

# Chapter 3—Affected Environment



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Hiking on the refuge

*The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land.*

*This sounds simple: do we not already sing our love for and obligation to the land of the free and the home of the brave? Yes, but just what and whom do we love? Certainly not the soil, which we are sending helter-skelter downriver. Certainly not the waters, which we assume have no function except to turn turbines, float barges, and carry off sewage. Certainly not the plants, of which we exterminate whole communities without batting an eye. Certainly not the animals, of which we have already extirpated many of the largest and most beautiful species. A land ethic of course cannot prevent the alteration, management, and use of these 'resources,' but it does affirm their right to continued existence, and, at least in spots, their continued existence in a natural state.*

*Aldo Leopold*

This chapter describes the characteristics and resources of the Rocky Mountain Arsenal National Wildlife Refuge in the categories listed below and provides the basis for the environmental analysis presented in chapter 4:

- Physical Environment
- Biological Environment
- Special Management Areas
- Visitor Services
- Communications and Outreach
- Partnerships
- Human History and Cultural Resources
- Research and Science
- Infrastructure and Operations
- Access and Transportation
- Socioeconomic Environment

## 3.1 Physical Environment

This section describes the physical environment of the refuge. Physical characteristics comprise physiography, water resources, air quality, climate, night sky, and soundscapes.

## Physiography

### Topography

The surface topography on the refuge has been shaped largely by erosional and depositional processes associated with the South Platte River and its tributaries. The land shape varies from almost level to gently rolling, with slopes typically less than 3 percent and terrace escarpments with slopes up to 10 percent. In general, the land surface slopes to the northwest, with elevations ranging from 5,136 feet along the northwest boundary to 5,340 feet at southeastern boundary (figure 12). Rattlesnake Hill and Henderson Hill are prominent high points in the central and northeastern portions of the refuge, respectively (FWS 1996a). As part of the cleanup of the Rocky Mountain Arsenal, two prominent landfills were constructed in the center of the property at 5,302 and 5,314 feet.

### Geology

The refuge lies in the Denver Basin, a north-south fold in the regional geology that extends along the Front Range from Cheyenne, Wyoming, to Colorado Springs, Colorado. Surface geologic deposits consist primarily of unconsolidated river sediments (alluvium) deposited by the South Platte River system and covered partially by windblown (aeolian) sediment. The uppermost bedrock layer is called the Denver Formation. This layer was originally 900 feet thick, but has eroded completely in the nearby South Platte River area, and is 500 feet thick at the southeast corner of the refuge (Morrison-Knudsen Environmental Services Inc. 1989). Wind-deposited material is thickest in the south and southwest sections of the refuge. Most of the alluvial deposits on the refuge are fine-textured, except for remnants of cobble alluvium on Rattlesnake Hill, on Henderson Hill, and in the North Plants Area (James P. Walsh & Associates Inc. 1991).

Soils developed from both wind- and water-deposited material. Soils formed from water-transported material are derived from shales, sandstone, and granite. These soils are generally of clay to loam texture, although cobbly material occurs on hills in the northern portion of the refuge (James P. Walsh & Associates Inc. 1991). Soils developed from wind-deposited material are typically sandy in texture. Throughout the refuge, soils formed under grassland vegetation are typically dark colored with high organic matter content (figure 13).

Bresser soils make up the most common soil series on the refuge. These soils occur on sandy, wind-deposited plains in the southwestern and southern portions of the refuge. Bresser soils are deep and well drained with medium to coarse textures. Weld series soils occur extensively in the northeastern portion of the refuge. These soils are formed from alluvial and wind-deposited material and have fine to medium textures. Ascalon soils are found on old alluvial terraces, escarpments, and aeolian plains in the central and northern areas of the refuge. Satanta soils are similar to Ascalon but are finer textured. The well-drained Nunn soils are found in moderate distribution over the north and east portions of the refuge. The coarse sandy textured Truckton soils are found to a limited extent in the south and west portions of the refuge; they are highly susceptible to wind erosion. Aquic Haplustolls are deep, poorly drained soils occurring primarily along First Creek (James P. Walsh & Associates Inc. 1991).

Refuge soils are subject to wind and water erosion. The Nunn and Satanta soils are the most susceptible to water erosion. Truckton, Bresser, and Ascalon soils have the greatest potential for wind erosion when vegetation is removed. Revegetation potential is moderate for most soils on the refuge, although some soils may have revegetation limitations associated with slope, water holding capacity, or depth.

### Effect of Remediation on Soils

The effects of manufacturing ordnance and pesticides on refuge wildlife and habitats, and the subsequent plans that were developed to clean up contaminants, are well documented in the 1996 ROD (Foster Wheeler Environmental Corporation 1996). In summary, disposal practices typical of the production era included treating and discharging waste products into evaporation basins. However, by the early 1950s, chemical wastes were leaching through the soil into groundwater and were affecting wildlife. In 1983, EPA listed the site as a Superfund Cleanup site. Subsequent cleanup activities have included construction of borrow areas, caps, covers, landfills, and other remediation structures that disturbed thousands of acres on the present-day refuge. These activities have been ongoing since 1988 and were concluded in the fall of 2011. In some cases (such as Section 36), the surface topography of an entire section was completely recontoured to facilitate cleanup and drainage from the Integrated Cover System, whereas in other sections borrow areas had to be excavated to depths ranging from 1 to more than 20 feet.

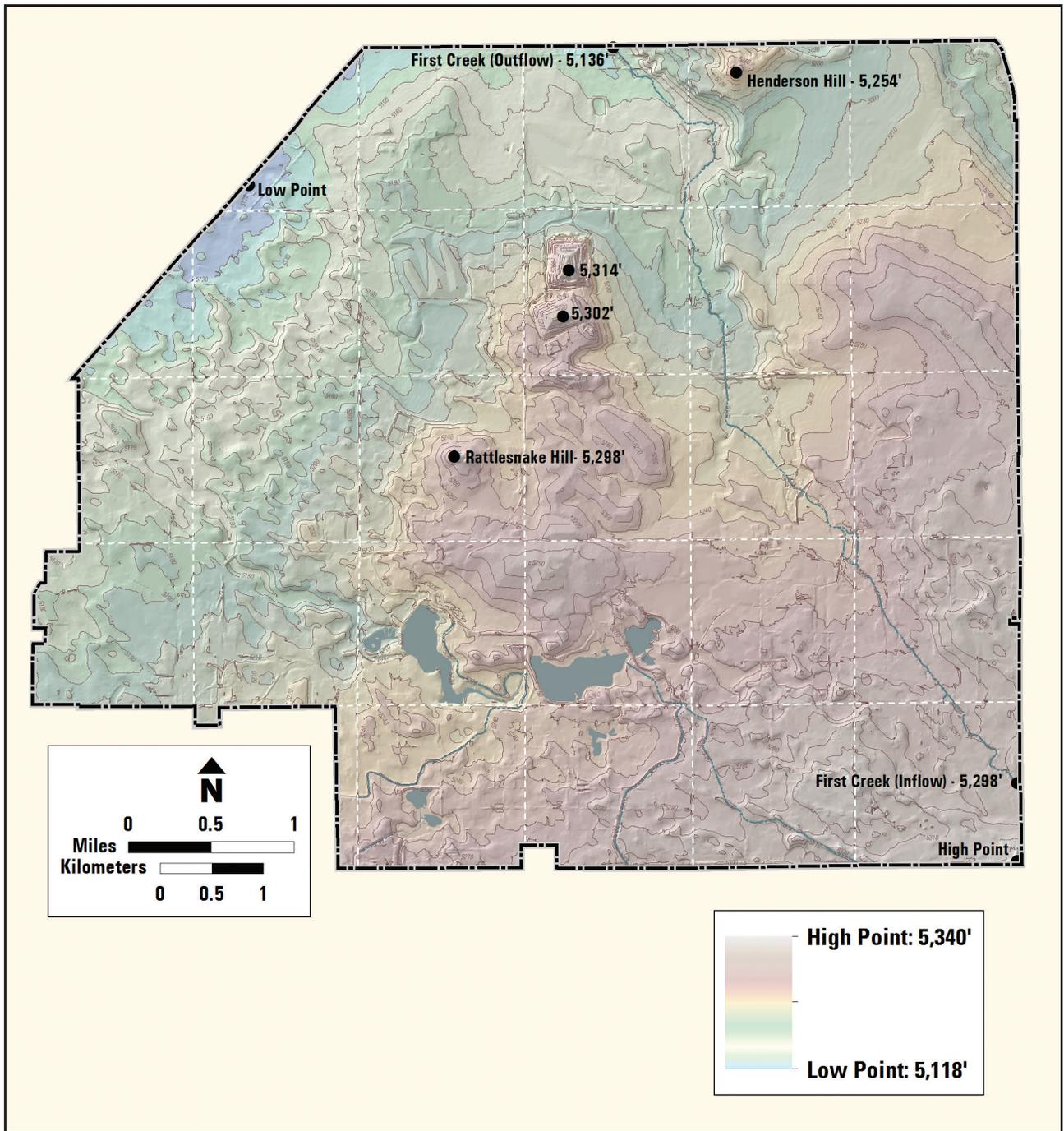


Figure 12. Topography of Rocky Mountain Arsenal National Wildlife Refuge, Colorado.

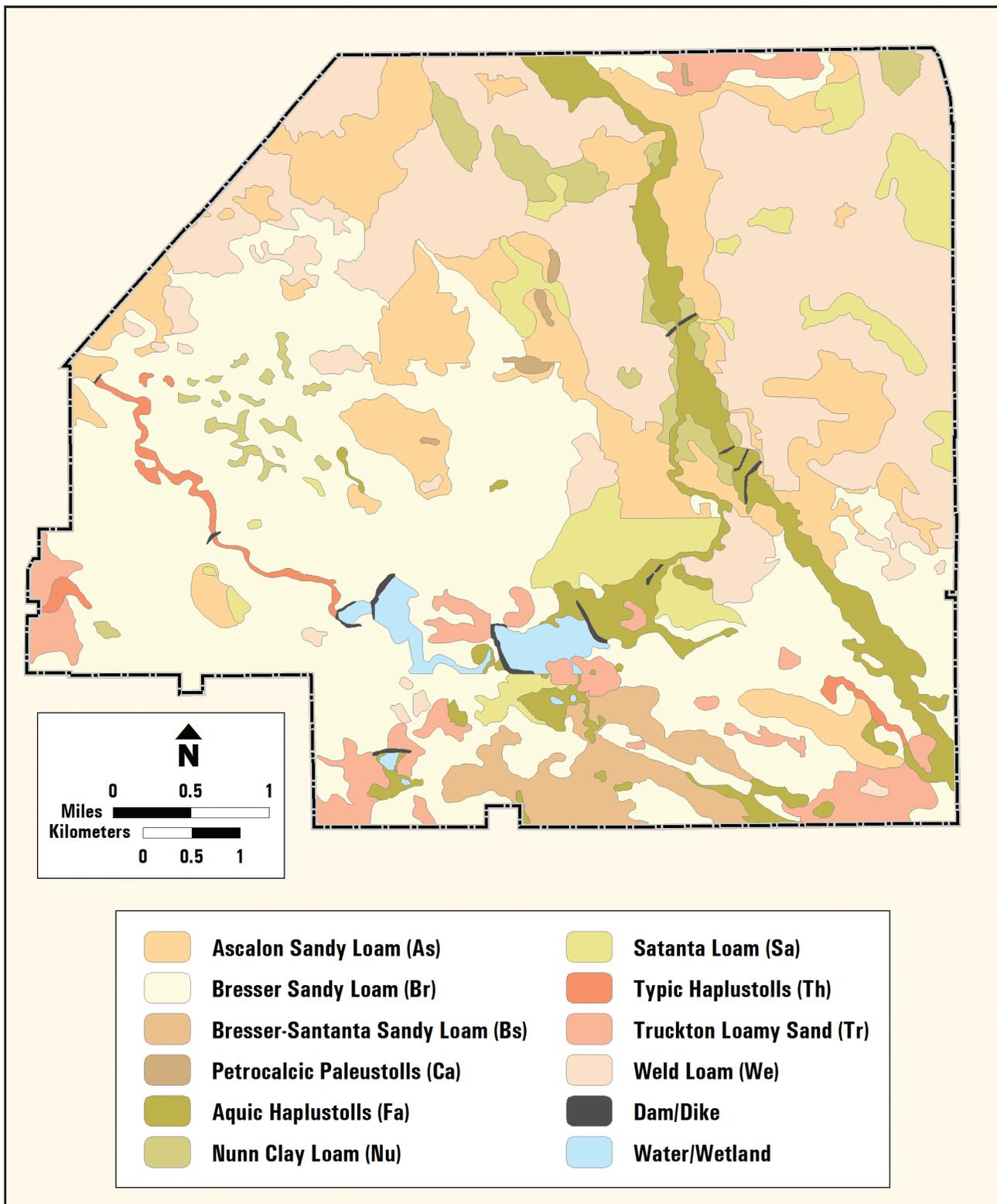


Figure 13. Soil classes in Rocky Mountain Arsenal National Wildlife Refuge, Colorado.

## Water Resources

The refuge lies within several drainage basins that are tributary to the South Platte River, less than 2 miles northwest of the refuge. These basins include Irondale Gulch, First Creek, Second Creek, and several small areas that originally drained directly into the South Platte River. As a result of human alterations, some of these latter areas now drain to either Irondale Gulch or First Creek. The Irondale Gulch and First Creek basins cover more than 91 percent of the total refuge area (FWS 1996a).

In the 1870s, homesteaders were well established in the vicinity of the present-day refuge (Hoffecker 2001). Attempts to improve the area for agricultural production were initiated as early as 1883 with the construction of the Sand Creek lateral irrigation canal, which was eventually expanded into an intricate system of irrigation canals, reservoirs, and ponds. Between 1910 and 1920, portions of First Creek were channelized, the Highline Canal system and Ladora (“La Dore”) Reservoir were constructed, and the dam forming Derby Lake was built (Hoffecker 2001). During U.S. Army operations and subsequent cleanup, dams and other water management infrastructure were improved.

Water is currently impounded in the refuge’s reservoirs: Lake Ladora, Lake Mary, and Upper and Lower Derby Lakes. Water is also stored in the Havana Pond (figure 14). We allow natural processes to take place on the refuge’s 119 acres of wetlands to promote native emergent species and provide opportunistic benefits to wetland-dependent wildlife.

