is part of the Navajo Indian Reservation Roads Program, which is funded by the Navajo Nation General Fund, the Nation's Fuel Excise Tax, and through funding provided by the BIA.

Table 3-23. Roads included on the Navajo Nation Indian Reservation Road System as determined by the 2008 Navajo Road Inventory (NDOT 2009). The inventory was done as part of the long-range term planning for transportation on the Navajo Nation.

Agency	BIA	Tribal	State	County	Other BIA	Other Fed	Other	Agency Total
New Lands	86.7	0.0	89.3	0.0	0.0	0.0	0.0	176.0
Northern	1209.8	558.3	225.7	276.0	2.6	0.0	0.0	2272.4
Western	1446.0	731.5	529.4	242.1	23.3	2.0	0.8	2975.1
Eastern	666.0	197.3	413.2	795.2	0.0	16.3	0.0	2088.0
Chinle	1028.0	372.6	60.8	306.9	11.3	18.8	0.0	1798.4
Ft. Defiance	1405.0	1036.0	261.9	264.9	9.7	0.1	0.0	2997.6
NIIP	306.4	0.0	15.2	22.4	0.0	0.0	0.0	344.0
TOTAL	**6147.9**	**2895.7**	**1595.5**	**1907.5**	**46.9**	**37.2**	**0.8**	**12631.5**

All roads on the Navajo Nation have a specified right-of-way associated with them that the managing agency is responsible for maintaining. The width of the right-of-way is determined by the type of road (e.g. one lane, multiple lane, paved, unpaved, etc.). Right-of-way maintenance includes management of weeds. Roads represent one of the major vectors for weed introductions

as seeds and plant parts can attach to vehicles and traffic can create microclimates where air movement can facilitate pollination and seed spread. Because members of the Navajo Nation often travel great distances for everything, roads can facilitate the spread of weeds between remote communities.

Air transportation also occurs on the Navajo Nation with the tribe owning and maintaining a number of airports on the Navajo Nation (**Figure 3-16**). The main airports are managed through the Navajo Department of Transportation by tribal, state, and federal funds. These primary airports include the Chinle Municipal Airport, Kayenta Airport, Tuba City Airport, Window Rock Airport, Crownpoint Airport, Shiprock Airstrip, Oljatoah Airstrip and the Ganado Airport. The airports are used for medical emergencies and tribal business with occasional use by tourists and aviation enthusiasts (Armstrong Consultants 2014). The Window Rock Airport is currently operated by the Navajo Nation Air Transportation Services under the Division of General Services, which charters flights for the Navajo Nation President and other tribal officials. Kayenta Airport is operated and administered by the Kayenta Township. All other airports are operated by the Navajo DOT's Department of Airport Maintenance with some funding from BIA DOT for emergency maintenance.

In addition to the primary airports, the Navajo Nation airport system includes 32 secondary airports (NDOT 2009). These consist of unpaved/dirt runways that do not have associated support facilities. Many are closed or in poor condition and are used for medical emergencies and emergency landings only (Armstrong Consultants 2014). There are also four privately owned and maintained airports on the Navajo Nation, which consist of Goulding's Airport, Thoreau Airport, Klagetoh Airport, and Black Mesa Airport.

Airports on the Navajo Nation are maintained for weeds. Heavy winds from air traffic can facilitate the pollination and spread of weeds. In rural areas where runways may only be a strip of cleared land, weeds can invade and quickly establish if regular maintenance is not performed. Camelthorn, for example, has been known to grow opportunistically in cracks in pavement, further degrading them. Spread of weeds along runways can degrade their quality for landings and take-offs, as weeds create additional obstacles. Some weed species, which grow in thick and tall clusters and clumps, can obstruct signs and information on the ground.

The Navajo Transit System (NTS) provides public transportation services on the Navajo Navajo to 57 of the 110 Chapters. Transportation is provided through an intercity bus service on seven fixed routes between major Navajo growth centers and border towns. They also operate the Flagstaff-Tuba City commuter route for weekday commuters and connections to the Hopi Transit System, Greyhound Busline, Amtrak Passenger Trains, Gallup Transit Express, Red Apple Transit, and the Flagstaff Mountain Line.

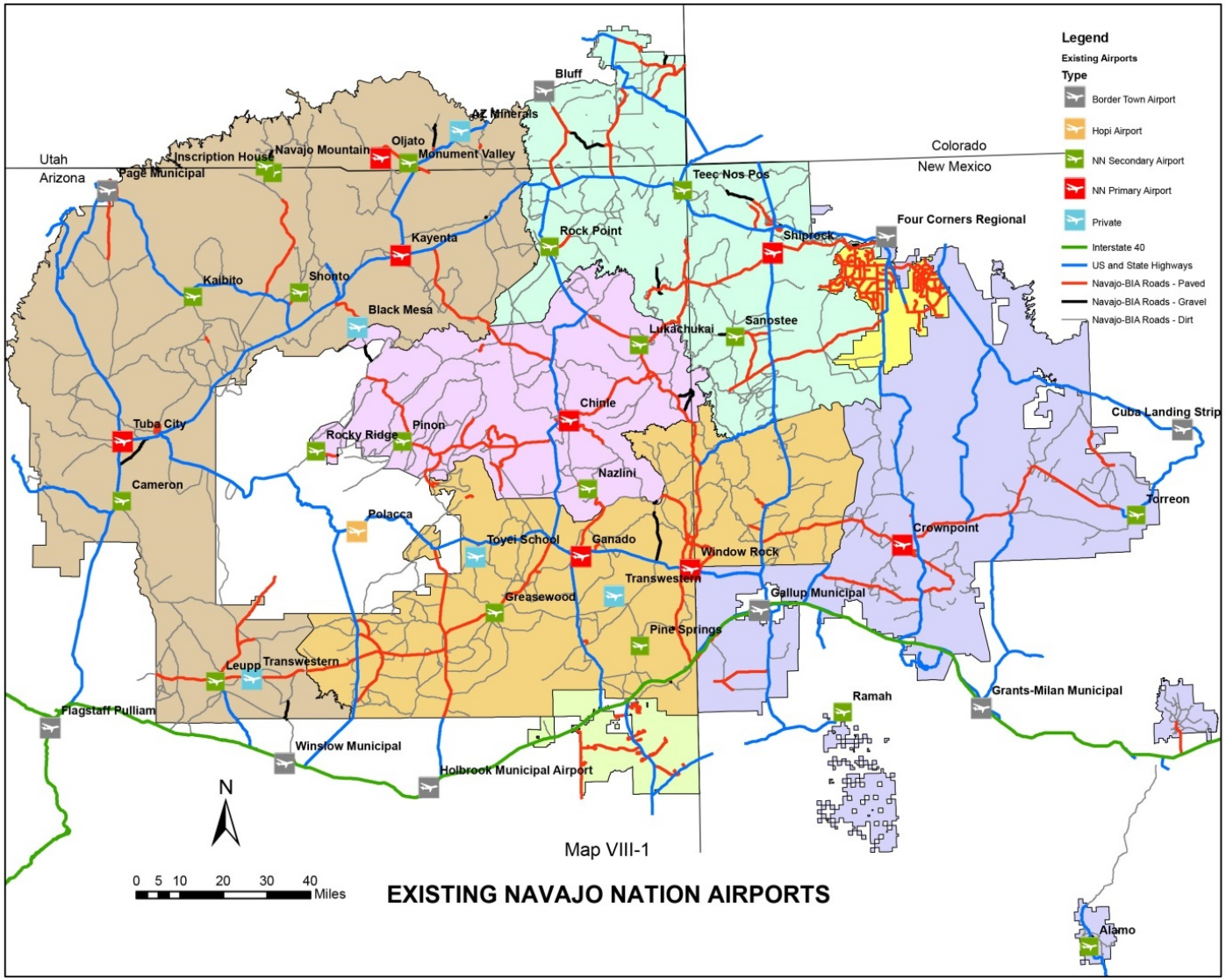

Figure 3-16. Map showing airports on the Navajo Nation. Map courtesy of Navajo Department of Transportation 2009 Long Range Transportation Plan.

Three major railroad companies have railroad lines that run across the Navajo Nation and include the Burlington Northern Santa Fe Railroad (BNSF), the Black Mesa and Lake Powell Railroad (BLKM), and Amtrak Passenger Rail Service. The BNSF railway runs from Los Angeles, CA to Chicago, IL and crosses northern Arizona and New Mexico, where it runs through the southern portion of the Navajo Nation through the New Lands and Church Rock (NM) Chapters and the checkerboard area of the Eastern Navajo Agency. BNSF operates a freight rail services along its railway, which is estimated to transport around 275,000 tons by 2015 (NDOT 2009). Amtrak provides passenger rail services along the BNSF railway with stations in Gallup, New Mexico and Winslow and Flagstaff, Arizona. The BLKM railway operates in the western portion of the Navajo Nation and is used to transport coal from strip mines on Black Mesa to the Salt River Project Navajo Generating Station near Page, Arizona. Since it is unconnected to other railways, it is currently only used for hauling coal, although there are tribal plans to potentially expand the railway to New Lands to help with economic development of the area.

Rights of way associated with railway lines pose an additional area where weeds may be introduced or established. Railroads serve as another vector for the spread and establishment of noxious weed species. The standard right-of-way for railway lines are set at 100 ft on most public land, but authorization for the right-of-way is still granted by the BIA, which may adjust the size of the railway right-of-way depending on the use (25 CFR 169). BNSF currently has a vegetation control plan which requires the removal of vegetation along rail. The BNSF Program is done in coordination with state and county officials using an integrated system to address weeds covered by state requirements. Weed control along railways is important to maintain safety, rail bed quality, and prevent fires (Nyberg 2001).

3.9 Cultural Resources

More than 11,000 years of human existence are represented in the area encompassed by the Navajo Nation. Archaeologists generally divide the cultural history of the area (and the greater American Southwest) into five major periods: Paleoindian, Archaic, Formative, Protohistoric, and Historic.

3.9.1 Paleoindian and Archaic

Paleoindian – Paleoindian peoples (9500 B.C.) are recognized as the earliest inhabitants of the Four Corners Area. It is believed that these groups were extremely mobile and relied heavily on hunting the megafauna that existed in the Pleistocene epoch. This subsistence strategy was complimented by limited gathering. The Paleoindian period is marked by different cultural complexes distinguished by projectile point styles and technologies that are associated with different fauna (e.g., Clovis and Folsom).

