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

TASK E: FINAL FIELD ASSESSMENTS

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Section 1. Executive summary

During the 2014 field season we conducted the final round of field data collection. None of the plots received further vegetation treatments or squirrel translocations in 2014. This document has been written to satisfy the reporting requirements for Task E, and reports on the completion of tasks carrying out the final round of field data collection.

Section 2. Introduction

Although the Western Burrowing Owl (*Athene cunicularia hypugaea*) is a widespread species that shows tolerance towards human disturbances, observations of population decline across its range have been published in the past 15 years (Sheffield 1997, Desmond et al. 2000, Poulin et al. 2005). In California, burrowing owl population declines and local extinctions have been recorded in southern and coastal locations undergoing urbanization (Gervais et al. 2008). In San Diego County, historical and recent surveys indicate that the number of occupied burrowing owl colonies is also declining (Unitt 2004). Some local declines in California have not been considered important because of the presence of a large source population of burrowing owls in the Imperial Valley, estimated at 5,600 pairs in 1992-1993 (DeSante et al. 2004). The burrowing owl is listed as a Species of Special Concern in California (a status that lacks protective measures), and is unlikely to be granted a higher priority status due to the Imperial Valley population. However, this source population is also currently declining for unknown reasons. A 28% decline was observed between 2007 and 2008 (Manning 2009), and a subsequent survey indicated a second year of decline (D. Deutschman, unpublished data). Managers in southern California have concerns about these warning signs, and there is interest in developing conservation strategies for the species at the regional level.

Three factors should be considered to be the ultimate underlying causes of burrowing owl population decline in southern California. Reduction in habitat area is the first factor, caused by urban development and invasion of grasslands by exotic annual grasses. In San Diego County, native species habitat has been lost to urbanization and the construction of housing, buildings, and roads (Gervais et al. 2008). The second factor is changes in habitat composition and structure. Native grasslands have been converted to exotic annual grass species, such as wild oat (*Avena fatua*) and brome (*Bromus diandrus*, *Bromus madritensis*), which are key invasive species that have been present in California for more than a century (D' Antonio et al. 2007). These species create taller and denser layers of vegetation and thatch which impede owl foraging and predator detection. The third factor is changes in the distribution and abundance of the fossorial mammal, California Ground Squirrel (*Otospermophilus beecheyi*), that produces burrows for burrowing owls. Ground squirrels are an important key to establishing self-sustaining burrowing owl populations in southern California, but squirrels were historically- and still are currently- widely perceived as pests that damage crops and need to be controlled (Marsh 1998). Squirrels have been targeted by control efforts and have been eradicated in many locations (Lenihan 2007).

The intent of this study is to design a method for restoring burrowing owl habitat through re-establishing key ecological processes (George and Zack 2001). It will focus on the California ground squirrel as an ecosystem engineer responsible for creating burrows and maintaining the low, open vegetation structure preferred by owls (Green and Anthony 1989). The presence of burrows available for occupancy is an important factor for owl habitat selection, and research has shown that burrowing owls respond positively to the placement of artificial burrows in relocation and site restoration projects (Trulio 1995, Smith and Belthoff 2001, Belthoff and Smith 2003, Smith et al. 2005). However, there are disadvantages to the use of artificial burrows, in that they require periodic maintenance and replacement, and have the effect of acclimating owls to artificial conditions in locations that may not otherwise provide appropriate habitat. The intent of this project is to develop an alternative method of increasing burrow availability by avoiding the use of man-made structures and increasing the presence of burrowing mammals.

In addition to the creation of burrows, squirrels cut and trample grass and forb stems during their normal foraging activity, and there have been qualitative observations that their activity maintains a lower and more open vegetation community (Fitch 1948). For owls, low vegetation makes detection of predators and prey easier. Squirrel effects on vegetation structure are important because of the widespread invasion of exotic annual grass and forb species into California grasslands. Exotic grasses grow quickly after winter and spring rains, competing with native grass species for soil nutrients, moisture, and space. They die and then dry out completely as daytime temperatures increase from spring to the summer season. The aboveground plant material produced is tall and dense, and as it dries out it piles up on the ground in a thick layer of thatch (Corbin and D'Antonio 2004).

