Saint Mary's University of Minnesota

GeoSpatial Services

New Mexico Environment Department
Surface Water Quality Bureau
Wetlands Program

Mapping and Classification of Wetlands in the Gila Region of Western New Mexico

ON THE COVER
Mountain view in the Gila Study Area, New Mexico.
SMUMN GSS photo.

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Acronyms and Abbreviations

AIH – Aquatic Invertebrate Habitat

BSS – Bank and Shoreline Stabilization

CAR - Carbon Sequestration

CIR – Color Infrared

DEM – Digital Elevation Model

DOQQ - Digital Orthophoto Quarter Quadrangle

DRG – Digital Raster Graphic of United States Geological Survey 1:24,000 scale topographic map

EPA – United States Environmental Protection Agency

Esri – Environmental Systems Research Institute

FH – Fish Habitat

FGDC – Federal Geographic Data Committee

GIS – Geographic Information Systems

GPS – Global Positioning System

GR – Groundwater Recharge

HGM – Hydrogeomorphic

NAD – North American Datum

NAIP – National Agricultural Imagery Program

NMED – New Mexico Environment Department

NMRAM – New Mexico Rapid Assessment Method

NOAA – National Oceanic and Atmospheric Administration

NHD – National Hydrography Dataset

NRCS – Natural Resources Conservation Service

NT – Nutrient Transformation

NWI – National Wetland Inventory

Acronyms and Abbreviations (continued)

OWH – Other Wildlife Habitat

PQAPP - Project Quality Assurance Project Plan

RGB - Red, Green and Blue (true color)

SM – Streamflow Maintenance

SMUMN GSS – Saint Mary's University of Minnesota, GeoSpatial Services

SQL – Structured Query Language

SR – Sediment and Other Particulate Retention

SSURGO – Soil Survey Geographic Database

SWD – Surface Water Detention

SWQB – Surface Water Quality Bureau of New Mexico Environment Department

USDA – United States Department of Agriculture

USACE – United States Army Corps of Engineers

USFS - United States Forest Service

USFWS – United States Fish and Wildlife Service

USGS – United States Geological Survey

UWPC – Unique, Uncommon, or Highly Diverse Wetland Plan Communities

WBIRD – Waterfowl and Water Bird Habitat

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The Gila River within the Gila National Forest in northern Grant County, NM.

Executive Summary

This project is part of a larger effort being undertaken by the New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) Wetlands Program to protect and restore New Mexico's remaining wetlands and to increase self-sustaining, naturally functioning wetlands and riparian areas for the benefit of the state into the future. Funding for the project was provided by the U.S. Environmental Protection Agency (EPA) Region 6 through a Clean Water Act Section 104(b)(3) Wetlands Program Development Grant to NMED.

The project, entitled "Mapping and Classification of Wetlands in the Gila Region of Western New Mexico" used geospatial techniques and image interpretation processes to remotely map and classify wetlands (includes deepwater habitats) and riparian areas in western New Mexico. Wetlands for the project area were mapped and classified using on-screen digitizing methods in a Geographical Information System (GIS). This process was supported by development of a selective image interpretation key that resulted from field verification of image signatures and wetland classifications. Wetland image interpretation employed a variety of input image and collateral data sources as well as field verification techniques. All mapping was completed at an on-screen scale of 1:12,000 or larger in compliance with national wetland mapping standards (FGDC 2009).

Wetlands were mapped in compliance with the Federal Geographic Data Committee (FGDC) Wetlands Mapping Standard (FGDC 2009) which uses the National Wetlands Inventory (NWI) classification system developed by Cowardin et.al. (1979). Simultaneously, wetland features were assigned codes from the Landscape Position, Landform, Water Flow Path, and Water body Type (LLWW) classification system developed by Tiner (2011). To add richness to the wetland data, wetlands were also characterized by hydrogeomorphic (HGM) descriptors developed by Brinson (1993), and then correlated to a variety of potential wetland functions. Lastly, riparian areas were mapped, often adjacent to floodplain wetlands, using A System for Mapping Riparian Areas in the Western United States developed by Dick et al. (USFWS 2009).

The project area was just over 8.1 million acres in size. Based on the final wetland mapping, 7,967,695 acres (~98.3%) of the study area is upland habitat and 139,203 acres (~1.7%) is a combination of wetland, deepwater habitat, and riparian area habitat. Riverine system wetlands make up 67% of the wetland area, palustrine 21%, and lacustrine 12%.

Classification of wetlands using the FGDC Wetlands Mapping Standard, combined with the addition of LLWW descriptors and the development of a wetland functional correlation table for New Mexico, provided the opportunity to assign functional attributes to all wetland habitats in the project area. The functional assessment schema was developed through a 'best professional judgment' exercise utilizing a consensus of local, regional and national wetland biologists and natural resource professionals plus local stakeholders who were familiar with wetland habitats in the project area. The first step in this process was to develop group agreement on which wetland functions were important to assess for the project area. The group was then asked to document the wetland characteristics that were representative of specific functions and to correlate them to both NWI and LLWW codes. Finally, wetlands were categorized as either high or moderate for the performance of specific functions relative to other wetlands in the project area.

Wetland functions that were assessed within this project study area included:

1. Surface Water Detention;
2. Streamflow Maintenance;
3. Groundwater Recharge;
4. Carbon Sequestration;
5. Nutrient Transformation;
6. Sediment and Other Particulate Retention;
7. Bank and Shoreline Stabilization;
8. Fish Habitat;
9. Aquatic Invertebrate Habitat;
10. Waterfowl and Water Bird Habitat;
11. Other Wildlife Habitat; and,
12. Unique, Uncommon, or Highly Diverse Wetland Plant Communities.

Results from the wetland functional assessment indicated that Groundwater Recharge (GR) and Other Wildlife Habitat (OWH) were the most common wetland functions performed at a high level in the project area, at 67.4% and 48.5% of wetland acreage, respectively. Performance of Sediment & Other Particulate Retention (SR) and Surface Water Detention (SWD) at a moderate level were also common, representing 17.1% and 16.3% of wetland acreage, respectively. The least common functions performed include Stream-flow Maintenance (SM); Unique, Uncommon, or Highly Diverse Wetland Plant Communities (UWPC); and Bank & Shore Stabilization (BSS). These functional assessments are summarized and displayed in map form in the results section of this report (beginning with Figure 25 on p. 66) to provide a better understanding of the processes occurring in the watersheds across the project area.

The data and information developed through this mapping project supports several conclusions. Most importantly, there are a considerable number of wetlands across this portion of western New Mexico (over 31,000) and they are providing a wide range of important ecological functions. Secondly, when attempting to adapt mapping methodologies based on regional and local conditions, it is essential to involve local, regional, and national experts plus local stakeholders in the mapping and assessment processes.

It is important to incorporate both field evaluations (qualitative and quantitative) and collateral spatial data sources in order to support decisions related to wetland delineation, classification, and function. This is especially true in a semi-arid environment such as southern New Mexico, which experienced abnormally dry and moderate drought conditions during 2018 (NDMC 2020).

Finally, this is a landscape level mapping project and the resulting data should be used to support decision making at that scale. It is appropriate to use these data as a guide for further field data collection and investigation but not for site-specific compliance, restoration or mitigation activities.

Introduction

In 2017, the NMED SWQB identified a need to update and improve existing wetland information and to remotely map and classify wetlands and riparian areas of the Gila Region of Western New Mexico. Before the issuance of this request, this geographic region of New Mexico had no accurate or up-to-date wetland data. In response, the Gila region wetland mapping and classification project was initiated. As with previous New Mexico mapping projects (e.g., Jemez Mountains, Sacramento Mountains), the goal was to gather wetland information about watersheds in the Gila region utilizing a GIS-based approach in preparation for future planning, management, and protection efforts.

Given that wetland mapping in the project area was lacking, completion of this landscape level inventory process was important so that SWQB could continue the work of preserving and restoring the wetlands and riparian areas. This project was completed using modern aerial imagery, up-to-date geospatial technology, and in compliance with the Wetland Mapping Standards outlined by the FDGC (2009).

Work on this project, entitled “Mapping and Classification of Wetlands in the Gila Region of Western New Mexico,” was contracted by the NMED SWQB Wetlands Program to Saint Mary’s University of Minnesota’s Geospatial Services (SMUMN GSS) project center. The mapping began in 2019 and was initially completed in 2020. The decision was then made to update the mapping to NWI 2.0 (USFWS 2020), which was completed in 2021.

GeoSpatial Services operates as a Saint Mary’s University of Minnesota project center and provides consulting and data development services focused on wetland mapping and classification, natural resource management and GIS technology. SMUMN GSS is a key partner with the U.S. Fish and Wildlife Service (USFWS) and other state and local agencies working to provide comprehensive digital NWI for the conterminous United States and Alaska. SMUMN GSS was uniquely qualified to complete the project, having experience mapping wetlands in arid and semi-arid regions of the country. The project also relied on the collaborative input of local, regional and national wetland experts.

Project accomplishments include the completion of the NWI using the Wetlands Deepwater Habitats Classification (Cowardin et al. 1979) for all wetlands in the 8.1 million acre project area. Other tasks completed included the development and application of the LLWW classification tailored for arid region wetlands (Tiner 2011), riparian area classification (USFWS 2009), assignment of 12 potential functional attributes to appropriate wetlands, and the preliminary assignment of HGM wetland subclasses (after Brinson 1993). Each of these tasks satisfies wetland mapping standards established by the FGDC (FGDC 2009).

The utilization of geospatial concepts, map composition, metadata, aerial imagery, chart creation and geo-processing enhanced the completed project’s products. This project provides the NMED SWQB Wetlands Program with new and improved tools to protect and restore New Mexico’s remaining wetlands and riparian areas and to increase self-sustaining, naturally functioning wetlands and riparian areas for the benefit of water management in New Mexico. The information provided by this project also contributes to general watershed data for the State of New Mexico and to the development of mapping techniques for future wetland updates. This project can be used for more comprehensive water resource management and planning efforts or similar work that might be undertaken across New Mexico to improve knowledge of existing wetland areas and their functions. This project provides significant support for other habitat and water quality initiatives across southern New Mexico's watersheds.

A spring-fed wetland northwest of Silver City in Grant County, NM (SMUMN GSS photo, August 2018)

Background

The purpose of this project was to map and classify wetlands (including deepwater habitats) and riparian areas in the Gila Region of Western New Mexico. The project area spans approximately 8.1 million acres, creating an irregular-shaped rectangle comprised of 205 USGS 7.5 minute quadrangles (quads). The project area stretches from around Silver City in the south to Fence Lake in the north, and from the New Mexico-Arizona state line in the west to Elephant Butte Reservoir in the east. It includes portions of Cibola, Catron, Socorro, Sierra, Grant, Hidalgo, and Luna Counties. The project area also includes the Gila National Forest as well as the Gallo, San Francisco, and Mogollon Mountains.

Just over 31,700 polygons representing wetlands greater than one-quarter acre in size (FDGC 2009) were mapped and classified, totaling 133,361 acres (208 sq mi). The polygonal wetland features and deepwater habitat features include marshes, floodplains, cienagas, lakes and ponds, playas, rivers. Lastly, riparian polygon features are transition zones between rivers or lakes and upland; 2,566 features equaling approximately 5,840 acres (9 sq. mi) of riparian areas were captured. Figure 1 displays the wetland polygons and riparian areas in the Gila study area.

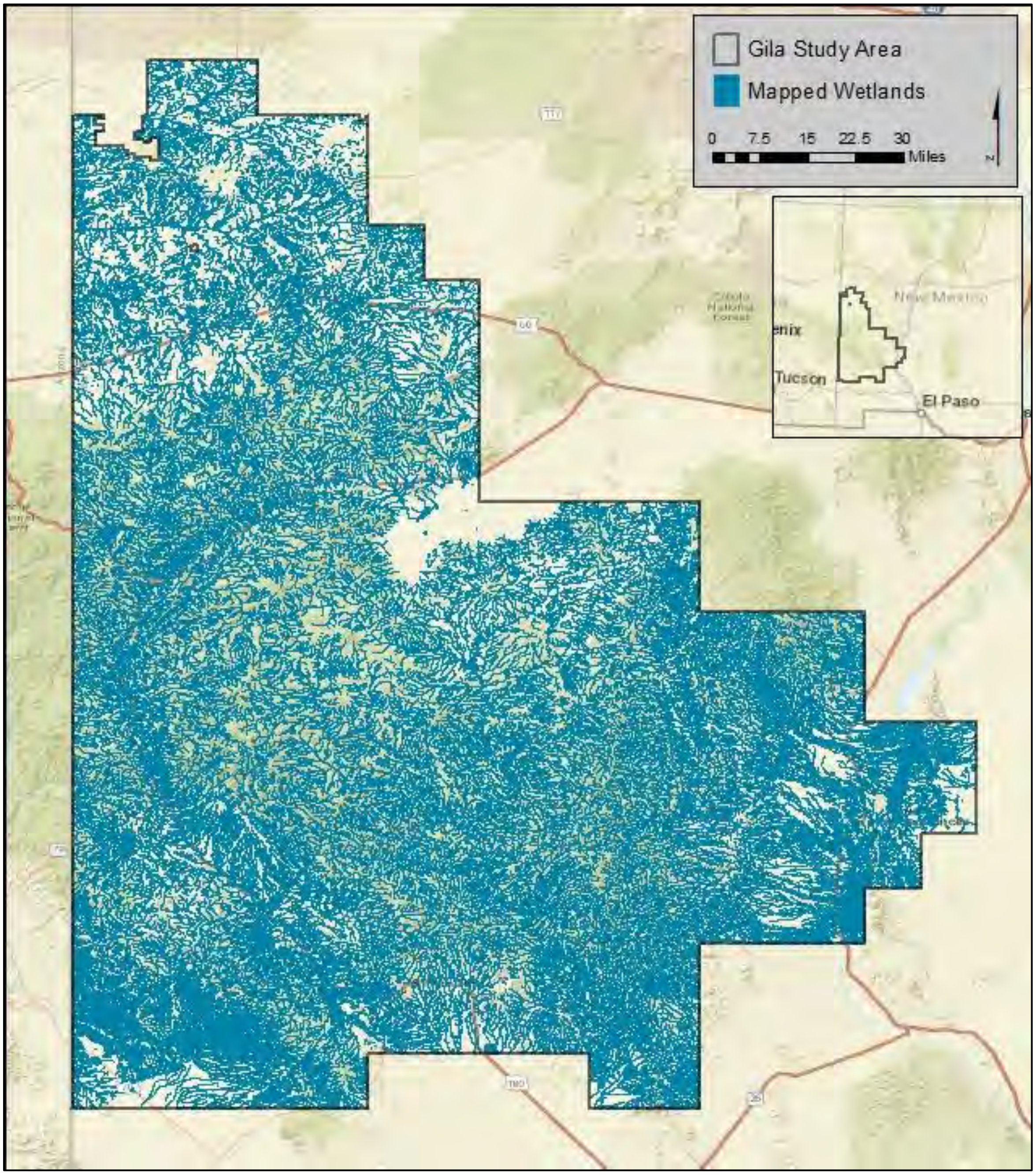


Figure 1. Gila study area with recently updated polygonal wetland features.

Geography

The topography of the project area includes the Rio Grande Valley in the east, mountains in the central and western portions, and the Colorado Plateau in the north. It includes portions of four different physiographic provinces: Basin and Range, Rio Grande Rift, Mogollon Datil Volcanic Field, and the Colorado Plateau (Figure 2; NMBGMR 2019). The Basin and Range province on the southern edge of the Gila study area is characterized by narrow mountain ranges separated by broad basins, where water may collect in sizable lakes and playas during wet years. The Rio Grande Rift is a north-to-south zone in the middle of the state that has formed as the Colorado

Plateau “pulls away” from the High Plains province to the east, causing the earth’s crust to stretch and thin (NMBGMR 2019). Large amounts of rift sediment have settled in the province’s basins, forming critical aquifers for several large cities. The Mogollon Datil Volcanic Field lies north of the Basin and Range, and consists of lavas and tuffs that erupted from volcanoes and calderas between 24 and 40 million years ago. It contains the highest point in southwestern New Mexico, “Whitewater Baldy”, at 10,895 ft. The Colorado Plateau covers the northwest portion of the state and of the Gila project area. It is characterized by relatively flat, colorful sedimentary rocks that have been shaped into mesas, buttes, and other erosive features by water over time.

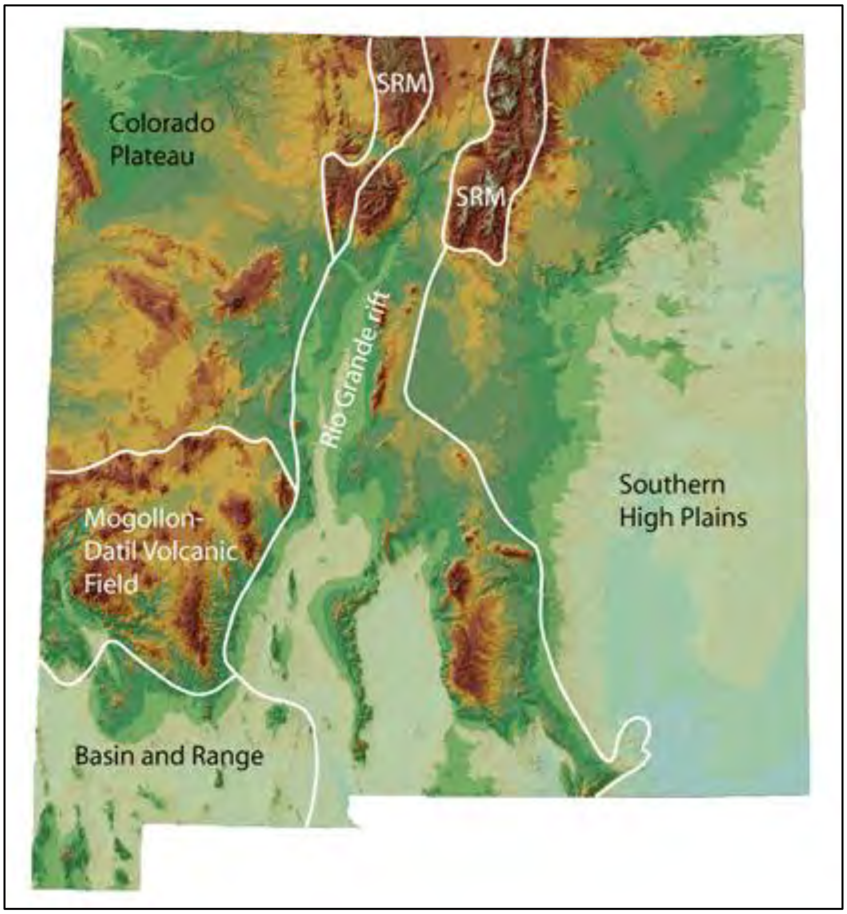


Figure 2. The physiographic provinces of New Mexico (NMBGMR 2019). SRM = Southern Rocky Mountains.

Watersheds (Subbasins)

The western portion of the project area lies within the Lower Colorado watershed (Hydrologic Unit Code [HUC] 15), and the eastern portion falls in the Rio Grande watershed (HUC 13). The Lower Colorado is represented by eight subbasins (8-digit HUCs): Little Colorado Headwaters, Upper Little Colorado, Carrizo Wash, Zuni, Upper Gila, Animas Valley, Upper Gila-Mangas, and San Francisco (Figure 3). This area includes the headwaters of the Gila River, which flows west across Arizona and joins the Colorado River near Yuma.

The Rio Grande watershed is represented by seven subbasins (8-digit HUCs): Mimbres, El Paso-Las Cruces, Caballo, Jornada Draw, Elephant Butte Reservoir, Plains of San Agustin, and North

Plains (Figure 3). The Rio Grande flows through the far eastern portion of the project area, and two river impoundments fall within project boundaries: the Caballo Reservoir and Elephant Butte Reservoir.

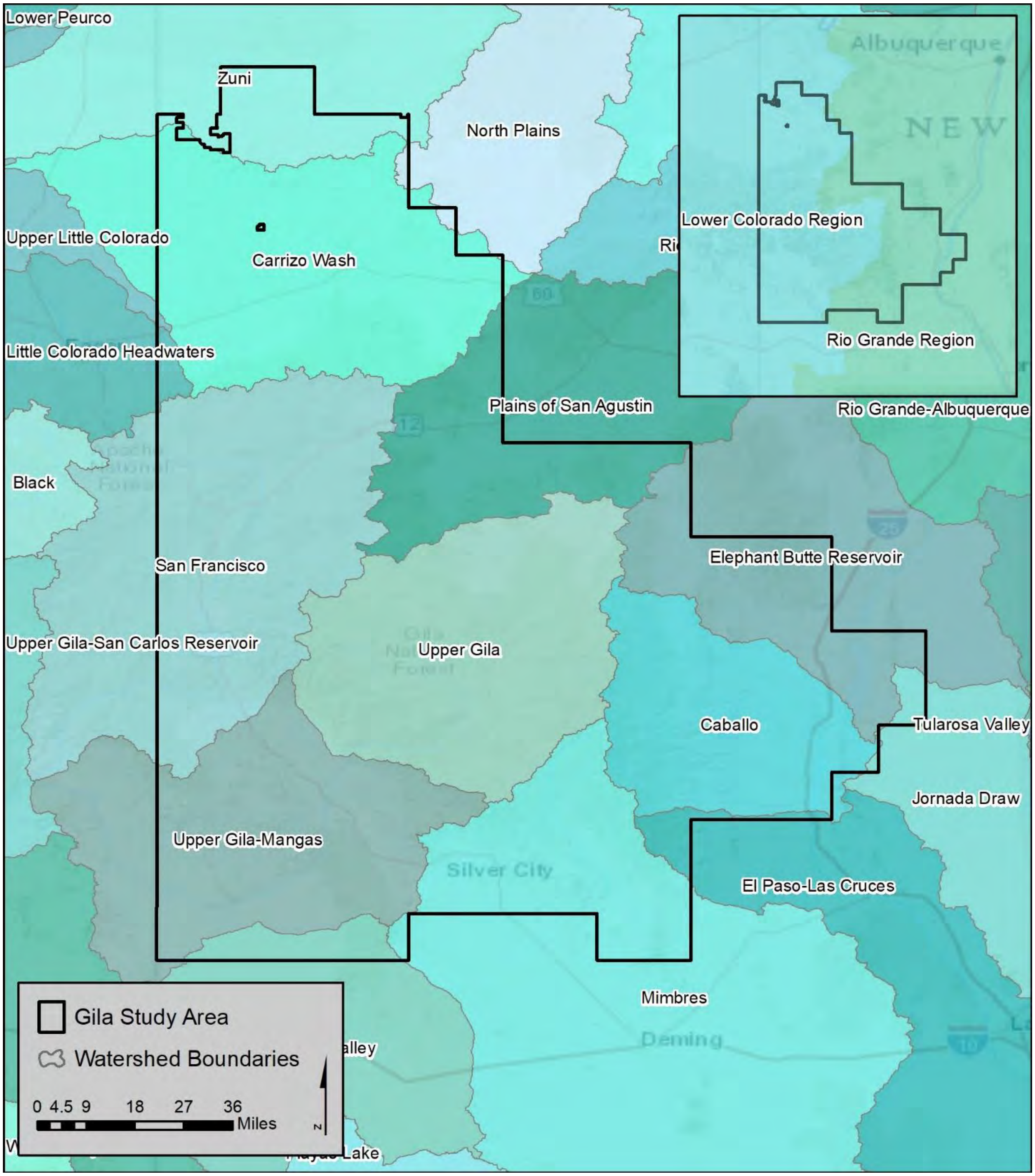


Figure 3. Sub-basins (8-digit HUCs) in the Gila Study Area.

Climate

The climate of New Mexico is continental and relatively mild, with seasonal temperature variation, low relative humidity, and light precipitation totals (NM Climate Center 2019). Temperatures and precipitation in western New Mexico typically vary with elevation. Areas of higher elevation, such as the many mountain ranges, can receive substantially more precipitation than lower-lying areas. This is illustrated by 30-year climate normals (1980-2010) for localities in the region (Table 1). The town of Truth or Consequences, at a lower elevation in the eastern portion of the study area (Figure 4), averaged 10.9 inches of annual precipitation and a mean annual temperature of 62°F (NCEI 2020). Luna, at a higher elevation on the state's western border, averaged 18.1 inches of precipitation annually with a mean temperature around 48°F. Fort Bayard, on the southern end of the study area at a mid-elevation, averaged 17.0 inches of precipitation annually and a mean temperature of 59°F (NCEI 2020).

Table 1. 30-year climate normals for towns within or near the Gila study area (NCEI 2020).

Town	Elevation (ft)	Mean days max ≥ 90°F	Mean days min ≤ 32°F	Annual mean (°F)	Total annual precipitation (in)
Truth or Consequences	4,296	94.9	82.0	61.5	10.9
Fort Bayard	6,099	36.1	61.0	59.2	17.0
Luna	7,050	9.9	220.9	47.5	18.1

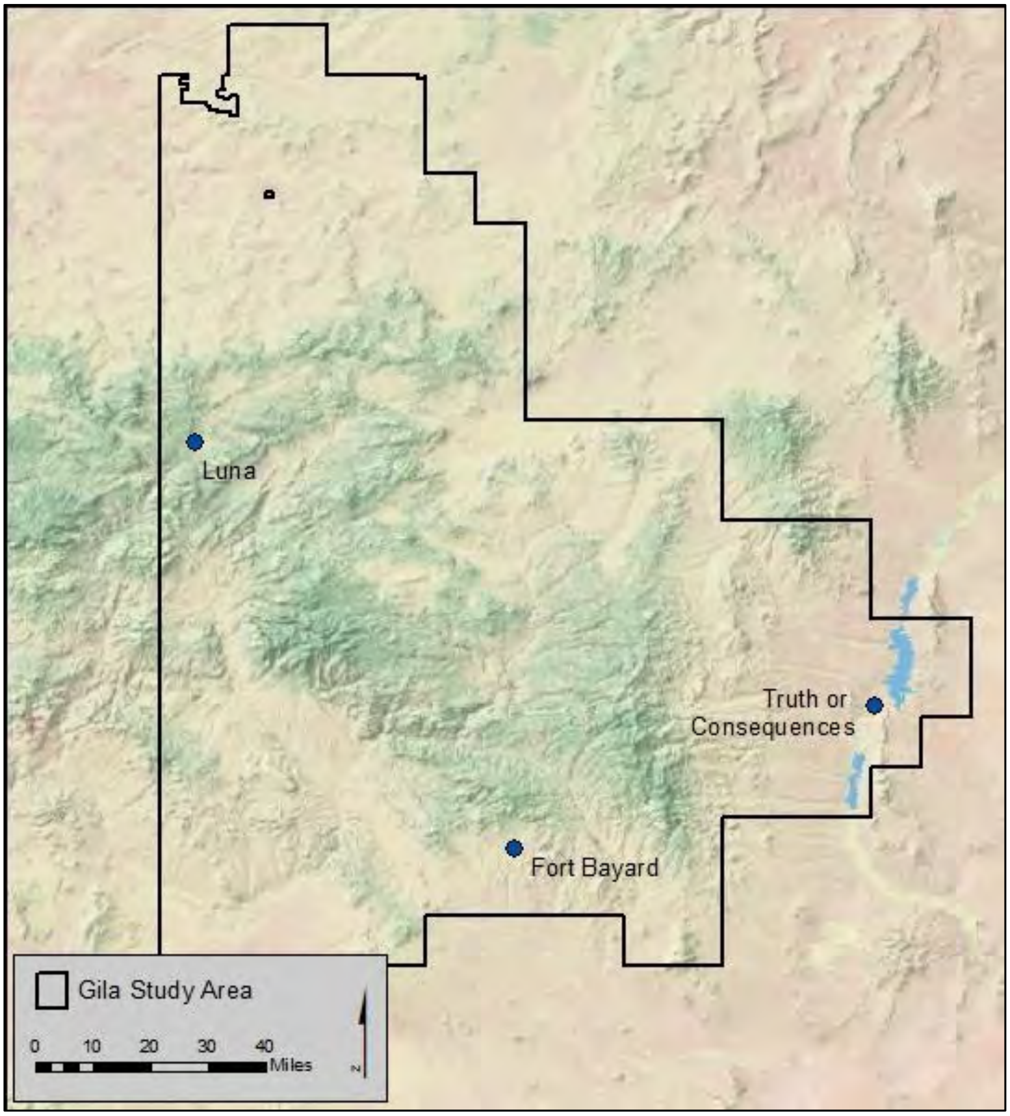


Figure 4. Location of climate stations included in Table 1.

Soil

Soil data provides valuable information to image interpreters during the wetland mapping and classification process. Of most importance was the consideration of hydric soils located in the project area which, along with certain vegetation, become indicators for wetland delineation and classification. Soils in the Gila project area can vary greatly due to factors such as elevation, underlying geology, and climate. The most common soils include mollisols (e.g., haplostolls, argiborolls), entisols (e.g., ustorthents, torrifluvents), and aridisols (e.g., haplargids). Entisols occur in areas of recently deposited sediments such as active floodplains, where there is little soil development beyond a topsoil horizon (SSSA 2020). Aridisols, as the name implies, occur in dry climates and often contain accumulations of salt, gypsum, or carbonates. Mollisols are fertile grassland soils often found at higher elevations in climates with pronounced dry seasons. Their surface soil horizons are typically dark from the annual accumulation of organic matter to the soil from plant roots (SSSA 2020). According to NRCS soil mapping, 18 different soil types occur within the project area (NRCS 2012). The major soil types (by percent of total area) are presented in Table 2.

Table 2. Major soil types in the Gila project area (NRCS 2012).

Soil type	% of total area
Haplustolls-Argiustolls-Rockland	20.1
Argiborolls-Cryoborolls-Ustorthents	12.7
Torrifluvents-Calciorthids-Torriorthents	11.2
Haplargids	10.7
Argiustolls-Haplargids-Rockland	8.2
Haplargids-Rough Broken Land	6.0
Rockland-Haplargids	5.3
Argiustolls-Haplustolls-Rockland	4.5
Haplargids-Torripsamments	4.3
Haplargids-Torrithents-Rockland	3.9
Haplargids-Torriorthents	3.2
Haplargids-Haplustolls-Rockland	2.2
Calciorthids-Paleorthids	2.0
Haplargids-Paleargids	1.8
Torrifluvents-Haplargids-Haplustolls	1.6
Camborthids-Torriorthents	1.2
Torrerts-Torriorthents	0.8
Gypsiorthids-Torriorthents-Gypsum Land	0.3

Ecoregions

The Gila project area contains three Level III ecoregions: the Arizona/New Mexico Mountains, the Arizona/New Mexico Plateau, and the Chihuahuan Desert. Within those Level III ecoregions, there are 11 Level IV ecoregions (Figure 5).

