Appendix H – Prescribed Grazing Plan for Bitter Creek NWR

Bitter Creek National Wildlife Refuge

Prescribed Grazing Plan

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Introduction

Bitter Creek National Wildlife Refuge (NWR) is part of the Hopper Mountain NWR Complex; Bitter Creek NWR and Hopper Mountain NWR are the primary refuges for field activities associated with the California condor (*Gymnogyps californianus*) Recovery Program. Bitter Creek NWR is mostly located in southwestern Kern County in the Transverse Ranges, with small portion in Ventura County (Figure 1), approximately 80 miles north of Los Angeles and approximately 10 miles southwest of the community of Maricopa in the foothills above the San Joaquin Valley. The approved acquisition boundary also extends into a small portion of San Luis Obispo County. Several California ecoregions adjoin in this part of the state. This is "Condor Country" and the natural vegetation and wildlife habitat in this region is expansive and diverse (Darlington 1987; Twisselmann 1967). The refuge is located in the southwestern subdivision of the California Floristic Province, which is adjacent to six other subdivisions. The California Floristic Province contains one-quarter of the North American flora, with over half endemic to California (Faber 1997; Hickman 1993).

The refuge is located adjacent to other conservation lands (Figure 1) administered and managed by the Bureau of Land Management (BLM) (Carrizo Plain National Monument), U.S. Forest Service (USFS) (Los Padres National Forest), California Department of Fish and Game (CDFG) (Elkhorn Plain, Carrizo Plain), The Nature Conservancy (Carrizo Plain), Wildlands Conservancy (Wind Wolves Preserve), and the Tejon Ranch Conservancy (Tejon Ranch). These agencies and private organizations manage habitats for diverse native plants and wildlife, including local endemic species; endangered, threatened and special status species; and migratory birds. Habitat management in this area, including vegetation management, control of invasive plant species, and reduction of hazardous fuels, includes a multitude of activities that involve planning and partnerships to implement.

This plan addresses the management of grasslands and other associated rangeland types at Bitter Creek NWR, which include over 9,000 acres of this 14,097-acre refuge. The environmental planning process can be understood as a hierarchy of goals, objectives, and strategies. This process has been underway for several years at the Hopper Mountain NWR Complex, with considerable progress in identifying issues and public concerns (Draft CCP USFWS 2012a). Goals are broad statements of the desired future conditions for refuge resources. Objectives are derived from goals and provide a foundation for determining strategies, monitoring refuge accomplishments, and evaluating success. Objectives either explicitly or implicitly recommend specific actions selected from a set of appropriate tools (Bush 2006). For example, a proposal to implement prescribed livestock grazing to manage grassland habitat addresses a goal (see Goal 2, below) by implementing actions in a strategy (see Strategy 2.2.3, below).

The grazing prescriptions to follow will help achieve objectives set forth in the Hopper Mountain, Bitter Creek, and Blue Ridge NWRs Comprehensive Conservation Plan/Environmental Assessment (Final CCP) (USFWS 2013).

Goals, Objectives and Strategies

The following goals, objectives and strategies from the Final CCP are those that include a grazing element and form the basis for grazing prescriptions and recommendations. They are slightly changed from the goals, objectives, and strategies in the Draft CCP (USFWS 2012a). These goals, objectives and strategies provide criteria for assessing success in achieving said goals and objectives, primarily on grasslands, but also on associated key rangeland types within the complex. Rangelands are best defined collectively as grasslands, shrublands, and savannas (Heady and Child 1994).

GOAL 2:

Protect and enhance Bitter Creek NWR grasslands to promote ecologically sound conditions to support a diversity of migratory birds and special status plant and animal species.

Objective 2.2: Within 10 years, provide suitable grassland habitat with vegetation height between approximately 1 to 4 inches, shrub cover less than 20%, and residual dry matter between 300 and 600 pounds/acre to benefit San Joaquin Valley special status species (such as San Joaquin kit fox, giant kangaroo rat, blunt-nosed leopard lizard, Nelson's antelope squirrel) on approximately 1,300 acres in the northwest portion of the refuge.

Grazing related strategies

2.2.2 Evaluate and implement various grassland management tools to achieve habitat objectives (e.g., grazing, over-seeding with native perennial grasses and forbs requiring the use of local ecotypes [from seeds collected on-site], mowing, herbicide).

2.2.3 Implement prescribed grazing through annual permits and agreements if appropriate to meet habitat objectives.

2.2.4 Monitor vegetation and animal community responses to management actions and evaluate data to inform adaptive management.

Objective 2.3: Within 10 years of CCP approval, manage up to 7,000 acres of the refuge's grasslands to achieve a mosaic of habitat structure and floristic diversity, including scattered shrubs, to support a diversity of grassland birds. Manage approximately one-third as short grassland (height 3 to 8 inches), another third as medium grassland (height 6 to 12 inches), and another third as tall grasslands (height 12 to 25 inches), and monitor for native plants.

Grazing related strategies

2.3.2 Evaluate and implement various grassland management tools (e.g., grazing, over-seeding with native perennial grasses and forbs requiring the use of local ecotypes [from seeds collected on-site], mowing, herbicide) to achieve habitat objectives.

2.3.3 Consider implementing prescribed grazing through permits and agreements when appropriate to meet habitat objectives.

2.3.4 Develop and implement protocols to monitor vegetation and animal community responses to management actions and evaluate data to inform adaptive management.

2.3.5 Coordinate with neighboring land management agencies and organizations to share best practices for achieving management objectives.

2.3.6 Use prescribed livestock grazing to manage grass height and cover density for target species' habitat conditions, reduce competition from non-native annual grasses and forbs, improve available soil moisture, manage for grassland mosaics, encourage germination of native species, and allow oak recruitment in grassland savannas, as applicable.

2.3.7 Monitor native plant composition and frequency over time to track succession and density.

Objective 2.4: Prevent the infestation of new invasive plant species and reduce the range and coverage of existing invasive species by 25%, including yellow star thistle (*Centaurea solstitialis L.*), and non-native mustards (e.g., *Hirschfeldia incana, Sisymbrium* sp.).

Grazing related strategy

2.4.4 Evaluate the use of prescribed livestock grazing to reduce invasive plants as part of the IPM Plan.

GOAL 4:
Restore and maintain riparian and wetland communities to support native plants and wildlife.

Objective 4.3: Within 5 years of CCP approval, restore natural spring flow in 3 sub-watersheds within the 6 watersheds on Bitter Creek NWR to support native plants and wildlife.

Grazing related strategies

4.3.2 Reduce and modify water control structures to restore natural flows and eliminate diversion of water except as needed for fire suppression, bunkhouse use, and prescribed livestock grazing needs.

4.3.3 Require exclusionary fencing to protect riparian areas and wetlands prior to implementation of prescribed grazing in adjacent grasslands.

Objective 4.4: Maintain and improve existing tricolored blackbird breeding habitat by providing open accessible water (within 950 feet of the colony) suitable nesting substrate (cattail, nettles, bulrush, and willows), and foraging habitat (within about 9,800 feet of the colony).

Grazing related strategies

4.4.3 Fence out livestock and native grazers from historic tricolored blackbird nesting and breeding habitat to maintain vegetation cover.

4.4.4 Consider and evaluate the use of livestock grazing in areas adjacent to tricolored blackbird breeding colonies to optimize grassland foraging areas.

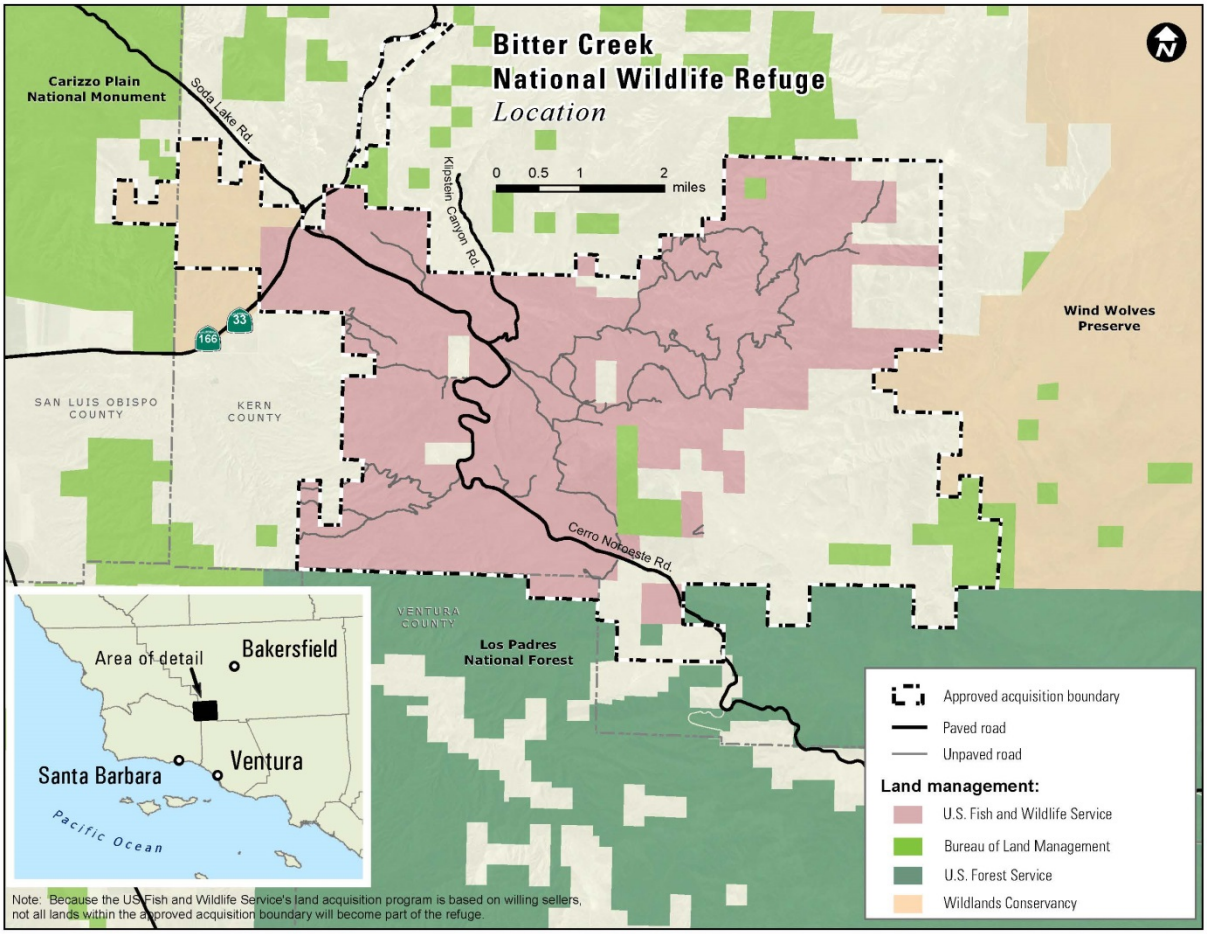
Background

Healthy rangeland ecosystems supporting native plants and providing habitat for dependent wildlife species are the primary and overarching goals supported by grazing related objectives and strategies. Improving wildlife habitat by changing vegetation structure and composition, and by providing a variety of levels of annual grass residual dry matter (RDM), is a primary purpose for a prescribed grazing program. A grazing plan is necessary to implement the management strategies and outline monitoring required to track accomplishments and adapt new or revised prescriptions to achieve success (Bush 2006).

The science base for grazing management has been significantly improved and enhanced over the past decade, culminating in reviews, analyses, and recommendations for rangeland management practices in North America (Briske et al. 2011), reviews of effects of practices on California grasslands (Stahlheber and D'Antonio 2013, Huntsinger at al. 2007)), and general management recommendations for California rangelands (Huntsinger et al. 2007). Those authors concluded that the result of any specific grazing practice is highly site (in many cases, this is equivalent to soil type) specific and primarily depends on the interaction of site and weather with grazing. This means that even if there were experimental results from grazing studies in the region of Bitter Creek, the results would have limited predictive value for grazing management (Bartolome et al. 2009). The approach currently recommended applies general principles for grazing management (described below) under monitoring sufficient to inform adaptive management decisions (Herrick et al. 2012).

This grazing plan includes general prescriptions for specified managed grazing units. Grazing parameters (period, season, AUMs) should be given some flexibility due to the uncertainties of precipitation and temperatures and their consequent effect on grass and other herbaceous growth. This grazing plan is intended to be a dynamic and adaptive document; initial stocking rates will be established using production estimates from similar soils on adjacent surveys, then refined over time by monitoring RDM and annual production and utilization on small exclusion plots located on major soil/aspect types on the refuge. This approach is now common practice for grazing plans (Huntsinger et al 2007).

Figure 1. Bitter Creek National Wildlife Refuge and vicinity.



Vegetation and Wildlife Management

Livestock grazing as a tool for vegetation and habitat management has logistical advantages and disadvantages, and both benefits and impacts on the environment, communities, and plant and animal taxa. A number of tools can be used to manipulate vegetation to benefit wildlife and plant communities. In grasslands, grazing, mechanical methods (e.g., mowing), prescribed fire, and chemical applications have all been used to varying degrees of success, depending on site conditions, specific objectives, prohibitions, and available funding (see Briske 2011). In many cases, multiple tools are employed in combination. On a large scale, prescribed grazing can be an economical, reliable, and practical method

used solely or in conjunction with other methods to achieve desired future conditions (Huntsinger et al. 2007).

Published research evaluating the use of grazing as a conservation tool for native vegetation restoration and management reports mixed results for California (Kimball and Schiffman 2003, Huntsinger et al. 2007). In a meta-analysis of grazing studies in California's Mediterranean-type grasslands Stahlheber and D'Antonio (2013) reported that grazing often increased native grasses, but also non-native forbs, and sometimes increased native forbs; but the results all appeared to be highly site-specific and dependent on weather patterns. Published research includes results with benefits from grazing (Germano et al. 2012; Knopf and Rupert 1995), but published work specific to the San Joaquin Valley is scarce. The research done at the Carrizo Plains by Christian and colleagues (Christian et al. In Prep), and widely cited as disproving the hypothesis that grazing favors native plants is not published, and probably should better be understood as inconclusive rather than showing that grazing does not benefit native plants.

