



## **Columbian Black-tailed Deer (*Odocoileus hemionus columbianus*) Surveys on the Lower Cottonwood Creek Wildlife Area, 2005 – 2009**



*Columbian black-tailed deer buck. Photo by Tommy J. Grove.*

**Prepared By:** Lara A. Sparks  
*January 2013*

**Los Banos Wildlife Area Publication #:** 48

**Status:** Final Report

**For additional copies, contact:** Resource Assessment Program  
Ca. Department of Fish & Wildlife  
18110 W. Henry Miller Rd.  
Los Banos, CA 93635  
Phone: (209) 826-0463  
Fax: (209) 826-1761

## **Abstract**

Cattle grazing has been used annually from October through January on Lower Cottonwood Creek Wildlife Area (LCCWA) since 2002 to aid in the prevention of wildfires and reduce non-native grasses on the property. Fenced cattle exclusions were constructed on the area in 2005 to provide refuge for wildlife and offer habitat diversity by protecting areas of grassland, riparian and shrubland. The California Department of Fish and Wildlife began monitoring the Columbian black-tailed deer population on LCCWA to determine if they continue to use the area while cattle are present, and to see if they utilize the cattle exclusions. From 2005 through 2009, we made a total of 2,282 deer observations on LCCWA and the San Luis Reservoir State Recreation Area (State Parks) combined, with an average of 2.1 deer per 100 hectares. Numbers decreased each year from 2.8 deer per 100 ha tallied in 2005-2006 to an average of 1.2 deer per 100 ha from 2007-2009. We consistently found a higher density of deer using State Parks land than LCCWA, which were primarily within one area of riparian habitat. Deer utilized LCCWA year-round, with the highest densities occurring within Exclusions 1 and 4, which are the largest of the four cattle exclusions. Since 2005 we observed an average ratio of 30 bucks per 100 does, with higher ratios found on LCCWA than on State Parks (34 and 25 bucks per 100 does, respectively). We observed an average of 69 fawns per 100 does on both properties combined, but found a higher ratio of fawns on State Parks (80 fawns per 100 does) than on LCCWA (57 fawns per 100 does). These ratios fall within the ranges documented in this region from 1961-1995. Due to inconsistencies over the course of the study such as data gaps, observer bias and a lack of vegetation surveys, strong correlations could not be deduced on deer use or habitat preferences. However, overall deer numbers observed during our surveys do appear to be correlated with rainfall.

*Keywords: deer, Odocoileus hemionus columbianus, grazing, habitat use, annual grassland*

## **Introduction**

The California Department of Fish & Wildlife (CDFW) owns several properties located along the central California Coast Range of Merced County, including the Lower Cottonwood Creek Wildlife Area (LCCWA). LCCWA is primarily made up of annual grassland and is managed to provide habitat for a variety of wildlife. In the winter of 2002, CDFW introduced cattle grazing as a management technique to reduce non-native grasses and to lower the density of annual grasses and litter, which provide fuel for wildfires common to the area. Grazing has since been utilized annually, typically from October through January, except during the fall of 2007 through late winter 2008. During that time a grazing contract was not utilized in order to provide a recovery period

for the vegetation following a drought year. Cattle grazing intensity ranged from 1.90 ha/animal unit month (AUM) to 3.04 ha/AUM (average  $2.42 \pm 0.16$  ha/AUM), which is considered a short-term and heavy grazing management regime (W. Cook, Jr. pers. comm. March 15, 2011). Several fenced cattle exclusion areas were constructed in 2005 to provide refuge for wildlife while grazing takes place, as well as to protect the limited riparian and shrubland habitats found on the property. They also contribute to habitat diversity by providing grazed annual grassland (763 ha), ungrazed annual grassland (93 ha), ungrazed riparian (7 ha) and ungrazed shrubland (6 ha).

After cattle exclusion areas were installed on LCCWA, the CDFW wished to study the response of wildlife to grazing and their use of these exclusions while cattle are both on and off the property. The main species of interest for this study was the Columbian black-tailed deer (*Odocoileus hemionius columbianus*), primarily because LCCWA supports a moderate deer hunting public use program. Other research has been conducted to study the competition between deer and cattle, however many of these evaluated only summer grazing regimes (Bowyer and Bleich 1984, Kie et al. 1991, Loft et al. 1991). In contrast with such studies, we were interested in documenting how deer respond to grazing that occurs from late fall into winter. Our primary objective was to see if deer remained on the area while cattle were present, and if they utilized the cattle exclusions provided. We were also interested in observing any changes in behavior, such as amount of time spent foraging, during cattle presence and after cattle were removed from the property. Secondarily, we wished to determine if the hunting that occurs on LCCWA affects the timing of deer use on the area or alters their behavior in any way.

## **Study Area**

The LCCWA (869 ha) lies on the eastern most edge of the Coast Range within western Merced County, approximately 24 km west of the city of Los Banos along Highway 152 (Figure 1). The San Luis Reservoir State Recreation Area (State Parks), owned by the California Department of Parks & Recreation, borders LCCWA to the south and east, and a privately owned cattle ranch is adjacent to the northern side of the wildlife area. To the west lies the San Luis Reservoir, while the O'Neill Forebay is

east of the wildlife area. LCCWA is owned by the CDFW as part of the Los Banos Wildlife Area Complex and is managed for wildlife and public recreation. Public use on the area is primarily hunting of deer, wild pig and dove. The habitat is largely annual grassland with a small, narrow section of mixed willow riparian and shrubland. Elevations range from 90-390 m and the climate is characterized by hot, dry summers and cool, wet winters. Precipitation averages 27 cm per year and occurs primarily between October and April (California Department of Fish and Game 2010).

