Final Report

Habitat Relationships along the Middle Rio Grande in New Mexico for the Endangered Southwestern Willow Flycatcher

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Table of Contents

List of Figures

Habitat Relationships along the Middle Rio Grande in New Mexico for the Endangered Southwestern Willow Flycatcher

Executive Summary

The Southwestern Willow Flycatcher (flycatcher; *Empidonax traillii extimus*) is listed as *Endangered* by the U.S. Fish and Wildlife Service under the authority of the Endangered Species Act (ESA). It is also listed as *Endangered* by the states of New Mexico, Colorado, California, Texas, and Utah and a species of concern in Arizona and a *Critically Imperiled* species in Nevada. It is viewed by many as an important indicator of riparian ecosystem health.

The following report, completed by Tetra Tech under a delivery order from the U.S. Army Corps of Engineers, Albuquerque District, presents the results from an assessment focusing on issues and key habitat relationships for the flycatcher along the Middle Rio Grande (MRG) in New Mexico. It includes an analysis of existing flycatcher habitat along the MRG in terms of plant species composition and structure, patch size, location of existing breeding territories, potential for negative impacts due to groundwater change, fire, tamarisk (or saltcedar; *Tamarix* spp.) biocontrol by Tamarisk Leaf Beetle (TLB; *Diorhabda* spp.) defoliation and movement, other stressors, and connectivity and distance of habitat to surface water. Life history and autecological attributes are summarized, including food habits, feeding habitat, breeding chronology, nesting habitat, relationships of nest sites to surface water, and projections of overbanking producing floodplain inundation in relation to nest sites. Summaries of ESA regulatory requirements for the species' listing, Recovery Plan, Critical Habitat Designation, and historical provisions of the 2003Biological Opinion for water operations along the MRG are also provided.

Tetra Tech targeted potential defoliation of tamarisk by the TLB as an imminent threat to flycatcher recovery along the MRG. Starting from recent efforts by the Bureau of Reclamation (USBR) to map vegetation and then classify flycatcher habitat suitability along the MRG, Tetra Tech developed a model to identify priority areas dominated by tamarisk where new habitat restoration should predominately focus.

We identified and delimited 103 tamarisk-dominated flycatcher restoration sites totaling 325 acres. The sites extend from near Los Lunas (south of NM Highway 6, approximately rivermile 159) to the full-pool area and delta of Elephant Butte Reservoir (approximately rivermile 40). Many sites include sub-sites (indicated by an alphabetic suffix, e.g., 1a, 1b, 1c) to preserve the original vegetation mapping by USBR and to provide flexibility in restoration planning and implementation. Information for all sites is provided in the report and electronically in a polygon feature class with the additional data amended to the attribute table.

The report includes several recommendations:

1) Ongoing flycatcher and TLB monitoring efforts should be continued in the MRG;

2) The USBR recommendation that habitat suitability mapping should be repeated at 3-5 year intervals should be followed;
3) Additional monitoring is required both regionally and along the MRG to assess the rate of spread and defoliation caused by TLB;
4) In order to assess the efficacy of resprout control, TLB monitoring should not stop upon widespread or locally significant defoliation;
5) Future flycatcher restoration efforts should be geographically dispersed to ensure a more sustainable and resilient population in the MRG Management Unit; and
6) Since the last substantial updates to the MRG FLO-2D model were done in 2006, we strongly recommend updating the floodplain inundation model.

Habitat Relationships along the Middle Rio Grande in New Mexico for the Endangered Southwestern Willow Flycatcher

1. Introduction

The Southwestern Willow Flycatcher (flycatcher or SWFL; *Empidonax traillii extimus*) has been listed as *Endangered* by the US Fish and Wildlife Service (USFWS 1995) under the authority of the Endangered Species Act (ESA). It is also listed as *Endangered* by the states of New Mexico, Colorado, California, Texas, and Utah (NMGF 1996; CPW 2012; CDFG 1991; TWPD 2005; UDWR 1997). The State of Arizona includes the flycatcher on its draft list of *Wildlife of Special Concern* and the State of Nevada lists it as S1B, a subspecies considered to be *Critically Imperiled* that breeds within the state (AGFD 1996; NNHP 2014). The flycatcher is also viewed by many as an important indicator of riparian ecosystem health (e.g., Finch 1999).

The following sections present the results from the second of two Middle Rio Grande (MRG) habitat assessments completed by Tetra Tech under a delivery order from the US Army Corps of Engineers, Albuquerque District (USACE). The previous assessment involved the ecohydrology and related habitat relationships of the endangered Rio Grande silvery minnow (silvery minnow, *Hybognathus amarus*; Tetra Tech 2014) whereas the following focuses on issues and key habitat relationships for the flycatcher. Recovery of these two endangered species is the principal motivation for the habitat restoration efforts along the MRG and central to the charter of the Middle Rio Grande Endangered Species Collaborative Program (Collaborative Program).

1.1. Study Goals and Objectives

The USACE delivery order specified, in part, that Tetra Tech complete an analysis of existing flycatcher habitat (as possible) along the MRG in terms of plant species composition and structure, patch size, location of existing breeding territories, potential for negative impacts due to groundwater change , fire, tamarisk (or saltcedar; *Tamarix* spp.) biocontrol by Tamarisk Leaf Beetle (TLB; *Diorhabda* spp.) defoliation and movement, other stressors, and connectivity and distance of habitat to surface water. Subsequent to the USACE delivery order, the Bureau of Reclamation (USBR) completed a flycatcher habitat suitability assessment, which includes updated vegetation mapping along the MRG from the south boundary of Isleta Pueblo to the delta of Elephant Butte Reservoir (USBR 2013b). Our work builds from this study and uses the vegetation mapping as a type of base layer to which Tetra Tech has added other aspects of this project's assessment.

Since USBR (2013b) provides a synthesis of suitable flycatcher habitat in the MRG, we focus the majority of our efforts on the impacts of the TLB. It is our intent to aid the USACE and Collaborative Program in identifying and prioritizing at-risk flycatcher habitat and thus areas of potential restoration needs. Where possible, we also characterize other factors that may influence flycatcher habitat. The restoration sites we provide should be viewed as a first approximation of at-risk areas; in short, it locates the intersection of flycatcher breeding areas (colonies) with areas of tamarisk dominance or co-dominance that may be subject to defoliation by the TLB. The source data used to derive this relationship is generally current but cannot fully augment field investigations. Nonetheless, it is important to begin the process of planning and restoration now as newly restored habitat will generally take from 3-5 years to develop into viable and productive flycatcher habitat.

1.2. Flycatcher Distribution and Habitat Restoration Needs

The flycatcher is small migrant songbird that winters in Central America and breeds in riparian areas of northern Mexico and the southwestern United States from west Texas to southern California and into southern Nevada, Utah, and Colorado (Fig. 1). Nest sites are predominately in native willow, but are common in stands dominated by non-native tamarisk and/or Russian olive. Cup-shaped nests, variously constructed of leaves, grass, fibers, feathers, and animal hair, are typically placed within a vertical or nearly vertical upward-pronged, multi-twig fork of small-diameter branches (McCabe 1991; also, see photo at right). Such twig structures readily form in most middle-age willows (approximately 3-15 years) however, as these trees mature and grow in height, the prevalence of this twig structure and thus the suitability of these sites for flycatcher nesting typically decline. In contrast, the twig structure of tamarisk changes very little over time, such that the small diameter stems that provide suitable nest locations tend to persist in mature saltcedar (USFWS 2002; Moore and Ahlers 2006).

Example of a typical flycatcher nest. (M. Marcus photo 2014)

Since these and other changes can affect the suitability of breeding habitat, it is important to have new or additional areas available to which flycatchers can readily move (USFWS 2002). Historically in the MRG, channel avulsion during high-flow events would relocate the active channel and promote the establishment of new willow communities (USFWS 2002); however, under contemporary conditions where flows are highly regulated, regeneration of the floodplain seldom occur without implementing some mechanical form of habitat restoration.

Because different geographic areas within the breeding range of the flycatcher call for different management approaches (e.g., potential threats, water resources, jurisdictional authority, etc.) recovery of the flycatcher has been divided into six Recovery Units (USFWS 2002). Recovery Units are then subdivided into Management Units that tend to reflect major drainages (or Cataloging Units) at the forth Hydrologic Unit Code (HUC) level; although some Management Units contain more than one Cataloging Unit or a single Cataloging Unit can be divided into multiple Management Units.

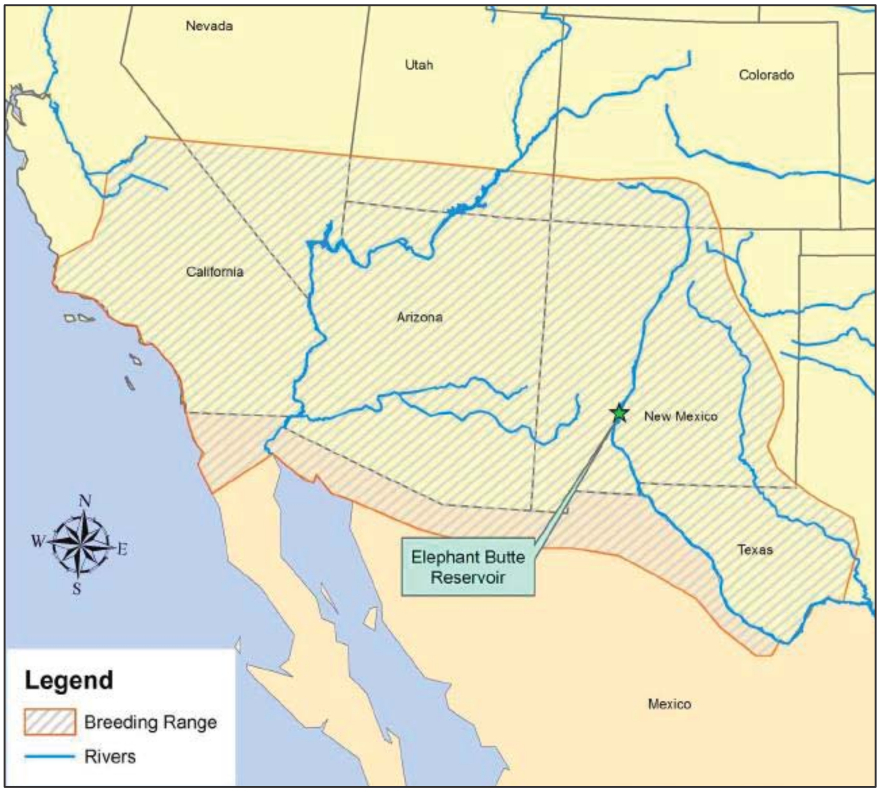


Figure 1. Breeding range of the southwestern willow flycatcher (from Moore and Ahlers 2012).

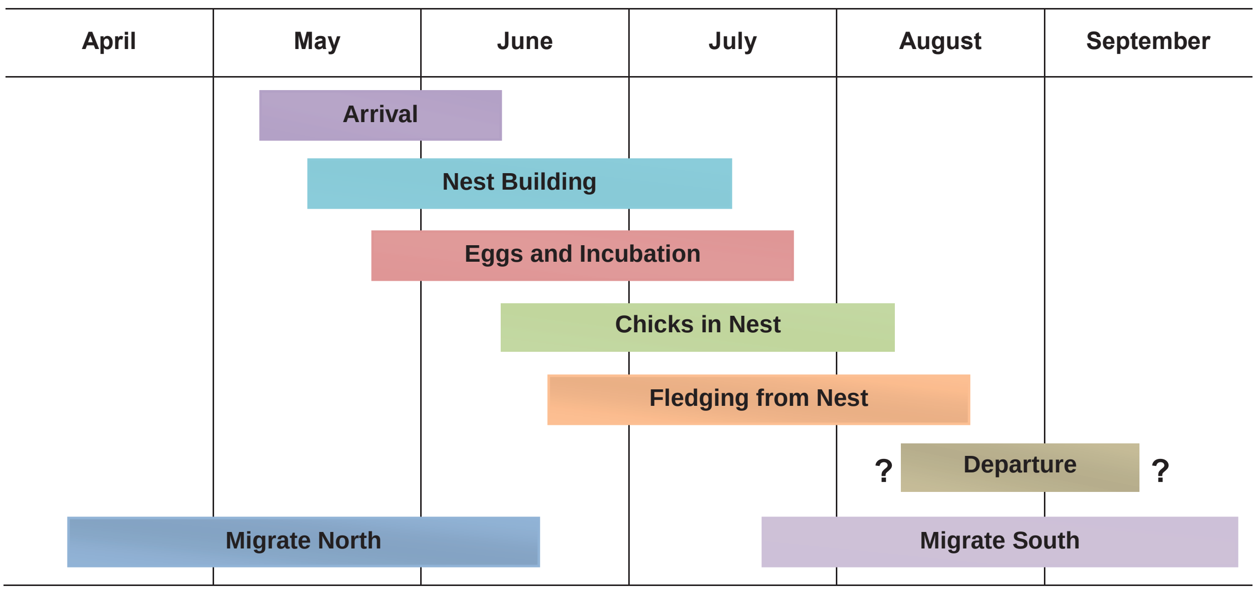
The MRG Management Unit extends from the Interstate 25 Bridge, south of Albuquerque, to Elephant Butte Dam, New Mexico (approximately 146 rivermiles). In 2013, USBR surveyed 227 active nest sites (classified as either "pair" or "pair with nest") in the MRG Management Unit (USBR 2013a) not including tribal lands. Of these nest sites, 182 (80.2%) were located in the southernmost reach (15.1%) of the MRG Management Unit – an area within the full pool extent of Elephant Butte Reservoir that has become vegetated from continuously declining reservoir levels. This reach is a key area in the MRG Management Unit but during our recent visit to this reach, we noted the habitat to be seriously degraded from stand age/succession and drought-related effects. In addition, the arrival and imminent defoliation of tamarisk by the TLB is an additional component threatening flycatcher habitat in this area. Hence, the viability of this comparatively small area is in question and measures need to be taken to foster additional breeding habitat throughout the MRG Management Unit.

2. Flycatcher Biology and Habitat Relationships

2.1. Overview of Breeding Chronology

The flycatcher is a small passerine (perching bird, order *Passeriformes*) about 15 cm (6 inches) long and has a life span of generally 1 to 3 years, with some individuals living 4 to 7 years (Langridge and Sogge 1997; Paxton et al. 1997; Netter et al. 1998). They winter in Neotropical areas of southern Mexico and Central America and begin to arrive at New Mexico breeding sites in early May (Figure 2).

Individual birds often have strong site fidelity, tending to return to the same breeding area each year but not necessarily to the same nest site or territory (USFWS 2002). Some individuals will move to new breeding areas, even in entirely different watersheds (USFWS 2002). In New Mexico, flycatchers build nests and lay eggs in late May and early June, with young being fledged by early July; however, these characteristics are locally affected by altitude, latitude, and re-nesting attempts. Second broods or nesting attempts can occur into the month of August. The adults and juveniles begin their southern migration in July and August, 3 to 4 weeks after completion of nesting (Figure 2).



Adapted by Tetra Tech (2004) from BOR and USACE, 2003; Sogge, 2000; and USFWS, 2002

Figure 2. Nesting chronology for Southwestern Willow Flycatchers in NM.

2.2. Food Habits and Feeding Habitat

While an understanding of the food habits and prey base of flycatchers is still evolving, flycatcher species catch insects on the wing and glean prey from foliage and the ground (Drost et al. 2001; DeLay et al. 2002). Their food includes ground- and vegetation-dwelling insects, spiders, and flying insects (Beal 1912; McCabe 1991). Dietary data from study sites in New Mexico, Arizona, and California indicate that the most common invertebrates in feces of the flycatcher included bees, wasps, leafhoppers, beetles, lady bugs, dragonflies, and damselflies (Drost et al. 2001; DeLay et al. 2002). In general, these insect groups tend to hover or crawl on vegetation, behaviors that tend to make them relatively easy prey for flycatchers. Of note, the majority of these insects have only terrestrial stages. Typically, only a minor component of the flycatcher diet is composed of invertebrates with obligate aquatic stages, such as dragonflies and damselflies (DeLay et al. 1999, 2002; Drost et al. 2001). Durst et al. (2008) provides additional information on the age, habitat, and yearly variation in the diet of flycatchers.

Flycatchers also occasionally consume small fruits, such as elderberries (*Sambucus canadensis*) or blackberries (*Rubus* spp.) although this is not considered an important food source during the breeding season (McCabe 1991). Drost et al. (2001) suggests that since flycatchers appear to be dietary generalists, they are less likely to encounter food shortages. In contrast, DeLay et al. (2002) concluded that flycatchers are selective and could be susceptible to stochastic or deterministic declines in their insect food base. Also, Durst et al. (2008) reported that a severe drought at their Roosevelt Lake study area in central Arizona resulted in reduced prey base and near total reproductive failure, but they detected no major shift in the composition of adult diet during their study. Owen and Sogge (2002) studied the physiological conditions of the flycatcher in native- and exotic-dominated stands and found that invertebrate communities associated with some tamarisk-dominated and mixed native-tamarisk vegetation communities “may provide better energetic/dietary conditions than native habitat”. Whether these results can be applied to the MRG requires additional investigation. Additional research is needed on how temporal variation in the arthropod prey abundance may affect variation in diet and impact breeding or nestling success.

In addition to established breeding habitat, riparian woodlands along the MRG appear to be important stopover habitats for migrating flycatchers. The most common native vegetation used as stopover habitat by migrating flycatchers is coyote willow (*Salix exigua*). As such, coyote willow habitats should be actively monitored, maintained, preserved, and restored where possible to help protect endangered flycatchers (Yong and Finch 1997).

2.3. Breeding Habitat

2.3.1. General Habitat Associations

The following describes some general habitat characteristics and associations for flycatcher breeding habitat (USFWS 2002):

- Thickets of trees and shrubs used for flycatcher nesting range in height from 6 to 98 feet.
- Nest sites typically have dense foliage from the ground level up to approximately 13 feet above ground, although dense foliage may exist only at the shrub level or as a low dense canopy.
- Nest sites typically have a dense canopy, but nests may be placed in a tree at the edge of a habitat patch, with sparse canopy overhead.
- Flycatchers generally place their nests within small-diameter stems and twigs, typically in upward-pronged, multi-twig cup structures.
- Average patch size used as the breeding territory by a single pair of flycatchers is 2.7 ± 0.2 acre of dense, riparian vegetation.

- Average total vegetation patch size, with one or more breeding flycatchers, averages 21.2 acres, with the majority of sites toward the smaller end – the median patch size is 4.4 acres.
- Mean patch size of breeding sites supporting 10 or more flycatcher territories is 62.2 acres.
- Flycatchers nest in patches as small as 0.25 acre along the Rio Grande and as large as 175 acres in the upper Gila River in New Mexico (Cooper 1997, as cited in USFWS 2002).
- Approximately half of the flycatcher nesting territories documented throughout its range in 2001 consisted of greater than 90 percent native plants (Sogge et al. 2003), with approximately 90 percent of these territories being in habitats of willow (*Salix* spp.), tamarisk, or boxelder (*Acer negundo*) as the dominant tree species.
- Across its breeding range, nesting success rates have been reported to be comparable for flycatchers nesting in either native vegetation or tamarisk-dominated habitats (Sferra et al. 2000).
- Occupied sites usually consist of dense vegetation in the patch interior, or an aggregate of dense patches interspersed with openings, with this dense vegetation occurring most often within the first 10 to 13 feet aboveground.
- In almost all cases, slow-moving or still surface water and/or saturated soil are present at or near breeding sites during wet or non-drought years.

2.3.2. General Characterization of MRG Nesting Habitat

Historical characterizations of flycatcher nesting habitat along the MRG primarily include descriptions of thickets of willows (*Salix* spp.) and seep willow (*Baccharis* spp.) with an overstory of scattered cottonwood (*Populus deltoides* var. *wizlensii*) (Phillips 1948; Unitt 1987). More recent observations of breeding habitat used by flycatchers along the Rio Grande report nests in both native and non-native plant communities. In addition to nesting in both Goodding's and coyote willows, flycatchers along the MRG also build nests in tamarisk and occasionally Russian olive and seep willow (Moore and Ahlers 2003; White 2006).

The USBR's nest monitoring during 2012 found flycatcher nesting more common in native willow dominated habitat (48 percent) relative to exotic dominated (22 percent) or mixed dominance (29 percent) habitats, with dominance defined a 75 percent willow or exotic species (Moore and Ahlers 2012). Moore and Ahlers (2012) continue to suggest that:

> *Drought conditions and senescence of natives, primarily in the Elephant Butte Reservoir delta, are allowing exotic saltcedar to become more of a habitat component and promoting [flycatchers] to occupy lesser quality habitat. This shift may benefit the [flycatcher] in times of drought as saltcedar is more drought tolerant and may provide a refuge until conditions are suitable for native habitat. Conversely, with the potential arrival of the saltcedar leaf beetle (Diorhabda spp.), which had been documented on the Rio Grande within approximately 100 miles both up and downstream of San Marcial, the conversion of habitat to a greater percentage of saltcedar could be a trap once the beetles arrive and defoliate the saltcedar.*

Figure 3 shows the shift of nesting substrate by MRG flycatchers from 1999 to 2012.

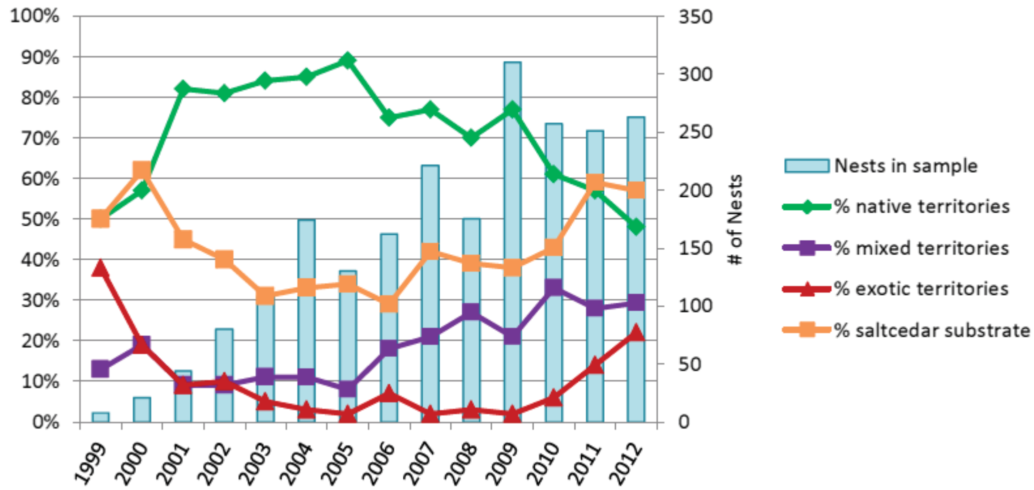


Figure 3. Percentage of flycatcher territories by habitat vegetation dominance (native, exotic, or mixed) of nesting substrate within the MRG, 1999 to 2012 (from Moore and Ahlers 2012).

2.3.3. Relationship of Flycatcher MRG Nesting Habitat to Surface Water

Collaborative Program Sponsored Literature Review – Copeland et al. (2009) prepared a literature review on the water needs of the flycatcher. They screened 92 reports for direct and indirect relationships between hydrology and flycatcher habitat use or demographics. Few of the reports were peer reviewed and the methods differed greatly. For the 78 independent studies, 27 reports described direct hydrographic relationships to flycatchers and 10 reports linked hydrology to flycatcher demographics. Copeland et al. (2009) concluded:

> *To date, there is insufficient information to answer questions on the extent and duration of water availability and how water benefits SWFL reproductive success during the breeding season. ….*
>
> *SWFLs appear to have adapted to some variation in annual water availability. …. Because more studies found a positive relationship between proximity to water and SWFLs at spatial scales larger than nest sites, other factors besides the nest site itself are likely affected by hydrology and affect SWFL fitness (e.g., food availability, foraging efficiency, microclimate, and possibly predator access). ….*
>
> *Winter rainfall and streamflow were the best explanatory variables for annual variation in SWFL nest success, but nest height and predation rates also affected nest success. The highest reproductive rates occurred at intermediate levels of winter precipitation. Both drought years and years with high reservoir levels resulting in inundation of habitat had negative effects on SWFL reproductive success. ….*

> *SWFLs select areas with available water, probably because of its effect on reproductive success, although how water availability affects SWFL fitness is unknown at this time. Too much or too little water has negative effects on habitat selection due to changes in vegetation density and structure, and on reproductive success due to food availability, microclimate, vegetative cover, and predator access. There may be an optimum range of water availability for SWFLs to reproduce successfully. Above this range, inundation or flooding results in removal or degradation of habitat; below this range, drought or low water tables may result in desiccation, tree mortality, and salinization. Within this optimum range (which may differ among sites according to climate, hydrology, and geomorphology), territories may differ in quality. Water availability may be a component of territory quality; but only one study has examined territory quality, focusing on vegetative characteristics and food availability. It is also possible that territories with water availability similar to natural flow regimes of southwestern rivers (i.e., surface water dries out in the season) may be of higher quality and result in higher fitness.*

Isleta Field Study – Flycatchers have been known to nest at the Pueblo of Isleta since 1994, when the first systematic studies of the area were performed (Mund et al. 1994; Smith and Johnson 2007). The Pueblo has maintained a program to increase surface water supplies to traditional flycatcher nesting areas, with the objective of enhancing flycatcher breeding habitat on the Pueblo.

For five years staff from Natural Heritage New Mexico conducted studies that included assessing water requirements for flycatcher habitat and nesting on the Pueblo (Smith and Johnson 2007). Water levels in the traditional nesting area varied widely during their study. For example, in 2003 the entire site and all territories were completely dry. In contrast, the entire area was flooded at the beginning of the 2005 breeding season to a depth of over a meter in some places, and soil in all territories remained saturated throughout the nesting period. In 2004, the nesting season started with several territories being at least partially inundated and most other territories having saturated soil.

The site monitoring found that flycatchers located their nests primarily near the edge of thickets, in plants providing relatively dense cover above the nest. These flycatchers, however, did not show consistent preferences for any specific plant species for use as nest substrate, with nests placed in Russian olive, coyote willow, and tamarisk. Vegetation structure and proximity to water appeared more influential than plant species for locating nests. Additionally, the nests tended to be placed in vegetation that was denser from 0-3 m and 3-6 m above the ground, but not necessarily above 6 m. Smith and Johnson (2007) suggest that it may be important for a nest territory to have an overstory but the overstory may not need to be directly above the nest.

This study suggests that vegetation density at and above unsuccessful nests was not different from that of successful nests. The only discernable difference between successful and unsuccessful nests appeared to be that vegetation directly surrounding unsuccessful nests was less dense at 3-6 m and above 6 m. Further, nests parasitized by brown-headed cowbirds (*Molothrus ater*) had less dense vegetation above and surrounding the nest, with understory density similar for both parasitized and unparasitized nests. The sparse vegetation directly above parasitized nests may have allowed cowbirds to see the nest more readily or observe the visiting adult more easily.

Predation and nest parasitism by cowbirds were highest in the driest year and lowest in the moderately wet year. Nesting success was highest in the moderate year and lowest in the dry year. Flycatchers had greatest nesting success, experienced the least parasitism and least predation in the moderately wet year.

In summary, Smith and Johnson (2007) concluded that the Isleta flycatcher population appeared to prefer two vegetation types: habitats dominated by dense native shrub or by dense exotic shrub. In addition, the Isleta flycatchers showed a preference to nest in close proximity to water.

USBR Monitoring Studies 2004-2012 – The USBR have monitored flycatcher nest sites in the MRG between 2004 and 2012 (Moore and Ahlers 2012). They found that 93 percent of nests (n = 1943) occurred within 100 m (328 feet) of surface water and 86 percent were within 50 m (164 feet) of surface water (Moore and Ahlers 2012). While nesting success was slightly higher for nests closer to water, the difference was not statistically different between the two distance categories. Productivity of successful nests (i.e., number of birds fledged) was greater for those nests within 50 m of water but, again, was not statistically different from nests within 100 m of water. Comprehensive monitoring results for hydrologic conditions immediately under each nest indicated that, for all nests with known outcomes between 2004 and 2012 (n = 1943), 42 percent were in locations that were dry for the entire breeding season, 3 percent were located where it was saturated or flooded and subsequently dry, and 55 percent were where it was saturated all season; of the latter group, 30 percent were flooded all season. Nests that were dry all season were statistically less successful ($p = 0.01$) at fledging offspring than those that were either flooded or saturated all season; nests dry all season were depredated ($p = 0.01$) and parasitized significantly more often ($p < 0.01$) than nests either above flooded areas or saturated soils. In addition, successful nests above dry soil were significantly less productive than those above flooded conditions or saturated soil ($p < 0.01$).

2.4. Population Trends along the MRG

USBR survey data (Moore and Ahlers 2012) also suggest some noteworthy population trends that underscore the current need for habitat restoration. While the reach from the San Marcial Railroad Bridge to Elephant Butte Reservoir has consistently been the most populated in the MRG Management Unit, recent trends indicate a declining number of territories (Figure 4).

