Bitter Creek National Wildlife Refuge

Independent Rangeland Review

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CHAPTER 1

INTRODUCTION

Purpose

The purpose of this range review is to assess the potential to use grazing and rangeland practices to meet habitat management objectives at Bitter Creek National Wildlife Refuge (BCNWR). Development of science based objectives for management of California's non-native annual dominated grasslands, that are feasible and measurable, are dependent on knowledge of the grassland and rangeland management. As BCNWR is dominated by non-native annual grasslands and has articulated grassland restoration objectives in its draft environmental assessment (USFWS 2008) we will focus most of our attention on the grassland and grazing.

Grazing and Haying Policies

The 1997 NWRS Improvement Act established a hierarchy of three tiers for management of the NWRS (Appendix A). Tier 1 provides for management that supports the mission of the NWRS including conservation, management, and restoration of fish, wildlife, plants, and their habitats. Tier 2 management is for wildlife-dependent public uses. There are six of these congressionally identified uses: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. The third tier of NWRS management priority is for other general public uses. This includes other types of recreation, economic uses, and other public uses. When livestock grazing or haying supports refuge habitat goals and objectives it falls in the first tier management priority. When grazing and haying are not specifically used on a refuge to help achieve wildlife and habitat goals and objectives, then these activities fall into the third tier.

Livestock grazing and haying occur on a number of National Wildlife Refuges. US Fish and Wildlife Service (USFWS) recognizes that in certain circumstances properly managed grazing can be a valuable and cost-effective tool to help a refuge achieve its wildlife and habitat goals and objectives. Examples include short-term, high-intensity grazing at a particular time of year to help control invasive plants and thereby give native species a more competitive advantage; or using grazing or haying to remove tall or decadent grasses and provide short, vigorous grass fields for use by migrating or wintering geese and sandhill cranes (*Grus Canadensis*). These management practices help refuges to achieve refuge purposes, goals, and objectives. Grazing and haying in these cases are considered Tier 1 management priorities under the 1997 NWRS Improvement Act. For a variety of reasons, grazing and haying are often managed differently on national wildlife refuges than on other public lands. The USFWS policies for grazing and haying can be reviewed in Appendix A.

The USFWS follows a refuge-specific, public process to open a refuge to a use or program of uses such as grazing and haying. This includes conducting scientific and technical analyses, and making a legal decision called a compatibility determination. A proposed use, including grazing or haying, can only be allowed on a refuge if it is determined compatible. A compatible use is one that will not materially interfere with or detract from fulfilling the refuge's mission. Among other things, a compatibility determination involves evaluation of a proposed use's effects upon refuge fish, wildlife, plants, and their habitats; potential conflicts with other refuge uses, especially wildlife-dependent public uses; indirect, future, and cumulative effects; precedence-setting implications; maintenance and monitoring costs; and off-refuge opportunities to exercise the use in question. Because refuges are closed until opened, they cannot be opened until it is officially found that the proposed use is compatible. There is opportunity for public review and comment in the compatibility determination process.

When grazing or haying is allowed on a refuge, it occurs through issuance of a special use permit. The USFWS policies provide guidance for permitting refuge specialized uses, including economic uses like grazing and haying. Among other things, the policy makes it clear that, except in unusual circumstances, specialized uses on national wildlife refuges are privileges granted by the USFWS. Policies also provide guidance on selection of permittees, charging fees to cover administrative costs and benefits received by permittees, and contents of a permit. Regulations establish a process for appealing denial of an application for a refuge special use permit.

The USFWS appropriateness policy is also applicable to consideration of grazing or haying as an existing or proposed refuge use unless the program is specifically used as a management technique to help achieve refuge wildlife and habitat goals and objectives. An appropriateness finding is developed internally by the Refuge Manager. There is no public involvement or administrative appeal provisions for appropriateness findings.

Policies of the USFWS favor management that restores or mimics natural ecosystem processes or functions to achieve refuge purposes. In selected circumstances, grazing and haying may serve in that role by simulating grazing by large, native herbivores. The policy goes on to state that by their nature mechanized haying and grazing by domestic livestock are not natural processes, and these practices can also cause environmental harm. Examples include reducing habitat quantity (e.g., through grazing desirable, non-target plant species); degrading habitat quality (e.g., through deposition of feces in or adjacent to waterways); facilitating introduction of alien, including invasive species (e.g., through seeds carried in hair, on vehicles and farm machinery, and in feces); and disturbing or competing with wildlife (e.g., through presence of permittees and vehicles/farm machinery, and grazing plants that also provide forage for wildlife). Refuge uses which conflict with the legal requirement to maintain biological integrity, diversity, and environmental health are not compatible.

The policies of USFWS provide general guidance on the processes, philosophies, and other considerations associated with all planning for management of refuges. Development of refuge-specific comprehensive conservation plans (CCPs) are the most inclusive of refuge plans and address, among other things, development of goals, objectives, and strategies associated with management of fish, wildlife, plants, and their habitats; management of wildlife-dependent public uses; protection of cultural resources; administration of special management areas; and management of economic and other uses.

It is USFWS policy to attain and maintain naturalness and, to the extent possible, natural diversity should be considered in all habitat and population management activities. Additionally, the least intensive management measures required to attain objectives should be used where practical and economically feasible. Habitat management practices will be designed and implemented so that the appearance of naturalness is maintained. Grazing programs may be implemented only when they benefit or are not harmful to wildlife and wildlife habitat" and "Frequency of grazing will vary according to productivity and condition of the site and should be held to the minimum necessary to achieve the desired results.

Scope and Organization

Managing vegetation using an array of management practices, including grazing, can move BCNWR landscapes toward its habitat goals. In this report we focus on grazing and its potential positive and negative effects in non-native annual dominated grasslands containing more than 400 native and non-native annual and perennial species. First we will review pertinent literature regarding the history of California grasslands, their restoration and the ecology and management of grazing. In the resource inventory we will briefly review pertinent resources and characteristics that may influence the management of BCNWR rangelands and then we will discuss grazing and vegetation management practices that may help move refuge habitats toward goals and objectives stated in the 2008 EA (USFWS 2008). We will then propose grazing and other management practices that have the potential to meet some of these stated goals. In the section on inventory and monitoring we will review some appropriate methods of inventory, short-term monitoring and long-term monitoring that can provide feedback to management in an adaptive management process. Finally we will make some recommendations that we believe could help USFWS reach some of its habitat management goals for BCNWR. This report is a starting point for exploring the potential to manage habitat using domestic livestock grazing.

CHAPTER 2

LITERATURE REVIEW & CITATIONS

Introduction

The BCNWR is dominated by non-native annual grasslands and has articulated grassland restoration objectives in its draft environmental assessment (USFWS 2008). Following is a brief review of grassland history, grassland restoration and grazing management followed by important literature citations. Rangeland terminology (Appendix F) follows that published by the Society for Range Management (1989). Reviewing this literature will improve the science base of future environmental assessments and plans and avoid confusion regarding alternative grazing practices.

Grassland History

Most of California's grasslands are dominated by non-native grasses and forbs of Mediterranean origin (Heady 1977, Baker 1989, Keeley 1990), although alien taxa in California come from all parts of the world (Hickman 1993). The pre-settlement composition of Mediterranean-type grasslands and the understories of associated shrublands and woodlands, now dominated by non-native annual species, are uncertain. Classical ecologist Fredrick Clements first proposed that the vegetation of the Central Valley, the central and southern Coast Ranges, and the valleys of southern California was perennial grassland (Clements 1920) and proposed that these were dominated by *Stipa* spp. Clements relied on observations of scattered patches of purple needlegrass (*Nassella pulchra*) along railroad rights-of-way (Keeley 1990, Hamilton 1997). It since has been suggested that several other perennial grasses (e.g. *Poa secunda, Leymus triticoides, Melica* spp*., Muhlenbergia rigens*) were historically more important constituents in some environments (Keeley 1990, Holland and Keil 1995, Holstein 2001, Schiffman 2007b).

The hypothesis that many of California's current grasslands were formerly dominated by woody vegetation and not "pristine" prairie (Cooper 1922) has been less popular, but has received some scientific support (Hamilton 1997). Cooper noted numerous examples where repeated burning, often intentionally, was sufficient to eliminate woody vegetation and replace it with weedy annuals. Some annual grassland sites may have in fact previously been dominated by coastal scrub (Hopkinson and Huntsinger 2005) or native annuals (Solomeschch and Barbour 2004) and not perennial bunchgrasses. Keeley (1993) compared site characteristics of grasslands with significant native perennial grass stands and sites lacking native perennial grasses and concluded that in the absence of disturbance by fire and livestock grazing, sites often were re-colonized by shrubs.

While the pre-settlement grassland commonly included native perennial grasses, the composition (species and amounts) of the pre-settlement grassland is uncertain. Invasion of non-native annual species is well documented beginning with European exploration and settlement as early as the late 1600s (Hendry 1931). The major period of invasion was in the 18th century and many of these species were well established by the following century (Keeley 1990) and invasion and expansion continue today.

While livestock grazing has been implicated as a primary reason for conversion of California's grassland to one dominated by non-native annuals (Biswell 1956, Baker 1978, Minnich 1980, Sims 1988, Jackson 1985, Schoenherr 1992, Holland & Keil 1995, Hamilton 1997), some recent studies suggest that, in many areas, tillage associated with crop agriculture may have been the primary cause of the conversion (D'Antonio et al. 2007). In these areas, livestock grazing may have been the initial stressor but cultivation was probably the primary stressor leading to reduced distribution and dominance of native perennial grasses (D' Antonio et al. 2007). Vegetation type conversions, for the purpose of increasing forage production and reducing fire hazard, have also been responsible for conversion of woodlands and shrublands to grasslands (Love et al. 1952). Severe droughts in 1828, 1862 and 1864 have also contributed to the conversion to non-native annual-dominated grassland (Baker 1978, Keeley 1990, Heady 1977). Others have suggested that high frequency burning first by native peoples and later by Europeans may have made the former grassland susceptible to invasion by non-native species (Hervey 1949, Zavon 1982, Ahmed 1983, Keeley 1990, Fossom 1990), but Keeley and Fotheringham (2001) concluded that the effects of pre-European anthropogenic fires "were likely limited due to low population density and reduced mobility". In regards to BCNWR and southwestern San Joaquin Valley and foothills there is no record of intentional or routine burning by Native Americans or settlers. More recently, Malmstrom et al. (2006) have implicated grass infections with barley yellow dwarf virus in the susceptibility of native grasslands to invasion. While all of the grassland was not subject to identical stresses the various combinations of drought, fire, cultivation and grazing can reasonably be implicated in the transition from native grassland to non-native annual-dominated grassland.

The removal of plant tissue by multiple agents (including fire and herbivory) is a fundamental process in grassland ecosystems (Knapp et al. 1999, Woodward et al. 2004, Bond et al. 2005, Jackson and Bartolome 2007). Grasses have evolved habits and structures to avoid or tolerate (Holechek et al. 2004) above ground tissue loss and they sometimes respond to fire and grazing with elevated growth rates (Knapp 1985, Knapp and Gilliam 1985, Ferraro and Oesterheld 2002).

While grassland plants may avoid or tolerate grazing, grazing alters inter- and intra-specific competition resulting in short and long-term changes in species composition. Based on the Clemensian climax community concept (Clements 1936) retrogression from climax due to grazing could be reversed by removal of grazing and this model was supported by observations of perennial grasslands in the Midwestern U.S. However this paradigm is not supported in California's non-native annual dominated grassland where removal of grazing does not return the grassland to a perennial dominated climax state (Biswell 1956, Heady 1958, Naveh 1967, White 1967, LeHouerou 1972, The conversion of pre-settlement Mediterranean-type grasslands including grass-shrub and grass-forb communities and the understory of oak-woodlands has been so complete that return to the presumed pre-settlement state is apparently an irreversible transition (George 1992, Briske 2003).

Grassland Restoration

According to the Flora of Kern County (Twisselman 1967) botanical collecting began very late in Kern County. John Fremont recorded botanical names in his journal as he traveled through Kern County in 1844. Coastal regions and the Sacramento Valley were settled before the first Kern County collections in 1853 near Fort Tejon. These dates are after the start of the invasion of non-native annuals that now dominate the grassland. Thus we are uncertain of the pre-settlement herbaceous composition of BCNWR. Longer-lived woody plants such as saltbush (*Atriplex* spp.), oaks (*Quercus* spp.) and juniper (*Juniperus* spp) were presumably part of the pre-settlement composition.

Restoration of the native grassland has been a recurring objective of range managers on California's non-native annual grasslands (Kay et al. 1981, George et al. 1992). The goal of restoring grasslands to some pre-settlement condition has proven to be unrealistic because not only is there uncertainty about the historical composition and extent of California native grasslands but restoration failure is common (and few showcase their failures) (Jackson and Bartolome 2007).

A common goal of restoration practitioners is to return a habitat to its presumed pre-settlement condition. However, the ecosystem dynamics and services of the pre-settlement California grassland are unknown and the species composition is uncertain (Jackson and Bartolome 2007). While the composition of the pre-settlement grassland is uncertain, it is important to attempt to establish its composition as well as historic records and research will allow (Fisher et al. 2009). Without knowledge of the pre-settlement condition, goals to return habitat to a more desirable condition involving a particular species composition, community structure or set of ecosystems functions are common (D'Antonio and Myerson 2002).

Before any restoration is begun, site suitability needs to be assessed (Keeley 1993). While increasing native perennial grasses may be appropriate on sites supporting a strong perennial grass component, other sites may be more suitable for attempts to restore native shrublands or native annual forb-dominated ecosystems. There is a mistaken notion by some land managers that any non-native dominated-annual grassland is suitable for restoration with native perennial grasses (Keeley 1993). Environmental NGOs, such as the Nature Conservancy, and government agencies overseeing parks and preserves have frequently assumed that the pre-settlement ecosystems were bunchgrass-dominated, so management and restoration efforts tend to focus on restoring a bunchgrass landscape (Blumler 2002).

Research projects focused on restoring native perennial grasses have affirmed the challenge of their establishment, especially from seed (Dyer et al. 1996; Stromberg and Kephart 1996). Other studies have determined that the more abundant and faster-growing annual grass species can form dense stands, monopolize resources, and restrict the growth and survival of perennial grass seedlings (Bartolome and Gemmill 1981; Dyer et al. 1996; Dyer and Rice 1997; Hamilton et al. 1999; Brown and Rice 2000). Studies of fire and grazing have also failed to find practices that increase native perennials, thus where the grassland is steep, rocky or arid little opportunity exists for increasing native perennials. An extensive review of native grassland research conducted throughout California attempted to quantitatively evaluate the potential for use of grazing and prescribed fire as tools to enhance native grass populations (D' Antonio et al. 2006). Unfortunately, they found only a few studies that examined the impact of grazing and fire on native plants, and many of these studies lacked replication of treatments or controls to be included in a quantitative analysis.

Grazing Management

Livestock grazing on public land is an emotional issue with some citing degradation of public resources while others support livestock grazing as an appropriate use. Beyond the emotional arguments is a complex of practical experience, scientific information, ecosystem processes and local culture related to livestock grazing that must be carefully analyzed with respect to land management objectives (Bush 2008). For the land manager the question should not be "to graze" or "not to graze" but evaluation of the expected beneficial and detrimental effects of grazing relative to management's objectives. For BCNWR managing vegetation is an objective. Vegetation can be managed or changed using fire, grazing, herbicides, mechanical control methods and by seeding desired species.

