Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Southwestern Willow Flycatcher Surveys and Monitoring Along the Lower Colorado River and Tributaries

2019 Annual Report

March 2020

Work conducted under LCR MSCP Work Task D2

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Lower Colorado River Multi-Species Conservation Program

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2019 Annual Report

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Multi-Species Conservation Program
Bureau of Reclamation
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ACRONYMS AND ABBREVIATIONS

ALAM	Alamo Lake study area
BA	biological assessment
BBIRD	Breeding Biology Research and Monitoring Database
BIWI	Bill Williams study area
BO	biological opinion
cfs	cubic foot/feet per second
CIBO	Cibola study area
cm	centimeter(s)
cottonwood-willow	Fremont cottonwood-Goodding's willow (*Populus fremontii-Salix gooddingii*)
cowbird	brown-headed cowbird(s) (*Molothrus ater*)
CVCA	Cibola Valley Conservation Area
FR	Federal Register
ha	hectare(s)
HCP	Habitat Conservation Plan
km	kilometer(s)
LCR	lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
LDCA	Laguna Division Conservation Area
m	meter(s)
MITT	Mittry Lake study area
n	sample size
Pa	Pascal(s)
PVER	Palo Verde Ecological Reserve
Reclamation	Bureau of Reclamation
RH	relative humidity
SE	standard error
sp.	unidentified single species
spp.	unidentified multiple species in a genus
SWCA	SWCA Environmental Consultants
T	temperature
TES	threatened, endangered, and sensitive
TOPO	Topock Marsh study area
U.S.	United States
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VP	vapor pressure
wet soils	inundated or saturated soils
YUMA	Yuma study area

Symbols

x	by
°	degrees
°C	degrees Celsius
=	equal to
>	greater than
≥	greater than or equal to
<	less than
≤	less than or equal to
#	number
%	percent
®	registered trademark
–	to
^	to the power of

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Attachment

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2 Field Data Forms

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4 Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Dates for Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2019

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6 Contributing Personnel

EXECUTIVE SUMMARY

SWCA Environmental Consultants (SWCA) was contracted by the Bureau of Reclamation (Reclamation) to continue surveys, monitoring, and ecological studies of southwestern willow flycatchers (*Empidonax traillii extimus*)[1] in suitable and/or historical riparian and wetland habitats throughout the lower Colorado River (LCR) region and along its tributaries in 2019.

The current geographic scope of the project includes the LCR and portions of its major tributaries downstream from Hoover Dam. Surveys were completed in selected sites throughout the project area; sites on a triennial schedule were not surveyed in 2019. SWCA completed territory monitoring at the Alamo Lake study area (ALAM) and within Lower Colorado River Multi-Species Conservation Program (LCR MSCP) conservation areas to determine the number of resident and paired flycatchers. More intensive territory monitoring, with the intention of locating flycatcher nests, was completed at the Topock Marsh (TOPO) and Bill Williams (BIWI) study areas outside of conservation areas to document nest fate, brood parasitism, and causes of nest failure.

Recorded broadcasts of flycatcher song and calls were used to elicit willow flycatcher responses at 67 sites, ranging in size from < 1 to 41 hectares, along the LCR and its tributaries from Topock Marsh, Arizona, south to Yuma, Arizona. Sites were visited in accordance with the five-survey protocol between May 15 and July 17, 2019. Surveys were conducted in six additional sites as part of habitat evaluation, and eight sites were evaluated but not surveyed. In addition to the surveys completed by SWCA, Reclamation completed broadcast surveys at Hunters Hole.

A total of 263 adult flycatchers and willow flycatchers were detected in the project area in 2019. Of these, 158 flycatchers from 95 territories were recorded at 13 sites within TOPO, BIWI, and ALAM, Arizona. An additional 105 willow flycatchers that did not occupy territories were detected across all study areas. Of these willow flycatchers, 74 were recorded south of Parker Dam between May 16 and June 12, and subsequent surveys and behavioral observations suggest they were not resident individuals but were most likely spring migrants.

Binoculars were used to determine the identity of previously color-banded flycatchers by observing, from a distance, the unique color combinations on their legs. Field personnel also used digital cameras to take pictures of flycatchers; these photos supplemented any resight data. Of the 263 adult flycatchers and willow flycatchers detected in 2019, 9 (3%) were known to be banded, and 6 of the 9 were individually identified. A total of 107 adults were known to be unbanded, and band status was undetermined for 147 adults.

[1] Throughout this document, when residency status for an individual is undetermined and the subspecies is unknown, the term "willow flycatcher" is used to refer to *E. traillii*. The term "flycatcher" refers to *E. t. extimus*.

In 2018, 10 adult, resident flycatchers were individually identified at study areas that were monitored by SWCA in both 2018 and 2019. Of these 10 flycatchers, 3 were detected in 2019. Two of the returning flycatchers were detected at the same study area where they were resident in 2018. The third flycatcher moved 69.2 kilometers (km) from BIWI Wispy Willow to TOPO Hell Bird. No within-year, between-study-area movements or juvenile dispersals were detected in 2019. Two between-year movements were detected for flycatchers that were most recently identified prior to 2018. One flycatcher that was last detected along the Virgin River in southern Nevada in 2013 was at ALAM Middle Earth 02 in 2019, a dispersal distance of 268.1 km. The second flycatcher was last detected along the Muddy River in southern Nevada in 2009 and was at ALAM Prospect 01 in 2019, a dispersal distance of 259.4 km.

Across all sites in TOPO and BIWI where intensive territory monitoring was conducted, nine flycatcher nesting attempts in eight nest structures were found at TOPO; no flycatcher pairs were documented at BIWI. Seven nests were known to contain flycatcher eggs and were used in calculating nest success and productivity. Five (71%) of the seven nests fledged flycatcher young, and the remaining two nests failed. One nest was parasitized by brown-headed cowbirds (*Molothrus ater*) during incubation, at which time all flycatcher eggs disappeared, and the nest was deserted. No cowbird eggs were addled or replaced in 2019. Twelve flycatcher fledglings were produced at TOPO, resulting in mean nest productivity of 1.71 (standard error = 0.52) and mean fecundity of 2.0 (standard error = 0.52).

Soil moisture conditions were described up to four times at each of the nine nesting attempts at TOPO. Soil moisture conditions were described at eight nests within 4 days of the nest being found; two were found during building, two were found during laying, and four were found during incubation. All nests were within 30 meters (m) of wet soils when they were found. Soil moisture conditions recorded during building and laying likely represent the conditions that were present when the female flycatcher selected the nest site. All four nests that were found during building or laying were within 2 m of wet soil when they were found. A slight drying trend was apparent from mid-June to mid-August, with a decrease in the presence of wet soils beneath nests and in the nest vicinity and a corresponding increase in the distance to wet soils, which reached 50 m at one nest by mid-August.

The species of tree or shrub in which a nest was placed, as well as a visual estimate of the percentage of vegetation volume that consisted of tamarisk (*Tamarix* spp.) within 2 and 5 m of the nest, was recorded at each of the nine flycatcher nesting attempts at TOPO. The purpose of quantifying the amount of tamarisk near each nest is to determine the potential impact of defoliation due to tamarisk beetles (*Diorhabda* spp.), which have been present at TOPO since 2017 and were documented in the study area throughout the breeding season in 2019. Seven nesting attempts were in areas where vegetation was > 75% tamarisk, one was in a mix of tamarisk and coyote willow (*Salix exigua*), and one was in an area that was > 75% Goodding's willow (*Salix gooddingii*). Seven nest structures were placed in tamarisk and one was in a

Goodding's willow. Nest height across all vegetation types ranged from 2.1 to 4.0 m (average = 2.9, standard error = 0.2). Tamarisk was a substantial component of the vegetation surrounding eight of the nine nesting attempts. The tamarisk within 5 m of each nest were green until mid- or late July, when the tamarisk foliage turned brown as the result of tamarisk beetle activity

An iButton data logger was deployed at each of seven flycatcher nest structures after the nest was confirmed to not be in the building or laying phase. No logger was deployed at the eighth nest structure, which disappeared soon after it was found. The loggers were deployed between mid-June and mid-July and remained in place until mid-August. The branch on which one iButton was hung had fallen by the time iButtons were retrieved, and the iButton could not be found. Data from two of the remaining six iButtons could not be downloaded because the batteries had ceased functioning during the iButton deployment. The remaining four iButtons functioned normally. The small sample size precluded meaningful comparisons between microclimate conditions observed in 2019 and those observed in other years.

Chapter 1 – Introduction

SPECIES INTRODUCTION

The southwestern willow flycatcher (*Empidonax traillii extimus*) is one of four currently recognized subspecies of willow flycatcher (Unitt 1987). It breeds in dense, mesic riparian habitats at scattered, isolated sites in New Mexico, Arizona, southern California, southern Nevada, southern Utah, southwestern Colorado, and, at least historically, extreme northwestern Mexico and western Texas (figure 1-1) (Unitt 1987).

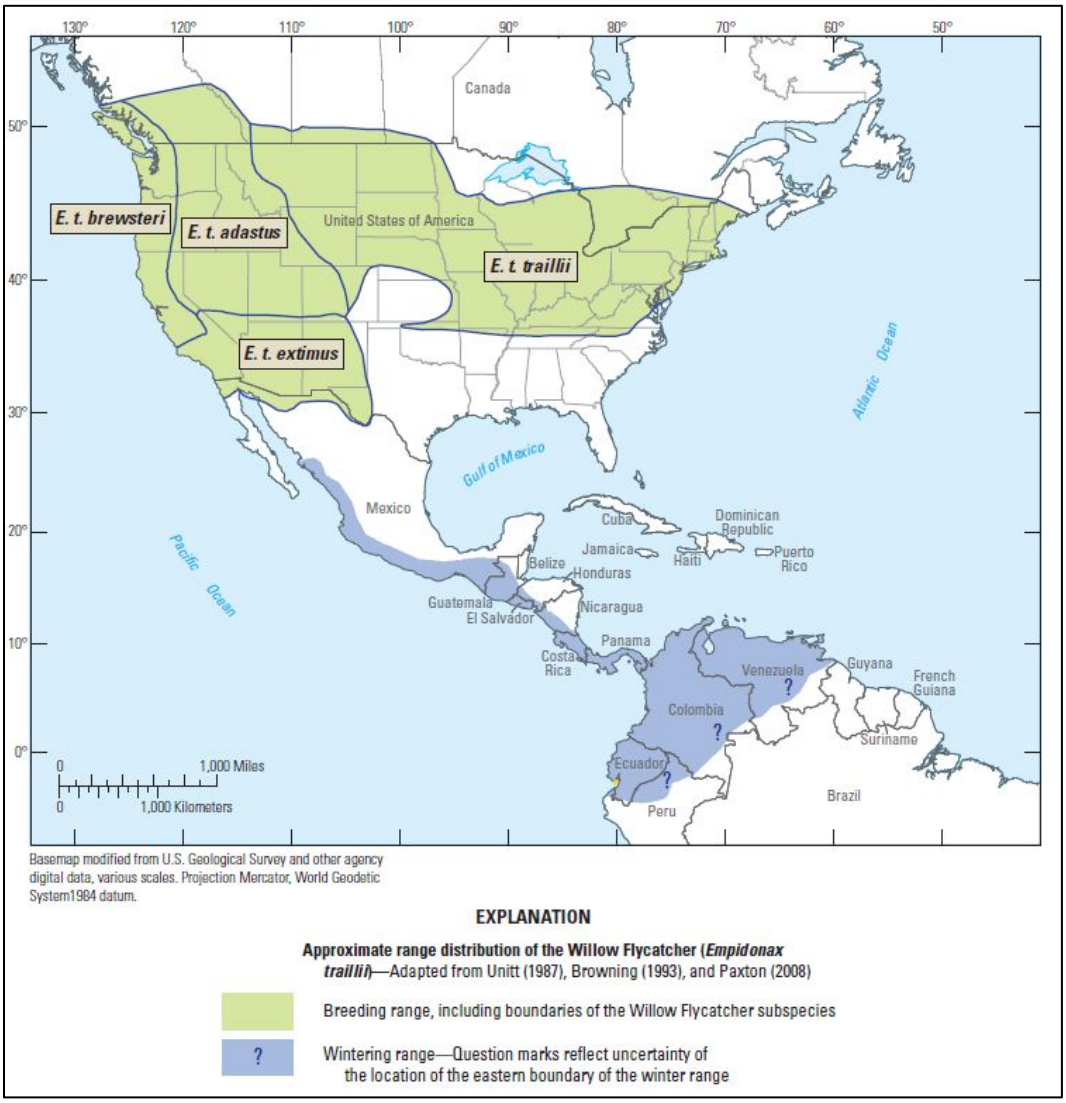

Figure 1-1.—Breeding range distribution of the subspecies of the willow flycatcher (*Empidonax traillii*).
From Sogge et al. (2010).

In the Southwest, most flycatcher[1] breeding territories are found within small breeding sites containing five or fewer territories (Durst et al. 2006). One of the last long-distance neotropical migrants to arrive in North America in spring, the flycatcher has a short, approximately 100-day breeding season, with individuals typically arriving in May or June and departing in August (Sogge et al. 2010). All four subspecies of the willow flycatcher spend the non-breeding season in portions of southern Mexico, Central America, and northwestern South America (Howell and Webb 1995; Ridgely and Tudor 1994; Stiles and Skutch 1989; Unitt 1997), with wintering ground habitat being similar to habitat on the breeding grounds (Lynn et al. 2003). Willow flycatchers have been recorded on their wintering grounds from central Mexico to southern Central America as early as mid-August (Howell and Webb 1995; Stiles and Skutch 1989), and wintering, resident individuals have been recorded in southern Central America as late as the end of May (Koronkiewicz et al. 2006).

Historical breeding records and museum collections indicate that a sizable population of flycatchers may have existed along the most southerly stretches of the lower Colorado River (LCR) (Unitt 1987). The most recent collection of a breeding flycatcher along the LCR south of the Bill Williams River, Arizona, was in 1938, and no nests have been found in this area since before 1970 (Unitt 1987), though northbound and southbound migrant willow flycatchers use the riparian corridor (Brown et al. 1987; McKernan and Braden 2002; McLeod and Pellegrini 2013; McLeod et al. 2008, 2018a; Phillips et al. 1964; this document). Factors contributing to the decline of flycatchers on their breeding grounds include loss, degradation, and/or fragmentation of riparian habitat; invasion of riparian habitat by non-native plants; and brood parasitism by brown-headed cowbirds (*Molothrus ater*) (hereafter cowbirds) (Marshall and Stoleson 2000; U.S. Fish and Wildlife Service [USFWS] 1995). Because of low population numbers range-wide, identifying and conserving flycatcher breeding sites is thought to be crucial to the recovery of the subspecies (USFWS 2002).

Tamarisk Leaf Beetles

Tamarisk leaf beetles (*Diorhabda* spp.) were introduced to the United States as biological control for tamarisk (*Tamarix* spp.), a non-native riparian plant that has become widespread in the Western United States. Tamarisk beetles feed on tamarisk foliage, scraping away the cuticle of the leaf and causing desiccation of the foliage, which turns yellow and then brown and then falls from the plant. When the plant refoliates, it often has a reduced foliage volume, and the leaves often have a clumpy or tufted appearance. Repeated defoliation can result in dieback of terminal branches, partial mortality, or complete mortality of the plant. Tamarisk defoliation

[1] Throughout this document, when residency status for an individual is undetermined and the subspecies is unknown, the term "willow flycatcher" is used to refer to *E. traillii*. The term "flycatcher" refers to *E. t. extimus*.

during the flycatcher breeding season poses a threat to flycatchers nesting in tamarisk stands, likely exposing flycatcher nests to adverse microclimate conditions and increased risks of depredation and parasitism. Dieback and mortality of the tamarisk as the result of repeated defoliation can also reduce the suitability of tamarisk stands as breeding habitat for flycatchers.

Northern tamarisk beetles (*D. carinulata*) were released in St. George, Utah, in 2006, and widespread defoliation was first observed in St. George in 2008. The area of defoliation on the Virgin River expanded downstream annually, encompassing the entire stretch of the Virgin River to Lake Mead, Nevada, by the end of the breeding season in 2011. Tamarisk beetles continued spreading downstream along the LCR in 2012, and by the end of the 2012 breeding season, they were found as far downstream as the lower end of Lake Mohave (Arizona and California) (T. Dudley 2012, personal communication). By fall 2013, tamarisk beetles were detected approximately 11 kilometers (km) south of Lake Mohave at Big Bend State Park, Nevada (B. Bloodworth 2014, personal communication). No substantial southerly movement was recorded in 2014 (T. Dudley 2014, personal communication), but by August 2015, beetles were detected approximately 11 km south of Big Bend (T. Dudley 2015, personal communication). Beetles expanded their range an additional 110 km downstream on the LCR in 2016 and by the end of the summer were found at Topock Marsh, in Topock Gorge, along the shores of Lake Havasu (Arizona and California), on the Parker Strip, and on the Bill Williams River as far upstream as Kohen Ranch (L. Harter 2016, personal communication; M.A. McLeod, personal observation; S. Ketcham 2016, personal communication). Beetles continued to spread in 2017, arriving at Blythe, California, on the LCR (B. Bloodworth 2017, personal communication) and at Alamo Lake (McLeod et al. 2018b). Beetles were detected approximately 65 km south of Blythe at the Imperial National Wildlife Refuge in October 2018 (E. Munes 2018, personal communication).

Bureau of Reclamation Project History

In 1995, the Bureau of Reclamation (Reclamation); other Federal, State, and Tribal agencies; and environmental and recreational interests agreed to form a partnership to develop and implement the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) for long-term endangered species compliance and management in the historical floodplain of the LCR. As a step in developing the LCR MSCP, Reclamation prepared a biological assessment (BA) in August 1996, evaluating the effects of dam operations and maintenance activities on threatened, endangered, and sensitive (TES) species. These species included the flycatcher, which was listed by the USFWS as endangered in 1995 (60 FR 10694–10715). In response to the BA, the USFWS issued a biological opinion (BO) in April 1997, which outlined several terms and conditions Reclamation must implement in order not to jeopardize these species. Among these terms and conditions was the requirement to survey and monitor occupied and potential habitat for flycatchers along the LCR for a period of 5 years. The studies were intended to determine the

number of flycatcher territories, status of breeding pairs, nest success, the biotic and abiotic characteristics of occupied flycatcher sites, and cowbird brood parasitism rates. In 2002, Reclamation reinitiated consultation with the USFWS on the effects of continued dam operations and maintenance of TES species along the LCR. The USFWS responded with a BO in April 2002, requiring continued flycatcher studies along the LCR through April 2005.

The LCR MSCP is a 50-year program that seeks to protect 27 TES species and their habitats along the LCR while maintaining river regulation and water management required by law. The LCR MSCP was approved in April 2005 with the signing of a Record of Decision by the Secretary of the U.S. Department of the Interior, and implementation of the program began in October 2005. Documentation for the LCR MSCP includes a Habitat Conservation Plan (HCP), a BA/BO, and an environmental impact statement. The HCP specifies monitoring and research measures that call for surveys and research to better define habitat requirements for the flycatcher and studies to determine the effects of cowbird nest parasitism on flycatcher reproduction. The HCP also calls for the creation of a system of conservation areas, where habitat would be created for the benefit of many species, including the flycatcher.

Reclamation initiated flycatcher studies along the LCR in 1996 in anticipation of the requirements outlined in the BOs that were part of LCR MSCP development. These studies have been conducted annually since 1996 and were completed in 1996–2002 by the San Bernardino County Museum and in 2003–19 by SWCA Environmental Consultants (SWCA). Prior to 2017, Reclamation's flycatcher studies included several breeding areas in southern Nevada, and color banding and intensive territory and nest monitoring were completed wherever territorial flycatchers were detected. Beginning in 2018, the geographic scope of the project was reduced to include only the LCR and portions of its major tributaries downstream from Hoover Dam, banding was largely discontinued, and intensive territory and nest monitoring was completed only in specific portions of the project area.

Throughout the history of this project, SWCA has designated "survey sites" (an area of riparian habitat that can generally be covered via presence/absence surveys by one person in a single morning) and grouped those survey sites geographically into "study areas." In 2013, a three-tiered geographic naming convention was instituted by the LCR MSCP that designates area, site, and section, with area covering the largest extent and section the smallest. SWCA's designation of "survey site" is equivalent to section. A study area does not always correspond to a LCR MSCP area; in some cases, a study area encompasses multiple areas, and in others, an area encompasses multiple study areas. The relationship of the LCR MSCP area and site classifications to the designations of survey site and study area is shown in attachment 1. Throughout this report, the terminology of survey site and study area is used for ease of comparison with earlier reports.

DESCRIPTION OF STUDIES

Study areas included in the project in 2019 (figure 1-2) are: (1) Topock Marsh (TOPO) on the LCR, Havasu National Wildlife Refuge, Arizona; (2) Bill Williams (BIWI), along the Bill Williams River, Arizona; (3) Alamo Lake (ALAM), Arizona; (4) Palo Verde Ecological Reserve (PVER), within the PVER Conservation Area north of Blythe, California; (5) Cibola (CIBO), along the LCR in and around the Cibola National Wildlife Refuge, Arizona; (6) Mittry Lake (MITT), along the LCR around Mittry Lake, Arizona and California; and (9) Yuma (YUMA), along the LCR between Yuma and the Southerly International Boundary with Mexico and along the Gila River between Yuma and Dome, Arizona.

Specific components of the 2019 study, and the chapters in which they are addressed, are as follows:

Chapter 2 – Site Descriptions. A general site description, including major types of vegetation and hydrological conditions, was completed for each survey site at least three times during the survey season. This chapter gives a general description of each survey site and discusses habitat quality and changes in habitat quality.

Chapter 3 – Presence/Absence Surveys and Territory Monitoring. Presence/absence surveys, following a five-survey protocol (per Sogge et al. 2010), were conducted at pre-selected survey sites. A portion of the sites are surveyed every 3 years; these were not surveyed in 2019. Territory monitoring (visiting locations of flycatcher detections with the intention of determining whether a territory was present and if it consisted of a single flycatcher or a pair) was completed at ALAM and within LCR MSCP conservation areas. This chapter presents the methodology and results of surveys and territory monitoring.

Chapter 4 – Resighting. Flycatchers were resighted during surveys and territory and nest monitoring activities. This chapter summarizes the number of banded and unbanded flycatchers detected, lists banded flycatchers that could be individually identified, and discusses between-year movements and dispersal.

Chapter 5 – Nest Monitoring and Nest Site Characteristics. Intensive territory monitoring, with the intention of locating flycatcher nests, was completed at TOPO and BIWI outside of conservation areas. Any flycatcher nests that were found in these areas were monitored to determine nest fates. Data on surface hydrology, vegetation type, and microclimate were collected at these nest locations. This chapter summarizes nesting attempts, nest fates, and productivity for monitored flycatcher nests and reports the conditions of vegetation type, soil moisture, temperature, and humidity recorded at these nest sites.

Chapter 6 – Summary of Study Design Discussions. For ease of reference, this chapter summarizes all study design discussions from previous chapters.

Figure 1-2.—Locations of southwestern willow flycatcher study areas along the LCR and its tributaries, 2019.
(Note: Study area labels represent the approximate center of multiple sites within that region.)

Chapter 2 – Site Descriptions

INTRODUCTION

During each year of the flycatcher study, SWCA has formulated qualitative descriptions of the vegetation and soil moisture characteristics of each site surveyed for flycatchers or evaluated as a potential survey site. These descriptions make it possible to track changes in habitat conditions and quality over time.

METHODS

Site Selection

Survey sites were selected based on locations surveyed during previous years of flycatcher studies along the LCR (McLeod et al. 2018a) and evaluation on foot during the 2019 survey period. Reclamation biologist Chris Dodge guided and approved survey site selection. Survey sites in the Topock Gorge study area and those located south of Parker Dam but outside LCR MSCP conservation areas are currently surveyed every 3 years and were not surveyed in 2019. Some sites in BIWI were surveyed irregularly in earlier years, but these were returned to the annual schedule starting in 2018 when they were included in the Middle Bill Williams River National Wildlife Refuge as creditable acreage under the LCR MSCP. Several of these sites were scheduled for evaluation in 2019 based on conditions observed in 2018. All sites that were surveyed irregularly in years prior to 2018 were ones at which no territorial flycatchers had been detected in recent years and at which vegetation and hydrology were unlikely to change without a major flood event.

During the survey season, on-the-ground habitat reconnaissance and evaluation were conducted to locate additional potentially suitable flycatcher habitat and to re-evaluate areas visited in previous years and noted as having the potential to become suitable habitat. Personnel focused habitat reconnaissance and evaluation in areas that appeared to match the criteria for suitable habitat (see "Habitat Suitability Criteria" below) either in aerial imagery or from a distance on the ground. If the evaluation site met the criteria for suitable habitat, the site was added to the survey site list and scheduled for surveys for the remainder of the season. If the evaluation site did not meet the criteria for suitable habitat, but field personnel judged that it could potentially mature and develop missing criteria in future years, the site was scheduled for re-evaluation in future seasons.

Field personnel were provided with high-resolution digital aerial photographs of all survey sites and potential survey sites. Aerial imagery was georeferenced and overlain with an outline of the proposed survey area. Boundaries of a survey site were sometimes refined during the season based on conditions observed on the ground.

Habitat Suitability Criteria

Habitat suitability criteria (table 2-1) were developed to guide the evaluation of each site in terms of its suitability for flycatchers. The criteria were based upon habitat conditions documented in flycatcher territories along the LCR (McLeod and Pellegrini 2013; McLeod et al. 2008) as well as descriptions of suitable habitat in Sogge et al. (2010). Criteria were defined for both minimally suitable habitat and preferred nesting habitat. Any survey site could include both suitable and unsuitable habitat because boundaries were drawn to encompass the maximum known extent of suitable habitat, and unsuitable riparian vegetation contiguous with suitable habitat was often included as part of the survey areas. The presence of the various components of suitable and preferred habitat was evaluated based on data recorded during site descriptions.