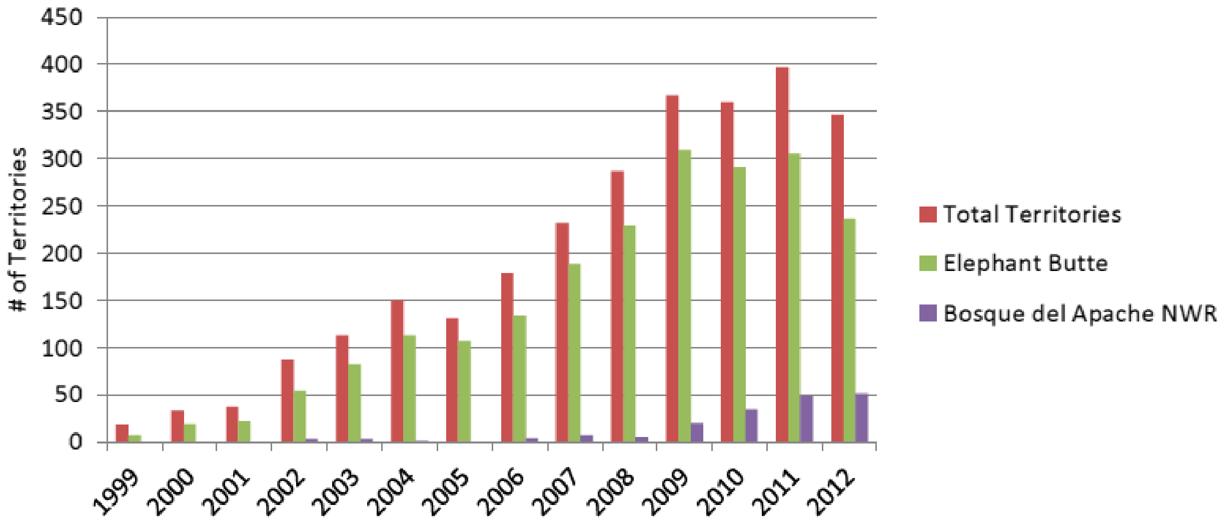


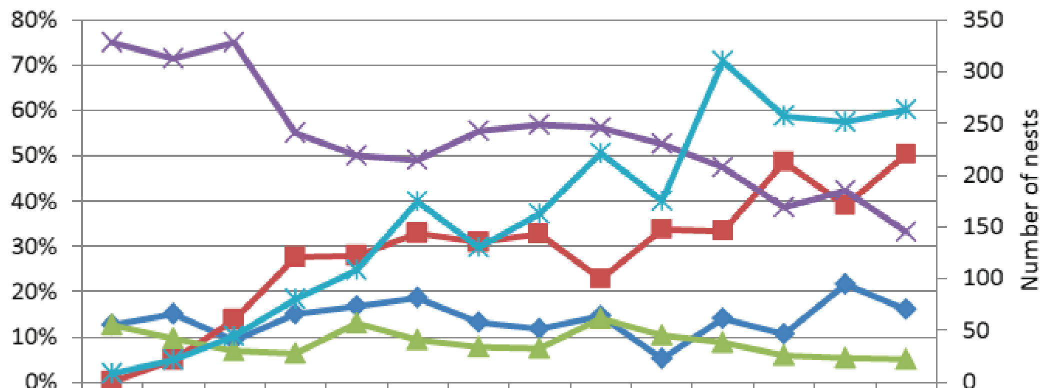
Figure 4. Overview of flycatcher territories within the MRG, 1999 to 2012 (from Moore and Ahlers 2012).

Interestingly, the number of nests within the Bosque del Apache National Wildlife Refuge (BdA NWR) show an increasing trend since 2006. Of greatest concern, however, is the overall decline in the total number of territories. Considering their affinity to nest near water and the increased success rates such sites produce, the recent decreases are likely to be related, at least in part, to the pervasive drought conditions throughout the MRG Management Unit. Further, the decrease of territories in the Elephant Butte area (i.e., the most populous and productive area in the MRG Management Unit) coupled with the increase in territories at BdA NWR suggests that the breeding population is shifting location to some degree and the decadence of the Elephant Butte habitat is beginning to take a toll on metapopulation numbers. A possible reason for this decline may be due to the lack of suitable habitat near the Elephant Butte area to support an immigrating population that retains some degree of site fidelity. Again, a compounding issue is the habitat loss that will likely result from tamarisk defoliation by the TLB. Taken together, and in combination with other stressors, the potential habitat loss represents a significant threat to the future viability of flycatcher habitat in the MRG Management Unit. Without intervention, it is likely that this metapopulation will continue to decline.

2.5. Nest Depredation and Parasitism

An overall decline in nest success has occurred in the MRG, with recent nesting success being less than 50 percent of that found in 2009 (Figure 5). Moore and Ahlers (2012) attributed this decline to the recent increase in depredation rates and they speculate that the cause of this increase may be linked to deteriorating habitat quality observed in both the reservoir full-pool area and BdA NWR. They suggest that the decline in habitat quality is the result of reduced plant vigor caused by prolonged inundation during 2007 and 2010 and the drought of 2011/2012.

Previously, from 1999 to 2004, USBR biologists monitored potential host nests to determine the effectiveness of brown-headed cowbird trapping efforts conducted from 1997 through 2001 to better understand how brood parasitism affected nest productivity of flycatchers in the MRG Management Unit. One of the monitored areas supported year-round grazing and one lacked any livestock grazing. Higher quality habitat appeared to attract greater numbers of nesting flycatcher, which, in turn, appeared to attract greater numbers of cowbirds. While the results suggested that trapping may have reduced brood parasitism, specific conclusions on the effects of decreased cowbird parasitism were confounded by factors such as habitat condition, predation on nestlings, and nest abandonment (Moore and Ahlers 2006). As such, cowbird trapping to reduce nest parasitism was discontinued. Starting in 2002 and continuing through 2012, the practice of adding or removing cowbird eggs from parasitized nests was initiated when necessary and possible; the USBR biologists recommended that this practice should continue whenever doing so would produce minimal disturbance to the nests and adult flycatchers (Moore and Ahlers 2012).



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Parasitism	13%	15%	9%	15%	17%	19%	13%	12%	15%	5%	14%	11%	22%	16%
Depredation	0%	5%	14%	28%	28%	33%	31%	33%	23%	34%	33%	49%	39%	50%
Abandonment	13%	10%	7%	6%	13%	9%	8%	7%	14%	10%	9%	6%	5%	5%
Nest Success	75%	71%	75%	55%	50%	49%	55%	57%	56%	53%	47%	39%	42%	33%
Number of Nests	8	21	44	80	108	174	130	162	221	175	310	257	251	263

Figure 5. Summary of flycatcher nesting observations at USBR monitored sites from 1999 to 2012 (from Moore and Ahlers 2012).

3. Endangered Species Act

3.1. Recovery Criteria

The flycatcher was listed as *endangered* under the ESA (16 U.S.C. 1531 *et seq.*) on February 27, 1995 (60 FR 10694). Since 2003 the numbers of flycatcher territories in the MRG Management Unit have continued to exceed the goal of 100 established in the recovery plan (USFWS 2002) with a maximum of almost 400 in 2011. Again, the majority of past and present breeding activity has occurred in the southernmost portions of the management unit, although recent trends suggest that it may be transitioning northward. By comparison, however, except for Isleta Pueblo, there are relatively few flycatcher territories elsewhere in the MRG Management Unit.

As with all species listed under the ESA, the recovery objectives are to down-list the flycatcher to a *threatened* status and ultimately delist it when warranted. Down listing by the USFWS may be considered when either one of the following criterion are satisfied (USFWS 2002):

A. Increase the total known population to a minimum of 1,950 territories across its southwestern US range (equating to approximately 3,900 individuals), geographically distributed to allow proper functioning as metapopulations, so that the flycatcher is no longer in danger of extinction. For reclassification to threatened status, these prescribed numbers and distributions must be reached as a minimum, and maintained over a five-year period, or

B. Increase the total known population to a minimum of 1,500 territories (equating to approximately 3,000 individuals), geographically distributed among Management Units and Recovery Units, so that the flycatcher is no longer in danger of extinction. For reclassification to threatened status, these prescribed numbers and distributions must be reached as a minimum, and maintained over a three-year period, and the habitats supporting these flycatchers must be protected from threats and loss.

Delisting by the USFWS may be considered if both of the following criteria are satisfied (USFWS 2002):

1. Meet and maintain, at a minimum, the population levels and geographic distribution specified under reclassification to threatened Criterion A; increase the total known population to a minimum of 1,950 territories (equating to approximately 3,900 individuals), geographically distributed to allow proper functioning as metapopulations, as presented in Table 10 in the Recovery Plan; and

2. Provide protection from threats and create/secure sufficient habitat to assure maintenance of these populations and/or habitats over time. The sites containing flycatcher breeding groups, in sufficient number and distribution to warrant downlisting, must be protected into the foreseeable future through development and implementation of conservation management agreements (e.g., public land management planning process for Federal lands, habitat conservation plans (under Section 10 of the ESA), conservation easements, and land acquisition agreements for private lands, and intergovernmental conservation agreements with Tribes). Prior to delisting, the USFWS must confirm that the agreements have been created and executed in such a way as to achieve their role in flycatcher recovery, and individual agreements for all areas within all Management Units (public, private, and Tribal) that are critical to metapopulation stability (including suitable, unoccupied habitat) must have demonstrated their effectiveness for a period of at least 5 years.

3.2. Historical Provisions of the 2003 Biological Opinion

On March 17, 2003 the USFWS issued a Biological and Conference Opinion (hereafter BO) on the *Effects of Actions Associated with the Programmatic Biological Assessment of the Bureau of Reclamation's Water and River Maintenance Operations, Army Corps of Engineers' Flood Control Operations, and Related Non-Federal Actions on the Middle Rio Grande, New Mexico* (USFWS 2003). This BO presented a Reasonable and Prudent Alternative (RPA) with 32 separate elements that the USFWS believed would help to avoid jeopardy to the silvery minnow and flycatcher or adverse modification of their habitat. Under formal Section 7 consultations of the ESA, an RPA is defined as an alternative that:

1. Can be implemented in a manner consistent with the intended purpose of the proposed action,
2. Can be implemented in a manner consistent with the action agency's legal authority and jurisdiction,
3. Are economically and technically feasible, and
4. Would, as the USFWS believes, avoid the likelihood of jeopardizing the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat.

The BO acknowledged that the MRG would likely be under very restrictive water management conditions, which would present significant challenges for both silvery minnow and flycatcher recovery over the 10-year consultation period (ending in 2013). In addition, the BO states that innovative solutions would clearly be needed to meet these challenges and the RPA reflects the difficult conditions. Each element under the RPA thus included the USFWS's rationale for its incorporation in the BO. We present this information as it had guided much of the recovery efforts in the MRG over the last decade. A subsequent BO is pending and will likely contain many similar RPA elements.

The following is a subset of the RPA elements and rationale that have specific or indirect relations to the flycatcher (USFWS 2002). Several of the USFWS rationale statements, presented in the following, are abridged for relevance to the flycatcher only. A number of references to "primary constituent elements" are also made. These refer to the nature of critical habitat designation and the physical or biological attributes that are identified by the USFWS as essential to the species' conservation. Such references in the following relate to the silvery minnow; however, the primary constituent elements that refer to flycatcher critical habitat are discussed later.

Water Operations Elements

Applies in all years

Element B) In coordination with the Service, USBR and the Corps shall release any supplemental water in a manner that will most benefit listed species.

Rationale – The intent of element B is to provide as much habitat as possible for the silvery minnow and flycatcher. Managing available water efficiently is necessary to create habitats that allow these species to persist whenever possible.

Element C) USBR, in coordination with parties to the consultation, shall conduct routine monitoring of river flow conditions when flows are 300 cfs or less at San Acacia, and report information regularly to the Service through the water operations conference calls and meetings.

Rationale – Having current information on the flows will allow parties to the consultation and the Service to react quickly to rapidly changing conditions on the river (such as thunderstorm events) and facilitate better coordination among agencies to prevent unexpected drying, prepare for silvery minnow rescues, and provide water to flycatcher nest sites.

Element D) USBR, in coordination with parties to the consultation, shall ensure that active flycatcher territories supported by pumping from the Low Flow Conveyance Channel (LFCC) are provided with surface water or moist soils in the Rio Grande from June 15 to September 1. If, as a result of the proposed action, active territories are dried along the Rio Grande or irrigation drains, options for providing these territories with surface water or moist soils will be pursued and implemented if at all practicable. We anticipate that implementation of this element would not require ponded surface water throughout the entire nesting season. For example, water could be provided to a site for a few days, the water source cut off, the area allowed to move from standing water to moist soils, and the water source turned back on prior to the site drying. The practicability and methods (releases from drains, pumping, or other means) of providing water to a site will be determined through coordination with the Service.

Rationale – The presence of surface water is considered one of the most important factors in determining suitable flycatcher breeding sites. Providing the necessary water under and around nest sites should encourage flycatchers to continue their breeding attempt. Renesting is known to occur at numerous Middle Rio Grande sites and egg laying can continue during August. For this reason, water in proximity to territories is needed through September 1 of each year.

[1]Dry years and/or when storage restrictions from Article VI and/or VII of the [2]Compact are in effect

Element F) Action agencies, in coordination with parties to the consultation, shall provide year-round continuous river flow from Cochiti Dam to Isleta Diversion Dam with a minimum flow of 100 cfs at the Central Bridge gage.

> *Rationale – … The presence of surface water is considered one of the most important factors in determining suitable flycatcher breeding sites. Providing the necessary moisture under and around nest sites should encourage flycatchers to continue their breeding attempt.*

Element G) USBR shall pump from the LFCC as soon as needed to manage river recession. The pumping capacity must meet or exceed the total capacity of pumps used in the 2002 irrigation season (150 cfs). Pumping shall continue when it will benefit the flycatcher and its habitats. Areas upstream, downstream, and between pumps shall be surveyed prior to intermittency for the presence of breeding flycatchers and pumping continued, if the Service determines it will benefit flycatchers. Coordination with the Service regarding managing river recession and keeping flycatcher areas wet will occur.

> *Rationale – The presence of surface water is considered one of the most important factors in determining suitable flycatcher breeding sites. Providing the necessary moisture under and around nest sites should encourage flycatchers to continue their breeding attempt.*

[3]Average Years

Element H) Action agencies, in coordination with parties to the consultation, shall provide continuous river flow from Cochiti Dam to the southern boundary of silvery minnow critical habitat from November 16 to June 15.

Element I) Action agencies, in coordination with parties to the consultation, shall, from June 16 to July 1 of each year, ramp down the flow to achieve a target flow of 50 cfs over San Acacia Diversion Dam through November 15.

Element J) Action agencies, in coordination with parties to the consultation, shall provide year-round continuous river flow from Cochiti Dam to Isleta Diversion Dam with a target flow of 100 cfs over Isleta Diversion Dam.

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[1] Dry years are defined as the NRCS April 1 streamflow forecast at the Otowi Gage is less than 80 percent of average (mean of the 30-yr period of 1971-2000).

[2] Rio Grande Compact; http://www.ose.state.nm.us/isc_rio_grande_compact.html.

[3] Average years are defined as the NRCS April 1 streamflow forecast at the Otowi Gage is 80 to 120 percent of average (mean of the 30-yr period of 1971-2000).

Element K) USBR shall pump from the LFCC if needed to manage river recession and maintain connectivity. The pumping capacity must meet or exceed the total capacity of pumps used in the 2002 irrigation season (150 cfs). Pumping shall continue when it will benefit the flycatcher and its habitats. Areas upstream, downstream, and between pumps shall be surveyed prior to intermittency for the presence of breeding flycatchers and pumping continued, if the Service determines it will benefit flycatchers. Location of pumps and decisions regarding cessation of pumping will be made in coordination with the Service.

> *Rationale – Elements H through K … This water will also provide water adjacent to flycatcher nesting areas, which is an element of their preferred breeding habitat. These flows assist in maintaining and regenerating essential riparian vegetation for flycatcher shelter, feeding, and breeding. …*

[4]Wet Years

Element L) Action agencies, in coordination with parties to the consultation, shall provide continuous river flow from Cochiti Dam to the southern boundary of silvery minnow critical habitat from November 16 to June 15, with a target flow of 100 cfs at the San Marcial Floodway gage.

Element M) Action agencies, in coordination with parties to the consultation, shall, from June 16 to July 1 of each year, ramp down the flow to achieve a target flow of 100 cfs over San Acacia Diversion Dam through November 15.

Element N) Action agencies, in coordination with parties to the consultation, shall provide year-round continuous river flow from Cochiti Dam to Isleta Diversion Dam with a target flow of 150 cfs over Isleta Diversion Dam.

> *Rationale – … (Elements L through N)… Higher flows will provide water adjacent to flycatcher nesting areas, which is an element of their preferred breeding habitat. These flows will also assist in maintaining and regenerating essential riparian vegetation for flycatcher shelter, feeding, and breeding. Although populations of both species may not immediately rebound, if wet years occur, we anticipate that the populations of the silvery minnow and flycatcher would respond positively based on improved habitat conditions and an increase in habitat.*

Element O) USBR shall pump from the LFCC if needed to manage river recession and maintain river connectivity. The pumping capacity must meet or exceed the total capacity of pumps used in the 2002 irrigation season (150 cfs). Pumping shall continue to maintain river connectivity.

> *Rationale – The presence of surface water is considered one of the most important factors in determining suitable flycatcher breeding sites. Pumping will provide*

[4] Wet years are defined as the NRCS April 1 streamflow forecast at the Otowi Gage is 120 percent of average (mean of the 30-yr period of 1971-2000).

continuous flow for a longer period of time leading to greater insect production, increased chick survival, and potentially the opportunity for a second brood. … We would anticipate survival and reproductive success to increase.

Habitat Improvement Elements

Element P) Action agencies, in coordination with parties to the consultation, shall prevent or minimize destruction of potential or suitable flycatcher habitat when installing pumps or groundwater wells and coordinate with the Service prior to their installation if this action may affect flycatcher habitat.

Rationale – Transects through, or openings in, the riparian vegetation of suitable flycatcher habitat can fragment the habitat patch, reducing its attractiveness to newly arriving flycatchers. Fragmentation can also increase the risk of predation and parasitism to nesting flycatchers by increasing access to the nest site. Suitable habitat can be destroyed or compromised by groundwater pumping through reduction in extent or health of riparian vegetation or by reducing production of insects needed by flycatchers for food.

Element S) In consultation with the Service and appropriate Pueblos and in coordination with parties to the consultation, action agencies shall conduct habitat/ecosystem restoration projects in the Middle Rio Grande to increase backwaters and oxbows, widen the river channel, and/or lower river banks to produce shallow water habitats, overbank flooding, and regenerating stands of willows and cottonwood to benefit the silvery minnow, the flycatcher, or their habitats. Projects should be examined for depletions. It is the Service's understanding that the objective of the action agencies and parties to the consultation is to develop projects that are depletion neutral. By 2013, additional restoration totaling 1,600 acres (648 hectares) will be completed in the action area. In the short term (5 years or less), the emphasis for silvery minnow habitat restoration projects shall be placed on river reaches north of the San Acacia Diversion Dam. This restoration will be distributed throughout the action area. Habitat restoration projects fulfilling RPA element J, from the June 29, 2001, biological opinion, shall be completed. The action agencies and parties to the consultation, in coordination with the Service, shall develop time tables and prioritize areas for restoration. Projects should result in the restoration/creation of blocks of habitat 24 hectares (60 acres) or larger. Consultation with the Service for each site will tier to this biological opinion.

Monitoring will be conducted for each project annually for 10 years in order to assess whether created habitats are self-sustaining, successfully regenerating, and are supporting the flycatcher and silvery minnow. Monitoring reports will be provided to the Service by January 31 of each year. Adaptive management principles will be used, if necessary, to obtain successful restoration of silvery minnow and flycatcher habitats. The environmental evaluation process for two projects should begin within 30 days of issuance of this biological opinion and construction should begin no later than twelve months from that date.

Rationale – Creation of riparian habitat will help distribute and stabilize sediment and provide the low velocity, backwater habitats needed by the silvery minnow and flycatcher. Overbank flooding is necessary to sustain the native riparian vegetation and wetlands that the flycatcher requires for shelter, feeding, and breeding. The project size is derived from a flycatcher site on the Middle Rio Grande that has contained several nesting pairs in recent breeding seasons. Element S will help alleviate jeopardy to the continued existence of the species by improving existing habitat and increasing the total amount of habitat for silvery minnows. Low velocity habitat and silt and sand substrates provide food, shelter, and sites for reproduction, and are essential for the survival and reproduction of silvery minnow. This element will help alleviate adverse modification to silvery minnow critical habitat by providing for the necessary habitat components of primary constituent elements 1 and 2.

Element T) When bioengineering (as described in USBR's biological assessment) cannot be used in USBR river maintenance projects, habitat restoration will be implemented to offset adverse environmental impacts resulting from river alteration. Habitat restoration efforts should replace the ecological functions and values of the affected area, both temporally and spatially. A restoration plan, to be approved by the Service, should be produced for each restoration site that includes (but is not limited to): (1) The acreage and ecological value of the habitat to be impacted and restored, (2) measurable success criteria, (3) time frames for achieving project objectives, and (4) a remediation plan should the restoration site not succeed. Habitat restoration will occur within the same or adjoining reach as the river maintenance project, or in tributaries of those reaches, in consultation with the Service.

Rationale – Habitat restoration will help offset the adverse effects to silvery minnow and flycatcher habitat caused by river engineering techniques. Based on the importance of the riverine and riparian habitats along the Rio Grande to the flycatcher and silvery minnow, detailed restoration planning and implementation is necessary for ensuring no net loss of 98 *ecological function and value. This element will help alleviate adverse modification to silvery minnow critical habitat by providing for the necessary habitat components of primary constituent elements 1 and 2.*

Element U) Action agencies, in coordination with parties to the consultation, shall collaborate on the river realignment and proposed relocation of the San Marcial Railroad Bridge project, which is necessary to increase the safe channel capacity within the Middle Rio Grande. Construction for the relocation of the San Marcial Railroad Bridge will be initiated by September 30, 2008.

Element V) Each year that the NRCS April 1 Streamflow Forecast is at or above average at Otowi and flows are legally and physically available, the Corps shall bypass or release floodwater during the spring to provide for overbank flooding. The overbank flooding will be used to create an increased number of backwater habitats for the silvery minnow and flycatcher. The timing, amount, and locations of overbank flooding will be planned each year in conjunction with the Service and may be conducted in coordination with compact deliveries.

Element X) Action agencies, in coordination with parties to the consultation and in consultation with the Service, shall prevent encroachment of tamarisk on the existing channel and destabilize islands, point bars, banks, or sand bars in the Angostura, Isleta, and San Acacia Reaches. The methods used and areas proposed for destabilization should be agreed upon by the Service, USBR, the Corps, and appropriate Pueblos and landowners. This activity should not adversely affect flycatcher habitat. This action should be undertaken where reaches are dry and the Service encourages the action agencies and parties to the consultation to begin this action during the summer of 2003. Projects should be examined for depletions. It is the Service's understanding that the objective of the action agencies and parties to the consultation is to develop projects that are depletion neutral.

Rationale – The purpose of elements U through X is to maintain or improve the quality and quantity of habitat available for the silvery minnow and flycatcher. These elements avoid the destruction or adverse modification of silvery minnow critical habitat by ensuring primary constituent elements are provided or restored. It is expected that by improving the habitat condition that reproduction, recruitment, and survival of the species will increase. This element will help alleviate adverse modification to silvery minnow critical habitat by providing for the necessary habitat components of primary constituent elements 1 and 2.

Reporting Element

Element FF) Action agencies, in coordination with parties to the consultation, shall provide a consolidated report on the status of all RPA elements to the Service by December 31 of each year.

The BO also contains five Reasonable and Prudent Measures (RPM) that the USFWS believes are necessary and appropriate to reduce the impacts of incidental take by direct means or through the adverse modification of habitat. Of the five RPMs, only 3-5 apply to the flycatcher. The three relevant RPMs are as follows:

RPM 3) Action agencies and parties to the consultation shall minimize the take of silvery minnows and flycatcher from a lack of water availability due to the proposed action.

In order to implement RPM 3 action agencies and parties to the consultation shall:

3.1 – Continue to seek and release supplemental water from all available sources. This will minimize take by ensuring that as much habitat as possible is available for the silvery minnow and flycatcher.

3.2 – Develop a plan for acquiring water from willing leasers or sellers to provide supplemental water for the benefit of the species. This will minimize take by ensuring that as much habitat as possible is available for the silvery minnow and flycatcher. This plan should be completed within 18 months from the date of issuance of the biological opinion.

RPM 4) USBR and parties to the consultation shall minimize the loss of flycatcher territories caused by river drying.

In order to implement RPM 4 action agencies and parties to the consultation shall:

4.1 – Purchase pumps and/or equipment that are designated for pumping available surface water into, or adjacent to, established flycatcher territories that are drying (for example territories within Sevilleta National Wildlife Refuge and La Joya State Wildlife Refuge). This pump should be relatively small capacity, easy to install, and not dependent upon installation of check dams or other structures. Pump installation shall be determined on a case-by-case basis, in conjunction with the Service.

5) Action agencies and parties to the consultation shall minimize the reduction of flycatcher reproductive success due to cowbird parasitism.

In order to implement RPM 5 action agencies and parties to the consultation shall:

5.1 – Continue to monitor cowbird parasitism, remove cowbird eggs from parasitized nests, and report results to the Service annually. If parasitism levels above 20 percent are documented in a reach, then action agencies and parties to the consultation will discuss renewing a cowbird trapping program in that reach with the Service.

Lastly, the BO presents 25 Conservation Recommendations (CR). These CRs are designed to minimize or avoid adverse effects to the listed species or their designated critical habitat, help implement recovery plans, or develop useful information for future application. As before, CRs relevant to the flycatcher (14) are as follows:

CR5) Provide for citizen education and outreach regarding prevention of pollution to water resources and the effects that pollution has on river ecosystems.

CR 7) Develop an agricultural forbearance program that could provide additional supplemental water for the conservation of the silvery minnow and flycatcher.

CR 8) Work with the Endangered Species Act Collaborative Program Interim Steering Committee, Natural Resource Conservation Service, and other parties to the consultation to develop a program for conversion of high water-use crops to lower water-use crops, and increases in agricultural efficiencies. The Program shall seek to determine how water savings can be applied to conservation activities (i.e., supplemental water program) being undertaken for the silvery minnow and flycatcher, consistent with State and Federal Law.

CR 10) Continue to work collaboratively to develop and implement a long-term plan to benefit the recovery of the silvery minnow and flycatcher.

CR 11) Survey and monitor all suitable flycatcher habitats throughout the action area annually. Using habitat characteristics agreed to in coordination with the Service, map and monitor all suitable and potential flycatcher habitats within the action area and report findings to the Service annually.

CR 12) Provide funding ($125,000) for research to better understand micro- and macro-habitat characteristics of occupied flycatcher habitat and methods to most successfully restore it in the action area. Plan this research in coordination with the Service. Begin to implement the findings as soon as available in the restoration and adaptive management projects for the flycatcher described in the RPA.

CR 13) Develop a contingency plan in the event of wildfire in flycatcher habitat that would reduce impacts to endangered species.

CR 14) Monitor fluctuations of groundwater in the shallow and deep aquifers to better understand the groundwater/surface water relationship.

CR 15) Implement a strategy to improve water management/efficiency related to the irrigation system (e.g., changing irrigation practices, etc.) in coordination with an interagency advisory group. Determine how water savings can be applied to conservation activities (i.e., supplemental water program) being undertaken for the silvery minnow and flycatcher, consistent with State and Federal Law.

CR16) Encourage adaptive management of flows and conservation of water to benefit listed species.

CR 17) In accordance with State and Federal law, secure storage space and acquire water rights to create a permanent conservation pool to benefit endangered species.

CR 19) The NMDA is currently administering the New Mexico Saltcedar Control Project through local soil & water conservation districts along the Rio Grande. The NMDA should continue this effort. In order to avoid and minimize impact to flycatcher, the NMDA, in conjunction with the parties to this consultation, should: (1) Ensure no active flycatcher territories are treated prior to surveying an area, and (2) seek funding for restoration of suitable (or potential) flycatcher habitat that is removed as a result of the New Mexico Saltcedar Control Project.

CR 21) Within one year of the signature date for this biological opinion, in consultation with the Service, the Bureau should address the flycatcher population within the high water mark of Elephant Butte Reservoir.

CR 24) Develop and implement a plan to limit encroachment of permanent dwellings into the 10,000 cfs floodplain.

3.3. Designated Critical Habitat

Critical habitat was originally designated for the flycatcher on July 22, 1997 along 599 rivermiles in Arizona, California, and New Mexico (USFWS 1997a). A correction notice was then published on August 20, 1997 that served to clarify the lateral extent of the designated critical habitat (USFWS 1997b). In 2001, the 10th Circuit Court of Appeals ruled that the designation included a faulty economic analysis and vacated the designation. Then in 2005, the USFWS re-designated critical habitat totaling 120,824 acres (737 rivermiles) within Arizona, California, Nevada, New Mexico and Utah (USFWS 2005). Due to another lawsuit, the USFWS agreed to revise critical habitat for the flycatcher on July 13, 2010. Meanwhile, the 2005 critical habitat designation remained in place. On August 15, 2011, the USFWS proposed a revision of critical habitat (USFWS 2011) with the public comment period reopening on July 12, 2012 (USFWS 2012). Most recently, on January 3, 2013 the final rule designating revised critical habitat was published becoming effective on February 4, 2013 (USFWS 2013).

The final rule includes approximately 1,227 rivermiles in 24 Management Units. There are 1,975 stream segments, with the lateral extent including the riparian areas contained in the 100-year floodplain or flood-prone areas encompassing an area of approximately 208,973 acres. Critical habitat is located on a combination of Federal, State, tribal, and private lands in selected counties in southern parts of California, Nevada, Utah and Colorado, and across Arizona, New Mexico, and parts of west Texas.

In New Mexico critical habitat is limited to areas within Catron, Grant, Hidalgo, Mora, Rio Arriba, Socorro, Taos, and Valencia Counties. It is designated along 250 rivermiles on a combination of Federal, State, and private lands. The majority of these lands are located within the Rio Grande Recovery Unit, which primarily includes the Rio Grande watershed from its headwaters in southern Colorado downstream to the Pecos River confluence in Texas. It is made up of the San Luis Valley Management Unit in Colorado, and the Upper Rio Grande, Middle Rio Grande, and Lower Rio Grande Management Units in New Mexico.

Within the Upper Rio Grande Management Unit, critical habitat is designated along the Rio Grande, Rio Grande del Rancho, Coyote Creek, and Rio Fernando (see USFWS 2013 for locations and detailed descriptions).

There is no critical habitat designated in the Lower Rio Grande Management Unit due to an ongoing commitment to comprehensively manage flycatcher habitat through the development and protection of habitat and water transaction agreements. In addition, there were no large breeding populations to guide critical habitat designation in this management unit.