Grazing managers can influence or control the season, frequency, duration and intensity of grazing. Grazing managers can also manipulate livestock distribution through the placement of fences, water developments, supplements and other attractants (George et al. 2007). Grazing may occur all year or it may occur just during a certain period or season of the year. Season of grazing has to do with when during the year that grazing occurs. A season can be fall, winter, spring or summer but it can also be some other specified time period such as targeting grazing during flowering or dry season grazing. Frequency and duration of grazing have to do with how often a pasture is grazed, how long a pasture is grazed and how long it is rested between grazings. Intensity of grazing has to do with stock density, stocking rate and carrying capacity. Stock density is the number of animals per acre at any point in time. This term is often used in intensive grazing management systems. Stocking rate is the number of specific kinds and classes of animals grazing a unit of land for a specified time period. Carrying capacity or grazing capacity is the maximum stocking rate possible while maintaining or improving vegetation or related resources. It may vary from year to year on the same area due to fluctuating forage production caused by variations in the timing and amount of precipitation (George et al. 2001).

Prescribed grazing is a term that covers application of season, intensity, frequency and duration of grazing to meet objectives for the site, pasture, ranch or refuge. Prescribed Grazing is a practice in the USDA Natural Resources Conservation Technical Guide (http://efotg.nrcs.usda.gov/references/public/NE/NE528.pdf) and it is applied all over the United States. It is defined as managing the controlled harvest of vegetation with grazing animals. Removal of herbage will be in accordance with site production limitations, rate of plant growth and the physiological needs of vegetation. Prescribed grazing is intended to manage the kind of animal, animal numbers, grazing distribution, length of grazing periods and timing of use to provide sufficient deferment from grazing during the growing period. Grazing prescriptions are designed to protect soil, water, air, plant and animal resources when locating livestock feeding, handling and watering facilities and to manage grazing animals to maintain adequate vegetative cover on sensitive areas (i.e. riparian, wetland, and habitats of concern).

Targeted grazing is a recent term that is the application of a specific kind of livestock at a determined season, duration, and intensity to accomplish defined vegetation or landscape goals. This concept has been around for decades and has taken many names, including prescribed grazing and managed herbivory. The major difference between good grazing management and targeted grazing is that targeted grazing refocuses outputs of grazing from livestock production to vegetation and landscape enhancement. The concept of a target requires that one has a clear image on which to focus and then aims something (i.e., an arrow) at the target to accomplish the desired outcome. In the case of targeted grazing, the land manager must have a clear vision of the desired plant community and landscape, and the livestock manager must have the skill to aim livestock at the target to accomplish land management goals.

Like crop production, urban development, forest harvest, fire protection and other human activities; grazing by wild and domestic herbivores alters ecosystem structure and function, biodiversity, habitat, hydrology, water quality and other ecosystem services. Critics of livestock grazing raise legitimate issues that must be considered when developing a grazing regime for public land. Some common concerns are listed in Table 1. Many of these concerns are the result of improper grazing management. For example, maintaining proper stocking rate and proper season of use can reduce the impact of species preferences on species composition and keep bare ground below levels that may lead to soil erosion. Application of practices such as water developments and nutritional supplement placement can be used to manipulate livestock distribution so that animal concentration impacts (trampling, nutrient deposition and heavy grazing) can be minimized or prevented (Bailey et al. 1996). Rotational grazing practices that increase stock density for short periods followed by adequate periods of rest can moderate preferential grazing of preferred species and also reduce congregation of livestock in preferred rest areas. Concerns about transport of non-native seeds (Vavra et al. 2007) can be addressed by maintaining a resident herd and to some degree by quarantining new incoming animals. Other concerns such as impacts on biological crusts and soil mycorrhizae have not been sufficiently studied to confirm the extent of the impact or practices that could mitigate these impacts.

Several authors (Fleischner 1994, Trimble and Mendel 1995, Belsky et al. 1999) have reviewed the effects of livestock grazing on species composition of communities, ecosystem structure (vegetation stratification, soils), and ecosystem function (hydrology, nutrient cycling and succession). While these reviews raise important issues, they have been criticized for not citing studies where few or no livestock grazing effects were found, for citing studies that were poorly designed, and for not acknowledging similar impacts by native herbivores (Brown and McDonald 1995). Several researchers have been critical of comparisons between grazed areas in riparian zones and similar grazing exclosures (Rinne and LaFayeue 1991, Larsen et al. 1998, and Sarr 2002) and many of these criticisms can be extended to similar comparisons on upland sites. Sarr (2002) reviewed exclosure studies and reported that exclosure-based research has left considerable scientific uncertainty due to popularization of relatively few studies, weak study designs, a poor understanding of the scales and mechanisms of ecosystem recovery, and selective, agenda-laden literature reviews advocating for or against public lands livestock grazing. Exclosures are often too small (< 125 acres) and improperly placed to accurately measure the responses of aquatic organisms or geomorphic processes to livestock removal. Depending upon the site conditions when and where livestock exclosures are established, post-exclusion dynamics may vary considerably. Systems can recover quickly and predictably with livestock removal (the “rubber band” model), fail to recover due to changes in system structure or function (the “Humpty Dumpty” model), or recover slowly and remain more sensitive to livestock impacts than they were before grazing was initiated (the “broken leg” model). Sarr presents ideas for strengthening the scientific basis for livestock exclosure research including: (1) incorporation of meta-analyses and critical reviews; (2) use of restoration ecology as a unifying conceptual framework; (3) development of long-term research programs; (4) improved exclosure placement/design; and (5) a stronger commitment to collection of pre-treatment data. Properly designed exclosure studies could provide useful insights into grazing effects but few meet these criteria.

To be fair there are also papers that present the benefits of grazing without adequately describing the grazing regime studied or for ignoring negative impacts of grazing cited in the literature. High quality grazing management research requires a description of the grazing regime studied (season, frequency, intensity and duration of grazing) and of the site conditions (soils, weather, vegetation, etc) where the study was conducted. It also requires that conclusions be supported by the results. Studies that detect adverse impacts of grazing can only draw conclusions about the specific treatments applied and the site studied. Too frequently they have been used to indict all grazing rather than identify practices that are beneficial versus those that are not.

The objective of exclosure and other studies should be to understand grazing so that it is properly managed to meet objectives. Studies need to completely describe grazing treatments as to season, intensity, frequency and duration. Additionally comparisons of various grazing management practices and no grazing are needed so that the long term effects of grazing on ecosystem services can be determined.

A common conclusion from exclosure studies on California’s non-native annual dominated grasslands is that native plants do not typically become dominant after protection from grazing. One explanation of this finding is that livestock grazing explains less of the variation in plant distribution than site specific factors such as climate, soil characteristics, land use history and topographic characteristics (Stromberg and Griffin 1996). Another explanation is that, focusing on native perennial grasses, we may fail to detect changes in the composition of other native species. Huntsinger et al. (2007) summarized studies of the effects of livestock grazing on native California grassland plants.

While grazing by wild and domestic herbivores is known to alter ecosystem structure and function, even partial knowledge of the grazing practices that led to these alterations can be used to apply grazing practices to partially reverse these alterations or move to some new desired ecosystem structure that meets society‘s needs for habitat, open space, biodiversity, clean water and other ecosystem services. Grazing has been shown to alter grassland species composition but removal of grazing also results in change. In the non-native annual dominated grasslands of California grazing has contributed to the transition from a native perennial dominated state to a non-native annual dominated state but removal of grazing has not resulted in reversal to a pre-settlement state. In several studies, year-round livestock exclusion has been shown to reduce diversity of herbaceous native and exotic plant species, in some cases to the detriment of threatened species that depend on non-grass species (Weiss 1999, Hayes and Holl 2003, Kelt et al. 2005, Marty 2005, Pyke and Marty 2005). On the other hand, livestock grazing also has been found to be detrimental to rare, threatened, or endangered plant species that occur at BCNWR (CNPS, Bates 1983, Andreasen submitted, US Fish & Wildlife Service 1990, Williams et al. 1998, Mazer et al. 1983, Taylor and Davilla 1986).

There have been several studies that have reported that cessation of grazing may have detrimental effects on native flora and fauna. In a well documented study removal of grazing decreased native vernal pool plant and aquatic invertebrate species and application of grazing increased these species but ungrazed pools had 88% higher cover of exotic annual grasses and 47% lower relative cover of native species than pools grazed at historical levels (continuously grazed)(Marty 2005). Additionally the inundation period of the pools was reduced in ungrazed pools, which, based on the Pyke and Marty (2005) model with hypothesized climate changes, could make it difficult for some endemic vernal pool species to complete their life cycle. Weiss (1999) surveyed Bay checkerspot butterfly populations in serpentine grasslands south of San Jose, California and found grazing exclusion led to loss of the butterfly.

Benefits of grazing have also been documented in coastal grasslands. Hayes (1998) reports that cessation of grazing is a threat to annual wild flower displays. One species, Santa Cruz tarplant (*Holocarpha macradenia*), flourished with grazing but disappeared when grazing was removed. In another study Hayes and Holl (2003) found that native annual forb richness and cover were greater in grazed sites and this effect coincided with decreased vegetation height and litter depth. Native grass cover and species richness did not differ in grazed and ungrazed sites but cover and species richness of native perennial forbs was higher on ungrazed sites. Based on these results, Hayes and Holl (2003) concluded that their results suggested that cattle grazing may be a valuable management tool to conserve native annual forbs and possibly other species of concern. This study was done in California coastal prairie that is much more mesic than BCNWR so it is less applicable than studies done in habitats similar to BCNWR.

Grazing management has been effective in controlling noxious weeds such as medusahead and yellow starthistle (DiTomaso 2000, 2006, 2008) although the authors concluded that gazing is unlikely to be a practical solution for management of large-scale infestations. Properly timed grazing can reduce flowering in non-native annual plants such as ripgut brome (*Bromus diandrus*), and red brome (*Bromus madritensis*) (Savelle and Heady 1970, Germano et al. 2004, McGarvey 2009 and Battles et al. in press). Grazing can also impede invasion of the grassland by shrubs such as coyote bush (*Baccharis pilularis*, McBride and Heady 1968). Grazing exclusion often leads to ripgut brome (*Bromus diandrus*) dominance (Heady 1968, Heady et al. 1991) while grazing can reduce ripgut brome by reducing residual dry matter (Heady 1958).

Managed grazing may also benefit animal habitat. The US Fish and Wildlife Service recognized that grazing and maintenance of stock ponds can provide suitable breeding habitat for the California red-legged frog and the California tiger salamander. Germano et al. (2001) found that the cover of non-native grasses and forbs often creates an impenetrable thicket for small, ground-dwelling vertebrates. An on-going long term study in Kern County has found that several animals are often higher on grazed plots than in ungrazed plots including short nosed kangaroo rats, giant kangaroo rats, sage sparrows, horned larks, western meadowlarks and blunt-nosed leopard lizards (Germano et al. 2006).

Grazing may also reduce fire hazard. Fuel management studies have shown that spread rate and flame length are lower when dry grass fuel load is less than 800 lb/a when compared to dry grass fuel loads of 2200 lb/a (about 1 foot tall) (Scott and Burgan 2005). Monitoring at several points on the BCNWR reveals RDM levels ranging from less than 100 lbs/a to more than 6000 lbs/a with the majority exceeding 800 lb/a (Appendix E).

Table 1. Some negative impacts of livestock and grazing and practices that reduced or prevent these impacts.

Negative Impacts	Management Practices
Livestock transport seeds of non-native species into uninfested sites (Lacey 1987, Schiffman 1997, Vavra et al. 2007).	In the context of BCNWR or anywhere in California's annual dominated grasslands there is no such thing as an uninfested site. Non-native seeds are transported in many ways including vehicle traffic, management staff and wildlife. Unless these vectors are also managed little will be accomplished by restricting livestock transport. Once non-native plant suppression is effectively reducing competition with desired species then transport of non-native species can be addressed. Maintaining a resident herd of livestock would be the most logical means of stopping livestock transport of non-native seed. Quarantine of incoming livestock in corrals or holding pastures can reduce transport of non-native seeds but would not completely stop transport.
Livestock preferentially graze on native plant species over alien plant species (Lacey 1987, Fleischner 1994, and Vavra et al. 2007).	High stock densities for short periods of time followed by adequate rest periods can effectively reduce the effects of preferential grazing.
Livestock may change plant competition relationships in ways that favor alien species (Baker 1978, Lacey 1987, and Vavra et al. 2007).	High stock densities for short periods of time followed by adequate rest periods may help to equalize grazing pressure on non-native species and preferred species.
Livestock create patches of bare, disturbed soils that act as an alien plant seedbed (Ellison 1960, Schiffman 1997, Vavra et al. 2007).	Use light to moderate stocking rates to minimize bare ground. Often rodent activity is a larger source of bare patches on California's annual dominated rangelands.

Table 1 (continued)

Negative Impacts	Management Practices
Livestock destroy biological soil crusts that stabilize soils and inhibit alien and native seed germination (Belknap et al. 2001).	While livestock have been shown to damage biological crusts in the arid southwest it is uncertain whether this is an issue on BCNWR. According to Brotherson et al. (1983) management techniques favoring the maintenance of cryptogrammic crusts are not well worked out and Anderson et al. (1982) indicated that management practices are possible and should take into account the timing of grazing use to avoid the season of low precipitation, high temperature, and the incidence of torrential rains. Like other impacts of grazing we are uncertain whether all grazing is detrimental or if there are grazing management practices that can ameliorate or prevent effects on cryptogrammic crusts.
Livestock create patches of nitrogen-rich soils, which favor nitrogen-loving alien species.	Poor livestock distribution can result in development of nitrogen rich patches by strategic use of distribution practices can moderate to reduce congregation in the same rest areas for long periods. Intensive rotational grazing also moderates this effect.
Livestock reduce concentrations of soil mycorrhizae required by most western native species.	Mycorrhizae requirements of western native species are not sufficiently known and the impact of livestock on soil mycorrhizae has been rarely reported. Belsky and Gelbard (2000), a non-peer reviewed report, reported this grazing effect from a single symposium report that may or may not have been peer reviewed. A quick literature search revealed little substantiation to this claim.
Livestock accelerate soil erosion that buries alien seeds and facilitates their germination.	Peer reviewed reports by recognized grazing scientists (e.g. Vavra et al 2007) report that wild and domestic can enhance exotic plant invasion, establishment and spread because 1)many exotic plants are adapted to ground disturbances created by ungulates, 2) ungulates transport non-native seeds, and 3) ungulates prefer natives or non-natives.

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CHAPTER 3

RESOURCE INVENTORY

Introduction

Bitter Creek National Wildlife Refuge (BCNWR) is approximately eight miles south of Maricopa, California in the arid foothills of southwestern Kern County, California. Elevation ranges from 1,600 to 4,680 feet above sea level. It is located in the northern reaches of the Transverse Range, an ecologically diverse region where the Coast Range, Sierra Nevada mountains, western Mojave Desert, and San Joaquin Valley converge. The refuge is described as an integral link in the chain of unique habitats that create a vital corridor for wildlife from the deserts of the Mojave to the Pacific Ocean. Although initial acquisition of the Hudson Ranch and adjoining properties began in 1985, most of the BCNWR's 14,095 acres were acquired in 1986. Although the BCNWR provides habitat for many listed species, the primary goal for the establishment of the BCNWR was to preserve essential foraging and roosting habitat for the California condor (*Gymnogyps californianus*).