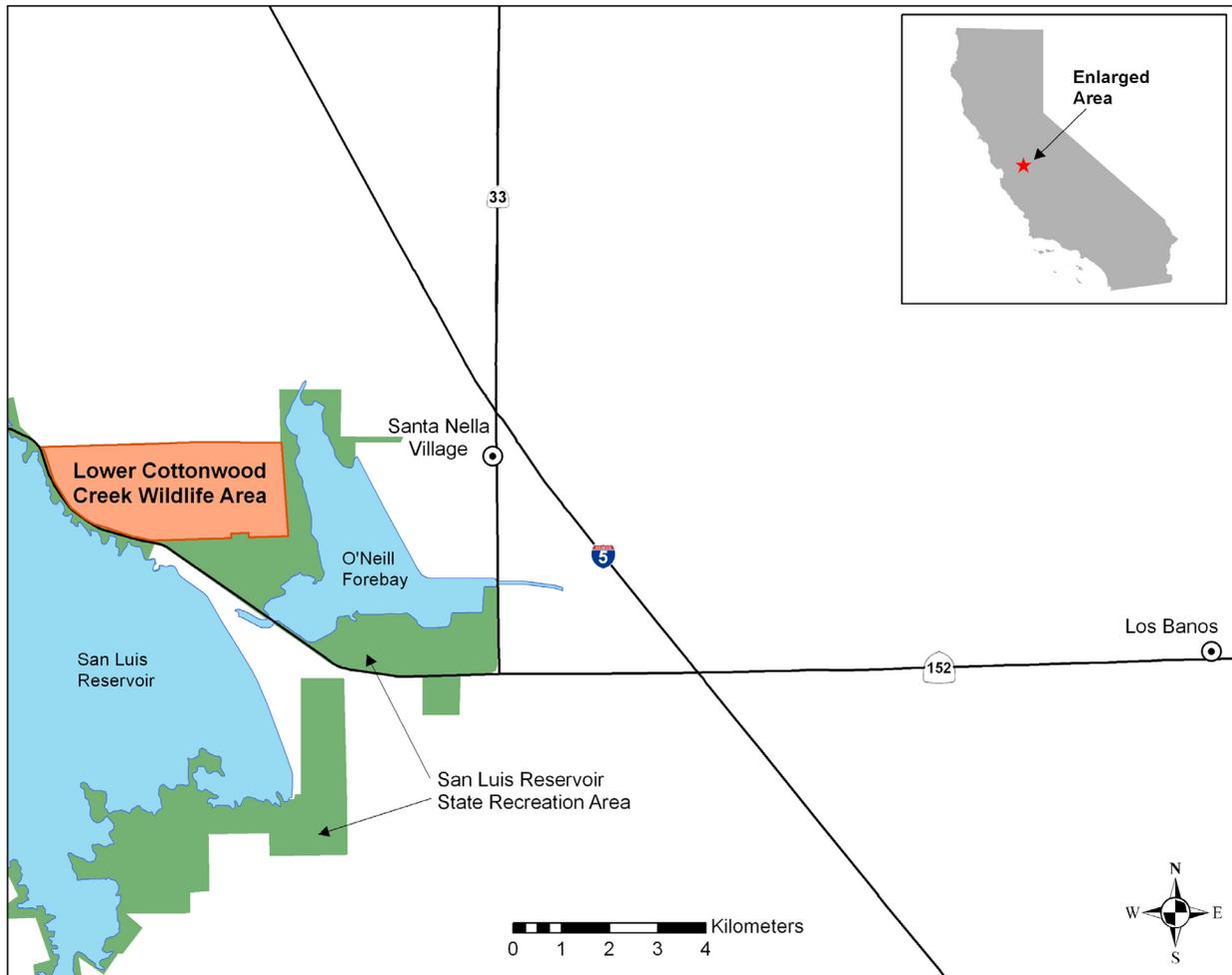


Figure 1. Location of the Lower Cottonwood Creek Wildlife Area, Merced County, California.

## Methods

We created a fixed driving route (15.6 km), which began south of LCCWA on the adjacent State Parks land and continued onto the wildlife area, primarily following

firebreaks (Figure 2). The route segment on State Parks was included within our study area because it contains riparian habitat adjacent to LCCWA that deer frequently utilized. Each month, we conducted two daytime and two nighttime driving surveys (daytime surveys did not immediately follow nighttime surveys), with surveys lasting approximately one to three and a half hours. Morning surveys began half an hour before sunrise or until light levels allowed us to see without the use of vehicle headlights. We began night surveys one hour after sunset and used vehicle high beams, as well as one million candle power hand-held spotlights to detect animal eye shine. For morning and night surveys, we recorded the beginning and ending times, wind conditions (using the Beaufort scale) and general weather conditions; surveys were not conducted during heavy rain or fog. We also made note if any cattle were observed using the wildlife area during the survey. A minimum of two surveyors (one on each side of the vehicle) drove the route at no more than 16-24 km/h (10-15 mph) while scanning as far as we could see on either side of the route. For portions of the driving route that came to a dead end, we doubled back and retraced parts of the course. However, we took special care to not recount any animals while driving these sections. When we detected deer or eye shine, the vehicle was stopped and we used binoculars to identify the total number of deer within the group. A group of deer consisted of either one deer by itself or several deer located within close proximity to each other (i.e. a herd). Within each group we also identified every individual deer's age class (adult, juvenile, fawn), sex, and its behavior (foraging, standing, moving or bedded) when we first observed it. When we were unable to determine the sex of an adult deer, we recorded it simply as an "adult." Any deer that we could not definitively identify as either an adult or fawn was listed as an "unknown." Using a paper topographic map, we also marked the location of each group of deer observed. We used a Global Positioning System (GPS) unit equipped with our survey route, which showed our location and made it easier for us to estimate the distance and direction of each deer group from our vehicle. By noting the position of each group of deer, we then documented the property owner (LCCWA, State Parks or private), as well as if deer were using grazed (LCCWA or private) or ungrazed (State Parks or fenced exclusions within LCCWA) areas. When we encountered any other mammals along our survey

route, we recorded these species as incidental sightings. Any observations of special status species were submitted to the California Natural Diversity Database (CNDDDB).

After each survey, we entered all data into an Access database and digitized each deer group location within ArcMap. To standardize our data, we calculated all sightings as number of deer per 100 hectares. The area of visibility was determined by delineating on a topographic map the land visible while we drove the route during the day, as well as at night with a spotlight. We then digitized this area within ArcMap to calculate our total area surveyed.

