Affected Environment

CHAPTER 3

CHAPTER 3: AFFECTED ENVIRONMENT

The "Affected Environment" describes existing conditions for those elements of the natural and cultural environments that would be affected by implementing the actions considered in this draft plan/EIS. Because ORV use occurs in two distinct areas of Lake Meredith National Recreation Area, management actions proposed in this draft plan/EIS would only be applied to these areas of the national recreation area. Therefore, the discussion of the affected environment is limited to only those resources that may be affected by actions taken in Rosita Flats or Blue Creek. The following topics were addressed for the affected environment: soils, vegetation, water resources, wildlife and wildlife habitat, threatened and endangered species / species of concern, archeological resources, visitor use and experience / health and safety, and Lake Meredith National Recreation Area management and operations.

The "Affected Environment" describes existing conditions for those elements of the natural and cultural environments that would be affected by implementing the actions considered in this draft plan/EIS.

SOILS

In the current location of the national recreation area, the Canadian River has carved a narrow, steep-walled canyon from 200 to 300 feet deep and up to 2 miles wide. Between this canyon and the caprock, many tributary streams have caused a rough and broken topography known as the Canadian River Breaks. The construction of Sanford Dam between these "breaks" created Lake Meredith.

Over 67 percent of the land base of the national recreation area is composed of slopes greater than or equal to 12 percent. Problems associated with soils in the Lake Meredith National Recreation Area are generally related to soil texture (grain size) and slope. Unvegetated areas are subject to erosion by wind and water. In the national recreation area, soil compaction, erosion, and slumping occurs along roads, where vegetation cover is sparse, and on steep slopes. These areas are especially prone to erosion from surface runoff during storms. Accelerated erosion is more prevalent on steeper slopes and other disturbed areas, particularly where vegetation has been removed and cut-and-fill activities have occurred (NPS 2002a). These areas would be more highly susceptible to soil-surface disturbance, such as ORV use. Concerns related to increased erosion of soils include sediment delivery to streams and other water bodies, which decreases water quality.

K factor is a measure of the susceptibility of soil to erosion.

Soils present at Lake Meredith National Recreation Area are described in detail for each of the two management areas. The discussion provides a description of soil associations and their respective erodibility factor ("K factor"). K factor is a measure of the soil's susceptibility to erosion. Soils high in clay have low K values, about 0.05 to 0.15, because they are resistant to detachment (or erosion). Coarse-textured soils, such as sandy soils, have low K values, about 0.05 to 0.2, because of low runoff, even though these soils are easily detached. Medium-textured soils, such as the silt loam soils, have moderate K values, about 0.25 to 0.4, because they are moderately susceptible to detachment and they produce moderate runoff. Soils having a high silt content are the most erodible of all soils. They are easily detached and tend to crust and produce high rates of runoff. Values of K for these soils tend to be greater than 0.4 (Institute of Water Research 2009).

BLUE CREEK

Typical Soils and Vegetation in Blue Creek

The soils at the Blue Creek ORV use area remain in better condition than at Rosita Flats due to greater ranger presence and the rangers' ability to control ORV impacts on hillsides and slopes. Aside from rough broken land, soils present in the current extent of ORV boundaries in the Blue Creek area include Enterprise and Riverwash (NRCS 2009). These soils and their associated erodibility are further described in table 5 and shown on figure 12. Enterprise has the largest K factor at 0.43, and thus is the soil with the most potential to be eroded. Rough broken land in the Blue Creek area has a K factor of 0.37, and riverwash has a K factor of 0.17. Based on these definitions, Blue Creek is composed mostly of soils that are well drained with moderate to high K factors. In the Blue Creek ORV use area, soils highly susceptible to erosion (i.e., with K factors greater than 0.4) compose approximately 0.62 acres, or 0.2 percent of the total area.

TABLE 5: SOIL TYPES AND ACREAGES IN THE BLUE CREEK OFF-ROAD VEHICLE USE AREA

Soil Association	Soil Series	Description	K Factor	Acres in ORV Use Area
Enterprise very fine sandy loam, 5% to 8% slopes	Enterprise	Very deep, well-drained, moderately rapidly permeable soils that formed in loamy eolian sediments. These soils are on nearly level to moderately steep plains on terrace pediments in the Central Rolling Red Plains. Slopes range from 0% to 20%.	0.43 (high)	0.62
Riverwash	Riverwash	Riverwash describes excessively drained alluvium soil or sediments deposited by a river or other running water. Alluvium is typically made up of a variety of materials, including fine particles of silt and clay and larger particles of sand and gravel. Riverwash has a representative slope value of 1%.	0.17 (low)	83.32
Rough broken land	Rough broken land	Rough broken land describes well-drained colluvium; loose bodies of sediment deposited or built up at the bottom of a low-grade slope or against a barrier on that slope, transported by gravity. Rough broken land has a representative slope value of 50%.	0.37 (moderate)	167.99
Water	Water	NA	NA	23.07

Source: NRCS 2009.

Notes:

Acreage of soils in Blue Creek ORV Use Area with *high* erodibility factors: 0.62.

Acreage of soils in Blue Creek ORV Use Area with *moderate* erodibility factors: 167.99.

Acreage of soils in Blue Creek ORV Use Area with *low* erodibility factors: 83.32.

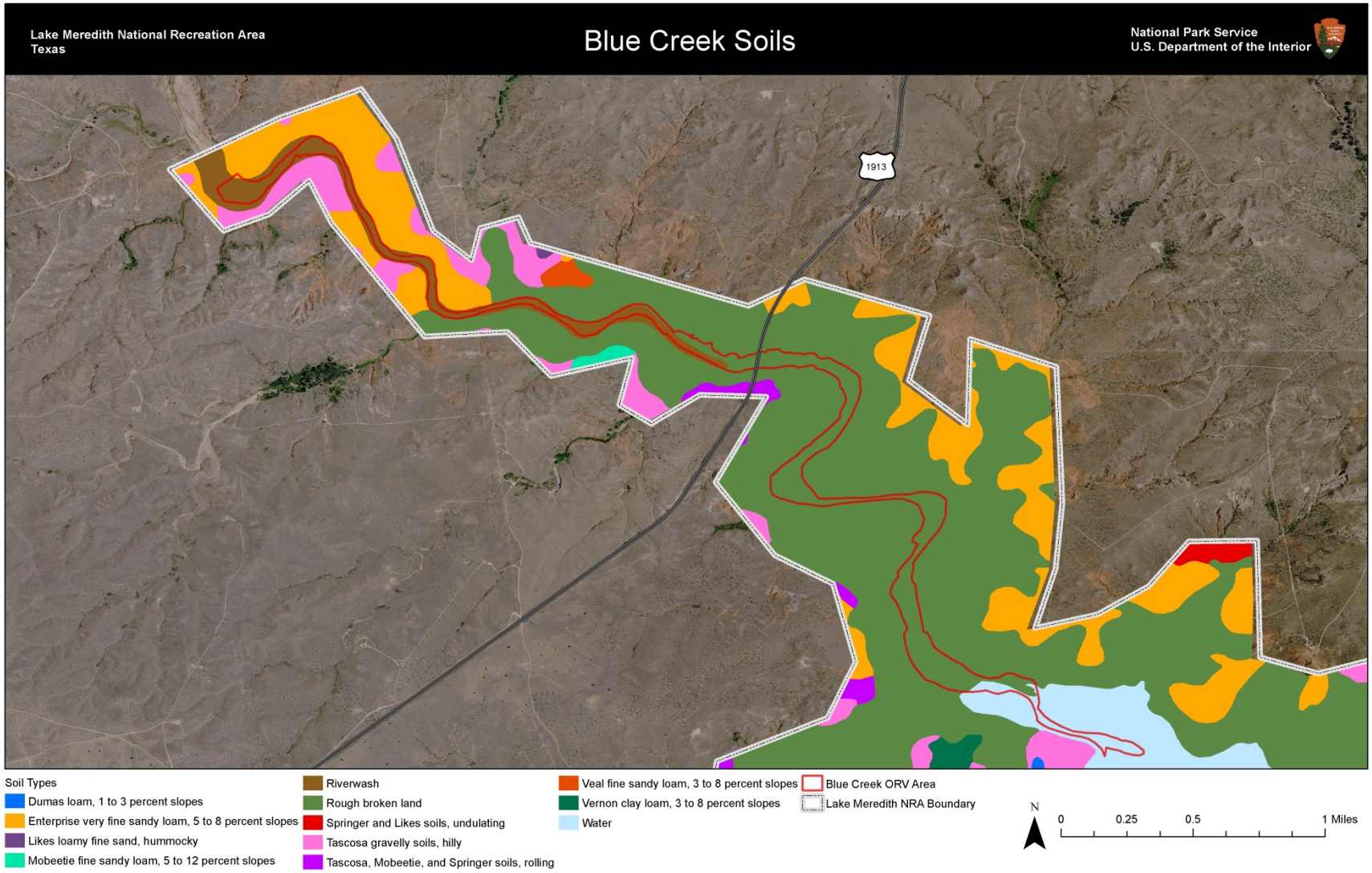


FIGURE 12: SOIL TYPES IN BLUE CREEK OFF-ROAD VEHICLE USE AREA

ROSITA FLATS

As described in chapter 1, soil erosion from ORV use has occurred and continues to occur in the designated area of Rosita, particularly between the entrance and Bull Taco Hill. Extensive soil erosion has occurred over the last 40 years, primarily due to the use of ORVs above the 3,000-foot elevation contour. On hillsides with slopes of 15 degrees or more, the soils often erode during and after rainfall events because of the steep slopes combined with the removal of vegetation by ORV use. These soils and their associated erodibility are further described in table 6 and shown on figure 13.

Example of Steep Slopes and Soils Erosion in Rosita Flats

Soils series present in the current extent of the ORV use area in Rosita Flats include Aspermont, Enterprise, Burson, Quinlan, Clairemont, Likes, Lincoln, Mobeetie, Riverwash, Tascosa, Tivoli, Weymouth, Vernon, and Yomont (NRCS 2009). As presented in table 6, Yomont association soil has the largest K factor, at 0.49, and thus has the most potential to be eroded; Clairemont soils have a K factor of 0.43; Aspermont–Enterprise and Burson–Quinlan–Rock outcrop associations have a K factor of 0.37, steep; and remaining soils and associations found in Rosita Flats have K factors between 0.15 and 0.32. These K factors, however, represent the soils in their natural condition. They do not indicate how past management or misuse of a soil increases soil erodibility. In those areas where the subsoil is exposed, the organic matter has been depleted, and/or the soil structure destroyed or soil compaction has reduced permeability, the K factor would increase regardless of soil type (Institute of Water Research 2009). Based on these definitions, Rosita Flats is composed mostly of well-drained, moderate-to-high K factor soils. In the Rosita Flats ORV use area, soils highly susceptible to erosion (i.e., with K factors greater than 0.4) compose approximately 126 acres, or 7 percent of the total area.

TABLE 6: SOIL TYPES AND ACREAGES IN THE ROSITA FLATS OFF-ROAD VEHICLE USE AREA

Soil Association	Soil Series	Description	K Factor	Acres in ORV Use Area
Aspermont–Enterprise association, undulating	Aspermont	Deep, well-drained, moderately slow or moderately permeable soils. These soils formed in calcareous silty colluvium over redbed siltstone and claystone of Permian age. These very gently sloping to steep soils are on sideslopes or summits on uplands. Slope ranges from 1% to 25%.	0.37 (moderate)	22.10
	Enterprise	Very deep, well-drained, moderately rapidly permeable soils that formed in loamy eolian sediments. These soils are on nearly level to moderately steep plains on terrace pediments in the Central Rolling Red Plains. Slopes range from 0% to 20%.		

Soil Association	Soil Series	Description	K Factor	Acres in ORV Use Area
Burson–Quinlan–Rock outcrop association, steep	Burson	Very shallow, well-drained, moderately permeable soils derived from loamy residuum from sandstones and siltstones of Triassic and/or Permian age. The soils are on gently sloping to very steep ridges, knolls, side slopes, and erosion remnants. Slope ranges from 3% to 80%.	0.37 (moderate)	60.54
	Quinlan	Shallow, well-drained, moderately rapid to moderately permeable soils that formed in loamy residuum weathered from noncemented, calcareous sandstone bedrock of Permian age. These soils are on nearly level to steep ridges and escarpments in the Central Rolling Red Plains. Slope ranges from 1% to 50%.		
Clairemont silty clay loam, occasionally flooded	Clairemont	Very deep, well-drained, moderately permeable soils that formed in calcareous silty alluvium. The soils are on nearly level flood plains of the Central Rolling Red Plains, Rolling Limestone Prairies, and the Central Prairies. Slopes range from 0% to 2%.	0.43 (high)	56.95
Likes loamy fine sand, 1% to 8% slopes	Likes	Very deep, excessively drained, rapidly permeable soils. These soils formed in sandy colluvium and alluvium derived from the Ogallala Formation of Miocene–Pliocene age. These soils are on very gently sloping valley flats or gently sloping to moderately steep valley sides. Slope ranges from 1% to 20%.	0.15 (low)	36.28
Lincoln soils, frequently flooded	Lincoln	Very deep, somewhat excessively drained, rapidly permeable floodplain soils that formed in sandy fluvial sediments of Recent age. These soils are on nearly level to undulating flood plains in the Central Rolling Red Plains and Southern High Plains Breaks. Slope ranges from 0% to 3%.	0.17 (low)	945.33
Mobeetie fine sandy loam, 5% to 12% slopes	Mobeetie	Very deep, well-drained, moderately rapidly permeable soils that formed in calcareous, sandy alluvium and colluvium derived from the Ogallala Formation of Miocene–Pliocene age. These soils are on nearly level to gently sloping valley flats or gently sloping to steep valley side or scarp. Slope ranges from 0% to 45%.	0.24 (moderate)	22.07
Riverwash	Riverwash	Riverwash describes excessively drained alluvium soil or sediments deposited by a river or other running water. Alluvium is typically made up of a variety of materials, including fine particles of silt and clay and larger particles of sand and gravel. Riverwash has a representative slope value of 1%.	0.17 (low)	457.67

Soil Association	Soil Series	Description	K Factor	Acres in ORV Use Area
Tascosa association, hilly	Tascosa	Deep, well-drained, moderately permeable soils that formed in sandy and gravelly alluvial sediments of the Ogallala Formation of Miocene-Pliocene age. These soils are on convex, gently sloping to steep knobs and erosional hillslopes in the Canadian Breaks and margins of the Southern High Plains. Slope ranges from 3% to 30%.	0.15 (low)	4.59
Tivoli fine sand	Tivoli	Very deep, excessively drained, rapidly permeable soils that formed in sandy eolian sediments. These soils are on undulating to hummocky sand dunes on stream terraces in the Central Rolling Red Plains and the Southern High Plains Breaks. Water runs off the surface very slowly. Slopes are complex and are 1% to 45%.	0.15 (low)	38.54
Weymouth–Vernon association, undulating	Weymouth	Weymouth series comprises deep, well-drained, moderately permeable upland soils. These soils formed in clayey shales. Slopes range from 1% to 12%.	0.32 (moderate)	27.20
	Vernon	Moderately deep over claystone bedrock, well-drained, very slowly permeable soils that formed in residuum over noncemented claystone bedrock or dense clay of Permian age. These soils are on gently sloping to steep plains and escarpments of the Central Rolling Red Plains, Central Limestone Prairies and North Central Prairie. Slopes range from 1% to 45%.		
Yomont soils, frequently flooded	Yomont	Very deep, well-drained, moderately rapidly permeable soils that formed in calcareous loamy alluvial sediments of Permian age redbeds. These soils are on nearly level flood plains of the Central Rolling Red Plains. Slopes range from 0% to 2%.	0.49 (high)	68.73

Source: NRCS 2009.

