Lower Cache Creek Invasive Species Mapping and Prioritization Project

August 16, 2016

Prepared for the Cache Creek Conservancy

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Introduction

Lower Cache Creek in Yolo County is adaptively managed for multiple goals and objectives through implementation of the Cache Creek Area Plan (CCAP), which includes the Cache Creek Resource Management Plan (CCRMP) area and the Off-Channel Mining Plan (OCMP) area (Fig. 1). Development of these plans was based on the key assumption that lower Cache Creek should be viewed as an integrated system, with an emphasis on adaptive management that balances agriculture, aggregate mining, biological resources, water resources, floodway and channel stability, open space and recreation, and the cultural landscape.

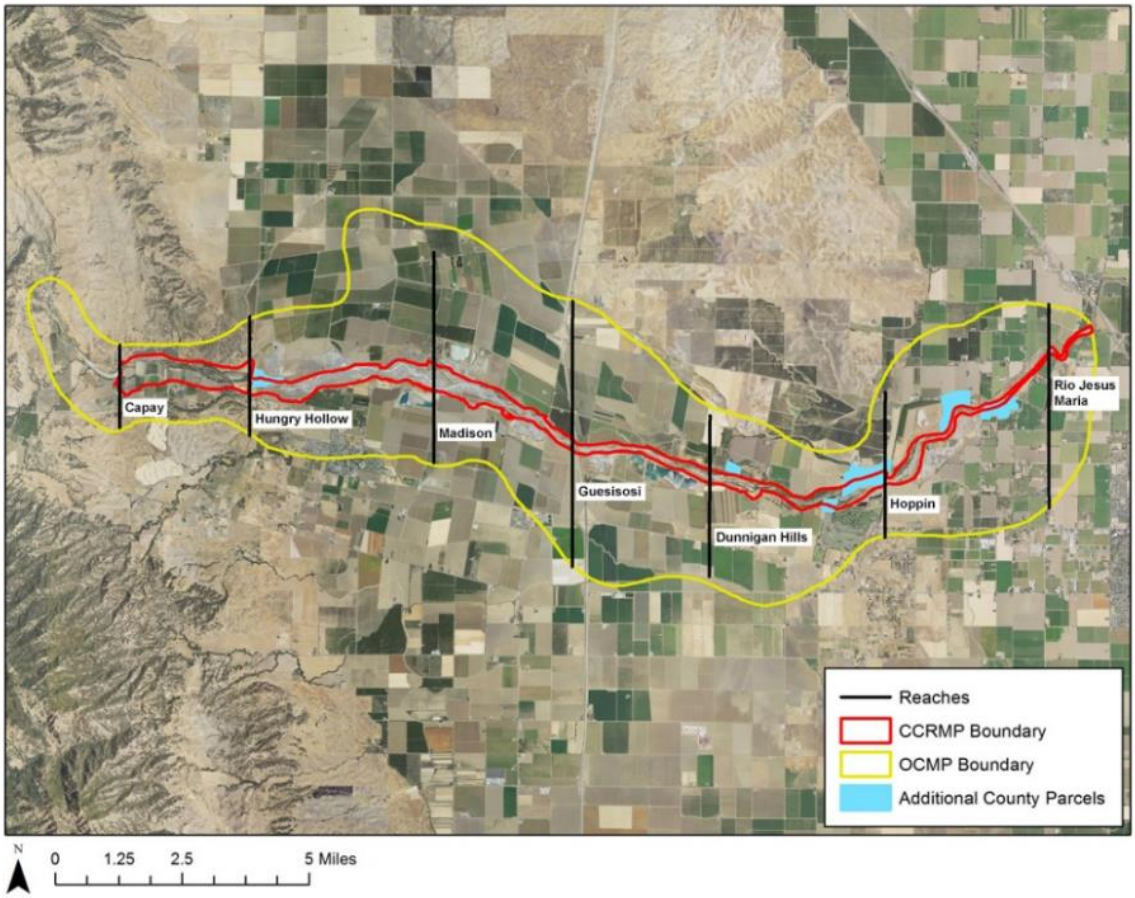


Figure 1. Boundaries of the Cache Creek Resource Management Plan (CCRMP) and Off-Channel Mining Plan (OCMP) areas, and the seven reaches of lower Cache Creek within the CCRMP area. County-owned properties surveyed as part of the Project are also depicted.

The *Lower Cache Creek Invasive Species Mapping and Prioritization Project* (Project) was initiated in 2016 by the Cache Creek Conservancy with support from Yolo County Office of Natural Resources. The overarching goal of this Project was to comprehensively assess the distribution and status of a suite of invasive plant species within the CCRMP and six additional County-owned parcels (Fig. 1, the Project area) in order to inform adaptive management of the creek's biological resources. Specific objectives included:

1. Map extent and distribution of existing priority invasive species that have been the focus of over 10 years of intensive treatment efforts;
2. Map extent and distribution of potential new priority invasive species that have established in the region;
3. Produce a spatially-explicit baseline of invasive species extent and distribution for the purposes of assessing and informing past, present, and future adaptive management;
4. Identify opportunities to implement restoration activities to reduce invasive species, restore native habitat, and enhance ecosystem services.

Methods

Species selection

Twenty-five species of nonnative and invasive species were mapped during the Project (Table 1), with three species of herbaceous thistles (Italian thistle, bull thistle, and milk thistle) combined into a single "thistle" category.

Common Name	Scientific Name	Growth Form
Arundo	*Arundo donax*	Herbaceous
Bamboo	Various	Herbaceous
Barbed goatgrass	*Aegilops triuncialis*	Herbaceous
Common teasel	*Dipsacus fullonum*	Herbaceous
Edible fig	*Ficus carica*	Shrub/tree
Eucalyptus	*Eucalyptus* spp.	Tree
Fan palm	*Washingtonia robusta*	Shrub/tree
Fennel	*Foeniculum vulgare*	Herbaceous
Himalayan blackberry	*Rubus armeniacus*	Herbaceous
Medusahead	*Elymus caput-medusae*	Herbaceous
Oleander	*Nerium oleander*	Shrub
Pampas grass	*Cortaderia selloana*	Herbaceous
Perennial pepperweed	*Lepidium latifolium*	Herbaceous
Poison hemlock	*Conium maculatum*	Herbaceous
Purple loosestrife	*Lythrum salicaria*	Herbaceous
Ravenna grass	*Saccharum ravennae*	Herbaceous
Stinkwort	*Dittrichia graveolens*	Herbaceous
Tamarisk	*Tamarix* spp.	Shrub
Thistles (Italian, bull, milk)	*Carduus pycnocephalus* *Cirsium vulgare* *Silybum marianum*	Herbaceous
Tree of heaven	*Ailanthus altissima*	Tree
Tree tobacco	*Nicotiana glauca*	Shrub/tree
Yellow flag iris	*Iris pseudacorus*	Herbaceous
Yellow starthistle	*Centaurea solstitialis*	Herbaceous

Table 1. Species selected for the lower Cache Creek Invasive Species Mapping and Prioritization Project.

All species but bamboo, common teasel (*Dipsacus fullonum*), oleander (*Nerium oleander*), fan palm (*Washingtonia robusta*), and pampas grass (*Cortaderia selloana*) were identified as priority targets of mapping before field work began, while these five additional species were added once they were observed in the field. Species were chosen as mapping targets based on a variety of factors including 1) known presence and abundance along lower Cache Creek, 2) concern over future invasion or expansion of existing small patches, 3) State rankings of invasiveness and negative impacts (e.g., Cal-IPC ranking), and 4) in the case of arundo (*Arundo donax*), Ravenna grass (*Saccharum ravennae*), and tamarisk (*Tamarisk* spp.), the need to assess progress after more than ten years of eradication efforts along lower Cache Creek (see *Discussion* for summary of past invasive species treatments).

Field data collection

Beginning with the upstream portion of lower Cache Creek (Capay reach, see Fig. 1), the entire CCRMP area and the six additional County parcels (Capay Open Space Park, Millsap, Wild Wings, Cache Creek Nature Preserve, Woodland Reif, and Correll Rodgers) were searched on foot from April – June 2016 for the priority species (Table 1). Data were recorded using a cloud-based mobile mapping application (AmigoCloud) on an iPad tablet, with an approximate accuracy of ± 1-2 m. Priority species occurring as discrete individuals were mapped as points and were assigned to either small, medium, or large size classes estimated for each individual species based on the observed size distribution. Priority species occurring in dense clusters, including herbaceous species such as perennial pepperweed and Himalayan blackberry and woody shrubs and trees such as tamarisk and tree of heaven, were recorded as patches. When possible, the exact patch shape and extent was recorded or estimated from the 2015 aerial photography that served as a base layer in the AmigoCloud application. Otherwise, the approximate length and width of priority species patches was estimated in the field, and these values were used to approximate the patch size in ArcGIS 10.1 (ESRI).

At the same time that invasive species were mapped, restoration opportunities were also identified across the Project area. Reference points were collected within areas that appeared to be priority candidates for enhancement or restoration of riparian forests, oak woodlands, grasslands, and wetlands. Locations of existing revegetation or restoration sites were also recorded, although no attempt was made to comprehensively map all previously-implemented revegetation and restoration projects.

Data analysis

Point and patch data for all Project species were downloaded from AmigoCloud and analyzed in ArcGIS. For the CCRMP potion of the Project, reach-specific maps were created to visualize extent and distribution of previous focal species (arundo, Ravenna grass, and tamarisk; Appendix 1), as well as widespread or new priority species (fennel, edible fig, barbed goatgrass,

common teasel, poison hemlock, Himalayan blackberry, medusahead, perennial pepperweed, thistles, tree of heaven, tree tobacco, and yellow starthistle; Appendix 2). Maps were not created for some uncommon and/or lower priority species (bamboo, eucalyptus, fan palm, oleander, pampas grass, purple loosestrife, stinkwort, yellow flag iris), although the data are now available for Conservancy staff to do so at a later date. For the County-owned parcels, a single map was created for each parcel that displayed the extent and distribution of all Project species (Appendix 3).

The number of points (plants) and patches of each Project species was calculated by reach and for each County parcel. The total acreage of each Project species in each reach and on each County parcel was estimated by combining calculated patch areas with estimated area of small, medium, and large points (plants); see Appendix 4 for point area estimates by species. All data were exported as ESRI shapefiles, and were provided to the Cache Creek Conservancy after completion of this report.

Restoration opportunities were compiled and annotated based on potential habitat goals (riparian forest, oak woodland / grassland complex, grassland, wetland). At some sites with robust native forest cover, understory enhancement was identified as the habitat goal. This management action would include removal of invasive species and woody debris, followed by planting of native understory species including grasses, sedges, forbs, and shrubs.

Results

Invasive Species Within CCRMP Area

A total of 1,794 individual plants and 876 patches were mapped within the CCRMP. The most widespread species in terms of the number of points and patches were tamarisk (537 points, 42 patches), tree tobacco (414 points, 152 patches), arundo (389 points, 43 patches), Ravenna grass (273 points, 30 patches), perennial pepperweed (27 points, 187 patches), Himalayan blackberry (20 points, 129 patches), thistles (2 points, 166 patches), edible fig (66 points, 4 patches), and yellow starthistle (5 points, 60 patches) (Table 2).

The most widespread species in terms of estimated area within the CCRMP were thistles (113.16 ac), perennial pepperweed (54.46 ac), yellow starthistle (53.55 ac), Himalayan blackberry (16.80 ac), poison hemlock (14.60 ac), and tamarisk (10.88 ac). Additional species with > 1 ac area within the CCRMP included tree tobacco (4.49 ac), arundo (3.75 ac), tree of heaven (1.96 ac), and barbed goatgrass (1.27 ac) (Table 3).

Species	Capay Reach				Hungry Hollow Reach				Madison Reach				Guesisosi Reach				Dunnigan Hills Reach				Hoppin Reach				Rio Jesus Maria Reach			
	Points			Patches	Points			Patches	Points			Patches	Points			Patches	Points			Patches	Points			Patches	Points			Patches
	Small	*Medium*	*Large*		*Small*	*Medium*	*Large*		*Small*	*Medium*	*Large*		*Small*	*Medium*	*Large*		*Small*	*Medium*	*Large*		*Small*	*Medium*	*Large*		*Small*	*Medium*	*Large*	
Arundo	87	74	13	31	9	26	4	0	3	7	10	1	1	12	15	1	7	49	41	7	0	16	12	1	0	2	1	2
Bamboo	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barbed goatgrass	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Common teasel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	0	0	0	1	0	0	0	0
Edible fig	9	11	14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	4	2	2	7	13	1	0	0	1	0
Eucalyptus	0	0	3	1	0	0	0	0	0	0	0	0	0	0	1	0	0	3	1	1	0	0	0	1	0	0	0	0
Fan palm	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fennel	3	13	4	1	0	0	0	2	0	0	0	0	0	2	4	1	0	0	1	0	0	0	0	1	0	0	0	0
Himalayan blackberry	4	4	0	40	0	0	0	0	0	1	0	3	0	0	0	1	0	5	5	54	0	0	1	31	0	0	0	0
Medusahead	0	1	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Oleander	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Perennial pepperweed	0	3	4	69	0	2	16	8	0	0	2	31	0	0	0	11	0	0	0	38	0	0	0	29	0	0	0	1
Poison hemlock	0	1	4	8	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	5	0	0	0	4	0	0	0	0
Purple loosestrife	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0
Ravenna grass	15	46	52	12	3	4	1	0	1	8	2	0	4	8	5	5	0	59	52	10	1	7	5	3	0	0	0	0
Stinkwort	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0
Tamarisk	36	48	15	6	47	31	6	1	19	37	46	5	10	14	28	3	28	56	34	22	4	35	33	4	0	5	5	1
Thistles	0	0	0	79	0	1	0	5	0	0	0	39	0	0	0	9	0	0	0	24	0	0	1	8	0	0	0	2
Tree of heaven	2	6	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Tree tobacco	26	50	62	63	1	13	12	1	1	10	10	6	1	18	7	12	11	61	41	26	2	33	37	39	0	9	9	5
Yellow flag iris	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yellow starthistle	0	0	1	14	0	4	0	6	0	0	0	15	0	0	0	3	0	0	0	13	0	0	0	9	0	0	0	0

Table 2. Counts of points (individual plants) and patches of priority invasive species within each reach of lower Cache Creek within the CCRMP.

Species	Capay Reach		Hungry Hollow Reach		Madison Reach		Guesisosi Reach		Dunnigan Hills Reach		Hoppin Reach		Rio Jesus Maria Reach		*Grand total (ac)*
	Total (m^2)	Total (ac)	Total (m^2)	Total (ac)	Total (m^2)	Total (ac)	Total (m^2)	Total (ac)	Total (m^2)	Total (ac)	Total (m^2)	Total (ac)	Total (m^2)	Total (ac)	
Arundo	6835.52	1.69	37.25	0.01	304.66	0.08	59.23	0.01	7739.64	1.91	170.25	0.04	44.25	0.01	3.75
Bamboo	2.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barbed goatgrass	3674.24	0.91	9.00	0.00	0.00	0.00	1472.70	0.36	0.00	0.00	0.00	0.00	0.00	0.00	1.27
Eucalyptus	1260.38	0.31	0.00	0.00	0.00	0.00	4.00	0.00	1007.00	0.25	1000.00	0.25	0.00	0.00	0.81
Fennel	4.86	0.00	193.53	0.05	0.00	0.00	859.77	0.21	0.25	0.00	100.00	0.02	0.00	0.00	0.29
Edible fig	212.25	0.05	0.00	0.00	0.00	0.00	0.00	0.00	39.00	0.01	259.50	0.06	4.00	0.00	0.13
Poison hemlock	71.06	0.02	300.00	0.07	47472.62	11.73	2483.48	0.61	1957.60	0.48	6799.99	1.68	0.00	0.00	14.60
Himalayan blackberry	3016.20	0.75	0.00	0.00	396.64	0.10	30.00	0.01	48913.43	12.09	15612.38	3.86	0.00	0.00	16.80
Medusahead	13.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	9.00	0.00	0.00	0.00	0.00	0.00	0.01
Oleander	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.25	0.00	0.00	0.00	0.00	0.00	0.00
Fan palm	2.50	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perennial pepperweed	2980.65	0.74	801.26	0.20	46789.79	11.56	4981.85	1.23	56010.17	13.84	105155.02	25.98	3658.12	0.90	54.46
Purple loosestrife	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	112.25	0.03	0.00	0.00	0.00	0.00	0.03
Ravenna grass	102.44	0.03	2.19	0.00	4.06	0.00	410.94	0.10	200.90	0.05	100.73	0.02	0.00	0.00	0.20
Stinkwort	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	11.00	0.00	0.00	0.00	0.01
Tamarisk	123.75	0.03	58.25	0.01	2538.17	0.63	9013.15	2.23	27204.16	6.72	5043.02	1.25	66.25	0.02	10.88
Common teasel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	827.07	0.20	3.00	0.00	0.00	0.00	0.21
Thistles	44569.40	11.01	14733.95	3.64	81607.46	20.17	79670.49	19.69	71909.28	17.77	154692.11	38.23	10760.95	2.66	113.16
Tree of heaven	3464.50	0.86	0.00	0.00	0.00	0.00	0.00	0.00	4448.56	1.10	0.00	0.00	0.00	0.00	1.96
Tree tobacco	849.09	0.21	43.25	0.01	546.32	0.13	3776.60	0.93	8657.82	2.14	3930.43	0.97	369.25	0.09	4.49
Yellow iris	3.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Yellow starthistle	4794.35	1.18	501.70	0.12	61446.77	15.18	9532.05	2.36	20363.90	5.03	99310.21	24.54	20742.73	5.13	53.55
Total area by reach (ac)		17.79		4.12		59.58		27.75		61.63		96.91		8.81	**276.59**

Table 3. Estimated area of invasive species within each reach of lower Cache Creek within the CCRMP.