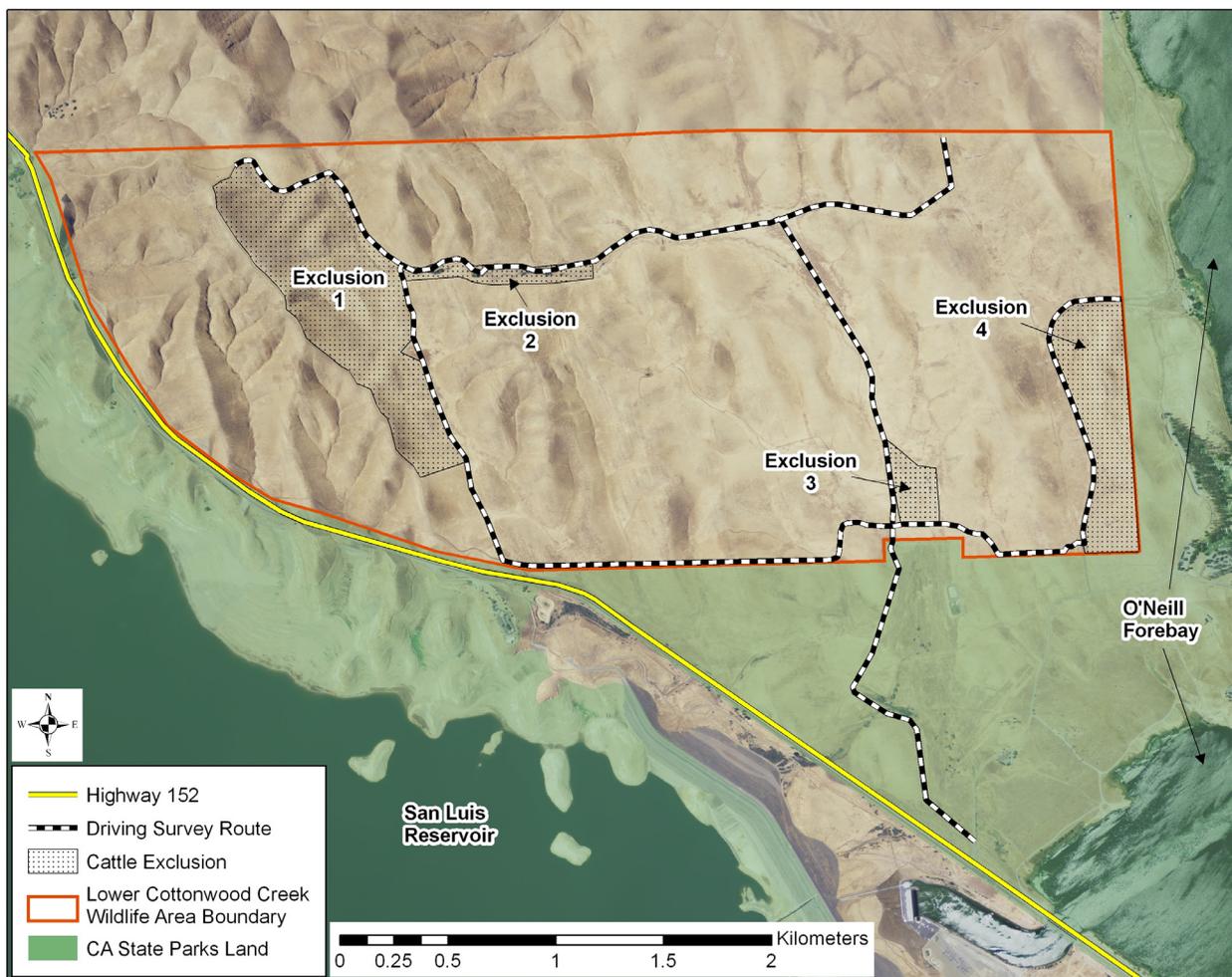


Figure 2. Deer survey route within the Lower Cottonwood Creek Wildlife Area and San Luis Reservoir State Recreation Area, Merced County, California, 2005-2009.

## Results

Between May 2005 and December 2009 we conducted a total of 143 (73 daytime and 70 nighttime) deer surveys on LCCWA and State Parks, encompassing a total of 921 ha during each day survey and 669 ha during each night survey. Of the land we were able to view from along the survey route (Figure 3), 75% of the total area of LCCWA could be seen during the day, while we could only observe 59% of the property at night. Within LCCWA, 94% of the cattle exclusion areas were visible during the day, while we were only able to view 80% of these areas at night (Table 1).

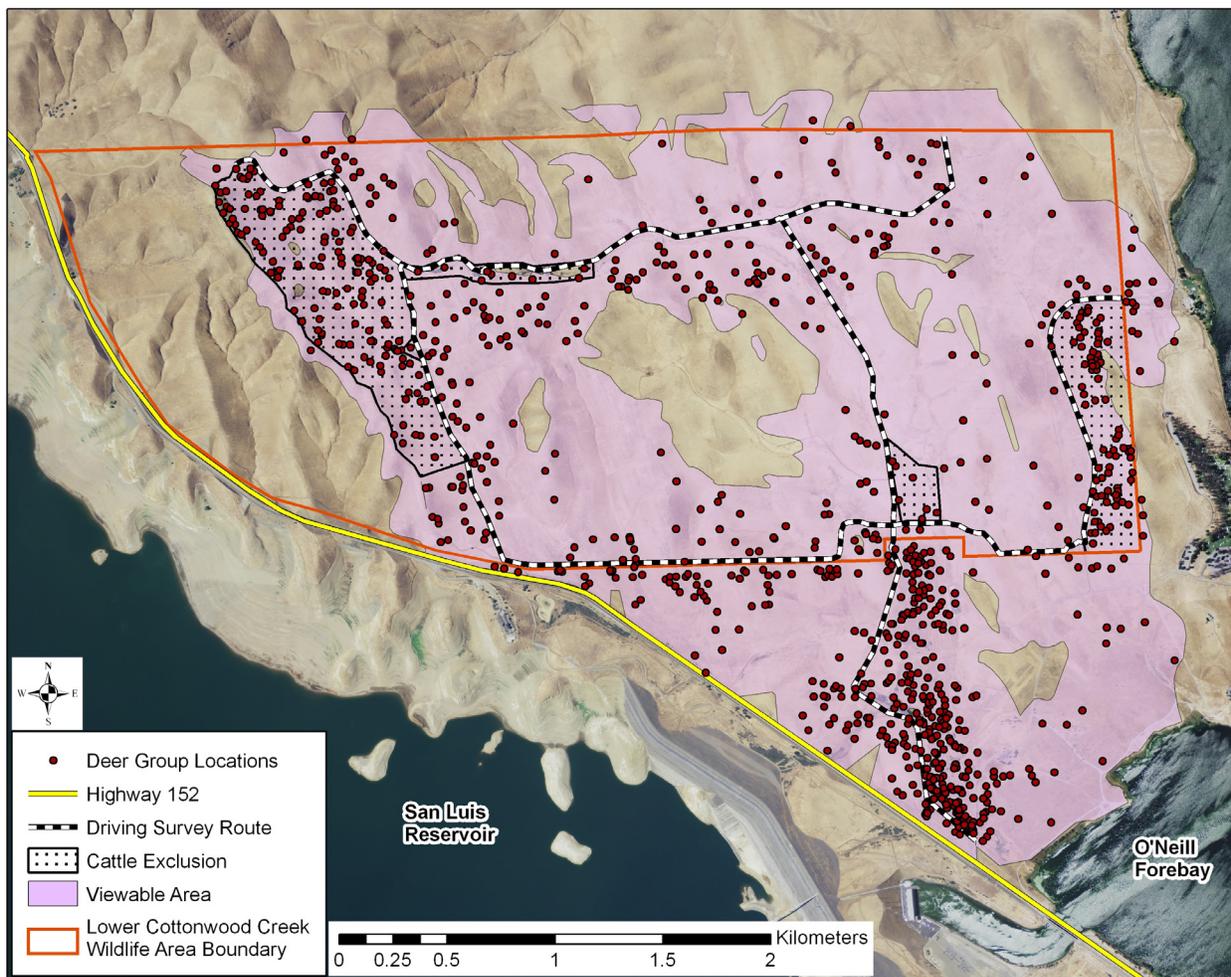


Figure 3. Viewable area and deer group locations observed on the Lower Cottonwood Creek Wildlife Area and San Luis Reservoir State Recreation Area, Merced County, California, 2005-2009.