Land Use History

Documented agricultural land uses began with the arrival of Spanish settlers who introduced large numbers of livestock (e.g. cattle, horses, and sheep). As the surrounding landscape was converted to agricultural and urban development, the BCNWR was intermittently grazed by livestock, and some areas were converted to cropland. After purchasing the BCNWR in 1985, the USFWS allowed seasonal grazing on a year-long basis to continue. From 1985 to 1995, the BCNWR was managed as part of the Kern National Wildlife BCNWR Complex. Management activities were limited to oversight and adjustment of the grazing program, site restoration and the monitoring of species and habitats. The Hopper Mountain National Wildlife BCNWR Complex took over management of the BCNWR in 1995, with continued oversight and modification of the grazing program, limited herbicide application, monitoring for the presence of native species, and other habitat management activities (including installation of permanent fencing around riparian and designated sensitive areas). Until 2005, the BCNWR was subject to year round grazing. Since 2005, there has been no grazing by domestic livestock on BCNWR management units.

In 1988 cattle were fenced from several drainages where stinging nettles provided the nesting substrate for tri-colored black birds (*Agelaius tricolor*). Due to drought grazing was terminated in all areas west of Cerro Noroestre Road in 1990 which included much of the former dry farmed land and refuge stocking rate was reduced from around 750 cows to 453 cows. Additional reductions resulted in only 50 head grazing the BCNWR by August 1990. Later that year 5300 acres were removed from grazing. In October 1992 stocking rate was increased from 135 head to 300 head of cattle and an additional 1922 acres (Unit 9) were grazed to reduce fiddleneck (*Amsinkia* spp) and mustard (*Brassica* spp.) that had accumulated after three years of no grazing. In 2000 the Timbers Area was fenced from cattle.

In May 1996 a review panel recommended using grazing as a land management tool even though it is not essential to condor recovery efforts. The group recommended the continued use of grazing as a land management tool with several modifications including: implementing cool season grazing and reducing or eliminating warm season grazing, evaluating rest-rotation grazing techniques, exploring fire as a management tool, and fencing all riparian areas, ponds, juniper-scrub, and live oak stands. They also recommended T&E species surveys.

Climate and Weather

Southwest Kern County is in a Mediterranean climate zone characterized by cool moist winters and long hot summers. In winter, the average temperature is 48.5 degrees F and the average daily minimum temperature is 38.3 degrees. The lowest temperatures on record are 15 degrees at Maricopa on December 6, 1978; 19 degrees at Bakersfield on December 23, 1998; and 8 degrees at Lebec on January 18, 2001. In summer, the average temperature is 80.7 degrees and the average daily maximum temperature is 94.8 degrees. The highest temperatures on record are 116 degrees at Maricopa on July 1, 1950, and 115 degrees at Bakersfield on the same day.

There are several weather stations in the vicinity of BCNWR (Figure 1). The Pattiway weather station (34.93°N 119.38°W) is on the refuge at an elevation of 3865 feet above sea level. There are four weather stations (Snedden, Smith Flat, Burgess and Golden Rule) on the adjacent Snedden Ranch, one of which is reported in Figure 1. The lower elevations of BCNWR receive less than 8 inches of rainfall annually. The nearest weather stations with rainfall averages less than 8 inches are Cuyama, Cuyama Ranger Station, Taft and Maricopa.

There have been several drought years in southwestern Kern County. There was a series of drought years from 1887-89 that reduced hay reserves on ranches around the San Joaquin Valley. This was followed by a severe winter in 1889-90 that exhausted hay supplies and resulted in large cattle losses (Treadwell 1981). Many cattlemen were financially ruined and some lost their homes. Based on records from the Hudson Ranch (Pattiway rain gauge) 1933-34 was the driest year and 1971-72 the second driest year from 1915-16 through 1978-79. Cow herds on adjacent ranches were cut severely in 1970-71 and this was followed in 1975-76 by another poor forage year. The five forage years from 1986-87 through 1990-91 resulted in cow herd reductions to 40 percent of normal. In 2007-2008 there was very little rain after January leaving the lower elevation forage levels especially low.

Fire

While Native Americans and early settlers used fire elsewhere in California, there is no reliable record of intentional burning by these groups in the foothills of the southwest San Joaquin Valley. According to local residents in the last 50 years the few wildfires on BCNWR were human-caused and one was caused by lightning. Most fires from 1982 to 2003 occurred along highways and county roads. The Soda Fire started on June 4, 2005 near the intersection of Highway 166/33 and Cerro Noroeste Road just east of BCNWR. The fire quickly spread onto the refuge with the aid of west bound winds. It then spread onto the private Wind Wolves Preserve and was finally contained on the BLM Carrizo Plain National Monument just east of the Highway 33 turnoff. The fire burned 94 acres of grassland habitat on a refuge parcel located on the north side of Highway 166/33. The BCNWR is served by the Kern County Fire Department.

Earthquakes

The San Andreas Fault passes through the BCNWR from southeast to northwest. The Fort Tejon earthquake of 1857 was one of the greatest earthquakes ever recorded in the U.S., and left a surface rupture scar over 350 kilometers in length along the San Andreas fault. The Kern County earthquake of 1952 caused immense and widespread damage. The quake occurred on the White Wolf fault, a reverse fault (with some left-lateral component of slip) north of the intersection of the Garlock and San Andreas faults.

Soils

A new survey of the soils of the Southwest Kern County was published in 2009 and is available from the local USDA NRCS Office in Bakersfield. Soils types on the Refuge include Balhud, Balhud-Pelato Association, Bittercreek, Bittercreek-Balhud Association, Camatta Family-Bittercreek-Pattiway Association, Nord Family, Pattiway-Balhud Association, Pattiway-Camatta Family Association, Pelato-Balhud, Rettib-Balhud Association, and Sanhud.

Vegetation

Scientists are uncertain of the pre-settlement vegetation types in California's Mediterranean-type rangelands and there is no record of communities or plant species composition for BCNWR or southwestern Kern County. The current BCNWR grassland areas were probably a mix of native annual and perennial grasses and forbs. The oak, juniper, saltbush and other woody species were surely part of the pre-settlement woodland and shrublands. Currently the BCNWR is primarily an annual dominated grassland. Native flora found on the BCNWR are the California sagebrush (*Artemisia californica*), goldenbush (*Haplopappus linearifolius*), pine bluegrass (*Poa scabrella*), yellow wallflower (*Erysimum maniliforme*), golden poppy (*Eschscholzia californica*), *squirrel tail grass (Elymus elymoides), fiddlenecks (Amsinckia spp.), elderberry (Sambucus mexicana), saltbush (Atriplex spp.),* and several other species.

Plant surveys conducted at BCNWR include 1) 1980-83 survey included in the Biological Assessment of the Hudson Ranch (Lawrence 1987), 2) 1996 Flora of Bitter Creek NWR by Tim Tomas and Carl Wishner compiled on April 13-14, 1996, 3) 1997 Plant Survey of Bitter Creek NWR by N. Misa Werner, and 4) 2009 Plant Survey Report by Pam DeVries. Elizabeth Painter compiled a list of 400 taxa from these surveys in 2009 (Appendix B). While these surveys provide lists of species present at the times of the surveys, they do not provide any measure of abundance or precise location.

According to Twisselman (1967) native perennial grasses are present in the upper Sonoran Life Zone but not in the lower Sonoran Life Zone. Thus practices to maintain native perennial grasses should target the upper Sonoran Life Zone. The lower elevations of BCNWR are in or near the lower Sonoran Life Zone. Botanical surveys should be conducted to determine if native perennial grasses occur in the lower elevations of BCNWR.

Kern mallow (*Eremalche kernensis*), an endangered species, has not been officially found on BCNWR. However by some narrow botanical definitions some botanists believe that Parry's mallow (*Eremalche parryi)* may be Kern mallow. Kern mallow is potentially threatened both by uncontrolled grazing and cessation of grazing. The species typically occurs in valley saltbush scrub communities, where it grows under and around saltbush plants and in patches with other herbaceous plants. It typically grows in areas where shrub cover is less than 25 percent, on alkaline sandy loam or clay soils, and at elevations of 315 to 900 feet. While decades of grazing and trampling, mostly by sheep, has lead to localized destruction of Kern mallow in the Lokern area (Presley 1994, Mazer et al. 1993 and Taylor and Davilla 1986), light to moderate grazing may serve to reduce competition in areas that are dominated by aggressive exotics (Cypher 1994).

The 2009 Plant Survey Report (DeVries 2009) briefly describes 14 plant communities or series on BCNWR (Appendix C):

California Annual Grassland Series

Native Perennial Grasslands

Goldenbush Scrub

Bush Lupine Scrub

California Buckwheat Series

Rubber Rabbitbrush Series

Mixed Saltbush Series

Mixed Scrub Series

Mixed Scrub Oak/Singleleaf Pinyon Pine Series

California Juniper Series

Red Willow Series

Fresh Water Marsh

Riparian Scrub

Ornamental and Orchard

Microbiotic Crusts

Microbiotic crusts are common in semiarid and arid environments but their presence on BCNWR is uncertain. Belnap (1997) has reviewed the ecology of microbiotic crusts and reports that trampling by livestock, humans and wildlife may break these crusts that may be valuable in breaking rain-drop impacts and in fixing nitrogen. Rosentreter et al. (2007) describes several groups and species of biological crusts and recommends inventory and monitoring procedures. Crust organisms are quickly able to utilize moisture from rainfall and dew and may retain water under high tension making them extremely drought tolerant. Studies of microbiotic crusts have shown that they may increase, decrease or have no effect on infiltration and these differences are site specific and often related to soil texture and chemical properties of the soil. When broken by trampling they may reform as soon as enough moisture and temperature are adequate or it may take several years for them to reform. Research has shown that emergence densities of vascular plants are greater when crusts are removed or destroyed (Prasse and Bornkamm 2000). While it has not been demonstrated in annual dominated rangelands, intact microbiotic crusts may reduce the safe sites for seed germination and seedling establishment, thus influencing species composition. Litter and the resulting increases in infiltration and decreases in surface run-off are important indicators of rangeland health and of downstream water quality.

Wildlife Resources

In addition to providing historical roosting and foraging habitat for condors, the BCNWR is also used extensively by several species of raptors including golden eagles (*Aguila chrysaetos*), red-tailed hawks (*Buteo jamaicensis*), northern harriers (*Circus cyaneus*), American kestrels (*Falco sparverius*), Cooper's hawks (*Accipiter cooperii*), prairie falcons (*Falco mexicanus*), and numerous species of neotropical migratory and resident songbirds. Reintroduced mammals include pronghorn antelope (*Antilocapra americana*), and tule elk (*Cervus nannodes*) that have migrated from adjacent properties. Other mammals include mule deer (*Odocoileus hemionus*), mountain lion (*Felis concolor*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), badger (*Taxidea taxus*), the Federally Endangered San Joaquin kit fox (*Vulpes macrotis*), grey fox (*Urocyon cinereoargenteus*), spotted skunk (*Spilogale putorius*), raccoon (*Procyon lotor*), the Federally Endangered giant kangaroo rat (*Dipodomys ingens*), and numerous other native rodent species. Among the reptiles found on the BCNWR are western fence lizard (*Sceloporus occidentalis*), and the gopher snake (*Pituophis melanoleucus*). The endangered blunt-nose leopard lizard (*Gambelia silus*) has not been found at BCNWR. The tule elk and antelope that have been sighted on BCNWR are from reintroduced herds from nearby reserves.

While it is not within the scope of this range review to address wildlife resources, there are several species mentioned in the EA (2008) that can be effected and possibly managed using grazing as a tool. These species are San Joaquin Kit Fox (SJKF), Western Burrowing Owl (WBO), Blunt-nosed Leopard Lizard (BNLL), Giant Kangaroo Rat (GKR) and the Tri-colored Blackbird (TRBL). There may be other species of interest that can be addressed during the CCP process.

San Joaquin Kit Fox (SJKF)

According to the EA (USFWS 2008) San Joaquin kit foxes (*Vulpes macrotis mutica*) have been sighted in the 1980s and 90s. Appendix D is a list of San Joaquin kit fox sightings at BCNWR. These sightings were in three general areas of the refuge: 1) the vicinity of the Cliff Hudson residence, 2) near the intersection of Cerro Noroeste Road and Highway 166 and 3) north of the "Timbers" in the area of the north loop road near the boundary of Sections 17 and 18. An active SJKF den observed in the 1980's at an elevation of 4,000 feet on the refuge is the highest on record for the species. Night surveys in

1991 and 1992 verified the existence of the SJKF in two of the known localities and generated the first record of SJKF reproduction on the refuge. One sighting occurred in 1996 near the Cerro Noroeste Road and Highway 166 intersection. No sightings of San Joaquin kit fox have been reported since then.

Vegetation cover (Gerrard et al. (2001) and soil characteristics (O'Farrell 1993, Bell 1998) are important habitat components for SJKF. The EA (USFWS 2008) indicates that the kit fox is thought to prefer friable soils for ease of digging and maintaining dens (O'Farrell 1983). Presence of hardpan layers, near-surface water or bedrock is a significant deterrent to denning. However, the role of soil type in influencing SJKF habitat value is not well understood. Bell (1998) indicates that the SJKF is found on virtually every soil type, including high-clay soils in eastern-Alameda–Contra Costa. The EA (USFWS 2008) also reports that the SJKF prefers reduced vegetative cover but we have not been able to substantiate that finding in the literature.

Livestock grazing is not thought to be detrimental to SJKF (Morrell 1975, Orloff et al. 1986), but may alter the numbers of different prey species, depending on the intensity of the grazing. Livestock grazing may benefit kit foxes in some areas (Laughrin 1970, Balestreri 1981), but grazing that destroys shrub cover and reduces prey abundance may be detrimental (O'Farrell et al. 1980, O'Farrell and McCue 1981. USFWS I983, Kato 1986).

Western Burrowing Owl (WBO)

Surveys conducted in 1994 and 2006 confirmed the presence of Western Burrowing Owls (*Athene cunicularia*) throughout the refuge. Most of these sightings were made in the northern portion of the refuge; however, sightings were also made in the more southerly high elevation areas and along the slopes of Pelato Peak in the central portion of the refuge.

Habitat requirements for WBO include low-growing vegetation (< 6 inches in height) and burrow availability (Orth and Kennedy 2001). Suitable habitat is found in annual and perennial grasslands, deserts, and arid scrublands (Zarn 1974). Grasslands grazed by livestock are utilized because vegetation is relatively short (MacCracken et al. 1985, Haug and Oliphant 1990, Plumpton and Lutz 1993). However, if the pasture is overgrazed, WBO will not burrow due to the over abundance of bare ground (Haug and Oliphant 1990). The WBO exhibits strong site-fidelity and it may use the same site for breeding, wintering, foraging, and/or migration stopovers year after year (Dechant et al 2003).

Blunt-nosed Leopard Lizard (BNLL)

Blunt-nosed leopard lizards (*Gambelia sila*) have not been found on BCNWR. Surveys confirming their presence or absence are needed on the refuge. According to the EA (USFWS 2008) the potential range of the BNLL on the refuge is probably limited to the lower reaches of Bitter Creek canyon where the grasslands give way to areas interspersed with saltbush (*Atriplex* spp.) and bare ground.

The BNLL inhabits undeveloped arid areas with spotted vegetation on the San Joaquin Valley floor typically associated with alkaline (having a pH greater than 7) and saline soils (Stebbins 1985). In the foothills, they inhabit chenopod shrub communities such as common saltbush (*Atriplex polycarpa*) and spiny saltbush (*Atriplex spinifera*) associated with non-alkaline and sandy soils. Vegetation is typically bunch and annual grasses and saltbush (Williams et al. 1998). BNLL inhabit open, sparsely vegetated areas of low relief on the San Joaquin Valley floor and in surrounding foothills (Smith 1946, Montanucci 1965). In general blunt nosed leopard lizards are absent from areas of steep slope and dense vegetation and are found between 30 and 792 meters (98 to 2,600 feet) in elevation (Montanucci 1965, Sandoval et al 2005).