Archaic – The Paleoindian period was followed by the Archaic period, which extended from approximately 6000 B.C. to roughly 500 B.C. at which time the adoption of maize-based agriculture was beginning to be significantly embraced (Smiley and Parry 1990; Wills 1988). The transition to agriculture, which probably began by 1000 B.C., undoubtedly overlaps to some

extent with the continuation of hunter-gatherer lifeways in some areas. The Archaic is subdivided to the Early (ca. 6000–5000 B.C.), Middle (5000–2000 B.C.), and Late (2000–500 B.C.) periods. This sequence appears to reflect large-scale patterns seen throughout the American West that are evident in material culture and projectile point types (Huckell 1996). There was a shift from hunting large game animals to a more varied hunting and gathering lifestyle that focused more on smaller game and floral resources than did Paleoindian groups. Agricultural practices entered into the subsistence mix during the Late Archaic. Archaic populations were more sedentary than the preceding Paleoindians, but they were still fairly mobile. Many appear to have moved on a seasonal basis, utilizing the resources of different environmental zones as they became available and reoccupying structures and sites they had inhabited before (Huckell 1996).

Early Agricultural Period – Southwestern archaeologists have traditionally used the presence of cultigens as the introduction of agriculture, marking the end of the Archaic period and the beginning of the Formative period. Work over the past 20 years (e.g., Huckell 1996), however, has increasingly demonstrated that substantial integration of agriculture into the foraging economies of the Archaic occurred 3,000 to 3,500 years ago. Therefore, the end of the Archaic and the beginning of the Formative can be difficult to clearly establish. Consequently, this transitional period is sometimes referred to as the Early Agricultural period (Bungart et al. 2004). Although the timing of this transition varied in different geographic areas, the Early Agricultural period broadly dates from around 1000 B.C. to as late as A.D. 500 in some locales. For example, maize has been found on Carrizo Wash in west-central New Mexico dating to as early as 2000 B.C. (Huber and Miljour 2004) and in the Chinle Valley and on Black Mesa dating to as early as 1000 B.C. (Gilpin 1994, Smiley 1994).

The Early Agricultural period demarcates the period during which domesticates were first used and marks the beginning of a transition from hunting and gathering to corn and squash cultivation. The transition to agriculture marks an important shift toward increased sedentism, reduced mobility, population growth, and greater population density. Increased sedentism resulted in relatively substantial houses, numerous storage facilities, and denser trash accumulations. Accordingly, archaeological sites of this period are generally more visible and of a different character than those of the Archaic (Bungart et al. 2004).

3.9.2 Formative

The Formative era is characterized by substantial reliance on maize horticulture and other domesticated crops, a transition to settled village life with construction of permanent dwellings, and later, ceramic pottery production. The Formative era peoples in and around the Navajo Nation are commonly referred to as the Anasazi. Researches have recognized geographic differences in the development and adoption of their Formative traditions, particularly the later periods. Consequently, several different cultural-temporal sequences have been utilized to study

the Formative era across the northern Southwest and the Navajo Nation. The sequence presented here is a more generalized chronology based on the Pecos Classification (Kidder 1927).

Basketmaker II – The Basketmaker tradition was named for its finely woven baskets and lack of pottery. The Basketmaker II period is characterized by the adoption of shallow pit structures for habitation and pits (often bell-shaped) or cists for storage of surplus foods. The atlatl and darts are the primary projectile technology, and corn and squash are the main domesticated crops. Basketmaker II sites, often small dispersed hamlets, roughly date from the first couple centuries A.D. to about A.D. 500.

Basketmaker III – The Basketmaker III period (approximately A.D. 500–750) marks the beginning of an even more sedentary agricultural lifestyle with the manufacture and use of ceramics (almost exclusively plainwares), the adoption of the bow and arrow, and the addition of beans to the list of cultigens. Site types include small villages.

Pueblo I – During the Pueblo I period (A.D. 700–900) there were large villages in some areas with occasional great kivas. Habitation sites are often "unit pueblos" consisting of subterranean circular/semi-circular structures accompanied by a roomblock of jacal or masonry surface rooms. Ceramics include both plain and neck-banded gray pottery with smaller quantities of black-on-white types and decorated redwares.

Pueblo II – The Pueblo II period (A.D. 900–1150) was marked by population expansion and habitation in surface masonry roomblocks. The Chacoan florescence occurred during this period with "Great Houses", great kivas, roads, etc. present in many (but not all) regions. Site types include both Great Houses and unit pueblo sites with notable differences between the two. Ceramics from this time period include corrugated grayware and elaborately decorated black-on-white pottery, plus decorated red or orange ceramics in some areas.

Pueblo III – Pueblo III period (A.D. 1150–1350) is marked by the presence of large pueblos in some areas with a more dispersed pattern in others, and high kiva to room ratios. Cliff dwellings and towers are indicative of this period in some regions. Ceramics include corrugated grayware and elaborately decorated black-on-white pottery, plus decorated red or orange ceramics in some areas. Large portions of the Four Corners region were abandoned by 1300 or shortly thereafter.

Pueblo IV – The Pueblo IV period (A.D. 1350–1600) overlaps with the start of the protohistoric period in some parts of the Southwest. Generally, the Pueblo IV period was a time of considerable change in the Four Corners region with shifts in populations, changes in cultures, and the spread of the kachina religion. Large plaza-oriented pueblos with low kiva to room ratios developed among the more sedentary populations in the western pueblo areas, whereas more mobile populations tended to reside in smaller and more dispersed habitations. Plain utility wares replaced corrugated utility pottery, and black-on-white pottery decline in frequency in relation to red, orange, and yellowwares.

3.9.3 Protohistoric

Navajo – The official position of the NNHPD is that the Navajo (Diné) "have been here since time immemorial" (NNHPD 2010). Many versions of Navajo oral history indicate that the first four Navajo clans arrived in the area known as the *Dinétah* (the ancestral Navajo heartland) after their migration from the western ocean after entering the Fourth World (Yazzie 1982) (although some versions state it is the Fifth World [Zolbrod 1984]). The core of the Dinétah region is regarded to be the Largo and Gobernador drainages south of the San Juan River in New Mexico. These canyons are located to the east and south of Farmington, New Mexico and include Blanco, Largo, Carrizo, and Gobernador canyons (Towner and Dean 1996). The oldest known definitive Navajo archaeological remains have been identified in this area (Towner and Dean 1996), with many radiocarbon dated samples from this region predating A.D. 1500 (Fetterman 1996).

Some interpretations of Navajo oral history place the arrival of the Navajo into the Dinétah sometime during the 1300s or earlier (Roessel 1983). Other interpretations suggest the forebearers of the Navajo arrived in the region much earlier (ca. A.D. 1000) and co-existed with the Anasazi (Brugge 1992), or that the Navajo are descendants of the earlier Archaic inhabitants of the region (Kelley and Francis 1994, 1998). Regardless, the Navajo Nation claims cultural affiliation with the Anasazi people (NNHPD 2010). From the Largo-Gobernador heartland area the Navajo spread out into the broader traditional Navajo homeland, the boundary of which is demarcated by four sacred mountains, each located in one of the cardinal directions around the region. The western sacred mountain is the San Francisco Peaks (known as Dook'o'oosłíid in Navajo, translated Abalone Shell Mountain) near Flagstaff, Arizona. The eastern is Blanca Peak (Sisnaajiní in Navajo, translated Dawn or White Shell Mountain) near Alamosa, Colorado. The northern is Mt. Hesperus (Dibé Ntsaa in Navajo, translated Big Mountain Sheep) near Durango, Colorado, and the southern mountain is Mt. Taylor (Tsoodził in Navajo, translated Blue Bead or Turquoise Mountain) at Grants, New Mexico.

Early Navajo sites are characterized by forked-stick hogans, log and brush structures, temporary brush structures, ramadas, lean-tos, windbreaks, sweatlodges, light ceramic (Dinetah Gray and a variety of Puebloan tradewares) and lithic artifact scatters, and hearths (Brown and Hancock 1992, Oakes 2007). At this time the Navajo were mobile bands of hunters and gatherers that alternated use of highland and lowland areas on a seasonal basis and practiced limited agriculture (Ayers 2008).

3.9.4 Historic

Although Europeans visited the Southwest in the early 1500s, many historians consider the region's Historic period (a time of written records) to have begun in 1598. This is when Don Juan de Oñate began the colonization of New Mexico in conjunction with a mission to convert the indigenous populations to Christianity.

Early Historic period Navajo sites are similar to those utilized earlier, but a new architectural style/site type began to be used: defensively situated masonry pueblitos (Oakes 2007). Whitson

(2009) states that axe-cut trees dating to this time period are fairly common, but artifacts are generally sparse at most sites. Gobernador Polychrome has been identified on sites dating to circa A.D. 1625–1640 (Reed and Reed 1996), and serve as a good indicator of early historic period Navajo sites. In addition to Gobernador Polychrome, ceramics include Dinetah Gray and a variety of imported wares such as Rio Grande Glaze Ware, Jemez Black-on-white, Jeddito Yellow Ware, Jeddito Black-on-yellow, and Sikiatki Polychrome. Other artifacts include European trade goods, bone and shell ornaments, and wood items. The early historic period is also marked by the introduction of domesticated animals such as sheep, goats, and horse (Oakes 2007), and the appearance of masked dancers and kachina-like figures on Navajo rock art. Agriculture appears to have been the primary subsistence base supplemented with small-scale sheep and goat herding (Ayers 2008).

Navajo traditional history, historical documentation, and archaeological research show that Navajos were living in the region west of the Chuska Mountains (located near the present-day Arizona and New Mexico border) at least as early as the late A.D. 1600s. However, current archaeological knowledge of early Navajo use of the region west of the Chuska Mountains is not as widespread or thorough as it is for the Largo-Gobernador area (Gilpin 1996). Prevailing scholarly theories hold that in the early A.D. 1800s the western periphery of Navajo occupation extended no farther west than the Hopi Mesas. However, historical and ethnohistorical accounts document ancestral Navajo use of the Grand Canyon and Coconino Plateau region by the end of the A.D. 1600s (Begay and Roberts 1996). Over 60 tree-ring dates from hogans and other structures west of the Little Colorado River, including the Coconino Basin, Gray Mountain, and Red Butte areas, indicate occupation during the eighteenth century, demonstrating that by the early to middle A.D. 1700s Navajo occupation of the Coconino Plateau was well established (Begay and Roberts 1996).

Starting in the late 1700s the Navajo lifeway is characterized by greater reliance on pastoralism and is marked by conflicts with encroaching Euroamericans. There was a shift from large defensive pueblitos to smaller camouflaged hogans. Reliance on the horse increased, and raiding of Spanish and Pueblo settlements became an important part of the Navajo subsistence economy (Ayers 2008). This era ended in 1863 when the U.S. Army forcibly incarcerated large portions of the Navajo population near Fort Sumner, New Mexico.