Notes:

Acreage of soils in Rosita Flats ORV Use Area with *high* erodibility factors: 125.68.

Acreage of soils in Rosita Flats ORV Use Area with *moderate* erodibility factors: 131.91.

Acreage of soils in Rosita Flats ORV Use Area with *low* erodibility factors: 1,482.41.

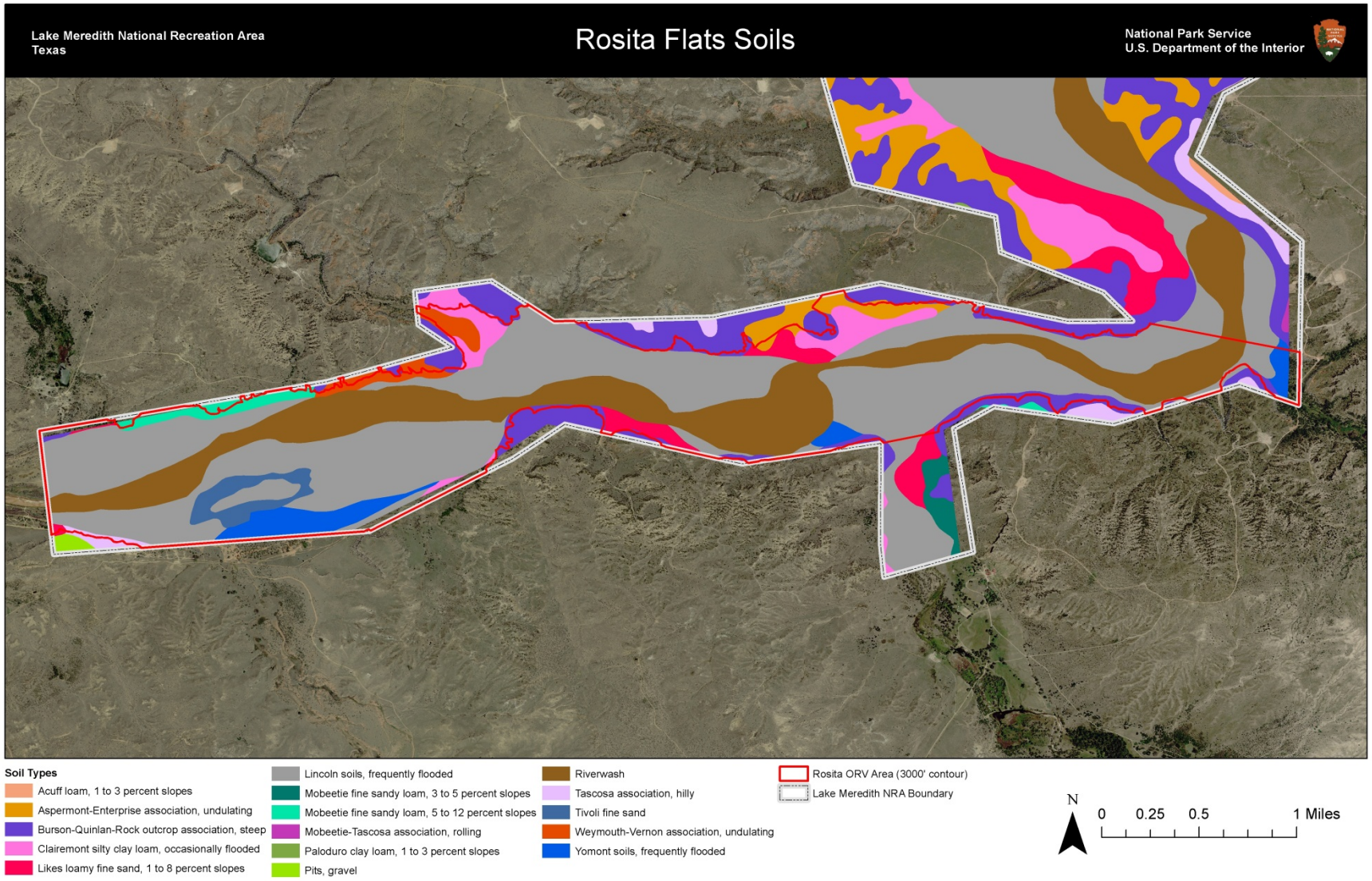


FIGURE 13: SOIL TYPES IN ROSITA FLATS OFF-ROAD VEHICLE USE AREA

VEGETATION

The vegetation of the national recreation area is relatively sparse, due to soil and climatic conditions, and consists primarily of grasses and drought-tolerant shrubs. In addition, stands of hackberry (*Celtis* spp.) and cottonwood trees (*Populus deltoides*) grow alongside canyons and riverbanks, and multiple other trees are found where they were previously planted around developed sites (NPS 1996). Although sparse, vegetation in the area is important to the overall health of the national recreation area and provides important habitat for wildlife. Vegetation also holds and traps blowing sediment, thereby preventing erosion, and is a primary factor in the national recreation area's visual quality and biodiversity.

Cottonwood Trees in Rosita Flats

Within the national recreation area, there are currently two areas (Blue Creek and Rosita Flats) designated for ORV use (which includes motorcycles, three- and four-wheelers, and dune buggies). Vegetation characteristics in these use areas are discussed later. Trees in the riparian areas have also been impacted through their roots becoming exposed by ORV traffic close to the trunks.

Control of Nonnative Vegetation

There is always a risk of nonnative plant species invading the site of any surface disturbance. Activities that disturb plant communities, such as through removal of vegetation, may affect their succession and composition. If the plant community is severely damaged, nonnative plants may move in and establish a permanent change in vegetation detrimental to either the establishment of a natural plant community or the reestablishment of native wildlife species.

Nonnative vegetation is a potential threat to the native vegetation communities of the national recreation area. Thirty-seven nonnative species have been documented in the national recreation area, 10 of which have been classified as "highly invasive" and are displacing native species and 8 of which are classified as "invasive and potentially problematic." The most common highly invasive species found at the national recreation area include Russian thistle, commonly known as Mexican fireweed; *Kochia scoparia*; and saltcedar, which affects approximately 7,000 acres (NPS 2002a). Invasive or noxious weeds present a potential threat to the ecosystems of national park units throughout the country and control or eradication of these species is often extremely difficult and expensive. In both areas of the national recreation area where ORV use occurs, the NPS is managing saltcedar by cutting and burning, followed by treatment with approved herbicides.

BLUE CREEK

The Blue Creek area is located in the northwest corner of the national recreation area (see figure 2). ORV use in this area has caused vegetation damage primarily along the national recreation area's northwest boundary, where a small tributary creek leads to a waterfall. Broad ORV tracks, cutting through the vegetation, parallel the creek and cross it several times. The waterfall area is badly damaged. In addition to extensive trampling by feet and ORV wheels, large plants (trumpet evening primrose [*Oenothera*

jamesii]) have been dug out and removed from immediately around the waterfall, perhaps by individuals attempting to grow them in cultivation (Nesom and O'Kennon 2005). The south side of Blue Creek near Timber Hollow and near the former location of the "Big Tree" has extensive ORV use, with ruts as deep as 8 feet causing damage to current vegetation in the area. Current vegetation found in the Blue Creek ORV use area is presented below.

Types of Vegetation Classifications Found in Blue Creek

Although all of the following vegetation classifications are found in Blue Creek (NPS 2002a; Nelson et al. 1999), the predominant classifications are mixed grassland, yucca grassland, mesquite grassland, and emergent scrub/shrub. Although not as pronounced, the following vegetation classifications are also found in the area: vegetated cliffs, mixed forest, unconsolidated shore, and riverine grassland (NPS 2002a).

Mixed Grassland—Densely vegetated with mesquite, small soapweed yucca (*Yucca glauca* Nutt. var. *glauca*), blue stem grasses (*Andropogon gerardii*), grama grasses (*Bouteloua*), purple threeawn (*Aristida purpurea* Nutt.), and others. Mixed large vegetation may be mesquite, yucca, or other woody plants.

Yucca Grassland—Similar to mixed and mesquite grassland; densely vegetated with small soapweed yucca, mesquite, blue stem grasses, purple threeawn, and others, with yucca the predominant larger vegetation.

Mesquite Grassland—Similar to mixed grassland; densely vegetated areas comprising small soapweed yucca, blue stem grasses, grama grasses, purple threeawn, and others, with mesquite the predominant larger vegetation.

Emergent Scrub/Shrub—Low-lying areas that may be inundated by lake level fluctuations and are vegetated with common reeds (*Phragmites australis*), switchgrass (*Panicum virgatum* L.), cottonwoods, willows (*Salix*), saltcedar, and seep willow (*Baccharis salicifolia*).

Vegetated Cliffs—Composed of sloped areas along ravines that are sparsely vegetated with blue stem mesquite (*Prosopis* spp.), grama grasses, netleaf hackberry (*Celtis reticulata* Torr.), and soapberry (*Sapindus saponaria*).

Mixed Forest—Areas that are densely populated with trees including hackberry, one-seed juniper (*Juniperus monosperma*), cottonwood, soapberry, mesquite, and saltcedar.

Unconsolidated Shore—Areas adjacent to inland waters consisting of fine sands with little or no vegetation. If vegetation is present, it is sparse, with species such as salt grass (*Distichlis spicata*), saltcedar, or herbaceous plants.

Riverine Grassland—Areas that are densely vegetated with switchgrass, common reed, seep willow, saltcedar), yellow or white sweet clover (*Melilotus* spp.), and others.

ROSITA FLATS

Rosita Flats is located in the southwest corner of Lake Meredith National Recreation Area (see figure 3). Damage to the natural communities in the Rosita Flats area is extensive. It is also highly conspicuous. Vegetation on the canyon walls and hills has been severely damaged by ORVs. Dunes and floodplains have been left vulnerable due to ORV use (Nesom and O'Kennon 2005). Evidence of unauthorized ORV use is also found at Bull Taco Hill, which is outside the ORV use area because it is above the 3,000-feet

elevation contour. In the riparian area along Rosita Flats, the national recreation area manages saltcedar, which has been identified as an invasive species. The saltcedar is managed by cutting, burning, and then applying approved herbicides. Hundreds of acres of saltcedar are controlled using this method at Lake Meredith National Recreation Area (NPS 2002a). Current vegetation found in Rosita Flats is presented below.

Types of Vegetation Classifications Found in Rosita Flats

The predominant vegetation classifications found at Rosita Flats are yucca grassland, disturbed grassland, and emergent vegetation (NPS 2002a; Nelson et al. 1999). Other vegetation classifications that are found in the area to a lesser extent include mixed forest, mixed grassland, mesquite grassland, vegetated cliffs, emergent scrub/shrub, and riverine grassland (NPS 2002a).

Yucca Grassland—Similar to mixed and mesquite grassland; densely vegetated with small soapweed yucca, mesquite, blue stem grasses, purple threeawn, and others, with yucca the predominant larger vegetation.

Disturbed Grassland—Disturbed grasslands are sparsely vegetated with switchgrass, common reed, seep willow, saltcedar, yellow or white sweet clover, and others.

Emergent Vegetation—Low-lying areas comprising emergent vegetation are occasionally inundated with freshwater from rain events or lake level fluctuations. These areas are dominated by reeds, rushes (J *Juncus*), cattails (*Typha*), *Scirpus*, and others.

Mixed Forest—Areas that are densely populated with trees including hackberry, one-seed juniper, cottonwood, soapberry, mesquite, and saltcedar.

Mixed Grassland—Densely vegetated with mesquite, small soapweed, blue stem grasses, grama grasses, purple threeawn, and others. Mixed large vegetation may be mesquite, yucca, or other woody plants.

Mesquite Grassland—Similar to mixed grassland; densely vegetated areas comprising small soapweed yucca, blue stem grasses, grama grasses, purple threeawn, and others, with mesquite the predominant larger vegetation.

Vegetated Cliffs—Composed of sloped areas along ravines that are sparsely vegetated with blue stem, mesquite, grama grasses, netleaf hackberry, and soapberry.

Emergent Scrub/Shrub—Low-lying areas that may be inundated by lake level fluctuations and are vegetated with reeds, switchgrass, cottonwoods, willows, saltcedar, and seep willow.

Riverine Grassland—Areas that are densely vegetated with switchgrass, common reed, seep willow, saltcedar, yellow or white sweet clover, and others.

WATER RESOURCES

Water quantity and quality affect ecology and visitor experience in the Lake Meredith National Recreation Area, which contains water resources in the form of impounded reservoir water and tributaries, as well as groundwater in various aquifers. Within the Blue Creek and Rosita Flats ORV use areas, current management allows the operation of vehicles in and adjacent to portions of Big Blue Creek, the Canadian River, and Bonita Creek.

SURFACE WATER

Roughly 99 miles of streams, fed primarily by springs, feed into Lake Meredith National Recreation Area. Lake Meredith water is ultimately blended with wellfield water from the Ogallala aquifer to supply drinking water to the 11 member cities of the CRMWA, including Amarillo and Lubbock (NPS 2007b). The Canadian River watershed, within which the national recreation area is located, encompasses over 13,000 square miles. The Mora River, Ute Creek, and Rita Blanco Creek supplement flow to the Canadian River above Lake Meredith. Conchas Lake, Lake Rita Blanca, and Ute Reservoir are also located upbasin of the national recreation area. Very few well-defined drainages exist within the Canadian River watershed, which is relatively flat with an eastward slope of 8 to 10 feet per mile. In some areas throughout the watershed, surface water runoff is restricted to depressions that cover the plains, forming small ponds (playa lakes), where it evaporates or percolates into groundwater (NPS 2002a). The primary drainage in and out of the lake is the Canadian River, which originates on the eastern slope of the Sangre de Cristo Mountains in northeastern New Mexico and flows underground for much of its distance as it is fed by snowmelt in the mountains, rainfall, and groundwater discharge in the form of springs emerging from the Ogallala and other formations. The Canadian River also flows through the Rosita Flats ORV use area before it enters Lake Meredith. Big Blue Creek, which flows through the Blue Creek ORV use area, is a tributary to Lake Meredith.

Canadian River at Rosita Flats

Big Blue Creek

SURFACE WATER QUALITY

Under the 1972 federal Clean Water Act and subsequent amendments, states are required to develop water quality standards for all surface waters, monitor these waters, and identify and list those waters not meeting water quality standards. A water quality standard is the combination of its designated use and the water quality criteria designed to protect that use. Examples of designated uses include recreational activities (fishing and swimming) and drinking water supply. For the purpose of water quality regulation, the State of Texas has divided the Canadian River Basin into five stream segments encompassing over 294 miles of river, tributaries, and reservoirs. Segment 0102 covers 30 miles and includes Lake Meredith, from the Sanford Dam to the confluence of Camp Creek in Potter County. This segment is designated for contact recreation, aquatic life, and public water supply.

In conformity with the aforementioned federal requirements, the TCEQ identifies the water bodies in or bordering Texas for which effluent limitations are not stringent enough to implement water quality

standards and for which the associated pollutants are suitable for measurement by maximum daily load. In addition, the TCEQ also develops a schedule identifying total maximum daily loads (TMDLs) that will be initiated in the next two years for priority impaired waters. In the 2008 Texas Water Quality Inventory and 303(d) List (TCEQ 2008), one of three subcategories was assigned to each impaired parameter to provide information about water quality status and management activities on that water body.

The categories are defined as:

- Category 5: The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.
- Category 5a: A TMDL is underway, scheduled, or will be scheduled.
- Category 5b: A review of the water quality standards for this water body will be conducted before a TMDL is scheduled.
- Category 5c: Additional data and information will be collected before a TMDL is scheduled.

Several surface water impairments exist in the vicinity of Lake Meredith. These are detailed in table 7.