Capay Reach. Invasive species were generally widespread throughout this reach, in which well-developed patches of riparian forest and scrub were also common. Arundo, Ravenna grass, and tamarisk plants and patches were observed throughout this reach in locations along the channel and in off-channel locations including irrigation ditches (Tables 2-3; Appendix 1, Fig. 1). Numerous small individuals of all three species were observed, strongly suggesting that new recruits are in the process of establishing (Table 2). Many individual plants and large patches of thistles, yellow starthistle, tree tobacco, tree of heaven, and goatgrass were also observed, as were many plants and smaller patches of Himalayan blackberry, perennial pepperweed, thistles, tree tobacco, and yellow starthistle (Table 3; Appendix 2, Fig. 1). Patches of these species were particularly dense in previously forested areas that had been recently been burned, apparently in order to remove woody debris. This reach was also the only location in which bamboo and yellow flag iris were observed within the CCRMP and on the six County-owned parcels, although it is likely that the latter species occurs in other locations within the Project area.

Hungry Hollow Reach. Mirroring the overall lack of riparian forests and scrub vegetation, invasive species were relatively uncommon in this reach although arundo and tamarisk were present throughout as both individual plants and patches. Ravenna grass was also observed, but was far less common than arundo and tamarisk (Tables 2-3; Appendix 1, Fig. 2). Establishment of small tamarisk plants was commonly observed, and to a lesser extent also for arundo (Table 2). Large patches of thistles were observed, as were smaller patches of perennial pepperweed and scattered individuals of these and other Project species (Table 3; Appendix 2, Fig. 2).

Madison Reach. Overall, this reach is only slightly more vegetated than the Hungry Hollow reach. Invasive species were somewhat common in this reach, including numerous tamarisk points and patches and lesser amounts of arundo and Ravenna grass (Tables 2-3; Appendix 1, Fig. 3). As in the Hungry Hollow reach, numerous small tamarisk plants were observed suggesting recent establishment (Table 2). One large patch of poison hemlock and numerous patches of perennial pepperweed, thistles, and yellow starthistle were observed, as were both individual plants and patches of tree tobacco (Tables 2-3; Appendix 2, Fig. 3).

Guesisosi Reach. Invasive species were somewhat common in this reach, including numerous tamarisk plants and patches as well as some plants and patches of arundo and Ravenna grass (Tables 2-3; Appendix 1, Fig. 4). As in upstream reaches, small tamarisk were relatively common suggesting recent establishment (Table 2). Tree tobacco was also fairly widespread across this reach, as were patches of thistles, yellow starthistle, and perennial pepperweed (Tables 2-3; Appendix 2, Fig. 4).

Dunnigan Hills Reach. As in the Capay reach, invasive species were widespread in the Dunnigan Hills reach, which is also characterized by extensive riparian forest and scrub vegetation. Numerous individual plants and patches of arundo, Ravenna grass, and tamarisk were observed throughout this reach, including many small plants of all three species suggesting

recent establishment (Tables 2-3; Appendix 1, Fig. 5). Numerous individual plants and patches of thistle, yellow starthistle, perennial pepperweed, Himalayan blackberry, edible fig, and tree of heaven were observed throughout this reach, including the most extensive stands of Himalayan blackberry within the CCRMP (Tables 2-3; Appendix 2, Fig. 5). Patches of common teasel and stinkwort, which appear to be spreading, were also observed within this reach (Table 3; Appendix 2, Fig. 5).

Hoppin Reach. Invasive species were widespread along this reach, especially within the upstream half (Appendix 1, Fig. 6; Appendix 2, Fig 6). Individual plants and patches of arundo, Ravenna grass, and tamarisk were commonly observed, especially for tamarisk (Tables 2-3; Appendix 1, Fig. 6). Small plants of these three species were rarely observed (Table 3). Numerous other Project species were observed throughout this reach, including numerous individual plants and extensive patches of Himalayan blackberry, perennial pepperweed, thistles, tree tobacco and yellow starthistle (Tables 2-3; Appendix 2, Fig. 6).

Rio Jesus Maria Reach. Invasive species were relatively uncommon in this reach, with arundo and tamarisk plants and patches present but scattered and Ravenna grass absent completely (Tables 2-3; Appendix 1, Fig. 7). Large patches of perennial pepperweed, thistles, and yellow starthistle were observed, with individual plants and smaller patches of tree tobacco also common (Tables 2-3; Appendix 2, Fig. 7).

Invasive Species on County-Owned Parcels

Across the six parcels, 132 individual plants and 121 patches were mapped. It is important to note that four of the six parcels overlapped with the CCRMP area (e.g., Capay Open Space Park, Wild Wings, Cache Creek Nature Preserve, and Correll Rodgers; see Fig. 1), thus results reported below for those parcels include some individual plants and patches also reported for the CCRMP. The most widespread species in terms of the number of points and patches were tree tobacco (53 points, 16 patches), yellow starthistle (5 points, 26 patches), thistles (6 points, 20 patches), Himalayan blackberry (5 points, 24 patches), perennial pepperweed (4 points, 21 patches), tamarisk (20 points, 1 patch), edible fig (14 points, 2 patches), arundo (11 points, 1 patch), and Ravenna grass (12 points) (Table 4). The most widespread species in terms of estimated area across the six parcels were yellow starthistle (42.39 ac), perennial pepperweed (25.65 ac), Himalayan blackberry (13.46 ac), and tree of heaven (4.02 ac) (Table 5).

Capay Open Space Park. Invasive species were relatively uncommon at Capay Open Space Park (COSP), but did include a small number of arundo, Ravenna grass, and tamarisk plans (Tables 4-5; Appendix 3, Fig. 1). Perennial pepperweed, thistles, and yellow starthistle were also observed, although not to a great extent (Table 5; Appendix 3, Fig. 1). Some tree of heaven

individuals were also present on the far western boundary of COSP, but were not included in the dataset.

Millsap Property. Invasive species were relatively uncommon at the Millsap property in terms of the number of species, with arundo, Ravenna grass, and most other species being absent. However, an extensive patch of thistles is present, as is a large patch of tamarisk, several individual tamarisk plants that appear to be resprouting from previous treatments, and two patches of yellow starthistle (Tables 4-5, Appendix 3, Fig. 2).

Wild Wings. Invasive species were relatively uncommon at the Wild Wings property, with arundo, Ravenna grass, tamarisk, and most other species being absent. However, significant patches of perennial pepperweed, thistles, and yellow starthistle were observed across the site in addition to patches of Himalayan blackberry along the canal (Tables 4-5; Appendix 3, Fig. 3). In addition, one patch of pampas grass approximately 110 ft^2 (0.003 ac) in size was observed in the southeastern corner of the site along the margin of the golf course, which was the only observation of pampas grass anywhere along lower Cache Creek during the Project.

Cache Creek Nature Preserve. Invasive species were relatively common at the Cache Creek Nature Preserve (CCNP), especially within the portion of the parcel that also fell within the CCRMP area (Tables 4-5; Appendix 3, Fig. 4). A relatively small number of individual plants and patches of arundo, Ravenna grass, and tamarisk were observed intermixed with abundant plants and patches of tree tobacco, edible fig, and Himalayan blackberry, with the latter species common within the slough. Purple loosestrife and stinkwort were also observed within the CCNP boundary, in addition to small amounts of other Project species.

Woodland Reif. Invasive species were relatively uncommon on the Woodland Reif parcel, with the exception of scattered arundo, tree tobacco, and tamarisk in addition to extensive patches of yellow starthistle and one smaller patch of perennial pepperweed (Tables 4-5; Appendix 3, Fig. 5).

Correll Rodgers. Vegetation on the Correll Rodgers parcel was characterized by extensive stands of hemlock, perennial pepperweed, thistles, and yellow starthistle, in addition to some scattered tree tobacco and a single large arundo plant (Appendix 3, Fig. 6). Arundo, tamarisk, and most other Project species were absent from the parcel, although dense woody vegetation may have obscured some individuals.

Additional Nonnative and Invasive Species

Besides the priority Project species, numerous other nonnative and potentially invasive species were observed within the CCRMP and on the six County-owned parcels. These included grasses such as Smilo grass (*Piptotherum miliaceum*), ripgut brome (*Bromus diandrus*), soft chess (*Bromus hordeaceus*), Italian ryegrass (*Lolium multiflorum*), wild oat (*Avena fatua*), nonnative barley (*Hordeum* spp.), rattail fescue (*Festuca myuros*) and Johnson grass (*Sorghum*

halepense) in addition to forbs such as horehound (*Marrubium vulgare*), various mustards (e.g., *Hirschfeldia* spp., *Brassica* spp.), geranium (*Geranium* spp.), and filaree (*Erodium* spp.) among many others. Across the CCRMP and the six County properties, nonnative species (Project species plus additional species listed above) comprise an estimated 95% of the herbaceous understory and open areas.

Species	Capay Open Space Park				Millsap				Wild Wings				Cache Creek Nature Preserve				Woodland Reif				Correll Rogers			
	Points			Patches	Points			Patches	Points			Patches	Points			Patches	Points			Patches	Points			Patches
	Small	*Medium*	*Large*		*Small*	*Medium*	*Large*		*Small*	*Medium*	*Large*		*Small*	*Medium*	*Large*		*Small*	*Medium*	*Large*		*Small*	*Medium*	*Large*	
Arundo	0	2	0	0	0	0	0	0	0	0	0	0	3	2	1	1	0	2	0	0	0	0	1	0
Barbed goatgrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common teasel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0	0
Edible fig	0	0	0	0	0	0	0	0	0	0	0	0	1	6	7	2	0	0	0	0	0	0	0	0
Eucalyptus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fan palm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fennel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Himalayan blackberry	0	0	0	0	0	0	0	0	0	0	0	2	0	2	3	22	0	0	0	0	0	0	0	0
Medusahead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oleander	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pampas grass	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Perennial pepperweed	0	1	3	0	0	0	0	0	0	0	0	2	0	0	0	11	0	0	0	1	0	0	0	7
Poison hemlock	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Purple loosestrife	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Ravenna grass	1	0	0	0	0	0	0	0	0	0	0	0	1	1	9	0	0	0	0	0	0	0	0	0
Stinkwort	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Tamarisk	2	1	1	0	1	1	1	1	0	0	0	0	1	6	5	0	0	1	0	0	0	0	0	0
Thistles	0	5	1	1	0	0	0	1	0	0	0	8	0	0	0	5	0	0	0	0	0	0	0	5
Tree of heaven	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tree tobacco	1	2	4	0	0	0	0	0	0	0	0	0	11	13	18	15	0	2	0	0	0	0	2	1
Yellow flag iris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yellow starthistle	0	5	0	2	0	0	0	2	0	0	0	6	0	0	0	2	0	0	0	8	0	0	0	6

Table 4. Counts of points (individual plants) and patches of invasive species on each County-owned parcel along lower Cache Creek.

Species	Capay Open Space Park		Millsap		Wild Wings		Cache Creek Nature Preserve		Woodland Reif		Correll Rodgers		*Grand total (ac)*
	Total (m^2)	*Total (ac)*	*Total (m^2)*	*Total (ac)*	*Total (m^2)*	*Total (ac)*	*Total (m^2)*	*Total (ac)*	*Total (m^2)*	*Total (ac)*	*Total (m^2)*	*Total (ac)*	
Arundo	2.00	0.00	0.00	0.00	0.00	0.00	303.31	0.07	2.00	0.00	2.25	0.00	0.08
Bamboo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barbed goatgrass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Common teasel	0.00	0.00	0.00	0.00	0.00	0.00	91.25	0.02	0.00	0.00	0.00	0.00	0.02
Edible fig	0.00	0.00	0.00	0.00	0.00	0.00	52.25	0.01	0.00	0.00	0.00	0.00	0.01
Eucalyptus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fan palm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fennel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Himalayan blackberry	0.00	0.00	0.00	0.00	196.49	0.05	54282.57	13.41	0.00	0.00	0.00	0.00	13.46
Medusahead	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oleander	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pampas grass	0.00	0.00	0.00	0.00	9.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Perennial pepperweed	0.81	0.00	0.00	0.00	390.78	0.10	908.00	0.22	178.77	0.04	102343.89	25.29	25.65
Poison hemlock	0.00	0.00	0.00	0.00	0.00	0.00	120.00	0.03	0.00	0.00	1364.93	0.34	0.37
Purple loosestrife	0.00	0.00	0.00	0.00	0.00	0.00	4.25	0.00	0.00	0.00	0.00	0.00	0.00
Ravenna grass	0.06	0.00	0.00	0.00	0.00	0.00	9.31	0.00	0.00	0.00	0.00	0.00	0.00
Stinkwort	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00
Tamarisk	3.75	0.00	3715.98	0.92	0.00	0.00	17.50	0.00	1.00	0.00	0.00	0.00	0.92
Thistles	100.56	0.02	23989.42	5.93	1880.01	0.46	0.00	0.00	0.00	0.00	19810.37	4.90	11.31
Tree of heaven	0.00	0.00	0.00	0.00	0.00	0.00	16275.62	4.02	0.00	0.00	0.00	0.00	4.02
Tree tobacco	11.25	0.00	0.00	0.00	0.00	0.00	1178.87	0.29	2.00	0.00	229.50	0.06	0.35
Yellow flag iris	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Yellow starthistle	393.47	0.10	347.88	0.09	545.00	0.13	2424.31	0.60	104128.81	25.73	63716.54	15.74	42.39
Total area by parcel (ac)		0.13		6.93		0.75		18.70		25.78		46.32	98.61

Table 5. Estimated area of invasive species on each County-owned property along lower Cache Creek.

Restoration Opportunities

Numerous restoration opportunities were identified across the Project area, some of which are already being considered by Conservancy and County staff (Appendix 4, Figs. 1-2). More detailed observations for specific locations are embedded in the dataset delivered to the Conservancy. As with any habitat restoration project, more detailed site assessments would need to be undertaken in advance of any project implementation. Some previous revegetation and/or restoration sites were identified, but these are only a subset of all of the previously-implemented projects within the Project area (e.g., extensive restoration efforts at Cache Creek Nature Preserve and Capay Open Space Park).

Discussion and Recommendations

History of Invasive Species Treatment on Lower Cache Creek

At the time of the 1995 Technical Study, both arundo and tamarisk were observed to be widespread along lower Cache Creek (Northwest 1995). Similar observations were made by members of the Cache Creek Technical Advisory Committee in past annual reports (e.g., Yolo County 1998; Yolo County 1999; Yolo County 2006). Both arundo and tamarisk have been priority targets for treatment since adoption of the CCAP in 1996, and Ravenna grass has been a priority for more than a decade. Significant investment during this time was made by Yolo County and the Cache Creek Conservancy regarding control of these three species, which previously dominated large portions of the CCRMP. An annual "Creek Spray" has been led by the Conservancy for the past 10 years, and smaller-scale control projects also have been implemented. More recently, the Conservancy initiated a large-scale Himalayan blackberry treatment project at the Cache Creek Nature Preserve.