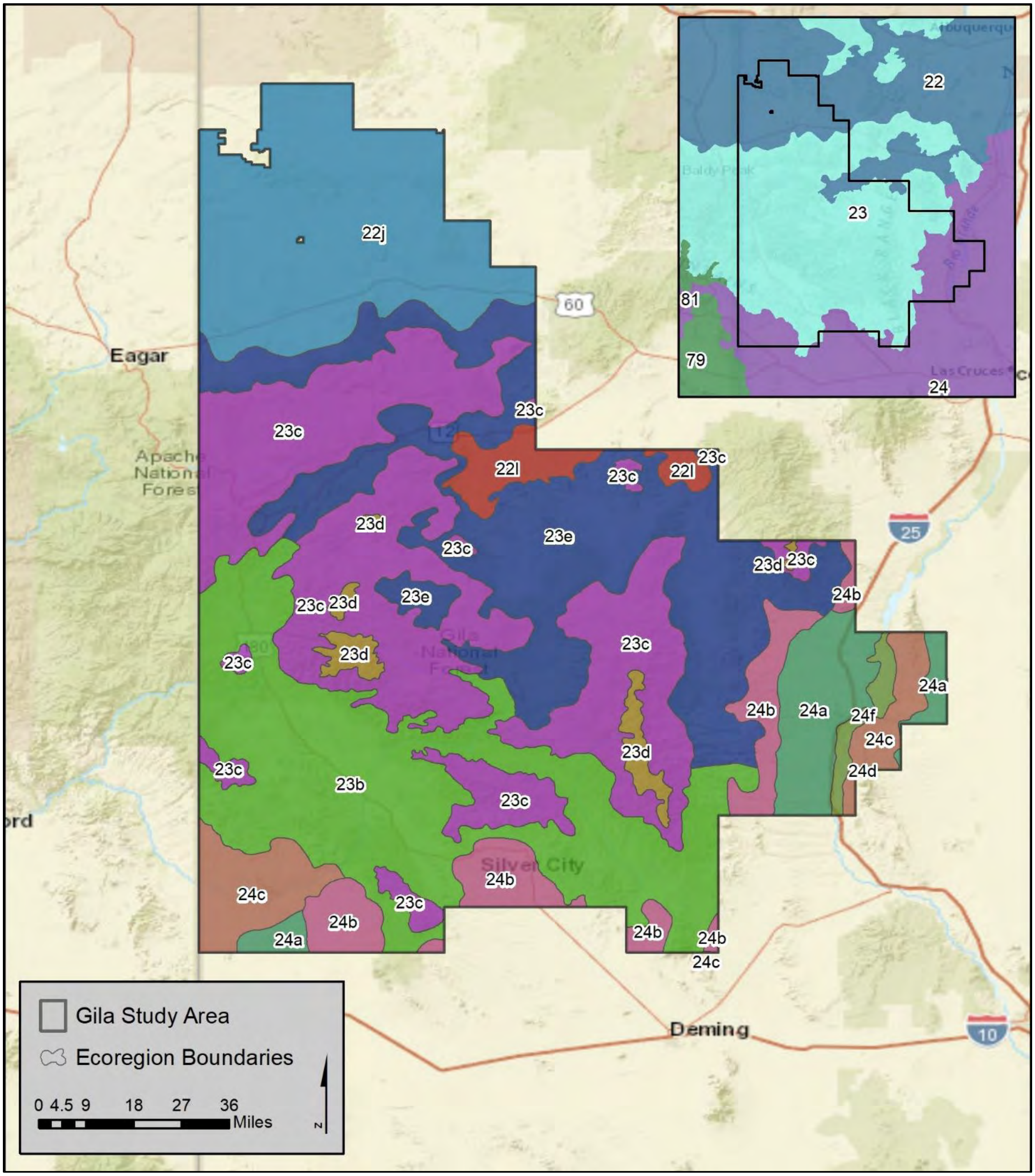


Figure 5. Level IV Ecoregions in the study area (main map) and Level III Ecoregions (small inset map).

Level IV Ecoregions (*Main Map*)			
Code	Name	Code	Name
22j	Semiarid Tablelands	24c	Low Mountains and Bajadas
22l	Plains of San Agustin	24d	Chihuahuan Montane Woodlands
23b	Madrean Lower Montane Woodlands	24f	Rio Grande Floodplain
23c	Montane Conifer Forests	**Level III Ecoregions (Inset Map)**	

23d	Arizona/New Mexico Subalpine Forests	22	Arizona/New Mexico Plateau
23e	Conifer Woodlands & Savannas	23	Arizona/New Mexico Mountains
24a	Chihuahuan Basins and Playas	24	Chihuahuan Deserts
24b	Chihuahuan Desert Grasslands		

The following descriptions of ecoregions come from Griffith et al. (2006).

The Arizona/New Mexico Plateau (Ecoregion 22)
The Arizona/New Mexico Plateau represents a large transitional region between the drier shrublands and wooded higher relief tablelands of the Colorado Plateaus in the north, the lower, hotter, less vegetated Mojave Basin and Range in the west, and forested mountain ecoregions that border the region on the northeast and south. Local relief in the region varies from a few feet on plains and mesa tops to well over 1,000 feet along tableland side slopes. The Continental Divide splits the region, but is not a prominent topographic feature. The region extends across northern Arizona, northwestern New Mexico, and into Colorado in the San Luis Valley.

Level IV Ecoregions within the Arizona/New Mexico Plateau:

Semiarid Tablelands (22j)
The Semiarid Tablelands consists of mesas, plateaus, valleys, and canyons formed mostly from flat to gently dipping sedimentary rocks, along with some areas of Tertiary and Quaternary volcanic fields. The region contains areas of high relief and some low relief plains. Bedrock exposures are common. Grass, shrubs, and woodland cover the tablelands. The vegetation is not as sparse as in Ecoregion 22i to the north or 22m to the east. It lacks the denser pine forests of the higher and more mountainous Ecoregion 23. Scattered junipers occur on shallow, stony soils, and are dense in some areas. Pinyon-juniper woodland is also common in some areas. Saltbush species, alkali sacaton, sand dropseed, and mixed grama grasses occur.

Plains of San Agustin (22l)
The Plains of San Agustin are mostly a topographically closed basin, with some alluvial fans and piedmont slopes near the surrounding mountains of Ecoregion 23. Beach and lacustrine deposits mark various stages of Pleistocene Lake San Agustin. Clay to fine-grained sand lake bed sediments, linear beach-ridge sand deposits, and some sand sheets and dune sand deposits occur. The sandy areas are mostly stabilized by grasses and low shrubs. Vegetation of alkali sacaton, fourwing saltbush, and greasewood is found in the low areas. Some western wheatgrass, vine-mesquite, areas of blue grama and sand dropseed occur. Higher elevation slopes have some pinyon-juniper savanna with an understory of blue grama, dropseeds, Indian ricegrass, and bottlebrush squirreltail grasses. Livestock grazing is the predominant land use.

The Arizona/New Mexico Mountains (Ecoregion 23)
The Arizona/New Mexico Mountains are distinguished from neighboring mountainous ecoregions by their lower elevations and associated vegetation indicative of drier, warmer environments, due in part to the region's more southerly location. Forests of spruce, fir, and Douglas-fir, common in the Southern Rockies (21) and the Wasatch and Uinta Mountains (19), are only found in limited areas at the highest elevations in this region. Chaparral is common at lower elevations in some areas, pinyon-juniper and oak woodlands are found at lower and middle elevations, and the higher elevations are mostly covered with open to dense ponderosa pine forests. These mountains are the northern extent of some Mexican plant and animal species.

Surrounded by deserts or grasslands, these mountains in New Mexico can be considered biogeographical islands.

Level IV Ecoregions within the Arizona/New Mexico Mountains:

Madrean Lower Montane Woodlands (23b)

The Madrean Lower Montane Woodlands ecoregion covers the slopes of the Guadalupe, Sacramento, Mimbres, Big Burro, and Mogollon mountains, generally between 5,500 to 7,200 feet, with densities of juniper, pinyon pine, and oak varying according to aspect. There are some similarities to Ecoregion 23e; however, Ecoregion 23b has milder winters, wetter summers, and inclusions of alligator juniper and Madrean evergreen oak species. At middle elevations, dense thickets of shrubs such as desert ceanothus, alderleaf mountain mahogany, and catclaw mimosa form chaparral communities. Other areas are grassy and park-like with scattered trees. A few small areas of ponderosa pine, Douglas-fir, or southwestern white pine occur at the highest elevations, outliers of Ecoregions 23c or 23f. In the west, the Gila River and tributaries have many endemic aquatic organisms including fish, amphibians, and insects.

Montane Conifer Forests (23c)

The Montane Conifer Forests are found west of the Rio Grande at elevations from about 7,000 to 9,500 feet. Ponderosa pine and Gambel oak are common, along with mountain mahogany and serviceberry. Some Douglas-fir, southwestern white pine, and white fir occur in a few areas. Blue spruce may occasionally be found in cool, moist canyons. The influence of the Sierra Madre flora is seen mostly in the southern mountains and diminishes to the north. In the far south, other oaks appear, such as silverleaf oak, netleaf oak, Arizona white oak, and Emory oak. The summer rains are especially important for herbaceous plants. The region is geologically diverse with volcanic, sedimentary, and some intrusive and crystalline rocks. Endemic Gila trout occur in some of the region’s streams. Livestock grazing, logging, and recreation are the primary land uses. Wildfire is an important feature influencing the forested ecosystems in this region.

Arizona/New Mexico Subalpine Forests (23d)

The Arizona/New Mexico Subalpine Forests occur west of the Rio Grande at the higher elevations, generally above 9500 feet. The region includes parts of the Mogollon Mountains, Black Range, San Mateo Mountains, Magdalena Mountains, and Mount Taylor. The peak elevations are mostly above 10,000 feet. Although there are some vegetational differences from mountain range to mountain range within Ecoregion 23d, the major forest trees include Engelmann spruce, corkbark fir, blue spruce, white fir, and aspen. Some Douglas-fir occurs at lower elevations. Cryic soils developed on the mixed geology of mostly Tertiary volcanics and Tertiary intrusives, with only minor areas of Precambrian rocks in the Black Range.

Conifer Woodlands and Savannas (23e)

The Conifer Woodlands and Savannas ecoregion is an area of mostly pinyon-juniper woodlands, with some ponderosa pine at higher elevations. It often intermingles with grasslands and shrublands. Although elevations are higher than surrounding Ecoregion 22 areas, the boundaries tend to be transitional. The region is generally cooler, with more uniform winter and summer seasonal moisture compared to the Madrean Lower Montane Woodlands at lower elevations. It also lacks the milder winters, wetter summers, chaparral, Madrean oaks, and other species of those montane woodlands.

Chihuahuan Deserts (Ecoregion 24)

This desert ecoregion extends from the Madrean Archipelago (79) in southeast Arizona to the Edwards Plateau (30) in south-central Texas. It is the northern portion of the southernmost desert in North America that extends more than 500 miles south into Mexico. The physiography is generally a continuation of basin and range terrain that is typical of the Mojave Basin and Range (14) and the Central Basin and Range (13) ecoregions to the west and north, although the pattern of alternating mountains and valleys is not as pronounced as it is in Ecoregions 13 and 14. The mountain ranges (sky islands) are a geologic mix of Tertiary volcanic and intrusive granitic rocks, Paleozoic sedimentary layers, and some Precambrian granitic plutonic rocks. Outside the major river drainages, such as the Rio Grande and Pecos River, the landscape is largely internally drained. Vegetative cover is predominantly desert grassland and arid shrubland, except for high elevation islands of oak, juniper, and pinyon pine woodland. The extent of desert shrubland is increasing across lowlands and mountain foothills due to gradual desertification caused in part by historical grazing pressure.

Level IV Ecoregions within the Chihuahuan Deserts:

Chihuahuan Basins and Playas (24a)

The Chihuahuan Basins and Playas include alluvial fans, internally drained basins, and river valleys mostly below 4500 feet. The major Chihuahuan basins formed during Tertiary Basin and Range tectonism when the Earth's crust stretched and fault collapse resulted in sediment-filled basins. These low elevation areas are some of the hottest and most arid habitats in the state. The playas and basin floors have saline or alkaline soils and areas of salt flats, dunes, and windblown sand. The typical desert shrubs and grasses, the dominant creosotebush, along with tarbush, fourwing saltbush, acacias, gyp grama, and alkali sacaton, must withstand large seasonal and diurnal ranges in temperature, low available moisture, and a high evapotranspiration rate. Horse crippler and other cacti are common. Bitter Lake near Roswell is a biologically significant wetland area. It has a high diversity of dragonflies and damselflies, including the continent's largest and smallest dragonfly species.

Chihuahuan Desert Grasslands (24b)

The Chihuahuan Desert Grasslands occur in areas of fine-textured soils, such as silts and clays, that have a higher water retention capacity than coarse-textured, rocky soil. The grasslands occur in areas of somewhat higher annual precipitation (10 to 15 inches) than the Chihuahuan Basins and Playas (24a), such as elevated basins between mountain ranges, low mountain benches and plateau tops, and northfacing mountain slopes. Grasslands were once more widespread, but heavy grazing in the late 19th and early 20th centuries was unsustainable, and desert shrubs invaded where the grass cover became fragmented. In grassland areas with lower rainfall, areal coverage of grasses may be sparse, 10% or less. Some areas are now mostly shrubs as grasslands continue to decline due to erosion, drought, and climatic change. Typical grasses are black, blue, and sideoats grama, dropseeds, bush muhly, and tobosa, with scattered creosotebush, and prickly pear and cholla cacti.

Low Mountains and Bajadas (24c)

The Low Mountains and Bajadas include several disjunct hilly areas that have a mixed geology. The mountainous terrain has shallow soil, exposed bedrock, and coarse rocky substrates. Alluvial fans of rubble, sand, and gravel build at the base of the mountains and often coalesce to form bajadas. Vegetation includes mostly desert shrubs, such as sotol, lechuguilla, yucca, ocotillo, lotebush, tarbush, and pricklypear, with a sparse intervening cover of black grama and other grasses. At higher elevations, there may be scattered one-seeded juniper and pinyon pine. Strips of gray oak, velvet ash, and little walnut etch the patterns of intermittent and ephemeral drainages, and oaks may spread up north-facing slopes from the riparian zones.

Chihuahuan Montane Woodlands (24d)

The Chihuahuan Montane Woodlands ecoregion comprises the higher elevation mountainous areas, generally above 5,000 or 6,000 feet. These include the Chisos, Davis, Glass, and Apache mountains of Texas and the Organ, Florida, San Andres, and Oscura mountains of New Mexico. Increased precipitation in the mountains supports woodland areas except on sunny, exposed slopes that may have grass and chaparral only. Oaks, junipers, and pinyon pines predominate on all these mountain ranges. At lower elevations they occur in canyons and shaded hollows, and with increasing elevation and moisture levels, form more dense woodlands. Coniferous forests are limited in extent; some ponderosa pine, southwestern white pine, and relict Douglas-fir grow at the highest elevations in a few areas. In these higher ranges, trees sometimes grow with a grassy understory, or with a brush cover of bigtooth maple, madrone, little walnut, oak chaparral, and grapevines. The higher mountainous areas are a major refuge for larger ungulates, such as mule deer and desert bighorn sheep.

Rio Grande Floodplain (24f)

The Chihuahuan Desert portion of the Rio Grande Floodplain has some similarities to Ecoregion 22g upstream. Hydrology has been altered by upstream impoundments, by Elephant Butte and Caballo reservoirs, and by channelization in this region. Annual flooding of terraces and benches has been eliminated. Riparian woodlands and shrublands have been greatly reduced and invasive salt cedar has expanded. Narrow bands of cropland, orchards, vineyards, and small farms occur in portions of this ecoregion. The southern Rio Grande valley in New Mexico is still an important wintering area for sandhill cranes, snow geese, and other migratory waterfowl. Urban land uses are spreading in the Las Cruces and El Paso areas. Drought, aquifer depletion, and agricultural irrigation create water supply concerns in Texas and Mexico.

Land Ownership and Use

The land in the Gila project area is divided between private and public ownership. The majority of public lands in the study area are managed by the U.S. Forest Service (USFS) and the BLM (Figure 6). The remaining public land is owned by the New Mexico state government, the National Park Service (NPS), and the Department of Defense (DOD). Most of the forested land in the project area lies in the Gila National Forest and is managed by the USFS. The Gila National Forest includes three wilderness areas totaling 792,584 acres, which is more wilderness than any other National Forest in the Southwest (USFS 2020).

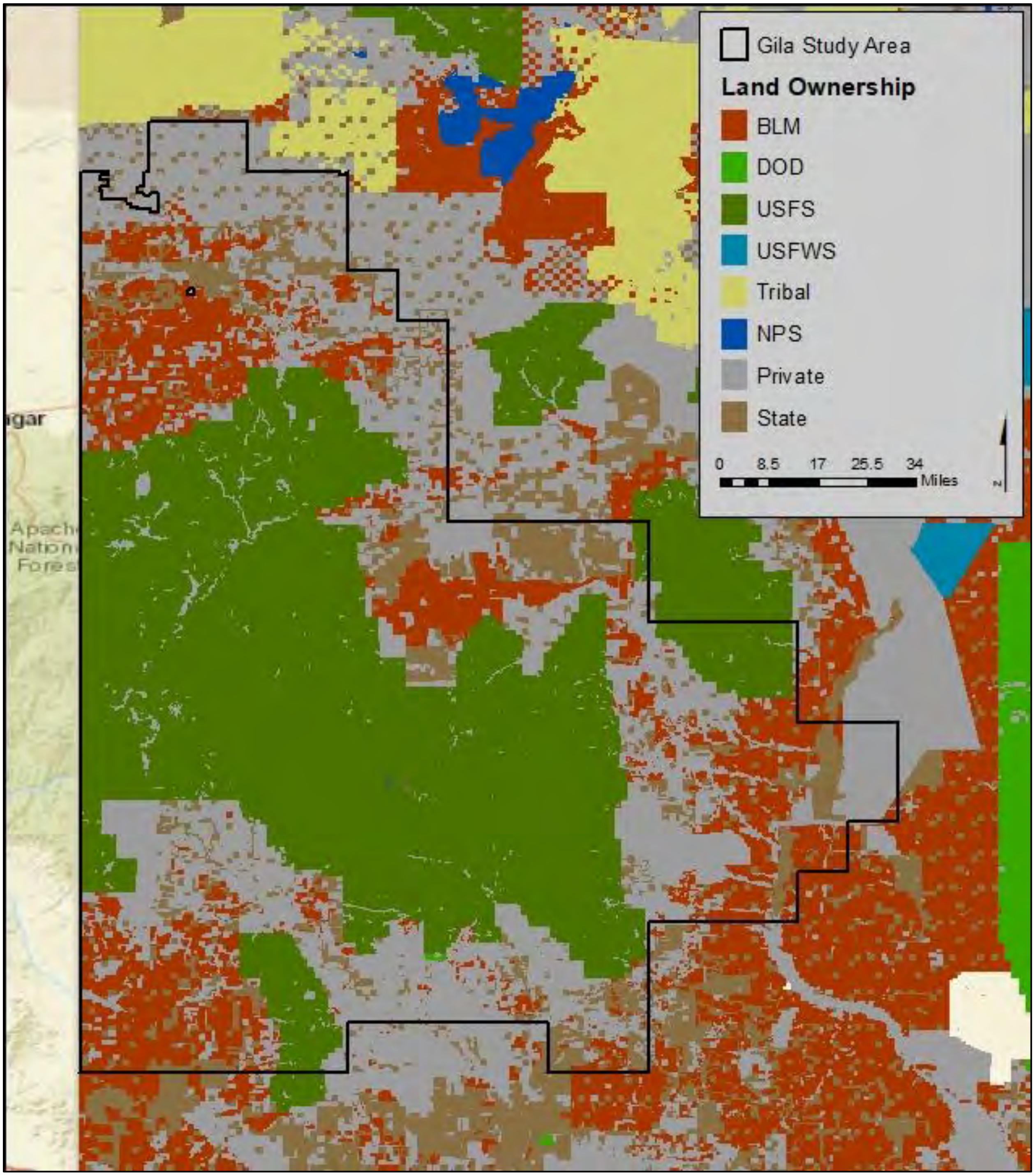


Figure 6. Land ownership in the Gila project area (BLM 2021).

As of 2016, the most common land cover types in the project area were shrub/scrub (46%) and evergreen forest (40%) (USGS 2019). Herbaceous cover accounts for nearly 13% of all lands while developed lands cover just 0.5% of the MRG study area, mainly in and around Silver City and Truth or Consequences. Agricultural uses (pasture, hay, crops) account for <1% of land cover, primarily concentrated along the Gila River in the southwest corner of the project area (USGS 2019). A generalized land cover/land use map of the study area is provided in Figure 7.

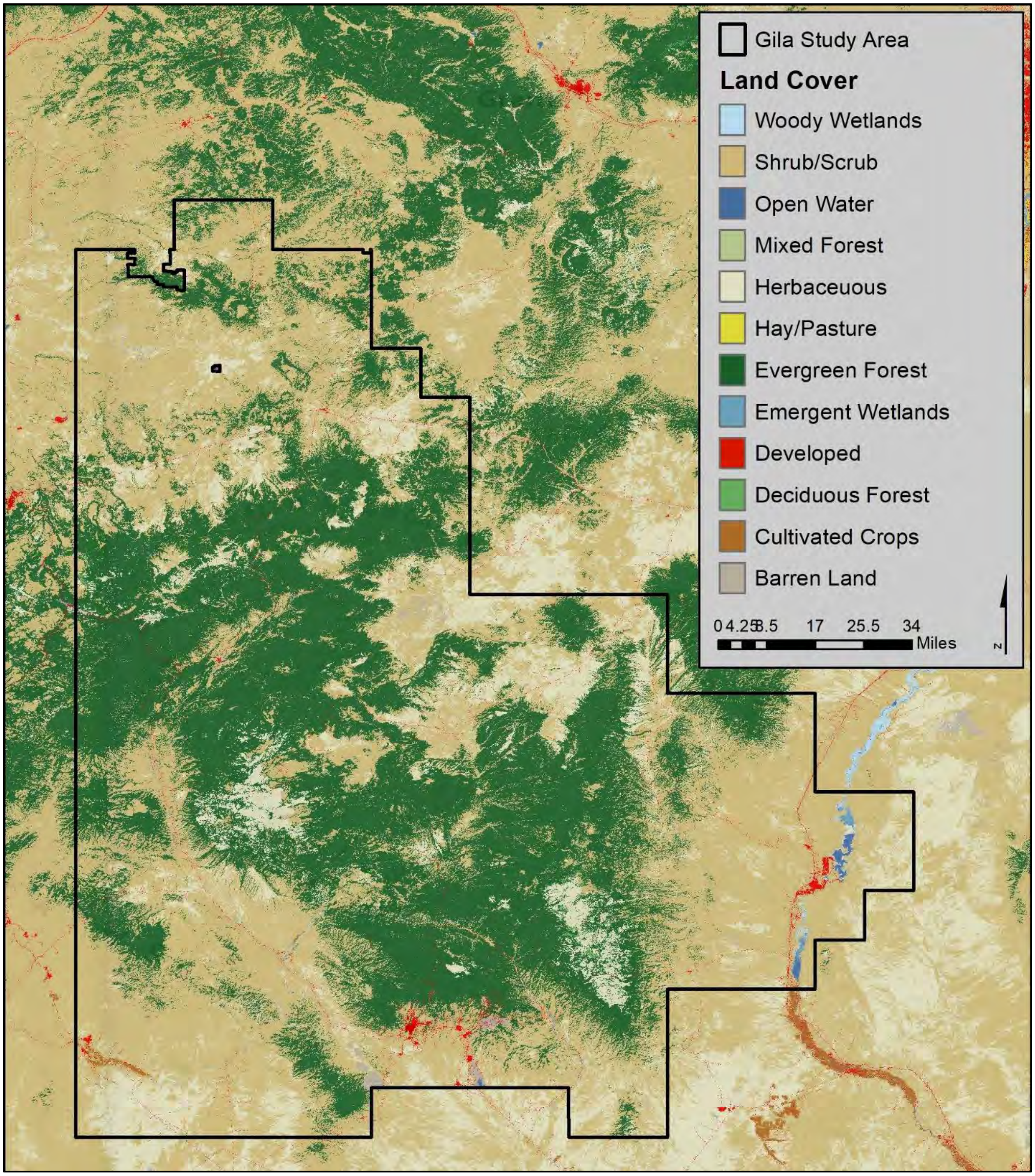


Figure 7. Land cover/land use in the Gila project area.

Wetland Mapping and Classification Systems

GIS technology has allowed wetland mapping to advance from hard copy maps drawn directly on reproducible Mylar film to large, searchable geodatabases able to satisfy any number of user queries. Currently, wetlands are mapped using on-screen digitizing methods by highly trained image interpreters. Aerial imagery serves as a base map and is combined with collateral data such as soils, topographic, hydrologic, and land cover information. This information allows a skilled interpreter to make informed wetland mapping and classification determinations. The use of a GIS geodatabase structure provides the advantage of being able to assign any number of attributes (and any number of classification systems) to characterize wetland features. How various wetland attributes are assigned is dependent on the particular classification system in use. In the case of the Mapping and Classification of Wetlands in the Gila Region of Western New Mexico, three classification systems are relevant (Appendix A, B): The Wetlands and Deepwater Habitats Classification (Cowardin et al. 1979); Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Water body Type Descriptors (LLWW) (Tiner 2011), and A System for Mapping Riparian Areas in the Western United States (USFWS 2009).

Notation for the Reader:

> Classification codes are provided throughout the document for the purposes of review. Conventions on wetland code notations in this report are as follows: The Wetlands and Deepwater Habitats Classification System (Cowardin et al. 1979) codes are *italicized*; Dichotomous Keys and Mapping Codes for Landscape Position, Landform, Water Flow Path, and Water body Type Descriptors (LLWW) are <u>*italicized and underlined*</u>; codes for A System for Mapping Riparian Areas in the Western United States are **bolded.** The "%" character is a placeholder or 'wildcard' indicating various options might be used. The following information summarizes the wetland classification systems applied to the mapped project area in New Mexico.

National Wetlands Inventory (NWI)

The USFWS is responsible for the development and management of the NWI, an ongoing national program. The National Wetlands Classification System (Wetlands and Deepwater Habitats Classification, Cowardin et al. 1979) was adopted in 1996 by the NWI program and is used for wetland mapping across the country for conservation purposes. Any partner providing mapping services for the NWI must also adhere to the NWI Data Collection Requirements and Procedures for Mapping Wetland, Deepwater and Related Habitats for the United States implemented in 2009. This program satisfies the federal standard for wetland mapping and classification adopted by the FGDC in 2009 (FGDC 2009).

A wetland is defined by the NWI Program as "land supporting hydrophytic plant communities, land with hydric soils, or land where the water table is at or near the surface for part of the year". If these conditions are met, the area can be identified as a wetland. With the use of current and high resolution aerial photography, the presence of hydrophytic vegetation becomes a dominant factor in identifying and classifying wetlands. Collateral data is also used to aid in classification and normally consists of soils, topographic, and land cover data. Soil data, for example, provides information on the location of hydric soils while topographic data provides insight into surface hydrology. Collateral data is important especially when mapping semi-arid regions such as those found in the project area of New Mexico.

The Wetlands and Deepwater Habitats Classification used for the NWI describes wetland characteristics in a hierarchal order including:

- System
- Subsystem (with the exception of the Palustrine System)
- Class
- Subclass (only required for Forested, Scrub-Shrub, and Emergent Classes)
- Water Regime
- Special Modifiers (only required where applicable)

Alphanumeric codes representing the classification of each wetland provide descriptions about the wetland, the water regime, plant communities, alterations by humans or wildlife, and surface hydrology. The classification index first defines wetlands in the broadest sense by identifying their System with a single uppercase alphabetic (letter) code. There are five Systems including *M* (Marine), *E* (Estuarine), *L* (Lacustrine), *R* (Riverine), and *P* (Palustrine). Of these, only the latter three apply to the project study area in New Mexico (the first two refer to coastal and offshore saltwater environments).

The *R* (Riverine System) (Figure 8) includes deepwater habitats and mostly non-vegetated wetlands contained in natural or artificial channels periodically or continuously containing flowing water or which form a connecting link between the two bodies of standing water. Three out of five of the Subsystems from the *R* (Riverine) System were found in the New Mexico project area. These include *R2* (Lower Perennial), *R3* (Upper Perennial), and *R4* (Intermittent). Examples include rivers, streams, creeks, arroyos, washes, or ditches.

The *L* (Lacustrine System) (Figure 9), includes wetlands and deepwater habitats defined by all of the following characteristics: deep water situated in a topographic depression or a dammed river channel, area of wetland lacking trees, shrubs, or persistent emergents, emergent mosses or lichens with greater than 30% aerial coverage; wetland area exceeding 20 acres; or total wetland area less than 8 hectares and deeper than 6.6 meters at low water. There are two Subsystems in the Lacustrine System: *L1* (Limnetic) and *L2* (Littoral). Wetland examples include lakes, reservoirs, or intermittent lakes such as playa lakes unique to the region.

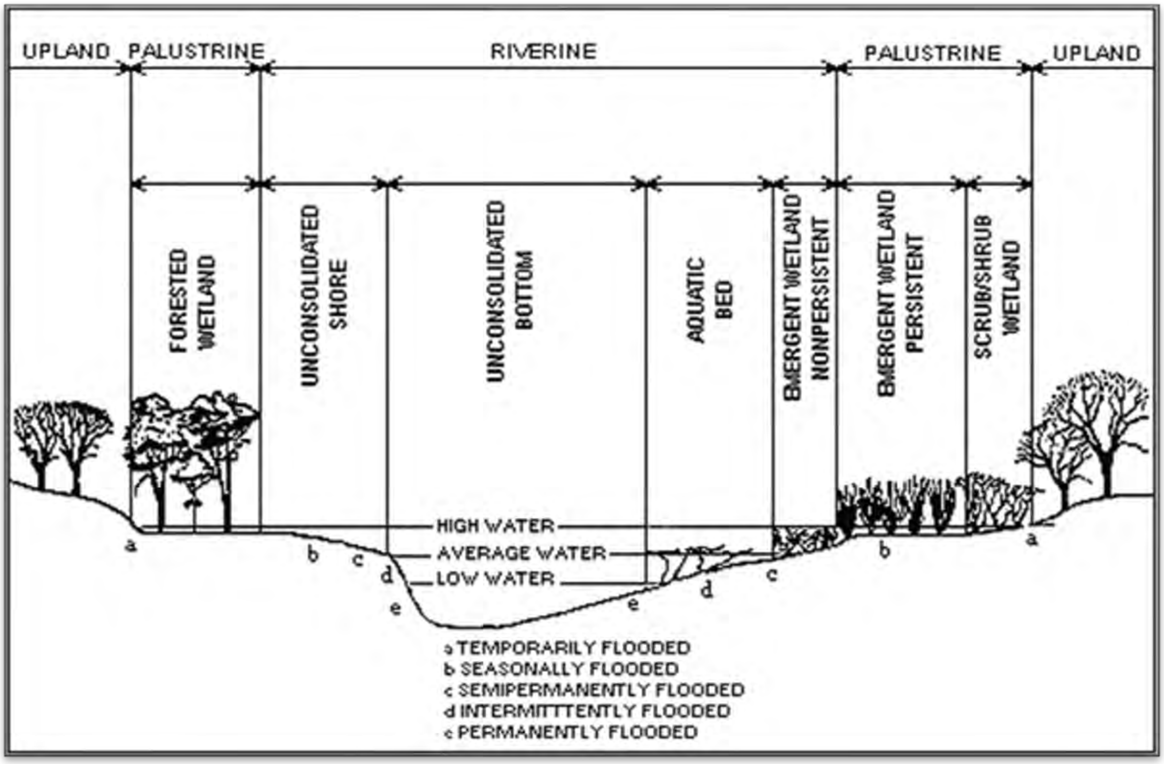


Figure 8. Diagram depicts a riverine system and the appropriate Cowardin et al. (1979) associations.

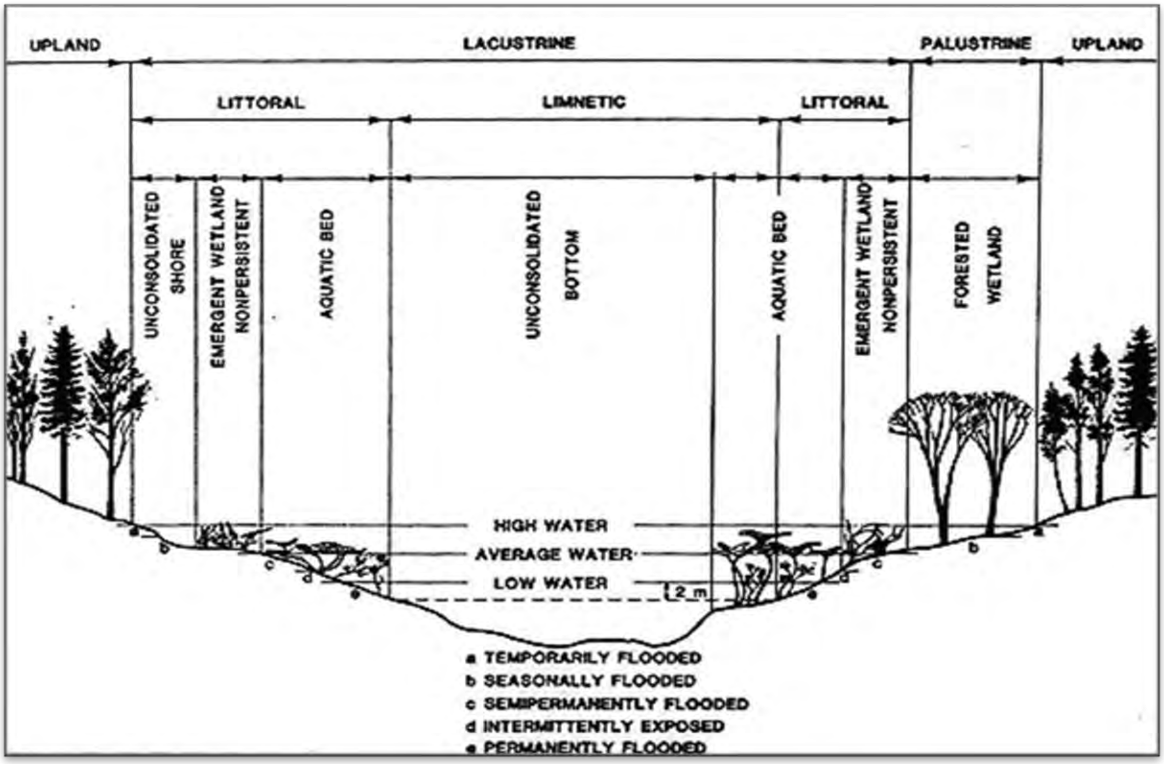


Figure 9. Diagram depicts a lacustrine system and the appropriate Cowardin et al. (1979) associations.

