South County Grasslands Project
Phase 2

2015 Final Report

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1 PROJECT SUMMARY

In 2011 in conjunction with the South County Land Managers, the Conservation Biology Institute (CBI) and The Nature Conservancy (TNC), developed landscape-scale conservation visions and restoration plans for native grassland and forbland habitats, specifically targeting Otay tarplant (OTP) and Quino checkerspot butterfly (QCB) (Table 1-1). These groups also worked with the San Diego Management and Monitoring Program to develop goals and objectives for these species and habitats as part of the Management Strategic Plan (SDMMP 2013).

Over the past 3 years, Phase II of the South County Grasslands project has tested restoration methods at eight study sites (Figure 1) at Sycamore Canyon (Bureau of Land Management), Proctor Valley (National Wildlife Refuge), Sweetwater Reservoir (National Wildlife Refuge), and Rancho Jamul Ecological Reserve (California Department of Fish and Wildlife) to determine the most effective method for controlling invasive grasses and restoring native grasslands and forblands. The ultimate objective of the project is to develop Best Management Practices (BMPs) for landscape-scale restoration of native grasslands and forblands.

Land IQ developed the experimental design for Phase II, which incorporated mechanical and chemical methods of weed control, including mowing, line trimming, and use of herbicides. A natural fire and a prescribed fire at two RJER sites were incorporated into the design. Over multiple treatments, vegetation was cut prior to seed set to reduce input of invasive grass seeds to the near-surface soil seed bank. The experimental layout was completed in the field in Fall 2013, and the sites were dethatched prior to the first round of treatments in 2014. Invasive grass treatments were applied twice per year (winter and spring). The timing of treatments was driven primarily by weather events and plant phenology.

S&S Seeds, assisted by volunteers from the Earth Discovery Institute, collected local seeds in 2014 and 2015, per seed mix specifications developed by Land IQ for the project. Low rainfall in 2014 and 2015 reduced flowering and seed production and thus, the amount of seed available for collection. Recon Native Plants, Inc. (RNP) bulked seed for OTP, purple needlegrass (*Stipa pulchra*), and foothill needlegrass (*Stipa lepida*). These three species were selected because of their relative scarcity in the area and thus difficulty in collecting them. First generation (F1) OTP bulked seed collected at RJER will be seeded in the OTP experimental plots at Site 4 (RJER) in Phase III (Fall 2015), and bulked seed from the other two OTP populations (Gobbler's Knob and Shinohara) will be processed and stored at Rancho Santa Ana Botanic Garden (RSABG) for use in the U.S. Geological Survey (USGS) OTP genetics study (planned for 2016) and/or used to enhance or create new populations by seeding into one of the study sites.

Site preparation was completed in spring 2015, with 3 years of treatment at Sites 4, 5, and 8 and 2 years of treatment at Sites 1, 2, 3, 6, and 7. The following results, as targeted in our initial proposal, were achieved:

- 7.8-acres total of site preparation for habitat restoration of grassland, forbland, QCB habitat, and OTP habitat.
- 35.2 acres of invasive grass treatment in the buffers around Sites 2, 4, 5, 6, 7, and 8.

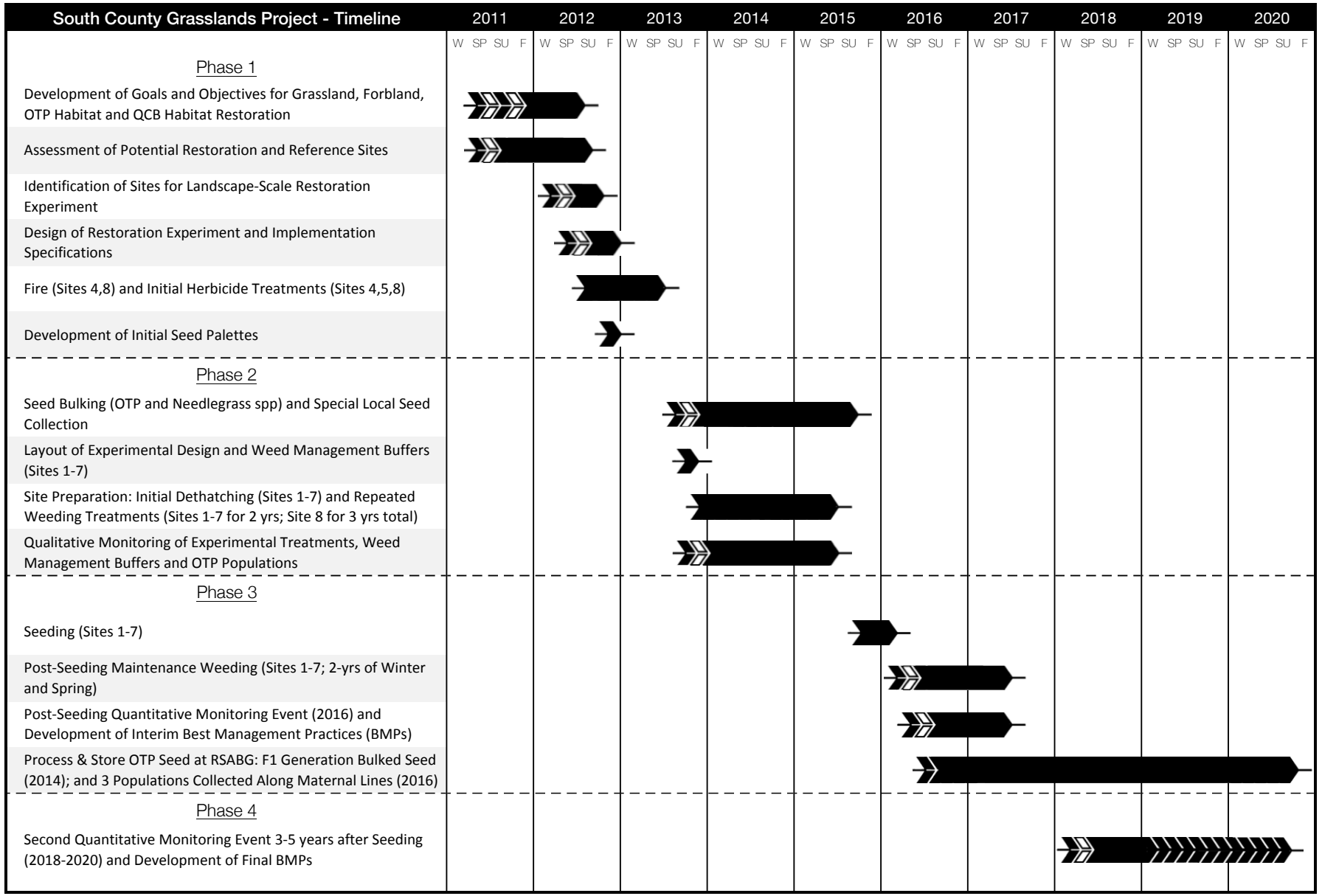
- 3 acres of invasives treatment around QCB habitat restoration plots.
- Production of 1.17-lbs of rough cleaned F1 OTP seed from three populations.
- Production of 1.3-lbs of cleaned *Stipa lepida* and 17.6-lbs of *Stipa pulchra* F1 seed for use in the seed mixes to be installed Fall 2015.
- Special local seed collection for seed material to be installed in Fall 2015 at Sites 1-7.
- Qualitative monitoring by EDI volunteers at designated photo points; results will be used for analysis and interpretation of the quantitative datasets to be collected in 2016 and again in 3-5 years post-seeding.

PHASE III

As part of Phase III, weed management buffers will be maintained by line trimming and targeted herbicide application. Sites 1-7 will be seeded in Fall 2015 with the appropriate restoration seed mix prepared from seed collected by S&S Seeds and EDI volunteers. These seed mixes will be augmented with commercially grown nursery seed and the *Stipa* seed bulked at RNP to ensure an ecologically diverse seed palette. Two quantitative sampling events will be used to inform development of interim BMPs. In Spring 2016, quantitative and semi-quantitative data will be collected in experimental plots using both quadrat and relevé methods, respectively, to assess post-seeding vegetation cover and diversity. This sampling will document relative effectiveness of the site preparation methods in the first growing season post-seeding, including species germination from both the seed mix and the extant native seed bank. In addition, we will compare monitoring methods to determine if the more cost-effective relevé method provides an appropriate level of detail to inform adaptive management.

The interim BMPs will guide management, restoration, and monitoring in the short-term. Additional monitoring will be necessary 3-5 years after seeding to approximate the long-term trajectory and success of the experimental restoration treatments, which can be accomplished in a final Phase 4 of the Project.

Table 1-1. Timeline of the Four Phases of the San Diego South County Grasslands Project. The primary goal of the Project is the development of Best Management Practices (BMPs) for restoration and weed management of 4 critical habitat types [Grassland, Forbland, Otay Tarplant (OTP) Habitat and Quino Checkerspot Butterfly (QCB) Habitat] under management at the landscape scale. Management interventions being studied include site-preparation/weed-management techniques (fire, mowing, line trimming, herbicide and hand-weeding) and seeding methods (2-way drill seeding, seeding in strips, seed balls and broadcast hand seeding). The restoration experiment is laid out at eight Sites across four Properties (Rancho Jamul Ecological Reserve, Sycamore Canyon, and the San Diego National Wildlife Refuge at Proctor Valley and Sweetwater Reservoir) and three Land Owners/Managers (CDFW, BLM, USFWS). Maintenance weeding will be conducted for two years post-seeding. Quantitative data will be collected in 2016 and again 3-5 years after seeding (2018-2020) for the development of final restoration BMPs for the 4 habitat types.



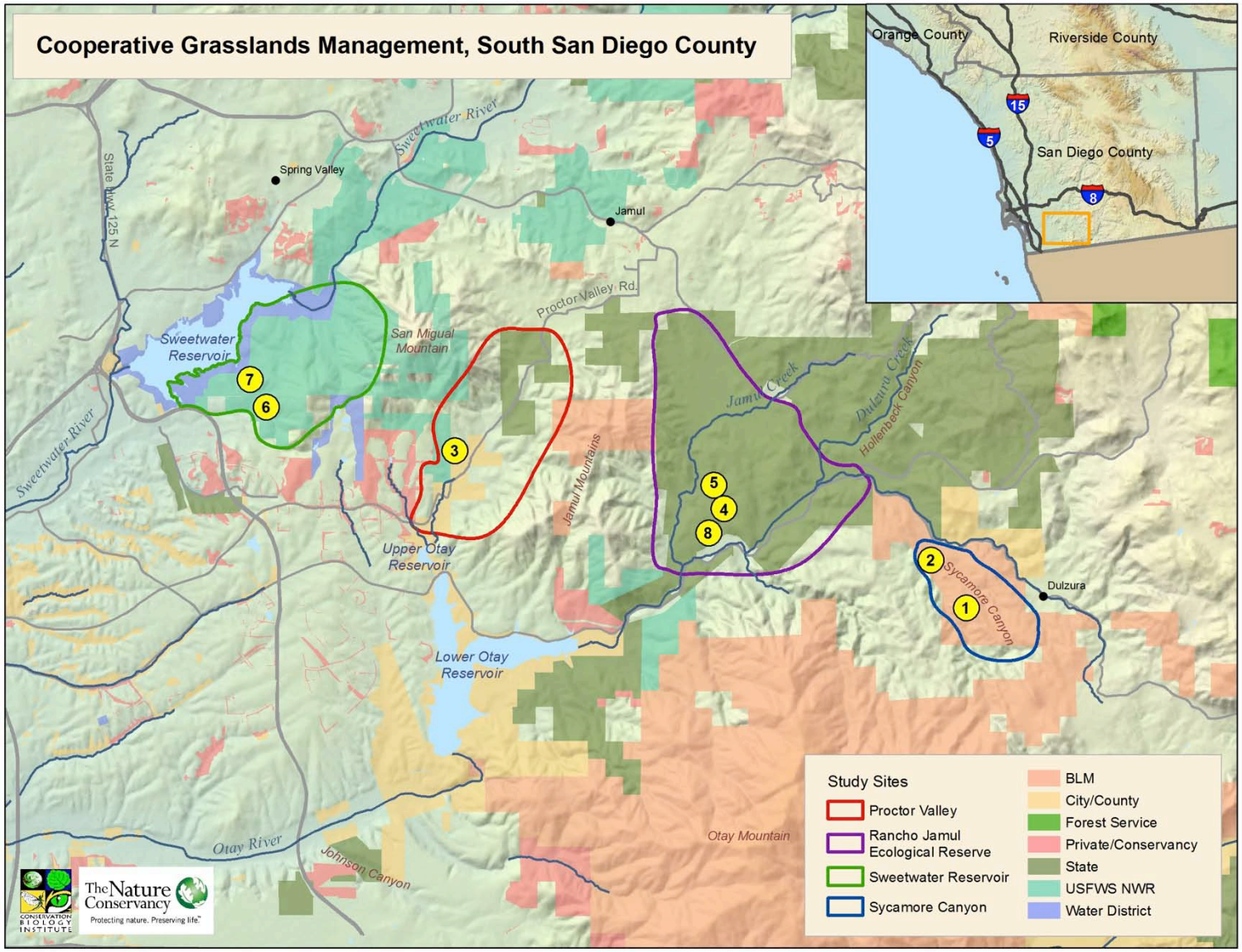


Figure 1-1 South County Grasslands Study Sites.

2 PROJECT GOALS AND OBJECTIVES

The goals and objectives developed in Phase I, based on habitat assessments, consultation with scientific experts, literature review, and collaboration with the South County Land Managers, were refined in Phase II through continued collaboration with the scientific and land management community. Project goals are summarized below and detailed in Appendix 1.

Forbland and Quino Checkerspot (QCB) Habitat Goals: Develop BMPs for forbland and QCB habitat restoration to benefit QCB and related larval food plant species; restore forbland and QCB habitat at Sycamore Canyon and Proctor Valley to enhance habitat quality and improve connectivity between QCB occurrences; and maintain an additional 10 acres of mowed buffer to reduce the weed seed bank for future restoration actions. Use results to develop BMPs that are cost-effective at the landscape-scale and can be adapted for different environmental conditions.

Native Grassland and Otay Tarplant (OTP) Habitat Goals: Develop BMPs for native grassland and OTP habitat restoration; restore native grassland and OTP habitat at RJER and Sweetwater Reservoir to benefit multiple MSP priority species associated with grassland; and maintain an additional 25.2 acres of mowed buffer to reduce the weed seed bank for future restoration actions. Use results to develop restoration and monitoring BMPs that are cost-effective at the landscape-scale and can be adapted for different environmental conditions.

OTP Seed Bulking and Storage Goals: Collect, process, and bulk OTP seed from wild collections in a nursery setting; store the F1 generation OTP seed for use in the USGS OTP genetics study to address three OTP management questions: (1) can seed from different locations (regional occurrences) be moved and mixed to enhance and create OTP populations?; (2) can seed from F1 nursery seed bulking efforts be used to enhance and expand OTP populations?; and (3) are there genetic differences between OTP seed collections from different years?

Project goals and objectives for OTP conservation and restoration were updated following discussions at the Otay tarplant (*Deinandra conjugens*) Climate Adaptation Workshop on June 23, 2014. TNC facilitated the workshop and distributed Recommendations for Management and Monitoring of OTP (September 26, 2014) to maintain viable populations across the species range as the climate changes (Attachment 1).

3 RESTORATION EXPERIMENT DESIGN AND SPECIFICATIONS

The restoration experiment was designed to inform the development of restoration and management BMPs for native grasslands, forblands, QCB habitat, and OTP habitat in South County. Appendix 2 presents the Project Restoration Experiment Design and Specifications, including the background for the relevant research questions, experimental design to inform landscape-scale restoration, specifications for plot layout, site preparation, and seeding techniques. The post-seeding weed management plan and specifications will be developed in Phase III, to guide hand-weeding of the seeded restoration plots in 2016 and 2017.

Bulked soil samples (0-6 inches in depth) were collected from sites 1 – 7 and analyzed. The soil sampling and analysis results are documented in the Soil Sample Analysis Summary Memorandum, dated December 5, 2013 (see Appendix 3). The results will be used in the analysis and interpretation of differences and similarities in vegetation diversity and cover in the experimental treatments.

4 RESTORATION EXPERIMENT LAYOUT

The restoration experiment layout was completed in Fall 2013. Appendix 4 presents a summary of the layout by habitat type, including the plot dimensions and replicates at each site. A summary of site preparation methods and timing is included, along with a series of maps showing site locations, access, and plot layout at each site. The geospatial data associated with these maps has been uploaded to CBI's Data Basin website (www.databasin.org) where it is available to the South County Land Managers and project collaborators.

5 RESTORATION EXPERIMENT IMPLEMENTATION

Implementation of the restoration experiments began in 2012, with a wildfire that burned Site 4 in June 2012. The California Department of Forestry and Fire Protection (Cal Fire) conducted a prescribed burn on Site 8 in October 2012, and CDFW conducted herbicide and broadleaf weed treatments in Spring 2013. The full restoration experimental design was installed in Fall 2013 across all eight sites. See Appendix 5 for information on treatment activity and dates, and relevant notes on weeding activities.

Pre-vegetation clearing surveys were conducted prior to work to avoid impacts to sensitive and protected species. Dot-seed plaintain (*Plantago erecta*) was found on the access road leading to Site 3 in Winter 2015. To avoid potential impacts to QCB larvae, restoration crews were not allowed to drive on the access road and were directed to walk around the *P. erecta* population.

Access was coordinated with land managers prior to weeding events so that land managers could notified staff of scheduled restoration activities.

Fire suppression equipment was available but not used during weeding activities. Fire suppression equipment included extinguishers with pressurized water and a water truck, as warranted by fuel load and weather conditions. Spotters were used when mowing equipment was used during periods of fire danger. The water truck was necessary during the initial dethatching event when fuel loads were high, but was not necessary in subsequent seasons when dry fuel was minimal and humidity was high.

A challenge facing the mowing treatments in 2015 was vegetative and flowering height of purple false brome (*Brachypodium distachyon*) that had germinated in grassland plots. Because of the high percentage of bare ground, evaporation from the soil surface was higher than when there is an annual grass thatch; consequently, available soil moisture was relatively low. Due to low soil moisture, below average rainfall in Winter and Spring 2015, and warm temperatures, *B. distachyon* flowered when it was only 1-2 inches above the soil surface. This required the use of a flail mower, mounted to a skid steer, hydraulically driven, so that the grass could be mowed at the soil surface. Mowing this low requires slower

speeds to ensure good cutting of the grass near the surface. On average, the skid steer mounted flail mower (7-ft width) required 60 minutes to cut 1 acre (active mowing time, not including set-up and travel time) when cutting at 1-2 inches high, compared to an average of 30 minutes per acre in experimental plots where grass was flowering at a greater height and mowed to 4-6 inches high with a 14-ft wide rotary mower pulled with a tractor. For both mowing set-ups, assume 1.5-hrs per day for set-up, daily maintenance and tear down (30 min. for unloading off trailer and set-up; 30 min. for daily maintenance; and 30 min. for loading back on the trailer).

Fusilade® II applications and mowing of exotic grasses do not coincide because of different vegetation growth conditions necessary for the treatments to be effective. Vegetative grass growth and flowering are driven by soil moisture availability, air temperature, and humidity. Annual grass needs to be tall enough to mow with the equipment, whereas these grasses can be treated with Fusilade® II relatively soon after germination (e.g., 1-6 inches in height). As a result of these differences, mowed treatment plots have more thatch and less bare ground than herbicide-treated plots.

Broadleaf weeds tend to germinate quicker and grow larger in the herbicide plots in the first year, post-Fusilade® II application because of the increase in bare ground and reduction in invasive grass cover. Competition for resources between the invasive grasses and native forbs is eliminated or reduced post-Fusilade® II application as the invasive grasses die.

Despite the dominance of invasive grasses in experimental plots, there is also a well-developed, exotic broadleaf forb seed bank. Broadleaf exotic weeds germinate when there are gaps in vegetative cover. In herbicide plots with low levels of invasive grasses and thatch and relatively high levels of bare ground, we observed broadleaf weeds germinating and growing in the first year of treatment (2014). Conversely, broadleaf forbs were expressed only in the second year of treatment (2015) in mow/line-trim plots, which are characterized by higher levels of thatch and less bare ground. Monitoring in 5-10 years will determine if the long-term trajectory (as measured by diversity and cover of natives and invasives) of these two site preparation methods will converge or be significantly different.

6 SEED BULKING RESULTS

OTAY TARPLANT

OTP seed from RJER will be used for seeding the Site 4 OTP experimental treatment plots. Discussions with Kris Preston (USGS) and Bruce Baldwin (Jepson Herbarium) informed the decision to use F1 OTP seed, originally collected from Site 8 at RJER, for seeding to expand the existing population in experimental treatment plots at Site 4. The OTP plots at Site 4 were located outside the known existing perimeter of the OTP population (as mapped in 2013). The existing OTP population germinated, flowered, and was mapped on the lower slopes of Site 4 in Spring/Summer 2013. There may be OTP in the seed bank within the OTP experimental treatment plots, adjacent to the population mapped in 2013; hence, the site will be monitored to determine if any OTP growth in the experimental treatment plots is from the F1 OTP seed to be installed Fall 2015 or from an existing seed bank.

The remaining bulked F1 OTP seed, originally collected from Gobbler's Knob and Shinohara, will be transferred to RSABG for processing and storage.

See Table 6-1 for a summary of the F1 OTP seed bulking efforts by RNP in 2014. The seed tests for purity and viability are presented in Attachment 2.

Table 6-1 Otay Tarplant (*Deinandra conjugens*) Seed Bulking Results

Source Population	Quantity of 1-gallon size plants (6/19/2014)	Uncleaned Seed/Plant Material (lbs) (8/30/2014)	Rough Cleaned Seed Material (lbs) (9/30/2014)	Purity	Viability (Dormant)	Pure Live Seed
Gobbler's Knob	132	4.7	0.51	26.40%	47% (31%)	12.41%
RJER(Site 8)	111	1.4	0.37	24.39%	70% (43%)	17.07%
Shinohara	93	1.2	0.29	21.15%	68% (47%)	14.38%

PLS = Pure Live Seed; Dormant seed determined by tetrazolium staining, which stains only living embryos; if the embryo is alive, we can infer it is dormant.

NEEDLEGRASSES

Limited amounts of the two target needlegrass species were available for wild local seed collection in 2014 and 2015. Therefore, RNP bulked needlegrass seed for use in the restoration seed mixes. Enough *Stipa lepida* was produced by RNP per the restoration seed mix specifications, but the *S. pulchra* seed may be insufficient, depending on pure live seed (PLS) rates in the final seed mix. EDI volunteers also collected a small amount of *Stipa* sp. seed, which will be included in the final seed mix. The seed mixes for installation in Fall 2015 will be finalized in Phase III, following seed test results of local seed collection by S&S Seeds.

See Table 6-2 for a summary of the F1 needlegrass species seed bulking results from RNP, 2014. The seed tests for purity and viability are presented in Attachment 2.

Table 6-2 Needlegrass (*Stipa lepida* and *S. pulchra*) Seed Bulking Results

Species	Cleaned Seed (lbs) (8/30/2014)	Cleaned Seed (lbs) (9/30/2014)	Purity	Viability (Dormant)	Pure Live Seed (PLS)
Stipa lepida	1.3	0.51	98.48%	84% (0%)	82.72%
Stipa pulchra	17.6	0.37	97.43%	82% (10%)	89.64%

PLS = Pure Live Seed; Dormant seed determined by tetrazolium test.

In Phase 3 (2016), CBI will collect OTP seed along maternal lines from three populations for use in a future seed bulking operation for the project (i.e., Sweetwater, Sites 6 and 7). Collected seed will be delivered to RSABG for processing, testing, and storage for up to 5 years. The seed may be used for the USGS OTP genetics study (planned for 2016) or in future seed bulking operations for enhancement of core OTP habitat or expansion/creation of new habitat in suitable conditions. The OTP genetics study will inform how OTP seed from different populations and F1 OTP seed from nursery seed bulking will be used.

7 LOCAL SEED COLLECTION RESULTS

Appendix 2 presents the restoration seed mixes and specifications for each of the four habitats. Special local seed collection began in 2014 and will be completed in Fall 2015, with delivery of the following four seed palettes (rates estimated and subject to change based on seed availability): est. 19 lbs/ac forbland; 13.5 lbs/ac QCB habitat; 23.4 lbs/ac native grassland; and 18.9 lbs/ac OTP habitat. For some native species, local seed collection has been constrained by drought and competition from invasive species, primarily in annual grasslands.

Seed mixes will be finalized in Phase III and adjusted based on seed purity and viability analysis, available seed material from collection, additional seed of species not included in the seed palettes but collected opportunistically during seed collection, desired species diversity, ecological niches, and pure live seed rates.

Areas to be seeded include 0.44 acre of forbland (Site 2), 0.22 acre of QCB habitat (Sites 1 and 3), 4.86 acres of native grassland, and 1.72 acres of OTP habitat (Sites 4-7). Following installation of seed mixes, any remaining seed collected on public lands will be purchased from S&S Seed and delivered to the land managers for use on conserved lands.

Seed collection efforts for this and other restoration projects on conserved lands have demonstrated the need for a regional seed bank to provide a secure source of genetically appropriate material for seed bulking or out-planting. Components of a regional seed bank program include (1) developing species-specific seed collection goals, objectives, and priorities, (2) identifying species-specific collecting locations and methods (including collecting across multiple habitats and in multiple years), (3) identifying appropriate seed transfer zones, based on genetic considerations, (4) developing seed bulking BMPs, including climatically appropriate nursery locations, nursery practices, and maximum number of seed generations that can be bulked *ex situ* to maintain genetic integrity, (5) identifying appropriate seed storage and seed testing facilities, and (6) identifying and securing a stable, long-term funding source for collecting and testing seed and maintaining seed collections.

8 MONITORING AND REPORTING

Surveys were conducted at all sites prior to initial dethatching and before winter and spring vegetation clearing events to ensure that sensitive species were avoided during clearing activities. Treatments were timed with weed phenology, driven by weather and near surface soil moisture conditions, to reduce input of invasive seeds to the subsurface soil seed bank. Soil was minimally disturbed (<5 cm) during treatments to avoid exposing and promoting germination of invasive plant seeds buried deep in the soil seed bank. With time,

and dominance of native vegetation cover, the deeper invasives seed bank will decay and eventually be reduced.

Photo monitoring viewpoints were established and photos taken at selected treatment and control plots in 2013. EDI volunteers continued photo monitoring in 2014 and 2015 and will continue in Phase III. The photos will assist in interpretation of monitoring data to be collected in 2016 beyond.

Annual surveys were conducted at Sites 4-8 in 2013, 2014, and 2015 to determine presence/absence of OTP populations. Where found, we mapped population extent using a sub-meter GPS and estimated population size for each polygon. This work will continue in Phase III.

As part of Phase III, quantitative sampling of Sites 1-7 in 2016 will inform development of interim BMPs. A second quantitative sampling event will inform final restoration BMPs. Site 8 will be monitored qualitatively on an annual basis to determine the long-term effectiveness of previous site treatments in controlling invasive species and maintaining the productivity and fecundity of the extant OTP population.