In the Temblor Range, Jackson and Bartolome (2002) found that RDM influenced plant species competition, including abundance of the native *Lotus wrangelianus* (synonym *Acmispon wrangelianus*), but only in some years. "Grazing" is very poorly characterized in most studies, making results difficult to properly interpret (Huntsinger et al. 2007). The objects being manipulated often vary greatly and defy any broad attempt to group them into simple categories. Habitat manipulation often positively impacts one species (or group), while negatively impacting other species. Thus, characterizing the effects of grazing depends on a narrow frame of reference and is likely to be very site-specific (Jackson and Bartolome 2007).

Prehistoric and historical grazers/browsers played a role in developing California animal and plant communities (Edwards 2007); yet climate, land use, and vegetation changes at different temporal and spatial scales make historical comparisons of doubtful value for predicting current grazing effects for a given location (Jackson and Bartolome 2007) . Still, domestic livestock are appropriate for vegetation management in weedy plant and animal communities (Germano et al. 2012; Griggs 2000; Thomsen et al. 1993), and livestock grazing remains a tool for ecosystem restoration even in lands previously degraded by excessive livestock grazing (Huntsinger et al. 2007, Papanastasis 2009).

Cattle are the livestock of choice for managing grasslands at Bitter Creek NWR because of historic precedence, availability, and the way cattle graze. Cattle are generalist herbivores that prefer grasses like those dominating the California annual-type grassland (Van Dyne and Heady 1965), including several dominant species at Bitter Creek NWR. As a result, some wildflowers (also referred to as forbs and legumes) may benefit from the reduction of non-native annual grass biomass, including active growing plants and standing dead plant material and thatch; there are some good examples from serpentine soils in northern California (e.g. Huenneke et al. 1990). The type of cattle (the various range beef cattle, dairy cattle) and class (cow with calf, heifers, steers, bulls) can influence cattle movement and consumption of vegetation over a range of plant palatability (Heady and Child 1994, Huntsinger et al 2007). Other domestic livestock like sheep and goats would require additional infrastructure, including fences that are more restrictive of native ungulate movements (Bush 2006, Kindschy et al. 1980, Huntsinger et al. 2007). The difficulty in controlling distribution and numbers of wild ungulates makes their use in prescribed grazing impractical (Huntsinger et al. 2007).

Grazing for Vegetation and Wildlife Management at Bitter Creek NWR

George and McDougald (2010) conducted an independent range review for Bitter Creek NWR to advise refuge management on how to proceed with a vegetation and wildlife habitat management program using cattle grazing as the primary tool for reducing and controlling RDM. Their report was well done from the perspective of range conservation and management to promote a commercial cattle operation, but the

RDM recommendations addressed only two vegetative conditions: 300–600 pounds/acre and 800–1,000 pounds/acre. The review lacked direction from the refuge on which trust species to focus habitat management objectives. George and McDougald (2010) based management recommendations on distinguishing the low and high elevation refuge units and managing RDM from a perspective of maximum sustained yield to support cattle on the refuge through wet years (average and high grass production) and dry years (low grass production).

While the specific George and McDougald (2010) RDM recommendations may be useful for certain refuge targets, their distribution of the two recommended RDM levels was not optimal for refuge resource targets. For example, management units 9, portions of 10B, and 12 were included in the higher elevation/higher RDM recommendation. However, these units have flatter terrain and are adjacent to the Carrizo Plain National Monument (NM), which provides habitat for San Joaquin Valley recovery vertebrate species (e.g., San Joaquin kit fox (*Vulpes macrotus mutica*), giant kangaroo rat (*Dipodomys ingens*), and the blunt-nosed leopard lizard (*Gambelia sila*)), so they are more suitable for lower RDM and more likely to become occupied by these species. Terrain (slope grade) and soils are important considerations for prescribing habitat management for burrowing animals and specific resource targets (e.g., San Joaquin Valley recovery vertebrate species, burrowing owl). For example, many of the San Joaquin Valley recovery vertebrate species may benefit from more frequent grazing than recommended for a sustained yield cattle operation; therefore, it becomes necessary to identify flatter terrain for the applied greater grazing pressure these taxa require and avoid steep terrain where greater grazing pressure would result in negative impacts, such as soil erosion. The RDM approach was designed to manage livestock grazing intensity and distribution (Bartolome et al. 2006). It has been successfully adapted to determining grazing capacity (McDougald et al. 1991) and to managing for target vertebrates (Germano et al. 2012). Further development and refinement of target RDM levels for prescribed grazing has been implemented in several California grazing plans and should be a part of Bitter Creek adaptive management and monitoring.

The review received sharp public criticism for interpretation of literature reviewed to support the use of cattle grazing to enhance wildlife and plant habitats (Painter 2010). Most of the issues noted above revolve around the interpretation of the interactions of grazing, weather, and site (Stahlheber and D'Antonio 2013, Huntsinger et al. 2007). These issues are not easily resolved with traditional experiments (Bartolome et al. 2009) and are better addressed in the framework of adaptive management and monitoring (Herrick et al. 2012). Bitter Creek NWR will implement long-term monitoring of RDM and refuge management targets (i.e., endangered and threatened species, species of concern, migratory birds, special status plants) as part of adaptive management of grazing.

Site Description and Resource Inventory

Chapter 3 of the CCP provides a detailed description of the site and refuge resources at Bitter Creek NWR. The following sections provide highlights of the site description and resources.

Land Use History

The Bitter Creek area was first settled by European homesteaders in the late 1800s. For much of the time since, the area was used for cattle grazing. After its establishment as a national wildlife refuge in 1985, special use permit(s) authorizing grazing on approximately 9,200 acres on the main portion of the refuge were issued annually by the Service between about 1985 and 2004. That permit expired on September 30, 2005, and the Service has not issued any additional permits covering this portion of the refuge since that date. One private neighboring landowner was, and continues to be, authorized to use a small, non-contiguous portion of the refuge for grazing under an annual permit.

When the permit for grazing the main unit was in place, lower elevations were grazed during winter/spring from December 15 to June 15, alternating with higher elevations from June 15 to December 15. The base herd could not exceed 370 animal units (forage consumption on the basis of one standard mature 1,000-pound cow, either dry or with calf up to 6 months old) at any one time, for a maximum of 4,400 animal unit months (AUM).

Climate and Weather

Bitter Creek NWR, situated in the upper foothills at the southwestern corner of the San Joaquin Valley, is located within the "California Dry Steppe Province" according to Bailey's Life Zones. This life zone is characterized by hot, dry summers and mild, foggy winters. Temperature extremes may climb above 100 degrees F in summer and drop below freezing in winter. Precipitation levels peak December through April. Annual average temperature near the refuge ranges from a minimum of about 42 degrees F to a maximum of about 72 degrees F based on average climate conditions from 1971-2000. The lowest temperatures occur in December (ranging from a monthly minimum of 33 degrees F to a monthly maximum 58 degrees F), and the highest temperatures occur in July (ranging from a monthly minimum of about 55 degrees F to a monthly maximum of about 90 degrees F). The lowest temperature on record is 15 degrees F at the Maricopa, California, weather station in December 1978, and 8 degrees F at the Lebec station in January 2001. The average daily temperature in winter is 48.5 degrees F, and the average daily minimum temperature is 38 degrees F. In summer, average daily temperature is 80.7 degrees F, and average daily maximum is 94.8 degrees F. The highest temperature on record is 116 degrees F at the Maricopa station in July 1950.

Weather can vary considerably on the refuge, depending on the elevation and specific site. Higher elevations, especially above 4,000 feet, are relatively cool and receive more moisture; snow is common during winter storms. Lower sites, particularly in Bitter Creek Canyon, which range down to 1,600 feet, are warmer, receive less moisture, and rarely receive snow. North-facing slopes are cooler and wetter than slopes with other aspects.

Annual precipitation near the refuge is 9.82 inches per year based on average climate conditions from 1971-2000, with the lowest precipitation occurring in July (average of 0.01 inches) and the greatest precipitation occurring in March (2.17 inches). About 80% of precipitation generally occurs from November through March.

Soils

The refuge lies almost entirely within the footprint of the southwestern Kern County soil survey (NRCS 2009), which provides detailed descriptions of soil map units, phases, complexes and associations (Figure 2). Table 1 provides a complete list of soils found on the refuge.

The soil survey does not include ecological site (areas of similar plant frequency, density, cover) descriptions, which would be useful to better delineate grazing cells (several grazing cells or fenced grazing pastures may be within a larger management unit). The NRCS now has over 24,000 ecological site descriptions, but those in California still lack well-developed State and Transition models and therefore only include very broad management recommendations (see Bestelmeyer et al. 2011). The existing NRCS range site descriptions do include reasonably accurate estimates of forage production. However, soil map units are nevertheless useful as the basis for grazing cell design at Bitter Creek NWR.

Grazing Infrastructure

Bitter Creek NWR is crisscrossed by approximately 49 miles of paved (~9.5 miles) and dirt/gravel roads (39.5 miles; Figure 3). Cerro Noroeste Road, which bisects the refuge for approximately 7.5 miles and runs southeast from State Route 166/33, is the longest stretch of paved road. Klipstein Canyon Road (~1 mile) and the approximately 1 mile of State Route 166/33 that intersects the northwestern corner are the only other sections of paved road adjacent to the refuge. Roughly 39.5 miles of dirt and gravel roads provide reliable access to key portions of the refuge west of Bitter Creek Canyon in the dry season; however, access to areas east of the canyon is restricted to four-wheel drive vehicles even in the dry season. Roads are often impassable in the winter and after rain events.

Bitter Creek NWR has an intricate and expansive water system of 22 water tanks, fed by several springs, and nearly 10.5 miles of pipes. There are cattle troughs associated with many, but not all, of the tanks (Figure 3). Metal corrals exist in the center of the refuge, approximately 1.25 miles from Cerro Noroeste Road.

Most, but not all, management units are completely fenced, and approximately 60 miles of fencing exists on the refuge (Figure 4). The design of existing management units and their associated infrastructure are a good starting point for developing the grazing plan. Using the prior grazing scheme as a starting point is a very common and efficient approach (Bush 2006). As described in the Grazing Prescriptions section of this plan, additional fencing is called for to protect sensitive areas (e.g., riparian areas) and provide for enhanced management flexibility.

Table 1. Soil types, acres, and associated vegetation at Bitter Creek NWR.

Soil Map Unit ID Symbol[1]	Detailed Soil Map Unit Name	Area (acres)	Vegetation/Landcover[2]	Area/Special Status Plants[3]
35[4]	Morical-Supan-Greenbluff families association, 10-60% slopes	137	California Naturalized Annual and Perennial Grassland	
36[4]	Oak Glen-Supan-Hagen families complex, 0-10% slopes	156	Central and South Coastal California Seral Scrub, California Juniper Woodland, California Naturalized Annual and Perennial Grassland	
41	Rincon-Livermore-Modesto families association, 30-60% slopes	1	Central and South Coastal California Seral Scrub; California Juniper Woodland	
219	Xerothents-Badlands complex, 30–75% slopes	1	Barren Mountain Slopes	
393	Pleito sandy clay loam, 9–30% slopes	30	California Naturalized Annual and Perennial Grassland	
394	Pleito-Xeric Torriorthents, very gravelly, association, 15-100% slopes	37	California Naturalized Annual and Perennial Grassland	
398	Calcic Haploserepts-Calcic Pachic Argixerolls, fine Xerorthents, shallow, complex, 30–75% slopes	388	California Naturalized Annual and Perennial Grassland	

Soil Map Unit ID Symbol[1]	Detailed Soil Map Unit Name	Area (acres)	Vegetation/Landcover[2]	Area/Special Status Plants[3]
403	Loslobos-Calleguas association, 30–100% slopes	962	Central and South Coastal California Seral Scrub, Mixed Herb and Grass, California Naturalized Annual and Perennial Grassland, Mixed Scrub Oak Woodland	Lemmon's jewelflower
432	Littlesignal-Badlands-Cochora association, 15-75% slopes	23	California Naturalized Annual and Perennial Grassland	
490	Padres sandy loam, 2–9% slopes	7	California Naturalized Annual and Perennial Grassland	
510	Xeric Torriorthents_Badlands-Beam association complex, 30–75% slopes	86	California Naturalized Annual and Perennial Grassland	
515	Zonap-Badlands-Beam complex, 30–75% slopes	274	California Juniper Woodland, Central and South Coastal California Seral Scrub	stinkbells; Unit 11
516	Zonap-Beam complex, 15–30% slopes	471	California Juniper Woodland, Central and South Coastal California Seral Scrub	Kern mallow, Mojave paintbrush, Cuyama gilia
540	Xeric Torriorthents, very gravelly-Badlands complex, 30-75% slopes	1	California Naturalized Annual and Perennial Grassland	
571	Hilbrick-Rock outcrop complex, 15–75% slopes	119	California Naturalized Annual and Perennial Grassland, Mixed Herb and Grass	
583	Bellyspring-Xeric Torriothents complex, 9–15% slopes	44	Central and South Coastal California Seral Scrub, California Naturalized Annual and Perennial Grassland	gypsum-loving larkspur
585	Bellyspring-Xeric Torriothents complex, 30–50% slopes	10	California Naturalized Annual and Perennial Grassland	gypsum-loving larkspur
586	Panoza-Beam complex, 15–30% slopes	3	California Naturalized Annual and Perennial Grassland	
640	Bitcreek-Dibble-Eaglerest complex, 15–50% slopes	198	California Naturalized Annual and Perennial Grassland	
700	Xerolls, loamy-skeletal-Los Gatos complex, 30–75% slopes	246	Mixed Scrub Oak/Pinyon Woodland, Central and South Coastal California Seral Scrub	Headwall oaks
750	Ballinger silty clay, 15–30% slopes	7	Mixed Herb and Grass	
760	Ballinger silty clay, 45–75% slopes	7	California Juniper Woodland	

Soil Map Unit ID Symbol[1]	Detailed Soil Map Unit Name	Area (acres)	Vegetation/Landcover[2]	Area/Special Status Plants[3]
919	Zonap-Harrisranch-Beam complex, 15–50% slopes	1,172	California Juniper Woodland, Central and South Coastal California Seral Scrub	Kern mallow, Mojave paintbrush, gypsum-loving larkspur (Unit 11)
930	Bitcreek-Shimmon-Badhud complex, 9–30% slopes	4,446	California Naturalized Annual and Perennial Grassland	
932	Bitcreek-Shimmon-Badhud complex, 30–75% slopes	2,248	Mixed Scrub Oak Woodland, Central and South Coastal California Seral Scrub, Mixed Herb and Grass, California Naturalized Annual and Perennial Grassland	Timbers, Uncle Charlie's Exclosure, Klipstein Exclosure
940	Bitcreek sandy loam, 2–9% slopes	141	California Naturalized Annual and Perennial Grassland	
950	Pleito-Ballinger-Balhud complex, 15–50% slopes	608	California Naturalized Annual and Perennial Grassland	
951	Pleito-Ballinger-Balhud complex, 5–30% slopes	476	California Naturalized Annual and Perennial Grassland	
955	Calcic Haploxerepts-Xerothents, shallow-Badlands complex, 30–100% slopes	1,321	Mixed Saltbush Scrub, Central and South Coastal California Seral Scrub	Kern mallow (Unit 2,Bitter Creek Canyon; Unit 11)
970	Harrisranch-Bittcreek complex, 9–50% slopes	960	California Naturalized Annual and Perennial Grassland, California Perennial Grassland, Western Chokecherry Thicket	silky lupine, California androsace, adobe yampah

[1] Detailed descriptions of soil map units are presented at: http://soildatamart.nrcs.usda.gov/manuscripts/CA691/0/kernSW.pdf.