- **Lake Mary Dam**—Lake Mary was created by a U.S. Army equipment operator and has not been significantly modified since.
- **Ladora Dam**—In the late 1800s, the “La Dore” reservoir was created by homesteaders. In 1942–1943, the U.S. Army raised the elevation of this dam by 5 feet to increase reservoir capacity. In 1998, the Army completed repairs to the dam and added a new outlet works and spillway.
- **Lower Derby Dam**—Local farmers constructed a dam around 1900. In the 1940s, the U.S. Army raised the crest of the existing embankment, creating what is now known as Lower Derby Dam. The dam was further rehabilitated in 1990 including the addition of a needed spillway.
- **Upper Derby Dam**—It is unknown if an earlier dam or other impoundment existed in

the current location of Upper Derby Dam, but in 1942–1943 the U.S. Army constructed a dam, several canals, and an outlet that matches what exists today. In 1973, Upper Derby Dam overtopped, breached, and was reconstructed (U.S. Army Corps of Engineers 2014). Currently, the dam is in need of major improvements. Many of these improvements require the removal of some trees. For that reason, prior to transfer, Upper Derby Dam will be breached to allow only a small amount of water to be retained behind the structure (FWS 2013a).

- **Havana Pond Dam**—This dam was constructed in 1973 as a part of the enlargement of the old Stapleton airport, and it began holding water in 1974. This dam is operated and maintained by the City and County of Denver.

## Surface Water Quality

Water quality classifications and numeric standards for the refuge’s reservoirs are governed by the State of Colorado. In 2009, the Colorado Water Quality Control Commission erred in grouping the refuge’s reservoirs into a new segment with other lakes in the Upper South Platte River basin. This change conflicted with prohibitions on the former Superfund site. In 2014, the Commission agreed to a request from the refuge to place its reservoirs into its own segment (Segment 22b—Upper South Platte River).

Both offsite and onsite sources of contamination have adversely affected surface water quality on the refuge (FWS 1996b). USGS has monitored the quality and quantity of incoming streamflow to the refuge since the early 1990s. In most cases, incoming streamflows have failed to meet State standards for water quality (Gordon et al. 2005).

We will attempt to achieve and maintain a water quality standard in all reservoirs (pH = 6.5–9.0 and minimum dissolved oxygen concentration of 5.0 mg/L) (CDPHE 2012) and provide a quality sport fishery for individual reservoirs as defined in our aquatic management stepdown plan (FWS 2006a).

## Urban Drainage and Flood Control

Beginning in at least 1987, the Federal Government recognized that flooding in the Irondale Gulch basin was imminent. At that time, USACE recommended that agreements be developed to allow upstream development while protecting on-post interests and requiring that all new upstream development include sufficient storage for total retention of any increased runoff (Sizemore 1987). Ultimately

the decision was made not to accept any additional water from upstream developments in the City of Denver (Heim 1987).

In 2002, the U.S. Army and UDFCD prepared a drainage study for the Irondale Gulch drainage basin in the southern portion of the refuge. The purpose of the drainage study was to provide preliminary design alternatives for a system to convey periodic stormwater discharge, mitigate the effect of 100-year storm events, and enhance water quality on the refuge (ERO Resources Corporation 2002). In 2003, the U.S. Army signed a Finding of No Significant Impact (FONSI) that would increase trash collection features, enlarge the Uvalda Interceptor, and enhance water storage in the so-called Railroad Embankment. This decision document also proposed enlarging storage capacity in Upper Derby Lake, although this modification has been determined to be infeasible. In 2007, all this information was incorporated into an intergovernmental agreement between UDFCD, the City and County of Denver, and the Federal Government.

Development in the northeast Denver area has continued, and periodic flooding occurs on the refuge. In September 2013, northeast Denver experienced historic flash flooding that caused the Havana Pond dam to breach and caused millions of dollars in damage to the refuge. A similar event occurred in 1973 when the Upper Derby dam was overtopped and failed.

## **Groundwater**

The refuge lies within the Denver groundwater basin. Surficial streams and wind-deposited soils contain water, as do several bedrock aquifers. Unconsolidated deposits cover nearly all of the refuge, underlain by the sedimentary Denver Formation. Shallow groundwater flow occurs primarily in the unconsolidated deposits, but also in the weathered outer layer of the Denver Formation. Water levels range from less than 5 feet below ground surface in the area of the reservoirs and First Creek to more than 60 feet on the west side of the refuge. Groundwater level fluctuations are generally less than 2 feet. Groundwater flows are to the north and northwest (FWS 1996a).

Previous human activities and cleanup operations have altered the water table and flow direction locally. These changes include the boundary containment and treatment systems associated with remediation, recharge from surface water impoundments, and subsidence due to well pumping. The shallow aquifer is recharged from precipitation, surface water, and discharges to surface water (principally the South Platte River). It is also recharged from and

discharges to the Denver Formation aquifer (FWS 1996a).

The Denver Formation aquifer is separated from the shallow alluvial Row system by relatively impermeable shale or claystone. The Denver Formation, 200–500 feet thick under the refuge, contains water-bearing layers of sandstone and siltstone in poorly defined, irregular, interconnected beds that range in thickness from a few inches to 50 feet. A small amount of recharge occurs from the overly unconfined aquifer and from bedrock outcrops, which occur in only a few locations. Discharge from the Denver Formation occurs by lateral flow into the unconfined aquifer and by leakage to the underlying Arapahoe bedrock aquifer (FWS 1996a).

Surface cleanup of the Rocky Mountain Arsenal was completed in 2011, but the groundwater monitoring and remediation continue. The largest areas of contaminated groundwater—in the north, central, and western parts of the refuge—occur as spatially distinct contaminant plumes. The plumes contain one or more contaminants migrating together through the shallow aquifer. Migration has resulted in the merging of contaminant plumes from individual source areas. At the north and northwest refuge boundaries, contaminated shallow groundwater is being removed, treated, and returned to the flow system downstream. Groundwater intercept-and-treat systems are located at various locations within the refuge (FWS 1996a).

## **Platte River Depletions**

In 2013, we completed formal consultation on our Federal water use pursuant to Section 7(a)(2) of the Endangered Species Act of 1973, as amended. This consultation was completed as part of the HMP (FWS 2013a) and is tied to the Service's 2006 programmatic biological opinion for the Platte River Recovery Implementation Program. This biological opinion concluded that the refuge's use of up to 1,400 acre-feet of water per year is not likely to jeopardize the continued existence of the whooping crane, interior least tern, and pallid sturgeon, all federally listed as endangered; or the northern Great Plains population of piping plover or western fringed orchid, both federally listed as threatened, in the central and lower Platte River; nor will it destroy designated critical habitat for the whooping crane.

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## **Air Quality**

For air quality planning purposes, the refuge is within the boundary of the Denver Metropolitan

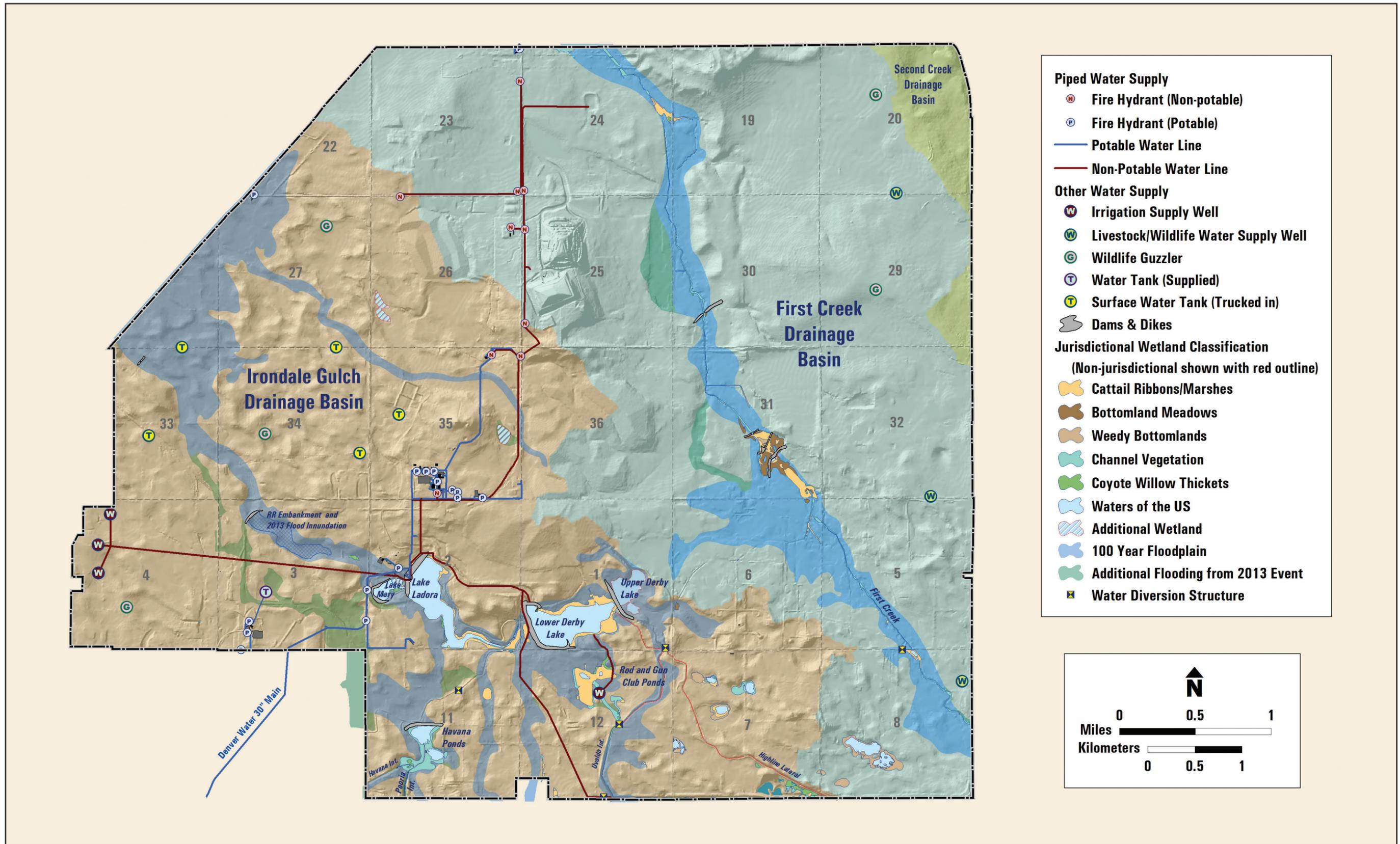


Figure 14. Surface hydrology and water infrastructure on Rocky Mountain Arsenal National Wildlife Refuge, Colorado.



area. For many years, the Denver Metropolitan area has experienced carbon monoxide and particulate matter air pollution as well as visibility problems. In July 2012, EPA classified the metropolitan area as a marginal nonattainment area. A nonattainment area is one in which air quality does not meet the ozone standards set forth by the Federal government in 2008. The primary air quality concern in the region is ozone (CDPHE 2014b).

The refuge is in Adams County, Colorado. In 2011, less than 1 percent of days exceeded the required standards for particulate matter and only 3 days exceeded the daily maximum 8-hour standards for average ozone concentrations (CDPHE 2014a). Further, in 2013, there were 256 days when the air quality in the area was considered good or better. The primary air quality concern in Adams County is ozone (EPA 2013).

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## Climate

The climate of the refuge is characterized as semiarid with wide variations in seasonal and daily temperatures. January is the coldest month with an average high temperature of 43 °F and an average low of 16 °F. July is the hottest month with an average high temperature of 88 °F and an average low of 59 °F (FWS 1996b).

Colorado's climate is unlike that of any other state—it is characterized by the high elevations and complex topography of the Rocky Mountains, the Colorado plateau and valleys of the West Slope, and the high plains falling off from the Continental Divide toward the east (Ray et al. 2008). The mountains to the west create what is known as a rain shadow—that is, storms forming over the mountains often dissipate before reaching the refuge. Weather on the refuge is dominated by warm-season precipitation, largely a result of localized convective storms. Precipitation varies from 12 to 16 inches annually, with 80 percent occurring from April to September. Average annual precipitation actually increases as one travels eastward from the refuge onto the eastern Colorado plains. May is normally the wettest month, averaging 2.5 inches. Summer precipitation is largely the result of convective thunderstorms, often accompanied by hail. Precipitation from these storms can be quite variable, although 60 percent of the rainfall events occurring from May to August produce less than 0.8 inch per event. In contrast, January is normally the driest month, averaging 0.5 inch (1.2 cm) (FWS 1996b). Winter precipitation (December–February) constitutes a relatively small proportion of the total annual precipitation (Lauenroth and Milchunas 1992).

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## Night Sky

One of the most rapidly increasing alterations to the natural environment is the alteration of the ambient light levels in the night environment produced by anthropogenic, or artificial, light. At the turn of the century, it was estimated that two-thirds of the country's population live where they cannot see the Milky Way (Cinzano et al. 2001). While you will never be able to see the Milky Way from the refuge, lands in the northeast portion of the refuge offer twice the visibility of surrounding communities. As the Denver Metropolitan area continues to enlarge, this is a value worthy of our protection.

The National Park Service's Natural Sounds and Night Skies Division examined a light pollution model output of the three national wildlife refuges located in the Denver Metropolitan area (figure 15). Under the values predicted by this model, stargazing and other nighttime aesthetic values would be substantially compromised and terrain features would be substantially illuminated. The refuge has a predicted mean Anthropogenic Light Ratio (ALR) of 28.0 (minimum = 20.2, maximum = 37.1). An ALR of 0.0 would be a pristine natural area and an ALR of 28.0 would be 2,800 percent brighter than the natural light from the night sky (Moore et al. 2013). This predicted level is where one would also have heightened concern over ecological impacts, though no specific thresholds are presented (Chad Moore, NPS, Night Sky Program Manager; email communication; February 25, 2014).

Light pollution is a relatively easy environmental problem to resolve. Solutions are immediate and effective, and they often save money. The following practices are recommended to improve lighting: determine if light is needed, and why; use artificial light only when actually needed; use the right amount of light for the task; direct the light only to the places where needed; eliminate glare; minimize obtrusive lighting (also known as light trespass); minimize direct upward light, a major cause of urban sky glow; turn lights off when not needed; use motion sensors when possible; install dimmers or multi-level lighting; use energy-efficient sources; and minimize energy waste (Alvarez del Castillo and Crawford 2001).