Table 1. Total number of hectares and the amount of area viewable during morning and night surveys on the Lower Cottonwood Creek Wildlife Area, Merced County, California, 2005-2009.

<i>Area</i>	<i>Total Hectares</i>	<i>Morning Survey Viewable Area (ha)</i>	<i>Night Survey Viewable Area (ha)</i>
Grazed	763	534	431
Exclusion 1	63	61	47
Exclusion 2	7	6	5
Exclusion 3	6	6	6
Exclusion 4	30	27	27

In all surveys combined, we counted a total of 973 groups and 2,282 deer sightings, the majority of which were observed on either State Parks or LCCWA (Figure 3). Because of the location of our survey route, we only recorded a total of 25 deer observations on either private property or California Department of Transportation land (a small section between LCCWA and Highway 152), and thus we have not included them in our analyses. Of the deer seen on LCCWA or State Parks, we calculated an average of 0.9 groups and 2.1 deer per 100 ha. We found slightly more deer groups during nighttime than daytime surveys (1.0 groups and 0.8 groups per 100 ha, respectively). However, for individual deer sightings, we observed a similar number of deer during both the night and day (2.0 and 2.1 deer per 100 ha, respectively). During the 2005-2006 survey period we detected more groups, as well as number of deer (Figure 4), than the 2007-2009 period. On average, we identified 1.3 deer groups per 100 ha from 2005-2006, while our groups observed in 2007-2009 dropped to 0.5 per 100 ha. Similarly, the number of deer tallied in 2005-2006 was 2.8 per 100 ha, while we counted an average of 1.2 deer per 100 ha from 2007-2009. Despite the decrease in deer densities over the five year period, there were some common trends as well. Each year the number of deer observations increased from June through September and again in January, and numbers consistently decreased primarily during April and May.

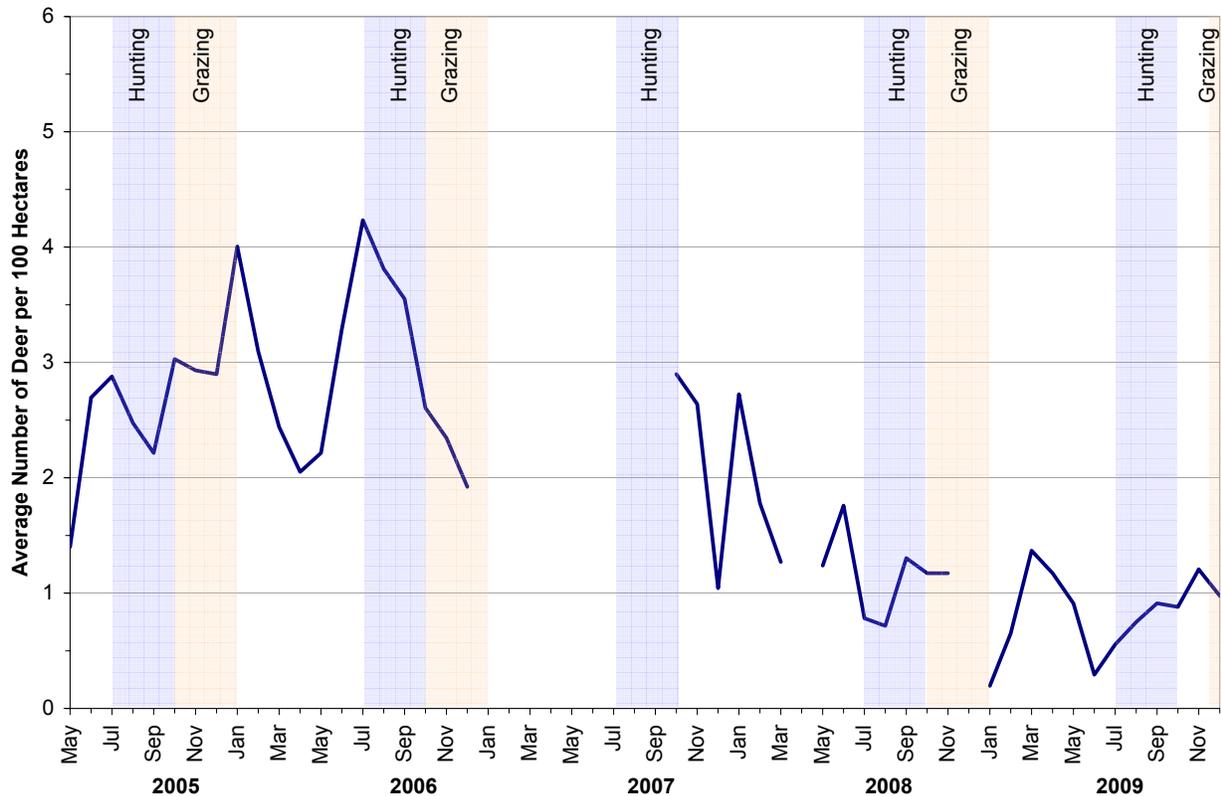


Figure 4. Average number of deer per 100 hectares observed on the Lower Cottonwood Creek Wildlife Area and San Luis Reservoir State Recreation Area, 2005-2009. (Surveys were not conducted in Jan-Sep 2007 or Apr and Dec 2008.)

When we compared the number of deer observed per property, we found more deer using State Parks land than LCCWA (4.2 and 1.3 deer per 100 ha, respectively). On State Parks, where hunting is not allowed, densities of deer peaked just prior to, or during, the deer hunting season in most years (Figure 5). On LCCWA, we did not find a strong correlation between deer densities and time of year. Although numbers were consistently low, deer continued to utilize the area during the hunting and grazing periods (Figure 5). Time of day also did not affect deer numbers on LCCWA, however on State Parks there was a higher average number of deer observed at night than during the day (4.6 and 3.9 deer per 100 ha, respectively). Deer use between the different management areas within LCCWA varied with location and time of day, with Exclusion 1 having the highest number of deer per 100 ha during daytime surveys (5.5 deer per 100 ha) and Exclusion 4 during nighttime surveys (6.1 deer per 100 ha). We also observed more deer per 100 ha on these two sub-areas than State Parks land. Deer density also varied within sub-areas during periods of cattle presence and



behaviors varied greatly. We found more deer standing within the grazed area, and moving in Exclusion 2 than other behaviors. Within Exclusion 3, over 50% of our observations were of deer bedded down. The behaviors we observed also differed between day and night surveys, but patterns were similar on both LCCWA and State Parks. During morning surveys for both properties combined, we observed 45% of the deer foraging and 28% standing. At night we found 38% of deer bedded down and 28% standing.

