Monitoring and Adaptive Management of Burrowing Owl on Conserved Lands in Southern San Diego County

TASK C: EFFICACY OF HABITAT ENHANCEMENT

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Section 1. Executive summary

The Multiple Species Conservation Program has prioritized the Western Burrowing Owl (*Athene cunicularia hypugaea*) as one of 11 animal species at the highest risk of extinction in San Diego County (Regan et al. 2008). Burrowing owls are also listed as a Species of Special Concern by the State of California (Shuford and Gardali 2008). In San Diego, records indicate that burrowing owls previously inhabited a higher number of locations in the county than are currently occupied (Unitt 2004). Population declines and local extinctions have been recorded through surveys in southern and coastal locations undergoing urbanization (Gervais et al. 2008). Some local declines in California have not been considered important because of the presence of a very large source population of burrowing owls in the Imperial Valley, estimated at 5,600 pairs in 1992-1993 (DeSante et al. 2004). However, this population is currently declining for unknown reasons. Population size was estimated at 4900 in 2007 but only 3600 in 2008 (Manning 2009). Subsequent surveys indicate the decline has continued (D. Deutschman and J. Simonsen-Marchant, unpublished data). Local population declines have also been reported in locations elsewhere in the United States (Desmond et al. 2000).

The factors that are potentially responsible for declines in burrowing owl population size include reductions in habitat area and changes to habitat quality. Burrowing owl habitat in southern California has been reduced by urban development, exotic species invasions, and increases in fire frequency. In San Diego County, much native species habitat has been lost to urbanization and the building of housing, buildings, and roads. In addition, native grasslands have been converted to exotic annual grasslands dominated by species such as wild oat (*Avena fatua*) and brome (*Bromus diandrus*, *Bromus madritensis*). These invaders have been present in California for more than a century and are key species in the widespread type conversion of native (often perennial) grasslands to exotic annual grasslands (D' Antonio et al. 2007).

The purpose of this study is to develop habitat enhancement techniques for re-establishing and maintaining low, open grassland habitat for owls. For owls, low vegetation makes locating and capturing rodents easier. It also increases the odds that burrowing owls will detect predators before they strike. The study will also focus on increasing burrow availability by increasing the presence of the burrowing mammal most important to burrowing owls in the San Diego region, the California ground squirrel (*Spermophilus beecheyi*). The presence of burrows available for occupancy may be an important factor for burrowing owl populations (Moulton et al. 2006). In addition to creating burrows, squirrels cut grass and forb stems during their normal foraging activity, and they trample the vegetation enough to keep the vegetation community lower and more open than it would be otherwise (Fitch 1948).

Much of the significance of this study is in its focus on the reestablishment of the California ground squirrel as an ecosystem engineer that supports burrowing owls through its burrowing and foraging activities. Therefore, we need to take the habitat requirements of squirrels into account. The effects on the California ground squirrel of type conversion to exotic annual grasslands are largely unstudied; however, forage for squirrels may be impacted by the abundance of native plants and seeds relative to exotic species. Thick thatch may impede foraging and burrow digging activities. Dense ground cover may also reduce the ability of California ground squirrels to visually detect predators. The habitat enhancement treatments in this study are designed to reduce vegetation density and the amount of thatch cover on the soil surface. We will assess whether California ground squirrel persistence and burrowing activity is higher after the vegetation treatments. Since California ground squirrels alter vegetation structure through foraging activities, we also expect that in locations with greater squirrel activity, vegetation density and thatch cover will remain lower and bare ground cover will remain higher. The study design includes an examination of this positive feedback of squirrel activity on vegetation structure.

Soils also play a role in the success of habitat enhancement treatments. Higher levels of soil compaction may be associated with lower levels of burrowing activity. Many grasslands in San Diego County have previously been used for agriculture, grazing, and other activities that compact the soil, and we hypothesize that more compacted soils are less suitable for burrowing. Therefore the habitat enhancement treatments include a soil decompaction treatment.

The habitat enhancement treatments are designed to manipulate habitat structure, soil compaction, and squirrel presence in order to enable examination of the relationships between these variables. The purpose of these treatments is to contribute to the development of a protocol to produce self-sustaining squirrel populations after a onetime implementation by land managers, as a first step in re-establishing burrowing owl populations. One drawback of habitat enhancement is that it incurs costs of money and time, and if the treatment needs to be repeated periodically, future expenditures must be planned. Therefore, an important goal for habitat enhancement is to establish populations that sustain themselves in the long-term as wild populations.

This document has been written to satisfy the reporting requirements for Task C, and reports on the completion of tasks assessing the efficacy of the habitat enhancement experiment.

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Section 2. Methods

Plot establishment

The site selection rules were designed to include locations with an existing plant community of native or exotic grassland. Sites were established on a range of soil types; however, soil consisting of dense and heavy material such as clay may not be suitable for burrowing. Also, squirrels are not strong enough to move rocks and cobbles out of the way. For these reasons the Diablo clay soil type was excluded as unsuitable for burrowing activity. We established 7 pairs of plots across the three study sites to allow us to account for variation due to site. The proposal called for up to 9 pairs of plots, but the number was reduced due to space constraints and management restrictions such as established buffer zones around breeding bird nests and cultural sites. The plots were paired for vegetation community, soil type, slope, and aspect. West-facing aspects were avoided due to concerns that the stronger afternoon heat of these sites may limit squirrel activity. The plots were spaced to maintain a distance of at least 75 m between plots in a pair, and at least 300 m between different pairs.

Plot size and layout

The circular plots are 100 m in diameter, with an area of 7854 m^2 (1.94 acres). Each circle is divided evenly into three wedges on the compass bearings of 0, 120, and 240 degrees. Each wedge encompasses 2618 m^2 (0.65 acres) and is considered an experimental subplot. The wedges of each plot have been treated with two treatments (mowing, mowing plus decompaction), as well as a control treatment. In each pair of plots, one plot received the squirrel translocation treatment, and the other plot did not (Figure 1). The paired plot design allows us to separate the direct effects of vegetation manipulation from the ecosystem engineering effects of ground squirrels.