Livestock grazing can result in the removal of herbaceous vegetation and shrub cover, destruction of rodent burrows and associated soil erosion if the stocking rate is too high or animals are left on the range too long after annual plants have died (Chesemore 1981, Williams and Tordoff 1988). Light or moderate grazing may be beneficial (USFWS 1985 a, Germano and William 1992, Chesemore 1980). Chesemore (1980) suggested that 15 percent to 30 percent ground cover was optimal for leopard lizard habitat and greater than 50 percent was unsuitable. Researchers have hypothesized that BNLL prefer lightly grazed grasslands whereas ungrazed areas are dominated by red brome which is a taller, denser introduced grass (Mullen 1981, Chesemore 1980).

Giant Kangaroo Rat (GKR)

The population size and distribution of giant kangaroo rats (*Dipodomys ingens*) on the refuge is not known at this time (USFWS 2008). However, the adjacent Carrizo Plain National Monument supports some of the largest known populations of this species and the potential for dispersal and colonization on the refuge is possible. Surveys are needed to confirm the presence or absence of this species at BCNWR.

The GKR are considered keystone species in grasslands and shrub communities. Unpublished studies (Christian et al. *in prep*) of May-November grazing at the Carrizo Plain National Monument have reportedly found that grazing has had a negative effect during four years of the study and no effect for the other two years of the study. However this study is of limited value to grazing management unless intensity of grazing is reported. Moderate levels of grazing in Panoche and Silver Creek watersheds in Fresno County probably have maintained near optimum habitat for GKR (Williams et al. 1998 - pg 93). The population as a whole seems to have no preference in soil types, but prefer areas with slopes less than 22 percent and elevation of 2,850 feet or lower (Williams et al. 1998 - pg 91-92). However, of the remaining suitable habitat, they seem to show a preference for annual grasslands of gently rolling hills (less than 10 percent) and friable (brittle, readily crumble), sandy-loam soils. Their estimated home range is the same for either sex, 60 to 350 square meters (71 to 420 square yards).

Tri-colored Blackbird (TRBL)

Tri-colored Blackbird (TRBL) colonies on the refuge are located at several different riparian sites with colony sizes varying by year. These sites occur at various elevations and are characterized by substantial populations of tule reeds (*Scirpus acutus*) and/or stinging nettle (*Urtica dioica* ssp. *holoserica*). The largest colony is found in the area of Spanish Spring in the north part of the refuge, this area has supported breeding colonies numbering as high as 3000 individuals in recent years. Other known locations include the main spring and red lake areas in the western portion or the refuge, and several small ponds which are filled seasonally or with the water distribution infrastructure located on the refuge. One characteristic shared by all sites is healthy populations of the vegetation necessary for nesting. The use of photo monitoring has shown that the exclusion of cattle from these riparian areas has allowed the wetland plants, specifically the tule reeds and stinging nettle, to establish stands healthy enough to support TRBL breeding colonies.

Management Units

There are 20 fenced management units at BCNWR (Figure 2). These units were fenced by the Hudson Ranch to keep cattle out of farmed ground and by the US FWS to keep cattle away from the condor cage. The area, carrying capacity, RDM targets and vegetation types for each of these units is reported in Table 2. Management units such as 2, 9, and 11, are large. Grazing use will be reduced in areas more than 1 mile from water. Units 2 and 10b include small areas that are more than 1 mile from stock water. Units 11 and 12 have no developed stock water.

Unit 2 is a key unit in the future management of BCNWR. If it is grazed then there is potential to maintain a herd on the refuge all year round. If it is not grazed there will not be a good December - June grazing resource on the refuge and grazing may be limited to the higher elevations in June - December. Unit 2 is the main low elevation unit at BCNWR. The forage growth is usually greater in this unit in the fall-winter than higher elevation units. Thus this unit is a good candidate for December - June grazing.

While there is a need for a thorough survey to determine (verify) the presence of the Blunt-nosed Leopard Lizard and Giant Kangaroo Rat, Unit 2 is the low elevation unit with low-growing sparse vegetation and areas of gentle slopes that have been reported as characteristic of the habitat for one or more of these species. These gentle slopes are adjacent to the very steep slopes of Bitter Creek canyon. Unit 2 produces abundant forage in normal years. Moderate levels of grazing could be applied to create or maintain low residual dry matter in Unit 2. With some fencing an ungrazed area could be set aside for comparison of animal populations and habitat between grazed and ungrazed areas.

Native perennial grasses are common on BCNWR. The DeVries report (2009) indicates the presence of sizable native perennial grass patches in Units 6 and 12. One of these pastures should be grazed during rapid spring growth to a stubble height of 2 to 4 inches during a grazing period of 7 to 10 days and then allowed to rest at least a month to allow the perennial grasses to rest and regrow. This grazing treatment should be applied just before red brome (most prevalent annual competitor) starts to flower. Native perennial grass density and spread, and red brome flowering success and ground cover could be monitored to determine the effectiveness of this gazing practice. These same attributes should be monitored in the ungrazed pasture for comparison purposes. This comparison should be conducted for at least 5 years before drawing any conclusions or changing management.

Carrying Capacity

Carrying capacity is calculated as animal unit months per acre using a scorecard (Tables 3 and 4) that adjusts for aspect, slope and canopy cover. This scorecard was adapted from the scorecard used by

University of California in Tulare and Fresno Counties. Mel George and Neil McDougald field verified the scorecards in most of the grassland, juniper and oak-woodland management units of BCNWR in 2009-10.

To produce a carrying capacity map a slope (0-10 %, 10-25 %, 25-40% and >40%) and aspect (north and east slopes and south and west slopes) map was generated from the digital elevation model (DEM) for BCNWR (Figure 3). Most of the refuge is grassland and did not require adjustment of carrying capacity due to canopy cover. Carrying capacity based on slope and aspect was downgraded for the units with significant canopy cover (Klipstein Canyon, Uncle Charlies, Timbers, Headwall and Unit 11).

The resulting map (Figure 4) was used to estimate carrying capacity for each management unit (Table 2). The total carrying capacity with no units excluded is 4758 AUMs. This would support 397 animal units (1000 lb cows) for one year. According to BCNWR records stocking rate in 2003 (Unit 1,2,3,6,8,9, 10B), 2004 (Units 1,2,6,9,10A) and 2005 (Units 1,2,9, 10A) was 492, 636, and 448 AUMs, respectively. The Steinbeck Ranch indicates that prior to stock reductions and eventual termination of grazing, they grazed 380 animal units on BCNWR. They used Bitter Creek Canyon (Unit 2) from December to June and then moved to the higher elevation units from June – December. This represents approximately 4560 AUMs depending on beef cow size and other factors. For another comparison adjacent ranches require 25 to 30 acres to support one animal unit for one year. At this rate, BCNWR with a total area of 14,300 acres, would support 476 animal units for one year. While BCNWR has sufficient average forage production to support around 400 cows all year, during dry years this stocking rate would be unsustainable. To reduce the impact of poor forage years (i.e. drought) many livestock operations maintain long-term stocking rates that are less than the ranches carrying capacity. This lower stocking rate results in excess forage in the good and average years but reduces the forage demands during dry years. The intent of this below carrying capacity stocking rate is to reduce hay feeding, herd reductions and weight loss during drought years. BCWNR goals and objectives developed during the conservation planning process and annual operating plans will dictate future stocking rate.

Table 2. Bitter Creek National Wildlife Refuge management units, area, carrying capacity, RDM targets and vegetation types.

UNIT NAME	**AREA**	**CARRYING CAPACITY**	**RDM TARGET**	**VEGETATION TYPES**
	(acres)	**AUMs**	**(lbs/acre)**	**(DeVries 2009)**
Unit 1	770	374	800 – 1000	Calif. Annual Grassland Series (Calif. AGS)
Unit 1B	55	25	800 – 1000	Calif. AGS
Unit 2	4926	1286	800 – 1000	Calif. AGS,Mixed Scrub Oak (MSO) Series, California Buckwheat Series on steep slopes, Mixed Saltbush Series, and Riparian Scrub.
Unit 3 East	693	271	800 – 1000	Calif. AGS, Bush Lupine Scrub, California Buckwheat Series, Rubber Rabbitbrush Series,
Unit 3 West	787	300	800 – 1000	Calif. AGS, Bush Lupine Scrub, Rubber Rabbitbrush Series,
Unit 6	444	222	800 – 1000	Calif. AGS, Native Perennial, California Juniper
Unit 7	129	33	800 – 1000	Calif. AGS,
Unit 8	68	37	800 – 1000	Calif. AGS, Rubber Rabbitbrush Series,
Unit 9	2329	1131	800 – 1000	Calif. AGS, Goldenbush Scrub, Bush Lupine Scrub, Mixed Saltbush Series,
Unit 10A	229	117	800 – 1000	Calif. AGS, Fresh Water Marsh
Unit 10B	587	255	800 – 1000	Calif. AGS, Bush Lupine Scrub
Unit 11	1789	254	800 – 1000	California Juniper Series, Goldenbush Scrub, California Buckwheat Series,
Unit 12	128	74	800 – 1000	Calif. AGS, Native Perennial Grassland series, Bush Lupine Scrub
Bogle In holding	72	36	800 – 1000	Calif. AGS,
Corral-Pond	3	1	800 – 1000	Corral & Pond
Headwall Oaks	246	18	800 – 1000	MSO series, MSO/Singleleaf Pinyon Pine Series, Red Willow Series
Klipstein Exclosure	475	162	800 – 1000	MSO series
Timbers In holding	145	22	800 – 1000	MSO series
Uncle Charlies Exclosure	422	139	800 – 1000	MSO series
W of 166N	3.5	2	800 – 1000	Calif. AGS,
TOTAL	**4758**			

Table 3. Bitter Creek NWR Carrying Capacity on north and east facing slopes.

Canopy Cover (%)	Slope Classes (%)			
	<10	10-25	25-40	>40
	AUM/Acre - average year			
<10	0.8	0.5	0.2	0.1
10-25	0.7	0.4	0.1	0
>25	0.3	0.1	0	0

Table 4. Bitter Creek NWR Carrying Capacity on south and west facing slopes.

Canopy Cover (%)	Slope Classes (%)			
	<10	10-25	25-40	>40
	AUM/Acre - average year			
<10	0.5	0.3	0.2	0.1
10-25	0.3	0.2	0.1	0
>25	0.2	0.1	0	0

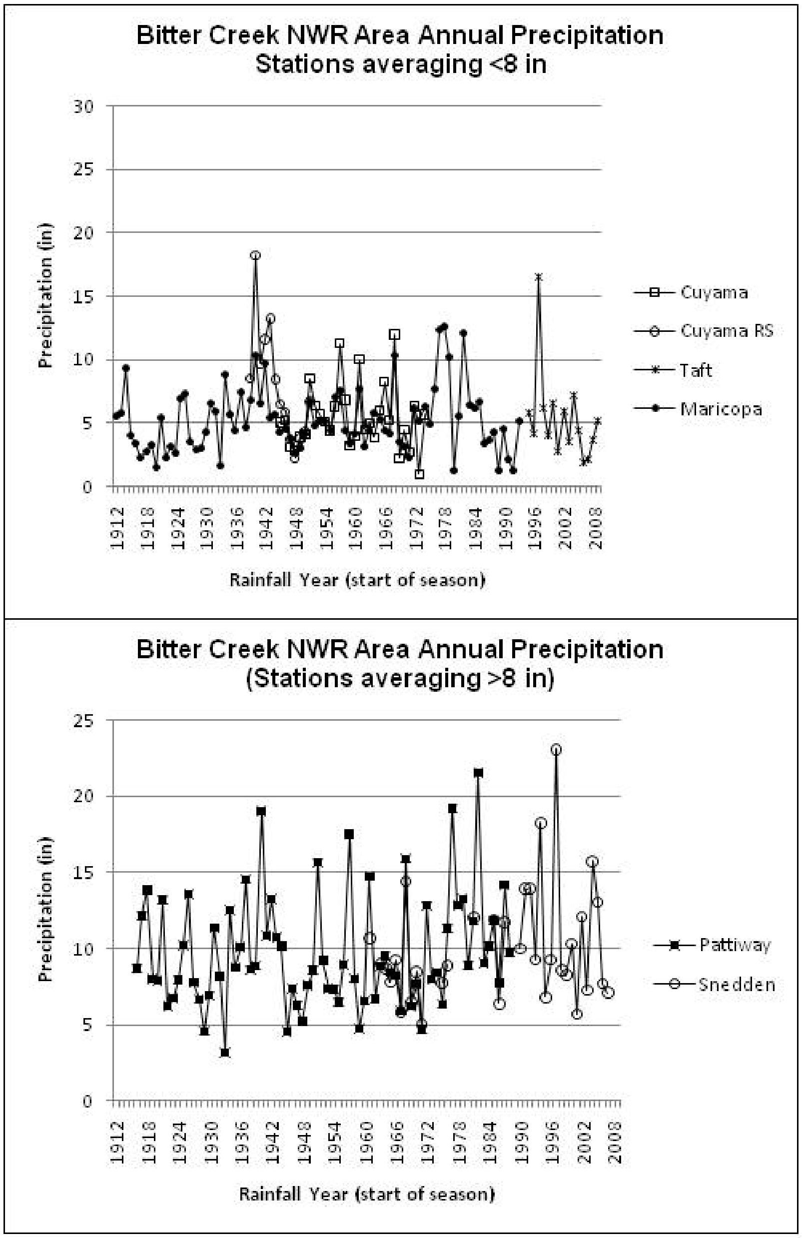

Figure 1. Annual precipitation at weather stations above and below 8 inches of annual precipitation in the vicinity of Bitter Creek National Wildlife Refuge.