[2] Vegetation/landcover types listed are the predominant types within the soil map unit.

[3] Lemmon's jewelflower (*Caulanthus coulteri* var. *lemmonii*); stinkbells (*Fritillaria agrestis*); Kern mallow (*Eremalche parryi* subsp. *kernensis*); Mojave paintbrush (*Castilleja plagiotoma*); Cuyama gilia (*Gilia latiflora* subsp. *cuyamensis*); gypsum-loving larkspur (*Delphinium gypsophilum* subsp. *gypsophilum*); silky lupine (*Lupinus elatus*); California androsace (*Androsace elongata* subsp. *acuta*); adobe yampah (*Perideridia pringlei*). Soil in Units 2 and 3 may be suitable for gypsum-loving larkspur (*Delphinium gypsophilum* subsp. *gypsophilum*). Soil in Unit 3 may be suitable for Cuyama gilia (*Gilia latiflora* subsp. *cuyamensis*).

[4] Locations of this soil type are not within units proposed for grazing.

[5] Hopper Mountain National Wildlife Refuge Complex Service-owned lands total 14,097 acres. Acreages are approximate and in some cases estimated based on un-surveyed boundaries.

Vegetation

Bitter Creek is composed of at least 14 landcover types, including but not limited to California naturalized annual and perennial grassland (annual grasslands), California perennial grassland (perennial grasslands), central and south coastal California seral scrub (shrublands) dominated by California buckwheat, bush lupine, goldenbush and rubber rabbitbrush, mixed saltbush scrub, and oak and juniper woodlands (Table 2; Figure 5). Annual grassland, dominated by non-native annual grasses of Mediterranean origin, is the most abundant vegetation, covering more than 9,000 acres. Common grass species within the California naturalized annual and perennial grassland include red brome (*Bromus madritensis* subsp. *rubens*

[*Bromus rubens*]), soft chess (*Bromus hordeaceus* [*Bromus mollis*]), ripgut brome (*Bromus diandrus* [*Bromus rigidus*]), typical California brome *(Bromus carinatus* var. *carinatus)*, wild oats *(Avena barbata* and *Avena fatua)*, cheat grass (*Bromus tectorum*), and smoothbarley (*Hordeum murinum* subsp. *glaucum* [*Hordeum glaucum, Hordeum stebbinsii*]).

Patterns of vegetation and landcover are associated with soil type, as are the current known distributions of some special status plants. Vegetation types and some special status plants occur in multiple soil map units (Table 1). Figure 5 shows the landcover (including vegetation types) at Bitter Creek NWR. For a list of plants found on Bitter Creek NWR, see the appendices to the CCP.

Small areas of native perennial grassland have been mapped adjacent to the Headwall oaks and chokecherry thicket in unit 3 East (Figure 5), and perennial grasses occur in various sized patches throughout the refuge (Table 2, footnote 2; Figure 5). The potential for Bitter Creek NWR to have been previously dominated by native perennial grasses is uncertain, as for most of the California grassland (Bartolome et al. 2008). The geologic and soil diversity combined with the regions' aridity would possibly provide conditions for shrub and herbaceous communities (Hamilton 1997; Schiffman 2000). Under current ecological conditions, the annual grassland is considered a stable type with many naturalized species (Heady 1988; Tausch et al. 1993; Bartolome et al. 2007).

Diverse plant taxa exist and potentially occur at the refuge (De Vries 2010; Painter 2010; Painter 2011) in a region of documented high plant diversity (Moe 1995; Twisselmann 1967). Dr. E. L. Painter notes there are records for over 1,500 specimens from the Bitter Creek NWR area, documenting nearly 500 taxa with collection dates ranging from 1934 to 2010. The existing records and vouchers should be reviewed by Hopper Mountain NWR Complex staff with an emphasis on rare taxa. Because only reconnaissance-level plant surveys have been conducted at Bitter Creek NWR, it cannot be assumed that past and current known special status plant locations are the only locations where they occur. Plant species often occur in multiple plant communities and on various soil types. Refuge Complex management will continue to support researchers and partners interested in establishing and regularly updating a data base with supporting vouchers for known locations of rare plant taxa.

Table 2. Vegetation/landcover and commonly associated plant and wildlife species.

(Wildlife species listed have been confirmed on Bitter Creek NWR.)

Vegetation/Landcover [1]	**Acres (% of Refuge Total)**[1]	**Plants**	**Wildlife**
California Naturalized Annual and Perennial Grassland [2, 3, 4]	9,799 (67%)	California brome, wild oats, ripgut brome, soft chess, foxtail chess, Mediterranean barley, Mediterranean schismus, small fescue	burrowing owl, short-eared owl, long-eared owl, northern harrier, Swainson's hawk, ferruginous hawk, prairie falcon, white-tailed kite, California condor, horned lark, western meadowlark, savannah sparrow, black-tailed jack rabbit, Nelson's antelope squirrel, Heermann's kangaroo rat, coyote, San Joaquin kit fox, tule elk, common side-blotched lizard, western whiptail
California Perennial Grassland [2, 3]	13	giant wild rye, alkali rye, big squirrel tail, California melic grass, purple needlegrass, nodding needlegrass, one-sided bluegrass	northern harrier, Swainson's hawk, ferruginous hawk, prairie falcon, white-tailed kite, California condor, grasshopper sparrow, western meadowlark
Mixed Herb and Grass	178 (1%)	Predominantly annuals, mixed grasses/wildflowers	white-tailed kite, mourning dove
Central and South Coastal California Seral Scrub	1,477 (10%)	goldenbush, rubber rabbitbrush, California buckwheat, bush lupine	loggerhead shrike, California quail, California thrasher, desert cottontail
Mixed Saltbush Scrub	948 (7%)	allscale, quail bush	greater roadrunner
Mixed Scrub Oak Woodland	469 (3%)	Alvord oak hybrid, Tucker's oak	western scrub-jay, oak titmouse, lark sparrow, mule deer
Mixed Scrub Oak/Single Leaf Pinyon Pine Woodland	217 (2%)	Alvord oak hybrid, Tucker's oak, single leaf pinyon pine	western scrub-jay, oak titmouse, lark sparrow, mule deer
California Juniper Woodland	1,252 (9%)	California juniper	
Wet Depression/Wetland	14	hoary (stinging) nettle, alkali sea-heath, saltgrass, alkali bulrush, narrow-leaved cattail	Baja California treefrog
Riparian Scrub	10	hoary (stinging) nettle, narrow-leaved willow, quail brush (big saltbush), narrow-leaved cattail	tricolored blackbird, common yellowthroat, blue grosbeak, song sparrow, tule elk

Riparian Woodland	3	Fremont cottonwood, narrow-leaved willow, Gooding's black willow, red willow	yellow-rumped warbler, black-headed grosbeak
Western Chokecherry Thicket	4	western chokecherry	
Bare (unvegetated or rock outcrop)	4		Heermann's kangaroo rat, Blainville's (coast) horned lizard, common side-blotched lizard
Ailanthus Stands	5	tree-of-heaven	

[1] Hopper Mountain National Wildlife Refuge Complex Service-owned lands total 14,097 acres. Vegetation/landcover acreages are approximate and, in some cases, estimated based on un-surveyed boundaries.

[2] Valley grassland vegetation is currently placed into two types, annual (typically naturalized non-native taxa) and perennial (mostly native taxa). Researchers have used 10% relative cover of perennial grasses as the threshold for distinguishing these two types of grasslands, with >10% combined relative cover of all perennial grasses to distinguish perennial grassland (Keeler-Wolf et al. 2007). However, Keeler-Wolf et al. (2007) caution that 10% is not a "magic" number; and for the CCP assessment, a value of 50% was used, such that areas are classified as perennial grassland if 50% or more of the grasses present are native perennials. At Bitter Creek NWR, these tend to be found on wetter slopes where creeping wildrye (*Leymus triticoides*) and lesser amounts of blue wildrye (*Elymus glaucus*) are found. *Bromus carinatus*, a native species of brome, is also found in a patch in the southern part of the refuge north of Cerro Noroeste Road near the chokecherry thicket.

[3] Variation in grassland species composition, cover, density, and vigor results in various "types" of "range sites," each with observed structural differences, even within the same map unit. An example comes from the Natural Resources Conservation Service (NRCS) refuge Field Tour on August 11, 2011—several stops were made on middle third of the refuge (3,300–4,000 ft.), all within Map Unit 930–Bitcreek-Shimmon-Balhud complex, 9–50% slopes. We observed five distinct "range types" based on grass species composition (non-native annual vs. native perennial) and structure/vigor (cover related to less vigor with spaces between grass and cover related to tall vigorous grasses becoming lodged and forming a dense, thick layers of thatch). Some of the variation in types could be attributed to slope aspect and terrain, perhaps even site land use history. Therefore, the soil map units are at a scale which includes several ecological sites. The southwest Kern County Soil Survey lacks ecological site descriptions, which would be useful in designing grazing prescriptions. However, NRCS formerly used Range Sites, and these were roughly equivalent to the 1960s-era Soil Associations (e.g., Arkley's 1962 Merced Area survey; Begg's 1968 Glenn County survey), which prove very useful in defining relatively homogeneous range sites within very heterogeneous soil-vegetation landscapes. The map units used for the refuge will be suitable for designing grazing cells when considering the logistics and practical placement of fences.

[4] Also includes various spring and summer wildflowers (forbs).

Table 3 includes the most up-to-date list of special status plant species occurring on Bitter Creek NWR with a determination of known or unknown effects of livestock grazing based on a current review of the literature for each species. Few long-term, experimental data exist for these special status species. Therefore, evaluation of potential livestock grazing effects for many of the species is necessarily qualitative and sometimes speculative and vague.

The five special status plant species that may be adversely affected by grazing are California jewelflower (*Caulanthus californica*), Lemmon's jewelflower (*Caulanthus coulteri* var. *lemmonii*), Kern mallow (*Eremalche parryi* subsp. *kernensis*), San Joaquin woolly-threads (*Monolopia congdonii*), and Temblor buckwheat (*Eriogonum temblorense*) (Table 3). There is no empirical evidence of the negative effects of livestock grazing for these plant species; however, professional opinion suggests the importance of monitoring these plant populations where they are found to occur. Prior to initiating grazing in Bitter Creek NWR management units that have not been previously surveyed, focused plant surveys will be conducted to document absence of federally-listed plants in the fenced unit. Also included in Table 3 are special status plants and potential effects of grazing and associated threats.

The potential effects of grazing on wildlife, plants, cultural resources, and other refuge resources are presented in the Environmental Assessment appendix to the Final CCP.

Table 3. Special status plants known to occur on and listed plants that may occur on Bitter Creek NWR, and potential effects of grazing.