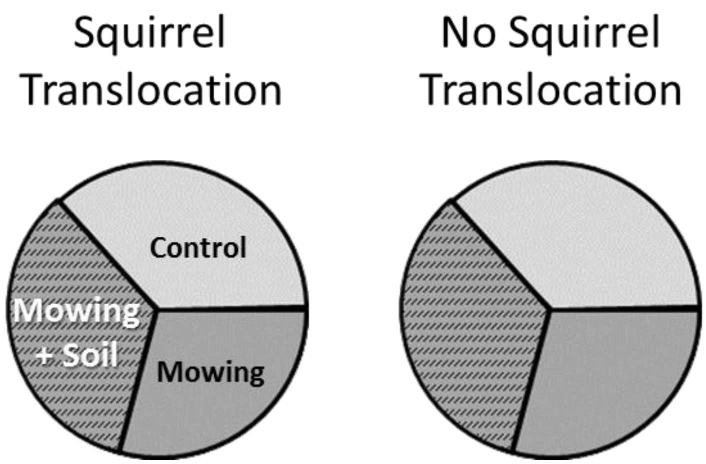


Figure 1. Paired design of the habitat enhancement/squirrel translocation experiment.

Treatment methods

Treatment 1: Mowing and thatch removal. Mowing and thatch removal was conducted without motorized equipment to minimize soil compaction and surface disturbance. Vegetation treatments occurred in May, at the end of the growing season for annual grasses but before grasses were dried out. Vegetation was mowed to a height of 7.5 – 15 cm using handheld weed-whackers, and the resulting thatch was raked and removed from the site. There was no soil disturbance from mowing or thatch removal.

Treatment 2: Mowing, thatch removal, and soil decompaction. The mowing and thatch removal for treatment 2 were the same as above. Soil decompaction was conducted with a one-person handheld auger fit with a 6 in. auger bit. The target result was a hole 0.3 m deep on a 45 degree angle into the ground, with some variation due to soil compaction and rockiness. Twenty holes were drilled per wedge to produce a density of one hole every 10 m^2, evenly distributed across the wedge.

Plot orientation: In most plots, the treatments were assigned as follows: treatment 1 (0-120 degrees), treatment 2 (120-240 degrees), and control (240-360 degrees). On plots adjacent to a feature such as a riparian strip or an archaeological site, the control plot (no mowing or soil decompaction) was located on the side nearest the feature, to minimize disturbance. The only plot that this rule applied to was SWTR5C, where the control was assigned to the 0-120 degree wedge, treatment 1 was assigned to the 120-240 degree wedge, and treatment 2 was assigned to the 240-360 degree wedge.

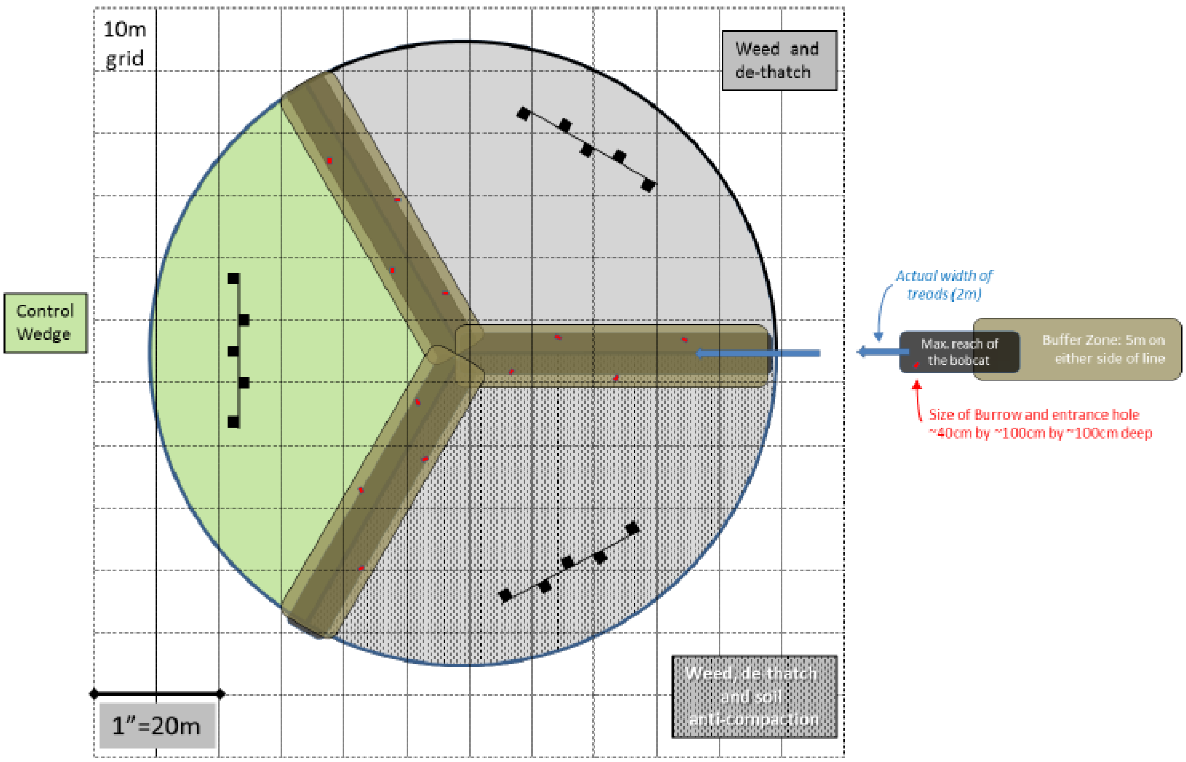


Figure 2. Scaled diagram of plot layout. The burrows were located along the strips dividing each treatment. Gray shading indicates both the footprint of the mechanized equipment used to install the burrows and the furthest reach of the digging arm. Burrows are denoted with red symbols that approximate the size of the burrow footprint. Vegetation transects are shown as a black line with squares that represent 1 m^2 quadrat locations.

Assessment methods

A pretreatment vegetation structure assessment was conducted in all wedges of each plot. The post-treatment habitat assessment was conducted once, after both the vegetation and squirrel translocation treatments had occurred. Assessments consisted of both qualitative (photopoints) and quantitative methods.

Vegetation cover and composition

For each treatment wedge, a 25 m transect was established (Figure 2). We collected point count data by reading 50 points per transect, one each 0.5 m. We recorded all species touching the point, and characterized the ground surface (bare ground, rock, litter, fine woody debris, etc).

For each transect, we also conducted five ocular estimates of cover utilizing a 1 m^2 quadrat. Cover estimates were by cover type (ie. bare, rock, fine woody debris) to characterize the ground surface, and totaled 100% per quadrat. We also estimated cover by species to characterize the plant community. The species data was intended to record all species in the quadrat. Species cover values represent the canopy cover of each species, and may add to greater or less than 100% cover per quadrat. These sampling methods characterized plant cover by invasive plant status (native versus non-native) and functional group (shrub, grass, forb), and assessed bare ground and thatch cover.