TABLE 7: SURFACE WATER IMPAIRMENTS IN THE VICINITY OF LAKE MEREDITH

Surface Water	Segment ID	303(d) List Category	Impairment	Year First Listed
Downstream half of lake, including Big Blue Creek arm	0102_01	5c	Chloride	2006
			Mercury in edible tissue	2002
			Sulfate	2006
			Total dissolved solids	2006
Upstream half of lake, above Big Blue Creek arm	0102_02	5c	Chloride	2006
			Mercury in edible tissue	2002
			Sulfate	2006
			Total dissolved solids	2006
Lake Meredith headwaters to Sand Creek	0103_01	5c	Chloride	2006
Sand Creek to Punta de Agua Creek	0103_02	5c	Chloride	2006
Punta de Agua Creek to New Mexico State Line	0103_03	5c	Chloride	2006

Source: TCEQ 2008.

In addition to the water quality impairments listed in table 7, there has been some concern that MTBE, an additive that is blended with gasoline during the refining process, may be present in Lake Meredith due to the large amount of watercraft usage. However, because no studies have been found thus far on this issue, the effects of this chemical on the lake are unknown (NPS 2002a).

Chloride is a drinking water contaminant present throughout Lake Meredith and its tributaries. Sources of chloride include oil and gas activities that produce brine, which can contaminate surface waters (TCEQ 2007). While it is not considered to present a risk to human health, the recommended maximum contaminant level for chloride is 250 milligrams per liter (mg/L) (equivalent to 250 parts per million

[ppm]). Exceeding this recommended level of chloride in drinking water results in a salty taste (EPA 2010). The EPA primary drinking water standards for chloride neither regulate nor provide for human health protection. Because fish and aquatic communities cannot survive in high chloride levels, aquatic life protection criteria require levels of less than 600 mg/L for chronic (long-term) exposure and less than 1,200 mg/L for short-term exposure (Kywater.org 2010). Water quality measurements at four locations in Rosita Flats indicate chloride levels ranging from 879 mg/L to 1,574 mg/L between 2002 and 2009 (Goodwin 2010). This indicates that the water at the Rosita Flats ORV use area is currently of very low quality due to chloride concentrations and is not suitable for various species of aquatic life. By contrast, water quality measurements at Big Blue Creek near the Blue Creek ORV use area taken between 1999 and 2009 indicate chloride concentrations in the range of 17 mg/L to 300 mg/L (Red River Authority of Texas [RRAT] 2010), which represents an acceptable level of risk to aquatic organisms in this tributary to Lake Meredith.

SOUNDSCAPES AND THE ACOUSTIC ENVIRONMENT

According to the NPS *Management Policies 2006* and Director's Order 47: *Sound Preservation and Noise Management*, an important component of the NPS mission is the preservation of the natural soundscapes associated with national park units (NPS 2000, 2006b). Natural soundscapes exist in the absence of human-caused sound. The natural soundscape is the aggregate of all the natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. Natural sounds are intrinsic elements of the environment and part of "the scenery and the natural and historic objects and the wild life" protected by the NPS Organic Act. They are vital to the visitor experience of many parks and provide valuable indicators of the health of various ecosystems. Natural sounds are necessary for ecological functioning and occur within and beyond the range of sounds that humans can perceive. Many mammals, insects, and birds decipher sounds to find desirable habitat and mates, avoid predators and protect young, establish territories, and meet other survival needs. Inappropriate sounds are of concern because they can impede ecological function and diminish the NPS's ability to accomplish its resource protection mission.

Examples of natural sounds commonly heard in the Lake Meredith National Recreation Area include bird songs, wind, and water. Examples of human-caused sounds commonly heard in some areas of the national recreation area include human voices and sounds produced by vehicles, motorboats, and jet airplanes. ORV sounds may be heard in the vicinity of the Blue Creek and Rosita Flats ORV use areas. During hunting season, the sound of gunfire may be prevalent in areas open to hunting. Human-caused sounds and sound levels (or loudness) may be appropriate or inappropriate depending on what uses occur in an area.

SOUNDSCAPES TERMINOLOGY

This section introduces the key terms used to evaluate soundscapes, and discusses the factors that influence human perception of sounds.

Percent Time Audible

Percent time audible is a metric used to describe the amount of time during the analysis period (e.g., hour, day, or season) that ORVs are audible to a human with normal hearing. The audibility of ORVs is determined, in part, by the natural ambient sound levels. Lower natural ambient sound levels result in higher ORV percent time audible. The converse is also true: higher natural ambient sound levels result in lower ORV percent time audible. The percent time audible indicator does not provide information on how loud or quiet ORV sounds are, only whether they are audible or not. Therefore, additional indicators of sound levels are also important to consider in conjunction with percent time audible. A description of

sound levels and sound metrics can be found in appendix B. Several examples of sound pressure levels in A-weighted decibel (dBA) scale are listed in table 8.

TABLE 8: DECIBEL LEVELS OF COMMON SOUND SOURCES

Sound	Noise Level (dBA)	Effect
Shotgun firing, jet takeoff (at 100–200 feet)	130	Painful
Turbo-prop at 200 feet, rock concert	110–140	Threshold of pain begins around 125 dBA
Thunderclap (near)	120	Threshold of sensation begins
Stereo (over 100 watts)	110–125	Regular exposure to sound over 100 dBA of more than one minute risks permanent hearing loss
Symphony orchestra, chainsaw, jackhammer	110	
Jet flyover (1,000 feet)	103	
Electric furnace, garbage truck, cement mixer	100	No more than 15 minutes of unprotected exposure recommended for sounds between 90 and 100 dBA
Subway, motorcycle (at 25 feet)	88	Very annoying
Lawnmower, nearby thunder	85–90	85 dBA is the level at which hearing damage (at 8 hours of exposure) begins
Recreational vehicles	70–90	
Diesel truck (40 mph at 50 feet)	84	80 dBA or higher is annoying, interferes with conversation; constant exposure may cause damage
Dishwasher, washing machine	75–78	70 dBA or higher is intrusive, interferes with telephone conversation
Vacuum cleaner	70	
Automobile (45 mph at 100 feet)	60	Comfortable hearing levels are under 60 dBA
Croaking raven (100 feet), conversation	50–65	
Quiet office	50–60	
Refrigerator humming	40	Quiet
Rustling leaves	20	Very quiet
Normal breathing	10	Barely audible
Lowest recorded natural ambient sound level during the winter in Yellowstone National Park backcountry	0	Approximate threshold of human hearing at 1 kilohertz

Source: Table adapted from the National Institute on Deafness and Other Communicative Disorders (http://www.nidcd.nih.gov/health/education/teachers/common_sounds.asp).

Natural Ambient Sound Levels

The natural ambient sound level (L_{nat}) is the baseline sound level that occurs in the absence of human-caused sound. L_{nat} is an estimate of the median ambient level for a site if all anthropogenic sources were removed.

Accurate estimates of L_{nat} require measurement periods with minimal levels of human-caused sound. Soundscapes monitoring was conducted at five sites in the national recreation area—two sites in the Blue Creek ORV use area and three sites in the Rosita Flats ORV use area. Non-natural sounds from oil derrick generators were audible at all monitoring locations for almost all hours of the day and night (e.g., non-natural sounds audible 100 percent or near 100 percent of the time). Traffic noise from U.S. Highway 87/287 similarly was audible at LAMR003, LAMR004, and LAMR005 in Rosita Flats at almost all hours of the day. In such cases, where periods devoid of human-caused sounds are rare, estimating L_{nat} can be problematic. One approach to estimating L_{nat} under such conditions is to state the L_{nat} as the minimum measured sound level. If non-natural noise is audible 100 percent of a given hour, then the L_{nat} is less than the measured minimum level. Using this approach, the mean hourly L_{nat} at the Rosita Flats ORV use area is 30 dBA and the mean hourly L_{nat} at the Blue Creek ORV use area is 26 dBA.

SOUNDSCAPES MONITORING

Soundscapes monitoring in the Lake Meredith National Recreation Area was conducted in late 2008 and early 2009. The 2008 monitoring during November and December is representative of the low ORV use or quiet season in the national recreation area. Measurements during February and March 2009, particularly during the Sand Drags event, are representative of peak use of the national recreation area. The annual Sand Drags event draws an estimated 30,000 people to Lake Meredith and adjacent lands for a weekend of motorsports activities. Attendees participate in semiorganized drag races along sand bars of the Canadian River. The event attracts many off-road enthusiasts, who drive ORVs including 4×4s, dune buggies, dirt bikes, ATVs, modified trucks, and lifted trucks. Use of the national recreation area is concentrated primarily in the Rosita ORV use area and off–national recreation area lands between U.S. Highway 287 and the Rosita entrance. The Blue Creek ORV use area also receives increased use. The following sections describe the soundscapes monitoring locations, data collection, data analysis methodology, and results. For additional detailed technical information on the soundscapes monitoring, refer to "Appendix B: Lake Meredith National Recreation Area Acoustic Monitoring and Modeling of Off-road Vehicles."

Soundscapes monitoring was conducted at a total of five sites—two sites in the Blue Creek ORV use area and three sites in the Rosita Flats ORV use area. The soundscape monitoring locations for Blue Creek and Rosita Flats are shown figure 14 and figure 15, respectively.

- Site LAMR001 was 1,100 feet west of highway FM 1913 in the Blue Creek ORV use area, on a slight rise near existing camping sites.
- Site LAMR002 was 200 feet east of FM 1913 in the Blue Creek ORV use area, near the sandbar.
- LAMR003 was 3.3 miles east of U.S. Highway 287, near a campsite/fire pit near the southeastern extent of Rosita, near a popular foot path that climbs up to a lookout on the bluff.
- LAMR004 was 2.5 miles east of U.S. Highway 287, near the center of Rosita in a large, relatively open area. There were several primary trails on all sides
- LAMR005 was 1.5 miles east of U.S. Highway 287, on a slight rise near the national recreation area entrance to Rosita. Almost all traffic entering the national recreation area passed by this monitor, located approximately 20 feet from the vehicles at the closest point of approach.

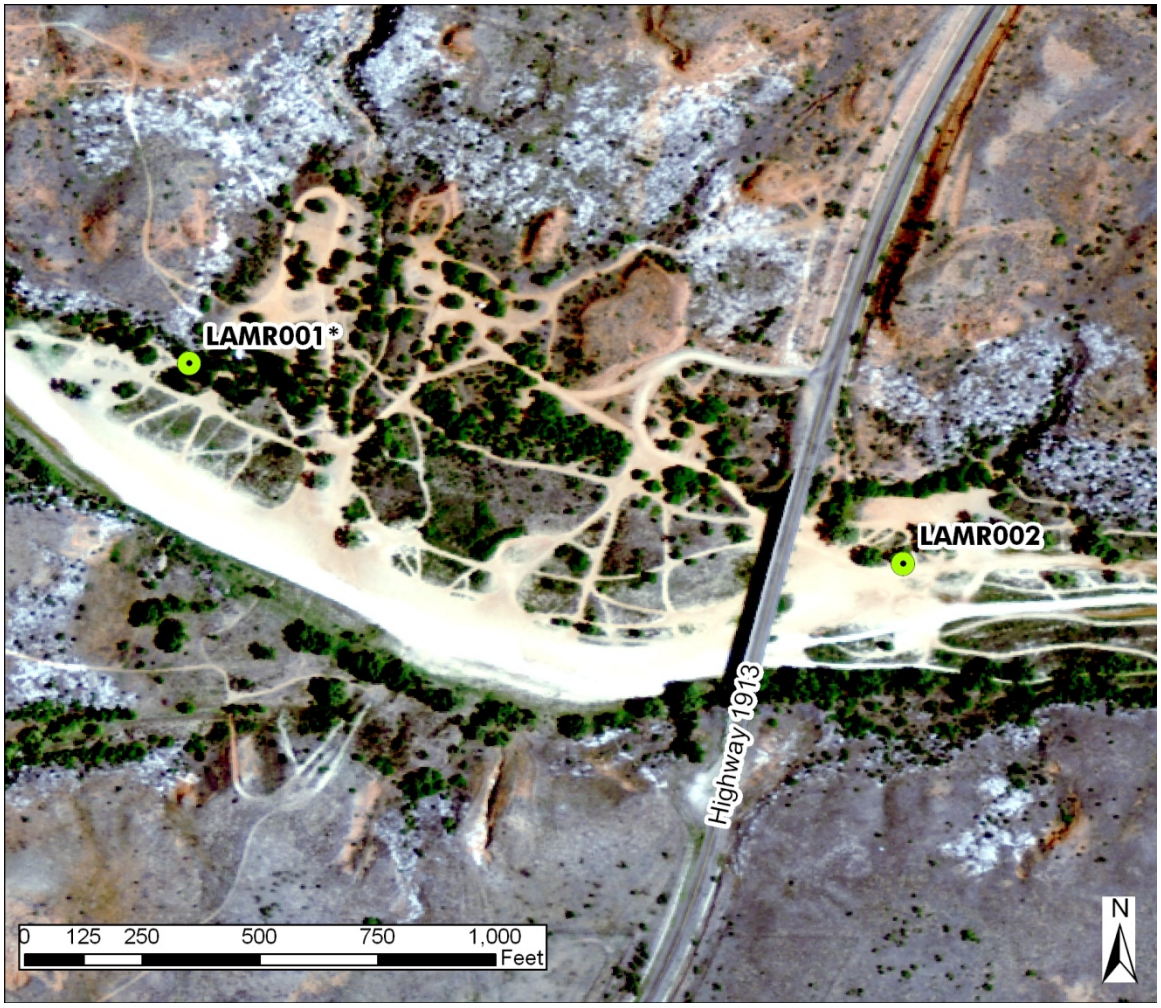


FIGURE 14: BLUE CREEK OFF-ROAD VEHICLE USE AREA SOUNDSCAPES MONITORING SITES

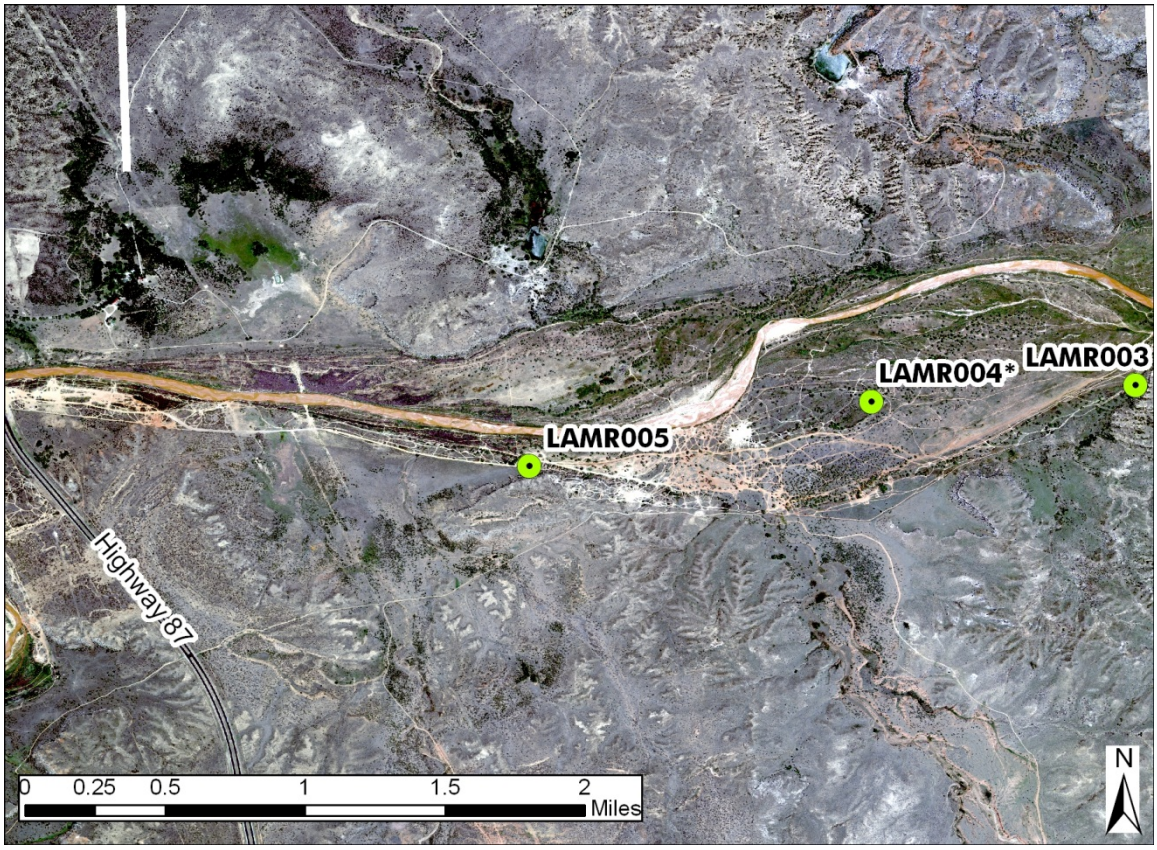


FIGURE 15: ROSITA FLATS OFF-ROAD VEHICLE USE AREA SOUNDSCAPES MONITORING SITES

ORV Percent Time Audible

Blue Creek—Figure 16 summarizes the median hourly ORV percent time audible results for the Blue Creek sites LAMR001 and LAMR002. ORV percent time audible at these sites is likely overestimated because it includes some on-road traffic on FM 1913.