Species	Special Status[1]	Habitat[1]	Potential Effects of Livestock Grazing and Associated Threats	Potential Effects Comparative Rating	Source, Type and Quality of Information Available
Astragalus hornii var. *hornii* (Horn's milk-vetch)	1B.1	Meadows and seeps, and playas (lake margins, alkaline)	Threatened by habitat alteration. Subject to eradication efforts in early 1900's because it is poisonous to livestock (Marsh 1909).	Unknown	Little to no data readily available
Caulanthus californicus (California jewelflower)	FE, CNPS 1B.1	Chenopod scrub, pinyon and juniper woodland [below 3,280 ft., dry plains and slopes)	Grazing during certain growth stages is believed to be detrimental (Mazer and Hendrickson 1993).[2] CNPS lists grazing as a threat to this species.[1]	-2 (probably adverse)	Experimental, scientific, or management report based on multi-year monitoring program
Caulanthus coulteri var. *lemmonii* (Lemmon's jewelflower)	CNPS 1B.2	Pinyon and juniper woodland, valley and foothill grassland	Empirical species-specific information on grazing not found. CNPS lists grazing as a threat to this species. [1]	-1 (possibly adverse)	Professional knowledge of authors
Eremalche parryi subsp. *kernensis* (Kern mallow)	FE, CNPS 1B.1	Chenopod scrub, valley and foothill grassland	Light grazing may have positive effects on seedling establishment and plant survival, but grazing may also reduce reproductive potential of individual plants.[2] CNPS lists grazing as a serious threat to this species.[1]	+2 (probably beneficial if not excessive)/ -1 (possibly adverse)	Experimental, scientific, or management report based on multi-year monitoring program
Eriogonum temblorense (Temblor buckwheat)	CNPS 1B.2	Valley and foothill grassland (clay and sandstone)	Minor threat from grazing; trampling (Lewis in litt. 1995). CNPS does not list grazing as a threat to this species. [1]	-1 (possibly adverse)	Little to no data readily available
Monardella linoides subsp. *oblonga* (Tehachapi monardella)	CNPS 1B.3	Lower montane coniferous forest, pinyon and juniper woodland, upper montane coniferous forest	Empirical species-specific information on grazing not found. CNPS does not list grazing as a threat to this species. [1]	Unknown	Little to no data readily available
Monolopia (=Lembertia) congdonii (San Joaquin woolly-threads)	FE, CNPS 1B.2	Chenopod scrub, valley and foothill grassland (sandy)	Seedlings did well under winter/spring grazing and clipping on two of three sites in a one-year study. Grazing during flowering may be detrimental to reproduction.[2] CNPS lists grazing and trampling as serious threats to this species.[1]	+2 (probably beneficial if not excessive)/ -2 (probably adverse)	Detailed descriptive data, management report based on short-term monitoring program

[1] Special status species include plants that are listed under the Federal Endangered Species Act and species that have been observed on the refuge and are ranked 1B in the California Native Plant Society's California Rare Plant Rank (http://www.cnps.org/cnps/rareplants). California Native Plant Society (2012). Inventory of rare and endangered plants, v7-06d 10-03-06. Accessed online August 2012 and April 2013 (http://www.rareplants.cnps.org).

[2] U.S. Fish and Wildlife Service (USFWS 1998).

FE: Federally-listed as endangered; Potential effects of livestock grazing: +3= Beneficial if not excessive; +2= Probably beneficial if not excessive; +1= Possibly beneficial if not excessive; 0= Neutral; -1=Possibly adverse; -2= Probably adverse; -3=Adverse. Source: UC Berkeley, Range Ecology Lab.

Wildlife

While best known for providing roosting and foraging habitat for the endangered California condor, the refuge also supports a diverse assemblage of wildlife. Many of these species regularly use or depend on grasslands. Species included in this group are birds that nest and forage primarily within grassland vegetation types and are considered grassland-obligate birds. The United States State of the Birds Report (U.S. NABCI Committee 2009) confirmed that grassland birds in North America are significantly and consistently declining at a rate more rapid than that of other bird groups. In a recent analysis of the North American Breeding Bird Survey (BBS), Sauer and Link (2011) report that from 1968-2008, grassland-obligate bird species survey-wide have a population change of negative 37% (CI -55.8, -10.4). Included in this declining trend across North America are common grassland species found on the refuge: grasshopper sparrow (*Ammodramus savannarum*), horned lark (*Eremophila alpestris*), savannah sparrow (*Passerculus sandwichensis*), and western meadowlark (*Sturnella neglecta*). In addition to a continent-wide decline, western meadowlarks and horned larks show a significant decline when the BBS dataset is restricted both to the California region and a more recent time period, 1980-2007 (Bartolome et al. 2013).

Tricolored blackbird, a species of special concern, nests in the nettles at Spanish Spring and other wetland areas and forages in nearby grasslands. Red-tailed hawk, prairie falcon, northern harrier, and burrowing owl also forage in the grasslands. Vesper sparrow is a regular winter visitor. For a list of birds found on Bitter Creek NWR, see the appendices to the Final CCP.

The federally endangered San Joaquin kit fox has been observed in the lower elevations in the northern portion of the refuge. Tule elk, introduced on nearby Wind Wolves Preserve, have dispersed onto the refuge and regularly use areas east of Bitter Creek canyon. Black-tailed deer (*Odocoileus hemionus columbianus*) is another common herbivore. Mountain lion, bobcat, black bear, and coyote are mammalian predators known to occur on Bitter Creek.

Table 2 provides a partial list of wildlife and associated plant communities at Bitter Creek NWR. For a list of wildlife found on Bitter Creek NWR, see the appendices to the Final CCP.

The potential effects of grazing on wildlife and plants are presented in the Environmental Assessment appendix to the Final CCP.

Figure 2. Soils at Bitter Creek National Wildlife Refuge.

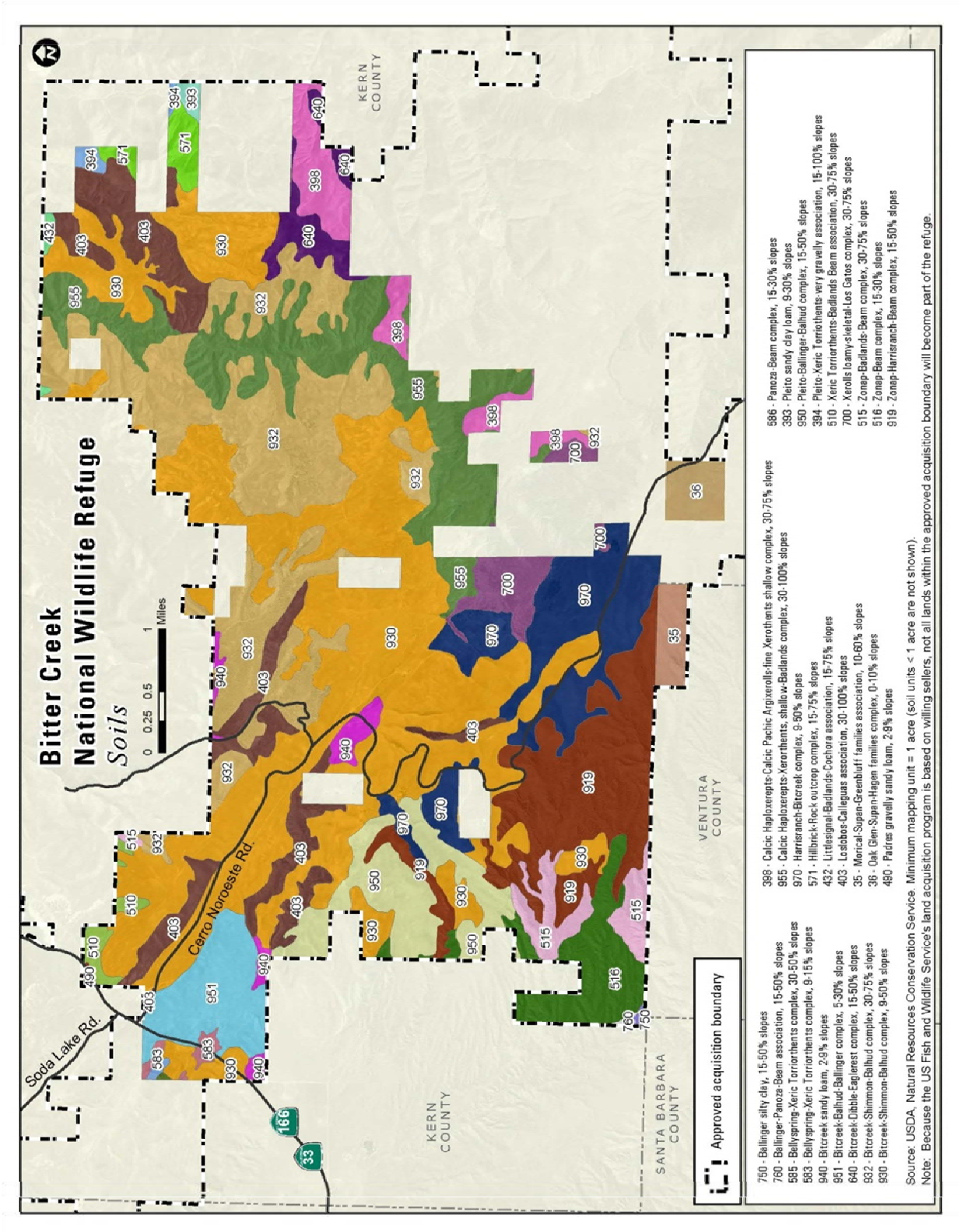


Figure 3. Roads, springs, water pipelines, fences, and other infrastructure at Bitter Creek National Wildlife Refuge.

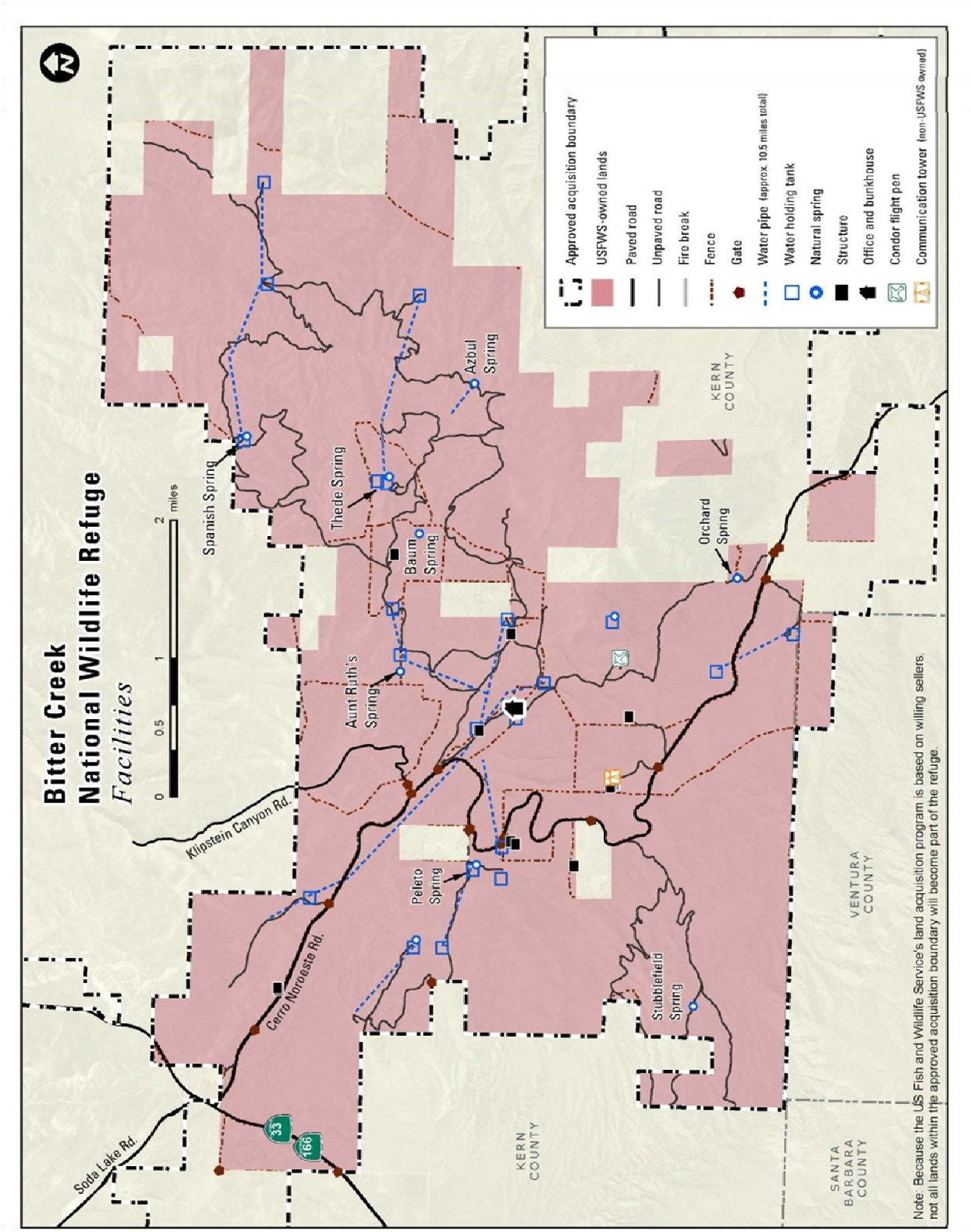


Figure 4. Proposed management units at Bitter Creek National Wildlife Refuge.