Appendix 1. Project Goals and Objectives

PROJECT GOALS AND OBJECTIVES:

Forbland and Quino Checkerspot (QCB) Habitat Goals: Develop Best Management Practices (BMPs) for forbland and QCB habitat restoration to benefit QCB and related larval food plant species; restore forbland and QCB habitat at Sycamore Canyon and Proctor Valley to enhance habitat quality and improve connectivity between QCB occurrences; and maintain an additional 10 acres of mowed buffer to reduce the weed seed bank for future restoration actions. Use results to develop restoration and monitoring BMPs that are most cost-effective at the landscape-scale and can be adapted for different environmental conditions.

Forbland Objectives:

a. Conduct site assessments of both contemporary occurrences/remnant-habitat and disturbed/type-converted habitat to describe existing ecological characteristics associated with vegetation cover (i.e. flora, soil, slope-aspect, topographic position) (Phase 1).
b. Assess the effectiveness of two site preparation techniques that limit soil disturbance while reducing weed cover in sites with good access and low native forbland cover, prior to the application of a forbland seed mix.
c. Restore 0.44 acre of QCB habitat at Sycamore Canyon (Site 2).
d. Evaluate effectiveness of mowing in the buffer area.

QCB Habitat Objectives:

a. Conduct site assessments of both contemporary occurrences/remnant-habitat and disturbed/type-converted habitat to describe existing ecological characteristics associated with vegetation cover (i.e. flora, soil, slope-aspect, topographic position) (Phase 1).
b. Assess the effectiveness of two seeding techniques in establishing Plantago erecta and other QCB associated plant species, including forbland species, on difficult to reach sites (i.e. ridgelines) and sites with sensitive soil crusts.
c. Restore 0.22 acre of QCB habitat at Sycamore Canyon and Proctor Valley (Sites 1 and 3).
d. Evaluate effectiveness of mowing in the buffer area.

Native Grassland and Otay Tarplant (OTP) Habitat Goals: Develop BMPs for native grassland and OTP habitat restoration; restore native grassland and OTP habitat at RJER and Sweetwater Reservoir to benefit multiple MSP priority species associated with grassland and adjacent coastal sage scrub communities; and maintain an additional 25.2 acres of mowed buffer to reduce the weed seed bank for future restoration actions. Use results to develop restoration and monitoring BMPs that are cost-effective at the landscape-scale and can be adapted for different environmental conditions.

Native Grassland Objectives:

a. Conduct site assessments of both contemporary occurrences/remnant-habitat and disturbed/type-converted habitat to describe existing ecological characteristics associated with vegetation cover (i.e. flora, soil, slope-aspect, topographic position) (Phase 1).
b. Compare the effectiveness of seeding the full extent of the native grassland restoration area versus the DeSimone strip method, which has the promise of native species recruitment from seeded strips into mowed buffer strips, thereby expanding the area capable of being restored when seed material is limited.

c. Determine whether a recent summer burn (6/20/12) has an impact on the success of either of the two restoration methods.
d. Evaluate whether hand-equipment (i.e., weed eaters) methods are as effective for native grassland restoration as larger mechanized equipment methods.
e. Compare non-native cover in sites with and without native seed addition in the fifth year after the end of three years of non-native vegetation management site preparation (Sites 4 and 8).
f. Restore 4.86 acres of native grassland habitat at RJER and Sweetwater Reservoir (Sites 4, 5, 6 and 7).
g. Evaluate effectiveness of mowing in the buffer area as an adaptive vegetation management method to reduce non-native and invasive species cover.

OTP Habitat Objectives:

a. Conduct site assessments of both core habitat (historic and extant populations) and potential restoration/expansion areas in disturbed/type-converted habitat to describe existing ecological characteristics associated with vegetation cover (i.e. flora, soil, slope-aspect, topographic position) (Phase 1).
b. Evaluate the success of establishing OTP populations using two-way drill seeding.
c. Determine if calcareous soils are limiting to the establishment of OTP populations.
d. Compare strategies for "seed banking" to conserve genetic diversity and provide a seed source in the event of a catastrophic disturbance: weed management to reduce the cover of exotics (especially annual grasses) in core (extant and historic) OTP populations, to increase population productivity and fecundity; and/or, seed collection for long-term storage in conservation seed collections and for use in seed bulking nursery operations to enhance existing populations or create new ones.
e. Restore 1.72 acres of native grassland habitat at RJER and Sweetwater Reservoir (Sites 4, 6 and 7).

    NOTE: OTP seed local to RJER has been collected and bulked by Recon Nursery; and, additional seed will be available for wild collection at RJER in 2015. However, it is expected that wild collected seed from Sweetwater (Sites 6 and 7) will not be available prior to seeding in fall 2015. Therefore, while the native grassland mix will be installed in the OTP Experimental Plots at Sites 6 and 7 at Sweetwater, OTP seed will not be added until/if the results of the OTP Genetics Study determines if seed collected and/or F1 bulked seed from other local populations can be added to create or recreate OTP occurrences at Sites 6 and 7. OTP seed would be hand-seeded at a later date (funding source TBD).

f. Evaluate effectiveness of mowing and herbicide application in the weed management buffer area as an adaptive vegetation management method to reduce non-native and invasive species cover.
g. Evaluate the success of experimental vegetation management approaches in Site 8, five years after the end of treatments. Treatments ended in 2015; therefore, the plots will be monitored with relevee or another appropriate monitoring method in 2020, assuming there are no weather-related monitoring issues (i.e. significantly below average rainfall in winter). The second quantitative monitoring of Sites 1-7 should be timed to occur with Site 8 in 2020, or at least 3-5 years after seeding (2018-2020).

Success Criteria and Monitoring: Experimental restoration methods, designed in Phase 1 of the South County Grasslands Project, were implemented beginning with Phase 2 and will be completed in Phase 3. In Phase 3, one sampling event will be conducted to determine the effective vegetation management (site preparation) and seeding techniques to inform development of initial restoration BMPs. Sampling will include quantitative (quadrat) and semi-quantitative (relevé) methods, which will be compared for use at the landscape-scale. In addition, Otay tarplant populations within treatment areas will be monitored qualitatively on an annual basis. A second quantitative monitoring event of Sites 1-8 will occur at least 3-5 years after seeding (calendar years 2018 to 2020, respectively) to evaluate the experimental restoration methods, in order to develop the full restoration BMPs. The final monitoring event for Site 8 would ideally occur 5 years (2020) after the end of the last weed management treatment. Five years is considered ideal because current practice to maintain the viability of an OTP population that occurs in an exotic annual grassland is to dethatch and conduct weed management approximately every 5 years. The second sampling event for Sites 1-8 will be conducted in Phase 4 of the Project.

OTP Seed Bulking and Storage Goals: Collect, process and bulk-grow OTP seed from wild collections in a nursery setting. Then, store the F1 (first generation) OTP seed and make available to the USGS OTP Genetics Study to include in future research efforts to address three OTP management questions: (1) can seed from different locations (regional occurrences) be moved and mixed to enhance and create OTP populations; (2) can seed from F1 nursery seed bulking efforts be used to enhance and expand OTP populations; and (3) are there important genetic differences between OTP seed collections from different years?

OTP Seed Bulking and Storage Objectives:

a. Identify the most promising methods for seed bulking of OTP to create F1 seed for genetics analysis and/or for a future habitat restoration activity (i.e. to enhance existing populations or create a new population in suitable habitat conditions) (Phase 1).
b. Collect, process and bulk-grow OTP seed collected from 3 extant populations in a nursery setting (Phase 2).
c. Provide Rancho Santa Ana Botanical Garden (RSABG) with F1 OTP seed bulked by Recon Nursery to clean, test and store (Phase 3).
d. RSABG will store the seed for a five-year period, or until it is used for research by USGS in the OTP Genetics Study or seeded in appropriate restoration sites (Phase 3).

Success Criteria and Quantitative Monitoring: Seed will be processed and tested for viability by RSABG, with results and seed provided to Genetics Study for research (i.e. common garden experiment) to address management questions.

OTP Seed Collection Objectives: Collect OTP seed to be used in a future nursery seed bulking program to enhance/create new OTP populations or expand existing occurrences, thereby preserving genetic diversity and protecting against losses from catastrophic disturbance.

OTP Seed Collection Objectives:

a. Collect OTP seed across three extant populations in 2016, if collection conditions are suitable (Phase 3).

b. Clean, test and store seed at RSABG for use in a future seed bulking operation to seed OTP habitat under management in the South County Grasslands Project (i.e. Sweetwater, Sites 6 and 7) (Phase 3).
c. Future seed bulking will occur following and based upon the results and management recommendations of the USGS OTP genetics study (scheduled to begin in 2016), including common garden studies (Phase 4?)

Success Criteria and Quantitative Monitoring: Seed will be collected and then processed, tested and stored for a period up to five years by RSABG.

Appendix 2. Restoration Experiment Design and Specifications

Restoration Specifications
South San Diego County Grasslands Project

Introduction

The Conservation Biology Institute (CBI) and The Nature Conservancy (TNC) have identified four study areas in south San Diego County for habitat restoration and management to support two listed species, the federally endangered Quino checkerspot butterfly (*Euphydryas editha quino*) (QCB) and the federally threatened and state endangered Otay tarplant (*Deinandra conjugens)* (OTP), as well as native forbland and perennial grassland habitats. The four study areas are Sycamore Canyon, Proctor Valley, Rancho Jamul Ecological Reserve and Sweetwater Reservoir. The following sections summarize the restoration site-specific restoration specifications. The study sites, existing conditions, and restoration measures are summarized in Appendix A, Table A1 for each site. Table 1 summarizes the restoration experiments for each habitat and site, including the size, number and layout of study plots for each site.

Table 1. Summary of Experimental Treatments by Habitat Type.

A. QCB, Test of Seeding Technique

	Restoration Site:	1	2	3	4	5	6	7
a)	Seed Balls [Fall 2015]	0.055	---	0.055	---	---	---	---
b)	Hand Seed [Fall 2015]	0.055	---	0.055	---	---	---	---

Site Preparation Notes: *No test of site preparation methods based on previous work (Dodero) and site conditions. The following will be conducted across the site:*
A. Dethatch and remove biomass with hand tools from seeding sites (primarily non-native forbs like Erodium sp.) [Fall 2013]
Then, conduct site preparation for 2 years: B. Hand weeding in winter (cut off non native forbs just below soil, avoiding crust areas.) [2014 and 2015]

Analysis Notes: *Can compare techniques within each unique, but fairly similar sites (1 and 3); can compare technique results between sites 1 and 3 if divergent performance; or pool data across sites 1 and 3 if no significant difference by site for each method.*

B. Forbland, Test of Site Preparation Method

	Restoration Site:	1	2	3	4	5	6	7
a)	Mow 2x (winter and spring), leave thatch, and as necessary apply non-selective herbicide (glyphosate) in spring [2014 and 2015]	---	0.22	---	---	---	---	---
b)	Mechanized application of non-selective herbicide (glyphosate) in winter and spring/summer, with no hand weeding [2014 and 2015]	---	0.22	---	---	---	---	---

Site Preparation Notes: *Dethatch with mechanical mowing and remove biomass (mechanized to the extent the site allows) [Fall 2013]*
Seeding Notes: *There will be no test of seeding methods. Use the same seed mix over the site, and seed with a broadcast pull-behind type seeder. [Fall 2015]*

Analysis Notes: *Compare site preparation methods within Site 2.*

C. Native Grassland, Test of Two Types of Mechanized Restoration Methods

	Restoration Site:	1	2	3	4	5	6	7
a)	Full Extent Seeding Method: Grass selective herbicide (Fluazifop) in winter for annual grasses followed by non-selective (glyphosate) in spring [2014 and 2015]; And, apply seed by two-way drill seeding (perpendicular passes) over entire plot. [Fall 2015]	---	---	---	0.71	0.71	0.71	---
b)	DeSimone Strip Method: Mow prior to annual grass at 'milk stage' and repeat mowing to control broad leafs later in spring [2014 and 2015]; And, apply seed with one-way drill seeding, leaving mowed unseeded buffer strips [Fall 2015]	---	---	---	0.71	0.71	0.71	---

IMPORTANT Background Notes: *CDFW treated NG areas in Sites 4 and 5 in Mar/Apr 2013 with Fusilade and conducted follow up mowing for broadleaf weeds. OTP area (lower slope of Area 4 was not treated) not treated. (Modification of original proposal to include an extra year of site prep. in NG restoration with and without fire pre-treatment at Sites 4 and 5 only)*

Site Preparation Notes: *Dethatch with mechanical mowing and biomass removal [Fall 2013].*
IMPORTANT Seeding Notes: *Although the seeding application methods are different (one- vs. two-way drill seeding), we must apply seed at the same density per unit area (aka 'at the same rate'). So a DeSimone Strip has the same density as the Full Extent seeded areas. As a result, there will be more total seed applied in the Full Extent Seeding Method, since the entire area will be seeded, but this is intentional as the DeSimone Strip Method is evaluating resources efficiencies by reducing the intensity of seeding and site prep over the same amount of area (with the goal of the same Long Term habitat value result).*

Analysis Notes: *Can compare performance of methods across all Sites (4, 5 and 6) irrespective of whether it was burned in Summer 2012 or not, followed by CDFW herbicide treatments in spring 2013; can compare method performance within sites if results are divergent based on Site; can compare methods based on whether site was burned (Site 4 in Summer 2012 and subsequently treated with herbicide by CDFW) or not burned recently (Site 5) prior to treatments between sites 4 and 5;and, can compare trajectory of sites 5 and 6 and see if there are Site-related differences in otherwise similar sites in terms of soil and weed cover or pool results to increase statistical power if similar based on qualitative observations and quantitative transect samples.*

D. Native Grassland, Test of Two Hand-Equipment Restoration Methods

	Restoration Site:	1	2	3	4	5	6	7
a)	Full Extent Seeding Method by Hand: Grass selective herbicide (Fluazifop) in winter for annual grasses followed by non-selective (glyphosate) in spring, as necessary [2014 and 2015]; And, hand broadcast seed at rate equal to that in strips, over entire plot. [Fall 2015]	---	---	---	---	---	---	0.3
b)	DeSimone Strip Method by Hand: Hand Mow prior to annual grass at 'milk stage' and repeat mowing to control broad leafs later in spring, as necessary [2014 and 2015]; And, hand broadcast seed in strips with mowed buffers between seeded areas [Fall 2015]	---	---	---	---	---	---	0.3

This is a test of methods were large equipment is not accessible.
Site Preparation Notes: *Dethatch with hand mowing and biomass removal [Fall 2013].*
Seeding Notes: *Seed application rates are equal in both methods, but because the entire area is being seeded in the Full Extent Method, then it will require more total seed than the DeSimone Strip Method.*

Analysis Notes: *Can compare relative success of two hand methods used in areas inaccessible for large equipment; and, can compare to equivalent mechanized method at Site 6, although mechanized would always be preferred when available because it is much more cost effective in a large scale restoration implementation project.*

E. OTP, Test of Soil Differences, Same Full Extent Restoration Methods

	Restoration Site:	1	2	3	4	5	6	7
a)	Full Extent Seeding Method: Grass selective herbicide (Fluazifop) in winter for annual grasses followed by non-selective (glyphosate) in spring [2014 and 2015]; And, apply seed by two-way drill seeding (perpendicular passes) over entire plot. [Fall 2015]	---	---	---	0.71	---	0.71	---

IMPORTANT Background Notes: *Areas of elevated lime content and high clay content at Site 4 at Rancho Jamul will be used to compare the effect of calcareous soils on OTP establishment with areas of similarly high clay content at Site 6 at Sweetwater Reservoir. The same restoration method will be applied at both sites across six randomly located replicate plots placed within the target soil conditions. Note: Sites 4, 5 and 6 have lime content and clayey soils. Site 7 does not have lime. Depending on the observed response, additional soil sampling may be conducted to determine if calcareous soils are impacting the presence/absence of OTP, or correlated with species diversity or cover.*

Site Preparation Notes: *Dethatch with mechanical mowing and biomass removal [Fall 2013].*
IMPORTANT Seeding Notes: *Seed application rates are equal to the Full Extent Method being used in the Native Grassland Test Plots using two-way drill seeding (used in Sites 4, 5 and 6), with the addition of OTP in the seed mix.*

Analysis Notes: *Can compare establishment of seed mix, including OTP between the two sites, and attribute differences in large part to observed differences in lime in the soil of the test plots. We will bulk soil samples from analysis with the area of interest and used field checks to place test plots in calcareous soils with high clay content at Site 4. But, in the future, additional soil samples could be taken per test plot and used to do regression against densities of OTP and/or the rest of the seed mix, if there are interesting patterns emerging that beg exploration (both within a site and across Sites 4 and 6).*

F. OTP, Test of Hand to Mechanized Full Extent Restoration Methods

	Restoration Site:	1	2	3	4	5	6	7
a)	Full Extent Seeding Method by Hand: Grass selective herbicide (Fluazifop) in winter for annual grasses followed by non-selective (glyphosate) in spring, as necessary [2014 and 2015]; And, hand broadcast seed at rate equal to that in Native Grassland Test Plots in Site 7, over entire plot. [Fall 2015]	---	---	---	---	---	The Same Plots, as above in Table 2E, Site 6 will be used for comparison	0.3

This is a test of methods were large equipment is not accessible.
Site Preparation Notes: *Dethatch with hand mowing and biomass removal [Fall 2013].*
Seeding Notes: *Seed application rates are equal to the Full Extent Method by Hand being used in the Native Grassland Test Plots using hand broadcast seed (used in Site 7), with the addition of OTP in the seed mix.*

Analysis Notes: *Can compare relative success of hand method used in areas inaccessible for large equipment (such as Site 7) to mechanized method in Site 6.*

Quino Checkerspot Butterfly and Forbland Habitat

QCB habitat consists of relatively small patches of specific native forb species, including QCB host plants, typically located in the shallow loamy soils on ridgelines, usually in open areas between shrubs in the sage scrub community (Longcore *et al.* 2003). Forbland habitat occurs on similar loamy to sandy loam soils and generally supports similar plant species. However, forblands are not necessarily located on ridgelines.

Generally, the shallow loamy to sandy loam soils best suited for QCB and forblands are dominated more by weedy, non-native forb species such as *Erodium* spp. rather than by dense cover from annual non-native grasses. Therefore, site preparation methods are less intensive than for habitats with dense annual grass thatch to remove. Additionally, the potential for soil crusts between plants limits the type of site preparation and seeding methods. Soil crusts perform several valuable ecological services, including holding soil in place, providing a favorable microclimate for insects and other soil organisms, and inhibiting non-native, weedy species invasion. As soil crusts are very slow to develop, disturbing the crust should be avoided, to the extent possible.

QCB Habitat Restoration and Experiment

Sites at Sycamore Canyon (Site 1) and Proctor Valley (Site 3) were identified as the most appropriate sites to test restoration methods for QCB habitat because they support the minimum habitat requirements (e.g., soils, topography, vegetative cover) and are near current or historic QCB occurrences.

Research Goal

Assess the effectiveness of two seeding techniques in establishing *Plantago erecta* and other QCB associated plant species, including forbland species, on difficult-to-reach sites (i.e. ridgelines) and sites with sensitive soil crusts.

Research Questions

- Do (a) seed ball or (b) hand-broadcast seeding techniques successfully establish *Plantago erecta* and other forbland plant species?
- Are there differences between techniques in the successful establishment of persistent populations of seeded species?
- Are there differences between techniques in the diversity and cover of native and non-native species in the years following seeding?
- Are there differences between the Sycamore Canyon and Proctor Valley Sites due to different underlying soil genesis and long-term fire histories that affect the success of the seeding techniques?

Experimental Design and Plot Size

In order to evaluate the effectiveness of two seeding techniques (seed balls and hand-seeding) to establish QCB habitat, these techniques will be applied as

treatments in a randomized complete block design (n=6), which will be repeated at both Site 1 in Sycamore Canyon and Site 3 in Proctor Valley.
The experimental design will be repeated at both Sites 1 and 3, because while both sites meet the minimum habitat requirements for QCB habitat, it is unknown whether landscape-scale factors unique to each site, (i.e. differences in underlying soil genesis or long-term fire histories) may affect the success of the seeding techniques.

The test plot size for each replicate of a treatment will be 20 x 20 feet. The same seed mix will be used for both techniques. The seeding treatments will be installed at both Sites within one week of each other.

The two seeding treatments will be blocked together along with a control (no seeding) treatment (forming a block that is 20 x 60 feet). The treatments will be randomly assigned to the plots within each block.

The blocks will be located within each Site by first surveying all of the potential QCB habitat restoration microsites that meet the minimum paired plot size (20 x 60-foot block) and minimum habitat requirements. The blocks will be numbered and 6 plots will be randomly selected for inclusion in the experiment. CBI and NewFields will be responsible for identifying the blocks and plots. The centroids of the plots will also be documented with geographic coordinates using a sub-meter Geographic Positioning System (GPS) and incorporated into a geospatial database.

The Contractor (Nakae) will stake the plots with reinforcing bar and polyvinyl chloride (PVC) pipe, color-coded and labeled with the treatment name to avoid ambiguity. The PVC pipe shall not be higher than average height of the adjacent shrubs or 0.5-meter, whichever is less, so as not to become an unintentional perch for a raptor.

Restoration Specifications

Based on current site conditions, the following restoration methods are proposed to test the effectiveness of two seed application techniques on the ridgelines at Site 1 in Sycamore Canyon and Site 3 in Proctor Valley:

Site Preparation

Dethatch across all test plots in fall 2013 and hand-weed in winter 2014, followed by spot herbicide treatment with non-selective glyphosate herbicide for all weeds in spring 2014. Repeat the site preparation method for a second year in 2015, including the hand-weeding in winter and spot herbicide treatment in spring.

Herbicide shall be applied according to the recommended application rate on the herbicide label for wildlands. Herbicide treatment shall be conducted only when weather conditions are conducive to effective uptake of the herbicide by the target species (e.g. sunny, dry with ambient temperatures at least 65 degrees Fahrenheit) and when plants are at the specified growth stage. Wind conditions should be five

miles per hour (mph) or less to minimize herbicide drift. Treated plants shall not be disturbed until the applied herbicide has had time to take effect per the manufacturer's instruction.

A brightly colored dye is recommended in all herbicide applications to aid the applicator in achieving good coverage of the target species. The material shall be a non-toxic material such as Blazon, Turfmark or equivalent. The dye shall be mixed with the herbicide at no more than half the rate specified on the label.

Seeding Technique Experiment

In fall 2015, after two seasons of weed management to prepare the sites, the following seeding techniques will be used: (a) seed balls formulated with the specified seed mix; and (b) scarification of disturbed and non-soil crust areas with hand-broadcast seeding with the seed mix (at Proctor Valley Site 3, focus seeding on disturbed openings in the shrub canopy and gopher mounds).

Seed Balls

It is envisioned that school-aged volunteers managed by CBI and TNC will create the seed balls for the QCB seeding experiment. The recipe for making the seed balls is as follows:

- 5 parts dry terra cotta clay
- 3 parts dry organic compost
- 1 part seed
- Enough water to bind all ingredients and allow for rolling into marble-sized balls.

The seed balls will be dried and delivered to the Contractor (Nakae) to distribute within identified test plots at Sites 1 and 3. Approximately, three to six seed balls will be applied per square foot for a total of between 14,000 and 28,000 seed balls for both Site 1 and Site 3.

Hand Broadcast

Prior to seeding, the surface of the plots will be lightly scarified with a rake. Identified plots at Site 1 and Site 3 will be hand-seeded using a small hand-held spreader to evenly broadcast the seeds. Following seeding, a rake will again be applied to lightly cover the seeds no more than ½-inch of soil.

Post-Seeding Weed Management

Prepare a post-seeding adaptive maintenance management plan, based on monitoring results. Weed management may continue with hand weeding only, or very selective spot herbicide application, as necessary.

A schedule for implementing the restoration treatments and monitoring events is presented in Table 2 for implementation at both Sites 1 and 3.

Table 2. Implementation and Short-Term Sampling Schedule for QCB Habitat Restoration Experiment.

Year	2013				2014				2015				2016			
Season	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F
Seed Collection				X	X	X	X	X	X	X	X					
Experiment Layout			X	•												
Site Preparation: Hand Weeding					X				X							
Spot Herbicide						X				X						
Seeding Treatments (n=6): (a) Seed Ball (b) Hand Seed												X X				
Post-Seeding Management													•	•		
Qualitative Monitoring					Qt	Qt	•	•	Qt	Qt	•	Qt	•	•		
Quantitative Sampling										$				X		

** = If necessary*
Qt = Once per quarter unless conditions require more oversight
$ = Not Conducted due to budget/funding constraints (Updated June 30, 2015)

Forbland Restoration and Experiment

Site 2 at the mouth of Sycamore Canyon lends itself to the comparison of two mechanized site preparation methods and one seeding method for restoration of a native forbland. The Site 2 conditions and proposed tests for site preparation are summarized in Table 1. The site has relatively sparse native forb component and it is accessible for larger equipment. The site preparation methods to test are (a) repeated mowing; and (b) broadcast application of herbicide with non-selective glyphosate. Seeding will be accomplished across all treatments using a mechanized broadcast method.

Research Goal

Assess the effectiveness of two mechanized site preparation techniques that limit soil disturbance while reducing weed cover in sites with good access and low native forbland cover, prior to the application of a forbland seed mix.

Research Questions

- Does (a) two years of winter and spring mowing, leaving thatch or (b) two years of winter and spring broadcast application of glyphosate more successfully reduce the cover of non-native forbs and grasses prior to seeding?
- Are there differences between techniques in the successful establishment of persistent populations of seeded species?

- Are there differences between techniques in the diversity and cover of native and non-native species in the years following seeding?

Experimental Design and Plot Size

In order to evaluate the effectiveness of two site preparation techniques (repeated mowing and repeated broadcast herbicide application) for the establishment of forbland habitat, eight replicates of each treatment will be randomly assigned to plots at Site 2 in Sycamore Canyon. The test plot size for each replicate will be 24 x 50 feet which is large enough to allow for the use of equipment fro both site preparation and seeding. Following two years of site preparation treatments, the plots will be seeded in the fall 2015 using a broadcast, pull-behind type seeder. Control plots will be established where no action occurs.

The total number of manipulated test plots is 16 (2 treatments x 8 replicates) and in aggregate is about 0.44 acres in size. The distribution of the replicate test plots will be blocked together by treatments within the approximately 14-acre site within a mowed buffer. The control plots will be located outside the mowed buffer.

CBI and NewFields will be responsible for identifying the blocks and plots. The corners of the plots will also be documented with geographic coordinates using a sub-meter GPS and incorporated into a geospatial database. Areas of cultural resources identified previously by (Bureau of Land Management) BLM will be avoided when locating the experimental blocks.

The Contractor (Nakae) will stake the plots with reinforcing bar and PVC pipe, color-coded and labeled with the treatment name to avoid ambiguity. The PVC pipe shall be 1 meter high on average to allow for visual contact by equipment operators.

Restoration Specifications

It is proposed to test two site preparation methods at Site 2 in Sycamore Canyon. The following sections describe the restoration methods.

Site Preparation

In fall 2013, the test plots will be mowed across the site within the test plots and buffer area. Thatch will be removed from the test plot areas only by first wind-rowing the thatch, either by hand or using a hay rake, and collecting and removing the thatch off site.

Once, the thatch removal is complete, weeding will be implemented using the following two treatments in identified plots:

(a) Repeated mowing in winter (1 time) and spring (1 time) for 2 years (2014 and 2015), leaving the thatch; and

(b) Herbicide treatment with non-selective Glyphosate for all weeds in winter (1 application) and spring/summer (1 application) for 2 years (2014 and 2015), with no hand-weeding or mowing. Herbicide shall be applied according to

the recommended application rate on the herbicide label for wildlands. Herbicide treatment shall be conducted only when weather conditions are conducive to effective uptake of the herbicide by the target species (e.g. sunny, dry with ambient temperatures at least 65 degrees Fahrenheit) and when plants are at the specified growth stage. Wind conditions should be five mph or less to minimize herbicide drift. Treated plants shall not be disturbed until the applied herbicide has had time to take effect per the manufacturer's instruction.