The *P* (Palustrine System) (Figure 10) includes all non-tidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all wetlands that occur in tidal areas where salinity due to ocean-derived salt is below 0.5 ppt. An estimated 95% of all wetlands in the U.S. are freshwater, palustrine wetlands, and will predominate in most wetland mapping efforts. There are no Subsystems in the Palustrine System. Examples of Palustrine wetlands found in the New Mexico project area include flooded basins, marshes, swamps, vegetated floodplains, cienegas, and ponds.

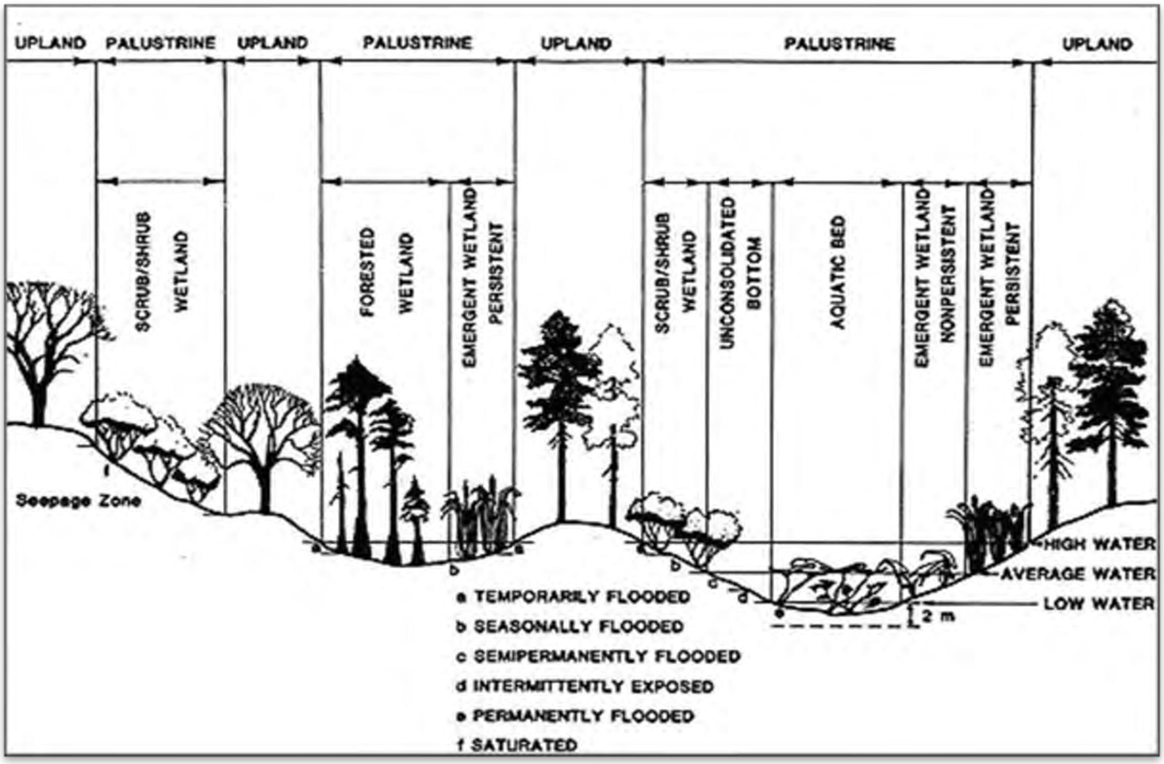


Figure 10. Diagram depicts a palustrine system and the appropriate Cowardin et al. (1979) associations.

After the System and Subsystem are classified, a Class is assigned which is denoted by a two-letter uppercase letter code referring to the dominant vegetation or substrate type. Examples of Classes for the project area include *UB* (Unconsolidated Bottom), *EM* (Emergent Vegetation), and *FO* (Forested). It is possible to have dual Classes assigned; these are separated and notated in the alphanumeric code with a slash "/".

The Subclass, while similar to a Subsystem, refers to a more specific type within the wetland Class and is coded with a single number. For example, the code *FO1* refers to broad-leaved deciduous forest while *FO4* refers to needle-leaved evergreen forest.

The meaning of a Subsystem code is dependent upon the particular System to which it is being applied. Similarly, the meaning of the Subclass is dependent on the Class to which it is being applied. Often times a wetland code is not classified to the Subclass level. In this case, there is no number representing a Subclass after the Class code itself.

There are several Modifiers in the classification system that may be applied to a wetland classification at the Class (or lower level) in the hierarchy. Modifiers include Water Regime, Special Modifiers, Water Chemistry, and Soil. Within these Modifiers are additional codes which describe the wetland in more detail. The Water Regime Modifier is sometimes referred to as the "hydrologic" Modifier. It consists of a single uppercase letter and encodes hydrologic information such as flooding frequency. The Water Regime Modifier is only applied during the growing season, because flooding during the dormant season does not significantly affect the vegetation that is present. The *B* (Seasonally Saturated) Water Regime is often used to classify hydric soils. Water Regimes include, in order of ascending wetness, *A* (Temporarily Flooded), *B* (Seasonally Saturated), *C* (Seasonally Flooded), *D* (Continuously Saturated), *E* (Seasonally Flooded/Saturated), *F* (Semipermanently Flooded), *G* (Intermittently Exposed), *H* (Permanently Flooded), *J* (Intermittently Flooded), and *K* (Artificially Flooded).

The Modifiers-Special Modifiers are notated as a single lower case letter. This code characterizes very specific physical conditions within a wetland including *b* (Beaver), *d* (Partly Drained/Ditched), *f* (Farmed), *h* (Diked/Impounded), *r* (Artificial), *s* (Spoils) or *x* (Excavated). The *x* (Excavated) and *h* (Diked/Impounded) codes from the Modifiers-Special Modifiers are most commonly applied because their presence is usually interpretable from aerial imagery.

The Modifiers-Water Chemistry indicate pH modifiers for fresh water. An example of the Water Chemistry modifier applied to the project area included the (*i*) alkaline code.

The Modifiers-Soil identify the presence of either organic (*g*) or mineral (*m*) soil conditions in a wetland.

A common characteristic of NWI classification data is that not all special modifiers are regularly used and that the lack of a special modifier does not necessarily mean that a particular condition does not exist in that wetland. This is especially true of Modifiers-Water Chemistry and Modifiers-Soil codes where interpretive limitations exist. It is also possible to have more than one special modifier attached to a wetland. As aerial imagery resolution improves and the availability of digital collateral data increases, the application of Modifiers in wetland mapping projects is increasing.

To help further illustrate the coding for the Wetlands and Deepwater Habitats Classification, (Cowardin et al. 1979), the following codes for various wetlands found in the project area are provided as examples:

PEM1Cx (Palustrine, Persistent Emergent, Seasonally Flooded, Excavated): these include wetlands with herbaceous, rooted hydrophytic vegetation that is present for most of the growing season in most years. Surface water is present for extended periods, especially early in the growing season, but is absent by the end of the growing season in most years. The wetland lies within a basin that has been artificially deepened by humans.

R4SB3J (Riverine, Intermittent, Streambed, Cobble-Gravel, Intermittently Flooded): these areas are dry wash linear channels. They appear white (or lighter) in aerial photography indicating the presence of sand, stones or bedrock.

L1UBHh (Lacustrine, Littoral, Unconsolidated Bottom, Permanently Flooded, Impounded): these are open water areas within reservoirs that were flooded at the date of the photograph acquisition. They are deeper than two meters and the total area of any of these reservoirs is greater than 20 acres.

Landscape Position, Landform, Water Flow Path & Water Body Classification (LLWW)

The applicability of NWI data for planning and decision support, especially related to wetland functional assessment, can be enhanced through the addition of hydrogeomorphic (HGM) descriptors to the wetland geodatabase. In recognition of this fact, the USFWS has developed a HGM classification system that is complimentary to the national wetlands classification system (Cowardin et al. 1979) and describes abiotic and landscape features such as Landscape Position (L), Landform (L), Water Flow Path (W) and Water body Type (W) or LLWW. This classification system is sometimes called 'NWI Plus' because of its relationship to the NWI; however, for clarity in this report it is referenced as "LLWW".

LLWW is not based on vegetation as indicators, but instead classifies wetlands and water bodies with the area's landscape position and hydrologic characteristics, which are more permanent on the earth's surface. In a similar manner to the Wetlands and Deepwater Habitats Classification (Cowardin et al. 1979), the LLWW system uses alphanumeric codes to describe wetland characteristics. The LLWW classification makes a distinction between wetlands and water bodies. Wetlands are vegetated, while water bodies are deep water habitats. The coding syntax can take two slightly different forms, depending on whether the feature is being classified as a wetland or a water body. Vegetated wetlands, such as marshes, wet meadows, and non-vegetated substrates that are periodically exposed (e.g., mud flats), are first classified using the wetland Landscape Position and Landform codes identified below. The LLWW code (noted here in italics and underlined); is expressed *Landscape Position, Landform, Water Flow Path, Modifier(s).*

In the LLWW system *Landscape Position* is denoted as an uppercase two letter code and describes whether the wetland is associated with a lake, river, or surrounded by uplands. There are also classifications for marine and coastal areas that do not apply in the case of the New Mexico study area of this report. Wetlands associated with lakes are defined as *LE* (Lentic). Wetlands associated with flowing water are classified as *LS* (Lotic Stream) or *LR* (Lotic River), depending upon their size. Wetlands that are surrounded by upland as part of an isolated basin are classified as *TE* (Terrene). In LLWW, the Landscape Position can be more specifically classified using a hierarchal combination of lowercase letters and numbers similar to the subsystem or subclass in the NWI classification system. The modifying codes are dependent on the Landscape Position code to which they are being applied.

The second portion of the LLWW code is *Landform*. This code is made up of two uppercase letters which can be classified more specifically with the addition of codes consisting of two lower case letters. Landform refers to the geomorphic structure on or in which the wetland resides. While both coastal and inland Landforms are defined in LLWW, only inland Landforms are present in the current study area. Landform codes include *SL* (Slope), *FR* (Fringe), *FP* (Floodplain), *BA* (Basin), and *FL* (Flat). Further classification of each Landform code may occur by adding an additional lowercase two letter code. For example, a *FR* (Fringe) wetland associated with a *pd* (Pond) would be coded as *FRpd*. Lowercase codes only apply to specific

Landform types, and although there is not any repetition in codes between the Landforms, the Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Waterbody Type Descriptors (Tiner 2011) should be consulted so that valid codes are accurately applied.

There are also *Water Flow Path* and *Other Modifier* codes within the LLWW schema. Since these are the same for both wetlands and water bodies, the Waterbody Type coding schema will be addressed first.

In LLWW, the *Waterbody Type* consists of an uppercase two letter code. There are six water body types, two coastal and four inland. Of the four inland types, three are present in the study area of New Mexico including *LK* (lake), *RV* (River), and *PD* (Pond). Additional codes consisting of a number followed by a lowercase letter may be added to further specify the wetland's characteristics. For example, woodland ponds surrounded by uplands are often common in watersheds and might be classified as *PD1c* (Pond, natural, woodland-dryland). When a wetland feature is classified as a Waterbody Type there is no Landform code applied; the wetland is considered to be its own Landform.

The next component of the code is *Water Flow Path*, which applies to both wetlands and water bodies as defined by LLWW. Water Flow Path refers to how and if the feature is part of the surface hydrology network. Common codes for Water Flow Path include *TH* (Throughflow), *IN* (Inflow), and *OU* (Outflow). Wetlands that are not directly connected to the surface hydrology network are classified as *VR* (Vertical Flow). Most of the Water Flow Path codes are the same for both wetlands and Waterbody Types but there are some small differences. As a result, reference materials need to be consulted to assure that appropriate codes are consistently applied. It should be emphasized that the LLWW classification can only consider surface hydrology. Subsurface hydrologic connectivity is not considered because these characteristics cannot be assessed through image interpretation.

Finally, the LLWW code includes *Other Modifiers*. These modifier codes consist of two lower case letters. Other Modifiers are used to encode very specific conditions, and more than one modifier may be used. Common examples are *fv* (floating vegetation on the surface) or the *hw* (headwater) modifier. Again, there are some differences in which modifiers can be applied to wetlands versus those applied to Waterbody Types.

LLWW codes can vary in length from five characters up to 14 or more characters, depending on how many modifiers are applied. Examples of LLWW codes classified in the Gila study area are provided below.

Example LLWW codes for wetland features found in the project area:

- *LS2BATHhi*: this *LS2* (middle gradient lotic stream) is in a *BA* (basin) with *TH* (Throughflow). The feature has been modified for or impacted by human use (*hi*).

- *RV2TH*: this *RV2* (middle gradient river) in New Mexico is usually connected upstream to headwater features and is downstream to a larger river network or wetland complex with TH (Throughflow). This stream or river has portions of riffles or rapids and is represented by such NWI (Cowardin et al. 1979) attributes as *R2RBG*.

- *ST3TIar*: this ST3 (high gradient stream) has TI (Intermittent Throughflow). The wetland feature includes a wash or gulch that temporarily or seasonally fills then flows after sufficient rain. This is known as an arroyo (*ar*) and the wetland is typically attributed as *R4SB3J* in the NWI (Cowardin et al. 1979) classification system.

- *LR2FPbaTH*: a basin wetland associated with a LR2 (middle gradient river) and a FP (Floodplain). The feature has TH (Throughflow). This means that the river floods the banks therefore enters and leaves the wetland structure. Cattail or willow marshes with river flooding access are NWI examples of this type of wetland. These might be coded as *PEM1F* or *PSS1C* in the NWI (Cowardin et al. 1979) system.

- *LS3FLTI*: this polygon shaped wetland is alongside a LS3 (Lotic Stream, high gradient). The landscape is FL (Flat) with TI (Intermittent Throughflow). *PEM1A, PFO1A*, or *PSS1A* are possible NWI attributes.

- *PD1OU*: this code refers to a small, natural Waterbody PD1 (Pond) with water flowing OU (Outflow) of the pond. *PUBG* is an example NWI code related to this LLWW code.

- *TEBAVRhi*: this code refers to a TE (Terrene) wetland surrounded by uplands. It is in a BA (basin), and due to the wetland being disconnected from the surface hydrology network it is given the VR (Vertical Flow) Water Flow Path codes. The feature is an artificial structure *hi* (modified for human use such as an excavation).

- *TESLOUdshw*: this attribute is for a TE (Terrene) feature that is surrounded by uplands. The Landscape Position is SL (Slope), causing OU (Outflow) into a larger terrene complex or possibly *ds* (discharges into a stream via seepage from the saturated wetland). An *hw* (headwater) wetland is one that provides a continual, perennial source of water for all other wetlands downstream. Headwaters are also known as first or second order streams, or may be wetlands adjacent to first and second order streams. These streams connect to a larger river network or complex downstream. *PEM1D* is a common NWI attribution for this type of wetland.

- *TEBAplIN*: this code refers to a TE (Terrene) wetland that is BA (basin-shaped). This complex is a *pl* (playa) wetland with IN (Inflow) of water. Examples of NWI codes for this wetland type are *PUS3C* or *PUS2A.*

Wetland Functional Assessment

Natural chemical, biological, and physical processes occur in wetland environments providing specific functions which contribute to broader ecosystem health. These wetland functions provide specific goods and services based on conditions and processes that are present. An objective for this project was to extend traditional wetland mapping by developing wetland classes and subclasses according to HGM characteristics and to then correlate LLWW descriptors and metrics to established wetland functions. The development of functional metrics for wetlands in the project area was completed in collaboration with state and federal wetland experts using their collective best professional judgment. The result was a correlation table of mapped wetland characteristics and their functional metrics for the project area (Appendix C).

Unique to New Mexico's geographic region, wetland functions established for the project area included Surface Water Detention; Streamflow Maintenance; Groundwater Recharge; Nutrient Transformation; Carbon Sequestration; Sediment and Other Particulate Retention; Bank and Shoreline Stabilization; Fish Habitat; Aquatic Invertebrate Habitat; Waterfowl and Waterbird Habitat; Other Wildlife Habitat; and Unique, Uncommon, or Highly Diverse Wetland Plant Communities Function.

Some wetland types in the project area were found to perform more than one function while others provided only a single, particular function. Upon analysis, and in consensus with the project team, certain wetlands were also classified as either highly or moderately performing a given function(s) relative to other wetlands in the project area. The correlation table developed by the project team established specific codes and conditions which allowed for extensive geospatial analysis of wetland functions for the project area. The criteria, codes, and conditions were summarized for each wetland function that was identified for the project area.

The completion of the mapping and classification of the project area including the wetland functional assessment will serve as a link to other wetland assessments, such as a Level 2 Rapid Wetlands Assessment Method or Level 3 Intensive Site Assessment, as desired in the future. All of the reviewed wetland classification codes combined within current GIS technology will allow stakeholders to query large spatial data sets and to determine the functionality of wetlands on a landscape scale.

A System for Mapping Riparian Areas in the Western United States

One of the requirements for the project was to delineate and classify riparian wetlands in the project area using technical procedures outlined by the USFWS for mapping riparian areas in the western United States. The NWI program recognized that in certain regions of the country, where evaporation exceeds precipitation, riparian habitats are as critical for wildlife as wetlands are in more humid regions.

Riparian areas are typically transitional lands between wetland and upland that contain plant communities contiguous to and affected by surface and subsurface hydrologic features of adjacent perennial or intermittent lotic and lentic water bodies such as rivers, streams, lakes, or drainage ways. As much as 80% of wildlife species in semi-arid western regions depend on riparian habitats for breeding or foraging. Riparian areas are important as they connect critical migration corridors. The condition of these riparian habitats is also important for maintaining healthy aquatic systems.

Given these well-documented values, the NWI program recognized a need to include these habitats in their inventory of areas west of the Mississippi River. To standardize this type of mapping, the USFWS developed a riparian classification system (Figure 11), as well as unique mapping conventions and standards for these types of wetlands (USFWS 2009). This classification system may be used alone or may supplement other wetland mapping efforts (such as the Wetlands and Deepwater Habitats Classification, or the LLWW system) to produce mapping products in arid or semi-arid regions of the country.

As with other wetland mapping, aerial imagery is the primary data source for riparian mapping and classification. Collateral data sets often used to complete this task include digital topographic maps, soils datasets, and local wildlife and plant community surveys or inventories.

Riparian areas have one or both of the following characteristics:

- Distinctly different vegetative species than adjacent areas, and
- Contain species that are similar to species in adjacent areas but exhibit more vigorous or robust growth forms.

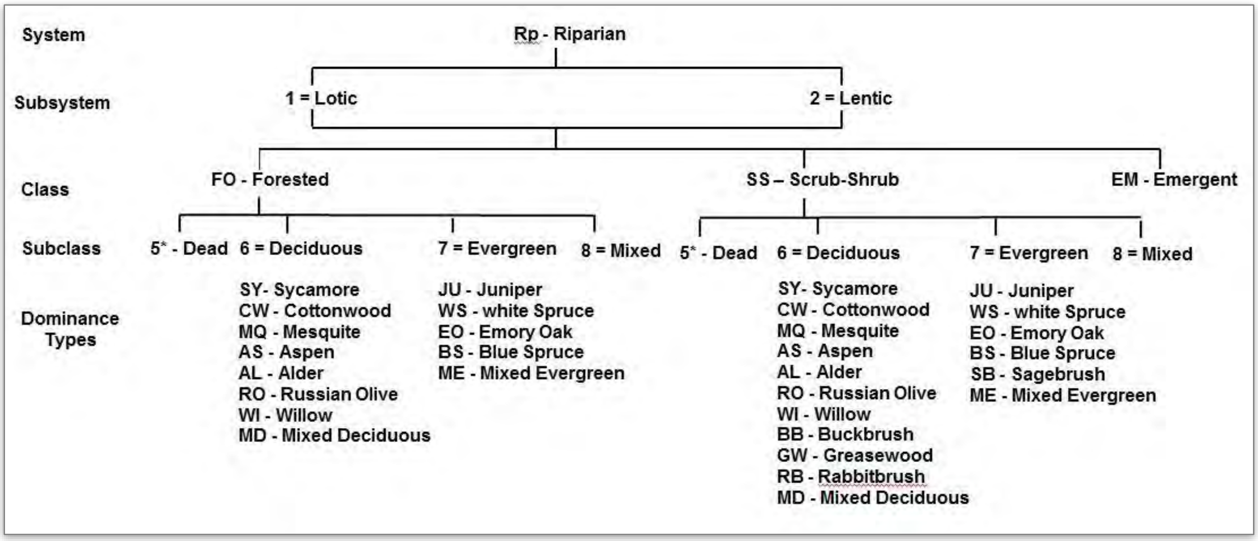


Figure 11. Riparian classification schema.

The riparian mapping system for areas in the western United States includes a hierarchical and open-ended coding system including System, Subsystem, Class, Subclass and Dominance Types:

- System is a single unit category - Rp (Riparian Vegetation);
- Subsystem defines two categories reflecting the water source for the riparian area, **1** (Lotic) or **2** (Lentic);
- Class describes the dominant life form of riparian vegetation. For these conventions, classes are **FO** (Forested) woody vegetation usually greater than 6 m in height, **SS** (Scrub/Shrub) woody vegetation usually less than 6 m in height, or **EM** (Emergent) erect, rooted vegetation with herbaceous stems;
- Subclass further describes the Class as **5** (Dead), **6** (Deciduous), **7** (Evergreen), or **8** (Mixed deciduous/evergreen);
- Dominance Type refers to vegetative species dominance within the mapping unit such as **CW** (Cottonwood), or **AL** (Alder). Dominance types vary throughout the western U.S.

Hydrogeomorphic (HGM) Classification

Another requirement of this project was to assign wetlands within the project study area to one of several regional HGM wetland subclasses (Brinson 1993). As part of this process, the project team worked jointly to develop a method of querying combinations of NWI and LLWW coded wetlands and other spatial layers (e.g., elevation bands representing alpine, montane and lowland ecoregions and confined and unconfined riverine valleys) to assign wetlands to one of several New Mexico HGM Regional Subclasses. These subclasses are listed in **Table 3**.

Table 3. HGM regional subclasses for New Mexico.

Riverine	Depressional	Slope	Flats
Subalpine Riverine	Artificial Depressional	Spring-fed Slope	Mineral Flats
Alluvial Fan Riverine	Natural Depressional	Headwater Slope	Organic Flats
Episodic Riverine	Playa Depressional	Irrigated Slope	
Lowland Confined Riverine		Other Slope	
Lowland Unconfined Riverine	**Fringe**		
Montane Confined Riverine	Lake Fringe		
Montane Unconfined Riverine			

Given that there was not a direct correlation between NWI and LLWW codes and regional subclasses, multiple data sources were often required to make interpretations. In addition, certain HGM regional subclasses were challenging to interpret because there was insufficient information in the current wetland data and available collateral sources to make a definitive assignment to an HGM subclass. These HGM regional subclasses included Episodic Riverine and Alluvial Fan Riverine.

Quality Assurance Considerations

The use of remotely sensed imagery to map and classify wetlands requires quality data, technology and skilled personnel. Accuracy in wetland mapping is a measurement of both errors of omission and/or commission. Errors of omission occur due to factors including scale and quality of the imagery, the map scale, environmental conditions when the imagery was taken, type of imagery, or even the quality of collateral datasets available. Errors of commission occur when wetlands are not classified correctly.

Project accuracy and potential limitations of this wetland mapping and classification were addressed by the application of an in-depth project quality assurance plan. This plan was developed in collaboration with the project team using the Wetlands Classification Standards established by the FGDC for the NWI. It was also developed according to EPA guidance (EPA 2003).

Mapping standards included thresholds for the identification of the target mapping unit (smallest wetland consistently mapped and classified at a particular scale), producer accuracy (percentage of features correctly identified and classified), feature accuracy (identification of wetland versus non wetland), and spatial accuracy of the final map product measured including the horizontal positional accuracy in relation to the imagery. Data verification was completed as required and included checks for logical consistency, edge matching and attribute validity. Wetland data was re-projected to Albers Equal-Area and the datum to the North American Datum 1983 (NAD83) prior to submission. Metadata conformed to FGDC Content Standard for Digital Geospatial Metadata (CSDGM).

Methods

Overview

This project, entitled "Mapping and Classification of Wetlands in the Gila Region of Western New Mexico", used geospatial techniques and image interpretation processes to remotely map and classify wetlands and riparian areas of the Gila project area. The intention of this effort was to complete wetland mapping and classification of wetlands in the project area for inclusion into the USFWS NWI. Other goals were to complete the LLWW classification (developed by Tiner 2003) by determining wetland classes and subclasses according to HGM characteristics, and to correlate LLWW metrics to wetland functions identified for the project area.

The completion of the project will serve as a link to future wetland assessments including the New Mexico Rapid Assessment Method (NMRAM). The requirement to complete mapping at a 1:12,000 resolution and to be in compliance with the National Wetlands Mapping Standard of the FGDC was achieved. Results from this project are important for wetland protection in New Mexico and will improve the knowledge of existing wetland areas and their functions. The results of this project will also provide a strong base for future wetland mapping updates for New Mexico.

The project was collaborative and dynamic in nature with input from multiple individuals and agencies at every stage. SMUMN GSS provided project management, technical expertise in wetland delineation from aerial imagery as well as the knowledge of wetland biology and HGM characteristics required to apply wetland classification. SMUMN GSS facilitated and mediated project team meetings and provided procedural guidance for wetland functional assessment exercises and the development of the quality assurance process.

The primary stakeholders included the SWQB of the NMED and the Region 2 USFWS NWI Program. Ralph Tiner of the USFWS provided expertise on the LLWW classification system and functional assessment.

The core project team is listed below:

Maryann McGraw – NMED SQWB - Wetlands Program Coordinator

Karen Menetrey - Environmental Scientist, NMED SWQB

John Anderson – SMUMN GSS - Senior Image Interpreter

Andy Robertson – SMUMN GSS - Project Manager

David Rokus - SMUMN GSS - QA/QC Specialist

Zack Ansel - SMUMN GSS – GIS Technician

Josh Balsiger - SMUMN GSS – GIS Technician

Gary Hunt – USFWS Regional Wetland Coordinator

The task of remote mapping and classifying of wetlands involves both the application of a scientific process as well as skilled project coordination. The Methods portion of this report discusses the entire wetland classification workflow as well as key project management activities.

Wetland Mapping and Classification Work Flow

To complete the project, SMUMN GSS applied a GIS workflow process developed and proven for wetland mapping and classification projects. The workflow process relied on a combination of digital datasets supported by field verification to delineate and classify wetland and riparian areas, validate image signatures, and also determine wetland function and hydrology. The completion of each workflow process step described below was critical to the success of the project's overall goal to develop a comprehensive wetland geodatabase for the project area using NWI standards in compliance with the FGDC.

Selection of digital imagery and collateral GIS datasets for the project

Digital imagery and collateral GIS datasets selected for the project included the most current digital orthophotography, scanned aerial photographs, data from the NRCS, the Soil Survey Geographic database (SSURGO) and county-specific soils inventory. In addition, digital topographic maps (digital raster graphic [DRG] format from the United States Geological Survey [USGS]), digital elevation models (DEM), and surface hydrology data (National Hydrology Dataset [NHD], along with state, and county level datasets) specific to streams, lakes, and rivers were used for analysis.

Digital Imagery

The primary source used for the study area came from aerial imagery supplied by the National Agriculture Imagery Program (NAIP) administered by the USDA's Farm Service Agency. NAIP aerial imagery is captured during growing seasons (referred to as "leaf-on" imagery) and taken with digital sensors during the day when there is less than 10% of cloud cover (so as to retain image integrity). The resulting digital orthophotography is typically made available for use to the public within a year; 2018 (the imagery chosen for this project) represented the eighth year that this process was completed for the entire state of New Mexico using one-meter specifications. This means that a one-meter ground sample distance had a horizontal accuracy that matched within six meters of photo-identifiable ground control points.

Spectral resolution used for NAIP imagery is RGB (Red, Green, and Blue) or natural color. This "true-color" imagery is typically the primary product of NAIP projects, with occasionally a fourth band providing CIR. True-color imagery shows the ground features as they appear to the human eye. Green vegetation appears green on the imagery, while water is generally black or blue, etc.

Google Earth™ software and imagery for the project area was also utilized. The image interpreter used the identify button to locate the coordinates of a signature or feature of interest, and those latitude and longitudes were then imported from ArcMap into Google Earth™. The "Time Slider" tool provided the image interpreter with the ability to view multiple years of aerial imagery, providing an advantage of reviewing average to current conditions, especially when determining the NWI (Cowardin et al. 1979) Modifiers for Water Regime (Figure 12). This option is particularly helpful if primary imagery is from a dry year, when wetland signatures are faint. The program also allowed a user to spin the cardinal direction of the imagery for multiple aspects and raise or lower the altitude point of view and quickly zoom in and out with the use of the mouse buttons. These options allow for many different observations of the wetland feature.

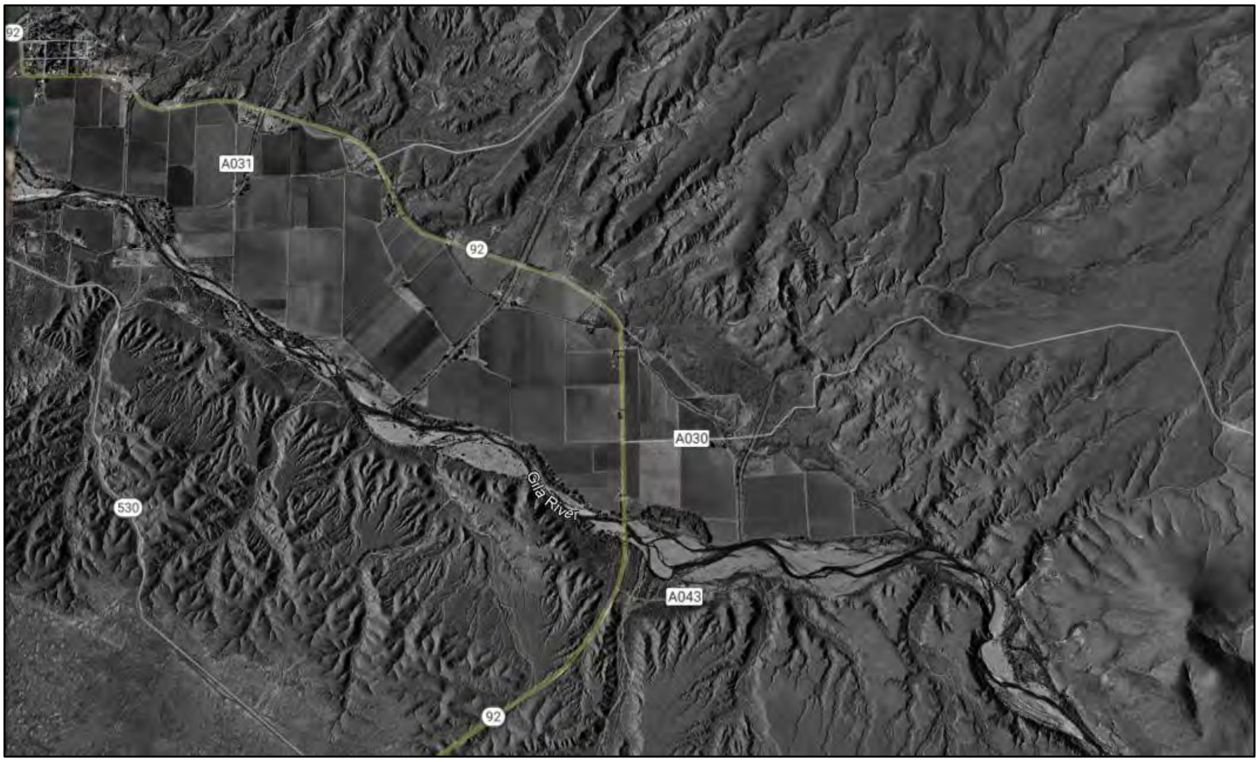


Figure 12. Historical imagery, like this 1998 aerial photograph of Gila River floodplain and farming community east of Duncan, Arizona. Over time, the agriculture fields will have center-pivot irrigation systems installed.