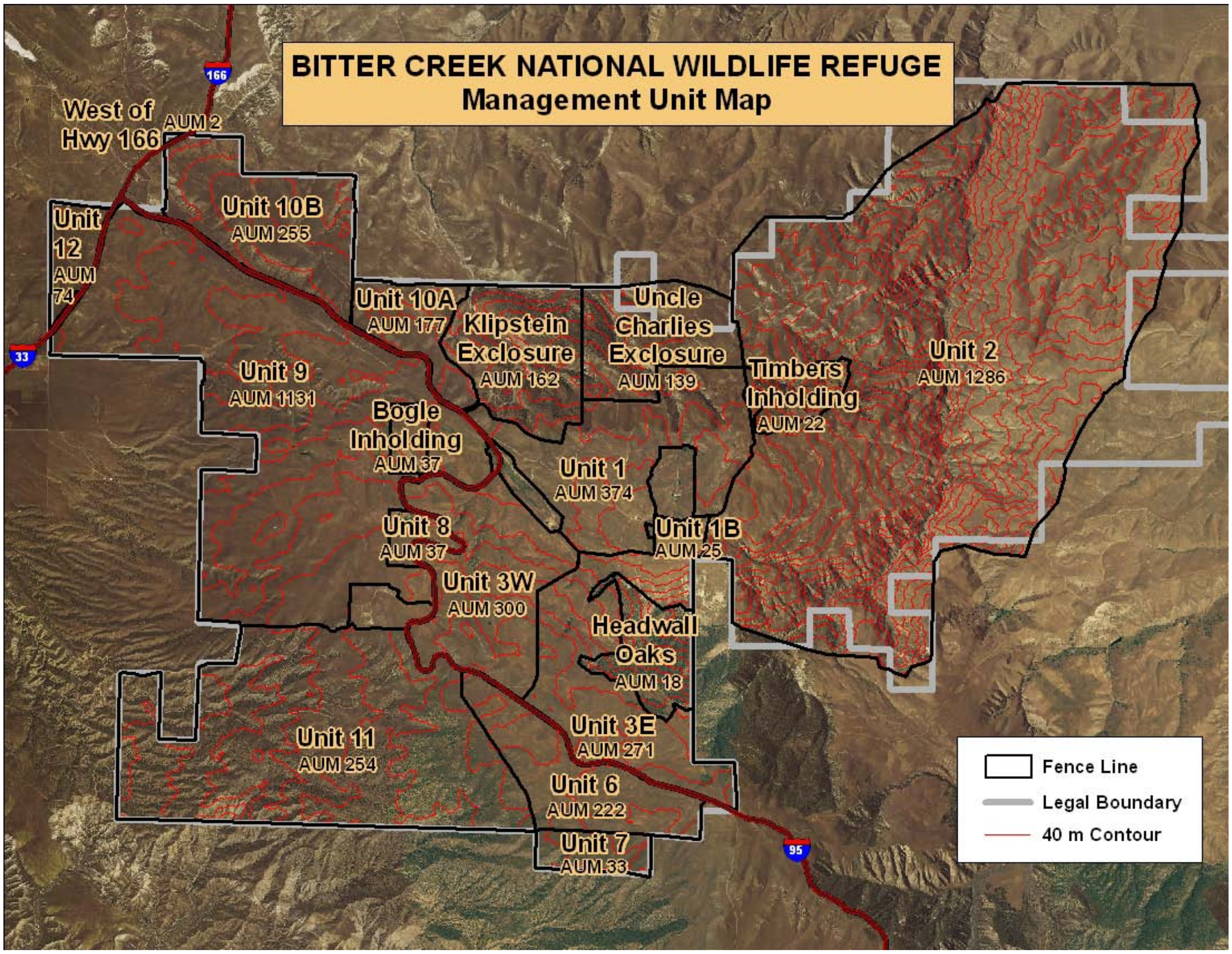

Figure 2. Bitter Creek National Wildlife Refuge Management Units.

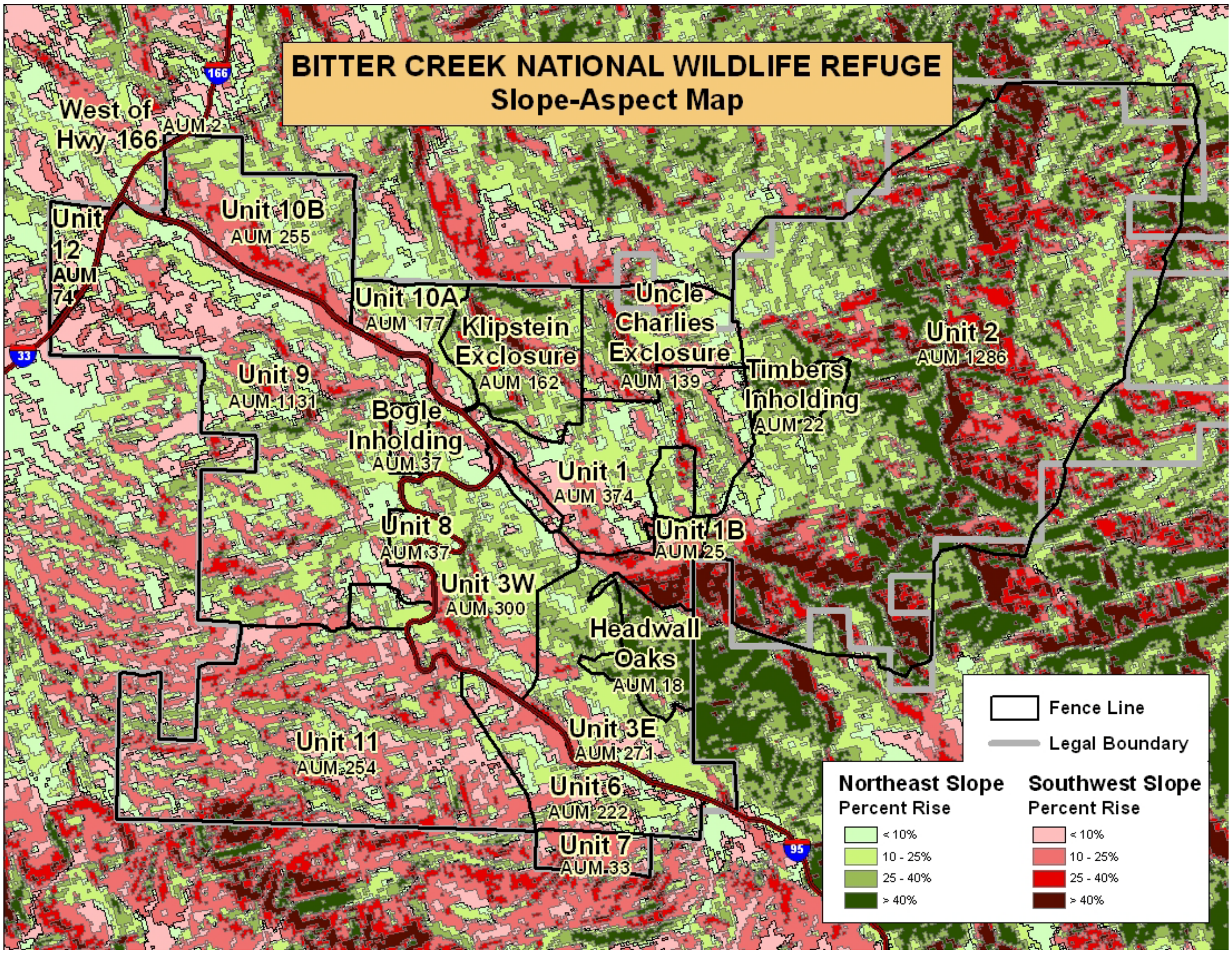

Figure 3. Bitter Creek National Wildlife Refuge Slope and Aspect Map.

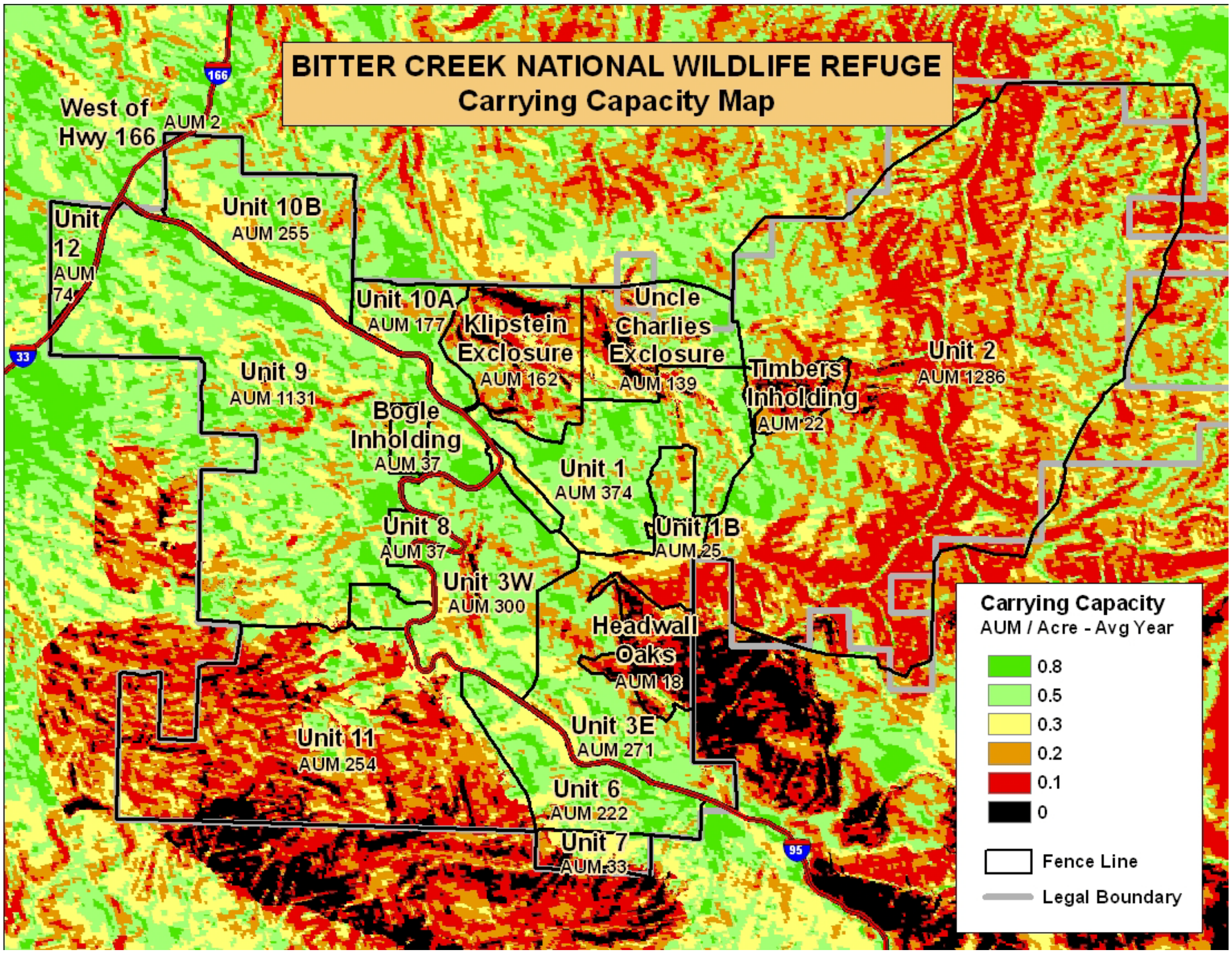

Figure 4. Carrying capacity of each Bitter Creek National Wildlife Refuge Management Unit.

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CHAPTER 4

GRAZING AND VEGETATION MANAGEMENT

Introduction

Prescribed grazing and other vegetation management practices, guided by specific measurable objectives are tools that natural resource managers can apply to influence the characteristics of vegetations and therefore wildlife habitat. In this chapter the potential application of prescribed grazing and vegetation management practices are reviewed. Application of prescribed grazing and management of livestock is facilitated by good livestock handling facilities (corals) and well maintained fences and water developments.

Prescribed Grazing

The USDA Natural Resources Conservation Service defines prescribed grazing as managing the controlled harvest of vegetation with grazing animals to meet management objectives. A prescribed grazing plan would define specific management objectives and practices for each management unit.

While the scientific literature reports cases of positive and detrimental grazing effects on species composition, native plants and biodiversity, few studies have tested practices that might be applicable to BCNWR. There are no studies that have tested an array of season, intensity, frequency and duration of grazing treatments that could guide application of grazing at BCNWR. To manage vegetation to meet habitat objectives BCNWR will have to test promising applications of season, intensity, frequency and duration of grazing to determine grazing practices that can move vegetation from its current state to desired future states. Range scientists and managers from University of California Cooperative Extension, USDA Natural Resources Conservation Service or other agencies could help BCNWR staff identify promising grazing practices after measurable objectives are determined for the refuge management units during Comprehensive Conservation Plan development.

Currently there is no livestock grazing at BCNWR. Too reinstate grazing we recommend development of a prescribed grazing management plan that addresses management of each unit based on US FWS objectives for each unit. The first element of any grazing plan is to determine long-term average carrying capacity of each management unit (pasture) and keep annual stocking rate below the long-term average carrying capacity. Stocking rate must be adjusted annually in response to yearly production conditions. Staff must monitor to stay within the RDM targets for each management unit. Grazing management practices should be selected and applied to low and high elevation management units.

Low elevation management units (Unit 2)

1. apply seasonal fall-winter grazing to selected low elevation portions of the refuge
2. apply moderate grazing intensity with an RDM target of 300 to 600 lb/a (Bartolome et al. 2006).
3. set aside similar parcels that will not be grazed and monitor RDM

4. Optionally set aside parcels for grazing in low production years. Using a rest-rotation grazing system at least one out of three or more parcels would not be grazed during average or high production years but all parcels could be used during low production years. Pasture subdivision and water development would be required to have enough pastures to do this.

High elevation management units (Units 1, 1B, 3East, 2 West, 6, 7, 8, 9,10A, 10B, 11 and 12)

1. apply spring – summer grazing to selected high elevation portions of the refuge
2. apply a moderate grazing intensity with an RDM target of 800 – 1000 lb/a (Bartolome et al. 2006)
3. set aside similar parcels that will not be grazed and monitor RDM
4. Optionally set aside parcels for grazing in low production years. Using a rest-rotation grazing system at least one out of three or more parcels would not be grazed during average or high production years but all parcels could be used during low production years.

Fall-winter(December – June) grazing in low elevation areas and spring-summer (June-December) grazing in high elevation areas are time-tested seasonal grazing practices that provide green feed for livestock for the maximum period of time. Monitoring RDM is a proven method for managers to assess the results of grazing by observing and measuring the amount of litter left behind at the end of the grazing season (Bartolome et al. 2006). These grazing practices may be implemented without additional cross fencing or water developments. Supplement sites (mineral and protein) should be pre-selected to attract livestock into under-used areas such as steeper slopes or areas that are more then 1/4-1/2 mile from water. Distribution of impact within these parcels could be improved with additional cross fencing and water development. These practices may provide short, sparse ground cover suitable for some special status species. More targeted grazing may be used to try to shift the competitive advantage from non-native annual plants to native annual and perennial grasses and forbs.

Kind and class of animal is an important consideration in a prescribed grazing plan, especially where selecting a lessee is involved. A beef cow herd that returns to the refuge annually will develop spatial memory of the management units and will distribute themselves more effectively than a new group of animals each year (e.g. stocker calves). A sheep operation with a herder can also be an effective means of applying and controlling grazing prescriptions.

Livestock Distribution

Poor livestock distribution is often the source of livestock grazing impacts on water quality, habitat and biodiversity. Strategic application of livestock distribution practices as part of a prescribed grazing plan can modify livestock behavior and improve livestock distribution. Water development and fencing are the most common distribution practices. While fencing is designed to contain or exclude livestock, strategic placement of water developments or protein supplements have proven to be effective livestock attractants that can be useful in large management units (Bailey and Welling 2001, George et al. 2007, 2008). Following are some common livestock distribution practices that may be useful at BCNWR:

Pasture subdivision: Too facilitate and refine the creation of grazed and ungrazed mosaics, large pastures may need to be cross-fenced and stock water developed.

Electric fencing: It is difficult to ground electric fencing on dry soils so electric fencing will only be useful during the wet season. Electric fencing requires daily monitoring to insure that it is functioning properly. Livestock must be trained to respect electric fences before they can be effective.

Permanent fencing: Reduce risk and liability by checking boundary fences, especially along roads, to insure they are intact and secure. Check internal fences so that livestock and pasture management runs smoothly during the grazing season. Check gate functionality and security. Functional fences and corals are essential to the control, movement and handling of livestock.

Water development: Water resources at BCNWR limit the opportunities to manipulate livestock distribution and to subdivide pastures. While there may be potential to add water lines, storage tanks, and troughs to the existing water distribution systems, the opportunities to develop more water sources are limited. Water systems must be maintained and monitored throughout the year.

