Appendix I. Grazing Plan

KNOXVILLE WILDLIFE AREA GRAZING PLAN

Introduction

This grazing plan, developed in collaboration with the California Department of Fish and Wildlife (CDFW) and the California Wildlife Foundation (CWF), describes a grazing program to support management goals and tasks that will ensure the long-term conservation of wildlife (invertebrates, amphibians, reptiles, birds, and mammals), special-status plants and plant communities and their habitats on the Knoxville Wildlife Area (KWA). The purpose of the plan is to develop a livestock grazing strategy to achieve vegetation and wildlife habitat goals. The Plan will describe specific grazing prescriptions, monitoring to evaluate adaptive grazing activities and habitat response. The Plan will be a component of the KWA's Land Management Plan (LMP) update, which is concurrently being developed.

Initiating grazing at KWA will be a major undertaking requiring investment in infrastructure (fences, gates, water developments and livestock handling facilities) and supportive lease agreements. Fence and stock water repairs are costly inputs required before grazing can start in each pasture or pasture. Additionally livestock handling facilities (loading chutes, corrals, etc.) need to be developed. This presents several challenges for CDFW and potential lessees.

1. CDFW does not have funding for needed infrastructure developments and state policies preclude trading grazing for infrastructure development in the lease agreement.
2. CDFW needs to find lessees that are willing and able to collaborate with KWA staff to meet CDFW management objectives. It will take time for the lessee to fully understand and engage CDFW's objectives. Therefore a long term lease of 5 years or more is critical to the long-term success of grazing management at KWA.
3. CDFW will need to vet potential lessees before entering into a long-term lease. A proposal and interview process could be used to vet potential lessees. KWA's long term plans should be part of the request for proposals so that potential lessees can gauge their ability to help CDFW meet grazing management objectives.
4. Vandalism is a concern on a wildlife area where public access and hunting are allowed. Damage to water tanks, troughs, pumps and other facilities can be expensive. Knowing and educating public users through an advisory committee might reduce vandalism.

Access is a problem for anyone managing a grazing operation on the KWA. The Knoxville-Berryessa Road is too rough, narrow and windy for cattle trucks to pass. Additionally there are currently no functional livestock handling facilities at either end of KWA. Consequently lessees will most likely access the KWA from the south end, possibly using the Airstrip Unit or other nearby flats at the south end as a holding field from which to move cattle onto the pastures. Because of access difficulty with cattle trucks it may be logical to start development of infrastructure on the south valley and gradually developing pastures in a northerly direction. Access by cattle trucks may be possible from Clearlake to the northern

pastures using the improved road developed for the mine but handling facilities and a truck turn around will be required.

Because water storage facilities need repairs it may be best to limit initial leases to the rainy (green) season when surface water is available in the pastures. A stocker operation could fit this limitation with the lease starting in the late fall or early winter when surface water is available and ending in the late spring when surface water becomes limiting and forage is mature and drying.

Coordinating CDFW wildlife and land management goals with grazing management requires a management team (CDFW and lessee) that has a common understanding of management goals in each grazing unit (pasture) and the capacity to manage adaptively and sometimes instantly to avoid problems or seize opportunities. Successful grazing managers (ranchers) often have to make quick decisions. Management teams need sufficient trust and knowledge to allow the grazer to make instant adjustments in grazing. An annual operating plan (AOP) can facilitate this process. Including a rangeland manager with lease management experience in the management team for KWA would facilitate implementation of grazing of KWA.

Livestock Grazing Management

Management History

Beginning around 1927, the Gamble family began buying up homesteads within the KWA, and eventually consolidated up to 18 homesteads into the "Knoxville Ranch" which included the Knoxville mine and town site. The Gambles used the ranch to run their herd of 400 beef cows, and also continued to work the mine. To increase forage production, the Gambles removed oaks from 2000 to 4000 acres of the Knoxville Ranch, including some areas that were completely cleared. In 1976 George Gamble closed the mine, and several years later razed what remained of the mine and the town because of looting and squatting. The old furnaces and piles of calcine (roasted ore) were buried.

In 1981, Homestake Mining Company bought the nearby Manhattan Mine after discovering an economic gold deposit in the same geologic formation that had produced mercury ore. Homestake dug an open pit mine at the site of the Manhattan Mine, and named the new operation the McLaughlin Mine. The McLaughlin pit was adjacent to the Knoxville Ranch, and in 1992 Homestake bought the Knoxville Ranch from the Gamble family in order to expand the pit. In 2000, Homestake sold the South Knoxville Ranch to CDFW (they retained the mineral rights), and kept the North Knoxville Ranch, which included a portion of the McLaughlin pit, the Knoxville Mine, and most of the Knoxville town site. Excavation at the pit ceased in 1996, and in 2002 the McLaughlin Mine was decommissioned and dismantled. Also in 2002, Homestake Mining Company (by then a subsidiary of Barrick Gold Corporation) signed an agreement with the University of California allowing the University to manage the property as a unit within its statewide Natural Reserve System. The Homestake property is currently managed by UC Davis as the McLaughlin Reserve, its primary function is to serve as an outdoor laboratory for academic teaching and research.

The KWA was purchased in three phases. The original property in the north was purchased from Homestake Mining Company on July 27, 2000 and is approximately 8,196 acres. The southern acquisition occurred in December 2005 and added 12,575 acres. The 738-acre Todd Ranch is located in the southern portion of the KWA and was purchased in December of 2008. A Land Management Plan (LMP) for the original 8,196-acre acquisition was completed and approved in June of 2005. All portions of the KWA formerly supported beef cattle operations. Currently, as a public State Wildlife Area, the main activities that occur on the property are hunting (e.g. deer, quail, and turkey), hiking, and wildlife viewing.

Terminology

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 (Becchetti et al. 2016).

Stocking rate and carrying capacity are often expressed as ***animal unit months*** (AUMs). The original definition of an AUM was the amount of forage a cow and her calf would consume in 1 month. This definition worked reasonably well for several years until cows started getting bigger and calf weaning weights increased. To accommodate bigger cows and calves the definition of an AUM was put on a weight basis. Today an ***animal unit*** (AU) is commonly defined as 1000 lbs. of body weight and an AUM is the amount of forage that an animal unit will consume in 1 month. If the cow and her calf weigh 1000 lbs. then they are still 1 animal unit. More likely the cow weighs 1200 lbs. and her calf grows to 400 or 500 lbs. by weaning. So the cow without a calf is 1.2 animal units. However, by weaning time the cow and her calf are around 1.6 or 1.7 animal units. The 1000 lb. animal unit can be applied to most large herbivores to get a rough estimate of stocking rate.

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. With 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.

Carrying Capacity

Carrying capacity is an average based on long-term records of climate, forage production, stocking rate and experience. The historic stocking rate of the two main ranches that occupied the KWA in the past was about 800 cows on about 20,000 acres or about 25 acres per AUM. Range forage productivity estimates from USDA Natural Resources Conservation Service (NRCS) Ecological Site Descriptions suggest that this stocking rate was conservative and below the actual carrying capacity. NRCS has estimated forage production for favorable (above average), normal (average) and unfavorable (below average) production years for the ecological sites on the KWA (Table 1). Forage estimates in 2016 confirmed the estimates presented in the ecological site descriptions. Forage production is largely controlled by the amount and timing of rainfall and can result in large differences between years. (Becchetti et al. 2016).

For this plan we have estimated carrying capacity (AUM/acre) using a scorecard (Table 2) that adjusts for slope and canopy cover. This scorecard was adapted from that developed by McDougald et.al (1991). This method adjusts carrying capacity based on 4 slope classes (0-10 %, 10-25 %, 25-40% and >40%) and 4 canopy cover classes (0-25, 25-50, 50-75, and 75-100 %). A slope class map (Figure 1) was generated from a digital elevation model and a canopy cover map (Figure 2) was generated from a 1 m NAIPs image (1 m pixel). A map of carrying capacity was generated by merging canopy cover and slope classes in Arc GIS (Figure 3). Carrying capacity was then estimated for each pasture or pasture (Table 3). Carrying capacity will be highest on open grasslands with gentle slopes and lowest on brushlands on steep terrain. The total carrying capacity for the north and south pastures (14378 acres) is 5166 AUMs or 33 acres per AUM (Table 3). This would support 430 animal units (1000 lb cows) for one year which is equivalent to 430 one thousand pound cows for one year or 1720 five hundred pound stockers for 6 months.