Of the total deer sightings on LCCWA and State Parks, we were able to determine sex and age of 77% of the individuals. We found 30 bucks per 100 does for both areas combined, with peak numbers of bucks occurring in the late summer and early fall of each year. In all years, we observed a higher buck to doe ratio on LCCWA than on State Parks (34 and 25 bucks per 100 does, respectively), with the highest ratio occurring in 2009 (Figure 6). Of the 11% of individuals we identified as adults of an unknown sex, the majority were observed during the late winter and early summer. We observed the first fawns of the year beginning in May and into June. For both properties combined we calculated an overall fawn to doe ratio on of 69 fawns per 100 does. In most survey years we observed over 60 fawns per 100 does, with nearly a one to one ratio in 2009 (Figure 7). We found a higher fawn ratio on State Parks (80 fawns per 100 does) than on LCCWA (57 fawns per 100 does). In all surveys combined we were unable to age or sex approximately 12% of the deer, the majority of which we observed during the night.

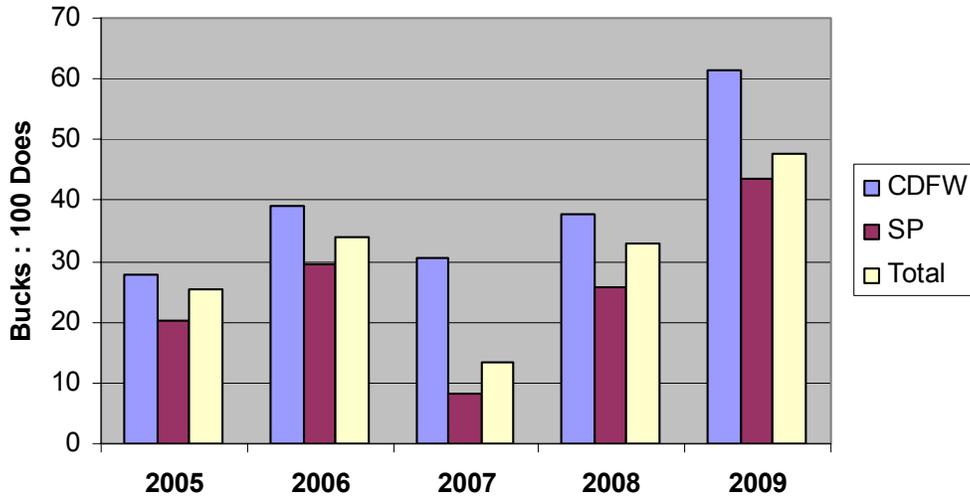


Figure 6. Number of bucks per 100 does on the Lower Cottonwood Creek Wildlife Area (CDFW) and San Luis Reservoir State Recreation Area (SP), 2005-2009. (Number of surveys per year: 2005 = 30, 2006 = 44, 2007 = 10, 2008 = 22, 2009 = 37.)

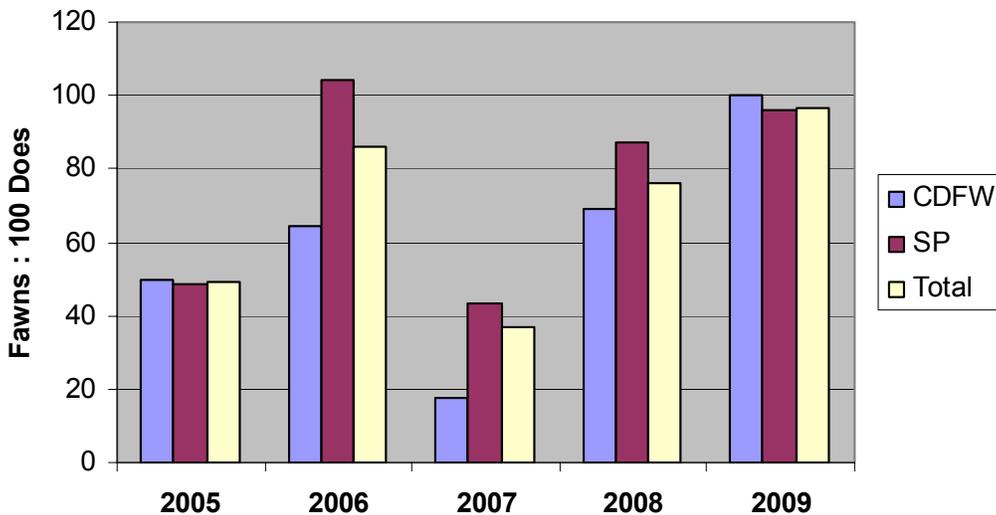


Figure 7. Number of fawns per 100 does on the Lower Cottonwood Creek Wildlife Area (CDFW) and San Luis Reservoir State Recreation Area (SP), 2005-2009. (Number of surveys per year: 2005 = 30, 2006 = 44, 2007 = 10, 2008 = 22, 2009 = 37.)

Incidental mammal species that we observed during our surveys are presented in Appendix A. Several species were commonly seen year-round along our route, including desert cottontails, black-tailed jackrabbits, badgers and coyotes. In 2007, we began tallying each individual mammal rather than recording a list of species. From 2007-2009, coyotes and feral pigs were the most numerous species we recorded. We also regularly observed two male tule elk using LCCWA from March through August in both 2008 and 2009.

## Discussion

Although this study was conducted over a period of five years, there have been many inconsistencies which have made it difficult for us to draw many conclusions from the data gathered. For example, surveys were suspended from January through September 2007 due to budgetary constraints. In addition, we were periodically unable to conduct surveys due to poor weather or road conditions, resulting in a lower number of surveys in various months each year, and inconsistently from year to year. Furthermore, the observers performing these surveys changed multiple times over the course of the study, with a total of 15 different personnel since 2005. Observer experience, such as general spotlighting techniques, ability to detect deer, as well as confidence in ageing and sexing deer, also varied among surveyors. A study by Kie and Boroski (1995) found that even with thoroughly training surveyors, their abilities to detect deer differed, which ultimately made it difficult to discern observer effects from yearly changes in deer population size. Despite these challenges we were able to make some inferences from our study with respect to deer use on LCCWA and surrounding State Parks land.