Beginning with the 1995 Technical Study and continuing in yearly annual reports, there have been recommendations to: 1) systematically map and monitor both untreated and treated invasive species plants and patches, and 2) replant treated areas with competitive native species to reduce risk of re-infestation (e.g., Northwest 1995; Yolo County 2006; Yolo County 2011). Beginning in 2006, an additional recommendation was made to expand the scope of invasive species mapping and treatment outside of the CCRMP boundary (e.g., upstream of Capay Dam, where extensive stands of arundo, Ravenna grass, and tamarisk are present) in recognition that dispersal of seeds and plant material from upstream populations was contributing to invasive species problems within the CCRMP (Yolo County 2006). In 2011, another recommendation was made regarding the need to prioritize other species in addition to arundo, Ravenna grass, and tamarisk (Yolo County 2011). The 2011 Yolo County report noted that, from 2009-2011, dramatic increases in milk thistle, Italian thistle, yellow starthistle, Himalayan blackberry, perennial pepperweed, and edible fig had been observed throughout the CCRMP. The report

further recommended that these species be mapped, treated, monitored, and replaced with native species. To date, logistical constraints and emphasis on arundo, Ravenna grass, and tamarisk have precluded formal adoption of these recommended adaptive management strategies. For example, spatially-explicit mapping and monitoring of invasive species was not implemented prior to this Project, which represents a new, more sophisticated approach to invasive species management along lower Cache Creek.

Extent and Distribution of Priority Invasive Species Within the Project Area

The original three priority invasive species (arundo, Ravenna grass, and tamarisk) have clearly been reduced in extent, based on historical accounts and on evidence observed in the field (e.g., dead tamarisk and arundo stands). However, the results of this Project show that a substantial number of individual plants and patches (albeit few large patches) of all three species remain in most reaches. Estimates of total area across the CCRMP include 3.75 ac. of arundo, 0.20 ac. of Ravenna grass, and 10.88 ac. of tamarisk, while 0.08 ac of arundo, <0.01 ac. of Ravenna grass, and 0.92 ac. of tamarisk were observed across the six County-owned parcels. (Table 3, Table 5; note that areas overlap so values are not necessarily additive). This is due to several reasons, including logistical constraints on past invasive species treatment efforts that resulted in crews focusing their efforts on locations close to, and easily accessible from, the main channel. Many individual plants and patches of these three species were found relatively far from the main channel, in areas more difficult to access or obscured under dense vegetation. In addition, all three species are found in abundance upstream of the Capay Dam, virtually assuring that annual dispersal of seeds and propagules occurs on a regular basis downstream to lower Cache Creek during higher flows. For example, during Project field work in the Capay Reach, living arundo fragments were observed floating downstream. Finally, some landowners have refused access to Conservancy staff and contractors, and large stands of arundo, tamarisk, and other invasive species have persisted on their properties for decades. These patches also may serve as source populations for the continued re-infestation of the surrounding area.

Regarding other invasive species within the Project area, it is clear from the results that numerous other aggressive invasive species have established and spread rapidly along lower Cache Creek. Chief among these are perennial pepperweed (54.46 ac within the CCRMP, 25.65 ac on County parcels), yellow starthistle (53.55 ac within the CCRMP, 42.39 ac on County parcels), thistles (113.16 ac within the CCRMP, 11.31 ac on County parcels, Himalayan blackberry (16.80 ac within the CCRMP, 13.46 ac on County parcels), and poison hemlock (14.60 ac within the CCRMP, 0.37 ac on County parcels) (Table 3, Table 5). While these values are not necessarily additive because of overlap between CCRMP and County parcel boundaries, even a conservative estimate of the acreage of these species is substantial. All of these species have the potential to spread rapidly and to create dense, monospecific stands that exclude native species. Complete eradication of these species is unlikely, but intensive control efforts will be

necessary to prevent these and other invasive species from spreading throughout the riparian corridor and degrading habitat and other biological resources associated with Cache Creek (see *Recommendations* below).

Given the sheer number of individual plants and patches mapped during this Project, it is anticipated that the results will be most useful for 1) establishing a spatially-explicit database for future invasive species treatment efforts, 2) site, subreach, or reach-scale project planning efforts, and 3) providing compelling information useful for writing grants, establishing collaborations, informing research, and generating momentum towards expanding invasive species treatment efforts on Cache Creek. Reach-scale maps (e.g., Appendix 1 and 2) are useful for communicating broad-scale patterns, while finer-scale data can be manipulated by Conservancy staff to inform site-level projects.

Restoration Opportunities

In general, active restoration of riparian forests is most appropriate in reaches in which groundwater depth and other factors will facilitate establishment of native forest species. However, in these areas, large stands of riparian forest often are already present. Thus, the focus in these areas may be better placed on understory enhancement; i.e., removal of invasive species and planting of competitive nature understory grasses and grass-like species (e.g., creeping wildlife, blue wildrye, California barley, various sedges and rushes), forbs (mugwort, gumplant, ragweed, Indian hemp, various milkweeds, various native clovers), and shrubs (e.g., wild rose, golden current, coffeeberry, buckbrush). In other areas, such as within the Hungry Hollow, Madison, and Guesisosi reaches, native forest species are slowly establishing and expanding (e.g, cottonwood, willows, mulefat). Passive restoration of riparian forests, achieved through invasive species removal and potentially additional flow releases during summer months, may be the optimal management strategy in these areas. For example, off-channel mining pits in some areas (e.g., Dunnigan Hills and Hoppin reaches) have revegetated naturally and have extensive stands of riparian forest. However, the understory communities in these areas are dominated by a mix of invasive species (arundo, tamarisk, perennial pepperweed, thistles, etc.) that are almost certainly reducing habitat value for wildlife and invertebrates while also inhibiting further recruitment of native plant species.

In many other locations, most of which are on upper terraces, little woody vegetation is present and the dominant species are thistles, perennial pepperweed, poison hemlock, yellow starthistle and other herbaceous species. On some of these areas, some remnant Valley oaks are still present, in addition to other native woody species such as elderberry. These areas are prime candidates for oak woodland restoration, including planting of native understory species. Elsewhere, such as on the Wild Wings parcel, highly compacted and gravelly soils most likely preclude planting of trees. Instead, a grassland-type community could be restored, including species adapted to harsh soil conditions such as native buckwheat.

Recommendations for Adaptive Management

As noted previously, this Project represents a significant step forward in terms of managing invasive species and enhancing biological resources along lower Cache Creek. Based on the results of this Project, the following recommendations are made to balance cost-effective invasive species management with the goals and objectives associated with implementation of the CCAP:

1. Formally expand the list of priority invasive species on lower Cache Creek.
    a. Add Himalayan blackberry, perennial pepperweed, poison hemlock, milk and Italian thistles, tree of heaven, tree tobacco, and yellow starthistle to the list of highest-priority species in addition to arundo, Ravenna grass, and tamarisk.
    b. Create a second tier of intermediate-priority species including barbed goatgrass, common teasel, edible fig, fennel, medusahead, purple loosestrife, and yellow flag iris.
    c. Create a third tier of lower-priority species including eucalyptus, fan palm, oleander, pampas grass, and stinkwort.
    d. Include in this framework the means to shift species between tiers, or to add/remove additional species as needed.

2. Using data from this Project, expand the annual "Creek Spray" and other invasive species control efforts to include additional species and areas based on priority, abundance at specific locations, and other factors.
    a. Utilize a spatially-explicit framework and methodology (e.g., mobile mapping technology) to implement and assess treatment efforts in order to ensure that all known plants and patches are treated, that treated plants and patches are monitored for resprouts, and that new plants and patches are recorded and added to the database.
    b. If contractors are used to implement invasive species treatments, they should be proficient with mobile mapping technology as a condition of the contract.
    c. Continue negotiations with landowners to allow for site access in order to treat remnant invasive species populations.

3. Initiate invasive species mapping and treatment projects above Capay Dam, and begin to work upstream to headwaters of Cache Creek in order to target source populations that continue to disperse downstream to lower Cache Creek. Seek collaboration with the Bureau of Land Management and local, state, and federal agencies for cost-sharing purposes.

4. Remove debris after invasive species treatment to maintain flows and allow for natural recruitment of native species. Dead tamarisk, arundo, and other woody plants should be cut during or after treatment and either burned on site or otherwise transported off-site.

5. Implement revegetation and restoration projects using local native species immediately after invasive species treatment.
    a. Develop a standard, cost-efficient mix of competitive native species that will establish and spread without the need for intensive and costly follow-up management. Such a mix would likely include creeping wildrye, mugwort, various sedges or rushes, quailbush, wild rose, and other species. Consider additional species (e.g., pollinator mixes) when logistically feasible.
    b. Consider balancing the removal of invasive species that provide resources for native wildlife (e.g., tree tobacco, which hummingbirds utilize as nectar resources) with local native species that provide the same service to wildlife (e.g., hummingbird sage).
    c. Consider invasive species control efforts as habitat "enhancement" projects that complement active restoration projects.

6. Utilize the results of this Project as impetus, seek additional grant funding to expand and enhance invasive treatment efforts on lower Cache Creek in conjunction with habitat restoration projects.

7. Repeat the methods used for this Project every five years over at least the next twenty years, in order to gauge progress in controlling past, present, and future priority invasive species as well as to inform adaptive management actions.

Conclusion

While high-quality riparian habitat is present along lower Cache Creek, numerous invasive species also are present and are having negative impacts on native plant, wildlife, and invertebrate species. Arundo, Ravenna grass, and tamarisk have been greatly reduced through more than a decade of intensive treatment efforts by the Cache Creek Conservancy. However, these species are still present throughout the area, and other species have established large populations that should be targeted through management actions. In addition, newly-arrived invasive species are poised to spread and establish, further stressing native species of plants, wildlife, and invertebrates. The results of this Project will serve as a spatially-explicit baseline that will enable more precise planning, implementation, and monitoring of invasive species treatment projects. Such projects should be implemented in conjunction with habitat enhancement and restoration efforts to maximize benefits for native species and ecosystem processes along lower Cache Creek.

References

Northwest Hydraulic Consultants. 1995. Technical Studies and Recommendations for the Lower Cache Creek Resource Management Plan.

Yolo County. 1998. Cache Creek Annual Status Report. Prepared by D. Morrison, J. Hart, K. O'Dea, G. Schladow.

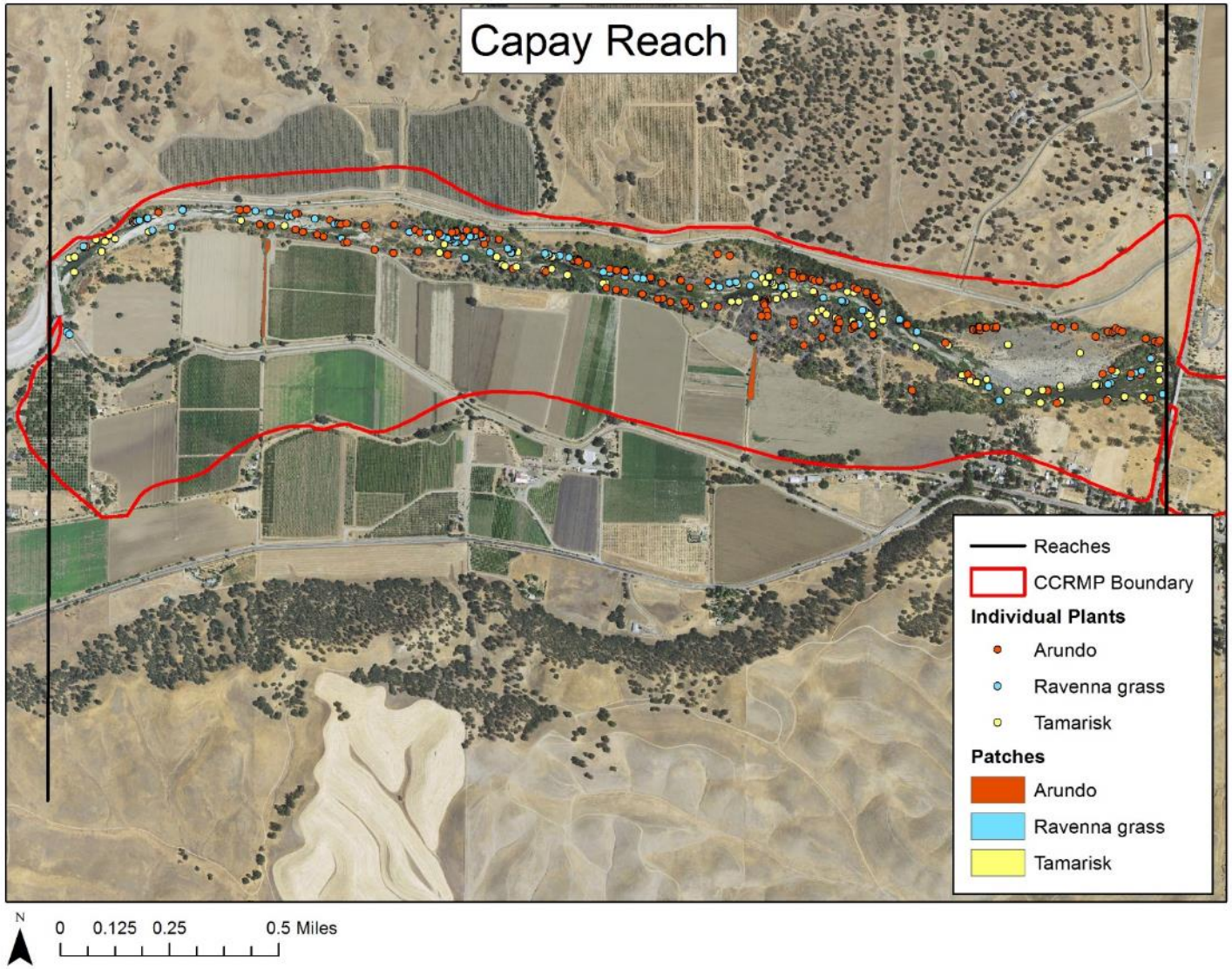
Yolo County. 1999. Cache Creek Annual Status Report. Prepared by D. Morrison, J. Hart, K. O'Dea, G. Schladow.

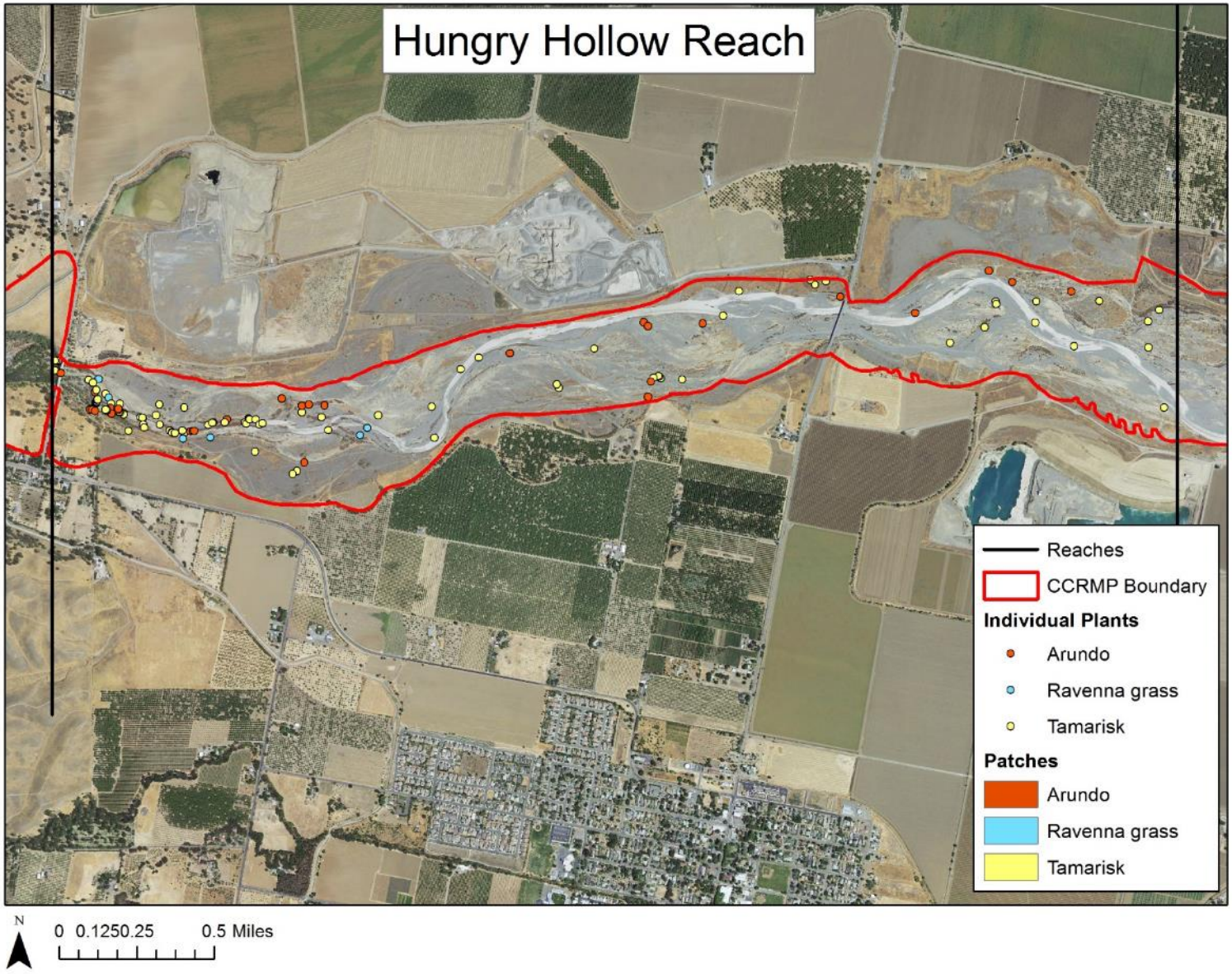
Yolo County. 2006. Cache Creek Status Report and Trend Analysis. Prepared by J. McIver, C. Alford, J. Hart, G. Schladow.