Vertical Structure

Vertical structure was assessed using a Robel pole vertical obstruction method, to a height of 1 m (Herrick et al. 2005). Vertical structure measures habitat structure in terms of height and homogeneity of vegetation cover, which provides information about habitat suitability for wildlife.

The Robel pole was placed at three points along the transect in each treatment wedge (at 5, 12, and 19 m). Two observations were read at each position from a distance of 5 m. The pole is divided into ten segments that are 10 cm long, plus another level of subdivision into 5 cm bands. The data sheet is recorded for the presence/absence (1/0) of visual obstruction at each band. A band is counted as obstructed if 25% or more of the band is obstructed (by vegetation, rock, woody debris, etc.)

Burrowing Activity

Observers walked a grid pattern through each wedge and recorded California ground squirrel activity. Burrows with an opening of at least 7 cm at the point of maximum diameter were recorded as probable California ground squirrel burrows. Burrow locations were marked with GPS, and the size and shape of both the burrow entrance and the burrow apron were recorded. If scat was found around the burrow or on the apron, it was identified to species and recorded. The condition of the burrow entrance (i.e. clear, cobwebbed, collapsed) was recorded, as well as other field notes about burrow condition and use.

Several areas of ground squirrel foraging and digging activity were identified by shallow scratches in the soil and by scat. These were recorded either as GPS points or polygons, depending on extent.

References

Herrick, J. E., J. W. Van Zee, K. M. Havstad, L. M. Burkett, and W. G. Whitford. 2005. Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems. USDA-ARS Jornada Experimental Range, Las Cruces, New Mexico.

Section 3. Study sites and plot locations

Study sites

The study is being conducted on three sites in southern San Diego County. Rancho Jamul Ecological Reserve is managed by the California Department of Fish and Game for sensitive habitat and species conservation. It consists of former agricultural fields and pasture on sandy loam soils. The current plant community primarily consists of non-native grasslands, riparian habitat, and coastal sage scrub on slopes (Figure 3).

The 164 acre Lonestar Ridge West parcel on Otay Mesa is owned by the California Department of Transportation (Caltrans) and is managed for species habitat (San Diego fairy shrimp, Quino checkerspot butterfly, burrowing owl, and sensitive plant species). The site currently consists primarily of non-native grassland, with small areas of coastal sage scrub, disturbed vernal pool wetlands, and eucalyptus woodlands on gravelly clay loam soils, but restoration activities are ongoing (Figure 4).

The San Diego-Sweetwater National Wildlife Refuge is managed by the U.S. Fish and Wildlife Service for sensitive habitat and species conservation. Primary management activities include exotic species removal and the restoration of vernal pools and coastal sage scrub. The current plant community consists of native and exotic grassland species and coastal sage scrub. Soils are silt loam, with cobbles (Figure 5).

Plot nomenclature and location data

Site codes were assigned to denote whether plots were located at Rancho Jamul (RJER), Sweetwater (SWTR), or Otay Mesa (OTAY). The plots are labeled with a unique numeral, plus a letter denoting which of the paired plots was the control (C, "Control") or the squirrel translocation (G, "Ground squirrel") plot. The GPS information needed to locate the plots is presented in Table 1.

Table 1. Final plot locations (Coordinate system WGS 84)

Site	Plot	X Coordinate	Y Coordinate
RJER	1C	-116.8632070	32.6951596
	1G	-116.8640860	32.6965543
	2C	-116.8701832	32.6938240
	2G	-116.8703999	32.6958499
	3C	-116.8661811	32.6845262
	3G	-116.8654600	32.6832400
SWTR	5C	-116.9679560	32.6936797
	5G	-116.9675031	32.6947163
	6C	-116.9849724	32.6872751
	6G	-116.9864816	32.6873812
OTAY	8C	-116.9674745	32.5764402
	8G	-116.9653895	32.5766168
	9C	-116.9661466	32.5829479
	9G	-116.9704641	32.5819183