Currently, ground squirrels are more likely to be found occupying the margins, rather than the interior, of grasslands with mixed native and exotic species composition, suggesting that some component of the habitat is not suitable. The shift in vegetation composition from historic conditions suggests that vegetation structure could be the driving factor. Dense ground cover may reduce the ability of ground squirrels to move around and to visually detect predators. Thick thatch may impede foraging and burrow digging activities. However, the effects of exotic annual grass and forb species on the California ground squirrel are largely unstudied.

One component of the restoration plan should be the reduction of current vegetation height and thatch depth. Mowing can realistically be conducted at the spatial scale needed to create adequate amounts of habitat for both burrowing owls and squirrels. Most owl foraging activities are concentrated to within about 600 m of the burrow (Haug and Oliphant 1990, Gervais et al. 2003), and it is feasible to mow at this scale. It should be anticipated that mowing could influence the balance between native and exotic grass species, but most grasslands are already highly invaded by exotic annual species.

Altering vegetation structure does not guarantee squirrels will colonize the site. It is possible that nearby resident squirrels may discover the treated area and colonize, but it also may be necessary to establish new squirrel colonies through translocation. Issues associated with translocation include rapid dispersal from the release site as individuals attempt to return to familiar territory or to find better habitat, and negative outcomes of dispersal such as increased squirrel mortality from predation or starvation. However, it may be possible to develop translocation protocols that increase the probability of survival to an acceptable level. For example, using acclimation cages can decrease the probability of dispersal by increasing the amount of acclimation time and decreases mortality by protecting squirrels from predators during the initial, most vulnerable period on the new site (Poulin et al. 2006). Translocating family groups and neighbors together can also decrease dispersal by preserving family and community organization (Shier 2006).

A third component that should be included addresses soil compaction, because grassland sites may have been impacted historically by grazing or agricultural activities. In addition, some selected sites may contain soils with larger proportions of dense material like clay. A treatment to physically reduce soil compaction may benefit owls by enabling faster squirrel burrowing rates. One important consideration is that the degree of decompaction should be kept low enough to enable the formation of stable burrow walls. A treatment such as auguring holes that resemble starter burrows would be more appropriate than tilling, which breaks up soils more thoroughly to lower depths. However, the approach needs to be tested experimentally first because soil disturbance may promote the germination of exotic annual grass seeds, and may cause increases in exotic grass cover, an unintentional consequence that should be avoided.

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.

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Section 3. 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. 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.

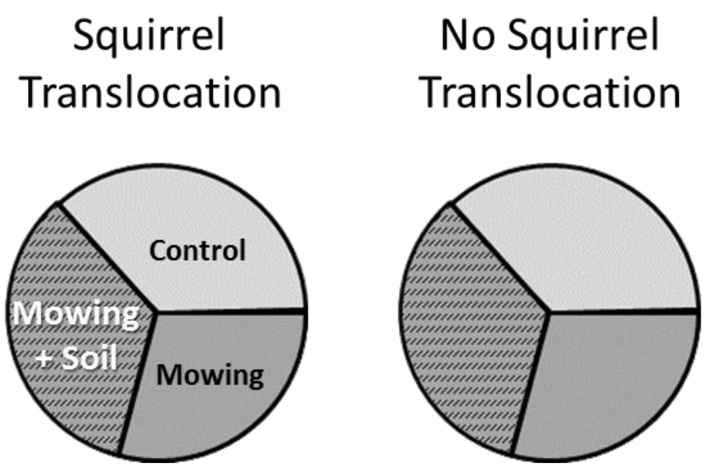

Figure 1. Paired design of the habitat enhancement/squirrel translocation experiment.

Treatment methods

In 2013 the same vegetation and soil decompaction methods were utilized as in 2011 and 2012.

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 all plots established in 2012, the treatments were assigned as follows: treatment 1 (0-120 degrees), treatment 2 (120-240 degrees), and control (240-360 degrees).