Table 2-1.—Southwestern willow flycatcher habitat suitability criteria for suitable and preferred habitat along the LCR and tributaries

Habitat metrics and components		Suitable habitat	Preferred nesting habitat
Metric	Patch width	≥ 10 meters	≥ 20 meters
	Canopy height	≥ 4.5 meters	≥ 5.5 meters
	Canopy closure	≥ 85%	≥ 90%
Component	Midstory structural components[1]	Dense layer of vegetation to provide cover for nests	Dense layer of vegetation to provide cover for nests
		Dense twig structure for nest placement	Dense twig structure for nest placement
		Flight paths present within the midstory	Flight paths present within the midstory
	Surface water or saturated soil[2]	Present or absent	Present within or adjacent to woody vegetation in at least May and June

[1] Structural components are those that have been observed in the field but that have not been quantitatively measured as part of this project. Components are recognizable even though they are not measured.

[2] Surface water or saturated soil is required to maintain suitable vegetation structure. Suitable vegetation structure may persist for a few years without nearby wet soils.

Site Descriptions

Because vegetation structure and surface soil moisture conditions within riparian habitats are seasonally dynamic, field personnel completed site description forms (attachment 2) for each flycatcher survey site at least three times throughout the survey season: early season (mid-May), mid-season (mid-June), and late season (mid-July). Prior to completing any site descriptions, all field personnel received training in the identification of common woody riparian species and in estimating vegetation height and canopy closure. Vegetation composition (native versus exotic) at survey sites followed the definitions of Sogge et al. (2010) and the flycatcher range-wide database. Vegetation composition was defined as (1) native: > 90% of the vegetation at a site was native, (2) exotic: > 90% of the vegetation at a site was exotic, (3) mixed-native: 50 to 90% of the vegetation at a site was native, or (4) mixed-exotic: 50 to 90% of the vegetation at a site was exotic. In addition to the overall vegetation composition, field personnel identified one or more vegetation types within the site and recorded the dominant overstory and understory species in each vegetation type. For each vegetation type, field personnel recorded visual estimates of overstory height (to the nearest meter [m]), understory height (to the nearest m), canopy closure (to the nearest 5%), and the percentage of the site occupied by that vegetation type.

Field personnel recorded various metrics of surface hydrology within the site: percentage of soil within the site that was inundated, saturated, damp, or dry (to the nearest 5%, unless one category comprised only 1 or 2% of the site); depth of any surface water (to the nearest centimeter [cm] or nearest 5 cm if > 5 cm); and distance to water (to the nearest m) if no saturated or inundated soil (hereafter wet soils) was documented in the site. Surface soil moisture categories were qualitatively determined as follows: inundated soils were those that had water visible on the surface; soils were considered saturated if compression of the soil (e.g., by stepping on it) caused water to be expressed; soils were considered dry if squeezing a handful of soil did not result in the soil sticking together; and damp soils were any that did not have surface water and did not meet the criteria for either saturated or dry (i.e., compressing a handful of soil caused the soil to stick together, but no water was expressed). Field personnel also recorded information on the presence or absence of tamarisk beetles at the site and the condition (green, yellow/brown, defoliated, refoliating, or dead) of any tamarisk within the site.

As part of each site description, field personnel provided a narrative description of the site and sketched the location of each vegetation type, surface water, and saturated soil on a map of the site that showed the site outline and aerial imagery. On each site description form, the observer selected a habitat suitability ranking on a scale of 1 to 5 based upon the observer's general impression, which was loosely guided by the criteria described above (see table 2-1). After the conclusion of field season, information from the site description forms was used in conjunction with

habitat photographs and comments in field notebooks and in survey data to formulate a comprehensive, qualitative description for each site and to assess habitat suitability.

RESULTS

Field personnel recorded site descriptions at 67 sites that were surveyed or monitored for flycatchers throughout the survey season and at an additional 6 sites that were surveyed at least once as part of habitat evaluations (see chapter 3 for details on survey effort). Field personnel spent 9.2 observer-hours conducting habitat evaluations and recording site descriptions at eight sites (Pipes 01, Pipes 03, Pig Hole, In Between, Pierced Egg, and Lost Lake Slough 01 at TOPO; and Beaver Pond North and Beaver Pond at BIWI) where no surveys were completed because of poor habitat quality. An additional 4.9 observer-hours were spent evaluating unsuitable portions of surveyed sites; these portions were not included in the regular surveys (see orthophotos in attachment 3 for boundaries of survey and evaluation sites in 2019).

Each site description below is organized into several parts: (1) Any notable geographic features within or adjacent to a site, (2) any stochastic events or observations of habitat conditions in recent years that are pertinent to understanding habitat conditions in 2019, (3) vegetation composition and structure, (4) vegetation condition, (5) tamarisk beetle activity, if tamarisk were present in the site and tamarisk beetles were noted in the study area, (6) surface hydrology and soil moisture conditions, and (7) habitat suitability. One or both of the first two parts are omitted for sites without notable geographic features and/or pertinent site history. Any characteristics that are common to all sites within a study area are described in the introduction to the study area. Tamarisk beetle activity is not described for evaluation sites, which were visited one to three times during the survey season.

Topock Marsh, Arizona

TOPO encompasses a large expanse of riparian vegetation, consisting primarily of monotypic tamarisk with isolated patches of tall Goodding's willows (*Salix gooddingii*), within the Havasu National Wildlife Refuge between the LCR to the west and the open water of Topock Marsh to the east. Seasonally wet, low-lying areas occur within the riparian vegetation. The elevation within the study area is approximately 140 m above mean sea level.

In August 2015, a wildfire burned through TOPO north of the Firebreak Canal, which bisects the riparian area. In April 2016, a second wildfire burned through TOPO south of South Dike Road. Each survey site in the areas affected by the fires

was partially to completely consumed. Vegetation within the burned sites has been regenerating, and surveys resumed in portions of two sites (The Wallows and In Between) in 2018 and in portions of two additional sites (PC6-1 and Lost Lake) in 2019. The remainder of the survey sites affected by the 2015 fire were evaluated in 2019 but not surveyed. Survey and evaluation sites within TOPO are listed below from north to south.

Feral pigs have been historically present throughout TOPO, and evidence of pigs was observed in 2019 in one survey site north of the Firebreak Canal and most sites south of the canal. Tamarisk beetles and patches of yellow or brown tamarisk foliage were noted in TOPO in May in areas outside any survey or evaluation site, and the affected area slowly increased until a majority of tamarisk in TOPO had desiccated foliage by late July. Marsh elevation data recorded at the South Dike gaging station show that water levels within Topock Marsh increased through mid-June and then declined during the remainder of the flycatcher breeding season. Marsh levels were 0.07–0.12 m lower throughout the 2019 survey season than they were on the corresponding day in 2018 (figure 2-1).

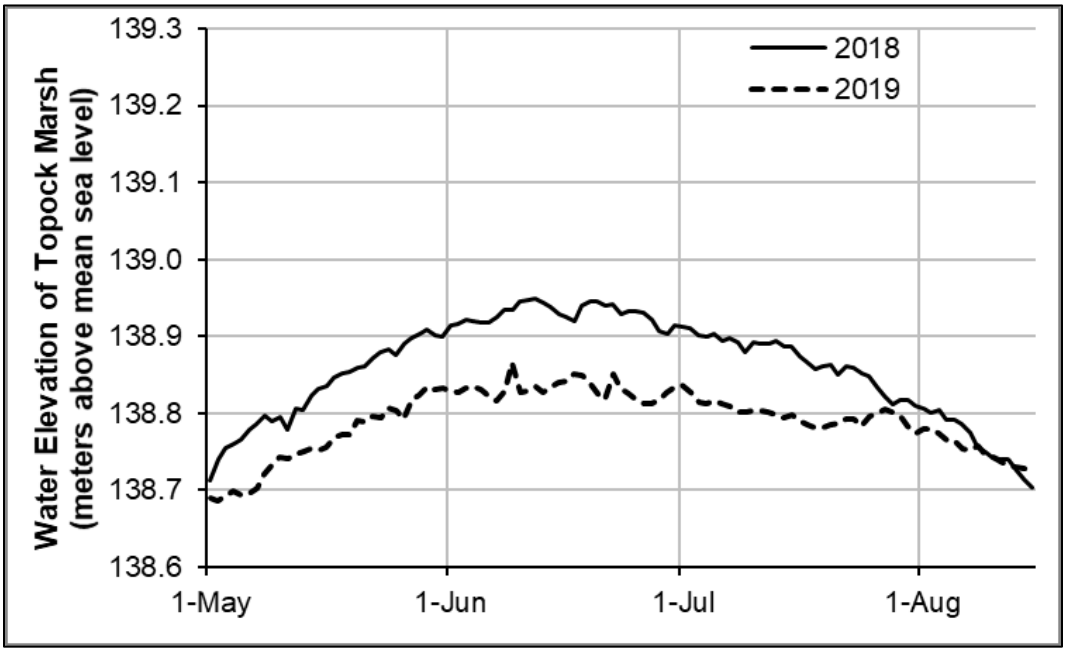

Figure 2-1.—Daily water elevation (meters above sea level) measured at the South Dike at Topock Marsh, May – August 2018–19.

The Wallows

History

The Wallows was completely consumed in the August 2015 fire. Surveys resumed in 2018.

Vegetation Composition and Structure

This survey site consisted of a 10-m-wide stand of 6–8-m-tall Goodding's willows that lined the northeastern end of an open cattail (*Typha* spp.) marsh. The Goodding's willows had an understory of cattails. Coyote willows (*Salix exigua*) 2.5–3 m in height and a few Fremont cottonwoods (*Populus fremontii*) (hereafter cottonwood) were present in a narrow band along the northeastern edge of the Goodding's willow stand. Coyote willows were also present in a 10-m-wide stand of 3–4-m-tall stems along the southeastern edge of the cattail marsh and Goodding's willow stand. Tamarisk, arrowweed (*Pluchea sericea*), and willow baccharis (*Baccharis salicina*) up to 2.5 m in height were present along the northern, eastern, and southern borders of the site. Canopy closure was 80–85% in the Goodding's willow and 70–80% in the coyote willows and varied directly with canopy height.

Vegetation Condition

There were a few standing snags in the site, but most had fallen. All living trees had full canopies and appeared healthy.

Tamarisk Beetle Activity

No signs of tamarisk beetles were observed in the site during any visit.

Surface Hydrology

Saturated soils were present in the cattail marsh when each site description was recorded (table 2-2). Soils under the willows were primarily damp, and soils became progressively drier and sandier with increasing distance from the willows and cattail marsh. Water levels within the site are dependent on the elevation of Topock Marsh, which increased gradually in 2019 to a peak in mid-June and then decreased gradually (see figure 2-1). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

Habitat Suitability

All characteristics of suitable habitat were present where canopy closure reached 85% (see table 2-1). However, stand width barely met the criterion for suitable habitat, and areas where all the other characteristics of suitable habitat were present occupied a limited areal extent. Vegetation structure is likely to continue developing in future years.

Table 2-2.—Summary of soil moisture conditions by survey site, 2019*

Study area[1]	Survey site	Percent of site inundated[2]	Depth (cm) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (m) to surface water or saturated soil[2]
TOPO	The Wallows	0 / 0 / 0	0 / 0 / 0	30 / 25 / 80	0 / 0 / 0
	PC6-1	0 / 10 / 0	0 / 3 / 0	0 / 15 / 0	75 / 0 / 75
	800M	20 / < 1 / 0	15 / 5 / 0	5 / 50 / 0	0 / 0 / 130
	Swine Paradise[4]	15 / 5 / 0	25 / 5 / 0	5 / 15 / 0	0 / 0 / 3
	Platform[4]	0 / <1 / 0	0 / 2 / 0	0 / < 1 / 0	15 / 0 / 12
	250M[4]	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	5 / 5 / 5
	Hell Bird[4]	10 / 20 / 15	20 / 30 / 40	20 / 5 / 5	0 / 0 / 0
	Glory Hole[4]	15 / 12 / 15	30 / 55 / 30	10 / 20 / 5	0 / 0 / 0
	Farm Ditch Road[4]	– / – / –	– / – / –	– / – / –	0 / 0 / 0
	CPhase 05[5]	0 / 0 / 3	0 / 0 / 15	0 / 0 / 5	15 / 15 / 0
	Lost Lake	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	20 / 5 / 60
	Lost Lake Slough 02	98 / 30 / 45	5 / 2 / 6	2 / 70 / 50	0 / 0 / 0
	Lost Lake Slough 03[4]	15 / 25 / 50	3 / 10 / 3	40 / 35 / 20	0 / 0 / 0
	Lost Lake Slough 04	– / 3 / 50	8 / 1 / 6	– / 75 / 35	0 / 0 / 0
BIWI	Wispy Willow[4]	35 / 4 / 5	35 / 15 / 10	10 / 1 / 45	0 / 0 / 0
	Site 01[4]	– / 10 / 0	– / 2 / 0	– / 10 / 45	0 / 0 / 0
	Site 04[4]	6 / 5 / 5	20 / 20 / 30	1 / 2 / 1	0 / 0 / 0
	Site 03	5 / 3 / 1	10 / 5 / 2	20 / 5 / 0	0 / 0 / 0
	Last Gasp	5 / 1 / 0	35 / 20 / 0	2 / 1 / 0	0 / 0 / 523
	Guinness	5 / 2 / 5	45 / 50 / 30	2 / 1 / 0	0 / 0 / 0
	Site 05	3 / 5 / 5	100 / 83 / 100	2 / 5 / 0	0 / 0 / 0
	Site 08	16 / 20 / 25	50 / 50 / 70	4 / 5 / 1	0 / 0 / 0
	Upstream Site 08[4]	5 / 5 / 5	25 / 27 / 20	5 / 7 / 10	0 / 0 / 0
	Planet Ranch Road	6 / 10 / 5	5 / 27 / 5	2 / 4 / 5	0 / 0 / 0
ALAM	Bullard Wash	100 / 100 / 100	> 200 / > 200 / > 200	0 / 0 / 0	0 / 0 / 0
	Camp 01	100 / 100 / 100	> 200 / > 200 / > 200	0 / 0 / 0	0 / 0 / 0
	Camp 02	100 / 100 / 100	> 200 / > 200 / > 200	0 / 0 / 0	0 / 0 / 0
	Camp 03	100 / 100 / 100	> 200 / > 200 / > 200	0 / 0 / 0	0 / 0 / 0
	Middle Earth 01	100 / 100 / 100	> 200 / > 200 / > 200	0 / 0 / 0	0 / 0 / 0
	Middle Earth 02	100 / 95 / 85	> 200 / > 150 / > 150	0 / 5 / 15	0 / 0 / 0
	Prospect 01	100 / 100 / 100	> 200 / > 150 / 100	0 / 0 / 0	0 / 0 / 0
	Burro Wash 01	100 / 100 / 100	> 200 / > 200 / > 200	0 / 0 / 0	0 / 0 / 0
	Burro Wash 02	100 / 100 / 100	> 200 / 200 / 200	0 / 0 / 0	0 / 0 / 0

Table 2-2.—Summary of soil moisture conditions by survey site, 2019*

Study area[1]	Survey site	Percent of site inundated[2]	Depth (cm) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (m) to surface water or saturated soil[2]
ALAM (cont.)	Motherlode 01	100 / 90 / 88	> 200 / 200 / 150	0 / 10 / 4	0 / 0 / 0
	Motherlode 02[6]	– / – / 35	– / – / 30	– / – / 40	– / – / 0
	Prospect 02[4,6]	– / – / 0	– / – / 0	– / – / 0	– / – / 0
	Motherlode 04	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	5 / 50 / 75
	Santa Maria North 01	4 / 3 / 3	8 / 3 / 5	0 / 2 / 1	0 / 0 / 0
PVER	Phase 02[5]	30 / 0 / 0	10 / 0 / 0	20 / 0 / 0	0 / 25 / 10
	Phase 03[5]	20 / 0 / 0	10 / 0 / 0	0 / 0 / 0	0 / 20 / 20
	Phase 04 Block 01[5]	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	56 / 56 / 56
	Phase 04 Block 02[5]	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	20 / 20 / 20
	Phase 04 Block 03[5]	0 / 30 / 0	0 / 6 / 0	0 / 40 / 0	145 / 0 / 145
	Phase 05 Block 01[5]	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	25 / 10 / 25
	Phase 05 Block 02[5]	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	25 / 25 / 25
	Phase 05 Block 03[5]	10 / 0 / 0	3 / 0 / 0	90 / 0 / 0	0 / 97 / 60
	Phase 06 Block 01[5]	0 / 40 / 30	0 / 7 / 6	0 / 5 / 20	97 / 0 / 0
	Phase 06 Block 02[5]	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	5 / 25 / 25
	Phase 07 Block 01[5]	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	110 / 8 / 20
	Phase 07 Block 02[5]	0 / 0 / 0	0 / 0 / 0	0 / 0 / 40	10 / 2 / 0
CIBO	Phase 01[5]	0 / 10 / 0	0 / 4 / 0	0 / 5 / 0	20 / 0 / 10
	Phase 02[5]	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	470 / 10 / 470
	Phase 03[5]	0 / 23 / 0	0 / 5 / 0	0 / 3 / 0	15 / 0 / 15
	Phase 08[5]	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	20 / 20 / 20
	Upper Hippy Fire[5]	0 / < 1 / < 1	0 / 3 / 4	0 / < 1 / 0	358 / 0 / 0
	Nature Trail[5]	5 / 0 / 0	5 / 0 / 0	0 / 0 / 0	0 / 1,190 / 10
	Lower Hippy Fire[5]	0 / < 1 / 0	0 / – / 0	0 / 0 / 0	10 / 0 / 10
	C2729[5]	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	5 / 10 / 10
MITT	C4958[5]	2 / 3 / 100	5 / 5 / 95	1 / 5 / 0	0 / 0 / 0
	C4911[5]	80 / 0 / 100	4 / 0 / 40	17 / 0 / 0	0 / 75 / 0
	C4913[5]	20 / 0 / 100	4 / 0 / 40	25 / 0 / 0	0 / 80 / 0
	C4959[5]	100 / 100 / 0	30 / 25 / 0	0 / 0 / 0	0 / 0 / 20
	C4961[5]	100 / 100 / 0	30 / 25 / 0	0 / 0 / 0	0 / 0 / 10
	C4960[5]	100 / 100 / 0	35 / 25 / 0	0 / 0 / 0	0 / 0 / 10

Table 2-2.—Summary of soil moisture conditions by survey site, 2019*

Study area[1]	Survey site	Percent of site inundated[2]	Depth (cm) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (m) to surface water or saturated soil[2]
YUMA	C4703[5]	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	15 / 15 / 15
	C4711[4]	2 / 2 / 2	– / – / –	0 / 0 / 0	0 / 0 / 0
	C4702[5]	2 / 0 / 2	3 / 0 / 5	0 / 0 / 0	0 / 25 / 0

* Values are given for each site as recorded in mid-May, mid-June, and mid-July. Evaluation sites are not included.

[1] TOPO = Topock Marsh, BIWI = Bill Williams, ALAM = Alamo Lake, PVER = Palo Verde Ecological Reserve, CIBO = Cibola, MITT = Mittry Lake, and YUMA = Yuma.
[2] – = Hydrologic information not recorded.
[3] Percent of site with saturated soil does not include inundated areas.
[4] Site borders marsh, river, lake, or pond.
[5] Site is irrigated as part of restoration efforts; amount of surface water highly variable throughout survey season.
[6] Site discovered partway through survey season with flycatchers.

PC6-1

History

PC6-1 was heavily damaged in the August 2015 fire. The site was evaluated in 2018, but all vegetation was too short to meet the suitability criteria. The site was evaluated again in 2019.

Vegetation Composition and Structure

Vegetation in the original site boundary consisted primarily of sparse 1–3-m-tall tamarisk. Arrowweed 2–3 m in height were present in large patches in the western half of the site. Canopy closure did not exceed 30% within the original site boundary, and the area within the original site boundary was evaluated but not surveyed.

A stringer of coyote willows 3–5 m in height with Goodding's willows 5–7 m in height and no understory was present just north of the original site boundary. The willows were present in two disjunct patches separated by a small cattail marsh. The willows and cattails were surrounded by dense arrowweed 2–2.5 m in height. Canopy closure within the willows was 65–85% and averaged 75%. This portion of the site was surveyed in 2019.

Vegetation Condition

All the willows appeared healthy, and no deadfall was noted.

Surface Hydrology

In the original site boundary, all soils were dry during a visit in May except for a small patch of saturated soil in the center of the site.

In the northern willow stringer, wet soils were observed in the cattail marsh between the two willow patches, and all other soils were damp when the June site description was recorded (see table 2-2). The entire site had damp soils when the May and July site descriptions were recorded. Water levels within the site are dependent on the elevation of Topock Marsh, which increased gradually in 2019 to a peak in mid-June and then decreased gradually (see figure 2-1). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

Habitat Suitability

Habitat within the original site boundary continued to regenerate in 2019 but still failed to meet any of the structural habitat suitability criteria (see table 2-1). Suitable habitat was present in the northern willow stringer where both canopy height and canopy closure met the criteria, though the areal extent of such habitat was limited. Suitable habitat is likely to increase in areal extent as the willows continue to grow.

800M

History

Most of 800M was consumed in the August 2015 fire. An evaluation in 2017 revealed the presence of relatively undamaged vegetation on the eastern side of the original site boundary, and this portion of the site was surveyed starting 2017.

Vegetation Composition and Structure

Vegetation in this survey site consisted of a 150- x 60-m stand of 4–6-m-tall tamarisk with scattered cattails and saltmarsh fleabane (*Pluchea odorata*). The tamarisk stand was bordered to the north and west by a cattail and bulrush (*Schoenoplectus californicus*) marsh. The southern 50 m of the site was dominated by dense 2.5-m-tall arrowweed and scattered 2.5-m-tall, regenerating tamarisk. Canopy closure reached 80–90% in the tallest tamarisk, 55% in the small clearings of cattails and herbaceous vegetation, and 20–30% in the northwestern cattail marsh and southern 50 m of the site.

Vegetation Condition

No signs of past damage or stress were evident in the tamarisk within the main portion of the site. Prior to the onset of beetle defoliation in mid-June, all tamarisk were lush and green. A few old snags were still scattered throughout the site, but most of these had fallen.

Tamarisk Beetle Activity

No signs of beetle activity were noted in May. A few beetles were observed in mid-June, and up to 70% of each tamarisk in the southern 50 m of the site was turning brown, while approximately 10% of each tamarisk had brown leaves in the remainder of the site. Many adult beetles and egg clusters were observed in July, and tamarisk throughout the site had a mixture of green leaves, yellow leaves, and defoliated branches.

Surface Hydrology

Wet soils were present in the marsh and in the tamarisk south and east of the marsh when the May and June site descriptions were recorded (see table 2-2). Most soils within the site were damp when the July site description was recorded. Water levels within the site are dependent on the elevation of Topock Marsh, which increased gradually in 2019 to a peak in mid-June and then decreased gradually (see figure 2-1). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

Habitat Suitability

All characteristics of suitable habitat were present where canopy closure reached 85% (see table 2-1). Vegetation height and density may increase in future years.

Swine Paradise

Geographic Features

The survey site known as Swine Paradise is adjacent to and south of the Firebreak Canal and is bordered to the east by Topock Marsh.

Vegetation Composition and Structure

Vegetation was mixed-exotic and consisted of tamarisk 3–8 m in height and scattered, emergent Goodding's willows up to 18 m in height. Both the tamarisk and Goodding's willows were significantly shorter in the southern quarter of the site, with no woody vegetation exceeding 8 m in height, and large patches of arrowweed dominated the understory in the southern half of the site. There was little understory directly beneath the Goodding's willows. A dense, 40- x 60-m patch of coyote willows 4–7 m in height was present in the northeastern corner of the site, adjacent to the Firebreak Canal. The coyote willows were shortest on the eastern edge of the site, adjacent to the open marsh, while the tamarisk were tallest adjacent to the coyote willow patch. Canopy closure reached 85% directly under the Goodding's willows. In the coyote willows, canopy closure was 70–85% and averaged 75%. In areas dominated by tamarisk, canopy closure was 50–85%, averaging 80% in the tallest tamarisk in the northern portion of the site and 65% in the shorter tamarisk in the southern portion of the site.

Vegetation Condition

Up to 40% of the branches on each tamarisk appeared dead. The foliage on many tamarisk had the clumpy growth form typical of previously defoliated plants. The ground beneath each of the Goodding's willows was thick with willow deadfall, though no current signs of stress were evident in the willows.

Tamarisk Beetle Activity

No signs of tamarisk beetles were observed in May or June. Early instar beetle larvae were observed in mid-July, and up to 15% of the foliage on each tamarisk was brown.

Surface Hydrology

Wet soils were present in the coyote willow patch when the May and June site descriptions were recorded (see table 2-2), but soils in the coyote willow patch were damp when the July site description was recorded. Nearly all soils in the remainder of the site were completely dry throughout the season. Swine Paradise borders the open water of Topock Marsh, and water levels within the site vary directly with those in Topock Marsh, which increased gradually in 2019 to a peak in mid-June and then decreased gradually (see figure 2-1). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

Habitat Suitability

Suitable habitat occurred where canopy closure reached 85% (see table 2-1) in the tamarisk and coyote willows, but these areas were limited in areal extent.

Platform

Geographic Features

The survey site known as Platform is bordered by the main refuge road to the west and Topock Marsh to the east.

Vegetation Composition and Structure

Vegetation at the site was exotic and consisted primarily of monotypic tamarisk 5–10 m in height with a few emergent Goodding's willows 15–18 m in height. A few screwbean mesquite (*Prosopis pubescens*) and honey mesquite (*Prosopis glandulosa*) trees were present along the western edge of the site. Two disjunct patches of coyote willows, each 60 m long, were present along the eastern edge, adjacent to the marsh. The northern coyote willow patch was approximately 5–10 m wide, though scattered coyote willows were present within the site up to 30 m from the

eastern edge, and the southern patch was approximately 35 m wide. Canopy closure reached 85% in the densest tamarisk and 80% under the Goodding's willows. Canopy closure in the coyote willows was not described.

Vegetation Condition

Up to one-third of the tamarisk were 50% dead, and the living portions of the plants had relatively sparse, clumpy foliage.