In 2008, ORV percent time audible was over 30 percent for the majority of the hours between 6:00 a.m. and 6:00 p.m. The highest median hourly percent time audible in 2008 was 44 percent for the 2:00 p.m. hour. ORV percent time audible was generally at or below 5 percent between 9:00 p.m. and 5:00 a.m.

In 2009, ORV percent time audible was over 40 percent between 2:00 p.m. and 8:00 p.m. The highest median hourly percent time audible in 2009 was 53 percent for the 4:00 p.m. hour. ORV percent time audible was below 10 percent overnight between 9:00 p.m. and 10:00 a.m. ORV percent time audible was slightly higher for a few hours during the Sand Drags event compared to the 2009 monitoring period as a whole, but in other hours was actually lower.

The comparison between the 2008 and 2009 data shows a higher percent time audible in 2008 in the mornings and a higher percent time audible in 2009 in the afternoons. This result could be indicative of a difference in ORV use patterns between November/December and February/March. One potential contributing factor to the difference could be the earlier hour of sunset in the winter.

Rosita Flats—Figure 17 summarizes the median hourly ORV percent time audible results for the Rosita Flats sites LAMR003, LAMR004, and LAMR005.

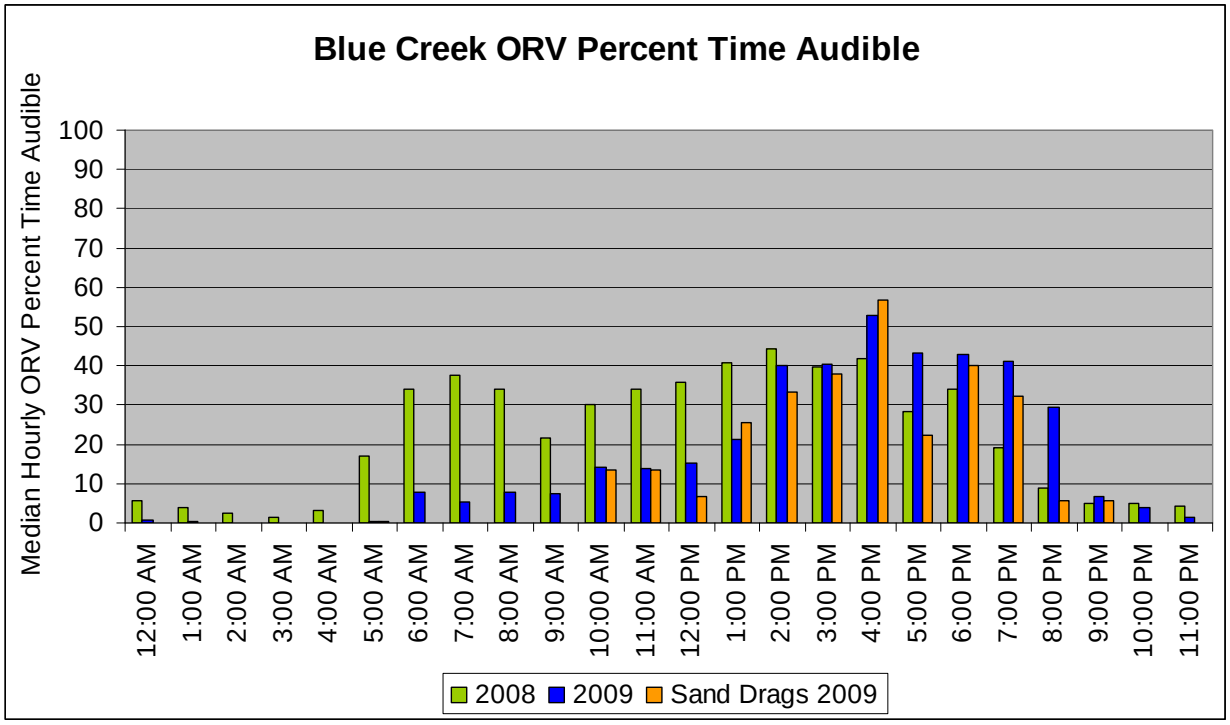


FIGURE 16: BLUE CREEK OFF-ROAD VEHICLE PERCENT TIME AUDIBLE

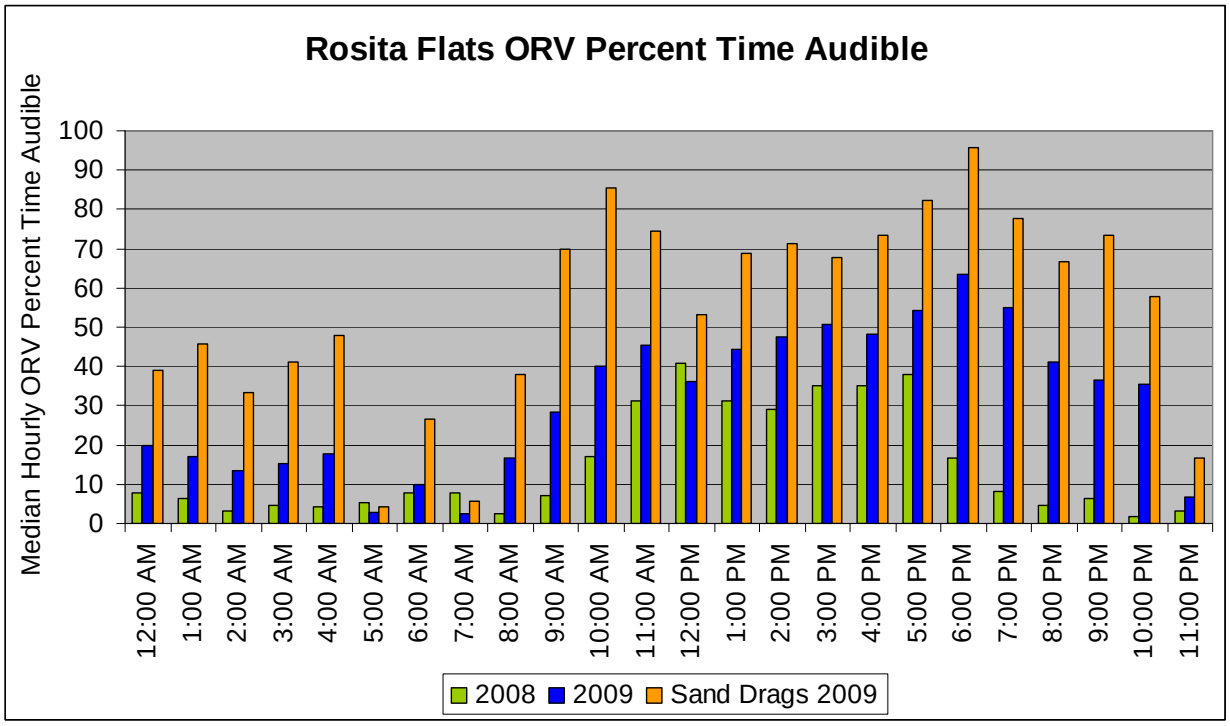


FIGURE 17: ROSITA FLATS OFF-ROAD VEHICLE PERCENT TIME AUDIBLE

In 2008, ORV percent time audible was at or above 30 percent for the majority of the hours between 11:00 a.m. and 6:00 p.m. The highest median hourly percent time audible in 2008 was 41 percent for the 12:00 p.m. hour. ORV percent time audible was below 10 percent between 7:00 p.m. and 10:00 a.m.

The early 2009 ORV percent time audible is substantially higher than in late 2008, reflecting the influence of the Sand Drags event on the 2009 results, as well as seasonal differences in ORV use levels at Rosita Flats. In 2009, ORV percent time audible was over 40 percent between 10:00 a.m. and 9:00 p.m. The highest median hourly percent time audible in 2009 was 63 percent for the 6:00 p.m. hour. ORV percent time audible was below 10 percent in only three hours—5:00 a.m. to 6:00 a.m., 7:00 a.m. to 8:00 a.m., and 11:00 p.m. to midnight.

During the 2009 Sand Drags weekend, ORV sound audibility at Rosita Flats increases substantially above the median levels for the 2009 monitoring period as a whole. Median hourly ORV percent time audible was at or above 60 percent for the majority of the hours between 9:00 a.m. and 11:00 p.m. The highest median hourly percent time audible during Sand Drags was 96 percent for the 6:00 p.m. hour. ORV audibility during Sand Drags continues to be well above typical levels throughout the night, with only two hours below 10 percent.

Maximum Sound Levels

Blue Creek—Figures 18 and 19 display the median hourly maximum sound levels (L_{max}) for the Blue Creek sites LAMR001 and LAMR002. At LAMR001, 2008 and 2009 L_{max} levels were similar throughout much of the day, with 2009 levels being higher than 2008 levels in the afternoon and evening. The highest hourly L_{max} level at LAMR001 in 2008 was 65 dBA between 2:00 p.m. and 3:00 p.m. In 2009, the highest L_{max} level occurred between 4:00 p.m. and 5:00 p.m. (74 dBA).

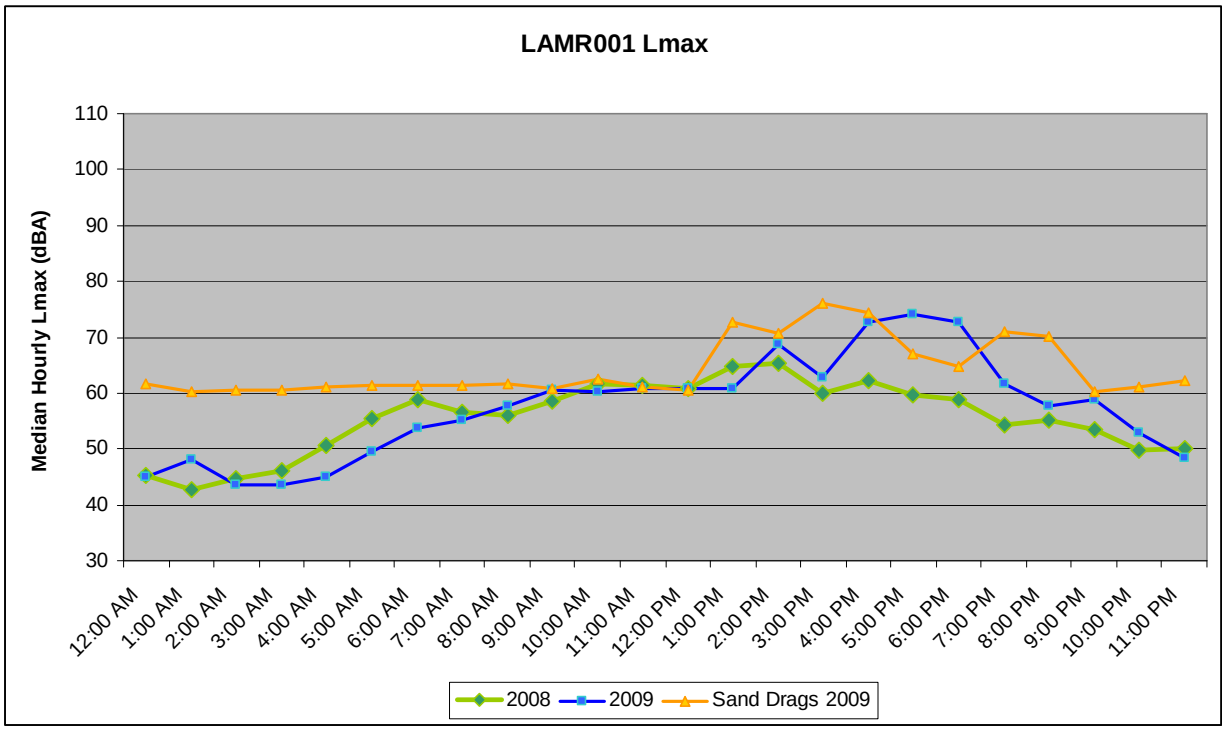


FIGURE 18: MEDIAN HOURLY L_{MAX} SOUND LEVELS FOR BLUE CREEK SITE LAMR001

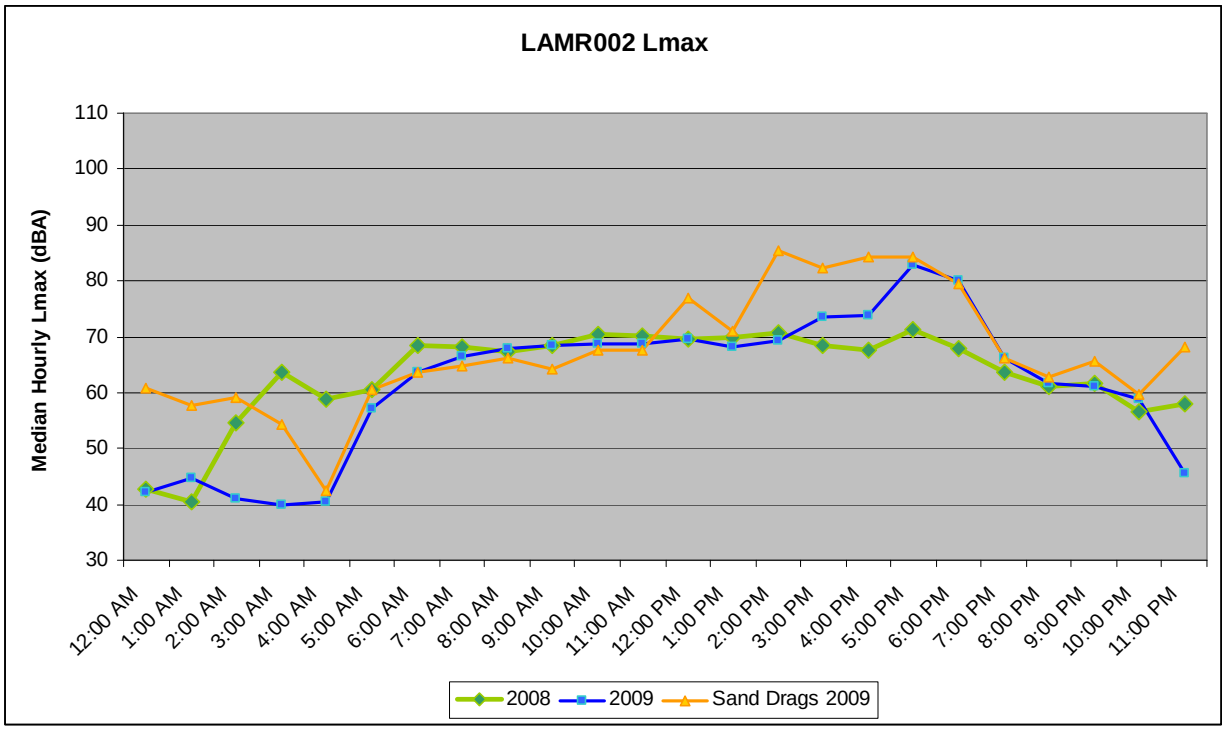


FIGURE 19: MEDIAN HOURLY L_{MAX} SOUND LEVELS FOR BLUE CREEK SITE LAMR002

At site LAMR002, L_{max} levels were nearly identical between 2008 and 2009 between 6:00 a.m. and 3:00 p.m. Greater variations occurred outside these hours, with 2009 levels being approximately 20 dBA lower than 2008 levels in the hours between 3:00 a.m. and 5:00 a.m. The 2009 L_{max} levels were higher than 2008 levels in the evenings at LMAR002.