Table 1. Forage production estimates(lbs/acre) for KWA soils and ecological sites during favorable, normal, and unfavorable years (Lake County Soil Survey).

Map Unit	Soil Series/Associations	Unfavorable	Normal	Favorable	Ecological Site
112	Bressia-Dibble complex, 5 to 15 % slope	2000	3000	3500	Fine Loamy Upland
113	Bressia-Dibble complex, 15 to 30 % slope	2000	3000	3500	Fine Loamy Upland
114	Bressia-Dibble complex, 30 to 50 % slope	2000	3000	3500	Fine Loamy Upland
115	Bressia-Dibble complex, 30 to 50 % slope	2000	3000	3500	Fine Loamy Upland
120	Contra Costa loam, 50 to 15 % slope	400	900	1300	Shallow Loamy Hills
128	Diablo clay, 15 to 30 % slope	1600	2500	3500	Deep Clay
129	Diablo clay, 30 to 50 % slope	1600	2500	3500	Deep Clay
151	Hambright-Rock outcrop complex, 2 to 30 % slope	600	1000	1600	Very Shallow Rocky
154	Henneke gravelly loam, 30 to 75 % slope	500	600	800	Rocky Serpentine
163	Maymen-Millsholm-Lodo association, 30 to 75 % slope	1300	900	400	Shallow Loamy Hills
166	Montara clay loam, 5 to 30 % slope	600	900	1400	Serpentine
175	Rock Outcrop	N/A	N/A	N/A	N/A
181	Yolo loam, 0 to 2 % slope	2000	3000	3500	
183	Water	N/A	N/A	N/A	N/A

N/A = not applicable

Table 2. Estimate carrying capacity (AUM/acre) for KWA based on slope and canopy cover.

Knoxville Wildlife Area Estimated Grazing Capacity				
	Slope Classes (%)			
Canopy Cover Classes (%)	< 10	10 - 25	25 - 40	> 40
	AUM/acre			
0 - 25	2	0.8	0.5	0.3
25 - 50	1.5	0.6	0.4	0.2
50 - 75	1	0.4	0.3	0.1
75 - 100	0.5	0.2	0.2	0.1
	RDM (lb/acre)			
	400	600	800	800