Tamarisk Beetle Activity

Beginning in mid-June, tamarisk beetle adults and/or larvae were present on each visit. Approximately 10–20% of the foliage was turning yellow in mid-June, and almost all foliage was yellow or brown in mid-July, although some tamarisk under the Goodding's willows were still green.

Surface Hydrology

Wet soils were present along the very eastern edge of the site bordering the marsh when the June site description was recorded (see table 2-2), but the remainder of the site was very dry. Platform borders the open water of Topock Marsh, and water levels within the site vary directly with those in Topock Marsh, which increased gradually in 2019 to a peak in mid-June and then decreased gradually (see figure 2-1). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

Habitat Suitability

The interior of the site lacked the wet soils typical of preferred habitat and the flight paths in the understory typical of suitable habitat (see table 2-1). Canopy closure did meet the criterion for suitable habitat in the densest tamarisk, but the areal extent of such vegetation was very limited.

250M

Geographic Features

The survey site known as 250M is bordered by the main refuge road to the west and Topock Marsh to the east.

Vegetation Composition and Structure

Vegetation was mixed-exotic, and composition and structure varied with distance from the road. Most of the site was vegetated in tamarisk 4–8 m in height, which was shorter near the road and taller near the eastern side of the site. A few emergent Goodding's willows approximately 12–15 m in height were present in the

north-central portion of the site, and honey mesquite 6–9 m in height were scattered in the southern half. A patch of coyote willows 45 x 90 m in size and 4–6 m in height was present along the northern edge of the site. The coyote willow stems were sparse and emerged through heaps of fallen coyote willows. Canopy closure in the tamarisk varied directly with canopy height, ranging from 40 to 90% and averaging 70%. Canopy closure in the coyote willows was 40–70% and averaged 65%, while canopy closure in the Goodding's willows was 45–85% and averaged 70%.

Vegetation Condition

On average, 50% of each tamarisk was dead, with some trees as much as 95% dead and others as little as 5% dead. The live foliage had the clumpy growth form typical of previously defoliated plants.

Tamarisk Beetle Activity

Tamarisk beetle adults were present in the site in late May and mid-July, and larvae were noted in mid-June. All tamarisk had some brown foliage by late June. Up to 50% of the tamarisk foliage was brown in mid-July, and the remainder was beginning to turn brown.

Surface Hydrology

Almost all soils observed during site description visits were dry, although small patches of damp soils were present (see table 2-2). 250M borders the open water of Topock Marsh, and water levels within the site vary directly with those in Topock Marsh, which increased gradually in 2019 to a peak in mid-June and then decreased gradually (see figure 2-1). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

Habitat Suitability

The interior of the site lacked the wet soils typical of preferred habitat and the flight paths in the understory typical of suitable habitat (see table 2-1). Canopy closure was also too low to meet the criterion for suitable habitat in most of the site. Places where canopy closure reached 85% were localized and limited in areal extent.

Hell Bird

Geographic Features

The survey site known as Hell Bird is on an island separated from the main riparian area by a narrow, deep channel. The site is bordered to the north by the open channel and to the east and south by marshes.

Vegetation Composition and Structure

Vegetation was mixed-exotic and consisted of a mosaic of tamarisk, Goodding's willows, and arrowweed. The northern two-thirds of the site was dominated by tamarisk 3–5 m in height. Several old channels were braided throughout this area and were primarily vegetated with arrowweed and the occasional bulrush. Goodding's willows ranging from 8 to 12 m and averaging 10 m in height were scattered throughout the northern two-thirds of the site, and the tallest Goodding's willows formed a stringer along the southern edge of this portion of the site. There was little understory beneath these Goodding's willows. Screwbean mesquite 4–6 m in height and 1–2-m-tall willow baccharis were widely scattered in this portion of the site, and coyote willows 2–5 m in height were present along the northern edge. Canopy closure in the northern two-thirds of the site was 50–75%, averaging 60% in the tamarisk and 55–85% under the Goodding's willows. Canopy closure reached 65% in the coyote willows.

The southern third of the site was dominated by cattail and bulrush marshes, which covered approximately 20% of the site's areal extent. Goodding's willows 10–12 m in height with 3–5-m-tall tamarisk in the understory were present along the southern edge of the site. Canopy closure was 85–90% under these Goodding's willows and as high as 85% in the surrounding tamarisk.

Vegetation Condition

Tamarisk in the northern two-thirds of the site exhibited widespread dieback of terminal branches, with 20–40% of each plant appearing to be dead. In contrast, no more than 5% of any tamarisk in the southern third of the site was dead. The Goodding's willows farthest from the cattail marshes showed the greatest signs of stress with many dead branches, broken tops, and oddly shaped and sparse canopies. Willows in this condition were most prevalent in the far southwestern corner and northern end of the site. Goodding's willows adjacent to the marshes showed little to no signs of stress, though there was extensive deadfall beneath many of these trees.

Tamarisk Beetle Activity

No signs of tamarisk beetles were noted until late June, when yellowing tamarisk were present in the northern half of the site. Tamarisk beetle adults, larvae, and eggs were observed in mid-July, mostly in the northern half of the site, where 30% of the tamarisk were completely brown and the remaining tamarisk were turning yellow. Tamarisk around active nest locations along the southern edge of the site turned yellow and brown in late July.

Surface Hydrology

The marshes in the southern third of the site were inundated when each site description was recorded, with the water depth averaging 20–40 cm and ranging up

to 50 cm (see table 2-2). Soils elsewhere were primarily dry, though some damp soils were noted, and shallow water was present in narrow channels near the northern edge of the site when the May and June site descriptions were recorded. The marshes in the site are connected to Topock Marsh, and water levels within the site vary directly with those in Topock Marsh, which increased gradually in 2019 to a peak in mid-June and then decreased gradually (see figure 2-1). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

Habitat Suitability

Canopy closure was too low in most of the northern two-thirds of the site to meet the suitability criterion (see table 2-1). Canopy closure in this portion of the site reached 85% under some Goodding's willows, but these areas lacked any sort of understory structure. Suitable habitat was present in the portions of the southern third of the site that contained woody vegetation. Preferred nesting habitat was present where canopy closure in the Goodding's willows reached 90%.

Glory Hole

Geographic Features

The survey site known as Glory Hole is on an island separated from the main riparian area by a narrow, deep channel and is contiguous with and immediately to the southwest of Hell Bird. The site is bordered on the north by a sand dune and on other sides by a mix of woody vegetation and marshes.

Vegetation Composition and Structure

Vegetation was mixed-exotic, and vegetation composition and structure were highly variable. The site was vegetated primarily by a mosaic of tamarisk 4–8 m in height and Goodding's willows 8–18 m in height. The Goodding's willows were most prevalent in the eastern half of the site and were tallest in the center. The northwestern edge of the site was dominated by tamarisk, with the tallest tamarisk present in the very western corner of the site. Honey mesquite trees up to 6 m in height and arrowweed were scattered in the southeastern lobe of the site. Marshes vegetated by cattails and bulrush were interspersed throughout the southern half of the site, and small patches of coyote willows up to 4 m in height were scattered along the marsh edges. Canopy closure was 70–90% in areas with Goodding's willows and varied directly with canopy height. In tamarisk-dominated areas, canopy closure was 30–85% and averaged 65% in the northeastern corner, 50% in the southeastern lobe, and 75% in the western corner.

Vegetation Condition

Tamarisk throughout the site exhibited dieback of terminal branches, with up to 20% of each plant appearing dead. Dieback was most prevalent along the northwestern edge of the site and in the southeastern lobe. Live vegetation in these areas also had the clumpy growth form typical of previously defoliated plants. Tamarisk in the center of the site appeared healthy, with only a little bit of clumpy foliage evident at the tops of trees. The healthiest Goodding's willows in the center of the site had lush foliage but had one or two large fallen limbs, which made the canopies appear ragged. In the northeastern corner and southeastern lobe, several Goodding's willows had dead limbs and broken tops or oddly shaped canopies. Deadfall was thick beneath all Goodding's willows.

Tamarisk Beetle Activity

No signs of tamarisk beetles were observed until mid-June, when tamarisk beetle larvae were noted near the southwestern edge of the site. In mid-July, no tamarisk beetle adults or larvae were observed, but 50% of the tamarisk appeared to be affected by beetles, with up to 15% of each tree having yellow foliage. By early August, 80% of the tamarisk appeared to be affected by beetles, and many trees were over 50% yellow.

Surface Hydrology

The marshes, totaling approximately 15% of the areal extent of Glory Hole, were inundated with an average of 30–55 cm of water when each site description was recorded (see table 2-2). Adjacent soils were damp to dry. The marshes in the site are connected to Topock Marsh, and water levels within the site vary directly with those in Topock Marsh, which increased gradually in 2019 to a peak in mid-June and then decreased gradually (see figure 2-1). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

Habitat Suitability

Portions of the site dominated by Goodding's willows where canopy closure met the suitability criterion had all the components of suitable or preferred nesting habitat (see table 2-1). Canopy closure also met the criterion for suitable habitat in limited patches of monotypic tamarisk. Canopy closure was too low in the remainder of the site to meet the suitability criterion.

Farm Ditch Road

Geographic Features

The survey site known as Farm Ditch Road is on the north side of Farm Ditch, a 10-m-wide channel bordered to the south by a gravel road. The interior of the site was described in 2015, at which time suitable habitat was present directly adjacent to

Farm Ditch (McLeod and Pellegrini 2017). Suitable habitat was within 50 m of the road, and surveys have been conducted from the road since 2015. Because the site was surveyed primarily from the road in 2019, a thorough assessment of vegetation structure and hydrology is not available.

Vegetation Composition and Structure

The southern edge of the site consisted of a mosaic of coyote willows, tamarisk, and honey mesquite 5–7 m in height with canopy closure of 65–85%. Cattails and bulrush were present along the very southern edge of the site and occasionally extended into the site. A stringer of widely spaced Goodding's willows 10–13 m in height was visible behind the coyote willows, tamarisk, and honey mesquite. On the eastern edge of the site, the Goodding's willows were 4–10 m in height and had a thick understory of 2-m-tall arrowweed.

Vegetation Condition

Between 5 and 40% of each tamarisk that was visible from the road appeared to be dead, and many of the coyote willows had dead tops. Both the coyote willows and tamarisk in one patch in the western half of the site appeared healthy and lush in comparison to the rest of the site. Canopy closure reached 85% only in this healthy patch of vegetation.

Tamarisk Beetle Activity

No tamarisk beetles were observed along the road, but up to 10% of tamarisk had yellow leaves when the June and July site descriptions were recorded.

Surface Hydrology

The extent of wet soils within the site was unknown in 2019, but wet soils could have existed given the presence of marsh vegetation extending into the site.

Habitat Suitability

Habitat suitability was not thoroughly assessed in 2019, as surveys were primarily conducted from outside the site. Vegetation along the southern edge of the site appeared to meet the criteria for suitable habitat where canopy closure reached 85% (see table 2-1); however, suitable habitat was limited in areal extent.

CPhase 05

Geographic Features

The survey site known as CPhase 05 is within the Beal Lake Conservation Area.

Vegetation Composition and Structure

Vegetation consisted of a mosaic of cottonwoods, Goodding's willows, coyote willows, honey mesquite, screwbean mesquite, willow baccharis, and arrowweed. Tamarisk were scattered throughout the site in low abundance. Vegetation species co-occurred in three general combinations. Approximately 55% of the site had a cottonwood overstory. The understory within cottonwoods varied and along the northern border of the site consisted of a mixture of honey and screwbean mesquite, willow baccharis, and arrowweed. In the remainder of the cottonwoods, the understory was absent or consisted of widely scattered honey mesquite. Canopy height in the cottonwoods averaged 10 m and ranged from 4 to 15 m. Canopy closure averaged 70% and ranged from 50 to 90%, varying directly with canopy height. Approximately 30% of the site was vegetated with 1–2-m-tall arrowweed and willow baccharis and 2–5-m-tall honey and screwbean mesquite. Canopy closure in these areas was 10–30% and varied directly with vegetation height. Approximately 10% of the site was vegetated with either Goodding's willows up to 7 m in height or coyote willows up to 4 m in height. Canopy closure in Goodding's willows was 40–60% and averaged 40%. In the coyote willows, canopy closure was 30%. The remaining 5% of the site was vegetated with a mixture of 4–6-m-tall Goodding's willows, 2–4-m-tall screwbean mesquite, and 2–2.5-m-tall tamarisk, arrowweed, willow baccharis, and coyote willows. Canopy closure in this cell did not exceed 50%.

Vegetation Condition

Most of the Goodding's and coyote willows were in poor condition, with the top half of most trees being completely dead and the bottom half having sparse foliage. A few Goodding's willows had full canopies, but these trees were widely scattered throughout the site and did not form a closed canopy. There were several areas throughout the site where the mesquite trees were completely dead, both in the understory of cottonwoods and where they were mixed with arrowweed. The live honey and screwbean mesquite all looked healthy. Low canopy closure in the cottonwoods was the result either of widely spaced trees that did not form a closed canopy or of trees with narrow canopies, small leaves, and dead limbs. The former were primarily along the northern border of the site and the latter along the eastern border. The healthiest cottonwoods occupied approximately 15% of the site near its center and had relatively full, dense canopies.

Surface Hydrology

No wet soils were observed when the May and June site descriptions were recorded (see table 2-2). Active irrigation was occurring when the July site description was recorded, and wet soils were present within 15 m of irrigation outlets. The amount of wet soils within the site is highly variable because the site is flood irrigated, and sandy soil allows the water to drain rapidly after irrigation.

Habitat Suitability

Canopy closure was too low to meet the criterion for suitable habitat in a majority of the site (see table 2-1). Where canopy closure reached 85%, the midstory structural components typical of suitable habitat were missing.

Lost Lake

Geographic Features

The survey site known as Lost Lake is in a strip of riparian vegetation that is separated from the Colorado River to the southwest by a low ridge of barren sand dunes and is bordered to the northeast by a cattail and bulrush marsh.

History

Lost Lake was heavily damaged in the April 2016 fire. The site was evaluated in 2018, but no portion of the site contained both suitable canopy closure and suitable patch width. The site was evaluated again in 2019.

Vegetation Composition and Structure

The northern edge of the original survey site consisted of a narrow (< 40 m wide) strip of mixed-native riparian vegetation 150 m in length. This strip of vegetation consisted of an overstory of planted cottonwoods 20 m in height on the edge of a cattail marsh, with an understory of 6-m-tall tamarisk, screwbean mesquite, and willow baccharis. The western 50 m of the original survey site was vegetated with widely scattered 3–4-m-tall screwbean mesquite and 3–5-m-tall tamarisk with sparse arrowweed and grassy areas. Most of the remainder of the original site consisted of a mixture of dense arrowweed 2–3 m in height with widely scattered screwbean and honey mesquite and tamarisk up to 5 m in height. Canopy closure reached 60% in the densest vegetation along the northern edge of the original survey site but was as low as 5% in areas with more widely scattered vegetation. These portions of the site were evaluated but not surveyed.

Near the northwestern end of the original site boundary there was a stand of coyote willows approximately 75 x 30 m in size, with tamarisk mixed in on the eastern and western ends. The coyote willows were 2.5–4 m in height with 65–85% canopy closure. Canopy height and closure were highest in a 20-x 20-m patch in the center of the stand. Some piles of deadfall were present and were least abundant in the center of the coyote willow stand. This portion of the site was surveyed.

Vegetation Condition

In the portion of the site that was evaluated but not surveyed, half of the cottonwoods were dead, and none of the canopies were interlocking. In the coyote willows, all the trees appeared healthy and lush.

Tamarisk Beetle Activity

Tamarisk beetle larvae were observed in and around the site starting in mid-June, and tamarisk immediately west of the site were brown. Tamarisk beetle larvae and adults were observed in the site in July.

Surface Hydrology

In the portion of the site that was evaluated but not surveyed, saturated soils were noted in the very northwestern end of the site during a visit in May; almost all other soils were dry. In the coyote willows, soils were completely damp when each site description was recorded (see table 2-2). Wet soils were present within 20 m of the western edge of the coyote willow stand when the May and June site descriptions were recorded. The surveyed area of Lost Lake is 70 m from the cattail and bulrush marsh that borders open water downstream from the water control structure at the outflow of Topock Marsh. Water levels in this area can fluctuate between and sometimes within visits (A. Pellegrini, personal observation), and it is possible that the amount of wet soils near the site varied widely.

Habitat Suitability

The portion of the original site that was evaluated but not surveyed did not contain any areas where canopy closure met the suitability criterion. In the coyote willow stand, all characteristics of suitable habitat were present except for canopy height, which was slightly too short (see table 2-1). The coyote willows have grown noticeably in the last couple of years and will likely continue to improve in suitability.

Lost Lake Slough 02

Geographic Features

The survey site known as Lost Lake Slough 02 is surrounded by a cattail and bulrush marsh.

Vegetation Composition and Structure

Vegetation within the site consisted of a stand of coyote willows 3–5 m in height with bulrush scattered throughout the understory. The coyote willows were shorter and more widely spaced in the northern half of the site than in the southern half, and the bulrush was more abundant in the northern half. Two tiny (10 x 12 m) patches of 8-m-tall tamarisk were also present. Canopy closure in the coyote willows was

60–85% and was lower in the northern half of the site than in the southern half. Areas with 85% canopy closure in the coyote willows were extremely localized. Canopy closure in the tamarisk was 80%.

Vegetation Condition

All vegetation in the site appeared healthy.

Tamarisk Beetle Activity

No signs of tamarisk beetles were observed in the site during any visit.

Surface Hydrology

Almost the entire site contained wet soils when each site description was recorded (see table 2-2). Lost Lake Slough 02 borders open water downstream from the water control structure at the outflow of Topock Marsh. Water levels in the site vary directly with those of the open water, which fluctuated between and sometimes within visits (A. Pellegrini, personal observation).

Habitat Suitability

Suitable habitat was present where both canopy height and canopy closure met the criteria (see table 2-1), though the areal extent of such habitat was limited. Canopy height and canopy closure in the northern half of the site were too low to meet either criterion.

Lost Lake Slough 03

Geographic Features

The survey site known as Lost Lake Slough 03 is bordered to the east by an open channel, to the north by a cattail and bulrush marsh, and to the south by dry uplands adjacent to a graded gravel road. The site is "L" shaped, with a short arm extending northeast along the open channel.

Vegetation Composition and Structure

The northern arm of the site was dominated by tamarisk 4–5 m in height with coyote willows and common reed mixed throughout the tamarisk. The remainder of the site was primarily wispy coyote willows 2.5–4 m in height, which were bordered to the south by scattered 1–2-m-tall arrowweed, tamarisk, and screwbean and honey mesquite. Many burned snags were present along the southern edge of the site.

Canopy closure in the coyote willows was 70–80%. When the tamarisk was green in May and June, canopy closure in the northern arm of the site was 85–90%. After the tamarisk began to turn yellow and brown, canopy closure dropped to 70%.

Vegetation Condition

Vegetation in the main portion of the site appeared lush and healthy.

Tamarisk Beetle Activity

No tamarisk beetle adults or larvae were observed in the site in May or June. A few adults and larvae, as well as yellowing tamarisk, were noted in the site starting in early July, and most of the tamarisk were yellow or brown by mid-July.

Surface Hydrology

Standing water was present in the site when each site description was recorded (see table 2-2). Lost Lake Slough 03 borders open water downstream from the water control structure at the outflow of Topock Marsh. Water levels in the site vary directly with those of the open water, which fluctuated between and sometimes within visits (A. Pellegrini, personal observation).

Habitat Suitability

During May and June, all components of suitable and preferred nesting habitat (see table 2-1) were present in the tall, dense tamarisk in the northern arm of the site. The coyote willows in the southern portion of the site, however, did not meet the canopy closure criterion for suitable habitat. Canopy closure in the tamarisk failed to meet the criterion for suitable habitat after the tamarisk foliage turned brown in July, although the other components of preferred nesting habitat were still present.

Lost Lake Slough 04

Geographic Features

The survey site known as Lost Lake Slough 04 is bordered by a marsh to the north and dry uplands to the south.

Vegetation Composition and Structure

The northern half of the site, adjacent to the marsh, consisted of a band of coyote willows ranging in height from 2 to 5 m. In the western half of the site, the coyote willows were shorter (2–4 m) and were mixed with 2-m-tall arrowweed. A 5–10-m-wide strip of 5-m-tall tamarisk was also present in the western half of the site. In the eastern half of the site, the vegetation transitioned to 4–5-m-tall coyote willows with 2-m-tall bulrush in the understory. Deadfall was thick throughout the site. The

southern edge of the site was dominated by a mix of tamarisk, arrowweed, and screwbean mesquite 2 m in height. Canopy closure was 65–80% and varied directly with canopy height.

A small (18 x 30 m) patch of coyote willows adjacent to the eastern end of Lost Lake Slough 04 was evaluated at the end of May. This patch was delineated as part of Lost Lake Slough 03 until 2018, when the Lost Lake Slough 03 boundary was redrawn to exclude the western half of the original site. This patch consisted entirely of coyote willows 4–5 m in height with 75–80% canopy closure. There were many dead stems mixed with the live stems and the combination of the two created vertical structure that lacked flyways. This patch was not surveyed in 2019.

Vegetation Condition

Up to 10% of each tamarisk appeared dead.

Tamarisk Beetle Activity

Adult tamarisk beetles were observed in the site in late June, and up to 25% of the tamarisk were yellow or brown in early to mid-July. No evidence of tamarisk beetle activity was noted in the site prior to late June.

Surface Hydrology

Standing water was present in the site when each site description was recorded (see table 2-2). Lost Lake Slough 04 borders open water downstream from the water control structure at the outflow of Topock Marsh. Water levels in the site vary directly with those of the open water, which fluctuated between and sometimes within visits (A. Pellegrini, personal observation).

Habitat Suitability

Canopy closure did not meet the criterion for suitable habitat anywhere in the site (see table 2-1). Re-examination of the area in 1–2 years would determine whether the coyote willows have increased in height or density and would reduce the chance that suitable habitat is overlooked.

Habitat Evaluation

Habitat evaluations were completed in 2019 at Pipes 01, Pipes 03, Pig Hole, In Between, and Pierced Egg, all of which were consumed in the August 2015 fire. These sites were evaluated in 2017 and 2018 but did not contain any suitable habitat in those years. The sites were evaluated again in May 2019 but did not contain

suitable habitat; therefore, they were not surveyed. No tamarisk beetles were observed during the site visits, though up to 20% of the tamarisk in some sites had rusty-brown foliage.

A habitat evaluation was also completed at Lost Lake Slough 01. Although the site was surveyed in 2018, no part of the site met the habitat suitability criteria (see table 2-1). The site was evaluated in 2019 to investigate an area adjacent to the southwestern boundary of the site that appeared on aerial imagery to contain coyote willows. No suitable habitat was present, and the site was not surveyed.

Pipes 01

Vegetation Composition and Structure

Vegetation in the site consisted of tamarisk ranging in height from 1 to 3.5 m and averaging 2 m in height. Dense arrowweed 2–3 m in height were present in the northeastern corner of the site. Canopy closure was < 20% throughout the site.

Vegetation Condition

All live vegetation looked healthy. Many charred snags were still standing and formed a distinct layer emerging above the regenerating tamarisk.

Surface Hydrology

All soils were dry and sandy except for a small patch of damp soil when the site was visited in May.

Habitat Suitability

No portion of the site had canopy closure that approached suitable levels (see table 2-1). Evaluating this site again in several years would ensure that no suitable habitat is overlooked.

Pipes 03

Vegetation Composition and Structure

Vegetation in the site consisted primarily of 1–3.5-m-tall, sparse tamarisk. Several dense patches of 2–3-m-tall arrowweed were mixed in with the tamarisk and covered approximately 30% of the site. Two small (< 10 x 10 m) clumps of Goodding's willows 6–7 m in height were present, with one on the northern border and one in the southern half of the site. Canopy closure did not exceed 30% anywhere in the site and was highest in the Goodding's willows.

Vegetation Condition

All live vegetation looked healthy. Many charred snags were still standing and formed a distinct layer emerging above the regenerating tamarisk.

Surface Hydrology

A small, 3-cm-deep puddle was present near the southwestern border of the site during the visit in May, and most of the rest of the soils were damp.

Habitat Suitability

No portion of the site had canopy closure that approached suitable levels (see table 2-1). Evaluating this site again in several years would ensure that no suitable habitat is overlooked.

Pig Hole

Vegetation Composition and Structure

Vegetation in most of the site consisted of 1–2.5-m-tall tamarisk. In the eastern quarter of the site, the tamarisk were 2–4 m in height and were mixed with 2–3-m-tall arrowweed. Cattails, willow baccharis, and saltmarsh fleabane were present in the eastern half of the site, just west of the arrowweed. Canopy closure did not exceed 10% anywhere in the site.

Vegetation Condition

The foliage on some tamarisk had the clumpy growth form typical of previously defoliated plants. Many charred snags were still standing and formed a distinct layer emerging above the regenerating tamarisk.

Surface Hydrology

Some damp soils were present in the area with cattails, but the remainder of the site was dry during the visit in May.

Habitat Suitability

No portion of the site had canopy closure that approached suitable levels (see table 2-1). Evaluating this site again in several years would ensure that no suitable habitat is overlooked.

In Between

Vegetation Composition and Structure

Vegetation in the site primarily consisted of 1–2-m-tall tamarisk. Several patches of 3–4-m-tall tamarisk were scattered through the site and covered approximately 20% of the site's areal extent. Arrowweed 2 m in height were present along the eastern border of the site. Canopy closure was 10% in the shorter tamarisk and 35% in the taller tamarisk.

Vegetation Condition

The foliage on some tamarisk had the clumpy growth form typical of previously defoliated plants. Many charred snags were still standing and formed a distinct layer emerging above the regenerating tamarisk.

Surface Hydrology

All soils observed during the site visit in May were dry.

Habitat Suitability

No portion of the site had canopy closure that approached suitable levels (see table 2-1). Evaluating this site again in several years would ensure that no suitable habitat is overlooked.