Yolo County. 2012. 2011 Cache Creek Annual Status Report. Prepared by E. Larsen, T. Horner, E. Ringelberg.

Appendices

Appendix 1. Reach-specific maps of the extent and distribution of arundo, Ravenna grass, and tamarisk by reach.




Hungry Hollow Reach
Reaches
CCRMP Boundary
Individual Plants
Arundo
Ravenna grass
Tamarisk
Patches
Arundo
Ravenna grass
Tamarisk
N
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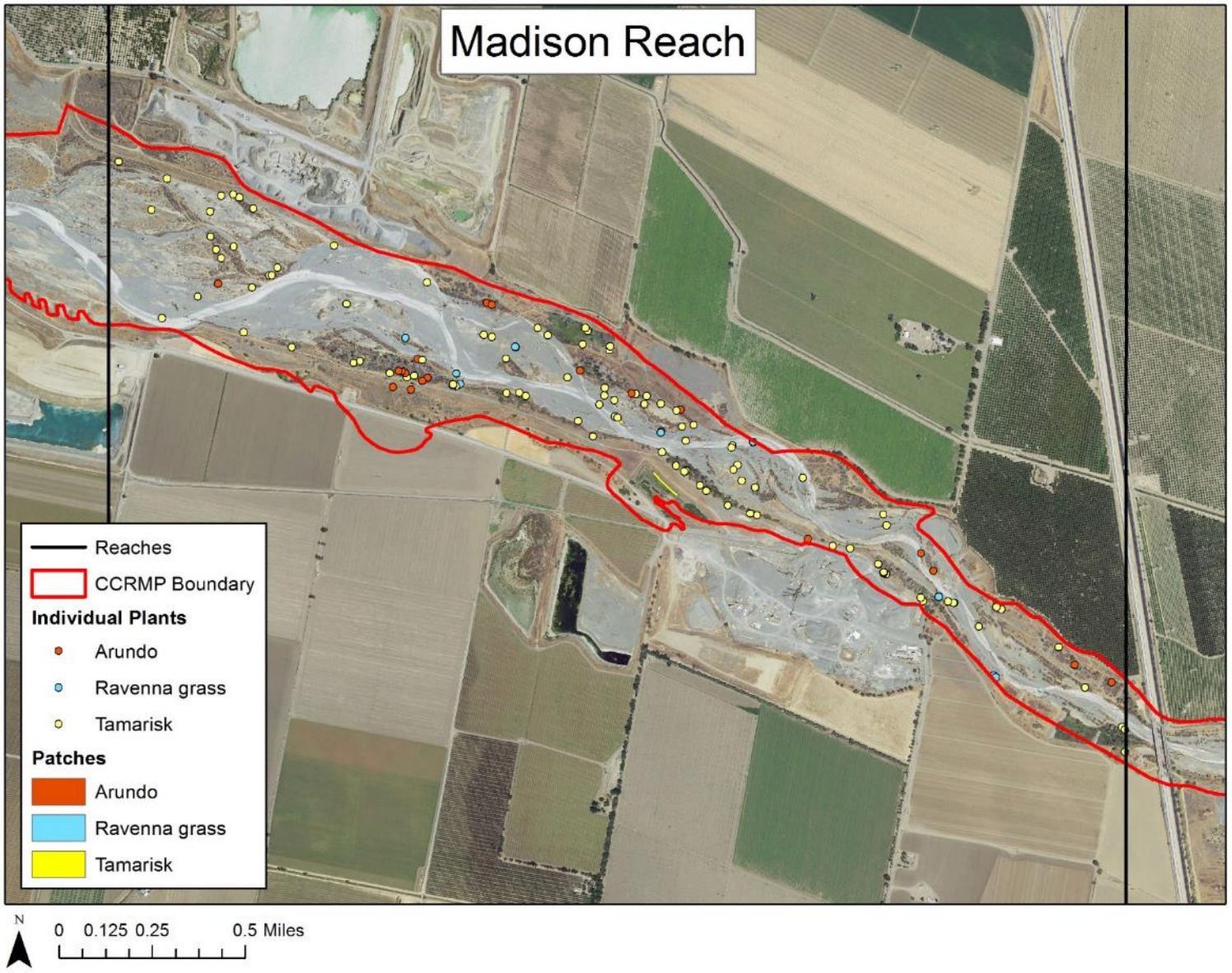
Madison Reach
Reaches
CCRMP Boundary
Individual Plants
Arundo
Ravenna grass
Tamarisk
Patches
Arundo
Ravenna grass
Tamarisk
N
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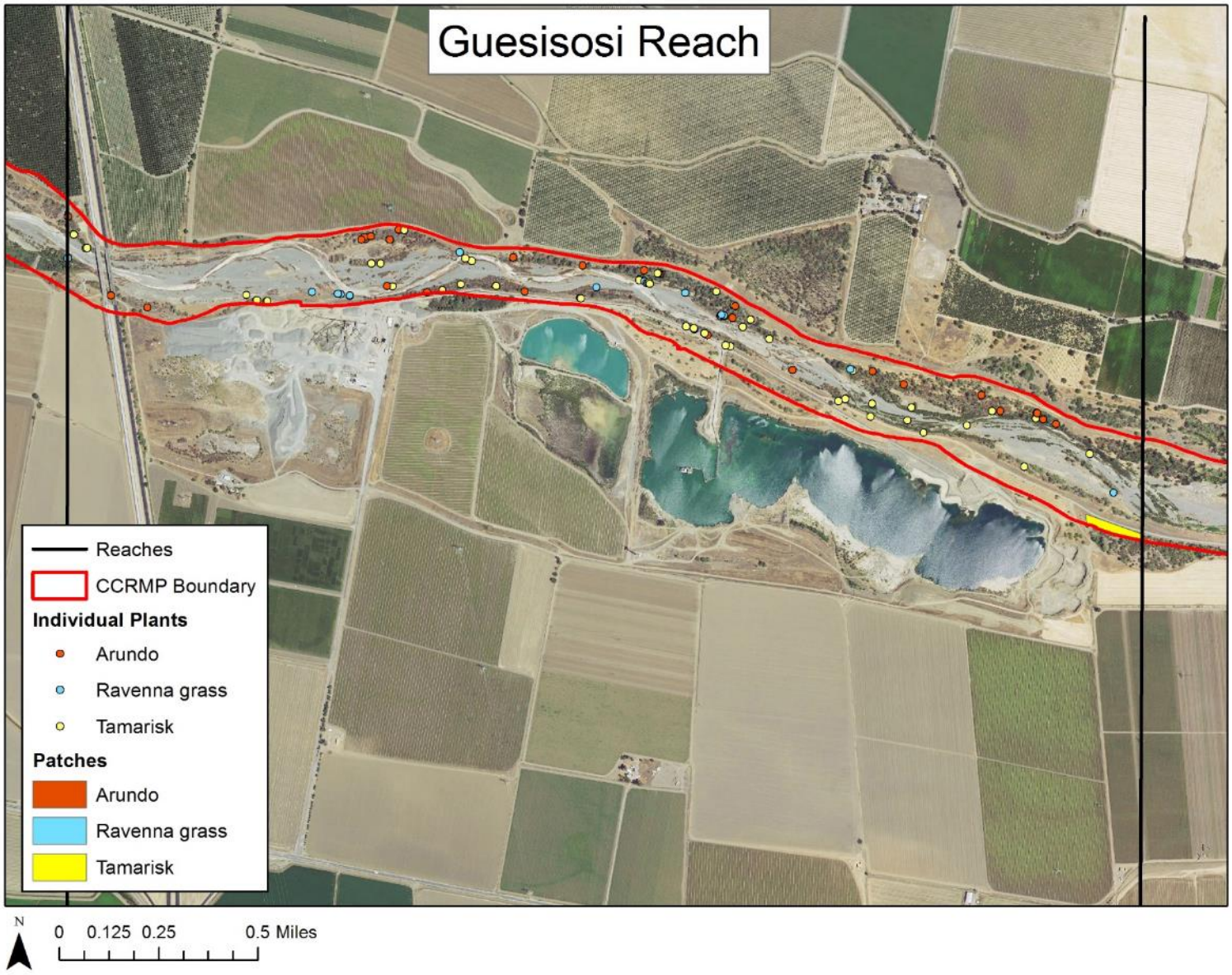
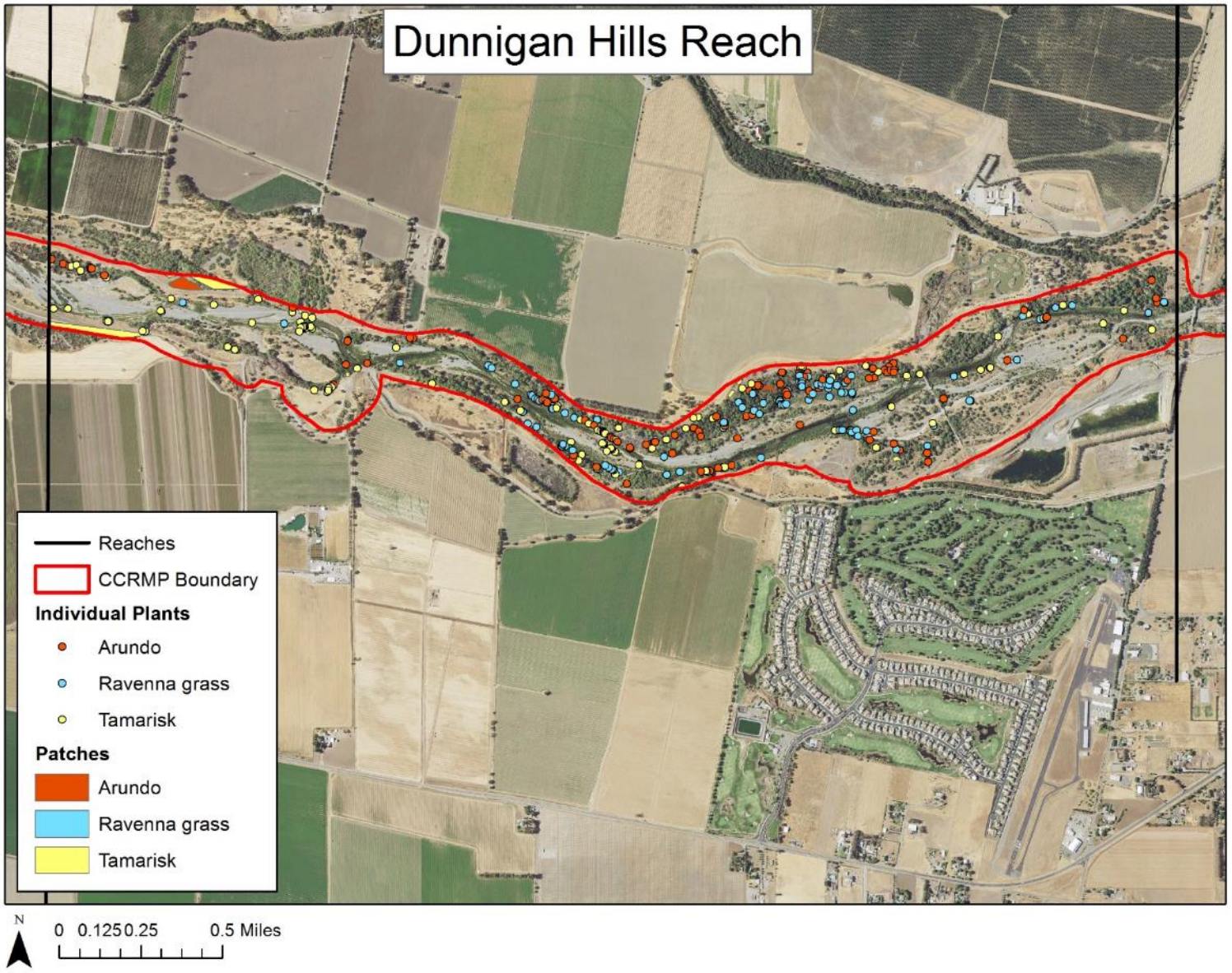

Guesisosi Reach
Reaches
CCRMP Boundary
Individual Plants
Arundo
Ravenna grass
Tamarisk
Patches
Arundo
Ravenna grass
Tamarisk
N
0 0.125 0.25 0.5 Miles