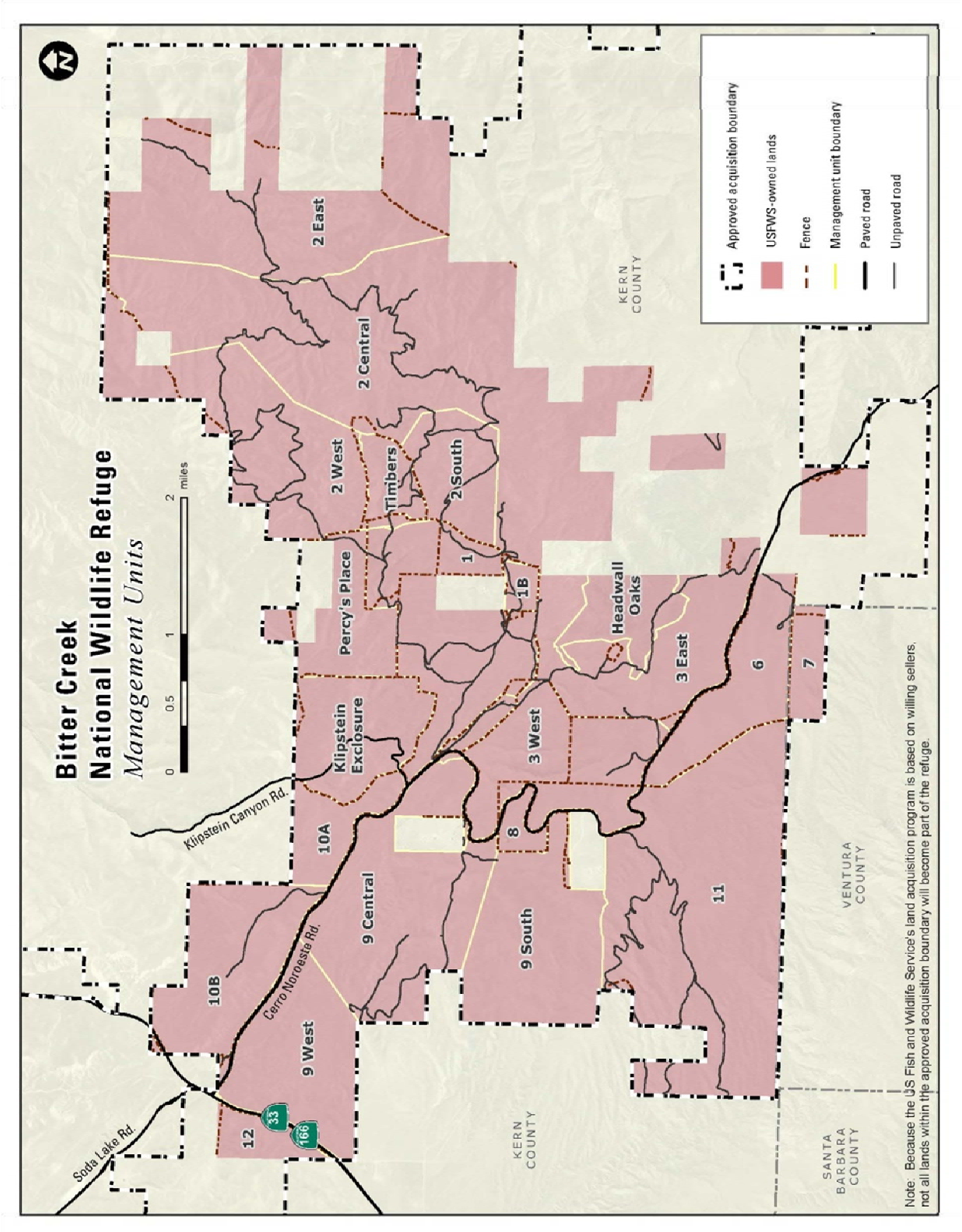
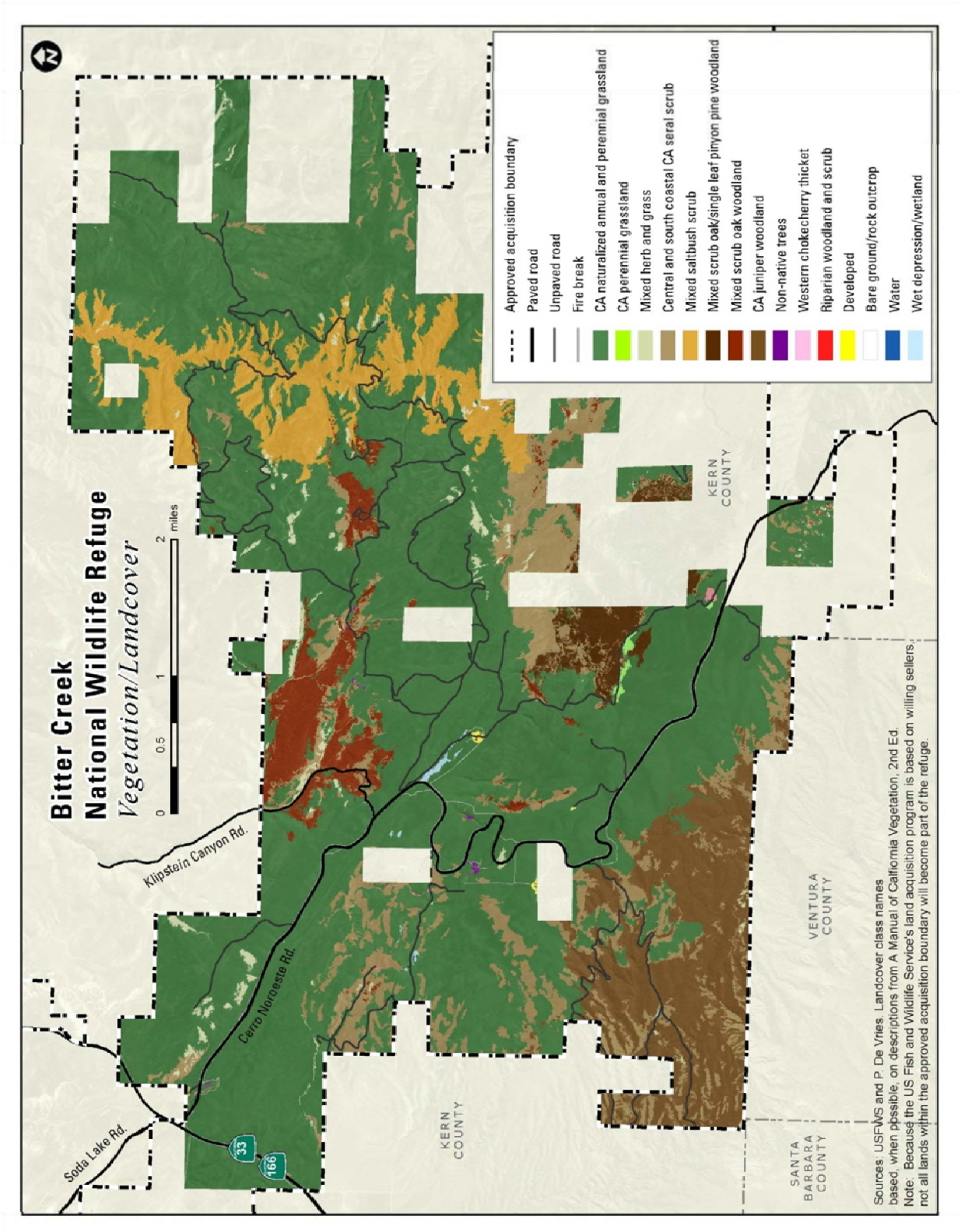


Figure 5. Vegetation/landcover at Bitter Creek National Wildlife Refuge.



Resource Targets and Target Conditions

Objectives set forth in the Hopper Mountain, Bitter Creek, and Blue Ridge National Wildlife Refuges Final Comprehensive Conservation Plan/Environmental Assessment (USFWS 2013) serve as guidelines for the development of this Prescribed Grazing Plan. Specifically, Objectives 2.2 and 2.3 describe desired conditions to provide habitat for San Joaquin Valley Special Status Species and a diversity of grassland birds, respectively; Objective 2.4 prevents and/or mitigates further invasion of non-native plants; Objective 4.3 protects riparian resources; and Objective 4.4 protects tricolored blackbird habitat (see beginning of document for text of goals and objectives). Reduction of rangeland fuels for protection from wildfires is explicitly included in the goals for the Hopper Mountain refuge, but not for Bitter Creek (Final CCP USFWS 2013).

In this Prescribed Grazing Plan, the term ***resource target*** refers to a specific species or group of species; grazing prescriptions will be implemented primarily for the purpose of improving habitat conditions (habitat quality) for resource targets. Desired habitat conditions associated with resource targets are referred to as ***target conditions***.

Grazing influences the abundance of San Joaquin Valley recovery vertebrates, such as San Joaquin kit fox, giant kangaroo rat, and blunt-nosed leopard lizard (Germano et al. 2012). Because the amount of bare ground, herbaceous plant height, and standing plant "thatch" are highly correlated with RDM (Germano et al. 2012), the amount of RDM will be used as the metric to measure habitat structure and livestock grazing prescriptions in annual grassland types. RDM and grass height classes will be used in grazing prescriptions to provide habitat for targeted resources.

Four target conditions have been identified for the selected resource targets (Table 4). Target conditions overlap for certain resources and are within the published guidelines for RDM (Bartolome et al. 2006). There are no published studies of the efficacy of different levels of grazing or of RDM for significantly reducing probability of ignition or rate of spread in California grassland fuels, but experienced wildland fire experts regard 600 lbs/acre of RDM/fuel as a threshold for adequate fire hazard protection (Scott Stephens pers. comm.). This level of RDM is within several, but not all of the four target conditions and can be considered as an auxiliary benefit of habitat management by grazing.

Vegetative production and resultant RDM levels vary considerably within short distances in each management unit; this is due to the heterogeneous nature of the geology and soils and the variations in livestock distribution across landscapes (Figure 2). For example, Soil Map Unit 930 (Bitcreek-Shimmon-Balhud complex), the predominant soil map unit within the prime grassland area of the refuge, is a complex of three soils ranging from shallow (10-20 inches) to very deep (>60 inches). During an August 11, 2011, Field Tour, sampled dry matter (DM) values from these two components were approximately 300 pounds/acre and 8,400 pounds/acre, respectively. The deeper component showed more than one growth year contributing to its DM value. Figure 6 shows examples of shallow soil components at the top of the hill and very deep soils at the bottom of the hill. The conditions shown in Figure 6 represent 6 years of non-grazing use.

This heterogeneity presents a challenge for targeting average RDM values across the landscape. The initial recommendations for measuring RDM used a few plots or ocular estimates in each pasture of interest (Clausen et al. 1982). This approach has been modified to include RDM mapping (Frost et al. 1988) within and between pastures. The most recent recommended approach, which has been applied by several agencies, establishes one or more standards for acceptable RDM levels as dictated by management goals and the ecological site and was recommended by George and McDougald (2010) for Bitter Creek. Because management goals for Bitter Creek include levels of RDM, RDM mapping should be the preferred monitoring approach. Target RDM levels can be developed adaptively during the

implementation of the grazing plan, but would start with the levels recommended above and by George and McDougald (2010).

Figure 6. Comparison of soil components in Soil Map Unit 930 (Bitcreek-Shimmon-Balhud) complex.

Season of use might be a tool to encourage grazing on the deeper soil components, which tend to also be northerly facing, and lessen the impact on the very shallow components, which tend to be south facing and west facing. Seasonal distribution of livestock use can be well-monitored by appropriate use of RDM mapping, as shown by management studies (Frost et al. 1988) and practiced by several land management agencies using technical guidelines (Wildland Solutions 2008), but this use of RDM monitoring is not yet fully supported by research.

Some bare ground (i.e., free of annual grass thatch) is required for San Joaquin special status recovery species (Germano et al. 2012). While bare ground is associated with very low and low RDM, the moderate RDM/medium grass target may also show 5-15% bare ground in localities at a fine scale (i.e., not widespread) as a result of the cattle prescription (through grazing and trampling), while the high grass target may show only minor amounts of bare ground. Short, moderate, and high grass targets will also contain bare ground and low plant density/low plant cover resulting from geologic (e.g., depth to bedrock) and edaphic (soil) conditions (e.g., mobile sand, high salinity/alkalinity). Trampling by livestock can cause temporary bare ground conditions, as can fire, rodent, and other wildlife activities (e.g., burrowing, harvesting, rooting, trampling), while permanent bare ground results from geologic and edaphic conditions. In some of these edaphic settings and with some species, bare ground provides space for annual spring and/or summer wildflowers.

Table 4. Resource targets and target conditions for grazing prescriptions.

Target Conditions: Very Low RDM/Short Grass Height

Resource Targets: San Joaquin Valley recovery species (USFWS 1998), including San Joaquin kit fox (*Vulpes macrotis mutica*); giant kangaroo rat (*Dipodomys ingens*); blunt-nosed leopard lizard (*Gambelia sila*); Nelson's antelope squirrel (*Ammospermophilus nelson*). Other resource targets: Surrogate species for San Joaquin Valley Recovery Vertebrates, including Heermann's kangaroo rat (*Dipodomys heermanni ssp.),* which likely occurs at lower elevations; and perhaps agile kangaroo rat (*Dipodomys agilis*), which possibly occurs at higher elevations, west of Cerro Noroeste Road. Migratory birds, such as horned lark.

Attribute	Upper limit	Lower limit
RDM	600 lbs/acre	300 lbs/acre
Grass Height	4 inches (10 cm)	1 inches (3 cm)

Target Conditions: Low RDM/Medium Grass Height

Resource Targets: Species of concern, including western burrowing owl (*Athene cunicularia hypugaea*), Blainville's horned lizard (*Phrynosoma blainvillii*); migratory birds, including horned lark (*Eremophila alpestris*); foraging habitat for breeding and wintering raptors; foraging habitat for tricolored blackbird (*Agelaius tricolor*); and native plants.

Attribute	Upper limit	Lower limit
RDM	1,000 lbs./acre	500 lbs./acre
Grass Height	8 inches (20 cm)	3 inches (8 cm)

Target Conditions: Moderate RDM/Medium Grass Height

Resource Targets: Migratory birds, including savannah sparrow (*Passerculus sandwichensis*); foraging habitat for breeding and wintering raptors; native plants.

Attribute	Upper limit	Lower limit
RDM*	1,500 lbs./acre	700 lbs./acre
Grass Height	12 inches (31 cm)	6 inches (15 cm)
	*On rolling hills and flats in Units 9 Central and 10A, 800–1,000 lbs. RDM/acre; on steep slopes and rolling hills of Units 2 West and 3 East, 700–1,500 lbs./acre.	

Target Conditions: High RDM/Tall Grass Height

Resource Targets: Northern harrier (*Circus cyaneus*); grasshopper sparrow (*Ammodramus savannarum*).

Attribute	Upper limit	Lower limit
RDM	2,000 lbs./acre	1,500 lbs./acre
Grass Height	25 inches (64 cm)	12 inches (31 cm)

Notes: Attributes are indicators of favorable or target conditions. Upper and lower limits represent the quantifiable boundaries for the attributes which, if exceeded, indicate non-desirable conditions. RDM refers to residual dry matter and is defined as old plant material left standing or on the ground at the beginning of a new growing seasons (Bartolome et al. 2006), measured in pounds/acre.