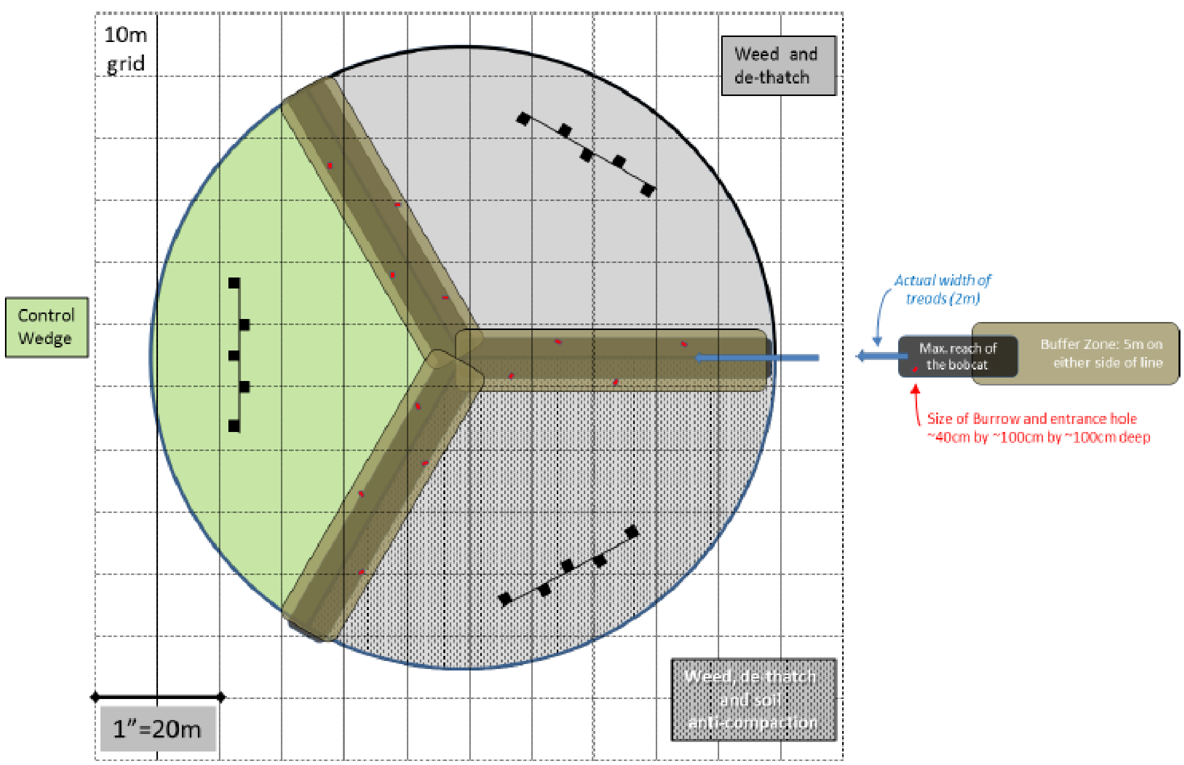

Figure 2. Scaled diagram of plot layout. The burrows were located along the strips dividing each treatment. Gray shading indicates both the footprint of the mechanized equipment used to install the burrows and the furthest reach of the digging arm. Burrows are denoted with red symbols that approximate 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

In all plots (2011-2013) a pretreatment vegetation structure assessment was conducted in all wedges of each plot before vegetation and soil treatments were applied. The post-treatment habitat assessment was conducted in all plots 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 (i.e. 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

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Section 4. 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). This site was included in the first year of the study, but further experimental treatments and monitoring have been discontinued due to ongoing Caltrans management activities that have significantly altered the site.

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 4).

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 2012 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
	2012NC	-116.8678850	32.6908910
	2012NG	-116.8691990	32.6863860
	2012SC	-116.8658350	32.6811170
	2012SG	-116.8662410	32.679062
SWTR	5C	-116.9679560	32.6936797
	5G	-116.9675031	32.6947163

