Atwell Island Upland Habitat Restoration Evaluation

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Introduction

A number of federal agencies joined forces approximately two decades ago to determine whether retired farmland could be restored for use by native species. Atwell Island was the site of one of two demonstration projects. The objectives stated at project initiation were as follows (Laymon et al. 2010, p. 3):

1. Restore lands with potential for native forb and grass dominance to a minimum of 15% native grass and forb cover.
2. Re-establish native shrub communities.
3. Restore a functioning, sustainable ecosystem supporting native wildlife species.

The objective of this study was to document habitat quality in the restored areas within the Atwell Island Restoration Project.

Methods

Study area

The Atwell Island Restoration Project is located in southeastern Kings and southwestern Tulare County, California, approximately 1 mile south of Alpaugh (Figure 1). The approximately 8,000-acre project area encompasses portions of Townships 23 and 24 South and Ranges 22 and 23 East, MDB&M. Much of the project area has been cultivated for over 100 years and was laser-leveled in recent decades to farm irrigated crops including alfalfa, cotton, oats, and safflower. Additionally, the project area includes 1,000 acres where grain was farmed more than 30 years ago but the land was never leveled; this area has not been restored and remains fallow. Within the project boundaries, one native (uncultivated) parcel of 360 acres remains in the northwest corner on the Sand Ridge topographic feature (Laymon et al. 2010).

The U.S. Bureau of Land Management (BLM), Bakersfield Field Office provided a database with the restoration details for selected plots and a base map for the area. The database identified each restoration plot ("field") by a hyphenated code representing the township, range, section, and a unique identification number which sometimes included a letter. The database included acreage, last crop grown, number of years fallow prior to restoration, whether and when it had