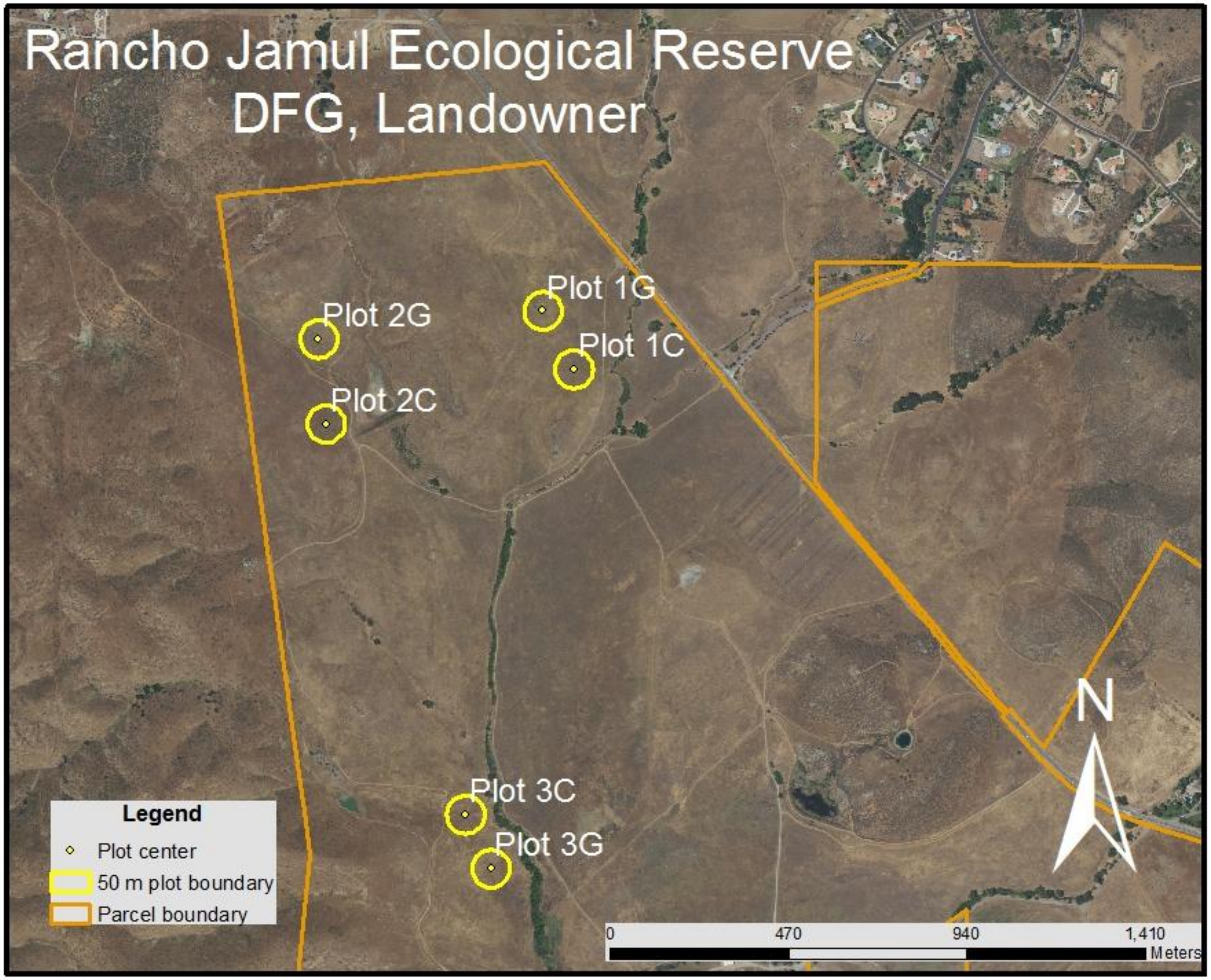


Figure 3. Map of plot locations at Rancho Jamul Ecological Reserve (RJER). Yellow circles represent plot boundaries and are scaled to show the extent of the 50 m plot radius.

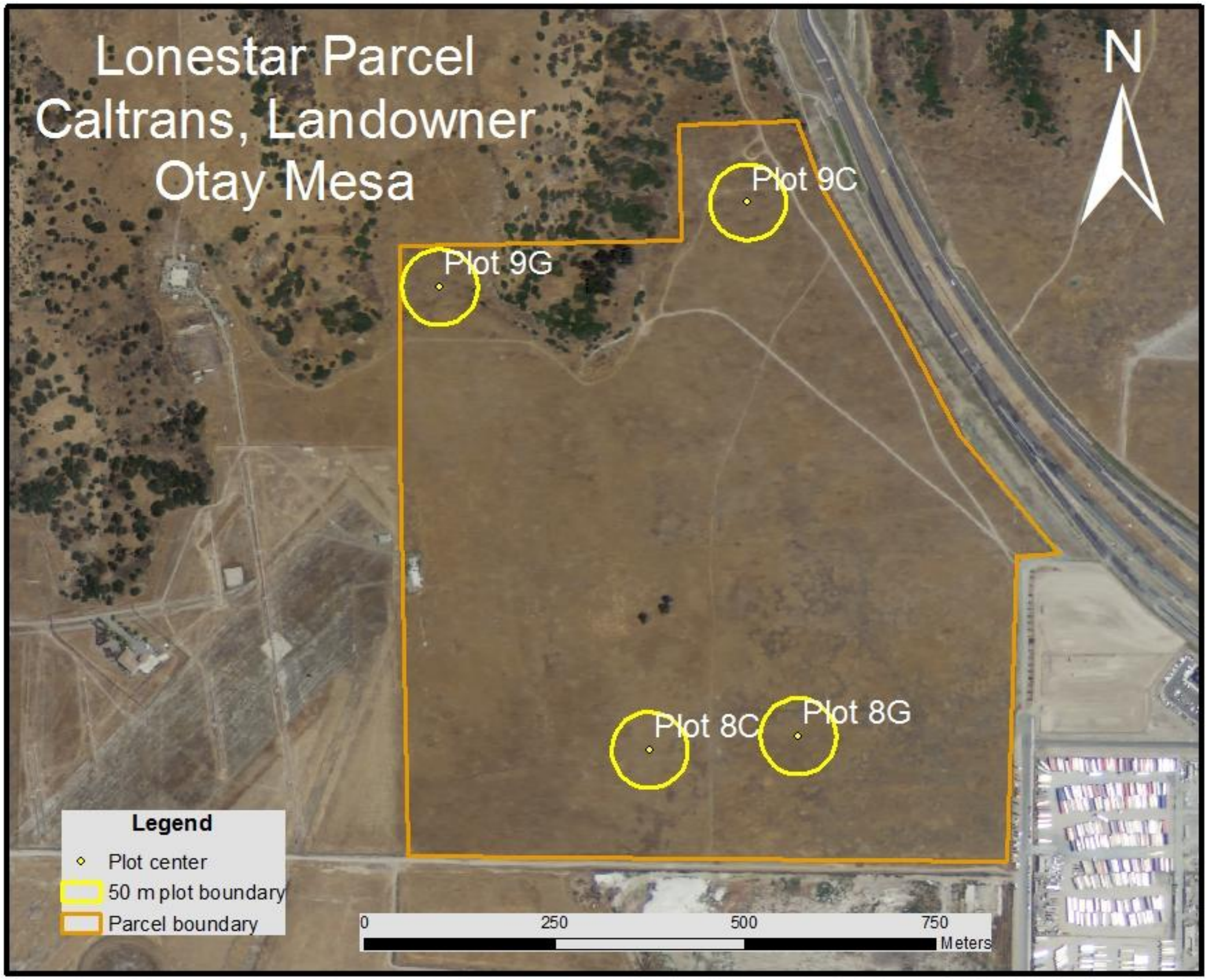


Figure 4. Map of plot locations at the Lonestar Parcel, Otay Mesa (OTAY)