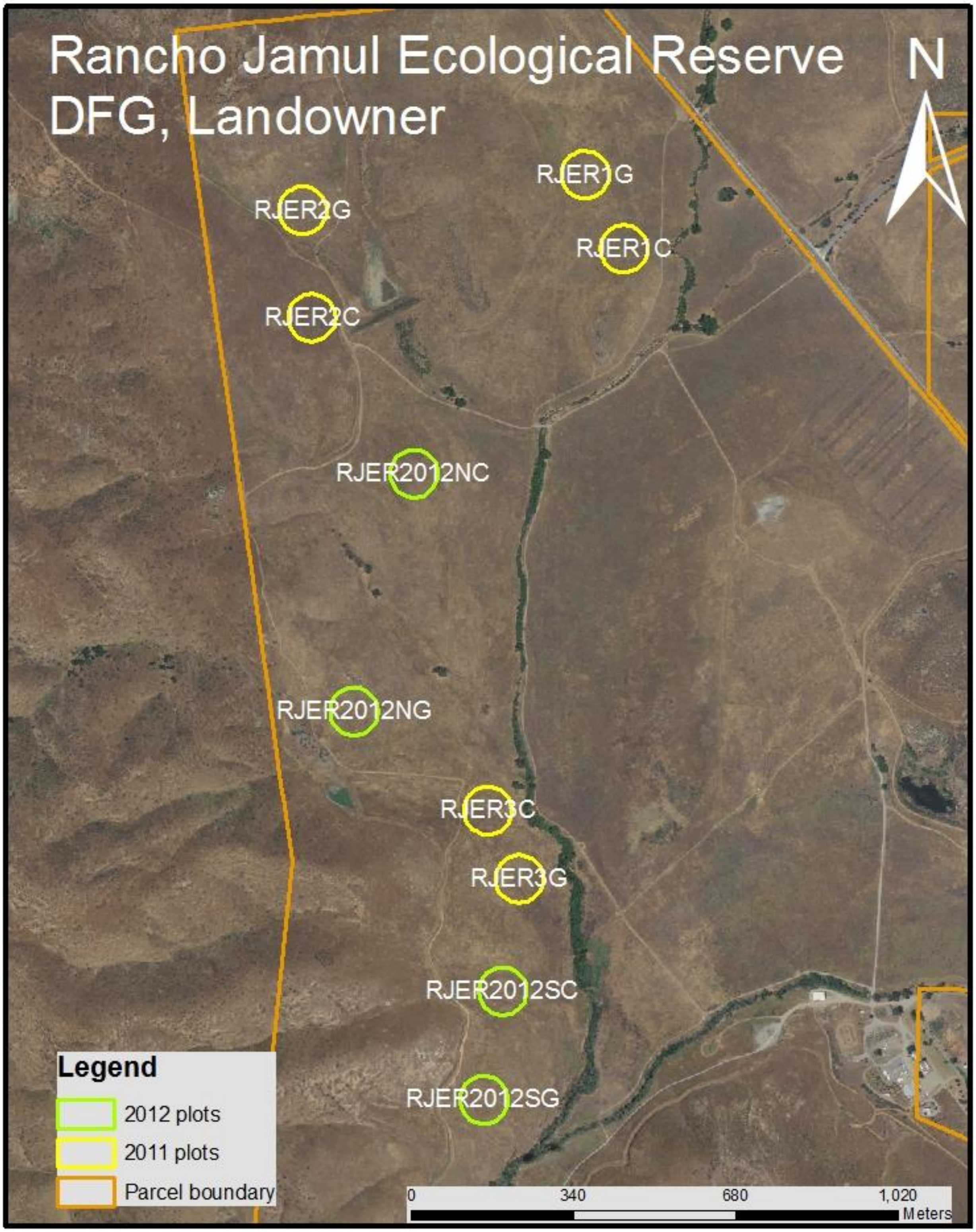

Figure 3. Map of plot locations at Rancho Jamul Ecological Reserve (RJER). Yellow circles represent plot boundaries and are scaled to show the extent of the 50 m plot radius.