A buffer of approximately 10 acres will be mowed around the experimental treatment blocks/plots in the winter (1 time) and spring/summer (1 time) of both years (2014 and 2015).

Seeding

There would be no test of seeding methods; therefore, the seed mix will be the same for all treatments. The seed mix for forbland restoration is shown in Appendix B (Table B3) and will be provided to the Contractor (Nakae). Wheat bran will be added to the seed mix at ¼ the weight of the specified bulk rate. The specified bulk seed mix and wheat bran will be mixed prior to delivery to the Contractor (Nakae), with identification tags listing each species by weight, including any weed seed in the mix as per required by law. Tags will be collected as seeding progresses.

All plots will be broadcast seeded with an 8-foot wide, pull-type broadcast seeder towing an 8-foot-wide culti-packer roller. A wheeled tractor will be used to pull the seeder. The tractor should be set at between 3 and 4 mph, and the seeder calibrated accordingly to dispense the appropriate amount of seed within each treatment plot. Seeds shall be planted at a depth of not less than ¼ inch and no greater than ½ inch.

Post-Seeding Weed Management

Prepare a post-seeding adaptive maintenance management plan, based on monitoring results. Weed management may include hand weeding, or selective spot herbicide application, as necessary.

A schedule for implementing the restoration treatments and monitoring events is presented in Table 3.

Table 3. Implementation and Monitoring Schedule for Forbland Restoration Experiment.

Year	2013				2014				2015				2016			
Season	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F
Seed Collection				X	X	X	X	X	X	X	X					
Experiment Layout			X	•												
Initial Mowing/Clearing				X												
Experimental Site Preparation Treatments: (a) Mowing (b) Broadcast Herbicide					X	X			X	X						
Mow Buffer Around Test Plots					X	X			X	X						
Seeding												X				
Qualitative Monitoring				Qt	Qt	Qt	•	•	Qt	Qt	•	•	Qt	Qt		
Quantitative Sampling										$				X		

* = If necessary
Qt = Once per quarter unless conditions require more oversight
$ = Not Conducted due to budget/funding constraints (Updated June 30, 2015)

Native Grassland Habitat and Otay Tarplant

Native grasslands generally occur on clay loam to clay soils that support native grasses, forbs and geophytes, but only scattered shrub species, if present at all. OTP occurs in heavy clay soils with native grasses or in clay occlusions between patches of scrub habitat (Bauder *et al.* 2002). Four sites, 4 through 7, are suitable for testing restoration techniques for native grasslands. Of those sites, four have heavy clay soils suitable for OTP restoration. Additionally, clay soil grasslands at Rancho Jamul that have experienced recent accidental ignition or prescribed fall season burns (Sites 4 and 8) provide a good comparison to clay soil grassland sites at Rancho Jamul (Site 5) and Sweetwater Reservoir (Sites 6 and 7) that will not be burned prior to restoration. Table 1 summarizes the sites and experimental treatments in Sites 4 through 7.

Studies of OTP and related tarplant species (*Deinandra fasciculat*a and *D. paniculata*) demonstrate the occurrence of OTP and the absence of other tarplant species on heavy clay soils (Bauder and Truesdale 2000). However, in one of the most clayey sites sampled by Bauder and Trousdale, OTP is absent, and *D. fasciculata* occurs with San Diego thornmint (*Acanthomintha ilicifolia*). The presence of San Diego thornmint suggests that the soil is calcareous (USFWS 2009a). At Rancho Jamul, one of the native grassland sites was formerly mined for limestone. Although the lower portion of the site with heavier clay soil does not appear to have limestone, soil testing would determine the presence or absence of limestone. This

spring 2013, OTP was observed in Site 4. There is the potential to compare OTP restoration at Site 4, within the heavier clay soils, to sites without limestone soils, such as in the Sweetwater Reservoir Sites 6 and 7. Results from this test could help to refine habitat requirements for OTP and identify potential sites for OTP establishment.

Native Grassland Restoration and Experiment

Research Goals

- Compare the effectiveness of seeding the full extent of the native grassland restoration area versus the DeSimone strip method, which has the promise of allowing for the recruitment of maturing seeded natives into mowed buffer strips, thereby expanding the area capable of being restored when seed material and/or resources are limited.
- Determine whether a recent fall burn an impact on the success of the two restoration approaches for native grassland restoration.
- Evaluate whether hand methods as effective for native grassland restoration as mechanized methods.

Research Questions

- Which of the following two restoration approaches is more effective in restoring native perennial grassland in a type-converted annual grassland, as measured by native cover and diversity (3, 5 and 10+ years post seeding)?
    - Repeat mowing for two years, followed by drill seeding one-way in strips with mowed buffers between seeded strips; or
    - Repeat herbicide application for two years (selective Fluazifop applied in winter for annual grasses and non-selective Glyphosate for all weeds in spring), followed by two-way drill seeding (perpendicular passes) across the entire site.
- What is the effect of a recent fall burn (one year prior to beginning of restoration) on the effectiveness of the two native grassland restoration approaches, compared to restoration in areas burned six years ago in the Harris fire?
- Are hand methods (weed whipping, backpack spraying and hand seeding) as effective as mechanized methods (mowing, mechanized broadcast spraying and drill seeding) in controlling non-natives and successfully establishing natives in native grassland restoration?

Experimental Design and Plot Size

The total number of manipulated grassland test plots is 48 (2 treatments x 6 replicates x 4 Sites) and in aggregate is 4.86 acres in size. The distribution of the replicate test plots will be blocked together by treatments within the four sites within a mowed buffer. The control plots will be located outside the mowed buffer.

CBI and NewFields will be responsible for identifying the blocks and plots at each of the four sites. The corners of the plots will also be documented with geographic coordinates using a sub-meter GPS and incorporated into a geospatial database.

The Contractor (Nakae) will stake the plots with reinforcing bar and PVC pipe, color coded and labeled with the treatment name to avoid ambiguity. The PVC pipe shall be 1-meter high on average to allow for visual contact by equipment operators.

Large-Scale Restoration

The effectiveness of two restoration approaches for relatively large-scale native grassland restoration will be tested as treatments in a paired sample experimental design (n=6) fully replicated across two sites with similar recent fire histories (Site 5 at Rancho Jamul and Site 6 at Sweetwater Reservoir) and at a third, Site 4 at Rancho Jamul, with a different fire history. Sites 4, 5, and 6 have similar soil types and clay content but differ in their fire histories. Site 4 was last burned in fall 2012, while Site 5 and 6 were not. Sites 4 and 5 were both burned in the 2003 Otay fire. All three sites were burned in the 2007 Harris fire.

The test plot size for each replicate of a treatment will be 72 x 72 feet. While the two treatments have different site preparation and seeding approaches determined by constraints of their design and requirements for weed management, both will have the same seed mix applied within seeded areas at the same density. For the DeSimone strip method, no seed will be applied in the approximately 6-foot mowed strips in between seeded strips.

A buffer area around the restoration treatments will be mowed in the grasslands for two years. Six control replicates will be randomly located outside of the restoration treatments and the mowed buffer.

Small-Scale Restoration

In order to evaluate the effectiveness of hand methods for relatively small-scale native grassland restoration, two restoration methods will be compared at Site 7 at Sweetwater Reservoir. The two methods are (a) DeSimone strip method with mowed buffers, and (b) herbicide control of weeds (selective Fluazifop in winter for annual grasses followed by non-selective Glyphosate for all weeds in spring/summer for 2 years). Both treatments will be hand seeded with the same seed mix at the same rates per unit area (or density). The test plot size will be 72 x 30 feet. Treatment samples will be paired and randomly distributed across the site (n=6). A buffer will be mowed around all paired samples. Six control plots will be located outside of the restoration plots and mowed buffer.

Restoration Specifications

It is proposed to test two site preparation methods for native grassland restoration scaled for both large and small restoration projects. Sites 4, 5 and 6 at both the Rancho Jamul and Sweetwater Reservoir study areas are large enough to test mechanized methods of mowing, herbicide applications, and seeding. Site 7 at

Sweetwater Reservoir will be used to test these same methods by hand equipment (e.g. weed whipping and hand seeding). The following treatments are proposed to test the effectiveness of two native grassland restoration approaches.

Site Preparation

The following activities are included in site preparation

- Fall 2012 burn at Rancho Jamul (Site 4);
- Initial Mowing and dethatching of plots, as necessary at Rancho Jamul (Sites 4 and 5) and Sweetwater Reservoir (Sites 6 and 7) in fall 2013. In large-scale plots, dethatching will be implemented using a tractor-pulled mower and windrowing thatch with a hay rake for removal off site. In small-scale plots, mowing will be accomplished with weed whips and raking to remove thatch off site.

Large-Scale Restoration

Once the initial mowing and dethatching is implemented, two approaches will be applied as site preparation continues (Sites 4, 5 and 6):

- DeSimone strip method
  - Site preparation: 2 years of mowing before annual grass seed reaches 'milk' stage to control annual grasses in winter and spring.
- Full extent seeding method
  - Site preparation: herbicide treatments with selective Fluazifop in winter for annual grasses followed by non-selective Glyphosate for all weeds in spring/summer for 2 years. Herbicide shall be applied according to the recommended application rate on the herbicide label for wildlands. Herbicide treatment shall be conducted only when weather conditions are conducive to effective uptake of the herbicide by the target species (e.g. sunny, dry with ambient temperatures at least 65 degrees Fahrenheit) and when plants are at the specified growth stage. Wind conditions should be five mph or less to minimize herbicide drift. Treated plants shall not be disturbed until the applied herbicide has had time to take effect per the manufacturer's instruction.
- For two years (2014 and 2015), at Sites 4, 5 and 6, a buffer will be mowed around the treatment plots twice per year (spring and fall) to manage the annual grasses without disturbing the soil.

Small-Scale Restoration

At Site 7 at Sweetwater Reservoir, similar restoration approaches will be applied as above, but with hand methods due to access limitations:

- DeSimone strip method
  - Site preparation: 2 years of line-trimming (weed-eating) by hand before annual grass seed reaches 'milk' stage to control annual grasses in winter and broad-leaf weeds in spring.
- Full extent seeded method
  - Site preparation: herbicide treatments with selective Fluazifop in winter for annual grasses followed by non-selective Glyphosate for all weeds in spring/summer for 2 years.
- For two years (2014 and 2015), a buffer will be hand-mowed around the treatment plots twice per year (spring and fall) to manage the annual grasses without disturbing the soil.

Seeding

While there are tests of strip seeding and full extend seeding methods, the seed mix will be the same for all treatments. The seed mix for native grassland restoration is shown in Appendix B (Table B4) and will be provided to the Contractor (Nakae). Because the seed will be both drill seeded and hand seeded, wheat bran will be added to the seed mix at ¼ the weight of the specified bulk rate to insure seeds do not clump in the seed bins. The specified bulk seed mix and wheat bran will be mixed prior to delivery to the Contractor (Nakae), with identification tags listing each plant species by weight, including any weed seed in the mix as per required by law. Tags will be collected as seeding progresses.

Large-Scale Restoration

All plots (Site 4, 5, and 6) will be drill seeded with an 8-foot wide, range drill-type seeder with row discs before and wheels behind the seed row. A wheeled tractor will be used to pull the seeder. The tractor should be set at between 3 and 4 mph, and the seeder calibrated accordingly to dispense the appropriate amount of seed within each treatment plot. Seeds shall be planted at a depth of not less than ¼ inch and no greater than ½ inch.

- DeSimone strip method
  - Seeding: drill seed one-way in strips with mowed buffers between seeded strips.
- Full extent seeding method
  - Seeding: drill seed two ways (perpendicular passes) over the entire plot.

SMALL-SCALE RESTORATION

Prior to seeding, the surface of the plots will be lightly scarified with a rake. All plots at Site 7 will be hand-seeded using a 'belly grinder' to broadcast seeds. The seeder will be calibrated and applied evenly over the test plots. Following seeding, a rake will again be applied to lightly cover the seeds no more than ½-in.

- DeSimone strip method
  - Seeding: hand broadcast seeding in strips.
- Full extent seeded method
  - Seeding: hand broadcast seeding.

Post-Seeding Weed Management

A post-seeding management plan will be prepared based on monitoring results that might continue with hand weeding only, or perhaps, continue mowing and herbicide tests. A schedule for implementing the restoration treatments and monitoring events is presented in Table 4.

Table 4. Implementation and Monitoring Schedule for Native Grassland Restoration Experiment.

Year	2013				2014				2015				2016			
Season	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F
Seed Collection					X	X	X	X	X	X	X					
Experiment Layout			X	•												
Initial Clearing				X												
Experimental Site Preparation Treatments (Sites 4,5,6): (a) Mowing (b) Broadcast Herbicide (Site 7): (c) Line Trimming (d) Backpack Spray					X	X			X	X						
Mow Buffer Around Test Plots					X	X			X	X						
Seeding (Sites 4,5,6): (a) Drill-Seed (1-way) (b) Drill-Seed (2-way) (Site 7): (c) Hand-Seed Strips (d) Hand-Seed												X				
Qualitative Monitoring				Qt	Qt	Qt	•	•	Qt	Qt	•	•	Qt	Qt		
Quantitative Sampling										$				X		

* = If necessary
Qt = Once per quarter unless conditions require more oversight
$ = Not Conducted due to budget/funding constraints (Updated June 30, 2015)

Otay Tarplant Habitat Restoration and Experiment

Sites with the minimum habitat requirements, especially high clay content soils, for OTP were identified at Site 4 at Rancho Jamul and Sites 6 and 7 at Sweetwater Reservoir. Site 4 is unique because it contains areas of calcareous soil (containing lime), which is hypothesized to be limiting to the establishment of OTP (see discussion above).

Research Goals

- Evaluate the success of establishing OTP populations using hand-broadcast seeding or two-way drill seeding.
- Determine if calcareous soils are limiting to the establishment of OTP populations.

Research Questions

- Are there significant differences in the successful establishment of OTP populations using hand-broadcast seeding compared with mechanized two-way drill seeding?
- Does the presence of lime in calcareous soil reduce the successful establishment of OTP populations in clay soils?

Experimental Design and Plot Size

Areas of elevated lime content and high clay content at Site 4 at Rancho Jamul will be used to compare the effect of calcareous soils on OTP establishment with areas of similarly high clay content at Site 6 at Sweetwater Reservoir. The same restoration method will be applied at both sites across six randomly located replicate plots placed within the target soil conditions at these two sites. The plots will be 72 x 72 feet.

At Site 7 at Sweetwater Reservoir, six additional plots (72 x 30 feet) will be randomly located within areas of high clay content for site preparation and hand seeding with the OTP added that will be used at Sites 4 and 6. The site preparation method will be the same as will be used in Site 7 for the native grassland hand method herbicide treatment.

The total number of manipulated OTP test plots is 18 (1 treatment x 6 replicates x 3 sites) and in aggregate is 1.72 acres in size. The distribution of the replicate test plots will be located in appropriate clay soils within the three sites within a mowed buffer. The control plots will be located outside the mowed buffer.

CBI and NewFields will be responsible for identifying the blocks and plots at each of the three sites. The corners of the plots will also be documented with geographic coordinates using a sub-meter GPS and incorporated into a geospatial database.

The Contractor (Nakae) will stake the plots with reinforcing bar and PVC pipe, color coded and labeled with the treatment name to avoid ambiguity. The PVC pipe shall be 1-meter high on average to allow for visual contact by equipment operators.

Restoration Specifications

At Sites 4, 6 and 7, areas with the highest clay content will be selected for testing OTP restoration. OTP restoration will be tested by seeding into plots treated as outlined above for the native grassland experimental treatments for repeated herbicide application and full extent seeding. The only difference in the method is the application of the OTP seed mix. (See Appendix B, Table B-5). The OTP seed mix is similar to the native grassland mix, but it focuses on species more likely to be found in heavy clay soils.

For clarity, the methods are repeated here:

- Pre-site preparation: mowing and dethatching of plots, as necessary at Rancho Jamul (Site 4) and Sweetwater Reservoir (Sites 6 and 7) in fall 2013.
- Site preparation:
    - Sites 4 and 6: mechanized broadcast application of herbicide with selective Fluazifop in winter for annual grasses followed by non-selective Glyphosate for all weeds in spring/summer for 2 years.
    - Site 7: backpack-type spray application of herbicide by hand with selective Fluazifop in winter for annual grasses followed by non-selective Glyphosate for all weeds in spring/summer for 2 years.
- Seeding:
    - Sites 4 and 6: drill seed two ways (perpendicular passes) over entire plot using a range drill type seeder.
    - Site 7: hand broadcast seed using a 'belly grinder'.
- Post Seeding Weed Management: Prepare a post seeding management plan, based on monitoring results that might continue with hand weeding only, or perhaps, continue mowing and herbicide tests.

A schedule for implementing the restoration treatments and monitoring events is presented in Table 5.

Table 5. Implementation and Monitoring Schedule for Otay Tarplant Habitat Restoration Experiment.

Year	2013				2014				2015				2016			
Season	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F
Seed Collection and Seed Bulking for OTP				X	X	X	X	X	X	X	X					
Experiment Layout			X	•												
Initial Clearing				X												
Experimental Site Preparation Treatments (Sites 4,6): Broadcast Herbicide (Site 7): Backpack Spray					X	X			X	X						
Mow Buffer Around Test Plots					X	X			X	X						
Seeding (Sites 4,6): Drill-Seed (2-way) (Site 7): Hand-Seed												X				
Qualitative Monitoring				Qt	Qt	Qt	•	•	Qt	Qt	•	•	Qt	Qt		
Quantitative Sampling										$				X		

** = If necessary*

Qt = Once per quarter unless conditions require more oversight

$ = Not Conducted due to budget/funding constraints (Updated June 30, 2015)

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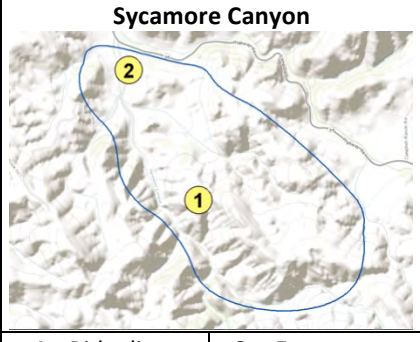
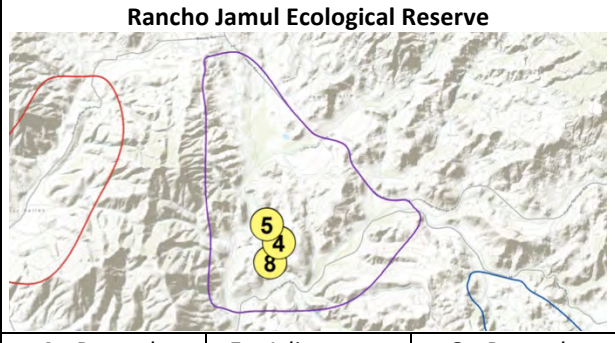
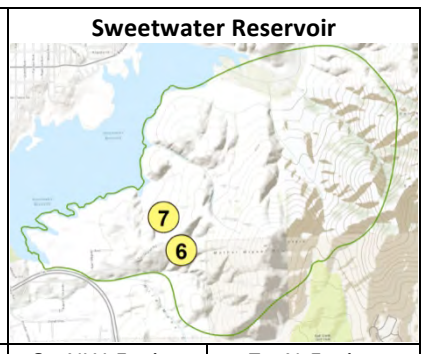
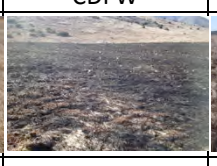
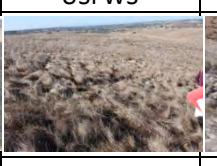
Appendix A

Table A1 - Phase II Restoration Areas and Experimental Treatments

Table A1. Phase II Restoration Areas and Experimental Treatments.

Property	**Sycamore Canyon**		**Proctor Valley**	**Rancho Jamul Ecological Reserve**			**Sweetwater Reservoir**	
								
Site	**1** - *Ridgelines*	**2** – *Entrance to Sycamore Canyon*	**3** – *Ridgelines and Slopes*	**4** - *Recently Burned Grassland*	**5** - *Adjacent to Burned Grassland*	**8** - *Recently Burned Grassland*	**6** - *NW-Facing Slope*	**7** - *N-Facing Slope*
Associated CBI HAP Polygon UIDs	12-2-33 12-2-34 12-2-36	11-2-11 11-2-12	11-4-15	11-1-09 (CDFW treated 5.6 ac in Mar/Apr 2013 and left 3.1 ac untreated)	Mar/Apr 2013 treated portion of site 5 = 2.32 ac (HA 13-1-85b) Untreated portion of site 5 = 8.21 ac (HAs 13-1-85a and 13-1-85c)	NA	11-3a-04 11-3a-06 11-3a-02	11-3a-29
Land Owner	BLM	BLM	USFWS	CDFW	CDFW	CDFW	USFWS	USFWS
Representative Site Photo								
Restoration Targets **Quino Checkerspot Butterfly (QCB) Habitat**	Treatments within open areas across 4.5-acres		Treatments within open areas across 11.5-acres					
Forbland		Treatments within 14-acres						
Otay Tarplant (OTP) Habitat				Treatments for OTP within 3-4 acres of lower slope		Treatments for OTP within ~2 acre historic OTP area (2004 observation) that was burned.	Treatments for OTP at northeast end within 15-acres of NG restoration area.	Treatments for OTP at lower slope within native grassland restoration area.
Native Grassland				Treatments for NG restoration within 2012 Fall burn. ~9.5-acres of upper slope within 13.5-acres.	Treatments for NG restoration in non-burned area within 5.5-acre site.		Treatments in non-burned site for NG restoration within 15-acres.	Treatments in non-burned site for NG restoration within 3.5-acres.
Existing Conditions								
Fire History (100-year Cal Fire Record)	--- Harris 10/2007 --- Otay 10/2003 Sycamore 8/1995 --- Honey 8/1976 --- --- ---	--- Harris 10/2007 --- Otay 10/2003 --- --- --- --- --- ---	--- Harris 10/2007 --- --- --- Miller 1985 --- --- Wet Back 1950 Wildfire 1911	Wildfire 6/2012 Harris 10/2007 --- Otay 10/2003 --- --- --- --- --- ---	--- Harris 10/2007 --- Otay 10/2003 --- --- --- --- --- ---	Prescribed 10/12 Harris 10/2007 --- Otay 10/2003 --- --- --- --- --- ---	--- Harris 10/2007 --- --- --- --- --- Laguna 9/1970 --- Wildfire 1911	--- Harris 10/2007 --- --- --- --- --- Laguna 9/1970 --- Wildfire 1911
Soil Type & Texture (USDA 1973)	Friant Series Ridges and slopes with rock outcrops and very shallow rocky fine sandy loam soils underlain by impervious bedrock	Escondido Series Lower slopes are well drained fine sandy loam, moderately deep (36-60 in. deep over rock). Ridge tops include Friant Series	San Miguel-Exchequer rocky silt loam	Bosanko Stony Clay Series Gentle to moderate slopes with clayey soil and common stones. Soil description includes soft lime concretions. ***Note:*** *Site 4 has limestone (indicates calcareous soils), obvious at the surface, in upper slope. See text.*			Diablo Clay Series within larger landscape mapped as San Miguel-Exchequer rocky silt loam	
Existing Habitat	Good quality CSS, with some cryptobiotic soil crusts. QCB host plant (*Plantago erecta*) observed in some areas per CBI/TNC.	Sparse shrub cover (*A. californica* and and areas of *N. pulchra* with interspaces dominated by *Erodium* and native forbs occasional. Surrounding areas dominated by more exotic grass (*Avena barbata, Bromus madritensis and Bromus diandrus*)	Sparse CSS with good cryptobiotic soil crusts. Interspaces dominated by *Erodium* spp. With native forbs occasional. Some areas were recently subject to USFWS restoration treatments, but poor germination rates observed to date. No existing QCB host plants here.	Mapped as *Nassella pulchra* Association pre-2012 fire. Scattered *N. pulchra* growing back after fire.	Remnant *N. pulchra* population similar to Site 4 and devoid of native shrubs.	Primarily annual grassland pre-2012 fire with historic populations of OTP documented before 2007 fire.	Mainly annual grasses, but at northeast end of site, *N. pulchra*, many geophytes, *Lessingia filanginifolia*, with scattered *Ferocactus viridescens.*	*N. pulchra*, w/ scattered *Artemisia californica* and *Baccharis sarothroides*.
Weed Load	Large openings in shrub canopy dominated by exotic forbs (especially *Erodium* spp.) with low annual grass biomass.			High percentage of *Brachypodium distachyon* and *Avena barbata*. Existing seedbank likely growing back post 2012 fire. Upper slope treated with herbicide to control grasses with follow up mowing	Similar to Site 4, with high cover of annual grass, including *A. barbata, B. distachyon* and *B. diandrus*	Dominated by annual grass, including *Avena spp.* and *B. diandrus*	Dominated by annual grass, including *Bra. distachyon*, *Bromus hordeaceus* and *Avena* spp., non native forbs also present, including *Raphanus sativus*, *Cynara cardunculus.*	Dominated by annual grass, including *Bra. distachyon*, *Bromus hordeaceus* and *Avena* spp., *Foeniculum vulgare*.
Ease of Access	Difficult (4WD)	Moderate (Dirt Road)	Moderate (Poor Dirt Road)	Moderate (Dirt Road)	Moderate (Dirt Road)	Moderate (Dirt Road)	Easy (Maintained Dirt Road)	Moderate, steep and rocky for equipment

Site	**1** - *Ridgelines*	**2** – *Entrance to Sycamore Canyon*	**3** – *Ridgelines and Slopes*	**4** - *Recently Burned Grassland*	**5** - *Adjacent to Burned Grassland*	**8** - *Recently Burned Grassland*	**6** - *NW-Facing Slope*	**7** - *N-Facing Slope*
Site-Specific Restoration Methods								
Pre-Seeding Site Preparation **(2 years for Sites 1,2,3,6 & 7: 2014 and 2015)** **(3 years for Sites 4,5 & 8: 2013-2015)**	No test of site preparation methods based on previous work (Dodero) and site conditions. The following will be conducted across the site: 1. Dethatch and remove biomass with hand tools from seeding sites (primarily non-native forbs like *Erodium* sp.). Then, conduct site preparation for 2 years: 2. Hand weeding in winter (cut off non native forbs just below soil, avoiding crust areas.) 3. Apply low dose of non-selective herbicide (Glyphosate) as necessary in spring.	1. Dethatch with mowing and remove biomass (mechanized to the extent the site allows) in fall 2013. Then, test two experimental site preparation treatments, conducted for 2 years each: A. Test repeat mowing in winter and spring, leaving thatch; or B. Test mechanized herbicide application of non-selective herbicide (Glyphosate) in winter and spring, with no hand weeding.	No test of site preparation methods based on previous work (Dodero) and site conditions. The following will be conducted across the site: 1. Dethatch in test areas where previous weeding/seedin g tests were conducted in the Proctor Valley site. To avoid damaging soil crusts, weed only areas without crust, (e.g. gopher mounds) Then, conduct site preparation for 2 years: 2. Hand weeding in winter (cut off non native forbs just below soil, avoiding crust areas.) 3. Apply low dose of non-selective herbicide (Glyphosate) as necessary in spring.	1. Site 4 was burned by a wildfire on June 20, 2012 – but, Site 5 was not. 2. CDFW treated NG areas in Sites 4 and 5 in Mar/Apr 2013 with Fusilade and conducted follow up mowing for broadleaf weeds. OTP area (lower slope of Area 4 was not treated) not treated. (Modification of original proposal to include an extra year of site prep. in NG restoration with and without fire pre-treatment) 3. Initial mechanical mowing and biomass removal (dethatching) in fall 2013. Then, test one of two restoration approaches: A. DeSimone strip method: Mow before annual grass seed is at 'milk stage'; with repeat mowing for broad leaf weeds; or B. Full extent seeding method: herbicide treatments with selective Fluazifop in winter for annual grasses followed by non-selective Glyphosate for all weeds in winter.		1. Cal-Fire conducted a prescribed burn on November 20-21, 2015. Then, test of three experimental weed management methods to reduce thatch and exotic cover in site with extant OTP population: A. Early winter Fluazifop application, followed with Glyphosate in spring, as needed; or B. Mow before annual grass seed is at 'milk stage' once, then no other treatment. C. Line Trim before annual grass seed is at 'milk stage' once, then no other treatment. *NOTE: Thatch developed after burn but before mow and line trim treatments.*	See Sites 4 and 5.	This site tests methods for sites where mechanized methods are not possible. 1. Initial mowing with weed whip and biomass removal in fall 2013. Then, test two experimental site preparation methods conducted for 2 years: A. Early winter Fluazifop application, followed with Glyphosate in spring, as needed; or B. Mow before annual grass seed is at 'milk stage'; with repeat mowing as necessary.
Mowed Buffer (acres) around Restoration Treatments (winter and spring in 2014 and 2015)	NA *(Control Highly Invasive Species in vicinity only)*	10	NA *(Control Highly Invasive Species in vicinity only)*	9.9	1.9	~20-30	9.2	4.2
Seeding Technique (Fall 2015)	Using the same seed mix, test two seeding methods. A. Seed balls; or B. Scarification and hand-seeding	There will be no test of seeding methods. Use the same seed mix over the site, and seed with a broadcast pull-behind type seeder.	See Site 1.	Using the same seed mix, apply the seed at equal rates: A. DeSimone strips: apply with one-way drill seeding, leaving mowed unseeded buffer strips; and B. Full extent: apply by two-way drill seeding (perpendicular passes) over entire plot.		The status of the historic OTP population will be assessed following site preparation treatments and the need for seed additions will be evaluated and a seeding plan developed.	See Sites 4 and 5.	Using the same seed mix, apply the seed at equal rates: A. Hand broadcast in strips with mowed buffers between seeded areas; or B. Hand broadcast see at rate equal to that in strips.
Post-Seeding Weed Management	Prepare a post seeding management plan, based on monitoring results that might continue with hand weeding only, or spot herbicide application.			Prepare a post seeding management plan, based on monitoring results that might manage with hand weeding or continue with mowing and herbicide tests.				