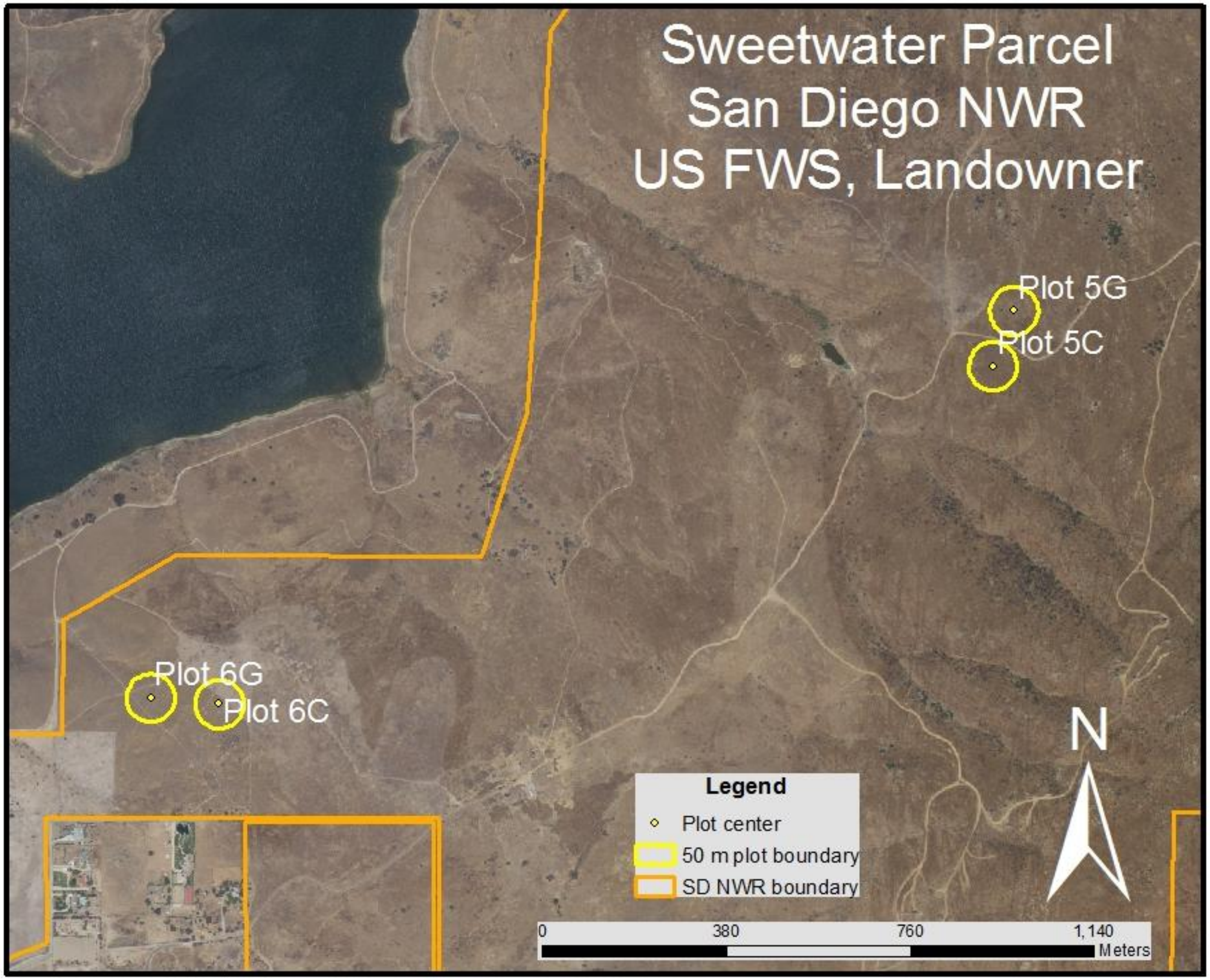


Figure 5. Map of plot locations at Sweetwater, San Diego National Wildlife Refuge (SWTR)

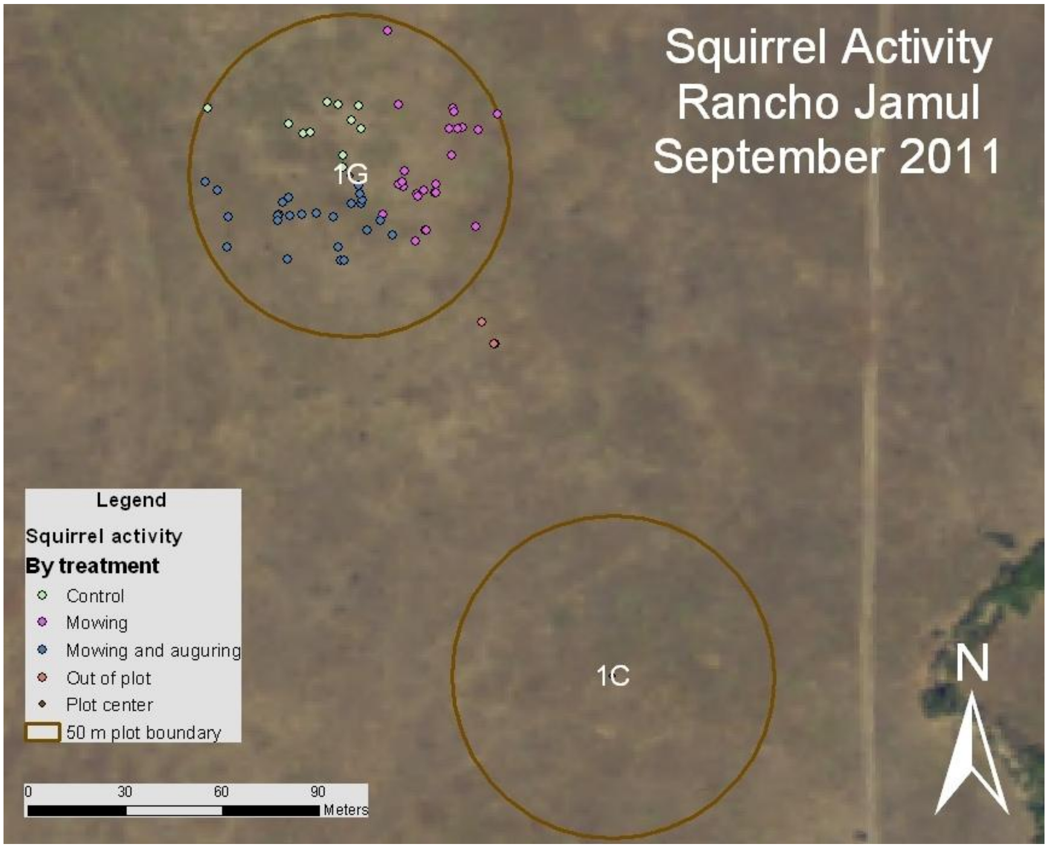
Section 4. Habitat Enhancement Completed Tasks Timeline