As with the L_{eq} sound levels, the L_{max} sound levels at LAMR001 during Sand Drags 2009 suggest a constant source of sound energy in the vicinity of this site during the night. Median hourly L_{max} levels at LAMR001 during Sand Drags were never below 60 dBA and were the highest between 3:00 p.m. and 4:00 p.m. (76 dBA). L_{max} sound levels at LAMR002 during Sand Drags were not substantially higher than the levels recorded during 2008 and the 2009 monitoring period as a whole.

Rosita Flats—Figures 20, 21, and 22 display the median hourly L_{max} sound levels for the Rosita Flats sites LAMR003, LAMR004, and LAMR005. The difference between 2008 and 2009 L_{max} levels was not substantial at any of the sites. During Sand Drags all sites experienced higher than typical L_{max} levels in almost every hour, but the magnitude of the increase varied between the sites, likely indicative of the relative proximity of each site to focus areas of ORV activity.

LAMR004 generally had the lowest sound levels of the three sites, with median hourly L_{max} never exceeding 70 dBA during the 2008 and 2009 monitoring periods. L_{max} levels dropped off to under 50 dBA at night at LAMR004. Sand Drags affected sound levels at this site the most between midnight and 4:00 a.m., with a 15 to 20 dBA increase over typical levels. During most of the day, the Sand Drags L_{max} sound levels were 10 dBA or less over typical levels.

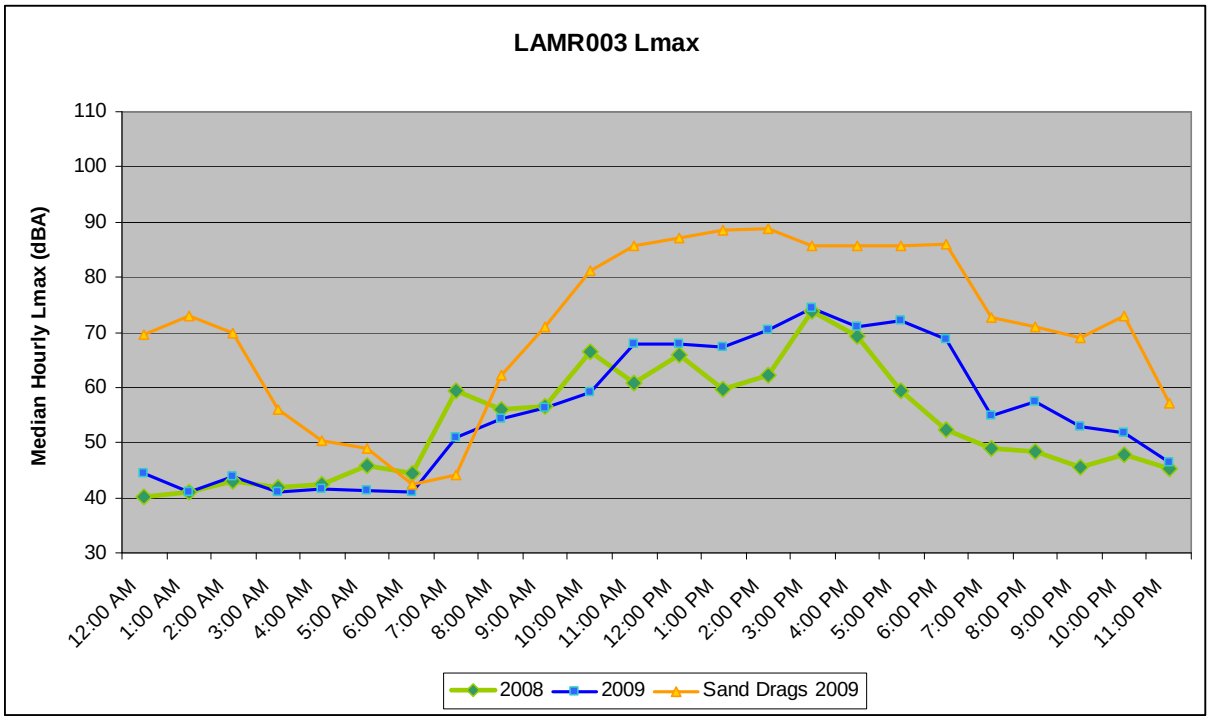


FIGURE 20: MEDIAN HOURLY L_{MAX} SOUND LEVELS FOR ROSITA FLATS SITE LAMR003

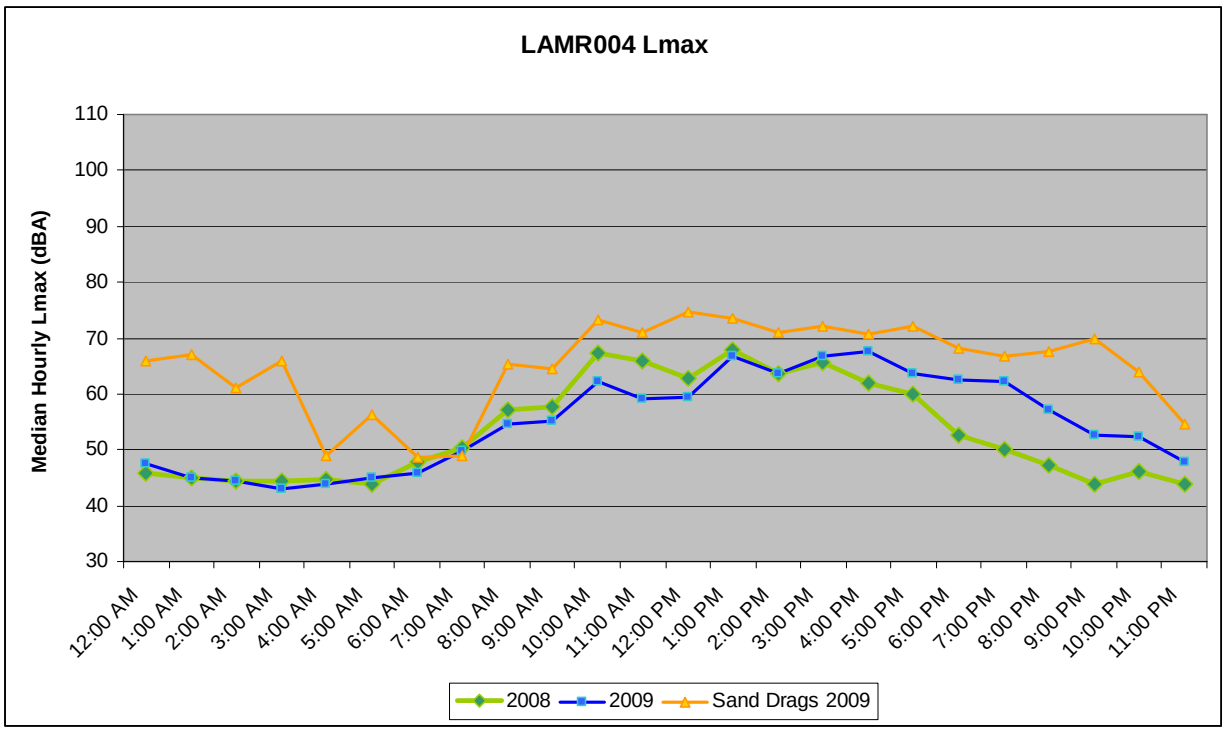


FIGURE 21: MEDIAN HOURLY L_{MAX} SOUND LEVELS FOR ROSITA FLATS SITE LAMR004

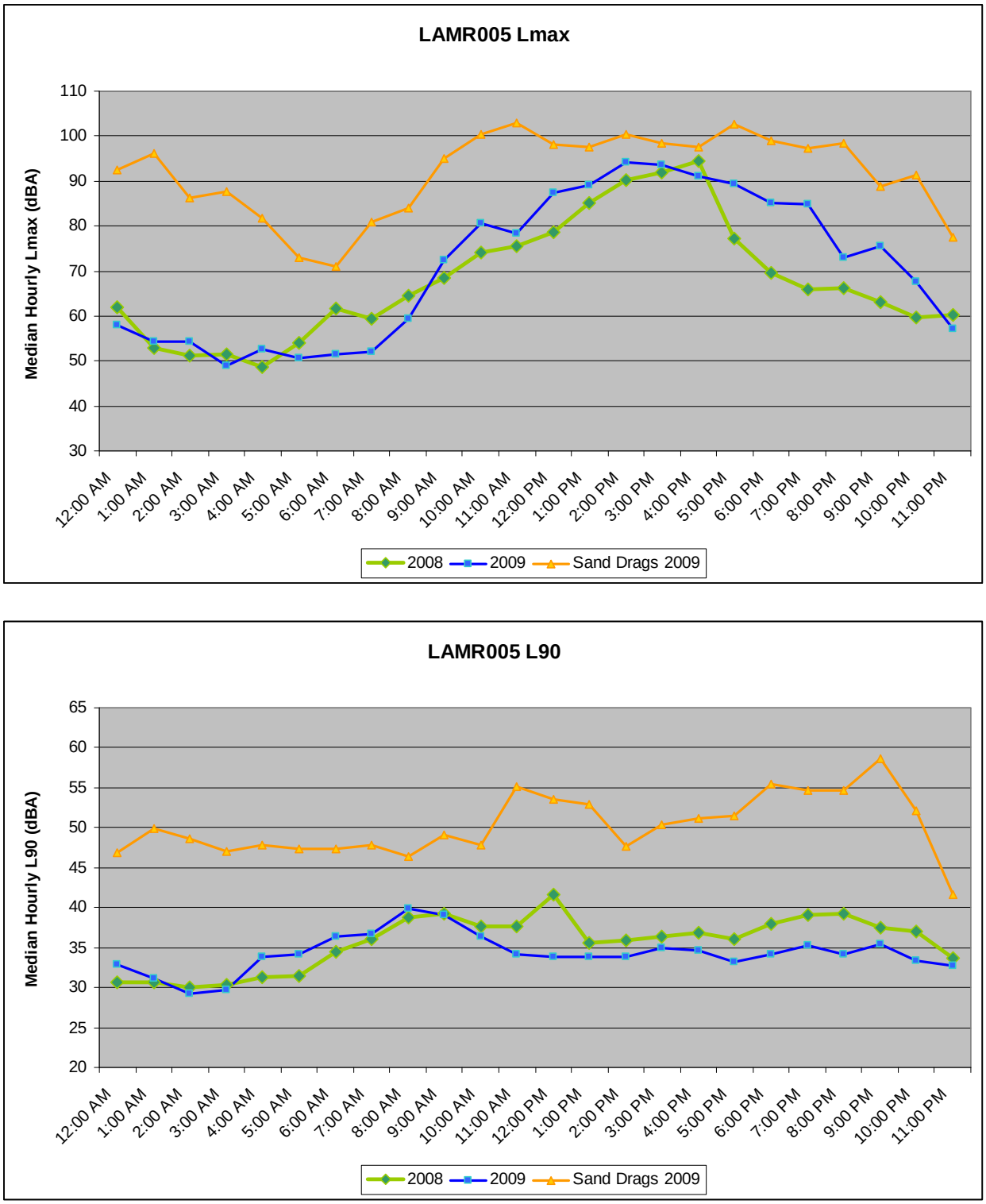


FIGURE 22: MEDIAN HOURLY L_{MAX} AND L_{90} SOUND LEVELS FOR ROSITA FLATS SITES LAMR005

At LAMR003, the highest typical L_{max} levels in the afternoon were slightly over 70 dBA and the lowest, between midnight and 7:00 a.m., were near 40 dBA. The Sand Drags event increased L_{max} levels by up to 30 dBA over typical levels. During Sand Drags, L_{max} levels were over 80 dBA and approaching 90 dBA between 10:00 a.m. and 7:00 p.m.

As a result of being located 20 feet from ORV traffic entering Rosita Flats, LAMR005 generally had the highest sound levels of the three Rosita Flats sites, with hourly L_{max} sound levels during the 2008 and 2009 monitoring peaking at over 90 dBA in the afternoon. In 2008, L_{max} levels were over 80 dBA between 1:00 p.m. and 5:00 p.m. The lowest nighttime L_{max} levels in 2008 and 2009 were around 50 dBA. The additional activity associated with Sand Drags increased L_{max} levels in all hours of the day at LAMR005. Between midnight and 6:00 a.m., the Sand Drags L_{max} levels were up between 30 and 40 dBA over 2008 levels. During four hours of the day, median hourly L_{max} levels at LAMR005 were at or exceeding 100 dBA during Sand Drags.

WILDLIFE AND WILDLIFE HABITAT

Lake Meredith National Recreation Area provides riparian, aquatic, and wetland habitats, all of which support diverse plant and animal species, including migratory waterfowl. The discussion of wildlife for the plan/EIS focuses on aquatic and terrestrial species, including fish, mammals, birds, and reptiles and amphibians in the national recreation area that could be affected by ORV use in Blue Creek and Rosita Flats.

FISH

Common Carp

Channel Catfish

The national recreation area provides important habitat for wildlife in the region, especially species dependent on water. There are approximately 28 different fish species known to inhabit Lake Meredith National Recreation Area, including the Canadian River and Big Blue Creek (NPS 2004; USGS 2006c). Surveys were conducted from May 2009 to January 2010 to document the presence and abundance of the Arkansas River shiner in the national recreation area and, specifically, in the Rosita ORV use area. The study area was the Canadian River from the U.S. Highway 287 bridge downstream to the mouth of Chicken Creek. During the four quarterly sampling events, a total of 4,383 fish, representing 16 species and 5 families, were captured, identified, and released (NPS 2010a). Aside from the Arkansas River shiner, which is discussed further under the "Threatened and Endangered Species / Species of Concern" section of this chapter, other common fish species captured included the plains minnow (*Hybognathus placitus*) (27 percent of the assemblage), peppered chub (*Macrhybopsis tetranema*) (17 percent), and red shiner (*Cyprinella lutrensis*) (14 percent) (NPS 2010a). Other fish species sampled (captured) in the surveys include fathead minnow (*Pimephales promelas*), common carp (*Cyprinus carpio*), plains killifish (*Fundulus zebrinus*), western mosquitofish (*Gambusia affinis*), inland silverside (*Menidia beryllina*), channel catfish (*Ictalurus punctatus*), black bullhead (*Ictalurus melas*), green sunfish (*Lepomis cyanellus*), flathead chub (*Platygobio gracilis*), bluegill (*Lepomis macrochirus*), orangespotted sunfish (*Lepomis humilis*), and yellow bullhead (*Ameiurus natalis*). Generally these fish species live in a variety of habitats, including shallow lakes, reservoirs, ponds, swamps, creeks, side pools of silty streams, and small to medium rivers with slow to moderate current; usually warm water with abundant vegetation. Spawning typically occurs in the spring and summer for the

majority of these fish species. Eggs are often laid in a nest on gravel or sandy silt bottoms in shallow water (NatureServe 2009). However, the peppered chub, plains minnow, and flathead chub broadcast semibuoyant, nonadhesive eggs in the water, which drift downstream during development (Durham and Wilde 2006).