Pierced Egg

Vegetation Composition and Structure

Vegetation in the site consisted primarily of 1–2-m-tall tamarisk. Dense patches of 2-m-tall arrowweed were present along the southern, western, and northern borders of the site. One small patch of 4–6-m-tall tamarisk and a few patches of cattails and bulrush were present in the southeastern portion of the site. Several small (< 10 x 10 m) clumps of Goodding's willows up to 5 m in height were sprouting from the bases of Goodding's willow snags in the western and southern portions of the site and just beyond the northeastern boundary. Canopy closure ranged from 10% in most of the site to 80% in the tallest tamarisk.

Vegetation Condition

All live vegetation looked healthy. Many charred snags were still standing and formed a distinct layer emerging above the regenerating tamarisk.

Surface Hydrology

Saturated soils were noted in several locations in the southeastern quarter of the site when the site was visited in May. Of the remaining soils, 75% were dry and the rest were damp.

Habitat Suitability

Vegetation in most of the site lacked all structural characteristics of suitable flycatcher habitat (see table 2-1). The tall patch of tamarisk had suitable canopy height, but canopy closure and patch size did not meet the suitability criteria. Evaluating this site again at the beginning of the next breeding season would ensure that no suitable habitat is overlooked.

Lost Lake Slough 01

Geographic Features

The survey site known as Lost Lake Slough 01 is approximately 100 m south of the bridge on South Dike Road. It is bordered by a bulrush marsh to the north, west, and south and by an open channel to the east.

Vegetation Composition and Structure

The site consisted of a 35- x 65-m patch of 3–7-m-tall tamarisk with scattered 2–5-m-tall coyote willows along the eastern edge of the site. A few honey and screwbean mesquite trees were scattered throughout the site; most of the mesquite trees were 3 m tall, but a few were 7 m tall. The area on the southwestern edge of the site that appeared on the aerial photo to contain coyote willows was a dense patch of 2-m-tall arrowweed. Canopy closure was 60–90% but reached 90% only under the tallest mesquites.

Vegetation Condition

Several of the large mesquite trees were completely dead, and many of the taller tamarisk had dead tops.

Surface Hydrology

Most of the site (90%) was inundated up to 10 cm in depth when the site was visited in May.

Habitat Suitability

Canopy closure was too low to meet the criterion for suitable habitat in most of the site (see table 2-1), and places where it was > 85% were limited to individual trees.

Although some trees reached 7 m in height, there was no continuous canopy present above 3 m in height. Surveys at this site could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

Bill Williams, Arizona

BIWI encompasses the Bill Williams River National Wildlife Refuge and adjacent Planet Ranch. The Bill Williams River National Wildlife Refuge contains the last expanse of naturally occurring native cottonwood-willow forest in the LCR region. The refuge encompasses over 2,500 hectares (ha) along the Bill Williams River upstream of its mouth at Lake Havasu and contains a mixture of native forest, stands of monotypic tamarisk, beaver ponds, and cattail marshes. Planet Ranch is located adjacent to the upstream portion of the refuge and was incorporated into the LCR MSCP in 2015. Survey sites within BIWI are listed below from west to east, moving progressively farther upstream, and range in elevation from 137 to 171 m above mean sea level. Survey sites from Site 03 to Site 05 and evaluation sites from Black Rail to Beaver Pond are within the Middle Bill Williams River National Wildlife Refuge, which is acreage creditable to the LCR MSCP.

The rate of discharge of the Bill Williams River (U.S. Geological Survey [USGS] Station #09426620, between Site 05 and Beaver Pond North), was 0.0 cubic foot per second (cfs) from mid-April 2015 through mid-March 2018 (USGS 2019a). During this period, surface water was restricted to deep channels and beaver ponds, and vegetation within much of BIWI showed increasing signs of stress and mortality from the lack of water. Releases from Alamo Dam in 2018 resulted in a peak daily average flow of 2,870 cfs in mid-March and sustained flows of 10–15 cfs throughout the flycatcher breeding season, and native plant recruitment was noted in some sites during the 2018 survey season (McLeod and Pellegrini 2019; USGS 2019a).

In 2019, signs of burros (*Equus asinus*) were seen from near the confluence of the Bill Williams River and Mohave Wash upstream through Planet Ranch and were especially abundant in the survey site known as Planet Ranch Road. Tamarisk beetles were detected throughout the study area, primarily during June and July. Water levels within survey sites in the Bill Williams River Delta vary with the level of Lake Havasu, which varied by approximately 0.5 m over the course of the survey season (figure 2-2). The average daily flow of the Bill Williams River in 2019 was > 0.0 cfs through late June but 0.0 cfs thereafter (figure 2-3), with surface water again restricted to deep channels and beaver ponds once the average daily flow reached 0.0 cfs.

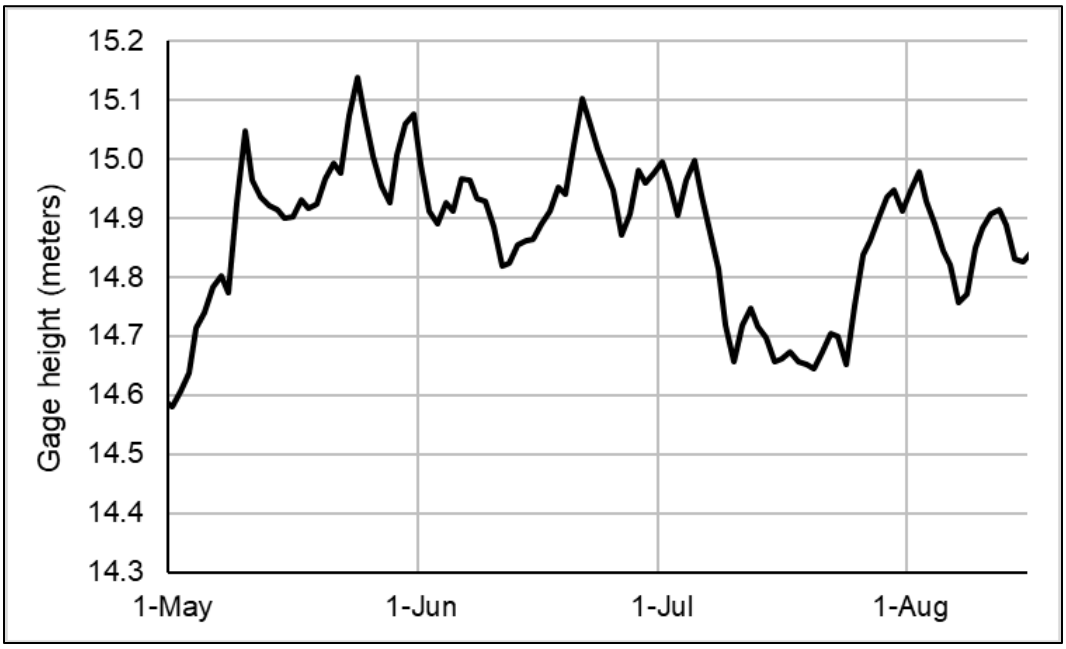

Figure 2-2.—Daily average gage height (m) recorded at Lake Havasu near Parker Dam, Arizona (USGS Station #09427500), May 1 – August 15, 2019.
Data source: USGS 2019b.

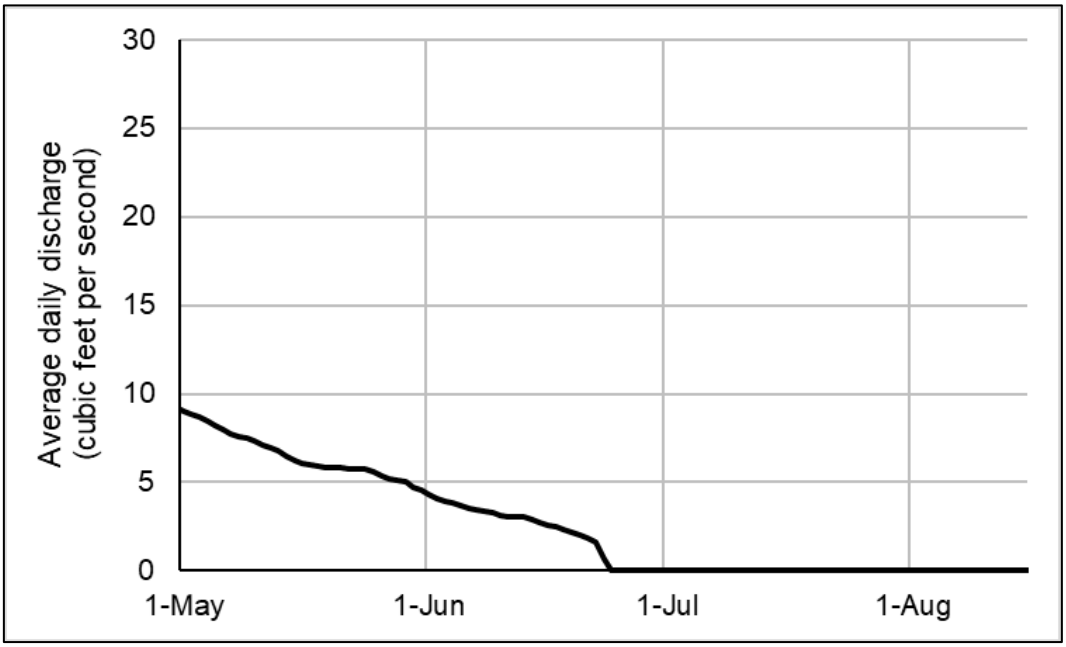

Figure 2-3.—Average daily discharge (cfs) recorded at the Bill Williams River near Parker, Arizona (USGS Station #09426620), May 1 – August 15, 2019.
Data source: USGS 2019c.

Wispy Willow

Geographic Features

The survey site known as Wispy Willow is bordered by the Bill Williams River to the south.

Vegetation Composition and Structure

Vegetation composition was mixed-native and consisted of 3–6-m-tall coyote willows and 3–6-m-tall tamarisk. The coyote willows were present throughout most of the southern three-quarters of the site. Within 40 m of the southwestern edge of the site, the coyote willows were 3–4 m in height and were mixed with dense cattails. Toward the middle of the site, the coyote willows were mixed with dense, dead, fallen woody vegetation instead of cattails. Canopy height in the coyote willows increased in the eastern half to 4–6 m. Tamarisk were mixed with the coyote willows along the eastern edge of the site and formed a narrow, monotypic stand near the middle of the site. The northern quarter of the site was vegetated with only tamarisk. Small cattail marshes were scattered along the southern, western, and northern borders. Canopy closure was 70–90% within the coyote willows and varied directly with height. Canopy closure in the tamarisk was typically 75% but reached 90% in the northwestern arm of the site.

Vegetation Condition

At the northern end of the site, up to 30% of the tamarisk were completely dead, and the live tamarisk had up to 50% dieback. Mortality was most prevalent in the northeastern arm, and many of the dead tamarisk have fallen. Within the remainder of the site, up to 10% of each tamarisk was dead. Although thick piles of coyote willow deadfall were present, no standing snags were observed.

Tamarisk Beetle Activity

No tamarisk beetle adults or larvae were observed during visits in May and early June. Beetle larvae were observed throughout the site in late June, and adult beetles were observed in July. Tamarisk foliage was green in May, starting to yellow in June, and completely brown with some new foliage in July.

Surface Hydrology

Standing water was present throughout the southwestern 20 m of the site bordering the river when the May site description was recorded (see table 2-2). When the June and July site descriptions were recorded, standing water was restricted to isolated cattail marshes and channels. This site is located within the Bill Williams River Delta, and water levels within the site vary directly with those in Lake Havasu (see figure 2-2).

Habitat Suitability

There was a patch of vegetation at the boundary of the coyote willows and tamarisk in the northern end of the site where all structural characteristics of preferred nesting habitat (see table 2-1) were present, except for canopy height, which was < 5 m. Suitable habitat was present where canopy closure reached 85%, but much of the site had canopy closure < 85% and an understory that was choked with either cattails or deadfall.

Site 01

Geographic Features

The survey site known as Site 01 is bordered to the west and south by a cattail marsh along the main channel and a side channel of the Bill Williams River.

Vegetation Composition and Structure

Vegetation was mixed-native and consisted of a mosaic of Goodding's willows, coyote willows, tamarisk, and arrowweed. The southern half of the site was dominated by a dense stand of coyote willows 2–5 m in height, which were larger in diameter along the southern edge of the site than elsewhere. A stand of 10–12-m-tall Goodding's willows and a dense patch of 2–4-m-tall arrowweed were present in the center of the coyote willow stand. Several small patches of 3–5-m-tall tamarisk were scattered throughout the coyote willow stand, and cattails were scattered within the coyote willows near the edges of the site. The northern half of the site was vegetated with a mixture of 3–5-m-tall tamarisk and dense 2–4-m-tall arrowweed with several stands of emergent 8–10-m-tall Goodding's willows and a few narrow, wispy patches of 2–4-m-tall coyote willows. Canopy closure within the coyote willows was 70–85% and averaged 75%. In the Goodding's willows, canopy closure reached 75–80% in the southern stand and was less than 75% in the northern stands. Canopy closure in the tamarisk patches was typically 75–80% but reached 90% in particularly dense patches.

Vegetation Condition

Up to 10% of each live tamarisk was dead, and up to 15% of the tamarisk were completely dead. The Goodding's willows had several broken branches and uneven crowns in the northern half of the site but had full, rounded crowns in the southern half.

Tamarisk Beetle Activity

No tamarisk beetle adults or larvae were observed during visits in May and early June. Larvae were observed throughout the site during visits in mid- to late June,

and adult beetles were observed in July. The tamarisk were mostly green in May but were starting to yellow in mid-June. Up to 50% of the tamarisk were brown in mid-July.

Surface Hydrology

Wet soils were present within the coyote willows along the southern and western edges of the site when the June and July site descriptions were recorded (see table 2-2). No data were collected on soil moisture conditions within the site in May. This site is located within the Bill Williams River Delta, and water levels within the site vary directly with those in Lake Havasu (see figure 2-2).

Habitat Suitability

Suitable habitat was present in places where canopy closure reached 85% (see table 2-1). Most of the interior of the site lacked the dense canopy closure typical of suitable habitat and lacked the wet soils typical of preferred nesting habitat.

Site 04

Vegetation Composition and Structure

Vegetation was mixed-native and consisted of an overstory of Goodding's willows 15–20 m in height, several 18–20-m-tall cottonwoods occurring as single trees or very small stands, and an understory of patches of 3–7-m-tall tamarisk and scattered mule-fat (*Baccharis salicifolia*), willow baccharis, and honey mesquite. Many of the overstory trees had no branches in the midstory. Patches of yerba mansa (*Anemopsis californicus*) were present in areas with little understory or deadfall. Many large willows and cottonwoods have fallen over the past several years, leaving large gaps in the canopy and creating piles of thick, dead, fallen woody vegetation. Deadfall was more prevalent in the northern half of the site. Canopy closure was 50–80%, averaging 65%, in the southern and western portions of the site and was 30–50% in the northern portion. Canopy closure was lowest in areas with high abundance of deadfall and canopy gaps and was highest in the cottonwood stands and larger tamarisk patches.

Vegetation Condition

Tamarisk mortality was widespread, although the percentage of dead trees varied from 20 to 100% from one patch to the next. The live tamarisk had at least 30% dieback. All Goodding's willows had some dead branches, and sparse canopies and dead branches were more common in the northern half of the site than in the southern half. Yellow leaves were also noted on the Goodding's willows in the northern half of the site in mid-June. The cottonwoods appeared healthy.

Tamarisk Beetle Activity

No tamarisk beetle adults or larvae were observed during visits in May. Adult beetles were observed in the southwestern quarter of the site in early June, and larvae were abundant throughout the site in mid- and late June. Adult beetles were abundant throughout the site in mid-July. All tamarisk foliage was green in mid-May. In mid-June, some tamarisk in the southwestern quarter of the site were beginning to yellow, and the rest of the tamarisk were green. In mid-July, 50% of the tamarisk were brown, and the remainder were mostly yellow with a small amount of green foliage.

Surface Hydrology

Wet soils were present in the deep, backwater channel on the western side of the site and in shallow stream channels in the southern portion when each site description was recorded (see table 2-2). Most of the remainder of the site was dry. The backwater channel connects to the Bill Williams River Delta, and water depth within the channel is influenced by water levels in Lake Havasu, which did not fluctuate enough to result in overbank flooding (see figure 2-2). Given that neither lake nor river levels fluctuated strongly during the season, soil moisture conditions likely did not fluctuate substantially from day to day.

Habitat Suitability

Much of the site lacks the midstory structural components typical of suitable habitat, and no portion of the site had canopy closure that met the suitability criterion (see table 2-1). Overall habitat suitability has declined in recent years as trees and large limbs have fallen and tamarisk have died, decreasing overall canopy closure.

Site 03

Vegetation Composition and Structure

Vegetation was mixed-native and consisted of an overstory of Goodding's willows 15–25 m in height, widely scattered cottonwoods, and an understory of scattered patches of monotypic tamarisk 3–7 m in height and loosely scattered mule-fat. Many of the overstory trees had no branches in the midstory. A small, monotypic stand of 10–15-m-tall velvet ash (*Fraxinus velutina*) was present in the eastern half of the site. In some areas where the understory was completely absent, yerba mansa grew in thick patches. Many large willows and cottonwoods have fallen over the past several years, leaving large gaps in the canopy and creating piles of thick, dead, fallen woody vegetation up to 1 m deep, particularly in the western portion of the site. Canopy closure averaged 60% across the site and ranged from 40% in areas with little understory and large gaps in the overstory to 85% in the velvet ash and the densest Goodding's willows and cottonwoods.

Vegetation Condition

Tamarisk mortality was widespread, although the percentage of dead trees varied from 20 to 100% from one patch to the next. The live tamarisk had at least 30% dieback. Many of the Goodding's willows had dead branches and the remnants of large limbs that had previously broken off. Insect herbivory was evident in some Goodding's willows on the southern side of the site, which had many skeletonized leaves when the June site description was recorded (figure 2-4).

Figure 2-4.—Skeletonized leaves of Goodding's willows in the southern half of Site 03 on June 18, 2019.

Tamarisk Beetle Activity

No tamarisk beetles were observed in May. A few adult beetles and many larvae were present in patches in June and July. Tamarisk foliage was green in May and was starting to yellow in a few places in June. In July, 85–100% of the tamarisk foliage in the southeastern portion of the site was brown, and some new leaves were beginning to grow. In the rest of the site, 10–60% of the tamarisk foliage was brown, and the remainder was green.

Surface Hydrology

Surface water was present when each site description was recorded (see table 2-2) and was more prevalent in the southeastern portion of the site. The remaining soils

were primarily damp. Given that neither lake nor river levels fluctuated strongly during the season (see figures 2-2 and 2-3), soil moisture conditions likely did not fluctuate substantially from day to day.

Habitat Suitability

Suitable habitat is present in the few areas where canopy closure reaches 85%, but most of the site lacks the midstory structural components and dense canopy closure typical of suitable habitat (see table 2-1). As in Site 04, canopy closure has decreased in recent years as the large overstory trees have lost many limbs.

Last Gasp

Geographic Features

The survey site known as Last Gasp is bisected by a channel of the Bill Williams River.

Vegetation Composition and Structure

Vegetation was mixed-native and consisted of a broken overstory of 15–20-m-tall cottonwoods and 4–10-m-tall Goodding's willows. The understory was patchy and consisted of 4–7-m-tall tamarisk in the eastern three-quarters of the site and 2-m-tall arrowweed and 3–6-m-tall honey mesquite in the western quarter. Some 2-m-tall mule-fat were also present along the edge of the channel, and a few sapling cottonwoods were scattered in the site. Canopy closure averaged 40% and was as high as 70% directly under the densest cottonwoods and willows.

Vegetation Condition

At least 50% of the tamarisk in the site were completely dead, and the remaining tamarisk had 20–80% dieback. Dead tamarisk were more prevalent along the southern edge of the western half of the site. Many of the shorter Goodding's willows had dead tops, with live vegetation occurring only on the lower portions of each stem, and many of the cottonwoods had narrow, linear canopies and dead branches.

Tamarisk Beetle Activity

No tamarisk beetles were observed in the site in May or June. Adult beetles were present in July on up to 50% of the live tamarisk. Tamarisk foliage was 100% green in the eastern half of the site and 50% yellow in the western half in mid-May, while half of all tamarisk foliage was yellow in mid-June. In mid-July, the tamarisk foliage

in the southern half of the site was completely brown while in the northern half of the site, the foliage on each live tamarisk was 60–90% brown with the remainder green.

Surface Hydrology

Standing water was present in the channel when the May and June site descriptions were recorded, but soils in the channel were damp when the July site description was recorded (see table 2-2). Soils away from the channel were dry. Water levels in the site are influenced by flows in the Bill Williams River and likely did not fluctuate substantially from day to day (see figure 2-3).

Habitat Suitability

Canopy closure was much lower than 85%; thus, the site does not meet all the criteria for suitable habitat (see table 2-1). If water levels increased enough that wet soils persisted outside of the channel, the vegetation could increase in density and suitability. Substantial regenerative growth is needed, however, before the site could meet the suitability criteria. Re-evaluation of this site in several years or after a high flow event would ensure that no suitable habitat is overlooked. In the meantime, surveys could be discontinued with minimal risk of overlooking suitable habitat.

Guinness

Geographic Features

The survey site known as Guinness is bisected by a channel of the Bill Williams River.

Vegetation Composition and Structure

Vegetation was mixed-native. Tamarisk 4–6 m in height with scattered 4–6-m-tall honey mesquite were present throughout the site and in the northern and southern thirds of the site formed an understory beneath a patchy overstory of 10–18-m-tall Goodding's willows and 20-m-tall cottonwoods. The overstory did not provide continuous canopy, and canopy closure averaged 50% across the site. Canopy closure reached 75–80% directly under the densest Goodding's willows, cottonwoods, and honey mesquite.

Vegetation Condition

Approximately 20% of the tamarisk appeared completely dead, and each live tamarisk had at least 30% dieback. Many of the overstory trees were dead, especially along the northern and southern borders of the site, and many of the live overstory trees had narrow canopies and dead branches. Live Goodding's willows, some of

which had relatively full canopies, were present in a narrow band (≤ 20 m wide) in the eastern third of the site. A few of the cottonwoods in the southern half of the site also had rounded, full canopies.

Tamarisk Beetle Activity

No tamarisk beetle adults or larvae were observed in May. Adult beetles were observed during all visits in June and July but were least numerous in late June, when beetle larvae were abundant. All tamarisk foliage was green in mid-May; a mixture of green, yellow, and brown in mid-June; and brown or defoliated in mid-July.

Surface Hydrology

The stream channel that bisects the site contained surface water when each site description was recorded (see table 2-2). Water levels in the site are directly influenced by the Bill Williams River and therefore likely did not fluctuate substantially from day to day (see figure 2-3).

Habitat Suitability

Canopy closure was much lower than 85%; thus, the site did not meet all the criteria for suitable habitat (see table 2-1). If water levels increased enough to fill the channel and wet soils persisted outside of the channel, the vegetation could increase in density and suitability. Substantial regenerative growth is needed, however, before the site could meet the suitability criteria. Re-evaluation of this site in several years or after a high flow event would ensure that no suitable habitat is overlooked. In the meantime, surveys could be discontinued with minimal risk of overlooking suitable habitat.

Site 05

Geographic Features

The survey site known as Site 05 is bordered to the northeast by steep cliffs and to the southwest by a dry river channel. A channel of the Bill Williams River is present along the northeastern border of the site.

Vegetation Composition and Structure

Vegetation was mixed-native, with a broken overstory of 10–12-m-tall Goodding's willows and 12–20-m-tall cottonwoods and an understory of 3–8-m-tall tamarisk. Goodding's willows dominated the overstory in the western two-thirds of the site, and cottonwoods dominated in the eastern third. The tamarisk were tallest and densest in the western third of the site. In the eastern third, the tamarisk were

shorter and more widely scattered, and Goodding's willows 6–9 m in height were the dominant understory species. Many gaps were present in the overstory where large trees had fallen, and there were young Goodding's willows and cottonwoods 4–6 m in height growing in many of the gaps. Canopy closure averaged 60% and varied from 35% in large canopy gaps to 85% near the beaver ponds in the northwestern portion of the site.

Vegetation Condition

Within 50 m of the southwestern edge of the site, most of the vegetation was dead. In the remainder of the site, the tamarisk had 10–20% dieback. There were a few cottonwood snags in the interior of the site. All living overstory trees had healthy foliage, but the presence of dead limbs and narrow crowns suggested previous stress.

Tamarisk Beetle Activity

Adult tamarisk beetles were present during visits in May and July, and abundant larvae with some adults were observed in June. The live tamarisk were mostly green with a little brown foliage in May; a mixture of green, yellow, brown, and leafless in June; and mostly brown and leafless with a little yellow foliage in July.

Surface Hydrology

Surface water and saturated soils were present in the stream channel along the northeastern edge of the site and in a series of deep (> 1 m) beaver ponds in the northern portion when each site description was recorded (see table 2-2). A string of shallow puddles was also present during the visit in May in the southeastern portion of the site. Soils away from the stream channels were dry throughout the season. Given that river levels did not fluctuate strongly during the season (see figure 2-3), it is unlikely that surface soil moisture conditions fluctuated substantially from day to day.

Habitat Suitability

Only the portions of the site with canopy closure of 85% along the main channel met all the criteria for suitable habitat (see table 2-1). Given the high degree of mortality and low canopy closure in much of the site, substantial regenerative growth is needed before additional portions of the site could meet the suitability criteria. Some regenerative growth was documented in 2019, and re-evaluation of this site at the beginning of the next survey season would ensure that no suitable habitat is overlooked.

Site 08

Geographic Features

The survey site known as Site 08 is confined to the north and south by high cliffs. The Bill Williams River flows into the eastern end of the site and runs along the northern boundary.

Vegetation Composition and Structure

Vegetation in the site was mixed-native. Immediately adjacent to the river channel, the vegetation consisted of tamarisk, honey mesquite, and cottonwood saplings ≤ 2 m in height. Within 40 m of the river channel, vegetation consisted of an overstory of Goodding's willows 6–16 m in height with scattered cottonwoods 13–18 m in height and an understory of 4–5-m-tall tamarisk with some arrowweed in the eastern half of the site and 4–5-m-tall honey mesquite in the northwestern portion. Canopy closure adjacent to the river channel averaged 70% and ranged from 40 to 85%, with the highest canopy closure in the densest and shortest Goodding's willow clumps. More than 40 m from the river channel, the site was vegetated with 3–5-m-tall tamarisk and scattered arrowweed and mule-fat. In the southern half of the site, there was also a patchy overstory of cottonwood snags. After an initial visit in May, the site boundary was reshaped to exclude habitat more than 40 m from the river channel. Canopy closure in the excluded portion did not exceed 40%.