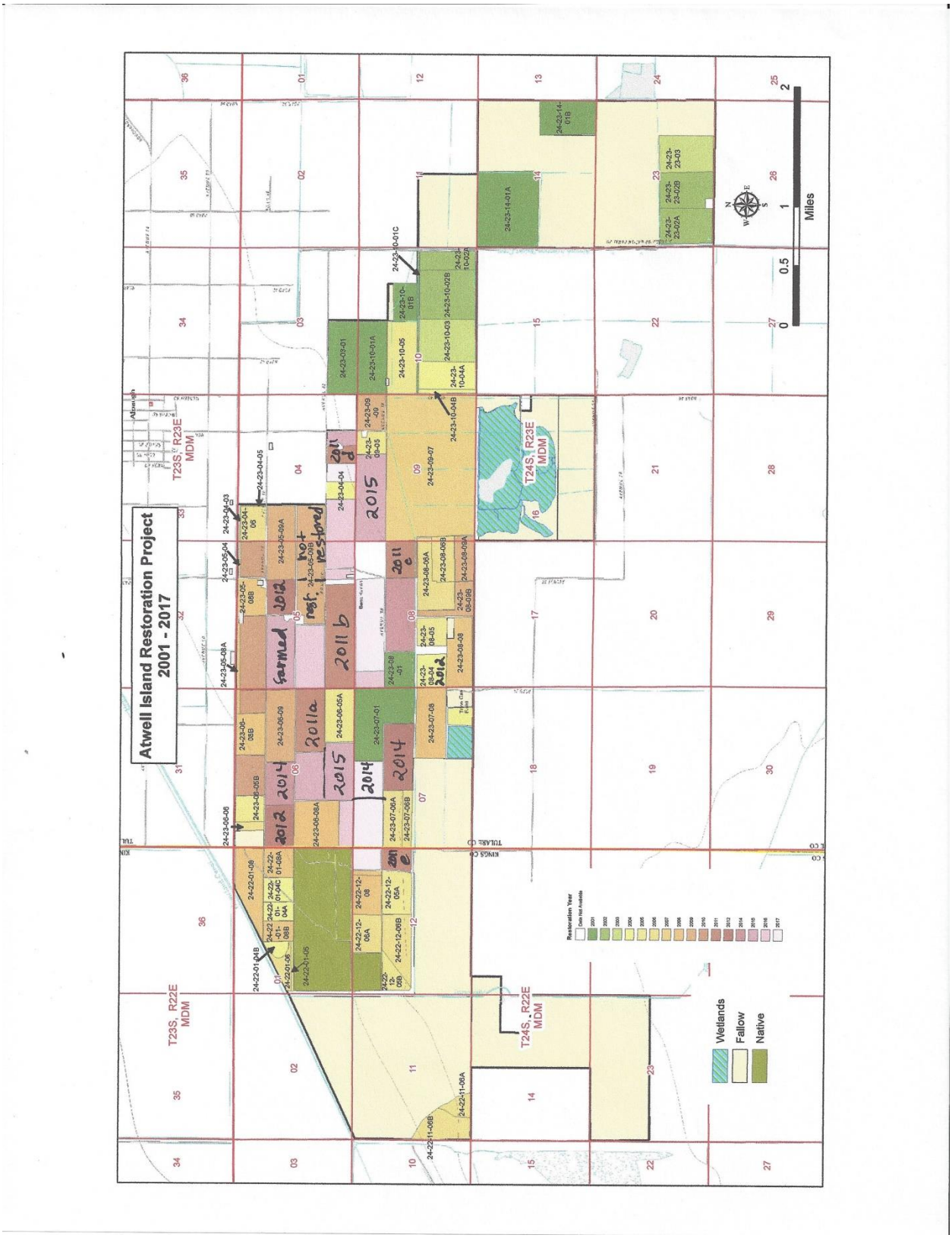

Figure 1. Map of the Atwell Island Restoration Project, Kings and Tulare Counties, CA.

been burned, type of mechanical treatment used, month and year of planting, type of planting equipment used, seeding rate overall and by species, seed origin, whether or not irrigation was applied, and soil series and texture. Figure 3-6 in the previous report (Laymon et al. 2010) provided a map of soil distribution that was helpful in determining the soil series for plots not in the database. Ms. Jihadda Govan, who managed the Atwell Island Restoration Project for several years until 2016, provided the year of restoration for 11 additional plots that had been seeded during her tenure (Figure 1) but details of the restoration treatment were not available.

Sampling

Personnel from the California State University-Stanislaus Endangered Species Recovery Program (ESRP) collected data from March 28 through April 6, 2017, and recorded their observations on a site-specific data sheet (Appendix A). ESRP staff assigned numeric codes comparable to those in the database to plots that were known to have been restored in specific years and described the location of plots for which they had no restoration year. In general, one person sampled each plot by walking a meandering transect covering a sufficient portion of the plot to describe the cover and dominant species composition. Observers made a point to cover at least 80 acres and to walk a transect of at least ½ mile total length unless plots were too small to accommodate those measurements. Plots were divided into two sampling units (subplots) if they had two clearly distinguishable vegetation types that differed considerably and were not intermixed. Tracks of each transect were recorded with the Avenza mobile telephone application and are available on request. At least one photograph was taken of each plot, and coordinates of the photo point and direction facing were recorded on the data sheet.

Absolute cover of both living and dead vegetation was recorded along with cover of litter (dead herbaceous plants from previous years) and bare ground; these values summed to 100. Shrubs and herbaceous plants were recorded separately. Average shrub height was noted in 0.5-meter increments for those less than 1 meter in height and 1-meter increments if larger. Moss and lichen were recorded as present but no further identification was attempted. Dominant vascular plant species were identified to the genus or species level; in all cases, plants were identified to the level necessary to determine whether they were native or non-native. The author keyed unknown or questionable plants collected by the field staff using a local flora (Moe 2016) and the most recent Jepson Manual (Baldwin et al. 2012). Dominant plant taxa were assigned to a modified Daubenmire cover class and as well as a subjective distribution category of continuous, patchy, scattered, or in a single location. All native plant taxa observed were recorded as present but were not assigned a cover class or category unless they were among the dominant species.

Both direct observation and sign (burrows, scats, tracks, etc.) were used to determine use of plots by wildlife. The animal groups recorded were rodents (gophers were recorded separately but have been merged with other rodents for this report), rabbits (i.e., lagomorphs, including hares), carnivores, lizards, and birds. Individual species were noted if identifiable, and animals not covered by any of the above groups also were noted on the data sheet. Observers assigned a usage level for each animal group if possible but otherwise just recorded the group as present. For rodents, the level was based on the average number of burrows or mounds visible from any given point, with two or fewer categorized as low, three to five as medium, and six or more as high. Rabbit, carnivore, and lizard categories were continuous, patchy, scattered, or in a single

location. Bird use categories included flying over, hunting (raptor), nesting, and resting or roosting.

Analysis

The large number of restoration treatments and lack of replication precluded statistical analysis of the data. Instead, this report just evaluates compliance with the success criteria for each of the restoration treatments and summarizes the relative presence of seeded species and wildlife groups in the plots. Any comparisons are based solely on inspection. In addition, shrub heights are tallied by category and discussed relative to time since planting.

Success criteria were defined as "sites with 15% native cover and 1% native shrub cover" (Laymon et al. 2010, p. 38). Based on the objectives stated earlier, I have interpreted this to mean that the former criterion refers to native herb cover only and that shrubs must be alive to satisfy the latter.

Results

Data were collected on a total of 69 plots or sub-plots, which comprised 65 restored plots as well as 2 native (uncultivated) and 2 fallow (unrestored) reference areas (Table 1). Six plots were subdivided into subplots and in two cases (24-23-09-07 A&D, 24-23-09-07 B&E) separately numbered fields were combined for sampling because the berms and flats were so closely spaced. Detailed restoration history was available for 37 of the 65 plots, and year of planting only for another 11.