Appendix B
Seed Tables

Appendix B - Table B1. Estimated Live Seed Need for each Species by Test Plot and Total for Project Collection. Live seed estimates based on Tables 2 – 5 for desired cover/occurrence in each habitat and average live seed estimated per bulk pound. The ultimate bulk pounds applied will be adjusted as necessary once seed tests confirm germination and purity of collected seeds.

Scientific Name	Common Name	Target Live Seed/Bulk Pound	Total LS Forbland Test Plots 0.44 acre	Total LS Quino Test Plots 0.22 acre	Total LS Grassland Test Plots 4.86 acre	Total LS Otay Tarplant Test Plots 1.72 acre	Total Live Seed Needed
Amsinkia intermedia	Fiddleneck	92,000			447,120		**447,120**
Calichortus splendens	Splendid mariposa lily	280,000			680,400	240,800	**921,200**
Castilleja exserta	Owl's clover	1,500,000	330,000	330,000	3,645,000		**4,305,000**
Corethrogyne filaginifolia	Cudleaf aster	25,800	5,676		62,694	22,188	**90,558**
Cryptantha intermedia	Common cryptantha	10,000	6,600	2,200			**8,800**
Croton setigerus	Turkey mullein	32,500	21,450		157,950		**179,400**
Daucus pusillus	Wild carrot	100,000	22,000		243,000		**265,000**
Dichelostemma capitatum	Blue dicks	488,000			473,360	165,920	**639,280**
*Deinandra conjugens**	Otay tarplant	180,000				619,200	**619,200**
Deinandra fasciculata	Fascicled tarplant	180,000	158,400		1,312,200		**1,470,600**
Gilia angelensis	Chaparral gilia	480,000		52,800			**52,800**
Grindelia camporum	Gumplant	35,000			85,050	30,100	**115,150**
Lasthenia californica	Dwarf goldfields	2,000,000	880,000	220,000	9,720,000	3,440,000	**14,260,000**
Layia platyglossa	Tidy tips	300,000	264,000		2,916,000	1,032,000	**4,212,000**
Logfia filaginoides	California filago	30,000	19,800				**19,800**
Lotus strigosus	Bishop's lotus	320,000	70,400				**70,400**

Scientific Name	Common Name	Target Live Seed/Bulk Pound	Total LS Forbland Test Plots 0.44 acre	Total LS Quino Test Plots 0.22 acre	Total LS Grassland Test Plots 4.86 acre	Total LS Otay Tarplant Test Plots 1.72 acre	Total Live Seed Needed
Lupinus bicolor	Miniature lupine	90,000	79,200	39,600	874,800	309,600	**1,303,200**
Lupinus microcarpus var. *densiflorus*	Chick lupine	10,500			51,030		**51,030**
Lupinus truncatus	Collar lupine	32,000	14,080				**14,080**
Osmadenia tenella	False rosinweed	100,000	44,000	11,000	486,000		**541,000**
Pentachata aurea	Golden-ray pentachaeta	100,000				86,000	**86,000**
Pectocarya penicillata	Winged pectocarya	10,000	2,200				**2,200**
*Plantago erecta**	Dotseed plantain	212,500	187,000	374,000			**561,000**
Sanicula arguta	Sharp toothed sanicle	100,000			97,000	34,000	**131,000**
Sidalcea malviflora	Checker bloom	30,000			72,900		**72,900**
Sisyrinchium bellum	Blue-eyed grass	240,000	105,600		1,749,600	619,200	**2,474,400**
Stipa lepida	Foothill needlegrass	269,750	118,690				**118,690**
Stipa pulchra	Purple needlegrass	82,000	36,080		3,188,160	1,128,320	**4,352,560**

***** May require collecting permit

Appendix B - Table B2. Forbland Seed Palette – 0.44 acres of test plots

Scientific Name	Common Name	Flowering Period	Source	Desired Cover	Average Live Seed/Bulk Pound	Estimated Bulk Rate/Acre
Castilleja exserta	Owl's clover	March-June	Collect	common	1,500,000	0.5
Corethrogyne filaginifolia	Sand aster	May - August	Collect	occasional	25,800	0.5
Cryptantha intermedia	Common cryptantha	March-July	Collect	occasional	10,000	1.5
Croton setigerus	Turkey mullein	July - September	Collect	common	32,500	1.5
Daucus pusillus	Wild carrot	March - May	Collect	occasional	100,000	0.5
Deinandra fasciculata	Fascicled tarplant	May- July	Collect	common	180,000	1.0
Lasthenia californica	Dwarf goldfields	March-May	Commercial	common	2,000,000	1.0
Layia platyglossa	Tidy tips	February-May	Collect	common	300,000	2.0
Logfia filaginoides	California filago	March - April	Collect	occasional	30,000	1.5
Lotus strigosus	Bishop's lotus	March-June	Commercial	occasional	320,000	0.5
Lupinus bicolor	Miniature lupine	March-June	Commercial	common	90,000	2.0
Lupinus truncatus	Collar lupine	March - June	Collect	occasional	32,000	1.0
Osmadenia tenella	False rosinweed	March-June	Collect	common	100,000	1.0
Pectocarya penicillata	Winged pectocarya	March-June	Collect	occasional	10,000	0.5
*Plantago erecta**	Dotseed plantain	March-April	Collect	common	212,500	2.0
Sisyrinchium bellum	Blue-eyed grass	March - May	Collect	common	240,000	1.0
Stipa lepida	Foothill needlegrass	March - May	Collect	occasional	269,750	1.0
Stipa pulchra	Purple needlegrass	March - May	Collect	occasional	82,000	1.0
					Total Estimated Bulk Pounds/Acre	**20.0**

***** May require collecting permit

Appendix B - Table B3. Quino Checkerspot Butterfly Seed Palette – 0.22 acre of test plots

Scientific Name	Common Name	Flowering Period	Source	Desired Cover	Average Live Seed/Bulk Pound	Estimated Bulk Rate/Acre
Castilleja exserta	Owl's clover	March-June	Collect	dominant	1,500,000	1.0
Cryptantha intermedia	Common cryptantha	March-July	Collect	occasional	10,000	1.0
Gilia angelensis	Chaparral gilia	March-May	Collect	occasional	480,000	0.5
Lasthenia californica	Dwarf goldfields	March-May	Commercial	common	2,000,000	0.5
Lupinus bicolor	Miniature lupine	March-June	Commercial	common	90,000	2.0
Osmadenia tenella	False rosinweed	March-June	Collect	occasional	100,000	0.5
*Plantago erecta**	Dotseed plantain	March-April	Collect	dominant	212,500	8.0
					Total Estimated Bulk Pounds/Acre	**13.5**

***** May require collecting permit

Appendix B - Table B4. Native Grassland Seed Palette – 4.86 acre of test plots

Scientific Name	Common Name	Flowering Period	Source	Desired Cover	Target Live Seed/Bulk Pound	Estimated Bulk Rate/Acre
Amsinkia intermedia	Fiddleneck	March - May	Collect	common	92,000	1.0
Calichortus splendens	Splendid mariposa lily	April - June	Collect	occasional	280,000	0.5
Castilleja exserta	Owl's clover	March -June	Collect	common	1,500,000	0.5
Corethrogyne filaginifolia	Cudleaf aster	May - August	Collect	occasional	25,800	0.5
Croton setigerus	Turkey mullein	July - September	Collect	occasional	32,500	1.0
Daucus pusillus	Wild carrot	March - May	Collect	occasional	100,000	0.5
Dichelostemma capitatum	Blue dicks	February - May	Collect	occasional	488,000	0.2
Deinandra fasciculata	Fascicled tarplant	May- July	Collect	common	180,000	1.5
Grindelia camporum	Gumplant	April- October	Collect	occasional	35,000	0.5
Lasthenia californica	Dwarf goldfields	March-May	Commercial	common	2,000,000	1.0
Layia platyglossa	Tidy tips	February-May	Collect	common	300,000	2.0
Lupinus bicolor	Miniature lupine	March-June	Commercial	common	90,000	2.0
Lupinus microcarpus var. *densiflorus*	Chick lupine	May - June	Collect	occasional	10,500	1.0
Osmadenia tenella	False rosinweed	March -June	Collect	common	100,000	1.0
Sanicula arguta	Sharp toothed sanicle	March-April	Collect	occasional	100,000	0.2
Sidalcea malviflora	Checker bloom	May - August	Collect	occasional	30,000	0.5
Sisyrinchium bellum	Blue-eyed grass	March - May	Collect	common	240,000	1.5
Stipa pulchra	Purple needlegrass	March - May	Collect	dominant	82,000	8.0
					Total Estimated Bulk Pounds/Acre	**23.4**

Appendix B - Table B5. Otay Tarplant Seed Palette – 1.72 acre of test plots

Scientific Name	Common Name	Flowering Period	Source	Desired Cover	Target Live Seed/Bulk Pound	Estimated Bulk Rate/Acre
Calichortus splendens	Splendid mariposa lily	April - June	Collect	occasional	280,000	0.5
Corethrogyne filaginifolia	Sand aster	May - August	Collect	occasional	25,800	0.5
Dichelostemma capitatum	Blue dicks	March - May	Collect	occasional	488,000	0.2
*Deinandra conjugens**	Otay tarplant	May- June	Collect	common	180,000	2.0
Grindelia camporum	Gumplant	April- October	Collect	occasional	35,000	0.5
Lasthenia californica	Dwarf goldfields	March-May	Commercial	common	2,000,000	1.0
Layia platyglossa	Tidy tips	February-May	Collect	common	300,000	2.0
Lupinus bicolor	Miniature lupine	March-June	Commercial	common	90,000	2.0
Pentachata aurea	Golden-ray pentachaeta	March-June	Collect	occasional	100,000	0.5
Sanicula arguta	Sharp toothed sanicle	March-April	Collect	occasional	100,000	0.2
Sisyrinchium bellum	Blue-eyed grass	March - May	Collect	common	240,000	1.5
Stipa pulchra	Purple needlegrass	March - May	Collect	dominant	82,000	8.0
					Total Estimated Bulk Pounds/Acre	**18.9**
***** May require collecting permit						

Appendix 3. Soil Sampling Analysis Summary Memorandum

LAND IQ

3791 Wade Street
Los Angeles, CA 90066
310-390-3635

MEMORANDUM

DATE: 5 December 2013

TO: Conservation Biology Institute
The Nature Conservancy
South County Land Managers

FROM: Travis Brooks
Associate Ecologist

SUBJECT: Soil Sample Analysis Summary
Phase 2 South County Grasslands Project

This memorandum summarizes the results of soil samples collected and laboratory analysis performed for the Phase 2 South County Grasslands Project.

Purpose of Soil Sampling at the Restoration Sites:

The experimental design is predicated upon the existence of relatively similar conditions between sites. Sites that are being paired or grouped for comparison were selected based upon similar current vegetation cover, disturbance histories, fire histories, topographic features and soil characteristics. There will naturally be inherent differences between Sites and experimental sample plots replicated within Sites. However, the intent is to minimize differences where possible so that the measured responses (native vegetation cover, diversity and structure) may be attributable to the experimental treatments applied. The experimental design and statistical tests that can be applied (e.g. paired T-tests and ANOVA) can help distinguish between differences in response attributable to the Site, variation between the same experimental treatments, and actual treatment effects.

Because many soil characteristics are difficult to verify in the field, it was necessary to document soil characteristics at the restoration Sites to verify assumptions in the experimental design were reasonable, and to provide baseline data for future analysis of short term and long term results. Further, the analysis can indicate if there any extreme soil conditions that would expect to prohibit successful establishment of the native seed mix.

Methodological Approach:

At each site soil samples were taken to characterize near surface soil (~0-6 inches depth) in the upper horizon below the organic layer. This depth was targeted because it is the soil layers that will have the greatest influence on the germination and early establishment of most of the natives targeted for seeding in the restoration plots. Generally, two or more samples were analyzed per site. One was taken from a soil core and a second sample was

taken for comparison. The second sample represents a bulked sample of three subsamples selected across the extent of site, adjacent to the experimental treatment blocks.

Soil sample analysis was conducted by Wallace Labs in El Segundo, California using standard methods to determine critical soil characteristics, including macro- and micronutrients, lime content, pH, salinity and soil texture. Field observations were used to help interpret the laboratory results in context of each restoration site.

Results and Discussion:

All of the restoration sites are low in nitrate and phosphorus, a typical phenomenon in southern California's xeric soils, making them nutrients limiting to plant growth. Magnesium is very high in some of soils, but not unusual in some of the high clay content soils included in this study. Other macro- and micro nutrients have elevated levels greater than is typical in agricultural soils, as an example frame of reference, but not unusual in most of these soil conditions, especially the high clay content expansive Vertisol soils that have cation exchange capacity.

The soils at the Quino Checkerspot Butterfly (QCB) Sites 1 (Sycamore Canyon) and 3 (Proctor Valley) were similar, and exhibited a pH on the lower end of typical soil pH range. Observations ranged from as low as 5.6 to 6.4, which is slightly acidic. And, the Sites had a gravelly loam soil texture that corresponds with the genetic soil forming processes at work in the thin ridgetop soils where high value QCB habitat is located.

Site 2 at Sycamore Canyon is a Forbland Restoration Site and is not being directly compared to another Site, but as expected has similar soil conditions to the QCB Sites 1 and 3, except for the fact that Site 2 soil does not have a significant gravel component. Site 2 has a loam texture soil and deeper soils occurring on the lower slopes of the rolling hills in Sycamore Canyon. And, pH is similar, although not quite as acidic (pH 6.4-6.6) as the QCB Sites.

The Native Grassland (NG) Restoration plots occur in Sites 4, 5, 6 and 7. Both NG experimental plots within Sites 4 and 5 have high clay contents, although Site 5 has a higher silt content (63.7%) and therefore is classified as silty clay loam, compared with clay or silty clay (clay content of 42.1-47.6%) in the upper slopes of Site 4. The NG plots in Site 4 have clay content closer to 34%. These differences may not be as apparent if several more samples were analyzed, based on field observations and hand texturing of the soils across the upper slopes of Site 4 and Site 5. Essentially both sites have clay soils, with some areas with heavier clay content that qualifies as silty clay and other areas closer with greater silt content. The lowest slopes in Site 4 are typified by a higher loam content (63.2-64.4%) and relatively low sand content. Both Sites 4 and 5 have lime content.

Sites 6 and 7 similarly have high clay content, like Sites 4 and 5 (clay content of 53.4-58.4%). Like Sites 4 and 5, Site 6 has lime content; however, Site 7 appears not to have significant lime content. This will need to be considered during the data analysis to consider whether it may have had a significant effect on measured response variables. At this time, it is suspected this may only change the relative diversity of the established natives from seed at Site 7 compared with 4, 5 or 6; however, total native cover is not expected to be impacted by lime content.

The clay content and presence or absence of lime of the Otay Tarplant (OTP) experimental plots is similar to the NG plots at Sites 6 and 7. Site 4 is different because the lower slopes where the OTP experimental plots are located have no lime (compared to lime in the NG plots up slope at Site 4) and have lower clay content (23.4-25%). While the clay content is lower in the OTP plots in Site 4 than the clay content in the upper NG plots, the clay content is within the range of what occurs at observed historic OTP populations. In 2013, some existing seedbank populations of OTP germinated in Site 4. One grab sample of the soil in one of the 2013 populations had high clay content of 45.3% and no lime. The working hypothesis is that the presence of lime will be negatively correlated with OTP occurrence and establishment in the experimental treatment plots. Therefore, we expect to see greater populations of seeded OTP in Site 4 than 6. While the clay content is significantly different between Sites 4 and 6, they are both high enough to be known to support OTP in other historic distributions, so it should not be a limiting factor, but could influence the magnitude of the response. The OTP experimental plots in Sites 6 and 7 have very similar high clay content, but Site 6 has lime and Site 7 does not. Therefore, this will provide another opportunity to test the impact of lime where clay content is not very different. The most significant confounding factor to consider for that comparison is that the OTP seed in Site 6 will be drill seeded, whereas the OTP seed in Site 7 will be hand-broadcast and raked in..

Lab ID	Field ID	Description	Property	Site	pH	salinity	texture	chloride	nitrate	phosphorus	potassium	iron	manganese	zinc	copper	boron	calcium	magnesium	sodium	sulfur	SAR	molybdenum	aluminum	arsenic	barium	cadmium	chromium	cobalt
13-283-01	Site01-Soil01-QCB	Grab Sample 0-6" depth	Sycamore Canyon	Site01	6.40	0.43	gravelly loam	58	10	3.9	190	14.42	25.04	1.05	1.24	0.23	299	164	26	5	0.8	0.02	n d	0.36	1.11	0.03	0.04	0.19
13-283-02	Site01-Soil02a-QCB	Soil Core 0-6" depth	Sycamore Canyon	Site01	6.13	0.39	NP	33	9	6.4	258	21.06	32.18	2.89	1.66	0.21	377	266	36	8	0.8	0.01	n d	0.27	1.82	0.06	0.06	0.20
13-310-22	Site03-Soil01-Forbland	QCB Soil Core 0-6" depth	Proctor Valley	Site03	6.54	0.51	gravelly loam	56	13	4.96	132.09	18.65	17.94	1.60	1.61	0.18	371.16	131.03	40.54	10.92	1.2	0.02	0.55	n d	0.29	2.10	0.04	0.04
13-310-23	Site03-Soil02-Forbland	QCB Grab Sample 0-6" depth	Proctor Valley	Site03	5.61	0.71	gravelly loam	111	22	6.74	224.33	22.91	57.09	3.16	1.28	0.21	385.23	232.46	50.86	14.36	1.1	n d	0.61	n d	0.26	1.34	0.06	0.09
13-283-03	Site02-Soil01-QCB	Grab Sample 0-6" depth	Sycamore Canyon	Site02	6.41	0.20	loam	21	2	5.5	146	21.38	23.98	1.25	1.34	0.21	362	90	14	5	0.7	0.01	n d	0.10	2.68	0.03	0.06	0.12
13-283-04	Site02-Soil02a-QCB	Soil Core 0-6" depth	Sycamore Canyon	Site02	6.63	0.25	NP	31	2	4.4	95	16.82	18.64	1.01	1.44	0.23	354	101	20	4	1.0	n d	n d	0.10	2.67	0.03	0.06	0.10
13-283-05	Site04-Soil01-OTP	Grab Sample 0-6" depth	Rancho Jamul	Site04	6.02	0.34	silt loam	52	2	3.9	191	9.96	14.93	1.47	1.59	0.14	369	422	55	8	1.2	0.03	n d	0.09	2.47	0.03	0.02	0.14
13-283-06	Site04-Soil02-OTP	Grab Sample 0-6" depth	Rancho Jamul	Site04	6.41	0.40	silt loam	60	2	5.8	205	12.45	32.34	4.02	2.56	0.09	353	391	42	9	0.9	n d	n d	0.06	1.84	0.06	0.05	0.24
13-283-07	Site04-Soil03-NG	Grab Sample 0-6" depth	Rancho Jamul	Site04	7.00	0.48	silty clay	47	7	3.2	118	4.32	2.91	0.34	1.38	0.09	351	193	48	7	0.4	n d	n d	0.09	0.41	0.03	n d	0.07
13-283-08	Site04-Soil04a_NG	Soil Core 0-6" depth	Rancho Jamul	Site04	7.53	0.36	silty clay	23	5	4.7	116	4.34	3.60	0.66	1.75	0.18	390	57	19	9	0.3	n d	n d	0.04	0.19	0.05	n d	0.03
13-283-09	Site04-Soil04b-NG	Soil Core 24-30" depth	Rancho Jamul	Site04	7.75	0.26	clay	15	3	1.3	27	1.25	0.50	0.15	0.59	0.19	354	137	39	5	0.5	n d	n d	0.07	0.15	n d	n d	0.04
13-283-10	Site04-Soil05a-NG	Soil Core 0-6" depth	Rancho Jamul	Site04	7.16	0.46	silty clay	16	3	2.1	135	2.76	4.10	0.32	0.73	0.21	317	701	66	7	0.7	n d	n d	0.06	1.09	0.03	n d	0.08
13-283-11	Site04-Soil05b-NG	Soil Core 24-30" depth	Rancho Jamul	Site04	7.34	0.33	NP	25	3	1.0	45	1.72	1.18	0.10	0.31	0.12	357	455	67	6	1.1	n d	n d	0.04	1.11	n d	n d	0.06
13-283-12	Site04-Soil06-Existing-OTP-Site	Grab Sample 0-6" depth	Rancho Jamul	Site04	6.78	0.43	silty clay	36	2	2.0	167	3.19	6.78	0.29	0.82	0.13	339	976	142	6	1.5	n d	n d	0.09	0.87	0.03	n d	0.09
13-283-13	Site05-Soil01-NG	Grab Sample 0-6" depth	Rancho Jamul	Site05	7.68	0.53	silty clay loam	30	21	4.8	165	2.53	4.13	0.69	1.30	0.20	400	62	35	11	0.5	0.02	n d	n d	0.21	0.04	n d	0.03
13-310-24	Site06-Soil01-NG	NG Grab Sample 0-6" depth	Sweetwater Reservoir	Site06	7.51	0.38	clay	35	5	3.06	142.54	3.20	2.38	0.45	1.74	0.32	245.64	553.96	69.25	4.50	0.6	n d	0.39	n d	n d	0.53	0.03	n d
13-310-25	Site06-Soil02-NG	NG Soil Core 0-6" depth	Sweetwater Reservoir	Site06	7.66	0.48	clay	83	4	1.70	28.75	1.95	0.39	0.24	1.59	0.07	273.47	214.76	107.73	2.44	0.9	n d	0.16	n d	n d	0.43	0.02	n d
13-310-30	Site06-Soil02b	NG Soil Core 38-42" depth	Sweetwater Reservoir	Site06	7.78	0.45	sandy clay loam	20	3	0.30	8.93	1.22	0.21	0.10	0.24	0.51	144.73	882.18	839.61	3.24	3.6	n d	0.01	n d	n d	0.12	0.02	n d
13-310-26	Site06-Soil03-OTP	OTP Grab Sample 0-6" depth	Sweetwater Reservoir	Site06	7.88	0.30	clay	19	4	1.80	68.66	4.27	0.78	0.48	1.78	0.27	297.50	286.80	54.66	4.36	0.5	n d	0.21	n d	n d	0.31	0.03	n d
13-310-27	Site07-Soil01	NG Grab Sample 0-6" depth	Sweetwater Reservoir	Site07	6.87	0.39	gravelly clay	48	9	1.91	139.26	4.07	2.88	1.62	2.14	0.23	447.18	1,155.65	84.01	4.88	1.1	n d	0.98	n d	0.03	1.52	0.06	0.02
13-310-28	Site07-Soil02	NG Soil Core 0-6" depth	Sweetwater Reservoir	Site07	7.02	0.26	gravelly clay	20	4	1.03	40.58	2.23	1.78	0.30	1.12	0.09	375.35	1,415.56	88.85	2.83	1.0	n d	0.42	n d	n d	1.27	0.04	n d
13-310-29	Site07-Soil03-OTP	OTP Grab Sample 0-6" depth	Sweetwater Reservoir	Site07	6.96	0.39	gravelly clay	48	4	2.09	88.60	4.85	8.57	1.47	2.28	0.08	384.03	1,216.53	129.61	4.61	1.1	n d	0.88	n d	n d	0.99	0.05	0.03