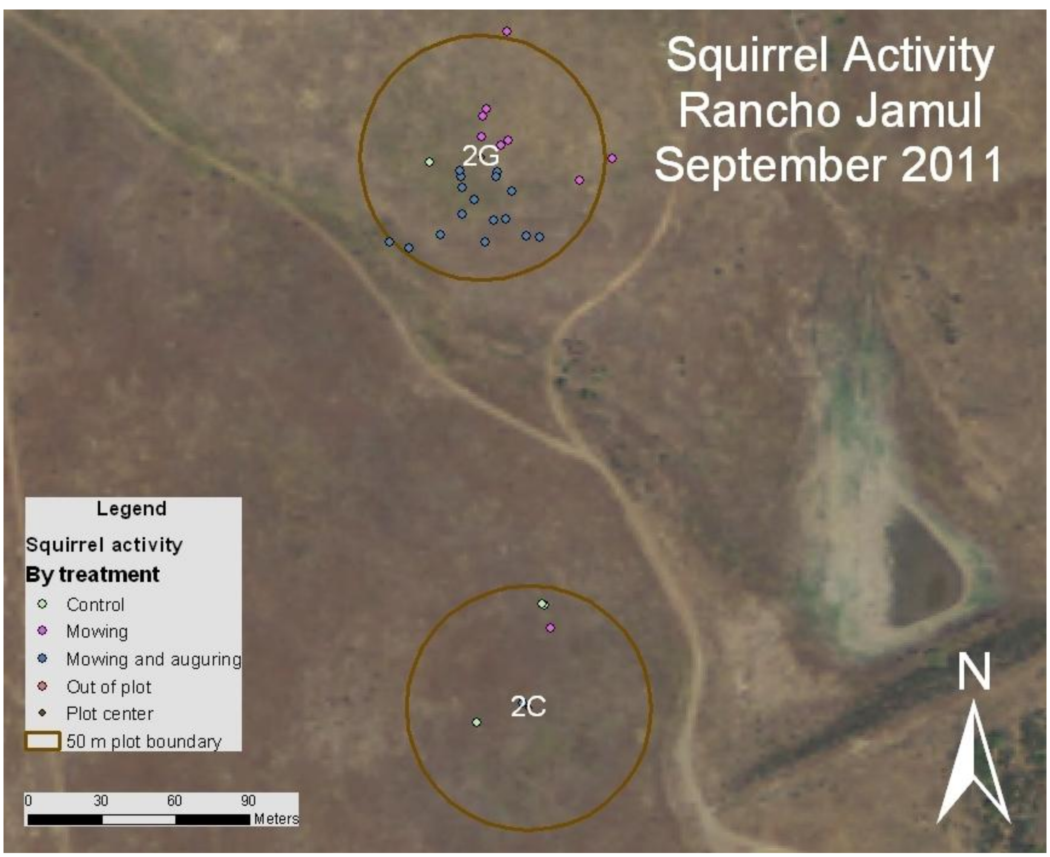
Tasks were conducted between March and September 2011.

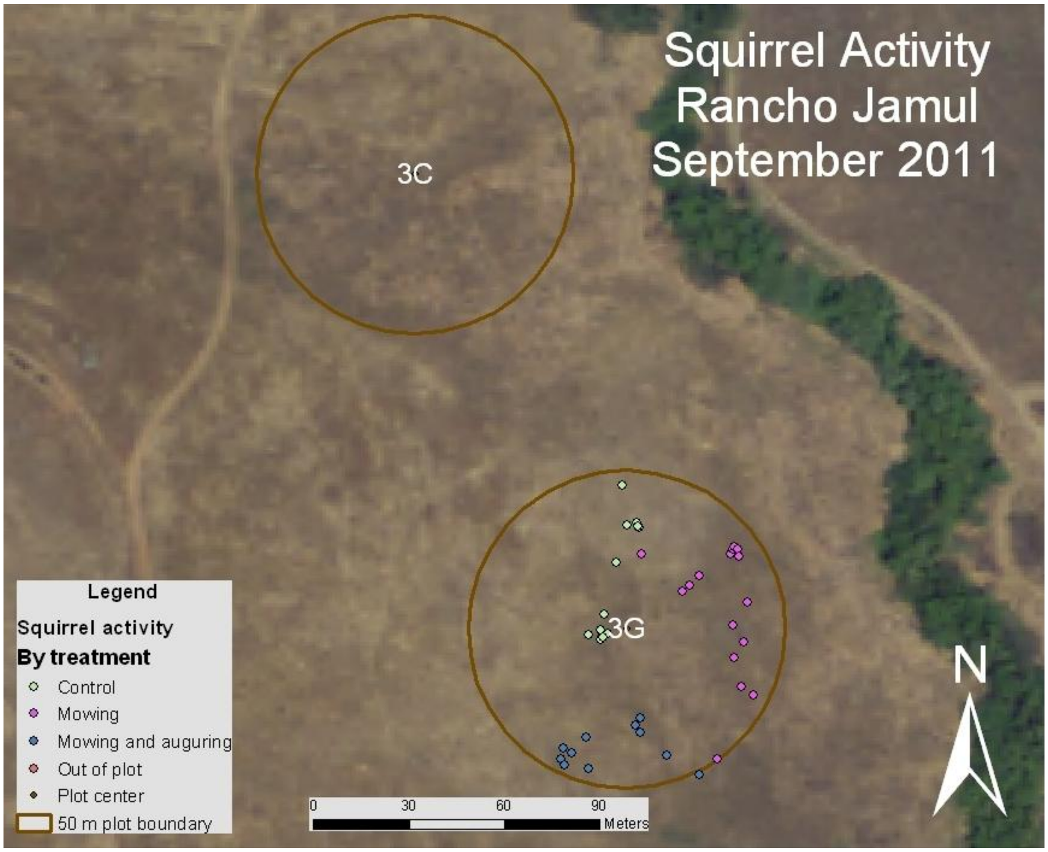
Table 2. Timeline of completed habitat enhancement tasks