Protein supplement: Placement of protein and mineral supplements can be used to attract livestock into an area targeted for grazing. Research has shown that dehydrated molasses protein supplements (e.g. Crystalyx) will attract livestock into an area and increase grazing use up to 600 yards from the supplement site (Bailey and Welling 2001, George et al. 2007, 2008). Supplement sites should be moved frequently to minimize trampling impacts. Trampled supplement sites could be good sites for native plant seeding trials.

Targeted Grazing Management

Targeted grazing is a term similar to prescribed grazing. It is the application of a specific kind of livestock at a determined season, duration, and intensity to accomplish defined vegetation or landscape goals. Spatial and temporal application of an array of grazing management practices have the potential to protect habitats and resource values in some management units, and strategically reduce competition from non-native invasive species in other management units. Following are some habitat goals where grazing could be used to at BCNWR using adaptive management: 1) managing habitat for Burrowing owls, blunt-nosed leopard lizards and possibly San Joaquin Kit Fox and Giant Kangaroo Rats, 2) suppress non-native annual plants, 3) reduce fire hazard, 4) Maintain native forb and perennial grass populations, 5) Protect riparian areas and manage riparian vegetation, and 6) maintaining a mosaic of herbaceous standing crop.

Vegetation Management Alternatives

In the draft environmental assessment (EA) for BCNWR (US FWS 2008), that was available for public review during 2008, four vegetation management alternatives were stated:

> Alternative A: Prescribed Year- Round Grazing as Primary Strategy - Secondary Herbicide Application (No Action Alternative).
>
> Alternative B: Prescribed Seasonal Grazing as Primary Strategy - Secondary Mowing and Herbicide Application.
>
> Alternative C: Prescribed Burning as Primary Strategy - Secondary Mowing and Herbicide Application.
>
> Alternative D: Prescribed Seasonal Grazing as Primary Strategy - Secondary Prescribed Burning, Mowing, and Herbicide Application (Preferred Alternative).

In a later unpublished revision of the EA prescribed burning was removed from the management alternatives and three alternatives were stated.

> Alternative A: Prescription Grazing as Primary Strategy. Herbicide Application, Mowing, and Native Plant Re-seeding as Secondary Strategies (Preferred Action).
>
> Alternative B: Year-round Grazing as Primary Strategy. Herbicide Application, Mowing, and Native Plant Re-seeding as Secondary Strategies.
>
> Alternative C: No Grazing. Herbicide Application, Mowing, and Native Plant Re-seeding as Primary Strategies (No Action Alternative).

The grazing terminology in these alternatives are potentially confusing because they do not adequately describe the proposed grazing regime(s). None of these alternatives sufficiently describes season, intensity, frequency and duration of grazing. This may result in misunderstandings during public review. Precise descriptions of season, intensity, frequency and duration of grazing for each alternative will help avoid misunderstanding by the reader of these management alternatives. Prescribed or prescription grazing is more than just seasonal grazing. It includes proper stocking rate, proper season of use and proper frequency and duration of use for the objectives stated by management. The term year-round grazing is generally not used in discussing grazing management. The more common term is yearlong grazing or continuous grazing which means a unit is grazed all year. That is, livestock are always present in the pasture. Year-round grazing of the refuge could mean livestock grazing in every unit 365 days per year or it is more likely intended to mean that livestock are grazing somewhere on the refuge all year. There is a big difference and alternative statements need to be clear about the intended meaning. If each unit is constantly grazed then there is no rest and no seasonal grazing. Until 2005 grazing at BCNWR was seasonal grazing on a yearlong basis with some units grazed in the fall-winter and others in spring- summer. In reality, year-round grazing is a form of prescribed grazing. It includes seasonal grazing and movement through different pastures during the year.

Grazing and Native Plants

It is a goal for BCNWR to maintain native plant populations but extreme competition from non-native grasses threatens the existing plant biodiversity. This report focuses on grazing as a vegetation management practice for managing annual grassland and associated communities. Removal of grazing from reserves and conservation trusts has been common and has been shown to reduce diversity of herbaceous native and exotic plant species, in some cases to the detriment of threatened species that depend on non-grass species (Weiss 1999, Hayes and Holl 2003, Kelt et al. 2005, Marty 2005, Pyke and Marty 2005).

A variety of experiments have shown that non-native annual grasses are able to reduce the growth and survival of native perennial grass individuals and to limit growth of native grass populations in and adjacent to California's central valley (Dyer and Rice 1997, 1999, Brown and Rice 2000, Marty et al. 2005). The negative effects of non-native annual grasses on all purple needlegrass life stages strongly suggest that exotic annuals have negative effect on many native perennial populations (Corbin et al. 2007).

While year-long heavy grazing is implicated in the reduction and loss of native species, the influence of prescribed grazing management practices such as seasonal grazing, reduced grazing intensities and rest from grazing on native species is not well studied. The effects of fire and grazing on purple needle grass have been studied more than most other native species and results are inconclusive. However, moderate grazing intensities and rest between grazing have been observed to increase the vigor of purple needlegrass.

Several species of native forbs (e.g., Iris spp., *Orthocarpus* spp., *Ranunculus* californica, *Limnathes* spp., and *Orcuttia* spp.) may increase under light to moderate grazing intensities (Edwards 1995, Barry 1998, Hayes and Holl 2003). Kern mallow (*Eremalche kernensis*), an endangered species, has not been officially found on BCNWR but is potentially threatened both by uncontrolled grazing and cessation of grazing (Cypher 1994).

Species composition has been largely unaffected by manipulation of grazing intensity in non-native annual grassland sites with only negligible native plant cover (Pitt and Heady 1979, Rosiere 1987, Jackson and Bartolome 2002). In grasslands composed of mixed non-native annual grassland and native annual species, such as vernal pools and serpentine sites, grazing has been used to promote native annual wildflowers (Weiss 1999, Marty 2005). In mixed annual and perennial grasslands on mesic sites effects of grazing on native plant composition has been variable (Bartolome et al. 1980). However several studies have demonstrated that mulch removal can be beneficial or have no effect on native plant seed production, seedling establishment, and seedling density or mortality (Savelle 1977, Dyer et al. 1996, Reynolds et al. 2001 and Marty et al. 2005).

The effectiveness of seasonal grazing on native plant vigor, survival and productivity has been mixed. Early spring grazing has been observed to suppress faster germinating exotic annual grasses reducing the competitive suppression of perennial bunchgrasses or native forbs whose seed germinated later than the grasses (Love 1944, Langstroth 1991, Dyer et al 1996). Grazing studies in Solano County have shown that seedling emergence and survival were higher in wet compared to dry season grazing (Fossum 1990, Langstroth 1991, Dyer et al 1996). However these results have not always been repeatable or long-lived because the long-term effects of the treatments were ameliorated by climatic conditions (Dyer et al. 1996). Bartolome et al. (2004) found an increase in purple needlegrass with wet-season grazing compared to dry season or continuous grazing over several years but they also found that purple needlegrass responded positively to removal of grazing.

While not compared to an experimental control, short duration grazing has been observed to increase the abundance of native perennial bunchgrasses and to decrease medusahead (*Taeniantherum caput-medusae*) or yellow star thistle (*Centaurea solstitialis*) (Reeves and Morris 2000, Kephart 2001). Short duration grazing is a rotational grazing system that provides for rest between grazings on a flexible schedule partly determined by pasture growth rate. These observations attest to the effectiveness of rest for increasing the vigor of perennial grasses that were already present. There is no experimental evidence that this grazing practice increased the spread or density of native plants.

We can deduce from these experiments that light or moderate grazing intensities, periodic rest from grazing and wet season grazing may improve the seed production, seedling establishment, survival and productivity of the one species, purple needlegrass that is commonly studied. We remain uncertain as to the effects of season, intensity, frequency and duration of grazing on most native species.

Carrizo Plain National Monument

Because of some similarities and proximity some of the analyses and findings of the Carrizo Plain National Monument (CPNM) Draft Resource Management Plan and Environmental Impact Statement may have relevance to Bitter Creek National Wildlife Refuge (CPNM 2009). The CPNM report describes an extensive array of conservation targets and ranks the state of knowledge regarding management practices that may be used to reach these conservation targets. With respect to grazing the CPNM report identifies several peer reviewed reports, some of which are cited in this report, and non-reviewed research reports that are relevant to these conservation targets. With respect to grazing one unpublished study by Christian et al. (in prep) as well as a study reported by the peer-reviewed paper by Kimball and Schiffman (2003) are frequently cited in the CPNM plan. The results of Kimball and Schiffman (2003) experiments are similar to the results of Christian et al. (in prep). We critique these papers because one is an example of a paper where broad conclusion about grazing practices were extended beyond the results of the study and the other is an example of abusive simulated grazing (clipping) treatments that should not be used to draw conclusions about proper grazing practices.

The Christian et al. report has been “in prep” for more than a year and was not available for this review. However, in an internet newsletter Christian et al. (2008) reported general results of the long-term grazing study at CPNM. They evaluated the hypothesis that a winter-spring (November – May) cattle grazing regime would benefit native annual flora by reducing the biomass and cover of non-native annual grasses, such as wild oats (*Avena* spp) and brome grasses (*Bromus* spp). The apparent assumption was that native annual species are limited by competition with non-native annual grasses, and that properly-timed grazing would decrease non-native annual grass cover and biomass and increase native annual grass and forb richness and cover.   After more than 10 years, this study found that the cover and diversity of native annual forbs was significantly lower in grazed areas compared to ungrazed areas. In contrast, native bunchgrasses exhibited a variable response to grazing that depended on soil and vegetation community type. Contrary to researcher expectations the cover of non-native annual grasses was greater in grazed areas relative to ungrazed areas. They concluded that two of the primary management objectives for using cattle grazing as a management tool (to enhance native plant species and to decrease exotic species) were not supported by this study. The Christian et al. study was also designed to monitor the effects of cattle grazing on the giant kangaroo rat (GKR), a keystone species in the CPNM ecosystem.   Previous studies in nearby the Lokern Natural Area grassland ecosystem (Germano et al. 2001) suggested that increased levels of plant biomass decrease the suitability of GKR habitat. In the CPNM study the effects of grazing varied across years with grazing having a negative effect on GKR habitat in four out of six years of the study and no effect in the other two years.

Christian et al. (2008) went on to conclude that their results did not support the general hypothesis that seasonal grazing is beneficial for the native plant communities found in the study area. This is not a valid conclusion. From this study they can only conclude that November – May seasonal grazing at the stocking rate applied was not effective. There are other, more targeted, applications of seasonal grazing, studied elsewhere in California that may be appropriate. For example there is growing evidence that non-native annual grass productivity and seed production can be reduced by strategically applying grazing at phenological stages, such as just prior to flower emergence, that impact flower and seed production (Savelle and Heady 1970, DiTomaso 2008, McGarvy 2009 and Battles et al. *in press*). In the DiTomaso (2008) study medusahead density was reduced the following year.   Before we declare that seasonal grazing is ineffective at reducing non-native annual grasses we need more studies like these that investigate different combinations of season, intensity, frequency and duration of grazing that potentially could meet management objectives.

One of the objectives of another CPNM study by Kimball and Schiffman (2003) was to determine whether native and alien species respond differently to grazing and, specifically, how cover and diversity are affected. They simulated grazing by clipping plots to 1 cm above ground level, 1 time (late February) or two times (late February and early March) or 3 times (late February, early March and early April). They compared these clipping treatments to plots that were not clipped with or without mulch removal. They applied these treatments in the spring of 1999, 2000, and 2001. This study followed the scientific method and properly drew conclusions based on the results. The problem with this study is that clipping to 1 cm is simulation of poor grazing management, but it is a good treatment if you want to show that really close clipping has potentially negative impacts on species composition.   Residual dry matter (RDM) guides (Bartolome et al. 2006) for low rainfall annual rangeland are in the range of 300 to 600 lb/a which is typically a clipping level of 2.5 to 5 cm. A 1 cm grazing height would substantially reduce litter (RDM less than 300 lb/a) and its positive soil protection and mulching effects.   Like the studies they cite Orodho et al (1998) and Kotanen and Bergelson (2000) this study should have included multiple clipping heights.   To determine the effect of intensity of clipping this study should have applied additional clipping levels (e.g. 2.5 cm, 5 cm, 10 cm, and more) that reflect the grazing levels that might be the objective of a well managed targeted grazing system.

Kimball and Schiffman (2003) concluded that the presence or absence of herbivores, rather than the intensity of herbivory, determined species composition. They can only conclude that clipping to 1 cm at one to three times each year for three years resulted in a negative effect on native plant diversity compared to not clipping. They cannot conclude that intensity of grazing did not influence species composition because they did not compare a range of clipping heights greater than a 1 cm to no clipping. Studies of multiple intensities or clipping at different seasons and frequencies could provide new knowledge that could be used to design targeted grazing regimes that could reduce alien annuals while attempting to maintain or increase native plant species.

Grazing is a complex ecosystem process. To test the hypothesis that livestock grazing can be used as a tool to meet ecosystem objectives we must have knowledge of the effects of season, intensity, frequency and duration of grazing on ecosystem services. There is not enough time or money to study the effect of all of the combinations of these grazing parameters. But we can increase our chances of learning how to properly apply grazing if we manage grazing using an adaptive management approach that includes measurable objectives/hypotheses, appropriate monitoring and long-term involvement of university and agency researchers, some of whom understand grazing and ranching practices and their application.

Grazing is an ecosystem process that results in environmental impacts. The mechanisms that result in environmental impacts are poorly understood by the public and by many conservation organizations that make public input to environmental assessments (EAs), environmental impact studies (EISs) and environmental impact reports (EIRs). While these reports are often well written, well researched documents, others base management plans on popular (but scientifically unsubstantiated) concepts (Painter 1995). While the public and interested parties have the right to make input, agency personnel who must process this public input need to seek outside assessments to establish the credibility of popular and peer reviewed science used to support their positions. As with the studies by Christian (in prep) and Kimball and Schiffman (2003) many grazing studies have been properly designed and conducted but treatments may have been selected that were not necessarily designed to answer key grazing management questions or the conclusions are not supported by the results of the study. Both of these studies conclude that grazing has negative effects on plant species composition and diversity under the conditions and location studied. While the grazing or clipping treatments that they applied may have resulted in negative effects on plant species composition, they cannot say that all grazing regimes would result in negative findings and discard grazing as a vegetation management practice. A more careful consideration of objectives, plant life cycles and targeted grazing practices, including no grazing are needed to find management practices that are effective.

Vegetation Management Practices

In addition to grazing, herbicides, mowing, cultivation and seeding may be appropriate practices for managing vegetation, especially in the higher elevations of BCNWR where annual rainfall is greater.

Herbicides can be used to reduce woody plants such as juniper and rabbitbrush and herbaceous weeds such as yellow starthistle. Non-native annual competition can also be reduced using appropriate herbicides prior to seeding native perennials. Mechanical methods can also be used to reduce woody and herbaceous species. Mechanical methods requiring large equipment that disturb the soil surface, increasing the potential for erosion and invasion of weeds, will require mitigation practices such as seeding and erosion control.

Seeding of perennial grasses and forbs may require local seed collection and increase in the years before seeding. Because of the low and poorly distributed rainfall the chances of crop failure are very high. If seeding is attempted it should be applied to small areas over several years to increase the chances of seeding during a good year and reducing the losses associated with a large seeding during one bad year. Prior to seeding, herbicides may be used to reduce competition from annuals.