Dunnigan Hills Reach
Reaches
CCRMP Boundary
Individual Plants
Arundo
Ravenna grass
Tamarisk
Patches
Arundo
Ravenna grass
Tamarisk
N
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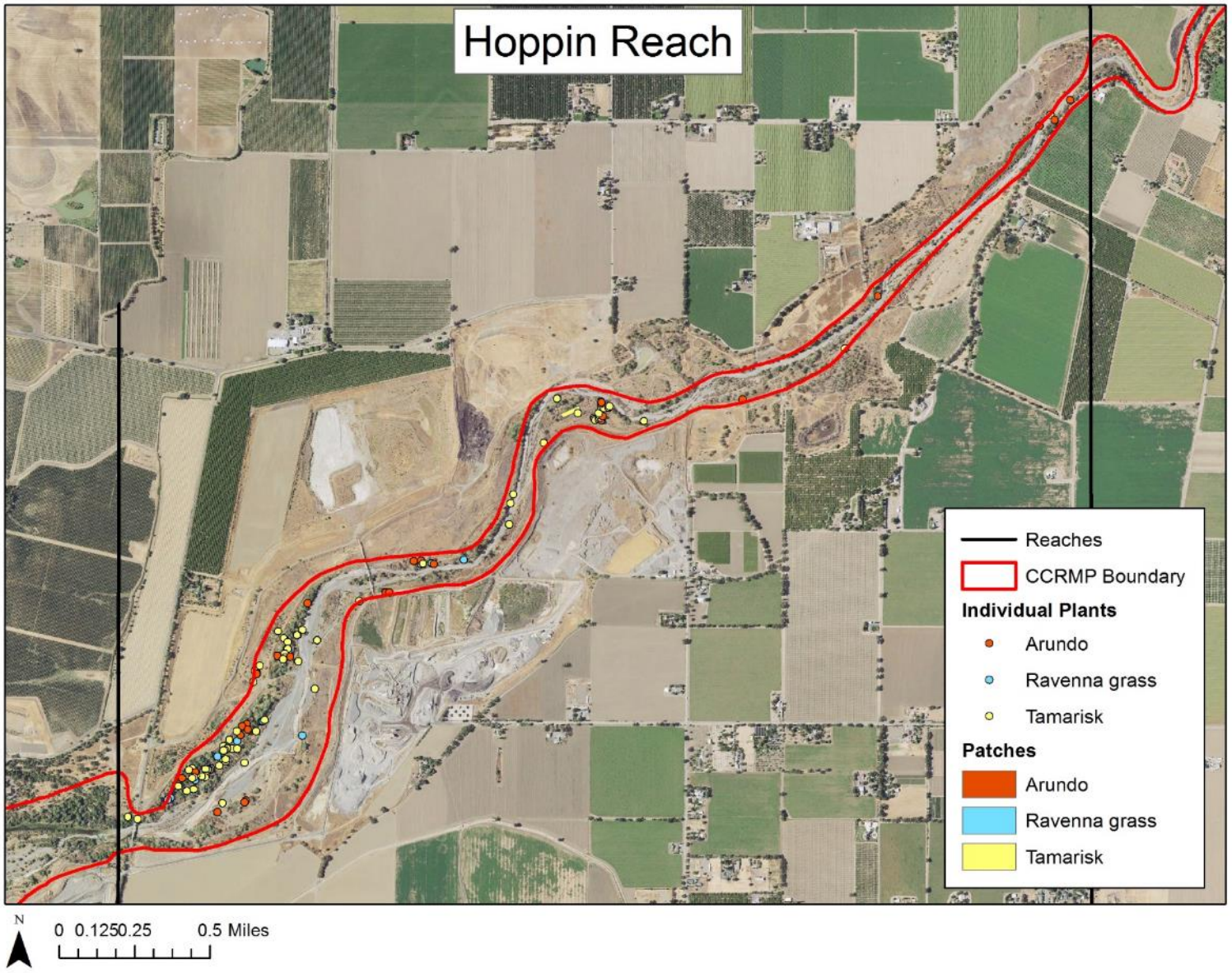
Hoppin Reach
Reaches
CCRMP Boundary
Individual Plants
Arundo
Ravenna grass
Tamarisk
Patches
Arundo
Ravenna grass
Tamarisk
N
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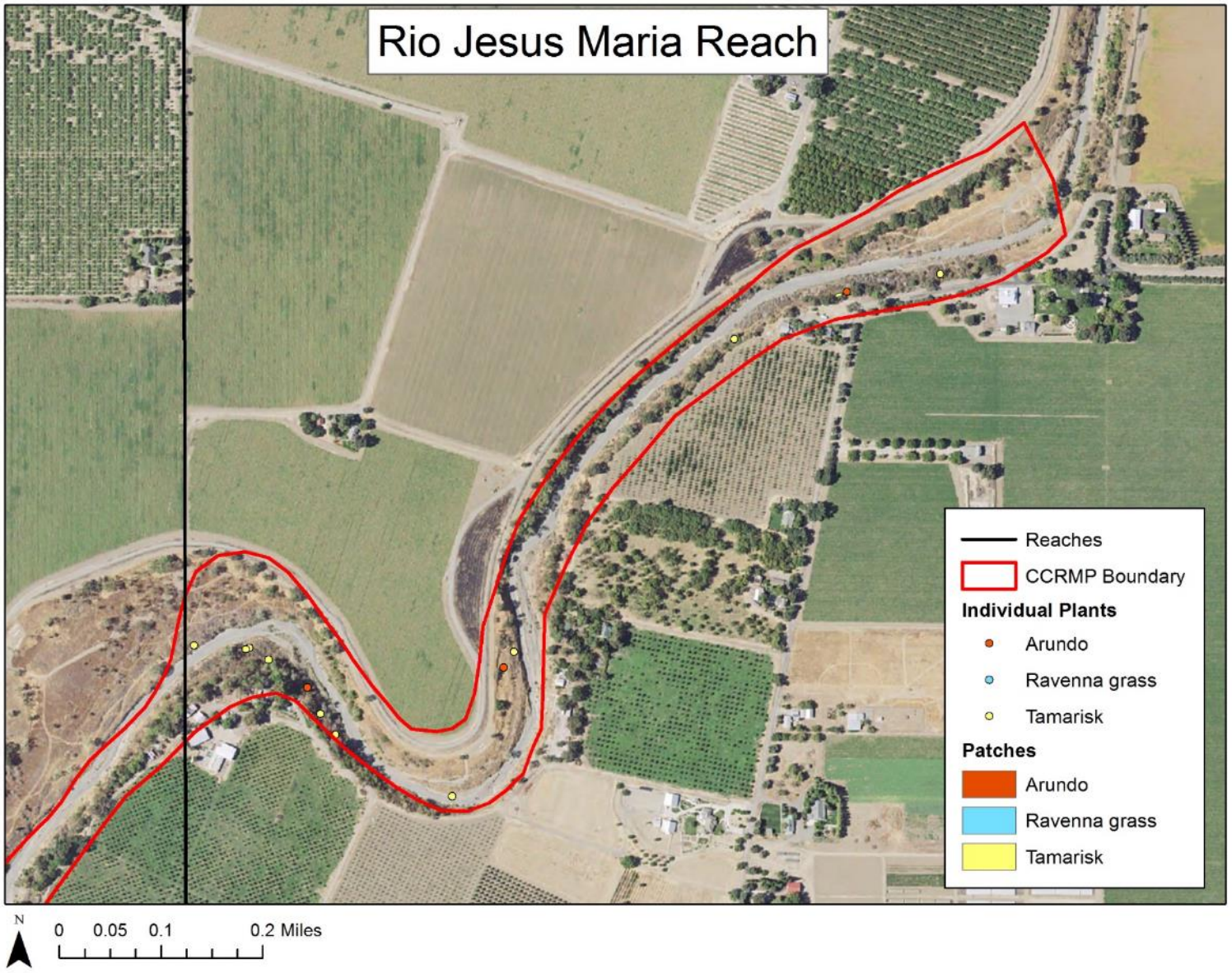
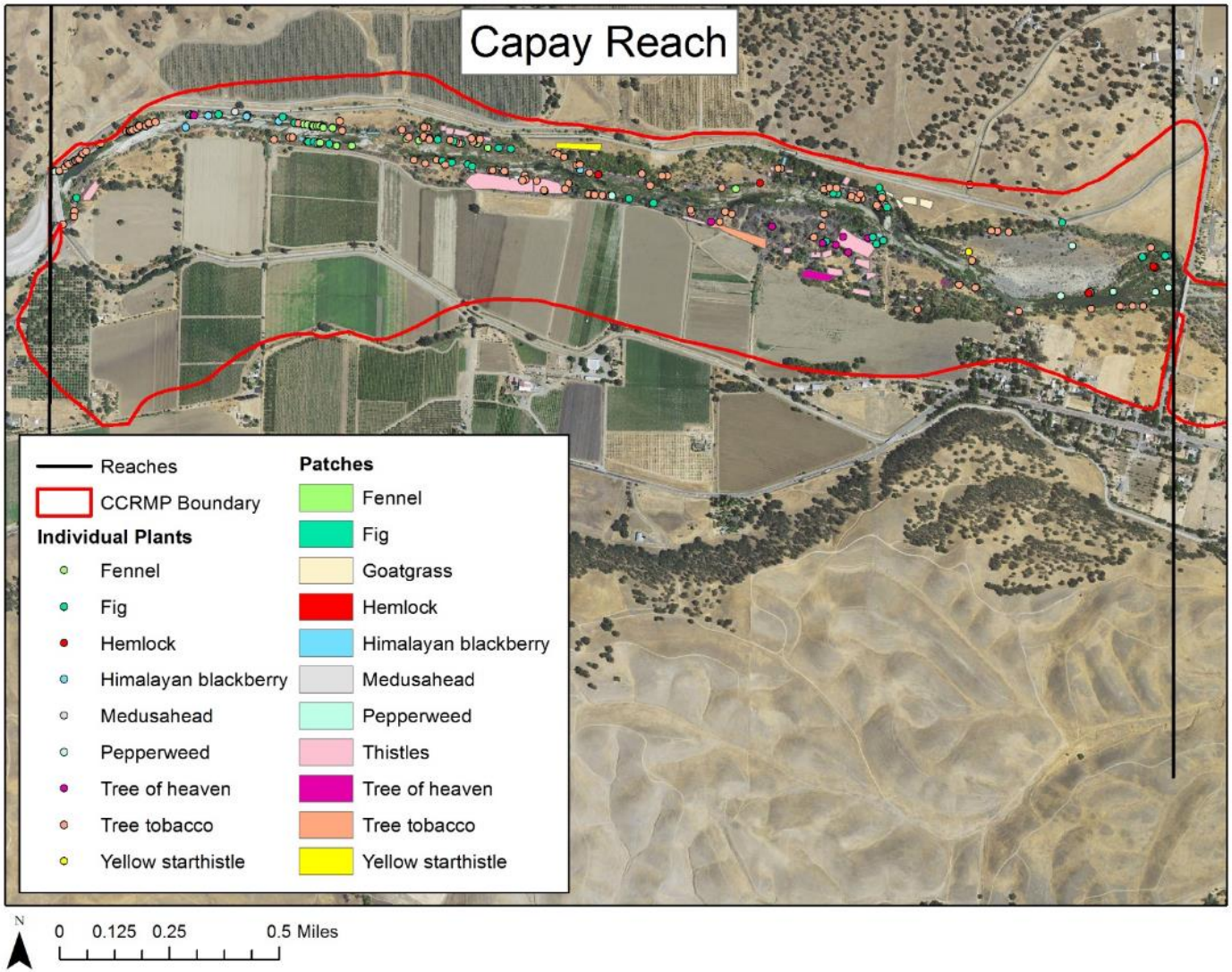
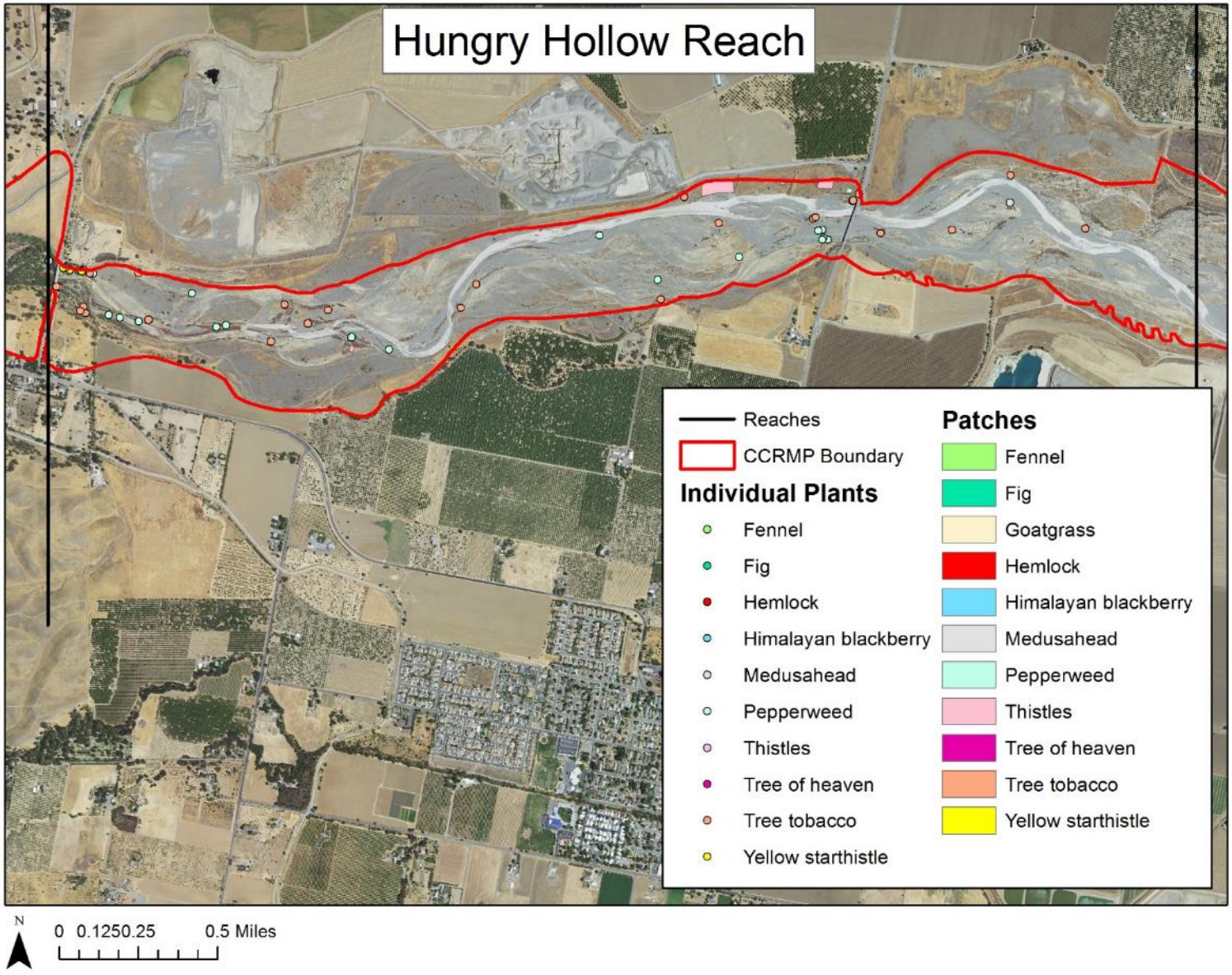
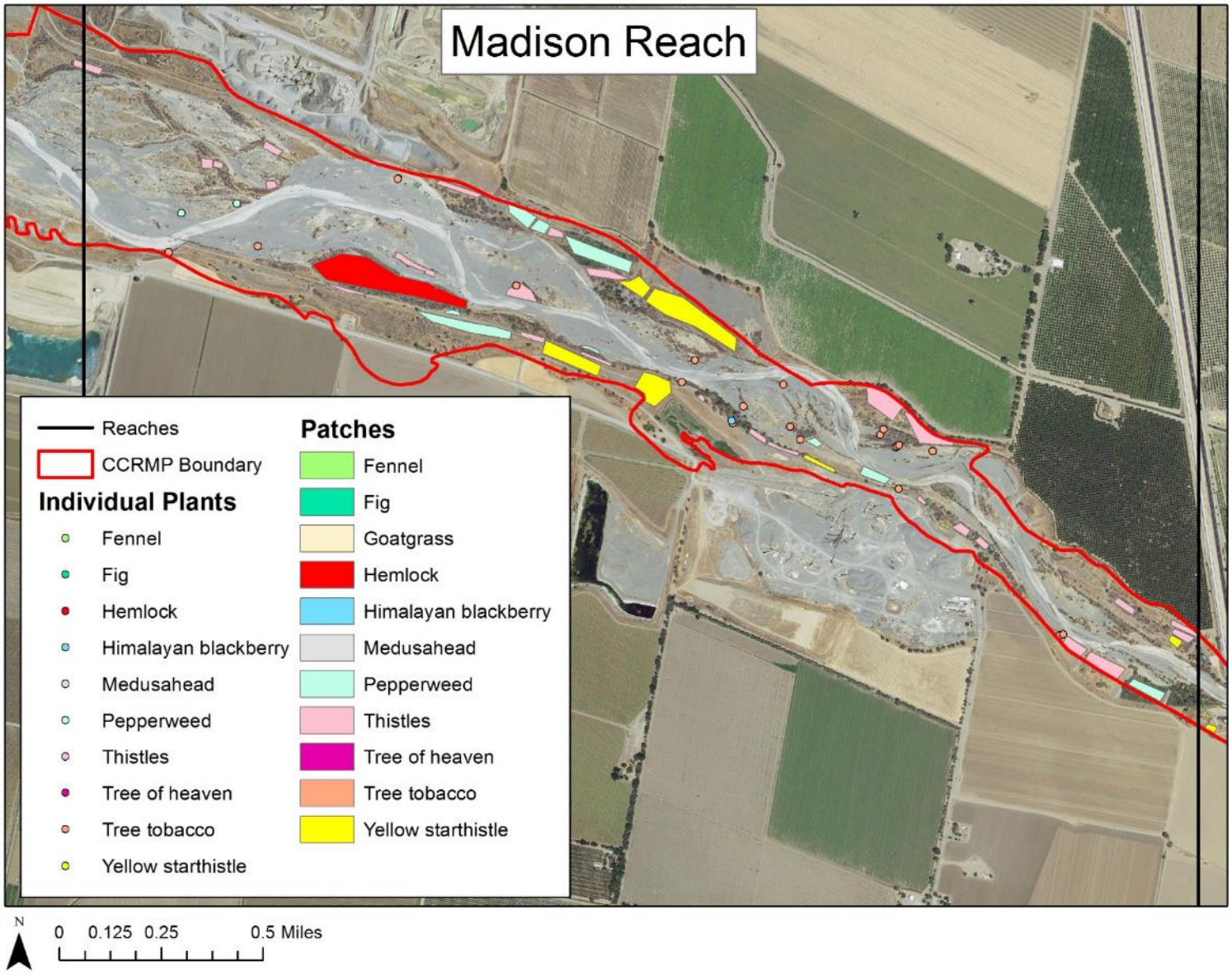
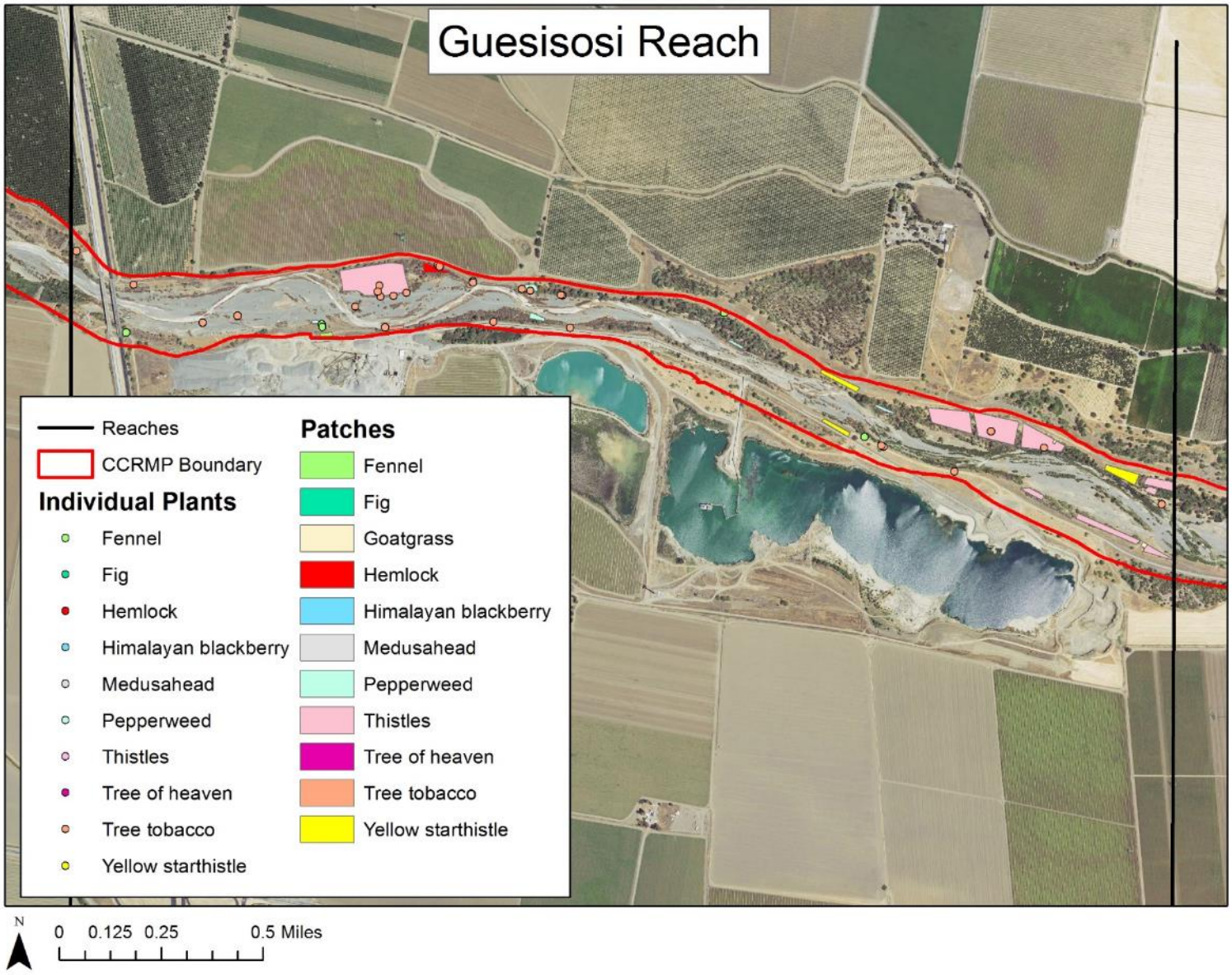