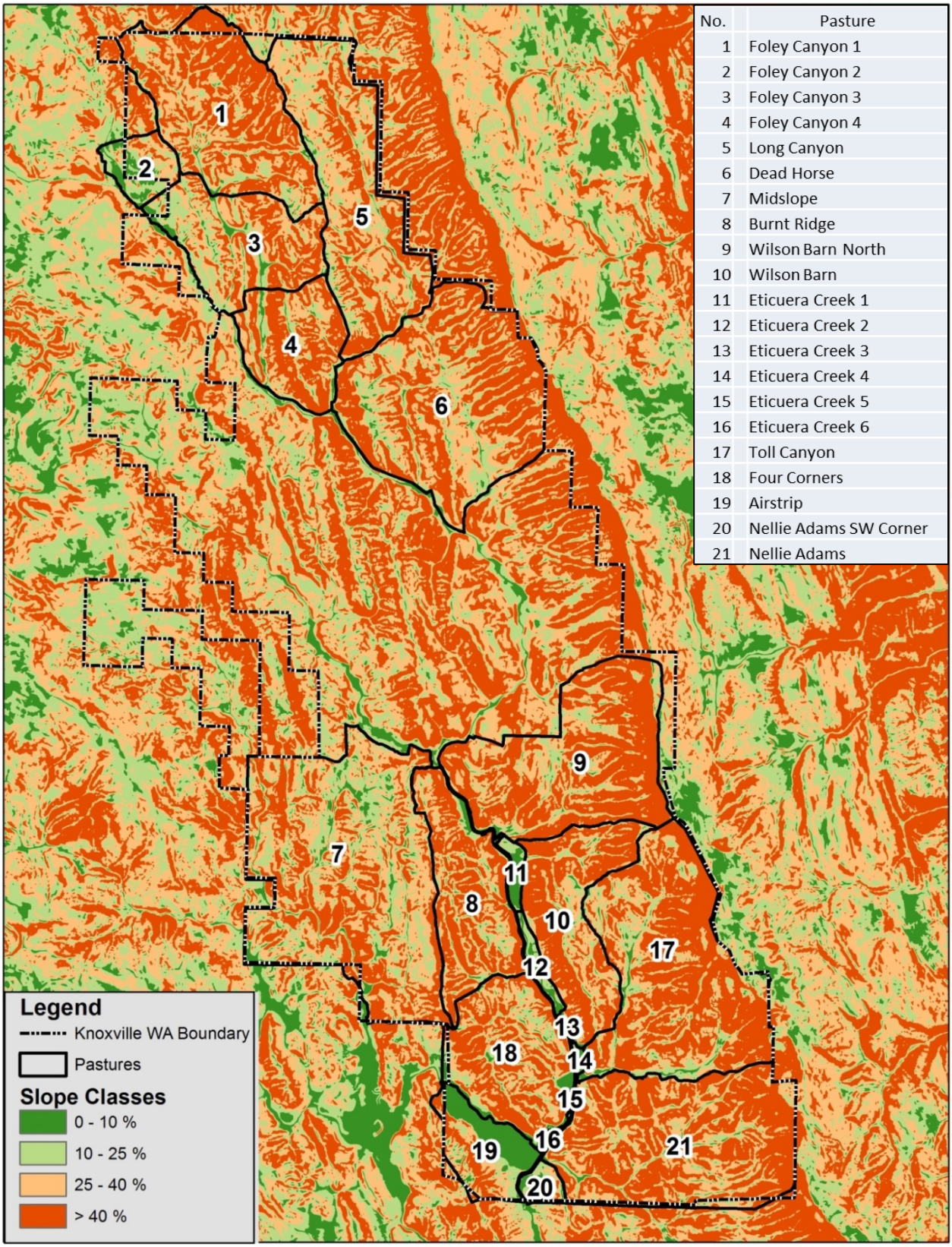


Figure 1. Knoxville Wildlife Area Slope Class Map

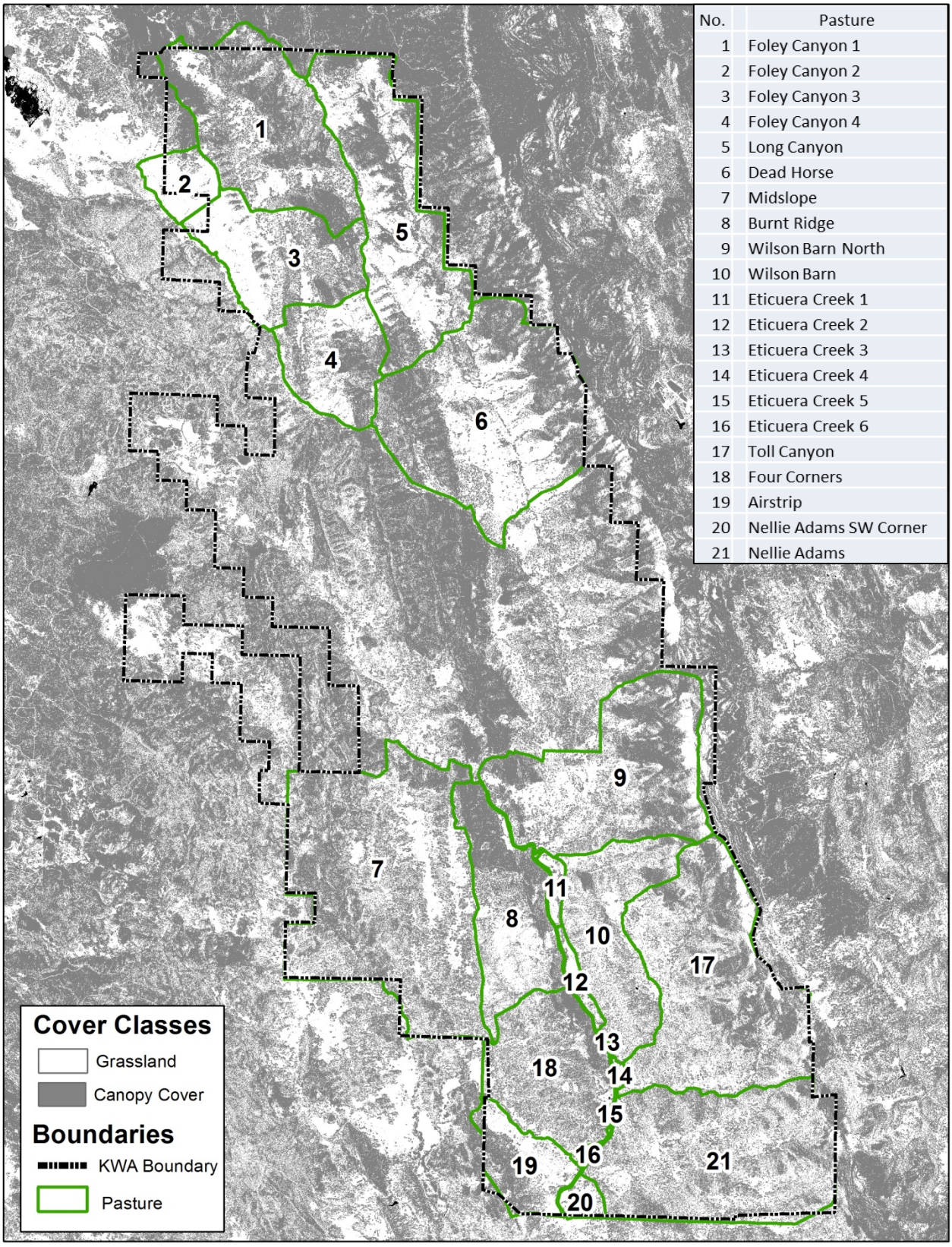


Figure 2. Knoxville Wildlife Area Vegetation Cover Map

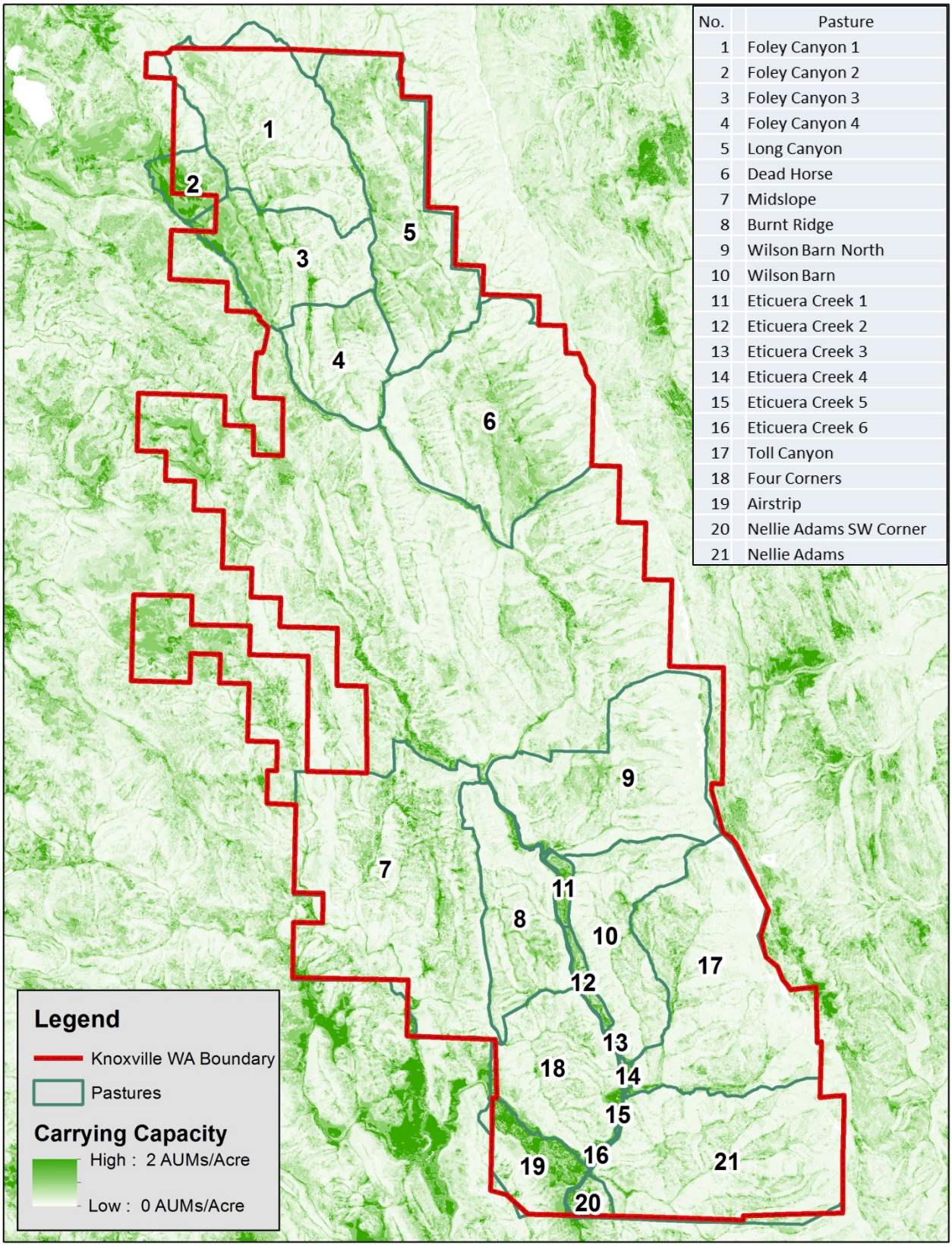


Figure 3. Knoxville Wildlife Area Carrying Capacity Map

Table 3. Pasture areas and carrying capacities for the North and South Pastures.

Map No.	Area (acres)	Carrying Capacity[1] (AUMs)	Stockers[2] (No./6 mo.)	Cows[3] (No./6 mo.)	Cows[4] (No./12 mo.)	Pasture Name
North Pastures						
1	1113	244	81	41	20	Foley Canyon 1
2	190	184	61	31	15	Foley Canyon 2
3	713	378	126	63	32	Foley Canyon 3
4	524	194	65	32	16	Foley Canyon 4
5	1171	423	141	71	35	Long Canyon
6	1586	469	156	78	39	Dead Horse
Total	**5297**	**1892**	**631**	**315**	**158**	
Footnotes:						
1	**1892**	divided by 12 months gives number of animal units that can be				
		supported for one year.			**158**	AUs can be supported
		for 1 year in the North Pastures combined.				
2	**631**	500 lb stockers (1/2 AU) can be grazed for 6 months (e.g. Dec.-May)				
		if you use all of the pastures for a total of 5297 acres.				
		This was determined by dividing 1892 AUMs by 1/2 AU and by 6 mo.				
3	**315**	1000 lb. cows (1 AU) can be grazed for 6 months (e.g. Dec.-May)				
		if you use all of the pastures for a total of 5297 acres.				
		This was determined by dividing 1892 AUMs by 1 AU and by 6 mo.				
4	***158***	1000 lb. cows (1 AU) can be grazed for 6 months (e.g. Dec.-May)				
		if you use all of the pastures for a total of 5297 acres.				
		This was determined by dividing 1892 AUMs by 1 AU and by 6 mo.				
To start out conservatively graze at a stocking rate that is about 1/2 of the carrying capacity. You can increase the stocking rate toward the carrying capacity as you gain experience. Therefore,		**315**	stockers would be a good starting point for the first year.			

Table 3 (cont).