Annual Planning and Reporting

With prescribed grazing the timing and intensity of grazing for each management unit should be planned with the lessee annually before the grazing season starts. Plans should address low and high production years. There should be agreement on supplement locations and fence and other maintenance requirements. The lessee and refuge range manager should sign and date the annual plan.

An annual report should be published each year. Livestock numbers, stocking rates, in and out dates and death losses should be recorded and published in the annual report. Grazing management (season, intensity, duration, frequency) and RDM should be reported for all management units, grazed and ungrazed. Any other vegetation management practices and their effectiveness should also be described. An annual report is an important way for the refuge to communicate with the public.

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CHAPTER 5

MANAGEMENT GOALS, OBJECTIVES, AND PROCEDURES

Adaptive Management

Effective natural resources management requires articulation of general goals and specific objectives. While general goals for BCNWR can be determined from the EA (USFWS 2008), specific objectives for each management unit have not been articulated. During the Comprehensive Conservation Planning process we recommend that the US FWS develop specific achievable and measurable objectives for each management unit at BCNWR and that these objectives be used to gauge progress and performance.

We also recommend that US FWS follow an adaptive management approach for setting objectives, implementing practices and monitoring progress. Adaptive management is a form of management based on experimentation. Guided by measurable objectives, It allows managers to monitor and evaluate management practices as they go along. Documenting adaptive management processes with rigorous monitoring can help resource professionals learn from these managed ecosystems, while maintaining information feedback to the manager. We recommend that the monitoring program be linked to the objectives to gauge progress and performance.

Successful rangeland and grazing management requires objectives that are feasible and measurable. Knowledge of grassland history, restoration and grazing management can help managers develop feasible objectives. Because pre-European conditions are uncertain (see Chapter 2) "return to pre-settlement conditions" is not a feasible objective based on today's knowledge. We can conclude from the grassland restoration literature that dependable restoration practices that consistently and effectively convert California's non-native annual-dominated grasslands to ecosystems dominated by native annual and perennial plants have not been developed. Therefore, restoration of former native ecosystems is not ecologically or economically feasible based on current knowledge. A more feasible objective would be to maintain existing native plant species and to test promising grazing and other management practices, including no grazing, that have potential to increase the vigor of natives, including native annuals and shrubs and reduce non-native annual grasses.

Conflicting results in peer reviewed and non-peer reviewed literature regarding management effects (grazing, fire, restoration) provide little guidance that would support specific grazing and vegetation management practices. Grazing has been shown to reduce non-native annual grass competition with native plants in some instances and not in others. Successful restoration of native perennial grasses on a multi-acre scale has been infrequent but occasionally encouraging. However, continued management level experimentation (trial and error) inherent in adaptive management is one path that may lead to identification of specific practices in a specific location. Reviewing existing knowledge early in the adaptive management process can help managers determine what we know (or think we know). For BCNWR we can be reasonably certain of the following:

1. Until 2005 all or part of BCNWR had been grazed and/or farmed for more than 100 years (Allbright 1990).
2. Native plant and animal species are present at BCNWR but their location and abundance is not well documented. Existing species lists do not adequately address location and abundance.
3. Natural and man-caused fires are hazardous to BCNWR facilities and resources and adjacent properties that depend on grazing for their livelihood.
4. Non-native annual plants compete with many remaining native plant species dominating ecosystem structure and function.
5. Non-native annual plants have altered habitat for native animal species.
6. Based on the literature review there is little that we can be certain of regarding the positive or negative effects of common season, intensity, duration and frequencies of grazing and other vegetation management practices on native vegetation and animals. These practices simply have not been studied or repeated on ecosystems similar to BCNWR following well stated hypotheses and experimental designs. However, we will suggest some potential practices that should be tested at BCNWR (see Goals C-G and I below).
7. While grazing has been shown to be beneficial to some native animals the scientific support for this is not extensive or broadly repeated.
8. Given the complexity of land management for multiple objectives and the scientific uncertainty about grazing or other management effects on habitat suitability, an adaptive management approach should be implemented to move BCNWR ecosystems away from their current condition toward a desired future condition described during Comprehensive Conservation Plan development.

Potential Goals, Objectives and Procedures

The goal of the Bitter Creek National Wildlife Refuge (BCNWR) is to maintain and improve habitat for native plants and animals. Several planning goals and objectives are stated in the BCNWR Proposed Habitat Management and Restoration Plan Environmental Assessment (USFWS 2008, pg 24-25). Some of these stated goals are really specific management objectives. For the purpose of this range review we have translated and revised these goals as follows:

A. Conduct a baseline inventory of plant communities and plant species composition
B. Conduct a baseline survey of specials status animal species
C. Protect special status species and manage suitable habitat
D. Reduce fire hazard
E. Maintain native perennial grass populations
F. Maintain native forb populations
G. Maintain, protect and enhance riparian areas,
H. Manage invasive weeds
I. Protect native plants and animals with unknown or uncertain habitat requirements

Goal A: Conduct a baseline inventory of plant communities and plant species composition.

Objective 1: Map vegetation

Procedure 1: Use the California Gap layer (Davis et al. 1998) over an aerial photography layer such as NAIPs (National Agricultural Imaging Program) to map grassland, oak and juniper plant communities.

Procedure 2: GPS boundaries of shrub and sub-shrub communities that may not be visible on common aerial photography. Alternatively, these shrub communities and series may be visible on higher quality aerial photography.

Objective 2: Inventory plant species composition in each plant community

Procedure 1: Determine plant species composition for each plant community or series listed in DeVries (2009) using the line-point intercept procedures described by Herrick et al. (2005a). Inventory and monitoring methods are described in Chapter 6 (Rangeland Inventory and Monitoring).

Procedure 2: Photograph the transect from each end. Re-photographing selected transects annually is an inexpensive monitoring methods that can detect changes in woody plant structure and grassland height. It is usually not a good method for recording grassland species composition (see Procedure 4)

Procedure 3: To detect change over time repeat the plant species composition survey (Procedure 1). Frequency of repetition depends on needs. For slow changes such as woody plant or native grass composition a frequency of 5 years or more may be adequate. If you are trying to document annual change in annual plant composition annual measurements are necessary, preferably on the same date or at the same phonological state.

Procedure 4: Photo-document small plots (e.g. $1m^2$) annually on the same date to document annual variation in plant species composition.

Objective 3: Survey for biotic crusts.

Procedure: Determine the presence, absence and species composition of biotic crusts along the same permanent transects used to survey plant species composition.

Objective 4: Survey rare plant species

Procedure 1: Conduct surveys of rare plant species following methods used by California Native Plant Society, California Department of Fish and Game or other recognized methods.

Procedure 2: Photo-document rare species and GPS their position.

Goal B: Conduct a baseline survey of special status animal species.

Objective 1: Define suitable habitat (elevation, slope, vegetation etc) for the special status animal species.

Procedure: Using information in the Resource Inventory (see chapter 3), from peer reviewed scientific literature (see chapter 2), agency reports and recognized experts; describe the locations (management units) of suitable habitat for special status animal species.

Objective 2: Estimate population size of special status animals in suitable habitat.

Procedure: Use standard wildlife population estimation procedures.

Goal C: Protect special status species and manage suitable habitat

Measurable Objective 1: In areas (primarily Unit 2) that are currently habitat or potential habitat for burrowing owls (most of refuge) and blunt nosed leopard lizards (below 2600 feet in elevation), manage annual dominated rangelands to provide short, sparse ground vegetation while maintaining adequate soil protection (see Chapter 3, Wildlife Resources) by leaving residual dry matter of 800 to 1000 lb/a going into the rainy season.

Procedure: Use grazing to maintain vegetation to provide suitable habitat for these species. Manage grazing intensity so that 800 to 1000 lb/a of RDM is left at the beginning of the rainy season.

Monitoring Procedure: Estimate RDM in September-October or before it rains.

Measurable Objective 2: Determine long-term (5 to 10 years) habitat and animal population differences (SJKF, WBO, BNLL, and the GKB) between grazed (RDM target of 800 – 1000 lb/a) and ungrazed management units (RDM greater than 800-1000 lb/a). From descriptions of suitable habitat in Chapter 3 we can conclude that low-growing, sparse ground vegetation is an important part of the habitat for WBO and BNLL. The BNLL avoids steep slopes and may not be expected above 2600 feet elevation. The WBO occurs throughout the refuge. Grazing effects on GKR are uncertain but moderate levels of grazing have been reported to maintain habitat for GKR. The GKR prefer slopes less than 22 percent and elevations below 2850 feet. Livestock grazing is not thought to be detrimental to the SJKF unless it destroys shrub cover or reduces prey cover.

Procedure: Subdivide Unit 2 (large unit with elevations below 2600 or 2850 feet) into two or more pastures and apply grazing to achieve RDM targets in one pasture and leave one pasture ungrazed.

Monitoring Procedures: Monitor RDM as described by Bartolome et al (2006). Estimate SJKF, BNLL, GKR and WBO populations in grazed and ungrazed pastures for 5 or more years.

Goal D: Reduce fire hazard

Measurable Objective: Maintain RDM at 800 lb/a or less in management units adjacent to public roads and property lines.

Procedure: Manage grazing intensity so that 800 lb/a or less of RDM is left at the beginning of the fire season in management units adjacent to public roads and property lines. There may be too few cows on too many acres to accomplish this RDM level by June 1. Therefore, it is more realistic to expect to achieve 800 lb RDM target by the end of the summer. Continue to disk along public roads.

Monitoring Procedure: Estimate RDM at the end of the dry season following the methods of Bartolome et al. (2006). Record date of disking.

Goal E: Maintain native perennial grass populations

Measurable Objective 1: Moderately graze (RDM 800 to 1000 lb/a) and provide for minimum 30 day rest periods between 1 week grazing periods during the growing season. As the DeVries (2009) report indicates that Units 2 and 6 have significant native perennial grass patches, these units would be candidates for this objective. Other units also have native perennial grasses and could be candidates.

Procedure: Cross fence units 2 and/or 6 into at least 5 pastures to provide for alternate graze and rest periods. This will require several miles of fencing and development of additional stockwater. Because this procedure intensifies grazing on small units (increased animal density) greater management oversight will be required. Utilization, animals and stock water should be checked every day. Don't go away for the weekend! To minimize the potential for erosion, minimize the amount of steep slopes in the subdivided pastures. While this rotational grazing procedure increases stock density, it does not increase stocking rate.

Monitoring Procedure: Estimate RDM at the end of the grazing season.

Measurable Objective 2: Reduce competition to native perennial grasses by reducing the density of red brome. Most of the annual grasses present during one growing season are germinated from seed produced the year before. Reducing flowering has been shown to reduce annual grass cover or density of some annual grasses (see Chapter 2) the following year. While this procedure is little studied in red brome it would be worthwhile to test the effect of targeted grazing on red brome flower production and cover. In the longer-term native perennial grass cover and patch size should be monitored to determine grazing treatment effects.

Monitoring Procedure: Survey flower density during the spring flowering period. Estimate the ground cover of red brome or other competing species the year following application of the targeted grazing treatment using the line-point intercept method. In the longer-term estimate changes in native perennial grass density and patch size.

Measurable Objective 3: Determine if there is a difference in red brome flower production and ground cover between pastures where targeted grazing was applied and management units where there was no grazing. In the long-term (5 years or more) determine if there is a difference in native perennial grass density and patch size between pastures where targeted grazing was applied and management units where there was no grazing.

Monitoring Procedure: Use the same monitoring procedures as in Measurable Objective 2 above.

Goal F: Maintain native forb populations

Measurable Objective: Close grazing to RDM levels below 1000 lbs/acre can increase forb production and composition. Most forbs are suppressed by competition from taller growing non-native annual grasses. This objective might be tried in any of the grassland units.

Monitoring Procedure: Estimate RDM at the end of the growing season following the methods of Bartolome et al. (2006).

Goal G: Maintain, protect and enhance riparian areas.

Measurable Objective: Riparian areas occupied by tricolor black birds should not be grazed. Other grassland riparian zones may be grazed, as needed, during the dry season to manage non-native annual vegetation. No grazing during the wet season.

Procedure: Fence riparian areas on flat to gentle slopes so that plant species, wet soils and streambanks can be protected from grazing. Grazing during the dry season may be used to manage vegetation. Bitter Creek canyon is rugged and it would be expensive to fence both sides of the stream channel. This would also impede wildlife and livestock movement. If there are sufficient livestock impacts in riparian zones along Bitter Creek, especially tricolor black bird habitat, these areas can be protected with small, less costly, exclosures.

Monitoring Procedure 1: Record date of fence installation. Record dates of grazing if grazed. Record any other management practices applied. Conduct long-term monitoring of species composition using line-point intercept transects installed during the inventory of plant species composition. Following the initial inventory, species composition could be determined on an interval of 5 or more years or as needed if there was an observed change or disturbance.

Monitoring Procedure 2: Photo-monitor from the same permanent points annually to document streambank vegetation. Visually monitor and photograph livestock impacts in riparian areas.

Goal H: Manage invasive weeds other than annual grasses (e.g. Yellow starthistle *Centaurea solstitialis*).

Measurable Objective: Control yellow starthistle and other target weeds in any units where there are problems.

Procedure: Treatment of yellow starthistle or other weeds with herbicides or mechanical removal before flowering can be an effective practice but it must be regularly and consistently applied. Mowing and grazing before spine development can suppress yellow starthistle. The University of California Weed Research and Information Center provides information on the management and control of starthistle and other weeds (http://wric.ucdavis.edu/yst/index.html).

Monitoring Procedure: Visually determine effectiveness of control. For more quantitative monitoring determine weed composition using the line-point intercept method (Herrick et al. 2005a) or by estimating the density in plots before and after treatment (Herrick et al. 2005b). Photograph before and after treatment.

Goal I: Protect native plants and animals with unknown or uncertain habitat requirements

Measurable Objective: Manage each unit to achieve a mosaic of ungrazed, light (RDM greater than 1000 lb/a), moderately (RDM 800 to 1000 lbs/a) and heavily grazed areas (RDM less than 800 lb/a). Given the diversity of growth habits; functional groups and life cycles of 400 native and non-native plant species; practices, including no grazing, that benefit one species or functional group may have negative effects on other species or functional groups. Given a diverse flora and fauna with conflicting growth or habitat requirements, management of large landscapes should strive for a diversity of habitat conditions. Managing for a diversity of ground vegetation levels ranging from no grazing to heavy grazing can create a mosaic of habitat conditions on a landscape that increases the chances that adequate habitat requirements for a variety of plant or animal species, communities or habitats will be met, not in the same place but across the BCNWR landscape. Rotating these treatments on an annual basis insures that no land unit is over used during the same season over a long period. Such a mosaic of conditions can be the result of following adaptive management concepts in the management of grazing.

Procedure: Managing pastures (management units) using different seasons and intensities of grazing can create a mosaic of ground cover conditions between pastures. To create a mosaic within a pasture use water trough placement and supplement placement to manipulate distribution of grazing. Adjusting animal numbers and/or length of the grazing period can also be used to produce a mosaic of different standing crops.

Monitoring Procedures: Monitor RDM at the end of the grazing season using the methods of Bartolome et al. (2006). Monitor and compare indicators of plant and animal abundance to determine progress toward habitat objectives.

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CHAPTER 6

RANGELAND INVENTORY AND MONITORING

Introduction

Inventory is the systematic acquisition and analysis of resource information needed for planning and management. Assessment is the process of estimating or judging the value or functional status of ecological processes. Monitoring is the orderly collection, analysis and interpretation of resource data to evaluate progress toward meeting management objectives. Monitoring requires a time series of data to detect changes in vegetation or other ecosystem characteristics. While the procedures discussed in this section are not the only ways to inventory and monitoring plant communities they are commonly used and well documented methods.