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## Soundscapes

Sound plays a vital role in ecological interactions as well as in visitors' experiences on the refuge. A soundscape refers to the totality of the perceived acoustical environment. A soundscape usually refers to human perception, but the term could also apply to

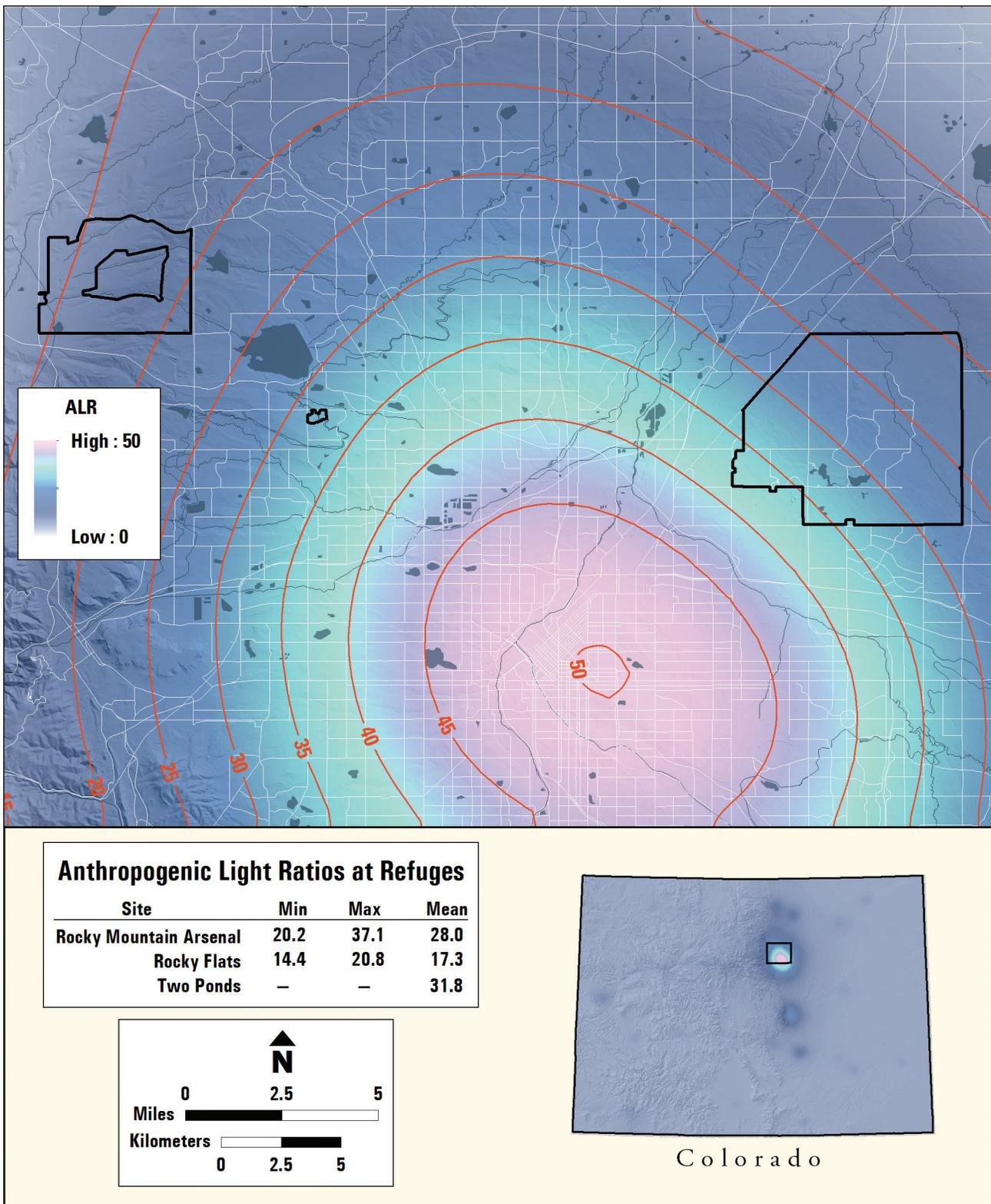


Figure 15. Anthropogenic light ratio of the night sky in the Rocky Mountain Arsenal National Wildlife Refuge Complex vicinity.

other species. A listening area is the area in which a sound can be perceived by an organism; the listening area shrinks when background sound levels increase (Turina et al. 2013). The failure to perceive a sound because other sounds are present is called masking. Masking interferes with wildlife communication, reproductive and territorial advertisement, and acoustical location of prey or predators (Barber et al. 2010). The effects of masking are not limited to wildlife. Masking also inhibits human communication and visitor detection of wildlife sounds. In urban settings, masking can prevent people from hearing important sounds like approaching people or vehicles and can interfere with the way visitors experience cultural sounds or interpretive programs (Turina et al. 2013). Seemingly small increases in sound levels can have substantial effects, particularly when quantified in terms of loss of listening area (Barber et al. 2010; Payne and Webb 1971). Each 3 decibel increase in the background sound level reduces a given listening area by half. Therefore, the presence and levels of nonnatural sounds are an important factor influencing future management of the refuge.

The National Park Service's Natural Sounds and Night Skies Division examined a sound level model output of the three national wildlife refuges in the Denver Metropolitan area (figure 16). This model shows anticipated existing sound levels, natural ambient sound levels, and impact levels from noise across the three units, for an average summer day. While the existing sound level metric reports current conditions (including anthropogenic and natural sound sources), the natural ambient sound level metric reports what conditions would be without human influence. The impact metric reports the difference between existing and natural to estimate the impact of noise on a given location. Based on predicted values, all three sites demonstrate mean impact levels of concern for protected natural areas near urban centers. Conditions at the refuge would warrant moderate concern, as the listening area is likely reduced by about 91 percent (Emma Lynch, NPS, Natural Sounds and Night Skies Division; email communication; February 25, 2014). Despite this concern, the refuge is significantly quieter than surrounding communities, and conditions vary considerably across the site.

Protection of acoustical environments has received growing attention from managers and policy makers as a result of an increased understanding of its role in overall ecosystem health and visitor enjoyment. Soundscape management is becoming more complex and challenging as threats to acoustic resources, both internal and external to park boundaries, increase (National Park Service 2012). Vehicles and aircraft are the largest source of noise on the refuge, but noise is also produced through routine refuge operations.

## 3.2 Biological Environment

### Habitat

Prior to European settlement, most of the area that is now the refuge was shortgrass or mixed-grass prairie, depending on the soil. Post-settlement, much of the land was converted to farming or grazing. Shortly after the U.S. Army took control of the land, the land around the facility was left untouched for several years until the Army planted crested wheat-grass, a nonnative grass species that is perfectly suited to the climate here.

During the cleanup period, thousands of acres of land were disturbed through the remediation process and many more were left in a decadent state. The Service has spent many years, with many more to go, to restore the land to as close to its native condition as possible.

The plant list for the refuge consists of 468 species, including 53 introduced species and 29 noxious weeds (refer to appendix G). Regardless of their origin, these plants represent several dominant habitats on the refuge that are addressed in the HMP (figure 17). Their presence and abundance influence the seed mixes used for prairie restoration and weed control strategies, such as chemical application versus manual removal. No federally listed plant species are known to occur on the refuge at this time.

### Federally Listed Plant Species

The Colorado butterfly plant, federally listed as threatened, occurs primarily in southeastern Wyoming, north-central Colorado, and extreme western Nebraska. The Colorado butterfly plant is typically found in wetland habitats along meandering stream channels on the high plains. In undisturbed sites, it grows among native grasses. Its establishment and survival are enhanced when dominant vegetation has been removed by disturbance (FWS 2010b). Two populations have been located near Fort Collins and another population was successfully introduced at the Chambers Preserve in Jefferson County, but surveys of the refuge have not located any populations of this species.

The Ute ladies' -tresses orchid, federally listed as threatened, is found along streams, in wetlands, and in other moist habitats along Colorado's Front Range and plains areas at elevations below 6,500 feet. The refuge contains habitat suitable for the orchid, but surveys of the refuge have not located any populations of this species (FWS 1996a).

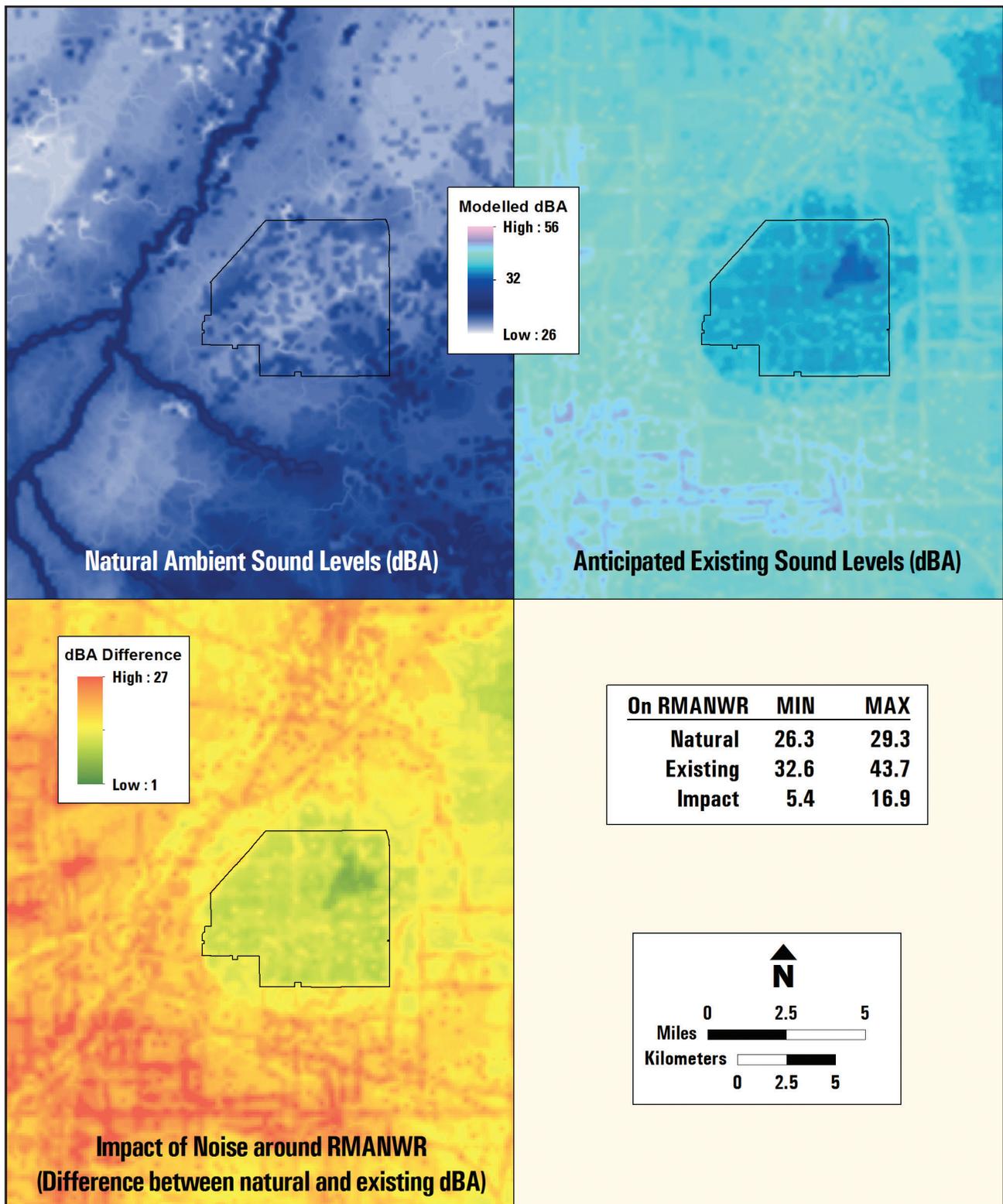


Figure 16. Comparison of natural and ambient sound levels in the vicinity of Rocky Mountain Arsenal National Wildlife Refuge, Colorado.

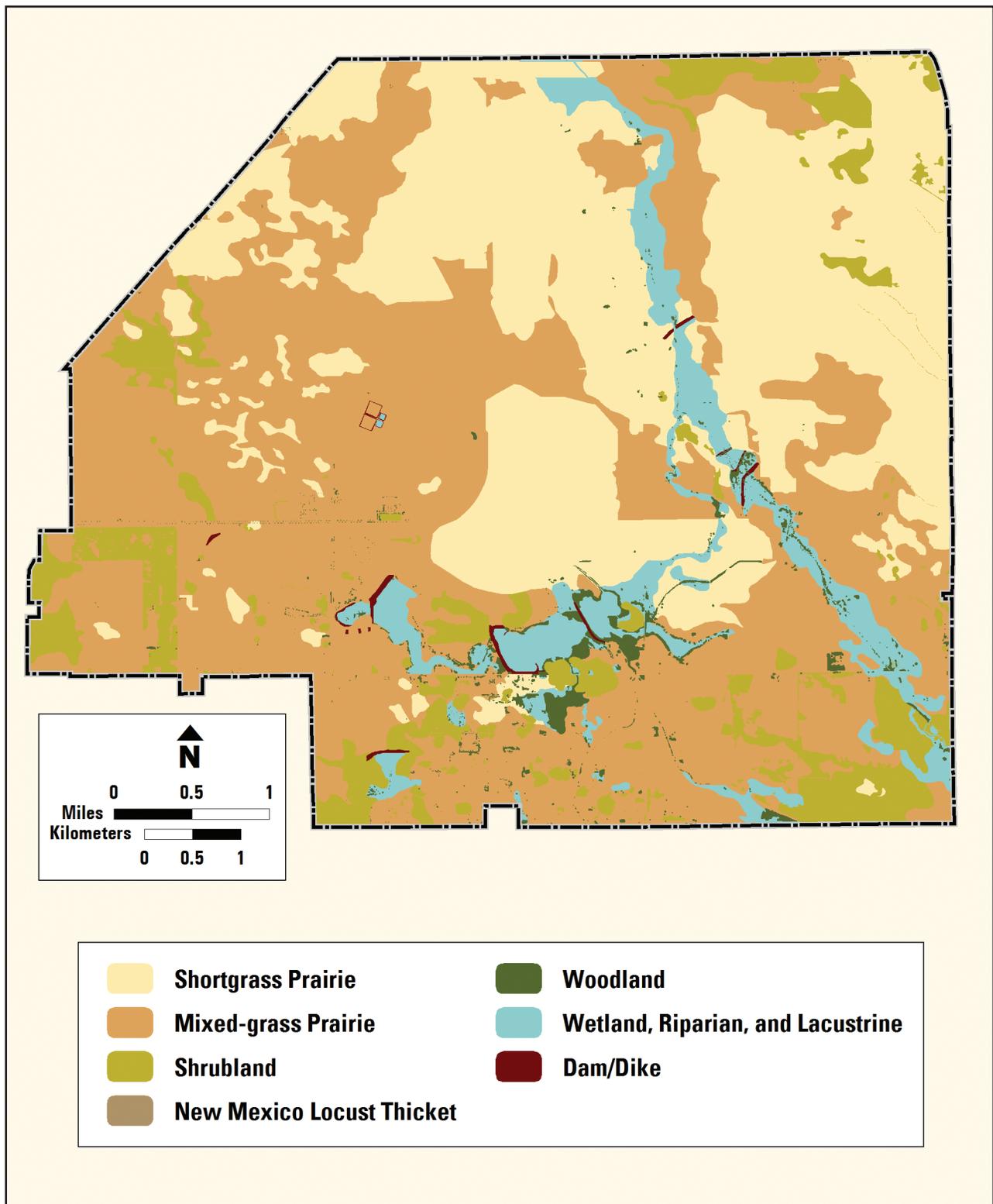


Figure 17. Habitat types on Rocky Mountain Arsenal National Wildlife Refuge, Colorado.