In 1868 a treaty with the federal government established a reservation for the Navajo, allowing them to return home. After leaving Fort Sumner, many Navajos returned to their old homes even though these were often outside the boundaries of the new reservation. Over time several additions were made to the original reservation, dramatically increasing its size (Goodman 1982). Pastoralism, often supplemented with limited agriculture, and exchange for outside goods through a series trading posts was the predominant lifestyle for many Navajos during the late 1800s and early 1900s. Tribal government was generally not centralized, with the population being organized into numerous bands, each with an appointed leader. Beginning in the 1920s the

Navajo Tribal government underwent a series of changes becoming more centrally organized over time with the establishment of local chapters and the Tribal Council (Goodman 1982).

3.10 Environmental Justice

The United States Environmental Protection Agency defines Environmental Justice as "the fair treatment and meaningful involvement of all people regardless of race, color, sex, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations, and policies."

Environmental injustices include the proper consideration of the negative effects of proposed projects on underserved ethnic or population groups. Modification of land, water, energy and air; unresponsive, unaccountable government policies and regulation; and lack of resources and power in affected communities contribute to environmental injustice.

Historically, tribes are vulnerable to impacts on Environmental Justice. Many are economically disadvantaged and susceptible to accepting projects that will make money but may have negative effects on the health of the population. Tribal leaders are forced to make difficult choices for the economic stability of their tribe and may not always be fully cognizant of the negative impacts of some of these projects. Examples are strip mining, coal-fired power plants, oil and gas development, and nuclear and toxic waste facilities that have documents effects on the air, water, and health of residents. There have been many instances in the history of the Navajo Nation where environmentally harmful projects were allowed to take place on tribal lands based on promises of economic prosperity for tribal members. Many times those projects not only resulted in major public health crises for many residents, but the promised economic advantages for the tribe were never fully realized. The impacts of the Black Mesa Coal Plant and mismanaged uranium mining operations on the health and well-being of Navajo tribal members are still being felt even to this day.

The U.S. EPA has established a National Tribal Toxics Committee (NTTC) to give Indian tribes greater input on issues related to chemical safety, toxic chemicals, and pollution prevention. The goal is to empower tribal communities to protect their health and environmental from the risk of toxic chemicals. EPA has had several initiatives within the last few years (2008-2012) to increase pesticide safety on Indian lands, reduce exposure to toxic chemical and prevent pollution in Indian Country (Tribal Law and Policy Institute, May 2011). For the Navajo Nation, the U.S. EPA has entered into a Memorandum of Understanding that the U.S. EPA will manage the federal Pesticide Applicator certification program while Navajo Nation EPA will be responsible for enforcement and compliance assistance (2005).

3.11 Climate Change

Climate change is currently altering the temperature and precipitation patterns, hydrology (stream flows and snowmelt), and ecosystems (species distributions and populations) of the

Southwest and the Navajo Nation (Cozzetto and Nania 2014). Elevated greenhouse gasses in the atmosphere have been linked to measured climatic changes; from 1901 to 2010 the Southwest has had an annual average temperature increase of 1.6 °F (+/- 0.5 °F) (Hoerling et al 2013). Furthermore, the years 2001 – 2010 were the warmest decade on record, both for the Southwest as a whole and for the states of Arizona, New Mexico, and Utah individually (Hoerling et al 2013). These increases in temperature were more marked in the spring and summer as compared to fall and winter—meaning there have been more heat waves and fewer cold periods. Increases in temperature from 2001-2010 have lengthened the freeze-free growing period by 17 days, as compared to the 20th century average (Hoerling et al 2013). Examination of University of Oregon PRISM temperature data since 1995 has shown that the Navajo Nation has experienced higher temperatures that the 1905-2011 long-term average (Crimmins et al 2013).

Between 1901 and 2010, there is no evidence of annual precipitation trends or extremes in the Southwest as a whole (Hoerling et al 2013). For example, the 2001 – 2010 decade was the driest on records for Arizona; however, it was notably wet decade for Utah and average for New Mexico (Hoerling et al 2013). Analysis of precipitation records and tree ring data on and near the Navajo Nation show wet periods in the early 1900s and in the 1980s with a pronounced drought in the 1950's (Crimmins et al 2013; Faulstich et al 2013; Redsteer et al 2011). However, there is evidence that drought, which is caused by lack of precipitation and exacerbated by wind, temperature, and humidity, is affecting the Southwest and the Navajo Nation in recent decades. Crimmins et al (2013) found evidence of extreme drought in the 1950s on the Navajo Nation and that since 1990 the Nation has experienced extreme swings between wet and dry periods. Another study shows that the Nation has undergone drought conditions, exacerbated by higher temperatures, from 1994 to 2009, with brief wet periods in 2004-5 and 2010 (Redsteer et al 2011). The Navajo Nation has since confirmed drought conditions in 2011, 2012, and 2013 (Cozzetto and Nania 2014). Tree ring analysis, covering a 412-year period of time, has shown longer and more severe drought events prior to the last century (Faulstich et al 2013). Thus current conditions indicate that the Nation has experienced drought in recent years, these droughts have been marked by extreme swings in wet and dry periods, and there is evidence of more severe and longer-lasting droughts in previous centuries.

Hydrologic changes experienced across the Southwest include declines in mountain snowpacks, increases in winter precipitation falling as rain rather than snow, earlier snowmelts, and below normal stream flows between 2001 and 2010 for the major Southwest river drainages of the Upper Colorado River and the Rio Grande (Hoerling et al 2013). For the Navajo Nation, interviews with 50 elders noted declines in snowpack over the past century, decreases in surface water features, water availability, and the disappearance of springs. These observations were corroborated using historic reports, and USGS stream gauge data for the reservation (Redsteer et al 2011). These sources of data have shown that many streams that were noted as perennial in the early 1900s are now intermittent and that many intermittent streams no longer flow (Redsteer et al 2011). Some specific examples are Moenkopi Wash and Lower Chinle Wash becoming

intermittent after 1960 and the Little Colorado River becoming intermittent at Holbrook in 2007 (Redsteer et al 2011). In addition to the loss of surface water, there have been observations of decreasing water quality with some wells in the southwestern Navajo Nation, where wells have becoming saline to the point of being unusable for livestock and corroding pipes and equipment. Decreases in water quality are thought to be due to lack of recharge and overutilization (Redsteer et al 2011).

In addition to observed changes in climate and hydrology, climate models predict that current trends will continue and in some cases worsen (Cozzetto and Nania 2014). For the Southwest as a whole, modeled data predict an annual average increase in temperature for the early 21st century of 1-4 °F and, depending on low versus high emission scenarios, temperatures will increase from 2-6 °F and 5-9 °F respectively towards the late 21st century (Cozzetto and Nania 2014). As with observed changes in the last century, the greatest temperature increases will occur in the summer, the freeze-free growing season will lengthen, and there will be increases in heat wave frequency, severity, and duration. While more difficult to model (thus less certain), precipitation patterns in the Southwest are not predicted to change significantly (Cayan et al 2013); however-due to warmer air being able to store more moisture-precipitation events are predicted to be more severe (Gershunov et al 2013). Drought and hydrologic effects are also thought to worsen across the region, with the current Southwest drought becoming commonplace towards the second half of the 21st century (Cayan et al 2013; Gershunov et al 2013).

3.11.1 Trends and Outlook

Changes in climate and hydrology will have profound effects on ecosystems and natural processes, including the spread on noxious/non-native species (Nania and Cozzetto 2014). Some ecosystem effects of particular concern for the Navajo Nation include changes in sand dune mobility and extent; wildfire frequency, duration, and severity; and decreases in water quality (Nania and Cozzetto 2014). Sand dunes currently cover 1/3 of the Navajo Nation, initially forming downwind of dry rivers and washes during the droughts of the 1950s (Redsteer et al 2013). Mobile dunes are destroying housing, covering transportation routes, and degrading range and agricultural lands (Redsteer et al. 2013). Increased drought may destabilize dunes currently covered in vegetation while dewatered water courses may contribute more sand to dune growth (Redsteer et al. 2013). Higher temperatures, increased drought, and earlier snowmelt are expected to increase wildfire frequency, duration, and size (Brown et al. 2013). According to one study, a 1.8 °F increase in temperature would be expected to result in a 380% increase in area burned in the mountains of Arizona and New Mexico and a 470% increase in area burned on the Colorado Plateau (NRC 2011; Fleishman et al. 2013). Climate change effects on water quality are numerous and multifarious, ranging from increases in water temperatures, lowered dissolved oxygen levels, increased turbidity and pollution levels, and potential groundwater salinization – all of these effects would have implications for aquatic ecosystems and water use throughout the Navajo Nation (Nania and Cozzetto 2014).

Other potential ecosystem alterations due to climate change include changes in nutrient cycling and productivity; changes in community composition, competition, and survival; habitat loss and conversion; shifts in species ranges; changes in phenology and development; changes in population size; de-coupling of ecological relationships (such as pollinator timing); and increased spread of parasites and diseases (Tillman and Siemann 2010; NFWPCAP 2012; Mawdsley et al 2009; NPS and CAW 2007). All of these factors may affect the spread of noxious, non-native species and the health and abundance of native plant populations. In the face of changing climatic and hydrologic conditions, noxious plants often have an advantage over native species (Fleischman et al. 2013). The qualities that make plants noxious: high rates of dispersal, reproduction, and growth, allow these plants to adapt to changing conditions (i.e. climate change). Thus, these advantages contribute to the expansion, establishment, and persistence of noxious species (Fleischman et al. 2013). Furthermore, climate change could trigger non-nave plants to become noxious. For example, prolonged drought or severe storms may unleash non-native species, contributing to their physiological advantage and subsequent spread (NFWPCAS 2012). Indeed, Wotkyns (2011) has documented that in a meeting of Southwest tribes, tribal representatives have expressed concern about recent increases in noxious species. Tribal members noted the replacement of native plants by Russian thistle, camelthorn, tamarisk, and cheatgrass (Wotkyns 2011; Grahame and Sisk 2002). Coconino County, which is principally located in the Navajo Nation, has the highest number of noxious species (280) in Arizona (EDDMapS 2012). Current observations and predicted increases in noxious species highlight the need for the Navajo Nation to take action on this issue.

3.11.2 Greenhouse Gas Emissions

The major contributors of greenhouse gas emissions on and adjacent to the Navajo Nation include the Navajo Generating Station, Four Corners Generating Station, San Juan Generating Station, and Cholla Generating Station (U.S. EPA 2014d, **Table 3-24**). The U.S. Environmental Protection Agency (U.S. EPA) is proposing emission guidelines, "Carbon Pollution Emission Guidelines for Existing Stationary Sources," for states to follow in developing plans to address greenhouse gas emissions from existing fossil fuel-fired electric generating units. The guidelines state that electric generating units (EGU) located in Indian country would not be encompassed within the state's Clean Air Act (CAA) Section III (d) plan (EPA 2014). It also allows a Tribe to obtain authority from the U.S. EPA to establish a CAA section III (d) plan itself, pursuant to the Tribal Authority Rule. The U.S. EPA is working with the Navajo Nation Carbon Team to develop a supplemental rule that sets tribal-specific goals for reducing carbon dioxide emissions and provides guidance for tribes to achieve these goals (Abasta 2014). The Navajo Nation Carbon Team consists of representatives from Navajo Nation, Navajo EPA, Division of Natural Resources, Navajo Tribal Utility Authority, Navajo Transitional Energy Corporation and Navajo Nation Oil and Gas Company. The purpose of the Navajo Nation Carbon Team is to take the lead in determining the course of action from an environmental, economic and cultural perspective in response to the U.S. EPA's Clean Power Plan.