NP=Not Performed

n d = non-detect by analytical method

Lab ID	Field ID	Description	Property	Site	lead	lithium	mercury	nickel	selenium	silver	strontium	tin	vanadium	lime	moisture	half sat	sand	silt	clay	gravel
13-283-01	Site01-Soil01-QCB	Grab Sample 0-6" depth	Sycamore Canyon	Site01	0.53	0.20	n d	0.37	n d	n d	1.03	n d	0.21	no	1.4%	16.0%	43.6%	41.8%	14.6%	20.7%
13-283-02	Site01-Soil02a-QCB	Soil Core 0-6" depth	Sycamore Canyon	Site01	0.90	0.26	n d	0.46	n d	n d	1.54	n d	0.25	no	1.6%	18.0%	NP	NP	NP	NP
13-310-22	Site03-Soil01-Forbland	QCB Soil Core 0-6" depth	Proctor Valley	Site03	0.10	1.12	0.26	n d	n d	n d	1.43	n d	0.19	no	2.9%	17.1%	51.2%	33.0%	15.7%	47.5%
13-310-23	Site03-Soil02-Forbland	QCB Grab Sample 0-6" depth	Proctor Valley	Site03	0.38	1.95	0.27	n d	n d	n d	1.60	n d	0.19	no	3.7%	22.3%	42.3%	37.5%	20.2%	22.2%
13-283-03	Site02-Soil01-QCB	Grab Sample 0-6" depth	Sycamore Canyon	Site02	0.44	0.24	n d	0.34	n d	n d	1.66	n d	0.22	no	0.8%	17.3%	48.2%	41.7%	10.1%	7.5%
13-283-04	Site02-Soil02a-QCB	Soil Core 0-6" depth	Sycamore Canyon	Site02	0.36	0.24	n d	0.29	n d	n d	1.94	n d	0.22	no	0.8%	15.3%	NP	NP	NP	NP
13-283-05	Site04-Soil01-OTP	Grab Sample 0-6" depth	Rancho Jamul	Site04	0.93	0.25	n d	0.32	n d	n d	1.85	n d	0.18	no	2.4%	20.4%	13.4%	63.2%	23.4%	4.4%
13-283-06	Site04-Soil02-OTP	Grab Sample 0-6" depth	Rancho Jamul	Site04	1.89	0.25	n d	0.38	n d	n d	1.83	n d	0.22	no	2.2%	23.9%	10.7%	64.4%	25.0%	15.2%
13-283-07	Site04-Soil03-NG	Grab Sample 0-6" depth	Rancho Jamul	Site04	0.80	0.26	n d	0.30	n d	n d	0.21	n d	0.57	yes	6.5%	31.4%	14.8%	40.7%	44.5%	7.7%
13-283-08	Site04-Soil04a_NG	Soil Core 0-6" depth	Rancho Jamul	Site04	1.18	0.26	n d	0.12	n d	n d	0.21	n d	0.70	yes	5.8%	32.2%	16.8%	41.0%	42.1%	1.9%
13-283-09	Site04-Soil04b-NG	Soil Core 24-30" depth	Rancho Jamul	Site04	0.25	0.25	n d	0.01	n d	n d	0.31	n d	1.38	yes	13.2%	31.6%	15.8%	36.7%	47.6%	3.3%
13-283-10	Site04-Soil05a-NG	Soil Core 0-6" depth	Rancho Jamul	Site04	0.42	0.22	n d	0.27	n d	n d	0.99	n d	0.27	no	6.3%	34.9%	14.1%	42.5%	43.4%	3.0%
13-283-11	Site04-Soil05b-NG	Soil Core 24-30" depth	Rancho Jamul	Site04	0.19	0.25	n d	0.10	n d	n d	1.07	n d	0.24	no	7.2%	22.5%	NP	NP	NP	NP
13-283-12	Site04-Soil06-Existing-OTP-Site	Grab Sample 0-6" depth	Rancho Jamul	Site04	0.27	0.26	n d	0.32	n d	n d	1.32	n d	0.21	no	4.7%	32.5%	9.5%	45.2%	45.3%	0.3%
13-283-13	Site05-Soil01-NG	Grab Sample 0-6" depth	Rancho Jamul	Site05	1.21	0.28	n d	0.15	n d	n d	0.19	n d	0.44	yes	6.9%	35.8%	2.3%	63.7%	34.0%	2.0%
13-310-24	Site06-Soil01-NG	NG Grab Sample 0-6" depth	Sweetwater Reservoir	Site06	0.14	0.97	0.19	n d	n d	n d	0.48	n d	0.55	yes	12.9%	39.8%	20.3%	26.3%	53.4%	9.9%
13-310-25	Site06-Soil02-NG	NG Soil Core 0-6" depth	Sweetwater Reservoir	Site06	0.03	0.91	0.23	n d	n d	n d	0.56	n d	0.75	high	14.0%	31.5%	13.2%	28.4%	58.4%	4.2%
13-310-30	Site06-Soil02b	NG Soil Core 38-42" depth	Sweetwater Reservoir	Site06	n d	0.29	0.13	n d	0.54	n d	0.45	n d	1.12	high	20.5%	25.0%	59.3%	19.4%	21.3%	2.2%
13-310-26	Site06-Soil03-OTP	OTP Grab Sample 0-6" depth	Sweetwater Reservoir	Site06	0.03	1.20	0.21	n d	n d	n d	0.39	n d	0.89	yes	13.8%	46.9%	12.2%	27.9%	60.0%	4.7%
13-310-27	Site07-Soil01	NG Grab Sample 0-6" depth	Sweetwater Reservoir	Site07	0.05	0.91	0.35	n d	n d	n d	2.31	n d	0.31	no	12.7%	28.8%	23.2%	33.9%	42.9%	28.3%
13-310-28	Site07-Soil02	NG Soil Core 0-6" depth	Sweetwater Reservoir	Site07	0.03	0.52	0.28	n d	n d	n d	1.88	n d	0.77	no	11.6%	39.9%	18.3%	26.9%	54.8%	22.5%
13-310-29	Site07-Soil03-OTP	OTP Grab Sample 0-6" depth	Sweetwater Reservoir	Site07	0.11	0.85	0.30	n d	n d	n d	1.62	n d	0.39	no	12.8%	45.9%	19.5%	28.3%	52.2%	24.0%

NP=Not Performed

n d = non-detect by analytical method

Appendix 4. Restoration Experiment Layout Summary and Maps

	Restoration Site:	QCB Site 1	Forbland Site 2	QCB Site 3	Native Grassland Site 4	Native Grassland Site 5	Native Grassland Site 6	Native Grassland Site 7
	Timing Quarter/Year	Sycamore Canyon	Sycamore Canyon	Proctor Valley	Rancho Jamul	Rancho Jamul	Sweetwater	Sweetwater
Number of Manipulative Treatments (Not including Control Treatment)	---	2	2	2	2	2	2	2
Number of Replicates	---	6	8	6	6	6	6	6
OTP Replicates in Sites 4, 6, 7 (Only 1 Treatment)	---	---	---	---	6	---	6	6
Size of individual test plots (sq ft)	---	400	1200	400	5184	5184	5184	2160
Dimensions of Plots (ft)		20 x 20	24 x 50 Randomly	20 x 20	72 x 72	72 x 72	72 x 72	72 x 30
Dimensions of Pair or Block (ft)	---	Block 20 x 60	Assigned	Block 20 x 60	Paired 72 x 144	Paired 72 x 144	Paired 72 x 144	Paired 72 x 60
Total Number of Manipulative Test Plots	---	12	16	12	12 NG and 6 OTP	12	12 NG and 6 OTP	12 NG and 6 OTP
Total Acreage of Manipulative Test Plots	---	0.11 QCB	0.44 Forb	0.11 QCB	1.42 NG and 0.71 OTP	1.42 NG	1.42 NG and 0.71 OTP	0.6 NG and 0.3 OTP
Non-Test Acreage Remaining to Mow as Buffer Around Restoration Treatments	---	NA	10	NA	9.9	1.9	9.2	4.2
Footprint Area of Site		*0.11*	*10.44*	*0.11*	*12.03*	*3.32*	*11.33*	*5.1*
Total Number of Plots (Manipulate + Control)	---	18	24	18	24	18	24	24
Total Number of Stakes (rebar + PVC)	---	72	96	72	96	72	96	96
Site Layout (2013)								
Staking Layout of Plots (Labor & Material)	4th 2013	✖	✖	✖	✖	✖	✖	✖
Initial Clearing (2013)								
Initial Mowing & Clearing of Test Plots	4th 2013	✖	✖	✖	✖	✖	✖	✖
1st Year Site Prep (2014)								
1st Year Hand Weeding in winter w/ follow-up spot spray in spring	1st & 2nd 2014	✖	---	✖	---	---	---	---
1st Year Mowing Around Natives (Treatment A - Mow 2x) (winter & spring)	1st & 2nd 2014	---	✖	---	---	---	---	---
1st Yr Herbicide Glyphosate Broadcast (Treatment B - Herbicide 2x) (winter & spring)	1st & 2nd 2014	---	✖	---	---	---	---	---
1st Year Herbicide-Fluasifop winter and Glyphosate spring (Treatment A - Full Extent Seeding)	1st & 2nd 2014	---	---	---	✖	✖	✖	✖
1st Yr Weed Whiping (Treatment B - DeSimone Strips) (winter & spring)	1st & 2nd 2014	---	---	---	---	---	---	✖
1st Year Mowing (Treatment B - DeSimone Strips) (winter & spring)	1st & 2nd 2014	---	---	---	✖	✖	✖	---
Water Truck 1st Yr	---	✖	✖	✖	✖	✖	✖	✖
1st Year Mowing of Buffer Around Test Plots	1st & 2nd 2014	---	✖	---	✖	✖	✖	✖
2nd Year Site Prep (2015)								
2nd Year Hand Weeding in winter w/ follow-up spot spray in spring	1st & 2nd 2015	✖	---	✖	---	---	---	---
2nd Year Mowing Around Natives (Treatment A - Mow 2x) (winter & spring)	1st & 2nd 2015	---	✖	---	---	---	---	---
2nd Yr Herbicide Glyphosate Broadcast (Treatment B - Herbicide 2x) (winter & spring)	1st & 2nd 2015	---	✖	---	---	---	---	---
2nd Year Herbicide-Fluasifop winter and Glyphosate spring (Treatment A - Full Extent Seeding)	1st & 2nd 2015	---	---	---	✖	✖	✖	✖
2nd Yr Weed Whiping (Treatment B - DeSimone Strips)	1st & 2nd 2015	---	---	---	---	---	---	✖
2nd Year Mowing (Treatment B - DeSimone Strips) (winter & spring)	1st & 2nd 2015	---	---	---	✖	✖	✖	---
Water Truck 2nd Yr	---	---	✖	---	---	---	---	---
2nd Year Mowing of Buffer Around Test Plots	1st & 2nd 2015	---	✖	---	✖	✖	✖	✖
Seed Collection, Bulking, Installation								
Test Plot Seed Collection (S&S Seeds)	All qrts	✖	✖	✖	✖	✖	✖	✖
Test Plot seeding (fall 2015)	4th 2015	✖	✖	✖	✖	✖	✖	✖
OTP seed incease (Recon)	4th 2013-3rd 2015	---	---	---	✖	---	✖	✖

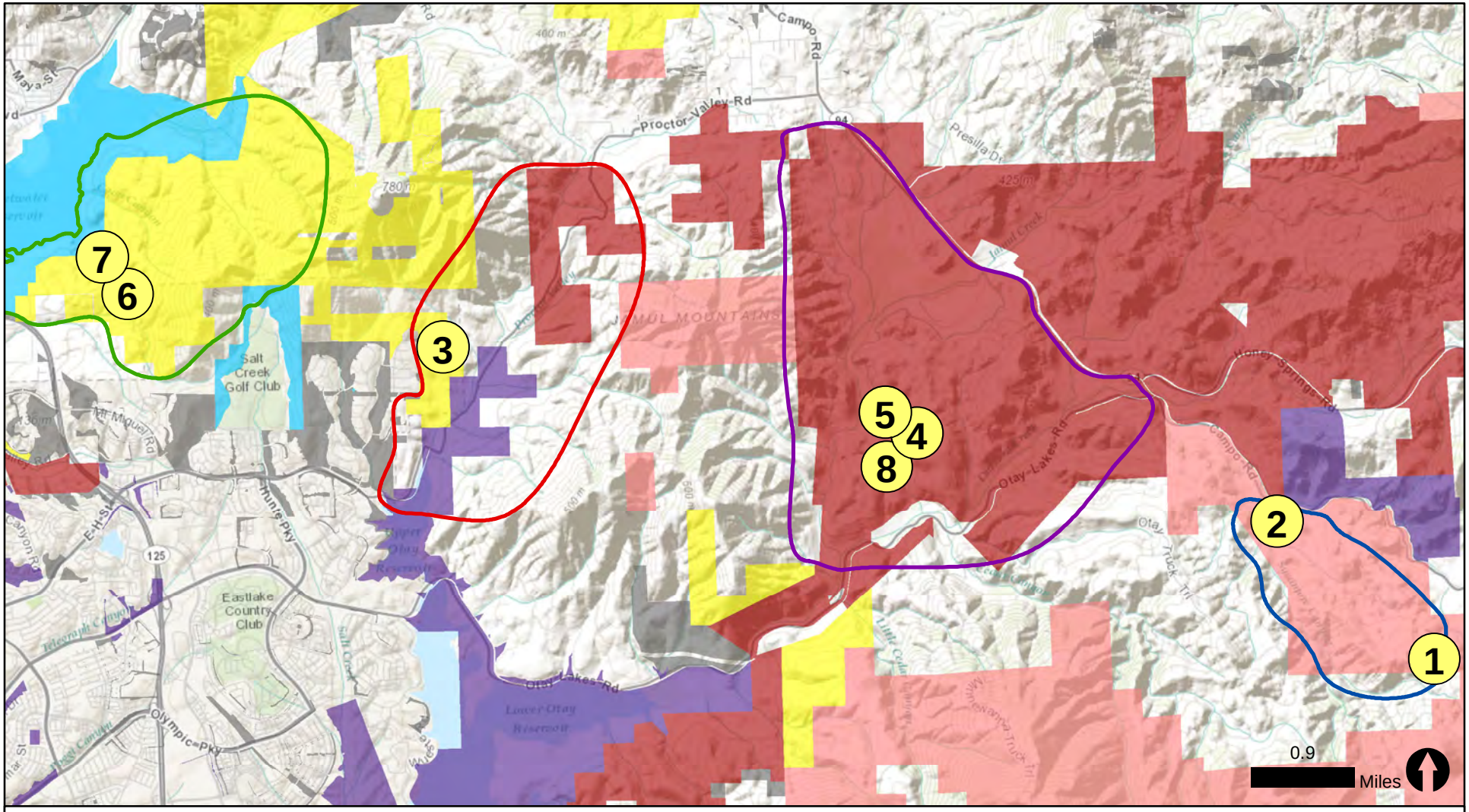


Figure 1. Phase 2 Habitat Restoration Experiment Site Locations.

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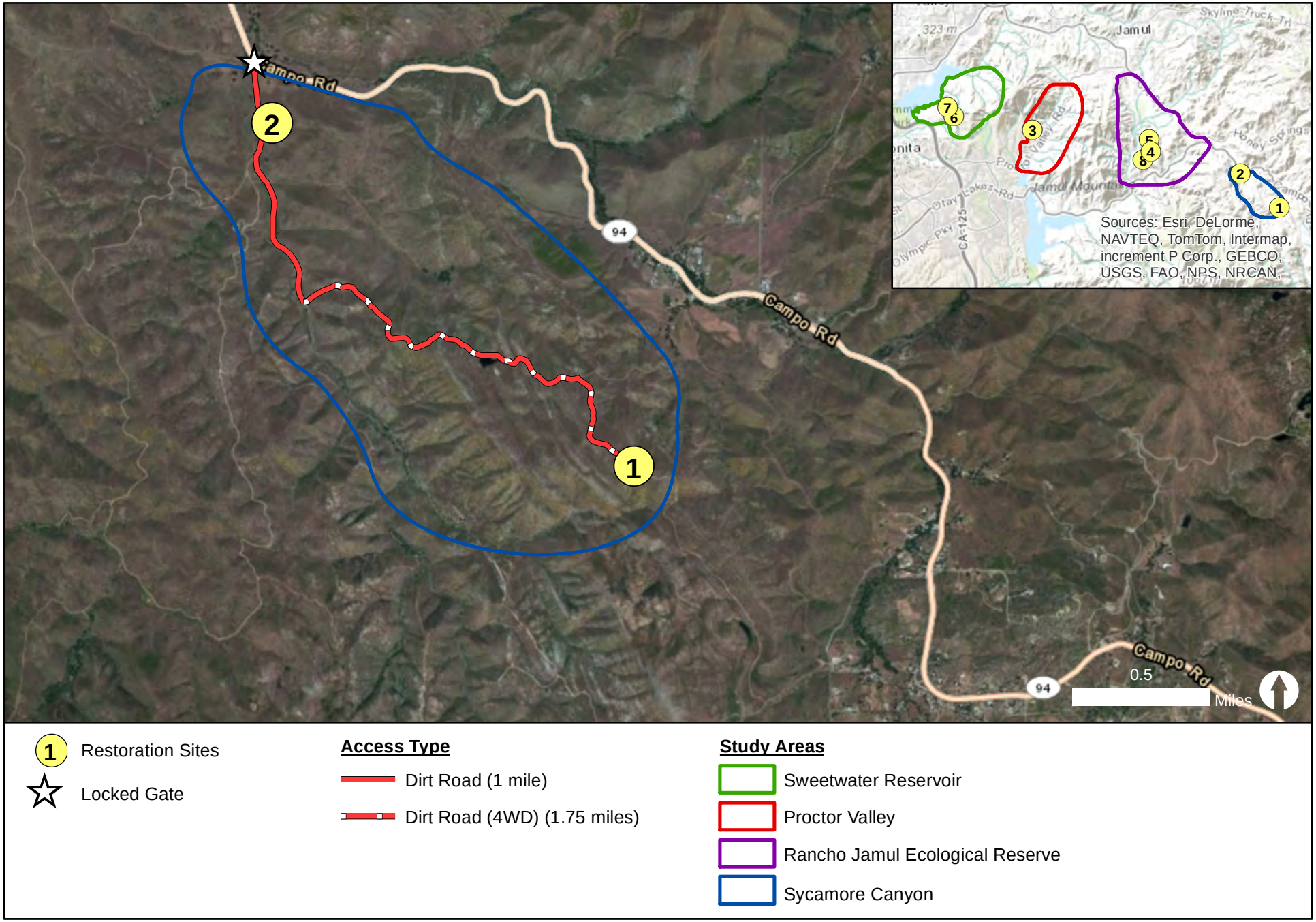

Figure 2. Sycamore Canyon Access to Restoration Sites 1 and 2.

LAND IQ

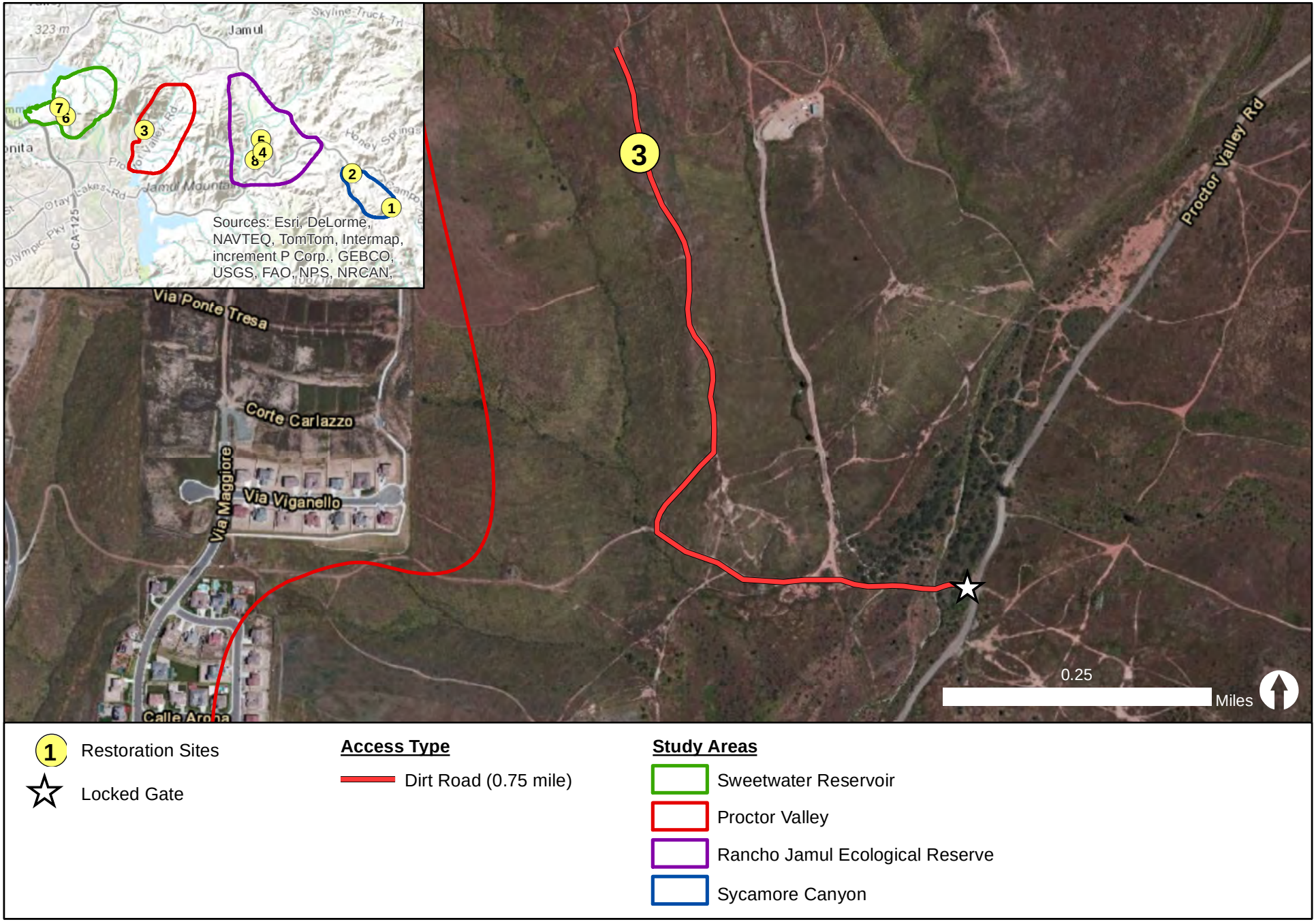

Figure 3. Proctor Valley Access to Restoration Site 3.

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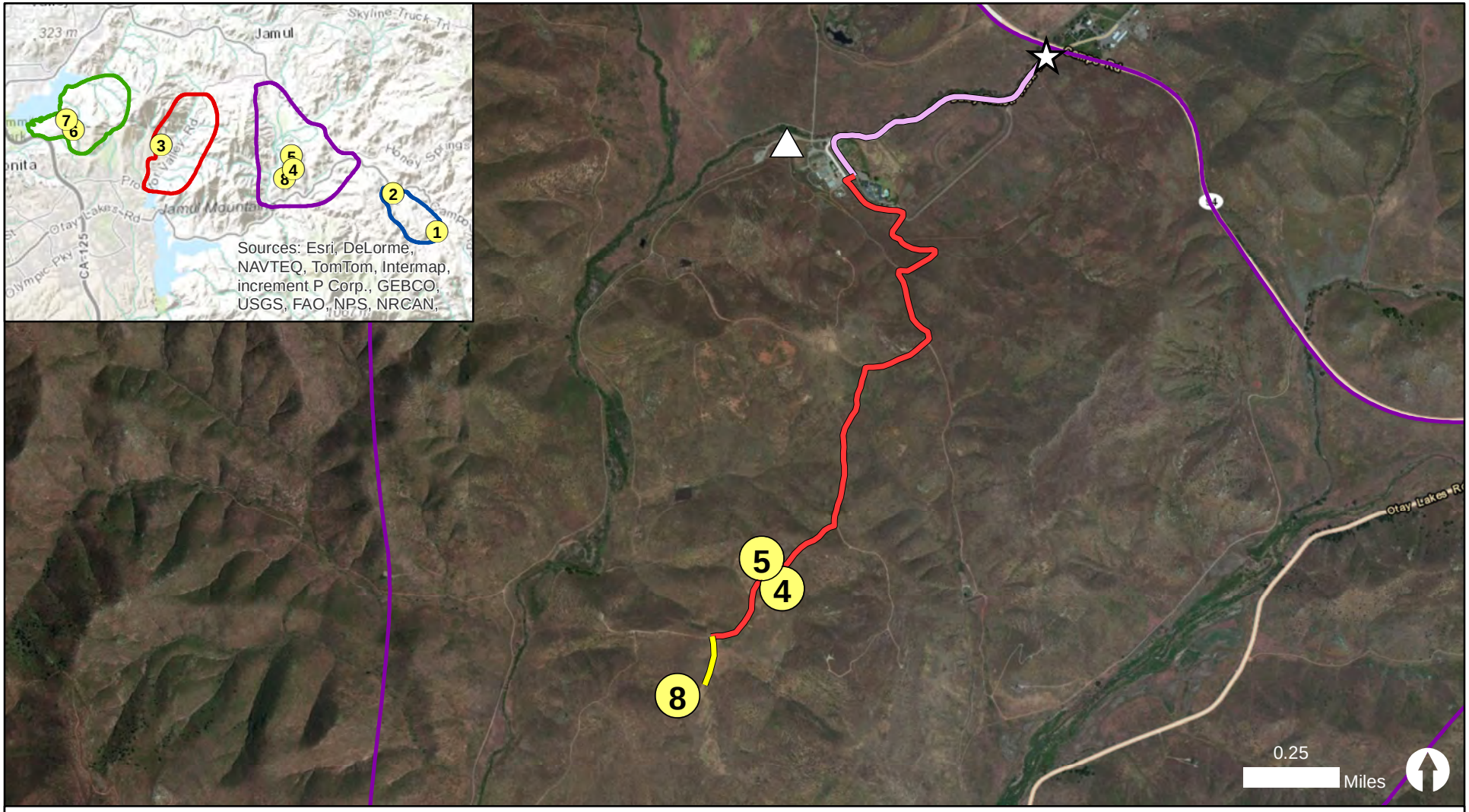

Figure 4. Rancho Jamul Ecological Reserve Access to Restoration Sites 4, 5 and 8.

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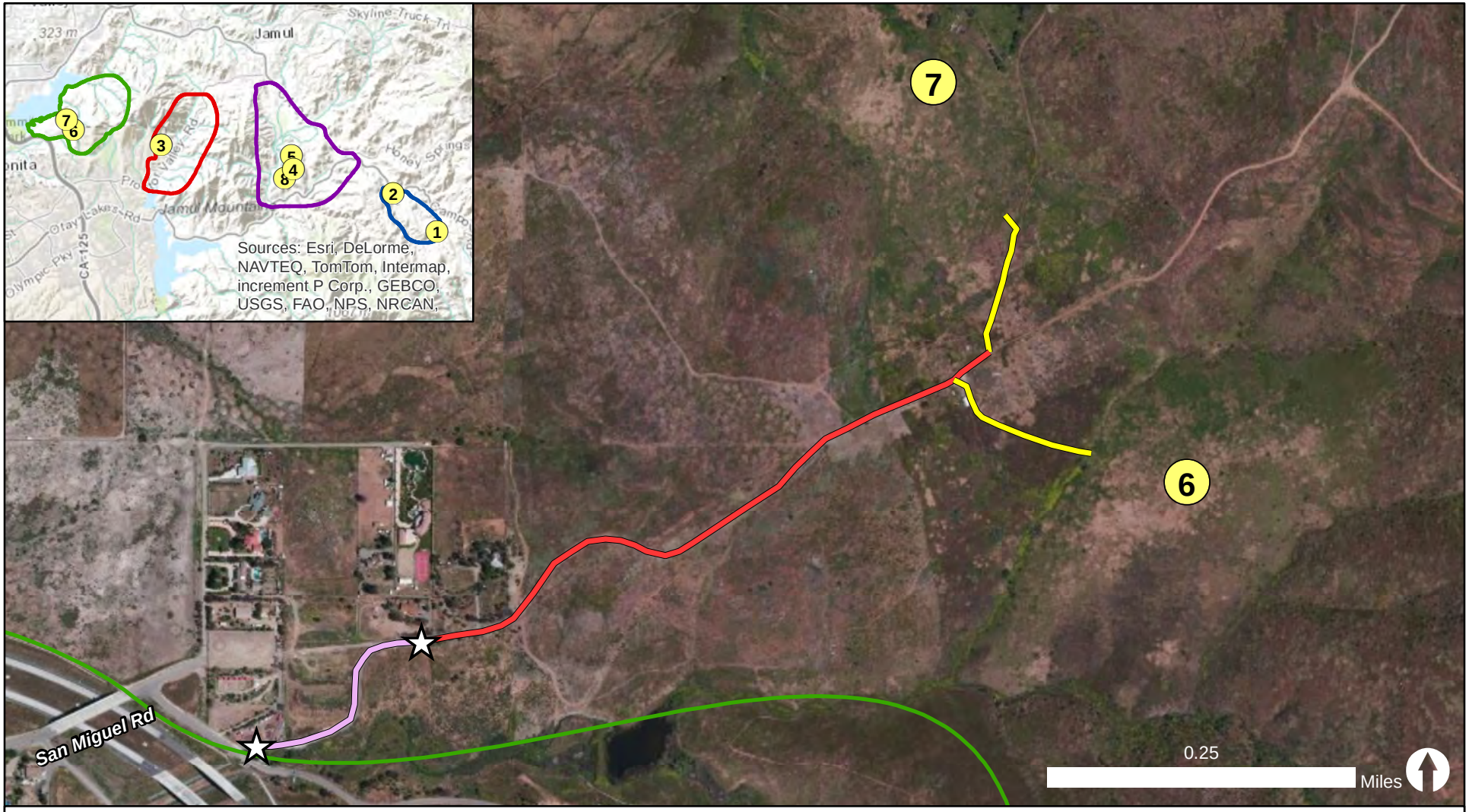

Figure 5. Sweetwater Reservoir (USFWS NWR) Access to Restoration Sites 6 and 7.