The Middle Rio Grande Management Unit included 112.1 miles of the Rio Grande that extends downstream of Isleta Pueblo and the Bernalillo-Valencia County line past the Sevilleta and Bosque del Apache NWRs into the upper part of Elephant Butte Reservoir, ending in Socorro County about 2.0 miles north of the Sierra County line, New Mexico. About 9.0 miles of the upper part of Elephant Butte Reservoir, downstream of the power-line crossing is included within the Critical Habitat designation (Figure 6).

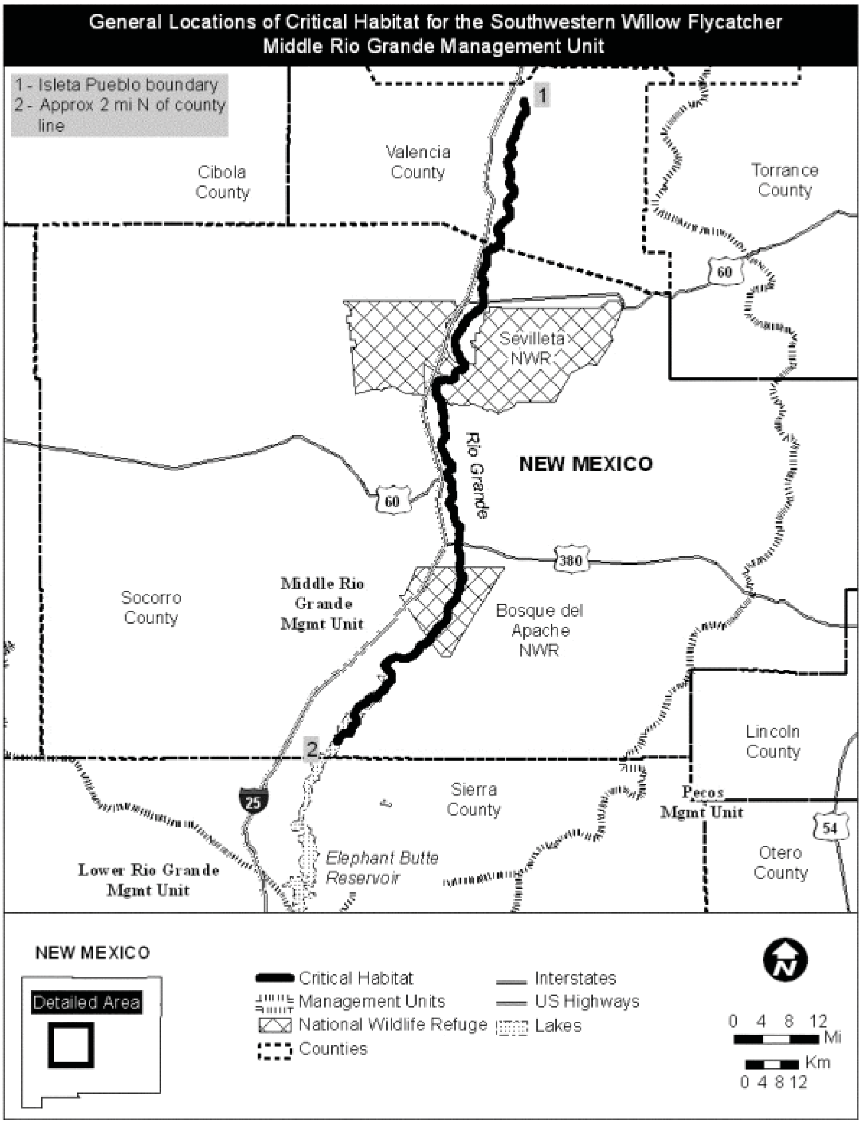

Figure 6. Southwestern willow flycatcher critical habitat designation for the Middle Rio Grande Management Unit (from USFWS 2013).

3.3.1. Primary Constituent Elements

Primary Constituent Elements are those specific attributes of the physical or biological features that provide for a species' life-history processes and are essential to the conservation of the species. The Primary Constituent Elements included in the critical habitat designation for flycatcher are (USFWS 2013):

Primary Constituent Element 1 – Riparian vegetation. Riparian habitat along a dynamic river or lakeside, in a natural or manmade successional environment (for nesting, foraging, migration, dispersal, and shelter) that is comprised of trees and shrubs (that can include Gooddings willow, coyote willow, Geyer's willow, arroyo willow, red willow, yewleaf willow, pacific willow, boxelder, tamarisk, Russian olive, buttonbush, cottonwood, stinging nettle, alder, velvet ash, poison hemlock, blackberry, seep willow, oak, rose, sycamore, false indigo, Pacific poison ivy, grape, Virginia creeper, Siberian elm, and walnut) and some combination of:

(a) Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 2 to 30 m (about 6 to 98 ft). Lower-stature thickets (2 to 4 m or 6 to 13 ft tall) are found at higher elevation riparian forests and tall-stature thickets are found at middle and lower-elevation riparian forests;

(b) Areas of dense riparian foliage at least from the ground level up to approximately 4 m (13 ft) above ground or dense foliage only at the shrub or tree level as a low, dense canopy;

(c) Sites for nesting that contain a dense (about 50 percent to 100 percent) tree or shrub (or both) canopy (the amount of cover provided by tree and shrub branches measured from the ground);

(d) Dense patches of riparian forests that are interspersed with small openings of open water or marsh or areas with shorter and sparser vegetation that creates a variety of habitat that is not uniformly dense. Patch size may be as small as 0.1 ha (0.25 ac) or as large as 70 ha (175 ac).

Primary Constituent Element 2 – Insect prey populations. A variety of insect prey populations found within or adjacent to riparian floodplains or moist environments, which can include: flying ants, wasps, and bees (*Hymenoptera*); dragonflies (*Odonata*); flies (*Diptera*); true bugs (*Hemiptera*); beetles (*Coleoptera*); butterflies, moths, and caterpillars (*Lepidoptera*); and spittlebugs (*Homoptera*).

4. Habitat in the Middle Rio Grande

4.1. 2013 USBR Habitat Suitability Model

4.1.1. Background

In December 2013, the USBR released a flycatcher habitat suitability model for the MRG (USBR 2013b). This model included the culmination of a number of previous efforts that effectively began in 1998 (Ahlers and White 2000). Central to these efforts, were a series of vegetation inventories and Geographic Information System (GIS) mapping projects that have been used to track riparian trends and successional patterns. More germane to Tetra Tech's flycatcher suitability model, the latest mapping products were used to identify and characterize both specific habitats and the ranges of suitable habitat types for the flycatcher within the modeled reaches. Overall, it is our intent that the flycatcher habitat suitability model would provide a valuable planning framework for sound resource management decisions for flycatcher habitat restoration planning and prioritization.

The USBR riparian vegetation surveys employed a classification system first developed by the Middle Rio Grande Biological Survey (Hink and Ohmart 1984). In short, the Hink and Ohmart methodology provides a dominance classification system of woody vegetation and structural types with species composition described for both the overstory and understory in a single coded value. Among other descriptors, the Hink and Ohmart system also includes percent cover. Over time, however, certain modifications have been implemented through various MRG assessments to account for additional plant species not encountered in the original surveys as well as to include an expanded set of site-specific attributes that document evidence and patterns of recent inundation (high water marks, sediment deposition, debris, etc.). Unfortunately, the latter has not been recorded in the available GIS products since they were included and documented in the Upper Rio Grande Water Operations Review and Environmental Impact Statement (URGWOPS) mapping efforts in 2002 (USACE et al. 2007). Consulting these past references and datasets, as well as the more recent examples (USBR 2013b; Ahlers et al. 2010) can provide further information and is strongly recommended.

The MRG study area for the 2002 URGWOPS mapping effort extended from the confluence of the Rio Chama to the full pool elevation of Elephant Butte Reservoir (approximately 7.2 rivermiles south of the San Marcial Railroad Bridge). Although USACE et al. (2007) contains modifications to the original Hink and Ohmart (1984) methodology, one purpose was the ability to compare these datasets in a change analysis as well as a comprehensive baseline evaluation of water operations alternatives upon riparian resources. Subsequently, in 2005, USBR mapped the area south of the full pool elevation to Monticello Bay using the same methods as USACE et al. (2007) in order to capture the vegetation communities that had developed due to receding storage levels in Elephant Butte Reservoir. In 2008, USBR also mapped the area between US Highway 60 and Elephant Butte Dam and developed an initial flycatcher suitability model for the MRG (Ahlers et al. 2010). Siegle et al. (2013) used the revised version of the initial model and contains the most comprehensive vegetation mapping available. It extends from the south boundary of Isleta Pueblo to Elephant Butte Dam and reflects a more contemporary distribution of flycatchers in the MRG.

4.1.2. Hink and Ohmart Classification and Habitat Modeling

An in-depth discussion of the Hink and Ohmart methodology is beyond the scope of our study report, but it is necessary to understand the fundamental aspects as they relate to flycatcher habitat and the suitability model. The modified Hink and Ohmart classification system is essentially a dominance-based hierarchy of woody riparian vegetation. By construction, the Hink and Ohmart schema can be used to describe any size stand (or polygon in a GIS). The minimum mapping unit described in USBR (2013b) was typically one acre. The Hink and Ohmart methodology provides a logical and repeatable framework for the description of both species composition and community type/forest structure within the canopy and understory layers. For each of these layers, the coded values can contain up to four species; to be included, a woody species must comprise a minimum of 25 percent relative cover in either the canopy or understory. Individual species within the canopy or understory are separated with a hyphen (-) and the canopy is separated from the understory by a slash (/). It is also possible to have a canopy with no understory or an understory, per se, with no canopy layer.

Plant species codes used in the modified Hink and Ohmart methodology and the habitat suitability model (USBR 2013b) are as follows:

Code	Common name	Scientific name
ATX	Fourwing saltbush	*Atriplex canescens*
B	Seep willow	*Baccharis salicifolia*
C	Cottonwood	*Populus* spp
CAT	Cattail	*Typha* spp
CR	Creosote	*Larrea tridentata*
CW	Coyote willow	*Salix exigua*
HMS	Honey mesquite	*Prosopis glandulosa*
MB	Mulberry	*Morus* spp
NMO	New Mexico olive	*Forestiera pubescens*
RO	Russian olive	*Elaeagnus angustifolia*
SBM	Screwbean mesquite	*Prosopis pubescens*
SC	Saltcedar	*Tamarix* spp
SE	Siberian elm	*Ulmus pumila*
TH	Tree of heaven	*Ailanthus altissima*
TW	Tree willow	*Salix gooddingii*

Codes used for non-woody vegetation and other cover types included in the Hink and Ohmart system are:

Code	Non-woody vegetation or cover type
MS	Dry meadow (grasses)
MH	Wet meadow/marsh with cattail, sedge, rush or other wetland species
OP	Open area (vegetation < 25% aerial coverage)
OW	Open water
Channel	Rio Grande
LFCC	Low Flow Conveyance Channel
Road	Road
RR	Railroad

Community types/forest structure are represented by an integer value at the end of the code and are described as follows (note a “d” represents an additional *dense* vegetation qualifier):

Type 1 – Tall/mature trees with a well-developed understory;

Tall or mature-aged trees (> 40 ft) with canopy covering ≥ 25% of the stand *and* understory layer (0-15 ft) covering ≥ 25% of the stand.

Type 1d – Type 1 with ≥ 50% total cover of one of the forest layers (canopy or understory).

Type 2 – Tall/mature trees with little or no understory;

Tall or mature-aged trees (> 40 ft) with canopy covering ≥ 25% of the stand *and* understory layer (0-15 ft) covering < 25% of the stand.

Type 2d – Type 2 with ≥ 50% total cover in the canopy layer.

Type 3 – Intermediate sized trees with well-developed understory;

Intermediate-sized trees (15-40 ft) with canopy covering ≥ 25% of the stand *and* understory layer (0-15 ft) covering ≥ 25% of the stand.

Type 3d – Type 3 with ≥ 50% total cover of one of the forest layers (canopy or understory).

Type 4 – Intermediate sized trees with little or no understory;

Intermediate-sized trees (15-40 ft) with canopy covering ≥ 25% of the stand *and* understory layer (0-15 ft) covering < 25% of the stand.

Type 4d – Type 4 with ≥ 50% total cover of the canopy layer.

Type 5 – Shrub-sized stands;

Understory layer (5-15 ft) covering ≥ 25% of the stand with no canopy layer.

Type 5d – Type 5 with > 50% total cover of the understory layer.

Type 6 – Very young and low growth;

Understory layer (0-5 ft) covering ≥ 25% of the stand with no canopy layer.

Examples of the modified Hink and Ohmart alphanumeric classification nomenclature are given as follows:

<u>Canopy and understory layer of ≥ 25% total cover present</u>

Canopy Layer/Understory Layer + Community Type (1 or 3)
Example: C-TW/SC3
Definition – An intermediate sized canopy of Cottonwood and tree willow with a well-developed tamarisk understory.

Canopy layer present with no understory

Canopy Layer + Type (2 or 4)
Example: C2
Definition – A tall/mature cottonwood canopy with little or no understory (community type 2).

No canopy layer present

Shrub or Young Growth Layer + Type (5 or 6)
Example: SC-B5
Definition – No canopy layer (community type 5) with a shrub-sized stand of tamarisk and seep willow.

As a precursor to habitat suitability modeling, a field verified and fully updated version of the MRG vegetation mapping was completed in 2012 (see USBR 2013b for the protocols and final production of these data) and used as the basis for examining the nature and distribution of flycatcher habitat. To identify trends in preferred habitat, over 1,000 flycatcher territories surveyed from 2006-2009 were overlaid with the vegetation mapping GIS. Territories surveyed from 2010-2012 were not used as a measure of habitat suitability as these were cited as being biased toward exotic vegetation classes (USBR 2013b). Further, the 2010-2012 were not used as a measure of habitat suitability in USBR (2013b). The geospatial processing empirically indicated which vegetation classes (i.e., Hink and Ohmart codes) appeared to possess the greatest potential for suitable and moderately suitable habitat. Likewise, the absence of a territory indicated which classes were not suitable habitats. Through known habitat associations and trends revealed in the GIS analysis, stands that were not occupied but met certain habitat criteria were also included in the suitable or moderately suitable categories. Conversely, sites having flycatcher territories were not necessarily included in the suitable categories (suitable or moderately suitable). The principal factors that influenced this were nest site fidelity and nest success; decadent habitat may continue to attract birds due to strong site fidelity and colonial nesting tendencies but nest success and fledging rates are negatively impacted by deteriorating site conditions. Nonetheless, the most suitable habitat was generally deemed to be in areas occupied by flycatchers. In addition, flycatcher habitat located within 50 m (164 ft) of water was used as a final qualifier to indicate the highest quality habitat. Ultimately, there were four categories of habitat derived: suitable, moderately suitable, unsuitable, and non-habitat. Each mapped stand (polygon) was assigned one of the categorical habitat classes.

5. Major Threats to Flycatcher Habitat in the Middle Rio Grande Management Unit

The final listing rule for the flycatcher identified the most significant threats to the species across its range as being the loss, modification, and fragmentation of its habitat as well as brood-parasitism by the brown-headed cowbird (USFWS 1995). In the final designation of flycatcher critical habitat, specific threats from climate change and the tamarisk leaf beetle were added (USFWS 2013). The following sections briefly discuss threats to flycatcher breeding habitat along the MRG.

5.1. Hydrology, Sediment, and Floodplain Connectivity

The alteration of the natural flow regime is regarded by many to be the single greatest and persistent threat to freshwater ecosystems (Sparks 1995; Poff et al. 1997; Lundqvist 1998; Ward et al. 1999; Naiman et al. 2002; Bunn and Arthington 2002; Carlisle et al. 2010). Dams and surface water diversions can dramatically alter the magnitude, timing, and rate of change of the natural hydrograph thus transforming the structure and function of both aquatic and riparian habitats (Gregory et al. 1991; Molles et al. 1995; Richter et al. 1996; Poff et al. 1997; Molles et al. 1998; Bunn and Arthington 2002; Tockner and Stanford 2002; Poff and Zimmerman 2010).

Another consequence of dams is a sequestration of sediment and thus the abstraction of a key element in normal channel avulsion behavior and dynamics. Along the Rio Grande, the effect of Cochiti Dam has been unmistakable; however, the overall effect of sediment retention does diminish in the downstream direction as tributary inputs and in-channel sources can augment the sediment load to some degree (MEI 2004; MEI 2006). Nonetheless, in the post-Cochiti era, suspended sediment concentrations have declined by about 99 percent at the Below Cochiti Dam gage (USGS 08317400) and by as much as 70 percent at San Marcial, some 165 rivermiles downstream (MEI 2006). It should be noted that 25 rivermiles upstream of Cochiti, sediment concentrations at the Otowi gage (USGS 08313000) have also declined by about 55 percent during the same period, precluding Cochiti Dam as the sole causal explanation of downstream sediment reduction (MEI 2006). Contributing factors likely include watershed improvements, widespread forest fire control, and sediment storage in arroyos that initially incised but then widened enough to allow net sediment deposition to occur (Schumn et al. 1984). Consistently low sediment loads in lotic, sand-bed systems will tend to result in varying degrees of channel incision.

A common and predictable outcome of flow regulation and sediment controls in naturally avulsive systems is the effective isolation of the downstream floodplain and its eventual conversion to a more upland state (Poff et al. 1997; Poff et. al. 2007; Poff and Zimmerman 2010). Stream discharge across virtually all but the lower-flow conditions can be greatly reduced and the vital connection between the river and its floodplain compromised. Organisms that have evolved a life history around this connection often experience substantial population declines or extirpation (Ward and Stanford 1995) and biodiversity inevitably suffers (Poff et al. 1997). The flycatcher ultimately relies on a connected and functioning floodplain for quality breeding habitat, which has suffered greatly in the MRG from both flow regulation and sediment control.

5.1.1. 2006 FLO-2D Model

To illustrate the widespread disconnection of the MRG floodplain, we briefly examine some of the results obtained by the 2006 FLO-2D hydrodynamic model (FLO-2D 2006). First, some background on the model itself is necessary.

FLO-2D is a dynamic flood routing model that simulates channel and unconfined overland flows. It models a given stream discharge over a complex topography and substrate roughness through the conservation of water volume. The model uses the full dynamic wave momentum equation and a central finite difference routing scheme with eight potential flow directions (orthogonal and diagonal) to predict the progression of a hydrograph over a system of square grid elements. In short, for our purposes here, the model determines the lateral extent of overbank inundation as well as the depth and velocity at each grid element (or cell).

The Rio Grande FLO-2D model (FLO-2D 2006) was originally constructed in 2001 using 500 ft. x 500 ft. (5.74 acres) grid elements and extended from Cochiti Dam to the San Marcial Railroad Bridge. The model used LiDAR and a variety of cross section survey data to determine grid elevations and was calibrated based on surveys during high flows in the Rio Grande in 1998. In 2006, the model was revised to use 250 ft. x 250 ft. (1.43 acre) grid elements making the model output more resolved. This model was again calibrated using 2005 runoff inundation mapping (Horner 2007) and cross section surveys (Tetra Tech 2005). The model was revised in 2010 with LiDAR data (USACE 2010) and 2009 cross section survey data located near RM 83 (cross section data collected for the Rivermile 83 Channel Re-alignment Project; Tetra Tech 2009). The revised model (2010) was used for a series of map books provided to the U.S. Army Corps of Engineers, Albuquerque District, which extends from the Angostura Diversion Dam to the San Marcial Railroad Bridge (Tetra Tech 2012; Tetra Tech 2013a; Tetra Tech 2013b). For the purposes of these map books, flow hydrographs with steady-state flows of 2,000; 3,500; 5,000; 7,000; and 10,000 cfs were chosen by the Collaborative Program Habitat Restoration Workgroup (HRW) to cover the range of flows anticipated in the MRG. 10,000 cfs is the maximum allowable release from Cochiti Dam although 7,000 cfs is the maximum that has been released since 1985 due to concerns about channel capacity and damage to flood control and conveyance infrastructure.

Albuquerque Reach (Angostura Diversion Dam to the north boundary of Isleta Pueblo) – In the Albuquerque reach, floodplain disconnection is almost complete. FLO-2D predicts very limited inundation at 5,000 cfs (10 acres in the oxbow area only). At 7,000 cfs, the area of inundation increases to 679 acres indicating the threshold for meaningful floodplain connection lies somewhere between 5,000 and 7,000 cfs. Again, flows of this magnitude are infrequent in the contemporary system due to channel capacity and infrastructure limitations. It is therefore not surprising that there are no known flycatchers breeding in the Albuquerque Reach since the 2004 surveys began; however, the USACE, USBR, the New Mexico Interstate Stream Commission, Albuquerque Metropolitan Arroyo Flood Control District, the City of Albuquerque, and Isleta Pueblo have constructed a number of habitat restoration projects in this reach in an effort to help address these issues. Completed projects include 119.7 acres of riparian restoration, 2,260 feet of backwater and high-flow side channels, and 11,867 feet of jetty jack removal; an additional 735 acres of various restoration treatments are planned but have not yet been constructed (Tetra Tech

2013). Unfortunately, these projects are not captured by the 2010 FLO-2D model used in this study.

Isleta Reach (south boundary of Isleta Pueblo to the San Acacia Diversion Dam) – The Isleta Reach shows a slight increase in functional floodplain connection. At 3,500 cfs, there is a limited area of inundation of approximately 53 acres, which drastically increases to 2,871 acres at 5,000 cfs. This clearly indicates a threshold between 3,500 and 5,000 cfs. Being further downstream and subject to flow attenuation, this is also a relatively infrequent event but can, at least in part, posit to explain the improved habitat conditions and greater number of flycatchers breeding in this reach (a total 144 territories from 2004-2013).

San Acacia Reach (San Acacia Diversion Dam to the San Marcial Railroad Bridge) – This reach shows the least degree of floodplain disconnection. Considerable inundation occurs at 2,000 cfs (1,664 acres) suggesting a threshold for floodplain connection exists somewhere below this discharge rate. Even with upstream flow attenuation, reaching this discharge level is more frequent. Although, the floodplain in this reach is ostensibly more accessible by lower magnitude flows, the lack of suitable vegetation may explain the similar number of flycatcher territories (169 from 2004-2013) for a reach that inundates more readily than the Isleta Reach. It should be noted that the vast majority of flycatcher territories (795 from 2004-2013) in the MRG Management Unit are located south of this reach in the full pool area and delta of Elephant Butte Reservoir.

5.2. Hydrology, Climate Change, and Groundwater Declines

The flycatcher is considered a riparian obligate species, with nest site selection and productivity closely linked to the occurrence of floodplain inundation or the presence of hydric soils. The prevailing drought conditions in the MRG over the past decade have led to the development of a large breeding population in a fairly restricted area of the Elephant Butte Reservoir delta and full-pool area. This area, however, can be drastically affected by rising or falling lake levels (Moore and Ahlers 2012). For example, two or three consecutive years of above average snowmelt runoff have the potential to raise reservoir levels and inundate willow-dominated breeding habitat. Conversely, regional climate change may pose a similar threat to flycatcher habitat in the delta as reservoir and shallow groundwater levels recede.

Although climate variability is a fundamental characteristic of the MRG, modern General Circulation Models (GCM) show a continued warming trend that is increasingly being forced by greenhouse gasses. The effects of warming will likely lead to a decreased water supply and thus an overall reduction in stream flow. The result is a greater shift toward regional aridity (Bui 2011; Gutzler 2013). Since regional drought conditions are predicted to continue and flycatcher habitat in the delta is likely to experience significant changes in the coming years, flycatcher breeding success and productivity in the MRG Management Unit is uncertain.

The sensitivity of salicaceous and other riparian plant species to relatively minor differences in groundwater elevations are well documented (Scott et al. 1993; Stromberg 1993; Busch and Smith 1995; Scott et al. 1996; Shafroth et al. 1998; Mahoney and Rood 1998; Johnson 2000; Horton and Clark 2001; Amlin and Rood 2002; Bennet and Simon 2004; Lite and Stromberg 2005; Bhattacharjee et al. 2006; Stella 2006). With continually declining storage levels in Elephant Butte Reservoir, river degradation and groundwater declines are expected to occur in many areas of the MRG important for flycatcher breeding. As a result, detrimental impacts on existing flycatcher habitat in the delta and full-pool area should also be expected. Given that such a high percentage of nest sites in the MRG Management Unit are vulnerable to storage level changes, it would be prudent to implement restoration projects further upstream (including the Isleta and Albuquerque Reaches), where the potential for dramatic changes in shallow groundwater levels are less likely. It should be noted, however, that drought conditions affecting reservoir levels would also affect upstream streamflow and shallow groundwater levels as well (Hurd and Coonrod 2008). Nonetheless, restoration in the upstream reaches is essential to species conservation and recovery as geographic diversity can mediate local extirpation events and adverse habitat changes.

5.3. Wildfire

Wildfire and drought are separate phenomena but interrelated hazards that can significantly affect flycatcher habitat (USFWS 2002; National Wildlife Federation 2008; Finch 2012; USFWS 2013). Dry, hot, and windy conditions can combine to produce vegetation and forest litter highly susceptible to wildfire and extended periods of drought can add to already dangerous seasonal conditions. It is difficult, however, to project how climate change will influence wildfire occurrence, size, and distribution but it is likely that temperature increases will result in higher vapor pressure deficits in summer and thus dryer and more fire-prone conditions throughout the region. In addition, the global Hadley Circulation is projected to move poleward and thus the suppression of winter precipitation will expand into subtropical latitudes (Gutzler 2013). Given the culmination of these and other climate change effects, the National Wildlife Federation (2008) projects that in the western U.S. the total annual burn area will double by late century, with New Mexico among the states projected to have the greatest increase in wildfire impacts.

5.3.1. Wildfire in the Middle Rio Grande

Wildfire data in the MRG is limited. It does not appear that any state or federal agency assumes the comprehensive task of tracking it in the MRG bosque. While other sources may exist, the only geospatial data we were able to obtain was provided by the Middle Rio Grande Conservancy District (MRGCD) and arrived as two discrete data types – a point and polygon shapefile. There is some overlap in the two datasets and one often documents a fire occurrence that the other does not. In addition, the time period the point data covers is from 1990-2003 whereas the polygon data, describing fire perimeters, covers the period of 1996-2011. The polygon dataset spans the Albuquerque reach south to San Acacia whereas the point dataset extends further northward from Santo Domingo Pueblo to roughly San Antonio. When considering both of these datasets, a crude estimate for the total area affected by wildfire since 1990 is between 11,000 and 12,000 acres.

When comparing the fire datasets and the flycatcher survey information (USBR 2013a) there is only one case where a documented fire and nesting location are coincident (although a number are in the general vicinity of each other). Given the uncertainty and possible incomplete nature of the fire data, it is difficult to draw any conclusions about the role wildfire has played on flycatcher habitat quality. While it can be said with some certainty that wildfire does pose a threat to the flycatcher and its habitat, there is no direct evidence that supports widespread habitat alteration by fire in the MRG. If, however, warming trends and drought conditions continue to prevail in the region, the impact of fire will become categorically more important and stand to be a key variable habitat quantity and quality.

5.4. Tamarisk Leaf Beetle

In addition to a broad commitment for flycatcher recovery, a major need in the MRG stems from the TLB and the potential for habitat alteration it represents – in general, it is common for the flycatcher to nest in structurally suitable tamarisk stands (e.g., Moore and Ahlers 2004). The northern TLB has been documented as far south as Lemitar (BEMP 2013) and the subtropical TLB has been detected along the Rio Grande approximately as far north as near Hatch and as far south near Socorro (Tamarisk Coalition 2014). With an expanding population, the TLB will quickly become part of the riparian ecology in the MRG. Since TLB has proved to be highly effective in defoliating and controlling invasive tamarisk in other areas, it is expected to produce, at minimum, short-term loss of productive flycatcher habitat along the MRG. Defoliation by the TLB results in a loss of cover and thus an increase in nest predation as well as a pivotal change in patch-level mesoclimate and nest-site microclimate conditions. Further, the more xeric surroundings fundamentally alter the food web of the flycatcher's breeding habitat. The net result can be a striking decline in reproductive success. For example, Tracy et al. (2014) report a 75 percent reduction in nest success in the first year (2009) of defoliation in St. George, UT. In the second year of defoliation (2010), flycatchers transitioned nest sites to willow dominated stands and nest success more than doubled from the steep decline of the previous year. Such results emphasize the need for habitat mitigation measures in the wake of widespread TLB defoliation. Unfortunately, comprehensive rehabilitation efforts are lacking (Dudley and Bean 2012) and this has generated a fundamental disconnect in the biocontrol of tamarisk and the needs of wildlife that have come to depend on the now common component of southwestern riparian communities. Habitat restoration represents a key bridge for accelerating habitat recovery following the TLB control of tamarisk to the long-term reclamation of important flycatcher breeding areas.

6. Restoration Site Identification in the MRG

6.1. Purpose and Introduction

The purpose of Tetra Tech's modeling effort is to provide an initial planning and restoration framework for flycatcher habitat impacted by the TLB. The approach presented here uses GIS to identify and delimit the spatial intersection of flycatcher breeding sites with areas dominated by tamarisk. Again, this is a first approximation and further on the ground investigations should be used to supplement potential restoration site evaluation. This model merely provides a means to identify at-risk, tamarisk-dominated habitat relative to current and past flycatcher nesting patterns in the MRG. It is expected that restoring such areas will not only mitigate for habitat loss due to the TLB but also serve to improve riparian habitat in general. While the potential restoration sites identified here are the result of a deterministic process, actual implementation at any of the sites is obviously subject to change through field investigations and the application of professional judgment. For example, existing budgets may limit restoration efforts at a 15-acre site to 5 acres with additional work to foster a more favorable hydrology. In any case, there is a considerable degree of flexibility in the restoration methods used at a given site with, potentially, comparable outcomes.