## **Prairie**

Historically, shortgrass prairie with inclusions of mixed-grass prairie and shrubland were the dominant plant communities on refuge lands. However, past activities resulted in the significant degradation of these communities or the conversion of the communities to artificial habitats such as reservoirs, created wetlands, homesteads, buildings, and shelterbelts. Similar losses and conversions have occurred throughout the Great Plains; statewide losses of presettlement shortgrass and mixed-grass prairie range from 29 to 79 percent and from 30 to 75 percent, respectively (Knopf 1994). Future threats to this ecosystem include continued loss to agriculture and other developments, encroachment of nonindigenous species, and loss of genetic diversity (Bachand 2001; Knopf 1994). These prairie ecosystems provide critical habitat for many priority bird species identified by the Service and other conservation entities; accordingly, native prairie was selected as a community of concern. This decision is supported by the Service's Biological Integrity, Diversity, and Environmental Health policy that directs biologists and managers to replicate, to the degree possible, presettlement habitats and ecosystem processes.

The extent of disturbed prairie at the time of refuge establishment was extensive, and the weedy forbs and grasses vegetation type occurred on approximately 10,739 acres (71 percent) of the refuge (FWS 1996a). When restoration is complete, native prairie will comprise approximately 12,680 acres (85 percent) of refuge lands and provide habitat requirements for lark buntings, grasshopper sparrows, burrowing owls, and Swainson's hawks. Prairies containing 5–25 percent live cover of shrubs are found throughout the refuge. Common shrubs include rubber rabbitbrush, sand sagebrush, and four-wing saltbush. In addition, yucca also provides a shrub-like function for some grassland birds and is found in both the shortgrass and mixed-grass prairie associations, primarily along ridgelines. These shrublands and associated grasslands provide habitat requirements for Cassin's sparrows.

## **Riparian Habitat**

Riparian habitats in the western states are known for their value as wildlife movement corridors and migration stopover destinations for birds. The only historic aquatic habitat on the refuge is First Creek, which has experienced some alteration to its hydrology, both historically and with current urban development. Approximately 6 miles of the creek traverse refuge property. However, the most prominent aquatic features on the refuge are artificial: Lake Mary, Lake Ladora, Lower Derby Lake, the Highline

Canal, Uvalda ditch, and Havana Ponds. Nevertheless, all these water bodies support a riparian plant community, comprising both herbaceous and woody species. Currently, the herbaceous community is dominated by noxious grass and forb species, including Canada thistle, white top, and smooth brome. Reed canarygrass is also found along the lower portions of First Creek, forming pure stands in some areas. Woody species are dominated by plains cottonwood, peach leaf willow, and coyote willow. Russian olive, a list B noxious weed, was also a very noticeable woody plant dominating the riparian understory until removal of nearly 7,000 trees. The cottonwood-willow gallery provides a primary habitat requirement for both nesting and wintering bald eagles. The HMP objective is to establish 1 mile of gallery forest dominated by cottonwoods by 2027. In addition, the value of riparian areas for foraging big brown bats will be investigated.

## **Lacustrine Habitat**

Lacustrine, or lake, habitat consists of five artificially created reservoirs and ponds: Lower Derby (73 surface acres), Upper Derby (0 surface acres), Ladora (48 surface acres), Mary (9 surface acres), Havana Ponds (39 surface acres), and Rod and Gun Club Pond (ephemeral). With the exception of Upper Derby, water sources for these lacustrine habitats are varied and include precipitation, flows from drainage interceptors (Uvalda, Peoria, Havana, and Joliet drainage ditches) that channel stormwater discharge, natural groundwater discharge, and pumped water from wells. The plant communities of reservoirs vary depending on the timing and extent of water level fluctuations. The Upper Derby basin, which only receives water periodically, is dominated by noxious weeds. The remaining reservoirs support emergent vegetation, primarily cattails in shallow water along shorelines, and various rooted and floating-leaved aquatic species in deeper portions of the basins that never dry. The HMP strategies for the reservoirs are to stock forage fish when necessary to maintain the sport fishery, conduct annual water quality monitoring, and control cattails as needed.

## **Woodlands**

Located in the Environmental Education Zone (primarily Sections 11 and 12), the woodland habitat type on the refuge is the result of past land use activities that involved conversion of native prairie to agriculture and the planting of trees around homesteads by settlers. Following transfer of ownership to the U.S. Army, additional trees were planted around new infrastructure, and agricultural lands were abandoned and allowed to revegetate naturally. Dur-

ing this time, additional trees became established as scattered individuals or as small groups in abandoned agricultural fields. Following acquisition by the Service, grasslands have been, or will be, restored to native prairie by seeding appropriate species based on soil type, but in general, trees were not removed. The term woodland is used to characterize interspersions of planted trees and shrub thickets with patches of grassland. The woody component of this habitat type can be classified based on the following species associations: (1) New Mexico locust thickets, (2) American plum and chokecherry thickets, (3) homestead site trees and planted groves, and (4) Russian olive. These created woodland habitats in the midst of restored grasslands are highly valuable for neotropical migrant songbirds as resting and foraging sites. They also provide hunting perches for bald eagles and Swainson's hawks. Deer frequently visit thickets to browse and for shelter.

### **Wildland Fire**

Prior to European settlement, grazing (primarily by bison, prairie dogs, and insects) and wildfire were the primary ecological disturbances that revitalized the grassland. Ignitions for wildfires were caused by both lightning and Native Americans. Depending on weather and fuel conditions, a wildfire could burn thousands of acres, creating a mosaic of burned, unburned, and grazed areas. Historical fire frequency was probably highly variable but has decreased since settlement (Umbanhowar 1996). Evidence that characterizes fire return intervals suggests about every 5–10 years on the moist portions of mixed-grass prairie and about 25 years on dry portions (Frost 1998; Wright and Bailey 1982).

After settlement by Europeans, wildfires were suppressed. However, agricultural burning by farmers in the area continues to this day. We have been using prescribed burning on the refuge since the late 1990s for managing habitats and reducing fuel loads near the wildland urban interface. Prescribed fire is currently used in all habitat types found within the refuge.

## **Wildlife**

Approximately 350 species of wildlife have been documented on the refuge (refer to appendix G). Wildlife species on the refuge have adapted to the many changes in their enclosed, fenced habitat surrounded by increased urbanization. As the fence and cattle guards were added to the perimeter landscape, some large mammals, mainly deer, could no longer enter or exit the refuge. Other wildlife, accustomed to the presence of buildings from farmhouses to fac-

tories, had to adjust to the absence of artificial structures and adapt to expanses of bare soil followed by reseeded natural vegetation. It has been difficult to track all the changes in species diversity and abundance. Some wildlife groups have been well documented on this site, while others have not been adequately inventoried.

### **Threatened and Endangered Species, Resources of Concern, and Surrogate Species**

The discovery of the formerly endangered bald eagle using First Creek within the Arsenal boundaries in 1986 was a determining factor in the establishment of this area as a national wildlife refuge. Like many wintering raptors, migrating bald eagles were attracted to the abundant food sources on the Arsenal site—particularly small mammals, and specifically the non-hibernating black-tailed prairie dog. The bald eagle was delisted in 2007 but still resides on the refuge both as a breeder and winter visitor and is identified in the HMP as a resource of concern. The nesting and roosting habitat remain protected from human disturbance during use by eagles.

The black-footed ferret, federally listed as endangered, is also directly linked to the prairie dog, both as a food source and for living space. Although black-footed ferrets were never documented as inhabiting the specific area of the refuge, they are an important component of the shortgrass prairie, and the refuge is within their historic range.

The Mexican spotted owl, federally listed as threatened, is considered a habitat specialist. These owls occur in both forested and rocky canyon habitats. Forests used for roosting and nesting often contain mature or old-growth stands with complex structure. In parts of their range, Mexican spotted owls occupy a variety of steep, rocky canyon habitats (FWS 2012b). In Colorado, spotted owls can be found in the foothills south of Denver and west of Colorado Springs (FWS 2012b). There are no owls on the refuge, nor is there suitable habitat for owls on the refuge.

The Preble's meadow jumping mouse, federally listed as threatened, occurs in riparian areas along Colorado's Front Range. Neither the mouse nor its habitat currently exists on the refuge.

To conceptualize an adaptive management plan for the refuge, we analyzed what wildlife species could benefit from the habitat we were creating and considered their local, regional, and national priorities to the Service. A thorough explanation for our choices and eliminations can be found in the HMP. The list of priority species, or resources of concern, comprised six bird and two mammal species that nest

**Table 12. Habitat needs for resources of concern and associated species, Rocky Mountain Arsenal National Wildlife Refuge, 2013.**

<i>Resource of Concern</i>	<i>Associated Species</i>	<i>Desired Vegetation Structure</i>
Bald eagle	Osprey	Riparian gallery cottonwoods
Swainson's hawk	Red-tailed hawk, ferruginous hawk, golden eagle, American kestrel, western and eastern kingbirds, loggerhead shrike	Isolated trees or small groups of trees in open perennial grasslands
Burrowing owl	Black-tailed prairie dog	Perennial grasslands with prairie dog towns
Cassin's sparrow*	Loggerhead shrike, lark bunting, western meadowlark, grasshopper sparrow, Swainson's hawk, short-eared owl, vesper sparrow	Perennial grassland and some shrubs
Lark bunting	Swainson's hawk, western meadowlark, long-billed curlew, short-eared owl, horned lark, ferruginous hawk	Perennial grassland
Grasshopper sparrow	Upland sandpiper, vesper sparrow, western meadowlark	Perennial grassland
Black-tailed prairie dog*	Burrowing owl, prairie rattlesnake, mountain plover, American bison, black-footed ferret	Perennial grassland
American bison*	Black-tailed prairie dog, burrowing owl, ferruginous hawk	Perennial grassland

\* These surrogate species are mentioned in section 2.2 of this document. At this time, the big brown bat has not been included as a resource of concern for the purposes of this EIS. The refuge might play an important role for this species; however, additional research is needed to determine if the species' fidelity to the site continues post-cleanup.

or breed within the refuge. For this EIS, we adopted four of these as surrogate species to represent the most abundant habitat, the prairie. The priority species and their associated habitats are listed in table 12.

In addition, the presence of the following taxa is significant to the understanding of other habitat uses on the refuge and choices for placement of roads, trails, and infrastructure.

### **Fishes**

Of the 14 fish species in refuge water bodies, 12 are native transplant introductions and 2 are exotic. The three main water bodies are artificial and have been managed to support a catch-and-release recreational fishery. Objectives in the HMP specify that balanced populations of largemouth bass and bluegill should be maintained in Lake Mary. The objective for Lake Ladora adds northern pike to those species. Lower Derby Lake is to be managed as a stocking source and for wildlife use. Three native fishes—channel catfish, fathead minnow, and green sunfish—also share the reservoirs with two nonnative rough fish species—common and grass carps. One more native fish, brook stickleback, and the introduced mosquitofish occupy First Creek and Parkfield Ponds.

### **Reptiles and Amphibians**

Reptiles and amphibians, collectively known as herptiles, total 24 documented species on the refuge,

but surveys have not been conducted recently. The 1994 species list included one salamander, three toads, three frogs, five turtles, three lizards, two skinks, and seven snakes. The determinations of occupied habitat and occurrences were based on existing literature for Adams County, Colorado (Hammerson 1986), and a local catch-and-release survey conducted in various habitats prior to the onset of cleanup on the Arsenal. During cleanup, not only were massive amounts of soil and vegetation removed or rearranged, but water sources fluctuated annually due to weather events and the deliberate manipulation of water for irrigation, dust control, flood prevention, and recreational use. Although these detrimental activities have been reduced and habitat has been created, the herptile species list did not increase based on a roadside survey done in 2005. For instance, although the northern leopard frog has not been found on the refuge, it is disappearing from locations in many western states because of threats such as habitat loss, disease, nonnative species, pollution, and climate change. There are no specific objectives for herpetofauna in the HMP, although the reservoirs are recognized as breeding and wintering habitat for some amphibians (USFWS 2013a:59). In addition, control of bullfrogs to improve the sport fishery may be indicated in future aquatic management plans.

## Birds

Unlike the residential and stable nature of the fish, herptile, and mammal communities, the bird species that use the refuge are highly mobile and variable. Therefore, although the number of bird species that have used the refuge is presently 282, this could change in the future. To illustrate the point, two species, the dickcissel and bobolink, were sighted on the refuge in spring 2014 for the first time, both in recently restored grassland habitats. Furthermore, upland game birds that were previously stocked for hunting, including ring-necked pheasant, northern bobwhite, chukar, and wild turkey, were removed from the list. Although waterfowl, shorebirds, and warblers have a high representation of species that occur on the refuge, the majority of these groups use the habitats for stopover points on migration to and from their breeding grounds or are rarely counted on surveys. Conversely, a high percentage of raptors and sparrows have been documented as breeding or overwintering on the refuge.

## Mammals

The present refuge mammal list comprises 37 species that are representative of the typical fauna of Adams County, Colorado. Recent additions include the bobcat and American beaver. One mammal that has been taken off the original list is the porcupine. Population estimates of some refuge mammals have been well documented by various censuses and surveys, from the heavily viewed deer and bison to the seldom-seen badgers and nocturnal bats. In the past, animal health and abundance were important tools for tracking exposure to contaminants manufactured here. Presently and in the future, the emphasis will be on monitoring the restored prairie habitat to sustain the prominent consumers of grassland vegetation, namely bison, white-tailed deer, mule deer, and prairie dogs (refer to “Appendix H—Forage Allocation Methodology for Use at RMANWR” in the HMP). We must also analyze another grazer, the pronghorn, if it is considered for reintroduction.

## 3.3 Visitor Services

Visitors to the refuge can enjoy a variety of compatible, wildlife-dependent recreational activities: fishing, wildlife observation, photography, environmental education, and interpretation. The refuge Visitor Center is open Wednesday through Sunday from 9 a.m. to 4 p.m. and is closed on all Federal holidays. The refuge is open to visitors from sunrise to

sunset every day and is closed on Thanksgiving, Christmas, and New Year’s Day. Information kiosks outside the Visitor Center, on the Legacy Loop, and at the Contact Station provide brochures and maps of the refuge for visitors.