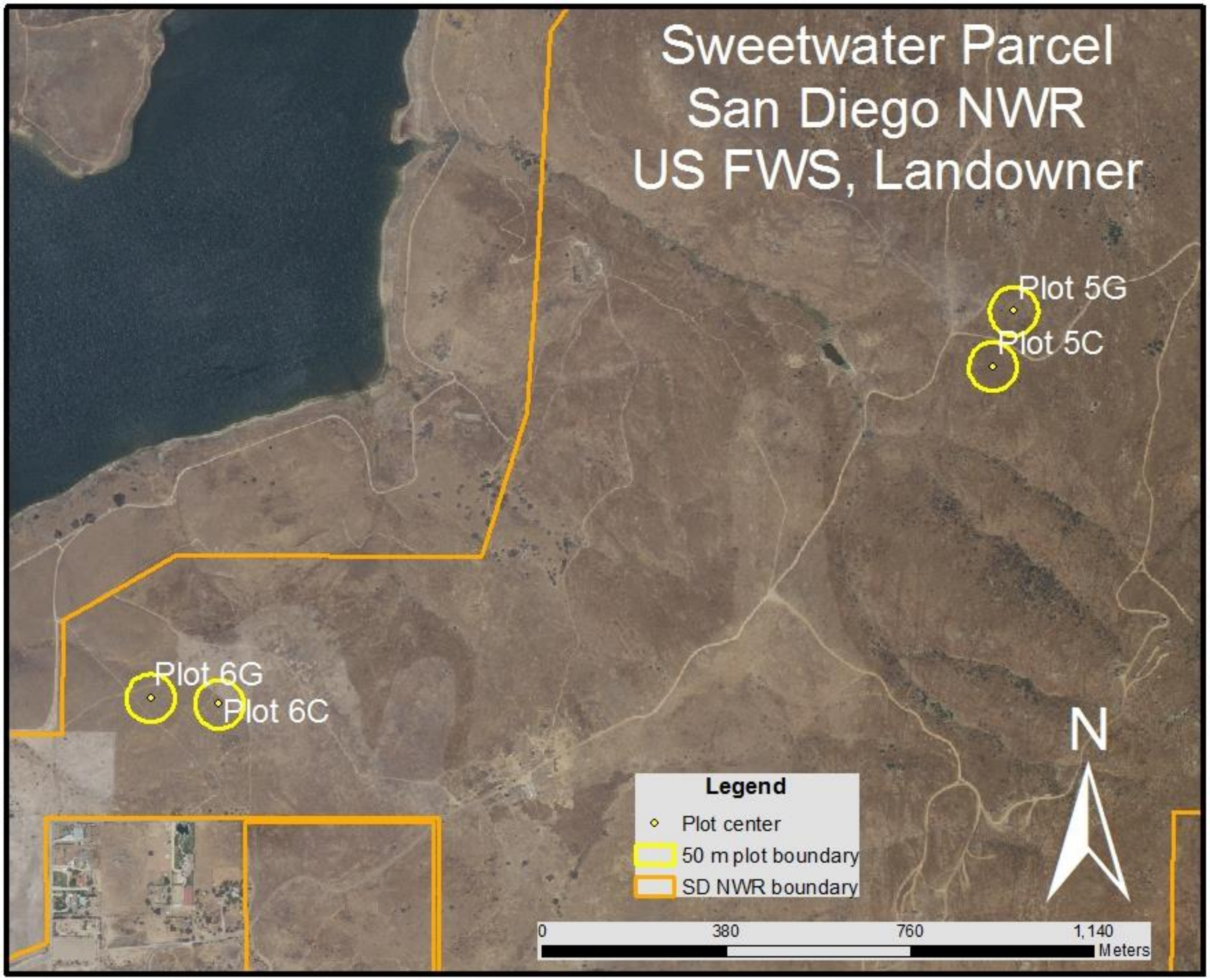

Figure 4. Map of plot locations at Sweetwater, San Diego National Wildlife Refuge (SWTR). Treatment and monitoring at SWTR6G and 6C were discontinued in 2012.

Section 5. Habitat Enhancement Completed Tasks Timeline

Tasks were conducted between March and April 2014.

Table 2. Timeline of completed habitat enhancement tasks

Dates	Site	Task
March 10 – March 29	RJER and SWTR	Squirrel activity assessment
April 3 – 13	RJER and SWTR	Photopoints
April 3 – 13	RJER and SWTR	Vegetation assessment

Section 6. 2014 Photopoints

RJER2012NC

RJER2012NG

RJER2012SC

RJER2012SG

RJER1C

RJER1G

RJER2C

RJER2G

RJER3C

RJER3G

SWTR5C

SWTR5G