LCCWA and State Parks are located within the eastern most edge of the Pacheco deer herd summer range (Smith 1983), which could explain the overall low numbers of deer seen during our surveys, although we did observe deer year-round. Our surveys showed that deer numbers tended to increase between June and September, which supports Smith's findings. This timing also corresponds to the deer's period of rut, or beginning of the breeding season, which may also make deer more active and/or visible. In addition, our buck numbers peaked at this time of year, which is when they have antlers and are more easily identified. Conversely, we found deer numbers decreased between April and May, corresponding to parturition, or the period when does are giving birth and thus are harder to detect. In addition to seasonal patterns, the sex and age ratios of the deer we observed during our study (Figures 6 and 7) also fell within the ranges reported for the Pacheco deer herd composition counts. From 1961-1995, the annual number of bucks tallied per 100 does ranged from 10 to 41, and the number of fawns per 100 does was found to be between 8 and 91 (California Department of Fish and Game 2012, Smith 1983). The fluctuations from

year to year were thought to be primarily related to annual rainfall and forage conditions. Smith further discussed that in years with low rainfall, there is not enough habitat that provides protective cover, especially for fawns, which could affect annual survival.

Throughout our study area, there are different types of habitats available for use by deer. However, we observed that certain areas along our survey route were used more often by deer than others. The large riparian area within State Parks was utilized heavily by deer throughout the study period. The numerous trees and shrubs provide cover and browse that is not as readily available on LCCWA, so there are many opportunities for all stages of the deer's life cycle, including general foraging, protection from predators, and safer birthing areas. The cover provided by this habitat most likely explains the higher number of fawns we observed on State Parks than on LCCWA. This area also has more year-round availability of water, which has been found to influence the distribution of mule deer (Bowyer 1984). Bowyer (1984) found that southern mule deer were strongly influenced by the availability of free water, especially during late summer when deer were found within 500 m of water. Not only does this riparian area have a small section that remains wet throughout most of the year, it also is in close proximity to the O'Neill Forebay, providing deer with another source of water. Deer within LCCWA have access to smaller water sources throughout the property in the form of stock ponds, troughs, and an ephemeral stream. However, depending on the time of year and amount of rainfall, these water sources can dry up, which could influence the distribution of deer in this area.

Within LCCWA, deer appeared to prefer using Exclusions 1 and 4, the two larger exclusion areas, during the course of our study. We found deer use of Exclusion 1 increased dramatically when cattle first arrived onto the property in 2005, although this pattern did not continue in subsequent years. Prior to 1979, when CDFW acquired LCCWA, livestock grazing was heavily used on this property and the surrounding landscape (California Department of Fish and Game 1978). CDFW documented "serious degradation" of the habitat caused by the grazing in this area and ended the practice to allow the vegetation to recover. By 2005, cattle grazing had only been reintroduced on LCCWA for three years, so perhaps the novelty of it initially moved the deer into the largest exclusion area. As the years progressed the deer may have

become more accustomed to the presence of cattle, and thus may not depend as heavily on the exclusion area. We also observed annual increases in deer using Exclusion 1 from June through August, which could be due to the taller vegetation offering better concealment from predators for both adults and young. A study of southern mule deer found that cattle grazing appeared to significantly reduce the amount of taller vegetation within a pasture, which most likely decreased the amount of suitable cover for does with fawns (Bowyer and Bleich 1984). Another study by Loeser et al. (2005) found that in an area with pronghorn (*Antilocapra americana*) where cattle were excluded from grazing for five years, horizontal plant cover increased by 8% when observed from 5 m away, but that at distances of 10-25 m there was no significant effect on the amount of cover the vegetation provides. Thus Loeser et al. (2005) suggested that removal of cattle could provide some additional cover for fawn survival, however not significantly enough to warrant using this management technique for short-term benefits. Our study did not include any vegetation surveys, which prevent us from correlating vegetative cover and doe or fawn use of this exclusion area, or knowing how the plant composition differs between the grazed and ungrazed grassland.

Exclusion 3 within LCCWA contains many shrubs which could offer a lot of protection for deer, however not many deer were observed using this area. Perhaps over time, as the shrubs grow and this habitat expands, more deer will begin to utilize this area. Another area that received very little use was Exclusion 2, which contains the only riparian habitat on the property, but is also one of the smallest exclusions on LCCWA. It may be that this riparian strip is too narrow for deer to find it useful for bedding down or foraging. In addition, the ephemeral stream that runs through the corridor does not provide water year-round or even every year. In 2004 an enhancement project was proposed to pump water from a well using a windmill above this canyon. The purpose of this project was to provide water along this corridor to be able to plant additional cottonwood (*Populus* sp.) and willow (*Salix* sp.) trees for wildlife, as well as to provide drinking water for cattle and wildlife (R. Sawyer pers. comm. August 13, 2012). However, a pipeline from the well, which would have expanded the riparian habitat, has not been installed and thus the water that is being pumped is only providing a drinking water source at a nearby trough. If this project is completed and

trees or shrubs begin to grow and expand this habitat, perhaps more deer will begin to use this area.

In addition to research comparing the effect of the availability of free drinking water with deer movement, several studies have been conducted looking at the effect of weather conditions on deer numbers in California (Marshal et al. 2002, Marshal and Bleich 2011, Monteith et al. 2011). Marshal et al. (2002) and Marshal and Bleich (2011) compared the relationship of the El Niño Southern Oscillation (ENSO), rainfall, and deer population trends (utilizing deer harvest data). The ENSO is a warming of ocean surface water in the western Pacific which also affects the atmosphere causing an increase in rainfall (Marshal et al. 2002). The southern oscillation index (SOI) is used to determine the intensity of an ENSO event (Marshal and Bleich 2011), and can ultimately predict an El Niño or La Niña weather pattern. Marshal and Bleich (2011) compared the average annual rainfall for each county in California to the SOI to determine if the county's rainfall is influenced by the intensity of the ENSO, and ultimately its effect on deer harvest numbers. For Merced County, they found that average annual rainfall is influenced by the ENSO, and thus our rainfall data should follow El Niño or La Niña weather patterns. When we look at total rainfall measured by the California Department of Water Resources (2012) near LCCWA (Figure 8), years with higher rainfall totals (2004/2005 and 2009/2010) do coincide with El Niño cycles (National Weather Service, Climate Prediction Center 2012). In addition to rainfall, Marshal and Bleich (2011) also found that deer harvest within Merced County was affected by ENSO episodes and showed that there appears to be a one-year lag from the SOI. This would mean that the number of deer harvested in one year would reflect the previous year's ENSO event. When we compare our deer observations with the local rainfall totals (Figure 8), the increasing and decreasing patterns appear to follow rainfall trends fairly well, although there may be up to a two-year lag. However, due to the small amount of data we have collected, we did not analyze these trends statistically. The local deer harvest information for LCCWA closely follows a trend in the number of deer we observed annually, with six deer taken each year in 2005 and 2006, two deer taken yearly in 2007 and 2008, then no deer taken in 2009 and an increase to four deer in 2010 (California

Department of Fish and Game 2011). But again, because our data is only for the one property, a significant correlation between number of deer harvested and rainfall cannot be determined.