Success Criteria

Among the restored plots sampled, 24 (36.9%) met both success criteria and 26 (40.0%) met one of the two (Table 2). The shrub success criterion was met more often than the herb criterion for those that achieved only one of the two (21/26 = 80.8% and 5/26 = 19.2%, respectively). Apparently, none of the native or fallow reference plots met both criteria (Table 2), but for one of the native plots that may be an artifact of sampling date. Plot 24-22-01-native 2 had sufficient native herb cover (16%) but all of the *Suaeda nigra* (formerly *S. moquinii*) shrubs were recorded as dead (Table 1) because they did not show any evidence of growth even though the same species in other plots had leaves. However, that corner of the native area had been flooded until just before sampling, which may have simply delayed leaf growth. The project site was not revisited after April to determine the status of these shrubs.

Restoration treatments and soil type (Table 2)

Field size: Gaps in the range of plot sizes suggested the categories shown in Table 2. Plots ranging in size from 25 to 52 acres were the most numerous and also achieved the highest success rate, with 41.2% meeting both criteria.

Last crop grown: The crop did not appear to influence the relative success rate.

Table 1. Data summary for all plots sampled at the Atwell Island Restoration Project in spring 2017. See Appendices B and C for species codes.

Refer to separate Excel file (occupies 2 pages).

Table 1 continues

Table 2. Number of plots meeting vegetation success criteria of 15% or more native herb cover and 1% or more shrub cover for each restoration treatment at the Atwell Island Restoration Project site, spring 2017.

Treatment	Total plots	Number of criteria met					
		Both		One		None	
		Count	Percent	Count	Percent	Count	Percent
REFERENCE							
Native [1] (uncultivated)	2	0	0.0	2	100.0	0	0.0
Fallow >30 years (unrestored)	2	0	0.0	2	100.0	0	0.0
ALL RESTORED							
Overall	65	24	36.9	26	40.0	15	23.1
FIELD SIZE							
≤ 20 acres	6	0	0.0	4	66.7	2	33.3
25-52 acres	17	7	41.2	9	52.9	1	5.9
70-100 acres	7	2	28.6	1	14.3	4	57.1
>100 acres	4	1	25.0	2	50.0	1	25.0
LAST CROP							
alfalfa	5	1	20.0	4	80.0	0	0.0
barley	3	1	33.3	2	66.7	0	0.0
oats	24	6	25.0	9	37.5	9	37.5
safflower	5	2	40.0	2	40.0	1	20.0
TIME FALLOW							
0 years	3	2	66.7	1	33.3	0	0.0
1 year	10	3	30.0	6	60.0	1	10.0
2 years	6	1	16.7	4	66.7	1	16.7
4 years	6	0	0.0	1	16.7	5	83.3
5 years	9	1	11.1	6	66.7	2	22.2
6 years	1	1	100.0	0	0.0	0	0.0
20 years	2	1	50.0	0	0.0	1	50.0
BURNED							
No	24	4	16.7	12	50.0	8	33.3
Yes	13	6	46.2	5	38.5	2	15.4

Treatment	Total plots	Number of criteria met					
		Both		One		None	
		Count	Percent	Count	Percent	Count	Percent
MECHANICAL							
Disked	5	3	60.0	1	20.0	1	20.0
ESRP preparation	7	1	14.3	3	42.9	3	42.9
Hedgerow prep.	5	0	0.0	3	60.0	2	40.0
None	14	5	35.7	6	42.9	4	28.6
Other	5	1	20.0	4	80.0	0	0.0
DATE PLANTED							
1/01-1/04	18	1	5.6	10	55.6	7	38.9
11/04-12/06	19	9	47.4	7	36.8	3	15.8
2011-2015	11	7	63.6	3	27.3	1	9.1
PLANTER							
Broadcast seeder	6	3	50.0	2	33.3	1	16.7
Imprinter	8	1	12.5	4	50.0	3	37.5
Range drill	19	5	26.3	8	42.1	6	31.6
Multiple types	4	1	25.0	3	75.0	0	0.0
SEED SOURCE & RATE							
Local <30 lbs/acre	16	6	37.5	6	37.5	4	25.0
Local >30 lbs/acre	9	3	33.3	5	55.6	1	11.1
S&S (commercial)	11	1	9.1	4	36.4	6	54.5
IRRIGATION							
No	29	9	31.0	12	41.4	8	27.6
Yes	8	1	12.5	4	50.0	3	37.5
SOIL SERIES [2, 3]							
Excelsior	8	8	100.0	0	0.0	0	0.0
multiple	7	3	42.9	1	14.3	3	42.9
Nahrub	24	3	12.5	12	50.0	9	37.5
Posochanet	25	10	40.0	12	48.0	3	12.0
Westcamp	1	0	0.0	1	100.0	0	0.0

[1] One of the two plots may have met both criteria. This count is based on the assumption that the shrubs were dead but they may have been dormant.