The U.S. EPA proposed a federal implementation plan for Navajo Generating Station and Four Corners Generating Station. The final action would require the Navajo Generating Station (NGS), one of the largest contributors of greenhouse gas emissions (GHG), to reduce NO_x emissions by over 80% over 2009-2044 (U.S. EPA 2014a). The primary goal of this reduction is to reduce the impact of NGS on visibility at 11 mandatory Class I Federal areas, including Grand Canyon National Park. Mandatory Class I Federal designation was given to 158 areas in existence as ofAugust 1977 that meet the following criteria: 1) all national parks greater than 6000 acres, 2) all national wilderness areas and national memorial parks greater than 5000 acres, and 3) one international park. Another large contributor of GHG on the Navajo Nation includes the Four Corners Power Plant (FCPP) administered by Arizona Public Service Company (APS). APS retired FCPP Units 1, 2, and 3 on January 1, 2014 and will comply with the Best Available Retrofit Technology (BART) emission limit for NOx of 0.098 lb/mmBtu on FCPP Units 4 and 5 by July 31, 2018 (Becker 2013).

While treating weeds may minimally contribute to greenhouse gas emissions by the exhaust from heavy machinery, airplanes and helicopters, and vehicles accessing sites, the small scale of the annual weed control projects is not anticipated to be a significant contributor.

Table 3-24. Annual Greenhouse Gas Emissions from Large Facilities on and adjacent to the Navajo Nation during 2013. Data obtained from EPA 2013 Greenhouse Gas Emissions from Large Facilities Reporting Program (http://ghgdata.epa.gov/ghgp/main.do).

Facility Name	Source/Process	On (O) or Adjacent (A) to Navajo Nation	Metric Tons		
			Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous oxide (N_2O)
Navajo Generating Station	Electricity generation from bituminous coal	O	16,165,262	47,760	82,808
Four-Corners Generating Station	Stationary combustion of natural gas	O	11,708,849	34,585	59,964
San Juan	Electricity generation from 2, subbituminous coal	A	11,301,684	31,116	53,976
Cholla	Electricity generation from bituminous coal	A	7,478,781	22,096	38,311
Station #3-Leupp CMP STN	Stationary combustion of natural gas	O	51,376	1,364	30
EPNG Station 6755, Ganado, AZ	Stationary combustion of natural gas	O	15,883	5,868	9

Facility Name	Source/Process	On (O) or Adjacent (A) to Navajo Nation	Metric Tons		
			Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous oxide (N_2O)
EPNG Station 6796, Window Rock, AZ	Stationary combustion of natural gas	O	73,970	24,548	42
Blanco Compressor Station C and D	Stationary combustion of petroleum and natural gas	O	269,934	9,353	151
San Juan River Gas Plant	Stationary combustion of petroleum and natural gas	A	49,765	1,601	29
Chaco Gas Plant	Stationary combustion of petroleum and natural gas	O	421,135	15,305	238

3.12 Areas with Special Designations and Uses

3.12.1 National Parks, Monuments and Recreation Areas

The National Park Service, under the authority of the Department of the Interior, manages several parks, monuments, and recreation areas in and around the Navajo Nation (**Figure 3-17**). Park Service lands managed within the Navajo Nation are still technically trust lands owned by the Navajo Nation that are managed separately by the Park Service to maintain their unique value. In some instances, such as Canyon de Chelly and Navajo National Monument, the National Park Service is tasked with managing cultural resources in the area, while the Navajo Nation still maintains responsibility for management of natural resources. Navajo Nation Law (Title 5, Navajo Nation Code 2501 et seq.), as amended, provides for the regulation of tour operations and guide services within the jurisdictional limits of the Navajo Nation. This law gives the Navajo Nation Parks and Recreation Department specific authority to issue reasonable rules and regulations to implement this Act, and which rules and regulations are herein prescribed. Along with tour services, the Navajo Nation Parks and Recreation Department along with local people work with the National Park Service (NPS) to develop cooperative management plans to better manage resources, and clearly define agency responsibilities, particularly at Canyon De Chelly. The NPS is responsible for controlling noxious weeds located within National Park Service managed lands. However, NPS has supported efforts to control noxious weeds on properties adjacent to NPS lands through financial contribution, technical assistance, access, or personnel. The NPS Watershed Crew has been contracted by the BIA to remove noxious species on Navajo Nation lands to prevent the spread from between the two land management areas.

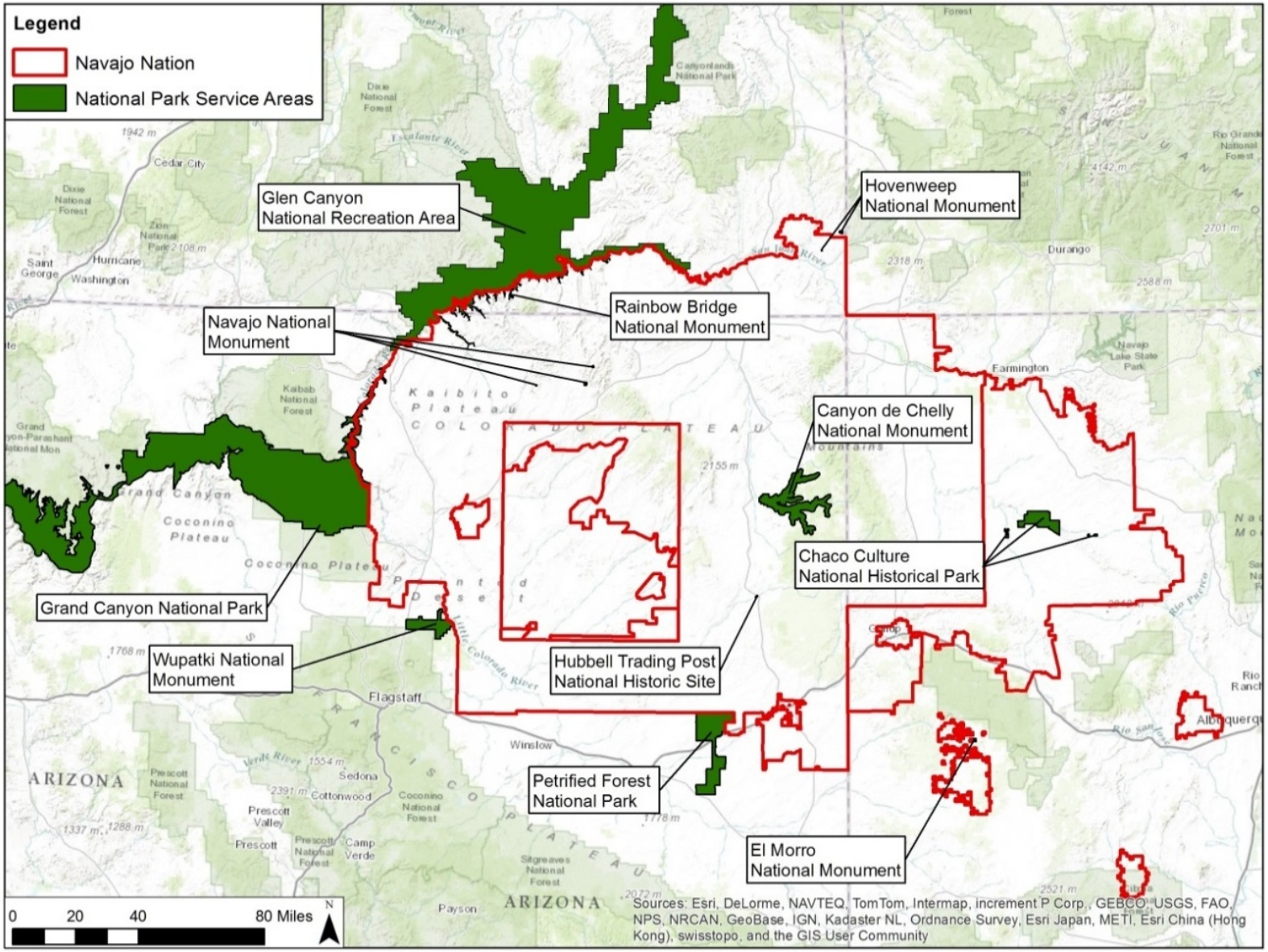

Figure 3-17. Map of all National Park Service lands managed in and around the Navajo Nation.

Hubbell Trading Post National Historic Site is located approximately ½ mile to the west of Ganado, Arizona on the Navajo Nation. This historic site comprises 160 acres of land owned by the National Park Service (NPS Website 2014). Visitors can see the historic trading post, homestead, and museum. The trading post was operated by the Hubble family until 1967 when the property was purchased by the National Park Service. The historic site is now run by the non-profit Western National Parks Association, who maintains the still active trading post. Ecological restoration efforts have occurred on portions of Pueblo Colorado Wash on park land since 1999, and have included the removal of noxious shrub species (tamarisk. and Russian olive), improvements to stream morphology, and planting native species (Wagner 2010). Hubble Trading Post is managed collectively with Navajo National Monument, and Canyon de Chelly as part of the Southern Four Corners Management Group. Until recently, the Four Corners Management Group had a full crew that was available to do weed management projects. However, funding cuts now only staff the crew with two people (Dean Schliting, Park Service Biologist, pers. comm., June 9th, 2014).

Canyon de Chelly National Monument is located in the northeastern corner of Arizona near the town of Chinle and is entirely contained within the Navajo Nation. The 84,000-acre park was established in 1931 to preserve cultural and archeological resources representing 4,000 years of continual occupation by Ancestral Puebloan Indians and historic and modern-day Navajo people (NPS 2005). Impressive cliff dwellings are the main visitor attraction. Approximately 40 Navajo families continue to live, graze, and farm the bottom lands within the monument (NPS Website 2014a). Canyon de Chelly is jointly managed between the National Park Service and the Navajo Nation. The Park Service is tasked with managing the cultural resources, park administration, and visitor services, while the Navajo Nation retains control of the land and minerals within the monument and is responsible for surface and sub-surface land use (NPS 2005).