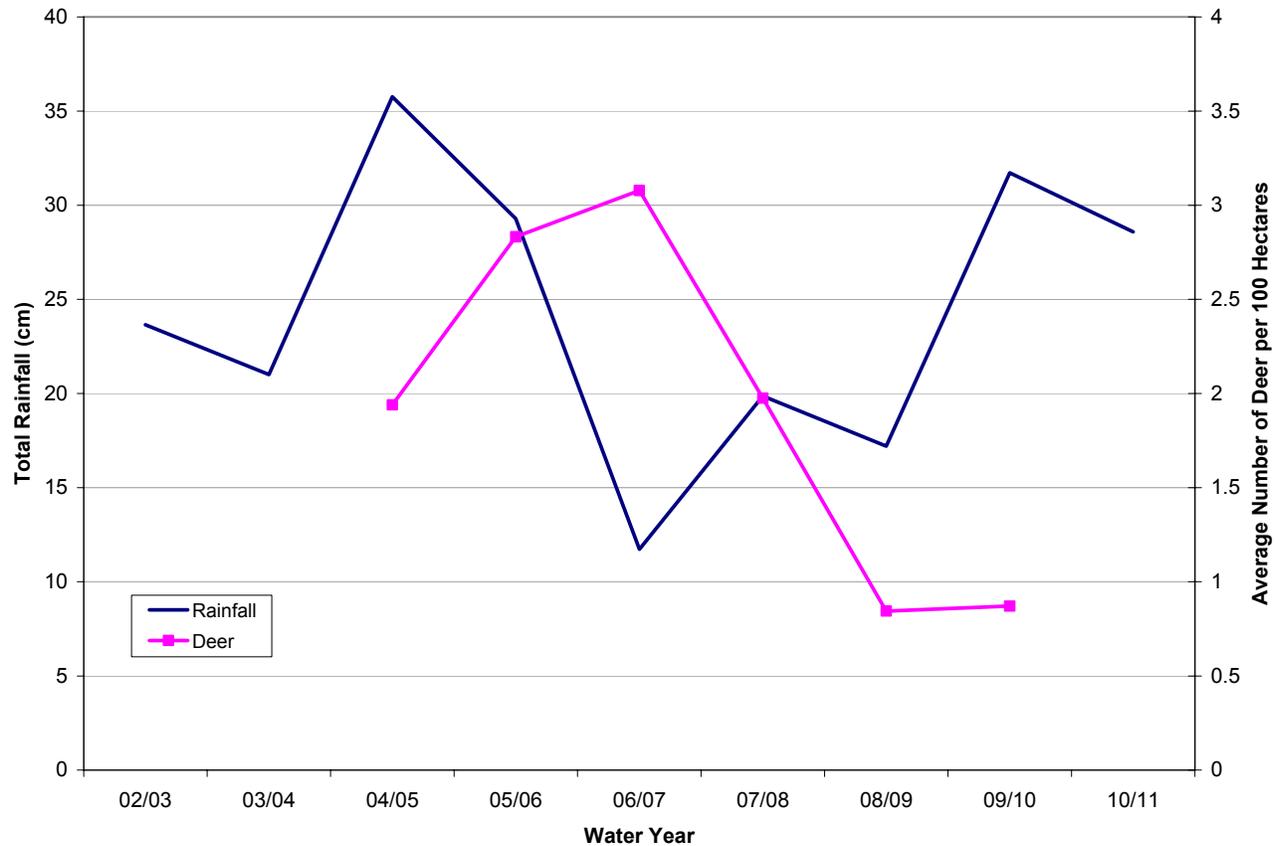


Figure 8. San Luis Reservoir precipitation totals for water years (July-June) 2002-2011 versus annual average number of deer per 100 hectares on the Lower Cottonwood Creek Wildlife Area and San Luis Reservoir State Recreation Area, 2005-2009. Deer averages were also calculated per water year.

The amount of rain influences annual plant growth, especially in arid regions, which can provide abundant forage for large herbivores during wet years and decrease plant growth in dry years, leading to more competition (Marshal et al. 2002). Cattle grazing on LCCWA may compete for forage with the local deer population, especially during low rainfall years. However, deer use on the area when cattle are also on the property does not seem to be greatly impacted. Most likely the time of year that the cattle are allowed to graze on LCCWA (October/November-January), as well as the low density of cattle, does not severely impact the amount of vegetation available to both species. By grazing during the late fall and early winter, plants would have had an

opportunity to begin growing once the rainy season began, providing plenty of forage for cattle and deer. In addition, cattle are removed from the property prior to spring, allowing the vegetation to recover during the height of the growing season. This practice provides high quality forage for pregnant does that will give birth by April. The cattle exclusion areas have also proven valuable to the deer using LCCWA, which may reduce the amount of competition with the cattle. However, without vegetation surveys throughout the property, deer use of these areas cannot be statistically correlated with cattle presence, nor can we effectively report direct competition for forage.

If the CDFW is interested in reassessing the deer population and the effectiveness of cattle grazing on LCCWA in future years, we recommend that the survey be modified to obtain more consistent data that can be statistically analyzed. For example, if a study were to resume examining deer response to continued cattle grazing, we believe it should be conducted under a more secure funding source to reduce the chance of missed surveying periods due to a lack of staff. This could also aid in having a smaller and more regular group of technicians conducting the surveys, reducing the amount of observer variation we experienced during our study. We also recommend that the project be conducted for a minimum of ten years to be able to track deer populations over several seasons and weather patterns, as well as to have a better understanding of the deer's response to cattle presence. Vegetation surveys should be included in the study in order to assess habitat response to cattle grazing, as well as to compare the effect of varying rainfall amounts. A primary goal for introducing cattle grazing on LCCWA was to reduce the amount on non-native grasses and encourage the growth of native grasses, such as purple needlegrass (*Nassella pulchra*). Although baseline vegetation surveys were not conducted prior to the introduction of cattle, subsequent vegetation sampling would aid in determining the current composition and density of grass species. Another benefit of grazing is a reduction in the amount of dry matter which can provide fuel for wildfires, a common occurrence along Highway 152. Despite the absence of concurrent surveys measuring the residual dry matter on LCCWA during this project period, there does appear to be a reduction in the number and sizes of wildfires on this property. Prior to 2002, there were wildfires in this area every summer, which continued into the first few years of grazing (R. Sawyer pers.