6.2. Datasets

The following describes the datasets that were used or derived in the site identification analysis:

1) ***USBR 2013a*** – Flycatcher survey data, 2004-2013; used only "pair" and "pair with nest" designations of the General_ID field (1,108 total) to limit the areas of interest to that where nesting is verified (pair with nest) or likely (pair). These two designations were treated as equivalent. A copy of USBR 2013a was used to store information on colonies, which in turn was used to examine the spatial distribution (dispersion) of each colony (also described in the Methods section below). Individual colonies were separated by the following rule: a colony was considered separate when the distance between any two nests (pair or pair with nest) was greater than 0.25 miles. This is essentially a colony-based, patch size estimate used to create an initial restoration envelope that reflects the overall spatial distribution of each unique colony. Colonies were separated by reach with code nomenclature = Reach and colony number. For example: SA1 = San Acacia Reach, Colony 1. Colonies are numbered from north to south with the reaches defined as follows:

    a. Isleta Reach (IS) = South boundary of Isleta Pueblo to San Acacia Diversion Dam;

    b. San Acacia Reach (SA) = San Acacia Diversion Dam to San Marcial Railroad Bridge and;

    c. San Marcial Reach (SM) = San Marcial Railroad Bridge to Elephant Butte delta.

2) ***USBR 2013b*** – Southwestern Willow Flycatcher Habitat Suitability Model. Vegetation mapping from this effort is the most recent and comprehensive in the MRG and spans from the south boundary of Isleta Pueblo to the Elephant Butte delta. These data were used to identify areas (mapped polygons) dominated by tamarisk.

3) ***USBR 2012*** – MRG LiDAR used for site-specific estimation of ground elevation values. These include minimum, maximum, average zonal, and average bank elevations. Average bank elevations were only calculated where the site was directly adjacent to the main channel. These values can be used as a rough estimation of existing or potential channel-floodplain connection.

4) ***NMOSE 2014*** **–** groundwater model results. The model output spans the MRG from Cochiti Dam to rivermile 61 (approximately 7.5 rivermiles south of the San Marcial Railroad Bridge) and thus does not cover the southernmost flycatcher breeding areas located in the full pool area and delta of Elephant Butte Reservoir. We must emphasize that these are model results and not measured values. In addition, these data have been used in the Upper Rio Grande Water Operations Model (URGWOM) to derive groundwater functions and previous Rio Grande silvery minnow habitat modeling.

Note: Tetra Tech will not create metadata for any of the above datasets.

6.3. Restoration Site Identification

The approach to site identification is a stepwise process using GIS and the datasets discussed above. All GIS operations were carried out in ESRI® ArcGIS 10.1 (ESRI 2012). The results of the site identification process produced a derived feature class where additional attributes pertaining to the restoration sites are stored. See below for further details on these attributes. The filename for the new feature class is "*draft_SC_SWFL_restoration_sites*" and includes FGDC metadata.

The process and methods for the stepwise site identification are described as follows:

1) In order to capture a colony's unique spatial distribution, or patch size, we employed the Standard Distance tool (Spatial Statistics). The Standard Distance tool is a measure of the degree to which nests are concentrated or dispersed around the geographic mean center. At 3 standard deviations, this covers 98% of the overall spatial distribution of the flycatcher colony. The tool produces a circular polygon which is then refined in the steps that follow.

2) For individual nests, we created a 210-foot radius buffer that produced full-circle polygons of approximately 3.2 acres each, roughly twice that cited in the recovery plan (USFWS 2002) for a single territory (1.5 acres). The reason for oversizing the buffer was to allow for reductions in area in the steps that follow.

3) The standard distance and buffer polygons were then clipped (trimmed) to remove nonsense areas such as the river channel and roads.

4) In the MRG, the highest quality flycatcher habitat is cited to exist within 50 meters of water (USBR 2013b). To keep restoration efforts focused on the most beneficial areas, we next created a 50-meter buffer around all open water sources mapped in USBR (2013b) and used this buffer to clip the standard distance and buffer polygons.

5) The resulting polygons represent flycatcher breeding territories (either single or groups) that reflect nest site fidelity and spatially explicit colonial patterns. Next, we used these polygons to clip the mapping of USBR (2013b) and thus extract the vegetation communities associated with the flycatcher territories.

6) Corrected slight digitizing errors from Step 5 (slivers and gaps) found in USBR (2013b).

7) Using the result of Step 6, we then selected and exported all tamarisk dominated categories (in the Hink and Ohmart nomenclature, tamarisk is denoted as “SC”, meaning saltcedar) as follows:

    a. SC in first or second position of the Hink and Ohmart code in either the canopy, understory, or single-story layers – SC is therefore a minimum of 25% cover and is one of only two dominant species in the stand (see 7b below).

    b. Omit any code where the canopy or understory layer has three or more species recorded. The rationale is that, in such a case, there exists a greater diversity of species to fill in when the TLB defoliates the stand.

8) The size of some polygons were adjusted to incorporate larger areas such that:

    a. Expanded smaller sites (fewer number of nests) to incorporate a larger area that makes a restoration effort more meaningful and cost-effective.

    b. Expanded existing sites with known nesting activity at some point in the past (2004-2013) to enhance habitat within the reach.

9) A centroid was then calculated for each site. A centroid is the geometric center and thus, for an irregularly shaped polygon, can lie outside of its boundaries.

10) For each potential restoration site (n = 103) we calculated the number of territories within each polygon (2004-2013) and the years of nesting activity to facilitate site prioritization.

11) An estimate of average bank and zonal elevation values (min, max, mean) were calculated for each identified site. This is useful for comparison of water surface elevations, adjacent polygons, gross cut-fill estimates, etc. Bank elevations used are estimates for areas of a given polygon that are ***adjacent*** to the 2012 channel (therefore a null value [-9999] can exist

for non-adjacent polygons). Some differences between 2011 orthophotography used in vegetation digitization (USBR 2013b) and the 2012 orthophotography and LiDAR (USBR 2012) were noted. No bankline elevations were calculated for sites along the LFCC and these were given -9999 null values. Because USBR (2013b) suitability polygons can overshoot the actual bank line, measured bank elevations are slightly landward of that boundary.

12) For each of the restoration sites, we calculated spatially averaged (mean) depth to groundwater estimates using NMOSE (2014) at 100; 500; 1,000; 2,000; 3,000; 5,000; 7,000; and 10,000 cfs. Negative values indicate surface water or emergent wetland areas. Areas not covered by the groundwater data (south of the Elephant Butte full-pool boundary) were given null values of -9999.

13) The area and perimeter of each restoration site were then calculated (English and SI units).

14) Updated and validated the attribute table of the *draft_SC_SWFL_restoration_sites* feature class with the above values.

6.3.1. Restoration Site Prioritization

In order to facilitate future planning, a prioritization of the potential restoration sites identified above was derived and included in the attribute table of the *draft_SC_SWFL_restoration_sites* feature class (see below for field names and detailed descriptions). The key drivers in site prioritization were recent breeding activity and a location within the Collaborative Program area (defined from the New Mexico-Colorado border to the power line crossing near the headwaters of Elephant Butte). We also created a lower tier priority for tamarisk-dominated sites within the full-pool and delta of Elephant Butte Reservoir (see Priority 4 below).

The site priority codes are defined as follows (note that all sites described below are tamarisk dominated):

- ***Priority 1*** – Are sites within the Program area that are coincident with 2010-2013 breeding activity (many of these sites have earlier nesting as well). Of course, this interval could be further parsed to subset sites for the most recent breeding activity (e.g., 2012-2013). We selected the 2010-2013 interval because the post 2009 period was cited in USBR (2013b) as being a general transition between native and tamarisk dominated breeding preferences. Presumably, this transition was in response to prevailing drought conditions and the decline of native habitat in the MRG (USBR 2013b). While the difference in the number of sites between the 2010-2013 and 2012-2013 intervals is negligible (17 vs. 15, respectively) the overall area is notably less; the 2010-2013 interval identifies 87.8 acres and the 2012-2013 interval is 69.9 acres, a 20.4 percent overall reduction. From an area perspective, the 2010-2013 interval provides a somewhat larger set of Priority 1 alternatives. Subsets based on number of territories with respect to survey year may be a better parsing approach but such distinctions were not performed in this analysis.

- ***Priority 2*** – Produced 13 sites that are within the Collaborative Program area and are classified as either suitable or moderately suitable habitat by USBR (2013b). Three of the Priority 2 sites have historical breeding activity (17 recorded territories) from 2004-2008. The total area is 24 acres.

- ***Priority 3*** – Are the remainder of all tamarisk-dominated sites identified through the process above within the Collaborative Program area. Here also, of the 17 Priority 3 sties, there are three with historic breeding activity (11 recorded territories) from 2004-2007. The total area is 42 acres.

Owing largely to the site selection process detailed above, Priority sites 1-3 are generally proximal to or at least near each other thus offering diverse opportunities for combining discrete sites to fit specific needs or goals. For example, one could choose to combine a Priority 1 site with an adjacent Priority 2 site, or portions therein, hence increasing the footprint of a given restoration project. The location and extent of Priority 1-3 sites, along with summary tables, are shown in Appendix A.

Again, Priority 4 sites are those within the full-pool footprint or contemporary delta of Elephant Butte Reservoir, which is not within the Collaborative Program area. Given the importance of these areas to the MRG Management Unit however, we provide a similar priority schema to foster restoration in the wake of the TLB should the Collaborative Program, or other entity, wish to undertake such efforts. The prioritization of the Elephant Butte area subsets the Priority 4 sites into three categories and are shown, with summary tables, in Appendix B:

- ***Priority 4(1)*** – Like the Priority 1 sites above, these are where tamarisk-dominated stands are coincident with 2010-2013 territories (242 recorded territories). There are 24 sites totaling 125.7 acres. The notion of further parsing these areas by more recent breeding activity is equally applicable but not practical as all sites herein show episodic breeding activity since the mid-2000s. For example, site 21f contains territories dated from 2005-2007 and 2012-2013. Here also, subsets based on number of territories with respect to survey year are a better parsing approach but such distinctions were not performed in this analysis.

- ***Priority 4(2)*** – This category contains the remainder of sites where historical breeding activity (2004-2009) has occurred. There are only three sites totaling of 8.5 acres.

- ***Priority 4(3)*** – Are the remainder of all tamarisk-dominated sites selected by the process described above yet containing no flycatcher territories. These sites are adjacent or near Priority 4(1) or 4(2) sites. There are 29 sites totaling 37.4 acres.

Again, the process of site selection resulted in the derivation of new feature class. This feature class (filename *draft_SC_SWFL_restoration_sites*) retains the attributes created in USBR (2013b) which should be consulted for details on the original study. Fields added by Tetra Tech that store information on the site selection process are detailed as follows:

- ***SiteID*** – a 5-character, alphanumeric string that contains unique identifiers for each restoration site, which increase from north to south. There are 25 sites in total with many being subdivided into smaller polygons (i.e., 1a, 1b, 1c, etc.). We elected not to merge these individual polygons to preserve the original vegetation codes mapped in USBR (2013b).

- ***Centroid_X and Centroid_Y*** – a double precision, floating-point field that contains the longitude and latitude coordinates of the geographic (geometric) center of a proposed flycatcher restoration site. The centroid of an *n*-dimensional figure is the arithmetic mean of all points in all coordinate (cardinal) directions. Hence, with an irregular polygon (site) the centroid can be a point located outside the polygon itself, which should not necessarily be considered the functional center of the site or polygon. The centroid coordinates are given in decimal degrees (west and north).

- ***NestInside*** – is a long integer field that indicates the total number of territories (points documented as "pair" and "pair with nest" in USBR 2013b) contained within a site (polygon). Values include all survey years from 2004-2013. These should be considered in conjunction with the "YrsNested" field described below.

- ***YrsNested*** – a 20-character string that indicates the years of breeding activity contained in the "NestInside" field described above. Note the syntax where a hyphen indicates a continuous period whereas a semicolon separates discrete nesting years (e.g., 2011-2013 and 2011; 2013, respectively).

- ***MinElev, MaxElev, and AvgZonElev*** – double precision, floating-point fields that provide the minimum, maximum, and mean elevation values within the boundary of a site. Values were obtained with the Zonal Statistics tool in ESRI® ArcGIS 10.1. Source elevation data is USBR 2012; NAVD 88, units = survey feet. Null values (where USBR 2012b data does not cover) are represented by -9999.

- ***AvgBnkElev*** – a double precision, floating-point field that provides an average bank elevation when a site boundary borders the active 2012 channel (USBR 2013b). Values were obtained with the Interpolate Line tool in ESRI® ArcGIS 10.1. Source elevation data is USBR 2012; NAVD 88, units = survey feet. Sites (polygons) that do not border the active channel or where USBR 2012 data is incomplete have null values. Null values are represented by -9999.

DGWxxx – double precision, floating-point fields that provide a series of eight discharge-indexed estimates of a site's depth to groundwater as derived from the New Mexico Interstate Stream Commission's Riparian Groundwater Model (NMOSE 2014). ***These are modeled estimates only and not measured values***. NMOSE (2014) is also used as a parameter dataset in the Upper Rio Grande Water Operations Model (URGWOM). Field abbreviations for the surface water discharge are: 100C = 100 cfs; 500C = 500 cfs; 1K = 1,000 cfs; 2K = 2,000 cfs; 3K = 3,000 cfs; 5K = 5,000 cfs; 7K = 7,000 cfs; and 10K = 10,000 cfs. DGW stands for depth to groundwater.

Each value is an average of all cells in the groundwater model within a given site at the indicated discharge (as above). For example, a record (row value) in the DGW5K field (column) is the average, site-specific depth to groundwater at 5,000 cfs. Cells from the groundwater model were selected as a spatial intersection with a given restoration site's boundary. Groundwater estimates are not area weighted. Negative values indicate emergent surface water (ponded, seeps, etc.) or wetland areas. Because the estimated values of groundwater depth are averaged, there is a natural variation within any given restoration site not captured by the single value reported in this field. NMOSE (2014) extends from Cochiti to approximately rivermile 61 (south of Ft. Craig) and thus does not cover a number of the identified restoration sites within the full-pool and delta of Elephant Butte Reservoir. Hence, null values, outside of the NMOSE (2014) model coverage, are again represented by -9999.

- ***NumGWCells*** **–** is a short integer field that relates the total number of groundwater cells (from NMOSE 2014) contained in each site's query.
- ***SitePrior*** **–** a short integer field that indicates the site (polygon) prioritization code described previously. The value domain is 1-4.
- ***PriorNotes*** **–** a 20-character string that supports the "SitePrior" field by summarizing the parameters that define the site priority values.
- ***P4SubPrior*** **–** a long integer field that provides the restoration subcategories for all Priority 4 sites (those within the full pool or current delta area of Elephant Butte Reservoir). The value domain is 1-3. For example, the field value of a Priority 4 site with 2010-2013 territories located within it would be 1 (see above for additional information on site prioritization definitions and rational). Null values, for sites within the Collaborative Program area, are -9999.
- ***Acres, Hectares, PerimFt, and PerimMeter*** – a set of double precision, floating-point fields that provide area and perimeter in English and SI units, respectively.

7. Results and Discussion: Restoration Site Identification

We identified and delimited 103 tamarisk-dominated flycatcher restoration sites totaling 325.4 acres. The overall extent spans from the Los Lunas area, south of NM Highway 6 (approximately rivermile 159) to the contemporary delta of Elephant Butte Reservoir (approximately rivermile 40). Each site was given a unique identifier that increases from north to south. Many sites are also broken into smaller sub-sites indicated by an alphabetic suffix (1a, 1b, 1c…). This was done to best preserve the original vegetation mapping (USBR 2013b) and provide some degree of flexibility in restoration planning and implementation. In addition, we developed a set of priority classifications intended to aid the Collaborative Program in establishing a future planning and restoration framework. Again, the principal factors guiding the prioritizations were recent breeding activity and being located within the Collaborative Program area. Sites outside of the Collaborative Program area (i.e., within the full-pool or current delta of Elephant Butte Reservoir) were given a lower priority. Nonetheless, the Elephant Butte population is extremely important to the MRG Management Unit, but is subject to future habitat alteration by reservoir operations, changing storage volumes, or channel degradation caused by a continued drought and drawdown of the reservoir. Hence, concerted and costly restoration efforts in this area may be ill advised. In addition, investing in a geographically diverse restoration effort will foster a more stable and resilient population to meet both recovery goals and buffer the effects of future habitat perturbations. For these reasons, we gave a higher priority to areas upstream of Elephant Butte Reservoir. Collaborative Program area sites are presented in Appendix A and the non-Program area (Elephant Butte sites) are presented in Appendix B. Both are rendered by a color scheme that clearly indicates a given site's priority status. Also shown are the centroid coordinates (decimal degrees) and the site's area (acres).

Along with supportive data, all identified restoration sites are stored and provided in an ESRI® personal geodatabase (.mdb) feature class with the additional data described above amended to the attribute table. This is in addition to the original attribute information contained in USBR 2013b, which reports the Hink and Ohmart vegetation codes mapped in 2002, 2008, and 2012 as well as descriptive information on percent cover and other useful stand-level characteristics. The full contents of the personal geodatabase are as follows:

Filename	Geometry	Description
draft_SC_SWFL_restoration_sites	Polygon	All restoration sites identified in this study (103, 325.4 acres)
SWFL_2004-2013_no_migrants	Point	USBR (2013a) flycatcher survey data filtered to exclude all migrants & unpaired males
USBR_polygons_used_50m_buffer	Polygon	USBR (2013b) polygons (classed as water) used to create a 50-meter buffer for site identification

50m_water_buffer	Polygon	The 50-meter buffer polygons created from the above
ISC_DTGW_cells	Polygon	NM Interstate Stream Commission groundwater model cells that intersect with draft restoration sites

The Priority 2 sites and USBR (2013b) also provide a number of additional options for habitat restoration. For example, sites that are tamarisk dominated but not necessarily flycatcher breeding areas and/or suitably classed tamarisk habitat. These are perhaps the most effective use of available resources, beyond addressing the at-risk breeding areas identified in this report (Priority 1 and 4(1) sites). Many, if not all, of the tamarisk dominated habitat will experience negative effects from the TLB at some point in the future, and the impacts to the flycatcher are likely to be substantial (Dudley and Bean 2012; Tracy et al. 2014). Restoration at or near the active breeding areas is therefore important in maintaining a productive breeding population in the MRG Management Unit. Restoration in other areas should not be omitted, however, from near-term consideration as impacts from the TLB poses broader threats to other organisms that have come to use tamarisk habitat. In addition, as opposed to a strictly species-centered approach, a broader methodology that integrates terrestrial and aquatic elements could be used to create restoration projects that benefit both the flycatcher and Rio Grande silvery minnow.

Although Tracy et al. (2014) suggest considerable and precipitous impacts on flycatcher nest success from defoliation, there are many unknowns in TLB autecology and the long-term interactions it has with the flycatcher. One of the more significant gaps is an in-depth understanding of the rate of defoliation with respect to stand size. Given this insight, managers may have a better idea of how long a breeding area might last after TLB arrival and thus a known variable in the planning process (environmental compliance, contracting, construction, etc.). Unfortunately, measures of defoliation rate and patterns of regrowth following initial TLB infestation and dieback have not been standardized and monitoring is effectively limited to presence-absence surveys by a host of different entities.

Again, this study constitutes a first order approximation of at-risk breeding areas. The need for site-specific evaluations including, but not limited to, hydrology and stage-discharge relationships, floodplain connection, vegetation community validation, site access issues, and groundwater dynamics cannot be overstated. Our intent here is to provide a logical set of potential restoration sites such that managers may begin a screening and planning process. It is also hoped that the geospatial approach may provide additional usefulness as a model for restoration site selection in the future.

8. Recommendations for Future Studies

Ongoing flycatcher and TLB monitoring efforts should be continued in the MRG. Undoubtedly, flycatcher monitoring will continue to be conducted by USBR and this is even more important in light of the TLB and future habitat restoration. USBR indicates that their existing habitat suitability mapping will be valid for the next 3-5 years and they recommend this work should be periodically repeated (USBR 2013b). We concur with this recommendation especially with respect to the potential stressors imparted by the TLB and the habitat alteration it represents.

Monitoring of the TLB in the western United States is currently being conducted by a number of public and private entities and should be continued along the MRG whenever possible. There are, however, aspects of TLB monitoring that appear to be neglected. The first has to do with rate of spread and defoliation at both the local and regional scales. The local scale is perhaps the most important in terms of flycatcher habitat in the MRG. While not standardized, a measure of defoliation rate at the stand-level (e.g., Nagler et al. 2014) would give managers a way to estimate a window of time in which to plan and implement restoration projects. In addition, TLB monitoring should not summarily stop upon significant defoliation. Monitoring of tamarisk resprouts should be conducted to determine whether and when TLB recolonization occurs (or if the extant population of beetles remains viable for resprout control). This is important in terms of long-term management of tamarisk as well as tamarisk-dominated flycatcher habitat reestablishing itself and becoming a recurring issue.

Lastly, we would recommend updating the floodplain inundation model(s). The last updates to the MRG FLO-2D model were done in 2006 (with some minor revisions in 2010 in the rivermile 83 area on Bosque del Apache NWR). While the Rio Grande is a highly altered and regulated river system, it is still subject to geomorphic change on relatively short time scales. This affects the river's ability to engage the floodplain; in some areas, the effect can be negative while in others it can be positive. A periodically revised hydraulic model (FLO-2D, SRH-2D, etc.) will identify both positively and negatively affected areas, and where restoration efforts are best suited in terms of floodplain connectivity, prevailing hydrology, and with respect to climate change. This can also help co-locate flycatcher and silvery minnow projects. Continued application of outdated models only adds to uncertainty and may lead to an inefficient use of limited resources.

Geospatial analysis and methods, such as those we have applied here, are an efficient way to identify and delineate potential restoration projects that have multidimensional variables and goals. Such approaches, however, are only as good as the input data and can be at times misleading if not carefully conducted. Nonetheless, we recommend similar methods whenever practicable.

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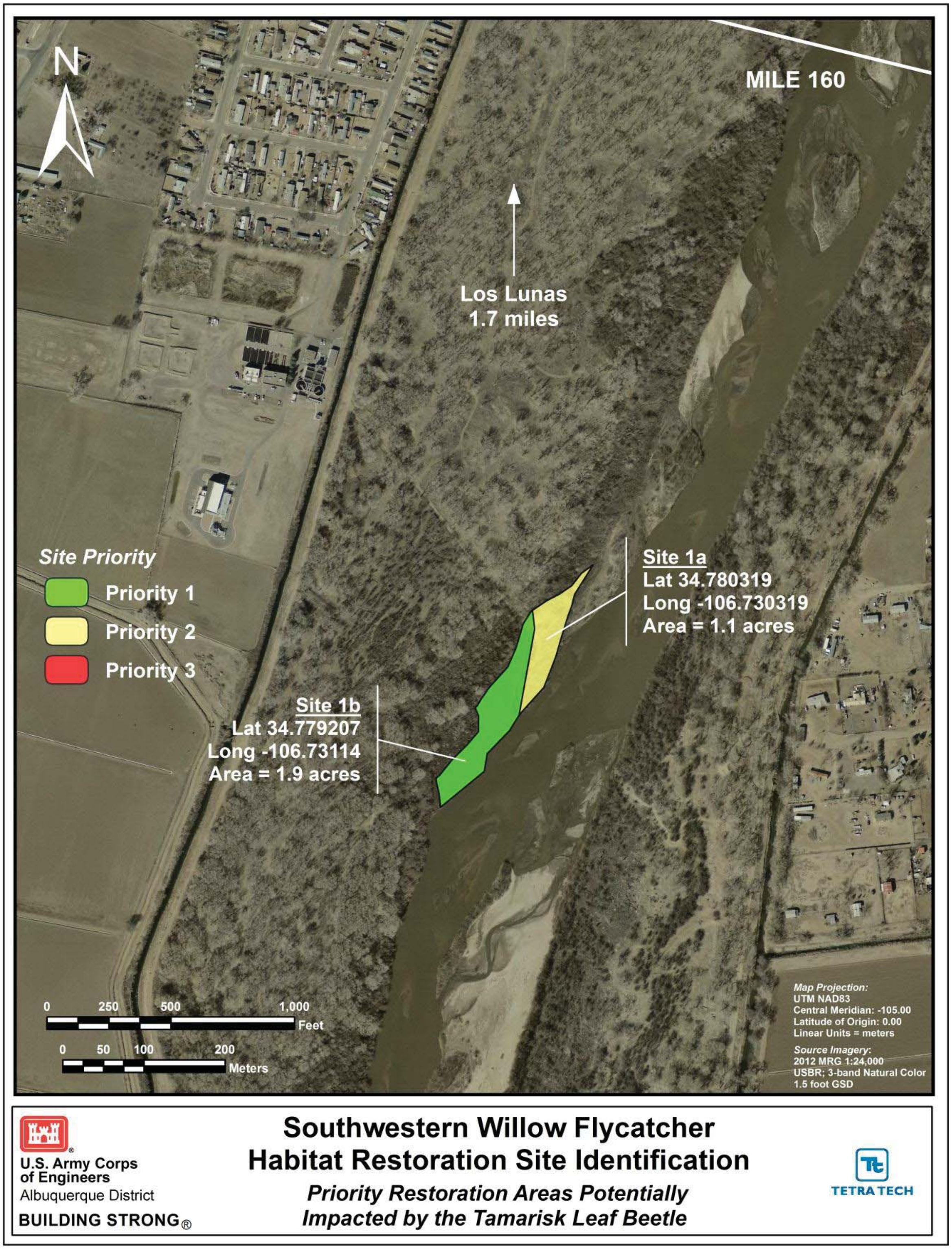
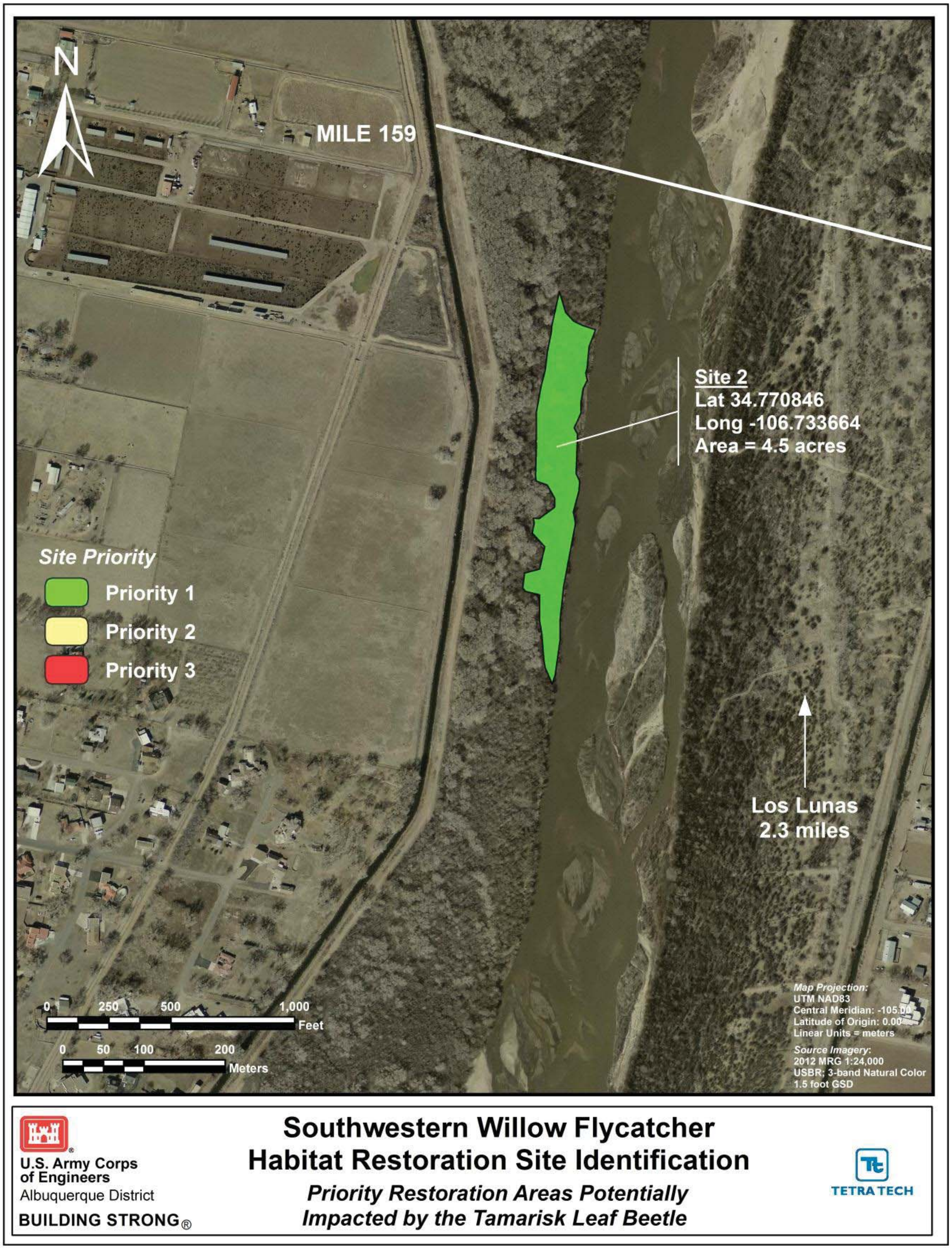
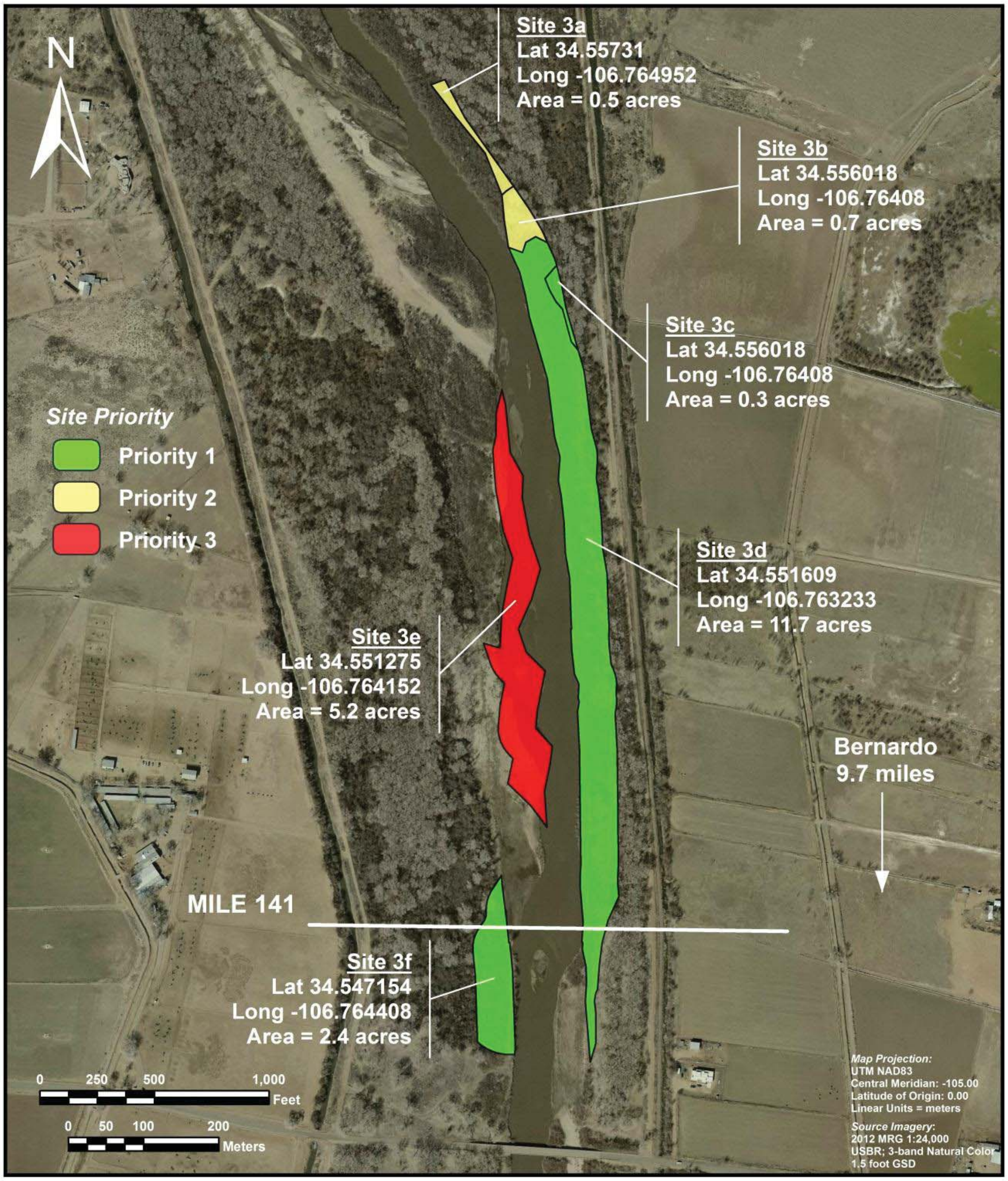
Appendix A