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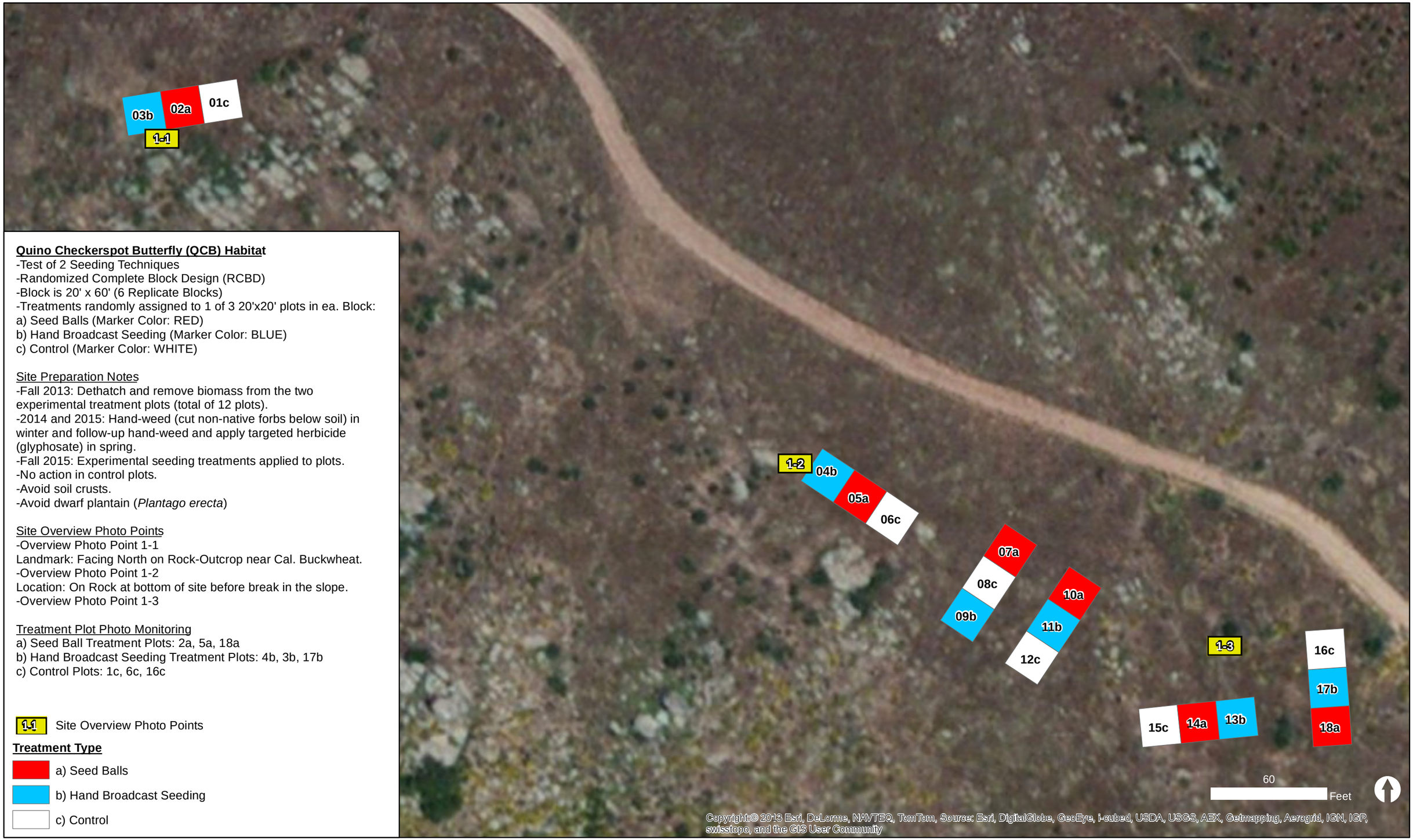

Quino Checkerspot Butterfly (QCB) Habitat
-Test of 2 Seeding Techniques
-Randomized Complete Block Design (RCBD)
-Block is 20' x 60' (6 Replicate Blocks)
-Treatments randomly assigned to 1 of 3 20'x20' plots in ea. Block:
a) Seed Balls (Marker Color: RED)
b) Hand Broadcast Seeding (Marker Color: BLUE)
c) Control (Marker Color: WHITE)

Site Preparation Notes
-Fall 2013: Dethatch and remove biomass from the two experimental treatment plots (total of 12 plots).
-2014 and 2015: Hand-weed (cut non-native forbs below soil) in winter and follow-up hand-weed and apply targeted herbicide (glyphosate) in spring.
-Fall 2015: Experimental seeding treatments applied to plots.
-No action in control plots.
-Avoid soil crusts.
-Avoid dwarf plantain (*Plantago erecta*)

Site Overview Photo Points
-Overview Photo Point 1-1
Landmark: Facing North on Rock-Outcrop near Cal. Buckwheat.
-Overview Photo Point 1-2
Location: On Rock at bottom of site before break in the slope.
-Overview Photo Point 1-3

Treatment Plot Photo Monitoring
a) Seed Ball Treatment Plots: 2a, 5a, 18a
b) Hand Broadcast Seeding Treatment Plots: 4b, 3b, 17b
c) Control Plots: 1c, 6c, 16c

1-1 Site Overview Photo Points

Treatment Type

a) Seed Balls

b) Hand Broadcast Seeding

c) Control

Figure 6. Sycamore Canyon Quino Checkerspot Butterfly Habitat Restoration Site 1.

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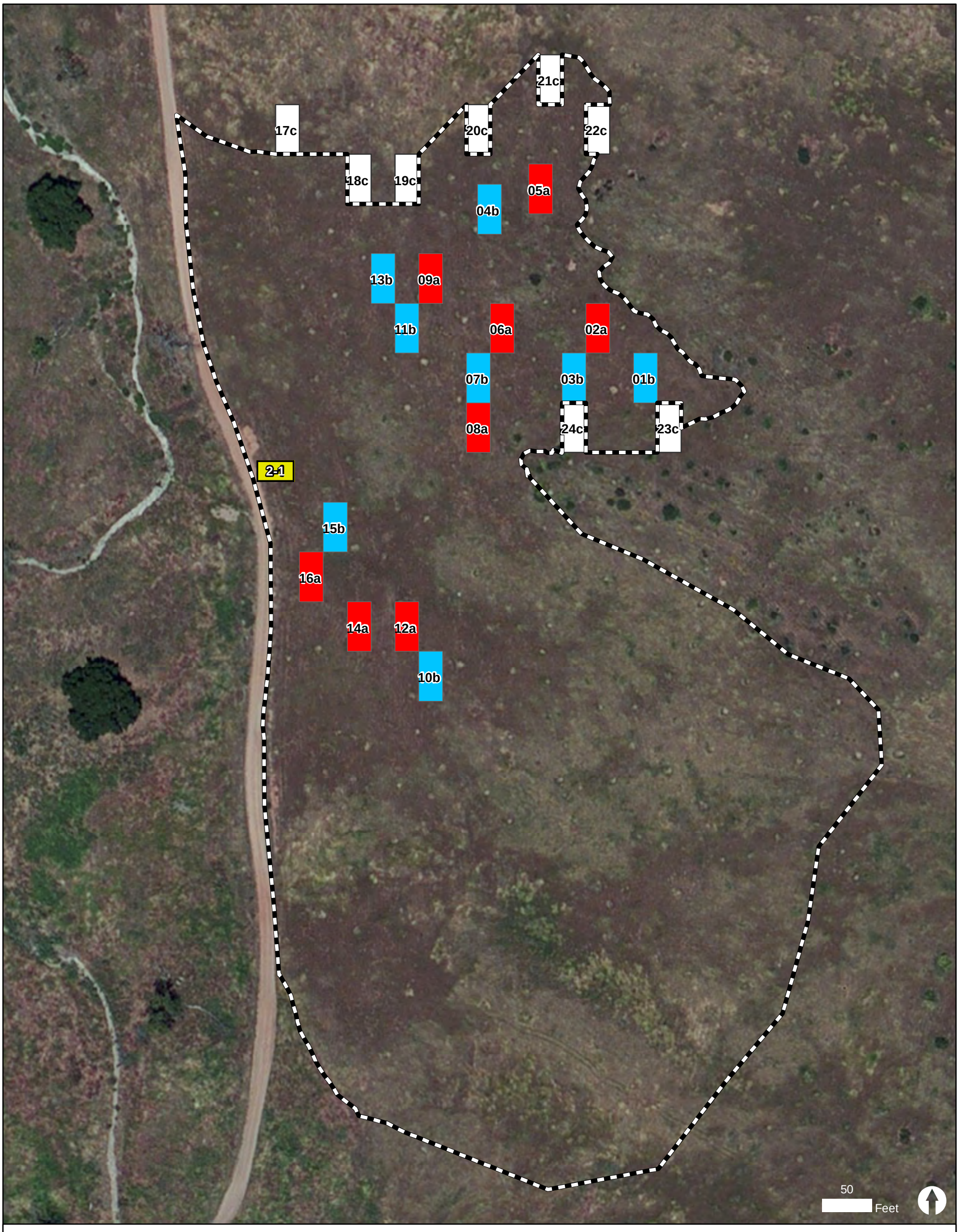

Forbland Habitat
-Test of 2 Site Preparation Methods
-Test Plot is 24' x 50' (8 Replicates)
-Plots randomly selected within identified area
-Treatments randomly assigned to test plots
-Control located outside mow buffer
a) Mow and Leave Thatch (Winter and Spring), Selective glyphosate in application in spring (Marker Color: RED)
b) Herbicide (Winter and Spring) (Marker Color: BLUE)
c) Control (Marker Color: WHITE)

Site Preparation Notes
-Fall 2013: Dethatch and remove biomass from experimental treatment plots (total of 16 plots).
-2014 and 2015: 1 of 2 Treatments applied.
-And, Mow 10 acre buffer 2x/year (winter and spring), leave thatch.
-Fall 2015: Broacast pull-type seeder.
-No action in control plots.
-Avoid soil crusts.

Site Overview Photo Points
-Overview Photo Point 2-1
Landmark: At edge of road, approx. in line with sycamore to the west across the drainage.

Treatment Plot Photo Monitoring
a) Mow 2x Plots: 2a, 8a, 12a
b) Herbicide 2x Plots: 1b, 3b, 9b, 13b
c) Control Plots: 17c, 19c, 22c, 23c

2-1 Site Overview Photo Points

Treatment Type
a) Mow 2x
b) Herbicide 2x
c) Control
Mow Buffer Boundary

Figure 7. Sycamore Canyon Forbland Restoration Site 2.

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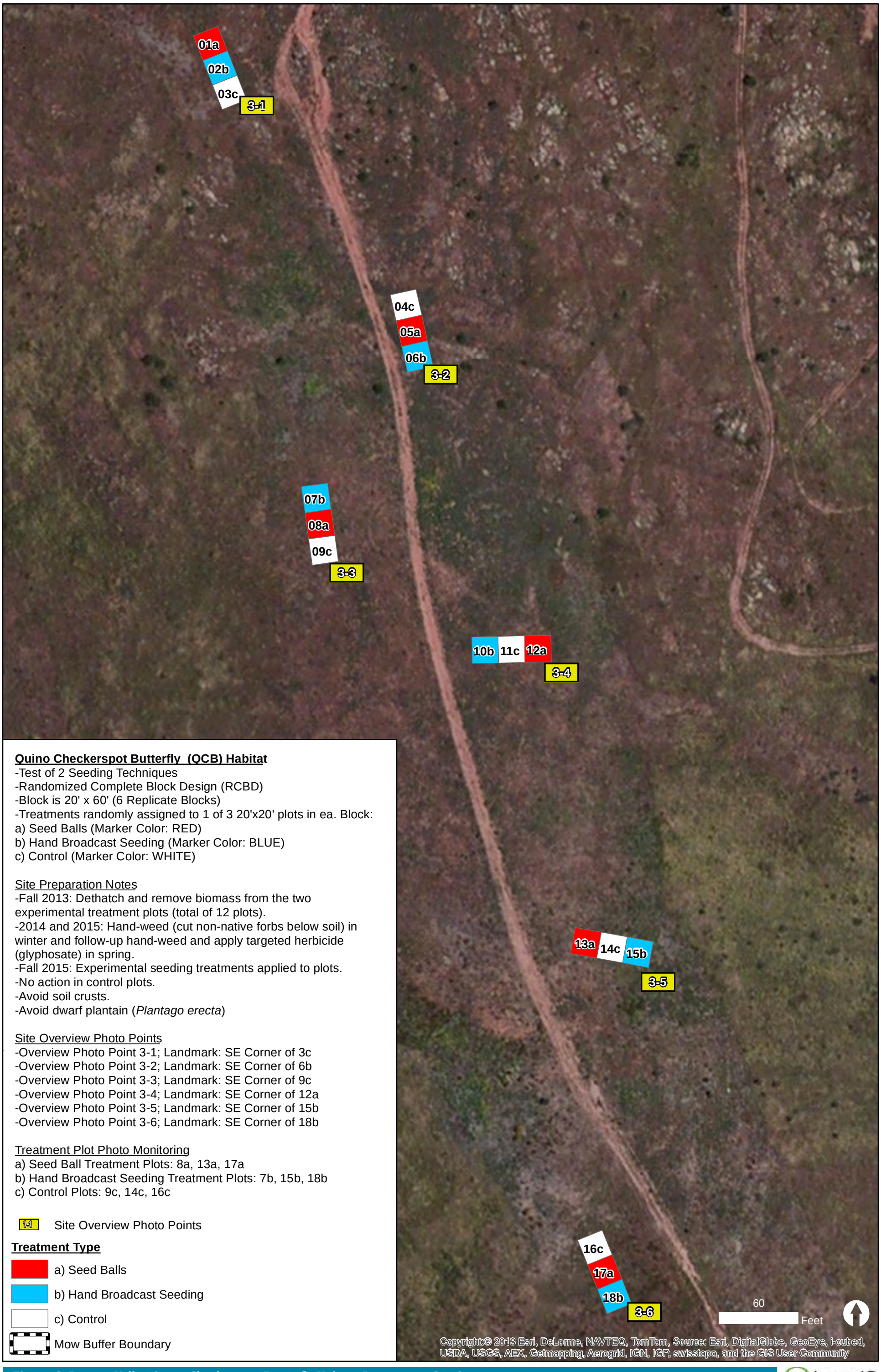

Quino Checkerspot Butterfly (QCB) Habitat
-Test of 2 Seeding Techniques
-Randomized Complete Block Design (RCBD)
-Block is 20' x 60' (6 Replicate Blocks)
-Treatments randomly assigned to 1 of 3 20'x20' plots in ea. Block:
a) Seed Balls (Marker Color: RED)
b) Hand Broadcast Seeding (Marker Color: BLUE)
c) Control (Marker Color: WHITE)

Site Preparation Notes
-Fall 2013: Dethatch and remove biomass from the two experimental treatment plots (total of 12 plots).
-2014 and 2015: Hand-weed (cut non-native forbs below soil) in winter and follow-up hand-weed and apply targeted herbicide (glyphosate) in spring.
-Fall 2015: Experimental seeding treatments applied to plots.
-No action in control plots.
-Avoid soil crusts.
-Avoid dwarf plantain (*Plantago erecta*)

Site Overview Photo Points
-Overview Photo Point 3-1; Landmark: SE Corner of 3c
-Overview Photo Point 3-2; Landmark: SE Corner of 6b
-Overview Photo Point 3-3; Landmark: SE Corner of 9c
-Overview Photo Point 3-4; Landmark: SE Corner of 12a
-Overview Photo Point 3-5; Landmark: SE Corner of 15b
-Overview Photo Point 3-6; Landmark: SE Corner of 18b

Treatment Plot Photo Monitoring
a) Seed Ball Treatment Plots: 8a, 13a, 17a
b) Hand Broadcast Seeding Treatment Plots: 7b, 15b, 18b
c) Control Plots: 9c, 14c, 16c

1-1 Site Overview Photo Points

Treatment Type

a) Seed Balls

b) Hand Broadcast Seeding

c) Control

Mow Buffer Boundary

Figure 8. Proctor Valley Quino Checkerspot Butterfly Habitat Restoration Site 3.

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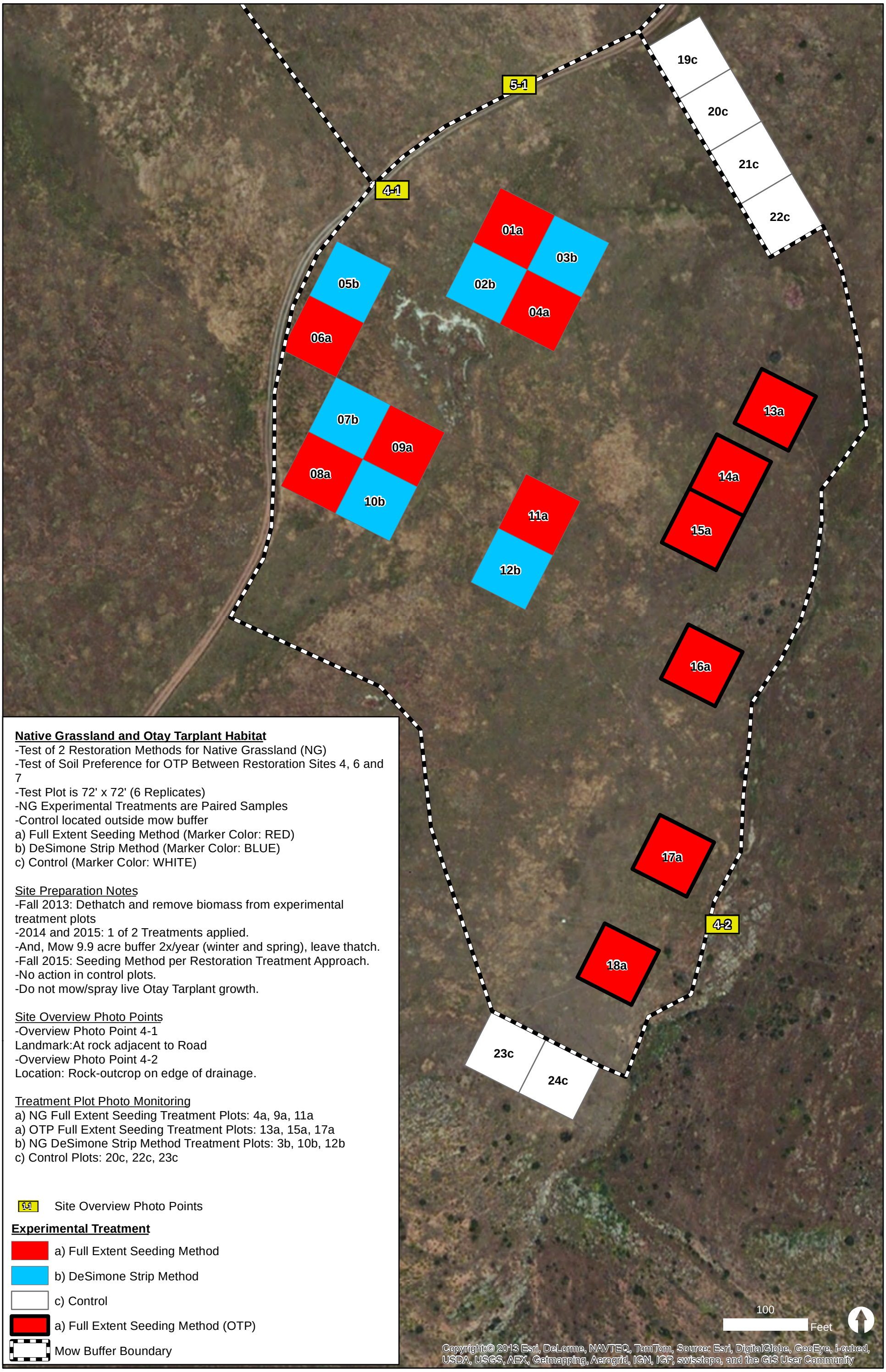


Native Grassland and Otay Tarplant Habitat
-Test of 2 Restoration Methods for Native Grassland (NG)
-Test of Soil Preference for OTP Between Restoration Sites 4, 6 and 7
-Test Plot is 72' x 72' (6 Replicates)
-NG Experimental Treatments are Paired Samples
-Control located outside mow buffer
a) Full Extent Seeding Method (Marker Color: RED)
b) DeSimone Strip Method (Marker Color: BLUE)
c) Control (Marker Color: WHITE)

Site Preparation Notes
-Fall 2013: Dethatch and remove biomass from experimental treatment plots
-2014 and 2015: 1 of 2 Treatments applied.
-And, Mow 9.9 acre buffer 2x/year (winter and spring), leave thatch.
-Fall 2015: Seeding Method per Restoration Treatment Approach.
-No action in control plots.
-Do not mow/spray live Otay Tarplant growth.

Site Overview Photo Points
-Overview Photo Point 4-1
Landmark:At rock adjacent to Road
-Overview Photo Point 4-2
Location: Rock-outcrop on edge of drainage.

Treatment Plot Photo Monitoring
a) NG Full Extent Seeding Treatment Plots: 4a, 9a, 11a
a) OTP Full Extent Seeding Treatment Plots: 13a, 15a, 17a
b) NG DeSimone Strip Method Treatment Plots: 3b, 10b, 12b
c) Control Plots: 20c, 22c, 23c

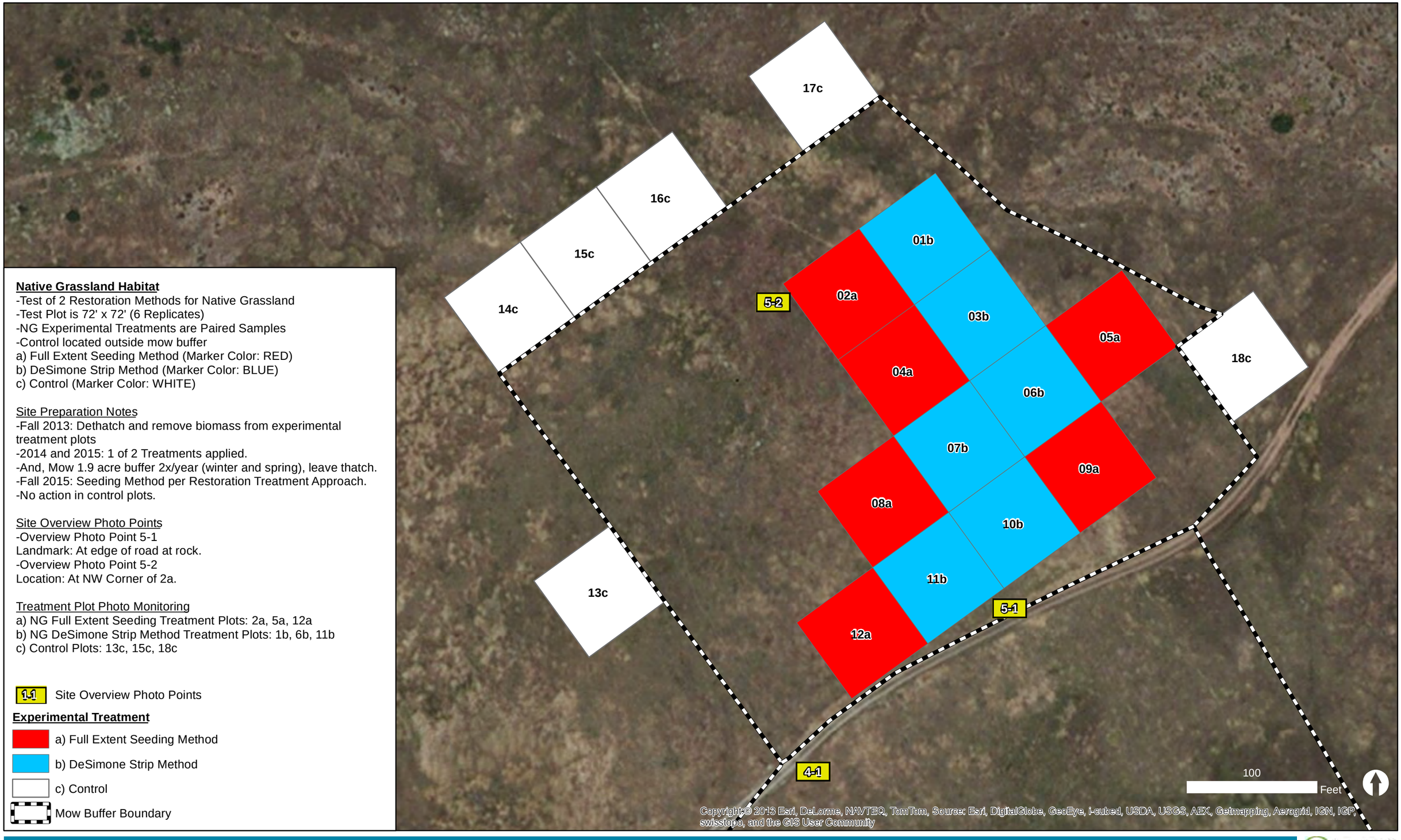
4-1 Site Overview Photo Points

Experimental Treatment

a) Full Extent Seeding Method
b) DeSimone Strip Method
c) Control
a) Full Extent Seeding Method (OTP)
Mow Buffer Boundary

Figure 9. Rancho Jamul Ecological Reserve Native Grassland and Otay Tarplant Habitat Restoration Site 4.