Map No.	Area (acres)	Carrying Capacity[1] (AUMs)	Stockers[2] (No./6 mo.)	Cows[3] (No./6 mo.)	Cows[4] (No./12 mo.)	Pasture Name
South Pastures						
7	2076	738	246	123	62	Midslope
8	708	194	65	32	16	Burnt Ridge
9	1267	287	96	48	24	Wilson Barn North
10	738	239	80	40	20	Wilson Barn
11	51	78	26	13	7	Eticuera Creek #1
12	61	55	18	9	5	Eticuera Creek #2
13	4	4	1	1	0	Eticuera Creek #3
14	13	17	6	3	1	Eticuera Creek #4
15	6	9	3	2	1	Eticuera Creek #5
16	7	12	4	2	1	Eticuera Creek #6
17	1524	513	171	86	43	Toll Canyon
18	770	259	86	43	22	Four Corners
19	335	346	115	58	29	Airstrip
20	71	69	23	12	6	Nellie Adams SW Corner
21	1450	454	151	76	38	Nellie Adams
Total	**9081**	**3274**	**1091**	**546**	**273**	

Footnotes:

1	**3274**	divided by 12 months gives number of animal units that can be supported for one year.	**273**	AUs can be supported for 1 year in the South Pastures combined.
2	**1091**	500 lb stockers (1/2 AU) can be grazed for 6 months (e.g. Dec - May) if you use all of the pastures for a total of 9081 acres. *This was determined by dividing 3274 AUMs by 1/2 AU and by 6 mo.*		
3	**546**	1000 lb. cows (1 AU) can be grazed for 6 months (e.g. Dec - May) if you use all of the pastures for a total of 9081 acres. *This was determined by dividing 3274 AUMs by 1 AU and by 6 mo.*		
4	***273***	1000 lb. cows (1 AU) can be grazed for 6 months (e.g. Dec - May) if you use all of the pastures for a total of 9081 acres. *This was determined by dividing 3274 AUMs by 1 AU and by 6 mo.*		

To start out conservatively graze at a stocking rate that is about 1/2 of the carrying capacity. You can increase the stocking rate toward the carrying capacity as you gain experience. Therefore, **546** stockers would be a good starting point for the first year.

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 nutritional supplements have proven to be effective livestock attractants that can be useful in large pastures (Bailey et al. 2001, George et al. 2007, 2008). Following are some common livestock distribution practices that may be useful at KWA:

Pasture subdivision: Too facilitate weed management and to refine the creation of grazed and ungrazed mosaics, large pastures may eventually 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 be most 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: Most fencing on KWA needs to be replaced or requires substantial repair. Effective boundary fences and fences along Knoxville Road are a high priority to keep livestock off of the road and on the property. Internal fences are important for effective grazing management. Wildlife friendly fences are preferred to reduce their impact on wildlife. Good gates are critical to ease of management and property security. Functional fences and corals are essential to the control, movement and handling of livestock.

Water development: Water resources at KWA 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 systems, the opportunities to develop more water sources are limited. Water systems must be maintained and monitored throughout the year. Bullet proof storage tanks and troughs may be needed.

Nutrient supplements: 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 et al. 2001, George et al. 2007, 2008). Supplement sites should be moved frequently to minimize trampling impacts. Trampled supplement sites may 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 pastures, and strategically reduce competition from non-native invasive species in other pastures. Following are some habitat goals where grazing could be used at KWA: 1) suppress non-native annual plants, 2) reduce fire hazard, 3) maintain native forb and perennial grass populations, 4) protect riparian areas and manage riparian vegetation, and 5) maintain a

mosaic of herbaceous cover heights that provide hiding cover as well as low cover for some rodents and ground dwelling birds, 6) protect selected oak seedlings and saplings.

Grazing Effects

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 long term heavy 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. 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 (*Euphydryas editha bayensis*) 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.

Grazing management has been effective in controlling noxious weeds such as medusahead (*Taeniatherum caput-medusae*) and yellow starthistle (*Centaurea solstitialis*) (DiTomaso 2000, 2006a, 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 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 (*Rana draytonii*) and the California tiger salamander (*Ambystoma californiense*). 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 populations of several animals are often higher on grazed plots than in ungrazed plots including short nosed kangaroo rats (*Dipodomys nitratoides brevinasus*), giant kangaroo rats (*Dipodomys ingens*), sage sparrows (*Artemisiospiza nevadensis*), horned larks (*Eremophila alpestris*), western meadowlarks (*Sturnella neglecta)* and blunt-nosed leopard lizards (*Gambelia sila)* (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).

Grazing and Native Plants

It is a goal for KWA 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, 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 2005). The negative effects of non-native annual grasses on all purple needlegrass (*Stipa pulcra or Nasella pulcra*) 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 needlegrass 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).

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).

Management Goals and Objectives

The overall goals for managing the KWA are to:

- Maintain and improve habitat for native plants and animals; improve biodiversity
- Reduce potential for hot, catastrophic fire; encourage low burns
- Maintain and increase native grasses and forbs
- Manage invasive weeds

Reaching these goals will require development of grazing infrastructure and vegetation management objectives.

Infrastructure Development Objectives

A livestock grazing operation requires fences, gates, stock water and livestock handling facilities. The extent of these developments depends on the kind of livestock operation. A beef stocker operation grazes calves on green grass in winter and spring and then markets the calves as the dry season approaches. Because there is water in the creeks during this grazing period a stocker operation can usually rely on surface water and may not require extensive water development. A stocker operation may also get along without livestock handling facilities, especially if the lessee has portable chutes and corrals or lives close enough to trail the cattle to on-ranch handling facilities. A winter-spring lease could also be used by a cow-calf operation but would have to leave when surface water was no longer available. An additional advantage of a winter-spring grazing lease is that it avoids deer and bear hunting season (Figure 4).

A seasonal sheep operation is also an alternative but the potential for predator losses and special fence requirements may preclude a sheep operation. However, the use of sheep and/or goats for targeted weed control by the lessee should not be precluded in the lease agreement. A year-around cow-calf operation requires stock water throughout the year but without water developments, handling facilities and other improvements KWA is not currently a viable site for a year around cow-calf operation.

A stocker operation or seasonal cow-calf operation would be viable initial operations at KWA. Such an operation could be initiated when sufficient boundary fences were in place. Internal fencing could be developed as grazing proceeds and during the summer-fall when grazing is not present.

Figure 4. Calendar of hunting seasons and stocker operations.

	J	A	S	O	N	D	J	F	M	A	M	J
Deer (Archery)	2nd Saturday in July to 1st Sunday in Aug											
Deer (Rifle)		2nd Sat in Aug to 3rd Sat in Sep										
Mourning Dove			Sep 1 -15		2nd Sat of Nov to end of 30 days							
California Quail				Last Sun in Sep to last Sun in Jan								
Turkey (Spring, Archery)											1st Mon in May to 3rd Sun in May	
Turkey (Fall)					2nd Sat in Nov to 2nd Sat in Dec							
Pigs						Pig hunting all year						
Bear	During deer hunting season											
Stocker												

Objective: Develop lease policies and a lessee selection process

CDFW does not have funding for needed infrastructure developments and state policies preclude trading grazing for infrastructure development in the lease agreement. KWA staff propose to use lease fees for habitat management including fencing to contain livestock. The fencing will be purchased by CDFW and installed by the lessee. The lessee will factor installation cost into the lease. CDFW needs to find a lessee with the willingness and ability to collaborate with CDFW on achieving KWA management objectives.

Some guidelines for developing a lease agreement.

1. Develop a lessee selection process that will identify a lessee willing to collaborate as a partner with CDFW to develop KWA grazing infrastructure.
    a. Develop a "request for grazing proposals" that will identify potential lessees.
    b. Review proposals and select a potential lessee(s).
    c. Interview lessees.
    d. Select a lessee and negotiate a lease agreement. A long-term lease (5 to 10 years) may be necessary to attract a lessee.
2. Develop an annual operating plan (AOP) with the lessee.