comm. December 13, 2012). Between 2005 and 2009, Sawyer recorded only one fire which extended onto LCCWA. In addition, fires that have begun along Highway 152 and State Parks land, which is not grazed, often do not spread far onto LCCWA. Not only could vegetation surveys such as measuring the amount of annual residual dry matter help to quantify the fuel load available for wildfires, they would also allow us to compare the foraging values between the grazed and ungrazed areas. In addition, these surveys may assist CDFW in determining if cattle grazing should occur during low rainfall years. For example, we may find that the current practice of delaying the grazing period or removing cattle completely from LCCWA following a drought year is beneficial for the annual grassland habitat and provides more forage for the deer. However, until we have data to show either the benefits or detriments of suspending grazing after a drought, we recommend that the grazing duration and intensity continue to be determined annually based upon the previous season's rainfall amounts. Because our data did show that the exclusion areas are used by deer, we believe they should remain in place and in operation. We also recommend that the water improvement project be completed to allow additional trees and shrubs to be planted and irrigated through the riparian corridor, as well as to provide wildlife with an additional drinking water source. If these enhancements occur, it could warrant a follow up study to assess if the additional habitat is being used by the local deer population.

### **Acknowledgements**

Funding for this study was provided by the California Department of Fish and Wildlife Resource Assessment Program. We would like to thank William Cook, Jr., manager of the Los Banos Wildlife Area Complex, for his interest and support of our monitoring efforts. Data collected by Justin Sloan, Christina Sousa, Linda Connolly, Lara Sparks, Kristy Benner, Matt Schaap, Melanie Bernal, Tim Edmunds, Eileen Edmunds, Tommy Grove, David Williams, Eric Scott, Melissa Odell, Kelly Leshner, and Ricardo Ortega.

## Literature Cited

- California Department of Fish and Game. 1978. Cottonwood Creek Wildlife Area. Preliminary Management Plan, Region 4. 6pp + appendices.
- California Department of Fish and Game. 2010. Rainfall data 1970-2010. Los Banos Wildlife Area unpublished data, Los Banos.
- California Department of Fish and Game. 2011. Lower Cottonwood Creek Wildlife Area public use data 2005-2010. Los Banos Wildlife Area unpublished data, Los Banos.
- California Department of Fish and Game. 2012. Pacheco deer herd composition counts, 1961-1995. Unpublished raw data, Los Banos.
- California Department of Water Resources. 2012. San Luis Reservoir rainfall data 2000-2011. San Luis Field Division unpublished data, Gustine.
- Bowyer, R. T. 1984. Sexual segregation in southern mule deer. *Journal of Mammology* 65(3):410-417.
- Bowyer, R. T., and V. C. Bleich. 1984. Effects of cattle grazing on selected habitats of southern mule deer. *California Fish and Game* 70(4):240-247.
- Kie, J. G., and B. B. Boroski. 1995. Using spotlight counts to estimate mule deer population size and trends. *California Fish and Game* 81(2):55-70.
- Kie, J. G., C. J. Evans, E. R. Loft, and J. W. Menke. 1991. Foraging behavior by mule deer: the influence of cattle grazing. *Journal of Wildlife Management* 55(4):665-674.
- Loeser, M. R., S. D. Mezulis, T. D. Sisk, and T. D. Theimer. 2005. Vegetative Cover and Forb Responses to Cattle Exclusion: Implications for Pronghorn. *Rangeland Ecology and Management* 58(3):234-238.
- Loft, E. R., J. W. Menke, and J. G. Kie. 1991. Habitat shifts by mule deer: the influence of cattle grazing. *Journal of Wildlife Management* 55(1):16-26.
- Marshal, J. P., and V. C. Bleich. 2011. Evidence of relationships between El Niño Southern Oscillation and mule deer harvest in California. *California Fish and Game* 97(2):84-97.
- Marshal, J. P., P. R. Krausman, V. C. Bleich, W. B. Ballard, and J. S. McKeever. 2002. Rainfall, El Niño, and Dynamics of Mule Deer in the Sonoran Desert, California. *Journal of Wildlife Management* 66(4):1283-1289.

Monteith, K. L., V. C. Bleich, T. R. Stephenson, B. M. Pierce, M. M. Conner, R. W. Klaver, and R. T. Bowyer. 2011. Timing of seasonal migration in mule deer: effects of climate, plant phenology, and life-history characteristics. *Ecosphere* 2(4):article 47. 34pp.

National Weather Service, Climate Prediction Center. [Online]. 2012. Historical El Nino/ La Nina episodes (1950-present). <[http://www.cpc.ncep.noaa.gov/products/analysis\\_monitoring/ensostuff/ensoyears.shtml](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml)>. Accessed June 19, 2012.

Smith, J. T. 1983. Management Plan for the Merced County Portion of the Pacheco Deer Herd. California Department of Fish and Game. 23pp + appendices.

### **Personal Communications**

William Cook, Jr. 2011. Wildlife Habitat Supervisor II. California Department of Fish and Game, Los Banos.

Randall Sawyer. 2012. Wildlife Habitat Assistant. California Department of Fish and Game, Los Banos.

**Appendix A.** Incidental mammal species<sup>1</sup> detected during the Lower Cottonwood Creek Wildlife Area deer surveys, May 2005-December 2009.

Bat

Unknown sp.

Desert Cottontail

*Sylvilagus audubonii*

Black-tailed Jackrabbit

*Lepus californicus*

Coyote

*Canus latrans*

Red Fox

*Vulpes vulpes*

Northern Raccoon

*Procyon lotor*

Long-tailed Weasel

*Mustela frenata*

American Badger

*Taxidea taxus*

Western Spotted Skunk

*Spilogale gracilis*

Striped Skunk

*Mephitis mephitis*

Feral Cat

*Felis catus*

Bobcat

*Lynx rufus*

Feral Pig

*Sus scrofa*

Tule Elk

*Cervus canadensis nannodes*

---

<sup>1</sup>The taxonomy for mammals follows:

Baker, R. J., L. C. Bradley, R. D. Bradley, J. W. Dragoo, M. D. Engstrom, R. Hoffman, C. A. Jones, F. Reid, D. W. Rice, and C. Jones. 2003. Revised Checklist of North American Mammals North of Mexico, 2003. Museum of Texas Tech University Occasional Papers 229:1-23.