[2] Listed as primary soil series if only a small portion of the plot belonged to a different series. Listed as multiple if two or more series occupied similar fractions of plot.

[3] Includes restored plots only.

Number of years fallow prior to restoration: A dichotomy was observed for success relative to the time a field had been fallow. Restoration plantings immediately following a crop were relatively successful (66.7%), as were those fallowed for 6 years or more (50-100% successful).

Burning: Prescribed burning prior to restoration was clearly beneficial for achieving the success criteria, with nearly half (46.2%) of burned plots meeting both criteria, compared to 16.7% for unburned plots.

Type of mechanical treatment used: Disking was associated with a higher success rate (60%) than other mechanical treatments.

Planting date: Plots planted from 2011 through 2015 met the success criteria better than older plantings, with 63.6% of the former achieving both criteria.

Type of planting equipment used: The use of a broadcast seeder, with which 50% of plots met both criteria, appears to be preferable to other forms of planting.

Seed source and rate: Locally-collected seed outperformed commercial seed from S&S by a factor of four to one (33.3-37.5% versus 9.1%). Seeding rate with the local source did not appear to make a difference in outcome.

Irrigation: Only a small proportion of the irrigated plots (12.5%) met both criteria, compared to 31% of plots that were not irrigated.

Soil series: Success rates were highest on Excelsior soils, where 100% of plots met both criteria. Plots on both Nahrub and Westcamp soils performed poorly, with 12% or less meeting both criteria and 40% of those on Nahrub soils meeting neither criterion.

Vegetation

Of 46 species seeded (including the individual species in the various S&S Seed mixtures), 22 (47.8%) were observed during the 2017 sampling period (Appendix B). At least 72 unique plant species were observed during sampling, of which 41 (56.9%) were native and 21 (29.2%) had been seeded; some of the latter may have dispersed from natural sources as well. Two prominent species pairs may represent misidentifications or taxonomic changes. The BLM database indicates that *Lasthenia californica* was seeded; due to taxonomic changes the local plants previously referred to this species now key as *L. gracilis* (Baldwin et al. 2012). The field crew did not attempt to identify every *Lasthenia* to species, but neither *L. californica* nor *L. gracilis* was reported or collected. For summary purposes *L. minor* and *Lasthenia* species were considered to represent the seeded taxon (Table 3). Although not attributable to a taxonomic change, the species pair *Layia glandulosa* (seeded) and *Layia pentachaeta* ssp. *albida* (observed) likely represent a misidentification in one of the taxa and thus the presence of the latter was counted as a successful restoration of the former.

Table 3. Native species composition relative to species seeded. Species shown in bold were observed at the Atwell Island Restoration Project site in spring 2017; those underlined had been seeded, whereas those listed in brackets had not been seeded. In some cases the species observed was a close relative of that seeded; these are separated by a slash (/) and assumed to represent the same taxon. See Appendix B for species acronyms.