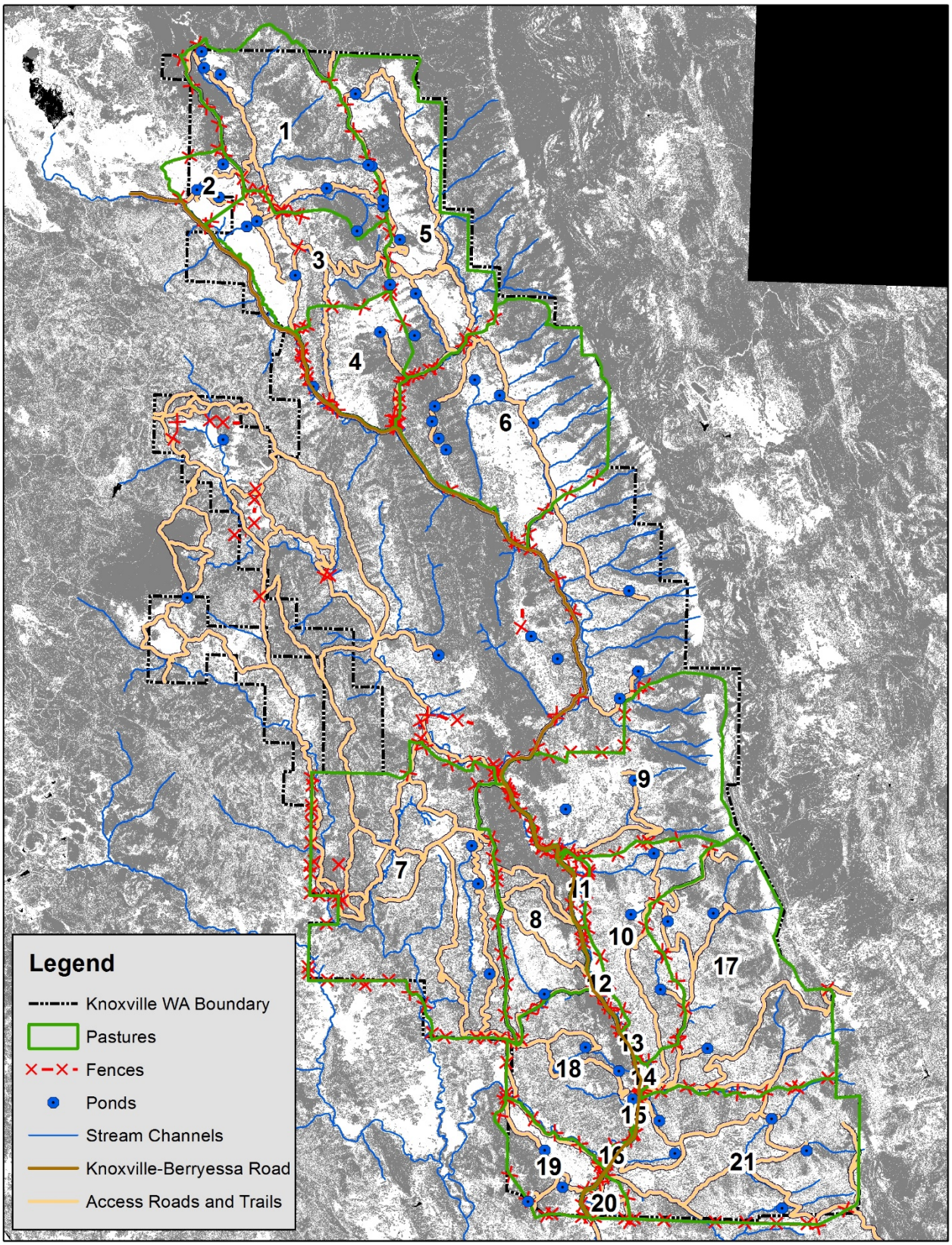
Objective: Replace or improve pasture fencing, stock water developments and handling facilities.

Existing fences need to be replaced or repaired throughout the KWA (Figure 5). Appendix A is an estimate of material costs for the east side of Knoxville Road from the southern boundary to the Wilson Barn North pasture (Appendix A1) and the north fence of the Wilson Barn North pasture (Appendix A2). There are no handling facilities at the south end of KWA and those at the north end (Figure 5) will require significant repair. There are more than 50 stock water ponds on KWA (Figure 5) but many need repair. Stockwater costs will vary greatly depending on lessee needs. Stockwater storage tanks may be needed as well as new pipelines and water troughs. Infrastructure requirements are extensive and must be prioritized in collaboration with a lessee. Initial grazing leases should rely on winter/spring surface water until water developments are installed or repaired. To provide an estimate of potential material and labor costs, Appendix B, the 2015 payment schedule for the USDA EQIP Program, is provided.

Fencing guidelines

1. Prioritize fence replacement and repair.
    a. Propose yearly fence replacement and repair and gate locations in the AOP.
    b. Install and repair fences and gates along the south pastures adjacent to Knoxville Road .
    c. Install and repair the north boundary fence of the Wilson Barn North p
    d. Install and repair the remaining boundary fences and gates around the south grazing area.
    e. Install and repair internal pasture fences and gates in the south grazing area.

Figure 5. Knoxville Wildlife Area pastures, fences, ponds, roads and streams.



   f. Install and repair fences and gates along the north pastures adjacent to Knoxville Road .
   g. Install and repair boundary fences and gates around the north grazing area.
   h. Install and repair internal pasture fences and gates in the north grazing area
2. Use a four wire fence with gates for road, boundary and internal fencing (see Appendix A for material/costs, see fence design from "A Landowner's Guide to Wildlife Friendly Fences", Paige 2012, pg. 21).
3. For ease of entry use steel gates on roads and at main passages between pastures.

Handling Facility Guidelines

1. Determine the need for handling facilities with lessee.
2. Plan and develop handling facilities including adequate space for trucks to turn around.

Water Developments

1. Determine the need and priorities for water developments with the lessee.
2. Prioritize stock pond repair and termination.
3. Determine and prioritize pipeline, storage tank and water trough needs with lessee.

Vegetation Management Objectives

Reducing invasive weeds especially yellow starthistle, medusahead and barbed goatgrass (*Aegilops triuncialis)* and increasing native grasses and forbs are high priority objective for KWA. Reducing fuel loads is also an objective at KWA. Reaching these objectives on 20,000 acres of diverse plant communities and ecological sites at KWA is a major long-term undertaking that must be prioritized. The KWA has been divided into pastures and grazing and restoration practices have been proposed for each unit (Table 4). Priority should be given to maintaining existing native populations and increasing natives on sites with a high potential to support native populations. Grazing practices should be targeted to support reduction of invasive weeds and fuel load while supporting native plant populations and restoration projects. Habitat and watershed values should be protected by apply grazing practices that protect and improve food and cover for wildlife, wetland and riparian vegetation, and erosion and sediment delivery.

Generic Management Unit Practices

Following are generic practices that may be implemented in each pasture (pasture). Objectives and priorities in each pasture will guide application of these practices.

Objective: Maintain and improve competitive ability of existing native grass populations.

Native grasses, mainly purple needlegrass, are widespread in grassland and oak-woodland communities at KWA. The objective for these existing stands should be to maintain the stands and improve their competitive ability. Proper grazing practices can maintain and improve the competitive ability of native grasses but increasing density will require seeding or transplanting of native grasses. These practices may receive priority in the Airstrip and Eticuera pastures.

Table 4. Pasture areas, carrying capacities, RDM targets and management priorities for the south and north pastures.

Pasture Name	Map No.	Management Priority
South Pastures		
Midslope	7	grazing to manage medushahead and goat grass.
Burnt Ridge	8	grazing to manage medushahead and goat grass.
Wilson Barn North	9	grazing to manage medushahead and goat grass.
Wilson Barn	10	grazing to manage medushahead and goat grass.
Eticuera Creek #1	11	yellow star thistle control, perennial grass seeding
Eticuera Creek #2	12	yellow star thistle control, perennial grass seeding
Eticuera Creek #3	13	yellow star thistle control, perennial grass seeding
Eticuera Creek #4	14	yellow star thistle control, perennial grass seeding
Eticuera Creek #5	15	yellow star thistle control, perennial grass seeding
Eticuera Creek #6	16	yellow star thistle control, perennial grass seeding
Toll Canyon	17	grazing to manage medushahead and goat grass.
Four Corners	18	grazing to manage medushahead and goat grass.
Airstrip	19	yellow star thistle control, perennial grass seeding
Nellie Adams SW Corner	20	grazing to manage medushahead and goat grass.
Nellie Adams	21	grazing to manage medushahead and goat grass.
North Pastures		
Foley Canyon 1	1	grazing to manage medushahead and goat grass.
Foley Canyon 2	2	grazing to manage medushahead and goat grass.
Foley Canyon 3	3	grazing to manage medushahead and goat grass.
Foley Canyon 4	4	grazing to manage medushahead and goat grass.
Long Canyon	5	grazing to manage medushahead and goat grass.
Dead Horse	6	grazing to manage medushahead and goat grass.