Vegetation Condition

Within 40 m of the river channel, the tamarisk had up to 10% dieback, and the overstory trees showed signs of previous stress, with dead branches and a few snags. In the excluded portion of the site, all the overstory trees were dead, and half of the tamarisk were completely dead while the other half had 50% dieback.

Tamarisk Beetle Activity

Tamarisk beetles were observed in the site during each visit. Adult beetles were present in the western portion of the site in May, while both adults and larvae were observed throughout the site in late June and mid-July. Most of the tamarisk foliage was green in May but had turned yellow or brown by mid-June. In mid-July, some of the tamarisk along the stream channel had green foliage, but tamarisk elsewhere in the site were 90% brown or defoliated.

Surface Hydrology

Beavers have dammed the river, and surface water was present in the river channel for the length of the site during each site description (see table 2-2). Soils away from the river channel were mostly dry, but damp soils were present in a few locations.

Surface water at the site is affected by riverflow but not by water levels in Lake Havasu. Given that the daily outflow from Alamo Dam varied only infrequently during the season (figure 2-5), it is likely that there were few day-to-day fluctuations in the extent and depth of surface water.

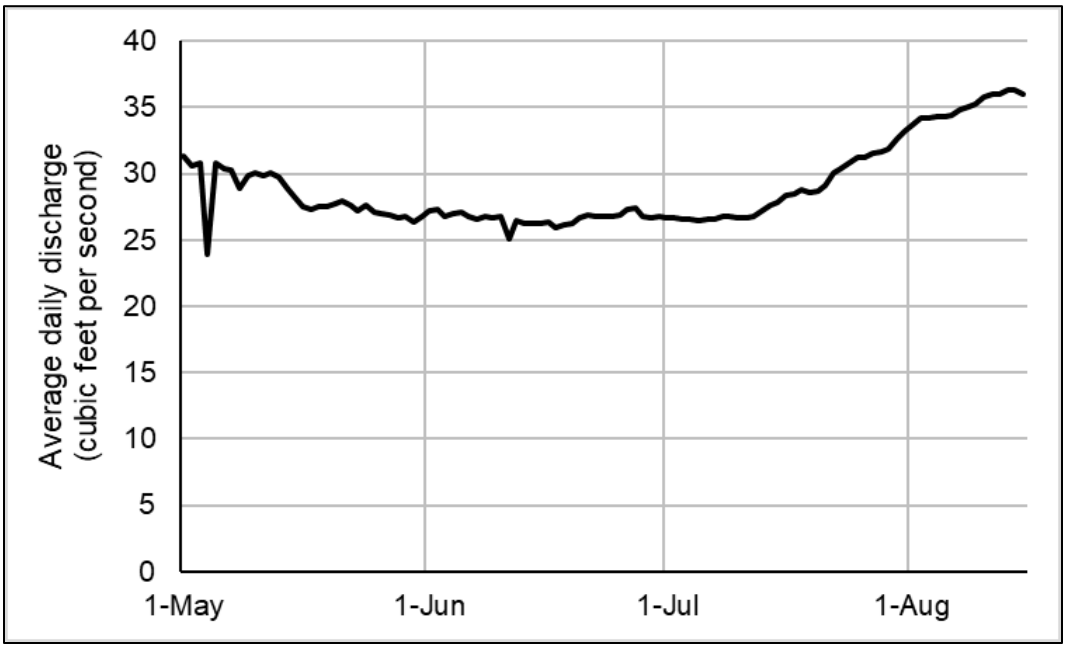

Figure 2-5.—Average daily discharge (cfs) recorded on the Bill Williams River below Alamo Dam (USGS Station #09426000), May 1 – August 15, 2019.
Data source: USGS 2019d.

Habitat Suitability

Portions of the site with canopy closure of 85% met all the structural criteria for suitable habitat (see table 2-1) but were limited in areal extent. Some regenerative growth was documented in 2019, and re-evaluation of this site at the beginning of the next survey season would ensure that no suitable habitat is overlooked.

Upstream Site 08

Geographic Features

The survey site known as Upstream Site 08 is bordered to the north and west by a cattail marsh.

Vegetation Composition and Structure

Vegetation consisted of a broken overstory of Goodding's willows, ranging from 8 to 15 m and averaging 9 m in height, and an understory of 3–7-m-tall tamarisk and 4–7-m-tall Goodding's willows. A few emergent cottonwoods up to 18 m in height

were scattered throughout the site. The cottonwoods and Goodding's willows formed a broken overstory in the northern half and southwestern quarter of the site. Several open areas dominated by either cattails or grasses were present in the southwestern quarter of the site. The southeastern quarter of the site was dominated by tamarisk with widely scattered, emergent cottonwoods and Goodding's willows. Canopy closure ranged from 30 to 90% and averaged 60%. Canopy closure of 85–90% was found only in a few clumps of Goodding's willows in the center of the site. Areas with 30–60% canopy closure occurred where large fallen trees created gaps and in open areas in the southwestern quarter.

Vegetation Condition

Each tamarisk exhibited 10–40% dieback. Several fallen cottonwoods and Goodding's willows were scattered throughout the site, and the living overstory trees had some dead branches and oddly shaped crowns.

Tamarisk Beetle Activity

No tamarisk beetle larvae or adults were observed during visits in May and early June. Beetle larvae were observed during visits in the second half of June, and dead adult beetles caught in spider webs and larval exoskeletons were observed during the visit in July. Tamarisk foliage was completely green in mid-May and was beginning to turn yellow and brown in mid-June. In mid-July, the tamarisk foliage was 50–90% brown with the higher percentages of brown foliage occurring in the eastern half of the site.

Surface Hydrology

Standing water was present in the cattail marsh that borders the site, and wet soils extended into the northern and western portions of the site when each site description was recorded (see table 2-2). Soils were dry in the southeastern quarter of the site and increasingly damp to the north and west when each site description was recorded. Surface water at the site is affected by riverflow but not by water levels in Lake Havasu. Given that daily outflow from Alamo Dam varied only infrequently during the season (see figure 2-5), it is likely that there were few day-to-day fluctuations in the extent and depth of surface water.

Habitat Suitability

Portions of the site with canopy closure of at least 85% met all the criteria for suitable habitat (see table 2-1) but were limited in areal extent. Some regenerative growth was documented in 2019, and re-evaluation of this site at the beginning of the next survey season would ensure that no suitable habitat is overlooked.

Planet Ranch Road

Geographic Features

The survey site known as Planet Ranch Road is in Planet Ranch, The western 50 m of the site contains a 20-m-wide beaver pond, and the remainder of the site has a network of braided channels that lead to the beaver pond.

Vegetation Composition and Structure

For 100 m upstream of the eastern end of the beaver pond, the site was vegetated by Goodding's willows 8–12 m in height with a few emergent 12–15-m-tall cottonwoods and an understory of 3–5-m-tall tamarisk and honey mesquite up to 7 m in height. Vegetation within the eastern 350 m of the site boundary consisted of cottonwoods 12–15 m in height with a mosaic of Goodding's willows 3–8 m in height and honey and screwbean mesquite 4–6 m in height. The understory was mule-fat and widely scattered 2–3-m-tall tamarisk. Goodding's willows occurred primarily in strips at the edge of the braided channels, which were dry in this portion of the site. Canopy closure ranged from 30% along wider portions of the dry channels to 85% in the densest stands of cottonwoods and Goodding's willows.

Vegetation Condition

The condition of the Goodding's willows varied within the site from snags and trees with dead tops in the eastern half of the site to healthy, lush trees near the beaver pond in the western portion of the site. Approximately 20% of the tamarisk were completely dead, with mortality most prevalent in the eastern portion of the site.

Tamarisk Beetle Activity

Tamarisk beetle larvae were detected in low abundance during the visits in the first half of June, but no adults or larvae were observed during visits in May, late June, or July. All tamarisk foliage was green in May, and no more than 5% of the tamarisk foliage was yellow or brown during June and July.

Surface Hydrology

The beaver pond contained water when each site description was recorded, and within the western 200 m of the site, small channels that supply water to the beaver pond contained scattered puddles and saturated soils (see table 2-2). Soils within the remainder of the site were dry. In this reach, surface water is affected by riverflow but not by water levels in Lake Havasu. The average daily outflow from Alamo Dam varied infrequently during the season (see figure 2-5), and it is likely that there were few day-to-day fluctuations in the extent and depth of surface water.

Habitat Suitability

The Goodding's willows adjacent to the beaver pond and patches of vegetation farther upstream where canopy closure reached 85% had all the characteristics of suitable habitat (see table 2-1). Habitat suitability at the site could improve in future years if canopy closure increases.

Habitat Evaluation

Evaluation sites in the Bill Williams River Delta (i.e., Coyote Crossing and Bill Willow) were scheduled for surveys in 2019, but surveys were discontinued partway through the survey season because of poor habitat suitability. Evaluation sites in or near the Middle Bill Williams River National Wildlife Refuge (i.e., Burn Edge, Black Rail, Beaver Pond North, and Beaver Pond) were surveyed in prior years but were evaluated at the beginning of 2019 because of poor habitat conditions observed in 2018. These sites were not surveyed following the evaluation. No signs of livestock were noted in any of the evaluation sites. No tamarisk beetles were observed in any evaluation site in May. Both Coyote Crossing and Bill Willow were visited in mid- to late June, and tamarisk beetle larvae or signs of defoliation were widespread in both sites at that time.

Coyote Crossing

Geographic Features

The survey site known as Coyote Crossing is bordered by cattail marshes to the north, south, and west and by the Bill Williams River to the east.

Vegetation Composition and Structure

In the southwestern two-thirds of the site, the vegetation was primarily cattails with a few live tamarisk 2–3 m in height and many dead and fallen tamarisk. Vegetation in the northeastern third of the site consisted of tamarisk 3–7 m in height with areas where very dense 2-m-tall cattails were mixed with the tamarisk and blocked any potential flight paths. Canopy closure did not exceed 40% anywhere in the site.

Vegetation Condition

In the southern two-thirds of the site, approximately 70% of the tamarisk were completely dead, and the live tamarisk had 30–40% dieback. Thick piles of dead, fallen woody vegetation were present in places, preventing growth of cattails. There were many short tamarisk stems in this portion of the site that appeared to be regenerative growth and did not show any signs of mortality. In the northeastern third of the site, 40% of the tamarisk were completely dead.

Surface Hydrology

Wet soils were present within the site when site descriptions were recorded in mid-May and mid-June. This site is located within the Bill Williams River Delta, and water levels within the site vary directly with those in Lake Havasu (see figure 2-2).

Habitat Suitability

A considerable amount of the woody vegetation in the site was dead, and canopy closure was much lower than 85%; thus, the site did not meet all the criteria for suitable habitat (see table 2-1). Re-evaluation of this site in several years would ensure that no suitable habitat is overlooked. In the meantime, surveys could be discontinued with minimal risk of overlooking suitable habitat.

Bill Willow

Geographic Features

The survey site known as Bill Willow is on the northern edge of an area that burned in 2006. It is bordered by a cattail marsh to the north, east, and west and by riparian vegetation to the south.

Vegetation Composition and Structure

Vegetation within the site consisted of 2–6-m-tall tamarisk. Cattail stands were scattered in the understory, particularly near the northern and western borders. A few emergent, 9–15-m-tall Goodding's willows were present along the southern and eastern borders, just outside the site. Canopy closure averaged 40–50% across the site but varied from 30% in sparse areas up to 75–90% in the densest clumps (≤ 5 m wide) of tamarisk.

Vegetation Condition

Approximately 40–50% of the tamarisk were completely dead, and the live tamarisk had 40–50% dieback. In the western quarter of the site, 50% of the tamarisk had fallen, and new, wispy stems up to 2 m in height were growing out of the fallen piles.

Surface Hydrology

A small amount of saturated soil was observed on the southern border when the May site description was recorded. Most soils were dry when both the May and June site descriptions were recorded. This site is located within the Bill Williams River Delta, and water levels within the site vary directly with those in Lake Havasu (see figure 2-2).

Habitat Suitability

Canopy closure was much lower than 85% in most of the site; thus, the site does not meet all the criteria for suitable habitat (see table 2-1). Areas where canopy closure reached 90% occurred only in small clumps where the tamarisk were leaning over, creating dense piles of standing woody vegetation but eliminating flight paths or suitable nesting structure. Given the high degree of mortality, substantial regenerative growth is needed before the site could meet the suitability criteria. Re-evaluation of this site in several years would ensure that no suitable habitat is overlooked. In the meantime, surveys could be discontinued with minimal risk of overlooking suitable habitat.

Burn Edge

Vegetation Composition and Structure

Vegetation was mixed-native and consisted of a broken overstory of 12–15-m-tall Goodding's willows and 20-m-tall cottonwoods. Many of the overstory trees had no branches in the midstory. The understory consisted of 3–8-m-tall tamarisk with willow baccharis, mule-fat, arrowweed, and honey mesquite scattered in low abundance throughout the site. Several open areas with thick piles of dead, fallen, woody vegetation were present. Canopy closure averaged 40% throughout the site and reached 60% only under the densest cottonwoods and Goodding's willows.

Vegetation Condition

At least 70% of the tamarisk were completely dead. The cottonwoods and Goodding's willows had narrow canopies and some dead branches.

Surface Hydrology

A beaver pond ran east-west along an old river channel through the center of the site and held shallow water during the visit in May. Most of the rest of the site was completely dry.

Habitat Suitability

Canopy closure was too low to meet the suitability criterion (see table 2-1). Midstory structural components were also missing from several areas of the site. Substantial tree mortality has occurred in recent years and was more evident in 2019 than in 2018; regenerative growth is needed before most of the site could meet the suitability criteria. If water levels increased enough to fill the channel and wet soils persisted outside of the channel, the vegetation could increase in density and suitability. Re-evaluation of this site in several years or after a high flow event would ensure that no suitable habitat is overlooked.

Black Rail

Vegetation Composition and Structure

Vegetation was mixed-native, with an overstory of cottonwoods 14–18 m in height in most of the site. The understory consisted of loosely scattered 3–4-m-tall tamarisk, 2–5-m-tall cottonwoods, 4-m-tall honey mesquite, and 1–2-m-tall mule-fat and willow baccharis. Cattails and bulrush 1–2 m in height and 10-m-tall Goodding's willow snags were also loosely scattered through the interior of the site. The western 30–40 m of the site was dominated by thick deadfall, with one small patch of 5–6-m-tall Goodding's willows growing through the deadfall near the west-central border of the site. A small (10 x 40 m) stringer of 5-m-tall cottonwoods was present along the northern border. Canopy closure was 30–60% and was highest in areas with a mature cottonwood overstory.

Vegetation Condition

About half of the tamarisk were completely dead. The overstory cottonwoods had narrow canopies and some dead branches. Almost all Goodding's willows in the site were completely dead, with the exception of the small patch on the western edge.

Surface Hydrology

Soils were mostly damp with one small area of wet soil in the center of the site during the visit in May.

Habitat Suitability

Canopy closure was too low throughout the site to meet the suitability criterion (see table 2-1), and substantial regenerative growth is needed before the site could meet the suitability criteria. Some regenerative growth was documented in 2019, and re-evaluation of this site at the beginning of the next survey season would ensure that no suitable habitat is overlooked.

Beaver Pond North

Geographic Features

The site known as Beaver Pond North encompasses the riparian vegetation along the Bill Williams River for approximately 900 m downstream from the outflow of Cave Wash. One channel of the Bill Williams River runs along the southern border of the site and another through the center.

Vegetation Composition and Structure

Vegetation in most of the site consisted of dead tamarisk with scattered arrowweed, honey mesquite, cottonwood and Goodding's willow snags, and occasional live, emergent cottonwoods or Goodding's willows. The river channel along the southern

border of the site was lined with intermittent stringers ≤ 5 m wide of 4–6-m-tall cottonwoods or Goodding's willows. Some 3–5-m-tall cottonwoods and Goodding's willows were scattered along the edge of the central river channel, and cattails lined the bottom of this channel. Canopy closure was 10–40% in most of the site and reached 60–80% in the stringers along the southern river channel.

Vegetation Condition

Over 90% of the woody vegetation was completely dead. The live, emergent cottonwoods and Goodding's willows had narrow canopies and dead branches.

Surface Hydrology

Surface water was present in both river channels during the visit in May. Water in the river channel in the center of the site consisted of several small, shallow, stagnant pools. Water in the southern channel consisted of a shallow, flowing stream. Soils away from the river channels were dry and sandy.

Habitat Suitability

Canopy closure was much lower than 85% throughout most of the site, and where canopy closure reached 80%, stand width was generally < 5 m; thus, no portion of this site met the criteria for suitable habitat (see table 2-1). Given the high degree of mortality away from the river channel, substantial regenerative growth is needed before this portion of the site could meet the suitability criteria. Re-evaluation of this portion of the site after a high flow event would ensure that no suitable habitat is overlooked. If the cottonwood and willow stringers along the southern channel expanded into the channel bottom, these stands could reach suitable patch width. Re-evaluation of the southern channel in future years would ensure no suitable habitat is overlooked.

Beaver Pond

Geographic Features

The site known as Beaver Pond encompasses the riparian vegetation along the Bill Williams River from approximately 350 m upstream of Mineral Wash downstream to the outflow of Cave Wash. The Bill Williams River runs through the center of the southern 400 m of the site and then bifurcates into two channels; one channel runs along the southern border of the site and the other through the center.

Vegetation Composition and Structure

Vegetation in most of the site consisted of dead tamarisk with scattered honey mesquite, cottonwood and Goodding's willow snags, and occasional live, emergent cottonwoods or Goodding's willows. The river channel along the southern border of

the site was lined with intermittent stringers ≤ 5 m wide of 4–6-m-tall cottonwoods or Goodding's willows with 80–90% canopy closure. One cottonwood stringer along the southern edge of river channel was ≤ 10 m wide and had 95% canopy closure. Canopy closure in the rest of the site was 10–40%.

Vegetation Condition

Over 90% of the woody vegetation in the site was completely dead. The remaining live, emergent cottonwoods and Goodding's willows had narrow canopies and dead branches.

Surface Hydrology

Flowing water was present in the southern river channel for the entire length of the site during the visit in May. Soils away from the active river channel were primarily dry.

Habitat Suitability

Canopy closure was much lower than 85% throughout most of the site, and where canopy closure reached 85%, stand width was generally < 10 m; thus, most of this site did not meet the criteria for suitable habitat (see table 2-1). One cottonwood stringer where patch width reached 10 m met all the criteria of preferred nesting habitat; however, patch size was approximately 0.05 ha, far smaller than a typical flycatcher territory. Given the high degree of mortality away from the river channel, substantial regenerative growth is needed before this portion of the site could meet the suitability criteria. Re-evaluation of this portion of the site after a high flow event would ensure that no suitable habitat is overlooked. If the cottonwood and willow stringers along the southern channel expanded into the channel bottom, these stands could reach suitable patch width. Re-evaluation of the southern channel in future years would ensure no suitable habitat is overlooked.

Alamo Lake, Arizona

ALAM is located along the Big Sandy and Santa Maria Rivers, near their confluence, and downstream along the Bill Williams River to the open water of Alamo Lake. The elevation within the study area is 335–347 m above mean sea level and increases from south to north. The level of Alamo Lake rose early in 2010 following a large rain event but declined over the next 5 years (figure 2-6). As lake levels declined, soils were exposed where most of the current survey and evaluation sites (South Camp, Sidebar 01, Camp 01–03, Middle Earth 01–02, Prospect 01, and Burro Wash 01–02) are located. Lake levels fluctuated in 2014–19, and some areas have grown and matured while patches of dead trees have developed in others.

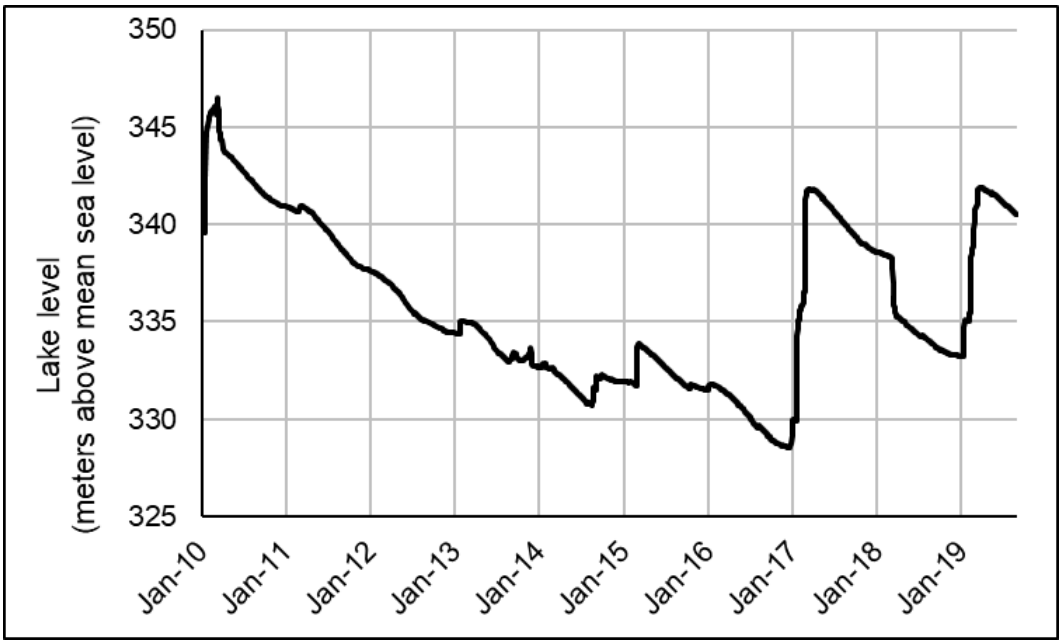

Figure 2-6.—Alamo Lake daily elevation (meters above mean sea level), 2010–19.
Data source: Lakes Online (2019).

Survey sites within ALAM are listed below from southwest to northeast, moving progressively farther upstream. Burros and cattle were heard from all sites at ALAM. Physical signs of cattle were noted only within or near sites (Motherlode 04 and Santa Maria North 01) that were not inundated by the lake. Many tamarisk in inundated sites were yellow throughout the survey season, likely as the result of prolonged inundation. Tamarisk beetles and patchy defoliation were observed throughout the season in some sites. Storm events over the 2018–19 winter increased the level of Alamo Lake, which peaked in March at 6.6 m higher than on the corresponding day in 2018. Surface water was present in most survey sites in 2019, with water levels gradually decreasing by 1.0 m over the breeding season. Many sites remained inundated by > 2 m of water throughout the survey season (see table 2-2). Surface hydrology is described in detail below for sites that were not completely inundated and for sites where water depth was < 2 m and thus could be easily measured. Average daily discharge was < 5.0 cfs on the Big Sandy River and 0.0 cfs on the Santa Maria River throughout the season (USGS 2019e, 2019f).

Bullard Wash

Geographic Features

The survey site known as Bullard Wash is on the eastern edge of the riparian area at the outflow of Bullard Wash.

Vegetation Composition and Structure

Most of the site consisted of Goodding's willows with the upper 6–10 m of the trees exposed above the surface of the water. Average canopy height was slightly shorter in the southeastern portion of the site than elsewhere. Tamarisk 1–3 m in height above the surface of the water were present in a small patch in the south-central portion of the site. Canopy closure in the Goodding's willows ranged from 40% along the site perimeter to 85% in places with the highest stem density. In the tamarisk, canopy closure was 20–45%.

Vegetation Condition

Up to 30% of the tamarisk in the site were completely dead; the remainder had varying densities and proportions of green and yellow foliage. By the time the July site description was recorded, several of the Goodding's willows had fallen over, creating gaps in the canopy and lowering the average canopy closure. All vegetation was completely dead at the southern tip of the site.

Tamarisk Beetle Activity

No tamarisk beetle adults or larvae were observed during any visit. The yellow foliage observed throughout the season was suspected to be the result of prolonged inundation.

Habitat Suitability

Suitable habitat was present where canopy closure reached 85% (see table 2-1), though areal extent of this habitat was limited.

Camp 01

Vegetation Composition and Structure

The site consisted of two patches of Goodding's willows at the outflows of two small washes; these patches were connected by a 10-m-wide strip of Goodding's willows. The Goodding's willows had the upper 3–7 m exposed above the surface of the lake. The tallest trees were in the two patches at the wash outflows. Canopy closure ranged from 60 to 85% and varied directly with canopy height.

Vegetation Condition

Dead trees were present along the upland edge of the southern patch. The remainder of the trees appeared healthy.

Habitat Suitability

Portions of the site with canopy closure of 85% met all the criteria for suitable habitat (see table 2-1).

Camp 02

Vegetation Composition and Structure

Vegetation consisted of a 50- x 100-m patch of Goodding's willows with the upper 3–7 m exposed above the surface of the lake. The tallest trees were in the southeastern portion of the site and the shortest along the northern edge. A few green tamarisk with the upper 2 m exposed above the surface of the lake were present in the very northwestern corner of the site. Canopy closure was 60–85% and varied directly with canopy height.

Vegetation Condition

A small patch of Goodding's willow snags was present in the western half of the site, but the remainder of the trees appeared healthy.

Habitat Suitability

Portions of the site with canopy closure of 85% met all the criteria for suitable habitat (see table 2-1).

Camp 03

Vegetation Composition and Structure

Vegetation consisted of Goodding's willows at the outflow of a wash with the upper 5–10 m of the trees exposed above the lake. Dead tamarisk emerging 1 m above the water were present along the northern edge of the site. Canopy closure was 35–90%, averaging 70%, and varied directly with canopy height and stem density.

Vegetation Condition

Willow snags and fallen trees were present in the western portion of the site, and all the tamarisk were dead, likely as the result of prolonged inundation. All other trees in the site appeared healthy.