## Hunting

Currently the refuge does not have a hunting program. The Federal Facilities Agreement currently prohibits the take of any wildlife on refuge property for consumptive purposes. Until this restriction is removed, a hunting program will not be established.

We are evaluating what animal populations—such as mourning dove, white-winged dove, Eurasian collared dove, mule deer, and white-tailed deer—could be hunted on the refuge. We are also evaluating opening the refuge to host a site for CPW’s hunter education programs, especially for youth hunters, with potential outreach to local schools.

## Doves

Two of the three dove species (mourning and white-winged) present on the refuge are migratory birds. The Eurasian collared dove is a nonnative, invasive species that is not afforded protection under the Migratory Bird Treaty Act and is hunted year-round in Colorado. The Refuge would only allow hunting of any dove species during the Colorado mourning dove season.

## Deer

Both mule deer and white-tail deer are currently present on the refuge. The deer herds on the refuge are isolated from other populations by the 8-foot chain-link fence constructed around the property in 1990. The deer herds, for practical purposes, should be considered closed populations with no immigration or emigration.

Deer hunting is a popular activity throughout Colorado, but because of the refuge’s juxtaposition to a large urban area and lack of public lands, most deer hunting in the immediate area surrounding the refuge takes place on private lands.

## Fishing

Public fishing is offered as a recreational, fee-based program (\$3.00 per day) from mid-April through mid-October. Three fishing piers and a floating boardwalk are located at Lake Mary, and a float-

ing boardwalk is located on the east end of Lake Ladora.

Lake Mary, Lake Ladora, and Lower Derby Lake are stocked annually with fry-sized fish to provide a food source for larger fish. These stockings are intended to maintain a healthy fishery in support of recreational sportfishing. Species stocked include bluegill, channel catfish, and fathead minnow. Fish stockings are coordinated and permitted through CPW.

## Events

The refuge hosts several annual fishing events. We host the Annual Fishing Frenzy—in partnership with the City of Commerce City and Bass Pro Shops—to educate and provide fishing opportunities to youth. It offers fishing instruction and classes in knot tying, fish identification, and casting techniques. The average estimated attendance for this one-day event is 900 visitors. We also host Refuge Day in October, attended by more than 500 visitors engaging in wildlife-focused activities to celebrate National Wildlife Refuge Week.

The refuge also hosts weekly therapeutic fishing programs throughout the fishing season on Lake Mary. The refuge's volunteer staff provides hands-on instruction and assistance to anglers. This highly successful program targets special needs groups (Craig Hospital, Children's Hospital, Colorado State Veterans Nursing Home, and Greely Center for Independence).

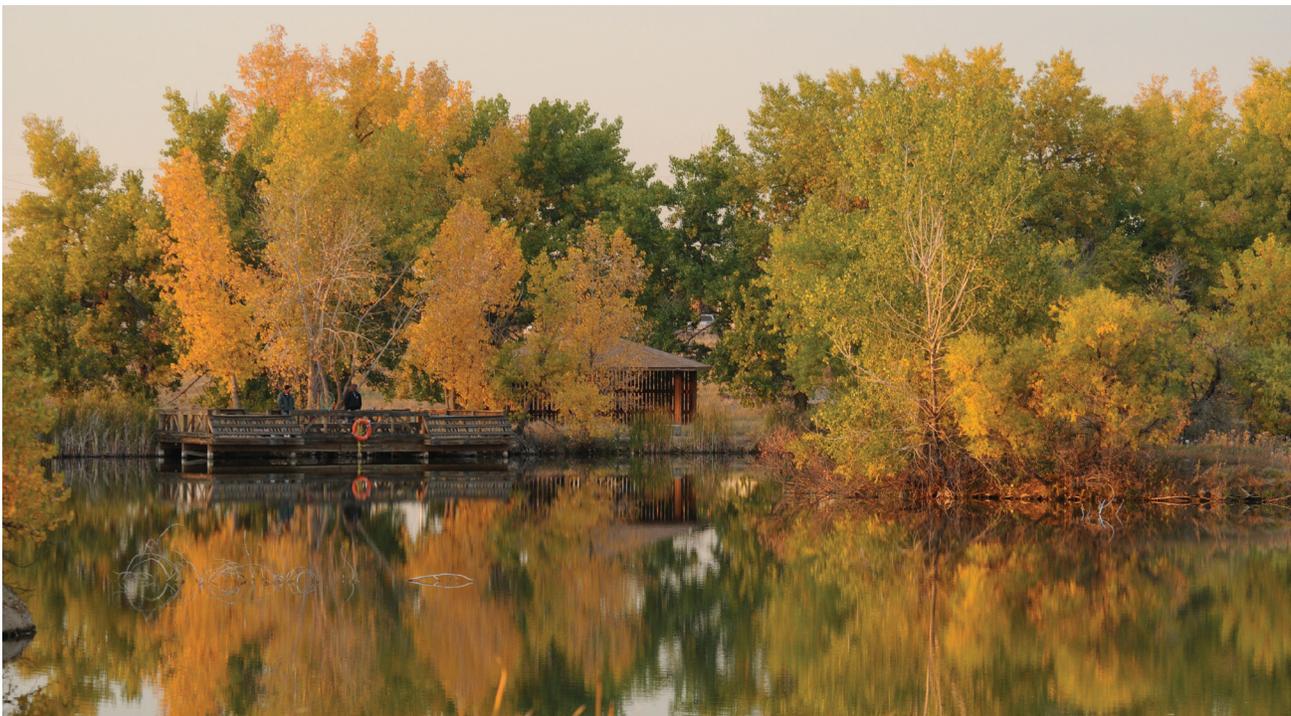
## Rules and Regulations

Current regulations allow fishing on the refuge from April 15 through October 15 annually. Fishing is allowed only on Lake Mary and Lake Ladora. Wading is allowed in Lake Ladora after Memorial Day. Only artificial bait is allowed for fishing on the refuge and all fish hooks must be barbless. Only catch-and-release fishing is allowed. All persons wishing to fish on the refuge must have a valid State fishing license, a fishing fee receipt, and a signed permit/fishing regulations (free). Because of human safety and wildlife disturbance concerns, we currently do not allow the use of boats or other vessels (such as float tubes) on the refuge.

## Reservoirs

Lake Mary is the smallest of the refuge's reservoirs at 8.4 acres with a maximum depth of 12.4 feet. It is an excellent resource for beginning anglers. Amenities include a floating boardwalk and fishing pier. Facilities are also accessible, providing equal opportunity for all to participate in and benefit from fishing programs and activities on the refuge. Fish species in Lake Mary include largemouth bass, channel catfish, white and black crappie, bluegill, grass carp, and yellow perch.

Lake Ladora, at 54.9 acres with a maximum depth of 17.6 feet, is open to bank fishing. Wading with calf, hip, or chest waders is allowed after Memorial Day.



© Rich Keen

Lake Mary is the smallest of the refuge's reservoirs at 8.4 acres.

Fish species include northern pike, largemouth bass, and bluegill.

Lower Derby Lake measures approximately 72.7 acres with a maximum depth of 11.5 feet. This reservoir is currently closed to fishing. Fish species include largemouth bass, bluegill, and channel catfish.

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## Wildlife Observation and Photography

The refuge is open to wildlife observation, but some areas are closed to protect sensitive wildlife. A viewing blind on the edge of Rod and Gun Club Pond is sheltered by cottonwood trees to offer views of wildlife and wetland habitat.

The refuge is open to photography, and an accessible (portable) blind is located at Havana Ponds. We issue a limited number of special use permits annually for commercial photography for a fee of \$50 dollars per person per day. We are evaluating this use to determine appropriate numbers of permits, as well as suitable roads for vehicle access because vehicle traffic on some roads and trails could pose safety issues for visitors using them.

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## Environmental Education and Interpretation

Environmental education is intended to teach visitors the history and importance of conservation. Through this process, we can encourage others' awareness, knowledge, attitudes, skills, motivation, and commitment to conserve our wildlife and natural resources. Environmental education uses onsite and offsite as well as distance learning materials and activities to explain the Refuge System's mission.

The refuge has dedicated curricula for offsite and onsite students, focusing on introducing first through fifth grade students to native wildlife. Students come from Adams County, Montbello, Denver, Commerce City, and area homeschools. We are in the process of developing Rhythms of the Refuge materials to provide refuge-specific activities that will address all grade levels. In addition, we regularly participate in the Aurora Youth Water Festival, with a focus on the value of water resources and habitat for wildlife.

Interpretation is the means by which we can encourage positive visitor attitudes about natural resources and refuges. We provide opportunities for visitors to create their own connections with

resources to promote an understanding of the relationship between individuals, resources, and the impacts of human activities. For many visitors, taking part in interpretive programs may be their primary contact with the refuge and their initial contact with conservation and wildlife. Well-designed interpretive programs can also be effective resource management tools. Refuge staff and volunteers conduct a variety of interpretive programs on the refuge through bus tours, hiking tours, and nature programs. Wildlife viewing tours are conducted year-round and are designed for all ages.

### *Visitor Center*

The refuge's 12,500 square-foot Visitor Center, completed in 2011, includes an exhibit hall that features prairie wildlife, history, and refuge management. The discovery room offers drop-in activities (such as tactile, crafts, and interactive displays). A 73-seat amphitheater has audiovisual capabilities for refuge interpretive programs. The Visitor Center also houses the Nature's Nest Books and Gifts store operated by Friends of Front Range Wildlife Refuges. An accessible amphitheater that seats 150 is adjacent to the Visitor Center, and a fenced pollinator garden is behind it.

### *Contact Station*

This 5,000-square-foot facility can accommodate 60 students. This facility has learning stations, tactile, and wildlife dioramas that can be used for environmental education. Teachers, scout groups, and other youth or homeschool groups can reserve this facility for environmental education with a refundable deposit. More than 20,000 students and teachers use this facility for self-guided programs each year.

### *Kiosks*

The refuge has a total of four informational kiosks. Three kiosks—at the Visitor Center, Legacy Loop, and the Contact Station—provide maps and information about facilities, programs, and regulations. Interpretive panels are located at the Visitor Center, Contact Station, and Lake Mary kiosks.

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## Recreation Fee Program

We manage a recreation fee program consisting of fishing fees (\$3.00 per day for visitors over 16) and the sale of Federal Recreation Lands Passes. The program's annual revenues of \$11,000–\$13,000 are used to make improvements to visitor facilities.

## Staff

Our visitor services staff consists of a permanent fulltime visitor services manager, an Environmental Education Specialist, a Supervisory Park Ranger, and three seasonal Park Rangers. Other refuge staff, seasonal employees, and volunteers assist in staffing the Visitor Center (see table 8 in chapter 2). Two fellowship positions assisted us in visitor services in 2014.

Our volunteer program is important to our success. Over 60 volunteers contributed more than 8,000 hours in 2013. These volunteers support our visitor services program; maintain facilities and trails; and assist with wildlife surveys, habitat restoration, and administrative duties. We work with Groundwork Denver and Mile High Youth Corps for improvements to facilities, trails, and habitat.

## 3.4 Communications and Outreach

With the help of our refuge volunteers, we currently reach out to traditional refuge visitors and our neighboring communities through our participation in community outreach events such as Refuge Day, Bass Pro Fishing Classic, Colorado Get Outdoors Day, Aurora Youth Water Festival, Barr Lake Birding Festival, and other such events.

In addition to special events and local career development programs, we carry out our visitor services programs onsite to promote the importance of the Service's new Urban Wildlife Conservation Program.

We manage the refuge's Web site and social media platforms to reach a broad spectrum of visitors. We distribute, both by email and in printed format at the Visitor Center, the quarterly Wild News publication, which contains a list of refuge tours and nature and interpretation programs. We distribute a general brochure and a rack card, and we are in the process of developing brochures for trails and auto tour routes.

## Media

The refuge has a Web site ([http://www.fws.gov/refuge/rocky\\_mountain\\_arsenal](http://www.fws.gov/refuge/rocky_mountain_arsenal)) and social media sites (Facebook and Flickr) that provide current information about refuge resources, programs, and

activities. Wild News is a quarterly publication that lists interpretive tours and programs, is sent to a 5,000-person mailing list, and is available in hard copy at the Visitor Center, information kiosks, and local community centers. Refuge staff is routinely interviewed by local area media. National Geographic photojournalists have recently completed projects on bison and burrowing owls.

## Brochures

Refuge information is available in the general brochure, rack card, trail map, fishing information (English and Spanish), and bird list. The Honker Scavenger Hunt is a popular guide to help youth explore the refuge. Brochures are provided to DIA, the Denver Convention and Visitor Bureau, REI, community recreation centers, and libraries. We are developing an interpretive brochure for our auto tour routes.



Cindy Souders / USFWS

*The Honker Scavenger Hunt is a popular guide to help youth explore the refuge.*

## Special Events

We partner with the City of Commerce City to host an annual Fishing Frenzy in April with an estimated 900 participants each year. Refuge Day is an annual event in October to celebrate the Refuge System with a variety of activities and an estimated 400 participants each year.

## 3.5 Partnerships

We partner with various organizations (such as the Rocky Mountain Greenway Trail Network and Sand Creek Greenway Partnerships) and municipalities to expand and interconnect the various regional trails to form a trail network connecting the refuge with Two Ponds NWR and Rocky Flats NWR. Our existing partnership with the Friends of Front Range Wildlife Refuges supports some of our refuge programs and assists us in operating the Nature's Nest Books and Gifts store in the Visitor Center. We maintain a partnership with the City of Commerce City and with Bass Pro Shops to carry out the annual Fishing Frenzy event on the refuge. We are currently working with the City and County of Denver and Rocky Mountain Bird Observatory to enact the Urban Bird Treaty in the Denver Metropolitan area. We would continue to implement the Urban Refuge Partnership with Environmental Learning for Kids at their property in Montbello. We would continue to develop our partnerships with the Denver Botanical Garden and Butterfly Pavilion for monarch and pol-



Cindy Souders / USFWS

*We rely on partnerships to carry out the annual Fishing Frenzy event on the refuge.*

linator programs and outreach. We would continue to work with Mile High Youth Corps and Groundwork Denver for habitat restoration projects. We maintain a partnership, through our Regional Office of Diversity and Civil Rights, with Arrupe High School, which allows one student to work with us one day per week at the Visitor Center.

## 3.6 Human History and Cultural Resources

The site of the refuge has a rich history of human occupation. Native Americans used the site for thousands of years. The area changed drastically with farming, military weapons production, commercial pesticide production, environmental restoration, and eventually habitat restoration and refuge development. Each period made its own impacts on the landscape, some more than others.