Rio Jesus Maria Reach
Reaches
CCRMP Boundary
Individual Plants
Arundo
Ravenna grass
Tamarisk
Patches
Arundo
Ravenna grass
Tamarisk
N
0 0.05 0.1 0.2 Miles

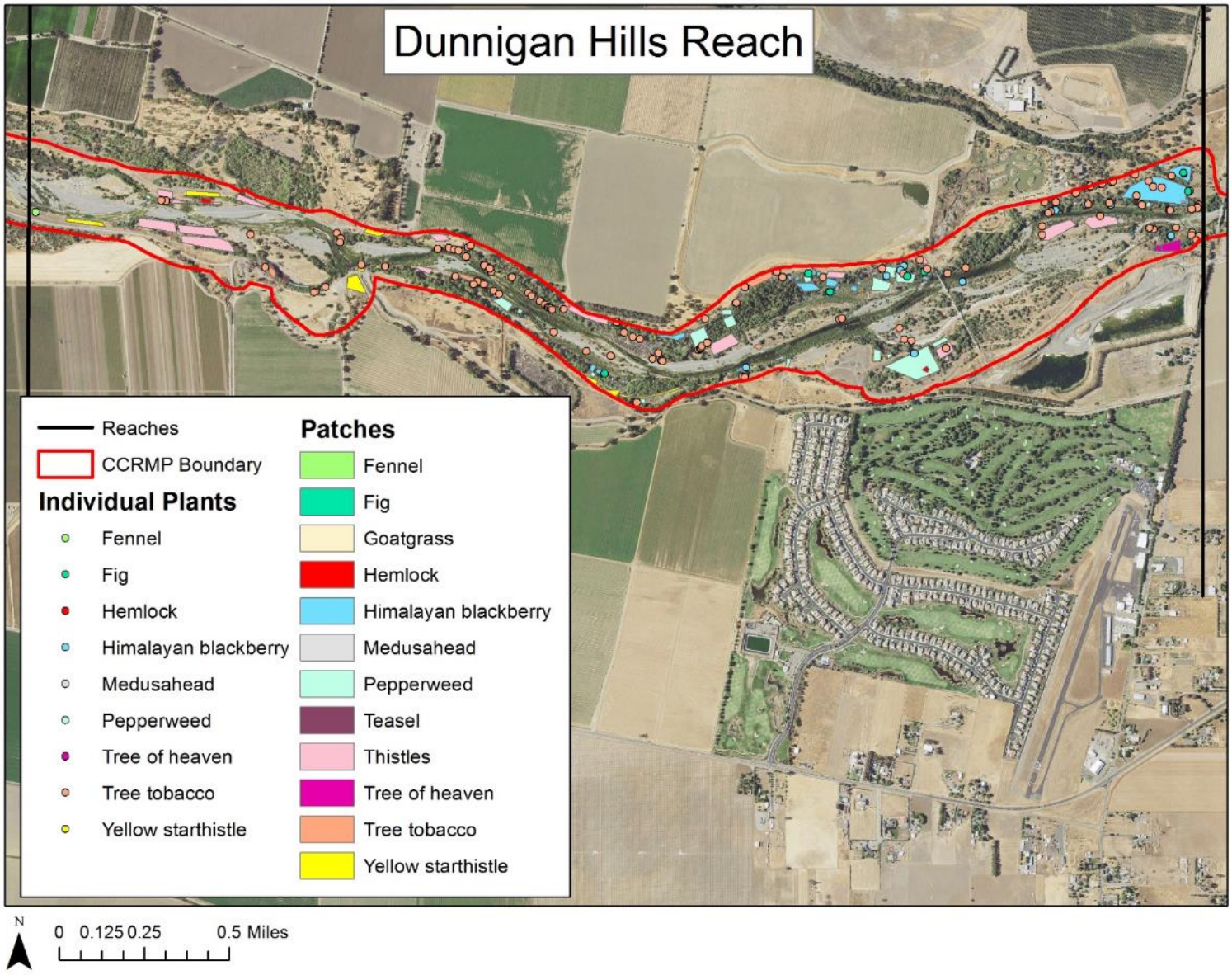
Appendix 2. Reach-specific maps of the extent and distribution of fennel, edible fig, barbed goatgrass, poison hemlock, Himalayan blackberry, medusahead, perennial pepperweed, thistles, tree of heaven, tree tobacco, and yellow starthistle.

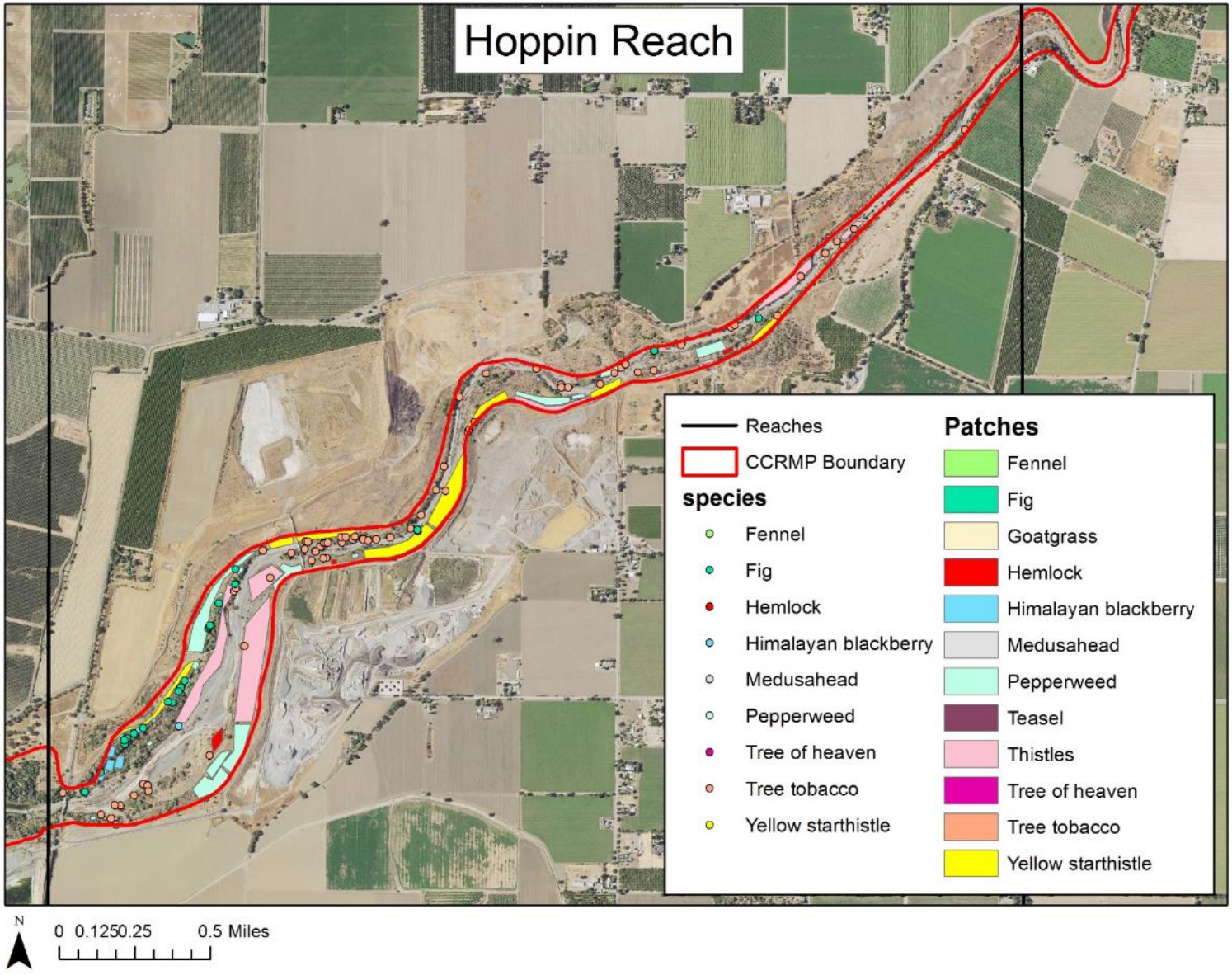


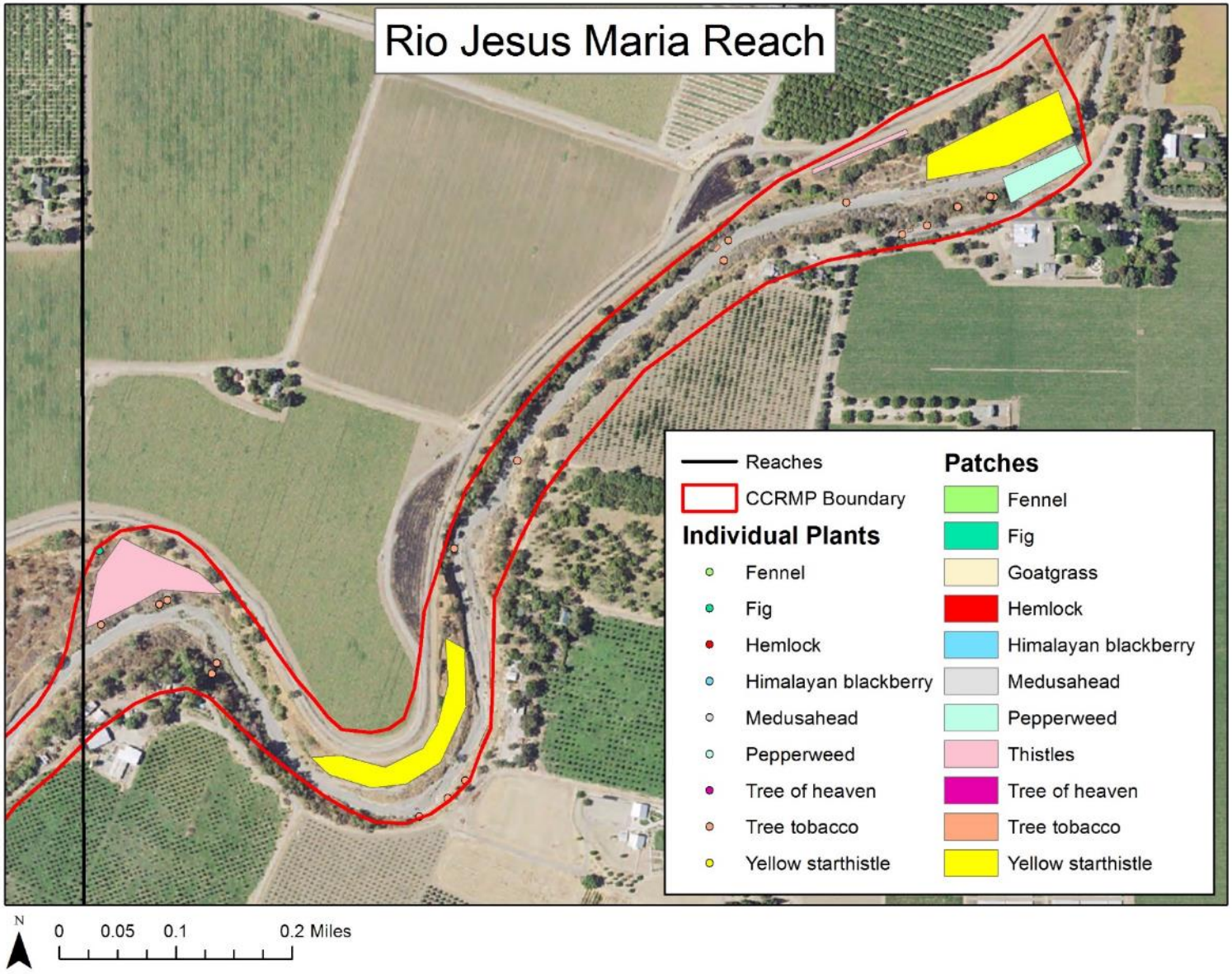

Hungry Hollow Reach
Reaches
CCRMP Boundary
Individual Plants
Fennel
Fig
Hemlock
Himalayan blackberry
Medusahead
Pepperweed
Thistles
Tree of heaven
Tree tobacco
Yellow starthistle
Patches
Fennel
Fig
Goatgrass
Hemlock
Himalayan blackberry
Medusahead
Pepperweed
Thistles
Tree of heaven
Tree tobacco
Yellow starthistle
N
0 0.1250.25 0.5 Miles