Habitat Suitability

Suitable habitat was present where canopy closure reached 85%, and preferred nesting habitat was present where canopy closure reached 90% (see table 2-1). Suitable and preferred nesting habitat were limited to the densest trees in the northeastern portion of the site.

Middle Earth 01

Vegetation Composition and Structure

The site consisted of two disjunct polygons of native vegetation. The northern polygon consisted of a 30–40-m-wide swath of Goodding's willows emerging 4–12 m above the surface of the lake and flanked by tamarisk emerging 1–3 m above the water. Some of the willows were leaning at 45° angles, creating pockets of very dense canopy closure. Canopy closure was 85–90% in the Goodding's willows and < 10% in the tamarisk.

Vegetation in the southern polygon consisted primarily of Goodding's willows emerging 7–15 m above the water. Patches of tamarisk emerging 1–2 m above the water were present along the northern and southern borders of the eastern half of the polygon. Canopy closure was 70–85% in the willows and 10% in the tamarisk. Structure in the Goodding's willows differed between the western third and eastern two-thirds of the southern polygon. In the western third, the Goodding's willows reached 7–10 m in height above the surface of the lake, and canopy closure was 70–85% and patchy with no discernable pattern. In the eastern two-thirds of the southern polygon, exposed willow height was 15 m, and canopy closure was 85%.

Vegetation Condition

Approximately 75% of the tamarisk appeared completely dead, likely as the result of prolonged inundation; another 15% were leafless but appeared to still be alive; and the remainder had a mix of green and yellow foliage. Some of the Goodding's willows in the northern polygon were leaning. All the other willows appeared healthy.

Tamarisk Beetle Activity

No tamarisk beetle adults or larvae were detected in the site during any visit.

Habitat Suitability

The Goodding's willows in the northern polygon had all the characteristics of suitable or preferred nesting habitat, depending on canopy closure (see table 2-1). Areas where canopy closure reached 85% in the southern polygon had all the characteristics of suitable habitat.

Middle Earth 02

Vegetation Composition and Structure

The survey site known as Middle Earth 02 consisted of a round polygon in the southern half of the site with a long, hook-shaped arm extending to the north and east. Vegetation in the eastern half of the southern portion consisted of Goodding's willows emerging 10–12 m in height above the lake with a low abundance of tamarisk in the understory. Canopy closure ranged from 75 to 95% and averaged 90% in this portion of the site. Toward the western edge of the southern portion, patches of tamarisk emerging 0.5–3 m above the water were common, and the Goodding's willows were patchy in distribution and averaged 8 m in height above the water. Canopy closure under the willows was 60–80% and averaged 75%. Canopy closure did not exceed 40% in the tamarisk patches.

The northern arm of the site was added in 2019 after reconnaissance yielded several flycatcher territories. Vegetation was a heterogenous mix of Goodding's willows emerging 5–15 m above the water and tamarisk 1–4 m in height above the water. A few cottonwoods emerging up to 10 m in height were scattered throughout the northern arm. Canopy closure was 55–90% in areas with a Goodding's willow overstory, with canopy closure varying directly with stem density and canopy height. Canopy closure in several Goodding's willows patches averaged 85%, while in other patches it averaged 70%. Canopy closure in areas dominated by tamarisk did not exceed 40%.

Vegetation Condition

Up to 50% of the tamarisk in some portions of the site appeared completely dead, and percent mortality varied inversely with tree height. The remaining tamarisk had a mixture of green and yellow foliage. Fallen Goodding's willows created several canopy gaps on the western side of the site, and some Goodding's willow snags were present in the southwestern corner.

Tamarisk Beetle Activity

Adult tamarisk beetles were observed on most of the tamarisk in the northern arm in July. Tamarisk beetle adults or larvae were not noted during any other visit. Up to 30% of the tamarisk foliage was yellow or brown throughout the season.

Surface Hydrology

The entire site contained wet soils when each site description was recorded (see table 2-2). In the very northern arm, the ratio of inundated to saturated soils decreased as the season progressed.

Habitat Suitability

The eastern half of the southern portion of the site contained all the characteristics of preferred nesting habitat (see table 2-1), as did some Goodding's willow patches in the northern arm. Areas of the site that had a significant tamarisk component lacked the canopy closure of suitable habitat.

Prospect 01

Vegetation Composition and Structure

The boundary of the survey site known as Prospect 01 was extended 130 m to the north to encompass flycatcher territories discovered during the survey season. Vegetation within the site was primarily native and consisted of a 20–40-m-wide strip of Goodding's willows emerging 6–12 m above the water with patches of tamarisk emerging 1–3 m above the water. The Goodding's willows were generally shorter in the southern end of the site than in the northern end. A 15-m-wide strip of dead Goodding's willows was present in the southern half of the site along the eastern edge. In the northern half of the site, a strip of tamarisk with a few Goodding's willows was present along the eastern edge. Canopy closure in the live Goodding's willows was 60–90% and varied directly with stem density and canopy height. Canopy closure was 30% in the strip of dead Goodding's willows and did not exceed 40% in the tamarisk strip.

Vegetation Condition

Other than the patch of dead Goodding's willows along the southeastern edge of the site, all vegetation appeared healthy.

Tamarisk Beetle Activity

No tamarisk beetle adults or larvae were observed in the site. Approximately 60% of the tamarisk foliage was yellow or brown in June, but this may have been the result of prolonged inundation.

Surface Hydrology

The entire site was inundated when each site description was recorded (see table 2-2). Average water depth slowly decreased from > 2 m in May to 1 m in mid-July.

Habitat Suitability

Portions of the site with canopy closure of at least 85% met all the criteria for suitable habitat, and areas with canopy closure of 90% met all the criteria for preferred nesting habitat (see table 2-1).

Burro Wash 01

Vegetation Composition and Structure

This site was expanded slightly to the north during the 2019 season to encompass a patch of dense vegetation between Burro Wash 01 and Burro Wash 02. Vegetation consisted primarily of Goodding's willows emerging 3–12 m (average 8–10 m) above the water. Tamarisk snags emerging 1–2 m above the water were present in the understory in the southeastern portion of the site. A portion of the southern end of the site contained only dead tamarisk with 10% canopy closure. Canopy closure in the Goodding's willows ranged from 35 to 90% and varied directly with canopy height. Several of the Goodding's willows fell in previous years; some of these remained alive and grew vertical shoots, creating a patchy and heterogenous mix of canopy heights and densities.

Vegetation Condition

All tamarisk were completely dead. All tamarisk also appeared completely dead in 2018, likely as the result of prolonged inundation in 2017 (McLeod and Pellegrini 2019). Small pockets of Goodding's willow snags were scattered throughout the site. All living trees appeared healthy in 2019. Freshly fallen Goodding's willows were noted in mid-July.

Habitat Suitability

Portions of the site with canopy closure of at least 85% met all the criteria for suitable habitat, and areas with canopy closure of 90% met all the criteria for preferred nesting habitat (see table 2-1).

Burro Wash 02

Vegetation Composition and Structure

The northern tip of the site was expanded to the east during the survey season to encompass additional dense vegetation. Vegetation within most of the site consisted of Goodding's willows emerging 2–15 m above the water. Tamarisk emerging 1–3 m above the water were present in the understory in portions of the northern end of the site. Several patches up to 100 x 50 m in size of Goodding's willow snags were present throughout the site but were more prevalent in the northern half. Canopy closure was 35–90% in most of the site and varied with the density of Goodding's willows. Canopy closure was 20–40% in areas with Goodding's willow snags or a large tamarisk component.

Vegetation Condition

Many of the tamarisk were partially dead. All tamarisk foliage was green at the beginning of the season but gradually turned yellow or brown. All living Goodding's willows appeared healthy. Newly fallen Goodding's willows were noted near the northern end of the site in July.

Tamarisk Beetle Activity

No tamarisk beetle adults or larvae were observed in the site during the survey season. Tamarisk foliage gradually became more yellow and brown during the survey season, possibly as the result of prolonged inundation.

Surface Hydrology

The entire site was inundated by the lake when each site description was recorded (see table 2-2). Most of the site was inundated to a depth > 2 m throughout the season, but by the time the July site description was recorded, the minimum water depth observed was 0.25 m near the northern upland edge.

Habitat Suitability

Portions of the site with canopy closure of at least 85% met all the criteria for suitable habitat, and areas with canopy closure of 90% met all the criteria for preferred nesting habitat (see table 2-1).

Motherlode 01

Vegetation Composition and Structure

The western half of the site consisted of an overstory of Goodding's willows emerging 4–15 m above the water with tamarisk emerging 1–2 m above the water widely scattered in the understory. Several areas had mostly dead or fallen Goodding's willows where canopy closure was 25–30%. Canopy closure in the rest of the western half of the site was 60–95%, with the densest canopy closure occurring at the northern border adjacent to Burro Wash 02.

The eastern border of the site was expanded to the east and north to encompass patches of dense vegetation. Vegetation in the eastern half of the site was similar to that in the western half, except that tamarisk up to 5 m in height formed a dense understory in many places, the Goodding's willow overstory was absent in a few patches, and thick deadfall was less abundant. Canopy closure ranged from 25 to 90% and varied directly with the density of Goodding's willows, averaging 75% in areas with Goodding's willows and 35% in areas with only tamarisk.

Vegetation Condition

Several Goodding's willow snags were still standing, but most had fallen. All living Goodding's willows appeared healthy. Many of the tamarisk were partially or completely dead, and small patches yellow and brown foliage were observed throughout the site. Several tamarisk throughout the site appeared unaffected by inundation or previous years of defoliation.

Tamarisk Beetle Activity

No tamarisk beetles were observed in the site during any visit, although beetle larvae were observed just outside the site boundary in May.

Surface Hydrology

The entire site was inundated by Alamo Lake in May, with water depths ranging from 15 cm in the eastern portion of the site to > 2 m of water elsewhere (see table 2-2). The area that had shallow water in May contained saturated soil in mid-June and damp soil in July.

Habitat Suitability

Portions of the site with canopy closure of at least 85% met all the criteria for suitable habitat, and areas with canopy closure of 90% met all the criteria for preferred nesting habitat (see table 2-1).

Motherlode 02

History

The survey site known as Motherlode 02 was surveyed in 2014–17. Surveys were discontinued after 2017 due to the high level of tree mortality in the site. Most of the original site burned in a fire in March 2019. Singing flycatchers were discovered adjacent to the southeastern edge of the original site in mid-June, at which time a new site boundary was drawn. Only one site description, which described vegetation in the southern 100 m of the western lobe and along the eastern edge, was completed. Habitat in the 100 m between these areas and in the northern 100 m of the western lobe (approximately 35% of the site) was not described in 2019.

Vegetation Composition and Structure

Vegetation in the southern portion of the western lobe consisted of Goodding's willows 2–10 m in height with widely scattered 1–4-m-tall tamarisk in the understory. The willows were generally not closely spaced, though a few clumps of trees were noted. Canopy closure averaged 60% and reached 85% in the densest clumps of trees.

Vegetation in the eastern lobe of the site consisted of Goodding's willows ranging from 4 to 18 m and averaging 10 m in height. Canopy height in the southern 200 m of the eastern lobe was ≤ 12 m. Tamarisk 0.5–2.5 m in height was present in the understory in the northern 100 m of the eastern lobe. The very northern edge of the eastern lobe consisted of burned and dead Goodding's willows 5–8 m in height. Canopy closure in the eastern lobe ranged from 50 to 80% but was typically 60–70%.

Vegetation Condition

The live Goodding's willows and the tamarisk all appeared healthy. Some Goodding's willow snags were present, both in the burned area and within the remainder of the site. Deadfall was present within the eastern lobe of the site.

Tamarisk Beetle Activity

No tamarisk beetles were observed in the site during the visit in July, and all tamarisk appeared green.

Surface Hydrology

The site was located at the northern extent of Alamo Lake, and 75% of the described portion of the site contained wet soils when the site description was recorded in July (see table 2-2). The northern edge of the eastern lobe had dry soils.

Habitat Suitability

Portions of the site with canopy closure of at least 85% met all the criteria for suitable habitat (see table 2-1).

Prospect 02

Geographic Features

The survey site known as Prospect 02 is a stringer of vegetation immediately adjacent to the channel of the Bill Williams River. This site was added during the 2019 season when a singing flycatcher was discovered in mid-June, and only one site description was completed.

Vegetation Composition and Structure

Vegetation consisted of a 20-m-wide stringer of 5–10-m-tall Goodding's willows with an understory of 4–6-m-tall tamarisk and a few *Baccharis* sp. shrubs. Canopy closure was 85% along the northwestern edge adjacent to the channel and decreased to 75% along the southeastern edge.

Vegetation Condition

All vegetation appeared healthy when the site description was recorded in early July.

Tamarisk Beetle Activity

No tamarisk beetles were observed within the site, and all tamarisk were green when the site description was recorded in early July.

Surface Hydrology

Soils were damp immediately adjacent to the river channel and completely dry in the rest of the site when the site description was recorded in early July (see table 2-2). This portion of the river channel was submerged beneath the lake throughout the survey season, and any changes in soil moisture within the site would by caused by local weather events or fluctuations in lake levels.

Habitat Suitability

Portions of the site with canopy closure of at least 85% met all the criteria for suitable habitat (see table 2-1).

Motherlode 04

Vegetation Composition and Structure

Vegetation in the southern half of the site consisted primarily of 2-m-tall arrowweed, mule-fat, and tamarisk, all of which occurred at relatively low densities. Canopy closure was 10%. After the initial visit in May, the site boundary was reshaped to exclude the southern half, and the remainder of this site description refers only to the reconfigured site.

Vegetation consisted primarily of a 15-m-tall overstory of Goodding's willows. Cottonwoods were mixed with the Goodding's willows along the western edge, and mule-fat were widely scattered in the eastern half. Canopy closure was 80–90% and averaged 85%.

Vegetation adjoining the eastern edge of the site was evaluated during a visit in May. Vegetation in this area consisted of a 10–25-m-wide strip of tamarisk 6 m in height. Up to 25% of the tamarisk had dead tops, and canopy closure was 85%.

Vegetation Condition

All vegetation appeared healthy.

Tamarisk Beetle Activity

Tamarisk beetle larvae were distributed throughout the tamarisk in mid-May, and beetles of unknown life stage were noted on 80% of the tamarisk in mid-July. No beetles were observed in mid-June. Approximately 10% of the tamarisk foliage was brown and the remainder was green in May; all foliage was green during the remaining visits.

Surface Hydrology

Damp soils were present in mid-May and mid-June in a high-flow channel that bisected the site; otherwise, all soils were dry (see table 2-2). Standing water was present in a small puddle in the high-flow channel 5 m from the site edge in mid-May, and the site was within 75 m of the lake edge throughout the season. Any changes in soil moisture within the site would be caused by local weather events or fluctuations in daily discharge in either the Big Sandy or Santa Maria Rivers. Daily discharge levels did not change more than 5 cfs in the Big Sandy River near Wikieup and were 0.0 cfs in the Santa Maria River near Bagdad during the survey season (USGS 2019e, 2019f). It is therefore likely that soil moisture did not fluctuate between site descriptions, aside from temporarily damp soils caused by seasonal rains.

Habitat Suitability

Most of the site had canopy closure of 85% and thus met all the criteria for suitable habitat (see table 2-1).

Santa Maria North 01

Vegetation Composition and Structure

Vegetation was mixed-native in composition and consisted primarily of cottonwoods and Goodding's willows 15–30 m in height with tamarisk 4–10 m in height in the understory. The density of both the overstory and understory was highly variable. The overstory was densest along the northern edge of the western half of the site. To the south and east of this area, the cottonwoods and willows occurred either as a broken overstory or as scattered, emergent trees. The overstory trees were largely absent from the southern edge of the site. Canopy closure was 50–90% under the overstory trees, depending on tree health and stem density, and 30–60% elsewhere. At the western end of the site, the southern boundary extended across the active channel of the Santa Maria River. Vegetation on the southern side of the river consisted of 8–15-m-tall cottonwoods and 3–8-m-tall Goodding's willows with 55–85% canopy closure.

Vegetation Condition

The tops of many Goodding's willows along the western edge of the site and along the southern extent of the cottonwood/willow overstory were dead, and piles of deadfall were present. Tamarisk away from both the cottonwood/willow overstory and the river channel were 80% dead. Tamarisk beneath the densest cottonwood/ willow overstory appeared healthy.

Tamarisk Beetle Activity

Tamarisk beetle adults and larvae were present in the site in May and June, and adults were observed in July. Much of the tamarisk foliage remained green throughout the season, with yellow and brown foliage in patches throughout the site.

Surface Hydrology

The Santa Maria River in the southwestern portion of the site contained surface water when each site description was recorded (see table 2-2), but a steep bank 1–2 m in height separated most of the site from the river channel. Most soils in the site interior were damp when the May and June site descriptions were recorded but were dry in mid-July. Daily discharge in the Santa Maria River near Bagdad was 0.0 cfs and did not fluctuate during the survey season (USGS 2019f). Soil moisture conditions at the site likely did not fluctuate substantially from day to day, aside from temporarily damp soils caused by seasonal rains.

Habitat Suitability

Suitable habitat was present in the few places where canopy closure reached 85% (see table 2-1).

Habitat Evaluation

Both evaluation sites (South Camp and Sidebar 01) were visited in May, when each site was inundated by Alamo Lake to a depth > 2 m.

South Camp

Vegetation Composition and Structure

Vegetation consisted entirely of Goodding's willows emerging 2–4 m above the surface of the water, and the average canopy height was shorter at the southern end of the site than at the northern end. Canopy closure ranged from < 50% to 70% and varied directly with canopy height. Each exposed tree crown was conical, and there was no continuous canopy in the site.

Vegetation Condition

Most of the trees in the center of the site were dead. Exposed portions of the rest of the trees appeared lush and healthy.

Habitat Suitability

No portion of the site contained vegetation that met the minimum suitable structural criteria (see table 2-1). Surveys were discontinued for the season after the second survey. Re-evaluation of this site at the beginning of future survey seasons would ensure no suitable habitat is overlooked.

Sidebar 01

Vegetation Composition and Structure

A patchy strip of Goodding's willows emerging 3 to 9 m above the water was present along the western edge of the site. Average canopy height above the water was 4 m, and canopy closure ranged from 50% between patches of trees to 80% under the taller trees. The densest vegetation was a patch of Goodding's willows, 10–20 m wide and 50 m long, along the eastern edge of the northern third of the site. Canopy height above the water ranged from 4 to 10 m and averaged 8 m, and canopy closure was 50–85%, varying directly with canopy height. The remainder of the site consisted of patches of Goodding's willows, most of which were dead, emerging 3–5 m above the water. Canopy closure in these areas was 10–50%.

Vegetation Condition

Most of the willows in the shortest patches in the northern half of the site were dead. All other trees appeared healthy.

Habitat Suitability

Tree mortality has increased steadily over the past few years, and canopy closure reached 85% only in clumps of the tallest Goodding's willows along the northeastern edge of the site. These clumps had the structural characteristics of suitable habitat (see table 2-1), but patch width rarely exceeded 10 m. Re-evaluation of this site at the beginning of future survey seasons would ensure no suitable habitat is overlooked.

Palo Verde Ecological Reserve, California

The PVER is a conservation area located on the California bank of the Colorado River. The elevation of the study area is 85–87 m above mean sea level. All sites are periodically flood irrigated and typically become completely dry between irrigation bouts. Soil moisture monitoring at Phase 02 in 2013 and 2014 found that

surface water was present in the site only during irrigation, and near-saturated soils were present only during and shortly after irrigation (GeoSystems Analysis, Inc. 2014). During the soil moisture monitoring, between March 1 and July 31, surface water was present no more than 8% of the time in 2013, and near-saturated soils were present up to 15% of the time in 2014. The surface hydrology conditions reported below for each site reflect what was seen on the days the site descriptions were recorded. Conclusions on the frequency and duration of surface water within each site could not be drawn because of the high variability in water levels associated with flood irrigation. However, surface water was likely present only during active irrigation (see GeoSystems Analysis, Inc. 2014).

Lands immediately to the west of the PVER are dominated by agricultural fields. The narrow strip of land between the conservation area and the river is dominated by tamarisk, and tamarisk beetles and small patches of defoliation were present starting in late June. No signs of livestock were documented in or around the PVER study area.

Phase 02

Vegetation Composition and Structure

The survey site known as Phase 02 was composed of distinct cells of vegetation, each dominated by a single tree species without any understory. Height and density of the vegetation varied within and between cells. The northern three-quarters of the site contained 30–40-m-wide cells, alternating between 10–14-m-tall Goodding's willows and 3–5-m-tall coyote willows. Emergent cottonwoods up to 16 m in height were scattered throughout the northern three-quarters of the site and were more prevalent in the western half. Emergent Goodding's willows were scattered throughout the coyote willow cells. Canopy closure in both types of willow cells was 60–85% in the Goodding's willows and 70–90% in the coyote willows and varied directly with vegetation height.

The southern quarter of the site was dominated by two large (225 x 60 m) patches of 18–20-m-tall cottonwoods. Canopy closure was 55–70% and varied with the prevalence of gaps in the canopy. The southern edge of the site was vegetated with a 20-m-wide swath of densely planted, 2–2.5-m-tall desert broom (*Baccharis sarothroides*). The full length of the western edge of the site consisted of a 30-m-wide cell of honey mesquite 3–6 m in height with 75–90% canopy closure.

Vegetation Condition

The Goodding's willows in the Goodding's willow cells had thin crowns and relatively small leaves. Several Goodding's willows were half dead, with live vegetation in the lower half of the tree and dead tops, or completely dead; these trees were most prevalent at the very western extent of the Goodding's willows. Dead coyote willows were also scattered throughout the site, though the remaining live

coyote willows had thick, green foliage. The ground beneath the cottonwoods was littered with deadfall both from whole trees and from many large limbs; several gaps were present in the canopy where whole trees fell.

Surface Hydrology

When the May site description was recorded, wet soils were present in the northern 50% of the site (see table 2-2). All soils were completely dry when the June and July site descriptions were recorded.

Habitat Suitability

All elements of suitable habitat were present in small portions of the site where canopy closure reached at least 85% (see table 2-1). This site lacked the continuous presence of wet soils and the canopy closure that are typical of preferred nesting habitat.

Phase 03

Vegetation Composition and Structure

This survey site was vegetated primarily with cottonwoods 12–20 m in height with little understory. Goodding's willows 6–8 m in height were present as scattered single stems throughout most of the site in what used to be single-tree-wide rows and were more prevalent near the western edge of the site. A 30-m-wide strip of 10–14-m-tall Goodding's willows was present along the eastern edge in the northern half of the site. Small (10 x 10 m) patches of small-diameter, 3–4-m-tall coyote willows were scattered throughout the understory and were most prevalent on the northern and southern edges of the site. *Baccharis* sp. shrubs were widely scattered and were typically 1.5 m in height but reached 2.5 m in height beneath the Goodding's willows in the northeastern corner of the site. Many trees in the southern half of the site and near the western edge had fallen, creating piles of deadfall 2–2.5 m in height. In places where there were no fallen trees, many downed cottonwood branches littered the ground. Most of the cottonwoods had narrow canopies at the very top of the tree and very few branches along the trunk. Cottonwoods adjacent to large gaps had larger-diameter trunks than trees elsewhere in the site and had foliage sprouting along the length of the trunk. Canopy closure was 40–80% throughout the site, averaging 60–80% along the northern edge and 40–60% along the western edge and southern half where there were more fallen trees.

Vegetation Condition

At the beginning of the season, almost all the cottonwoods had big, green leaves. The exception was a small patch of cottonwoods in the center of the site where 10–20% of the leaves were yellow. By the time the July site description was

recorded, 90% of the cottonwoods had some yellow leaves. The Goodding's willows along the eastern edge of the site had yellow and brown leaves throughout the season. The prevalence of discolored foliage increased toward the southern end of the Goodding's willow strip, reaching 50% yellow and 15% brown foliage. Many of the scattered, single Goodding's willows throughout the rest of the site had very sparse, narrow canopies, although some trees near the larger gaps had more extensive canopies. Most of the coyote willows were very wispy and half dead, with limited branching and little foliage.

Surface Hydrology

Surface water covered the northern 20% of the site, near the irrigation canal, when the May site description was recorded (see table 2-2). Soils were completely dry when the June and July site descriptions were recorded.

Habitat Suitability

Canopy closure within this site did not exceed 80%; thus, the site did not meet all the criteria for suitable habitat (see table 2-1).

Phase 04 Block 01

Vegetation Composition and Structure

The survey site known as Phase 04 Block 01 was vegetated primarily by Goodding's willows 10–12 m in height with five evenly spaced, 20-m-wide strips of cottonwoods up to 15 m in height. Coyote willows up to 5 m in height were present near the cottonwood strip boundaries, primarily near the northern and southern edges of the site. Canopy closure was 60–75% in areas dominated by Goodding's willows and 60–80% in the cottonwoods. *Baccharis* sp. shrubs formed a dense hedge on the northern edge of the site.

Vegetation Condition

Most of the shorter Goodding's willows had dead tops or dead branches, and the cottonwoods had thin canopies and small leaves. At least half of the coyote willows were dead, and living coyote willows were most prevalent along the southern edge of the site. Dead branches were thick on the ground throughout the site.

Surface Hydrology

All soils were completely dry when each site description was recorded, with the nearest surface water located in the Colorado River approximately 56 m from the site's southeastern corner (see table 2-2).

Habitat Suitability

Canopy closure within this site did not exceed 80%; thus, the site did not meet all the criteria for suitable habitat (see table 2-1).

Phase 04 Block 02

Vegetation Composition and Structure

The survey site known as Phase 04 Block 02 was vegetated primarily with Goodding's willows 10–15 m in height. Coyote willows 3–6 m in height were present in small clumps in the understory or in strips along the perimeter of the site. Cottonwoods 15–20 m in height were present in a square patch approximately 35 x 35 m in size near the center of the site. Canopy closure was 65–75% in the Goodding's willows and 70–75% in the cottonwoods.

Vegetation Condition

Most of the shorter Goodding's willows were either dead or had dead tops. Where the coyote willows extended into the site, most of the stems were dead. Dead branches were thick on the ground throughout the site.

Surface Hydrology

All soils were completely dry when each site description was recorded, with the nearest surface water located in the Colorado River approximately 20 m from the site's southeastern edge (see table 2-2).