Aggressive infestations of tamarisk and Russian olive, in combination with intensive historic grazing and tour operations in the riparian corridors of the monument, prompted the creation of a cooperative watershed restoration project in 2005. Infestations of noxious trees altered stream processes and led to channel incision and harmful erosion, threatening ancestral farmlands, archeological sites, and biodiversity within the monument (NPS 2005). Canyon de Chelly is managed collectively with Navajo National Monument, and Hubble Trading Post as part of the Southern Four Corners Management Group, which currently has a contract through the BIA's Chinle Navajo Agency to control tamarisk and Russian olive north of the park boundary in Chinle Wash. Through this agreement the Park Service and the BIA have cleared 100 acres of weed species using the cut stump method. Canyon de Chelly has also made an effort to control Russian knapweed in dispersed areas through the park. This volunteer effort was done opportunistically as infestations were identified.

Navajo National Monument is located wholly within the Navajo Nation in northeastern Arizona between Shonto and Kayenta. The monument was established in 1909 to protect some

of the most intact Ancestral Puebloan cliff dwellings in the Colorado Plateau and is comprises of three geographically separate units: Betatakin (406 acres) Keet Seel (158 acres), and Inscription House (39 acres) (Salas et al 2010). A Memorandum of Agreement was signed in 1962, expanding the park and formalizing economic opportunities within the monument for the Navajo Nation (Rothman 1991). Navajo National Monument is managed collectively with Canyon de Chelly, and Hubble Trading Post as part of the Southern Four Corners Management Group, which currently has a fund reimbursable contract through the BIA's Western Agency to control tamarisk (Ta*marix* spp.) and Russian olive (*Elaeaganus angustifolia*) adjacent to the park's units in Betatakin, Nitsin, and Tsegi Canyons. Through this agreement the Park Service and the BIA have cleared 60-70 acres of these weed species from Tsegi Canyon and 30-40 acres in Betatakin and Nitsin Canyons using the cut stump method. Until recently the Four Corners Management Group had a full crew that was available to do weed management projects; due to funding cuts, this crew is staffed with only two people now. (Dean Schliting, Park Service Biologist, pers. comm., June 9th, 2014)

Grand Canyon National Park (GCNP) is comprised of 1,217,403.3 acres and 277 river miles along the Colorado River (NPS 2013). GCNP is the second most visited park within the National Park System, with nearly five million visitors entering the park each year (NPCA 2014). The park is located directly to the west of the Navajo Nation and contains what were once traditional Navajo lands. There is a complicated history leading the formation of the park, starting with its designation as a forest reserve in in 1893, followed by national monument designation by Theodore Roosevelt in 1908. Finally, the Grand Canyon was designated as a national park in 1919. Later, in 1975 the park absorbed Marble Canyon National Monument through the Grand Canyon Enlargement Act (NPS 2013).

Because it is impossible to control every exotic plant that occurs in Grand Canyon National Park (GRCA), staff focuses management efforts on those species that have or could have the greatest impact to park resources or adjacent land activities. Prioritization of management activities both by species and their location helps guide the most efficient use of resources, specifically staff time and budget. The Exotic Plant Management Plan and Environmental Assessment (NPS 2009), approved in July of 2009, and the Alien Plant Ranking System (Makarick 1999; Hiebert and Stubbendieck, 1993) provide a framework for priority setting. High-priority species are those such as knapweed (*Centaurea* spp.) and thistles (*Carduus* spp., *Onopordum acanthium*), which vegetation program staff consider highly noxious or damaging, and which occur in limited numbers of populations in the park. Medium-priority species are considered moderately noxious, less damaging than high-priority species, or are more widely spread than high-priority species. Low priority species are those, such as filaree (*Erodium cicutarium*) or lambsquarter (*Chenopodium album*), which are noxious but less ecologically damaging, or are much more widely spread than high- and medium-priority species. Control of low- priority species is limited primarily to restoration areas and other special needs areas. Because the number of exotic

species entering the park changes over time, vegetation program biologists continue to review and update the exotic plant species and priority lists biennially.

As of 2014, there have been 201 exotic plant species found within the boundaries of Grand Canyon National Park (Lori Makarick and Melissa McMaster, personal communication June 13 2014). It is estimated that roughly half of the park's total acreage currently contains exotic plant species. Eighty-five plant species found in the park are currently considered noxious and of particular concern to Grand Canyon managers because they are aggressive and have potential to displace native vegetation. In the developed areas of the park, staff focus treatment efforts on high and medium priority species such as: jointed goatgrass (*Aegilops cylindrica*), diffuse knapweed (*Centaurea diffusa*), rush skeletonweed (*Chondrilla juncea*), houndstongue (*Cynoglossum officinale*), foxtail barley (*Hordeum jubatum*), catnip (*Nepeta cataria*), Scotch thistle (*Onopordum acanthium*), Himalayan blackberry (*Rubus discolor*), Mediterranean sage (*Salvia aethiopsis*), tamarisk (*Tamarisk ramosissima*), Siberian elm (*Ulmus pumila*), bull thistle (*Cirsium vulgare*), and horehound (*Marrubium vulgare*). In the backcountry areas of the park, staff treat the following high, medium and low priority species on an annual basis: Russian thistle (*Salsola tragus*), camelthorn (*Alhagi maurorum*), pampas grass (*Cortaderia* spp.), red brome (*Bromus rubens*), Sahara mustard (*Brassica tournefortii*), shiny bugseed (*Corispermum nitidum*), filaree (*Erodium cicutarium*), Russian olive (*Elaeagnus angustifolia*), perennial pepperweed (*Lepidium latifolium*), African mustard (*Malcolmia africana*), Ravenna grass (*Saccharum ravennae*), silverleaf nightshade (*Solanum elaeagnifolium*), and puncture vine (*Tribulus terrestris*).

Glen Canyon National Recreation Area (GCNRA) was established in 1972 and is located primarily in southeastern Utah with a small portion of the park in northern Arizona. GCNRA is composed of 1,236,880 acres of canyons, cliffs, and plateaus located around the Colorado River and its tributaries (the Green River and the San Juan River). The primary feature of the park is Lake Powell, which was formed by the completion of Glen Canyon Dam in 1964. Lake Powell stretches in length for 189 miles with a surface area of 68,000 ha. The recreation area contains historically traditional lands of the Navajo and borders the Navajo Nation on its southeastern side. Non-native plant species make up 11% of the flora of GCNRA. Russian olive (*Elaeagnus angustifolia*) and salt cedar (*Tamarix chinensis*) are present throughout the GCNRA's riparian communities. Eradication efforts have focused on the removal of Russian olive from the Escalante River and saltcedar from Lee's Ferry (Hill and Ayers 2009). Hill and Ayers (2009) have identified Sahara mustard (*Brassica tournefortii*), pampas grass (*Cortaderia selloana*), halogeton (*Halogeton glomeratus*), and Ravenna grass (*Saccharum ravennae*) as noxious species that require further management attention within GCNRA. The tamarisk leaf beetle (*Diorhabda carinulata*), a biological control agent released near St. George Utah in 2006, is thriving at several locations throughout the recreation area and causing tamarisk defoliation (NPS Website 2014b).

El Morro National Monument is located in west-central New Mexico and is comprised of 1,306 acres of grasslands, shrublands, pinyon-juniper forest and ponderosa pine forests. The main features of the park include the massive sandstone promontory "El Morro" which protects a reliable watering hole within its cliffs. This watering hole has been an attraction for centuries, providing a water source for Ancient Puebloans and a stopover for colonizing Spaniards and American. All three cultures left over 2,000 petroglyphs and inscriptions on the rock walls of the park. The ruins of Ancient Puebloan dwellings can be visited at the top of the promontory (NPS Website 2014b). Vegetation monitoring in 2009 reported an abundance of non-native exotic species within the monument including populations of cheetgrass (*Bromus tectorum*), lettuce (*Lactuca* spp.), goats beard (*Tragopogon* spp.), tumblemustard (*Sisymbrium altissimum*), and common mullein (*Verbascum thapus*) (Salas and Bolen 2010). David Hays, the monument's Natural Resource Manager, commented there is no designated funding or staff for weed management at the park; however, weeds are managed at El Morro. Cheat grass (*Bromus tectorum*) is the primary species of concern and there is a pending management plan that will use prescribed grazing to treat the weed. (David Hays personal communication, June 9th, 2014)

Petrified Forest National Park (PFNP) is located east of Holbrook in northeastern Arizona. The park is hour-glass shaped and approximately 40 miles in length, comprising approximately 37,421 acres. PFNP's southern border is adjacent to the Navajo Nation and the park contains inholdings consisting of Navajo Nation land and private cattle ranches. The park was first designated as a monument in 1906, gaining National Park status in 1962. Nearly 50% of the park is designated as wilderness, with a northern unit located in the Painted Desert and a southern unit in the Rainbow Forest area. PFNP contains some of the largest concentrations of petrified wood in the world, as its name implies, as well as numerous plant and animal fossils from the 225 million year-old Chinle Formation (Thomas et al 2009). Russian thistle (*Salsola tragus*) and *Tamarisk* spp. were noted as significant invasives in a 2009 vegetation report (Thomas et al. 2009). Park Superintendent, Brad Traver, commented that little comprehensive noxious weeds management has been done at the park. The projects that he noted were a Youth Conservation Corps crew that spent two weeks pulling tumble weeds (various species) and goatheads (*Tribulous terrestris*). Most other noxious control work has occurred around park facilities in the front country, including applying herbicide to Russian olives (*Elaeagnus angustifolia)* using the cut stump method. Traver also commented that the park has some existing funding to control Russian olives (*Elaeagnus angustifolia)* and *Tamarisk* spp. along the Rio Puerco in the park. (Brad Traver, Park Superintendent, personal communication, June 12th, 2014)

Hovenweep is located in southeastern Utah and on adjacent land in Colorado. The monument was established in 1923 to protect Ancient Puebloan ruins, containing impressive multi–story towers, distributed over a 20–mile expanse of mesa tops. Hovenweep totals 785 acres divided between six geographically separated management units: Square Tower, Cajon, Holly, Horseshoe/Hackberry, Cutthroat Castle, and Goodman Point. The Cajon Canyon unit is located

within the Navajo Nations's boundaries, while the Square Tower unit lies directly adjacent to the Navajo Nation near the Colorado/Utah border. The Square Tower unit contains most of the park's visitor facilities and is the most accessible unit (NPS 2011a). A 2003 non-native plant inventory identified eleven noxious species as "target species" (musk thistle (*Carduus nutans*), diffuse knapweed (*Centaurea diffusa*), spotted knapweed (*Centaurea maculosa*), Russian knapweed (*Centaurea repens*), squarrose knapweed (*Centaurea virgata v. squarrosa*), Canada thistle (*Cirsium arvense*), Russian olive (*Elaeagnus angustifolia*), horehound (*Marrubium vulgare*), Scotch thistle (*Onopordum acanthium*), saltcedar (*Tamarix ramosissima*), and Siberian elm (*Ulmus pumila*) (Dewey and Anderson 2005). Cheatgrass (*Bromus tectorum*) has also been identified as a noxious species of concern within the monument (NPS 2011a).