LAND IQ



Native Grassland Habitat
-Test of 2 Restoration Methods for Native Grassland
-Test Plot is 72' x 72' (6 Replicates)
-NG Experimental Treatments are Paired Samples
-Control located outside mow buffer
a) Full Extent Seeding Method (Marker Color: RED)
b) DeSimone Strip Method (Marker Color: BLUE)
c) Control (Marker Color: WHITE)

Site Preparation Notes
-Fall 2013: Dethatch and remove biomass from experimental treatment plots
-2014 and 2015: 1 of 2 Treatments applied.
-And, Mow 1.9 acre buffer 2x/year (winter and spring), leave thatch.
-Fall 2015: Seeding Method per Restoration Treatment Approach.
-No action in control plots.

Site Overview Photo Points
-Overview Photo Point 5-1
Landmark: At edge of road at rock.
-Overview Photo Point 5-2
Location: At NW Corner of 2a.

Treatment Plot Photo Monitoring
a) NG Full Extent Seeding Treatment Plots: 2a, 5a, 12a
b) NG DeSimone Strip Method Treatment Plots: 1b, 6b, 11b
c) Control Plots: 13c, 15c, 18c

1-1 Site Overview Photo Points

Experimental Treatment

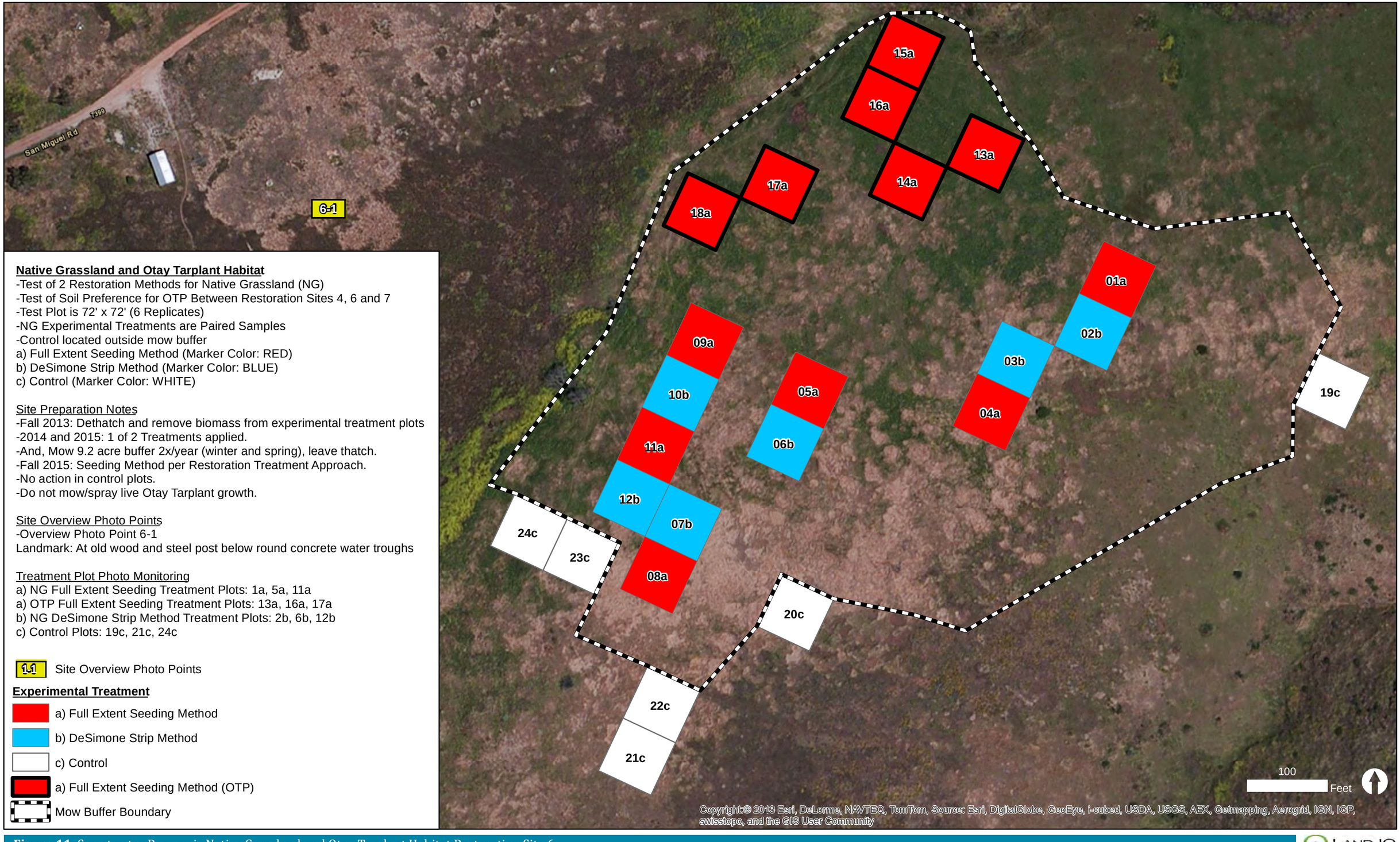
a) Full Extent Seeding Method

b) DeSimone Strip Method

c) Control

Mow Buffer Boundary

Figure 10. Rancho Jamul Ecological Reserve Native Grassland Restoration Site 5.



Native Grassland and Otay Tarplant Habitat
-Test of 2 Restoration Methods for Native Grassland (NG)
-Test of Soil Preference for OTP Between Restoration Sites 4, 6 and 7
-Test Plot is 72' x 72' (6 Replicates)
-NG Experimental Treatments are Paired Samples
-Control located outside mow buffer
a) Full Extent Seeding Method (Marker Color: RED)
b) DeSimone Strip Method (Marker Color: BLUE)
c) Control (Marker Color: WHITE)

Site Preparation Notes
-Fall 2013: Dethatch and remove biomass from experimental treatment plots
-2014 and 2015: 1 of 2 Treatments applied.
-And, Mow 9.2 acre buffer 2x/year (winter and spring), leave thatch.
-Fall 2015: Seeding Method per Restoration Treatment Approach.
-No action in control plots.
-Do not mow/spray live Otay Tarplant growth.

Site Overview Photo Points
-Overview Photo Point 6-1
Landmark: At old wood and steel post below round concrete water troughs

Treatment Plot Photo Monitoring
a) NG Full Extent Seeding Treatment Plots: 1a, 5a, 11a
a) OTP Full Extent Seeding Treatment Plots: 13a, 16a, 17a
b) NG DeSimone Strip Method Treatment Plots: 2b, 6b, 12b
c) Control Plots: 19c, 21c, 24c

1-1 Site Overview Photo Points

Experimental Treatment

a) Full Extent Seeding Method
b) DeSimone Strip Method
c) Control
a) Full Extent Seeding Method (OTP)
Mow Buffer Boundary

Figure 11. Sweetwater Reservoir Native Grassland and Otay Tarplant Habitat Restoration Site 6.

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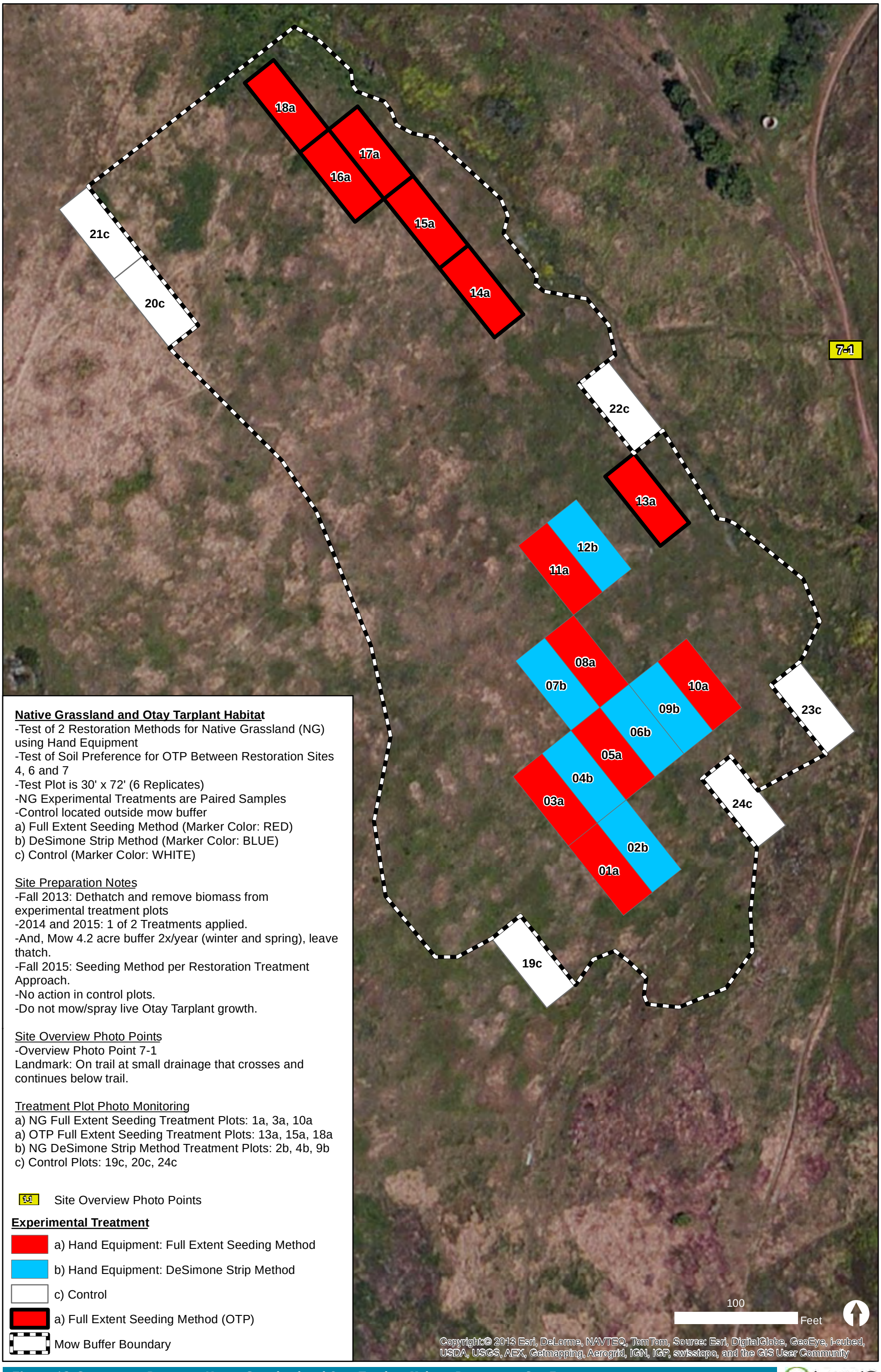

Native Grassland and Otay Tarplant Habitat
-Test of 2 Restoration Methods for Native Grassland (NG) using Hand Equipment
-Test of Soil Preference for OTP Between Restoration Sites 4, 6 and 7
-Test Plot is 30' x 72' (6 Replicates)
-NG Experimental Treatments are Paired Samples
-Control located outside mow buffer
a) Full Extent Seeding Method (Marker Color: RED)
b) DeSimone Strip Method (Marker Color: BLUE)
c) Control (Marker Color: WHITE)

Site Preparation Notes
-Fall 2013: Dethatch and remove biomass from experimental treatment plots
-2014 and 2015: 1 of 2 Treatments applied.
-And, Mow 4.2 acre buffer 2x/year (winter and spring), leave thatch.
-Fall 2015: Seeding Method per Restoration Treatment Approach.
-No action in control plots.
-Do not mow/spray live Otay Tarplant growth.

Site Overview Photo Points
-Overview Photo Point 7-1
Landmark: On trail at small drainage that crosses and continues below trail.

Treatment Plot Photo Monitoring
a) NG Full Extent Seeding Treatment Plots: 1a, 3a, 10a
a) OTP Full Extent Seeding Treatment Plots: 13a, 15a, 18a
b) NG DeSimone Strip Method Treatment Plots: 2b, 4b, 9b
c) Control Plots: 19c, 20c, 24c

7-1 Site Overview Photo Points

Experimental Treatment

a) Hand Equipment: Full Extent Seeding Method

b) Hand Equipment: DeSimone Strip Method

c) Control

a) Full Extent Seeding Method (OTP)

Mow Buffer Boundary

Figure 12. Sweetwater Reservoir Native Grassland and Otay Tarplant Habitat Restoration Site 7.

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Appendix 5. Restoration Experiment Implementation Timeline Detail

Appendix 5. Restoration Experiment Implementation Timeline Detail.

					Sycamore Canyon Bureau of Land Management (BLM) 1.665 acres				Sycamore Canyon Bureau of Land Management (BLM) 10.66 acres				SD National Wildlife Refuge at Proctor Valley U.S. Fish and Wildlife Service (USFWS) 1.665 acres			
				Property - Land Manager												
				Total Area at each Site under Land Management												
				Habitat Restoration Target(s)	QCB Habitat			Existing Habitat Invasive Plant Control	Forbland			Forbland and Scrub Mosaic	QCB Habitat			Existing Habitat Invasive Plant Control
				Site Preparation/Weed Management	Hand-Weed		Control	Invasive Plant Control Buffer	Line Trim 2x	Herbicide 2x	Control	Weed Management Buffer	Hand-Weed		Control	Invasive Plant Control Buffer
				Size of Area (Acres)	0.055	0.055	0.055	1.5	0.22	0.22	0.22	10	0.055	0.055	0.055	1.5
				Seeding Method (sch. For Fall 2015)	Hand-Seed	Seed Ball	NA	NA	Pull-Behind Broadcast Seed Spreader			NA	Hand-Seed	Seed Ball	NA	NA
Year	**Season**	**Activities**	**Description**	**Date(s)**	**Site 1**				**Site 2**				**Site 3**			
2012	**Summer**	'Otay' Wildfire at RJER	*30-acre' Otay' Human-ignited wildfire burns from the "Thousand Trails" Pio Pico RV Resort and Campground into RJER*	June 20												
	Fall	Cal-Fire Prescribed Burn at RJER (Burn Pre-Treatment) at Site 8	*Cal-Fire prescribed fire in annual grassland. "De-thatched" site in Fall 2012; however, looks like the new growth developed a significant thatch before it was controlled in 2013 (at least in the mow/line-trim plots)*	Nov 20-21												
2013	**Winter**	Herbicide (Fusilade) Full Coverage with Boomless spray nozzles	*4x6 Gator mounted spray rig with 70 gal capacity using boomless spray nozzles; 16 ounces/ac and No Foam A added plus blue dye*	Feb 7,14												
		Herbicide (Fusilade) Full Coverage with Boomless spray nozzles	*4x6 Gator mounted spray rig using boomless spray nozzles; 16 ounces/ac and No Foam A added plus blue dye; Strips between plots done with Backpack sprayer*	Feb 28												
	Spring	Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) and Garlon/Element 4 (triclopyr) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate + 2 oz Element 4; mix 3 to 1)*	March 13,28; April 9,17,24												
		Mow (Rotary)	*Skid-steer mounted rotary mower and left thatch in place*	March 26												
		Line Trim	*Line trim and left thatch in place*	March 26												
		Hebicide (Glyphosate) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate)*	March 29												
		Hand-cut flowering mustard	*Hand-cut flowering Brassica nigra to prevent seed production*	April 19,30												
	Fall	Soil Sampling and Analysis	*Analysis of soil in Experimental Plots, Sites 1-7*	Oct 7,8,30	✔	✔			✔	✔			✔	✔		
		Initial detatching of experimental treatment plots	*Sites 1-7, rotary mower, line trim, rake and dispose of off-site*	Nov 12-15	✔	✔			✔	✔			✔	✔		
2014	**Winter**	Hand-weed	*Hand-weed and selective line trimming of dense annual grass patches. Hand weed invasive plants only in buffera round treatment plots.*	Feb 25-29	✔	✔		✔					✔	✔		✔
		Herbicide (Fusilade) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels.*	Feb 25-29												
		Herbicide (Glyphosate) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels.*	Feb 25-29						✔						
		Herbicide (Fusilade) with Backpack Sprayer	*16 ounces/ac and No Foam A added plus blue dye applied with Backpack sprayer*	March 13												
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) and Garlon/Element 4 (triclopyr) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate + 2 oz Element 4; mix 3 to 1)*	March 11,13												
		Herbicide (Fusilade) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with two remote controlled 300-ft long retractable hose reels.*	March 18,19,20,28												
	Spring	Line Trim	*Line Trim around natives, cut broadleaf weeds (including Erodium spp) below rosette at soil surface; and cut annual grasses 1-2" above soil surface, after flowering, and before 'milk stage'*	March 24-28					✔							
		Mow (Rotary)	*Mow with rotary mower and leave thatch in place*	March 24-28								✔				
		Mow (Rotary)	*Skid-steer mounted rotary mower and left thatch in place*	March 25												
		Line Trim	*Line trim and left thatch in place*	March 25												
		Hebicide (Glyphosate) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate)*	April 16												
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) and Garlon/Element 4 (triclopyr) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate + 2 oz Element 4; mix 3 to 1)*	April 15,16,28												
		Hand-weed	*Hand-weed and selective line trimming of dense annual grass patches. Hand weed invasive plants only in buffera round treatment plots.*	May 5-9	✔	✔		✔					✔	✔		✔
		Herbicide (Glyphosate) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels. Avoid Bunchgrass, when possible.*	May 5-9												
		Herbicide (Glyphosate) with Backpack Sprayer	*Round-up (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer*	May 5-9						✔						
		Line Trim	*Line Trim around natives, cut broadleaf weeds (including Erodium spp) below rosette at soil surface; and cut annual grasses 1-2" above soil surface, after flowering, and before 'milk stage'*	May 5-9					✔							
		Mow (Rotary)	*Mow with rotary mower and leave thatch in place*	May 5-9								✔				
		Hand-cut flowering mustard and tocalote	*Hand-cut flowering Brassica nigra and Centaurea melitensis to prevent seed production*	June 6												
2015	**Winter**	Herbicide (Fusilade) with Backpack Sprayer	*16 ounces/ac and No Foam A added plus blue dye applied with Backpack sprayer*	Jan 23												
		Herbicide (Fusilade) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with two remote controlled 300-ft long retractable hose reels.*	Jan 7,8,15,20,21; Feb 5,6												
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants at 2 oz per g of water (+~0.7 oz Element 4 per g of water) using a backpack sprayer.*	Feb 12; March 16												
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants at 2 oz per g of water (+~0.7 oz Element 4 per g of water) using a backpack sprayer.*	Feb 5,11,19,24,25; March 4-6,10-13,16-19												
		Herbicide (Fusilade) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels.*	Feb 3-5												
		Herbicide (Glyphosate) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels.*	Feb 3-5						✔						
		Mow (Flail)	*Hydraulically Driven Flail Mower mounted to front of skid steer, set to mow at soil surface.*	Feb 24-25												
		Hand-weed	*Hand-weed and selective line trimming of dense annual grass patches. Hand weed invasive plants only in buffera round treatment plots.*	March 9-10	✔	✔		✔					✔	✔		✔
		Line Trim	*Line Trim around natives, cut broadleaf weeds (including Erodium spp) below rosette at soil surface; and cut annual grasses 1-2" above soil surface, after flowering, and before 'milk stage'*	March 16-20					✔							
		Mow (Flail)	*Hydraulically Driven Flail Mower mounted to front of skid steer, set to mow at soil surface.*	March 16-20								✔				
		Herbicide (Glyphosate) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels. Avoid Bunchgrass, when possible.*	March 16-20						✔						
		Line Trim	*Line trim and left thatch in place*	March 17												
	Spring	Mow (Rotary)	*Skid-steer mounted rotary mower and left thatch in place*	March 20												
		Hand-weed	*Hand-weed and selective line trimming of dense annual grass patches. Hand weed invasive plants only in buffera round treatment plots.*	April 20-24	✔	✔		✔					✔	✔		✔
		Line Trim	*Line Trim around natives, cut broadleaf weeds (including Erodium spp) below rosette at soil surface; and cut annual grasses 1-2" above soil surface, after flowering, and before 'milk stage'*	April 20-24					✔							
		Mow (Flail)	*Hydraulically Driven Flail Mower mounted to front of skid steer, set to mow at soil surface.*	April 20-24												
		Mow (Flail)	*Mow with PTO driven flail mower pulled behind tractor*	April 23-24												
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants at 2 oz per g of water (+~0.7 oz Element 4 per g of water) using a backpack sprayer.*	April 1,2,14-17,20-22; May 29; June 4,5,9,11,12,16												
		Hand-cut flowering mustard and tocalote	*Hand-cut flowering Brassica nigra and Centaurea melitensis to prevent seed production*	April 27-30; May 1,4-7,11-14,18-21,28,												

Appendix 5. Restoration Experiment Implementation Timeline Detail.

					Rancho Jamul Ecological Reserve (RJER) California Dept. of Fish and Wildlife (CDFW) 12.74 acres					Rancho Jamul Ecological Reserve (RJER) California Dept. of Fish and Wildlife (CDFW) 4.03 acres				SD National Wildlife Refuge at Sweetwater Reservoir U.S. Fish and Wildlife Service (USFWS) 12.04 acres					SD National Wildlife Refuge at Sweetwater Reservoir U.S. Fish and Wildlife Service (USFWS) 5.4 acres				
		Property - Land Manager																							
		Total Area at each Site under Land Management																							
		Habitat Restoration Target(s)			Native Grassland			OTP Habitat (Adj. to extant pop.)	Native Grassland and OTP Habitat (incl. extant pop.)	Native Grassland			Native Grassland and Scrub Mosaic	Native Grassland			OTP Habitat	Native Grassland and OTP Habitat	Native Grassland			OTP Habitat	Native Grassland and OTP Habitat
		Site Preparation/Weed Management			Mow 2x	Herbicide 2x	Control	Herbicide 2x	Weed Management Buffer	Mow 2x	Herbicide 2x	Control	Weed Management Buffer	Mow 2x	Herbicide 2x	Control	Herbicide 2x	Weed Management Buffer	Line Trim 2x	Herbicide 2x	Control	Herbicide 2x	Weed Management Buffer
		Size of Area (Acres)			0.71	0.71	0.71	0.71	9.9	0.71	0.71	0.71	1.9	0.71	0.71	0.71	0.71	9.2	0.3	0.3	0.3	0.3	4.2
		Seeding Method (sch. For Fall 2015)			1-way Drill in Strips	2-way Drill Full Extent	NA	2-way Drill Full Extent	NA	1-way Drill in Strips	2-way Drill Full Extent	NA	NA	1-way Drill in Strips	2-way Drill Full Extent	NA	2-way Drill Full Extent	NA	Broadcast Seed in Strips	Broadcast Seed Full Extent	NA	Broadcast Seed Full Extent	NA
Year	**Season**	**Activities**	**Description**	**Date(s)**	**Site 4**					**Site 5**				**Site 6**					**Site 7**				
2012	**Summer**	'Otay' Wildfire at RJER	*30-acre' Otay' Human-ignited wildfire burns from the "Thousand Trails" Pio Pico RV Resort and Campground into RJER*	June 20	✔	✔	✔	✔	✔														
	Fall	Cal-Fire Prescribed Burn at RJER (Burn Pre-Treatment) at Site 8	*Cal-Fire prescribed fire in annual grassland. "De-thatched" site in Fall 2012; however, looks like the new growth developed a significant thatch before it was controlled in 2013 (at least in the mow/line-trim plots)*	Nov 20-21																			
2013	**Winter**	Herbicide (Fusilade) Full Coverage with Boomless spray nozzles	*4x6 Gator mounted spray rig with 70 gal capacity using boomless spray nozzles; 16 ounces/ac and No Foam A added plus blue dye*	Feb 7,14																			
		Herbicide (Fusilade) Full Coverage with Boomless spray nozzles	*4x6 Gator mounted spray rig using boomless spray nozzles; 16 ounces/ac and No Foam A added plus blue dye; Strips between plots done with Backpack sprayer*	Feb 28	✔	✔	✔		✔	✔	✔	✔	✔										
	Spring	Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) and Garlon/Element 4 (triclopyr) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate + 2 oz Element 4; mix 3 to 1)*	March 13,28; April 9,17,24																			
		Mow (Rotary)	*Skid-steer mounted rotary mower and left thatch in place*	March 26																			
		Line Trim	*Line trim and left thatch in place*	March 26																			
		Hebicide (Glyphosate) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate)*	March 29																			
		Hand-cut flowering mustard	*Hand-cut flowering Brassica nigra to prevent seed production*	April 19,30																			
	Fall	Soil Sampling and Analysis	*Analysis of soil in Experimental Plots, Sites 1-7*	Oct 7,8,30	✔	✔		✔		✔	✔			✔	✔		✔		✔	✔		✔	
		Initial detatching of experimental treatment plots	*Sites 1-7, rotary mower, line trim, rake and dispose of off-site*	Nov 12-15	✔	✔		✔		✔	✔			✔	✔		✔		✔	✔		✔	
2014	**Winter**	Hand-weed	*Hand-weed and selective line trimming of dense annual grass patches. Hand weed invasive plants only in buffera round treatment plots.*	Feb 25-29																			
		Herbicide (Fusilade) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels.*	Feb 25-29		✔		✔			✔				✔		✔			✔		✔	
		Herbicide (Glyphosate) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels.*	Feb 25-29																			
		Herbicide (Fusilade) with Backpack Sprayer	*16 ounces/ac and No Foam A added plus blue dye applied with Backpack sprayer*	March 13																			
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) and Garlon/Element 4 (triclopyr) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate + 2 oz Element 4; mix 3 to 1)*	March 11,13																			
		Herbicide (Fusilade) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with two remote controlled 300-ft long retractable hose reels.*	March 18,19,20,28																			
	Spring	Line Trim	*Line Trim around natives, cut broadleaf weeds (including Erodium spp) below rosette at soil surface; and cut annual grasses 1-2" above soil surface, after flowering, and before 'milk stage'*	March 24-28															✔				
		Mow (Rotary)	*Mow with rotary mower and leave thatch in place*	March 24-28	✔				✔	✔			✔	✔				✔					✔
		Mow (Rotary)	*Skid-steer mounted rotary mower and left thatch in place*	March 25																			
		Line Trim	*Line trim and left thatch in place*	March 25																			
		Hebicide (Glyphosate) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate)*	April 16																			
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) and Garlon/Element 4 (triclopyr) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate + 2 oz Element 4; mix 3 to 1)*	April 15,16,28																			
		Hand-weed	*Hand-weed and selective line trimming of dense annual grass patches. Hand weed invasive plants only in buffera round treatment plots.*	May 5-9																			
		Herbicide (Glyphosate) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels. Avoid Bunchgrass, when possible.*	May 5-9		✔		✔			✔				✔		✔			✔		✔	
		Herbicide (Glyphosate) with Backpack Sprayer	*Round-up (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer*	May 5-9																			
		Line Trim	*Line Trim around natives, cut broadleaf weeds (including Erodium spp) below rosette at soil surface; and cut annual grasses 1-2" above soil surface, after flowering, and before 'milk stage'*	May 5-9															✔				
		Mow (Rotary)	*Mow with rotary mower and leave thatch in place*	May 5-9	✔				✔	✔			✔	✔				✔					✔
		Hand-cut flowering mustard and tocalote	*Hand-cut flowering Brassica nigra and Centaurea melitensis to prevent seed production*	June 6																			
2015	**Winter**	Herbicide (Fusilade) with Backpack Sprayer	*16 ounces/ac and No Foam A added plus blue dye applied with Backpack sprayer*	Jan 23																			
		Herbicide (Fusilade) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with two remote controlled 300-ft long retractable hose reels.*	Jan 7,8,15,20,21; Feb 5,6					✔				✔										
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants at 2 oz per g of water (+~0.7 oz Element 4 per g of water) using a backpack sprayer.*	Feb 12; March 16																			
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants at 2 oz per g of water (+~0.7 oz Element 4 per g of water) using a backpack sprayer.*	Feb 5,11,19,24,25; March 4-6,10-13,16-19																			
		Herbicide (Fusilade) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels.*	Feb 3-5		✔		✔			✔				✔		✔			✔		✔	
		Herbicide (Glyphosate) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels.*	Feb 3-5																			
		Mow (Flail)	*Hydraulically Driven Flail Mower mounted to front of skid steer, set to mow at soil surface.*	Feb 24-25										✔				✔					
		Hand-weed	*Hand-weed and selective line trimming of dense annual grass patches. Hand weed invasive plants only in buffera round treatment plots.*	March 9-10																			
		Line Trim	*Line Trim around natives, cut broadleaf weeds (including Erodium spp) below rosette at soil surface; and cut annual grasses 1-2" above soil surface, after flowering, and before 'milk stage'*	March 16-20															✔				
		Mow (Flail)	*Hydraulically Driven Flail Mower mounted to front of skid steer, set to mow at soil surface.*	March 16-20	✔					✔													✔
		Herbicide (Glyphosate) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels. Avoid Bunchgrass, when possible.*	March 16-20		✔		✔	✔		✔		✔		✔		✔			✔		✔	
		Line Trim	*Line trim and left thatch in place*	March 17																			
	Spring	Mow (Rotary)	*Skid-steer mounted rotary mower and left thatch in place*	March 20																			
		Hand-weed	*Hand-weed and selective line trimming of dense annual grass patches. Hand weed invasive plants only in buffera round treatment plots.*	April 20-24																			
		Line Trim	*Line Trim around natives, cut broadleaf weeds (including Erodium spp) below rosette at soil surface; and cut annual grasses 1-2" above soil surface, after flowering, and before 'milk stage'*	April 20-24															✔				
		Mow (Flail)	*Hydraulically Driven Flail Mower mounted to front of skid steer, set to mow at soil surface.*	April 20-24	✔					✔				✔									
		Mow (Flail)	*Mow with PTO driven flail mower pulled behind tractor*	April 23-24														✔					✔
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants at 2 oz per g of water (+~0.7 oz Element 4 per g of water) using a backpack sprayer.*	April 1,2,14-17,20-22; May 29; June 4,5,9,11,12,16																			
		Hand-cut flowering mustard and tocalote	*Hand-cut flowering Brassica nigra and Centaurea melitensis to prevent seed production*	April 27-30; May 1,4-7,11-14,18-21,28,																			

Appendix 5. Restoration Experiment Implementation Timeline Detail.