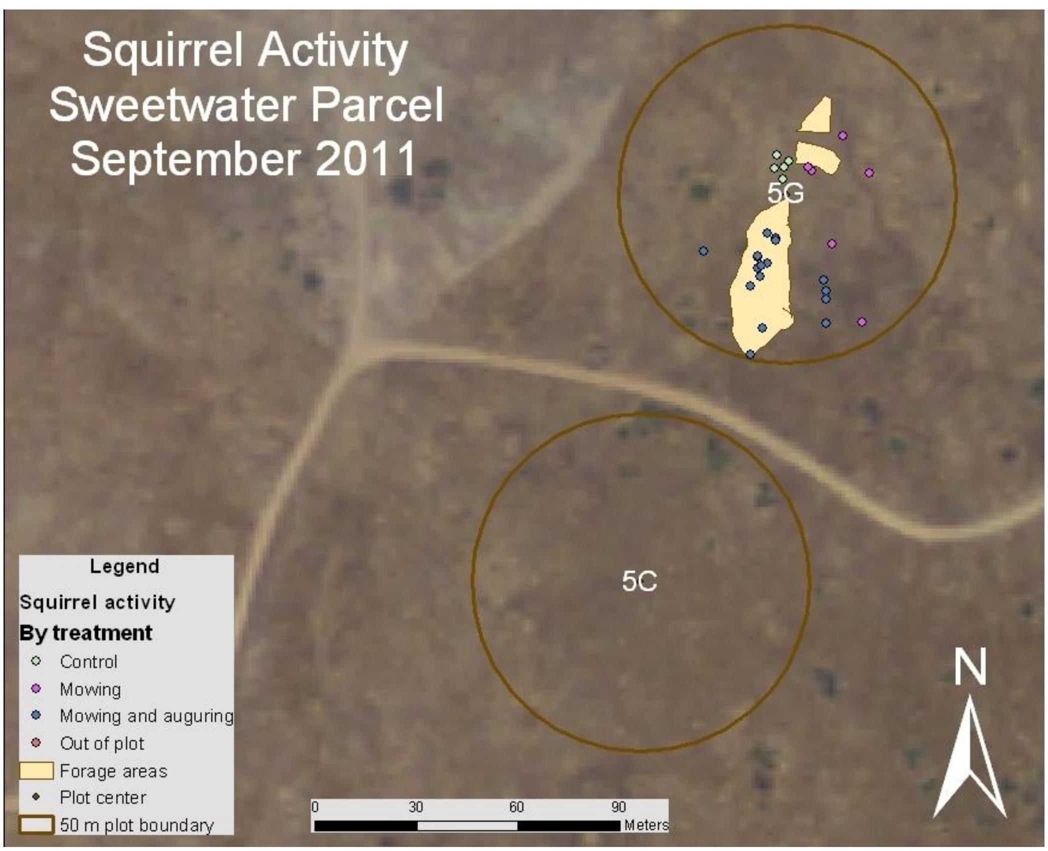
Dates	Site	Task
March 8 – May 9	All	Site selection and plot establishment
May 10 – 11	All	Pretreatment photopoints
April 19 – April 25 April 28 – May 3 April 29 – May 2	RJER OTAY SWTR	Pre-treatment vegetation assessment
May 10 – May 20 May 23 – May 31 June 1 - June 9	RJER OTAY SWTR	Vegetation manipulation
July 18 – 19	All	Post-treatment photopoints
August 1 August 5 August 15	SWTR OTAY RJER	Post-treatment vegetation assessment
September 14 - 19	All	Post-treatment squirrel activity assessment