Cattle Stocking Rates and Distribution within Fenced Cells

Traditionally, a goal for livestock grazing management was maximum uniformity of use within and between pastures (Heady and Child 1994). More recently, range scientists have argued that the benefits of heterogeneity for conservation goals outweigh those of uniform use (Bestlemeyer et al. 2011). Cattle

stocking densities are matched with the length of the grazing period, season of use, and the configuration of the pasture to use forage efficiently while still promoting vegetation heterogeneity beneficial for conservation goals including wildlife and plant species. Short duration grazing with high stocking density (high intensity), referred to as "flash grazing," may result in more even patch usage and less trails, and less trampling contouring on slopes in relatively smaller grazing cells. In cases where bare ground is desirable in the flatter terrain for San Joaquin Valley recovery vertebrate species (e.g., giant kangaroo rat, blunt-nosed leopard lizard), greater use by cattle can be encouraged through the use and distribution of salt, dietary supplements (without plant seed and other reproductive parts), and portable water troughs. The relative degree of uniform utilization and heterogeneity can best be determined through RDM mapping (Wildland Solutions 2008) and usefully fed back into modification of management practices.

Period of Grazing Prescriptions for Resource Targets

Land managers implement grazing during different periods for livestock production purposes and to manage plant response (Hayes and Holl 2003). In general, seasonal grazing systems have a long history of failure to produce consistent plant community or forage productivity responses on arid rangelands (Briske et al. 2011). Despite this, the grazing period is often shortened in practice, and can be effective in maintaining habitat heterogeneity and target RDM levels (Huntsinger et al. 2007). A seasonal grazing prescription can theoretically account for disturbance adaptations of various plants so that native plant diversity can be maintained. Bitter Creek NWR grazing prescriptions could be developed and tested for the various resource targets during different periods to the extent practical. For example, wildflower germination would likely be enhanced through the removal of high accumulated thatch. The best time to remove accumulated thatch is March through May or early June during periods of rapid growth. Another strategy is to remove accumulated thatch after the onset of rains and early grass germination in late fall and early winter—after a short period, cattle would be removed to reduce grazing pressure on green forbs and to prevent the trampling of wildflower seedlings. This may be critical for xeric grasslands with relatively low rainfall. In contrast, San Joaquin Valley recovery vertebrates require very short grass and open ground for mobility. Annual grasses must be removed during the active growing season (March-June) and, depending on stocking rates, just into the period of drying to create bare ground. Monitoring habitat conditions (e.g., RDM) and use by resource targets (e.g., select native plants, kangaroo rats, burrowing owl, migratory birds) will help inform the refuge to adapt grazing prescriptions to meet target resource goals. Because of the absence of a proven research base relating seasonal livestock use to species-specific responses, the above should be considered hypotheses to be tested through adaptive management.

Opportunities for evaluating flexible grazing periods occur with the four grazing treatments (for resource targets) (Table 4) for the various grazing cells throughout the refuge. Creating multiple grazing periods in the prescriptions will result in a multitude of target conditions, which will be assessed through monitoring surveys and potential research investigations through adaptive management so that resource objectives are met, while soils remain healthy and natural vegetation is enhanced. A specific process for implementing this approach has been recently developed (Herrick et al. 2012).

Grazing Prescriptions

Four RDM/grass height treatments are presented in Table 4 to meet target conditions for target resources. Table 5 describes how those treatments will be applied to management units at Bitter Creek NWR. These are initial prescriptions for units which have not been grazed in over 7 years and have stabilized at high levels of RDM. Ungrazed RDM normally is 50-100% higher than the peak levels observed with grazing due to carry over-between years (Bartolome et al. 2007). The prescriptions proposed include identified resource targets (USFWS 2013) and conditions (i.e., the associated prescribed field conditions

for RDM and grass height), potential cattle movements (based on resource targets and logistics), grazing period, and year into initial rotation (Table 6). Subsequent rotations must be determined through vegetation monitoring, particularly RDM.

Refuge unit or cell-specific projects identified in grazing permits are necessary to implement and maintain the cattle grazing program at Bitter Creek NWR (Table 6). They are planned in advance during the annual refuge/cooperator grazing meeting. Materials and refuge/cooperator responsibilities are identified in this portion of the plan. In addition, any concerns, issues, and sensitive natural (e.g., rare plant occurrences) or cultural resources issues are also identified. Other requirements are included in each permit.

The grazing plan fits into the overall goals for natural resource management at Hopper Mountain NWR Complex and is consistent with the Compatibility Determination for Grazing, Final CCP, and other refuge and United States Fish and Wildlife Service (Service) management programs and activities (USFWS 1998; USFWS 2011; USFWS 2013; USFWS 2012b). Livestock grazing will be conducted periodically through implementation of the annual habitat work plan, which details prescriptions for Service resource targets and associated target conditions.

The annual grazing plan and associated prescription(s) will be developed, reviewed, revised, and implemented by Hopper Mountain NWR Complex staff and in conjunction with the cooperator to meet habitat conditions for resource targets in each cell of the refuge. Grazing cooperators will provide the refuge with a pasture-by-pasture summary of the numbers, type, and class of cattle (or other livestock), grazing period(s), and distribution, annually, at the end of the federal fiscal year (FY), usually when residual dry matter is measured, and planning for the next year begins. Information from monitoring data (e.g., AUMs, RDM) will be summarized and assessed so that the impacts to refuge natural resources can be considered to adapt grazing prescriptions to the site specific conditions.

Hopper Mountain NWR Complex will issue permits or agreements (throughout this document, the term "permit" can refer to either a permit or an agreement), such as Cooperative Land Management Agreements or Special Use Permits, for livestock grazing at Bitter Creek NWR. Grazing cooperators will be selected based on their ability to meet the Service's habitat objectives for the particular management unit(s). Prospective cooperators will be evaluated based on a variety of factors such as past experience and performance with similar prescribed grazing efforts, availability of stock to meet grazing prescriptions and schedules, and in-kind work commitments. Each permit will identify the resource targets for specific areas where grazing will be prescribed, primarily to improve habitat conditions for resource targets. The permit will also include reporting requirements for livestock use, construction and maintenance of livestock infrastructure, and required response times for addition or removal of livestock to meet target conditions.

The Bitter Creek NWR grazing program will primarily include annual grassland and native perennial grassland. Mixed herb/grasses, shrublands, saltbush scrub, and Alvord oak and California juniper savannas are a secondary focus to the extent these vegetation types are dominated by annual grasses. Alvord oak and California juniper woodlands and portions of the mixed saltbush scrub above Bitter Creek canyon will be omitted from grazing treatments under the current plan. Results from future monitoring, especially on moderately sloped lower elevations where annual grasses could build large RDM levels over time, could inform future re-assessments of the grazing plan.

Bitter Creek NWR Management Units and Cells (Grazing Pastures)

In most cases, current refuge management units will serve as grazing cells, although larger management units will be subdivided and smaller units combined with others (Figure 4). These units, or divisions/combinations of these units, will identify the areas for grazing prescriptions. Ultimately, the

refuge and range ecology and management partners (such as NRCS, Cal Poly San Luis Obispo or others) may develop more practical management units, based on vegetation (herbaceous species frequency, density and cover), terrain (elevation, slope aspect and grade), habitat management objectives for resource targets and native plants, and logistical considerations (existing hard fences and corrals, additional fences and corrals, water sources, roads, and other refuge management programs and activities).

Facilities (Corrals, Fences, Gates, Water Supply, Range Rider Station)

Facilities necessary to implement the prescribed cattle grazing program with the cooperator include: improvements and maintenance of existing fences, corrals, and selected water supplies and access roads; the establishment of 1 new permanent corral and ~20 miles of permanent barbed-wire fence (four strand, using wildlife-friendly specifications that include appropriate wire spacing and smooth bottom and top strands) and gates; the acquisition of temporary corrals (heavy duty portable panels), portable electric-wire fences (may only work in relatively flat terrain with good soil moisture), solar panels, batteries, and portable water troughs. A range rider station may be necessary if the cooperator remains with the animals while they are in use (although sheep are not recommended for this plan on Bitter Creek NWR). The station usually consists of an area for parking a small travel trailer, pick-up truck, ATV, and water tender, which is used to fill portable troughs and moved along with the portable drift fences. It is necessary to augment existing facilities (Figure 3) to implement grazing for habitat management.

Cattle Distribution, Movements, and Rotation Cycles

The proposed cattle grazing program for Bitter Creek NWR will be implemented to provide habitat for resource targets at specific refuge cells within units (Table 5, Figure 4).

Cattle distribution, movements, and rotations are determined by refuge staff and the cooperator prior to implementing the prescriptions. Generally, a cell will be grazed once annually; however, it may be necessary to prescribe both fall and summer or spring and summer grazing to control different aspects of vegetation in a cell. An example would be a prescription needed to control a Russian thistle (*Salsola* sp.) invasion, which would include fall grazing to reduce RDM to enhance native annual spring wildflower germination conditions (with onset of winter rains) paired with summer (June–August) grazing to control Russian thistle. Another example would be a spring prescription to reduce annual grass height/RDM for San Joaquin Valley recovery resource targets paired with the same summer prescription to control Russian thistle. It may also be necessary to curtail grazing in one year or several years to meet resource objectives and to prevent damage to soils and vegetation.

Wildlife and vegetation resource targets (e.g., San Joaquin Valley recovery vertebrates, migratory birds, native plants) are the primary focus in developing this program. RDM/grass height target conditions and season of grazing are key considerations for resource target response to a prescription. The physical characteristics and location of units/cells are also important for developing prescriptions since resource targets may have certain habitat requirements or occur in specific locations. For example, very low RDM/short grass height conditions to provide habitat for San Joaquin Valley recovery vertebrates should occur in the flatter terrain, nearest existing populations. Grazing treatments should occur prior to emergence of blunt-nosed leopard lizards (prior to early April in most years) to provide suitable habitat for spring season feeding and reproduction activities. Within season, cattle movements among the units/cells must be logistically feasible and also account for herd size. To the extent possible, cattle movements should occur among adjacent units/cells, reducing the need for the cooperator to remove or add cattle. Cattle rotation cycles for the refuge units/cells will be determined through monitoring RDM and other habitat and resource conditions such as plant diversity, presence of invasive species, and erosion.

All livestock brought in to Bitter Creek NWR may also be subject to quarantine in a specific pasture, for a pre-determined period of time (e.g., 10 days), to avoid introduction of invasive plant species. This kind of quarantine is increasingly being required in grazing plans (Bush 2006).

Table 5. Land cover, acreage, and initial grazing prescriptions for management units at Bitter Creek NWR. (See Table 4 for detailed descriptions of target conditions.)

Refuge Unit/Cell	**Vegetation/Landcover**	**Acres**	**Target Conditions (RDM/Grass Height)**	**Target Conditions**	**AUM** [1]
1 and 1B	California Naturalized Annual and Perennial Grassland	770 + 55	Low/Short	500–1,000 lbs RDM/acre; 3 to 8 inches (8–20 cm)	TBD
2 West	California Naturalized Annual and Perennial Grassland, California Buckwheat (steep slopes), Mixed Saltbush Scrub	757	Moderate/Medium	700–1,500 lbs RDM /acre; 6 to 12 inches (15–31 cm)	TBD
2 South	California Naturalized Annual and Perennial Grassland, Mixed Saltbush Scrub	330	High/Tall	1,500–2,000 lbs RDM/acre; 12 to 25 inches (31–64 cm)	TBD
2 East	California Naturalized Annual and Perennial Grassland, California Buckwheat (steep slopes)	1,222	High/Tall	1,500–2,000 lbs RDM/acre; 12 to 25 inches (31–64 cm)	TBD
2, Bitter Creek Canyon	California Naturalized Annual and Perennial Grassland, Mixed Scrub Oak Woodland, California Buckwheat (steep slopes), Mixed Saltbush Scrub, Riparian Scrub	2,618	**No grazing**	Maintain/protect Bitter Creek Riparian Habitat and Bitter Creek canyon Saltbush Scrub (on steep terrain)	N/A
3 East	California Naturalized Annual and Perennial Grassland, California Perennial Grassland, Bush Lupine Scrub, California Buckwheat, Rubber Rabbitbrush	692	Moderate/Medium	700–1,500 lbs RDM/acre; 6 to 12 inches (15–31 cm)	TBD
3 West	California Naturalized Annual and Perennial Grassland, Bush Lupine Scrub, Rubber Rabbitbrush	643	High/Tall	1,500–2,000 lbs RDM/acre 12 to 25 inches (31–64 cm)	TBD
6	California Naturalized Annual and Perennial Grassland, California Perennial Grassland, California Juniper Woodland	444	Low/Short	500–1,000 lbs RDM/acre 3 to 8 inches (8–20 cm)	TBD
7	California Naturalized Annual and Perennial Grassland, California Juniper Woodland, Goldenbush Scrub, California Buckwheat	129	**No grazing**	Maintain Woodland and Scrub Vegetation	N/A
9 West	California Naturalized Annual and Perennial Grassland, Goldenbush Scrub, Bush Lupine Scrub, Mixed Saltbush Scrub	612	Very Low/Very Short and Open	300–600 lbs RDM/acre; 1 to 4 inches (3–10 cm)	TBD

Refuge Unit/Cell	Vegetation/Landcover	Acres	Target Conditions (RDM/Grass Height)	Target Conditions	AUM [1]
9 Central	California Naturalized Annual and Perennial Grassland, Goldenbush Scrub, Bush Lupine Scrub, Mixed Saltbush Scrub, Wetlands	979	Moderate/Medium	800–1,000 lbs RDM/acre; 6 to 8 inches (15–20 cm)	TBD
9 South and 8	California Naturalized Annual and Perennial Grassland, Goldenbush Scrub, Bush Lupine Scrub, Wetlands, Rubber Rabbitbrush	739 + 68	Low/Short	500–1,000 lbs. RDM/acre; 3 to 8 inches (8–20 cm)	TBD
10A	California Naturalized Annual and Perennial Grassland, Mixed Scrub Oak Woodland	229	Moderate/Medium	800–1,000 lbs. RDM/acre; 6 to 8 inches (15–20 cm)	TBD
10B	California Naturalized Annual and Perennial Grassland, Central and South Coastal California Seral Scrub	590	Very Low/Very Short and Open	300–600 lbs. RDM/acre; 1 to 4 inches (3–10 cm)	TBD
11	California Juniper Woodland, Goldenbush Scrub, California Buckwheat,	1,790	**No grazing**	Maintain Woodland and Scrub Vegetation	N/A
12	California Naturalized Annual and Perennial Grassland, California Perennial Grassland, Bush Lupine Scrub	128	Very Low/Very Short and Open	300–600 lbs. RDM/acre; 1 to 4 inches (3–10 cm)	TBD
Headwall Oaks	Mixed Scrub Oak Woodland, Mixed Scrub Oak/Pinyon Pine Woodland, Riparian Woodland	246	**No grazing**	Maintain Woodland Vegetation	N/A
Klipstein Exclosure	Mixed Scrub Oak Woodland, Central and South Coastal California Seral Scrub	475	**No grazing**	Maintain Woodland and Scrub Vegetation	N/A
Uncle Charlie's Exclosure	Mixed Scrub Oak Woodland, Central and South Coastal California Seral Scrub	422	**No grazing**	Maintain Woodland and Scrub Vegetation	N/A
Timber's	Mixed Scrub Oak Woodland, Central and South Coastal California Seral Scrub	145	**No grazing**	Maintain Woodland and Scrub Vegetation	N/A

[1] Stocking rates should be determined by subtracting the amount of residual material that "prescribed conditions" dictate should be left behind from the estimated seasonal production of herbaceous forage. That amount, less 25%, would then be converted into AUMs (at 760 lbs DM). Once the start/end dates when grazing would be acceptable on the refuge are determined, the numbers of animals of the species/size/type that would be required to remove the forage can be calculated. Also, determine the carrying capacity (acres/AUM) of each unit/cell (grazing pasture) based on the vegetation/forage available and terrain in each to get AUMs available in each unit/cell. Then determine the season to be used depending on the resource object/target conditions needs of each, and calculate the number of cattle based on the forage available and the period for the grazing treatment.