Monitoring should be based on ***measurable objectives*** from the refuge's natural resource, vegetation or grazing management plan. Development of specific objectives will help refuge managers determine what practices to apply. Stating measurable objectives will make it clear what should be monitored. For example some measurable objectives might be:

1. Increase native perennial grass cover or density by 10 percent in unit 12,
2. End the grazing season with 800 lb/a of RDM in unit 11,
3. Decrease juniper canopy cover by 20 percent.

These examples of measurable objectives clearly state a goal and indicate what should be monitored (grass cover or density, RDM and canopy cover) to detect progress toward the goal. Long-term monitoring is designed to document changes in the condition of the land or habitat, such as changes in vegetation structure or species composition and is normally repeated every one to five years. Short-term monitoring may be repeated at any time interval and is designed to check whether or not the management system is being followed (such as how much RDM remains). Long-term monitoring is used to generate a record of change, while short-term monitoring is used to establish an annual-use record and to inform management.

Resource Inventory

Resource inventory is essential for development of long-term objectives on the refuge. Inventory may include information about climate, soils, topography, vegetation, and wildlife. Inventory may also include current and past structures such as buildings, roads and fences. Daily temperature and precipitation is currently collected at a high elevation site (Pattiway) on BCNWR and is useful for evaluating or interpreting seasonal vegetation productivity. A low elevation weather station would improve interpretation of seasonal and annual plant production, RDM and grazing capacity. A recent soil survey is available for southwestern Kern County and the main soil series are listed in Section 2 (Resource Inventory).

Development of a plant species list is a form of inventory. Several vegetation surveys have been completed at BCNWR (Lawrence 1983, Tomas and Wishner 1996, Werner 1997 and DeVries 2009) and they have been compiled into the plant species list in Appendix B. Additionally, DeVries (2009) briefly described and classified BCNWR plant communities or series. While these vegetation surveys have resulted in a species list for the refuge they do not provide details of abundance, density or location necessary for refuge management planning. It also doesn't indicate whether they are present every year in the same locations. For this reason plant communities need to be mapped, plant community species composition surveyed and the presence, location and extent of rare species inventoried.

Vegetation Mapping

A vegetation map can be developed digitizing boundaries around visible vegetation communities on NAIPs (National Agricultural Imaging Program) aerial photography. Rather than digitizing by hand, placing the California Gap layer (Davis et al. 1998) over NAIPs aerial photography can provide an approximation of plant community boundaries but a supervised classification of the Gap layer is often necessary to fine tune vegetation type or plant community boundaries. A supervised classification is the movement of the gap layer boundaries by hand in ArcGIS so that they are more closely aligned with natural boundaries visible on the aerial photography. This procedure can be used to map grassland, oak and juniper plant communities at BCNWR. Because saltbush, buckwheat, rabbitbrush, bush lupine, goldenbush and other shrubs or sub-shrubs may not be visible on commonly available aerial photography (i.e. NAIPs), ground surveys of plant communities boundaries using GPS may be necessary to map all of the communities/series identified by DeVries (2009). Alternatively, these shrub communities and series may be visible on higher quality aerial photography. This alternative should be investigated before investing in a GPS survey of shrub and other community boundaries.

Plant Species Composition

Plant species composition of each plant community or series should be determined. Changes in more prevalent species due to grazing, weather, fire or other disturbances can usually be detected by monitoring cover by species. Species composition, canopy and ground cover (Coulloudon et al. 1999, Herrick et al. 2005 a, 2005b), including biological soil crusts (Rosentreter et al. 2007), should be established on selected key areas within each management unit. This would provide a measure of abundance and species composition that could be re-measured periodically, depending on expected rates of change or management treatment timing, as part of a vegetation monitoring program. This procedure could be used to identify large patches of native annual and perennial species as well as weed populations.

At a minimum plant species composition should be determined for representative areas in each plant community or series using the line-point intercept method. A more extensive survey could be completed by stratifying each community by slope and aspect or other important landscape attribute. Stratification can be completed by merging the slope and aspect map (Figure 3) with a plant community map. Permanent line-point intercept transects could then be placed on different slopes and aspects to inventory plant species composition.

The line-point intercept method involves placement of permanent transects and determination of plant species above and below points along the transect. Line-point intercept procedures have been well described by Herrick et al. (2005a, pg 9-15). This procedure can also be used to quantify soil cover, including vegetation, litter, rocks and biotic crusts. These measurements are related to wind and water erosion, water infiltration and the ability of the site to resist and recover from degradation. The line-point intercept method provides a good commonly used method for determining dominant plant species composition. If large gaps between plant canopies are of interest they can be quantified along the same transect following the methods of Herrick et al. (2005a, pg. 16-22). Gaps can be important indicators of erosion potential and weed invasion. If you wish to attempt to account for every species present (species richness) then the more time consuming modified Whittaker approach may be desirable Herrick et al (2005b, pg 57-60).

Plant Density

Estimates of plant density may be appropriate for monitoring weed control effectiveness or changes in native plant populations. Density of grasses and forbs is commonly conducted by counting the number of target species in a plot. Procedures and calculations for density measurements are presented by Herrick et al. (2005b, pg 79). Combining density measurements with a line-point intercept transect placed across the boundary of native plant or weed populations can be a useful method for detecting change in the boundary of native plant or weed patches. Because presence and density changes as the growing season progresses and between years it may be necessary to determine density more than once each year and during multiple years.

Survey rare plant species

Rare plant species may not be encountered using the line-point intercept method. Surveying or inventorying rare species is not a trivial task. Plants can be rare because 1) they are broadly distributed, but never abundant where found; 2) narrowly distributed or clumped, and abundant where found; or 3) narrowly distributed or clumped, and not abundant where found. Consequently, they can be hard to find and may be missed in a survey because the survey was not dense enough to cover the entire potential habitat or because the plant wasn't present at the time of the survey. It is very difficult to know that all occurrences of one or more rare plants on a give landscape have been identified. The California Native Plant Society recommends the following, "When a special status plant (or rare plant community) is located, a California Native Species (or Community) Field Survey Form or equivalent written form, accompanied by a copy of the appropriate portion of a 7.5-minute topographic map with the occurrence mapped, shall be completed, included within the survey report, and separately submitted to the California Natural Diversity Database. Population boundaries should be mapped as accurately as possible. The number of individuals in each population should be counted or estimated, as appropriate (http://cnps.org/cnps/rareplants/pdf/cnps_survey_guidelines.pdf). California Department of Fish & Game also has guidelines for surveying rare species at: (http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/Protocols_for_Surveying_and_Evaluating_Impacts.pdf).

In addition to rare plant inventories, staff should be able to identify these species or carry ID photos so that they can identify and record locations when they are out doing other tasks. Although expensive and time consuming the modified Whittaker approach Herrick et al (2005b, pg 57-60) for determining plant species richness is a quantitative means for attempting to find all plant species, including those that are rare. Because some plant species are present only part of the year this procedure must be repeated several times during the year.

Residual Dry Matter

Residual dry matter (RDM) is measured by clipping or by double sampling methods such as comparative yield or estimated using photo guides (Bartolome et al. 2002). Residual dry matter is the litter remaining in the fall at the end of the grazing season. It is an indicator of grazing use during the year. University of California has published RDM guides based on precipitation, slope and canopy cover (Bartolome et al. 2006). RDM should be visually estimated for each grazed and ungrazed management unit just before the start of the rainy season.

Refuge staff currently have a target RDM of 1000 lb/a for the upland grasslands. Refuge staff have measured RDM at 19 locations since 2003 and 2 locations since 2004 (Appendix E). In some years, RDM levels do not reach 1000 lb/a. Refuge staff should continue to collect RDM data and eventually set RDM targets for each management unit.

Photo-monitoring

Photo-monitoring is a cost effective means of documenting landscape conditions that requires little time but becomes a valuable record over time (McDougald et al. 2003). US FWS can develop a photo monitoring plan that meets refuge objectives during the Comprehensive Conservation Planning process. Annual photos of RDM taken at the same location can supplement measurements of RDM. Re-photographing landscapes in old photographs can provide a visual indication of large scale changes in vegetation structure. Recently Sony and other companies have begun producing “point and shoot” cameras with a built-in compass and GPS for under $400. These cameras would be good choices for photo-monitoring.

Inventory and monitoring can be costly in time and money. While photo-monitoring and good record keeping can fill many needs at low expense, measuring changes in species composition and other parameters can be costly in terms of labor. Careful consideration of measurable objectives can avoid unnecessary and non-productive monitoring. Consideration of reasonable rates of vegetation change, that effect monitoring frequency, can also reduce monitoring costs. Parameters that change rapidly (e.g. annual species composition) may require frequent monitoring while parameters that change more slowly (e.g. woody plant composition) may be monitored at intervals of several years.

Finally, we recommend that resource inventory and monitoring data be organized, interpreted and published annually as a means of communicating to the public about resource objectives and management activities.

Vegetation Monitoring Publications

There are several methods for measuring vegetation cover, density, frequency and biomass. Common methods have been described in "Monitoring Manual for Grassland, Shrubland and Savannah Ecosystems (Volumes 1 and 2) by Herrick et al. (2005). Following are several useful inventory and monitoring publications:

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CHAPTER 7

RECOMMENDATIONS

Management suggestions appear throughout this report. Following are recommendations that will improve rangeland management at BCNWR.

1. During the Comprehensive Conservation Planning (CCP) process we recommend that the US FWS develop specific achievable and measurable objectives for each management unit at BCNWR and that these objectives be used to gauge progress and performance.
2. Additionally we recommend that vegetation goals that support habitat goals for each management unit be developed and alternative practices that support these goals be included in the CCP.
3. During the CCP process we recommend that USFWS seek advice from range manager who is certified by California's Forestry Licensing Board or by a range manager who meets the US Office of Personnel Management's qualification standards for the Rangeland Management Series, 0454.
4. We also recommend that US FWS follow an adaptive management approach for setting objectives, implementing practices and monitoring progress.
5. We recommend that the monitoring program be linked to the objectives to gauge progress and performance.
6. We recommend that resource inventory and monitoring data be organized, interpreted and published annually as a means of communicating to the public about resource objectives and management activities.
7. We recommend that a thorough survey of plant communities and animal populations, including rare and endangered species, be completed and used to justify management of populations that are present . Scarce resources such as management time and funds should be directed at managing species that are shown by the surveys to be present. Species that have not been identified on the refuge should receive lower priory in the allocation of scarce resources.
8. Because USFWS is charged with maintaining naturalness, biological integrity, diversity and environmental health they need to fully explore and consider vegetation management practices that may move BCNWR vegetation from its current state to desired future states. For rangeland ecosystems we recommend that BCNWR continue to seek advice from certified range managers and range scientists during the upcoming Comprehensive Conservation Planning process and future rangeland management actives.
9. We recommend that restoration objectives state what ecosystem services the refuge expects to improve by restoring an area. During restoration project planning, justification for restoration should be articulated in terms of the ecosystem services that will be improved. While return to a pristine or native state is sufficient justification for many conservationists, others require convincing. Will the restoration reduce soil erosion compared to the existing state? Will habitat for one or more species be improved? Will infiltration of water into the soil be increased? Will the native state filter pollutants better than the current state? Will a native grassland resist invasion of weeds better than the existing grassland? Will the restored ecosystem have greater

biodiversity than the existing annual dominated community? Will the native state have a longer green season that could improve nutrient intake of native or introduced grazers? A great deal of public funding is allocated to ecosystem restoration through various government programs. In the case of USDA cost share funding the Office of Management of Budget is asking if the funding invested in conservation programs is worth the cost. Are the practices implemented in these programs effective at providing or improving one or more ecosystem services? The USDA Natural Resources Conservation Service, through the Conservation Effectiveness Assessment Program, is seeking to determine and report the effectiveness of conservation practices (Weltz et al. 2008).

10. Currently there is no livestock grazing at BCNWR. Too reinstate grazing we recommend development of a prescribed grazing management plan that addresses management of each unit based on USFWS objectives developed during the Comprehensive Conservation Planning process.
11. The first element of any grazing plan is to keep annual stocking rate below the long-term average carrying capacity. Stocking rate must be adjusted annually in response to yearly production conditions. Staff must monitor to stay within the RDM targets for each management unit.
12. Native perennial grasses are common on BCNWR. The DeVries report (2009) indicates the presence of sizable native perennial grass patches in Units 6 and 12. We recommend that one of these pastures be grazed during rapid spring growth to a stubble height of 2 to 4 inches during a grazing period of 7 to 10 days and then allowed to rest at least a month to allow the perennial grasses to rest and regrow. This grazing treatment should be applied just before red brome (most prevalent annual competitor) starts to flower. Native perennial grass density and spread, and red brome flowering success and ground cover could be monitored to determine the effectiveness of this gazing practices. These same attributes should be monitored in the ungrazed pasture for comparison purposes. This comparison should be conducted for at least 5 years before changing management.
13. We recommend the strategic application of livestock distribution practices as part of a prescribed grazing plan. Water development and fencing are the most common distribution practices. While fencing is designed to contain or exclude livestock, strategic placement of water developments or protein supplements have proven to be effective livestock attractants that can be useful in large management units.
14. We recommend that existing corrals and animal handling facilities be maintained. While potential grazing lessees may use portable corrals for handling livestock, the existing permanent facilities will be viewed as an important convenience by many potential lessees.
15. We recommend that BCNWR review the potential for predator losses during the condor release process. Are there practices that can be put in place to reduce the potential impact of coyotes on the condor release program? Are there opportunities to cooperator with neighboring properties to reduce the impact of coyote predation?
16. Given a diverse flora and fauna with conflicting habitat requirements, management of large landscapes should strive for a diversity of habitat conditions. Managing for a diversity of grazed conditions ranging from no grazing to heavy grazing can create a mosaic of habitat conditions on

a landscape that increases the chances that adequate habitat requirements for a variety of plant or animal species, communities or habitats will be met, not in the same place but across the BCNWR landscape.

17. We recommend the following management team characteristics:
    a. **Lessee:** To implement prescribed or targeted grazing practices effectively will require a lessee who is willing to check cattle and pastures frequently and to move livestock more frequently than may have been done in the past.
    b. **Rangeland Manager:** To plan for the management of rangelands and to implement and monitor prescribed or targeted grazing practices will require BCNWR staff that are familiar with the ecology and management grazing, the ecology and management of rangelands and the administration of grazing policies. Relationships between staff and lessee will need to be cooperative. We recommend that USFWS hire a new staff person who meets US Office of Personnel Management's qualification standards, for the Rangeland Management Series, 0454.
    c. **Management Team:** To successfully implement an adaptive management approach that includes grazing requires a supportive administrative and management team that is open to the potential to use grazing as a management tool and is willing to embark on a program of practice implementation and monitoring of at least 5 to 10 years.
18. Land management can be more efficient and effective if the refuge can build strong working relationships in the community. Discussions of fuel management, potential wildlife impacts on ranching operations, potential impacts of endangered species management on adjacent properties, and other issues and opportunities are needed. We recommend that the refuge develop a positive community outreach program that is informative and cooperative.

Literature Cited

Weltz, Mark A., Leonard Jolley, Mark Nearing, Jeff Stone, Dave Goodrich, Ken Spaeth, Jim Kiniry, Jeff Arnold, David Bubenheim, Mariano Hernandez, and Haiyan Wei. 2008. Assessing the benefits of grazing land conservation practices. Journal of Soil and Water Conservation 63:214A-217A.