Habitat Suitability

Canopy closure within this site did not exceed 75%; thus, the site did not meet all the criteria for suitable habitat (see table 2-1).

Phase 04 Block 03

Vegetation Composition and Structure

Vegetation within the survey site known as Phase 04 Block 03 was composed primarily of cottonwoods 12–18 m in height. Goodding's willows 8–12 m in height were present throughout site within rows that ranged from one tree to 20 m in width. Canopy height for both the cottonwoods and Goodding's willows was taller in the western half (15–18 m and 10–12 m, respectively) than in the eastern half of the site (12–15 m and 8–10 m, respectively). Coyote willows 3–5 m in height were the dominant woody species in gaps in the cottonwood canopy in the north-central portion. There was no continuous understory, though coyote willows 2–4 m in height, 4–7-m-tall Goodding's willows, and *Baccharis* sp. shrubs were widely scattered throughout the site. Canopy closure ranged from 40% in areas with gaps in the

canopy, which occurred primarily in the western half of the site, to 80% in the densest cottonwoods with little deadfall beneath them. Canopy closure was 60% in the cottonwoods along the southern and eastern edges of the eastern half of the site and wherever both cottonwoods and Goodding's willows formed the overstory.

Vegetation Condition

There were piles of deadfall up to 2 m deep and consisting of whole trees along the berms that separated the cells in the western half of the site. Many of the understory Goodding's willows were dead, and the remainder of the understory Goodding's willows had leaves only on the bottom quarter of the tree. Where coyote willows were present in the understory beneath the cottonwoods, they were spindly and half dead. Goodding's willows looked the healthiest in the 20-m-wide strips where they formed the dominant overstory. Many of the cottonwoods along the southern and eastern edges of the eastern half of the site had thin crowns with very small leaves, and there were a few completely dead cottonwoods in the southeastern corner.

Surface Hydrology

All soils were completely dry when the May and July site descriptions were recorded, with the nearest surface water located in the Colorado River approximately 145 m from the site's southern edge (see table 2-2). When the June site description was recorded, the northern border and 50% of the central portion of the site were covered by surface water, and saturated soils were present in most of the remainder of the site.

Habitat Suitability

Canopy closure within this site did not exceed 80%; thus, the site did not meet all the criteria for suitable habitat (see table 2-1).

Phase 05 Block 01

Vegetation Composition and Structure

The survey site known as Phase 05 Block 01 consisted of a heterogenous mix of cottonwoods with small patches and rows of Goodding's willows. Vegetation was tallest in the northwestern corner of the site with 12–15-m-tall cottonwoods and 10–12-m-tall Goodding's willows. In the remainder of the site, the cottonwoods were 8–12 m in height, and the Goodding's willows were 6–8 m in height. Canopy closure was 40–70% in the tallest cottonwoods and Goodding's willows in the northwestern corner of the site and 20–55% in the rest of the site. In the southern and eastern portions of the site, canopy closure reached 55% where cottonwoods dominated the overstory. Canopy closure was lowest in the northwestern corner where the cottonwoods were widely spaced.

Vegetation Condition

The healthiest patches of Goodding's willows occurred in the northwestern corner of the site, where the trees had lush, full canopies. Many of the Goodding's willows in the southern and eastern portions of the site had dead tops or dead limbs, and several Goodding's willows were completely dead in the eastern portion of the site.

Surface Hydrology

All soils were completely dry when each site description was recorded (see table 2-2). The nearest surface water was either in the Colorado River approximately 25 m from the site's southern edge or in an irrigation canal 10 m from the edge of the site.

Habitat Suitability

Canopy closure within this site did not exceed 70%; thus, the site did not meet all the criteria for suitable habitat (see table 2-1).

Phase 05 Block 02

Vegetation Composition and Structure

Vegetation within the survey site known as Phase 05 Block 02 consisted of cottonwoods 12–16 m in height and Goodding's willows 5–8 m in height in the western two-thirds of the site and Goodding's willows 8–12 m in height in the eastern third. Canopy closure was 50–75% in most of the site and was highest in the areas dominated by cottonwoods. A few large, open areas dominated by grass and shrubs ran diagonally through the center of the site from the northeast to the southwest. Canopy closure was 20–30% in these areas.

Vegetation Condition

Where Goodding's willows occurred beneath the cottonwoods, they were either dead or had dead tops. All other trees appeared healthy.

Surface Hydrology

All soils were completely dry when each site description was recorded (see table 2-2), and the nearest surface water was in the Colorado River approximately 25 m from the southern edge of the site.

Habitat Suitability

Canopy closure within this site did not exceed 75%; thus, the site did not meet all the criteria for suitable habitat (see table 2-1).

Phase 05 Block 03

Vegetation Composition and Structure

The survey site known as Phase 05 Block 03 was composed of three distinct cells of vegetation, each dominated by a single tree species. The eastern and western cells were predominantly cottonwoods 12–15 m in height with canopy closure ranging from 40 to 70%. The understory was widely scattered in the eastern and western cells and consisted of 0.5–1.5-m-tall *Baccharis* spp. shrubs, 4–8-m-tall Goodding's willows, and 1.5–3-m-tall honey mesquite, with understory height shorter in the western cell than in the eastern cell. The central cell was vegetated with Goodding's willows 6–12 m in height with 25–60% canopy closure. The understory was a mixture of *Baccharis* spp. shrubs 1–3 m in height, coyote willows 1–4 m in height, and honey mesquite 1–3 m in height.

Vegetation Condition

The cottonwoods in the eastern cell appeared healthy and had full crowns, whereas some cottonwoods in the western cell had dead tops or narrow crowns. Healthy, lush Goodding's willows were present along the northern border of the eastern and central cells, but many of the Goodding's willows elsewhere in the site were partially or completely dead, particularly in the western cell. Tree health was variable in the central cell, and there were several areas where most of the Goodding's willows were either dead or had dead tops. Deadfall was present in much of the site and was most prevalent in the western cell.

Surface Hydrology

The entire site contained wet soils when the May site description was recorded (see table 2-2). Soils were completely dry when the June and July site descriptions were recorded, and the nearest surface water was in the Colorado River approximately 97 m from the site's eastern edge and in an irrigation canal 60 m from the western edge, respectively.

Habitat Suitability

Canopy closure within this site did not exceed 70%; thus, the site did not meet all the criteria for suitable habitat (see table 2-1).

Phase 06 Block 01

Vegetation Composition and Structure

The survey site known as Phase 06 Block 01 was vegetated primarily with cottonwoods 15–18 m in height with narrow rows of Goodding's willows 8–12 m in height distributed throughout the site. The cottonwoods were slightly shorter on the eastern edge of the site, reaching 8–12 m in height. *Baccharis* sp. shrubs and

Goodding's willows 4–6 m in height formed a widely scattered understory. Coyote willows 1–4 m in height were present primarily along the northern and southern borders but also occasionally along the berms that separated cells in the site. Canopy closure was 45–85% and was lower in the western third (45–70%) and along the eastern edge (65–75%) than in the middle of the site.

Vegetation Condition

Many of the taller Goodding's willows had dead tops, and most of the shorter Goodding's willows were partially or completely dead. In the western third of the site, most of the Goodding's willows were partially or completely dead, regardless of height. Many of the live Goodding's and coyote willows in the western portion of the site had brown leaves when the July site description was recorded. There were areas with lush, healthy Goodding's willows, but these were widely scattered. The cottonwoods looked healthy for most of the season, but when the July site description was recorded, many of the cottonwoods in the eastern portion of the site showed signs of early leaf abscission with yellowing and freshly fallen leaves.

Surface Hydrology

All soils were dry when the May site description was recorded, and the nearest surface water was in the Colorado River approximately 97 m from the site's eastern edge (see table 2-2). When the June and July site descriptions were recorded, approximately 50% of the site contained wet soils.

Habitat Suitability

Although canopy closure reached suitable density (see table 2-1) in the densest cottonwoods, areas with suitable canopy closure lacked any type of midstory structure. Thus, although all elements of suitable habitat were present, these elements did not co-occur.

Phase 06 Block 02

Vegetation Composition and Structure

The survey site known as Phase 06 Block 02 was vegetated with a mosaic of 8–12-m-tall Goodding's willows and 12–18-m-tall cottonwoods. In the western three-quarters of the site, cottonwoods 12–16 m in height formed the main overstory, and Goodding's willows 8–14 m in height formed a subcanopy. The eastern quarter of the site was split into a section of 8–12-m-tall Goodding's willows and a section of monotypic, 10–12-m-tall cottonwoods. Coyote willows 1–4 m in height and mule-fat 1–2 m in height were widely scattered in the understory throughout the site. Canopy closure was 60–80% in areas with cottonwoods and 40–60% in areas dominated by Goodding's willows.

Vegetation Condition

Where the Goodding's willows dominated the canopy, many had dead tops. In the remainder of the site, where Goodding's willows formed a subcanopy, the taller Goodding's willows appeared healthy with full crowns, whereas most of the shorter Goodding's willows were partially or completely dead. At least 50% of the coyote willows throughout the site were dead. All the cottonwoods appeared healthy.

Surface Hydrology

A small amount of damp soil was noted when the May site description was recorded, and the nearest surface water was in an irrigation canal near the site (see table 2-2). All soils were completely dry when the June and July site descriptions were recorded, and the nearest water was in the Colorado River approximately 25 m to the east.

Habitat Suitability

Canopy closure within this site did not exceed 80%; thus, the site did not meet all the criteria for suitable habitat (see table 2-1).

Phase 07 Block 01

Vegetation Composition and Structure

The survey site known as Phase 07 Block 01 was vegetated with a mixture of cottonwoods and Goodding's willows. In most of the site, cottonwoods 12–16 m in height formed the overstory, and Goodding's willows 6–8 m in height formed the understory. There were a few areas on the eastern side of the site where Goodding's willows 8–10 m in height formed the overstory. Coyote willows occurred throughout the site, varying from 3-m-tall, widely spaced wispy stems in the center of the site to 5-m-tall stands on the northern and southern edges. *Baccharis* sp. shrubs were scattered throughout the site and sometimes occurred in long, dense rows 2–4 m in height. Several open areas with little to no vegetation were scattered throughout the site. Canopy closure was 70–85% in the cottonwoods, 70% where Goodding's willows dominated the canopy, and 60–75% in the coyote willows. Where the open areas with little vegetation occurred, canopy closure was 20–40%.

Vegetation Condition

The cottonwoods all appeared healthy throughout the season; no deadfall was noted within the site. Many of the Goodding's willows had dead tops or sparse canopies, particularly in the western side of the site. Most of the coyote willows in the interior of the site were dead.

Surface Hydrology

All soils were dry when the May and July site descriptions were recorded, and the nearest surface water was in the Colorado River approximately 110 m from the eastern site edge and an irrigation canal 20 m west of the site, respectively (see table 2-2). When the June site description was recorded, 30% of the site contained damp soils, and the nearest surface water was in a channel near the site.

Habitat Suitability

All characteristics of suitable habitat (see table 2-1) were present where canopy closure reached 85%. Most of the site, however, had canopy closure that did not reach suitable levels.

Phase 07 Block 02

Vegetation Composition and Structure

The survey site known as Phase 07 Block 02 was vegetated primarily by cottonwoods 12–18 m in height. Goodding's willows were present throughout the site either as a 6–10-m-tall subcanopy or as an 8–14-m-tall overstory. Coyote willows 2–4 m in height and *Baccharis* sp. shrubs were scattered throughout the site in the understory. In a few places, the coyote willows were present without any overstory. Canopy closure was 60–85% throughout the site, reaching 85% in the densest cottonwoods and averaging lower than 85% where Goodding's or coyote willows were more abundant.

Vegetation Condition

When the July site description was recorded, several cottonwoods were showing signs of early leaf abscission and were losing yellow or brown leaves. Where the Goodding's willows occurred as single stems or one-tree-wide rows under the cottonwoods, each stem was either dead or had foliage only near the bottom of the trunk. In areas where the Goodding's willows were dominant and not shaded by the cottonwoods, the trees either had completely live crowns or only the very top of the tree was dead. Coyote willows were healthier in the western half of the site than in the eastern half, where they were spindly and had little foliage.

Surface Hydrology

All soils were dry when the May site description was recorded, and the nearest surface water was in an irrigation canal approximately 10 m from the site edge (see table 2-2). Most soils (85%) were damp when the June site description was recorded, and the nearest surface water was in puddles adjacent to the site. When the July site description was recorded, 40% of soils were saturated and 20% were damp.

Habitat Suitability

Although canopy closure reached suitable density (see table 2-1) in a few places, areas with dense canopy closure lacked any type of midstory structure. Thus, although all elements of suitable habitat were present, these elements rarely co-occurred.

Cibola, Arizona

CIBO contains conservation area sites in the Cibola Valley Conservation Area (CVCA) and Cibola National Wildlife Refuge Unit #1 as well as survey sites in existing, unrestored riparian habitat. Only the sites in conservation areas were surveyed in 2019. The elevation of survey sites within conservation areas ranges from 70 to 73 m above mean sea level and decreases from north to south along the Colorado River. No signs of livestock were documented in or around any sites. Tamarisk beetles were noted in the study area starting in mid-June and were present by mid-July in each survey site that had a tamarisk component.

All conservation area sites, which are surrounded by agricultural fields, are periodically flood irrigated and typically become dry between irrigation bouts. Conclusions on the frequency and duration of surface water within the sites could not be drawn because of the high variability in water levels associated with flood irrigation.

Cibola Valley Conservation Area

Phase 01

Vegetation Composition and Structure

Phase 01 at the CVCA consisted of a mosaic of rectangular cells of cottonwoods, Goodding's willows, and coyote willows of varying sizes and densities. Each cell generally contained a single species and age class, though emergent Goodding's willows were present in the coyote willow cells. Most of the site was vegetated with cottonwoods 12–18 m in height, with the tallest cottonwoods on the eastern side of the site. Canopy closure in the cottonwoods ranged from 60 to 85% depending on how densely the trees were planted. The cells planted with Goodding's willows ranged widely in tree density. One Goodding's willow cell had trees 4–8 m in height with a grassy meadow at the northern end where the trees were widely scattered. The other Goodding's willow cell had trees 6–10 m in height and canopy closure of 50–60%. The coyote willows were 2–5 m in height with 70–90% canopy closure. *Baccharis* sp. shrubs 2–3 m in height were scattered in the understory in the eastern cells and in some of the coyote willow cells. Tamarisk up to 6 m in height were also scattered throughout the site.

Vegetation Condition

When the July site description was recorded, the cottonwoods on the western side of the site showed signs of early leaf abscission with extensive yellowing and many falling leaves. Many of the Goodding's willows had dead tops, and several were completely dead. One cell of coyote willows was 70% dead and the other was 40% dead.

Surface Hydrology

No wet soils were present when the May and July site descriptions were recorded, and the nearest surface water was in irrigation canals ≤ 10 m from the site edge (see table 2-2). When the June site description was recorded, 15% of the site contained wet soils.

Habitat Suitability

Portions of the cottonwood stands had canopy closure that met the criterion for suitable habitat (see table 2-1), but these stands lacked midstory structural components. A few places in the coyote willows cells, where both canopy height and canopy closure were high, met all the criteria for suitable habitat, but these were extremely limited in areal extent.

Phase 02

Vegetation Composition and Structure

The survey site known as Phase 02 at the CVCA consisted of two alternating types of rectangular cells. One type of cell consisted of cottonwoods 15–18 m in height mixed with Goodding's willows 10–12 m in height in the subcanopy and an understory of 3–4-m-tall coyote willows and 6–8-m-tall Goodding's willows. The cottonwood cells alternated with cells of coyote willows 2–6 m in height with emergent cottonwoods and Goodding's willows. Some 1–3-m-tall tamarisk and 2–6-m-tall honey mesquite were widely scattered throughout the site in both cell types. Canopy closure in the cottonwood-Goodding's willow cells ranged from 50 to 80% and was lower where Goodding's willows were more abundant. Canopy closure in the coyote willow cells was 40–60% and varied with the density and crown size of the emergent cottonwoods and Goodding's willows. There was a narrow (20-m-wide) strip of 10–12-m-tall Goodding's willows with 85% canopy closure on the very eastern edge of the site.

Vegetation Condition

In the cottonwood-willow cells, most of the shorter Goodding's willows were completely dead. Where the Goodding's willows were taller and part of the subcanopy, many had dead tops. The healthiest Goodding's willows were in the narrow strip on the eastern edge of the site. Most of the coyote willows were completely dead, though shorter, living coyote willows were growing up through the

dead stems. Most of the cottonwoods appeared healthy, though the trees along the very western edge of the site had smaller leaves and thinner canopies than those elsewhere in the site.

Surface Hydrology

All soils were dry when the May and July site descriptions were recorded, and the nearest surface water was in the Colorado River nearly 500 m from the site (see table 2-2). When the June site description was recorded, 10% of soils were damp, and the nearest surface water was in an irrigation canal north of the site.

Habitat Suitability

Most of this site lacked canopy closure that met the criterion for suitable habitat (see table 2-1). Suitable habitat was present where canopy closure reached 85% in the strip of Goodding's willows on the very eastern edge of the site.

Phase 03

Vegetation Composition and Structure

The survey site known as Phase 03 at the CVCA consisted of a mosaic of rectangular cells that were planted with cottonwoods, Goodding's willows, or coyote willows. The cells planted with cottonwoods covered about half of the site. Cottonwoods within these cells were typically 8–12 m in height, though the trees along the very western edge of the site were 14–16 m in height. In the northern two-thirds of the site, the cottonwoods were planted relatively densely, and 1–2-m-tall tamarisk and 1–5-m-tall honey mesquite were widely scattered in the understory. In the southern third of the site, the cottonwoods were planted relatively far apart and had a dense understory of 1–3-m-tall *Baccharis* sp. shrubs. At the very southern end of the site, the cottonwoods were again planted relatively close together, and some 2–3-m-tall coyote willow were present in the understory along with tamarisk and honey mesquite. Canopy closure in the cottonwood cells was 70–85% in the northern two-thirds of the site and 40–60% in the southern third.

Two cells contained Goodding's willows 8–10 m in height and widely scattered, emergent cottonwoods 14–18 m in height. *Baccharis* sp. shrubs 1–3 m in height and honey mesquite 2–4 m in height formed an understory in places. Two cells contained coyote willows 2–4 m in height, and emergent cottonwoods up to 16 m in height and Goodding's willows up to 12 m in height formed a broken overstory in places. Honey mesquite 2–7 m in height, 1–4-m-tall tamarisk, and 1–3-m-tall *Baccharis* sp. shrubs were present throughout the coyote willow cells and formed an understory layer where they occurred more densely. Canopy closure in the Goodding's and coyote willow cells was 20–60%.

Vegetation Condition

All the cottonwoods appeared relatively healthy, and emergent trees in the willow cells and those on the very western edge of the site appeared more robust than those elsewhere. There was very little deadfall in the cottonwoods, but many of the Goodding's willows were completely dead and had fallen. Of the Goodding's willows that were still standing, most had live foliage only on the lower half of the tree. At least 85% of the coyote willows were completely dead, with only a small section in each coyote willow cell where some stems were still alive.

Surface Hydrology

Soils were completely dry when the May and July site descriptions were recorded, and the nearest surface water was in a remnant puddle in a nearby irrigation ditch approximately 15 m from the site edge (see table 2-2). The June site description was generated on two separate days, 5 days apart. During the first visit, the northern third of the site was visited, and active irrigation was noted; 70% of this area contained wet soils. Five days later, the southern two-thirds of the site was visited; 80% of this area contained damp soils, with the nearest surface water in a remnant puddle in a nearby irrigation ditch.

Habitat Suitability

Portions of the cottonwood stands had canopy closure that met the criterion for suitable habitat but lacked midstory structural components (see table 2-1); thus, there was no portion of the site where all the elements of suitable habitat co-occurred. In most of the site, canopy closure was too low to meet the criterion for suitable habitat.

Phase 08

History

The survey site known as Phase 08 at the CVCA was surveyed for the first time in 2019. The entirety of the area was evaluated to determine the extent of potentially suitable habitat. Following evaluation, the site boundaries were reconfigured.

Vegetation Composition and Structure

The site was planted in a patchwork of rectangular cells. Vegetation in the original site boundary consisted of a mosaic of cottonwoods, Goodding's willows, honey mesquite, quailbush (*Atriplex lentiformis*), mule-fat, tamarisk, alfalfa (*Medicago sativa*), and prickly lettuce (*Lactuca serriola*). Most of the western half of the original site consisted of 1–4-m-tall quailbush, 2–4-m-tall tamarisk, 1–4-m-tall honey mesquite, and 2–4-m-tall mule-fat. Areas planted with cottonwoods varied widely in stem density from very widely spaced trees 4–6 m in height with 10–20% canopy closure to more densely spaced trees 3–12 m in height with 40–90% canopy closure. All

portions of the site that did not contain cottonwoods or Goodding's willows or where the cottonwoods were very widely spaced were excised from the survey site boundary after the first visit.

The reconfigured site consisted primarily of two types of cells. One type consisted of a mix of cottonwoods 6–10 m in height and Goodding's willows 4–7 m in height with an understory of tamarisk 2–4 m in height and mule-fat. Canopy closure ranged from 80 to 95%. All cells varied in canopy height and closure on an east-west gradient, with the tallest and densest vegetation occurring at the eastern end of the cells. The other type of cell consisted of clumps of cottonwoods 8–12 m in height in fields of prickly lettuce with varying densities of 3-m-tall tamarisk between the cottonwood clumps. The cottonwood clumps were generally 10 m or less in diameter. Canopy closure within the cottonwood clumps reached 85% and was 20–30% in the cell overall.

Vegetation Condition

All vegetation appeared healthy in May and June. When the July site description was recorded, some of the denser cottonwoods were developing yellow leaves.

Surface Hydrology

Soils were completely dry when the May and July site descriptions were recorded (see table 2-2). When the June site description was recorded, 85% of soils were damp. The nearest surface water was in an irrigation canal immediately to the north.

Habitat Suitability

Suitable habitat was present where canopy closure was at least 85% and patch width was at least 10 m (see table 2-1). In most of the site, canopy closure was too low to meet the criterion for suitable habitat. This is a young site, and vegetation structure is likely to continue developing in future years.

Cibola National Wildlife Refuge Unit #1

Upper Hippy Fire

Vegetation Composition and Structure

This survey site was vegetated primarily with cottonwoods 6–15 m in height. An irrigation canal bisected the site north to south, and the tallest trees were in the center of the site near the canal, with canopy height decreasing to the east and west. Goodding's willows 6–7 m in height and coyote willows 2–4 m in height were planted in narrow rows within the cottonwoods. There was one section of Goodding's willows 6–12 m in height and approximately 100 x 250 m in size in the eastern half of the site. As with the cottonwoods, canopy height was taller

(8–12 m) near the irrigation canal and shorter (6–9 m) to the east. There was an open, grassy area 40 x 40 m in size in the middle of the Goodding's willows. Coyote willows 2–4 m in height were present throughout the Goodding's willow section and as a small patch at the southern edge of the grassy opening. A few dense strips of mule-fat 2 m in height and with no overstory were present in both the eastern and western halves of the site. Canopy closure in the cottonwoods in most of the site varied directly with canopy height and ranged from 60 to 90%. In the Goodding's willow section, canopy closure did not exceed 75%. A narrow strip of cottonwoods and Goodding's willows along the northern edge of the western half of the site had canopy closure of 95%. The densest vegetation in the site was at an irrigation outlet in the southeastern corner and consisted of a clump of dense coyote willows 3–4 m in height surrounded by 18-m-tall, large-diameter cottonwoods with wide canopies. This patch was approximately 20 m across and had canopy closure > 95%.

Vegetation Condition

Most of the Goodding's and coyote willows in the narrow rows were mostly or completely dead. Live Goodding's willows had foliage only along the bottom third of the trunk, and live coyote willows were wispy stems with sparse foliage. The healthiest Goodding's willows were in the big section in the eastern half of the site, and the healthiest coyote willows were in the small patch at the southern edge of the grassy opening. The cottonwoods all appeared healthy, but canopies were fuller in the taller trees.

Surface Hydrology

All soils were damp when the May site description was recorded, and the nearest surface water was in the Colorado River approximately 358 m from the western edge of the site (see table 2-2). When the June site description was recorded, almost all soils were damp and there were a few puddles in the southwestern corner of the site. All soils were dry when the July site description was recorded, although surface water was present in the central irrigation canal.

Habitat Suitability

The 20-m-wide patch of dense vegetation in the southwestern corner of the site contained all the elements of suitable habitat (see table 2-1). Portions of the site adjacent to the irrigation canal had canopy closure that met the suitability criterion, but midstory structural elements were lacking; thus, this portion of the site did not meet all the criteria for suitable habitat. Canopy closure in the remainder of the site did not meet the criterion for suitable habitat.

Nature Trail

Vegetation Composition and Structure

The survey site known as Nature Trail consisted of a mosaic of cottonwoods, Goodding's willows, mesquite, and willow baccharis. Approximately half of the site consisted of scattered screwbean and honey mesquite 5–7 m in height with a thick understory of 1–4-m-tall willow baccharis. The ratio of mesquite to baccharis varied from stands of fairly continuous mesquite to almost pure baccharis. Canopy closure in areas dominated by mesquite and baccharis was 20–50% and varied directly with the amount of mesquite. The northern half of the site contained a cell approximately 100 x 275 m in size of Goodding's willows 4–9 m in height with 20–40% canopy closure. Cottonwoods 20 m in height with 65–80% canopy closure were present in the southwestern corner of the site and in narrow stringers along the pathways throughout the site. Willow baccharis 1.5 m in height formed a very sparse understory in the southwestern corner of the site.

Vegetation Condition

The majority of the Goodding's willows (> 90%) were mostly dead with only the bottom half of each stem supporting live foliage. All other vegetation in the site appeared healthy, though some of the cottonwoods were losing leaves when the July site description was recorded.

Surface Hydrology

A small amount of standing water was present in the southwestern corner of the site when the May site description was recorded, and most of the remaining soils were dry (see table 2-2). All soils were completely dry when the June and July site descriptions were recorded, and the nearest known surface water was either at the southeastern corner of Upper Hippy Fire approximately 1,200 m away or in an irrigation canal along the western edge of the site.