Topographic Data

The most up-to-date USGS DRG topographic data was used with a resolution of 1:24,000. DRGs are scanned, digitized and georeferenced topographic maps in a digital tiff file format. Digital images were georeferenced to a true ground coordinate and projected for consistency with USGS Digital Ortho Quadrangles (DOQ). The DRG data was used in the project area to accurately determine modifiers for water regime in the NWI (Cowardin et al. 1979) classification system.

Soils Data

SMUMN GSS analysts and technicians used existing soils data from the SSURGO, maintained by the NRCS. This database provided information about the soil in the project area including water capacity, soil reaction, electrical conductivity, frequency of flooding, yields for cropland, woodland, rangeland, and pastureland, as well as limitations affecting recreational development, building site development, and other engineering uses.

Hydrology Data

Data for streams, rivers, lakes and ponds from the USGS NHD was consulted. The Springs Stewardship Institute (SSI 2020) and the USFS provided additional springs layers and the NMED’s SWQB provided cienagas data.

Photointerpretation Expertise

Certified staff from SMUMN GSS utilized their experience in wetland image analysis and ground-truthing, in addition to their individual competencies in the field of wetland science, to determine imagery selection and the need for additional collateral data sources.

Development and Implementation of Continuous Quality Assurance Plan

Quality control was a critical component throughout this wetland mapping and classification project. In order to formalize required quality control procedures, SMUMN GSS worked with SWQB and USFWS personnel to develop a formal Project Quality Assurance Project Plan (PQAPP). Guidance was provided from the EPA using the document "Guidance for Geospatial Data Quality Assurance Project Plans" (EPA 2003).

The PQAPP addressed several requirements to ensure the quality of the mapping and classification project. This plan received formal approval from the EPA and SWQB in April 2016. The PQAPP also clarified several components within each major quality assurance task, including the following specific processes:

- Project Management: communication distribution list, project organization and line of authority charts, problem definition and background for the project, project task description, quality objectives and criteria, special training and certifications of personnel as well as documentation and record-keeping requirements.
- Data Generation and Acquisition: sampling process design, sampling and image acquisition methods, sample handling and custody, analytical methods, quality control, instrument and equipment testing, data acquisition and data management.
- Assessment and Oversight: acquisition and response actions, reports to management.
- Data Validation and Usability: data review, validation, and verification including validation and verification methods and reconciliation with data quality objectives.

Review of Original Wetland Delineations and Regional Datasets

These data were provided by NMED and USFWS, NWI Region 2. Additional wetland maps were collected from the USFWS. The information was used to assess original mapping conditions, to provide reference stereographic coverage, and to aid in signature confirmation for the 2018 NAIP imagery.

Development and Coordination of the Geodatabase

Implementation and complete support for hardware, software and database technology used for the project was provided by SMUMN GSS. Development of the geodatabase was completed using Environmental Systems Research Institute (Esri)™ software, ArcGIS™ (v10.7.1). Completed data were also submitted to the USFWS for the NWI Program in the required format and projection.

Establishment of Project Mapping Conventions

On-screen delineation of wetlands appropriate to the scale and accuracy of the aerial imagery was completed. Specifications included a minimum mapping unit size, maximum on screen zoom scale for boundary delineation, maximum on-screen zoom scale for classification decisions, and determinations regarding the handling of NWI classifications updates. SMUMN GSS facilitated key meetings with project partners to define all mapping and image interpretation conventions. These were reviewed and approved by the EPA. Specifications included a minimum mapping unit size for polygon wetland features (+/- one half acre in size). This met all specifications required for the NWI.

In 2015, the NWI program initiated a conversion to "NWI 2.0" mapping, which incorporates standard width flowpaths that were previously excluded from the NWI dataset as a polygonal feature class. These were however provided as linear features to the NMED as a secondary wetland dataset. This was an effort by NWI to capture additional wetland habitat features or "to complete existing segmented connections between wetlands" (USFWS 2021). An additional goal, particularly in arid and semi-arid regions such as New Mexico, is "to map potential connectivity for water and sediment transport" across the landscape (USFWS 2021). For example, in alluvial fan or overland flow situations, areas should be connected by a buffered centerline, so that connectivity of flow is captured (USFWS 2021). Additional direction includes using two primary data sources as guidance in the decision-making process of adding flowpaths and enhanced connectivity. USGS NHD flowpaths and USGS intermittent streams symbols on topographic DRGS influenced the flowpath presence and its spatial location when imagery signatures were absent. The NWI code for these features was R4SBJ (no streambed subclass), and the HGM Modifier was "2.0 Addition" so the features could be distinguished from other flowpaths in the dataset.

The decision point for image interpretation of whether a wetland should be a buffered linear feature as opposed to a polygon feature depended on a variety of factors including: size (width, extent), dryness, substrate type, association with other wetlands, and representation on collateral data. In general, wetlands captured as buffered linear features had a width of less than ten meters although occasionally wetlands of that width or smaller were captured as polygons if they were part of a larger polygonal wetland or contained permanent water.

Aerial Imagery Verification / Check Site Field Review

This step involved the performance of on-site field review of project area study sites to validate actual wetland conditions identified using area image signatures or other collateral data. The field review for the Gila project area was conducted in late August of 2018.

The field verification process involved three steps: 1) check-site selection; 2) in-field verification; and 3) post trip documentation.

Check-Site Selection

Leaf-on, 2018 True Color NAIP imagery was reviewed for check-site selection. Points representing sites to be visited were created interactively using ArcGIS 10.7.1. Check sites were selected in advance for areas that could not be clearly identified as upland or wetland or classified accurately on the imagery with the aid of the available NWI database coverage, DRG topographic maps, NRCS SSURGO data, and collateral imagery. Additional image sources accessed for check site selection included imagery available through Google Earth image library.

Field verification points were located at those sites where imagery signatures indicated that a wetland might exist, but wetland features were not obvious. Other check-site points were included where the NWI or Riparian classification needed clarification. For example, areas shaded as open water or contour intervals indicating topographic depressions were referenced to select possible locations of basins and ponds. Areas mapped as hydric soil in SSURGO provided check site locations for other wetland types including floodplain and saturated wetlands.

Additionally, site selection focused on identifying signatures of plant communities of interest such as sedge meadows, spring-fed wetlands (cienegas), and fens or bogs. Dominant riparian species such as cottonwood, willow, elm, and invasive salt cedar and Russian olive were also noted on aerial imagery and later captured in the project wetland geodatabase.

A total of 484 check-sites were pre-selected based on the above criteria. Hard-copy images showing accessible check sites were printed as map layouts for use under field conditions. Paper copies of 1:20,000-scale topographic maps were used in the field where hard copy imagery was absent.

Figure 13. A field check site on the West Fork of the Gila River in the Gila National Forest, near the Catron and Grant County boundary (SMUMN GSS photo).

Field data sheets, plant field guides, a magnification loupe, tree-spade, soil probe, laptop with ArcGIS, and a Munsell Soil Color Chart were accessible during the trip. Pre-trip logistics were arranged with NMED personnel. Sites and routes were recorded by a global position system (GPS) and image comparisons were completed on a field laptop running ArcGIS 10.7.1 to display the project imagery (2018 NAIP).

Field Verification

The field trip in August of 2018 consisted of a rapid inventory by vehicle of as many wetland features as possible in the project area. The field verification team included the Project Manager and Photo Interpreter from GSS SMUMN, and the Wetland Program Coordinator and Environmental Scientist from NMED SWQB. Most of the accessible or visible wetlands were located along public and accessible roads or in parklands that were easily reached by short hikes.

Approximately 216 sites were visited during the field trip (Appendix D). Selected check sites were documented using the NWI Field Data Sheet format. At these sites, surface hydrology indicators were observed, soil profiles were characterized where possible, and species of hydrophytes were documented to determine the presence or absence of wetland, classify wetland, and describe associated photo-signatures. The remaining sites were reviewed via a windshield survey and were documented with hand-written notes on the hard-copy images. Features were classified in the NWI Cowardin Classification System. At each site, a GPS point and a series of ground-level photos were taken. A map of the route taken during the field verification trip is displayed in Figure 14.

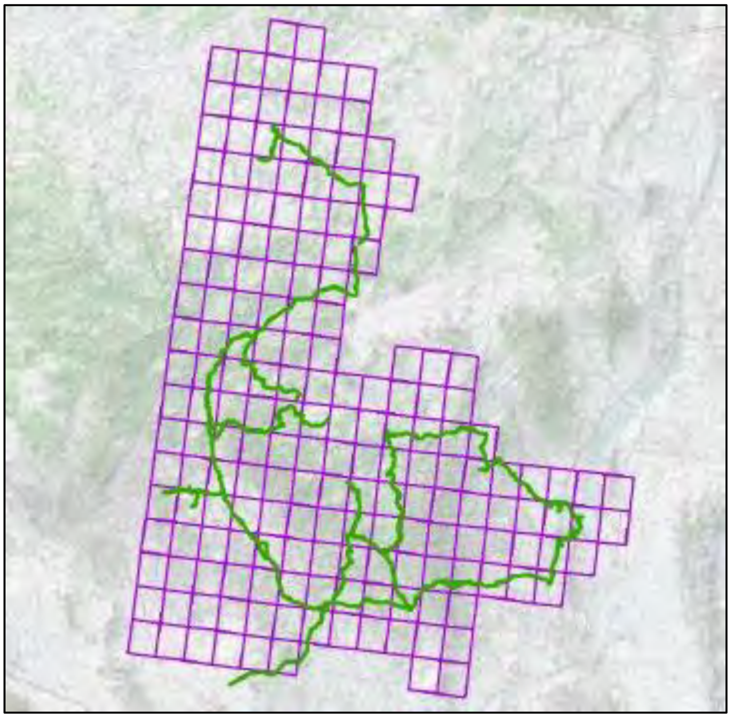


Figure 14. Route followed during the August 2018 Field Verification trip to the Gila project area.

Documentation

Baseline imagery and collateral data were reviewed and documented upon return from the field visit. A list of common wetland classifications and their associated photo signatures was compiled. Considerations as to applicability of collateral data to wetland/upland calls and wetland classification were documented. Outside signature questions were leveled on-screen and forwarded to local experts for discussion and assessment.

Field information was compiled into working documents entitled “Image Interpretation Conventions for the Gila Mountains Project Area” and “NWI and Riparian Codes and Signature Descriptions”. Photointerpretation of complex wetlands resources is a collaborative process. A continuous dialogue through the course of the production phase of the project helped to produce a high-quality product.

Figure 15. A semipermanently flooded wetland visited during field verification, approximately 24 miles east of Mogollon, NM (SMUMN GSS photo).

Observations

Palustrine wetlands with Water Regimes A (Temporarily flooded), B (Seasonally Saturated), and C (Seasonally Flooded) were most commonly found in the field. “A” and “C” wetlands were frequently associated with playas, livestock tanks, and narrow floodplains. “B” Water Regime wetlands were found primarily on slopes and mostly dominated by emergent, herbaceous plant species.

Polygons drawn to represent springs and seeps were no smaller than 0.1 to 0.25 acres in size and were delineated where present on DRGs (1:24,000 scale USGS topographic maps), identified on collateral GIS data from project partners, or visible on aerial imagery.

Saturated “B” Water Regime wetlands on slopes and flat were much more common higher in mountains. Those Cowardin “B” class wetlands which were seen to cross two contours were classified as Saturated, although many Bs on flats were also found at higher elevations. During discussions with the USFWS, it was acknowledged that these areas would likely only be found in the montane portions of the study area.

Lacustrine habitat was found within the shorelines of the Caballo and Elephant Butte Reservoirs. The majority of the areas within the spill elevations of these reservoirs are occupied by open water and sandy substrate with significant acreage dominated by emergent and shrub species. Open water will be classified using the “H” (Permanently Flooded), “G” (Intermittently Exposed), and “F” (Semipermanently Flooded) Water Regimes. Shoreline areas covered by sandy, gravel or unconsolidated substrate will be classified as “C” (Seasonally Flooded), “A” (Temporarily Flooded), and “J” (Intermittently Flooded).

Water Regimes for stream channels visited included “H” (Permanently Flooded), “G” (Intermittently Exposed), “C” (Seasonally Flooded), “A” (Temporarily Flooded), and “J” (Intermittently Flooded). Longer flooding duration segments were located in mountains and foothills. Intermittently Flooded “J” buffered linears dominate lowland areas. Few acequias were noted during field verification. Many of those that were observed were determined to be Seasonally Flooded. Channels with faint gray signatures will be assigned the "A" Water Regime or wetter depending upon presence of springs and water on one or more dates of imagery. Drainage features that are Intermittently Flooded will be characterized using the "J" Water Regime.

In order to be consistent with national conventions, areas delineated and classified as riparian will include areas adjacent to lentic and lotic waters. Most of the forested riparian areas were found to be dominated by cottonwood or a mix of deciduous species. Riparian zones were generally found to be occupied by salt cedar, and to a lesser extent by juniper.

Draft Map Production

Following approval of previous steps in the methodology by the project team and the completion of image interpretation conventions for each watershed, SMUMN GSS completed the wetland delineation and classification across the entire project study area. Collateral GIS data, field derived decision rules, team and wetland expert input, as well as established guidelines for each watershed were incorporated to ensure accuracy and consistency of the wetland database.

NWI – Wetlands and Deepwater Habitats Classification System (Cowardin et al. 1979)

Wetlands were delineated and classified for the NWI on screen using collateral data. Over 31,700 wetland polygons were identified and classified. Linear wetland features were buffered and included in the polygon count, as per NWI Version 2.0 requirements. The original imagery was broken into working units, typically by quadrangles, counties, or sub-watersheds. A file structure for work units was created in the geodatabase. The SMUMN GSS photo interpreter completed the on-screen digitizing and NWI classification for the entire project area. All wetland mapping was based on imagery, field investigations, collateral data and observations, and input from local and regional experts as needed. An example of delineated wetland boundaries displayed over aerial photography is displayed in Figure 16.

Figure 16. Sample of aerial photography in Catron County, along Centerfire Creek, within Gila National Forest. This image is viewed at a scale of 1:15,000. The image interpreter has digitized the physical boundaries of each wetland (wetland delineation) in ArcGIS and has also assigned a Wetlands and Deepwater Habitats Classification (Cowardin et al. 1979) attribute to each of the wetlands (classification).

While the delineation and classification steps were being completed, internal quality assurance steps were continually in process. These included personnel completing a zoomed-in review of each polygon to verify its appearance. Each feature was accepted, merged, or deleted as appropriate. Signature matching occurred by panning through the entire dataset at a scale of 1:10,000, which ensured that features within a complex were categorized accurately and consistently. This also verified hydrologically connected drainage systems or wetland complexes across roads or other human influences.

Digital line work for all wetlands was first reviewed at a scale of 1:5,000, which ensured that polygon features were appropriately pieced together. The entire dataset was then panned at a scale of 1:3,000 where jags, spikes, horns, zigzags, intersections, and corners (potential errors that can occur with digital delineation) were located and adjusted accordingly.

LLWW Classification System

The LLWW classification was completed on-screen using collateral GIS data including surface hydrology, DEM, and DRGs to define wetland functional values. SMUMN GSS previously collaborated with Ralph Tiner of USFWS to assist with regional considerations for this classification process (Figure 17).

Figure 17. Aerial photography over Catron County, along Centerfire Creek, viewed at a scale of 1:15,000. After completion of the wetland delineation, the image interpreter has assigned LLWW attributes to each wetland.

To ensure quality and consistency for the application of the LLWW classification system, SMUMN GSS analysts applied consistent mapping conventions determined by project team members. This process included the proficient crosswalk of attributes between the NWI (Cowardin et al. 1979) and LLWW classification systems. Typical guidelines for the application of various LLWW attributes included:

LLWW Terrene Feature Guidelines

- Wetlands with the Water Flow Path of *OU* (Outflow) in proximity to NHD streams were assigned *ds* (discharge to stream). While by LLWW definition only the *B* (Seasonally Saturated) Water Regime typically has this designation, the *A* (Temporarily Flooded) and *C* (Seasonally Flooded) Water Regimes also reflected this Water Flow Path and condition in the project area.

LLWW Lotic River and Lotic Stream Feature Guidelines

- All *R2* and *R3* streams and rivers were *TH* (Throughflow). *R4* streams and rivers were either *TH* (Throughflow) or *TI* (Intermittent Throughflow).
- *3* (High Gradient) was assigned to all first and second order *R3* (Riverine, Upper Perennial) and *R4* (Riverine, Intermittent) streams and rivers (ex. R3 = *ST3*)
- *3* (High Gradient) or *2* (Intermediate Gradient) was assigned to third order, and lower, streams and rivers and was also based on distance between contours
- *hw* (headwater) was assigned to all saturated *B*, *D*, or *E* water regimes with *%OUds*
- *hw* (headwater) was also assigned to all polygons both palustrine and riverine flowpaths that are above 8,000 feet with an intersection of contours as well as additional lower elevation peaks in flatter areas ranging from 6,500 feet and above. In areas where the density of springs was high the lasso selection tool was used to hand-select additional polygons for the *hw* designation.
- *ST2%* was a typical second order stream of *R4SBJ* or *R3RBH* (ex. *R4SBJ* became *ST2TI*),
- There were some situations where a wetland was in a floodplain location but was designated as a *TE* (Terrene) Landscape (as opposed to a standard Lotic River or Lotic Stream). This is a valid assignment in the LLWW classification system for those wetlands that are accumulating surface water from rainfall or snow melt, as opposed to having a direct connection to the river or stream as their water source.
- Arroyo coding reflected intermittent or ephemeral flow in LLWW code (ex. *ST2TI* for *R4SB%A* or *ST3arTI* for *R4SB%J*)
- *PEM1C* segments in *R4SBJ* arroyos were coded a *LS4BATI*
- *R_US%J* outwash areas were *LR1* or *LS* with a *TH* or *TI* flow path and *brow* (barren outwash) modifiers

- Topographical DRGs from the USGS were useful in determining Water Flow Path for the LLWW classification.

LLWW Modifier Guidelines

- *P%B* features adjacent to streams were coded as *ds* (discharge to stream)

Playa Feature Guidelines

- Image interpretation was used to locate both alkaline and non-alkaline playas. Lake sized wetlands greater than 20 acres and recognizable as playas were coded as *LK1IN* or *LK1fVR*. The *i* (Alkaline) modifier was used to identify playa ponds with noticeable salt content (ex. either *PEM1Ci* or *PUSCi* for *TEBAplVR*).

- *PUB%x* with playa ponds were coded as *PD3kVR*

- *TEBAplVR* was primarily used for *A* (Temporarily Flooded) or *J* (Intermittently Flooded) Water Regimes for playa basins.

LLWW Water Flow Path Guidelines

- Small water retention impoundments such as *P%h* were coded as *TEBAipTIhi* with inflow and outflow or *TEBAipINhi* if the feature was at the terminus of a stream. *PUB%h* ponds coded as *PD2%* were coded similarly as *TI* or *IN*.

- Wetland polygons at the top of a watershed were coded *OU* (Outflow) if they were part of a continuous stream or river system in either the NWI mapping or the NHD flowlines.

- Excavated basins or ponds regardless of substrate, or regime, *P%x* were most often attributed with vertical flow, *TEBAVRhi* or *PD3VR.*

  **NOTE: the use of the percent sign (%) is a wildcard or placeholder indicating that other coded information may occur here within the string of LLWW or NWI codes*

Wetland Functional Correlation Development

A correlation table documenting the characteristics of wetlands performing 12 specific functions was developed in a series of meetings with the project advisory team. This involved a review of similar processes completed for other regions in the country as well as in-depth discussion and planning with national and regional wetland experts. Of greatest concern was the applicability of functions to the semiarid region of the project area. The functional analysis was based on completed NWI and LLWW mapping and classification, and also the consequent correlation of these wetland characteristics to one of the 12 identified functions for the project area (Table 4). These functions were coded and placed in the geodatabase. A series of functional assessment maps were then produced, one map for each of the twelve functions in the project area. These maps served as a basis for the validation field review completed later for the project area.

Table 4. Wetland functions selected for inclusion in the Gila project area's wetland functional assessment.

Function	Function
Aquatic invertebrate habitat	Other wildlife habitat
Bank and shoreline stabilization	Sediment and other particle retention
Carbon sequestration	Streamflow maintenance
Fish habitat	Surface water detention
Groundwater recharge	Waterfowl and waterbird habitat
Nutrient transformation	Unique, uncommon, or highly diverse wetland plant communities

Riparian Classification System

Upon completion of the NWI and the LLWW classification systems, as well as the completion of the project area's functional analysis, riparian areas found in the project study area were delineated and classified. Riparian areas were mapped using standards and technical procedures compatible with other standards outlined for the collection of data by the USFWS NWI. The mapping of these areas allows planners to understand the location and characteristics of important riparian habitat areas for the purpose of both regional and national conservation efforts. Many riparian habitats support wildlife species with state or federal protection status.

HGM Classification

HGM wetland classifications (after Brinson 1993) were assigned to each polygon during the image interpretation process. In order to make the HGM assignments, the analyst took into account the first-hand knowledge of this landscape generated through ground-truthing project imagery, in consultation with NMED SWQB resource experts. HGM classifications were attributed after wetland and deepwater habitat polygons were delineated and attributed in the NWI and LLWW classification systems. These data were then used to make informed decisions regarding assignment of HGM classifications. Other important collateral datasets used included EPA Level IV Ecoregions mapping and characterizations and USGS Digital Raster Graph (DRG) symbols.

Table 5. HGM Classes, Subclasses, and Modifiers used in the project study area.

HGM Class	HGM Subclass	HGM Modifier
Depressional	Playa	Inflow
		Excavated Inflow
		Outflow
		Throughflow
		Throughflow Intermittent
		Vertical Flow
		Excavated Vertical Flow
	Artificial	Excavated
		Farmed
		Impounded
	Natural	Farmed
		Inflow

HGM Class	HGM Subclass	HGM Modifier
		Outflow Vertical Flow Throughflow Throughflow Intermittent
Riverine	Episodic	2.0 Connection
	Headwater	Outflow
	Montane Unconfined	Null
	Montane Canyon Confined	Null
	Lowland Unconfined	Excavated Farmed
	Lowland Canyon Confined	Excavated Throughflow
Slope	Headwater	Spring-fed Outflow Outflow Intermittent Throughflow Intermittent Vertical Flow
	Other	Outflow Outflow Intermittent Throughflow Throughflow Intermittent Vertical Flow
	Springfed	Outflow Throughflow
Lacustrine	Fringe	Null

The following sections describe each HGM class and provide a brief narrative for which wetlands (i.e., NWI & LLWW codes) and collateral data were used to identify each class, subclass, and modifier applied in the project area.

HGM Class - Depressional

Depressional wetlands occur in topographic depressions that allow accumulation of surface water. On a topographic map, these wetlands occur within a closed elevation contour. Dominant sources of water are precipitation and/or overland flow from adjacent uplands, but these wetlands may also have a ground water component to them. The direction of water movement is normally from the surrounding uplands toward the center of the depression. Depressional wetlands may have any combination of inlets and outlets or lack them completely. They may lose water through intermittent or perennial drainage from an outlet, by evapotranspiration, and, if they are not receiving groundwater discharge, may slowly contribute to groundwater. Depressional wetlands are not further defined by locations within other landform types.

HGM Subclasses

Natural
These are natural depressional wetlands where the water supply was primarily determined to be from groundwater or overland flow, not stream sources and where human impacts to surface hydrology are absent.

Playa
Playa wetlands were attributed in the LLWW System with the “pl” Modifier. HGM Modifiers consist of waterflow direction as assigned in LLWW coding (e.g., Inflow, Outflow, or Vertical Flow). Playas that have been partially altered through excavation were classified as Excavated Inflow and Excavated Vertical Flow.

Artificial
These are artificial depressional wetlands designed to capture or reduce the volume of flow in moving water. Those identifiable impacts were classified as Excavation (x) or Impoundment (h). Wetland areas that have been created and/or where ponding duration has become established inadvertently (e.g., road construction) were classified in the LLWW System as ‘human induced” (hi).

HGM Class- Riverine
Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Dominant water sources are overbank flow or side channel flow from the channel, or subsurface hydraulic connections between the stream channel and adjacent wetlands (hyporheic flow). Additional water sources include overland flow from adjacent uplands and precipitation. When overbank flow occurs, surface flows down the floodplain may dominate hydrodynamics. At the headwaters, riverine wetlands often intergrade with slope or depressional wetlands as the channel (bed) and bank disappear, or they may intergrade with poorly drained flats or uplands.

HGM Subclasses

Episodic Riverine
These riverine areas were classified as R4SB3J or R4SB4J in the NWI Classification System and as Stream-Throughflow Intermittent in the LLWW System. Many episodic riverine polygons were assigned a “2.0 Connection” modifier, referring to the fact that these features were added during the process of upgrading original mapping to NWI 2.0 standards. The transition to NWI 2.0, initiated in 2015, incorporates buffered linear features that were previously excluded from the polygonal feature class, in an effort to capture additional wetland habitat features or “to complete existing segmented connections between wetlands” (USFWS 2021). An additional goal, particularly in arid and semi-arid regions such as New Mexico, is “to map potential connectivity for water and sediment transport” across the landscape (USFWS 2021). For example, in alluvial fan or overland flow situations, areas should be connected by a buffered centerline, so that connectivity of flow is captured (USFWS 2021).

Montane Unconfined Riverine
The Montane Unconfined Riverine Wetland subclass includes unconfined streams and wetlands that are associated with mid-elevations (above ~8,000 ft in this project area) between the lowlands and subalpine and alpine elevations (Muldavin et al. 2011).

This classification was attributed based on two criteria. Firstly, these valleys were identified above approximately 8,000 ft in elevation within the Montane Conifer Forests (23c) or Conifer Woodlands and Savannas (23e) EPA Level IV Ecoregions. Secondly, using the ArcGIS Measuring Tool, the distance contour lines representing the location of the first bench on either side of a river or stream measured greater than 70 meters on the corresponding DRG overlay.

Montane Canyon (Confined) Riverine
The Montane Canyon (Confined) Riverine Wetland subclass is primarily found along confined stream reaches in the same elevation zone and intermixed with Montane Riverine Wetlands (Muldavin et al. 2011). This subclass is characterized by steep stream systems confined by the underlying bedrock, with channel substrates dominated by boulders and cobble. Typically, the streams have a narrow riparian zone and may lack a distinct floodplain (Muldavin et al. 2011).

This classification was attributed based on two criteria. Firstly, these valleys were identified above 8,000 ft in elevation within the Madrean Lower Montane Woodlands (23b), Montane Conifer Forests (23c), Arizona/New Mexico Subalpine Forests (23d), and Conifer Woodlands and Savannas (23e) EPA Level IV Ecoregions. Secondly, using the ArcGIS Measuring Tool the distance contour lines representing the location of the first bench on either side of a river or stream measured less than 70 meters on the corresponding DRG overlay.

Lowland Unconfined Riverine
These areas occurred in all three of the EPA Level III Ecoregions within the Gila project area (Arizona/New Mexico Plateau, Arizona/New Mexico Mountains, and Chihuahuan Deserts). At lower elevations (<8,000 ft for this project area), Montane Riverine Wetlands transition to Lowland Unconfined Riverine Wetlands. This subclass is associated with high-volume river systems with large drainage areas that can move various sediment size classes, creating complex fluvial terrains made up of large mid-channel and point bars, as well as multiple terraces and back channels (Muldavin et al. 2011).

This classification was attributed based on two criteria. Firstly, these valleys were identified below approximately 8,000 ft in elevation within the following EPA Level IV Ecoregions: Semiarid Tablelands (22j), Madrean Lower Montane Woodlands (23b), Montane Conifer Forests (23c), Conifer Woodlands and Savannas (23e), Chihuahuan Basins and Playas (24a), Chihuahuan Desert Grasslands (24b), Low Mountains and Bajadas (24c), and Rio Grande Floodplain (24f). Secondly, using the ArcGIS Measuring Tool the distance contour lines representing the location of the first bench on either side of a river or stream measured greater than 70 meters on the corresponding DRG overlay.

Lowland Confined (Canyon) Riverine
The Lowland Confined (Canyon) Riverine wetlands sub-class is typically found along confined stream reaches in the same elevation zone. They were also found in in all three of the EPA Level III Ecoregions within the Gila project area. This subclass is characterized by steep stream systems confined by the underlying bedrock or valley sides. These streams typically have a narrow riparian zone and may lack a distinct floodplain.

This classification was attributed based on two criteria. Firstly, these valleys were identified below approximately 8,000 ft in elevation. Secondly, using the ArcGIS Measuring Tool the distance contour lines representing the location of the first bench on either side of a river or stream measured less than 70 meters on the corresponding DRG overlay.

HGM Class - Lacustrine Fringe
Lacustrine Fringe Wetlands are found adjacent to lakes where the water elevation of the lake maintains the water table in the wetland (NRCS 2008). Additional sources of water are precipitation and groundwater discharge, the latter dominating where lacustrine fringe wetlands intergrade with uplands or slope wetlands (NRCS 2008). Surface water flow is bidirectional, typically controlled by water level fluctuations in the adjacent lake. Lacustrine fringe wetlands lose water through flow returning to the lake after flooding, by saturation surface flow, and by evapotranspiration (NRCS 2008). All lentic flats (FL) and basins (BA) affected by Bidirectional flow were classified in the lacustrine fringe class.

Lacustrine Fringe Wetlands in this study area are in the upstream areas of dammed river and stream valleys. They were attributed with the Impounded Special Modifier (h) in the NWI Classification System and as dammed (LE2_) in the LLWW System. The USGS Symbol representing "land subject to controlled inundation" was referred to during the interpretation process to assist in the determinations of upstream reaches with artificial inundation.

HGM Class - Slope
Slope wetlands are normally found where groundwater discharges to the land surface (NRCS 2008). They typically occur on sloping land; however, elevation gradients may range from steep hillsides to slight slopes. Slope wetlands are usually not capable of depressional water storage because the ground lacks the necessary enclosed basin or is convex in shape. The principal water source is usually groundwater flow, however interflow from surrounding uplands as well as precipitation may contribute. Hydrodynamics are dominated by downslope unidirectional water flow (NRCS 2008). Slope wetlands can occur in nearly flat landscapes where groundwater discharge is a dominant contributor to the wetland surface. These wetlands primarily lose water through surface flows, subsurface saturation, and evapotranspiration (NRCS 2008).

In this project area, wetlands identified as occurring on slopes were classified as having a Seasonally Saturated (B), Continuously Saturated (D), or Seasonally Flooded/Saturated (E) NWI Water Regime. They generally also were intersected by one or more DRG contour interval lines.

HGM Subclass

Spring-fed
During the wetland mapping exercise, spring locations were identified from four data sources including project imagery, USGS DRGs, Springs Stewardship Institute data, and an NMED SWQB cienegas point layer. Any visible wetland that contained a spring or was interpreted to be directly downstream and adjacent to a spring was coded with the LLWW sf (spring-fed) HGM Modifier. The spring-fed code was also applied to hill slope springs in valley walls that were adjacent to riverine wetlands but not dominantly hyporheic in nature.