Grazing guidelines for existing native grass populations:

1. First, do no harm! Avoid grazing closely and continuously over many months and years
2. Apply early spring grazing to reduce competition from invasive annuals.
    a. On productive soils, use heavy spring grazing to reduce invasive species and follow with rest during flowering and hard summer–fall grazing to reduce litter and produce a harsh microclimate for germination and seedling establishment the following growing season.
    b. On less-productive soils, limit heavy spring grazing to high-production years and follow with rest during flowering and hard summer–fall grazing to reduce litter and produce a harsh microclimate for germination and seedling establishment the following growing season.
3. Graze during the dry season to create a harsh soil surface microclimate during germination and seedling establishment the following year. This also reduces fuel load.
4. Rest for at least 4 weeks following spring grazing to allow regrowth and tillering. Rotational grazing can facilitate application of this rest treatment.
5. Rest during flowering to allow for seed set before soil moisture is depleted. Depending on the timing of spring grazing, Guideline 4 could accomplish this objective.
6. Avoid close grazing during the growing season. Minimum stubble height of 5–10 cm (2–4 inches) will ensure regrowth and tillering. Close grazing (less than 2.5 cm) throughout the growing season for two growing seasons in a row can result in plant mortality.
7. It might be logistically difficult to apply all of these guidelines in a timely manner to all pastures. If rest cannot be applied to all pastures during flowering and seed set annually, then this rest treatment should be rotated annually so that purple needlegrass has a chance to flower and set seed in each pasture every few years.
8. Rotational grazing can facilitate application of most of these practices. Rotational grazing that provides for at least 4 weeks of rest (Table 5) following grazing during the growing season, avoids grazing the same pasture during flowering each year, avoids grazing below a stubble height of 5 cm during the growing season, and removes standing litter during the dry season should maintain the vigor and competitive ability of purple needlegrass.

Objective: Restore native grasses and forbs

There are numerous sites where invasive weeds have replaced native grasses and are suppressing existing populations of native plants. On these sites grazing can suppress the invasive weeds but strategic application of herbicides and seeding may be required to increase the density and extent of native plant populations..

Guidelines for Native Grass and Forb Restoration

Site preparation is required before planting native plants. Site preparation involves weed control and seedbed preparation. Weed control can be accomplished by application of herbicides, burning, disking, mowing and often a combination of these control methods. The objective is to reduce competition from existing vegetation. It is important to begin weed control on the site as early as possible, even several years before planting. One of the least expensive ways to clear the weeds from the site before planting native grasses is simply to till the soil over a long enough period of time to exhaust the seed bank. You

till and kill seedlings before they produce seeds, then till again to kill the next crop of seeds in the soil. Eventually (1-3 years, with 3-4 tillage cycles each year) the number of seeds in the soil's "bank" of seeds

Table 5. Example of a 5 year grazing rotation sequence with grazing level and RDM targets assuming an annual early January in-date and late June out-date.

	Graze	Date																								RDM
Pasture Name	Level	J3	J10	J17	J24	J31	F7	F14	F21	F28	M6	M13	M20	M27	A3	A10	A17	A24	M1	M8	M15	M22	M29	J5	J12	J19	J26	Target
												YEAR 1																
Nellie Adams	Close									Medusahead Control:					X	X	X	X	X	X	X	X	X					500 to 800
Toll Canyon	No											No Grazing																Ungrazed
Wilson Barn	Mod	X	X					X	X															X	X			800 to 1000
Airstrip	R											Restoration Area may be grazed as needed																
Four Corners	Mod			X	X					X	X	X														X	X	800 to 1000
Burnt Ridge	No											No Grazing																Ungrazed
Midslope	Light					X							X															2000+
Wilson Barn North	Light						X							X														2000+
												YEAR 2																
Nellie Adams	Close									Medusahead Control:					X	X	X	X	X	X	X	X	X					500 to 800
Toll Canyon	Mod	X	X					X	X															X	X			800 to 1000
Wilson Barn	Light						X							X														2000+
Airstrip	R											Restoration Area may be grazed as needed																
Four Corners	No											No Grazing																Ungrazed
Burnt Ridge	Light					X							X															2000+
Midslope	No											No Grazing																Ungrazed
Wilson Barn North	Mod			X	X					X	X	X														X	X	800 to 1000
												YEAR 3																
Nellie Adams	Mod	X	X					X	X				X	X										X	X			800 to 1000
Toll Canyon	Light						X																					2000+
Wilson Barn	No											No Grazing																Ungrazed
Airstrip	R											Restoration Area may be grazed as needed																
Four Corners	Light					X																						2000+
Burnt Ridge	Mod									X	X	X														X	X	800 to 1000
Midslope	No											No Grazing																Ungrazed
Wilson Barn North	Close									Medusahead Control:					X	X	X	X	X	X	X	X	X					500 to 800
												YEAR 4																
Nellie Adams	Close									Medusahead Control:					X	X	X	X	X	X	X	X	X					500 to 800
Toll Canyon	Light					X																						2000+
Wilson Barn	Mod	X	X					X	X				X	X										X	X			800 to 1000
Airstrip	R											Restoration Area may be grazed as needed																
Four Corners	No											No Grazing																Ungrazed
Burnt Ridge	No											No Grazing																Ungrazed
Midslope	Mod			X	X					X	X	X														X	X	800 to 1000
Wilson Barn North	Light						X																					2000+
												YEAR 5																
Nellie Adams	Mod	X	X					X	X				X	X										X	X			800 to 1000
Toll Canyon	Light																											2000+
Wilson Barn	No											No Grazing																Ungrazed
Airstrip	R											Restoration Area may be grazed as needed																
Four Corners	Light																											2000+
Burnt Ridge	Mod			X	X					X	X	X														X	X	800 to 1000
Midslope	No											No Grazing																Ungrazed
Wilson Barn North	Close									Medusahead Control:					X	X	X	X	X	X	X	X	X					500 to 800

is exhausted. Where cultivation is possible growing a crop of oats for hay or grazing with broadleaf weed control has been used in preparation for perennial grass seedings. Seeding should be done in fall just before the beginning of the rainy season.

Objective: Suppress invasive weeds.

Published guides for controlling medusahead, goatgrass and yellow starthistle are available online. These reports cover chemical, mechanical, cultural and burning practices that research has shown to be effective in control of these weeds. In this plan we will concentrate on grazing as a method of weed management. For other practices managers should refer to the publications below. Because research is constantly working to find effective control practices it can be useful to check with the local UC Cooperative Extension livestock and range management farm advisor.

Medusahead: http://wric.ucdavis.edu/publications/MedusaheadManagementGuide_pub_2014.pdf

Barbed goatgrass: https://ucanr.edu/repository/fileaccess.cfm?article=158157&p=LGLOUW

Yellow starthistle: http://www.cal-ipc.org/ip/management/pdf/YSTMgmtweb.pdf

Guidelines for medusahead

Medusahead is an aggressive winter annual grass that has invaded millions of acres of California and western rangelands. It appears more commonly on high shrink-swell clay soils. Infested rangelands have suffered up to 75% reductions in grazing capacity. Control of small, isolated infestations is critical to keep it from becoming widespread. Kyser et al. (2014) have reviewed the ecology and management of medusahead.

Medusahead germinates after the first fall rains with smaller germination events occurring later in the wet season. Medusahead does not produce seed heads until late April or May, after most annuals have completed their life cycle. This late maturity date may allow medusahead to take advantage of late spring rains.

Methods for controlling medusahead have been studied and implemented since the 1950s. Control approaches have often targeted windows for burning when medusahead is still growing, but when most associated species are mature and dry (Kyser et al. 2008, Murphy and Lusk 1961, McKell et al. 1962). Grazing management approaches have successfully reduced flowering by targeting a narrow period just before the flower emerges in April or May (DiTomaso et al. 2008). Glyphosate can be an effective control method when applied in early spring to young medusahead plants. However, it is non-selective and can damage desirable broadleaf or grass vegetation, including native perennial grasses at moderate to high rates. In the correct ecosystem, proper timing and low rates of glyphosate can control medusahead without damaging desirable perennial plants (Kyser et al. 2012a). Fall applications of aminopyralid at high rates have been shown to prevent medusahead germination throughout the season (Kyser et al. 2012b).

Grazing

Grazing medusahead closely just before the flower emerges in the spring is a proven method to control this species. However, high stock densities are often necessary to get the close grazing required to reduce flowering. In one study this required 5 to 10 sheep on a 100 sq meter plot for one to two days

(DiTomaso et al. 2008). This is equivalent to 185 to 370 sheep per acre during the narrow window of treatment. With a window of 1 to 2 weeks for grazing before the flower emerges and the high stock densities necessary to reduce flowering, the area that can be treated annually will be small. Thus this method requires some planning and monitoring of medusahead as the time window approaches. This method may not be practical over large and/or scattered populations because livestock may graze on other species or may not be able to graze all individual plants prior to seed set.