Restoration Sites Located within the Program Area


MILE 160
N
Los Lunas
1.7 miles
Site Priority
Priority 1
Priority 2
Priority 3
Site 1a
Lat 34.780319
Long -106.730319
Area = 1.1 acres
Site 1b
Lat 34.779207
Long -106.73114
Area = 1.9 acres
0 250 500 1,000
Feet
0 50 100 200
Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
U.S. Army Corps of Engineers
Albuquerque District
BUILDING STRONG®
Southwestern Willow Flycatcher
Habitat Restoration Site Identification
Priority Restoration Areas Potentially
Impacted by the Tamarisk Leaf Beetle
TETRA TECH


N
MILE 159
Site 2
Lat 34.770846
Long -106.733664
Area = 4.5 acres
Site Priority
Priority 1
Priority 2
Priority 3
Los Lunas
2.3 miles
0 250 500 1,000
Feet
0 50 100 200
Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
U.S. Army Corps of Engineers
Albuquerque District
BUILDING STRONG®
Southwestern Willow Flycatcher
Habitat Restoration Site Identification
Priority Restoration Areas Potentially
Impacted by the Tamarisk Leaf Beetle
TETRA TECH



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Albuquerque District
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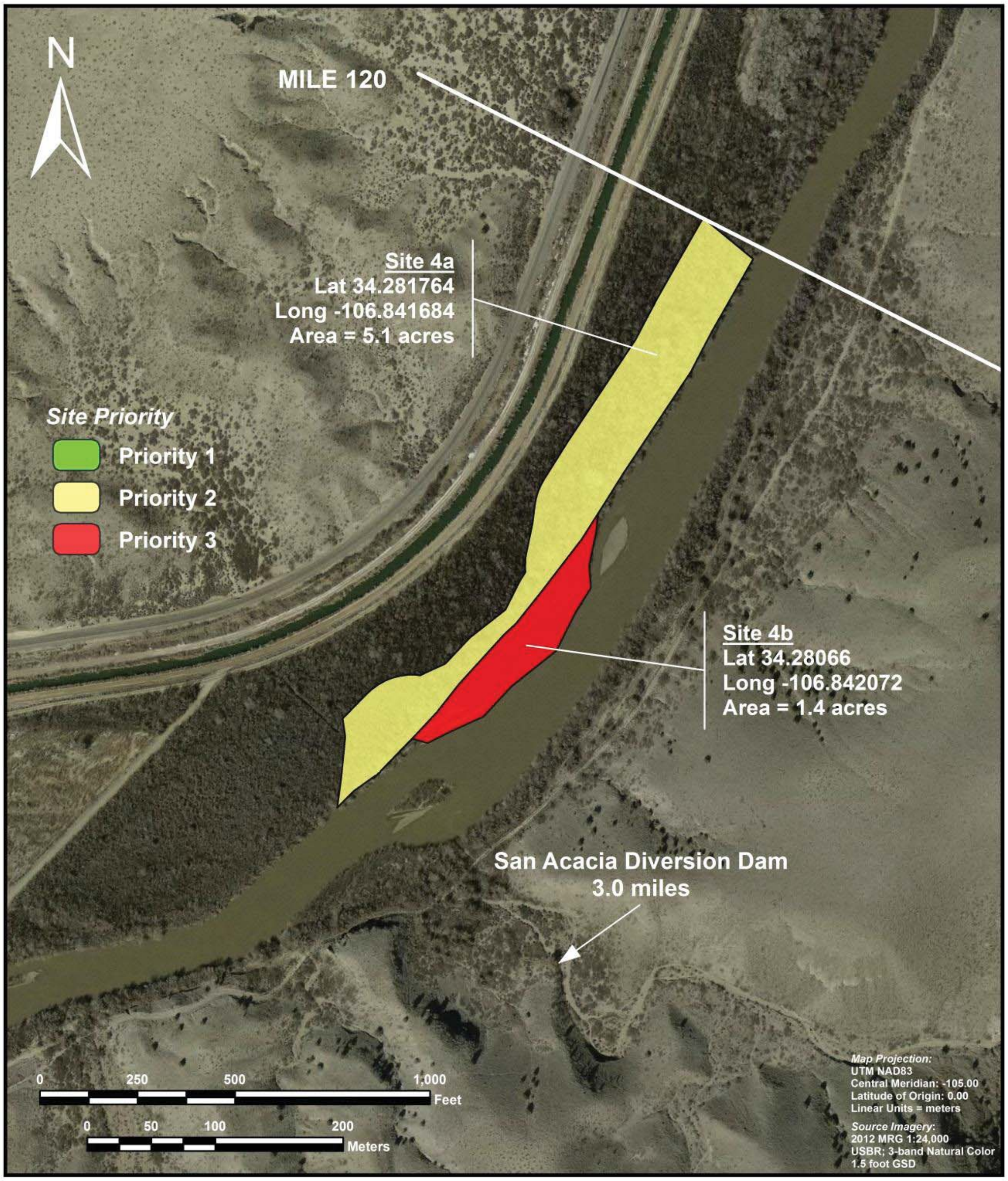
Southwestern Willow Flycatcher
Habitat Restoration Site Identification
Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle

TETRA TECH



U.S. Army Corps of Engineers
Albuquerque District
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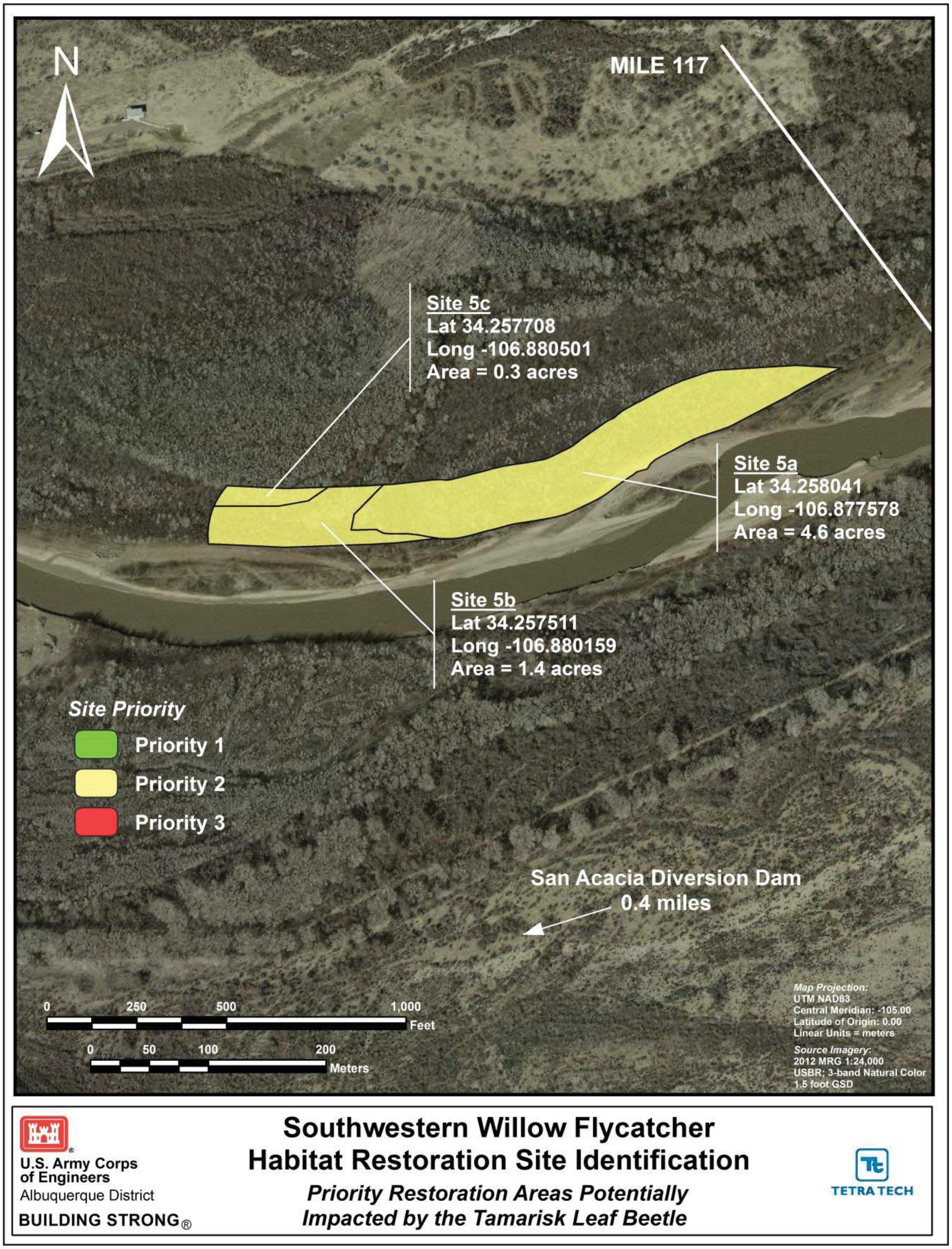
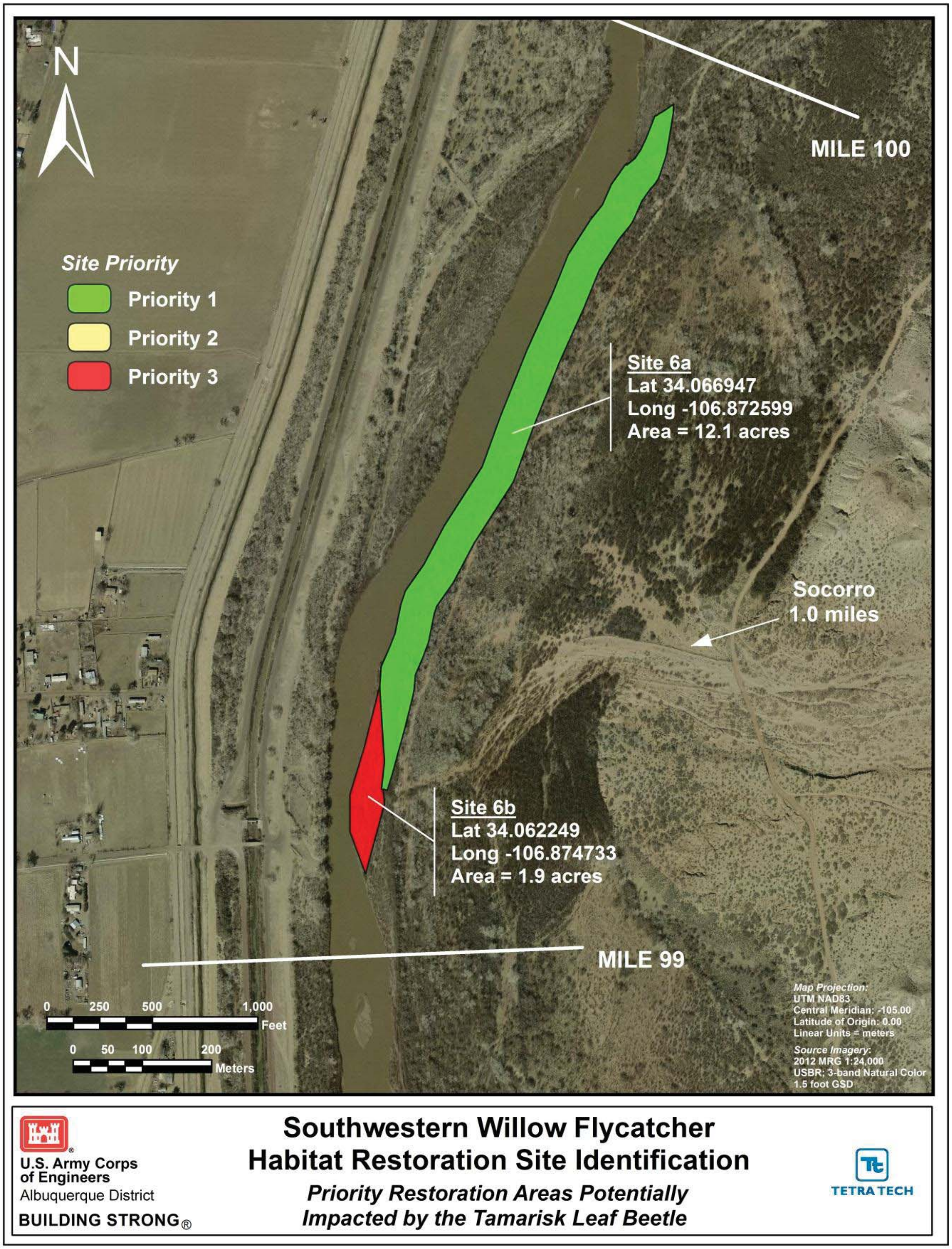
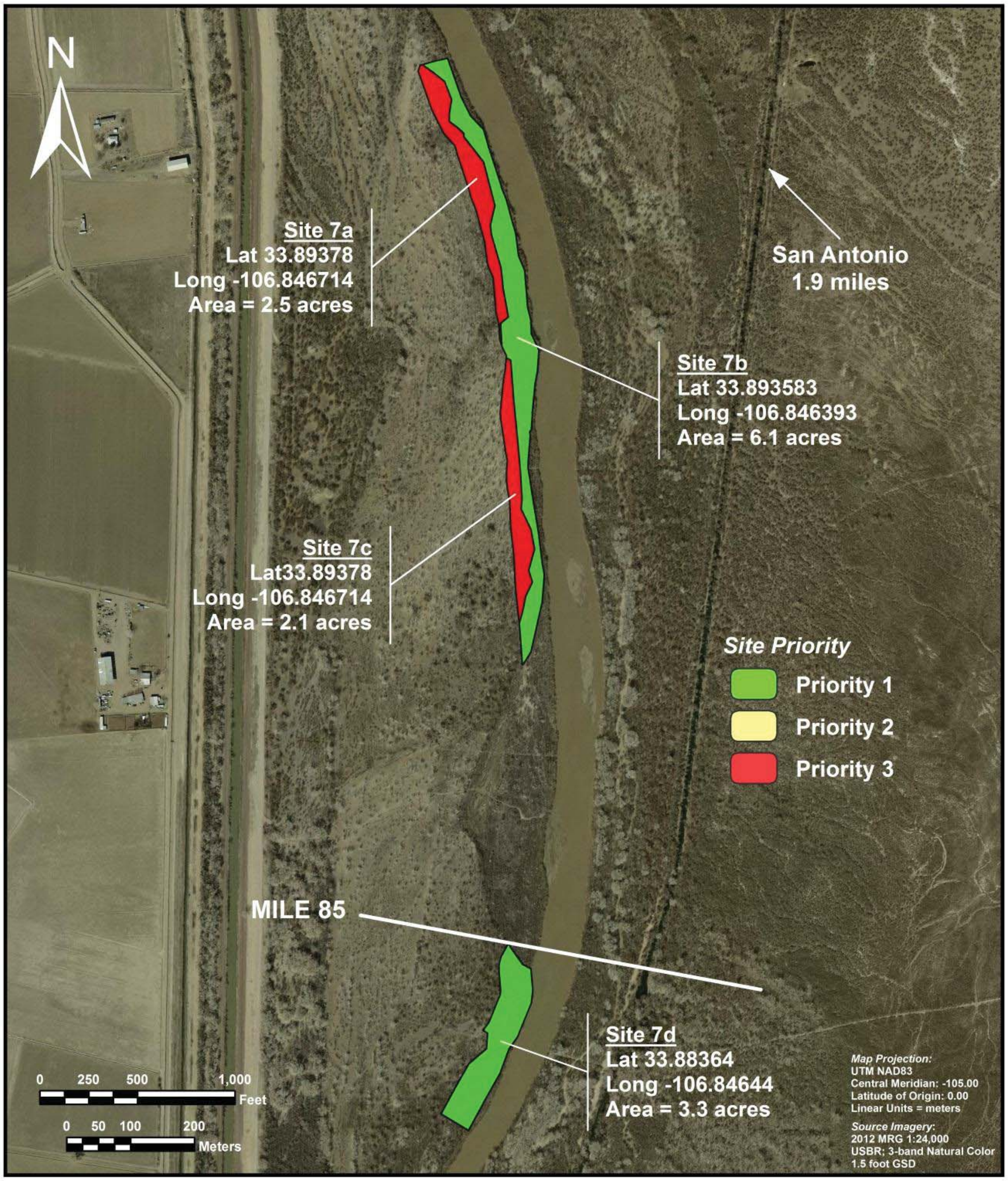
Southwestern Willow Flycatcher
Habitat Restoration Site Identification
Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle

TETRA TECH


N
MILE 117
Site 5c
Lat 34.257708
Long -106.880501
Area = 0.3 acres
Site 5a
Lat 34.258041
Long -106.877578
Area = 4.6 acres
Site 5b
Lat 34.257511
Long -106.880159
Area = 1.4 acres
Site Priority
Priority 1
Priority 2
Priority 3
San Acacia Diversion Dam
0.4 miles
0 250 500 1,000 Feet
0 50 100 200 Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
U.S. Army Corps of Engineers
Albuquerque District
BUILDING STRONG®
Southwestern Willow Flycatcher
Habitat Restoration Site Identification
Priority Restoration Areas Potentially
Impacted by the Tamarisk Leaf Beetle
TETRA TECH


N
Site Priority
Priority 1
Priority 2
Priority 3
MILE 100
Site 6a
Lat 34.066947
Long -106.872599
Area = 12.1 acres
Socorro
1.0 miles
Site 6b
Lat 34.062249
Long -106.874733
Area = 1.9 acres
MILE 99
0 250 500 1,000
Feet
0 50 100 200
Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
U.S. Army Corps of Engineers
Albuquerque District
BUILDING STRONG®
Southwestern Willow Flycatcher
Habitat Restoration Site Identification
Priority Restoration Areas Potentially
Impacted by the Tamarisk Leaf Beetle
TETRA TECH



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Albuquerque District
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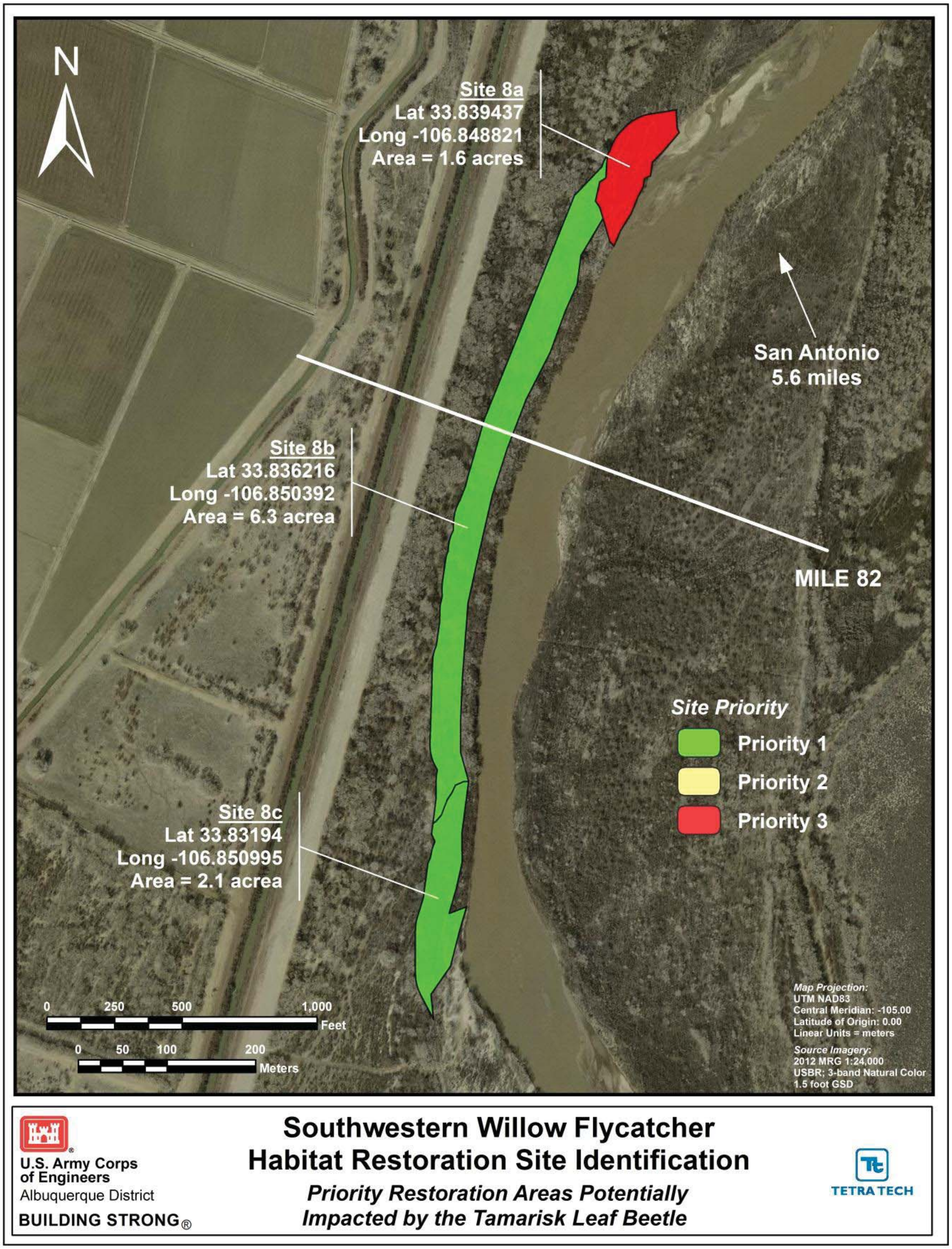
Southwestern Willow Flycatcher Habitat Restoration Site Identification

Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle

TETRA TECH


N
Site 8a
Lat 33.839437
Long -106.848821
Area = 1.6 acres
San Antonio
5.6 miles
Site 8b
Lat 33.836216
Long -106.850392
Area = 6.3 acrea
MILE 82
Site Priority
Priority 1
Priority 2
Priority 3
Site 8c
Lat 33.83194
Long -106.850995
Area = 2.1 acrea
0 250 500 1,000
Feet
0 50 100 200
Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
U.S. Army Corps of Engineers
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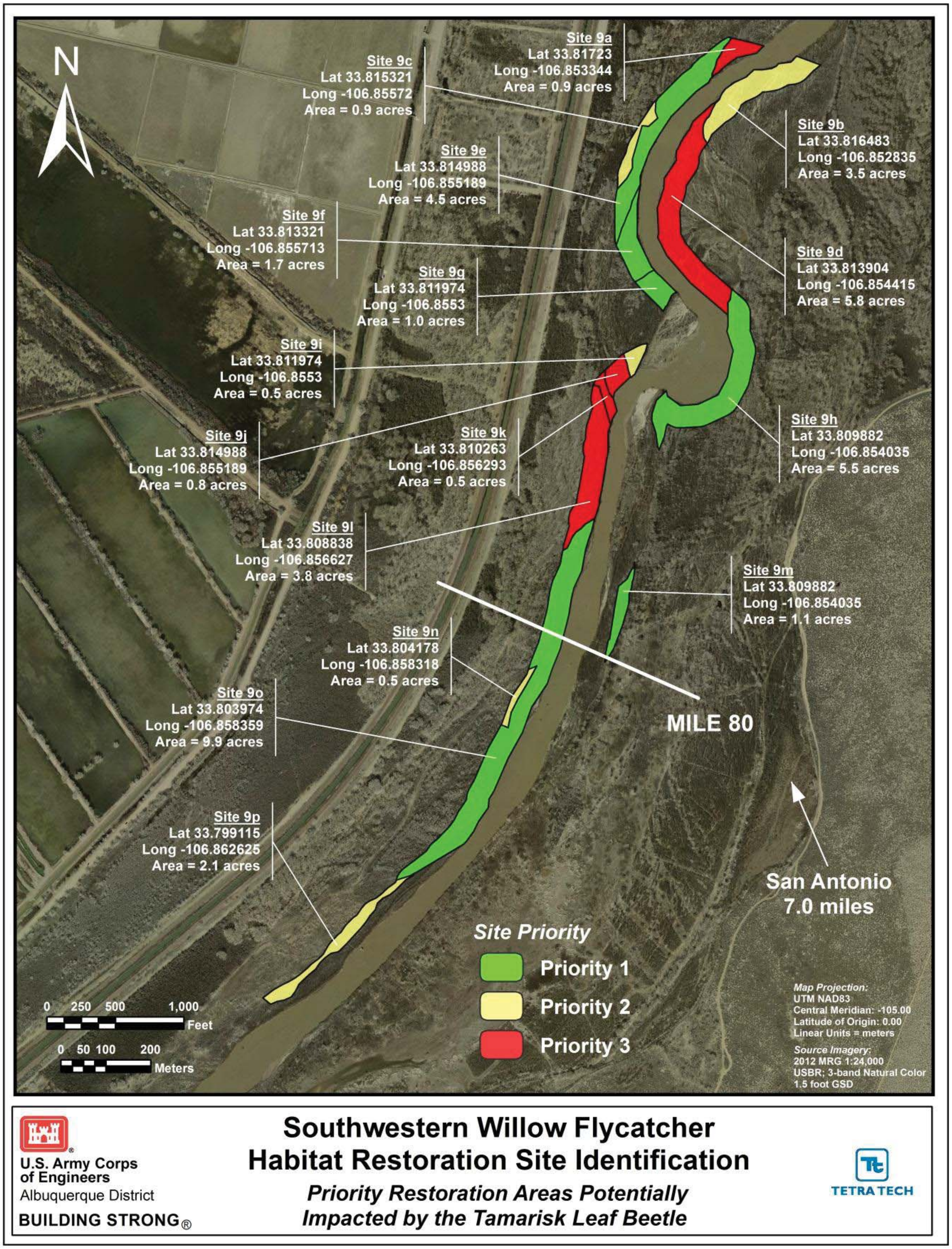
BUILDING STRONG®
Southwestern Willow Flycatcher
Habitat Restoration Site Identification
Priority Restoration Areas Potentially
Impacted by the Tamarisk Leaf Beetle
TETRA TECH