The warmouth (*Chaenobryttus coronarius*) and sand shiner (*Notropis stramineus*) were recorded in the Canadian River prior to the construction of Sanford Dam in 1962, but it is likely that these species, as well as the golden shiner (*Notemigonus crysoleucas*), were extirpated from the national recreation area after the impoundment (NPS 2004). Although the gizzard shad (*Dorosoma cepedianum*), river carpsucker (*Carpiodes carpio*), and white crappie (*Pomoxis annularis*) have been historically recorded in the national recreation area, none were recorded in the Canadian River and coastal waters of Big Blue Creek Bay in 2002 and 2003 (NPS 2004) or recently in the Canadian River in 2009 (NPS 2009f, 2009g, 2009h). It is likely that these fish species are still present in the lake (NPS 2004).

No recent sampling for the documented presence of fish has occurred in Big Blue Creek; however, it is possible that some of the fish sampled during the shiner survey in the Canadian River are present in that area. Although Texas Parks & Wildlife conducts sampling of fish annually in Lake Meredith, it does not conduct river sampling in the national recreation area (Munger 2011). A 1997 study collected only three fish species in Big Blue Creek at FM 1913, including 65 plains killifish, 5 bluegills, and 1 green sunfish. Big Blue Creek is generally characterized by shallow water running over a sandy bottom and dries up frequently during the year, possibly providing unsuitable habitat for some fish species found in the Canadian River (RRAT 1998).

Larger fish species common to Lake Meredith include walleye (*Stizostedion vitreum*), bass (*Micropterus salmoides*, *M. dolomieu*), and trout (*Salmo gairdnerii*, *S. trutta*). Although some of these species have been found in the Canadian River in the national recreation area, they generally live in moderately deep waters and are more common in Lake Meredith (NatureServe 2009; NPS 2004; Phillips 2004).

Primary threats to several fish species found in the national recreation area (e.g., flathead chub, shiner, and plains minnow) include habitat destruction, pollution, dewatering and stream channelization, impoundments altering natural flow regimes, and fluctuating water temperatures (NatureServe 2009). In the Blue Creek and Rosita ORV use areas, it is common for rivers and streams to dry up, leaving fish congregated in small to large puddles. ORVs that drive through the puddles pose a great threat to the congregated fish species (Wimer 2010a).

MAMMALS

The general surroundings of the Blue Creek and Rosita ORV use areas provide habitat for several mammals that depend on the mixed grassland habitats that exist along the tops of the mesas or the more riparian habitat types found along the Canadian River and Big Blue Creek shores. There are approximately 60 species of mammals believed to be native to the national recreation area, including carnivores, hoofed mammals, small mammals, and bats. Carnivorous mammals, such as coyotes (*Canis latrans*), swift foxes (*Vulpes velox*), and gray foxes (*Urocyon cinereoargenteus*), are present in the national recreation area with varying abundance for each species (NPS 2004). Coyotes are considered common and widespread in the national recreation area and can be found in all habitat types. The swift and gray foxes are considered uncommon to rare in the national recreation area, and can be found in riparian/cottonwood and prairie/grassland habitats (NPS 1977). One possible explanation for the fox scarcity may be coyote predation (NPS 2004). Swift fox suppression by coyote predation was demonstrated by a study in the Texas Panhandle in 1998–2001 (Kamler et al. 2003).

Bobcat (*Lynx rufus*) sightings are rare, but this species has also been known to inhabit the national recreation area and tends to prefer wooded and broken habitats (NPS 2004; Yancey et al. 1998). The American badger (*Taxidea taxus*) is uncommon in the national recreation area, but has been known to live in or near the Blue Creek and Rosita ORV use areas. In 2002–2003, badger tracks were regularly seen along Chicken Creek in Potter County, and one badger was seen on FM 1913 north of Big Blue Creek in Moore County (NPS 2004). Badgers favor open prairies and plains with sandy soil, and tend to avoid wooded regions and areas with rocky soils (Yancey et al. 1998).

Distributed in a variety of suitable habitats throughout Texas, the white-tailed deer (*Odocoileus virginianus*) is relatively common and widespread through riparian habitats of the Canadian River Valley and associated creeks, including Rosita Meadows (Manning and Jones 1998; NPS 2004). However, this deer also inhabits drier grassland areas favored by the mule deer. Mule deer (*Odocoileus hemionus*) are wide-ranging and inhabit mostly rocky slopes and uplands with juniper or mesquite savanna. Pronghorn antelope (*Antilocapra americana*) may occasionally stray into the area, but they are primarily found in the flatter topography in upland prairies away from the Canadian River (NPS 2004).

Common small mammals known to appear in Lake Meredith National Recreation Area include raccoons (*Procyon lotor*), ground squirrels (*Spermophilus tridecemlineatus*, *S. spilosoma*), shrews (*Cryptotis parva*, *Notiosorex crawfordi*), cottontails (*Sylvilagus audubonii, S. floridanus*), black-tailed jackrabbits (*Lepus californicus*), plains pocket gophers (*Geomys bursarius*), and several varieties of rats and mice. Other small mammals in the national recreation area include porcupines (*Erethizon dorsatum*), Virginia opossums (*Didelphis virginiana virginiana*), skunks (*Spilogale putorius, Mephitis mephitis*), eastern moles (*Scalopus aquaticus*), and beavers (*Castor canadensis*) (NPS 2004).

In the national recreation area, bat species are likely to be found in rock cliffs and/or riparian/cottonwood habitats (NPS 1977). The pallid bat (*Antrozous pallidus*) was the only bat species recorded in 2001–2003, and was found at the foot of Bull Taco Hill in Rosita Meadows (Potter County) in 2002. Several other species of bat have been known from unspecified locations in the national recreation area, including big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), and Townsend's big-eared bat (*Plecotus townsendii*), but were not observed in a 2001–2003 inventory. Bat surveys for this inventory were largely unsuccessful due to unceasing wind, although it can be stated that bats are probably not common in Lake Meredith National Recreation Area (NPS 2004).

BIRDS

Reservoirs, playa lakes, and river systems are used as important stopover points for birds during migration. A 2001–2003 inventory recorded the presence of 72 species of birds in Lake Meredith National Recreation Area. Prominent birdlife consists of wild turkeys (*Meleagris gallopavo*), northern bobwhites (*Colinus virginianus*), scaled quail (*Callipepla squamata*), mourning doves (*Zenaida macroura*), greater roadrunners (*Geococcyx californianus*), teals (*Anas* spp.), and red-winged blackbirds (*Agelaius phoeniceus*) (NPS 2009i). The national recreation area lies along the Central Flyway, which is a major north–south bird migration route located between the arid region to the west and the moister landscapes to the east. Large numbers of ducks, geese, and other migratory birds arrive seasonally to use open water areas as well as wetland areas during the fall through spring months.

Additional birds commonly seen in the national recreation area include mallards (*Anas platyrhynchos*), black-crowned night herons (*Nycticorax nycticorax*), Mississippi kites (*Ictinia mississippiensis*), American kestrels (*Falco sparverius*), ring-necked pheasants (*Phasianus colchicus*) (a nonnative species), common night-hawks (*Chordeiles minor*), woodpeckers (*Melanerpes erythrocephalus*, *Picoides scalaris*), western kingbirds (*Tyrannus verticalis*), flycatchers (*Tyrannus forficatus*, *Myiarchus cinerascens*), cliff swallows (*Petrochelidon pyrrhonota*), rock wrens (*Salpinctes obsoletus*), eastern bluebirds (*Sialia sialis*),

northern mockingbirds (*Mimus polyglottos*), common moorhens (*Gallinula chloropus*), gulls and terns, and several species of sparrow (NPS 2004; USGS 2006b).

Foraging great blue herons (*Ardea herodias*) have been observed throughout the Canadian River Valley, on the shores of Lake Meredith, and in Sanford Marsh. A 2002–2003 inventory listed this bird as an uncommon nesting species in the national recreation area. One rookery is known to exist in Hackberry Canyon and probably in the northwest corner of the national recreation area (most likely in a lower, heavily wooded part of Big Blue Creek) (NPS 2004). Great blue herons migrate to their northern breeding range between February and early May. Their nests are commonly high in trees in swamps and forested areas (NatureServe 2009).

Although several birds are observed in the Blue Creek and Rosita ORV use areas, no nesting is known to occur in these locations (Wimer 2010a).

REPTILES AND AMPHIBIANS

Approximately 32 species of reptiles and 11 species of amphibians are thought to be native to the national recreation area, including turtles, lizards, frogs, and snakes (NPS 2005a). Common amphibians known to live in the national recreation area include tiger salamander (*Ambystoma tigrinum*), five species of toad (*Bufo* spp.), two species of spadefoot (*Scaphiopus* spp.), cricket frog (*Acris crepitans*), leopard frog (*Rana pipiens*), and bullfrog (*Rana catesbeiana*). Common reptiles known to live in the national recreation area include six species of turtle (snapping, yellow mud, red-eared, ornate box, spiny softshell, and smooth softshell); nine species of lizards (lesser earless, greater earless, fence, side-blotched, Texas horned), including the Great Plains skink (*Eumeces obsoletus*), six-lined racerunner (*Cnemidophorus sexlineatus sexlineatus*), Texas spotted whiptail (*Cnemidophorus gularis gularis*), and checkered whiptail (*Cnemidophorus tesselatus*); and 23 species of snake, including two poisonous species, the prairie rattlesnake (*Crotalus viridis*) and western diamondback rattlesnake (*Crotalus atrox*) (NPS 2004; USGS 2006a).

The herpetofauna (i.e., amphibians and reptiles) at the national recreation area are not well known; however, a 2002–2003 inventory was conducted at Lake Meredith and Alibates Flint Quarries to better describe the vertebrate species located in the national recreation area (Patrikeev 2008). According to this inventory, the most common and widespread amphibian in the national recreation area was the Woodhouse's toad (*Bufo woodhousii woodhousii*). This species inhabits riparian and sandy areas, gradient slopes, and marshes, and often breeds in ephemeral pools and puddles along Big Blue Creek in the national recreation area (Patrikeev 2008). Eggs are laid in spring or summer, and the eggs and larvae generally develop in the shallow water of marshes, rain pools, ponds, and other bodies of water lacking a strong current. The Woodhouse's toad, in addition to other amphibians in the national recreation area, is most threatened by human-caused habitat degradation and by mortality on roads near breeding sites (NatureServe 2009).

The ornate box turtle (*Terrapene ornata ornata*) was the most frequently encountered turtle in the national recreation area during the 2002–2003 inventory. This turtle is mostly terrestrial and inhabits sandy areas, gradient slopes, borrow, and riparian habitats throughout the national recreation area (Patrikeev 2008). Although this species has not been seen in the study area, its presence is likely, due to its preference for damp environments (Wimer 2010a). The mating season for this species begins in the spring and continues throughout summer until October, with nesting occurring from May through July (Smithsonian Institute n.d.). The Texas horned lizard (*Phrynosoma cornutum*) is listed as a species of concern in Texas, but is widespread and common throughout the national recreation area. This species inhabits open arid and semiarid regions with sparse vegetation, and was most often found in gradient slopes, sandy areas, and on unpaved roads in the national recreation area (NatureServe 2009; Patriveek

2008). With a preference for higher dry areas, this turtle would likely be encountered along the tops of the mesas in Rosita Flats (Wimer 2010a). Their eggs are laid from May through July in nests dug in soil or under rocks (NatureServe 2009). The ornate box turtle and the Texas horned lizard are particularly vulnerable to changes in habitat, especially habitat fragmentation and destruction caused by human-related activities (NatureServe 2009; ARKive 2009).

THREATENED AND ENDANGERED SPECIES / SPECIES OF CONCERN

ARKANSAS RIVER SHINER

First described in 1926, the Arkansas River shiner is listed as threatened by the USFWS (63 FR 64772; USFWS 2005b). This small freshwater minnow has a dorsally flattened head, rounded snout, and small subterminal mouth. Dorsal coloration is typically light tan, with silvery sides gradually grading to white on the belly. Adults reach a maximum length of 2 inches (51 millimeters) (CRMWA 2005; USFWS 2005b).

Arkansas River Shiner
Photo by Ken Collins USFWS

Habitat and Distribution

The Arkansas River shiner historically inhabited the main channels of wide, shallow, sandy-bottomed rivers and larger streams of the Arkansas River basin. Adults are uncommon in quiet pools or backwaters, and are almost never found in tributaries with deep water and bottoms of mud or stone. Like most fish living in the highly variable environments of plains streams, shiners use a broad range of microhabitat features (USFWS 2005d). The Arkansas River shiner was described as having a high thermal and oxygen tolerance, indicating a high capacity to tolerate elevated temperatures and low dissolved oxygen concentrations. Microhabitat selection of this species in the Canadian River in New Mexico and Texas is influenced mainly by water depth and current velocity (USFWS 2005b). Frequent natural flooding is important in maintaining their habitat and helps them compete with invading nonnative aquatic species. The species needs more than 130 miles of unimpounded, flowing water to successfully complete its reproductive cycle (USFWS 2005d).

Microhabitat is the habitat (or environmental conditions and organisms) in the immediate vicinity of an organism. For example, within a larger habitat, such as a deciduous forest, there are a lot of microhabitats that exist – a fallen tree, under a rock, leaf litter, puddles, etc.

Historically, this species was widespread and abundant throughout the western portion of the Arkansas River Basin in Kansas, New Mexico, Oklahoma, and Texas. Within the last few decades, the Arkansas River shiner has disappeared from over 80 percent of its historical range and is almost entirely restricted to about 508 miles (820 kilometers) of the Canadian River in Oklahoma, Texas, and New Mexico (69 FR 59861). In the national recreation area, the Arkansas River shiner is abundant in the Canadian River from Chicken Creek upstream to the U.S. Highway 287 bridge. As described under the "Wildlife and Wildlife Habitat" section of this chapter, surveys were conducted from May 2009 to January 2010 to document the presence and abundance of the Arkansas River shiner and other fish species in the Rosita ORV use area. A total of 1,378 Arkansas River shiners were collected at each of the nine sites sampled during the spring, summer, fall, and winter surveys (see table 9) (NPS 2010a).

TABLE 9: ARKANSAS RIVER SHINERS CAPTURED BETWEEN CHICKEN CREEK AND THE U.S. HIGHWAY 287 BRIDGE AT LAKE MEREDITH NATIONAL RECREATION AREA IN SPRING 2009–WINTER 2010

Season	Site 1[a]	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9[b]	Species Totals	Proportion of Total Fish Captured
Spring	3	19	23	18	5	16	11	30	32	157	16.3
Summer	24	73	6	24	66	51	116	55	58	473	22.9
Fall	2	146	33	16	7	24	10	65	54	357	47.7
Winter	11	0	14	1	17	23	14	259	57	396	57.6
Total Captured	40	238	74	58	95	114	150	408	201	1,378	31.4

Source: NPS 2010a.

[a] Most downstream site; located at the mouth of Chicken Creek.

[b] Most upstream site; located approximately 100 meters (328 feet) downstream from the U.S. Highway 287 bridge; only sites 1–8 were located within Lake Meredith National Recreation Area.