Headwater
The Headwater HGM Modifier was applied to saturated, outflowing wetlands adjacent to first and second order streams in the project area's various mountain ranges. These were also assigned the HGM Modifier "Springfed" where they occurred along first and second order

streams. The HGM Modifier "Outflow" was assigned where a headwaters wetland occurred and springs were absent.

Other

These HGM Subclass areas are disconnected from channels. The HGM Modifier "Outflow" was applied if they were disassociated headwaters areas and springs.

Field Review of Draft Map

Quality Assurance – Review of Geodatabase

The USFWS NWI Master Geodatabase Verification Tool, established topology rules for NWI projects, and the wetland integrity of the geodatabase were all reviewed and validated. This step was completed using the Wetlands Data Verification Toolset developed for the NWI Program which helps to automate quality control steps for the wetland geodatabase.

SMUMN GSS also developed and applied a customized quality control assessment script in ArcGIS™ which resolved data integrity issues (e.g. topology, gaps, overlaps, ghosts and adjacent attributes). These automated tools completed the rigorous visual quality control process undertaken by the professional wetland image interpreter and geospatial analysts.

Visual checks of the mapping also assessed classification and delineation accuracy resulting in corrections, when appropriate, for errors of omission or commission. 100% of the spatial data was reviewed to ensure accuracy of the final mapping product to meet specifications of the FGDC National Wetland Mapping Standard.

Customer Review

Several draft datasets were submitted for review to both New Mexico's SWQB and NWI Region 2 coordinator. These draft reviews occurred in October 2019, February 2020 and April 2021. The database included all wetlands for a specified area of interest or the entire study area. The entirety of the submitted draft data, regardless of status, was finalized to complete data standards. Wetland polygons were clipped to the study area boundary, run for topologic consistency, attribute and size errors, and packaged into the NWI database schema. A supplemental map report accompanied the data to provide basic information about the study area and collateral data as well as included photo interpretation conventions. Wetland data was reviewed for missing wetlands, spatial accuracy, 2.0 connectivity, accuracy of attribution, precision of linework, and overall consistency of the data. These issues were expressed in a shapefile that included specific locations and a description of error type. GSS would then host a dialogue for addition review and input as needed, and revise the data in question. In addition, a complete survey of all remaining data was scanned and sorted to apply the suggested changes to the entire dataset.

Submission of Final Mapping Product

All mapping products, including a single geodatabase, hardcopy maps and the final report were submitted to the state of New Mexico for review and approval. A version of the geodatabase without LLWW or HGM codes was then submitted to the NWI program of the USFWS for inclusion into the NWI Master Geodatabase. The final database delivery to New Mexico was made in September 2021 which includes all riparian and wetland polygons with NWI, LLWW, and HGM attribution. This data includes wetland functions, parsed NWI attributes, and comprehensive metadata.

Results

Overview

The purpose of this project was to map and classify existing wetland resources found in the Gila study area of western New Mexico. Wetland data were summarized for both the NWI (Cowardin et al. 1979) and LLWW classification systems. The mapping and classification of riparian areas and a wetland functional analysis for the project area were also completed.

Acreages were determined from several spatial data layers which reside in the newly developed geodatabase using ArcMap (ver. 10.7.1) spatial and statistical analysis tools (Figure 18). Summary statistics and tables for each classification system are included here, along with representative images.

Figure 18. The use of a geodatabase allows for extensive analysis of many data layers. In the location shown above, the wetland classification was developed using spatial data layers such as hydrology, beaver habitat, vegetative cover, land use and land ownership.

NWI - Wetlands and Deepwater Classification Summary

Wetlands and deep water habitats comprised 133,362 acres (1.6%) of the total land in the approximately 8.1 million-acre project area. Over 31,700 polygon wetland features were mapped and classified from the Palustrine, Lacustrine or Riverine Systems using the Wetlands and

Deepwater Habitats Classification System (Cowardin et al. 1979) for the NWI. In total, 185 unique NWI codes were employed to classify wetland polygons in the project area (Appendix E).

Of the 31,736 polygon features delineated and classified, the Riverine System accounted for 62% of the polygons and nearly 67% of the wetland area. The Lacustrine System polygons were less than 0.5% of all polygons and 12% of the total wetland area. The Palustrine System polygons represented nearly 38% of polygons and accounted for nearly 21% of wetland area.

A summary table and comments for polygon wetland features found in the project area follow (Table 6). It should be noted that in these tables the System and Class sections should not be expected to sum to 100%. This is due to some entries in the table being not mutually exclusive of each other.

Table 6. NWI Polygon Wetland Summary.

Summary Parameters		**No. of polygons**	**% of total polygons***	**Area (acres)***	**% of project area***	**% of wetland area***
General						
All Polygons		31,736	--	133,362	1.6	--
NWI System/Subsystem						
P (all palustrine)	Palustrine, (no Subsystems in System)	11,931	37.6	28,009	0.3	21.0
L (all lacustrine)	Lacustrine, (combined subsystems)	72	0.2	16,577	0.2	12.4
L1	Lacustrine, Limnetic	11	<0.1	7,616	<0.1	5.7
L2	Lacustrine, Littoral	61	0.2	8,960	0.1	6.7
R (all riverine)	Riverine, (combined subsystems)	19,733	62.2	88,776	1.1	66.6
R2	Riverine, Lower Perennial	118	0.4	708	<0.1	0.5
R3	Riverine, Upper Perennial	2,975	9.4	6,538	0.1	4.9
R4	Riverine, Intermittent	16,640	52.4	81,530	1.0	61.1
NWI Class/Subclass						
AB	Aquatic Bed	34	0.1	17	<0.1	<0.1
EM	Emergent	2,402	7.6	7,852		5.9
EM/SS	Emergent/ Scrub-Shrub	37	0.1	2,194		1.6
FO	Forested	1,351	4.3	3,585		2.7
RB	Rock Bottom	9	<0.1	231	<0.1	0.2
SS (total)	Scrub-Shrub	1,364	4.3	4,725	<0.1	3.5
SS1	Broad-leaved Deciduous	1,266	4.0	4,298	<0.1	3.2
SS2	Needle-Leaved Deciduous	98	0.3	427	<0.1	0.3
SB (total)	Streambed	16,640	52.4	81,530	1.0	61.1
SB1	Bedrock	6	<0.1	19	<0.1	<0.1
SB2	Rubble	28	<0.1	285	<0.1	0.2
SB3	Cobble-Gravel	11,201	35.3	68,551	0.8	51.4
SB4	Sand	129	0.4	969	<0.1	0.7
SB5	Mud	26	<0.1	96	<0.1	<0.1

Summary Parameters		**No. of polygons**	**% of total polygons***	**Area (acres)***	**% of project area***	**% of wetland area***
SB7	Vegetated	241	0.8	506	<0.1	0.4
UB (total)	Unconsolidated Bottom	2,065	6.5	19,642	0.2	14.7
UB1	Cobble-Gravel	59	0.2	15,248	0.2	11.4
UB2	Sand	19	<0.1	2,025	<0.1	1.5
UB3	Mud	77	0.2	1,450	<0.1	1.1
US (total)	Unconsolidated Shore	7,834	24.7	13,586	0.2	10.2
US1	Cobble-Gravel	1,491	4.7	2,293	<0.1	1.7
US2	Sand	5,011	15.8	8,744	0.1	6.6
US3	Mud	855	2.7	970	<0.1	0.7
US5	Vegetated	476	1.5	1,578	<0.1	1.2
NWI Modifiers - Water Regime						
A	Temporarily Flooded	8,474	26.7	21,633	0.3	16.2
B	Seasonally Saturated	252	0.8	644	<0.1	0.4
C	Seasonally Flooded	1,011	3.2	2,688	<0.1	2.0
D	Continuously Saturated	18	<0.1	76	<0.1	<0.1
E	Seasonally Flooded/Saturated	15	<0.1	45	<0.1	<0.1
F	Semipermanently Flooded	1,916	6.0	1,888	<0.1	1.4
G	Intermittently Exposed	143	0.4	7,996	<0.1	6.0
H	Permanently Flooded	29	<0.1	8,702	0.1	6.5
J	Intermittently Flooded	19,824	62.5	88,322	1.1	66.2
K	Artificially Flooded	54	0.2	1,367	<0.1	1.0
NWI Modifiers - Special Modifiers						
f	Farmed	24	<0.1	147	<0.1	0.1
h	Diked/impounded	5,995	18.9	28,374	0.3	21.3
x	Excavated	1,250	3.9	2,334	<0.1	1.8
NWI Modifiers - Water Chemistry						
i	Alkaline	23	<0.1	1,574	<0.1	1.2

*Percentages rounded to the nearest 1/10th percent and area rounded to the nearest acre.

Palustrine System Feature Summary

Although a wide variety of wetland types (i.e., NWI codes) were mapped within the Gila study area, the Palustine System accounted for a vast majority of the total number and area of polygon wetland features. In total, there were approximately 12,000 acres of Palustrine polygon wetlands in the project area.

Within the Palustrine System the most frequent polygon feature classification was PUS2Ah (Palustrine, Unconsolidated Shore-Sand, Temporarily Flooded, Impounded). Over 1,600 wetlands were classified as this particular wetland type. PUS2Jh (Intermittently Flooded) was a close second, with nearly 1,550 polygons. Some additional common codes in the Palustrine System included PFO1A (Forested, Broad-leaved Deciduous, Temporarily Flooded) with around

1,270 features; PUBFh (Unconsolidated Bottom, Semipermanently Flooded, Impounded) with approximately 1,200 features; and PSS1A (Scrub-shrub, Broad-leaved Deciduous, Temporarily Flooded) with nearly 1,000 features.

Figure 19. A PEM1C wetland surrounding a PEM1F wetland in the Gila National Forest, northeast of Mogollon in southern Catron County (SMUMN GSS photo).

Lacustrine System Feature Summary

The Lacustrine wetland polygon features identified in the project area represented less than 1% of all the polygon wetlands mapped and classified, but 12.4% of total area (16,577acres). Nineteen different Lacustrine System attributes (codes) described 72 Lacustrine polygon features. The most common wetland feature in the Lacustrine System was L2UB1Gh (Lacustrine, Littoral, Unconsolidated Bottom, Cobble-Gravel, Intermittently Exposed, Impounded) with 26 polygons. The second most common type was L2US5Ah (Unconsolidated Shore, Vegetated, Temporarily Flooded, Impounded) with nine polygons.

The largest single Lacustrine System polygon feature in terms of acreage was an L2UBGh portion of Elephant Butte Reservoir at 6,351 acres in size. The bordering L1UBHh polygon, representing the deeper middle portions of Elephant Butte Reservoir, account for an addition 4,664 acres. This water body is an impoundment on the Rio Grande in Sierra County (Figure 20).

Figure 20. A lacustrine portion of Elephant Butte Reservoir, northeast of Truth or Conequences, NM (SMUMN GSS photo).

Riverine System Feature Summary

Some Riverine features were mapped initially as polygons while others were mapped first as linears and then buffered to create polygons. The Riverine System comprised 62% of all polygon features and nearly 67% of total wetland area.

The most common attribute (code) among the Riverine features, by far, was R4SB3J (Riverine, Intermittent, Cobble-Gravel Streambed, Intermittently Flooded) with 10,723 features. Other common attributes included R4SBJ (Intermittent, Streambed, Intermittently Flooded) with 5,009 features, R3US1A (Upper Perennial, Unconsolidated Shore, Cobble-Gravel, Temporarily Flooded) with 905 features, and R3US1J (Upper Perennial, Unconsolidated Shore, Sand, Intermittently Flooded) with 554 features.

Nearly 88,800 acres of riverine polygons were mapped, the majority of which were considered intermittent (Table 6). Perennial Riverine areas (R2, R3) mapped included the Rio Grande, the Gila, San Francisco, and Mimbres Rivers, and portions of Las Animas Creek.

Figure 21. An R3UB1H wetland in the Gila National Forest northeast of Glenwood (left) and an R4USJ wetland (arroyo) west of Silver City in Grant County (right, SMUMN GSS photos). Arroyos are dry creeks, stream beds, or gulches that temporarily fill with flowing water after sufficient rainfall and/or snow melt.

LLWW - Landscape Position, Landform, Water Flow Path, Water Body Type

Many unique LLWW attributes or codes were identified in the Gila project area. These included nearly 570 codes for polygon wetland features. To enhance the LLWW classification system being applied for New Mexico, the team utilized the Water Regime classifications from the NWI data to contribute to the identification of LLWW Landforms. These Landforms included Basin, Flat, Floodplain, Fringe, or Slope wetland areas.

The most common Landscape Position classification for wetland polygons within the study area was Terrene (TE), which accounted for nearly over 20% of total features but just 9% of total wetland area. The Lentic (LE) Landscape Position represented the greatest amount of wetland area at 11.8% while comprising just 1.2% of wetland polygons.

LLWW Water Body Type classifications were completed for lakes, ponds, rivers and streams. Streams (ST) were most numerous, comprising 52.5% of features and 61.6% of total wetland area. The most common streams, both in number of polygons and area, were High Gradient (ST3). Lakes (LK) were a distant second in wetland area at 7.5%.

The most common LLWW Landform was Basin (BA), with 20% of features and about 9% of total wetland area. Flat (FL) wetlands accounted for 7.5% of wetland area, Floodplain (FP) wetlands for 6.8% for 13.5%, and Fring (FR) wetlands for 4.8%.

The LLWW Water Flow Path classification included inflow, outflow, throughflow, vertical flow, and bidirectional-nontidal. The most common flow path in terms of number of polygons and wetland area was Throughflow-Intermittent (TI) with nearly 69% and 64%, respectively. Throughflow (TH) comprised 20% of polygons and nearly 18% of wetland area. Bidirectional-tidal made up just 1% of polygons but 9% of wetland area.

Additional descriptors, known as “Other Modifiers”, were added towards the end of LLWW codes. Over 30 Other Modifiers exist in the LLWW classification system, with many different combinations between these modifiers. For the project area, the most common modifiers were as follows: arroyo (ar) (34.2% of polygons), headwater (34.0%), barren (br) (3.1%), severely human-induced (hi) (1.2%), and spring-fed (1.1%).

The summary for the LLWW polygon data is presented in Table 7. The reader should note that not all of the table sections sum to 100%, because vegetated wetlands were classified with the LLWW Landscape Position while open water wetlands were classified with LLWW Waterbody Types. They are mutually exclusive of each other because LLWW Water Body Types do not receive a LLWW Landform classification.

Table 7. Summary of LLWW Codes for wetland polygons.

Summary parameter	No. of features	% of total features	Area (acres)	% of total wetland area	% of total project area
General					
Project Area	--	--	8,106,898	--	--
All Wetlands (polygons)	31,736	--	133,362	--	1.6
Landscape Position/Type					
Lentic (LE)	383	1.2	15,766	11.8	0.2
Natural Deep Lake (1)	3	<0.1	23	<0.1	<0.1
Dammed River Valley Lake (2)	7	<0.1	24	<0.1	<0.1
Reservoir (2a)	25	<0.1	74	<0.1	<0.1
Hydropower (2b)	338	1.1	15,587	11.7	0.2
Other Dammed Lake (3)	10	<0.1	59	<0.1	<0.1
Lotic River (LR)	4,791	15.1	8,546	6.4	0.1
Low Gradient (1)	1,728	5.4	4,815	3.6	<0.1
Middle Gradient (2)	3,060	9.6	3,727	2.8	<0.1
Dammed (6)	3	<0.1	5	<0.1	<0.1
Lotic Stream (LS)	1,389	4.4	2,335	1.8	<0.1
Low Gradient (1)	75	0.2	247	0.2	<0.1
Middle Gradient (2)	1,304	4.1	2,062	1.5	<0.1
High Gradient (3)	9	<0.1	24	<0.1	<0.1
Terrene (TE)	18,696	20.4	11,751	8.8	0.1

Summary parameter	No. of features	% of total features	Area (acres)	% of total wetland area	% of total project area
Water Body Type					
Lake (LK)	22	<0.1	9,957	7.5	0.1
Dammed River Valley (2)	17	<0.1	8,567	6.4	0.1
Other Dammed (3)	4	<0.1	133	0.1	<0.1
Shallow Excavated Lake (5)	1	<0.1	1,257		
Pond (PD)	1,943	6.1	933	0.7	<0.1
Natural (1)	55	0.2	22	<0.1	<0.1
Dammed/Impounded (2)	1,243	3.9	562	0.4	<0.1
Excavated (3)	645	2.0	348	0.3	<0.1
River (RV)	69	0.2	1,914	1.4	<0.1
Low Gradient (1)	30	<0.1	795	0.6	<0.1
Middle Gradient (2)	36	0.1	1,057	0.8	<0.1
High Gradient (3)	1	<0.1	24	<0.1	<0.1
Dammed Gradient (6)	2	<0.1	38	<0.1	<0.1
Stream (ST)	16,662	52.5	82,160	61.6	1.0
Low Gradient (1)	121	0.4	336	0.3	<0.1
Middle Gradient (2)	7,481	23.6	23,033	17.3	0.3
High Gradient (3)	8,920	28.1	58,438	43.8	0.7
Dammed (6)	1	<0.1	1	<0.1	<0.1
Artificial (7)	139	0.4	352	0.3	<0.1
Landform/Modifier					
Basin (BA)	6,339	20.0	12,311	9.2	0.1
Impoundment (ip)	4,314	13.6	3,277	2.5	<0.1
Pond (pd)	405	1.3	527	0.4	<0.1
Playa (pl)	1,060	3.3	6,391	4.8	<0.1
Salt Flat (sa)	5	<0.1	28	<0.1	<0.1
Flat (FL)	1,410	4.4	9,946	7.5	0.1
Impoundment (ip)	16	<0.1	50	<0.1	<0.1
Pond (pd)	10	<0.1	45	<0.1	<0.1
Floodplain (FP)	4,989	15.7	9,091	6.8	0.1
Basin (ba)	131	0.4	149	0.1	<0.1
Flat (fl)	4,818	15.2	8,834	6.6	0.1
Island (il)	35	0.1	89	<0.1	<0.1
Oxbow (ox)	5	<0.1	20	<0.1	<0.1
Fringe (FR)	30	0.1	6,371	4.8	<0.1
Island (il)	4	<0.1	1	<0.1	<0.1
Pond (pd)	2	<0.1	1	<0.1	<0.1
Island (IL)	2	<0.1	<1	<0.1	<0.1
Slope (SL)	267	0.8	673	0.5	<0.1
Pond (pd)	4	<0.1	8	<0.1	<0.1

Summary parameter	No. of features	% of total features	Area (acres)	% of total wetland area	% of total project area
Water Flow Path					
Bidirectional-nontidal (BI)	297	0.9	12,360	9.3	0.1
Inflow (IN)	1,114	3.5	4,752	3.6	<0.1
Outflow (OU)	275	0.9	626	0.5	<0.1
Outflow Intermittent (OI)	24	<0.1	57	<0.1	<0.1
Bidirectional-nontidal/throughflow (TB)	82	0.3	3,398	2.5	<0.1
Throughflow (TH)	6,300	19.8	23,291	17.5	0.3
Throughflow-intermittent (TI)	21,799	68.7	86,025	64.5	1.1
Vertical Flow (VR)	1,825	5.8	2,789	2.1	<0.1
Other Modifiers					
aquaculture (aq)	43	0.1	181	0.1	<0.1
arroyo (ar)	10,854	34.2	66,399	49.8	0.8
barren (br)	980	3.1	1,758	1.3	<0.1
cienega (cg)	29	<0.1	73	<0.1	<0.1
channelized flow (ch)	99	0.3	188	0.1	<0.1
partially drained (dr)	18	<0.1	108	<0.1	<0.1
discharge to stream (ds)	66	0.2	42	<0.1	<0.1
fragmented (fg)	29	<0.1	183	0.1	<0.1
severely human-induced (hi)	367	1.2	278	0.2	<0.1
headwater (hw)	8,850	27.9	45,309	34.0	0.6
irrigated (ir)	38	0.1	156	0.1	<0.1
oxbow (ox)	7	<0.1	85	<0.1	<0.1
spring-fed (sf)	362	1.1	2,752	2.1	<0.1
subsurface flow (ss)	11	<0.1	185	0.1	<0.1

*Percentages rounded to the nearest 1/10th percent and area rounded to the nearest acre.

Riparian Areas Summary

Serving as transitional areas between wetlands and adjacent uplands, riparian areas provide critical habitat for both resident and migratory wildlife. These areas are also important in maintaining wildlife corridors, especially in the western United States where the climate may be semi-arid or arid. The mapping of these areas for this project included the delineation and classification of features as outlined by the NWI Program of the USFWS. The classification system employed in the mapping process was the System for Mapping Riparian Areas in the Western United States (USFWS 2009).

Within the Gila project area, a total of 5,841 riparian acres were mapped and classified. Twelve unique riparian codes/types were mapped. Nearly all of the riparian acreage (97%) was in Lotic (flowing) subsystems, with <3% in Lentic (still) subsystems. The majority of these areas (60% by acreage) supported forested (FO) vegetation, with a smaller portion (39%) in scrub-shrub vegetation. All riparian areas were classified in the Deciduous (6) Subclass. Five Dominance Types were found: Mixed Deciduous (3,992 acres), Cottonwood (1,543 acres), Salt Cedar (148 acres), Willow (72 acres), and Russian Olive (42 acres). These classifications are summarized in Table 8 and all mapped riparian areas within the study boundary are shown in Figure 22.

Table 8. Riparian areas summary for the Gila project area.

Summary Parameter	Count	% of total riparian features	Area (acres)	% of riparian area	% of project area
General					
Total Project Area	--	--	8,106,898	--	--
Riparian Features	2,566	--	5,841	--	<0.1
Subsystem					
1 (Lotic)	2,496	97.3	5,181	88.7	<0.1
2 (Lentic)	70	2.7	660	11.3	<0.1
Class					
Forested	1,701	66.3	3,513	60.1	<0.1
Scrub-shrub	858	33.4	2,281	39.1	<0.1
Mixed Forested/ Scrub-shrub	7	0.3	46	0.8	<0.1
Subclass					
Deciduous	2,566	100	5,841	100	<0.1
Dominance Types					
Cottonwood	672	26.2	1,543	26.4	<0.1
Cottonwood/Salt Cedar	6	0.2	44	0.7	<0.1
Russian Olive	19	0.7	42	0.7	<0.1
Salt Cedar	50	1.9	148	2.5	<0.1
Willow	47	1.8	72	1.2	<0.1
Mixed Deciduous	1,772	69.1	3,992	68.3	<0.1

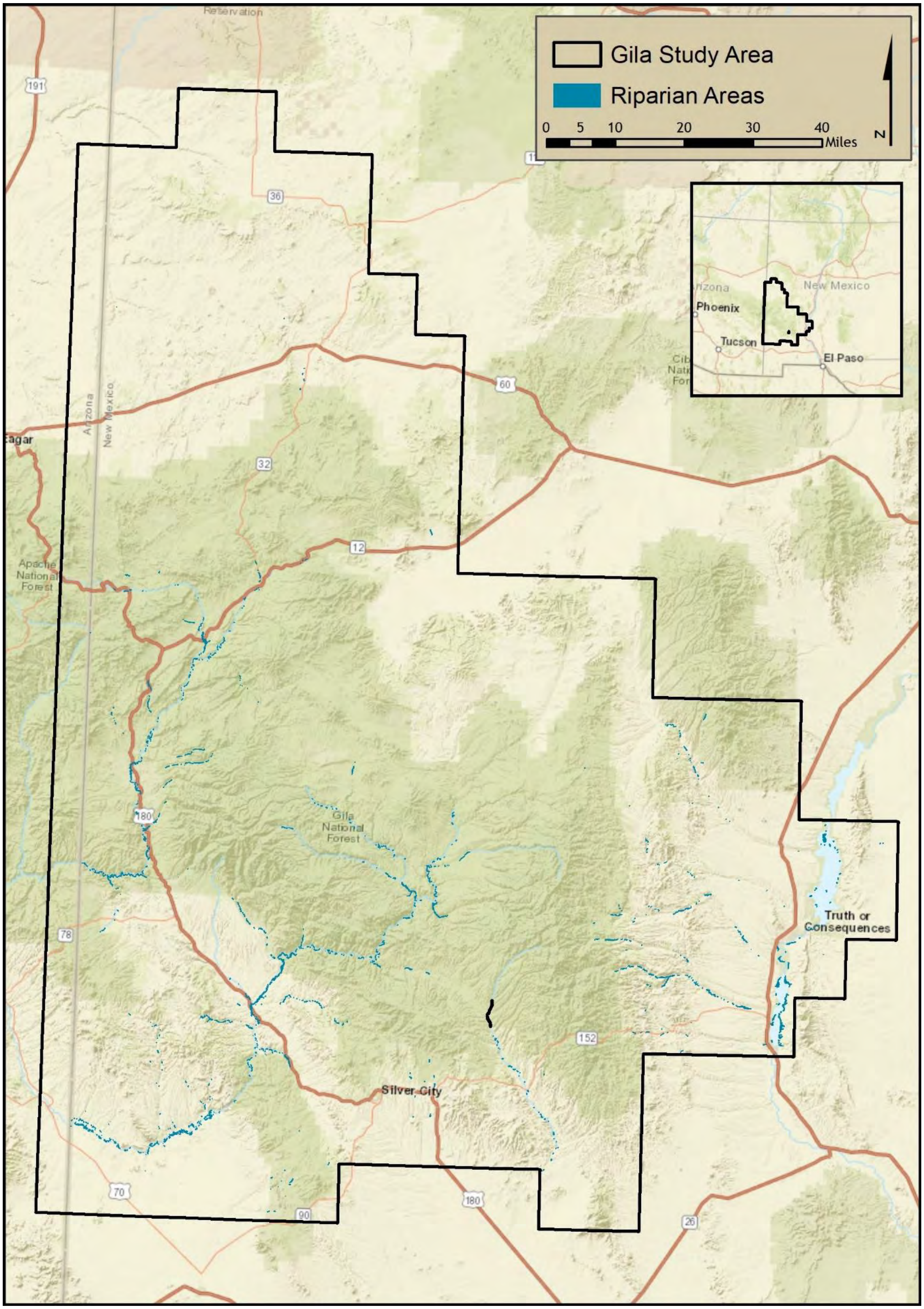


Figure 22. Riparian areas in the Gila project area.

HGM Classification Summary

The wetland polygons mapped in the Gila project area fell into four HGM classes and 12 HGM subclasses. Among the four classes, riverine wetlands were most common, with over 72% of total polygons and 71% of wetland area (Table 9). Depressional was second most common, comprising over 16% of total area. Slopes took up the least area at just 0.5%.

Among Riverine subclasses, episodic wetlands were most prevalent, making up 50.4% of all wetland polygons and approximately 58% of total area. Among Depressional features, artificial wetlands were most common, with 21% of all polygons and 11% of total area. Lacustrine fringe wetlands were a small number of total polygons (1.2%) but comprised nearly 12% of total area. Springfed slopes were rare, comprising just 0.2% of polygons and <0.1% of wetland area.

Modifiers were assigned to some polygons to provide additional information on HGM characteristics. Over 17% of all mapped polygons received an Impounded modifier. An additional 3.4% were classified as Excavated. A very small number of wetlands (<0.1%) in the project area were farmed.

Table 9. Summary of HGM classifications for wetland polygons.

Summary parameter	No. of features	% of total features	Area (acres)	% of total wetland area	% of total project area
General					
Project Area	--	--	8,106,898	--	--
All Wetlands (polygons)	31,736	--	133,362	--	1.6
HGM Class					
Depressional	8,166	25.7	21,958	16.5	0.3
Riverine	22,912	72.2	94,954	71.2	1.2
Slope	275	0.9	683	0.5	<0.1
Lacustrine	383	1.2	15,766	11.8	0.2
HGM Sublass[1]					
Artificial (D)	6,607	20.9	14,478	10.9	0.2
Episodic (R)	15,981	50.4	77,671	58.2	1.0
Fringe (L)	383	1.2	15,766	11.8	0.2
Headwater (S)	119	0.4	175	0.1	<0.1
Lowland Canyon Confined (R)	3,313	10.4	7,177	5.4	<0.1
Lowland Unconfined (R)	2,596	8.1	7,988	6.0	<0.1
Montane Canyon Confined (R)	849	2.7	1,714	1.3	<0.1
Montane Unconfined (R)	172	0.5	405	0.3	<0.1
Natural (D)	484	1.5	1,090	0.8	<0.1
Playa (D)	1,075	3.3	6,390	4.8	<0.1
Springfed (S)	59	0.2	113	<0.1	<0.1
Other (S)	99	0.3	398	0.3	<0.1
Modifiers					
Excavated (including exc inflow & vertical flow	1,084	3.4	1,960	1.5	<0.1

Summary parameter	No. of features	% of total features	Area (acres)	% of total wetland area	% of total project area
Farmed	21	<0.1	142	0.1	<0.1
Impounded	5,570	17.6	12,474	9.4	0.1
Inflow	126	0.4	2,687	2.0	<0.1
Outflow	180	0.6	534	0.4	<0.1
Outflow Intermittent	13	<0.1	30	<0.1	<0.1
Spring-fed	65	0.2	62	<0.1	<0.1
Throughflow	93	0.3	1,066	0.8	<0.1
Throughflow Intermittent	355	1.1	1,798	1.3	<0.1
Vertical Flow	899	2.8	2,211	1.7	<0.1
NWI 2.0 Connection	5,010	15.8	11,104	8.3	0.1

*Percentages rounded to the nearest 1/10th percent and area rounded to the nearest acre.

[1] Letters in parentheses represent the class for each subclass (D = depressional, R = riverine, S = slope, L = lacustrine).

Wetland Functional Assessment

The NWI classification system was applied to provide general baseline information about surface hydrology, plant communities, water chemistry, soils, and human impacts and wildlife influences on wetland hydrology and hydrophytic plant communities. Selection of specific NWI (Cowardin et al. 1979) system attributes in the project area during the mapping process also allowed for correlations with LLWW and HGM metrics to be made during the initial phased of the project. The final analysis of these combined coding systems resulted in the identification and classification of important wetland functions for the project area.

Wetlands perform a number of ecological functions that help improve and maintain environmental quality. When natural wetlands are degraded or filled, some wetland functions still occur through human intervention or technology. Healthy natural wetland systems technically provide functions most effectively in terms of cost and performance. Twelve wetland functions were identified as most pertinent for this project area in New Mexico.

- Aquatic Invertebrate Habitat (AIH) – habitat for aquatic invertebrates, a key component in the food chain and potential indicators of water quality,
- Bank and Shoreline Stabilization (BSS) – wetland plants help bind soil to limit or prevent erosion,
- Carbon Sequestration (CS) – serve as carbon sinks that help to trap atmospheric carbon, a component of several greenhouse gases,
- Fish Habitat (FH) – habitat for a variety of fish (including a special category containing factors that maintain cold water temperatures for certain species including trout),
- Groundwater Recharge (GR) – sustaining sub-surface water storage and supporting base flows,

- Nutrient Transformation (NT) – breaking down of nutrients from natural sources, fertilizers or other pollutants; essentially treating the runoff,

- Other Wildlife Habitat (OWH) – habitat for other wildlife (resident and migratory),

- Sediment and Other Particulate Retention (SR) – acting as filters to physically trap sediment particles before they are carried further downstream,

- Streamflow Maintenance (SM) – providing a source of water to sustain streams from drying up during periods of drought conditions or low discharge,

- Surface Water Detention (SWD) – storage of runoff from rain events or spring melt waters which reduce the force of peak flood levels downstream,

- Waterfowl and Water Bird Habitat (WBIRD) – habitat for waterfowl and other water birds,

- Unique, Uncommon, or Highly Diverse Wetland Plant Communities (UWPC) – sustains natural vegetation and ecosystems including rare species.

Since the NWI and the LLWW systems are complimentary, classification of functions may result from queries in the geodatabase of the Wetlands and Deepwater Habitats Classification (Cowardin et al. 1979) codes, LLWW codes, a combination of NWI and LLWW codes, or analysis and consideration of spatial constraints (such as adjacency or physical size). Using their best professional judgment, a correlation table was developed and refined by project team experts familiar with wetland science and regional conditions unique to New Mexico (Appendix C). The result of this collaboration was the creation of specific metrics to determine which wetlands performed various functions as identified from classification attributes available in the geodatabase.