Plot	Shrubs	Forbs	Grasses
24-22-11-06A	ATPO **FRSA** ISAC ISAR SUMO	**[AMME]** HEAN **HEPU** LACA/**[LAMI]** LAGL **LEDI** PHCI TRLA	
24-22-11-06B	**ATPO ISAC [SUMO]**	[**ASDI**] CAPU **[CRTR] [GULA]** HEPA **HEPU** LACA/**[LASP]** LAGL/**[LAPE]** MACO NEME PHTA **[SPMA]** TRER TROV	**[DISP]**
24-22-12-05A	**ATPO** ATSP FRSA ISAC **SUMO**	**[CRTR] [GULA]** HEPU LACA/**[LASP]** LAGL/**[LAPE] MACO** PHCI	SPAI
24-22-12-05B	ATLE **ATPO** ATSP **ISAC ISAR**	**[AMME]** COCA HEAN HEPU LACA/**[LASP]** LAGL/**[LAPE]** MACO **PHCI**	SPAI
24-22-12-06A	ATPO **[ATSP] ISAC [ISAR]** SUMO	**[AMME] HEPU** LAGL/**[LAPE]**	
24-22-12-06B	**ATPO** ATSP **ISAC** ISAR SEVE SUMO	[**AMME**] **[CRTR] [ERKE] HEPU** LACA/**[LASP]** LAGL/**[LAPE]** MALE **PHCI** TROV	
24-23-03-01	ALOC ATPO ATSP **FRSA** ISAC SUMO	**[AMME] [GULA]** HECU HEPU LACA **[LAPE]**	BRCA LETR SPAI VUMI
24-23-04-04	[**ATPO**] **[ISAC] [SUMO]**	**[AMME] [COCO] [GULA]** [**HEPU**] **[LAPE] [PHCI]**	
24-23-06-05A	ALOC ATLE **ATPO** ATSP ISAC **ISAR** SEVU **[SUMO]**	**[AMME]** COCO DICA HEPU LACA/**[LAMI]** LAGL/**[LAPE]** LOPU **MACO PHCI**	
24-23-06-05B	**ALOC ATPO** ATSP **FRSA ISAC SUMO**	**[AMME] HEPU** LACA/**[LASP]** LAGL/**[LAPE]** MACO **PHCI**	**[VUMI?]**
24-23-07-01	**ALOC ATPO ATSP FRSA** ISAC **SUMO**	**[AMME] [GULA]** HECU **HEPU** LACA/**[LASP] [LAPE] [PHCI]**	BRCA LETR **SPAI** VUMI
24-23-07-06A	**ATPO FRSA ISAC** SUMO	**[AMME]** HEPA **HEPU** LAFE LACA/[**LASP**] LAGL/**[LAPE]** LENI MACO **PHCI**	
24-23-07-06B	**ATPO FRSA** ISAC ISAR SUMO	COCO HEAN HEPA **HEPU** LACA/[**LASP**] LAGL/**[LAPE]** LEDI MOCO MALE **PHCI** TRLA	
24-23-08-01	ALOC **ATPO** ATSP FRSA ISAC **SUMO**	**[AMME] [GULA]** HECU HEPU LACA **[LAPE] [PHCI]**	BRCA LETR SPAI VUMI
24-23-08-05	ATLE **ATPO** ISAC	**[LASP] [LAPE] [LESP] [PHCI]**	
24-23-08-06A	**ATPO [ATSP**] FRSA ISAC **ISAR** SUMO	COCO **[GULA]**HEAN HEPA HEPU LACA**/[LASP]** LAGL/**[LAPE] LEDI MACO** MALE **PHCI** TRLA	
24-23-09-05	ATLE **ATPO** FRSA **ISAC ISAR**	**[AMME]** [**ATAR**] **[GULA] HEPU** LACA/**[LASP]** LAGL/**[LAPE] MACO PHCI**	SPAI
24-23-09-07A	**ATLE ATPO ISAC ISAR** SUMO		
24-23-09-07B	ALOC [**ATLE**] **ATPO ATSP** FRSA ISAC **ISAR SUMO**	**[AMME] [CABR] [GULA]** LACA/[**LASP**] LAGL/[**LAPE] [LESP]** MACO **PHCI**	
24-23-09-07D	ATSP FRSA **ISAC**	**[AMME] [CABR] [GULA] HEPU** LACA/[**LASP**] LAGL/**[LAPE] [LESP] MACO [MONU] PHCI**	HODE
24-23-09-07E	[**ATLE**] [**ATPO**] **ATSP** FRSA ISAC	**[AMME] [CABR] [GULA]** HEPU LACA/**[LASP**] LAGL/**[LAPE] [LESP]** MACO **PHCI**	HODE
24-23-09-07F	ALOC FRSA **SUMO**	**[AMME]** ASOX **[ATAR?] ERPA** GRCA **[HEPU] LAFE [LAPE] LEDI [MACO]** [**PHCI**] [**PLLE**] [**SPMA**] TROV	**HODE** LETR SPAI
24-23-10-01A	ALOC ATPO ATSP FRSA ISAC SUMO	**[AMME] [CAEX] [GULA]** HECU HEPU LACA **[LAPE] [LESP]**	BRCA LETR SPAI VUMI
24-23-10-01B	ATLE FRSA	**AMME [CAEX] [CRTR]** ERSE [**GULA**] HEAN HEPU **[LASP] [LAPE] [LESP]**	LETR VUMI
24-23-10-02A	ATLE FRSA [**ATPO**]	**AMME** DICA ERSE [**GULA**] HEAN HEPU **[LAPE] [LENI]**	LETR VUMI
24-23-10-02B	ALOC ATLE **ATPO** ATSP FRSA ISAC SUMO	**[AMME] [CAEX]** [**GULA**] HEAN HECU HEPU LACA **[LAPE]** [**PHCI**]	BRCA LETR SPAI VUMI
24-23-10-03A	ALOC ATLE **ATPO** ISAC ISAR	**[AMME]** HEAN **[LAPE]** MALE	
24-23-10-04A	ALOC ATLE **ATPO** ATSP FRSA ISAC ISAR SEVE SUMO	**[AMME] [ATAR?] [CAEX]** DAWR ERSE ESCA [**GULA**] HECU **HEPU** LACA**/[LASP]** LAGL/**[LAPE]** LUNA MACO **PHCI** PHTA TRLA	BRCA LETR SPAI VUMI
24-23-10-04B	[**ATPO**]	**[AMME]** CRTR **[GULA] [LAPE] [PHCI]** MALE	
24-23-10-05	ATLE **ATPO** ISAC **ISAR**	**[AMME] [CAEX] [GULA] HEPU** LAGL/**[LAPE] [LESP] [PLLE]**	
24-23-14-01A	ALOC ATPO ATSP **FRSA** ISAC SUMO	**[AMME]** [**ATAR?**] **[CAEX] [GULA]** HECU **HEPU** LACA **[LAPE] [LENI]**	BRCA LETR SPAI VUMI
24-23-14-01B	ATPO ATSP **FRSA** ISAC SUMO	**[AMME] [CABR]** ERSE GITR **[GULA] HEPU** LACA **[LESP]**	SPAI VUMI
24-23-23-02A	**ATPO** ATSP **FRSA** ISAC SUMO	**[AMME] [CABR]** ERSE GITR **[GULA] HEPU** LACA **[LAPE] [LENI]**	SPAI VUMI
24-23-23-02B	**ATSP FRSA** SUMO	**[AMME] [CABR]** CRTR **HEPU** LACA/**[LASP] [LAPE] [LESP]**	
24-23-23-03	ATSP **FRSA** SUMO	[**AMME**] [**CABR**] CRTR **[GULA] HEPU** LACA [**LAPE**] [**LESP**] MALE	