### Human History

The following is a very brief summary of the prehistory of the Rocky Mountain Arsenal National Wildlife Refuge. Sections of this summary are condensed versions of the background research undertaken as part of the archaeological investigations conducted in preparation for the cleanup of the Arsenal lands and eventual transfer to the Service (Gilmore et al. 1997) and for the proposed Northwest Parkway west of Denver (Painter et al. 2005). Additional detailed information is available in those publications and in the numerous sources cited as a part of that research.

### Prehistory

Current archaeological evidence indicates that the earliest humans migrated to the region near the close of the last Ice Age approximately 14,000 years ago. The sites and artifacts left by these early peoples are divided into five general stages:

- Paleoindian: 12,000 B.C.–5,700 B.C.
- Archaic: 5,700 B.C.–A.D. 150
- Late Prehistoric: A.D. 150–A.D. 1540
- Protohistoric: A.D. 1540–A.D. 1750
- Early Historic: A.D. 1750–A.D. 1850

The Paleoindian stage is the earliest evidence of human occupation in Colorado. The traditional view

of the Paleoindian pattern emphasizes a nomadic culture tied to the migration of large game, most notably extinct Pleistocene megafauna, including mammoths and the massive antique bison. Recent studies, however, indicate that Paleoindians also exploited smaller game, fish, and waterfowl, although to a much lesser extent (Kuehn 1998; Walker 1982; Wheat 1979; Wilmsen and Roberts 1978). Perhaps the most readily recognized stone tools in the Americas are associated with the Paleoindian stage—specifically the large, lanceolate, projectile points that are often fluted (i.e., long longitudinal flake scars extending from the base of the point along its centerline) and consistently well crafted. Paleoindian lithic assemblages are predominantly flaked stone tools believed to have been used primarily for hide and meat processing. Because population densities were low during the Paleoindian stage, sites (particularly camp sites) dating to this period are found less frequently than those of the subsequent stages.

The Archaic stage is marked by increasingly diverse food choices, an extensive feature assemblage including fire hearths and storage areas, and a variety of stone tool and projectile point styles. The beginning of the Archaic stage coincides roughly with the onset of the Altithermal climatic episode (approximately 7,000 B.C.–4,000 B.C.): a prolonged period of general warming and drying in western North America (Frison 1991). The change in weather patterns and environments resulted in the replacement of many Pleistocene animals with generally modern species. Collected wild plant foods made up a significant portion of the human diet during the Archaic stage, and small mammals, reptiles, and even insects were utilized as well. Ground stone implements used to process plant material such as nuts, seeds, berries, and fruits became common. Stone boiling pits, storage cists, and architectural features such as basin houses are also associated with the Archaic stage and are likely the result of increasing population density and a general shift toward more long-term settlements (Frison 1991; Metcalf and Black 1991; Shields 1998). Archaic projectile points are generally large and often are not as well crafted as points of the preceding Paleoindian stage.

The introduction of the bow and arrow and the use of pottery mark the onset of the Late Prehistoric stage, while the latter years include the earliest contacts of the native population with Europeans. Throughout the region this was a time of important changes in food choices, artifact types, and population distribution. This time period coincides with the introduction of the bow and arrow and the associated small triangular projectile point. A range of habitation sites with structures has been recorded in eastern Colorado, but there is no evidence of permanently settled villages. Ceramics are varied but in general

consist of cord-marked jars. Bone artifacts are common and include awls, fleshers, wrenches, and beads. Ground stone is abundant and varied, including not only manos and metates but also shaft abraders.

## **Early History**

The Protohistoric stage encompasses the span of time between the earliest European influences on the Native Americans and the onset of regular, direct contacts between Native Americans and persons of European descent. The A.D. 1540 date for the beginning of this stage corresponds with Coronado's first expedition to the southern plains of North America and, although the early Spanish explorers did not reach the refuge region, the expedition nevertheless represents the beginning of potential influences. Anglo incursions into the central and western high plains are known to have taken place infrequently during the latter half of the eighteenth century. External pressures in addition to the introduction of the horse and other material goods led to accelerated changes in the traditional cultures. A nomadic, equestrian lifestyle emphasizing bison hunting, generally with firearms, became pervasive among tribes occupying eastern Colorado. The circular arrangements of rock often associated with Protohistoric sites are thought to be primarily the remnants of tipi structures—rock weights used to secure the structure coverings.

Much more information is available for the post-A.D. 1725 periods. Most notably, historically identifiable tribes established a presence in the region. Historical records indicate that this particular span of time is characterized by successive incursions and retreats by various tribes. By 1725, incursions by Comanche and their Ute allies had forced the Apache to withdraw from Colorado. The short-lived Ute/Comanche alliance that successfully pushed the Apache south disintegrated by the late 1740s (Anderson 1989:34). The Comanche subsequently controlled southeastern Colorado until they were pushed south by the Kiowa and Kiowa Apache in the late 1780s (Jones et al. 1998). A later alliance among the Comanche, Kiowa, and Kiowa Apache was, in turn, challenged by Cheyenne and Arapaho entering the region in the first quarter of the nineteenth century. During this rather turbulent period of history, however, trade networks between Native American and Anglo groups became well established despite ongoing hostilities.

Although people of European descent had been in the area sporadically for several decades, in 1806 the U.S. Government funded the first major expedition to investigate central and southern portions of the newly acquired Louisiana Purchase. Led by Lt. Zebulon Pike, the expedition explored both the

Arkansas River and South Platte River basins and, along the eastern slope of the Rocky Mountains, came as far north as the Colorado Springs area before heading west. After Pike's foray, the next significant expedition to the Front Range area occurred in 1820. Commanded by Major Stephen H. Long of the U.S. Army, the exploration had a decidedly scientific emphasis and traveled west along the South Platte River to the foothills before heading south. The first accounts of the Denver area and the foothills to the west were provided by the Long expedition. It is interesting to note that neither man ever set foot on the peaks that were later named after them.

The 1820s and 1830s were also characterized by a flourishing fur trade. Notable mountain men such as Andrew Sublette and Louis Vasquez exploited the abundant animal resources along the Front Range. Vasquez and a band of trappers are reported to have camped at the confluence of the South Platte River and Clear Creek (known originally as the Vasquez River or Vasquez Fork), and from there followed Clear Creek to its source in the mountains. The booming fur trade led to the establishment of a series of trading posts bordering the eastern flanks of the Rocky Mountains from southeastern Colorado to southeastern Wyoming. By the early 1840s a growing scarcity of beaver and changes in European fashion led to a significant decrease in the fur trade.

Throughout much of the 1850s, the Colorado Piedmont and adjacent foothills remained devoid of permanent settlements. The discovery of gold quickly changed this situation. Gold was reportedly first found along the Front Range creeks sporadically during the late 1840s and early 1850s (Mehls 1984:33), particularly by miners on their way to the gold fields of California. However, the 1858 discovery of gold near the confluence of the South Platte River and Cherry Creek provided the initial impetus for large-scale mining in the region (Ubbelohde et al. 1995:56–57).

During the initial gold rush years northeast Colorado above the fortieth parallel (Baseline Road in Boulder, Colorado) was part of the Nebraska Territory, and the portion below the fortieth parallel (which includes the Rocky Mountain Arsenal) was part of the Kansas Territory. Colorado was proclaimed an official territory by the U.S. Congress after Kansas entered the Union in 1861 and became the 38th State in 1876.

Homesteading on what is now the refuge began in 1871. Due to the semiarid conditions, early homesteaders probably ranched more than they farmed. This situation changed when the Highline Canal and associated Sand Creek Lateral were constructed in the late 1870s. Although neither irrigation system provided reliable sources of water, homesteading in

the region continued to increase. At its greatest density of occupation in the early 1940s, the site had 474 individual property owners, 241 homes, and 2 schools (Clark 1997). Only one home still exists, built in 1912 by Gottlieb and Rose Egli (Peil 2002; Wright and Wright 2014). The home is being restored as a representation of the early agricultural days of the area.

## **Recent History**

### **Rocky Mountain Arsenal: Chemical Weapons and Industry (1942–1983)**

Following the bombing of Pearl Harbor on December 7, 1941, the United States found itself searching for ways to produce state-of-the-art chemical weapons. While the U.S. did not want to use them, leaders believed that a formidable stockpile of chemical weapons would probably deter Germany and Japan from using them (Hoffecker 2001), a strategy that appeared to work very well.

The U.S. Army needed to find the best place to build such a facility. The Rocky Mountain Arsenal location exhibited several favorable attributes: it was close to major existing railroad lines, had adequate water and electric power, was adjacent to a major metropolitan area that could provide large numbers of skilled laborers, and was too far inland to be bombed (Hoffecker 2001). In June 1942, almost 20,000 acres were condemned, all inhabitants were forced to evacuate their homes, and new facilities began to be constructed. Although this action was devastating to many families, no noticeable complaints were heard. People were willing to make serious sacrifices for the war effort.

The factories (later named South Plants) were constructed and staffed so quickly that the first batch of the blistering chemical known as mustard was produced on New Year's Day 1943 (Hoffecker 2001). Other chemical weapons produced at the Arsenal included lewisite (also a blistering agent) and chlorine. The reluctance of Germany and Japan to use chemical weapons against the U.S. and its closest allies quickly led to a reduced demand for production at the Arsenal. By late 1943, the factories largely produced incendiary weapons rather than poisonous chemicals. At first, magnesium bombs were made, but critical material shortages for those weapons led to napalm production instead. Fire bombs were used most notably on Hamburg and Schweinfurt, Germany, as well as on Tokyo and other Japanese cities—always with devastating results.

Other notable aspects of this period were the large numbers of women working in the factories, freeing up men to fight. This situation provided an excellent opportunity for women to demonstrate that they could essentially do what men could do. The

importance of women working in war materiel factories was embodied in posters of the iconic female worker, Rosie the Riveter. Approximately 70 percent of the Rocky Mountain Arsenal workers in World War II were women (Remediation Venture Office 1999).

The Arsenal became home to approximately 100 German and Italian prisoners-of-war. Rose Hill School in the southwestern portion of the Arsenal became the camp's administration building. POWs were put to work on a variety of tasks, most notably working in the employees' cafeteria.

The Arsenal was put in standby status following World War II. However, South Plants was reactivated for incendiary production less than 2 months after the beginning of the Korean War in 1950 (Hoffecker 2001).

Construction of a new factory complex (North Plants) began in January 1951. While described as an "incendiary oil plant," the facility's secret mission was to produce German Brown nerve agent, also known as Sarin (Hoffecker 2001). The Cold War was in full swing, and the Russians were known to have captured an entire Sarin plant in Germany and reassembled it in the Soviet Union. This organophosphorus compound could kill a person by only contacting a single drop on the skin. The agent was being produced at North Plants by the summer of 1953, and like other poisonous chemical weapons previously produced at the Arsenal, served only as a deterrent.

Several chemical facilities on the Arsenal site became available following World War II and were leased to Julius Hyman and Co. for the production of insecticides. Shell Chemical Co. acquired this company and significantly expanded commercial operations, eventually constructing 150 new buildings in the South Plants area (Remediation Venture Office 1999). Shell produced numerous types of pesticides until 1982 (Wright and Wright 2014).

### Environmental Cleanup (1983–2011)

Pollution—from spills, improper disposal, and even disposal practices thought safe at the time—became a serious problem. Buildings, soil, and groundwater all became contaminated, especially in the central core of the Arsenal. Contamination in groundwater and soil was spread through both infiltration and wind erosion, causing widespread issues. Fortunately, a large buffer area around the exterior of the factories kept most windblown contaminants onsite and slowed the movement of groundwater onto other properties.

In 1988, after considerable litigation, the U.S. Army and Shell signed a consent decree that set the way for a comprehensive cleanup. Remedial investigations were initiated in 1983 under CERCLA. The section of land (36) between North Plants and South

Plants was described by the Arsenal commander as the "most contaminated square mile in the nation." This statement was later exaggerated to "the most contaminated tract of real estate on the Planet Earth." Later that year, the Rocky Mountain Arsenal was nominated for the National Priorities List under Superfund (Hoffecker 2001).

Numerous actions—known as interim response actions—were conducted during the mid- to late 1980s to prevent further contamination while a formal cleanup plan was developed and approved by regulatory agencies. In 1996, the ROD was signed and intensive cleanup was initiated. The last of the ground projects (structures, soil, and containerized liquids) was completed in 2011. Groundwater cleanup will continue for decades to come (Wright and Wright 2014).

### Refuge Development (1992–Present)

Large numbers of bald eagles were discovered on the eastern side of Rocky Mountain Arsenal in December 1986 during a biological survey (Ron Beane, ERO Resources, senior wildlife biologist; email communication). Service biologists were brought to the Arsenal because the bald eagle was listed as endangered at the time, and the communal wintering roost along First Creek in Section 5 met the criteria for critical habitat for this species. Service biologists then discovered impressive numbers of



Cindy Souders / USFWS

*Large numbers of bald eagles were discovered on the eastern side of Rocky Mountain Arsenal in 1986.*

wildlife species and began efforts to convert the site into a national wildlife refuge. The Rocky Mountain Arsenal National Wildlife Refuge Act was signed into law in 1992, with language stating that it would be managed as if it were a refuge until officially becoming a refuge when declared clean. Jurisdiction of portions of the land was handed over to the Service starting in 2004. While the U.S. Army maintains jurisdiction of approximately 1,000 acres of mostly caps, covers, and groundwater remediation sites, the refuge controls about 15,000 acres (Hoffecker 2001; Wright and Wright 2014)—a very large tract of public land in a very urban area.



*The Egli House*

## Cultural Resources

### Known Cultural Resources

The 1994 and 1995 cultural resource survey of 11,725 acres of Arsenal lands identified a total of 235 cultural resources. Forty-two of these resources had been previously identified during earlier surveys. Of the 235 resources, 121 are sites or structures and 114 are isolated artifacts: small groupings of artifacts called Isolated Finds (IFs). The 121 sites or structures consist of 84 historic resources, 23 prehistoric sites, and 14 multi-component sites with both prehistoric and historic remains. The prehistoric sites are all classified as campsites or lithic scatters (stone tools and fragments of stone from tool manufacture). The vast majority of the historic sites are the remains of farmsteads or homesites that dated from 1871 to 1941 and were demolished when the army acquired the land in the early 1940s. Several trash scatters were also recorded, as were laterals and reservoirs associated with the Highline Canal.

The 114 IFs consist of 87 that are historic, 26 that are prehistoric, 1 one that is multi-component. The majority of the historic IFs are locations with the very limited remains of farmsteads and homesites or trash scatters with no research potential. Prehistoric IFs included isolated lithics, small groupings of lithics, or scatters of fire-altered rocks.

In addition to these cultural resources, seven resources representing the World War II and Cold War activities have been extensively recorded (appropriate recordation is legally sound mitigation) and subsequently demolished. Four Districts (South Plant, North Plant, Logistics Complex, and the Munitions Storage Complex); the Post Headquarters; the Fire Station Headquarters; and the Burlington Northern Railroad tracks were determined to be eligible for inclusion in the NRHP (Remediation Venture Office 1999).