In the spring survey, this species represented 16 percent of the fish captured and was the third most commonly collected fish. In the summer survey, this species represented 23 percent of the fish captured and was the second most commonly collected fish. The Arkansas River shiner represented 47 percent of the fish captured during the fall survey and was the most common fish collected. During the winter survey, the Arkansas River shiner was the most common fish collected, representing 57.6 percent of the total number of fish captured. Overall, the Arkansas River shiner was the most commonly captured fish, representing 31 percent of the assemblage. Across all sites, it occurred in 18 percent of spring samples, 63 percent of summer samples, 38 percent of fall samples, and 24 percent of winter samples (NPS 2010a). A spawning migration upstream would likely explain the relatively low abundance of the fish in the spring 2009 samples, as well as a predominance of one-year-old fish (NPS 2009f, 2009g). No sampling for the documented presence of the Arkansas River shiner has occurred elsewhere in the national recreation area; however, it is likely that the fish is present past Chicken Creek in the Canadian River (Wimer 2010a, 2010b).

Diet

The Arkansas River shiner is a generalist feeder. In the Canadian River of New Mexico and Texas, the stomach contents of this fish were dominated by detritus (such as leaf litter), invertebrates, grass seeds, and sand and silt. Invertebrates were the most important food item, followed by detrital material (69 FR 59863). The presence of sand and silt in the stomach of this species suggests that it forages among sediments on the river bottom. The common occurrence of terrestrial insects in the diet of the Arkansas River shiner indicates that this species also feeds in the water column on drifting invertebrates. The Canadian River is a relatively turbid stream, which might make locating insect prey difficult for some fish; however, the Arkansas River shiner possesses morphological adaptations for detecting prey in turbid waters (Wilde, Bonner, and Zwank 2001).

Breeding Biology

Examination of Arkansas River shiner reproductive organ development between 1996 and 1998 in the Canadian River in New Mexico and Texas demonstrated that the species undergoes multiple, asynchronous (i.e., not occurring at the same time) spawns in a single season (USFWS 2005b). The shiner appears to be in peak reproductive condition throughout May, June, and July; however, spawning may

take place as early as April and as late as September. Successful reproduction of this species appears to be strongly correlated with streamflow, where they are likely to spawn in the upper to mid-water column during elevated flows (70 FR 59825–59826; USFWS 2005a). The fish broadcast semibuoyant, nonadhesive eggs in unprepared, open water, which drift downstream as they develop (Durham and Wilde 2008; 70 FR 59808). In the absence of sufficient streamflows, the eggs would likely settle to the channel bottom and be smothered by silt and shifting substrates (70 FR 59825–59826). One study conducted in the Canadian River in Texas during the 2000 and 2001 reproductive seasons revealed that reproductive success for broadcast-spawning fish in the Canadian River is positively associated with the presence of discharge in the river (Durham and Wilde 2008).

Rapid hatching and development of young is one adaptation in plains fishes, including Arkansas River shiner, for survival in the harsh environments of plains streams. Arkansas River shiner eggs can hatch in 24 to 48 hours after spawning, and larvae are capable of swimming within 34 days (USFWS 2005b). The maximum lifespan is unknown, but the species' lifespan in the wild is likely less than three years (CRMWA 2005).

Risk Factors

The Arkansas River shiner is no longer believed to exist in the Arkansas River in Arkansas, Kansas, and Oklahoma, which is a loss of over 770 miles (1,240 kilometers) of previously occupied habitat (69 FR 59861). The decline of the shiner is primarily the result of modification of the duration and timing of streamflows, habitat loss by inundation, stream depletion due to water diversion and groundwater pumping, water quality degradation (caused by oil and gas, municipal sewage effluent, and manufacturing return flows), competition with invasive nonnative species, and the construction of impoundments (70 FR 59828; USFWS 2009). The fragmentation of streams and rivers, particularly with the construction of reservoirs, throughout the Great Plains has likely acted to increase the frequency of reproductive failure among broadcast-spawning species in these systems through restricting the upstream movement of adults to spawn, leaving drifting eggs without sufficient distance to develop and hatch before being transported into lentic habitats (still or relatively still standing water) (Durham and Wilde 2008).

In the national recreation area, it is common for rivers and streams to dry up, leaving fish congregated in small to large puddles. ORVs driven through these puddles pose a great threat to the congregated fish species, including the Arkansas River shiner (Wimer 2010a).

Critical Habitat

In October 2005, the USFWS published a final rule designating approximately 523 miles (856 kilometers) of rivers as critical habitat for the federally threatened Arkansas River shiner. The areas determined to contain features essential to the conservation of this species include portions of the Canadian River in New Mexico, Texas, and Oklahoma, the Beaver / North Canadian River in Oklahoma, the Cimarron River in Kansas and Oklahoma, and the Arkansas River in Kansas (USFWS 2005c). Although critical habitat is designated along the Canadian River in Texas, no critical habitat for the Arkansas River shiner is currently designated within the national recreation area (Wimer 2010a). The USFWS excluded from designation the proposed critical habitat unit (Unit 1a) in the Canadian River of New Mexico and Texas between Ute Reservoir and Lake Meredith, which includes the portion of the Canadian River within the park. The CRMWA, in cooperation with at least 23 other federal, state, and private partners, completed a special management plan for the Arkansas River shiner within this unit. After review of this special management plan, the USFWS determined that a reasonable certainty of execution and effectiveness exists such that conservation of the shiner would be promoted. Therefore, it was determined that the benefits of exclusion outweigh the benefits of designating critical habitat in this unit (70 FR 59823).

Recovery

The ESA requires the NPS to develop and implement recovery plans for listed species to identify reasonable actions needed to conserve and recover listed species. The recovery plan for the Arkansas River shiner includes measures to eliminate or reduce existing threats, protect existing populations and those areas containing suitable habitat, restore lost or degraded habitats, and preserve the genetic diversity of the species (USFWS 2005a). Recovery plans do not of themselves commit personnel or funds nor do they obligate an agency, entity, or person to implement the various tasks listed in the plan (USFWS 2001). In 2005, the CRMWA released an Arkansas River shiner management plan for the Canadian River from U.S. Highway 54 at Logan, New Mexico, to Lake Meredith, Texas (CRMWA 2005). However, due to limited staff, there are no current management actions being taken to enforce the guidelines of this plan at Lake Meredith (Wimer 2010a).

ARCHEOLOGICAL RESOURCES

The NPS defines archeological resources as "any material remains or physical evidence of past human life or activities which are of archeological interest, including the record of the effects of human activities on the environment. They are capable of revealing scientific or humanistic information through archeological research" (NPS 1998a). Archeological features are typically buried but may extend above ground; they are commonly associated with prehistoric peoples but may be products of more contemporary society.

The cultural history of the northern Texas Panhandle region encompasses at least 13,000 years of prehistory and history. Most of the early occupants were nomadic hunters and gatherers, moving from one locale to another following big game and plant resources. Later, about 1,800 years ago, subsistence became more focused more on farming and agriculture of plants brought into the region from northern Mexico, resulting in a semi-sedentary way of life. Many of these early people visited or actually controlled the nearby Alibates Flint Quarries area to obtain or trade stone for tool manufacturing.

Researchers differ slightly when dividing the cultural history and prehistory of the Texas Panhandle into periods, based on subsistence techniques and material technologies; two versions are presented in table 10.

TABLE 10: CULTURAL HISTORY AND PREHISTORY

From Cloud 2003	From 4G Consulting
Paleo-Indian (12,000 to 5,000 BC)	Paleo-Indian (11,500 to 8,000 BP – before present)
Early Archaic (5,000 to 2,000 BC)	Early-Middle Archaic (8,000 to 4,000 BP)
Late Archaic (2,000 BC to AD 200)	Late Archaic (4,000 BC to 1,800 BP – AD 200)
Early Neo-Indian (AD 200 to 1,100)	Plains Woodland (AD 200 to 1100)
Late Neo-Indian (AD 1100 to 1541)	Plains Village (AD 1100 to 1500)
Historic (AD 1541 to ca. 1950) – based on Coronado's entry into the Southwest	Protohistoric (AD 1500 to 1750)
	Historic (AD 1750 to 1950)

Sources: Cloud 2003; 4G Consulting 2005.

Paleo-Indian people were the big game hunters of the late Pleistocene–early Holocene period, tracking now extinct megafauna, such as mammoth and giant bison, as well as antelope, deer, small mammals, and

waterfowl. During the Archaic period, hunting of large game and small mammals continued, but more evidence of plant exploitation shows up in the archeological record.

The Woodland or Early Neo-Indian period is marked by changes in the material culture and subsistence base. Smaller projectile points (in this case, arrow points) indicate a broad-based large and small game hunting subsistence and the introduction of pottery indicates that plant processing and storage were important. Some pit houses, a less nomadic and more sedentary manifestation, have been found.

During the Plains Village or Late Neo-Indian period, semi-sedentism is seen in slab-lined semi-subterranean house structures grouped in hamlets or villages. As mentioned earlier, cultivated crops such as maize are found in the archeological record, and grinding stones and pottery support an agriculture-based subsistence.

Sedentism is the term archeologists use to describe the process of settling down to live in groups for periods of time. Settling down, picking a place and living in it for part of the year, is partially but not entirely related to how a group gets required resources—food and stone for tools and wood for housing and fires.

Apachean groups had entered the Panhandle in the 15th and 16th centuries, followed by subsequent Comanche groups and various other American Indian groups, such as the Kiowa, into the 1800s, subsisting on wild plants, bison, deer, and antelope (NPS 2002a). Archeological sites of this period include quarry/workshop sites, artifact scatters, tipi rings, and features such as hearths and roasting pits (NPS 2002a). These various tribes were in the general area of the national recreation area during historic times until they were subdued by the U.S. Army in the 1870s. At that time, small settlements of sheep herders (*pastores*) entered the region until they were likewise supplanted by farmers and ranchers in the 1880s (Cloud 2003).

Because of its use as a major trade route, the Canadian River and its tributaries were a major focal point for prehistoric and historic activities, as evidenced by a high density of sites located on the uplands, side drainages, and tributary drainages of the river (NPS 2002a). The majority of the dated archeological sites recorded in the Blue Creek and Rosita Flats areas are prehistoric Late Neo-Indian Substage / Plains Village Period Antelope Creek phase sites (NPS 2002a). Characterized by slab-lined house structures and storage pits, Borger Cordmarked pottery, arrow points, beveled knives, and bison bone tools and demonstrating agriculture including corn, beans, and squash, most of the sites date between AD 1200 and 1450 (Cloud 2003). The majority of archeological materials in the project area are chipped stone tools (4G Consulting 2005).

According to the NPS ASMIS (Archeological Sites Management Information System) database, approximately 280 archeological sites have been recorded within the boundaries of the national recreation area (NPS 2010b). These sites include more than 270 prehistoric sites or isolated finds and at least 5 historic sites with structures. Prehistoric site types range from quarries to burned stone scatters, to rock art, to rock shelters, to village and "pueblo" sites. Of the recorded sites, none are listed in or considered eligible for listing in the National Register of Historic Places (NPS 2010b).

BLUE CREEK

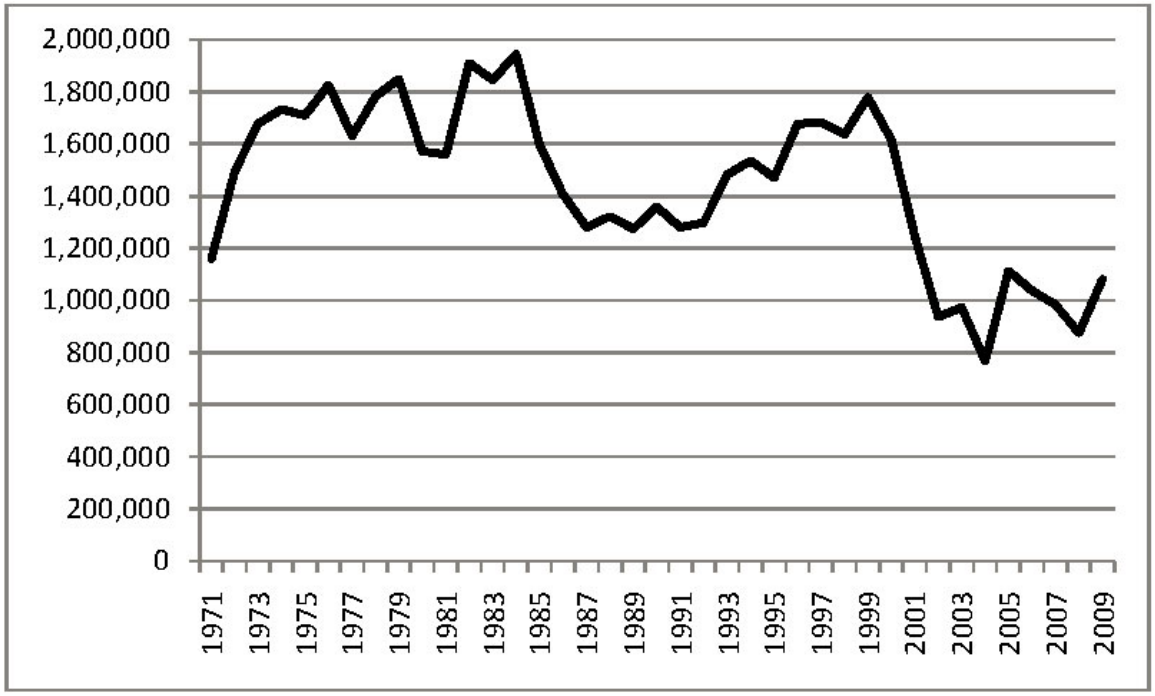
Recent cultural resource inventories have been conducted in or near the ORV use areas. For example, in 2003 the Big Bend Center of Sul Ross State University revisited 23 previously recorded sites and recorded 1 new prehistoric site on the rim or bluff above Blue Creek. The sites include village or hamlet sites and one possible multiple human burial site, all dating to the Antelope Creek phase (AD 1200–1450) (Cloud 2003).

ROSITA FLATS

Archeological surveys were conducted in the Rosita Flats area as part of a plan for prescribed burns in 2005 (4G Consulting 2005). Six previously recorded prehistoric and historic sites were revisited, including a Late Archaic / early Woodland component, one "Late Prehistoric" Antelope Creek phase village site, campsites, open sites with lithic debitage (stone debris from flintknapping), and one cave habitation site. Most sites are located on benches, knolls, or ridges above the Canadian River or tributaries.