Functional Assessment Model

The mapping of the project area included both wetland delineation and the assignment of individual attributes for the NWI (Cowardin and LLWW classification systems). This information was populated in the comprehensive geodatabase permitting a variety of queries, including the ability to classify wetlands by specific functions performed.

For example, the Bank and Shoreline (BSS) Function was one of twelve wetland functions identified for the project area. To locate wetlands that perform the BSS Function in the project area, a special GIS model was developed. The example of code and related models used to query the geodatabase is found below (Figure 23). Note that the SQL code was written to query attributes from both the NWI and LLWW classification systems to identify wetlands performing, in this case, the BSS function at a high capacity (bolded numbers represent different input parameters):

```
1.) ("LLWW" LIKE('LR%') AND ( "NWI_Class" = 'AB' OR "NWI_Class" = 'EM' OR "NWI_Class" = 'FO'
OR "NWI_Class" = 'SS' OR "NWI_Class2" = 'AB' OR "NWI_Class2" = 'EM' OR "NWI_Class2" = 'FO'
OR "NWI_Class2" = 'SS') AND NOT ( ("LLWW" LIKE ('LR%IL%') OR "LLWW" LIKE ('LR%IL') ) OR
("LLWW" LIKE ('%fm') OR "LLWW" LIKE ('%fm%'))))   2.) OR ("LLWW" LIKE('LS%') AND (
"NWI_Class" = 'AB' OR "NWI_Class" = 'EM' OR "NWI_Class" = 'FO' OR "NWI_Class" = 'SS' OR
"NWI_Class2" = 'AB' OR "NWI_Class2" = 'EM' OR "NWI_Class2" = 'FO' OR "NWI_Class2" = 'SS') AND
NOT ("LLWW" LIKE ('%fm') OR "LLWW" LIKE ('%fm%')))   .3.) OR ("LLWW" LIKE('LE%') AND (
"NWI_Class" = 'AB' OR "NWI_Class" = 'EM' OR "NWI_Class" = 'FO' OR "NWI_Class" = 'SS' OR
"NWI_Class2" = 'AB' OR "NWI_Class2" = 'EM' OR "NWI_Class2" = 'FO' OR "NWI_Class2" = 'SS') AND
NOT ( ("LLWW" LIKE ('LE%IL%') OR "LLWW" LIKE ('LE%IL')) OR ("LLWW" LIKE ('%fm') OR "LLWW"
LIKE ('%fm'))))   4.) OR ( "NWI_System" = 'R' AND "NWI_Class" = 'RS' ) OR ( "NWI_System" = 'L' AND
"NWI_Subsystem" = '2' AND "NWI_Class" = 'RS' )" = 'EM' OR "NWI_Class2" = 'FO' OR "NWI_Class2"
= 'SS') AND NOT ( ("LLWW" LIKE ('LR%IL%') OR "LLWW" LIKE ('LR%IL') ) OR ("LLWW" LIKE ('%fm')
OR "LLWW" LIKE ('%fm%')))) 5.) OR ("LLWW" LIKE('LS%') AND ( "NWI_Class" = 'AB' OR
"NWI_Class" = 'EM' OR "NWI_Class" = 'FO' OR "NWI_Class" = 'SS' OR "NWI_Class2" = 'AB' OR
"NWI_Class2" = 'EM' OR "NWI_Class2" = 'FO' OR "NWI_Class2" = 'SS') AND NOT ("LLWW" LIKE
('%fm') OR "LLWW" LIKE
```

Figure 23. Functional Assessment SQL Model.

Basically, the model in the example above was used to query the geodatabase and locate all vegetated lentic, lotic river, and stream polygons that were not islands or floating mats, and in addition, riverine or lacustrine rocky shores. These were the types of wetlands determined to perform the BSS Function in the project area.

For this report, narrative summaries, individual tables demonstrating the codes and conditions for each wetland function, and sample maps are included below. Since the project area is quite large, maps for each function are merely samples of particular focus areas selected for this review. The digital geodatabase, the primary deliverable for this project, contains the extensive attribute list of classification codes as well as function assignment for every wetland mapped and classified for the project.

Functional Assessment Codes and Conditions Notation

Several “Codes and Conditions” descriptions were created for each of the 12 wetland functions found in the Gila project area. These were developed as examples to define the relationship of codes between the wetland and deepwater Habitats Classification (Cowardin et al. 1979) and the LLWW classification attributes residing in the geodatabase. The Codes and Conditions for each function demonstrate how particular wetland functions might be identified.

These descriptions represent equivalent relationships to NWI and LLWW classification hierarchies per parameters defined by the best professional judgment of project team members. In general, the NWI (Cowardin et al. 1979) and LLWW classifications are joined together by the “AND” condition (to denote that one must contain a defined model parameter) or the “NOT” condition (to denote they must never contain a particular defined model parameter). Wildcard values denote that all values are present such as “%” for a single classification, “%” for mixes, conditional primary “/%” or conditional secondary “%/” mixes. Superscripted text may be found in any of the Codes and Conditions tables. These indicate that an additional comment or special condition exists.

The Codes and Conditions correlated descriptions were designed to be read from top to bottom and were split into categorical sections based strictly on their association between Landscape Position (LLWW) and System for NWI (Cowardin et al. 1979). The following sections include examples which demonstrate how the NWI and LLWW codes were integrated to identify wetland functionality.

As noted, there were twelve wetland functions identified for the project area. Descriptions, summaries and sample maps from selected focus areas all follow. Readers may want to review the wetland functional conditions and summaries in conjunction with model-defined parameters outlined in the Correlation between Functions and Wetland Types, New Mexico (Appendix C**)**.

Aquatic Invertebrate Habitat (AIH) Function

Over 17,931 acres of wetlands polygons were identified to perform the AIH function at the high level and approximately 2,687 acres of wetlands were ranked as moderate for this function. Aquatic invertebrate species live in all kinds of wetlands including lakes, rivers, streams, seeps, and ponds. As part of the aquatic food web, species such as mollusks, crustaceans, dragonflies, stoneflies, mayflies and water fleas all play a critical role in sustaining healthy aquatic ecosystems. Many winged adult forms of aquatic insects also provide food for various terrestrial birds, bats or reptiles. Aquatic invertebrate species and the habitats that sustain them are seriously imperiled due to wetland degradation. Some aquatic invertebrate species require a variety of habitats for their life cycle, while others tend to stay in much wetter areas throughout their lives. Typically, seasonally flooded to permanently flooded and shallower wetlands provide critical habitat to aquatic invertebrate species. Most classifications performing the AIH function included wetlands in the Palustrine or Lacustrine Littoral classifications.

NWI and LLWW codes for wetlands performing the AIH function at a *high* level included:

- *L2%* (Lacustrine, Littoral) wetlands in either the *F* (Semipermanently Flooded), *G* (Intermittently Exposed), *H* (Permanently Flooded) Water Regime,
- *P%* (Palustrine) with *UB* (Unconsolidated Bottom), *RB* (Rock Bottom), *AB* (Aquatic Bed), *EM* (Emergent), in the *F* (Semipermanently Flooded), *G* (Intermittently Exposed) or *H* (Permanently Flooded) Water Regime,
- *R%UB* (River, Unconsolidated Bottom), in the *H* (Permanently Flooded) water regime,
- <u>*PD1*</u> (Pond, Natural), <u>*PD2a*</u> (Pond, Impounded, Agriculture), <u>*PD2h*</u> (Pond, Dammed/impounded, Wildlife Management), <u>*PD3h*</u> (Pond, Excavated, Wildlife Management), <u>*PD4*</u> (Pond, Beaver) only associated with *P%* (Palustrine) wetlands with *UB* (Unconsolidated Bottom) or RB (Rock Bottom), in the *F* (Semiperminanetly Flooded) or *G* (Intermittently Exposed) Water Regimes.
- <u>*PD*</u> (Pond) including <u>*PD1*</u> (Pond, Natural), <u>*PD2a*</u> (Pond, Impounded, Agriculture), <u>*PD3a*</u> (Pond, Excavated, Agriculture), <u>*PD3b*</u> (Pond, Excavated, Aquaculture), <u>*PD3e*</u> (Pond, Excavated, Residential), <u>*PD3e*</u> (Pond, Excavated, Golf Course), <u>*PD3h*</u> (Pond, Excavated, Wildlife Management), associated with *P* (Palustrine) wetlands with *UB* (Unconsolidated Bottom) in the *H* (Permanently Flooded) Water Regime,
- <u>*LE%FR*</u> (Lentic, Fringe), particularly with an <u>*sf*</u> (Spring-fed) modifier

- Water Regimes *A* (Temporarily Flooded), *B* (Seasonally Saturated), *J* (Intermittently Flooded), and *K* (Artificially Flooded) were excluded.

NWI and LLWW codes for wetlands performing the AIH functions at a *moderate* level included:

- *LE%* (Lentic) that are also *PEM1C* (Palustrine, Emergent, Persistent, Temporarily Flooded) or PUSC (Palustrine, Unconsolidated Shore, Temporarily Flooded),
- *LR%* (Lotic River) that are also *PEM1C* (Palustrine, Emergent, Persistent, Temporarily Flooded) or PUSC (Palustrine, Unconsolidated Shore, Temporarily Flooded),
- *LS* (Lotic Stream) that are *PEM1C* (Palustrine, Emergent, Persistent, Temporarily Flooded) or PUSC (Palustrine, Unconsolidated Shore, Temporarily Flooded),
- *PD* (Ponds), including *PD1* (Pond, Natural), *PD2a* (Pond, Impounded, Agriculture), *PD2e* (Pond, Impounded, Residential), *PD3a* (Pond, Excavated, Agriculture), *PD3f* (Pond, Excavated, Sewage Treatment), *PD3k* (Pond, Excavated, Playa [altered]),
- *TEFRpd* (Terrene, Fringe, Pond) along those ponds, and *TEBA* (Terrene, Basin) including those impounded or created for wildlife management (*ip* and *wm* modifiers) and spring-fed tinajas (*sf* and/or *tj* modifiers),
- *LR_FPba* (Lentic River, Floodplain, Basin),
- Water Regimes of *A* (Temporarily Flooded), *B* (Seasonally Saturated), *J* (Intermittently Flooded), and *K* (Artificially Flooded) were excluded.

Due to the semi-arid/arid conditions in New Mexico, all ponds were selected as at least moderate for the AIH Function. This category may contain some industrial, agricultural or quarry ponds based on the classification system. There were very few of these types of features in this mapping area and capturing the stock ponds and larger depressional features was important. The classification system for this function may need to be refined in future mapping efforts if these features are found to be more common in the landscape. As noted above, this function should not include *A, B, J,* or *K* Water Regimes. This query also did not include any deep water habitats as mapped by NWI unless the LLWW wetland types were included in the query above.

Figure 24. The New Mexico Spadefoot Toad (*Spea multiplicata*) resides in floodplains or washes across the state and feeds on aquatic invertebrates (NMED SWQB photo).

A correlation table (Table 10) with specific conditions and codes that determine wetlands performing the AIH function from the project area geodatabase follows. Following the table is a map of a focus area displaying wetlands performing the AIH function (Figure 25). The focus area for the sample map is around the confluence of the East and West Forks of the Gila River in Grant County.

Table 10. Aquatic Invertebrate Habitat (AIH) Codes and Conditions.

Level of Function	Wetland Types
High	L1UBH; L2UB with an F, G or H regime; PAB3G; PEM1F (excluding excavated) also classified as LR, LS, TEFRpd, or TEFRipwm; unaltered PRBF; PUBF (excluding excavated and most also classified as PD2a); all PUBG and PUBH, R%UBH, R3RBH.
Moderate	PAB%F, PAB3H; PEM1C also classified as LSBATH, LRFPTH, LRFPbaVR, or LEBABIsf (vegetated only); PEM1Ch also classified as LE2aBATH; PEM1Fh and PEM1Fx also classified as TEFRTH, TEFRVR, or TEFROU (excluding those classified as high); altered PRBF; PRBH; PSS1C also classified as LR1FPba; PUBFh (excluding those classified as high), PUBFx; all PUSC, including modified; R%USC also classified as LRFPba NOTE: Exclude A, B, J, and K regimes from High and Moderate.

Figure 25. Aquatic Invertebrate Habitat (AIH) function sample map (around the confluence of the East and West Forks of the Gila River).

Bank and Shoreline Stabilization (BSS) Function

For this function, 15,102 acres of wetlands in the project area were predicted to function at a high level; another 737 acres were predicted to be moderate for bank and shoreline stabilization. Both natural shoreline stabilization structures and wetland vegetation prevent and mediate existing erosion through the binding of soils (Figure 26). Vegetation and mixed vegetation along lake, river, stream, and pond shorelines prevent soil from being washed or blown away.

Figure 26. Vegetation helps to stabilize the banks of this stream in the Gila study area (SMUMN GSS photo).

The presence of vegetation is the main factor which contributes to high functionality for Bank and Shoreline Stabilization (BSS). Non-island lentic, lotic river and lotic stream wetlands with vegetated NWI classes all function highly with respect to shoreline stabilization. The Query to identify wetlands performing the BSS function utilized both the NWI and LLWW classification systems.

LLWW and NWI codes for wetlands performing the BSS function at a *high* level included:

- <u>*LR%*</u> (Lotic River) and rivers with the NWI (Cowardin et al., 1979) codes for vegetation including *AB* (Aquatic Bed), *EM* (Emergent), or *SS* (Scrub Shrub),
- <u>*LS%*</u> (Lentic Stream) with *EM* (Emergent), *SS* (Scrub Shrub), or *FO* (Forested),
- <u>*LE%*</u> (Lentic Lake) with *AB* (Aquatic Bed), *EM* (Emergent), or *SS* (Scrub Shrub), or *FO* (Forested).

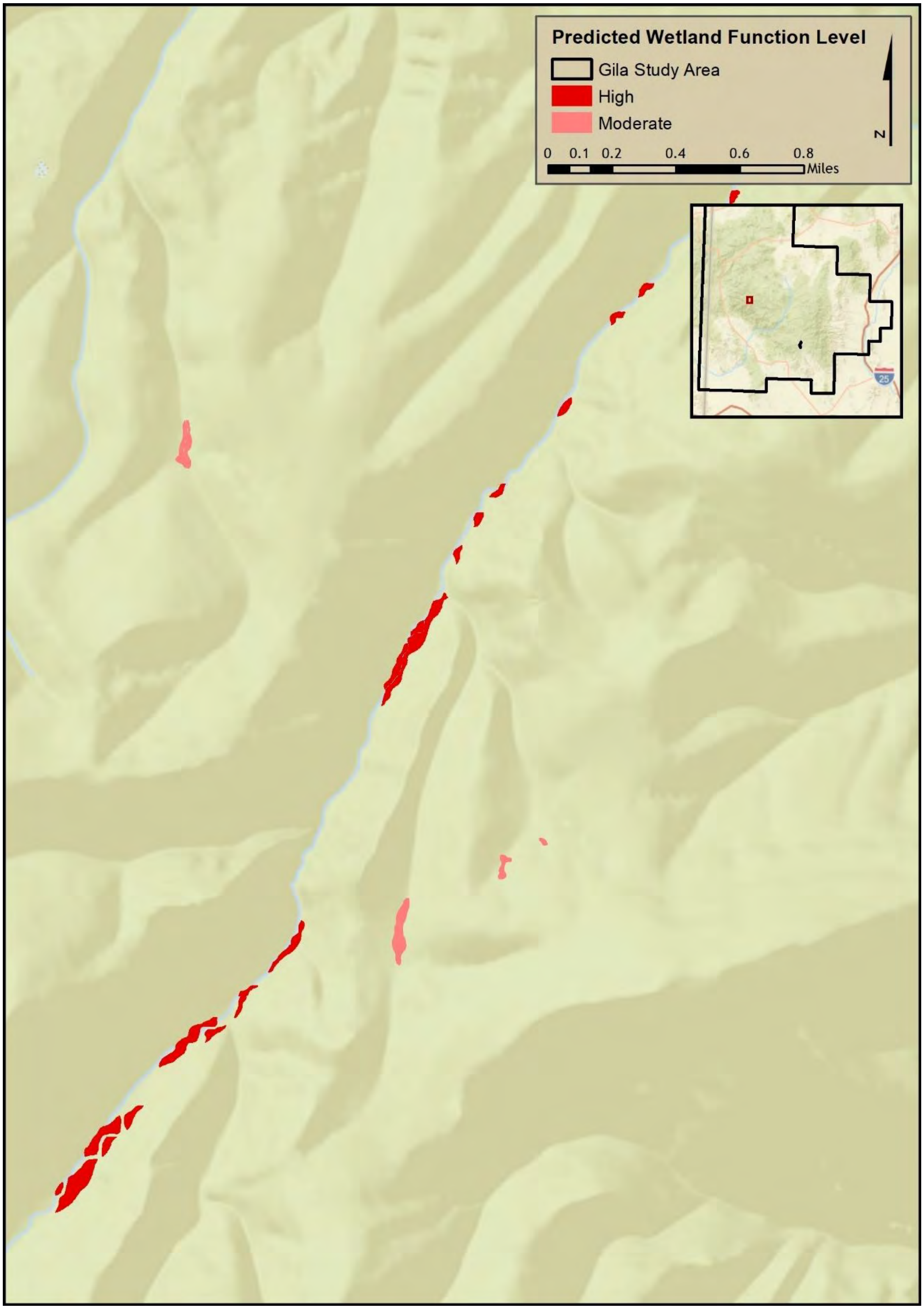
NWI and LLWW codes for wetlands performing the BSS function at a *moderate* level included:

- Vegetated wetlands with terrene LLWW attributes. These included *TE%pd* (Terrene, Pond) and *TE%OUhw* (Terrene, Outflow, Headwater) wetlands that were attributed as dominant vegetation from NWI codes including *AB* (Aquatic Bed), *EM* (Emergent), and *SS* (Scrub Shrub), wetlands.

Table 11. Bank and Shoreline Stabilization (BSS) Codes and Conditions.

Level of Function	Wetland Types
High	LE__(vegetated only - EM, SS, FO); LR_(AB, EM, SS); LS_(EM, SS, FO).
Moderate	TE__pd (AB, EM) or TE__OUhw (EM, SS).

Figure 27. Bank and Shoreline Stabilization (BSS) function sample map (along Iron Creek in southern Catron County).



Carbon Sequestration (CAR) Function

Wetlands performing the Carbon Sequestration (CAR) function at a high level included over 1,100 acres. An additional 15,054 acres were also identified as performing this function at a moderate level. Carbon sequestration occurs when wetlands act as reservoirs that absorb and store more environmental carbon than they release through chemical and biological processes such as photosynthesis. Typically, wetlands performing carbon sequestration are vegetated to some degree. Therefore, the attributes from the Wetlands and Deepwater Habitats Classification (Cowardin et al. 1979) were the primary source of information in making predictions regarding the CAR function. Soil and Water Regime information was also generally important in determining whether a wetland functioned at a high or moderate level.

NWI codes for wetlands performing the CAR Function at a high level included:

- *PAB* (Palustrine, Aquatic Bed) and PEM (Palustrine, Emergent) with F (Semipermanently Flooded) water regime,
- *PAB* (Palustrine, Aquatic Bed) with *H* (Permanently Flooded) or *G* (Intermittently Flooded) water regime,
- *PEM* (Palustrine, Emergent), *PSS* (Palustrine, Scrub Shrub), *PFO* (Palustrine, Forested), and mixes with *B* (Seasonally Saturated) or *C* (Seasonally Flooded) water regimes,

Excluded were LLWW codes for dammed, excavated for isolated impoundments ponds. Farmed wetlands (*f*) were not included in this function.

Table 12. Carbon Sequestration (CAR) Codes and Conditions.

Level of Function	Wetland Types
High	P__ (EM, SS, FO, and mixes)B; P__ (EM, SS, FO)C; P__ (AB, EM)F; P_(AB) H or G
Moderate	P__ (EM, SS, FO)A; PEM1E; PUB (but not PD2d or PD3 a1,b,c,d,e1, e4, f, gVR, iVR, jVR, and k; also exclude isolated impounded ponds). NOTE: Exclude wetlands with a J water regime and farmed wetlands (P__f) from this function

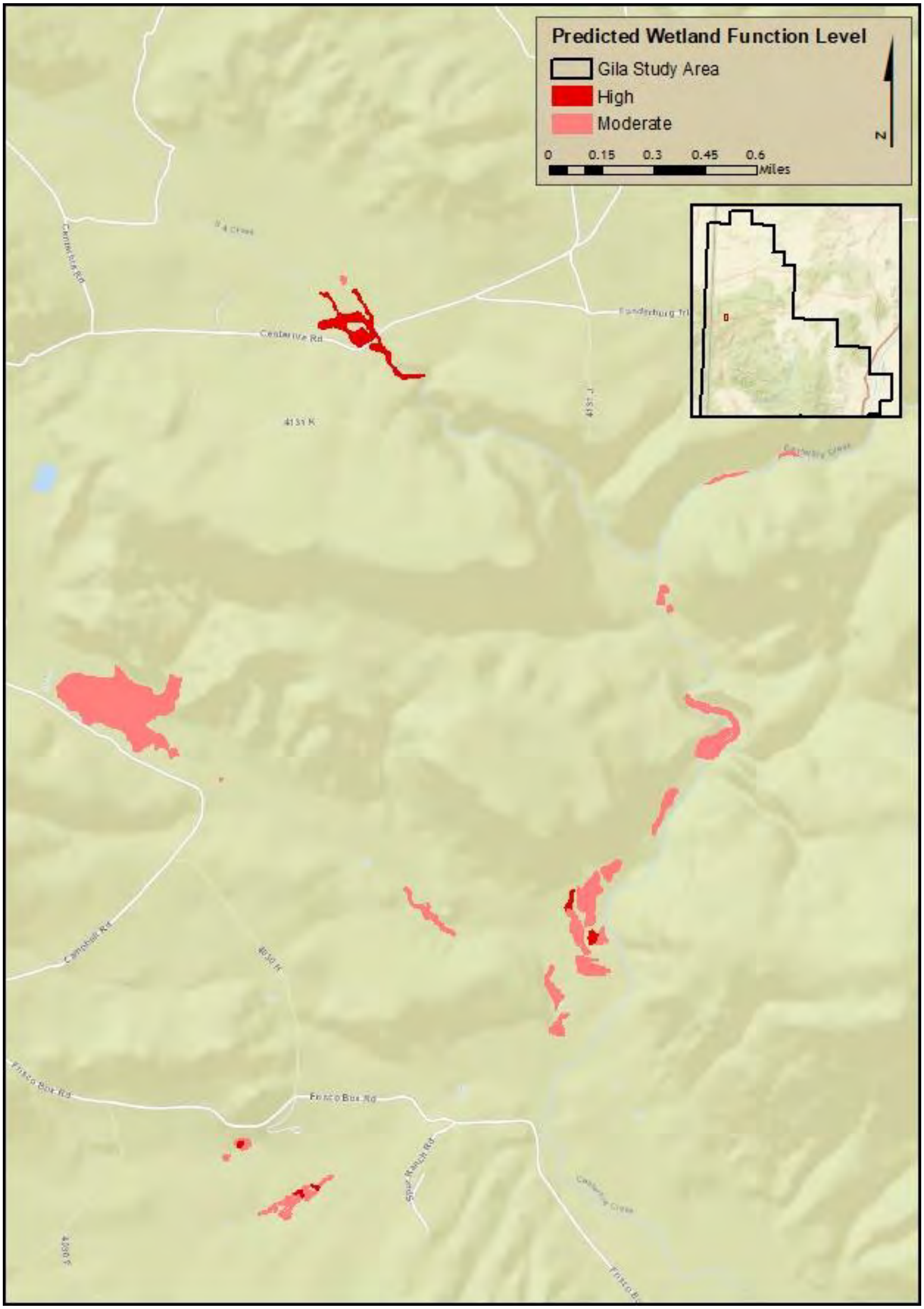


Figure 28. Carbon Sequestration (CAR) function sample map (near Centerfire Creek in western Catron County).

Fish Habitat (FH) Function

The FH function evaluation incorporated all streams and the water bodies that directly support fish life as well as adjacent wetlands that provide source water, nutrients, shade and woody debris. Wetlands performing this function included 18,323 acres of wetlands predicted has high and 670 acres as moderate. These wetlands include deep-water habitats such as the reservoirs in the project area.

Stream shading, an important factor for cold-water fish species habitat was also predicted for wetland features. A total of 4,659 acres of wetlands were predicted to provide stream shading for fish. Streams within the Gila study area identified by the State of New Mexico as “trout streams” are shown in Figure 29.

Wetlands performing the FH function provide an environment for various stages of a fish’s aquatic life cycle. Organisms on which fish feed need wetlands to survive. Wetlands provide spawning and nursery areas and wetland vegetation provides cover for small and young fish avoiding predators. Shade provided by wetland trees or shrubs also helps maintain cooler water temperatures for cold water species.

Figure 29. Trout streams within the Gila project area, as identified by the State of New Mexico.

Determining the FH function utilized a combination of both the Cowardin et al. (1979) and LLWW classification systems. Wetlands identified as high level for the FH function tended to have wetter water regimes and were typically associated with headwater wetlands or wetlands with large or moving bodies of water.

NWI and LLWW codes for wetlands performing the FH function at a *high* level included:

- Lakes or reservoirs which were coded as *L1* (Lacustrine, Limnetic) or *L2* (Lacustrine, Littoral) and which had a Water Regime modifier of either *F* (Semipermanently Flooded), *G* (Intermittently Exposed) or *H* (Permanently Flooded),
- *PAB* (Palustrine, Aquatic Bed) wetlands which were not excavated or impounded,
- *PUB* (Palustrine, Unconsolidated Bottom) wetlands with a *G* (Intermittently Exposed) and *H* (Permanently Flooded) water regime,
- *R%USC* (Riverine, Seasonally Flooded) wetlands
- *LK* (Lake) and *RV* (River),
- *PD* (Ponds) that were *PD1* (Pond, Natural), *PD2a* (Pond, Dammed/impounded, Agriculture) and *PD2h* (Pond, Dammed/impounded, Wildlife Management), *PD3b* (Pond, Excavated, Aquaculture), and *PD3h* (Pond, Excavated, Wildlife Management), associated with *PUB* (Unconcolidated Bottom) or RB (Rock Bottom) in the *F* (Semipermanently Flooded) Water Regime,
- *PD1* (Pond, Natural), *PD2e* (Pond, Dammed/impounded, Residential), *PD3a* (Pond, Excavated, Agriculture), *PD3g* (Pond, Excavated, golf course), *PD3h* (Pond, Excavated, Wildlife Management), and *PD4* (Pond, Beaver) associated with *PUB* (Unconcolidated Bottom) wetlands in the *G* (Intermittently Exposed) or *H* (Permanently Flooded) Water Regime,
- *NWI* Water Regimes *A* (Temporarily Flooded), *B* (Seasonally Saturated), *J* (Intermittently Flooded), and *K* (Artificially Flooded) were excluded.

LLWW and NWI codes for wetlands performing the FH function at a *moderate* level included:

- *LE%* (Lentic) AND *PEM1C* (Palustrine, Emergent, Persistent, Seasonally Flooded) as well as wetlands contiguous with the Waterbody Type,
- *LR%* (Lotic River) AND *PEM1C* (Palustrine, Emergent, Seasonally, Flooded) as well as wetlands contiguous with the Waterbody Type,
- *LS%* (Lotic Stream) AND *PEM1C* (Palustrine, Emergent, Seasonally Flooded) as well as wetlands contiguous with the Waterbody Type,
- *PD* (Pond) wetlands that were equal to or greater than one acre in size and were coded as *PD2a* (Pond, Dammed/impounded, Agriculture) or *PD3a* (Pond, Excavated, Agriculture),
- *TEFRpd* (Terrene, Fringe, Pond) along ponds.

Due to the very specific habitat conditions required for trout and other cold water species to thrive, a third level of performance specifically for trout was added to the FH function. These wetlands typically contribute to maintaining cooler water temperature through stream shading. Wetlands performing the FH shade function included:

- *LS%* (Lotic Stream) with *PSS* (Palustrine, Scrub-Shrub) or *PFO* (Palustrine, Forested) vegetation, especially those with an *sf* (Spring-fed) modifier
- *LR%* (Lotic River) with *PSS* (Palustrine, Scrub Shrub) vegetation.

Table 13. Fish Habitat (FH) codes and conditions.

Level of Function	Wetland Types
High	L%UB; PABG; PEM1F that are also LR, LS, and TEFR%sf; unaltered PRBF, PUBF; PUBG, PUBH; R%UBH, R3RBH; R4SBE; R___C or wetter that are designated fish bearing streams (Requires outside dataset to create Fish Bearing Streams input).
Moderate	PAB4Fh; PEM1C that are also LSBATH or LRFPTH (excluding oxbows); PSS1C that are also LRFPTH; PUBFh and PUBFx greater than one acre that are also PD; PUSC also classified as LRFP. NOTE: Exclude A, B, J and K regimes from High and Moderate
Stream Shading	PFO1A and PFO1C (excluding h modifier) also classified as LS; PSS1A (excluding h modifier), PSS1C, and PSS1J also classified as LS or LR.

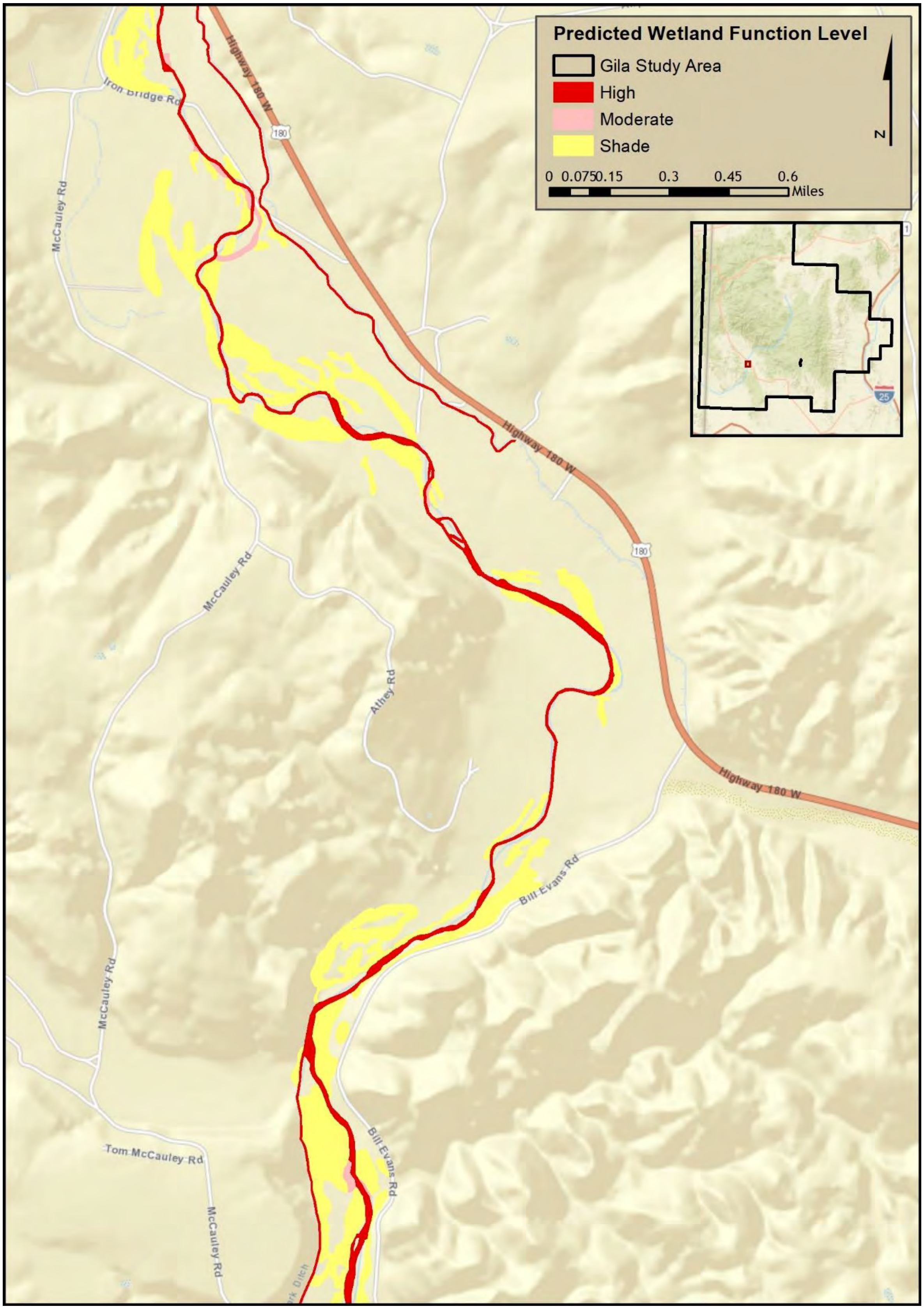


Figure 30. Fish Habitat (FH) function sample map (along the Gila River south of Cliff, NM).