Timing and Intensity of Grazing

1. Graze from late November to February to reduce thatch.
2. Graze from March to June to reduce medusahead flowering and seed set, target an RDM of 500-600 lb/a.
3. In years with late spring rainfall (May-June) the grazing season should be extended beyond June to impact medusahead regrowth following late rains.
4. Increase stock density in target areas just before medusahead flowers (April-May). Stock density can be increased by decreasing the size of the pasture using electric fencing. Graze the target area as close as possible.
5. Repeat the treatment in year 2.
6. Placement of protein supplements (e.g. Crystalyx) near medusahead patches may increase grazing and trampling in the patch.

Guidelines for barbed goatgrass

Barbed goatgrass is an aggressive winter annual that has spread rapidly throughout northern and central California below 3600 feet elevation. Barbed goatgrass populations create devastating monocultures that diminish species diversity and forage quantity and quality. Barbed goatgrass often grows within medusahead patches. Davy et al. (2008). have reviewed the life cycle and methods of control of barbed goatgrass.

The most important factor in controlling barbed goatgrass is early detection. Since seeds do not fall far from the mother plant, early infestations are generally restricted to small areas. However, the barbed awns attach easily to livestock and wildlife, enabling widespread seed distribution through animal movement. In as little as 3 years, an entire pasture or ranch can become infested with barbed goatgrass. Seeds of barbed goatgrass are also dispersed in hay from dryland pastures, thus spreading to more distant feeding areas and roadsides. Small patches are manageable; however, control of large infestations is extremely difficult. Various control methods have been tested with differing levels of success. In all cases where treatment requires the removal of litter, such as burning, desirable clover or grass species should be reseeded to prevent reinfestation or establishment of another undesirable species.

Mowing and Grazing

Early-growing-season mowing alone has shown limited benefit in barbed goatgrass control, as low growing or prostrate plants often escape injury. Heavy grazing during the growing period, followed by rest in late spring, tends to increase the density of barbed goatgrass due to the elimination of competing plants and barbed goatgrass's strong ability to regrow. Although livestock typically avoid barbed goatgrass, intensive grazing or mowing at early stages of seedhead emergence negates the selective feeding behavior of animals and can be very successful in preventing goatgrass seed formation. Heavy

defoliation at and just prior to seed head emergence can be very effective in limiting seed production, because plant maturity typically occurs when soil moisture is depleted for the growing season and root reserves are nearly exhausted from attempting seed formation. Mowing provides a longer window for defoliating plants because grazing time is limited by the protrusion of unpalatable awns once the seedheads emerge.

Guidelines for yellow starthistle

Yellow starthistle is a native of Eurasia and was first recorded in California in 1869. Now common on roadsides, rangeland, hay fields, pastures and waste areas, it is estimated to infest close to 8 million acres in California. The disturbance created by cultivation, poorly timed mowing, road building and maintenance or grazing favors this rapid colonizer. Yellow starthistle forms dense infestations and may produce allelochemicals that prevent growth of competing species, allowing starthistle to take over large areas of land. DiTomaso et al. (2006a) have reviewed the ecology and management of yellow starthistle.

Yellow starthistle plants develop a deep taproot allowing it to proliferate on dry sites or in dry years. The deep taproot extends below the zone of root competition of associated annual species and allows growth and flowering to occur well into the summer, long after other annual species have died and dried up. Yellow starthistle is able to regrow after top removal from mowing or grazing. Seed output can be as high as 29,000 seeds per square meter with about 95 percent of the seeds being viable. Most seeds germinate the following year, but some seeds can last 10 years or more in soil.

Grazing

Targeted grazing, when performed successfully, will reduce the population of yellow starthistle, minimize damage to desirable species, and support a more integrated approach to weed management. Cattle, sheep and goats have all been successful in controlling yellow starthistle. Choosing which species to use will depend on the stage of the yellow starthistle. Grazing can enhance other control methods for yellow starthistle such as herbicide applications.

Timing and Intensity of Grazing

High intensity grazing at bolting (May-June) can reduce flowering and seed production in yellow starthistle. Timing is critical to the success of grazing for yellow starthistle control. The ideal time to graze is when plants are most susceptible to defoliation or when the impact on desirable vegetation is minimal. Thomsen et al. (1989, 1990, 1993) showed that properly timed (May and June) intensive grazing by cattle or goats resulted in reduced growth, canopy cover, survivability, and reproductive capacity of yellow starthistle.

Repeated high-intensity cattle grazing reduced flowering heads of yellow starthistle by 78-91% (Thomsen et al. 1993). These plants were grazed after the stems had bolted but before the development of spiny seed heads. Cattle and sheep tend to avoid starthistle once the buds produce spines, whereas goats continue to browse plants even in the flowering stage (Thomsen et al. 1993). For this reason, goats have become a more popular method for controlling yellow starthistle in relatively small infestations. Thomsen et al. (1990, 1993) also reported that grazing the weed during the bolting stage could provide palatable high protein forage (8 to 14%). This can be particularly useful in late spring and early summer when other annual species have senesced.

Monitoring weed control effectiveness

Weed control effectiveness should be determined by estimating the cover of the target weed before and after control. The line point intercept method is a common means of estimating cover and can also determine changes in species composition in a treatment area. 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. (2005, pg 9-15). For management purposes photo-monitoring that shows change in weed populations at the same site before and after treatment is often adequate and it is less time consuming.

Objective: reduce fuel loads.

Guidelines for reducing fuel loads

Grazing Intensity: Livestock grazing can decrease the severity of fires by reducing fuel load. In grasslands with 2000 lbs/acre of grassy fuels, flames can be more than 50 feet long and difficult to control. In moderately grazed rangelands with 1,000 lbs/acre of grassy fuels, flames can be 4-10 feet long and thus more controllable. In heavily grazed areas with less than 500 lbs/acre of fuels, fires generally burn only in isolated patches because the fuels are usually discontinuous (Barry et al. 2011).

Season of Use: Areas grazed only during the early part of the growing season will tend to regrow during the late spring. Grazing late in the growing season and early in the dry season is the most effective time to lower flammable herbage levels prior to the dry vegetation period.

Livestock class: All classes of livestock can effectively reduce fuel load.

Monitoring: Residual dry matter (RDM) is usually monitored to determine grazing intensity but it can also be used to estimate fine fuel loads (Bartolome et al. 2006). Additionally fire resistance to control and rate of spread can be based on a combination of fuel load and type, slope, wind speed, and humidity.

Objective: Maintain and improve riparian areas

Guidelines for maintaining and improving riparian areas.

Ponds, intermittent streams and permanent streams are present on KWA. Because livestock grazing has not occurred on KWA for several decades there are no riparian areas that are currently impacted by livestock. Some riparian areas are fenced and others are too steep for cattle to access but others will be congregation areas for livestock as they access surface water or cross riparian zones on roads and trails. Uncertain of the location of these potential impact areas, KWA staff should monitor riparian areas for livestock impacts during and after grazing.

The degree of impact in riparian zones will vary depending on the number of head and their residence time in the riparian zone (George et al. 2011). During the growing season there is usually sufficient green forage away from the riparian zone that residence time in the riparian zone is minimized. However, as upland forage matures and dries riparian zones may become more attractive to grazing livestock. Practices such as placement of livestock attractants (water troughs, salt and other nutritional

supplements) away from the riparian zone can reduce residence time. Rotational grazing among several pastures reduces residence time in each pasture's riparian zones and provides for recovery from grazing. Exclusionary fencing is an expensive but certain method of reducing livestock residence time in a riparian zone that may be applied to critical areas identified by monitoring grazing impacts over the first few years of grazing. As a first line of defense we recommend that livestock be rotated among four or more pastures during the grazing season to reduce residence time and to provide recovery time (rest) for riparian zones. Table 5 is an example of a rotation scheme for the south pastures that reduces residence time in each pasture, provides for medusahead control and results in a mosaic of herbaceous vegetation heights ranging from closely grazed to ungrazed.