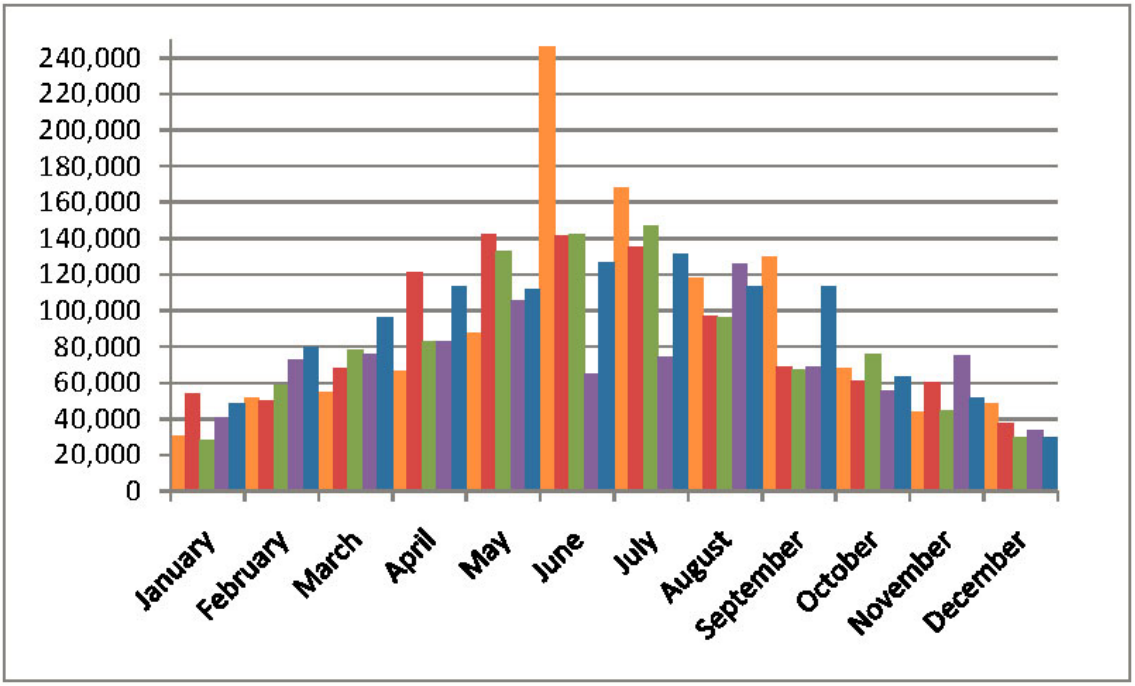
VISITOR USE AND EXPERIENCE / HEALTH AND SAFETY

Visitation to the national recreation area has decreased with occasional dips since the late 1990s. Since 1971, over 55 million people have visited the national recreation area, which preserves one of the largest human-made lakes in the Texas Panhandle (figure 23). Annual visitation has decreased from 1,779,138 in 1999 to 1,080,644 visitors in 2009. Figure 24 illustrates visitor use data for 2005 through December 2009, which indicate the highest use during May, June, and July, and lowest in January, February, and December. Overall, visitation to the national recreation area in 2009 (1,080,644) was higher than 2008 (875,280).



Source: NPS 2009b.

FIGURE 23: ANNUAL RECREATIONAL VISITATION AT LAKE MEREDITH NATIONAL RECREATION AREA, 1971–2009



Source: NPS 2009b.

FIGURE 24: MONTHLY RECREATIONAL VISITATION AT LAKE MEREDITH NATIONAL RECREATION AREA, JANUARY 2005–DECEMBER 2009

VISITOR CHARACTERISTICS

A study conducted from October 2003 to November 2004 by ASU showed that the majority of visitors (92 percent) were from Texas, approximately 3 percent were from Oklahoma, and smaller proportions of visitors came from 8 other states. Table 11 shows all 10 states and their respective visitation percentage. The average age of these visitors was 38 (ASU 2004).

TABLE 11: STATE RESIDENCE FOR VISITOR STUDY

State	Lake Meredith (%)
Colorado	1.4
Illinois	0.3
Kansas	1.7
Louisiana	0.3
Missouri	0.3
New Mexico	1.1
Oklahoma	2.5
South Carolina	0.3
South Dakota	0.3
Texas	91.9
Total	100

Source: ASU 2004.

RECREATIONAL OPPORTUNITIES AND USE AT LAKE MEREDITH NATIONAL RECREATION AREA

Lake Meredith National Recreation Area is located near the geographic center of the Texas Panhandle, about 40 miles northeast of Amarillo and 9 miles west of Borger. It is composed of 44,977.63 acres within its boundaries (NPS 2009a). Lake Meredith is used by visitors for many activities, including bird and wildlife viewing, boating, camping, fishing, hiking, horseback riding, hunting, ORV use, photography, picnicking, sightseeing, swimming, and water skiing. According to the 2004 ASU report, a survey conducted on site asked visitors to list activities in which they participated during their visit to the national recreation area; the three most popular were fishing, boating, and picnicking (ASU 2004). Table 12 presents the results of the activity participation survey. Because participants were allowed to check more than one activity they liked, the totals column, if added, is greater than 100 percent.

TABLE 12: ACTIVITY PARTICIPATION (ON-SITE SURVEY)

Activity	Specific Action	Total % of Visitors who Participated in these Activities
ORV	Four-wheel driving	10.7
	Motorized trail biking / dirt biking	7.7
	Dune buggy or sand rail driving	8
	ATV riding	14.1
Camping	Tent camping	22.4
	RV Camping	9.6
Water Use	Swimming	48
	Fishing from shore	34.4
	Boating	38.4
	Fishing from boat	35.5
	Water skiing	22.4
	Personal watercraft	9.1
	Sailboating	3.7
	Scuba diving	1.6
	Canoeing/Kayaking	1.1
Hunting	Bird hunting	4
	Deer hunting	5.3
	Bow hunting	2.7
Other Activities	Mountain biking	2.4
	Picnicking	50.1
	Trail hiking	14.1
	Wildlife viewing	13.9
	Photography	12
	Visiting archeological sites	5.9
	Horseback riding	1.1
	Other	3.2

Source: ASU 2004.

ASU survey respondents revealed that their primary uses of the national recreation area were water use, followed by other activities such as hiking, visiting archeological sites, photography, and wildlife viewing. ORV use was noted as the primary use by approximately 8 percent of visitors, while camping was approximately 1 percent of visitor use. Additional uses include picnicking, trail hiking, mountain biking, and hunting. Table 13 shows visitors' responses.

TABLE 13: PRIMARY ACTIVITY PARTICIPATION

Recreational Activity	Percent of Respondents Who Engaged in the Activity
ORV Use	11.4
Water Use	63.4
Picnicking	12.3
Other Activities	12.9
Total	100

Source: ASU 2004.

Developed facilities, such as the visitor center and campgrounds, are shown on figure 1 in chapter 1. The visitor center is located in the town of Fritch, east of the national recreation area. Campgrounds are located at Bugbee, Sanford-Yake, Cedar Canyon, Fritch Fortress, Harbor Bay, McBride Canyon, Mullinaw Creek, Rosita Flats, Plum Creek, Blue West, Blue East, Chimney Hollow, and Blue Creek Bridge. Boat launch areas are located at Sanford-Yake, Cedar Canyon, Fritch Fortress, Harbor Bay, Blue West, and Plum Creek.

ORV use is one of the wide varieties of recreational opportunities available at the national recreation area, and is often used as a means to take advantage of other experiences at the national recreation area, such as camping and hunting. Since the 1950s, ORV use has evolved from "river buggies," or surplus military vehicles, to dirt bikes, motor vehicles, and standard four-wheel drive vehicles. ORV use is allowed in two designated areas, Blue Creek and Rosita Flats.

Camping Area in Blue Creek

After the ASU study, use data has shown that ORV use continues to be popular. In 2008, approximately 42,070 people visited the national recreation area and used motorcycles or dune buggies. Respondents voiced concern over unregulated ORV use at the national recreation area and conflicts between ORV users and other groups (NPS 2008b). This is discussed in further detail in "Visitor Safety and Encounters."

Off-road Vehicle Use and Access

The national recreation area is the largest area of public lands in the Texas Panhandle. As a result, it provides opportunities for access to diverse, affordable, outdoor, and water-based recreational activities. ORV use has occurred at Rosita Flats and Blue Creek since the 1950s and still is popular today. Currently it is allowed only in these two sections of the national recreation area, Blue Creek and Rosita Flats, with approximately one-third of the national recreation area users participating in ORV use. The majority of ORV use at the national recreation area has been for recreation, as opposed to transportation. Local riders and families, as well as riders from urban areas, tend to favor Rosita Flats (ASU 2004).

ORV Use in Lake Meredith National Recreation Area

Blue Creek

Blue Creek, located on the northwest side of the lake, contains approximately 275 acres of land designated for ORV use. During 2008, over 42,000 visitors came to Blue Creek, which was a 19 percent increase in visitation from the previous year (NPS 2008a). Blue Creek offers a variety of visitor amenities in the ORV use areas, including picnic tables, grills, and vault-evaporator toilets. There are no flush toilets or drinking water available (NPS 2009c). Recreational opportunities at Blue Creek include camping, horseback riding, and ORV use. Types of ORVs allowed at Lake Meredith include ATVs, motorcycles, full-size ORVs, dune buggies, and sand rails. Blue Creek offers different terrain, more level and less extensive, compared to Rosita Flats (Trail Source 2009). National recreation area records show that fewer illegal operations of ORVs occur at Blue Creek because of a greater presence of ranger patrols (NPS 2007a).

Rosita Flats

Rosita Flats, which is located in the southern section of the national recreation area between the Canadian River bed east of the Dumas Bridge to Chicken Creek, contains approximately 1,740 acres of land designated for ORV use below the 3,000-foot elevation line. All vehicles are prohibited past the mouth of Chicken Creek. Tin-cup Canyon is closed to all vehicles. In 2008, over 197,582 people visited Rosita Flats, representing a 77.5 percent increase from the previous year (NPS 2008a). Rosita Flats is an area with an undeveloped campground with no picnic tables, toilets, or drinking water (NPS 2009c).

ORVs at Rosita Flats can be seen almost any day of the year. The average ORV user at Rosita Flats enjoys sightseeing, picnicking, and camping (either in tents or camp trailers) (NPS 2007a). Rosita Flats offers ORV users sand and hill climbs over some of the most diverse land in Texas (Trail Source 2009). Due to its difficult accessibility from the north entrance of the national recreation area, ranger patrols at Rosita Flats are not as frequent as in other areas of the national recreation area, such as Blue Creek, which has resulted in a high level of violations of ORV use regulations in the past (NPS 2007a).

ORV-related Events Outside the National Recreation Area—Sand Drags

The annual Sand Drags is an event held every February just outside the national recreation area to the north of Rosita Flats. In 2009, the event drew large crowds that spilled over into the national recreation area (NPS 2009e). The event has attracted over 30,000 spectators and hundreds of motorcycles, four-wheelers, sand rails, and river buggies that compete against each other in ORV races. The races attracts many outside visitors from states such as Oklahoma, New Mexico, and Colorado who would otherwise not likely visit the national recreation area.

VISITOR SAFETY AND ENCOUNTERS

As part of visitor experience, visitor safety is also considered. Visitors at Lake Meredith National Recreation Area are required to follow certain laws while using ORVs (NPS 2009d).

ORV Use in Lake Meredith National Recreation Area

- Riders of ATVs and motorcycles must wear a Department of Transportation–approved safety helmet.
- ATV riders
  - Must wear eye protection.
  - Must have Safety Certification with them at all times.
  - May not carry a passenger on an ATV unless the ATV is designed for a passenger.
  - May not operate an ATV in a manner that endangers, injures, or damages persons or property.
- Persons under 14 years old must be under direct supervision by their parent, guardian, or other adult authorized by their parent or guardian.
- General ORV laws:
  - Stay within marked boundaries and signs
  - Use or possession of alcohol while riding on an ATV or in any motor vehicle is prohibited
  - Organized events require a Special Use Permit
  - Head and tail lights are required either one-half hour before sunrise or after sunset, or when visibility is reduced
  - Speed limit in congested areas is limited to 15 mph or less, depending on conditions
  - Stay on established trails to prevent further erosion of resources
  - Do not litter; place litter in trash receptacles
  - Unattended or abandoned campfires are prohibited. Put out fires with water.

Vandalism to Amenities in Rosita Flats

Although ORV users are required to follow all laws, it is difficult for rangers to strictly enforce rules due to the remote location of ORV use areas. This can result in encounters between national recreation area visitors, destruction of national recreation area property, littering, trespassing, and not staying on national recreation area established trails. According to the ASU 2004 visitor study, people were concerned that there are too many ORV routes and that there is unregulated ORV use (ASU 2004). While there are no national recreation area–documented conflicts between ORV users, campers, fishermen, boaters, bird-watchers, or others, some public comments gathered through public scoping indicate that visitors are concerned for their safety in ORV use areas, particularly due to reckless driving, excessive alcohol consumption, excessive speeds, crime, and no respect for boundaries (tent camps and trails). Most user-group conflicts related to ORV use tend to be with other user groups perceiving conflicts with ORV users, although ORV users generally do not recognize these conflicts (ASU 2004). The study also showed concern from ORV users that national recreation area amenities are often destroyed and ORV use areas are dangerous and not a desirable family environment. During public scoping, ORV users expressed their desire for more land dedicated to ORV use because the current areas are too small.

LAKE MEREDITH NATIONAL RECREATION AREA MANAGEMENT AND OPERATIONS

Lake Meredith National Recreation Area is divided into six different management divisions, each with its own unique set of responsibilities. The national recreation area has a total of 29 permanent and 17 seasonal staff positions (Wimer 2009a). Management and operation of the national recreation area is provided by NPS staff organized into the following divisions.

NATIONAL RECREATION AREA MANAGEMENT AND ADMINISTRATION DIVISION

The national recreation area management and administration division conducts all national recreation area–wide management and support activities, including external affairs activities, national recreation area–level planning, human resource management, information technology, and financial management. Within this division there are no responsibilities directly related to ORVs.

RESOURCE MANAGEMENT DIVISION

The resource management division is responsible for activities related to the management, preservation, and protection of the national recreation area's cultural and natural resources, including scientific research, management, restoration, and resource protection planning. An aspect of this division's responsibilities unique to the national recreation area is that it must oversee the management of oil and gas operations in the national recreation area. There are two full-time employees in this division: the chief of resource management and an environmental protection specialist. This division monitors the condition of natural and cultural resources in the ORV use areas to control the spread of invasive species. Currently there is no special management in ORV use areas to help control the spread of invasive species (Wimer 2010c).

SOUTHERN PLAINS FIRE GROUP

This group is based at the national recreation area and is responsible for the implementation of the prescribed fire needs of seven parks across three states, including Lake Meredith National Recreation Area. Prescribed fire is an essential tool for managing resources, through hazard fuel reduction and ecosystem restoration. The fire crew also assists all local fire departments and other nearby parks. The NPS fire crew and law enforcement are stationed at the Rosita Flats ORV use area 24 hours a day during the annual Sand Drags event. Depending on the fire danger in the area, the fire crew will make sure visitors do not build campfires; however, fires are allowed in designated barbecue pits. Before the event the fire crew completes a "pre-burn," meaning that it burns a buffer around the area to help contain any fires that may begin to spread. The fire crew's ORV-management responsibilities occur only during Sand Drags. Law enforcement helps ensure that the public does not abuse alcohol during the event (Wimer 2010c).

VISITOR AND RESOURCE PROTECTION DIVISION

The visitor and resource protection division serves the public interest to protect people and resources, prevent crime, conduct investigations, apprehend criminals, and serve the needs of visitors to the national recreation area. This division is also referred to as "Law Enforcement." In relation to ORV management efforts, law enforcement staff members patrol the Blue Creek ORV use area several times per day or several days per week, depending on the season. The summer months of June, July, and August are the peak season, with the lowest visitation occurring in the winter months of December and January. The Rosita Flats ORV use area is patrolled less frequently, primarily due to its distance from the national recreation area headquarters. Rangers issue citations and make arrests for violations in these areas, which are often associated with alcohol, illegal drugs, or unsafe operations of a vehicle. Staff members from this division also respond to emergency situations, such as ORV accidents, wildfire, or search and rescue operations. This division is also responsible for repairing the fencing around ORV use areas and installing Carsonite posts to indicate ORV closures.

INTERPRETATION DIVISION

The interpretation division's chief objective is to facilitate a personal connection between the interests of the visitor and the importance of resources in the national recreation area. Interpretation staff members provide educational information using such methods as guided tours, signs and kiosks, visitor center displays, and campfire programs. There are no interpretive facilities at either of the two ORV use areas.

FACILITIES MANAGEMENT DIVISION

The facilities management division's mission is to ensure that natural and cultural resources are sustained for the future by providing stewardship of assets through maintenance practices, preservation techniques, and the use of new technologies. Facilities staff members maintain roads, paths, buildings, campgrounds, boat ramps, ORV use areas, and other facilities in the national recreation area. This division provides trash removal from mid-April to September on a daily basis and as needed (two to three times per week) from October to April at the Blue Creek ORV use area. Trash is removed weekly from the Rosita Flats ORV use area.