Groundwater Recharge (GR) Function

Approximately 89,830 acres of the wetlands mapped were found to perform the Groundwater Recharge (GR) function at a high capacity. Another 9,327 wetland acres were ranked as moderate.

Many wetlands contribute to the recharging of water tables known as the GR function. These wetlands are especially important for arid/semi-arid regions and may replenish aquifers or maintain groundwater resource important to wildlife. The GR function is primarily dependent upon the bedrock, soil, and the wetland's location. The wetland function was coded as either high or moderate depending on the permeability of underlying bedrock. A list of bedrock types assessed as being high or moderate for groundwater recharge was developed by the NMED SWQB based on assessment of the New Mexico Geology data layer using their best professional judgment. All wetland types falling within areas of high or moderate bedrock permeability were then ranked as high or moderate accordingly for this function (Table 14). For polygon wetlands that intersected with areas of high or moderate bedrock permeability, the entire polygon and any contiguous polygons (either within or outside of permeability zones) were selected as high or moderate for the function.

Table 14. Geologic Units & Groundwater Rating for intersection with wetland and riparian GIS data features.

Unit Abbreviation	Gradient / Geomorphology	Rating	Notes
Qa	*N/A*	High	Quaternary alluvium
Qe	*N/A*	High	Eolian deposits
Qe/Qp	*N/A*	High	Eolian and Piedmont alluvial: upper & mid Quaternary
Qoa	*N/A*	Moderate/High	Older alluvial, upland plains and piedmont areas, calic soils and eolian cover sediments
Ql	*N/A*	Moderate/High	Landslide deposits and colluvium
Qp	*N/A*	High	Piedmont deposits
Qp/QTsf	*N/A*	High	Piedmont deposits/Santa Fe Group, undivided Basin fill of Rio Grande rift
Qpl	*N/A*	Moderate	Lacustrine and playa-lake deposits
QTb	*N/A*	Low	Basaltic and andesitic volcanics interbedded with Pleistocene and Pliocene sedimentary units
QTp	*N/A*	High	Older piedmont alluvial deposits and shallow basin fill
QTs	*N/A*	High	Upper Santa Fe Group
QTsf	*N/A*	High	Santa Fe Group, undivided. Basin fill of Rio Grande rift region
Qv	*N/A*	Moderate	Basaltic volcanics; tuff rings, cinders, and proximal lavas
Tfl	*N/A*	High	Fence Lake Formation Conglomeratic sandstone, coarse fluvial volcanic sediments, pedogenic carbonates
Ti	*N/A*	Moderate	Tertiary intrusive rocks
TKav	*N/A*	Moderate/High	Andesitic volcanics
TKi	*N/A*	Low	Paleogene and Upper Cretaceous intrusive
Tla	*N/A*	Moderate	Lower middle Tertiary volcaniclastics
Tli	*N/A*	Low	Tertiary intrusive rocks
Tlrf	*N/A*	Low	Tertiary silicic lavas
Tlrp	*N/A*	Low	Lower middle Tertiary Datil Group rhyolitic dacitic
Tlv	*N/A*	Low	Lower middle Tertiary volcanic rocks

Unit Abbreviation	Gradient / Geomorphology	Rating	Notes
Tmb	*N/A*	Moderate	Basalt and andesite flows
Tnr	*N/A*	Low	Silicic to intermediate volcanic rocks
Tos	*N/A*	Moderate	Upper Tertiary sedimentary units
Tps	*N/A*	High	Paleogene sedimentary units; includes Baca, Galisteo, El Rito, Blanco Basin
Tui	*N/A*	Moderate	Miocene to Oligocene silicic to intermediate intrusive rocks; dikes, stocks, plugs, and diatremes
Tuim	*N/A*	Moderate	Upper and Middle Tertiary mafic intrusive rocks
Km	*N/A*	Low	Mancos Shale
Kmv	*N/A*	Moderate/High	Mesaverde Group with Gallup Sandstone, Crevasse Canyon Formation
Je	*N/A*	Moderate/High	Entrada Sandstone, Middle Jurassic; Callovian
Jze	*N/A*	Moderate/High	Zuni and Entrada Sandstones, undivided
Pb	*N/A*	Moderate	Bursum Formation; shale, arkose, & limestone; earliest Permian
Psa	*N/A*	High	San Andres Formation; limestone & dolomite with minor shale; Guadalupian in south, in part Leonardian to north
Py	tilted/faulted	Moderate	Yeso Formation
Pys	*N/A*	Moderate	Yeso, Glorieta and San Andres Formations, undivided
&	*N/A*	High	Pennsylvanian rocks, undivided
@c	*N/A*	Low	Chinle Group
MD	*N/A*	Low/Moderate	Mississippian and Devonian rocks, undivided; included Lake Valley Limestone
SO_	*N/A*	Moderate	Silurian through Cambrian rocks, undivided
Yp	*N/A*	Low	Middle Proterozoic plutonic rocks (> than 1600 Ma)

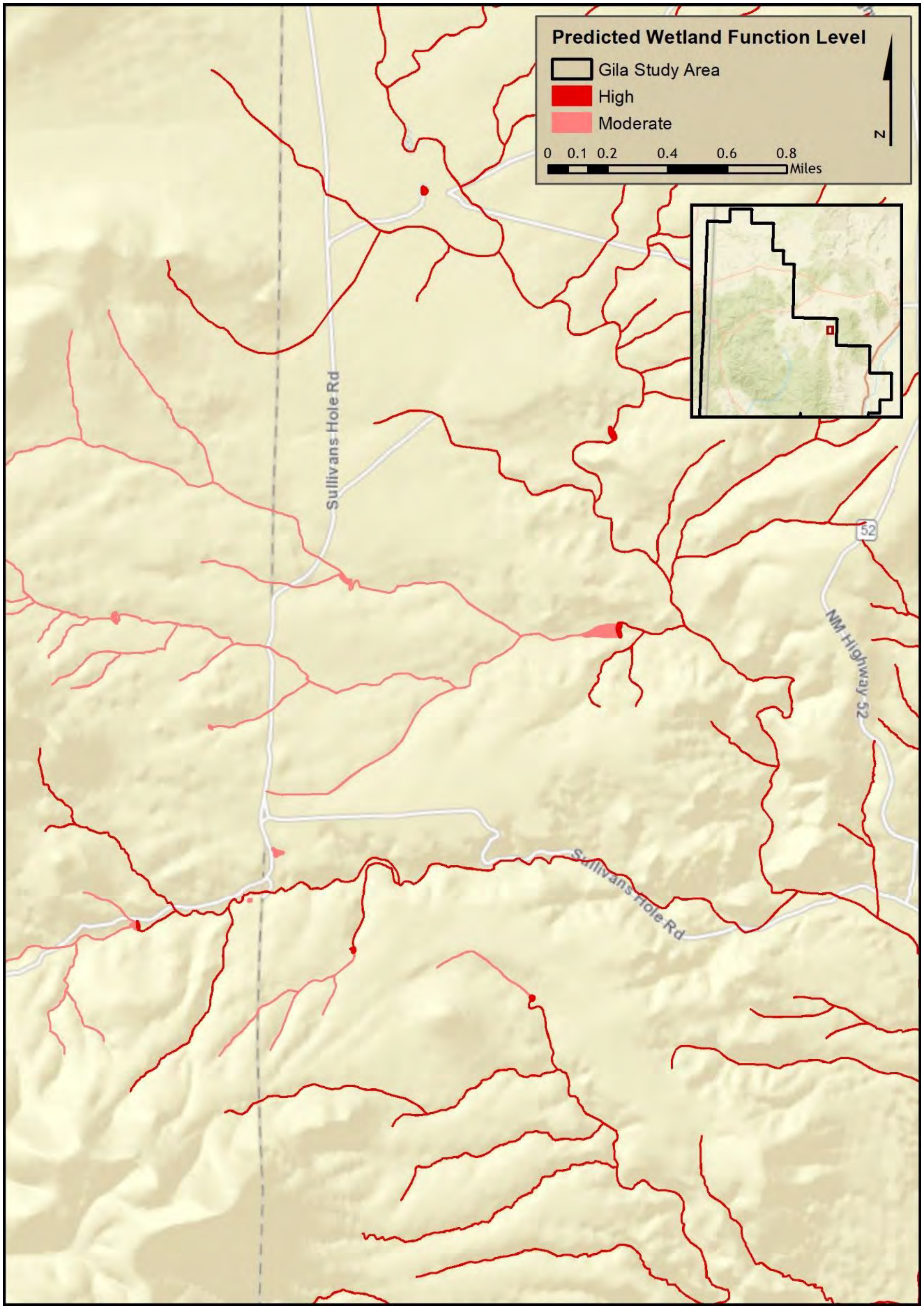


Figure 31. Groundwater Recharge (GR) function sample map (along tributaries of Alamosa Creek, on the Catron-Socorro County border).

Nutrient Transformation (NT) Function

Around 1,835 acres of polygon wetland features were ranked as performing the Nutrient Transformation (NT) function at a high level while 14,461 acres were ranked as moderate. Nutrient transformation refers to the natural chemical processes that remove or recycle compounds in the environment. In the case of many wetlands, nitrates and phosphorous from agricultural runoff are the primary nutrients of concern. Wetlands performing the NT function are sinks for excess nutrients. The nutrients are prevented from moving further through the watershed through either storage or by wetland vegetation using the nutrients for their own life cycle. The NT function is important for the maintenance and improvement of water quality.

To identify wetlands performing the NT function, the Landscape Position (from the LLWW) was less important than other wetland characteristics such as vegetation or soil type. For this reason, the NWI (Cowardin et al. 1979) classification became the primary system that helped to define the NT function for this project.

Generally, vegetated palustrine wetlands in the project area that were classified as Seasonally, Semipermanently, or Permanently Flooded all were identified as performing the NT function to a high degree (Table 15). The NWI codes to determine the NT function included:

- *PEM* (Palustrine, Emergent), *PSS* (Palustrine, Scrub Shrub), *PFO* (Palustrine, Forested) and mixes that were *C* (Seasonally Flooded),
- *PAB* (Palustrine, Aquatic Bed) and *PEM* that were *F* (Semipermanently Flooded),
- *PAB* that were *G* (Intermittently Exposed) or *H* (Permanently Flooded),
- Concentric rings within the NWI codes for Water Regime *C* (Seasonally Flooded) involving playa basins, were also rated as highly functional for Nutrient Transformation (NT). These wetlands were identified with a special spatial adjacency query within the geodatabase.

For moderate NT function activity, vegetation was also important. Moderately functioning wetlands, however, tend to be drier than their highly functioning counterparts. NWI codes for wetlands performing the NT function at a *moderate* level included:

- PEM (Palustrine, Emergent), PSS (Palustrine, Scrub Shrub), PFO (Palustrine, Forested) and mixes that were in Water Regime B (Seasonally Saturated), D (Continuously Saturated), or E (Seasonally Flooded/Saturated),
- PEM (Palustrine, Emergent), PSS (Palustrine, Scrub Shrub), PFO (Palustrine, Forested) and mixes that were A (Temporarily Flooded),
- PUB (Palustrine, Unconsolidated Bottom), mixed with PAB (Palustrine, Aquatic Bed) that were H (Permanently Flooded),

Farmed wetlands were not rated as significant for the NT function.

Table 15. Nutrient Transformation (NT) Conditions.

Level of Function	Wetland Types
High	unaltered PEM1A with “pl” (playa) modifier; P__(EM, SS, FO and mixes)C; P__(AB, EM)F; PABG and PABH; All concentric rings within C water regime playa basins.
Moderate	P__(EM, SS, FO)A (not associated with playas); P__(EM, SS, FO and mixes)B; PUB/ABH.
	NOTE: Farmed wetlands (PEM1_f) were not rated as significant for this function. Isolated J-types were not assigned a significant rating for this function.

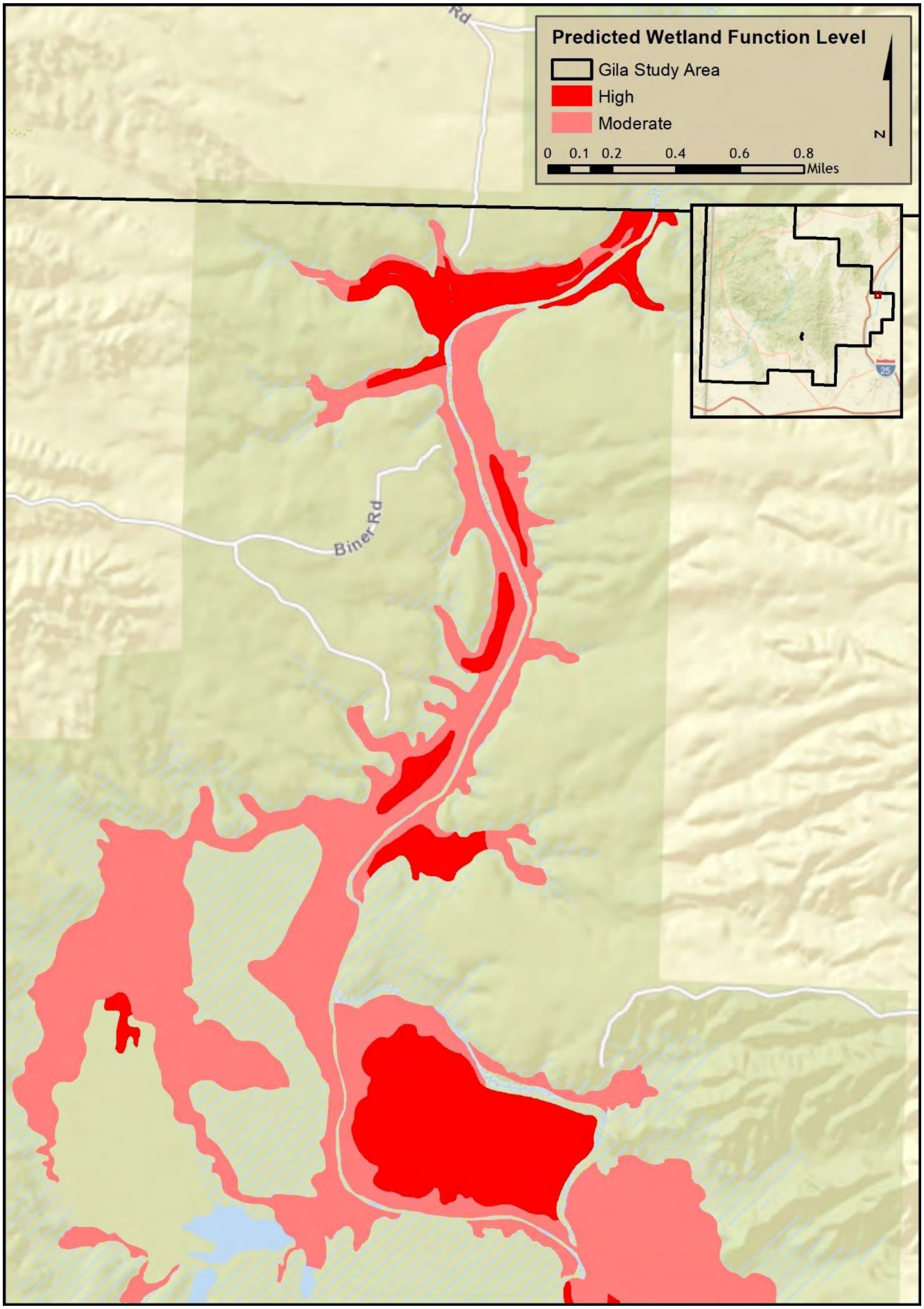


Figure 32. Nutrient Transformation (NT) function sample map (along the Rio Grande, north of Elephant Butte Reservoir).

Other Wildlife Habitat (OWH) Function

Due to the importance of this function for supporting natural wildlife populations, the queries for this function included both wetland and vegetated riparian features. For the Gila project area, approximately 64,627 acres of wetland were ranked as performing the OWH Function at a high level; 9,638 acres of wetland and riparian polygons ranked as moderate in the project area.

The OWH function is important for a variety of mammals, reptiles, and songbirds. While all wetlands and riparian areas containing vegetation are important for these species, the size of various wetlands and their mixtures of vegetation determine the level to which a wetland functions for the OWH function. Wetland/riparian complexes are also often comprised of different yet interconnected habitat types. This creates habitat corridors for both migratory and resident wildlife.

The size of the entire wetland complex determined the level of functioning versus the size of individual wetlands making up the complex. Characteristics of or codes for wetlands performing the OWH function at a *high* level included

- vegetated wetland or a wetland complex equal to or greater than 12 acres in size (which was also consistent with New Mexico's Rapid Assessment Method for wetlands),
- wetland complexes 5 to 12 acres in size with two or more NWI vegetated classes,
- *PD1* (Pond, Natural) with modifiers including *f* (playa), *i* (sinkhole prairie), and *tj* (Tinaja),
- Small wetlands (10 acres or less) which were Permanently Flooded (*H*), Intermittently Exposed (*G*), or Semipermanently Flooded (*F*), including *PUB* (Palustrine, Unconsolidated Bottom) and *PAB* (Palustrine, Aquatic Bed) water holes, except *PD2* (Pond, Dammed) or *PD3* (Pond, Excavated) wetlands with modifiers *c* (commercial), *e* (residential).

Vegetated wetlands that were not classified as highly functioning were classified as moderately function for the OWH function. The majority of these were *PEM1* wetlands in the *A* (Temporarily Flooded), *B* (Seasonally Saturated), or *C* (Seasonally Flooded) water regimes. Wetland complexes with two or more vegetation classes were attributed using a spatial adjacency query in the geodatabase. Vegetated riparian polygons (FO and SS) larger than 15 acres in size were also added to the OWH moderate function.

Vegetated wetlands were the focus, excluding *AB* (Aquatic Bed) from the size determination of a vegetated wetland complex. Included were vegetation mixes of *EM* (emergent), *SS* (Scrub Shrub) and *FO* (Forested) wetlands.

Table 16. Other Wildlife Habitat (OWH) Codes and Conditions.

Level of Function	Wetland Types
High	L2UB% and L2US; PAB% (excluding PABKx and PD2eTH); P%1A (EM, FO, SS) within complexes that meet the size requirements, also classified as LE2aFLTH, LS%FLTH, LS2FPTH, TEBAVR, TE%ipwmTH, LR%FPTH or LE1a%sf; P__1B (EM, FO, SS), PEM1E, and PEM1J (within complexes); PEM1C and PSS1C (within complexes) also classified as LE1aBABIsf, LE2aBATH, LS%BATH, LR2BATH (for PSS1C), LR%FPbaTH, TEBAOUsf,

Level of Function	Wetland Types
	TEBAipTH, or TEBAVR; PEM1F (within complexes) also classified as LS%FRTH, LS1BATH, LR1%TH, TEBAVR, TEFRip%, or TEFRpd%; PSS1J (within complexes) also classified as LE2aFLTB, LR1FPTH, or TEBAVR; PRBF and PRBH; PUBF (excluding PD3e and most PD3f), PUBG (excluding PD3e and PD3g); PUBH (excluding PD2e, PD3e, PD3f, PD3g); PUS1Jh; PUSA (within complexes) also classified as LR1FPTH, LS%THtj, TEBAipwmIN, or TEBATHsf; PUSC (within complexes) also classified as LE2aBATB, LR%FPTH, LS%BATHtj, TEBA%sf, or TEBAipwm; PUSJ (within complexes) also classified as TEBAplVR or TEFLipwm; R%RBA; R%UBH; R2US (excluding excavated) and R3US within complexes; R4SBJ and R4USJ within qualifying complexes
Moderate	L1UBH; PABHh also classified as PD2e; PABKx; PEM1A not already classified as high (and excluding LS1BATH; PEM1D; PEM1B, PEM1C (excluding small, isolated wetlands), PEM1E, and PEM1J not classified as high; PEM1Kx; PFO% not already classified as high; PSS% and mixes not already classified as high. Additionally, "Riparian" LIKE ('Rp1FO%') OR "Riparian" LIKE ('Rp1SS%')) AND "ACRES" > 15 .

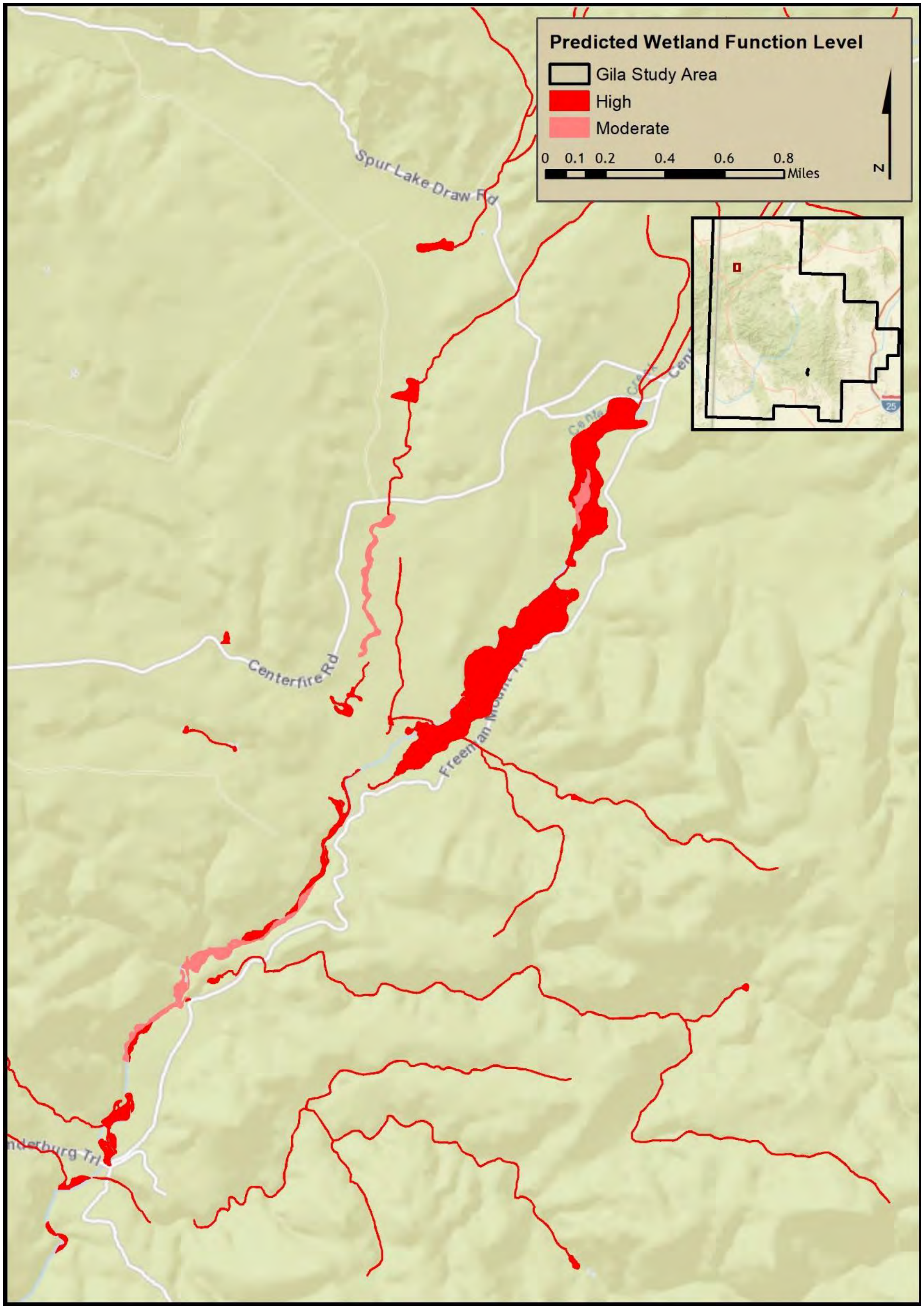


Figure 33. Other Wildlife Habitat (OWH) Function Sample Map (along Centerfire Creek in western Catron County).

Sediment and Other Particle Retention (SR) Function

Wetlands performing the Sediment and Other Particle Retention (SR) Function at a high level totaled 15,009 acres in the project area. Another 22,794 acres performed this function at a moderate level. Wetlands that physically trap particles affect water quality due to their sediment retention properties. In contrast to nutrient transformation, which involves chemical processes, the SR function is a physical process where the suspended particles are filtered by the soil and plant roots. This removal of suspended particles helps to improve water clarity and help maintain cooler temperatures on cold water streams.

Due to the physical nature of the SR function, the LLWW was the primary system used to make determinations, while the NWI vegetation class and Water Regime also factored into the classification process.

In general, wetlands functioning highly for the SR tended to be vegetated. However, *LEBA* (Lentic, Basins) and *LRFP* (Lotic River, Floodplain) were determined to perform sediment retention to a high degree regardless of the presence of vegetation. LLWW codes for wetlands performing the SR function at a *high* level included:

- *LEIL* (Lentic, Island) wetlands that were vegetated and coded as such in the NWI code as *EM* (Emergent), *LS%BA* (Lotic Stream, Basins), and vegetated although not farmed *LS%FR* (Lotic Stream, Fringe),
- Several terrene wetland types were determined to function highly for sediment retention. All LLWW ponded terrene throughflow wetlands were included (*TE_pdTH*), such as *TEBATH* (Terrene, Basin, Throughflow), *TEBATI* (Terrene, Basins, Intermittent Throughflow), and *TEFRTH* (Terrene, Fringe, Throughflow), and
- In terms of LLWW Waterbody types, all ponds that were dammed/impounded, including *PD2a* (Pond, Dammed, Agriculture), *PD2e* (Pond, Dammed, Residential), *PD2h* (Pond, Dammed, Wildlife Management), and ponds that were excavated including *PD3a* (Pond, Excavated, Agriculture-Livestock), or *PD3h* (Pond, Excavated, Wildlife Management).

LLWW or NWI codes for wetlands performing the SR function at a *moderate* level included:

- Non-vegetated *LEFR* (Lentic Fringe) and *LSFL* (Lotic Stream, Flats),
- LLWW classified ponds *TEBA* (Terrene, Basin), *PD1* (Ponds, Natural), *PD2* (Ponds, Dammed), and *PD3* (Ponds, Excavated) excluding commercial, industrial, residential sewage treatment, golf course, or mining ponds),
- *L2UB* (Lacustrine, Littoral, Unconsolidated Bottom) with an *F* (Semipermanently Flooded) or *G* (Intermittently Exposed) water regime.

It should be noted that the features coded as *R4SBJ* (arroyos) are known to contribute sediments to wetlands and were therefore excluded from this function. Saturated *B* Water Regime wetlands were also not identified as either high or moderately significant for the SR function.

Table 17. Sediment and Other Particulate Retention (SR) Codes and Conditions.

Level of Function	Wetland Types
High	LEBA; LEIL (excluding barren); LRFP; LRFR; LSBA; LS%FRTHsf, LS2FR; PDTH; TEBATH; TEFRpdTH.
Moderate	LEFL; LEFR (nonveg); LSFL; LSFPflTI; LSFRip; PD (excluding those classified as “high” and PD3 d, e, f,g, and j); TEBAIN, TEBAOU, TEBAVR (excluding “B” water regime); TEFL with “C” or “J” water regime; TEFRpd (excluding those classified as “high”); TESLOUir with “J” water regime. NOTE: Exclude R4SBJ (arroyos) since they contribute sediments. No “B” wetlands should be identified as significant for this function.

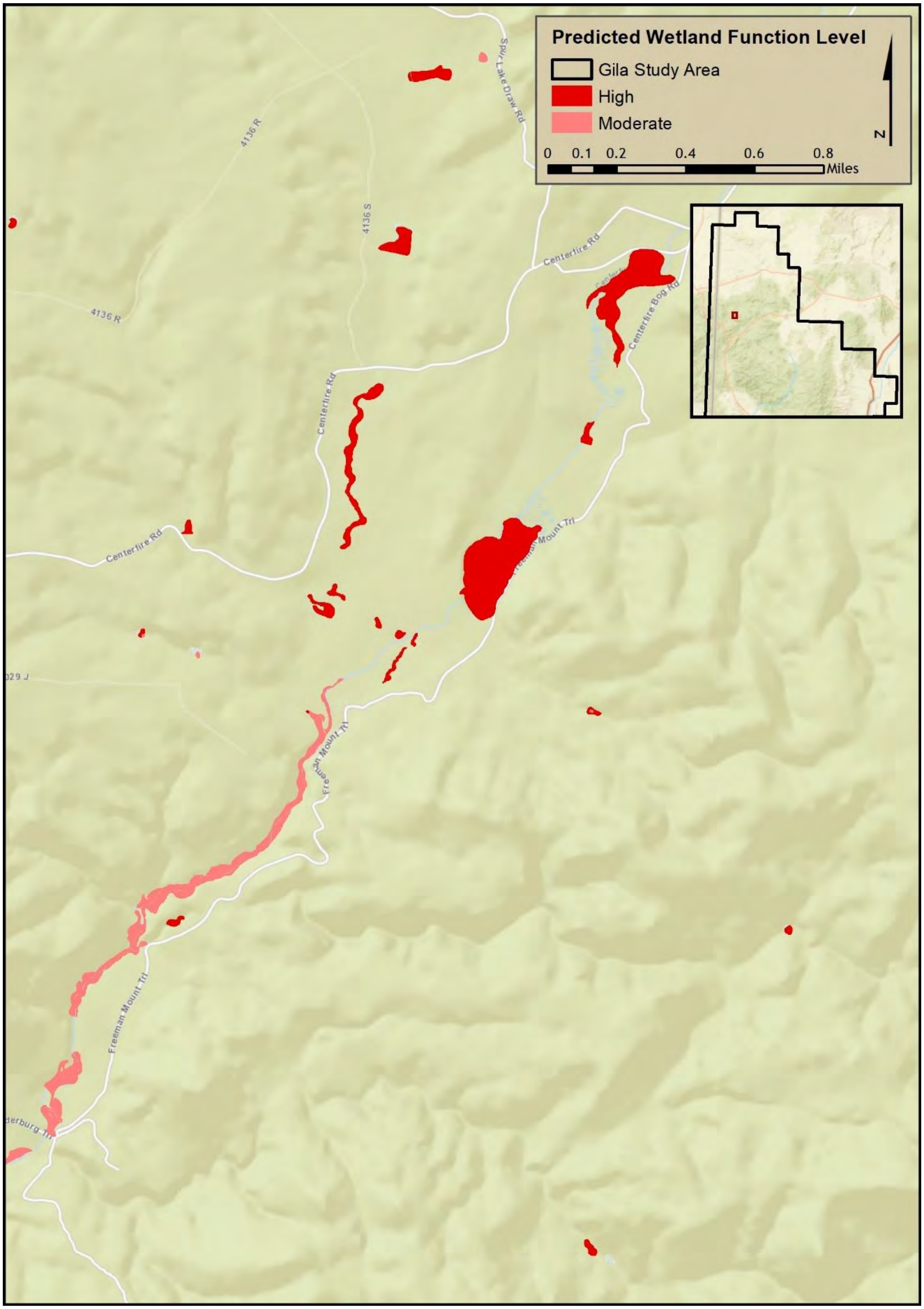


Figure 34. Sediment and Other Particulate Retention (SR) Function Sample Map (along Centerfire Creek in western Catron County).

Streamflow Maintenance (SM) Function

Approximately 2,718 acres of the wetlands mapped in the project area were predicted to perform the Streamflow Maintenance (SM) Function at a high level. An additional 628 acres of polygons performed at a moderate level.