Four of the remaining sites are determined eligible for inclusion in the NRHP: two prehistoric sites, the Sand Creek lateral to the Highline Canal, and the pioneer home and garage that Gottlieb and Rose Egli built in the early 1900s (Wright and Wright 2014). Subsurface testing at the two prehistoric sites revealed intact deposits with significant research potential. The Sand Creek Lateral is a part of the much larger Highline Canal system that was instrumental in the settlement of the region. The Egli home, which was listed in the Colorado State Register of Historic Places in 2002, dates to the early years of the twentieth century and is the only remaining example of pre-war historic settlement of the Refuge. The Service and the Friends of the Front Range Wildlife Refuges are renovating portions of the home to protect it from weather and wildlife.

### Artifact Collections

Wright and Wright (2014) produced table 13, which not only demonstrates a timeline for the events in the area, but also identifies the artifacts we have accessioned (that is, acquired or added) into our extensive collection. Their paper on the collection, “A Vision for the Future of the Past,” follows the theme of John Hoffecker’s (2001) book, “Twenty-Seven Square Miles.” Using the book as a model, Wright and Wright divided the historical timeline of the Arsenal into six distinct periods: Prehistoric; Explorers, Trappers, and Railroads; Homesteaders and Early Colorado Agriculture; World War II; The Cold War; and Cleanup and Refuge Transition. They made the following observations:

- The Rocky Mountain Arsenal’s unique success story seems to be a well-kept—or at best, misunderstood and/or underrepresented—secret. Even many of the employees are unaware of what it means, what it looks

**Table 13. Items accessioned into existing collection itemized by historical period, Rocky Mountain Arsenal National Wildlife Refuge, Colorado.**

<i>Period</i>	<i>Historical timelines and events*</i>	<i>Collection artifacts</i>
Prehistoric: 12,000 B.P. to A.D. 1350	Native American campsites along First Creek (two prehistoric sites eligible for listing in the NRHP) (Interpretation of this period not available in Visitor Center)	157 Accessions: points, scrapers, mano stones, pottery shards, grinding stone and metate, bison bones, stone flakes, and one stone spear point estimated 7,000 years old.
Explorers, Trappers, and Railroads: 1700s–late 1800s	(Historical events in refuge vicinity) <i>1820</i> : Major Stephen Long expedition, 1820, near Brighton, CO. <i>1860</i> : Wagon trails cross RMA to reach Denver and gold fields. <i>1869</i> : Denver Pacific Railroad reaches to within about one-half mile of the RMA's northwest corner. <i>1870</i> : Kansas Pacific RR comes within 2 miles south of RMA. <i>1881</i> : Chicago, Burlington and Quincy RR line is built adjacent to RMA's northwest edge, defining diagonal boundary. <i>1886</i> : East Colorado RR (narrow gauge) is operational, running roughly along present day 56th street. (Interpretation of this period not available in Visitor Center)	0 Accessions. No artifacts in collection representing this period.
Homesteaders and Early Colorado Agriculture: 1870–1942	<i>1871</i> : The first homesteader was Fred Steinhauer, 160-acre homestead in Section 4. Some 474 homesteads eventually occupy land that is to become Rocky Mountain Arsenal.	102 Accessions: mostly bottles and jars; also coins, children's toys, license plates, coins, two rifles, one shotgun. Also includes oral and video histories from homesteaders.
World War II: 1941–1945	<i>1941 (December 7)</i> : Japanese attack Pearl Harbor. December 7th Avenue—present-day 7th Avenue—is named in remembrance of the Pearl Harbor Attack, first road built into Arsenal. <i>1942</i> : (May 2) U.S. War Board announces 19,882 acres purchased outside Denver will be the future location of a chemical weapons production facility. In June, the first fully operational building is completed a full year ahead of schedule. <i>1942 (summer)</i> : All homesteaders are forced to vacate their properties. <i>1942–1945</i> : Mustard, lewisite, chlorine, M74s, M47s, and phosgene-containing shells are manufactured. About 70 percent of Arsenal employees are women (Rosie the Riveter and We Can Do It poster). <i>1943 (January 5)</i> : Building 111 is dedicated by a formal ceremony and flag-raising by Brigadier General Loucks. Workers commended. <i>1943</i> : South Plants manufacturing facility becomes operational, producing mustard gas, napalm and incendiary bombs (M47s, M69s, M20s), and “Willie-Peter” (white phosphorous) artillery rounds. <i>1943 (October)</i> : B17 Superfortresses using 1,300 M47 incendiary bombs destroy the Focke-Wulf aircraft assembly plant at Marienburg, East Prussia. M47s were also used for the air raid to the roller bearing plant in Schweinfurt, Germany, as well as the bombing of the Ploesti oil refineries in Rumania. <i>1943</i> : From November 6, 1943 to April 1946, U.S. Army operates a prisoner-of-war camp, with as many as 300 prisoners (in Section 3, near present-day Visitor Center). Old Rose Hill School converted into an administration complex for the POW camp. <i>1944</i> : Marge Brandow and Pete Fox (sisters) begin work at the Arsenal Incendiary Oil Bomb factory (oral history collection).	Accessions: helmets, bottles, 20 mm round, tags for Chemical Warfare Service, signs, Chemical Service insignia, flags.  We Can Do It poster at Visitor Center.  Partial bomb fin at Visitor Center.  One foundation of guard tower still present. One 10- by 10-ft WWII guard tower foundation on the north edge of Lake Ladora that guarded part of the South Plants perimeter.  Chalk writing in Section 6 bunker.  Oral histories in collection.

**Table 13. Items accessioned into existing collection itemized by historical period, Rocky Mountain Arsenal National Wildlife Refuge, Colorado.**

<i>Period</i>	<i>Historical timelines and events*</i>	<i>Collection artifacts</i>
	<p>1945 (March): Large-scale air raid by B-29 bombers over Tokyo, using M69 incendiary bombs. The air raid and subsequent fire-storm is believed to have killed an estimated 40,000 civilians and destroyed 16 square miles of the city. Raid is regarded as a key turning point in the air war over Japan.</p> <p>1945 (June): Nora Ruiz killed in pyrotechnic assembly line; five other women burned, some seriously.</p> <p>1945 (August): World War II ends. More than 100,000 tons of incendiary bombs are dropped on Japan, destroying 158 square miles of urban industrial areas and leaving 8.4 million people homeless. U.S. military estimates 40 percent of every Japanese city hit by incendiary bombs is destroyed.</p>	
Cold War: 1946–1982	<p>1945–1950: Demilitarization of mustard gas shells begins.</p> <p>1946: Arsenal is placed on standby status.</p> <p>1947: Portions of the facility are leased to private industry, including Shell Chemical Company and Julius Hyman and Company, which uses the facility to manufacture agricultural pesticides.</p> <p>1947–1949: Demilitarization of 155mm shells, 75mm shells, ANM76 bombs, M78 bombs, M79 bombs.</p> <p>1950–1952: Arsenal reactivated for Korean War. Manufactures M74 (M20A1 Cluster) bombs, M31 clusters, E101 clusters, E101R1 clusters, M15 hand grenades, white phosphorous cups, M23 fire bomb igniters, renovated M19 clusters.</p> <p>1951: Construction starts on the North Plants complex.</p> <p>1952: Shell Chemical Co. acquires Julius Hyman and Co, which had been producing agricultural chemicals. Shell continues to manufacture agricultural chemicals until 1982.</p> <p>1953: In summer, nerve gas production begins at North Plants Sarin (GB) complex. From 1953 to 1957, the Arsenal produces approximately 500,000 gallons of (GB) nerve agent Sarin, and was the free world's primary stockpile of that chemical agent.</p> <p>1956: Basin F is constructed, initiation of contamination cleanup efforts.</p> <p>1957: U.S. Army places the Arsenal on standby status and stops producing munitions.</p> <p>1959: Hydrazine blending and storage facility is constructed to make rocket fuel for U.S. Air Force, producing until 1982.</p> <p>1960s: Biological warfare program starts; collection of wheat rust spores from farmed fields Sections 23–26 for planned release in U.S.S.R. to cripple wheat crop. "Button bombs" and napalm are produced during the Vietnam war.</p> <p>1961: U.S. Army begins construction of a deep injection well; over the next 4 years 365 million gallons of waste are pumped 12,000 feet underground.</p> <p>1964–1973: Biological warfare activities—storage, planting, and destruction of wheat rust spores.</p> <p>1965: Earthquakes hit Denver area, stopping deep well injection the following year (1966).</p> <p>1967: Arsenal concentrates on production of rocket fuel for NASA.</p> <p>1968: President Johnson orders the destruction of excess and obsolete chemical weapons. Arsenal is chosen to demilitarize the U.S. Army's Sarin (GB) and mustard chemical agent supplies: Project Eagle (Phase I) for mustard; Project Eagle (Phase II) for Sarin. Demilitarization of M34 clusters (Sarin), Weteye bombs (Sarin), and Honest John warheads M190 and M139 bomblets (Sarin).</p>	<p>Accessions: approximately 200</p> <p>Includes: nerve gas manufacturing control panels; robotic arm for de-mil of M34 cluster bombs; munitions scale; X-ray machine; warning signs of all kinds; rubber protective suits; weight scale; wooden cart, wooden dolly, bombproof telephone and clocks; deep injection poster; GB emergency poisoning kit; policeman badges; fire department items; large purple mixer stick, some munitions, many forging tools.</p> <p>Also includes oral and video histories of employees who worked here during this time, not available in VC.</p> <p>Chiller gauges—item now in Butler Building</p>

**Table 13. Items accessioned into existing collection itemized by historical period, Rocky Mountain Arsenal National Wildlife Refuge, Colorado.**

<i>Period</i>	<i>Historical timelines and events*</i>	<i>Collection artifacts</i>
	<p>1969: Demonstrations against RMA occur for chemical contamination. Denver Post urges U.S. Army to close Arsenal.</p> <p>1970: North Plants manufacturing facility goes on standby status until closure in 1982. During this time it dismantles and disposes of U.S. Army ordnance. President Nixon promises destruction of all stockpiled chemical weapons.</p> <p>1971: Incineration of mustard gas begins and destruction of Sarin (Project Eagle). Arsenal's primary mission shifts from national defense and space exploration to destroying munition stockpiles and chemical warfare agents.</p> <p><i>1973</i>: M34 Cluster bombs filled with nerve gas are demilitarized. Stockpile of all biological agents destroyed.</p> <p><i>1974–1975</i>: Reports of pollutants in wells near Arsenal.</p> <p><i>1976</i>: Remaining stocks of phosgene gas are sold to private industry, removed from site. Destruction of Honest John warheads and nerve agent bomblets.</p> <p>1979: U.S. Army constructs its first groundwater treatment system to treat contaminated groundwater onsite.</p> <p>1982: All chemical manufacturing and demilitarization at the Arsenal ceases.</p>	Cluster bomblets in collection, one at Visitor Center.
Cleanup and Refuge Transition 1984–2011	<p><i>1983</i>: Cleanup investigations begin under CERCLA.</p> <p><i>1984</i>: Section 36 is described as “the most contaminated square mile in the world” and RMA is nominated to EPA's National Priorities List under Superfund law.</p> <p>1986: Roosting bald eagles found on RMA.</p> <p>1987: U.S. Army and Shell implement construction of groundwater treatment plants, cleaning up Basin F, dismantling rocket fuel blending facility, and asbestos removal. RMA is put on EPA's National Priorities List (Superfund).</p> <p>1989: Congressional members Pat Schroeder and Wayne Allard propose legislation to accelerate Arsenal cleanup and conversion to a national wildlife refuge.</p> <p>1992: 1992 Refuge Act, the founding legislation of Rocky Mountain Arsenal National Wildlife Refuge, passed by Congress.</p> <p>1995: The Record of Decision (ROD) directing cleanup is agreed upon by multiple Federal and State agencies.</p> <p>1997: U.S. Army and Shell undertake 21 specific cleanup projects outlined in the ROD.</p> <p>1998: Demolition of the U.S. Army's former manufacturing plants begins, eventually involving more than 300 structures and the recycling of 10,000 tons of steel.</p> <p>2003: Last of the Arsenal's chemical weapons manufacturing facilities and equipment are destroyed.</p> <p>2004: EPA certifies 5,000 acres for removal from the Superfund list; those acres are transferred to the Service, officially establishing the Rocky Mountain Arsenal National Wildlife Refuge.</p> <p><i>2011</i>: The last and final stages of ground projects associated with cleanup are completed.</p>	Accessions: 2 Map poster, picture, oral histories of Pat Schroeder and others.

\* Italicized dates reflect timeline items currently not represented on panels at the Visitor Center.

like, to have spent 14 years and \$2 billion on remediation and what happened before and after that; what 474 homesteads sprinkled across the (then) 25 square-mile landscape and the farm life of settlers looked like in the pre-World War II era; the significant role the Arsenal played in World War II and the Cold War: some of the many events that shaped the Arsenal into the thriving wild-life refuge it is today that hosts over 330 animal species and over 300 native plant species and boasts thousands of visitors per year. That is our heritage and our history. It is also the history of this country.

- This story—the full story and the details that make it interesting—should be told. The variety of historically significant cultural resources that have survived over the years are the original props: the most tangible pieces of the past. They speak volumes to and paint pictures for those who see and touch them. Environmental education opportunities abound. In addition to the public benefit, any items that could be potentially displayed in Service buildings would be seen and appreciated by employees passing through. It would be a unique keepsake for RMANWR employees as a way to have a visible reminder of its past, and a tribute to those whose efforts came before them.

## 3.7 Research and Science

We are currently engaged in several research and monitoring programs, and some of our management projects assist in research, monitoring, and inventory programs. We know that this work is and will continue to be helpful in making sound management decisions. For example, our burrowing owl trapping and banding activities add to other research underway on the migratory pathways of this species throughout western North America. Other monitoring and inventory activities and programs that we conduct annually on the refuge are listed below:

- Bald eagle winter roost and nest counts (cooperative effort with the Rocky Mountain Bird Observatory) to monitor overall riparian health at the Refuge as well as individual bald eagle reproductive production
- Monitoring of raptor nests (such as Swainson's hawk and burrowing owl)



*Bison roundup*

© Dave Showalter

- Electrofishing and gillnetting in refuge reservoirs to assess fish populations
- Fall deer census and bison roundup
- Monitoring of vegetation and native and invasive species (especially on restored habitat sites)
- Annual mourning dove banding
- Support of the Great Backyard Bird Count in February
- Christmas Bird Count in January
- Spring and fall bird counts in May and September
- Annual monitoring of black-tailed prairie dog locations and densities

While we do not actively undertake specific climate change research at this time, we work with U.S. Army personnel to collect meteorological data that may be useful in the future for identifying trends in climate change at the refuge. Currently we are not conducting any type of social science, social media, or emerging technologies research. Occasionally we allow social science research that might benefit our management of the refuge.