N
Site 9a
Lat 33.81723
Long -106.853344
Area = 0.9 acres
Site 9c
Lat 33.815321
Long -106.85572
Area = 0.9 acres
Site 9b
Lat 33.816483
Long -106.852835
Area = 3.5 acres
Site 9e
Lat 33.814988
Long -106.855189
Area = 4.5 acres
Site 9f
Lat 33.813321
Long -106.855713
Area = 1.7 acres
Site 9d
Lat 33.813904
Long -106.854415
Area = 5.8 acres
Site 9g
Lat 33.811974
Long -106.8553
Area = 1.0 acres
Site 9i
Lat 33.811974
Long -106.8553
Area = 0.5 acres
Site 9h
Lat 33.809882
Long -106.854035
Area = 5.5 acres
Site 9j
Lat 33.814988
Long -106.855189
Area = 0.8 acres
Site 9k
Lat 33.810263
Long -106.856293
Area = 0.5 acres
Site 9l
Lat 33.808838
Long -106.856627
Area = 3.8 acres
Site 9m
Lat 33.809882
Long -106.854035
Area = 1.1 acres
Site 9n
Lat 33.804178
Long -106.858318
Area = 0.5 acres
Site 9o
Lat 33.803974
Long -106.858359
Area = 9.9 acres
MILE 80
Site 9p
Lat 33.799115
Long -106.862625
Area = 2.1 acres
San Antonio
7.0 miles
Site Priority
Priority 1
Priority 2
Priority 3
0 250 500 1,000
Feet
0 50 100 200
Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
U.S. Army Corps
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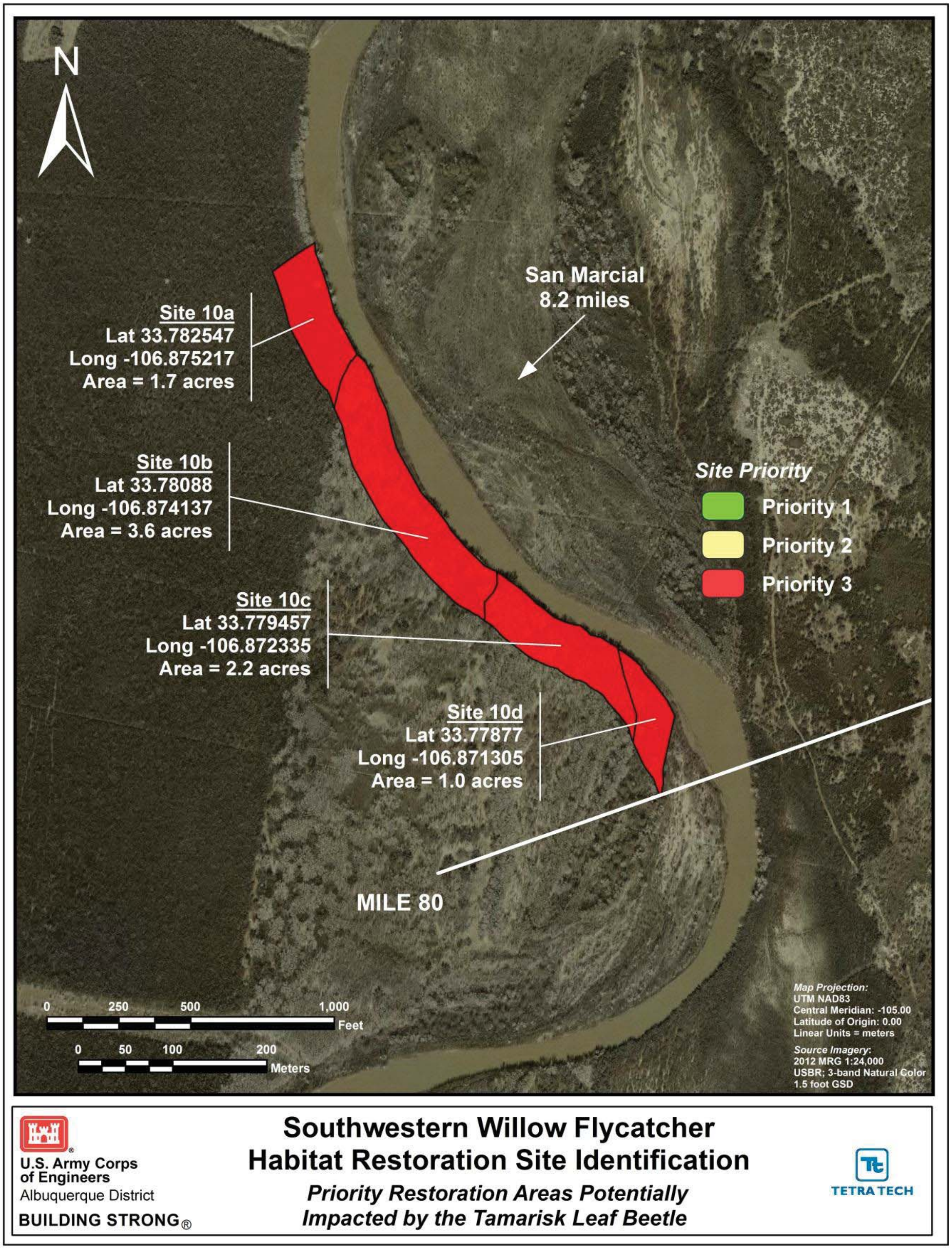
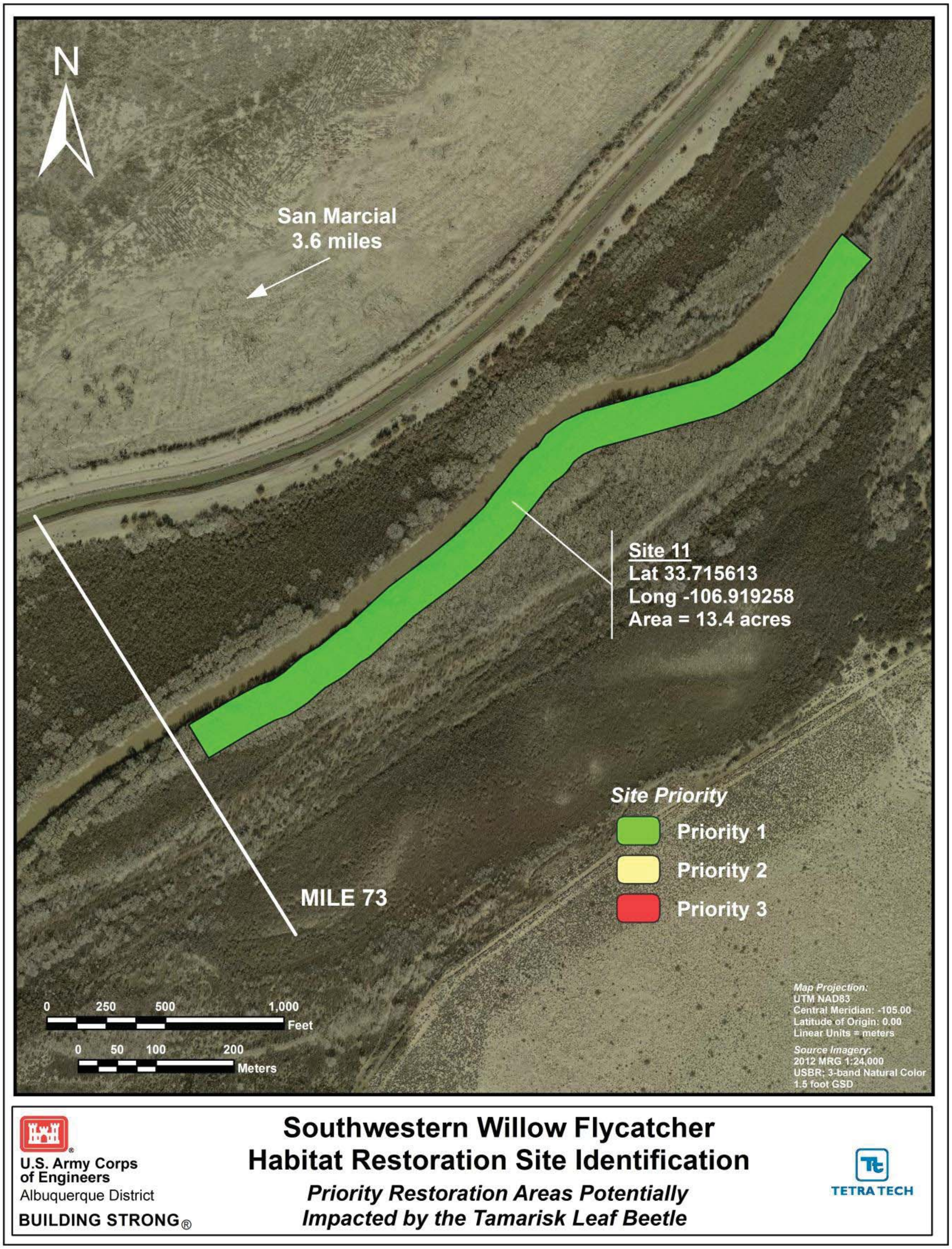
BUILDING STRONG®
Southwestern Willow Flycatcher
Habitat Restoration Site Identification
Priority Restoration Areas Potentially
Impacted by the Tamarisk Leaf Beetle
TETRA TECH


N
San Marcial
8.2 miles
Site 10a
Lat 33.782547
Long -106.875217
Area = 1.7 acres
Site 10b
Lat 33.78088
Long -106.874137
Area = 3.6 acres
Site 10c
Lat 33.779457
Long -106.872335
Area = 2.2 acres
Site 10d
Lat 33.77877
Long -106.871305
Area = 1.0 acres
Site Priority
Priority 1
Priority 2
Priority 3
MILE 80
0 250 500 1,000
Feet
0 50 100 200
Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
U.S. Army Corps of Engineers
Albuquerque District
BUILDING STRONG®
Southwestern Willow Flycatcher
Habitat Restoration Site Identification
Priority Restoration Areas Potentially
Impacted by the Tamarisk Leaf Beetle
TETRA TECH


N
San Marcial
3.6 miles
Site 11
Lat 33.715613
Long -106.919258
Area = 13.4 acres
Site Priority
Priority 1
Priority 2
Priority 3
MILE 73
0 250 500 1,000
Feet
0 50 100 200
Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
U.S. Army Corps
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BUILDING STRONG®
Southwestern Willow Flycatcher
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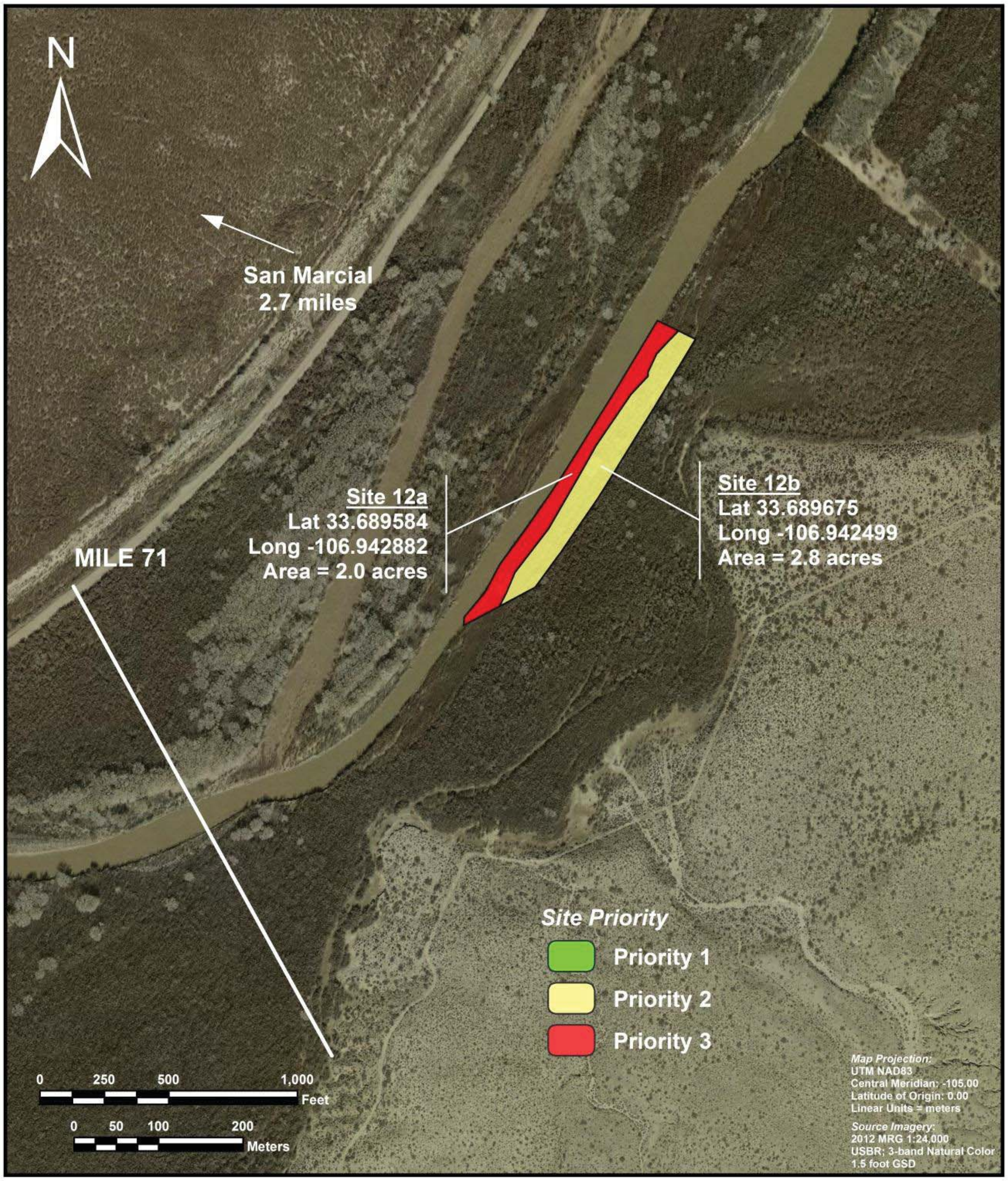
Impacted by the Tamarisk Leaf Beetle
TETRA TECH



U.S. Army Corps of Engineers
Albuquerque District
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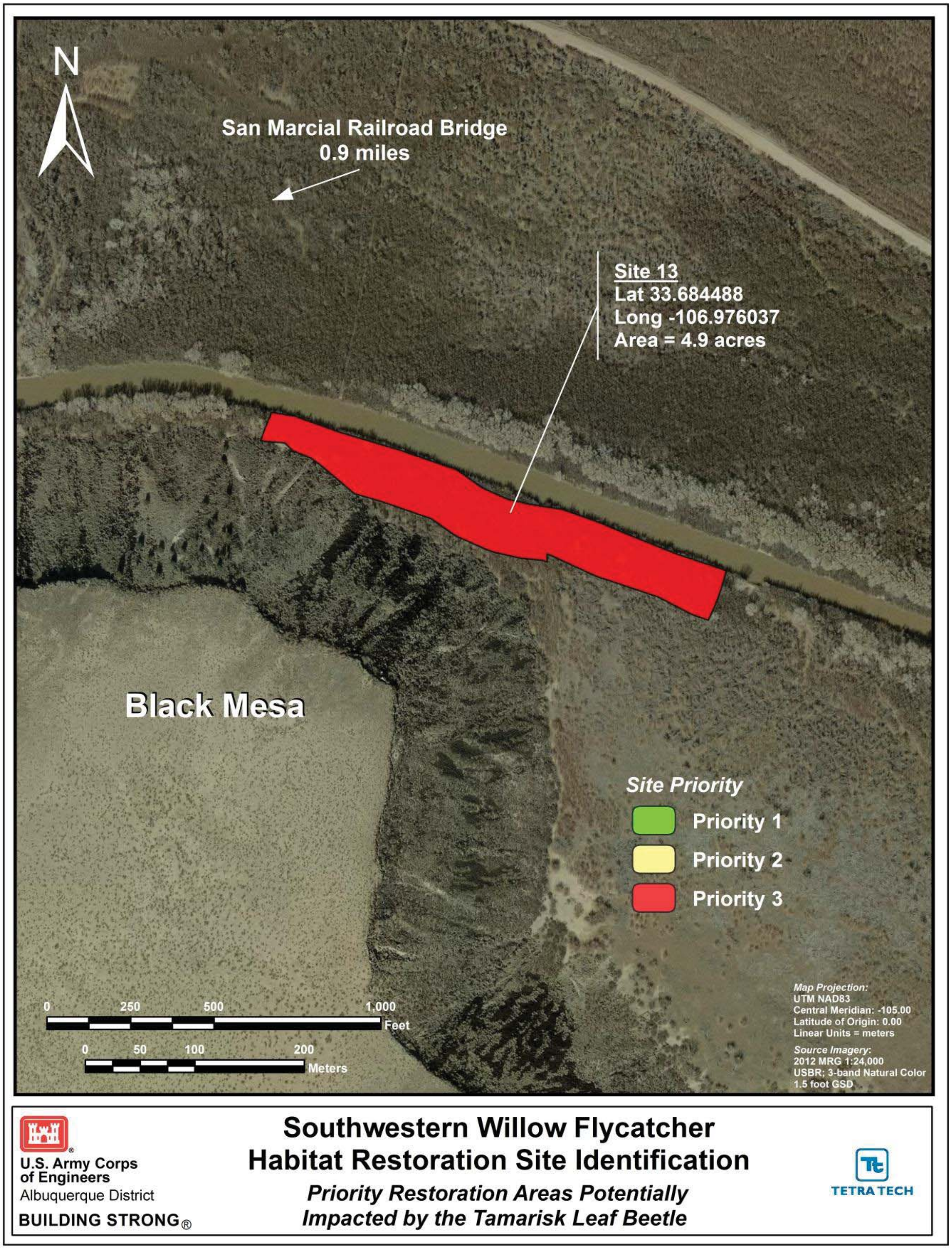
Southwestern Willow Flycatcher
Habitat Restoration Site Identification
Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle

TETRA TECH


N
San Marcial Railroad Bridge
0.9 miles
Site 13
Lat 33.684488
Long -106.976037
Area = 4.9 acres
Black Mesa
Site Priority
Priority 1
Priority 2
Priority 3
0 250 500 1,000 Feet
0 50 100 200 Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
U.S. Army Corps of Engineers
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BUILDING STRONG®
Southwestern Willow Flycatcher
Habitat Restoration Site Identification
Priority Restoration Areas Potentially
Impacted by the Tamarisk Leaf Beetle
TETRA TECH

Priority 1 Sites

Site ID	USBR Suitability	Hink and Ohmart 2012	Territories within Site	Survey Years	Area (acres)
1b	U	SC4d	1	2013	1.9
2	M	C-SC/CW-SC3d	1	2012	4.5
3c	M	C-RO/SC-RO3d	1	2013	0.3
3d	M	SC-RO5d	12	2011; 2013	11.7
3f	M	SC-RO4d	1	2013	2.4
6a	U	RO-C/SC-RO3	2	2012-13	12.1
7b	U	SC/SC-CW3	5	2011-13	6.1
7d	M	RO-SC/CW-RO-SC3	2	2012	3.3
8b	S	C-TW/SC3d	13	2007-08; 2010-13	6.3
8c	U	C/SC-RO1	6	2007; 2010-13	2.1
9e	U	C/CW-SC3d	1	2011	4.5
9f	S	TW/SC-CW3d	3	2011-13	1.7
9g	M	C/SC-CW3d	1	2012	1.0
9h	M	C/SC-CW3d	7	2010-13	5.5
9m	M	C/SC-CW3d	7	2011-13	1.1
9o	U	C/CW-SC3d	4	2012-13	9.9
11	U	C/SC1d	12	2004-07; 2009-10	13.4

Priority 2 Sites

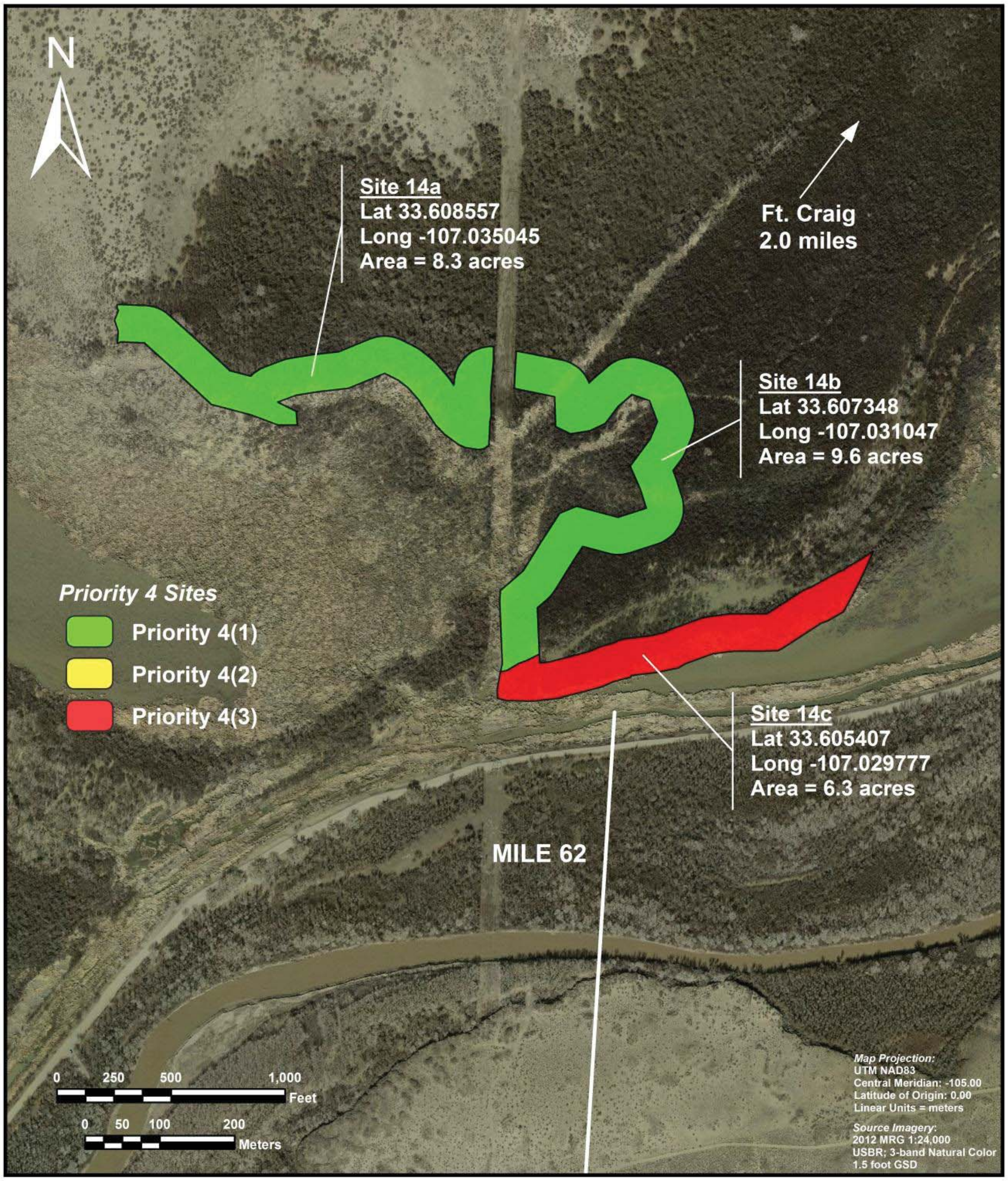
Site ID	USBR Suitability	Hink and Ohmart 2012	Territories within Site	Survey Years	Area (acres)
1a	M	RO-SC/CW3d	0	N/A	1.1
3a	M	RO-SC/SC-RO3d	0	N/A	0.5
3b	M	C-RO/SC-RO3d	0	N/A	0.7
4a	M	SC-RO5d	14	2004-06; 2008	5.1
5a	M	RO-C/RO-SC3d	0	N/A	4.6
5b	M	C-CW/CW-SC3d	1	2008	1.4
5c	M	C-RO/SC3d	0	N/A	0.3
9b	S	SC-CW5	0	N/A	3.5
9c	M	C-TW/SC-TW-C3	0	N/A	0.9
9i	M	C/SC-CW3d	0	N/A	0.5
9n	M	C-TW/CW-SC3	0	N/A	0.5
9p	S	SC-CW5d	0	N/A	2.1
12b	M	SC-TW/SC3d	2	2007-08	2.8

Priority 3 Sites

Site ID	USBR Suitability	Hink and Ohmart 2012	Territories within Site	Survey Years	Area (acres)
3e	U	RO-SC5	0	N/A	5.2
4b	U	SC5d	1	2005	1.4
6b	U	SC-CW6	0	N/A	1.9
7a	U	C/SC-B3	0	N/A	2.5
7c	U	C/SC-B3	0	N/A	2.1
8a	U	SC5d	0	N/A	1.6
9a	U	CW-SC6	0	N/A	0.9
9d	U	SC6	0	N/A	5.8
9j	U	C/CW-SC3d	0	N/A	0.8
9k	U	C/SC-TW1	0	N/A	0.5
9l	U	C/SC3	0	N/A	3.8
10a	U	SC/SC3d	0	N/A	1.7
10b	U	C-SC/SC3d	0	N/A	3.6
10c	U	C/SC-RO1d	2	2006-07	2.2
10d	U	C-RO/SC-CW3	0	N/A	1.0
12a	U	SC5d	0	N/A	2.0
13	U	C/SC-TW1	8	2004-05	4.9

Appendix B

Restoration Sites Located within Elephant Butte Full-pool and Delta



Southwestern Willow Flycatcher Habitat Restoration Site Identification: Elephant Butte Full-Pool & Delta

Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle

U.S. Army Corps of Engineers
Albuquerque District
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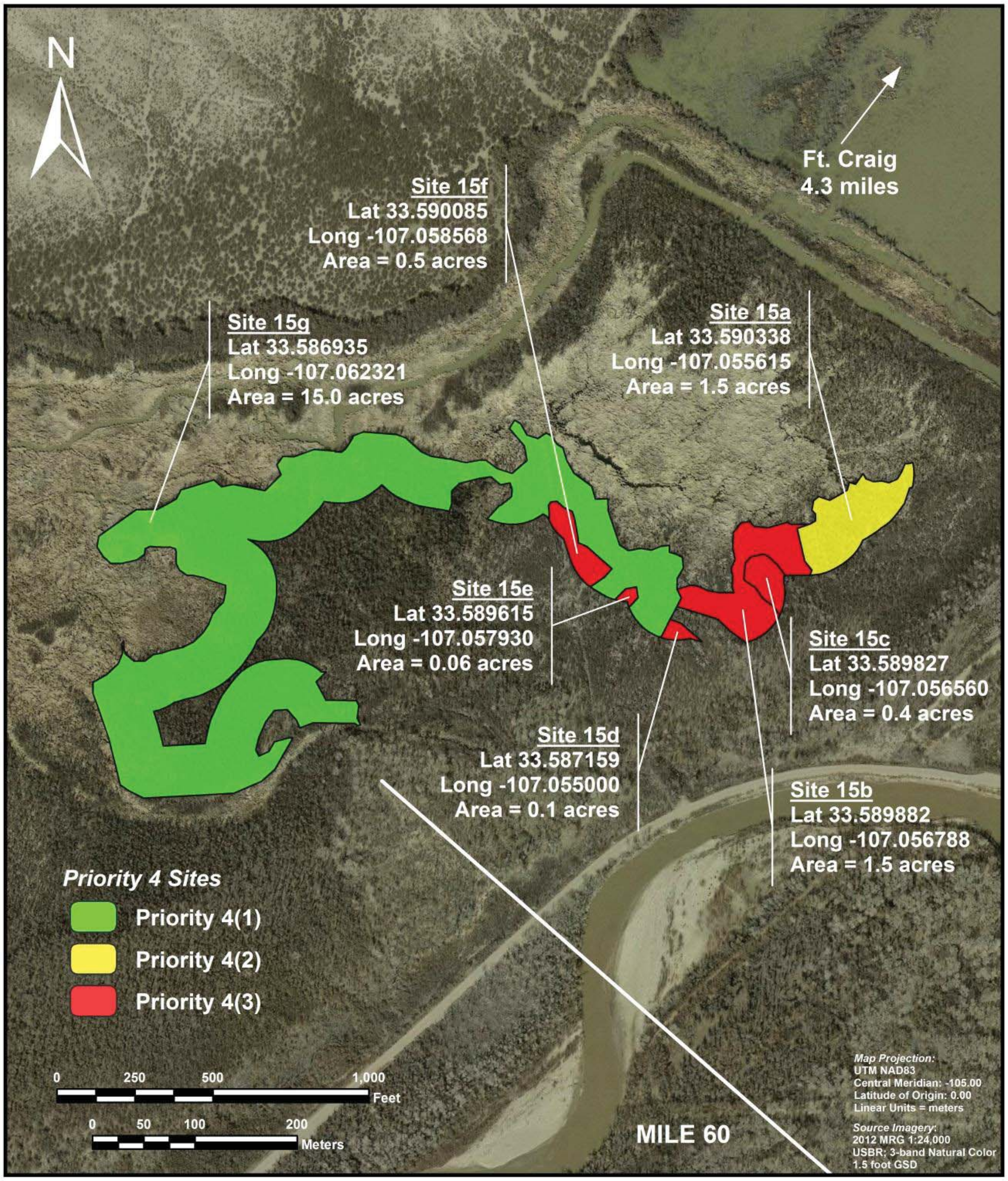
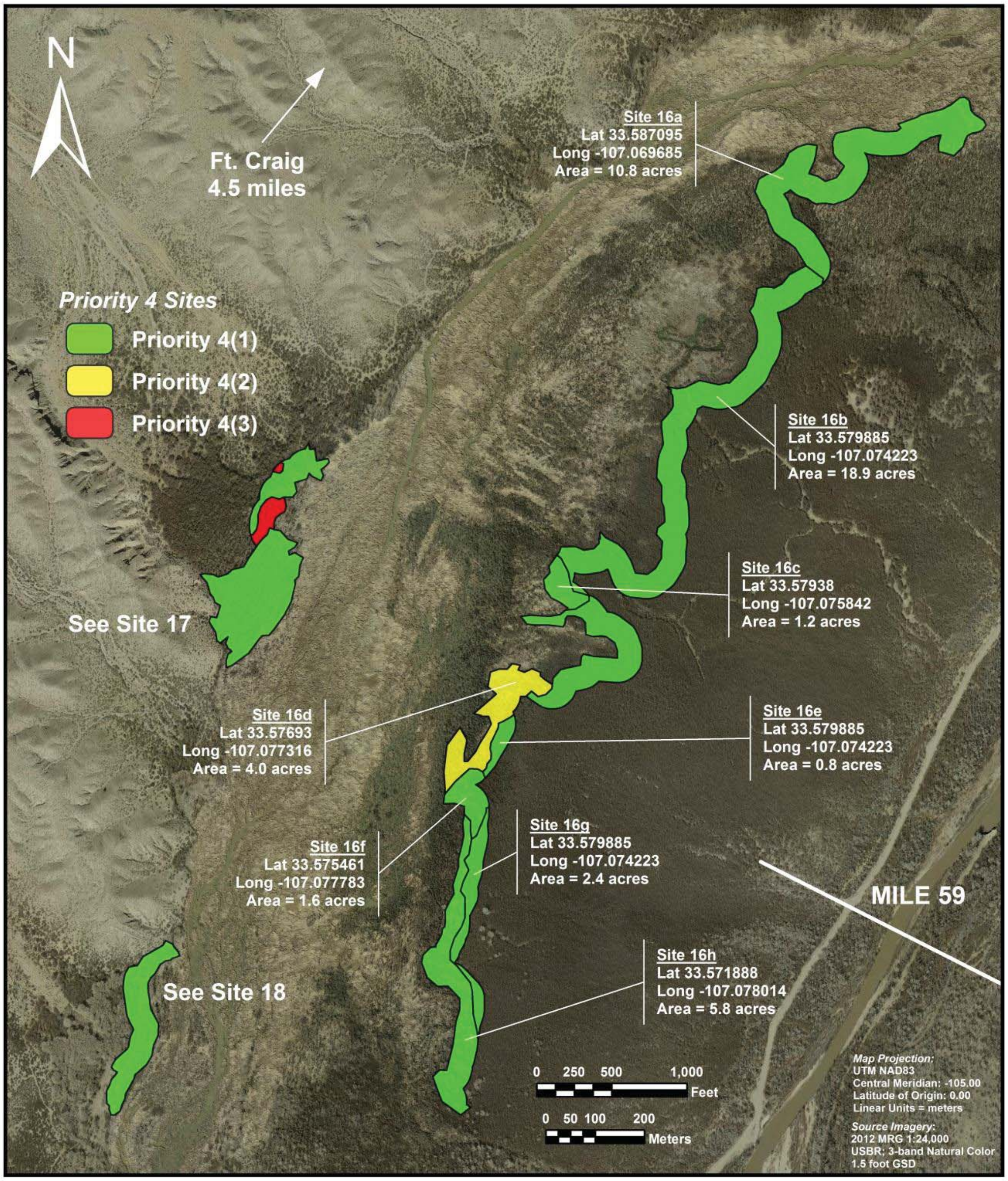
TETRA TECH