NRCS calculations: subtract target RDM from estimated average year production. This amount, less 50%, converted to AUM at 900 lbs dry matter (DM), assumes greater percentage wastage and/or less efficient utilization.

An AUM is the amount of forage required to support one cow plus a calf less than 6 months age for one month, and is approximately 1,000 lbs. on annual rangeland (Bush 2006).

RDM is best measured in the late summer/early fall (mid-September to early October), when annual grasses have dried prior to the onset of rains.

Table 6. Estimated implementation schedule, proposed grazing season, and rotation cycle.

Management Unit/Cell[1]	**Estimated Year of Potential Grazing Initiation[2,5]**	**Estimated Rotation Cycle (years between grazing)[3,5]**	**Estimated Grazing Season[4,5]**
1 and 1B	Year 3	2–3	Late Fall–Early Winter
2 West [6]	Year 4	3–4	Winter–Early Spring
2 South [6]	Year 4	4–6	Winter–Early Spring
2 East [6]	Year 5	4–6	Spring
2 BC Canyon	N/A	N/A	N/A
3 East	Year 2	2–4	Late Fall–Early Winter
3 West	Year 2	3–5	Late Fall–Early Winter
6	Year 2	2–3	Late Fall–Early Winter
7 [7,8]	TBD	TBD	TBD
9 West [6]	Year 1	Annual–2	Late Fall–Early Winter
9 Central [6]	Year 1	2–4	Late Fall–Early Winter
9 South and 8 [6]	Year 2	Annual–2	Late Fall–Early Winter
10A	Year 3	2–4	Spring
10B	Year 3	Annual–2	Spring
11 [7,8]	TBD	TBD	TBD
12	Year 3	Annual–2	Fall–Late Fall
Headwall Oaks	N/A	N/A	N/A
Klipstein Exclosure	N/A	N/A	N/A
Uncle Charlie's Exclosure	N/A	N/A	N/A
Timbers	N/A	N/A	N/A
Percy's Place	N/A	N/A	N/A

[1] Grazing units/cells or pastures are based on maintaining, splitting, and combining existing unit boundaries. These will likely be modified during fence constructions to accommodate terrain, natural resources, and logistics (fence construction alignment, grazing pasture connectivity, roads, water sources).

[2] Year 1 represents the first year of grazing, not necessarily a period of time from CCP approval. We anticipate grazing to commence after cooperator selection and required infrastructure improvements and biological monitoring and inventories are completed. Grazing implementation is subject to the professional judgment of the refuge manager regarding whether grazing can help achieve the rangeland objectives set forth in the CCP. TBD = to be determined. N/A = Not applicable.

[3] Cell rotation schedules here are speculative. They will be determined through monitoring RDM for targets. Very Low/short grass and Low RDM/short grass objective will likely require more frequent annual grazing rotations than Moderate RDM/medium grass and High RDM/tall grass objectives; likewise, Moderate RDM/medium grass will likely require more frequent annual grazing rotations than High RDM/tall grass. This is due to the generally arid climate of southwestern Kern County and the relatively slow growth rates and consequent accumulations of RDM. However, during the NRCS refuge Field Tour on August 11, 2011, we observed RDM conditions at the livestock exclosure; vegetation within and outside the exclosure was very similar, showing heavy thatch buildup primarily from rip-gut brome (*Bromus diandrus*). Since grazing in the area was prevalent until 2005, we speculated that the time period to convert from a healthy stand of annual grasses and forbs to heavy thatch can be fairly short, depending on soil and terrain of each pasture. To be determined by baseline RDM conditions and animals needed to meet prescription field conditions during the allotted grazing period (in most cases, shorter grazing periods will be preferable; exceptions would be during unusually long wet springs as in 2011. TBD = to be determined. N/A = Not applicable.

[4] Spring (late Feb/mid-March through mid-May/early-June, depending on the season's rainfall and temperatures) coincides with the period of relative abundant annual grass growth in California rangelands (roughly February through early June). Early spring would be the early part of this period (late Feb/mid-March through late March/mid-April, again depending on the season's rainfall and temps). Winter (late Nov/mid Dec through mid-Jan/mid Feb, depending on the seasons) would be the period of germination and very slow grass growth in California rangelands (roughly November through January). TBD = to be determined. N/A = Not applicable.

[5] Estimated year, estimated rotation cycle, and estimated grazing season are based on rangeland factors. Actual year, rotation cycle, dates within the grazing period, and other specifics may vary depending upon wildlife parameters, site conditions, logistics, and other variables. N/A = not applicable; this unit is closed to grazing.

[6] Units are subdivided into cells based on current unit boundaries; geography and logistics may result in changing grazing pasture configuration and size with these units and elsewhere (see footnote 1).

[7] Due to relatively low acres of annual grassland, Units 7 and 11 will be excluded from cattle grazing until fencing options, focused inventories for federally-protected species, and other means of vegetation management are fully considered. TBD = to be determined.

[8] Determine acres of annual grassland forage for future prescription.

Table 7. Potential cooperative land management projects for prescribed grazing.

Refuge Unit/Cell	Projects[1]	Materials	Responsibilities	Concerns/Issues/Notes Rare Plant Occurrences
1 1B	1) Install fences, cattle gates, maintain main barn corral and water facilities	1) Gates, corner posts, T-posts, barbed-wire, hot-wire[2] and charging system	1) Refuge provides materials and maintains corral and cattle water systems. 2) Cooperator builds hot-wire fence and maintains all fences and gates. 3) Refuge contracts permanent fence construction.	
2 West	1) Install fences, cattle gates, and maintain water facilities	1) Gates, corner posts, T-posts, barbed-wire, hot-wire and charging system	1) Refuge provides materials and maintains cattle water systems. 2) Cooperator builds hot-wire fence and maintains all fences and gates. 3) Refuge contracts permanent fence construction.	Kern mallow (*Eremalche parryi* subsp. *kernensis*), gypsum-loving larkspur (*Delphinium gypsophilum* subsp. *gypsophilum*)
2 South	1) Install fences, cattle gates, and maintain water facilities	1) Gates, corner posts, T-posts, barbed-wire, hot-wire and charging system		Kern mallow (*Eremalche parryi* subsp. *kernensis*), gypsum-loving larkspur (*Delphinium gypsophilum* subsp. *gypsophilum*)
2 East	1) Install fences, cattle gates, and maintain water facilities	1) Gates, corner posts, T-posts, barbed-wire, hot-wire and charging system	1) Refuge provides materials and maintains cattle water systems. 2) Cooperator builds hot-wire fence and maintains all fences and gates. 3) Refuge contracts permanent fence construction.	Kern mallow (*Eremalche parryi* subsp. *kernensis*), gypsum-loving larkspur (*Delphinium gypsophilum* subsp. *gypsophilum*) Potential tule elk disturbance
2 BC Canyon	1) Install fences and gates as necessary to complete fencing in adjacent grazed Unit 2 cells	1) Gates, corner posts, T-posts, barbed-wire, hot-wire and charging system	1) Refuge provides materials and maintains cattle water systems. 2) Cooperator builds hot-wire fence and maintains all fences and gates. 3) Refuge contracts permanent fence construction.	Riparian habitat along Bitter Creek and saltbush scrub on steep canyons; fence out cattle from adjacent grazing cells in Unit 2

Refuge Unit/Cell	**Projects**[1]	**Materials**	**Responsibilities**	**Concerns/Issues/Notes Rare Plant Occurrences**
3 East	1) Install fences, cattle gates, and maintain water facilities	1) Gates, corner posts, T-posts, barbed-wire, hot-wire and charging system	1) Refuge provides materials and maintains cattle water systems. 2) Cooperator builds hot-wire fence and maintains all fences and gates. 3) Refuge contracts permanent fence construction.	California androsace (*Androsace elongata* subsp. *acuta*), gypsum-loving larkspur (*Delphinium gypsophilum* subsp. *gypsophilum*), Cuyama gilia (*Gilia latiflora* subsp. *cuyamensis*), silky lupine (*Lupinus elatus*), adobe yampah (*Perideridia pringlei*)
3 West	1) Install fences, cattle gates, portable corral, and maintain water facilities, including portable water trough	1) Corral panels, gates, corner posts, T-posts, barbed-wire, hot-wire and charging system	1) Refuge provides materials and maintains cattle water systems. 2) Cooperator builds portable corral, hot-wire fence and maintains all fences and gates. 3) Refuge contracts permanent fence construction.	Lemmon's jewelflower (*Caulanthus coulteri* var. *lemmonii*), gypsum-loving larkspur (*Delphinium gypsophilum* subsp. *gypsophilum*), Cuyama gilia (*Gilia latiflora* subsp. *cuyamensis*)
6	1) Install fences, cattle gates, portable corral, and maintain water facilities	1) Corral panels, gates, corner posts, T-posts, barbed-wire, hot-wire and charging system	1) Refuge provides materials and maintains cattle water systems, and supplies water for trough. 2) Cooperator builds portable corral, hot-wire fence and maintains all fences and gates. 3) Refuge contracts permanent fence construction.	1) May need portable water trough and salt to lure cattle to relative flat terrain at E side to avoid trampling slope contour trails.
9 West	1) Install fences, cattle gates, permanent corral (Stubblefield Road Coral), and maintain water facilities, including portable water trough 2) Treat Russian thistle along NW boundary with glyphosate[3]	1) Corral posts (steel and wood), gates, corner posts, T-posts, barbed-wire, hot-wire and charging system	1) Refuge provides materials and maintains cattle water systems. 2) Cooperator builds hot-wire fence and maintains all fences, and gates, and supplies water for trough. 3) Refuge contracts corral and permanent fence construction. 4) Refuge provides herbicide; cooperator applies herbicide.	1) Potential Russian thistle (*Salsola tragus*) invasion from NW boundary fence line; this weed already occurs in the disked refuge firebreak. 2) May need portable water trough and salt to concentrate cattle in relative flat terrain for prescribed effect of bare ground. 3) Manage for San Joaquin Valley vertebrate species recovery.

Refuge Unit/Cell	Projects[1]	Materials	Responsibilities	Concerns/Issues/Notes Rare Plant Occurrences
9 Central	1) Install fences, cattle gates, and maintain water facilities	1) Gates, corner posts, T-posts, barbed-wire, hot-wire and charging system	1) Refuge provides materials and maintains cattle water systems. 2) Cooperator builds hot-wire fence and maintains all fences and gates. 3) Refuge contracts permanent fence construction.	1) May need portable water trough and salt to concentrate cattle in relative flat terrain for prescribed effect of bare ground.
9 South and 8	1) Install fences, cattle gates, and maintain water facilities, including portable water trough	1) Gates, corner posts, T-posts, barbed-wire, hot-wire and charging system	1) Refuge provides materials and maintains cattle water systems. 2) Cooperator builds hot-wire fence and maintains all fences and gates, and supplies water for trough. 3) Refuge contracts permanent fence construction.	
10A	1) Install fences, cattle gates, portable corral, and maintain water facilities	1) Corral panels, Gates, corner posts, T-posts, barbed-wire, hot-wire and charging system	1) Refuge provides materials and maintains cattle water systems. 2) Cooperator builds portable corral, hot-wire fence and maintains all fences and gates. 3) Refuge contracts permanent fence construction.	
10B	1) Install fences, cattle gates, and maintain water facilities, including portable water trough	1) Gates, corner posts, T-posts, barbed-wire, hot-wire and charging system	1) Refuge provides materials and maintains cattle water systems. 2) Cooperator builds hot-wire fence and maintains all fences and gates, and supplies water for trough. 3) Refuge contracts permanent fence construction.	1) May need portable water trough and salt to concentrate cattle in relative flat terrain for prescribed effect of bare ground. Lemmon's jewelflower (*Caulanthus coulteri* var. *lemmonii*)

Refuge Unit/Cell	Projects[1]	Materials	Responsibilities	Concerns/Issues/Notes Rare Plant Occurrences
12	1) Install fences, cattle gates, portable corral, and maintain water facilities	1) Corral panels, gates, corner posts, T-posts, barbed-wire, hot-wire and charging system	1) Refuge provides materials and maintains cattle water systems. 2) Cooperator builds portable corral, hot-wire fence and maintains all fences and gates. 3) Refuge contracts permanent fence construction.	Gypsum-loving larkspur (*Delphinium gypsophilum* subsp. *gypsophilum*) Potential San Joaquin Valley kit fox corridor between Carrizo Plain NM and Cuyama Valley

[1] These are the initial projects identified for implementing the cattle grazing program; additional projects will be identified during the refuge–cooperator prescribed cattle grazing meeting.