Among the 35 restoration plots for which seeding history was available, the most successful shrub was *Atriplex polycarpa*, which was observed in 20 of the 26 plots (76.9%) where it had been seeded and as a volunteer in 4 other plots (Table 3). *Peritoma (Isomeris) arborea* was second, in 7 of 12 (58.3%) seeded plots and 1 volunteer. Three of the four highly successful forbs among those seeded were in the family Asteraceae (Appendix B). *Layia pentachaeta* ssp. *albida* occurred in 18 of the 19 (94.7%) plots where a *Layia* species had been seeded and was a volunteer in 15 others. Other successful Asteraceae were the combined *Lasthenia* species (18/26 = 86.7% + 2 volunteer) and *Centromadia (Hemizonia) pungens* (17/28 = 60.7% + 2 volunteer). *Phacelia ciliata* was the second most successful forb (13/15 = 86.7% + 6 volunteer). These four forbs also were frequent dominants in plots for which no restoration history was available (Table 1). Native grasses had a poor success rate overall and were found in only 2 of 17 (11.8%) plots where one or more species had been seeded. Even though *Amsinckia menziesii* had been seeded into only two plots it was ubiquitous, as was *Caulanthus (Guillenia) lasiophyllus*, which had not been used at all in the restoration plantings.

Shrub height was recorded for 51 of the restored plots and all 4 reference plots. Shrub cover was absent in 7 (13.7%) of the restored plots and one fallow reference plot. Most species of shrubs observed in the other reference plots (*Frankenia salina, Isocoma acradenia,* and *Suaeda moquinii*) are relatively short in growth habit and did not exceed 0.5 meter in height; the tallest shrub in the reference plots (up to 1 m) was *Atriplex polycarpa*, in part of the native area. The majority of the shrubs in restored plots were moderate in height, with 19 (37.3%) and 16 (31.4%) in the 0.5-1 meter and 1-2 meter height classes, respectively. No shrubs over 2 m in height were observed during sampling. Time since planting did not seem to influence current shrub height. Among the 16 restored plots with shrubs a meter or more in height, 9 (56.3%) were planted between 2001 and 2006, 3 (18.8%) between 2007 and 2010, and 4 (25.0%) from 2011 through 2015.

Rare Plants

Three of the plant taxa that have been seeded into the Atwell Island Restoration Project have some status as rare plants (California Native Plant Society 2017). *Eremalche parryi* ssp. *kernensis* (Kern mallow) is Federally listed as endangered and has a state Rare Plant Rank of 1B.2, meaning that it is rare and endangered in California and elsewhere. At the time this taxon was seeded into the restoration plots, sources outside of the Lokern Natural Area of Kern County were not considered to represent the rare species. It was observed in one depression in plot number 24-23-09-07F but could be in others because only 9 depressions were visited in the course of this sampling. *Lasthenia ferrisiae* (Ferris' goldfields), which has a Rare Plant Rank of 4.2, meaning it is a species of limited distribution in California, was observed in multiple depressions in the same field. The third species, *Trichostema ovatum* (San Joaquin bluecurls) also has a Rare Plant Rank of 4.2. According to the BLM database, it was seeded into three of the sampled plots but was not observed in spring 2017.