Southwestern Willow Flycatcher Habitat Restoration Site Identification: Elephant Butte Full-Pool & Delta

Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle



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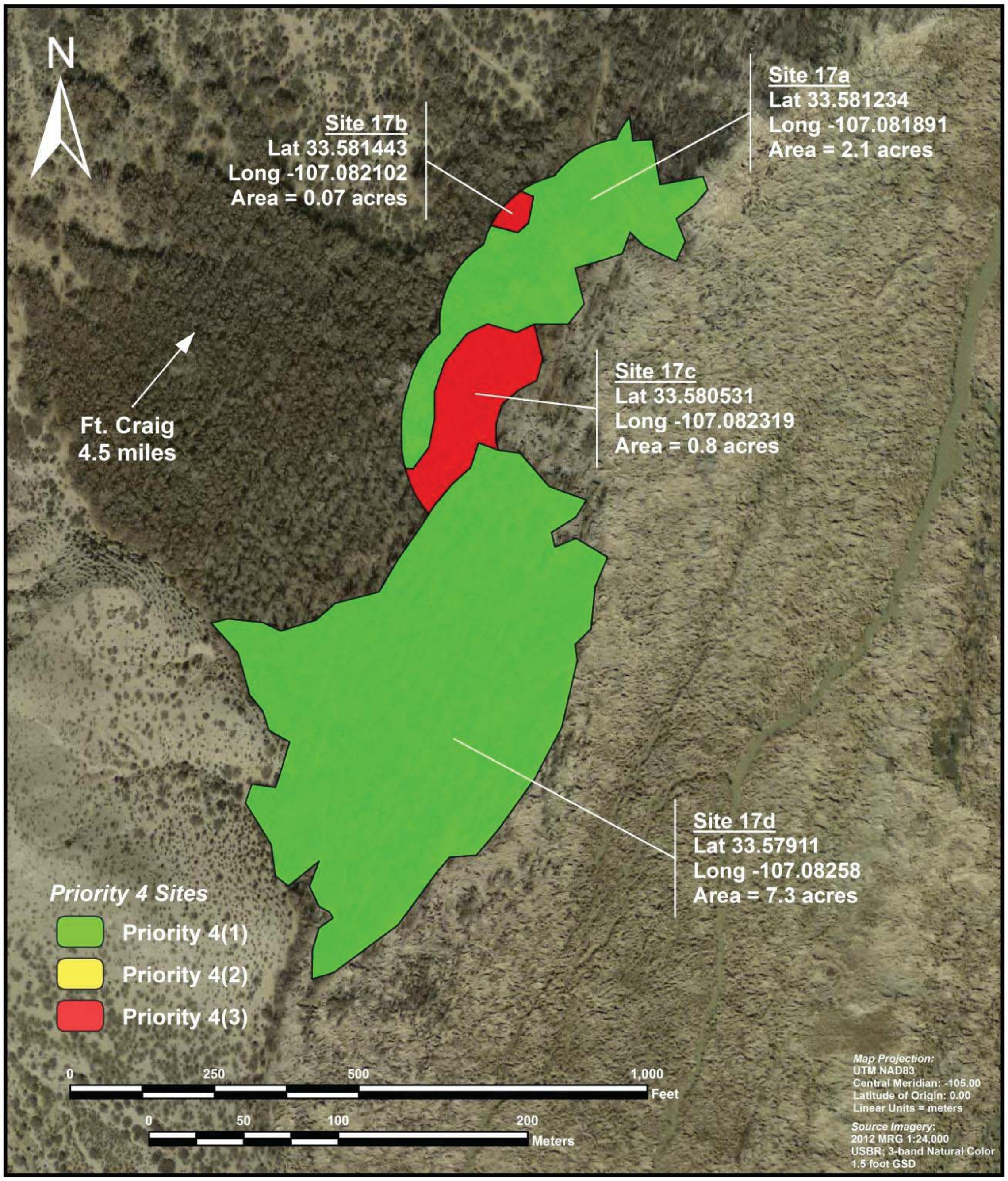
Southwestern Willow Flycatcher Habitat Restoration Site Identification: Elephant Butte Full-Pool & Delta

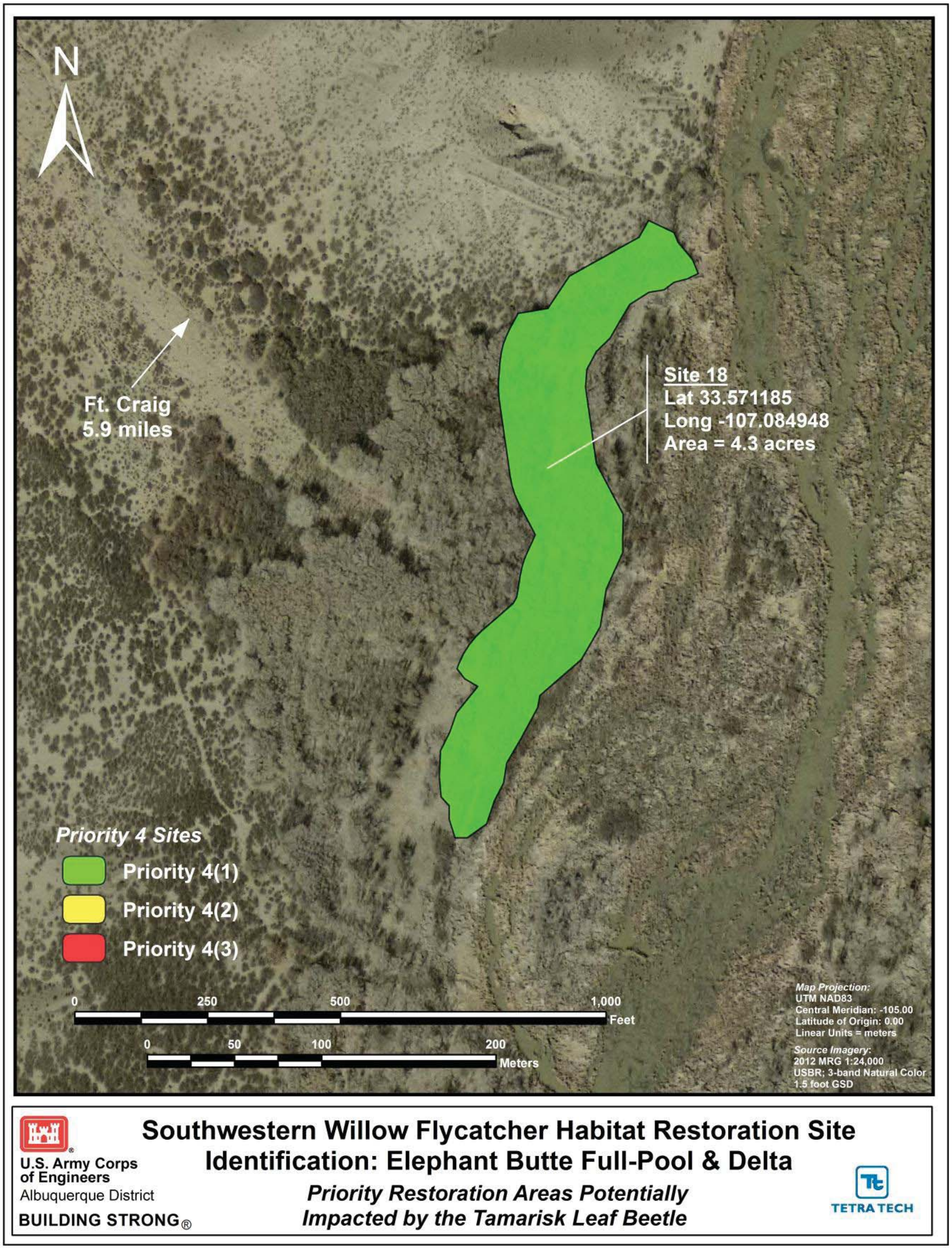
Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle

TETRA TECH



Southwestern Willow Flycatcher Habitat Restoration Site Identification: Elephant Butte Full-Pool & Delta

Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle


N
Ft. Craig
5.9 miles
Site 18
Lat 33.571185
Long -107.084948
Area = 4.3 acres
Priority 4 Sites
Priority 4(1)
Priority 4(2)
Priority 4(3)
0 250 500 1,000 Feet
0 50 100 200 Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
U.S. Army Corps of Engineers
Albuquerque District
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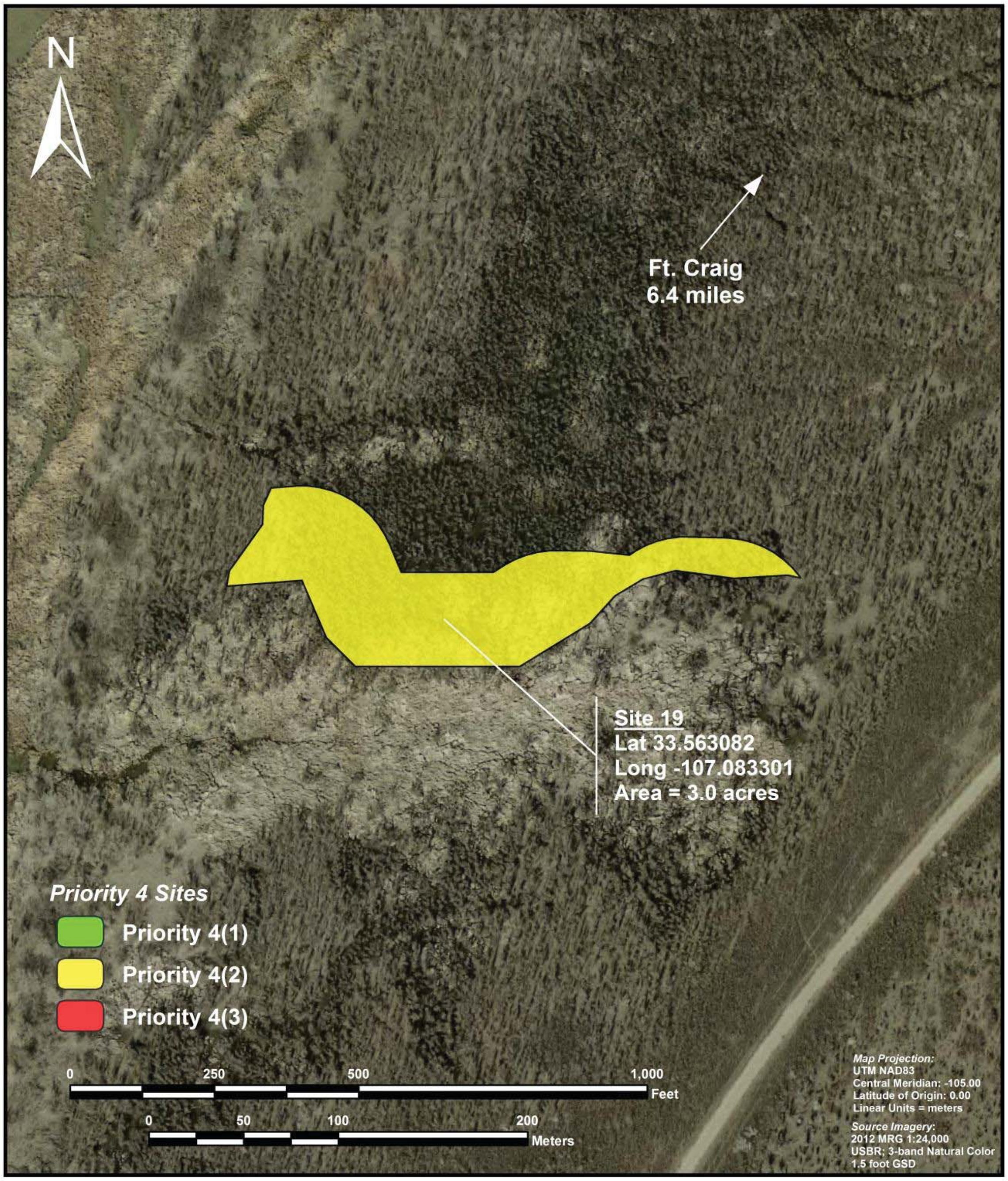
Southwestern Willow Flycatcher Habitat Restoration Site
Identification: Elephant Butte Full-Pool & Delta
Priority Restoration Areas Potentially
Impacted by the Tamarisk Leaf Beetle
TETRA TECH



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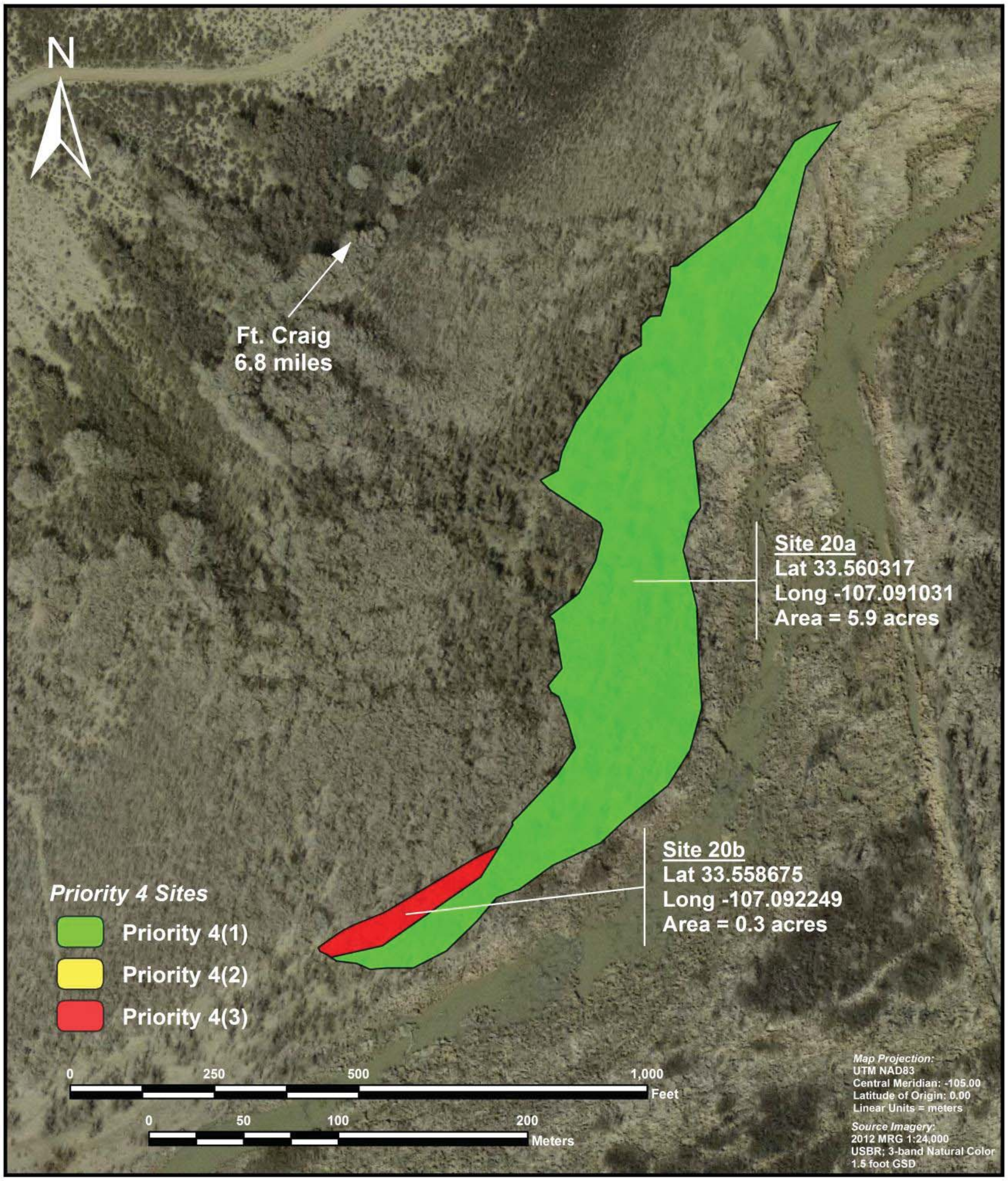
Southwestern Willow Flycatcher Habitat Restoration Site Identification: Elephant Butte Full-Pool & Delta

Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle

TETRA TECH



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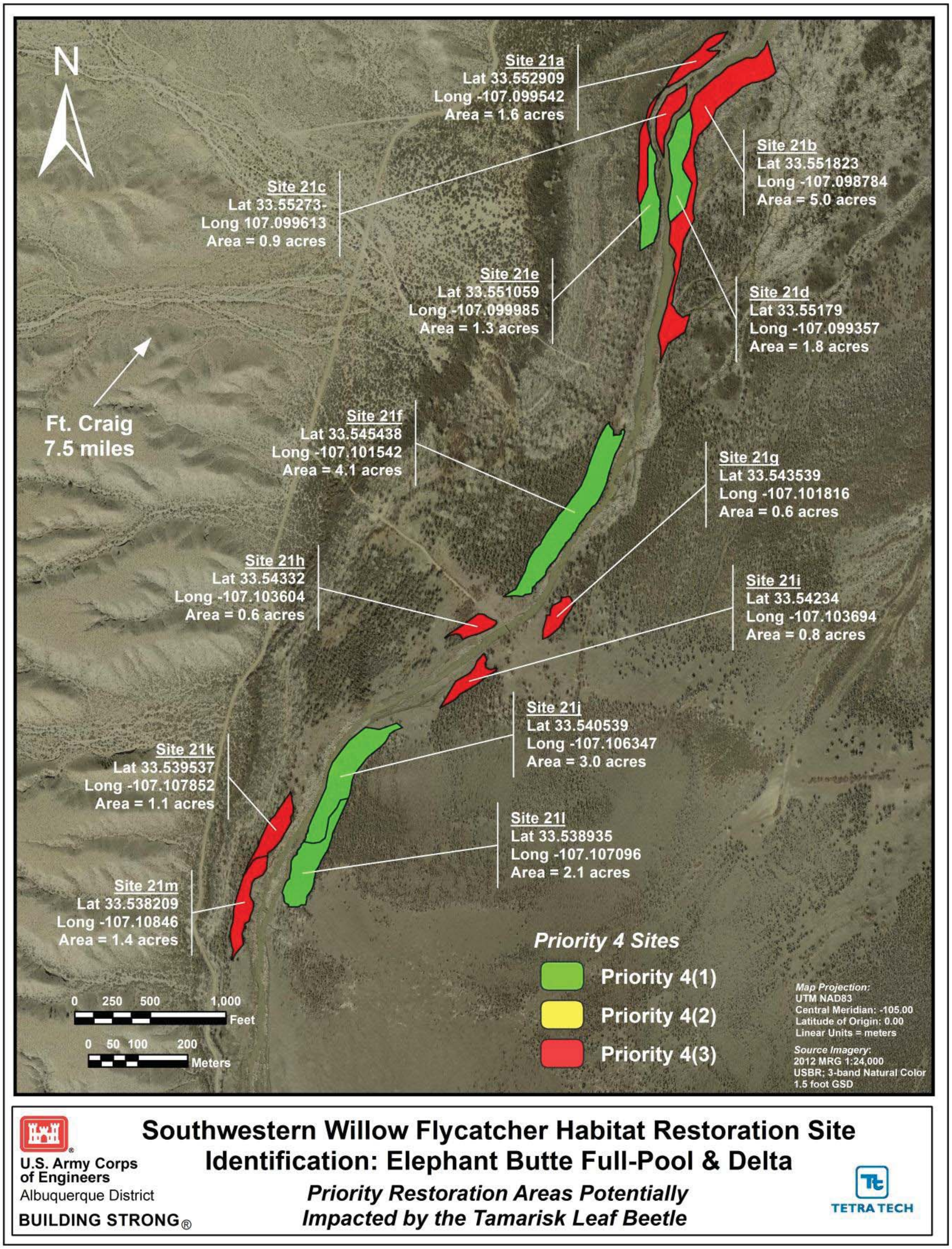
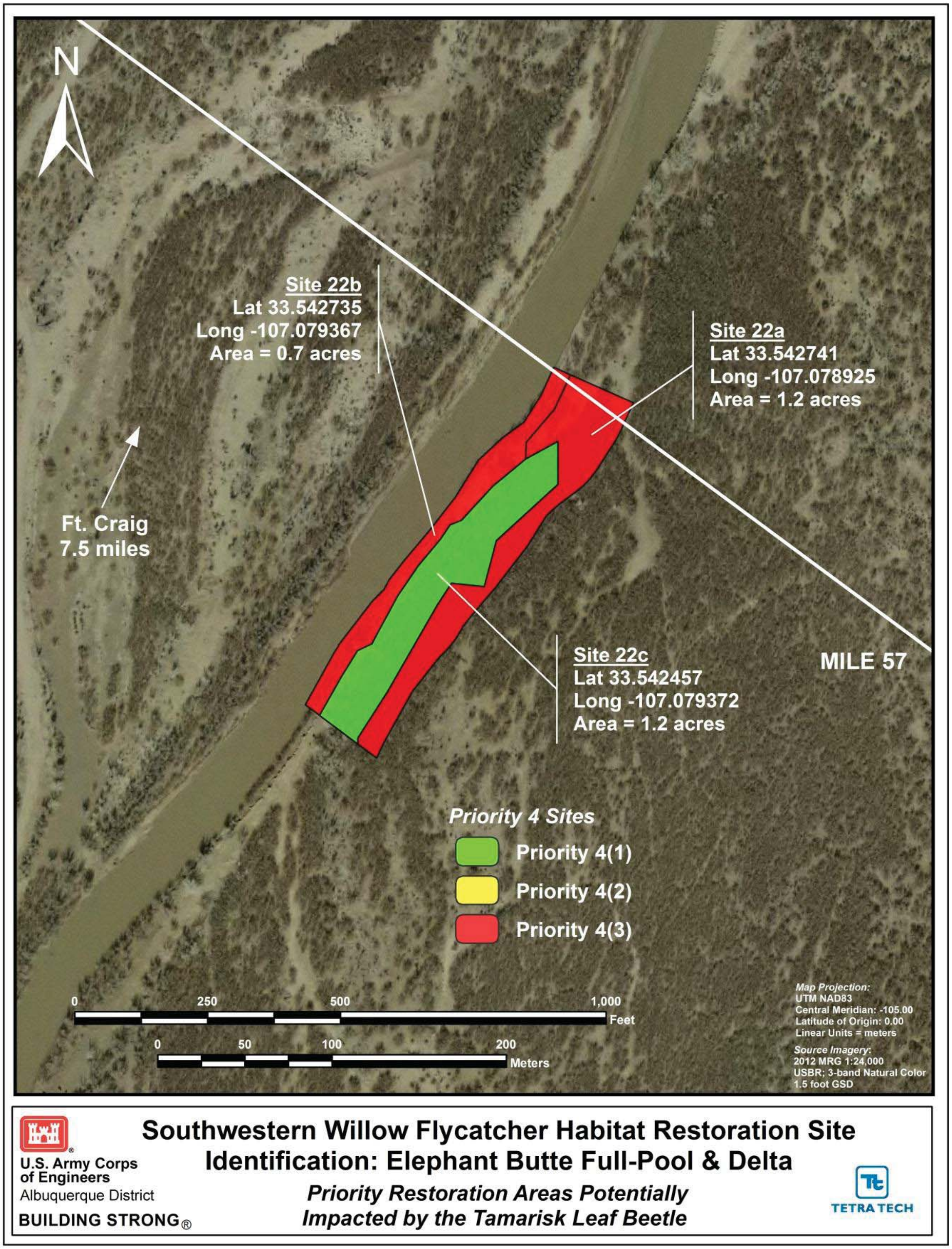
Southwestern Willow Flycatcher Habitat Restoration Site Identification: Elephant Butte Full-Pool & Delta

Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle

TETRA TECH


N
Site 21a
Lat 33.552909
Long -107.099542
Area = 1.6 acres
Site 21b
Lat 33.551823
Long -107.098784
Area = 5.0 acres
Site 21c
Lat 33.55273-
Long 107.099613
Area = 0.9 acres
Site 21e
Lat 33.551059
Long -107.099985
Area = 1.3 acres
Site 21d
Lat 33.55179
Long -107.099357
Area = 1.8 acres
Ft. Craig
7.5 miles
Site 21f
Lat 33.545438
Long -107.101542
Area = 4.1 acres
Site 21g
Lat 33.543539
Long -107.101816
Area = 0.6 acres
Site 21h
Lat 33.54332
Long -107.103604
Area = 0.6 acres
Site 21i
Lat 33.54234
Long -107.103694
Area = 0.8 acres
Site 21j
Lat 33.540539
Long -107.106347
Area = 3.0 acres
Site 21k
Lat 33.539537
Long -107.107852
Area = 1.1 acres
Site 21l
Lat 33.538935
Long -107.107096
Area = 2.1 acres
Site 21m
Lat 33.538209
Long -107.10846
Area = 1.4 acres
Priority 4 Sites
Priority 4(1)
Priority 4(2)
Priority 4(3)
0 250 500 1,000
Feet
0 50 100 200
Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
U.S. Army Corps of Engineers
Albuquerque District
BUILDING STRONG®
Southwestern Willow Flycatcher Habitat Restoration Site Identification: Elephant Butte Full-Pool & Delta
Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle
TETRA TECH


N
Site 22b
Lat 33.542735
Long -107.079367
Area = 0.7 acres
Site 22a
Lat 33.542741
Long -107.078925
Area = 1.2 acres
Ft. Craig
7.5 miles
Site 22c
Lat 33.542457
Long -107.079372
Area = 1.2 acres
MILE 57
Priority 4 Sites
Priority 4(1)
Priority 4(2)
Priority 4(3)
0 250 500 1,000 Feet
0 50 100 200 Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
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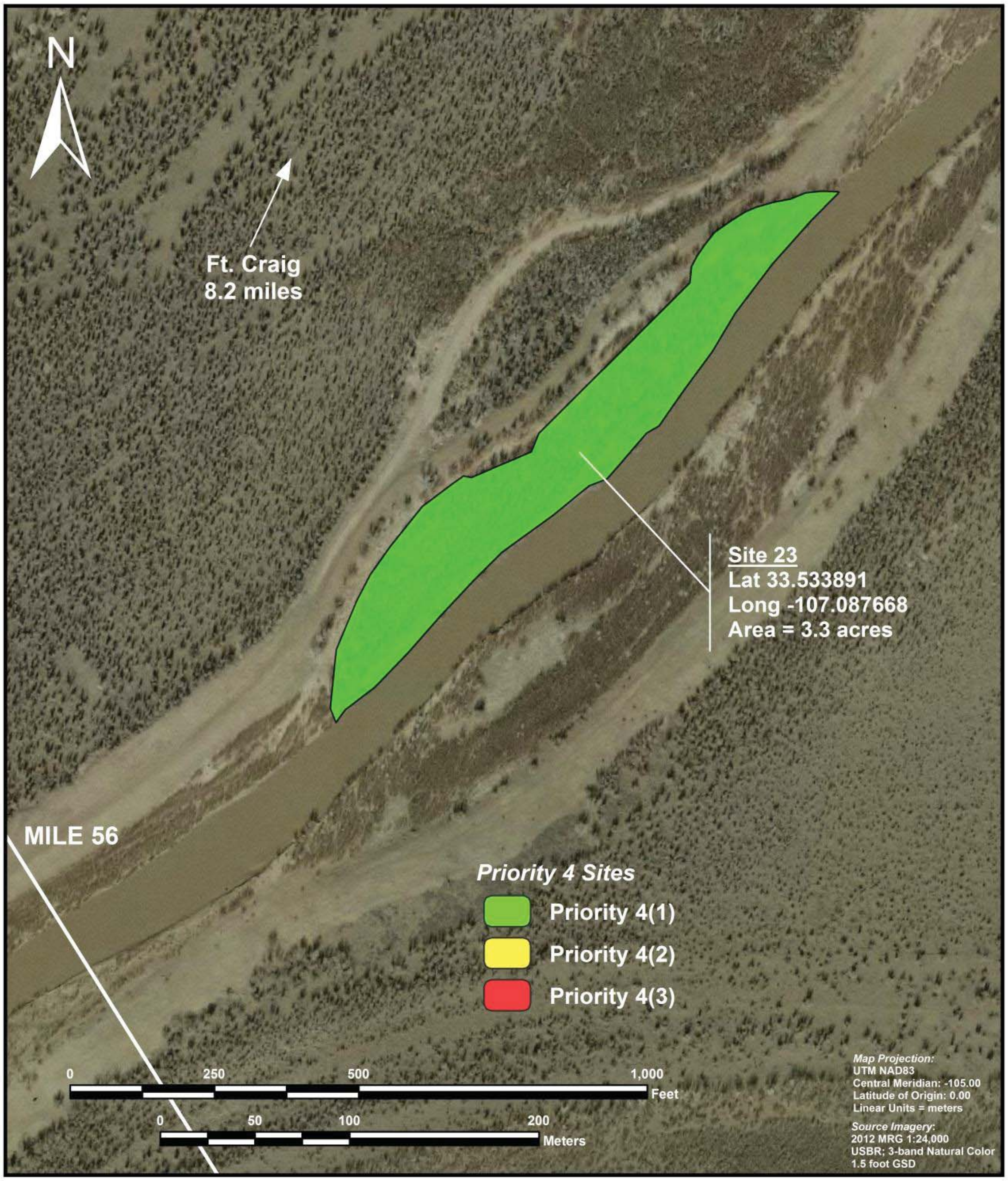
Impacted by the Tamarisk Leaf Beetle
TETRA TECH