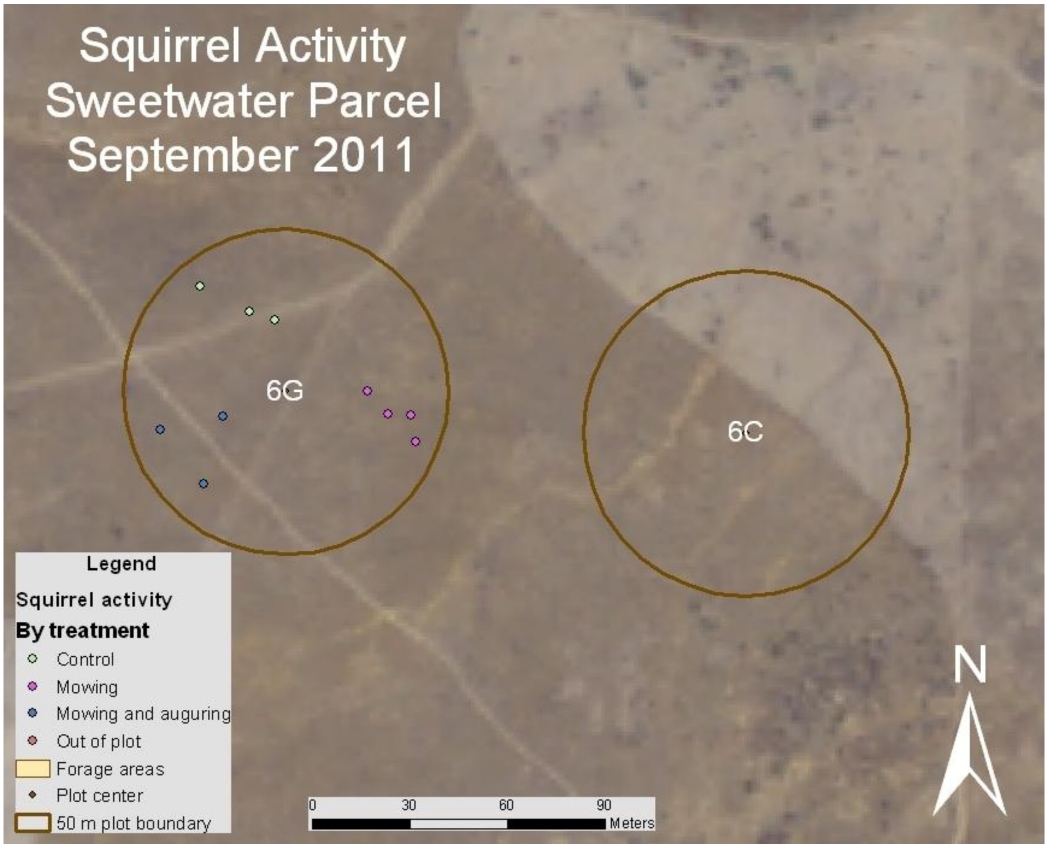
Section 5. Burrowing Activity

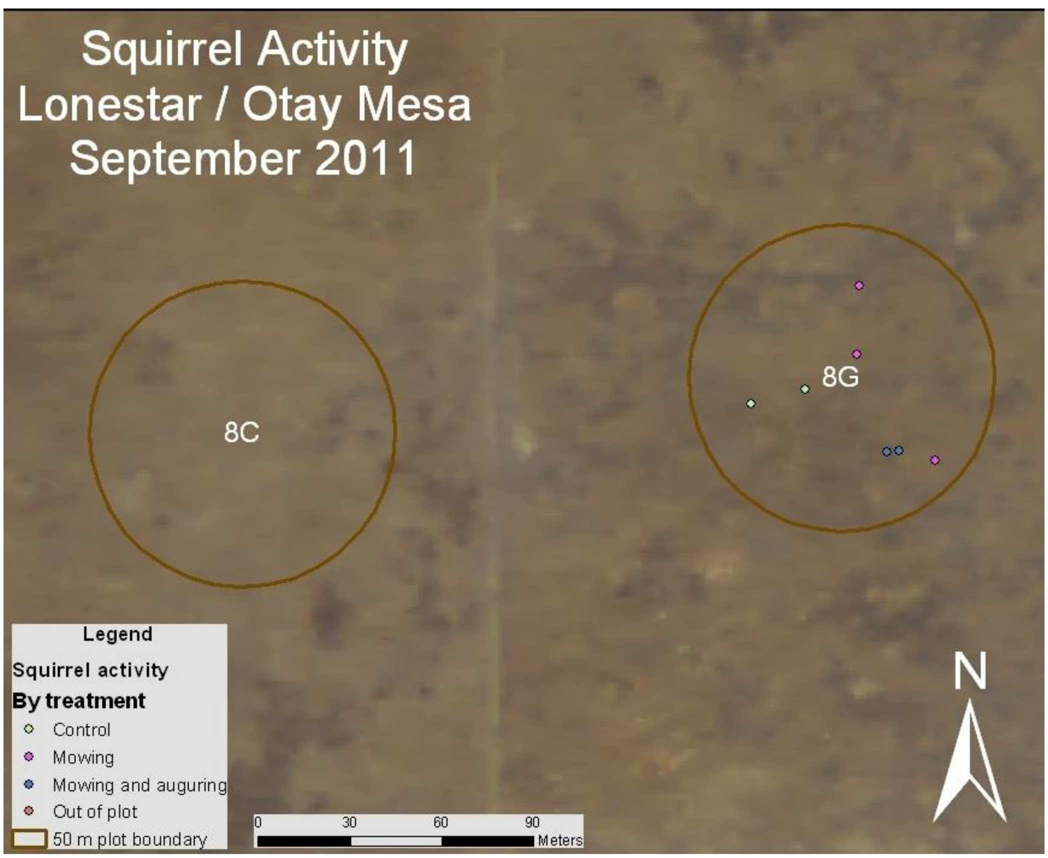

Squirrel Activity
Rancho Jamul
September 2011
1G
1C
Legend
Squirrel activity
By treatment
Control
Mowing
Mowing and auguring
Out of plot
Plot center
50 m plot boundary
0 30 60 90
Meters
N

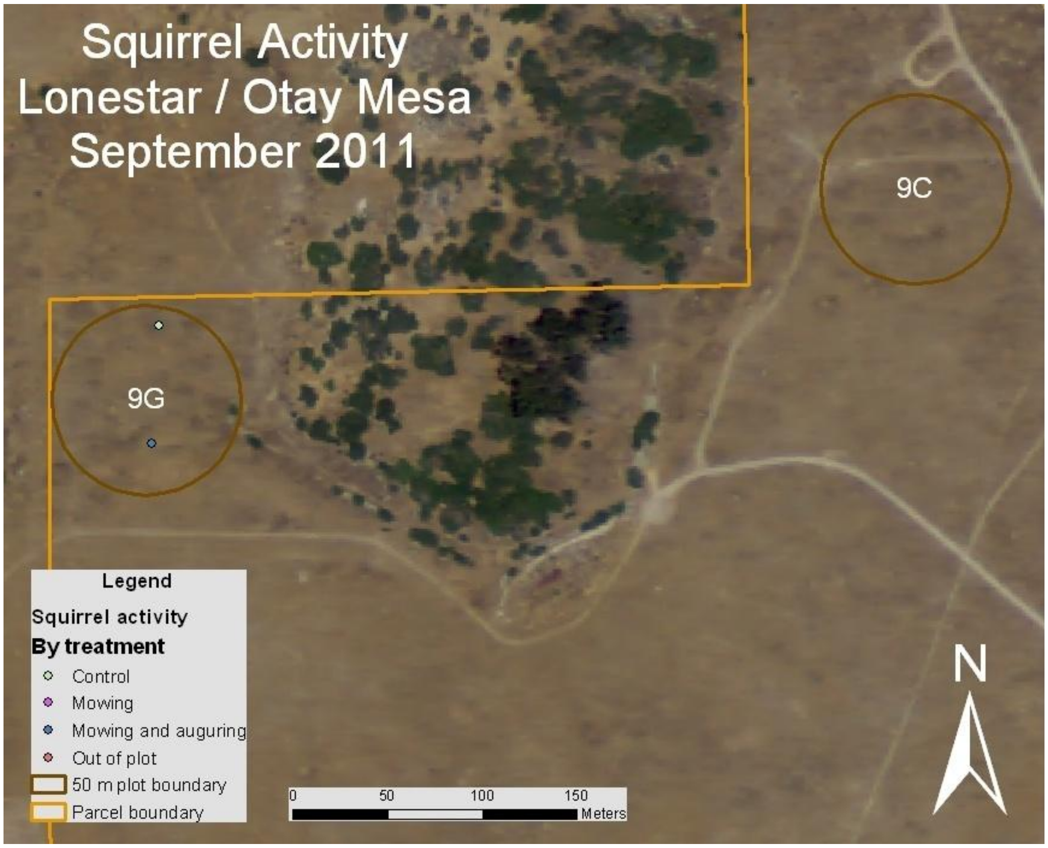

Squirrel Activity
Rancho Jamul
September 2011
2G
2C
Legend
Squirrel activity
By treatment
Control
Mowing
Mowing and auguring
Out of plot
Plot center
50 m plot boundary
0 30 60 90
Meters
N


Squirrel Activity
Rancho Jamul
September 2011
3C
3G
Legend
Squirrel activity
By treatment
Control
Mowing
Mowing and auguring
Out of plot
Plot center
50 m plot boundary
0 30 60 90
Meters
N


Squirrel Activity
Sweetwater Parcel
September 2011
5G
5C
Legend
Squirrel activity
By treatment
Control
Mowing
Mowing and auguring
Out of plot
Forage areas
Plot center
50 m plot boundary
0 30 60 90
Meters
N


Squirrel Activity
Sweetwater Parcel
September 2011
6G
6C
Legend
Squirrel activity
By treatment
Control
Mowing
Mowing and auguring
Out of plot
Forage areas
Plot center
50 m plot boundary
0
30
60
90
Meters
N


Squirrel Activity
Lonestar / Otay Mesa
September 2011
8C
8G
Legend
Squirrel activity
By treatment
Control
Mowing
Mowing and auguring
Out of plot
50 m plot boundary
0
30
60
90
Meters
N


Squirrel Activity
Lonestar / Otay Mesa
September 2011
9C
9G
Legend
Squirrel activity
By treatment
Control
Mowing
Mowing and auguring
Out of plot
50 m plot boundary
Parcel boundary
0
50
100
150
Meters
N

Section 6. Datasheets