Wildlife

At least 31 unique species of vertebrate animals were observed on the sampled plots, including 3 reptiles, 21 birds, and 7 mammals (Appendix C). Only two of the 65 restored plots (24-23-05-09B E and W) exhibited no sign of wildlife. The conditions in these two sub-plots were extreme among those sampled in 2017 (Table 1). The eastern sub-plot was the only one that had 100%

cover of non-native herbs and no bare ground. Although the western sub-plot had more diverse vegetation structure, with 30% shrub cover, 10% native herbs, and 40% cover of non-native herbs, it also had 20% cover of litter (residual dry matter), leaving no bare ground. However, several other plots that had conditions comparable to the western sub-plot exhibited at least some wildlife use. It is possible that a more thorough inspection of the plot would have revealed animal activity.

Most of the wildlife observed at the Atwell Island Restoration Project were generalist species. Rodent activity (primarily kangaroo rat) was noted in 57 of the 65 (87.7%) restored plots. Although the Federally and State endangered Tipton kangaroo rat (*Dipodomys nitratoides nitratoides*) is known to inhabit the native (uncultivated) parcel in the Sand Ridge area of the project site, only Heermann's kangaroo rats (*D. heermanni*) have been trapped in the restored plots (L. Saslaw, personal communication). The next most common wildlife group was birds, with from one to six different species using 45 (69.2%) of the plots either for hunting, resting, or nesting; the most commonly observed bird (in 14 plots) was "sparrows" which were not identified to species, followed by red-winged blackbirds (*Agelaius phoeniceus*), white-crowned sparrows (*Zonotrichia leucophrys*), and western meadowlarks (*Sturnella neglecta*) in 9 plots each. Cottontail rabbit (*Sylvilagus audubonii*) or jackrabbit (*Lepus californicus*) activity was documented through direct observation or the presence of pellets in 22 (33.8%) plots and lizard (primarily *Uta stansburiana*) activity in 18 (27.7%). Scats, tracks, and dens indicative of carnivore activity were noted in 10 (15.4%) plots.

Wildlife species of special concern (California Department of Fish and Wildlife 2017) observed included coast horned lizards (*Phrynosoma blainvillii*), possibly a coachwhip (*Masticophis flagellum ruddocki*), and burrowing owl (*Athene cunicularia*). Coast horned lizards were observed in the native (uncultivated) parcel, where they have been documented previously (L. Saslaw, personal communication) and in one restored plot immediately south of the native parcel. Burrowing owls nested in at least five plots. Scat consistent in size with the endangered San Joaquin kit fox (*Vulpes macrotis mutica*) was observed in 24-23-23-03 at an artificial kit fox den that ESRP employees had installed many years ago (B. Cypher, personal communication).

Discussion

Considering that all fields in the Atwell Island Restoration Project had been cultivated at one time, the fact that more than three quarters of the restored plots met one or both success criteria was impressive. Surprisingly, the most recently planted plots (2011-2015) met the success criteria better than older plantings. Perhaps there will be attrition in shrubs over time, but given that shrub cover was generally 10% or higher among recently restored plots that met both criteria, they are likely to maintain at least 1% shrub cover. Moreover, the shrubs in these plots have already survived a prolonged during their early years.

As discussed in the last report on the Atwell Island Restoration Project (Laymon et al. 2010), the use of locally-collected seed is definitely preferable to commercial seed. Even if the cost per pound was more, the improved success would be worth the difference, especially considering the expense of site preparation, planting, and associated restoration.

Although not an actual treatment that can be manipulated, soil can have a profound impact on restoration success (Laymon et al. 2010). The plots restored using the ESRP technique of site preparation (disked and contoured to create berms and seeded with imprinter) are a good example. Three of the seven were on Posochanet silt loam, two on Nahrub silt loam, and the remaining two plots included both soil series. Of the three plots exclusively on Posochanet soils (24-23-07-01, 24-23-07-01SE, and 24-23-08-01), one met both success criteria and the others met the shrub criterion only. The two plots exclusively on Narub soils (24-23-14-01A E and W) were less successful; one met the herb criterion and the other did not meet either. The plots on mixed soils (24-23-03-01 and 24-23-10-01A) did not meet either criterion.

Several plots had been grazed by cattle. In one instance (24-23-08-04), the observer noted that cattle had damaged the shrubs to the point where both live and dead shrub cover plot-wide were recorded as zero, even though a few remnant shrubs were present that could be identified to species. Yet, other grazed plots (such as 24-22-12-06A and 24-22-12-08) met both success criteria and provided habitat for a wide range of wildlife, including rare species. Carefully managed livestock grazing could benefit wildlife in areas dominated by non-native plants without damaging shrubs.