Rainbow Bridge National Monument (RBNM) is located in southern Utah along the San Juan branch of Lake Powel. The 160-acre monument is surrounded on its northern, eastern, and western sides by Glen Canyon National Recreation area, with the Navajo Nation directly to the south. RBNM is a separate unit of the National Park system; however, management of the monument is overseen by Glen Canyon National Recreation Area. The monument was created in 1910 to protect the world's largest natural bridge (290 feet high with a span of 275 feet). Rainbow Bridge has been a sacred site to American Indians for centuries (Graham 2009). A 1993 General Management Plan for the park consulted five nations associated with Rainbow Bridge: Navajo, Hopi, San Juan Southern Paiute, Kaibab Paiute, and White Mesa Ute. These tribes view Rainbow Bridge as a sacred site, which should be protected and visited in a manner that respects their cultures. This includes preventing visitors from approaching or walking beneath the bridge. Today, the NPS asks visitors to be respectful of these requests (2014c).

Wupatki National Monument is located near Flagstaff in Coconino County, Arizona where it is managed as part of the Flagstaff Area National Monuments (which includes nearby Sunset Crater National Monument and Walnut Canyon National Monument). Wupatki comprises 35,422 acres of grasslands, mesas, buttes, and volcanic hills. The Little Colorado River defines the eastern border of the monument, with the Navajo Nation located on the west. The monument was established in 1924 to protect the ruins of the Citidel and Wupatki pueblos; since then, boundaries have been adjusted to include additional archeological resources (Graham 2011). There are approximately 2,400 archeological sites catalogued within the monument (Ort et al 2008). Noxious weeds at Wupatki are currently managed under the Invasive Plant Management Plan for all Flagstaff Area National Monuments (NPS 2009)

3.12.2 Navajo Tribal Parks and Recreation Areas

The Navajo Nation Parks and Recreation Department or Tribal Parks (NNTP) was established in 1964 to steward the Navajo Nations tribal parks. Currently, the NNTP is the custodian of five tribal parks, one monument, and one veteran's memorial. NNTP is tasked with protecting these lands for future generations. Currently, noxious species management work is only being done within the Navajo Tribal Parks systems at Canyon de Chelly, where the park is co-managed by

Navajo Parks and Recreation and the National Park Service. Further weed management activities are currently needed within the Navajo Park system, but no formal plans or projects are anticipated in the next five years (Murray Lee, Senior Planner at Navajo Parks and Recreation Department, personal communication, June 6th, 2014).

Monument Valley Navajo Tribal Park is located northeast of Kayenta on the Arizona/Utah border. The park comprises 91,696 acres of Great Basin desert surrounding massive sandstone buttes, towering up to 1,000 feet above the desert floor. The park offers a visitor center, camp ground, scenic driving route, hiking trails, and guided tours (NNTP 2014).

Lake Powell Navajo Tribal Park manages five areas just east of Page, Arizona within the LeChee Chapter of the Navajo Nation. These areas include Upper Antelope Canyon, Lower Antelope Canyon, Upper Part of East Waterholes, Lower Part of East Water Holes, and Rainbow Bridge Trail. Upper Antelope Canyon is called *Tse' bighanilini,* which translates to "the place where water runs through rocks", aptly describing this 120-foot deep slot canyon that attracts thousands of tourists each year. Lower Antelope Canyon, called *Hasdestwazi* or "spiraling arches", consists of more sculpted sandstone slot canyons, but is deeper and slightly less accessible. Both the Upper and Lower East Water Holes, bisected by Highway 89, are located near Antelope Canyon and offer visitors access to more slot canyons that drain into Lake Powell (NNTP 2014a and TAS 2014). The Rainbow Bridge Trail is a 13-mile backcountry trail that traverses the Navajo Nation to reach Navajo Bridge National Monument (Clark 2014).

Little Colorado River Gorge Navajo Tribal Park comprises three park areas near Camron, Arizona on the Navajo Nation. The park includes two viewpoints overlooking the Little Colorado River Gorge off of SR 64, the east side of Marble Canyon outside the Grand Canyon National Park Boundary (including trails along the East Rim of the Grand Canyon), and Grand Falls northeast of Flagstaff in the Painted Desert. Marble Canyon consists of the section of the Colorado River from Lee's Ferry to the confluence with the Little Colorado River. The sculpted limestone walls of Marble Canyon mark the beginning of the Grand Canyon, and, while Marble Canyon itself is part of Grand Canyon National Park, the lands east of the canyon are part of the Navajo Nation; Navajo Tribal Parks manages any trails along this East Rim of the Grand Canyon from Cameron to Page, Arizona. Grand Falls is a natural cascade in the Little Colorado River that was formed by lava flows blocking the river. Grand Falls can form a roaring waterfall during the rainy season. The management of these park areas is coordinated out of the tribal Park Office/Visitor Center in Cameron, AZ (NNTP 2014b).

Four Corners Monument is located at the only location in the United States where four states intersect: Arizona, Colorado, Utah, and New Mexico. The park offers a granite and brass plaza that celebrates the intersection of the four states. Picnic tables and restrooms are available for visitors (NNTP 2014c).

Window Rock Navajo Tribal Park and Veteran's Memorial is located near the Navajo Nation's Administrative Center in Window Rock, Arizona. The park protects the large sandstone arch, which is Window Rock's namesake. It is also the location of a Veterans Memorial, constructed at the base of the Window Rock Arch. The memorial was designed and constructed by Navajo to recognize the Navajo Code Talkers that used the Navajo language as a form of encryption during WWII (NNTP 2014d).

The San Juan River flows along the northern border of the Navajo Nation and is a popular recreation designation for rafting and fishing. One of the major launch points for the river is Montezuma Creek, which is on the Navajo Nation. Additionally, the south bank of the river, from Mexican Hat to Lake Powell, is part of Lake Powel Navajo Tribal Park. Visitors are required to have a permit to hike and camp on the south bank of the river.

Bowl Canyon Recreation Area is located in the Chuska Mountains near Crystal, New Mexico. The park provides camping areas, the Camp Asááyi lodge, and access to the 36 acre Asááyi Lake. Popular activities at the park include canoeing, fishing, hiking, picnicking, and camping.

3.12.3 Forest Management Units

The Navajo Nation has 537,553 acres of commercial timber land, which is divided into two management units. The Defiance Unit contains 225,675 total acres, of which 217,099 acres are operable tribal trust timber land. The Chuska-Tsaile Unit is made up of 311,878 total acres, of which 281,798 acres are operable tribal trust timber land. In the Defiance Unit, pondersosa pine makes up 99% of the net board feet, while Douglas makes up the remaining 1%. In the Chuska-Tsaile Unit ponderosa pine makes up 91% of the net board feet, with the remaining board feet comprised of Douglass fir (7%) and aspen (2%).These numbers were taken from the 10 Year Forest Plan – Navajo Indian Reservation (1982). Noxious, non-native plants jeopardize the health of forest ecosystems (USFS 2014) and can reduce silvicultural yields (Stokes and Willoughby 2013). Timber harvesting practices such the construction of haul roads, operation of heavy equipment, and the removal of overstory habitat are forms of disturbance that can lead to the spread of noxious weeds. The Forest Management Unit is managed under the Bureau of Indian Affair's Navajo Nation Forest Management Plan (2000) in cooperation with the Navajo Forest Service Program under the Division of Natural Resources.

3.12.4 Wilderness

There are currently two wilderness areas found within the Navajo Nation: Bisti/De-Na-Zin Wilderness Area, and Ah-shi-sle-pah Wilderness Study Area (**Figure 3-18**). Both are located in Eastern Navajo Agency and managed by the Bureau of Land Management. It is not known how much of the area is currently infested with weeds. Current populations are likely small, but have the potential to grow. While the Bureau of Land Management has the responsibility for managing and controlling weed populations within each of these areas, infestations could spread to the Navajo Nation and required cooperative efforts by the BIA to manage and address spreading weed issues.

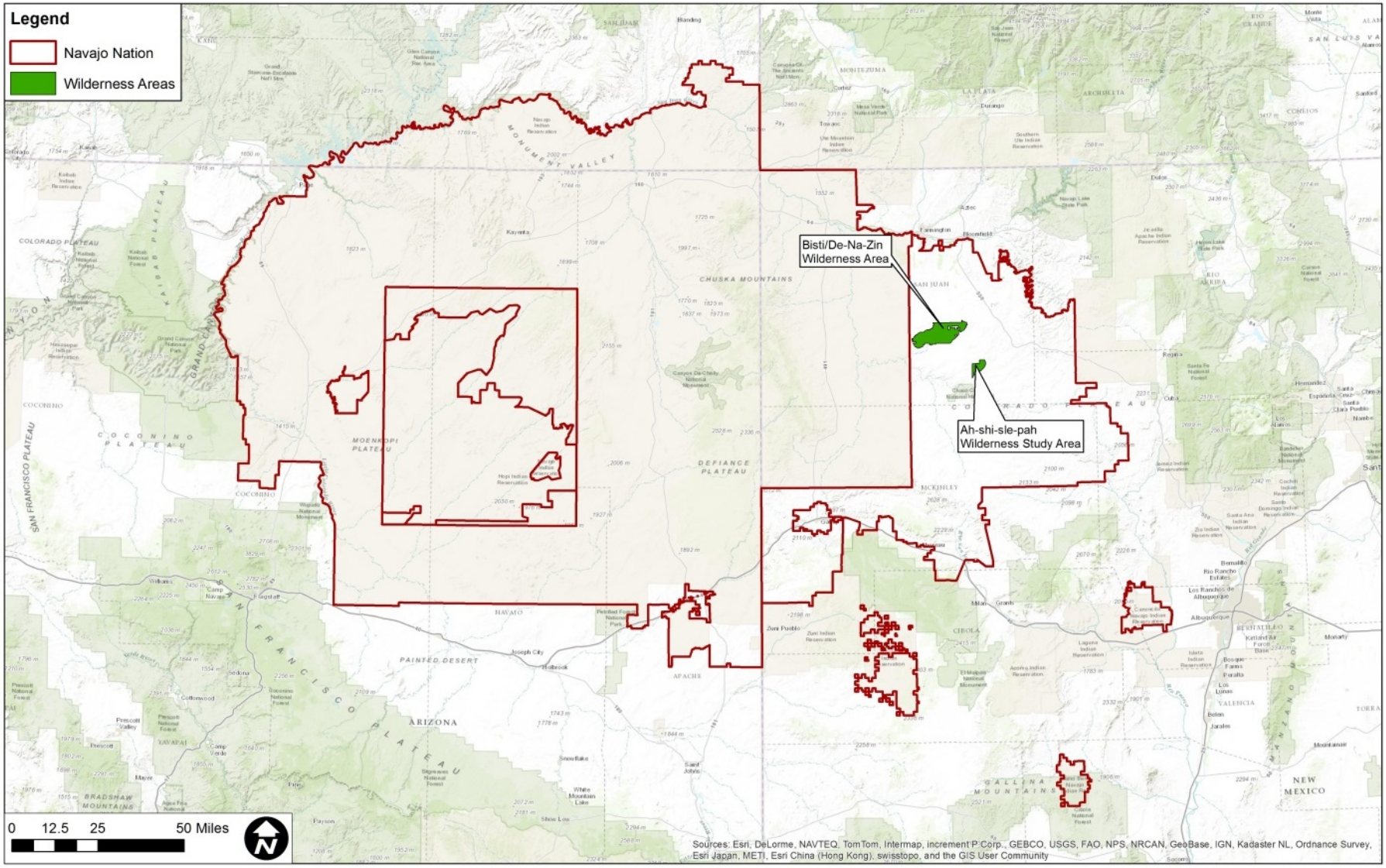

Figure 3-18. Wilderness areas found on the Navajo Nation. All wilderness areas are currently managed by the Bureau of Land Management.