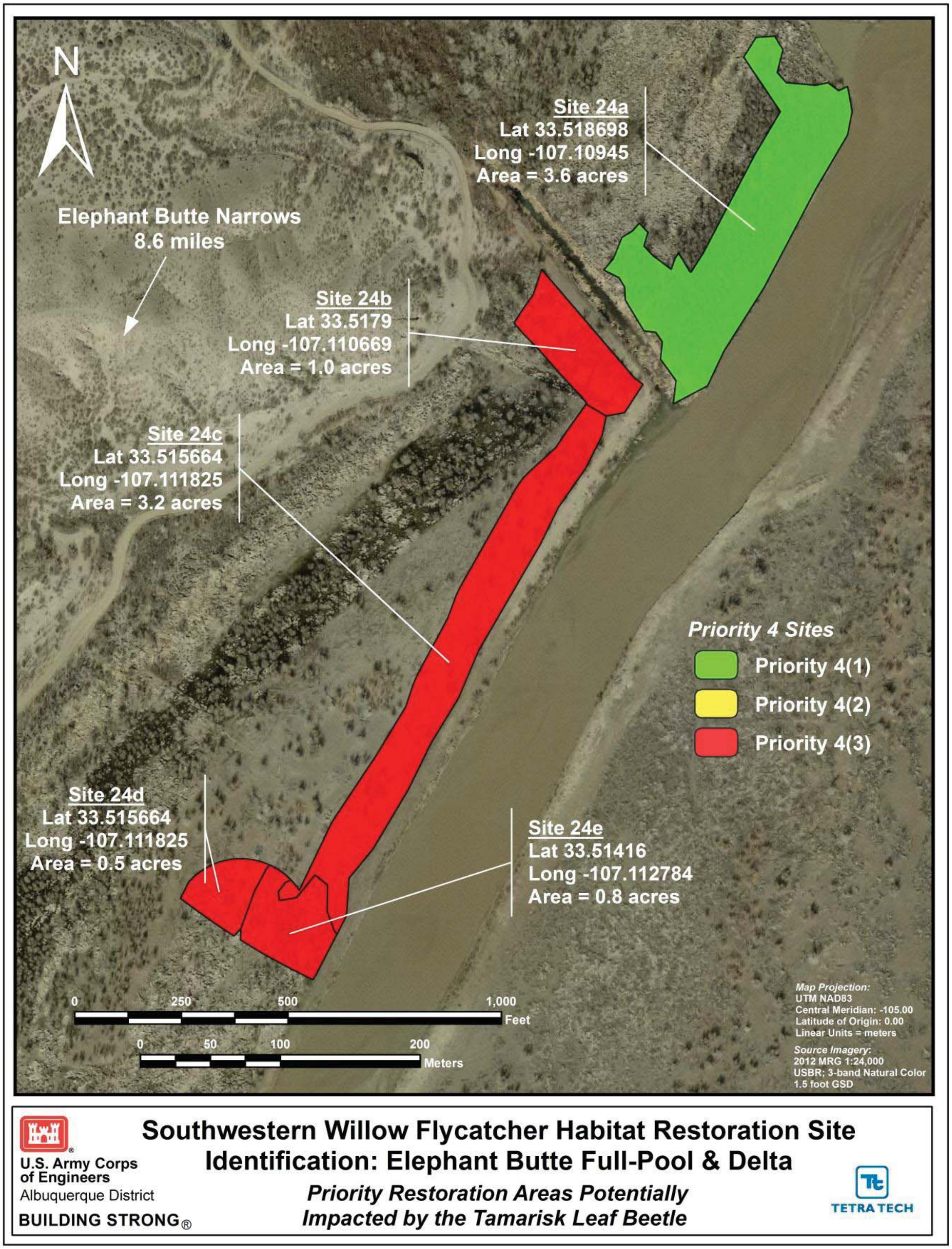


U.S. Army Corps of Engineers
Albuquerque District
BUILDING STRONG®

Southwestern Willow Flycatcher Habitat Restoration Site Identification: Elephant Butte Full-Pool & Delta

Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle

TETRA TECH


N
Elephant Butte Narrows
8.6 miles
Site 24a
Lat 33.518698
Long -107.10945
Area = 3.6 acres
Site 24b
Lat 33.5179
Long -107.110669
Area = 1.0 acres
Site 24c
Lat 33.515664
Long -107.111825
Area = 3.2 acres
Site 24d
Lat 33.515664
Long -107.111825
Area = 0.5 acres
Site 24e
Lat 33.51416
Long -107.112784
Area = 0.8 acres
Priority 4 Sites
Priority 4(1)
Priority 4(2)
Priority 4(3)
0 250 500 1,000 Feet
0 50 100 200 Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
U.S. Army Corps of Engineers
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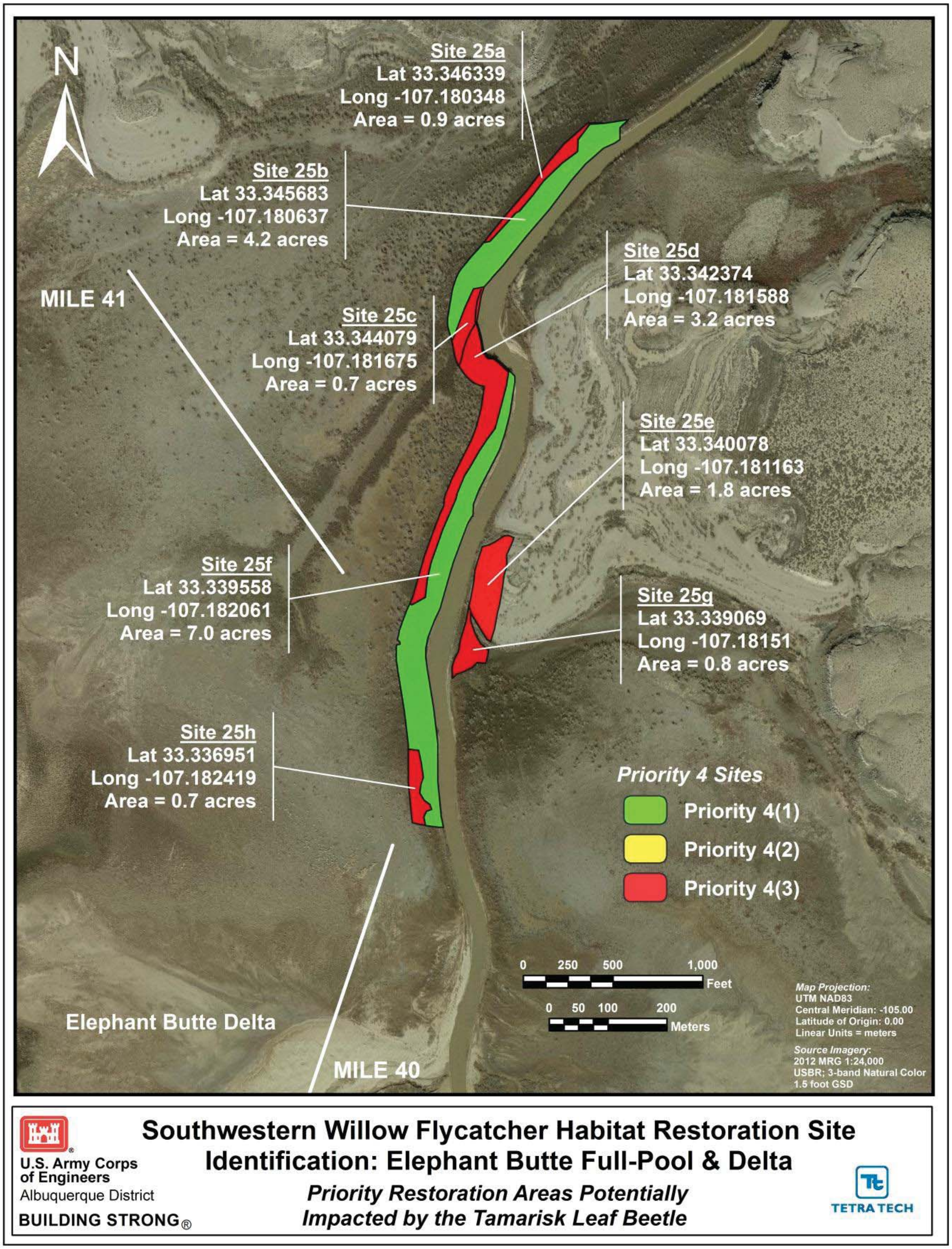
BUILDING STRONG®
Southwestern Willow Flycatcher Habitat Restoration Site Identification: Elephant Butte Full-Pool & Delta
Priority Restoration Areas Potentially Impacted by the Tamarisk Leaf Beetle
TETRA TECH


N
Site 25a
Lat 33.346339
Long -107.180348
Area = 0.9 acres
Site 25b
Lat 33.345683
Long -107.180637
Area = 4.2 acres
Site 25d
Lat 33.342374
Long -107.181588
Area = 3.2 acres
MILE 41
Site 25c
Lat 33.344079
Long -107.181675
Area = 0.7 acres
Site 25e
Lat 33.340078
Long -107.181163
Area = 1.8 acres
Site 25f
Lat 33.339558
Long -107.182061
Area = 7.0 acres
Site 25g
Lat 33.339069
Long -107.18151
Area = 0.8 acres
Site 25h
Lat 33.336951
Long -107.182419
Area = 0.7 acres
Priority 4 Sites
Priority 4(1)
Priority 4(2)
Priority 4(3)
0 250 500 1,000
Feet
0 50 100 200
Meters
Map Projection:
UTM NAD83
Central Meridian: -105.00
Latitude of Origin: 0.00
Linear Units = meters
Source Imagery:
2012 MRG 1:24,000
USBR; 3-band Natural Color
1.5 foot GSD
Elephant Butte Delta
MILE 40
U.S. Army Corps of Engineers
Albuquerque District
BUILDING STRONG®
Southwestern Willow Flycatcher Habitat Restoration Site
Identification: Elephant Butte Full-Pool & Delta
Priority Restoration Areas Potentially
Impacted by the Tamarisk Leaf Beetle
TETRA TECH

Priority 4(1) Sites

Site ID	USBR Suitability	Hink and Ohmart 2012	Territories within Site	Survey Years	Area (acres)
14a	U	SC4d	3	2013	8.3
14b	U	SC/SC3d	2	2012-13	9.6
15g	S	TW/CW-SC3d	47	2004-07; 2012-13	15.0
16a	S	TW/SC-TW3	14	2004-07; 2012-13	10.8
16b	U	SC5d	12	2005-06; 2012-13	18.9
16c	S	SC-CW5d	1	2013	1.2
16e	U	SC5d	4	2012	0.8
16f	S	SC-CW5d	3	2012-13	1.6
16g	U	SC5d	5	2012-13	2.4
16h	S	TW-C/SC-CW3d	17	2006; 2012-13	5.8
17a	S	TW-C/TW-SC3d	3	2012-13	2.1
17d	S	TW-SC/SC-CW3d	46	2007; 2012-13	7.3
18	U	C-TW/SC1d	4	2012-13	4.3
20a	S	TW-C/TW-SC3	14	2012-13	5.9
21d	S	TW-C/SC-CW3d	2	2013	1.8
21e	U	C/SC-B3	1	2013	1.3
21f	S	TW/SC3	15	2005-07; 2012-13	4.1
21j	S	TW-C/TW-SC3	4	2012-13	3.0
21l	S	TW/TW-SC3d	16	2004-07; 2012-13	2.1
22c	M	SC-TW/SC3d	1	2013	1.2
23	S	TW-C/SC-CW3d	2	2012-13	3.3
24a	M	TW-SC4d	20	2012-13	3.6
25b	S	TW-SC/SC-TW3d	2	2013	4.2
25f	U	SC-TW5d	4	2013	7.0

Priority 4(2) Sites

Site ID	USBR Suitability	Hink and Ohmart 2012	Territories within Site	Survey Years	Area (acres)
15a	M	TW-SC5d	1	2007	1.5
16d	U	SC-CAT5d	3	2006-07	4.0
19	S	TW/SC3d	2	2007	3.0

Priority 4(3) Sites

Site ID	USBR Suitability	Hink and Ohmart 2012	Territories within Site	Survey Years	Area (acres)
14c	U	SC-CAT5d	0	N/A	6.3
15b	U	SC5d	0	N/A	1.5
15c	M	TW-SC5d	0	N/A	0.4
15d	U	SC5d	0	N/A	0.1
15e	U	SC5d	0	N/A	0.1
15f	U	SC5d	0	N/A	0.5
17b	U	SC5d	0	N/A	0.1
17c	M	TW-SC4d	0	N/A	0.8
20b	U	C/SC3d	0	N/A	0.3
21a	U	SC/SC3d	0	N/A	1.6
21b	S	TW/SC-TW3d	0	N/A	5.0
21c	S	TW-C/SC3d	0	N/A	0.9
21g	U	TW/SC1	0	N/A	0.6
21h	U	SC5d	0	N/A	0.6
21i	U	C/TW-SC1	0	N/A	0.8
21k	U	C-TW/SC-C3	0	N/A	1.1
21m	M	TW/B-SC3	0	N/A	1.4
22a	U	SC5d	0	N/A	1.2
22b	S	TW/TW-SC3	0	N/A	0.7
24b	U	TW/SC1	0	N/A	1.0
24c	S	TW/SC3	0	N/A	3.2
24d	S	TW/SC3	0	N/A	0.5
24e	S	TW/SC-CW3	0	N/A	0.8
25a	U	SC5d	0	N/A	0.9
25c	U	SC5d	0	N/A	0.7

Priority 4(3) Sites (cont.)

Site ID	USBR Suitability	Hink and Ohmart 2012	Territories within Site	Survey Years	Area (acres)
25d	U	SC/SC3d	0	N/A	3.2
25e	U	SC5	0	N/A	1.8
25g	S	SC-CW5d	0	N/A	0.8
25h	U	SC5	0	N/A	0.7

Appendix C

Comments and Responses on this Report

DOCUMENT REVIEW COMMENTS — **DATE:1-2-2015**

PROJECT TITLE: Habitat Relationships along the Middle Rio Grande in New Mexico for the Endangered Southwestern Willow Flycatcher

REPORT DATE: October 2014 (PDF version said September 2014)

REVIEWED BY: Various

AGENCY NAME: Various

LEGEND ***(for ACTION column below)***

A-APPROVED D-DISAPPROVED C-CONCUR E-EXCEPTION

ITEM NO.	Chapter, Section, Page, Table, Figure or Drawing No.	COMMENT	Reviewer	ACTION
1	p. 2	The statement, "however, under contemporary conditions where flows are highly regulated, such regenerative floodplain processes seldom occur without purposeful habitat restoration" should be clarified. When and where in the MRG have avulsions been used for purposeful riparian habitat restoration? At which flows and where did those occur?	USFWS	E-The statement was not intended to literally suggest that avulsion has been used, but that mechanical modification of the floodplain is now required. The sentence has been rewritten, replacing "purposeful" with "implementing some mechanical form of"
2	p. 3	The statement, "This reach is a key area in the MRG Management Unit but is seriously degraded from stand age/succession and drought-related effects" needs citation support.	USFWS	C-We added to the sentence, "… during our recent visit to this reach, we noted the habitat to be seriously degraded …"
3	p. 4.	Statements such as, "In general, these insect groups tend to hover or crawl on vegetation, behaviors that tend to make them easy prey for nimble flycatchers" should be	USFWS	C/E-The word "nimble" has been deleted. The concept that slow moving insects would be relatively easy to catch requires no citation; "relatively" has

		supported by citations or omitted. Which vegetation types, what behaviors predispose prey to insectivore capture, how easy is capture and compared to which other activities so characterized? All biased or subjective generalities should be grounded in scientific citations or removed from report. Diet summary should be updated to include the work of Durst et al. 2008. Age, habitat, and yearly variation in the diet of a generalist insectivore, the southwestern willow flycatcher. The Condor 110(3):514–525. Statements about typical flycatcher diets should be qualified by flycatcher life stage (adult vs. fledgling), vegetation (native vs nonnative), annual variation, and the strength of the inferences used to support the generalities made etc.		been added to sentence. Reference to Durst et al. 2008 has been added at reviewer's request. The request for an extended discussion of flycatcher diets by life stage, season, etc., extends beyond the scope and needs intended in the summary provided. Such information can be extracted from the citations provided.
4	p. 5.	The report cites Drost et al. (2001) to suggest that since flycatchers appear to be dietary generalists, [therefore,] they are less likely to encounter food shortages. This statement suggests to the reader that any insect prey, whatever the density, is sufficient for flycatcher nesting success. However, Durst et al. (2008) suggested that reduced prey abundance has been associated with reproductive failure. It remains unclear how potential temporal variation in the arthropod prey abundance may affect variation in diet and impact breeding or nestling success and the statement should be clarified and supported with citations for life stage, vegetation type, survey methods.	USFWS	C-The current reference to DeLay et al. 2002 in the report already noted the possibility of food shortage effects, which we considered adequate. But, at the reviewer's request, additional reference to Durst et al. 2008 has been included. Also, to clarify, Durst et al. 2008 does not say that food limitation caused reproductive failure, instead they say, "In 2002, a severe drought resulted in reduced prey base and near total reproductive failure, but we detected no major shift in the composition of adult diet during that year…." The reviewer's statement on the need for more research has been included.
5	p. 5.	The statement, "The most common native vegetation	USFWS	E-At this time quantitative information on willow

		used as stopover habitat by migrating flycatchers is coyote willow (Salix exigua). As such, coyote willow habitats should be actively monitored, maintained, preserved, and restored where possible to help protect endangered flycatchers" should be further clarified as to how large of a patch of willows, and at what frequency should such patches occur to maintain optimal energetics for migratory flycatchers to be supported.		patches that can address the reviewer's request does not exist, to our knowledge. Research needs, as defined by the cited authors, remain the state of the needs today. No change is made in the report.
6	Section 5.1	Description of the degree of impacts, and recommendations for how far these natural processes can be restored should be explicitly stated within all available authorities.	USFWS	E-The section provides the needed introduction on the current risks to the flycatcher. Meaningful quantitative recommendations on restoration goals cannot be made until updated FLO-2D modeling is available, as was frequently highlighted as a need in the report. We assume the reviewer is requesting specific discussion of regulatory authorities for restoration, which exceeds the scope of this project.
7	p. 31.	The statement, "It is therefore not surprising that there are no known flycatchers breeding in the Albuquerque Reach since the 2004 surveys began; however, the USACE, USBR, the New Mexico Interstate Stream Commission, Albuquerque Metropolitan Arroyo Flood Control District, the City of Albuquerque, and Isleta Pueblo have constructed a number of habitat restoration projects in this reach in an effort to help address these issues" should be further quantified for the number of acres that have been restored, when, and followed by the statement of occupancy and nesting success after restoration efforts were complete. These statements identify a factor, associated with flooding the floodplain,	USFWS	C/E-This sentence has been added to the report: "Completed projects include 119.7 acres of riparian restoration, 2,260 feet of backwater and high-flow side channels, and 11,867 feet of jetty jack removal; an additional 735 acres of various restoration treatments are planned but have not yet been constructed (Tetra Tech 2013)." The report statement, "no known flycatchers breeding in the Albuquerque Reach since the 2004 surveys began" remains unchanged. Indeed, the discussion of the importance of floods and floodplain to flycatchers does begin with Section 5.1 on page 29; however, while proximity to water along the MRG appears

		that were not described earlier with proximity to surface water being a primary factor for nesting success.		linked to nesting success, this may be only an artifact of the confined nature of the riparian zone along the MRG. Specifically, some of the cited studies included in the report, but not expanded on in our discussion, have found nest site fidelity and other factors in Arizona and other areas to sometimes be more important that distance to water. We opted not to add potentials for uncertainty and controversy, as well as research needs for flycatcher along the MRG by expanding this discussion in this report.
8	p. 32	The relative probabilities of detrimental impacts due to dramatic changes in shallow groundwater levels that affect riparian vegetation and flycatcher habitat should be quantified for the delta as well as in the San Acacia, Isleta, Angostura and upstream reaches in order to properly support the recommendations provided.	USFWS	E-Available information is lacking to quantitatively address MRG groundwater to flycatcher habitat relations with any reasonable certainty. Despite this data gap, we continue to believe it is prudent to include the qualitative recommendation presented to help reduce the long-term risk to the persistence of flycatchers and their habitat. If the review has evidence otherwise, and we know of none, then these recommendations can be deleted. No change in text.
9	Section 5.3.1.	This section is poorly quantified. A rapid prototype of vegetation change probability based on flammability, random effects, and fire propagation should be developed in this section for it to be considered along with other factors.	USFWS	E-Unfortunately, despite our considerable effort to identify and present better quantification of fire effects, suitable records do not exist. No change in text.
10	Section 5.4. p33	The statement, “as a rule, in the absence of native vegetation, it is common for the flycatcher to nest in structurally suitable tamarisk stands” should be provided citation support as it is characterized as a “rule.” Furthermore, the citation support should identify the	USFWS	C/E- As is common usage, “as a rule” was used as a synonym for “in general.” The phase was revised to read, “…in general, it is common for the flycatcher to nest in structurally suitable tamarisk stands (e.g., Moore and Ahlers 2004).” The 2014 information

		complete absence of native vegetation in the supporting studies. This report should be updated with the most recent 2014 data that TLB has been documented throughout the MRG (Tamarisk Coalition, Grand Junction, CO).		from the TC, not available when the report was drafted has been added. Of, note, the TC 2014 TLB map does not show the TLB to be "documented throughout the MRG," only as far south as near Socorro and north to near Hatch, with holes in that distribution where the beetle has not been found.
11	Section 5.4. p34	The statement "habitat restoration represents a key bridge for accelerating habitat recovery following the TLB control of tamarisk to the long-term reclamation of important flycatcher breeding areas" is not supported by previous statements. The term "habitat restoration" should be defined. It is unclear whether and what type of activities are envisioned for the report (i.e., debris removal, natural regeneration, artificial planting, etc.) that should be accelerated. From the Tracey et al. (2014) citation, there appeared to be only a one-year loss of productivity before flycatcher nest success doubled. How could any proposed accelerated habitat restoration efforts match the level of natural riparian regeneration within one year at sites that have suitable hydrology? Nonetheless, this risk factor was carried forth into the executive summary whereas fire modeling, flood management, and the long-term resiliency of riparian flycatcher habitat by various hydrology, stage-discharge relationships, and floodplain connection is not mentioned as a method of natural resilient habitat restoration and yet is undoubtedly more efficacious.	USFWS,	D-We do not agree that the quoted statement from the report "is not supported by previous statements." We do not agree that "habitat restoration" needs defining. Later sections of the report characterize the nature or restoration needed, which do not need repeating here. The quote from the report states "long-term reclamation," as such we are confused about the reviewer's comments misdirecting the purpose of the paragraph to short term recovery. The reference to Tracey et al. notes that the flycatchers moved to other suitable nesting sites. If TLB eliminates the bulk of suitable tamarisk nesting substrates along the MRG, habitat restoration would clearly have the potential of providing long-term benefits.
12	All	This report ignores the need for describing site-specific evaluations of hydrology and stage-discharge	USFWS	D-Our identification of priority sites for restoration began with the habitat model developed by

		relationships, floodplain connection, vegetation community validation, site access issues, fire dynamics, drought, and groundwater dynamic relationships and instead solely focuses on areas in the MRG dominated by Tamarix spp. It identifies sites for restoration without addressing the underlying causes of impairment, or other risks and uncertainty associated with its prioritization recommendations. We recommend a quantitative approach addressing long term uncertainties associated with hydrology, groundwater and floodplain connection associated with the prioritized restoration sites recommended in this report.		Reclamation. This model and the habitats identified include all relevant factors affection habitat along the MRG, as listed by the reviewer. We, through several presentations to the Program's Habitat Restoration Workgroup, reached agreement on the approach and we saw no reason to reinvent Reclamation's extensive effort of assessing existing habitat suitability for flycatchers. As such, all key influences on nest site selection for MRG flycatcher are inherently included in the site selection process presented in Section 6.3. Threats from TLB have been identified by the Workgroup and by us as the greatest present threat to MRG flycatcher habitat, therefore this threat became the primary focus of this report. Should MRG flycatchers survive this threat and should updated FLO-2D outputs become available, future assessments can then begin to consider updating this assessment. Section 7 of the report, among other sections, emphasizes the need for evaluating such variables and this report is intended to provide a logical set of potential restoration sites that are the intersection of saltcedar-dominated and currently occupied stands.
13	Section 6.3, #7	Having trouble understanding rationale, particularly 7.b. Were the presence/dominance of willows considered in prioritization?	MRGCD	E/C – This assessment is predicated and focused on the anticipated impacts of the TLB on SC-dominated and currently occupied flycatcher nesting sites. Although the presence/absence of willow is clearly an important consideration, the evaluation of such

				conditions is best addressed on a site-specific investigation basis. The sites identified here, are a first approximation (see section 6.1) and intended as a planning level estimation. A footnote has been added to the text providing this information.
14		Would it make sense to focus on Priority 2 unoccupied sites first? How do we avoid short term negative impacts to breeding sites/habitat?	MRGCD	C – This is clearly a viable and potentially preferable option. We state in Section 7: "The Priority 2 sites and USBR (2013b) also provide a number of additional options for habitat restoration. For example, sites that are tamarisk dominated but not necessarily flycatcher breeding areas and/or suitably classed tamarisk habitat. These are perhaps the most effective use of available resources, beyond addressing the at-risk breeding areas identified in this report (Priority 1 and 4(1) sites). Many, if not all, of the tamarisk dominated habitat will experience negative effects from the TLB at some time in the future, and the impacts to the flycatcher are likely to be substantial (Dudley and Bean 2012; Tracy et al. 2014). Restoration at or near the active breeding areas is therefore important in maintaining a productive breeding population in the MRG Management Unit. Restoration in other areas should not be omitted, however, from near-term consideration as impacts from the TLB poses broader threats to other organisms that have come to use tamarisk habitat. In addition, as opposed to a strictly species-centered approach, a broader methodology that integrates terrestrial and aquatic elements could be used to create restoration projects that benefit both

				the flycatcher and Rio Grande silvery minnow." Since we have little or no knowledge of future budgets, it is difficult to further prioritize restoration activities/sites and is better left to future site-specific investigations by agency/Program personnel. In other words, it is difficult to know for certain which approach is best when so many variables remain unknown (budgets, actualized impacts to SC habitat, rate of defoliation, recolonization of veg, drought status/favorable hydrology, etc.). Thus, rather than further constraining restoration priority sites we chose to leave the set of sites broader and more flexible. This leaves more investigation work for the future but is likely to be most beneficial for the species and the wisest use of limited resources. Cross reference to the Section 7 discussion of priority 2 sites has been included in the new section 6.3.2, which is described in the following two responses.
15		Are there any recommendations for phasing projects or when to undertake restoration in recently occupied habitats? Should it be done only after beetle damage occurs or before? Or can we only restore areas that are determine to be unoccupied?	MRGCD	C – Good questions! See also comments/responses 13, 14, and 16. Phasing is a prudent approach and could both maximize habitat restoration benefits while minimizing adverse impacts during construction. There is an array of alternative phasing scenarios that could take place involving the sites classified 1s, 2s, and 3s, each involves consideration of the timing and level of funding/resources for TLB-related restoration efforts. These future considerations are impossible for us to anticipate. Addressing restoration needs for 2s or 3s could be

				more or less expensive and time-intensive depending on size, favorable hydrology, etc. One of the central assumptions in this assessment is the presence of SWFL in more recent times – they are there for a reason that may not be completely captured by vegetation assessments alone and therefore we have recommended that focusing first on sites classified as 1s as being the more immediate need. Restoration at sites characterized as 2s and 3s would involve a more holistic/ecosystem approach, which could be considered more desirable, but may be constrained for budgetary reasons. Another possibility is certain combinations of restoration classified as 1s, 2s, and 3s for project areas that are located within close proximities. At this time, we considered it best to defer determinations on which approach to employ to future ground investigations when the availability of funding and other resources are known. In addition, any activities within areas having Critical Habitat designations for listed species will have to be coordinated through and approved by the USFWS, who will ultimately determine restoration parameters, timing, etc. Again, approaches (or combinations therein) are greatly influenced by budgets, actual TLB impacts, etc. and is best formalized after site-specific investigations and further consideration by agency/Program staff. The above response was included in a new section 6.3.2 Considerations for Potential Phasing of

				Restoration Sites.
16		I understand the concept of the highest priority areas are those with the greatest impacts to flycatchers with the impending leaf beetle presence. However, I would guess that as far as a habitat restoration prioritization, the areas marked as 2s, 3s and 4s would probably be a higher priority for actually doing some on the ground restoration work. I'm assuming that would be the case because then managers could create suitable habitat adjacent to occupied habitat, that, hopefully, could be ready once the flycatchers are ready to leave occupied areas, or forced to leave once nest success is so low from beetle defoliation. Is that the right way to interpret that? It wouldn't be to make it the first priority to modify occupied habitat first right? Or are we assuming, that by the time managers are actually able to do some on the ground restoration, those flycatcher populations will have already dispersed from their currently occupied patches?	USBR	C – Most definitely concur. This is clearly an option and viable approach (see also previous comments and responses, 13-15) as there is an array of plausible scenarios that could take place. The new section 6.3.2, and the above response, includes additional consideration added to the report in response to this comment.
17	Page 25, 1rst par	I would suggest re-wording the phrase "identify and characterize both specific and the ranges of suitable habitat types…" - It seems like a word is missing after "specific". Perhaps this would work: "identify and characterize specific suitable habitat types and their ranges"?	USACE	C- Statement revised to, "… to identify and characterize both specific habitats and the ranges of suitable habitat types…."
18		I am attaching 2013 and 2014 TLB reports for reference	USACE	C-Thank you