## 3.8 Infrastructure and Operations

Our visitor facilities include a Visitor Center, a Contact Station, four information kiosks, two amphitheaters (one behind the Visitor Center and one at

Lake Mary), a fee station (iron ranger), and a wildlife viewing blind.

The refuge has entrance signs at the main gate and the Havana gate, as well as guide and directional signs throughout the refuge. We have installed and maintain interpretive signs at three of the information kiosks, the Contact Station, and Lake Mary.

There are five major dams on the refuge. Upper Derby, Lower Derby, Ladora, and Lake Mary dams are currently owned and operated by the U.S. Army. Havana Pond dam is owned and operated by the City of Denver and UDFCD. We are not planning to accept transfer of the U.S. Army dams until the necessary repairs on Lower Derby, Ladora, and Lake Mary dams have been completed. Upper Derby would be partially breached prior to transfer and would no longer be considered a dam. Because of the damages resulting from floods in 2013, Havana Pond is currently impaired but is undergoing repairs.

The entire refuge is surrounded by 8-foot chain-link fence to preclude deer movement across the refuge boundary and to contain the refuge bison herd within the boundary. Several miles of fencing within the refuge support the refuge's habitat and wildlife management activities.

The refuge is open from sunrise to sunset. Visitors are generally not allowed in the refuge during hours of darkness.

We manage the refuge in adherence to the Service's climate change policy, taking all the necessary measures to increase energy efficiency and reduce the carbon footprint of our operations.

Tables 6 and 7 in "Section 2.11—Funding and Personnel" provide information on the refuge's current funding and personnel (as well as on the different alternatives' scenarios). Every year we have around 80 volunteers who actively support refuge operations by staffing the front desk of the Visitor Center, conducting interpretive tours and programs, performing light maintenance of trails and facilities, assisting with biological surveys, and staffing special events. Together with our volunteers we maintain a fenced pollinator garden behind the Visitor Center.

## 3.9 Access and Transportation

### Roads

Currently there are 7.8 miles of roads open to the public: 7.2 miles of asphalt roads and 0.6 mile of gravel roads. Roads open to the public consist of the



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*Our visitor facilities include a Visitor Center.*

entrance road, Legacy Loop, a portion of the Wildlife Drive, and several small access roads to points of interest such as fishing reservoirs. All existing public roads are open to two-way vehicular traffic. There are 43.5 miles of administrative roads—asphalt, gravel, and two-tracks—used to access sites throughout the refuge; these are closed to the public. Roads are maintained by refuge and U.S. Army staff on an as-needed basis.

### Trails

Currently there are 27.1 miles of trails in and surrounding the refuge that are open to the public. Approximately two-thirds of this trail system is the refuge Perimeter Trail. Within the refuge, approximately 10 miles of nature trails are open to hiking and snowshoeing (Legacy, Discovery, Havana Pond, and Prairie Trails). These trails are surfaced with crushed gravel fines material. Bicycle access is only allowed on the entrance road from the main gate to the Visitor Center.

### Access

Public access to the refuge is currently limited to the main entrance, known as the Prairie Gateway, at 6550 Gateway Road north of the Dick's Sporting Goods Event Complex. Visitors typically access the refuge from Quebec Street and 64th Avenue. Prairie Parkway heads southeast approximately 0.6 mile to a left turn onto Gateway Road. The main refuge entrance is 0.8 mile farther on Gateway Road. Visitors may have difficulty finding the entrance because of the multiple turns and less than optimal directional signs. Furthermore, Commerce City's Prairie Gateway Open Space Trail follows both Prairie Parkway and Gateway Road, contributing to the confu-

sion: visitors sometimes believe they are at the refuge when in fact they have not yet reached the entrance. Finally, the current refuge entrance gate—a sliding chain link gate—is uninviting, and visitors occasionally leave, believing that it is not the entrance.

For administrative purposes, three additional regular vehicle access points are on the north, west and south sides of the refuge. Several other locked swing gates can be used for emergencies.

quently, a comprehensive signage plan is needed. Visitors can, however, obtain a refuge map at the Visitor Center, the Wildlife Drive kiosk, or the Contact Station kiosk.

## 3.10 Socioeconomic Environment

### Way-Finding within the Refuge

Way-finding within the refuge consists of brown signs that direct visitors along our auto tour routes and to points of interest such as fishing reservoirs and trailheads. For their safety, visitors are reminded to stay in their vehicles while in the bison pasture. However, signage across the refuge has been inconsistent because of the change in management from the U.S. Army to the Service. Conse-

### Social and Economic Context

Tables 14 and 15 provide key demographic data for understanding the refuge vicinity's communities. The refuge is situated in a diverse area in the Colorado Front Range region. A variety of socioeconomic and cultural barriers may impede residents from participating in outdoor recreation. Community character-

**Table 14. Comparison of U.S. Census data to the results of the Rocky Mountain Arsenal National Wildlife Refuge visitor survey.**

	<i>US Census —Aurora</i>	<i>US Census— Commerce City</i>	<i>US Census —Denver</i>	<i>2012 Visitor Survey</i>
Population	339,030	48,421	634,265	N/A
Median Income	\$51,048	\$60,963	\$49,091	\$75,000–\$99,999
College or higher	26.6%	20.1%	42.2%	48%
Race				
Native American	1.0%	1.5%	1.4%	5%
Asian	4.9%	2.2%	3.4%	3%
Black or African American	15.7%	3.1%	10.2%	3%
Hispanic	28.7%	46.8%	31.8%	7%
Native Hawaiian or Pacific Islander	0.3%	0.1%	0.1%	1%
White	61.1%	69.1%	68.9%	95%

**Table 15. Enrollment and demographics of public school districts surrounding the Rocky Mountain Arsenal National Wildlife Refuge, 2013.**

	<i>Aurora Public Schools</i>	<i>Adams 14</i>	<i>School District 27J</i>	<i>Denver Public Schools</i>
Enrollment	37,389	7,321	16,193	81,870
Native American	0.7%	< 1%	0.7%	0.8%
Asian	4.6%	< 1%	2.8%	3.3%
Black or African American	17.9%	2%	1.9%	14.5%
Hispanic	54.7%	83%	45.0%	58.0%
White	17.8%	13%	47.3%	20.3%
Other	4.4%	< 2%	2.1%	2.9%
Free/Reduced Lunch	71%	72.5%	37.7%	68%

istics provide a context for understanding potential barriers to visiting and engaging with the refuge. Accordingly, understanding the present characteristics of surrounding communities can help refuge staff determine how best to serve local residents, while exploring trends in community characteristics can assist with planning into the future (USGS 2014a).

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## Population

In 2012, the total population of the eight-county local area near the Refuge was more than 3.1 million people, or roughly 60 percent of Colorado's total population. However, these eight counties contain a combined area of less than 10 percent of the State's total area (10,200 square miles compared to the State's 103,600 square miles), giving the local area a disproportionately dense population compared to the State overall. In fact, each of the eight counties is more densely populated than the State as a whole. In 2012, Denver County had the largest resident population (619,000) and was also the most densely populated (more than 4,000 people per square mile) of the eight counties. Broomfield County had the smallest population (57,000), but being smallest of the eight counties (153 square miles), it was also the second most densely populated (1,700 thousand persons per square mile). Weld County was the least densely populated county (65 persons per square mile), but it is by far the largest of the eight counties (nearly 4,000 square miles) (USGS 2014b).

Since 1990, population has increased steadily in all eight counties near the refuge, in many instances outpacing the growth rate of the State as a whole. From 2000 to 2010, Adams, Broomfield, Larimer, and Weld Counties all grew at a rate faster than that of the State. The projected growth rates for 2010–2020 for Broomfield, Denver, Larimer, and Weld Counties similarly outstrip that for the State (USGS 2014a).

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## Race and Ethnicity

The growing population of the eight local area counties has become more diverse over time. Minority populations in all counties have steadily increased over the last few decades. Denver, Adams, Arapahoe, and Weld Counties have the highest percentages of minority residents. In the case of Denver and Adams Counties, minorities constitute almost half the population and, with the exception of Larimer County, minorities make up 20 percent or more of the population in each county. Both Hispanic/Latino and non-white populations have increased in all counties since

1980. Adams, Denver, and Weld Counties have the highest percentages of Hispanic/Latino residents, while Denver, Arapahoe, and Adams have the highest percentages of non-white residents. There are a variety of racial groups within the non-white population; racial and ethnic groups are rarely homogenous and there may be more diversity within a group than between groups (USGS 2014a).

A diversity index (that is, a statistical calculation of the probability that two individuals selected at random from a given census tract are from different racial or ethnic groups) shows how diversity varies from neighborhood to neighborhood. The neighborhoods closest to the refuge include some of the most diverse neighborhoods in the Denver Metropolitan area. Census tracts nearest the refuge have lower percentages of white residents and higher percentages of Hispanic/Latino residents than tracts farther away (USGS 2014a).

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## Age

Overall, the population around the refuge is aging. The percentage of households with children has decreased over time in all counties. However, the decline in some counties, such as Broomfield, Adams, and Weld, has been minimal since 1990. At the same time, the percentage of the population over the age of 65 has increased in most counties except in Denver and Weld, where it has decreased or remained stable (USGS 2014a). The median age of residents in each of the eight counties ranged from 32.6 in Adams County to 40.6 in Jefferson County (USGS 2014b).

The neighborhoods around the refuge tend to have more households with children under the age of 18 than neighborhoods farther away. The percentages of older residents in the census tracts near the refuge mirror the county averages, with fewer than 15 percent of people aged 65 and over (USGS 2014a).

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## Education

The percentage of residents with at least some college education in the region has risen over time to more than 50 percent in all counties by 2010. Conversely, in 2010, in some counties, such as Adams, Denver, and Weld, 15 percent or more of the residents had less than a high school degree. Additionally, in 2010 in all counties, except Boulder, a fifth to a quarter of residents had a high school degree or less (USGS 2014a).

While the overall level of education for the region has increased over time, a closer look at the census

tracts around the refuge reveals neighborhoods with high percentages of residents age 25 and above without high school degrees. In several census tracts to the west and southwest of the refuge, 41 percent or more of the residents age 25 and above do not have high school degrees (USGS 2014a).

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## Income, Employment and Poverty

Median incomes (adjusted to 2010 dollars) have generally risen over time in the region, despite a drop in 2010 in all counties except Weld. The gap between the lowest and highest income has widened slightly. In 1980, the highest and lowest median incomes for any individual county were \$22,594 apart; in 2010, the highest and lowest median incomes were \$28,090 apart. The percentage of people living below the poverty level remained relatively steady over time in the region until 2010, when it increased in all counties. Larimer, Boulder, and Arapahoe Counties saw the biggest increases (4 percent or more) from 2000 to 2010 in the percentage of people living below the poverty level. The decrease in median incomes and increase in percentage of people living below the poverty level from 2000 to 2010 most likely reflects the effects of the recession of 2007–2009 (USGS 2014a).

Though the percentage of residents living below the poverty level is relatively low at the county level, most of the census tracts near the refuge exceed the percentage of impoverished residents in their counties by a substantial amount. In many of the neighborhoods on the west and south sides of the refuge, one-fifth to two-fifths of the residents are living below the poverty level (USGS 2014a).

Comparing the 2013 average unemployment rates between the eight counties further reveals some differences in relative economic health. Across the eight-county region, average 2013 unemployment ranged from a low of 5.2 percent in Boulder County to a high of 7.5 percent in Adams County. The unemployment rate for six of the eight counties is comparatively similar (within one percentage point) to the State's average unemployment rate of 6.8 percent in 2013. Deviating from this trend are Boulder and Larimer Counties, each with unemployment rates at or below 5.4 percent. This suggests a relatively healthier economic situation for employees in those two counties compared to both the State's average and to the other six counties in the eight-county local area (USGS 2014b).

The eight-county area boasted more than 1.5 million full-time jobs in 2012. Accounting for more than one in every five jobs, education, health care, and social assistance was the largest industry category

within the eight counties. The region is also a hub for professional and scientific industries, accounting for 14.6 percent of total employment. Additionally, combined employment in all travel and tourism sectors—retail trade, transportation, arts, entertainment and recreation, and accommodation and food—constituted more than 25 percent of total employment in the eight-county region. Construction and manufacturing also have a large combined presence, with nearly 15 percent of total employment falling into one of these sectors (USGS 2014b).

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## Access to Transportation

The majority of households in the region have access to two or more vehicles, but the percentage of households with access to one or no vehicle has increased slightly in all counties except Larimer and Broomfield. In some counties, such as Denver, Arapahoe, and Boulder, a quarter or more of the households have access to only one or no vehicle. Despite a lack of access to vehicles for these households, in each county only a small percentage of working residents aged 16 and over use public transportation to get to work (USGS 2014a).

The neighborhoods around the refuge tend to have access to fewer vehicles than the county-wide levels. In several census tracts west and south of the refuge, from two-fifths to three-fifths of residents have access to one or no vehicle. Despite a relatively widespread lack of access to vehicles, 10 percent or fewer of workers aged 16 and over in neighborhoods near the refuge use public transportation to get to work (USGS 2014a).

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## Recreation and Tourism

Outdoor recreation is an important component of Colorado's economy, contributing more than \$34.5 billion in total economic output and supporting 313 thousand jobs statewide in 2013. With more than 24 million acres of federally managed lands, Colorado hosts a diverse range of outdoor recreational opportunities. In 2013, 90 percent of Colorado residents participated in some form of outdoor recreation. The three most reported popular outdoor recreational activities in Colorado are walking, hiking/backpacking, and picnicking (USGS 2014b).

Fishing, hunting, and wildlife-viewing are also popular recreational activities within Colorado, with approximately 2.3 million residents and nonresidents participating in wildlife-related activities in the State during 2011. Approximately 70 percent of peo-

ple who participated in wildlife-related activities in Colorado reported engaging in wildlife viewing, while 40 percent engaged in either hunting or fishing. In 2011, residents and nonresidents spent a total of 6.9 million days watching wildlife away from home, with residents accounting for 69 percent of wildlife watching days. Colorado residents accounted for 71 percent of the 2.2 million hunting days in 2011, and accounted for 89 percent of the 8.4 million fishing days. Spending associated with all wildlife recreation in Colorado totaled \$2.98 billion in 2011; of this amount nearly 42 percent were trip-related expenditures, 52 percent was spent on equipment, and the remaining 6 percent was spent on other related items (USGS 2014b).



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*Refuge Day*