[2] Hot-wire (electric) fence may only be feasible in relatively flat terrain with good soil moisture.

[3] Only herbicides and pesticides approved by the refuge may be applied on National Wildlife Refuge System lands. Possible approved herbicides include: Roundup (glyphosate) for over-land applications; Rodeo or Aquamaster (glyphosates) for over-water applications; 2-4,D; Garlon; Transline; Telar; Habitat; Forefront; Milestone; or generic equivalents. The Service maintains an annual, regional approval process for all herbicides and pesticides used on refuge lands.

Monitoring and Evaluation

Surveys are necessary to provide baseline conditions (record of characteristics), to monitor the effects of the grazing prescriptions, to quantify progress towards meeting objectives, and to adjust management practices for an adaptive management system in a changing environment (Bush 2006; Herrick et al. 2012). There are two main components to monitoring: compliance and effectiveness. Compliance monitoring can be fairly inexpensive and involves checking to see if the regulations and expectations of a grazing plan or lease are being met. Effectiveness monitoring can be more time consuming and costly, but is mandatory to ensure habitat objectives are being met and grazing treatments are achieving the desired results (Bush 2006). Because the site-specific effects of grazing in this arid-grassland system are essential information upon which grazing management decisions are based, the refuge will implement various levels of adaptive management and monitoring based on staff and partnership resources (Table 8). Monitoring is tied directly to the habitat/wildlife plan objectives (rationale and background for the objectives are provided in Chapter 4 of the CCP). For each habitat/wildlife related objective the monitoring approach is stated below. The following lists habitat/wildlife objectives and the general monitoring approaches that can be used to assess whether objectives are achieved. Table 8 provides more detailed information on types of surveys required to monitor vegetation and target species responses to management actions (grazing prescriptions). Surveys will be prioritized and implemented subject to available resources.

Objective 2.2: Within 10 years, provide suitable grassland habitat with vegetation height between approximately 1 to 4 inches, shrub cover less than 20%, and residual dry matter between 300 and 600 pounds/acre to enhance San Joaquin Valley special status species (such as San Joaquin kit fox, giant kangaroo rat, blunt-nosed leopard lizard, Nelson's antelope squirrel) on approximately 1,300 acres in the northwest portion of the refuge.

MONITORING APPROACH: Map RDM each Fall for the entire area, accompanied with plots for stubble height estimates and shrub cover. Estimate abundance of target species.

Objective 2.3: Within 10 years of CCP approval, manage up to 7,000 acres of the refuge's grasslands to achieve a mosaic of habitat structure and floristic diversity, including scattered shrubs, to support a diversity of grassland birds. Manage approximately one-third as short grassland (height 3 to 8 inches), another third as medium grassland (height 6 to 12 inches), and another third as tall grasslands (height 12 to 25 inches), and monitor for native plants.

MONITORING APPROACH: Map Fall RDM annually; establish permanent plots to determine vegetation composition. Establish time/area count plots to determine bird diversity.

Objective 2.4: Prevent the infestation of new invasive plant species and reduce the range and coverage of existing invasive species by 25%, including yellow star thistle (*Centaurea solstitialis L.*), and target non-native mustards (*e.g. Hirschfeldia incana, Sysimbrium officianale*).

MONITORING APPROACH: Establish permanent plots or transects in areas with targeted invasive plants; survey and map new infestations.

Objective 4.3: Within 5 years of CCP approval, restore natural spring flow in 3 subwatersheds within the 6 watersheds on Bitter Creek NWR to support native plants and wildlife.

MONITORING APPROACH: Map RDM in Fall; ensure that vegetation monitoring plots are established in riparian habitats to evaluate species composition, richness, and diversity; and ensure that livestock distribution and seasonal use minimizes effects on riparian habitat.

Objective 4.4: Maintain existing tricolored blackbird breeding habitat, and improve habitat by providing open accessible water (within 950 feet of the colony), suitable nesting substrate (cattail, nettles, bulrush, and willows), and foraging habitat (within about 9,800 feet of the colony).

MONITORING APPROACH: Map RDM in Fall; ensure that vegetation plots are established adjacent to tricolored blackbird habitats; and ensure that livestock distribution and seasonal use minimizes effects on riparian habitat.

Cattle Use Monitoring

Periodic (at least bi-weekly) refuge site inspections by the wildlife refuge manager and wildlife biologist will be conducted to assure proper implementation of the grazing plan. Regular site inspections are conducted by the cooperator to assure integrity and proper functioning of fencing and water supply. Under certain prescriptions, portable water troughs, salt licks, and processed food supplements (i.e., without seeds and other plant reproductive parts) will be moved to locations by the cooperator to improve cattle distribution for meeting target conditions.

For compliance purposes, the major issues are the number, distribution, and timing of grazing (Bush 2006). This can be handled in two parts: Number and class of animals need to be recorded in and out on each pasture, with dates. This can be handled by the lessee through required reports. The cooperator will document and provide to the refuge the dates cattle are placed into a cell and the dates they are removed, the grazing period, and the number and class of cattle or other livestock. The refuge manager will verify the numbers of cattle and dates they are placed into and removed from each cell. The apparent utilization and distribution can later be tracked with use of RDM mapping. This should be done by either the Service or trained range managers. RDM mapping is a good check on the accuracy of reported livestock numbers.

Vegetation Monitoring

When targeting invasive species, trade-offs occur among species within a community due to individual plant species life history traits interacting with site and weather (Huntsinger et al 2007). Therefore, monitoring becomes imperative and is used for making decisions based on an approach of adaptive management (Herrick et al 2012).

Various forms of vegetation monitoring are available (Bartolome et al. 2006; Elzinga et al. 1998; George et al. 1992; Haydock and Shaw 1995; Wildland Solutions 2008). The best approach depends on goals (Bush 2006) and range from the very qualitative walk-through site inspection and permanent photo-station to more quantitative techniques, such as measuring RDM and other methods such as nested frequency frames for tracking plant species composition through time. Frequency, cover, and density are commonly used measures of plant dominance. They can be combined to calculate Importance Value (IV) and displayed in a phytograph, which uses the contributions of each metric into a single graph. Each technique has utility and is most effective if used to record both pre- and post-management treatments. Permanent monitoring stations will be identified in the refuge GIS database. Photos and quantitative data serve as a permanent record of site conditions associated with the vegetation management/grazing program. Plant surveys will be conducted and plants identified, and resource targets will be monitored as part of the grazing program. Where special status species occur, permanent monitoring locations will be established and sampled annually. It is imperative that this data collection begins prior to initiating grazing treatments in each unit/cell.

Unique vegetation management partnership opportunities exist with the NRCS and California Polytechnic State University, San Luis Obispo (Cal Poly SLO). Under supervision of Dr. Marc Horney, Department of Animal Science, Cal Poly SLO, and cooperating with NRCS Rangeland Management Specialist Jeff Hansen, Fresno Office, range ecology and conservation students may conduct annual RDM and photo-station monitoring at the refuge. Additional vegetation monitoring could be developed through cooperative studies (Table 8).

Special Status Native Plants

As previously mentioned, Bitter Creek NWR provides important habitat for a large and diverse native flora. Federal and state listed species occur and potentially occur at the refuge, as do several species of special concern, local endemic, and rare plants. Plant surveys should be conducted annually during spring and into fall to track selected plant populations throughout the refuge (Table 8), but particularly in the cells where prescribed grazing occurs. The abundance of rare species in this grassland vary considerably from year-to-year, which makes annual monitoring important. Therefore, measuring fewer monitoring points annually is preferable to measuring many plots more irregularly. The Service would assess grazing effects on plant populations. The U.S. Fish and Wildlife Service Region 8 Inventory and Monitoring Program may also facilitate a special status plant inventory.

Bird Monitoring

Migratory birds are a primary trust species for the Service and identified in wildlife objectives for the Final CCP (USFWS 2013). At a minimum, breeding bird survey and monitoring stations should be established at the refuge. Standard methods for surveying for birds are described in Ralph et al. 1993 and Ralph et al. 1995.

Winter migratory birds and raptors are important avian refuge resources and periodic monitoring survey routes should be established to assess refuge use and response to the cattle grazing prescriptions. The burrowing owl was once common at Bitter Creek NWR, but observations have become less frequent in recent years. This may be a result of declining habitat quality due to an accumulation of thatch.

Burrowing owls nest in burrows excavated by California ground squirrel (*Spermophilus beecheyi*). Since cattle grazing to provide low RDM/short grass target conditions may increase ground squirrel activity, grazing may benefit burrowing owls. The refuge has data from a previous burrowing owl survey. A route will be established to assess burrowing owl response to grazing prescriptions.

The U.S. Fish and Wildlife Service Region 8 Inventory and Monitoring Program may facilitate bird monitoring at the refuge, and other potential partners include PRBO Conservation Science, which has recently begun grassland bird monitoring at Carrizo Plain NM and Hungry Valley.

Small Mammal Monitoring

San Joaquin Valley recovery vertebrates are trust species for the Service and identified in wildlife objectives for the Final CCP (USFWS 2013). Monitoring the effects of the prescribed grazing program for these and associated taxa (i.e., other species of species of concern and potential surrogate species) is a high priority for the refuge. Live trapping and walk-through surveys should be conducted in a variety of habitats that characterize grassland, mixed scrub and shrub, and savanna vegetation.

Partnerships could be developed with Cal Poly San Luis Obispo (e.g., Cal Poly SLO student chapter of The Wildlife Society and appropriate faculty sponsor) and California State University, Bakersfield (e.g., David Germano).

Table 8. Potential surveys for prescribed grazing and other habitat management activities at Bitter Creek National Wildlife Refuge. Surveys will be prioritized and implemented subject to available resources.

Monitoring Survey	**Monitoring Period**
Routine Site Inspections	Regularly, while cattle are in
Residual dry matter (RDM) mapping for prescriptions/targets within management units	September/early October[1]
Photo-stations supporting RDM mapping and target levels.	September/early October RDM
Plant Frequency, Cover and Density—for Importance Values[2] and photographs	Spring and late summer
Native wildflower species richness	Spring and late summer
Native grass cover	Late spring
San Joaquin kit fox– Visual Survey Route, Scent Tracking Stations, Camera Stations	TBD
Giant kangaroo rat and other small mammals– Sherman Live Trapping	TBD
Blunt-nosed leopard lizard– Visual Area Search	TBD
San Joaquin antelope squirrel– Visual Area Search	TBD
Blainville's (coast) horned lizard– Visual Area Search	TBD
Burrowing Owl– Visual Survey Route	TBD
Heermann's and agile kangaroo rat– Sherman Live Trap	TBD
Point Count Stations	Spring–early summer
Periodic Survey Route	Bi-monthly to capture seasonal and migration patterns
Kern mallow – observed in Units 2 and 11	TBD
San Joaquin woollythreads	TBD
California jewelflower	TBD
Horn's milk-vetch	TBD
Lemmon's jewelflower – observed in Units 3 West and 10B	TBD
Temblor buckwheat	TBD
Tehachapi monardella	TBD
Regional Endemic Species: Kern primrose sphinx moth – potential in Unit 9 on suncups (*Camissonia* sp.)	TBD
Pollinators: Various functional groups of bees, wasps, beetles, butterflies, moths, flies, and spiders.	TBD

Potential research investigations for habitat management activities at Bitter Creek NWR would include studies in natural history, such as those identified by the U.S. Fish and Wildlife Service San Joaquin Valley recovery plan (USFWS 1996). Potential funding sources include the Central Valley Project Conservation Program and Central Valley Project Improvement Act Habitat Restoration Program (U.S. Bureau of Reclamation Managing Water in the West and U.S. Fish and Wildlife Service Pacific Southwest Region). Investigations of ecological relationships that the monitoring design does not address are also recommended; for example, the effect of season and grazing period on native spring and summer wildflowers.

Summary of Implementation Schedule

Prescribed cattle grazing at Bitter Creek NWR will be phased in over a period of 5 years (Table 9). During this period, the various RDM/grass height target field conditions will be implemented for the first time, resulting in approximately 8,258 acres of grazed grasslands at the refuge (Table 9). Some units/cells, especially the very low and low RDM treatments, may be grazed more than one year during this 5-year phase in.

Table 9. Suggested schedule for initial unit/cell prescribed grazing by RDM/grass height targets.

Target Conditions	**Year 1**[1]	**Year 2**[1]	**Year 3**[1]	**Year 4**[1]	**Year 5**[1]	**Total Acres**[1]
Acres Very Low RDM/short grass	612	TBD[2]	718	TBD[2]	TBD[2]	1,330
Acres Low RDM/short grass	TBD	1,251	825	TBD[2]	TBD[2]	2,076
Acres Moderate RDM /medium grass	979	692	229	757	TBD[2]	2,657
Acres High RDM/tall grass	TBD[2]	643	TBD[2]	330	1,222	2,195
Total Acres	1,591	2,586	1,772	1,087	1,222	8,258

[1] Year 1 represents the first year of grazing, not necessarily a period of time from CCP approval. We anticipate grazing to commence in the fall of 2014 after cooperator selection and required infrastructure improvements and biological monitoring and inventories are completed. Acreage totals are approximate and may vary considerably depending on evaluation of baseline conditions.

[2] TBD: It may be necessary to develop annual grazing prescriptions for units/cells grazed in previous years; this will be determined through monitoring RDM and other habitat and resource conditions.

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