Madison Reach
Reaches
CCRMP Boundary
Individual Plants
Fennel
Fig
Hemlock
Himalayan blackberry
Medusahead
Pepperweed
Thistles
Tree of heaven
Tree tobacco
Yellow starthistle
Patches
Fennel
Fig
Goatgrass
Hemlock
Himalayan blackberry
Medusahead
Pepperweed
Thistles
Tree of heaven
Tree tobacco
Yellow starthistle
N
0 0.125 0.25 0.5 Miles

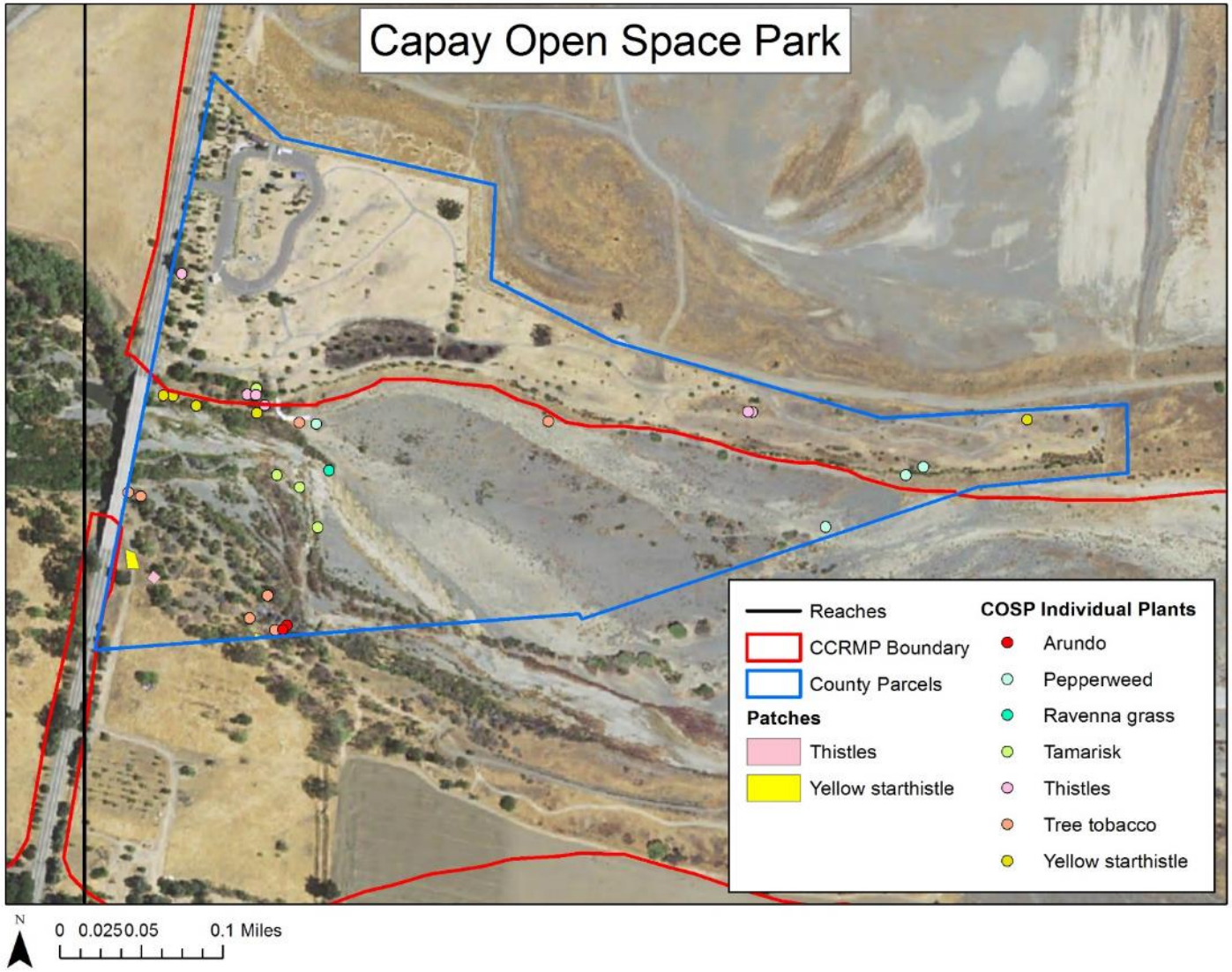

Guesisosi Reach
Reaches
CCRMP Boundary
Individual Plants
Fennel
Fig
Hemlock
Himalayan blackberry
Medusahead
Pepperweed
Thistles
Tree of heaven
Tree tobacco
Yellow starthistle
Patches
Fennel
Fig
Goatgrass
Hemlock
Himalayan blackberry
Medusahead
Pepperweed
Thistles
Tree of heaven
Tree tobacco
Yellow starthistle
N
0 0.125 0.25 0.5 Miles


Dunnigan Hills Reach
Reaches
CCRMP Boundary
Individual Plants
Fennel
Fig
Hemlock
Himalayan blackberry
Medusahead
Pepperweed
Tree of heaven
Tree tobacco
Yellow starthistle
Patches
Fennel
Fig
Goatgrass
Hemlock
Himalayan blackberry
Medusahead
Pepperweed
Teasel
Thistles
Tree of heaven
Tree tobacco
Yellow starthistle
N
0 0.125 0.25 0.5 Miles

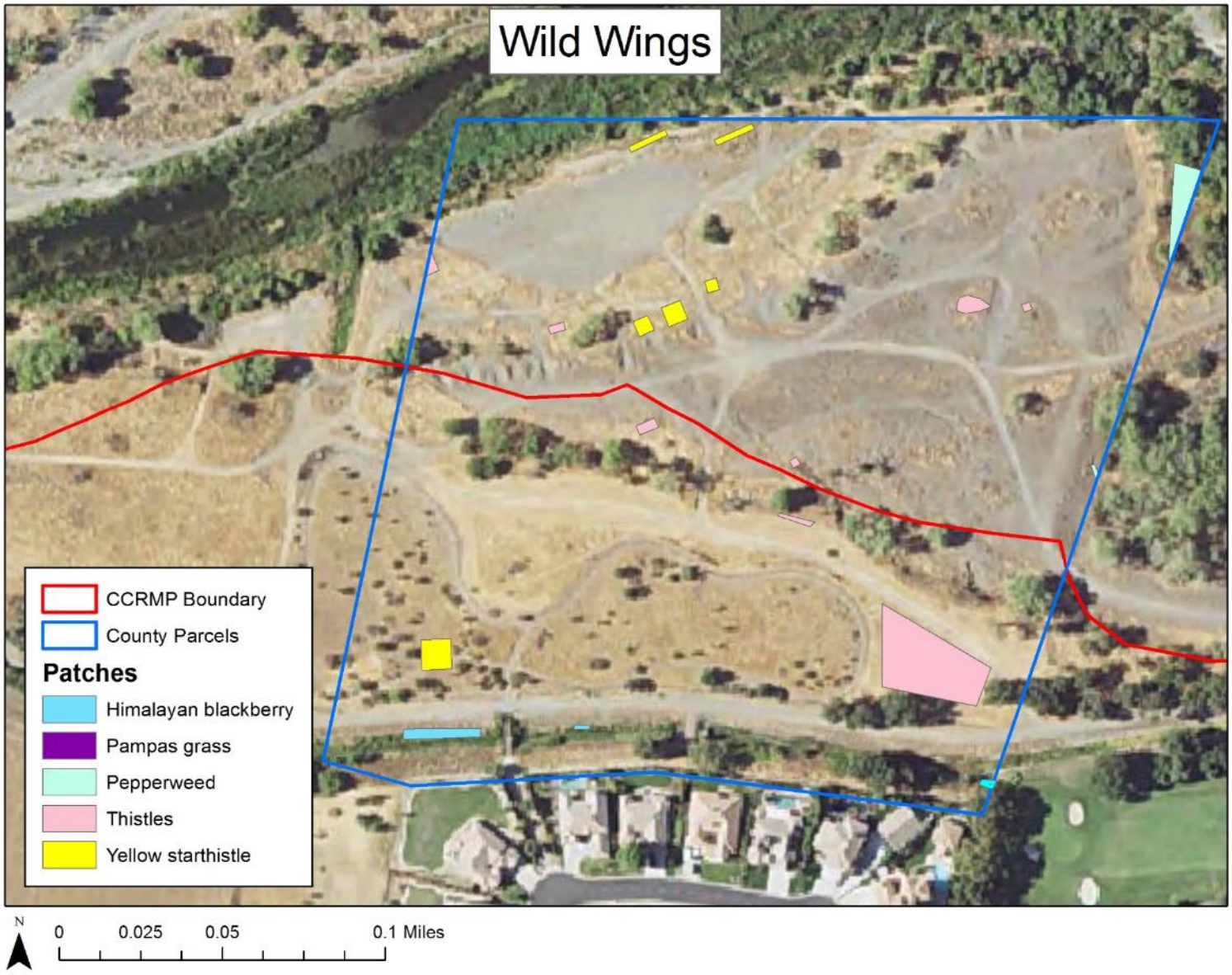

Hoppin Reach
Reaches
CCRMP Boundary
species
Fennel
Fig
Hemlock
Himalayan blackberry
Medusahead
Pepperweed
Tree of heaven
Tree tobacco
Yellow starthistle
Patches
Fennel
Fig
Goatgrass
Hemlock
Himalayan blackberry
Medusahead
Pepperweed
Teasel
Thistles
Tree of heaven
Tree tobacco
Yellow starthistle
N
0 0.1250.25 0.5 Miles

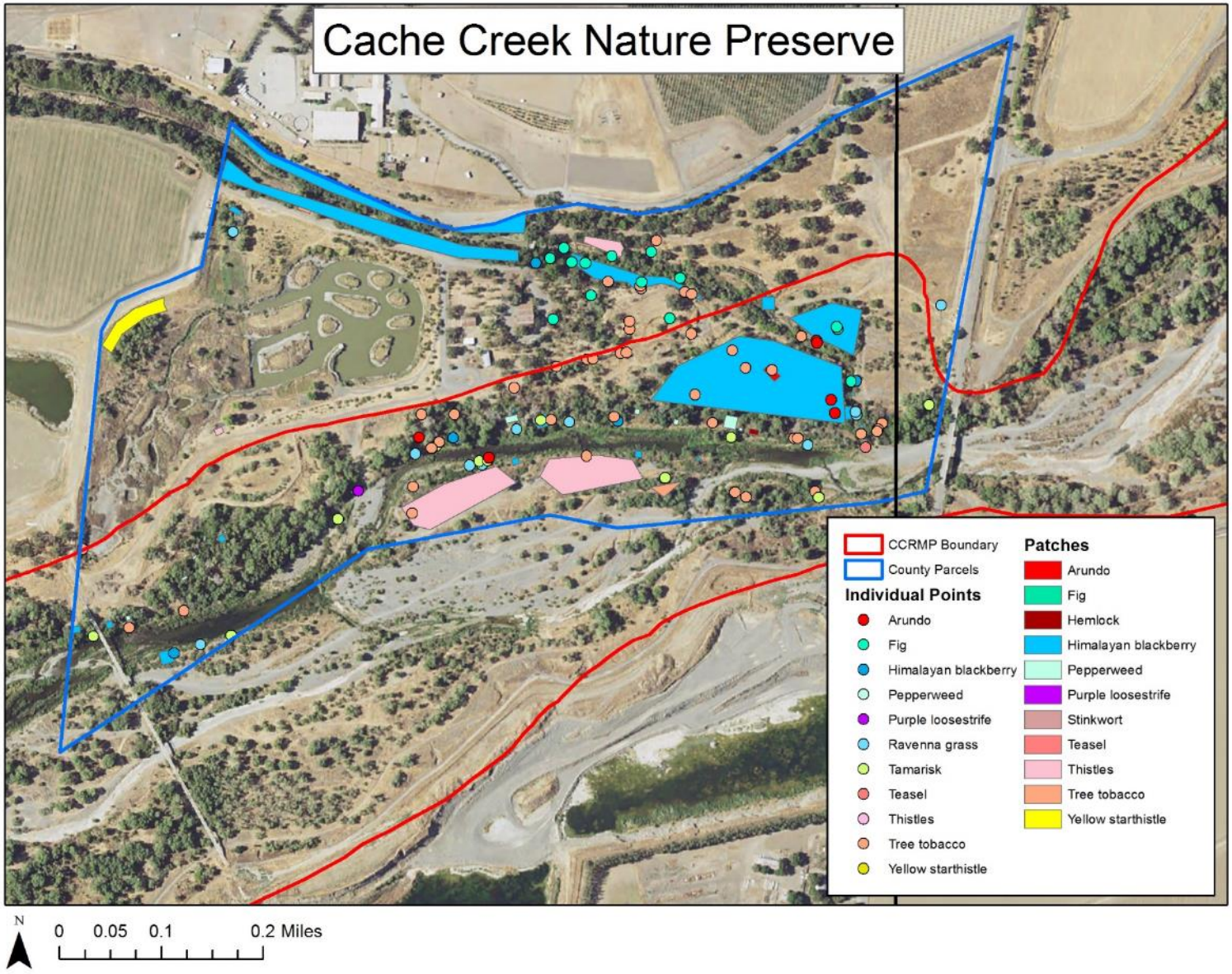

Rio Jesus Maria Reach
Reaches
CCRMP Boundary
Individual Plants
Fennel
Fig
Hemlock
Himalayan blackberry
Medusahead
Pepperweed
Tree of heaven
Tree tobacco
Yellow starthistle
Patches
Fennel
Fig
Goatgrass
Hemlock
Himalayan blackberry
Medusahead
Pepperweed
Thistles
Tree of heaven
Tree tobacco
Yellow starthistle
N
0
0.05
0.1
0.2 Miles

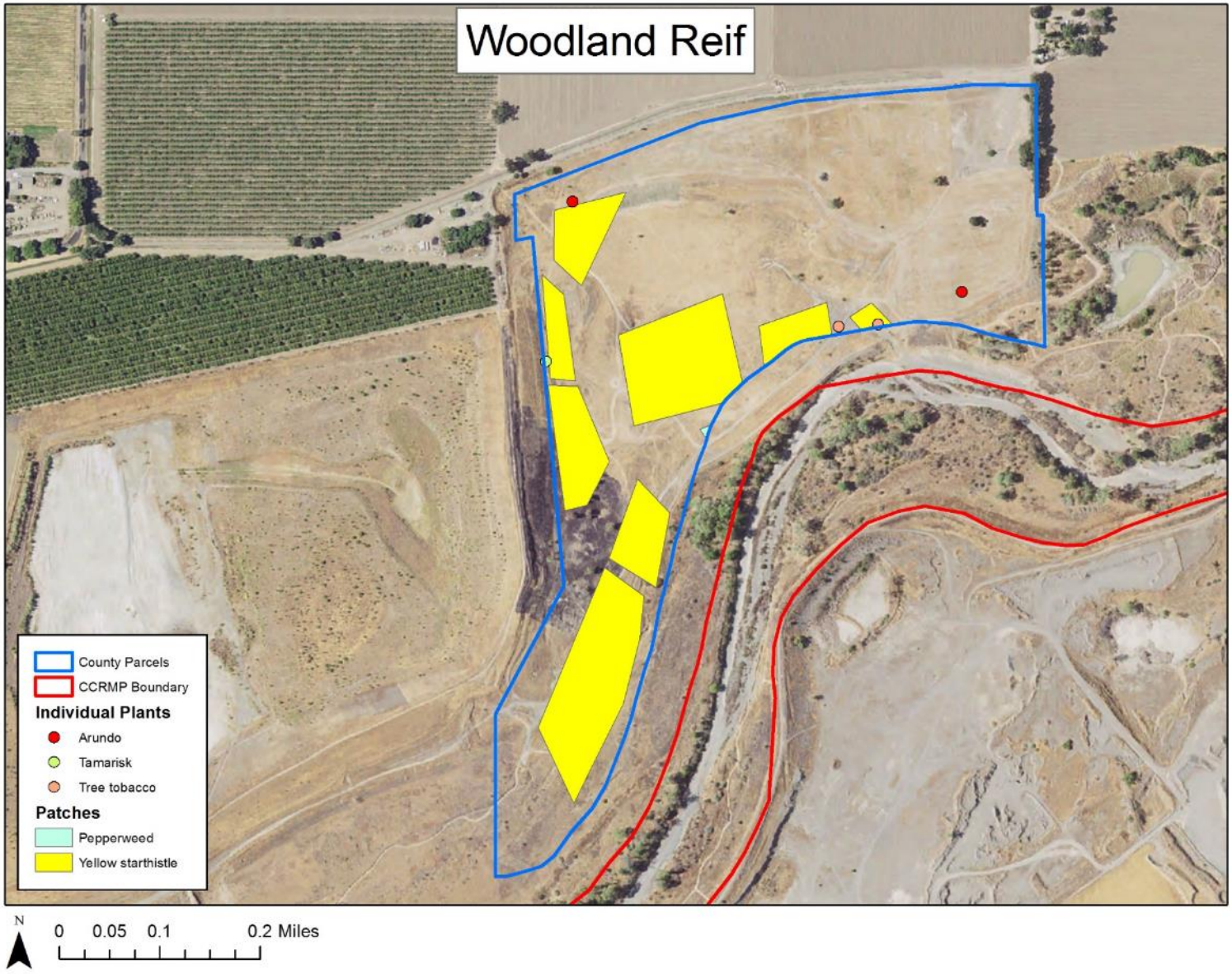
Appendix 3. Maps of the extent and distribution of all Project species on the six County-owned parcels adjacent to, or overlapping with, the CCRMP boundary along lower Cache Creek.