			Property - Land Manager	Rancho Jamul Ecological Reserve (RJER) California Dept. of Fish and Wildlife (CDFW)								
			Total Area at each Site under Land Management	~29 acres								
			Habitat Restoration Target(s)	OTP Habitat (incl. extant pop.)				Native Grassland and OTP Habitat (incl. extant pop.)	Native Grassland			
			Site Preparation/Weed Management	Mow	Line Trim	Herbicide	Control	Weed Management Buffer (south of Site 8 Test Plots)	Weed Management Buffer (N & W of Site 8 Test Plots)	Weed Management Buffer (east of Site 8 Test Plots)		
			Size of Area (Acres)	0.2	0.2	0.2	0.2	~5 acres	~15 acres	~8 acres		
			Seeding Method (sch. For Fall 2015)	NA								
Year	**Season**	**Activities**	**Description**	**Date(s)**	**Site 8**							
2012	**Summer**	'Otay' Wildfire at RJER	*30-acre' Otay' Human-ignited wildfire burns from the "Thousand Trails" Pio Pico RV Resort and Campground into RJER*	June 20							✔	
	Fall	Cal-Fire Prescribed Burn at RJER (Burn Pre-Treatment) at Site 8	*Cal-Fire prescribed fire in annual grassland. "De-thatched" site in Fall 2012; however, looks like the new growth developed a significant thatch before it was controlled in 2013 (at least in the mow/line-trim plots)*	Nov 20-21	✔	✔	✔	✔		✔		
2013	**Winter**	Herbicide (Fusilade) Full Coverage with Boomless spray nozzles	*4x6 Gator mounted spray rig with 70 gal capacity using boomless spray nozzles; 16 ounces/ac and No Foam A added plus blue dye*	Feb 7,14					✔	✔	✔	
		Herbicide (Fusilade) Full Coverage with Boomless spray nozzles	*4x6 Gator mounted spray rig using boomless spray nozzles; 16 ounces/ac and No Foam A added plus blue dye; Strips between plots done with Backpack sprayer*	Feb 28			✔					
	Spring	Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) and Garlon/Element 4 (triclopyr) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate + 2 oz Element 4; mix 3 to 1)*	March 13,28; April 9,17,24					✔	✔	✔	
		Mow (Rotary)	*Skid-steer mounted rotary mower and left thatch in place*	March 26	✔							
		Line Trim	*Line trim and left thatch in place*	March 26		✔						
		Hebicide (Glyphosate) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate)*	March 29			✔					
		Hand-cut flowering mustard	*Hand-cut flowering Brassica nigra to prevent seed production*	April 19,30					✔	✔	✔	
	Fall	Soil Sampling and Analysis	*Analysis of soil in Experimental Plots, Sites 1-7*	Oct 7,8,30								
		Initial detatching of experimental treatment plots	*Sites 1-7, rotary mower, line trim, rake and dispose of off-site*	Nov 12-15								
2014	**Winter**	Hand-weed	*Hand-weed and selective line trimming of dense annual grass patches. Hand weed invasive plants only in buffera round treatment plots.*	Feb 25-29								
		Herbicide (Fusilade) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels.*	Feb 25-29								
		Herbicide (Glyphosate) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels.*	Feb 25-29								
		Herbicide (Fusilade) with Backpack Sprayer	*16 ounces/ac and No Foam A added plus blue dye applied with Backpack sprayer*	March 13			✔					
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) and Garlon/Element 4 (triclopyr) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate + 2 oz Element 4; mix 3 to 1)*	March 11,13			✔		✔	✔	✔	
		Herbicide (Fusilade) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with two remote controlled 300-ft long retractable hose reels.*	March 18,19,20,28					✔	✔	✔	
	Spring	Line Trim	*Line Trim around natives, cut broadleaf weeds (including Erodium spp) below rosette at soil surface; and cut annual grasses 1-2" above soil surface, after flowering, and before 'milk stage'*	March 24-28								
		Mow (Rotary)	*Mow with rotary mower and leave thatch in place*	March 24-28								
		Mow (Rotary)	*Skid-steer mounted rotary mower and left thatch in place*	March 25	✔							
		Line Trim	*Line trim and left thatch in place*	March 25		✔						
		Hebicide (Glyphosate) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate)*	April 16			✔					
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) and Garlon/Element 4 (triclopyr) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer; one backpack = 3 gallons of mix (6 oz glyhposate + 2 oz Element 4; mix 3 to 1)*	April 15,16,28					✔	✔	✔	
		Hand-weed	*Hand-weed and selective line trimming of dense annual grass patches. Hand weed invasive plants only in buffera round treatment plots.*	May 5-9								
		Herbicide (Glyphosate) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels. Avoid Bunchgrass, when possible.*	May 5-9								
		Herbicide (Glyphosate) with Backpack Sprayer	*Round-up (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants using a backpack sprayer*	May 5-9								
		Line Trim	*Line Trim around natives, cut broadleaf weeds (including Erodium spp) below rosette at soil surface; and cut annual grasses 1-2" above soil surface, after flowering, and before 'milk stage'*	May 5-9								
		Mow (Rotary)	*Mow with rotary mower and leave thatch in place*	May 5-9								
		Hand-cut flowering mustard and tocalote	*Hand-cut flowering Brassica nigra and Centaurea melitensis to prevent seed production*	June 6					✔	✔	✔	
2015	**Winter**	Herbicide (Fusilade) with Backpack Sprayer	*16 ounces/ac and No Foam A added plus blue dye applied with Backpack sprayer*	Jan 23			✔					
		Herbicide (Fusilade) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with two remote controlled 300-ft long retractable hose reels.*	Jan 7,8,15,20,21; Feb 5,6					✔	✔	✔	
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants at 2 oz per g of water (+~0.7 oz Element 4 per g of water) using a backpack sprayer.*	Feb 12; March 16			✔					
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants at 2 oz per g of water (+~0.7 oz Element 4 per g of water) using a backpack sprayer.*	Feb 5,11,19,24,25; March 4-6,10-13,16-19			✔		✔	✔	✔	
		Herbicide (Fusilade) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels.*	Feb 3-5								
		Herbicide (Glyphosate) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels.*	Feb 3-5								
		Mow (Flail)	*Hydraulically Driven Flail Mower mounted to front of skid steer, set to mow at soil surface.*	Feb 24-25								
		Hand-weed	*Hand-weed and selective line trimming of dense annual grass patches. Hand weed invasive plants only in buffera round treatment plots.*	March 9-10								
		Line Trim	*Line Trim around natives, cut broadleaf weeds (including Erodium spp) below rosette at soil surface; and cut annual grasses 1-2" above soil surface, after flowering, and before 'milk stage'*	March 16-20								
		Mow (Flail)	*Hydraulically Driven Flail Mower mounted to front of skid steer, set to mow at soil surface.*	March 16-20								
		Herbicide (Glyphosate) with Intelli-Spray System (ISS)	*170 gallon capacity 4x4 pick-up bed ISS rig with one remote controlled 300-ft long retractable hose reels. Avoid Bunchgrass, when possible.*	March 16-20								
		Line Trim	*Line trim and left thatch in place*	March 17		✔						
	Spring	Mow (Rotary)	*Skid-steer mounted rotary mower and left thatch in place*	March 20	✔							
		Hand-weed	*Hand-weed and selective line trimming of dense annual grass patches. Hand weed invasive plants only in buffera round treatment plots.*	April 20-24								
		Line Trim	*Line Trim around natives, cut broadleaf weeds (including Erodium spp) below rosette at soil surface; and cut annual grasses 1-2" above soil surface, after flowering, and before 'milk stage'*	April 20-24								
		Mow (Flail)	*Hydraulically Driven Flail Mower mounted to front of skid steer, set to mow at soil surface.*	April 20-24								
		Mow (Flail)	*Mow with PTO driven flail mower pulled behind tractor*	April 23-24								
		Hebicide (Glyphosate + Element 4) Targeted Spot-Spray of broadleaf weeds	*Accord XRT II (glyphosate-based herbicide) was applied (spot treatments) to nonnative, broad leaf plants at 2 oz per g of water (+~0.7 oz Element 4 per g of water) using a backpack sprayer.*	April 1,2,14-17,20-22; May 29; June 4,5,9,11,12,16					✔	✔	✔	
		Hand-cut flowering mustard and tocalote	*Hand-cut flowering Brassica nigra and Centaurea melitensis to prevent seed production*	April 27-30; May 1,4-7,11-14,18-21,28,					✔	✔	✔	

Attachment 1. Otay Tarplant (*Deinandra conjugens*) Climate Adaptation Workshop Recommendations for Management and Monitoring

Otay Tarplant (*Deinandra conjugens*) Climate Adaptation Workshop
June 23, 2014
Rancho Jamul Ecological Reserve

Participants:

- Bruce Baldwin- Curator of Jepson Herbarium, U. C. Berkeley
- Travis Brooks- Land IQ
- Elsa Cleland- UC San Diego
- Erin Conlisk – UC Berkeley
- Mark Dodero- RECON
- Pete Famolaro – Sweetwater Authority
- Patricia Gordon-Reedy- Conservation Biology Institute
- Betty Grisle- USFWS
- David Lawhead - CDFW
- John Martin- San Diego National Wildlife Refuge
- Scott McMillan- AECOM
- Betsy Miller- City of San Diego
- Sophie Parker- TNC
- Kris Preston- USGS/San Diego Management and Monitoring Program
- John Randall- TNC
- Trish Smith- TNC
- Jessie Vinje- Conservation Biology Institute

Workshop Objectives

1. Produce recommendations for management and monitoring actions to maintain viable populations of Otay tarplant across the species full range in the decades/century ahead as the climate changes.
2. Hold and record discussion of key issues and produce recommendations that can be compared with those from two similar workshops (focused on different species) and sifted for best approaches to answering questions of how to manage and monitor rare plant species to ensure their long term viability even as the climate changes during the decades and century ahead.

Recommendations

1. Adopt San Diego Management and Monitoring Program's Otay tarplant conservation goal: maintain large populations, expand small populations, and establish new populations, to increase resilience to environmental stochasticity, maintain genetic diversity and ensure persistence for more than 100 years in native plant communities.
    a. Since Otay Tarplant is not the only species that is being managed for; focus, where possible, on holistic, system-wide restoration approaches that may require less management in the future.
    b. Consider whether increased frequency and severity of drought may actually favor Otay tarplant over some of its non-native competitors:

i. Its seed banks can apparently persist for long, dry periods, and it appears to be good at reacting to (taking advantage of) large bursts of resources (e.g. rainfall) that come its way.
ii. It has some strategies to cope with (thrive under?) a fluctuating climate; variability may be an advantage to this species

2. Manage and Stabilize Existing Populations and, where possible, expand existing populations
    a. Thatch reduction (using mechanical methods, grazing and/or fire)
        i. Once sites have a low level of invasive species (5-10%), we can wait a few years before revisiting site and de-thatching again.
        ii. Implement rotational weed control/dethatch treatments every 5-10 years
    b. Thatch reduction followed by herbicide treatment of non-native grasses and forbs
        i. Institute flexible funding so funds can be banked year after year and then used for weed control at the right time (e.g. in high rainfall years)
        ii. It is possible that climate change might favor exotic forbs so we need to be ready for that – thatch removal alone may not be enough.
    c. Conduct studies to determine best methods for promoting Otay tarplant populations
        i. NOTE: Bruce Baldwin reported that results of trials of different management regimes for Santa Cruz tarplant included burning, mowing, scraping:
            1. Burning and mowing did not stimulate recruitment despite confirmation of a large, viable soil seed bank.
            2. Burning replaced one exotic grass with another and in general increased non-native forbs;
            3. Scraping resulted in big resurgence of Santa Cruz tarplant and native forbs came back too. These desirable responses lasted a half-dozen years.
        ii. Also determine whether deep thatch may have positive impact (in addition to negative impacts) in some situations by shielding soils, keeping them from getting so much hotter and drier and thereby buffering climate changes

3. If after 5 years there is no/inadequate response, the management approach may need to change and "radical" options including translocation outside current range should be considered.

    NOTES:

    a. Do we need to have a good rainfall year before deciding to change management tactics?
    b. Or should we stop waiting since rainfall seems to have declined over time, and we may rarely get "good" rainfall years anymore?
    c. Should we design strategies as if things were going to get worse very fast?
    d. A range shift north and up in elevation may not be possible for this species because its habitat is already fragmented and because the soil types that support Otay tarplant appear to be limited to an area barely exceeding the current range of the species. (But, see 5.b.)

4. Gather and store Otay tarplant seed in bulk for use in restoring/supplementing populations at sites where populations are lost due to prolonged drought or repeated fires.
    a. Consider and use supplemental watering under certain circumstances:
        i. When seeds germinate following an early rainfall event but appear in danger of all dying without producing seeds because no rains occur afterwards.
        ii. When attempting to gather large amounts of seed and rainfall is inadequate to support abundant seed production (An early indication of the need for such supplemental watering may be the absence of larger plants which generally produce significantly more seed per unit area than small plants).

5. Look for undetected populations, particularly at edges of the species' range
    a. Expand surveys for Otay tarplant to all areas of southwestern San Diego county where clay lenses are present, including areas of grayish-white clay soil which extend north of Mission Valley and are present in the canyons that routes 163, 805 and 15 follow southward towards Mission Valley's south wall.
    b. Conduct greenhouse/field plot studies to determine which types of clays can support the species in the absence of competition.

6. Gain a better understanding of factors that drive Otay tarplant populations boom and bust years
    a. Use local weather data to determine if rainfall patterns and temperature regimes correspond with good Otay tarplant years and bad Otay tarplant years at specific sites.
        i. Are rainfall events at a particular time of year most important for Otay tarplant abundance and for Otay tarplant seed output?
        ii. Does previous season precipitation play a major role in Otay tarplant abundance and for Otay tarplant seed output?
        iii. Are late summer and autumn temperature regimes important for cueing germination?
    b. Carry out studies to determine whether habitat conditions or seed limitation play important roles in determining Otay tarplant abundance and seed output
    c. Implement an Otay tarplant abundance monitoring scheme that involves yearly counts so that the correlations could be identified.

7. Conduct seed bank and seed germination studies
    a. Viability and size of seed bank
    b. How do different types and cohorts of seed differ with regard to dormancy, cues needed to break dormancy, longevity?
    c. Use information on differences between germination rates and cues necessary to break dormancy to model long-term survival of Otay tarplant under shifting conditions and to determine whether the species may effectively be hedging its bets on low and high rainfall years.

8. Conduct genetics study
    a. Support proposed study of tarplant genetics described by Kris Preston which would build on work conducted by Bauder and Truesdale (2000). Recommend that it includes:
        i. Plants from several of the Mexican populations, especially those deemed the southernmost and the hottest and driest sites
        ii. Sampling within populations to allow assessment of how varied populations are from one another.
        iii. Material gathered from seedbank (with plants grown out if needed for analysis) and current year to look for strong genetic differences between cohorts.
        iv. Use results (and other information) to help determine whether and when it may be appropriate to plant seed from one location at another site.
            1. Some movement of seed has already occurred. Conduct land manager surveys to gain a better understanding of how much seed movement has occurred already. Use study to determine whether this has influenced genetics of populations that received "foreign" seeds.
            2. Bruce Baldwin noted that different chromosome arrangements exist within some tarplant species, including in *Deinandra* and the closely related genus *Holocarpha*; this can result in chromosomally differentiated populations that are completely intersterile and therefore qualify as distinct "biological species" (even if the difference is not apparent in the phenotype). Evolutionarily and ecologically divergent sets of populations that retain interfertility with other populations also have been detected within some tarplant species. Such populations could be irreplaceable but could be degraded by the importation of seed from other sites. It may not be possible to undo the impacts of such mixing. This may call for steps to prevent the importation of seed in populations where this condition is suspected or possible.

9. Promote native pollinators
    a. Ensure protection of intact matrix habitat (i.e., CSS) around populations of Otay tarplant.
    b. Consider clearing vegetation and thatch around sites for ground nesters, or providing wood blocks "swiss-cheesed" with holes for cavity nesters.
    c. Consult with UCSD student James Hung to learn more about pollinators of Otay tarplant

10. Promote changes in the permitting process to make rules clearer, and to make it easier to conduct research designed to understand and enhance the viability of Otay tarplant (and other rare/covered species) populations. Note however, that movement of seed between populations should be restricted at least until detailed genetic studies have been conducted, for the reasons discussed under 8.a.iv.2.

Background Information

Our recommendations are based on our expectation that the climate and other environmental conditions in the regions will change in the coming decades and century:

a. Higher average temperatures and increased lows and nighttime temperatures.
b. Droughts more severe and more frequent
    i. Change in timing of precipitation events.
c. More big rainstorms and associated high flow events in area rivers (i.e. flashier rainfall)
d. Lower soil moisture (even if average rainfall increases, since temperatures and evapotranspiration will be higher)
e. Nitrogen deposition expected to increase
f. More frequent wildfires as ignitions increase due to increasing human population in the area
    i. Shift in timing of wildfires as Santa Ana winds become more common in the spring and early summer

Attachment 2. Recon Native Plant, Inc. Bulked Seed Analyses for Purity and Viability:

Deinandra conjugens – Gobbler's population
Deinandra conjugens – RJER population
Deinandra conjugens – Shinohara population
Stipa lepida
Stipa pulchra

Ransom Seed Laboratory, Inc.
P.O. Box 300, Carpinteria, CA 93014-0300, USA
Telephone: (805) 684-3427 Email: ransomsl@silcom.com
www.ransomseedlab.com

Report Of Seed Analysis

Account No.	Date Received	Date Completed	Lab Number
391	10/27/14	12/04/14	14-14110

RECON NATIVE PLANTS
1755 SATURN PLANTS
SAN DIEGO CA 92154

Sender's Information*

Kind	**DEINANDRA CONJUGENS**
Variety	**--**
Lot Number	**7/14/14 GOBBLER'S**
Other	

*The information above is provided by the sender.

Purity Analysis		Viability Analysis				
Pure Seed Components	**Purity**	**Days Tested**	**Germination %**	**Dormant %**	**Hard %**	**Total Viable**
DEINANDRA CONJUGENS	**26.40%**	**21**	**16**	**31**	**-N-**	**47**
Crop Seed	**0.00%**					
Inert Matter	**73.58%**					
Weed Seed	**0.02%**					

Other Crop Seeds: In 2 grams **None Found**

Noxious Weed Seeds: In 2 grams **None Found**
(C) California Noxious, (O) Other Noxious

Other Weed Seeds: In 2 grams	**# per lb**
EUPHORBIA SP.	227
SENECIO SP.	227

Other Determinations:	
Live Seed Per Pound	167,526
P.L.S.	12.41 %

Germination Remarks
DORMANT SEED DETERMINED BY TZ.

Purity Remarks
INERT MATTER: BROKEN SEED, PLANT MATERIAL

Tests Requested Purity, Germination, P.L.S., Live Seed Per Pound. No other tests requested.

Signature:

Issued by Registered Member No.67. Society of Commercial Seed Technologies.
Aleta Meyr, RST; Michael Aberle, RST

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Report Of Seed Analysis

Account No.	Date Received	Date Completed	Lab Number
391	10/27/14	12/04/14	14-14109

RECON NATIVE PLANTS
1755 SATURN PLANTS
SAN DIEGO CA 92154

Sender's Information*

Kind	**DEINANDRA CONJUGENS**
Variety	**--**
Lot Number	**7/14/14 RANCHO JAMUL**
Other	

*The information above is provided by the sender.

Purity Analysis		Viability Analysis				
Pure Seed Components	**Purity**	**Days Tested**	**Germination %**	**Dormant %**	**Hard %**	**Total Viable**
DEINANDRA CONJUGENS	**24.39%**	**21**	**27**	**43**	**-N-**	**70**
Crop Seed	**0.00%**					
Inert Matter	**75.61%**					
Weed Seed	**0.00%**					

Other Crop Seeds: In 1.8 grams **None Found**

Noxious Weed Seeds: In 1.8 grams **None Found**
(C) California Noxious, (O) Other Noxious

Other Weed Seeds: In 1.8 grams **None Found**

Other Determinations:

Live Seed Per Pound	153,833
P.L.S.	17.07 %

Germination Remarks
DORMANT SEED: 22% GERMINATED WHEN PRECHILLED; 21% DETERMINED BY TZ.

Purity Remarks
INERT MATTER: BROKEN SEED, PLANT MATERIAL

Tests Requested Purity, Germination, P.L.S., Live Seed Per Pound. No other tests requested.

Signature:

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Report Of Seed Analysis

Account No.	Date Received	Date Completed	Lab Number
391	10/27/14	12/04/14	14-14108

RECON NATIVE PLANTS
1755 SATURN PLANTS
SAN DIEGO CA 92154

Sender's Information*

Kind	**DEINANDRA CONJUGENS**
Variety	**--**
Lot Number	**7/14/14 SHINOHARA**
Other	

*The information above is provided by the sender.

Purity Analysis		Viability Analysis				
Pure Seed Components	**Purity**	**Days Tested**	**Germination %**	**Dormant %**	**Hard %**	**Total Viable**
DEINANDRA CONJUGENS	**21.15%**	**21**	**21**	**47**	**-N-**	**68**
Crop Seed	**0.00%**					
Inert Matter	**78.77%**					
Weed Seed	**0.08%**					

Other Crop Seeds: In 2 grams **None Found**

Noxious Weed Seeds: In 2 grams **None Found**
(C) California Noxious, (O) Other Noxious

Other Weed Seeds: In 2 grams	**# per lb**
SONCHUS OLERACEUS	907
UNKNOWN BRASSICACEAE	454

Other Determinations:	
Live Seed Per Pound	146,701
P.L.S.	14.38 %

Germination Remarks
DORMANT SEED: 13% GERMINATED WHEN PRECHILLED; 34% DETERMINED BY TZ.

Purity Remarks
INERT MATTER: PLANT MATERIAL

Tests Requested Purity, Germination, P.L.S., Live Seed Per Pound. No other tests requested.

Signature:

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Report Of Seed Analysis

Account No.	Date Received	Date Completed	Lab Number
391	10/27/14	11/24/14	14-14106

RECON NATIVE PLANTS
1755 SATURN PLANTS
SAN DIEGO CA 92154

Sender's Information*

Kind	**STIPA LEPIDA**
Variety	**--**
Lot Number	**8/20/14 SCGP**
Other	**(NASSELLA)**

*The information above is provided by the sender.

Purity Analysis

Pure Seed Components	Purity
STIPA LEPIDA	**98.48%**
Crop Seed	**0.05%**
Inert Matter	**1.34%**
Weed Seed	**0.13%**

Viability Analysis

Days Tested	Germination %	Dormant %	Hard %	Total Viable
21	**84**	**-N-**	**-N-**	**84**

Other Crop Seeds: In 20 grams

	# per lb
BROMUS HORDEACEUS	136

Noxious Weed Seeds: In 20 grams **None Found**
(C) California Noxious, (O) Other Noxious

Other Weed Seeds: In 20 grams

	# per lb
VULPIA MYUROS	680
CAPSELLA BURSA PASTORIS	23
HORDEUM SP.	23
SESAMUM SP.	23

Other Determinations:

Live Seed Per Pound	263,950
P.L.S.	82.72 %

Purity Remarks
INERT MATTER: PLANT MATERIAL, SOIL

Tests Requested Purity, Germination, P.L.S., Live Seed Per Pound. No other tests requested.

Signature:

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Report Of Seed Analysis

Account No.	Date Received	Date Completed	Lab Number
391	10/27/14	11/20/14	14-14107

RECON NATIVE PLANTS
1755 SATURN PLANTS
SAN DIEGO CA 92154

Sender's Information*

Kind	**STIPA PULCHRA**
Variety	**--**
Lot Number	**8/20/14 SCGP**
Other	**(NASSELLA)**

*The information above is provided by the sender.

Purity Analysis

Pure Seed Components	Purity
STIPA PULCHRA	**97.43%**
Crop Seed	**0.08%**
Inert Matter	**2.40%**
Weed Seed	**0.09%**

Viability Analysis

Days Tested	Germination %	Dormant %	Hard %	Total Viable
21	**82**	**10**	**-N-**	**92**

Other Crop Seeds: In 100 grams

	# per lb
BROMUS CARINATUS	68

Noxious Weed Seeds: In 100 grams **None Found**
(C) California Noxious, (O) Other Noxious

Other Weed Seeds: In 100 grams

	# per lb
BROMUS CATHARTICUS	41
HORDEUM SP.	9
VULPIA MYUROS	9
CHENOPODIUM SP.	5
MELICA SP.	5

Other Determinations:

Live Seed Per Pound	84,651
P.L.S.	89.64 %

Germination Remarks
DORMANT SEED: 10% GERMINATED WHEN PRECHILLED AND GA3 ADDED

Purity Remarks
INERT MATTER: BROKEN SEED, PLANT MATERIAL, SOIL

Tests Requested Purity, Germination, P.L.S., Live Seed Per Pound. No other tests requested.

Signature:

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