Objective: Maintain and increase habitat diversity

Guidelines for maintaining and increasing habitat diversity

Barry et al. (2011) have compiled grazing practices that may be used to manipulate habitat values and animal populations. Grazing can be used to diversify habitat by leaving a mosaic of herbaceous vegetation levels ranging from closely grazed to ungrazed. Close grazing tends to increase low growing forbs such as filaree and various legumes while light to moderate grazing tends to support a grass dominated ground cover. A vegetation mosaic insures that tall vegetation is available for fawning and hiding habitat, while short to moderate vegetation is available to certain rodents and ground dwelling birds. Target vegetation levels can be rotated annually so that each pasture is not grazed every few years providing tall herbaceous vegetation. A closely grazed year might be followed by an ungrazed or lightly grazed year to provide for vegetation recovery from close grazing. A mosaic of herbaceous vegetation levels can be achieved using rotational grazing that is planned annually in the AOP (Table 6).

Guidelines for rotational grazing

Rotational grazing of four or more pastures in a planned sequence can reduce impacts in riparian zones and facilitate a mosaic of herbage levels. By changing the herbage level treatment annually each pasture will provide a different herbage level over a period of years and no pasture will be closely grazed several years in a row. When a pasture is targeted for medusahead control it could be one of the closely grazed pastures in the annual sequence. Table 5 is an example of a grazing rotation plan for the south pastures at KWA assuming an in date of the first week in January and an out date at the end of June. Of course the sequence in this plan would be changed depending on available livestock numbers and herbage level monitoring during the grazing season. If livestock numbers are low the herbage levels for each pasture may not be achievable unless additional pasture are ungrazed or grazed less than suggested in this example.

Guidelines for stock ponds

Stock pond and associated wetland habitat can be protected by fencing these areas from grazing and installing a pipeline, storage tank and trough downstream. This should enhance amphibian and reptile habitat around stock ponds and wet areas.

Table 6. Example of an annual plan for the south pastures that rotates end of grazing residue levels over a 10 year period.

Pasture Name	Year									
	1	2	3	4	5	6	7	8	9	10
South Pastures										
Nellie Adams	Close	Close	Mod	Close	Mod	Close	No	Mod	Light	Mod
Toll Canyon	No	Mod	Light	Light	No	Light	No	No	No	Light
Wilson Barn	Mod	Light	No	Mod	No	Light	Close	Close	Mod	Close
Four Corners	Mod	No	Light	No	Mod	Mod	LIght	Mod	No	Light
Burnt Ridge	No	Light	Mod	No	Light	Mod	Light	No	Light	No
Midslope	Light	No	No	Mod	Close	Close	Mod	Close	Mod	Close
Wilson Barn North	Light	Mod	Close	Close	Mod	Close	Mod	Close	No	Mod

Objective: Protect oak seedlings and saplings.

Competition for soil moisture by annual plants, rodent populations, fire and livestock and wildlife grazing and browsing contribute to poor regeneration of oaks. Since the 1980s the University of California Division of Agriculture and Natural Resources in collaboration with state and federal agencies have developed methods for improving oak regeneration (McCreary 2001). Weed control, mulching, seedling screens have been used to successfully protect oak seedlings to the sapling and young tree stage. Research at the University of California Sierra Foothill Research and Extension Center has shown that 4 foot tree shelters are adequate to protect oaks from grazing and browsing by cattle and deer (McCreary 2001).

Drought Management

Drought can be defined as a deficiency in precipitation over an extended period of time, usually a season or more. In a grazing plan the focus is on reduced precipitation and resulting loss of vegetation and water resources. Monitoring monthly precipitation and comparing to averages (Table 7) can help managers determine if precipitation is below average. Monitoring forage levels and surface water availability can help managers determine the need for adjustments in the annual grazing plan including in dates, out dates and stocking rate.

Ranchers anticipate the start of the rainy season every fall. Receiving rain by mid-November is a good start but does not guarantee a good rainfall or forage year. Low or late Fall rainfall will result in low forage levels at the end of December and beginning of the following year. As the growing season progresses in the new year rainfall is stored in the soil to support rapid spring growth that usually starts in March or late February. If rainfall is adequate during this period forage production for the year may reach average levels. However if rainfall is low spring forage production may be below average and result in a decision to reduce stocking rate or shorten the grazing season (earlier end date).

Table 7. Average temperature and precipitation for Lake Berreyessa.

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Annual
Average Max. T (F)	93.4	93.3	88.1	79.1	65.4	56.2	56.1	60.3	63.5	69.9	77.4	85.9	74
Average Min. T (F)	60.4	60.6	56.9	51.6	44.4	39.6	38	40.9	41.8	44.8	50.2	56.7	48.8
Average Precipitation (in.)	0.02	0.19	0.22	1.32	3.05	4.01	6.07	4.39	2.76	1.88	0.3	0.23	24.44

CDFW and the grazing lessee should jointly develop a drought plan that addresses forage and water constraints and habitat needs at KWA. This should include changes to in dates and out dates and stocking rate for the grazing season. It may also include feeding of hay or other supplements.

Drought monitoring

- Monitor rainfall starting in September.
- Low rainfall, lack of surface water and poor forage production in the fall may require a delay in the grazing in-date and adjustment in the initial stocking rate.
- Because it commonly turns cold around the middle of November, forage levels may increase slowly or not at all through the cold winter months until warm weather begins in late February or March.
- If rainfall in December and January are low then forage levels will be low during the early part of the growing season and grazing capacity will be reduced. I
- If February and March rainfall is low then spring forage production may be low.
- If there is little or no rainfall during early April then the growing season will end in May.

Management Unit Plans

Table 4 lists some management priorities for each KWA pasture. Generally, yellow star thistle control and perennial grass planting are priorities in the Airstrip and Eticuera Creek pastures. Grazing to reduce medusahead will be a priority in the Toll Canyon, Nellie Adams and Wilson Barn South pastures but these practices can be applied to only one or two pastures each year depending on the number of cattle available for close grazing in March and April. The remaining pastures will be ungrazed or grazed to moderate (RDM=800 to 100 lb./a) or light (RDM=2000 lb. +) levels. These treatments will be rotated to provide a mosaic of short to tall herbaceous ground cover. Rotation also insures that pastures are not grazed at the same time each year or closely grazed for several years in a row. Table 5 is an example of annual grazing sequences for five years. This table should be revised annually as part of the A.O.P. This table includes approximate in-dates (January 3 in the example), out-dates (week of June 26 in the example) and carrying capacity of the pasture in animal units months.

During annual grazing planning the desired herbage level at the end of the growing season will be identified in the grazing level column of the table. The target RDM for the end of the grazing season will reflect the desired grazing level treatment. Next weekly periods of grazing will be proposed for each pasture. The pasture grazed for medusahead control should be designated first as it requires grazing during a specific period (April and May) to reduce medusahead flowering. The grazing periods for other pastures can be then be designated.

As grazing periods and grazing levels are proposed managers should insure 1) that a pasture is not grazed at the same time every year, 2) that grazing starts in a different pasture each year, 3) a mosaic of RDM levels is identified for the pastures and 4) the desired grazing level for a pasture is not the same for several years in a row.

Finally, actual stocking rate should never exceed carrying capacity. Initially it is recommended that the stocking rate be low and then increased as managers gain experience and monitoring indicates that there is additional unused grazing capacity.

Annual Planning and Reporting

With prescribed grazing the timing and intensity of grazing for each pasture 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 KWA manager should sign and date the AOP.

An annual report could 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 pastures, grazed and ungrazed. Any other vegetation management practices and their effectiveness should also be described. An annual report is an important way for CDFW to communicate with the public.

Advisory Committee

KWA staff should consider establishing an advisory committee. An advisory committee to KWA could be a way to establish communications and support for developing the grazing program and other management activities. An advisory committee that included local conservation groups, local hunters, ranchers and natural resource professionals could help CDFW by communicating with conservation groups, hunters, range management organizations and other interest groups about proposed management. Communication with hunters might reduce vandalism of KWA infrastructure.

Steps for Getting Started

- Develop a request for grazing proposals
- Organize a committee to review proposals and interview applicants
- Send the RGP to livestock and range management organizations

- Hold an informational meeting for interested grazers.
- Set a deadline for proposals.
- Review proposals and interview selected applicants.
- Complete lease agreement.
- Complete an Annual Operating Plan for the first grazing season.
- Start grazing.
- Complete an annual report following the first year.
- Complete an Annual Operating Plan for the second year.

Important References

We have cited several reports in this plan and they are listed in the Literature Cited section. Following are a few references that can guide managers in the application of weed control or grazing management practices. Copies of these reports are available on the internet.

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Plan Contractor

This plan was completed on October 24, 2016 by Melvin R. George, Certified Range Manager No. 27.