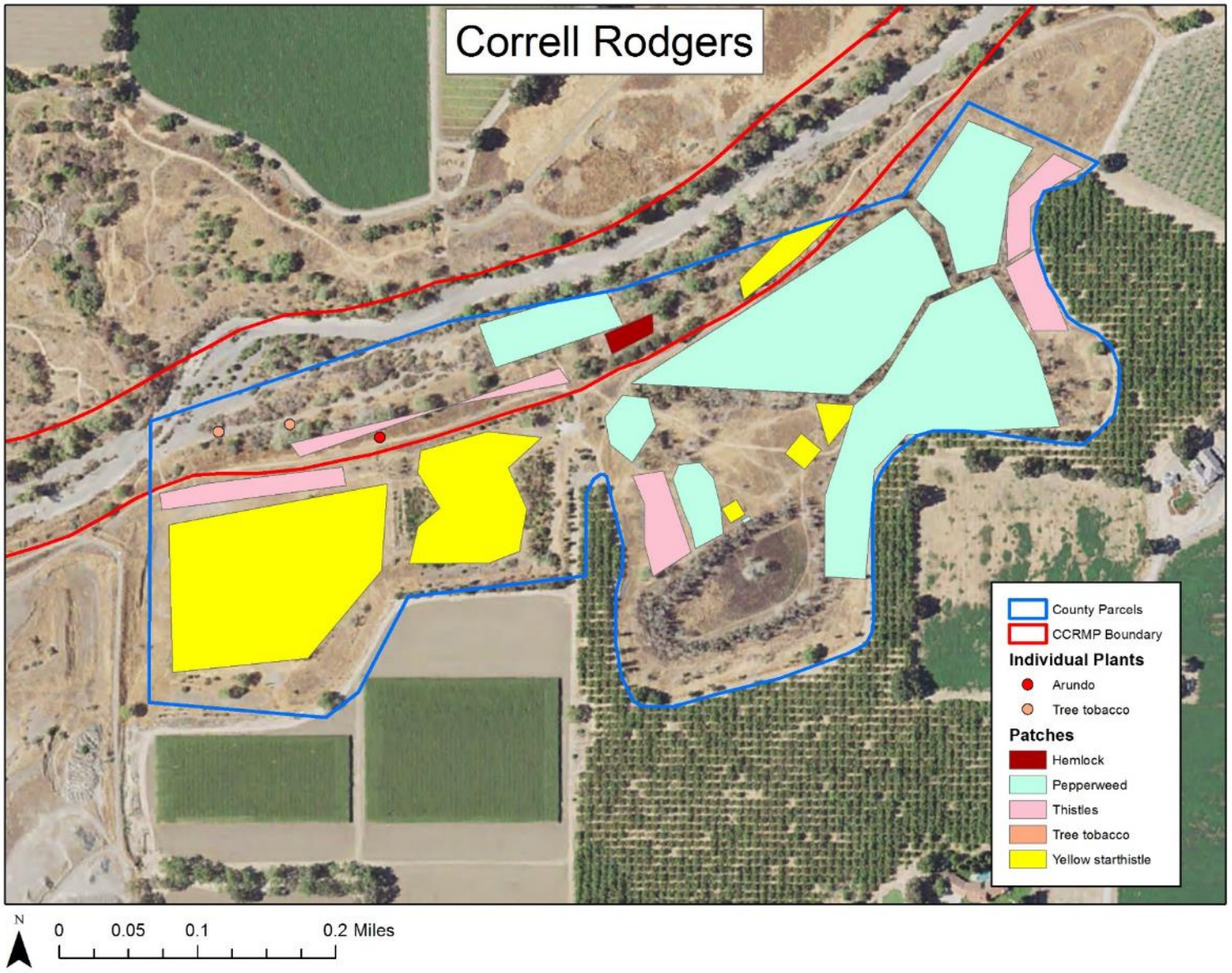



Millsap Property
CCRMP Boundary
County Parcels
Individual Plants
Tamarisk
Patches
Tamarisk
Thistles
Yellow starthistle
N
0
0.025
0.05
0.1 Miles


Wild Wings
CCRMP Boundary
County Parcels
Patches
Himalayan blackberry
Pampas grass
Pepperweed
Thistles
Yellow starthistle
N
0
0.025
0.05
0.1 Miles


Cache Creek Nature Preserve
CCRMP Boundary
County Parcels
Individual Points
Arundo
Fig
Himalayan blackberry
Pepperweed
Purple loosestrife
Ravenna grass
Tamarisk
Teasel
Thistles
Tree tobacco
Yellow starthistle
Patches
Arundo
Fig
Hemlock
Himalayan blackberry
Pepperweed
Purple loosestrife
Stinkwort
Teasel
Thistles
Tree tobacco
Yellow starthistle
N
0 0.05 0.1 0.2 Miles

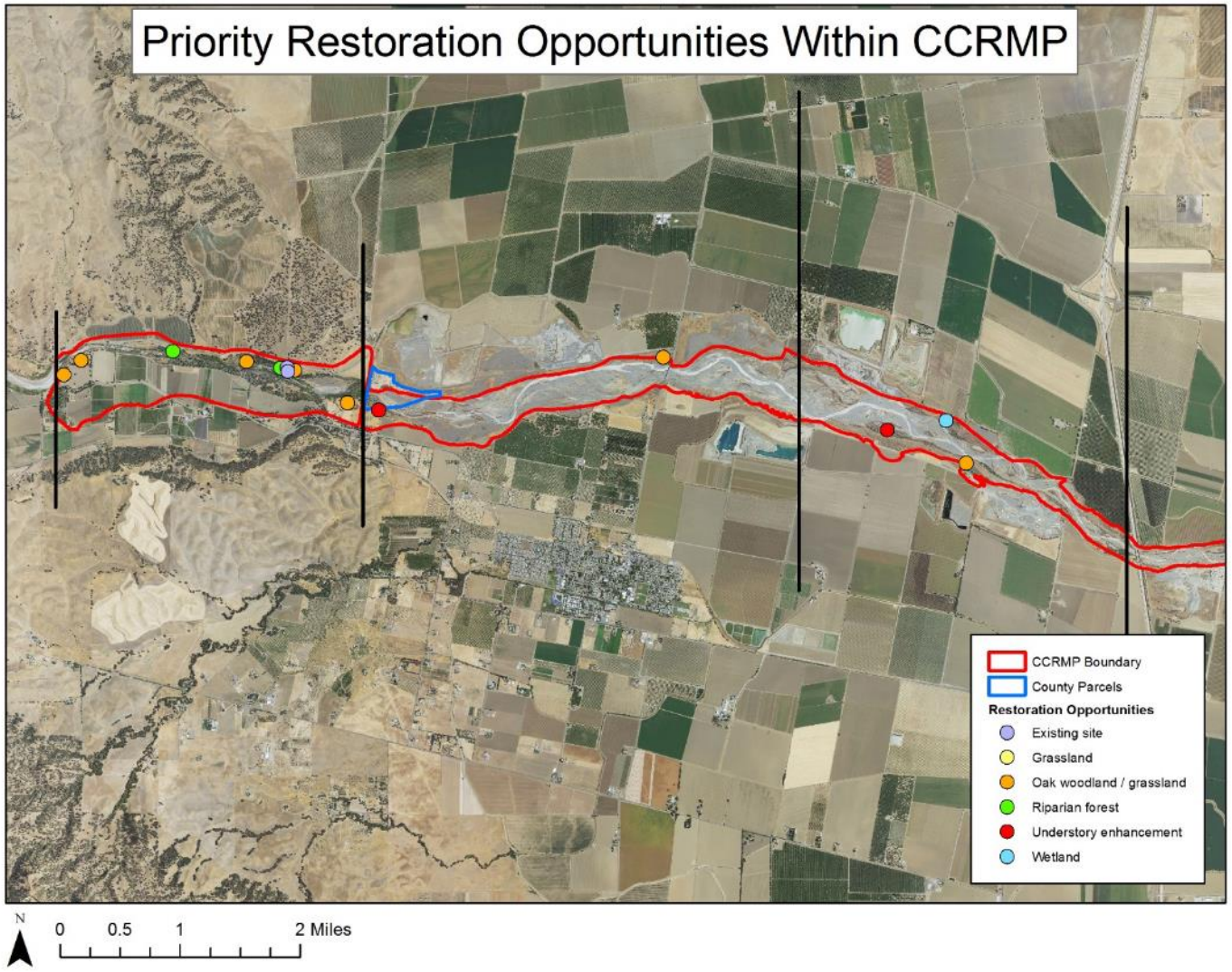

Woodland Reif
County Parcels
CCRMP Boundary
Individual Plants
Arundo
Tamarisk
Tree tobacco
Patches
Pepperweed
Yellow starthistle
N
0 0.05 0.1 0.2 Miles

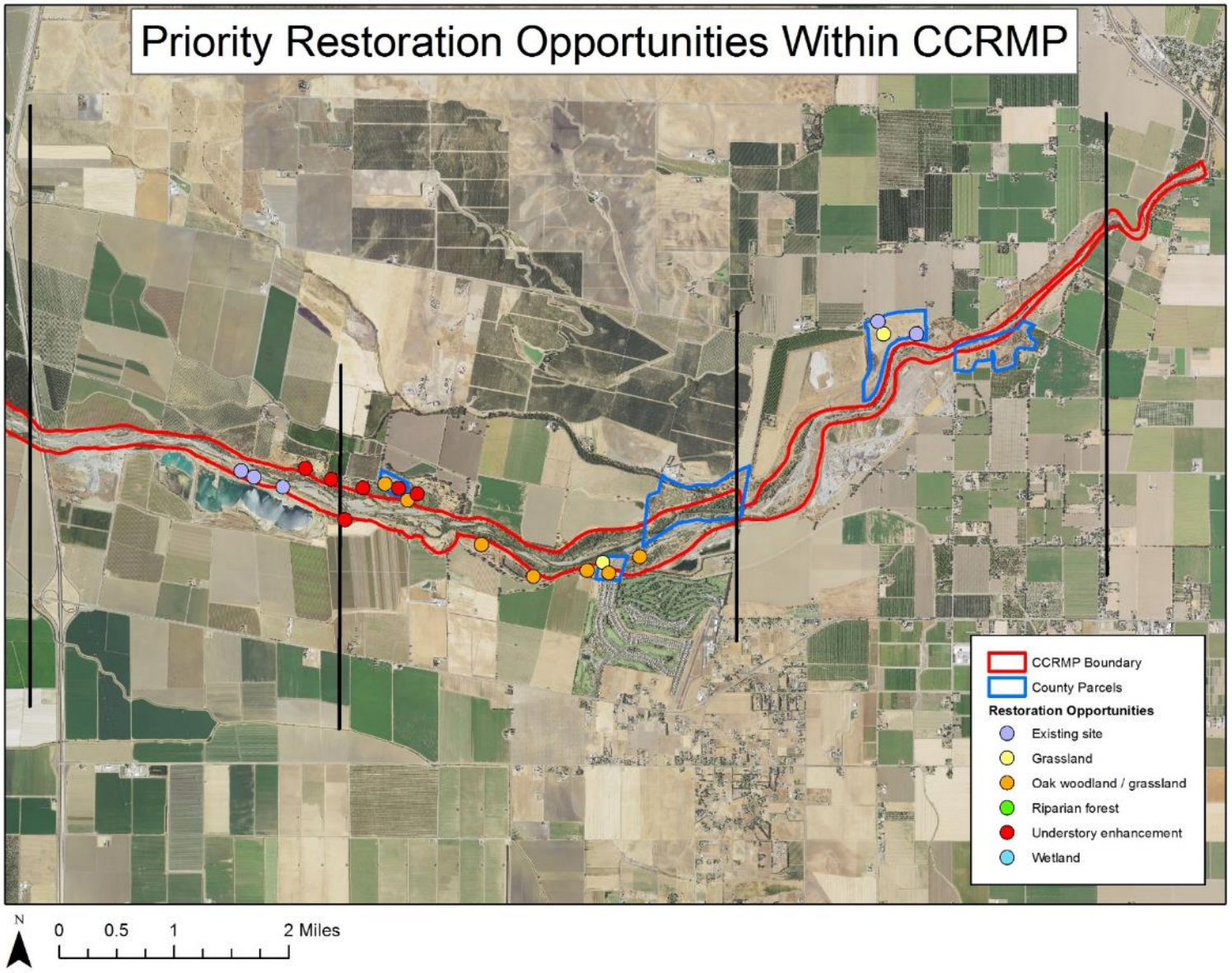

Correll Rodgers
County Parcels
CCRMP Boundary
Individual Plants
Arundo
Tree tobacco
Patches
Hemlock
Pepperweed
Thistles
Tree tobacco
Yellow starthistle
N
0
0.05
0.1
0.2 Miles

Appendix 4. Area estimates used to calculate approximate area (m^2 and ft^2) of discrete individual plants (points) of Project species; general size classes were: small, medium, and large. Project species not listed were only recorded as patches, never as points.

	Size class					
Species	Small (m^2)	Small (ft^2)	Medium (m^2)	Medium (ft^2)	Large (m^2)	Large (ft^2)
Arundo	0.25	2.69	1.00	10.76	2.25	24.22
Bamboo	0.25	2.69	1.00	10.76	2.25	24.22
Common teasel	0.02	0.17	0.06	0.67	0.25	2.69
Edible fig	0.25	2.69	1.00	10.76	4.00	43.06
Eucalyptus	0.25	2.69	1.00	10.76	4.00	43.06
Fan Palm	0.25	2.69	1.00	10.76	2.25	24.22
Fennel	0.02	0.17	0.06	0.67	0.25	2.69
Himalayan blackberry	0.25	2.69	1.00	10.76	4.00	43.06
Medusahead	0.02	0.17	0.06	0.67	0.25	2.69
Oleander	0.25	2.69	1.00	10.76	2.25	24.22
Perennial pepperweed	0.02	0.17	0.06	0.67	0.25	2.69
Poison hemlock	0.02	0.17	0.06	0.67	0.25	2.69
Purple loosestrife	0.02	0.17	0.06	0.67	0.25	2.69
Ravenna grass	0.06	0.67	0.25	2.69	1.00	10.76
Tamarisk	0.25	2.69	1.00	10.76	2.25	24.22
Thistles	0.02	0.17	0.06	0.67	0.25	2.69
Tree of heaven	0.25	2.69	1.00	10.76	4.00	43.06
Tree tobacco	0.25	2.69	1.00	10.76	2.25	24.22
Yellow flag iris	0.02	0.17	0.06	0.67	0.25	2.69
Yellow starthistle	0.02	0.17	0.06	0.67	0.25	2.69

Appendix 5. Maps of approximate locations of restoration opportunities identified during Project field work. Colors represent potential habitat goals of restoration projects if implemented.




Priority Restoration Opportunities Within CCRMP
CCRMP Boundary
County Parcels
Restoration Opportunities
Existing site
Grassland
Oak woodland / grassland
Riparian forest
Understory enhancement
Wetland
N
0
0.5
1
2 Miles