Bisti/De-Na-Zin Wilderness Area is a 45,000-acre remote area of steeply eroded badlands with some of the most unusual scenery found in the Four Corners region. The area was established as a wilderness area in 1984 and is managed by the Bureau of Land Management (41,170 acres), except for a few parcels of Navajo-owned land. It contains a variety of resources, including remote wind-eroded sandstone and shale badlands with striking geologic features and high scenic value. The wilderness area is located on Intermountain Basin Shale Badlands with desert grasslands typified by low to medium tall grasses and very few woody plants. It is rich in paleontological resources and contains over 50 archaeological sites. As a wilderness area, Bisti/De-Na-Zin offers opportunities for solitude and primitive recreation. There is a lack of water available at the site and only two trails for visitor use.

Ah-shi-sle-pah Wilderness Study Area is over 6,500 acres and is located near Chaco Culture National Historic Park in the checkerboard area of the northern Eastern Navajo Agency. The area is known for its unique badland scenery with outcrops, rugged terrain, and rock spires. Ah-shi-sle-pah is also rich in paleontological resources and archaeological sites, many of which are sacred to the Navajo people (Sullivan 2006). The area was established as a Wilderness Study Area in 1992 due to its unique landscape, fossils, and solitude

3.12.5 Biological Preserves

Biological Preserves on the Navajo Nation are managed by the Navajo Nation Department of Fish and Wildlife. These areas are defined by the Navajo Nation's Biological Resource Land use Clearance Policies and Procedures (RCS-44-08) and are areas which contain excellent or potentially excellent habitat that have been set aside for protection from human activities (NNDFW 2008a). As such, the Navajo Nation prohibits any new developments in these areas with the exception of some enhancement projects within these habitats. Such projects are only implemented based on NNDFW approval and need. Currently, the Biological Preserves on the Navajo Nation are located near Shiprock, a few locations along the San Juan River, along Marble Canyon, at various locations in the Chuska Mountains, Navajo Mountain, between Chimney and Monument Rocks, and near Sand Cone Springs (**Figure 3-19**).

Many of the preserves located along river corridors are designated to help preserve habitat for a number of federally and tribally listed fish species. The Biological Preserves located near Shiprock are designated due to presence of Mesa Verde cactus (*Sclerocactus mesae-verdae*) in the area. These preserves cover approximately 13,287 acre divided between four conservation areas: El Malpais, Many Devils Wash, Rattlesnake and Monument Rocks (NNDFW 2007). These conservation areas were developed in collaboration with the U.S. Fish and Wildlife Service as mitigation for development at Shiprock, Cudei, and Hogback Chapters. Not much is currently known about the state of weed populations within these areas. Due to the sensitive nature of these preserves, the BIA is not proposing weed treatments in these areas, and the responsibility for habitat enhancements that require management of noxious weeds will be left to the discretion of the NNDFW.

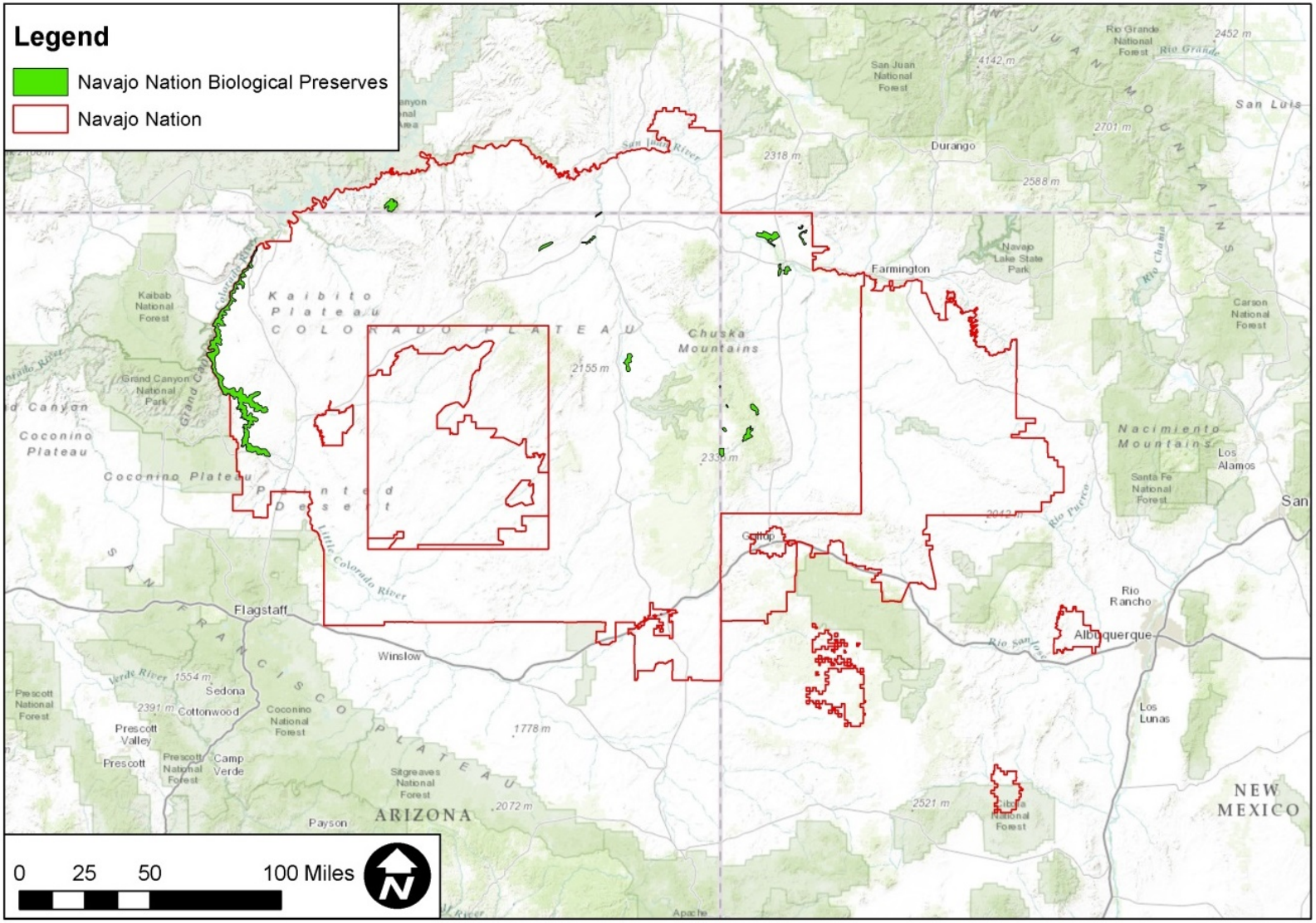

Figure 3-19. Map of the Biological Preserves as defined by the Navajo Nation Department of Fish and Wildlife according to the Biological Resource Land Use Clearance Policies and Procedures.

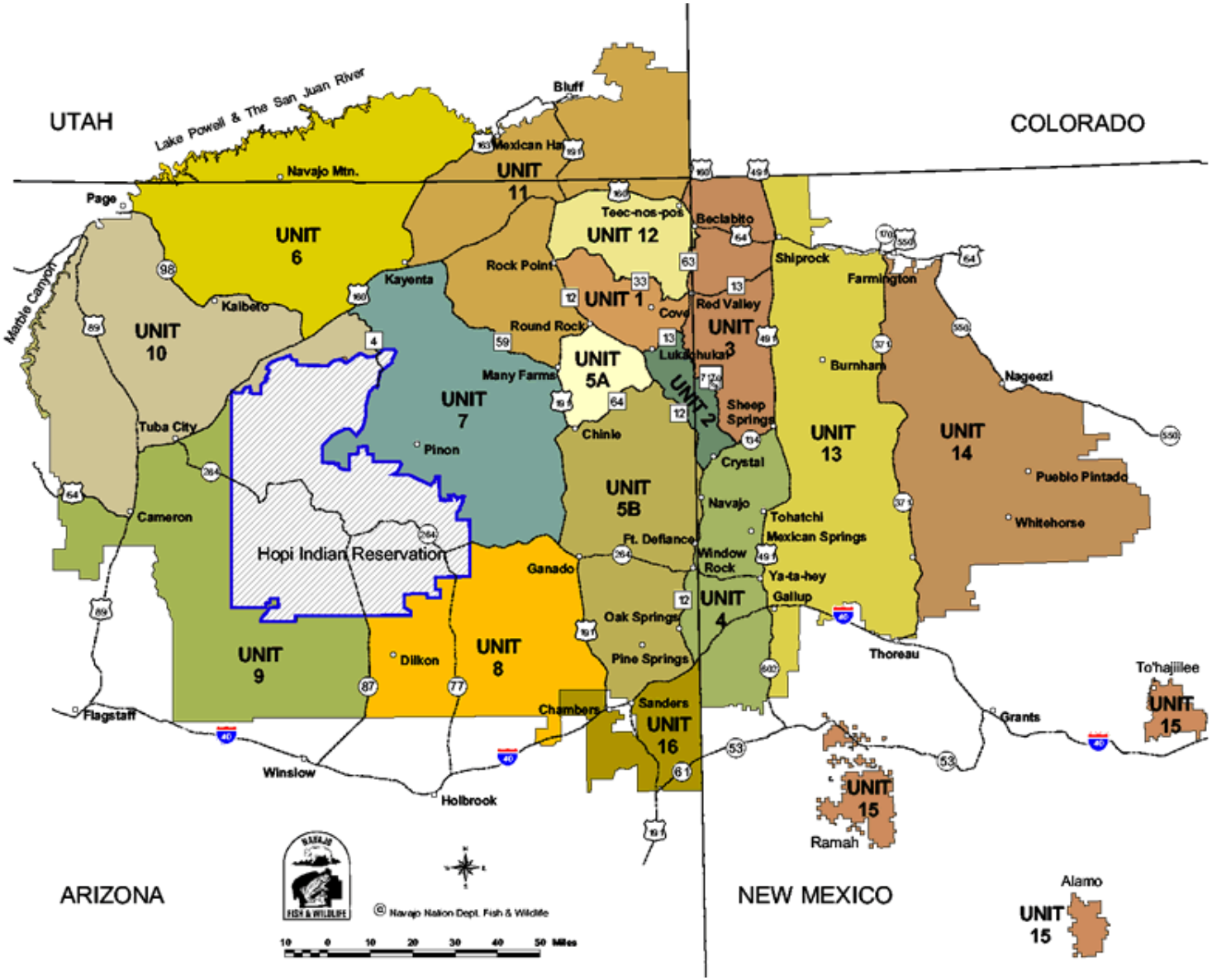

Figure 3-20. Big game hunting units managed by the Navajo Nation (NNDFW, 2015 http://www.nndfw.org/hunt_unit_maps/hunt_unit.htm).