The two plots where no wildlife sign or presence was observed (24-23-05-09B E and W) may benefit from additional restoration. The addition of berms to both may help provide some bare ground, which is lacking, and provide burrowing sites for rodents. Also, creation of shrub islands in the former may increase attractiveness to birds and rabbits. Cattle grazing could benefit the latter plot by reducing litter and creating openings.

If the stated objectives are considered on a site-wide basis rather than a plot-by-plot basis, they may well have been met. Certainly the objective of wildlife use has been achieved, even where the vegetation objectives have not. Yet, despite the relative success of the restoration project overall, the success criteria and even the objectives may be inappropriate. Bare ground may be a more appropriate measure of suitability for wildlife than percent cover of native herbs, especially with respect to the endemic wildlife of the San Joaquin Valley, many of which are recognized as endangered or threatened species.

Limitations

The species list per plot and for the entire project area is by no means comprehensive. The field crew did not cover 100% of each plot, did not make repeat visits to a given plot, and did not conduct targeted surveys for wildlife. Moreover, due to variations in observer experience, some plants and birds were identified only to genus or above. Another factor that can affect species observations is weather. Relative cover of vegetation varies with rainfall and temperature patterns and could be substantially different in another year, and certain conditions are conducive to one type of wildlife but not another.

As mentioned previously, statistical analysis of the data was not appropriate. Means were not calculated because the data were not normally distributed. Even the summary approach used to gauge success for each restoration technique is statistically invalid in that the various techniques are not independent and the same plots are analyzed multiple times, but it provided the only reasonable form of comparison available.

Recommendations

Although these results do not have the weight of statistics to make informed decisions, some aspects are sufficiently clear that reasonable conclusions may be drawn. Thus, the following guidelines are offered for ongoing restoration at the Atwell Island Restoration Project:

- Focus on the most effective treatments for future restoration
    - Either restore immediately (even interplanting into a crop) or wait 6 years or more.
    - Burn plots before seeding
    - Prepare sites by disking followed by berm construction
    - Use a broadcast seeder, range drill, or combination of these rather than an imprinter
    - Use local seed
    - Seed early in the rainy season
    - Do not bother to irrigate
- Include berms, shrub islands, and if possible, water features to attract various types of vertebrate wildlife.
- Employ techniques to create bare ground in plots where it is lacking.
- Consider allowing livestock grazing in plots with high litter, excessive shrub cover, or little wildlife use. This would create openings and attract insects that could provide food sources for lizards and birds.
- Focus on seeding the most successful shrubs (*Atriplex polycarpa* and *Peritoma arborea*) and herbs: *Centromadia (Hemizonia) pungens*, *Lasthenia* species, *Layia pentachaeta* ssp. *albida*, and *Phacelia ciliata*. *Amsinckia menziesii* and *Caulanthus (Guillenia) lasiophyllus* can be expected to seed in without human intervention.
- Plots that met only the herb criterion could benefit from creation of shrub islands (distinct clusters of shrubs, as opposed to rows), as could those with no rabbit or bird use.

If BLM wishes to increase wildlife use in accordance with Objective 3, the following fields may benefit from the additional restoration actions specified:

<u>ADD SHRUB ISLANDS</u>
24-22-11-06A
24-22-11-fallow
24-23-03-01
24-23-05-09B E
24-23-06-08B W
East of 24-23-06-08B
24-23-08-01
24-23-08-04
24-23-08-05
24-23-08-06A E & W
24-23-08-06B
24-23-08-08
24-23-08-09A
24-23-08-09B

24-23-09-09
24-23-10-01A
24-23-10-01B
24-23-10-02A
24-23-10-02B
24-23-10-04A
24-23-10-04B
24-23-14-01A E & W
24-23-14-01B
24-23-23-02B
24-23-23-03

ADD BERMS
21-22-12-05B
24-23-05-09B E & W
24-23-05-2011b
24-23-06-08A E
East of 24-23-06-08B
24-23-06-2012
24-23-08-06A E
24-23-08-2011c
24-23-09-2015

LIVESTOCK GRAZING
24-23-05-2012
East of 24-23-06-08A
East of 24-23-06-08B
24-23-06-2012
24-23-06-2014
24-23-07-01 & SEQ
24-23-07-2014
24-23-08-01
24-23-08-06A E & W
24-23-08-06B
24-23-08-08
24-23-08-2011c
24-23-09-2015
24-23-10-01A
24-23-10-01B
24-23-10-02A
24-23-10-02B
24-23-10-01A
24-23-10-03
24-23-10-01A
24-23-10-04A
24-23-10-04B
24-23-10-05
24-23-14-01A E

24-23-14-0B
24-23-14-02A
24-23-23-02B (has been sheep grazed; try cattle)

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Appendices

A. Blank data sheet
B. Plant list with species codes
C. Animal list with species codes