Streamflow maintenance is the ability of a watershed to keep water traveling through a drainage system. Wetlands that help maintain streamflow are those that contribute water to the interconnected conduits within a watershed. The wetlands that typically provide the highest function for SM include headwaters and unaltered wetlands located in the upper reaches of a watershed or wetlands that contain soils with high water holding capacity.

Many streams visible on aerial photography, but not represented on USGS Digital Raster Graphics (topographic maps) or in the NHD database were identified during the image interpretation process for this project. These streams were delineated and classified during the project, and therefore now contribute to the inclusion of all headwater wetlands that are highly functional for the SM function.

Wetlands were classified as *%hw* (headwater) when they were found to be adjacent to First or Second Order Streams (as defined by hydrologic mapping for this project). These wetlands perform the Streamflow Maintenance function at a *high* level, in addition to unaltered wetlands coded in LLWW with modifiers such as *sf* (spring-fed) (Table 18). Excluded were wetlands coded with a *J* (Intermittently Flooded) Water Regime.

Table 18. Streamflow Maintenance (SM) Codes and Conditions.

Level of Function	Wetland Types
High	"hw", "sf", and "ds" wetlands (unaltered - excluding "d", "h", and "x" types and "J" types); LE1% (excluding "J" water regime); LK1aVR; LR%BA; LR%FPba (excluding "J" water regime); LS%BA (excluding "J" water regime);
Moderate	altered "hw" and "sf" wetlands (include NWI "d", "h" and "x" modifiers). Exclude J water regimes.

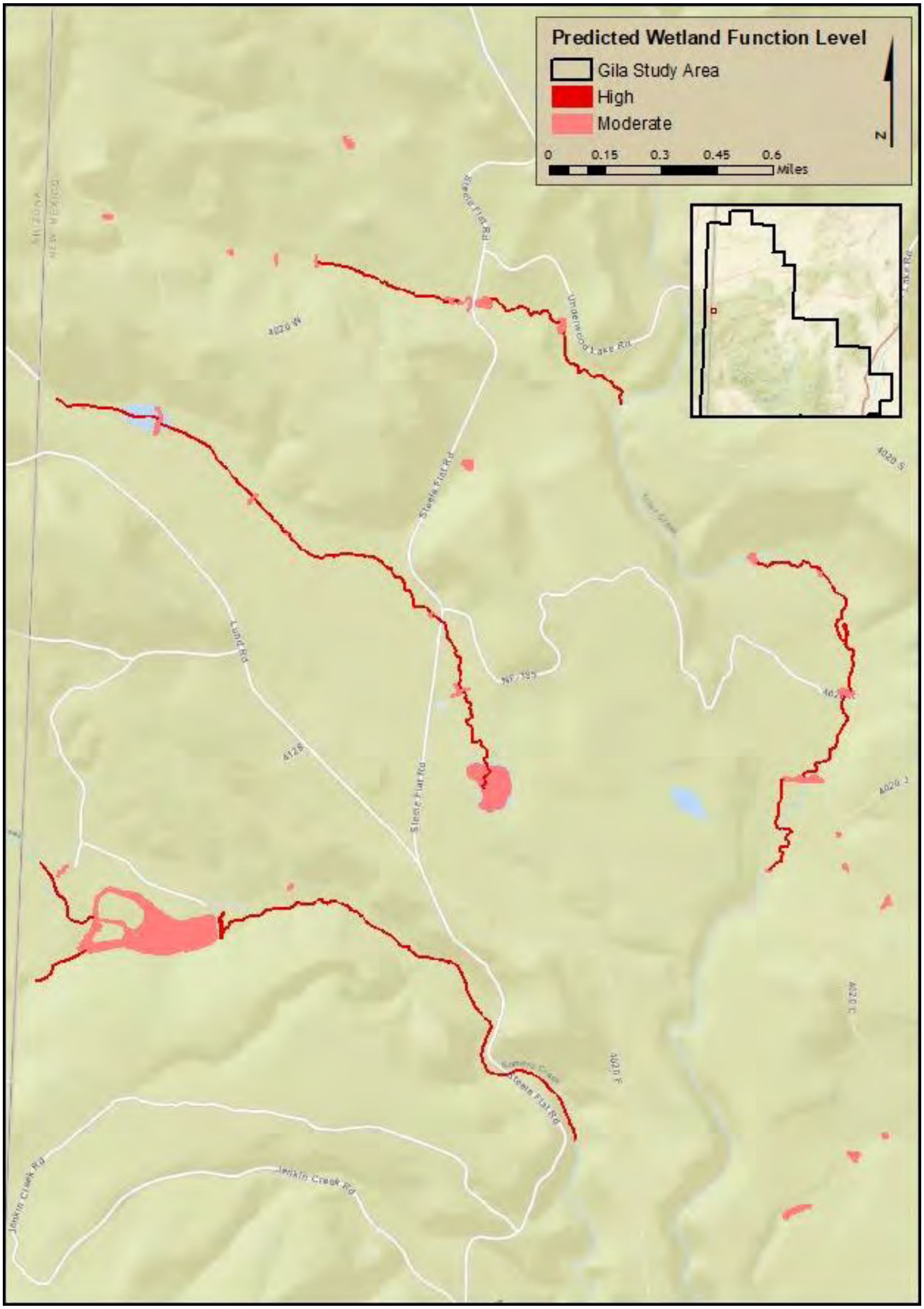


Figure 35. Streamflow Maintenance function sample map (along Trout and Romero Creeks near New Mexico's western border).

Surface Water Detention (SWD) Function

Over 7,613 acres of the wetlands mapped were found to be performing the Surface Water Detention (SWD) function at a high level. Moderate performance for the SWD function included 21,759 acres of polygon wetlands.

Wetlands trap and store surface water from precipitation or spring snowmelt. This water is slowly released through surface or underground hydrologic networks. In general, depressional wetlands that capture and store precipitation or runoff are performing the function known as Surface Water Detention (SWD). This important function provides ground water recharge points found in wetlands near stream or river floodplains or in lake basins, fringe areas, or islands. From the human perspective, this process equates to lower peak flood levels downstream.

There were a number of LLWW classifications that indicated that a wetland performed this function at a *high* level, such as wetlands coded as *LEBA%* (Lentic, Basins). This was true except when the *LE%* code was noted as a *LE5* (Lentic, Excavated) or *LE6* (Lentic, Other artificial lake) wetland when the NWI water regime modifier was *K* (Artificially Flooded), except for when the wetland was part of a reservoir or a dammed lake. Other wetlands performing this function at a high capacity included:

- Lentic/lake basins such as *LEFR* (Lentic, Fringe) which perform the surface water detention function at a high level. Again, this excluded *LE5* (Lentic, Excavated) and *LE6* (Lentic, Other artificial lake) wetlands, or wetlands with the NWI water regime modifier of *K* (unless the wetland was located within a reservoir or a dammed lake),
- Lentic wetlands found in a *LEFL%* (Lentic, Flat Landform), part of a reservoir or dammed lake and dammed river valley lakes and other dammed lakes that were not part of an impoundment,
- *LRFPba* (Lotic River, Floodplain basin) wetlands except for *LR4* (Lotic River, Intermittent),
- *LSFR* (Lotic Stream) as well as *LRFR* (Lotic River, Fringe) wetlands, except when located in the *A* (Temporarily Flooded) Water Regime,
- Terrene Landscapes also performed the SWD function at a high level. These included *TEFRpdTH* (Terrene, Fringe, pond, Throughflow) and *TEBATH* (Terrene, Basin) LLWW Water Flow Paths where throughflow of water was present,
- LLWW Waterbody Types which were dammed or excavated ponds (*PD%*). Examples of these ponds might include commercial, industrial or residential storm water ponds or ponds that had been created by beavers.

The high function level for the SWD function generally did not include wetlands form the *A, B* or *J* Water regimes (Temporarily Flooded, Saturated, and Intermittently Flooded) with two exceptions. Deepwater habitat (e.g., the deepwater portion of lakes such as NWI code *L1UBH*) was also excluded from this function as these features are not wetlands.

All wetlands not specifically identified as highly functioning, or wetlands listed as an exception, performed the function of SWD to a *moderate* level. But this was especially so for *LR%FP* (Lotic River, Floodplain), and *LS%FL* (Lotic Streams, Flat Landform), lentic wetlands other than noted above, terrene wetlands in a flat interfluve landform (*TEFL*), *TEFRpd* (Terrene, Fringe, ponds) or terrene basins (*TEBA*) other than noted above.

Table 19. Surface Water Detention (SWD) Codes and Condition.

Level of Function	Wetland Types
High	LEBA (excluding A and J regimes); LE1FL; LEFR (excluding the "C" water regime); LRBA (not "A" water regime); LRFPba (excluding "A" and "J" water regimes); LR1FR; LSBA (excluding "A" and "J" water regimes); LSFR; PD1TH (especially spring-fed and tinaja), PD2TH, PD3IN, PD3a2OU, PD3TH, PD3a2VR (excluding "A" water regime), PD3e1VR, PD3eTH, PD3hTH, PD3iTH, PD4TH; TEBATH with a "C" or "F" water regime, TEFRpdTH NOTE: This function includes wetlands adjacent to deepwater habitat, but does not include the water bodies themselves.
Moderate	LE2aILrs; LR%FPfl; LS%FL; PD1VR, PD%OU, PD2IN, PD3VR (except for PD3a2 wetter than an "A" regime and PD3e1), PD3eIN, PD3g%, PD3INsf; TEBA (other than previously selected; excluding impounded TEBAVR with "A" water regime), TEFL, TEFR (other than previously selected)

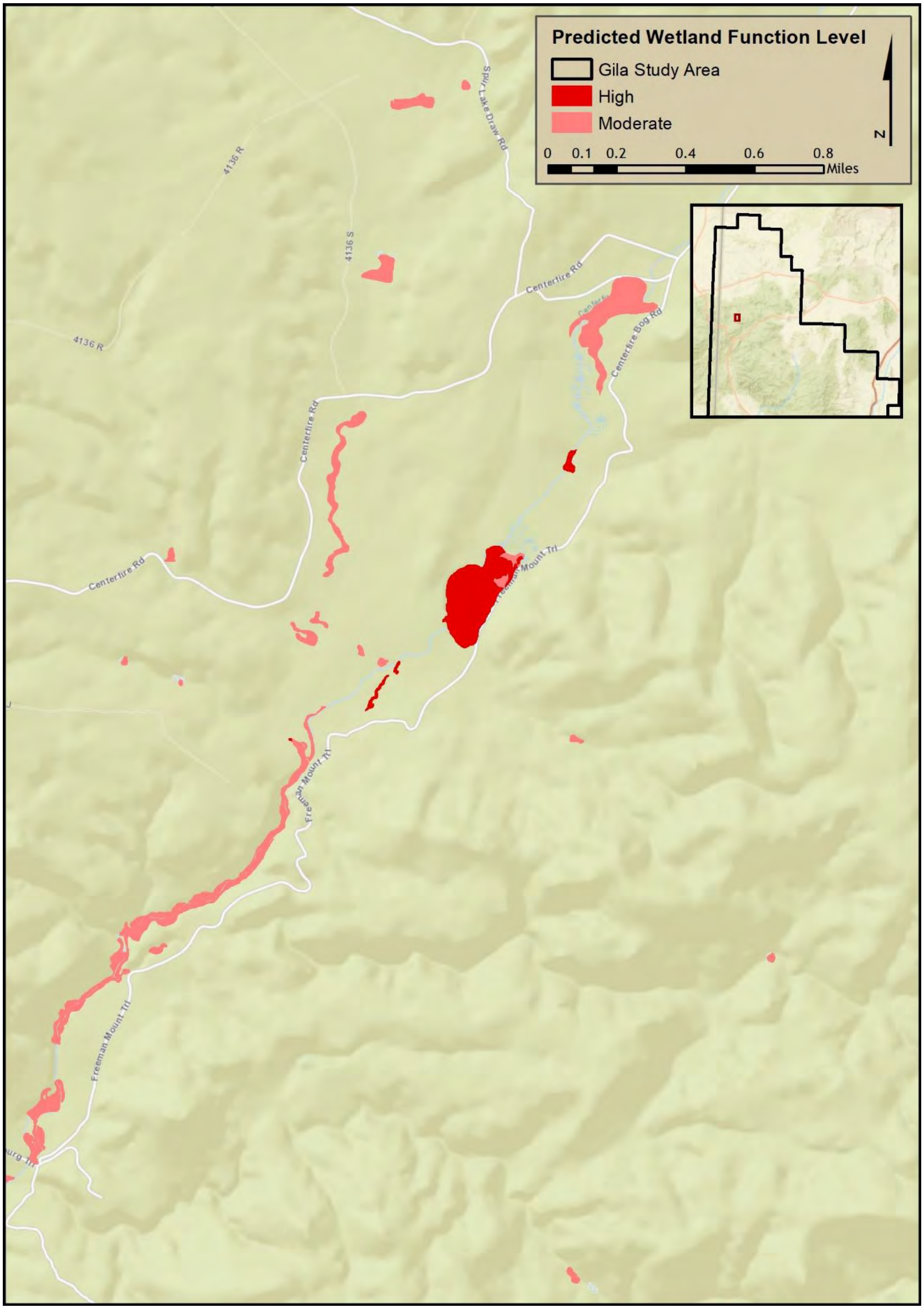


Figure 36. Surface Water Detention function sample map (along Centerfire Creek, a tributary of the San Francisco River).

Waterfowl and Water Bird Habitat (WBIRD) Function

The Waterfowl and Water Bird Habitat function (WBIRD) was found to be performed at a high level in 1,201 acres of wetland polygons and at a moderate level in 16,997 acres. Within the WBIRD function, the project team was interested in looking specifically at sandhill crane and wood duck habitat (Figure 37). Of the acres performing the WBIRD function, 2,651 acres were deemed sandhill crane habitat and just 84 acres were wood duck habitat.

Figure 37. The sandhill crane (left, NPS photo) and wood duck (right, USFWS photo) are two wetland-dependent birds of special interest in New Mexico.

A number of bird species rely on wetlands and associated habitats for survival. Depending on the species, critical habitat is typically associated with open water, from large littoral areas to forested ponds or streams. Wetlands performing this function provide semiaquatic or riparian habitats for many species of waterfowl, water birds or shorebirds. Due to the variety of species using these habitats, there are a range of wetland classifications that function at a high level for the WBIRD function.

NWI and LLWW codes for wetlands performing the WBIRD function at a *high* level included:

- *L2UBF* (Lacustrine, Littoral, Unconsolidated Bottom, Semipermanently Flooded) and *L2USC* (Lacustrine, Littoral, Unconsolidated Shore, Seasonally Flooded),
- *P%* (Palustrine) in the *F* (Semipermanently Flooded) Water Regime and adjacent to *PD1* (Pond, Natural) or *PD2* (Pond, Dammed/impounded),
- *PAB* (Palustrine, Aquatic Bed) waters that were not excavated or impounded,
- *PUBH* (Palustrine, Unconsolidated Bottom) in the *G* (Intermittently Exposed) and *H* (Permanently Flooded) water regimes,
- *PEM1%h* (Palustrine, Emergent, Persistent, Diked/impounded), in the *C* (Seasonally Flooded) and *F* (Semipermanently Flooded) water regimes,
- *LS%* (Lotic Stream) vegetated with *EM1* (Emergent, Persistent) but not *LR4* (Lotic River Intermittent),
- *LR%* (Lotic River) vegetated with *EM1* (Emergent, Persistent) but not *LR4* (Lotic River Intermittent),

- *TE%hw* (Terrene, headwaters) also classified as *PEM1C* (Palustrine, Emergent, Persistent, Seasonally Flooded), and *TE%* with impounded or created for wildlife management (*ip* and *wm* modifiers),
- *PD2h* (Pond, Dammed/impounded, Wildlife Management), *PD3h* (Pond, Excavated, Wildlife Management), *PD4* (Pond, Beaver),
- *PD1* (Pond, Natural) associated with *P* (Palustrine) wetlands with *UB* (Unconsolidated Bottom) or *RB* (Rock Bottom) in either the *F* (Semipermanently Flooded) or *H* (Permanently Flooded) Water Regimes,
- Beaver wetlands coded with the *b* (Beaver) modifier or as *bv* (Beaver) in LLWW.

NWI and LLWW codes for wetlands performing the WBIRD function at a *moderate* level included *L2UB* (Lacustrine, Littoral, Unconsolidated Bottom) wetlands not listed in the high category above.

- Ponds equal to or greater than one acre in size, *PD1* (Natural), *PD2a* (Pond, Dammed/impounded, Agricultural), or *PD3a* (Pond, Excavated, Agricultural),
- *P%F* (Palustrine, Vegetated, Semipermanently Flooded),
- *PAB* (Palustrine, Aquatic Bed) that were impounded or excavated and greater than one acre in size,
- *LE%FR* (Lentic Stream, Fringe) with a *G* (Intermittently Exposed) water regime,
- *TEBA%* (Terrene, Basin), that are also classified as *PEM1* (Palustrine, Emergent, Persistent) in the *C* (Seasonally Flooded) or *F* (Semipermanently Flooded) water regimes.

The majority of wetlands providing sandhill crane habitat were *R%US* in the *A* (Temporarily Flooded) or *C* (Seasonally Flooded) water regime. Most wetlands providing wood duck habitat were *PSS1C*, including some with a *b* (Beaver) modifier.

Table 20. Waterfowl and Waterbird Habitat (WBIRD) Codes and Conditions.

Level of Function	Wetland Types
High	L2UBF; L2USC (including modified); PAB3G; PEM1C also classified as LS, LRFP, LEBABIsf; TEBAhw; all PEM1Ch; PEM1F also classified as LR, LS, or TEFRpd; PEM1Fh also classified as LR, LS, TEFRpdTHsf, or TEFRipwm; PFO1Ab; PRBF; PSS1Cb; PUBF (excluding excavated and some impounded); PUBGh also classified as PD4TH and PD2hTH; PUBGx also classified as PD3hTH; PUBH also classified as PD1THsf, PD1iOUsf
Moderate	L1UBH; L2UBG and L2UBH; PABF; PEM1C (>1 acre) also classified as TEBA%; PEM1F (excluding those classified as high); PUBFh (>1 acre) also classified as PD2a2IN or PD2a2OU; PUBFx (>1 acre) also classified as PD3a2VR; PUBG (>1 acre) also classified as PD1 or PD2a2; PUBH (>1 acre) not already classified as high; PUBKx (>1 acre) also classified as PD3a%VR; PUSKx (>1 acre); R2UBH

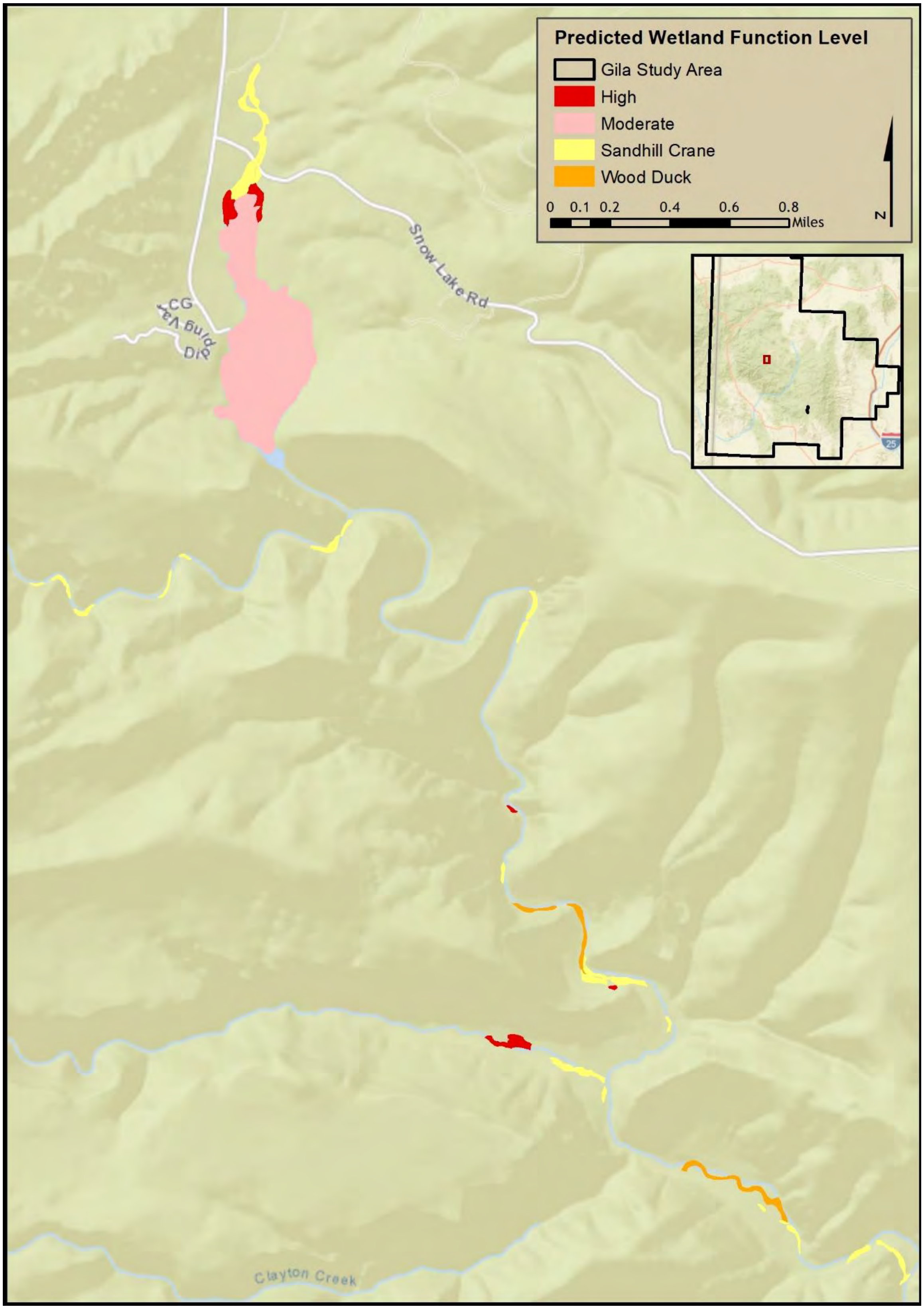


Figure 38. Waterbird and Waterfowl Habitat (WBIRD) Function Sample Map (along the Middle Fork of the Gila River).

Unique, Uncommon, or Highly Diverse Wetland Plant Communities (UWPC) Function

The Unique, Uncommon, or Highly Diverse Wetland Plant Communities (UWPC) function is intended to identify wetlands having state or regional significance. For New Mexico, this function continues to be developed as the evaluation of unique wetland types is ongoing. Regionally-significant wetland types for the Southwest area of the country included *sf* (Spring-fed) wetlands that were coded as such based on image interpretation or which were within 125 meters of a spring identified by either a federal or State of New Mexico database. Examples include LLWW codes of *TESLOUsf* (Terrene, Slope, Outflow, Spring-fed) or *TEBA%sf* (Terrene, Basin, Spring-fed). Other regionally-significant wetlands include riparian, desert, or un-grazed wetlands which remain relatively undisturbed.

Analysis found that approximately 3,397 acres of wetlands provided the UWPC function. These wetlands were considered regionally significant and included seeps and springs, particularly spring-fed palustrine wetlands (*TE%sf*), streams (*LS2%sf*, *ST2%sf, ST3%sf*) and ponds (*PD%sf*).

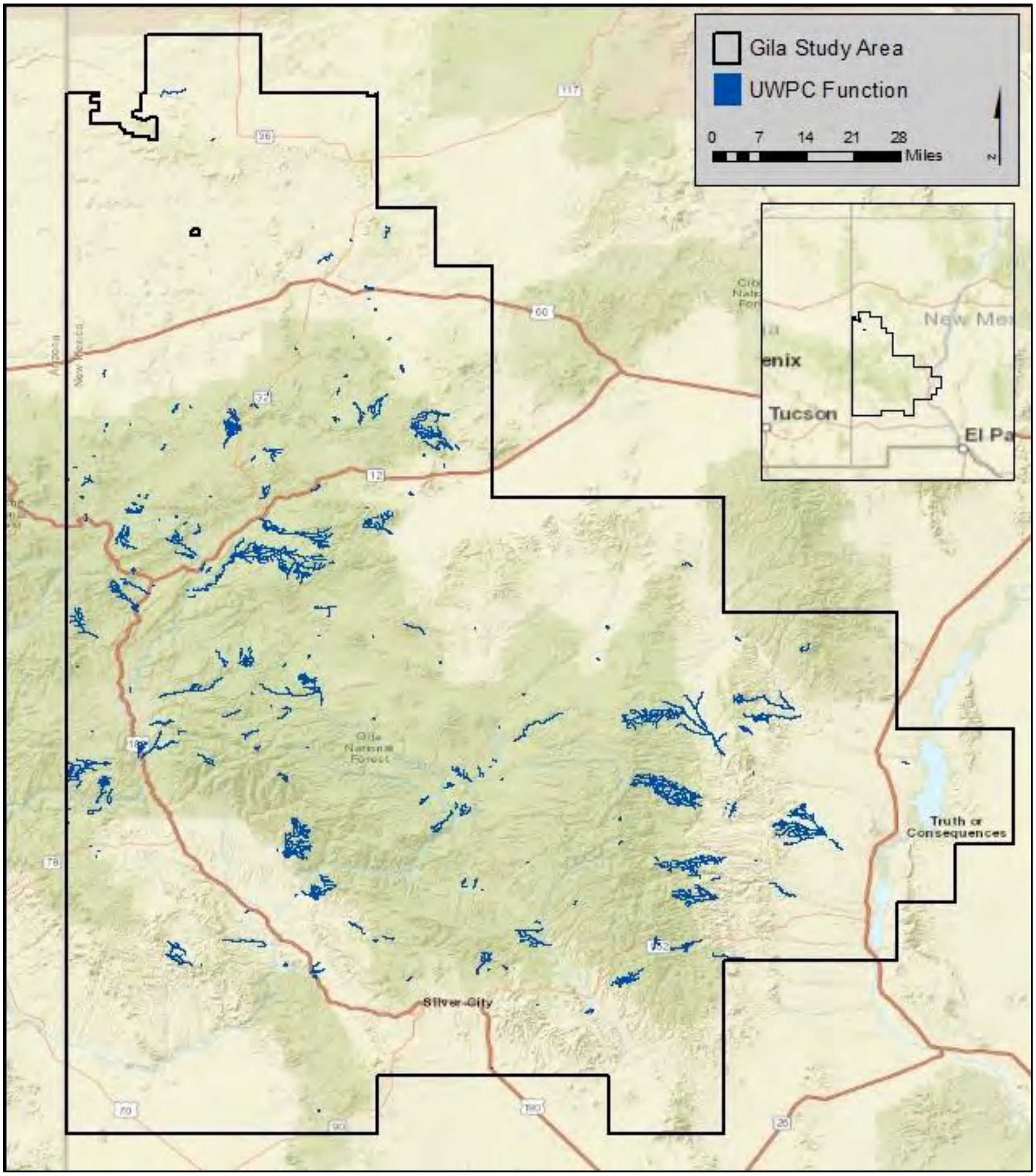


Figure 39. UWPC Function wetlands across the Gila study area.

Wetland Function Summary

Summaries of statistics for all twelve of the wetland functions identified for the project area are incorporated into a single table below (Table 21). The acreages for wetlands were calculated for both highly and moderately functioning conditions (and specific conditions as appropriate to each function). In order to better understand the contributions of wetlands in the watershed, the total acreage and percentage was also calculated for each function. While wetland classifications (e.g., NWI, LLWW) are discrete and a single feature cannot be assigned multiple classifications within the same system, a single wetland may perform multiple wetland functions. High and moderate designations within each function category are, however, mutually exclusive.

Table 21. Wetland and Aquatic Habitat Functional Assessment Summary.

	Polygon Wetland Features		
Parameter	**Area (acres)**	**% of wetland polygons**	**% of project area**
Project area	8,106,898	--	--
Wetlands	133,362	--	1.6
Aquatic Invertebrate Habitat (AIH)			
High	17,931	13.4	0.2
Moderate	2,687	2.0	<0.1
Bank & Shoreline Stabilization (BSS)			
High	15,102	11.3	0.2
Moderate	737	0.5	<0.1
Carbon Sequestration (CAR)			
High	1,100	0.8	<0.1
Moderate	15,054	11.3	0.2
Fish Habitat (FH)			
High	18,323	13.7	0.2
Moderate	670	0.5	<0.1
Stream Shading	4,659	3.5	<0.1
Groundwater recharge (GR)			
High	89,830	67.4	1.1
Moderate	9,327	7.0	0.1
Nutrient Transformation (NT)			
High	1,835	1.4	<0.1
Moderate	14,461	10.8	0.2
Other Wildlife Habitat (OWH)*			
High	64,627	48.5	0.8
Moderate	9,638	7.2	0.1
Sediment & Other Particulate Retention (SR)			
High	15,009	11.2	0.2
Moderate	22,794	17.1	0.3
Stream-flow Maintenance (SM)			
High	2,718	2.0	<0.1
Moderate	628	0.5	<0.1
Surface Water Detention (SWD)			
High	7,613	5.7	0.1
Moderate	21,759	16.3	0.3
Waterfowl & Water Bird Habitat (WBIRD)			
High	1,201	0.9	<0.1

Parameter	Polygon Wetland Features		
	Area (acres)	% of wetland polygons	% of project area
Moderate	16,997	12.7	0.2
Sandhill Crane	2,651	2.0	<0.1
Wood Duck	84	<0.1	<0.1
Unique, Uncommon, or Highly Diverse Wetland Plant Communities (UWPC)			
Regionally Significant (SW U.S.)	3,397	2.5	<0.1

* Vegetated riparian areas (5,841 acres) were also considered for the OWH function at a moderate level in addition to NWI wetland area. The total acreage of NWI wetlands and riparian areas combined (139,203 acres) were used to calculate “% of wetland polygons” for this function’s moderate level.

Observations

The purpose of this project was to describe the existing wetland conditions in the Gila area of western New Mexico. This was accomplished by first mapping and classifying the wetlands using the FGDC National Wetland Mapping Standard and then applying the LLWW classification system to the mapped wetlands as additional descriptive metrics. Riparian areas were also mapped using the System for Mapping Riparian Areas in the Western United States. The classified wetland data combined with best professional judgment from local, regional and national experts was then used to develop a wetland functional assessment schema and perform a functional analysis. Functional analysis provides a better understanding of the roles played by these critical wetlands and watersheds in New Mexico. Wetland mapping also provides a better understanding of how conditions are changing over time. The knowledge gained through completion of the project provides the basis for the following observations:

1. The LLWW classification system provides a useful tool for storing HGM metrics of wetland function. The codes are quite detailed and must be regionally adapted.

2. Expert local and regional input is required for determining applicable/appropriate wetland functions for specific study areas and for defining the wetland types that perform those functions. A comprehensive understanding of both the FGDC and LLWW classification systems is essential for participating in this process.

3. FGDC, LLWW and spatial metrics (e.g., adjacency and connectivity) are required for adequate assignment of wetlands to functional categories because each plays a role. In particular, Cowardin et al. (1979) water regimes are critically important for determining wetland function.

4. During delineation and classification, image interpreters should employ as complete a range of FGDC, Cowardin et al. (1979), and LLWW modifiers as project imagery will support in order to provide detail for the functional assessment. Where feasible, this process should also include incorporation of classified upland buffers and vegetative species. Species may be coded with the wetland indicator status defined in the NRCS PLANTS database (https://plants.usda.gov).

5. Multiple dates of field work help to adequately validate image signatures, delineation, classification and functional assignments.

6. When available, detailed soils, surface geology and bedrock geology help to define subsurface and internal drainage, which may have implications for functional assessment assignments.

7. Image interpretation should capture standardized-width flowpaths, represented as narrow polygons, in order to adequately depict hydrologic connectivity and fully utilize the LLWW classification system. The incorporation of NWI 2.0 standards has increased that connectivity and improved the accuracy of wetland functional assessments. The new 2.0 guidance allows for overland flow connectivity and asks that water flowpaths be mapped farther up watershed reaches, thus linking more wetland polygons to these flow paths. The result is a more cohesive polygon dataset that is bound together in a more complete and interrelated representation.

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