3.13 Resource Use

3.13.1 Hunting and Fishing

The Navajo Nation Department of Fish and Wildlife (NNDFW) is responsible for selling and regulating hunting and fishing permits on the Navajo Nation. Big game and fishing permits are available to both Navajo and non-Navajos. All waters of the Navajo Nation that are managed for fish are opened to fishing with a permit (**Table 3-25**). Trout, catfish and bass have a bag limit of eight fish per day, except for four bass at Morgan Lake and four trout at Whiskey Lake. There are no bag limits on bluegills, sunfish, bullheads, crayfish and waterdogs. In order to promote higher quality fishing at Whiskey Lake and Morgan Lake timing restrictions occur.

Table 3-25. Fishing waters of the Navajo Nation and species of fish (Navajo Nation Fishing and Boating Regulations, RCS-166-91, 5.00).

Fishing Waters	Primary Species
Asaayi Lake	Rainbow Trout
Berland Lake	Rainbow Trout
Cutter Dam Reservoir	Rainbow Trout, Brown Trout, Cutthroat Trout, Bullhead
Cow Springs Lake	Channel Catfish, Largemouth Bass, Bluegill
Ganado Lake	Channel Catfish, Largemouth Bass
Many Farms Lake	Channel Catfish, Largemouth Bass, Bluegill
Morgan Lake	Channel Catfish, Largemouth Bass, Bluegill, Carp
Red Lake*	Largemouth Bass, Channel Catfish, Bullhead
San Juan River	Channel Catfish
Tsaile Lake *	Channel Catfish, Rainbow Trout, Brown Trout, Brook Trout, Cutthroat Trout
Wheatfields Lake	Rainbow Trout, Brown Trout, Brook Trout, Cutthroat Trout
White Mesa Lake	Rainbow Trout

*At the time of this writing, Red Lake and Tsaile Lake have been drained to address repairs to their dams. Once construction has completed, both are expected to be filled and utilized as fisheries again.

Big game populations are monitored and managed to ensure that they do not become endangered, diseased, over-populated or cause too many human conflicts (Cole 2014a). The big game species that are managed through hunting permits include deer, elk, turkey, pronghorn, black bear, desert bighorn sheep, and mountain lions (**Table 3-26**). There are 17 hunt units across the Navajo Nation (**Figure 3-20**). Big game hunting permits are available to Navajo tribal members and to a lesser extent Non-Navajos (**Table 3-26**). Pronghorn and desert bighorn sheep are listed as endangered (Group 3) on the Navajo Nation by the NNFWS; however, a small number of permits are issued to hunt these species (two permits for desert bighorn and three permits for pronghorn for the 2014-2015 season). Three additional permits for bighorn sheep are also made available to the general public via auctions through Safari International, Grand Slam/Ovis, and the Wild Sheep Foundation. The endangered desert bighorn permits are an economic revenue source for the Navajo Nation, where non-Navajos will pay between $35,000 and $55,000 for a hunting permit (Cole 2014b).

Table 3-26. Navajo Nation big game hunting permits available for 2014-2015 (Navajo Nation Department of Fish and Wildlife Navajo and Non-Navajo Big Game Proclamation 2014-2015).

Permit Type	# of Navajo Permits Available	# of Non-Navajo Permits Available	Open Units
Archery Deer	353	39	1-5, 8-15
Muzzleloader Deer	53	7	1-3
Riffle Deer	658	71	1-15
Youth Deer	52	4	2,3,5,12
Archery Elk	258	45	1-5, 7, 12-14
Youth Elk	70	10	1-8, 11-14
Muzzleloader Elk	78	8	1-8, 11-14
General Elk- Any Elk	171	25	1-8, 11-14
General Elk- Antlerless	341	80	1-16
Turkey	150	2	1-5, 15
Pronghorn	3	0	16
Black Bear	31	5	1-5, 12
Desert Bighorn	2 rams	0*	11
Trophy Deer	5	10	1-16
Trophy Elk	5	7	1-16
Mountain Lion	Unlimited	Unlimited	1-16

*Three additional permits are sold by public auctions through the conservation groups, Safari International, Grand Slam/Ovis, and the Wild Sheep Foundation. These auctions are not announced through the annual Navajo Nation Department of Fish and Wildlife Big Game Proclamations.

3.13.2 Recreation

The Navajo Nation offers many recreational activities for its members and the public. The National Parks and Tribal Parks on the Navajo Nation provide rivers, canyons, scenic vistas, mountains and mesas for hiking opportunities, photography, wildlife viewing, fishing, and guided tours. Campgrounds at National and Tribal Parks offer car camping opportunities and numerous backcountry trails and routes can be accessed by backpacking. Several scenic byways, including Diné Biítah; Kayenta-Monument Valley; Naat'tsis'aan (Navajo Mountain); Tse'nikani (Flat Mesa Rock); Trail of the Ancients; and Vermillion Cliffs provide driving opportunities to experience the geology, geography, photography, wildlife viewing and cultural values of the Navajo Nation. The San Juan River provides remote, multi-day river rafting opportunities for private and commercial outfitters.

There are three casinos and one casino resort on the Navajo Nation. Twin Arrows Navajo Casino Resort is a full-service destination casino resort that offers gaming tables, hotel, conference center, entertainment amphitheater, and several restaurants. Northern Edge Navajo Casino, Fire Rock Navajo Casino, and Flowing Water Navajo Casino offer gaming and restaurants.

Transportation corridors to recreation sites provide an unobstructed route for weed species to travel and infest new locations. Vehicles using scenic drives may introduce weeds to areas that previously did not have weeds, by transporting weed seed and plant material on the wheels and the undercarriage. Vehicles using dirt roads may further disturb areas making them more prone to weed infestation. Low impact activities, such as hiking, camping, photography, and wildlife viewing are not likely to further contribute to excess disturbance and weed spread.

3.13.3 Land Use Plans

In 1998 the Tribal Council of the Navajo Nation approved Title 26, The Navajo Nation Local Governance Act (LGA) of the Navajo Nation Code. The purpose of the LGA is to recognize governance at the local level and give Navajo Chapters the authority to adopt ordinances, make decisions regarding local matters, and develop land to meet community needs. In order to achieve this autonomy, chapters must complete a certification process for the "Community Based Land Use Plan (Land Use plan)" by the Transportation and Community Development Committee (TCDC). In order to develop a successful plan, three needs are required, including 1) comply with the Navajo Nation Local Governance Act (LGA); 2) leverage for tribal, state and federal project development funding, and 3) to identify areas of land for community facilities, residential and commercial developments, and preserve grazing, cultural, and open areas (TCDCF-13-02). The plans require the following information: 1) community education and participation plan; 2) community assessment information describing the goals, priorities, and vision for the future of the community; 3) inventory and assessment of pertinent existing natural, cultural, and human resources, land carrying capacity, and community infrastructure; 4) an open space plan; 5) a land use plan; 6) a thoroughfare plan; and 7) a community facilities plan. There are a total of 110 Chapters on the Navajo Nation, of which 98 have completed the Community Based Land Use Plans, and 35 Chapters that are certified (Gardner 2014).

The land use plans provide general information (soils, geology, vegetation, wildlife, water resources, culturally significant areas, environmentally sensitive areas, slope and topography) on selected sites for new development (housing, schools, other basic community development) and future growth. Many Land Use plans discuss the importance of land preservation and restoration to improve grazing, natural resources and soil erosion. Poor rangeland health and a shortage of forage for livestock are recognized by the majority of Land Use plans as an issue that needs to be addressed. Some of the suggestions for addressing poor rangeland health include the need for conservation practices, good land stewardship, grazing rotation, noxious species eradication, and native plant restoration. Chinle Chapter identifies the need to eradicate Russian olive and tamarisk in the canyons, because it prevents customary users from being able to farm (Takahashi Associates 2006).

3.14 Other Values

3.14.1 Noise and Light

Due to the rural location of the Navajo Nation, ambient noise levels and light pollution are relatively low, with increasing noise and light traffic closer to communities. The primary contributors of noise and light pollution include the mining operations, casinos and freeways. As all weed treatments would take place during the day, light pollution is not a concern for this action. However, the different methods and the techniques could contribute to noise pollution depending on the techniques utilized and their duration. The table below describes different noise levels that could be encountered on the Navajo Nation (**Table 3-27**).

Table 3-27. Average noise levels for typical outdoor activities and equipment used for weed management equipment. Humans begin to experience hearing loss when exposed to noises greater than 85 dBA for more than 8 hours. The noise level experienced by an individual largely depends on their distance from the source (NIOSH 2011).

Noise Source	Noise Level (dBA)
Whisper	30
Light Auto Traffic (100 ft)+	50
Normal Conversation	60
Freeway Traffic+	70
Lawnmower	90
Heavy truck (50 ft)+	90
Helicopter*	
Take off	91
Flyover	90
Approach	94
Bulldozer	105
Chainsaw	110

*Source: FAA 2012

+Source: http://www.nonoise.org/resource/educat/ownpage/soundlev.htm

In many areas of the Navajo Nation, the level of noise experienced varies by location and population. More heavily populated areas, such as major towns like Shiprock or Tuba City, will experience higher background noise levels from increased traffic and activity. More remote areas, such as homesites or along river corridors, would experience more natural soundscapes with limited noise from heavy equipment operation or traffic. The impacts of noises from weed treatments will largely depend on where treatments are implemented (remote vs. developed areas) and what treatments are implemented (mechanical vs. manual). How far away an individual or community may be from the source of the noise may also impact how the sound will affect someone.