Habitat Suitability

Canopy closure was too low to meet the criterion for suitable habitat (see table 2-1).

Lower Hippy Fire

History

The survey site known as Lower Hippy Fire was surveyed for the first time in 2019. The entirety of the area was evaluated to determine the extent of potentially suitable habitat. Following evaluation, the site boundaries were reconfigured.

Vegetation Composition and Structure

The original site area was divided vertically by a north-south road and irrigation canal, with one-quarter of the site to the west (western block) and three-quarters to the east. The area to the east was further divided into six blocks by five east-west dirt roads. Vegetation in the western block was mostly 2–3-m-tall arrowweed and saltbush with widely scattered tamarisk 2–5 m in height. Vegetation in the southernmost block on the east side of the original site consisted of stringers of 3–4-m-tall cottonwoods, honey mesquite, and tamarisk along narrow, 0.5-m-deep ditches. Soil between the ditches was barren, and canopy closure ranged from 10% between the ditches to 60% along the ditches. The western half of the northernmost block contained very widely spaced 4–6-m-tall cottonwoods, 2–3-m-tall honey mesquite, and 1–2-m-tall tamarisk, and canopy closure did not exceed 10%. All three of these areas were excised from the original survey site boundary and were not surveyed after the initial visit.

The reconfigured site was planted in a patchwork of approximately rectangular cells. One cell near the northern end of the site consisted of Goodding's willows 7–8 m in height with an understory of coyote willows 2.5 m in height and 60% canopy closure. The remaining 95% of the site consisted primarily of cottonwoods of varying heights and planting densities. Some cells were park-like and consisted of widely spaced single trees or clumps of cottonwoods 4–12 m in height with 60–85% canopy closure and patchy tamarisk 2–3 m in height between the cottonwood clumps. Other cells consisted of closely spaced, slender cottonwoods averaging 8 m in height. Portions of these cells had single rows of Goodding's willows 5 m in height and coyote willows 3 m in height. Canopy closure in the densely planted cells ranged from 75 to 95%, with the tallest trees and densest canopy closure occurring on the western side of the site. Rows and clumps of mule-fat were present intermittently throughout the site.

Vegetation Condition

All the Goodding's and coyote willows were spindly with sparse foliage, and a few of the Goodding's willows had dead tops. Most of the cottonwoods appeared healthy, though a few had thin crowns.

Surface Hydrology

A majority (90–95%) of soils were dry, with the remainder damp, when the May and July site descriptions were recorded, and the nearest surface water was in an irrigation canal immediately east of the site (see table 2-2). A small puddle was present at an irrigation outlet when the June site description was recorded, and all other soils were dry.

Habitat Suitability

Portions of the site where canopy closure was ≥ 85% had the structural characteristics of suitable or preferred nesting habitat (see table 2-1), though the site lacked the wet soils typical of preferred habitat. Canopy closure in the remainder of the site did not meet the criterion for suitable habitat. This is a young site, and vegetation structure is likely to continue developing in future years.

C2729

Vegetation Composition and Structure

The survey site known as C2729 consisted of a mosaic of cottonwoods and coyote willows and was bisected east to west by a road. The northern half of the site was vegetated with a broken overstory of widely spaced cottonwoods and a coyote willow understory. Tamarisk 0.5–1.5 m in height were widely scattered in the northern half of the site. The cottonwoods were 12–15 m in height, and the coyote willows were 2–4 m in height. Canopy closure was 40–70% and was highest along the western edge of the site.

The southern half of the site was vegetated primarily with coyote willows with scattered tamarisk 3–5 m in height and emergent cottonwoods 12–15 m in height. Canopy height in the northwestern two-thirds of the southern half averaged 4–5 m for both the coyote willows and tamarisk, and canopy closure was 50–80%. The southeastern third of the southern half was sparsely vegetated with 3–4 m coyote willows and tamarisk, and canopy closure was 15–30%. Honey mesquite were scattered in the southern half of the site.

Vegetation Condition

Most of the coyote willows in the northern half of the site were completely dead, and those that were still living had leaves only on the lowest quarter of the plant. Most of the coyote willows in the northwestern two-thirds of the southern half of the site were alive and appeared healthy. In the southeastern third of the southern half, 70% of the coyote willows were dead and the remainder had dead tops.

Surface Hydrology

A small percentage of damp soils (≤ 10%) were noted when the May and July site descriptions were recorded, and all other soils were dry (see table 2-2). All soils were dry when the June site description was recorded. The nearest standing water was either in an irrigation canal adjacent to the site or in neighboring irrigated riparian habitat.

Habitat Suitability

Canopy closure did not meet the criterion for suitable habitat (see table 2-1).

Mittry Lake, Arizona and California

MITT is located north of Mittry Lake and west of the Mittry Lake Wildlife Area and contains conservation area sites in the Laguna Division Conservation Area (LDCA) as well as survey sites in existing, unrestored riparian habitat. The elevation in this study area is 48–49 m above mean sea level. Only the sites in the LDCA were surveyed in 2019. No signs of livestock or tamarisk beetles were noted within or near any of the survey sites, and all vegetation appeared healthy.

Sites within the LDCA are irrigated via manipulation of the water level in a central channel that runs north-south through the conservation area. Water levels in the northern and southern halves of the LDCA are controlled separately. When water levels are high, the effect resembles overbank flooding. The irrigation schedule in 2019 called for high water levels to alternate between the two halves at 3-week intervals starting on May 15 (C. Dodge 2019, personal communication). High water levels resulted in sites being completely inundated, while low water levels resulted in sites being mostly or completely dry.

Laguna Division Conservation Area

C4958

History

The survey site known as C4958 was surveyed for the first time in 2019. The entirety of the originally proposed area was evaluated to determine the extent of potentially suitable habitat. Following evaluation, the site boundaries were reconfigured.

Vegetation Composition and Structure

C4958 was vegetated primarily with coyote willows and was bisected by a channel running the length of the site. The northern 100 m of the originally proposed site consisted of sparse coyote willows approximately 3 m in height, and this area was not surveyed after the initial visit in May. In the reconfigured site, canopy height was 3.5–4 m near the southern end, 3–3.5 m at the northern end, and 1–2 m in shallower portions of the channel. Tamarisk and arrowweed 2 m in height were scattered throughout the coyote willows. Canopy closure varied from 60% in the shortest coyote willows to 85% in the tallest. Cottonwoods 9–10 m in height were present at the southern edge of the site. There was no understory beneath the cottonwoods on the western side of the channel, but small branches along the cottonwood trunks created some midstory structure, and canopy closure was 90–95%. On the eastern side of the channel, the cottonwoods formed a single-tree-wide stringer with an understory of coyote willows and 60% canopy closure.

Surface Hydrology

Surface water and saturated soils were present in a channel in the northeastern portion of the site when the May and June site descriptions were recorded (see table 2-2), and all other soils were dry. When the July site description was recorded, the entire site was inundated.

Habitat Suitability

Canopy height and canopy closure in the coyote willows were slightly too low to meet the suitability criteria (see table 2-1). Suitable habitat was present in the cottonwoods west of the channel. East of the channel, canopy closure in the cottonwoods was too low. This is a relatively young site, and it is likely that canopy closure and overall structure will improve as the site matures.

C4911

Vegetation Composition and Structure

Vegetation in the survey site known as C4911 consisted primarily of 7–10-m-tall cottonwoods and Goodding's willows. The understory consisted of scattered honey mesquite 2–4 m in height, 1–2-m-tall bulrush, 1–2-m-tall arrowweed, and a few scattered 1–2-m-tall tamarisk. Canopy height was shorter (7–9 m) in the southern third of the site and taller (8–10 m) in the northern two-thirds. Within each of these sections, the tallest vegetation was near the western edge of the site. Canopy closure varied directly with canopy height and was 50–80%. In the very northeastern corner of the site was a patch of coyote willows 3–5 m in height with 75–80% canopy closure. The western edge of the site was vegetated with dense arrowweed 2–2.5 m in height.

Surface Hydrology

When the May site description was recorded, 97% of the site contained either shallow standing water or saturated soils (see table 2-2). When the June site description was recorded, the entire site was dry, and the nearest standing water was in the central channel that bisects the conservation area, approximately 75 m due east of the site. When the July site description was recorded, the entire site was inundated with an average of 40 cm of water.

Habitat Suitability

Canopy closure was too low to meet the suitability criterion (see table 2-1). This is a relatively young site, and it is likely that canopy closure and overall structure will improve as the site matures.

C4913

Vegetation Composition and Structure

The survey site known as C4913 consisted of a mosaic of cottonwoods, Goodding's willows, and coyote willows. The northeastern third of the site was vegetated primarily with coyote willows 3–4 m in height with a few trees up to 5 m in height along the eastern border near the road. Canopy closure varied from 60 to 80% in accordance with canopy height. The southwestern two-thirds of the site was vegetated primarily with clumps of cottonwoods 8–10 m in height and a heterogeneous understory of Goodding's willows 7–8 m in height, honey and screwbean mesquite 4–7 m in height, and arrowweed and willow baccharis 2 m in height. Canopy closure in this section was 65–85%.

Surface Hydrology

When the May site description was recorded, approximately half of the site contained either shallow standing water or saturated soils (see table 2-2). When the June site description was recorded, the entire site was dry, and the nearest standing water was in the central channel that bisects the conservation area, approximately 80 m due west of the site. When the July site description was recorded, the entire site was inundated with an average of 40 cm of water.

Habitat Suitability

Suitable habitat was present where canopy closure reached 85% (see table 2-1). This is a relatively young site, and it is likely that canopy closure and overall structure will continue to improve as the site matures.

C4959

History

The survey site known as C4959 was surveyed for the first time in 2019. The entirety of the originally proposed area was surveyed.

Vegetation Composition and Structure

C4959 was vegetated primarily with coyote willows 3–3.5 m in height with scattered, emergent 4–6-m-tall Goodding's willows and 5–7-m-tall cottonwoods. Cattails were scattered throughout the understory. Canopy closure was 40–60% and varied with canopy height and stem density.

Surface Hydrology

When the May and June site descriptions were recorded, 100% of the site was inundated to a depth of 25–30 cm (see table 2-2). All soils were completely dry when the July site description was recorded, and the nearest surface water was in a channel 20 m due east of the site.

Habitat Suitability

Canopy closure was too low throughout the site to meet the minimum suitability criterion (see table 2-1). This is a relatively young site, and it is likely that overall structure will improve as the site matures.

C4961

History

The survey site known as C4961 was surveyed for the first time in 2019. The entirety of the originally proposed area was surveyed.

Vegetation Composition and Structure

C4961 consisted of a mosaic of cottonwoods up to 7 m in height, Goodding's willows 5–7 m in height, and coyote willows 3–4.5 m in height. The understory was a mixture of arrowweed, cattails, tamarisk, and honey mesquite up to 2 m in height. Canopy closure was 40–80% and averaged 60%.

Surface Hydrology

When the May and June site descriptions were recorded, 100% of the site was inundated to a depth of 25–30 cm (see table 2-2). All soils were completely dry when the July site description was recorded, and the nearest surface water was in a channel 10 m due north of the site.

Habitat Suitability

Canopy closure was too low throughout the site to meet the minimum suitability criterion (see table 2-1). This is a relatively young site, and it is likely that overall structure will improve as the site matures.

C4960

History

The survey site known as C4960 was surveyed for the first time in 2019. The entirety of the originally proposed area was surveyed.

Vegetation Composition and Structure

C4960 consisted of a mosaic of single-species rows of cottonwoods 5–10 m in height, Goodding's willows 5–9 m in height, and coyote willows 2–4 m in height with no understory. The combination of widely spaced rows and narrow tree canopies resulted in a broken overstory. Vegetation was taller and denser in the southern third of the site than in the northern two-thirds. In the southern third, average canopy height was approximately 8 m for cottonwoods and 7 m for Goodding's willows. In the northern two-thirds of the site, average canopy height was 6 m for cottonwoods and 5 m for Goodding's willows. Canopy closure varied from 30 to 80% and averaged 40% in the northern two-thirds and 60% in the southern third.

Surface Hydrology

When the May and June site descriptions were recorded, 100% of the site was inundated to a depth of 25–35 cm (see table 2-2). All soils were completely dry when the July site description was recorded, and the nearest surface water was in a channel 10 m due west of the site.

Habitat Suitability

Canopy closure was too low throughout the site to meet the minimum suitability criterion (see table 2-1). This is a relatively young site, and it is likely that overall structure will improve as the site matures.

Habitat Evaluation

Two patches of trees southwest of C4961 were also evaluated during the initial visit to the LDCA in May. The patch nearest to C4961 was vegetated with coyote willows 2–3.5 m in height with scattered arrowweed and tamarisk 2 m in height. Several single-tree-wide stringers of 8-m-tall cottonwoods and 7-m-tall Goodding's willows with narrow canopies were present in the western half of the patch. Cattails were scattered throughout the patch, and canopy closure was 40%. This patch had many of the same components as C4961, but the overall structure was shorter and more open. It is likely that the vegetation structure will continue to develop as the patch matures.

The second evaluated patch consisted of coyote willows up to 3 m in height with 60% canopy closure. The vegetation was too short and open to be suitable, but it is likely that the vegetation structure will continue to develop as the patch matures.

Yuma, Arizona

YUMA is located along the Colorado and Gila Rivers near the city of Yuma. The study area includes two conservation areas: Yuma East Wetlands, approximately

4 km downstream from the Colorado and Gila confluence, and Hunters Hole, 3 km north of the Southerly International Boundary with Mexico. YUMA also includes unrestored sites along the Gila River from the confluence upstream to the Gila Gravity Canal. Only the sites in conservation areas were surveyed in 2019. The elevation within the study area ranges from 46 m at the farthest upstream site along the Gila River to 26 m at Hunters Hole. All conservation area sites are periodically flood irrigated and typically become dry between irrigation bouts. Conclusions on the frequency and duration of surface water within each site could not be drawn because of the high variability in water levels associated with flood irrigation. All survey sites within the study area are located within a matrix of agricultural lands. No signs of livestock or tamarisk beetles were noted within or around any of the survey sites.

Yuma East Wetlands

C4703

Vegetation Composition and Structure

The survey site known as C4703 was bisected by a dirt road and irrigation channel. Vegetation consisted primarily of cottonwoods 10–15 m in height. The understory was composed of scattered 2-m-tall willow baccharis and 2–6-m-tall honey and screwbean mesquite. Canopy closure within the cottonwoods was 40–80% and did not vary in any noticeable pattern. A stand of 2–4-m-tall coyote willows 60 x 120 m in size with emergent Goodding's willows 8–10 m in height and cottonwoods 12–14 m in height was present along the western edge of the site. Canopy closure in this area was 90%.

Vegetation Condition

Several dead, standing cottonwoods were scattered throughout the site, and other cottonwoods had thin crowns or partially dead tops. Several dead stems were present in the coyote willow patch, but most of the stems were alive and had full canopies.

Surface Hydrology

Soils were completely dry when each site description was recorded, and the nearest surface water was in an open channel immediately northwest of the site (see table 2-2).

Habitat Suitability

Most of the site lacked the canopy closure and/or the midstory structure of suitable habitat (see table 2-1). Canopy closure reached suitable levels in the stand of coyote willows on the western side of the site, although the stems appeared wispy and closely spaced, providing few flyways.

C4711

Vegetation Composition and Structure

The survey site known as C4711 consisted of a stringer of cottonwoods, Goodding's willows, and coyote willows along the northern edge of a cattail-bulrush marsh. The site was bisected by an open water channel extending north from the marsh. East of the channel, the stringer was rarely more than one tree wide and consisted of 10–12-m-tall cottonwoods with a few Goodding's willows. West of the channel, the stringer widened slightly and consisted of 8–10-m-tall Goodding's willows and 15-m-tall cottonwoods. The understory, which was very sparse east of the channel and thicker to the west, consisted of 2–3-m-tall mule-fat and willow baccharis and 2–6-m-tall honey and screwbean mesquite. The very western end of the stringer consisted of a patch of coyote willows approximately 80 x 10 m in size and 4–5 m in height. Canopy closure was 50–60% in the cottonwoods and Goodding's willows and 85–90% in the coyote willows. Around the channel, only the understory species were present. There was a small area of dead cattails and bulrush along the southern edge of the western portion of the site.

Vegetation Condition

Some dead branches were present in the cottonwoods and Goodding's willows, but overall the trees appeared healthy. Many dead stems were present in the coyote willows with live growth present only within 2 m of the ground.

Surface Hydrology

Standing water was documented in the open water channel when all three site descriptions were recorded, and all other observed soils were dry (see table 2-2).

Habitat Suitability

Canopy closure within most of the site was too low to meet the criterion for suitable habitat (see table 2-1). Canopy closure reached suitable levels in the coyote willows, but much of the cover was provided by dead stems that were too closely spaced to provide flight paths.

C4702

Vegetation Composition and Structure

The survey site known as C4702 consisted primarily of cottonwoods 8–15 m in height with a patchy understory of 2-m-tall willow baccharis and 2–6-m-tall honey mesquite. The habitat was divided into cells that were separated by dirt roads, and vegetation density varied by cell, with canopy closure ranging from 40 to 80%. Areas with lower canopy closure were characterized by more widely spaced trees and a more dominant understory. One cell on the western side of the site contained a 20-m-wide stand of cottonwoods 10–12 m in height with 60–80% canopy closure and no understory. This cottonwood stand was bordered to the west by a stand of coyote willows roughly 70 x 50 m in size and 3–5 m in height with 90% canopy closure.

Vegetation Condition

Some of the cottonwoods had very sparse canopies and small leaves, while others had more robust leaves and appeared healthy. The coyote willows appeared lush and healthy.

Surface Hydrology

Residual standing water was present in an irrigation canal running through the site when the May and July site descriptions were recorded, but all other soils in the site were dry (see table 2-2). Damp soils were present in 40% of the site when the June site description was recorded, and the nearest surface water was in an irrigation canal just south of the site.

Habitat Suitability

The coyote willow patch had the canopy closure of preferred nesting habitat, but the stems were too closely spaced to provide flight paths (see table 2-1). Most of the remainder of the site lacked the canopy closure needed for suitable habitat.

Hunters Hole

This survey site was incorporated into the LCR MSCP as a conservation area, and planting was completed in 2013. The northern two-thirds of the site consisted of patches of cottonwoods and Goodding's willows, small patches of coyote willow, and scattered honey mesquite. The density of the patches was widely variable, and canopy closure ranged from 50 to 90%. The densest and tallest vegetation occurred in the center of the site, where canopy height reached 10 m. The southern third of the site was open, with scattered honey mesquite and little ground cover. The site was bordered to the east by agricultural fields and on other sides by open areas sparsely vegetated by tamarisk.

The site is periodically flood irrigated and typically becomes completely dry between irrigation bouts. Habitat suitability and vegetation condition at the site were not assessed.

DISCUSSION

Tamarisk beetles were active at TOPO, BIWI, ALAM, and CIBO in 2019. The heaviest defoliation occurred in July at all study areas but was widespread only at CIBO. At TOPO, BIWI, and ALAM, defoliation was patchy, not only at the landscape level but also within individual trees. Dieback of the tamarisk as the result of previous defoliation events was apparent throughout TOPO, BIWI, and ALAM but was most severe at BIWI and ALAM. The dieback reduced canopy closure, often to levels below the suitability criterion. The effect of tamarisk defoliation on canopy closure in TOPO, BIWI, and ALAM in 2019 was not as dramatic as in previous years, both because defoliation was patchy in all three study areas and because the initial canopy closure in areas with dieback was lower at the start of the 2019 survey season than at the start of previous survey seasons. Regrowth of vegetation is needed in sites with tamarisk dieback before they can meet the criteria of suitable flycatcher habitat again.

Areas of BIWI upstream of Site 03 have experienced widespread mortality of native trees in the last few years as the result of low streamflow and a drop in the water table. Releases from Alamo Dam in March 2018 resulted in flooding that wetted areas of BIWI that had been dry in recent years, and streamflow in the Bill Williams River remained > 0.0 cfs through the first half of the 2019 survey season. Little change in the condition of the overstory trees was evident, but several localized areas of young cottonwoods and Goodding's willows were present along the stream margins in Site 05, Black Rail, Beaver Pond North, Beaver Pond, and Site 08.

Tamarisk in BIWI were defoliated throughout the 2017 breeding season and much of the 2018 breeding season. In 2018, complete tamarisk mortality was most evident upstream of Site 03 and was likely the result of a combination of water stress and defoliation by tamarisk beetles; partial dieback was noted elsewhere. The extent of tamarisk mortality increased in 2019 and was evident in the Bill Williams River Delta in sites occupied by breeding flycatchers as recently as 2017. These sites consisted either entirely of tamarisk or of a mix of tamarisk and coyote willows with a few Goodding's willows. Between the continued increase in tamarisk mortality and a lack of significant improvement in sites dominated by cottonwood-willow stands, there was no overall improvement in habitat quality in BIWI from 2018 to 2019. Significant regrowth of vegetation is needed before many sites in BIWI can meet the criteria of suitable flycatcher habitat.

Habitat quality at several sites at the CVCA and the PVER has declined in recent years as trees have become less robust or died, decreasing canopy closure. Canopy closure declined most noticeably at the CVCA, where large swaths of coyote willows were dead. Habitat quality at the LDCA improved, however, as trees matured and canopy height and closure increased.

Chapter 3 – Presence/Absence Surveys and Territory Monitoring

INTRODUCTION

Broadcasts of recorded conspecific vocalizations are useful in eliciting responses from nearby willow flycatchers, and multiple broadcast surveys conducted throughout the breeding season are the standard technique for determining the presence or absence of *E. t. extimus* (Sogge et al. 2010). According to Sogge et al. (2010) and the USFWS (2002), willow flycatchers detected between approximately June 15 and July 20 in the breeding range of *E. t. extimus* (see figure 1-1) probably belong to the southwestern subspecies. However, because northbound individuals of all western subspecies of the willow flycatcher migrate through areas where *E. t. extimus* are actively nesting, and southbound migrants occur where *E. t. extimus* are still breeding (Sogge et al. 2010; USFWS 2002), field confirmation of the southwestern subspecies is problematic. For example, the northwestern *E. t. brewsteri*, far more numerous than *E. t. extimus*, has been documented migrating north in southern California as late as June 20 (Garrett and Dunn 1981), and Phillips et al. 1964 (as cited in Unitt 1987) documented *E. t. brewsteri* collected in southern Arizona on June 23. An understanding of willow flycatcher migration ecology in combination with multiple broadcast surveys conducted throughout the breeding season is therefore needed to assess the presence and territorial status of flycatchers.

Migration routes used by *E. t. extimus* are not well documented, though more is known of northbound migration in spring than southbound migration in fall because willow flycatchers are more vocal in spring and can therefore be distinguished from other *Empidonax* species. During northbound migration, all subspecies of willow flycatchers use riparian habitats similar to breeding habitat along major river drainages in the Southwest such as the Rio Grande (Finch and Kelly 1999), LCR (McKernan and Braden 1999), San Juan River (Johnson and Sogge 1997), and the Green River (M. Johnson, unpublished data). Although migrating willow flycatchers may favor young, native willow (*Salix* spp.) habitats (Yong and Finch 1997), migrants are also found in both spring and fall in a variety of habitats that are unsuitable for breeding. These migration stopover habitats, even though not used for breeding, are likely important for both reproduction and survival. For most long-distance neotropical migrant passerines, migration stopover habitats are needed to replenish energy reserves to continue northbound or southbound migration.

In 2019, SWCA completed broadcast surveys at sites in seven study areas (TOPO, BIWI, ALAM, PVER, CIBO, MITT, and YUMA) along the LCR and its tributaries to detect both migrant willow flycatchers and resident flycatchers (see figure 1-2). Reclamation completed surveys at Hunters Hole, and results of those surveys are included here.

METHODS

Broadcast Surveys

To elicit responses from nearby willow flycatchers, field personnel broadcast conspecific vocalizations recorded throughout the Southwest in 1996–98. All flycatcher surveys were conducted according to the methods described in Sogge et al. (2010) and followed the five-survey protocol, which calls for one survey between May 15 and 31, two surveys between June 1 and 24, and two additional surveys between June 25 and July 17. The surveys were separated by a minimum of 5 days whenever logistically possible. Field personnel surveyed within the habitat wherever possible using a Sansa® Clip or AGPTEK G05S MP3 player coupled to a Radio Shack 277-1008C or Vomaxtech Limited C3 speaker. In dense habitats, surveyors stopped every 30–40 m and broadcast flycatcher primary song (*fitz-bew*) and calls (*breets*). Survey points were more widely spaced in relatively open habitats. Field personnel watched for willow flycatchers and listened for vocal responses for approximately 1 to 2 minutes before proceeding to the next survey station. If an unidentified *Empidonax* flycatcher was observed but did not respond with song to the initial broadcast, other conspecific vocalizations were broadcast, including *creets/breets*, *wee-oos*, *whitts*, *churr/kitters*, and a set of interaction calls given by a mated pair of flycatchers (per Lynn et al. 2003). These calls are frequently effective in eliciting a *fitz-bew* song, thereby enabling surveyors to positively identify willow flycatchers. Whenever a willow flycatcher was detected, the surveyor proceeded at least 50 m beyond the bird before resuming the survey to minimize the likelihood of the bird following the surveyor and being double counted.

Territory Monitoring

At all sites, field personnel discontinued broadcast surveys within a radius of 50 m and commenced territory monitoring wherever a flycatcher displaying territorial behavior (e.g., singing insistently from multiple perches) was detected. At study areas where breeding flycatchers were known to occur (i.e., TOPO, BIWI, and ALAM), all willow flycatcher detections, regardless of whether territorial behaviors were observed, were followed with monitoring visits to reduce the likelihood of a territory being overlooked. Each location where territory monitoring occurred was assigned a unique "territory number" to facilitate tracking of monitoring activities.

At ALAM and at LCR MSCP conservation areas surveyed by SWCA,[1] monitoring was completed in conjunction with surveys, and detection locations were revisited, at minimum, in accordance with the survey schedule. The goal of territory monitoring at these sites was to determine the number of territories and whether each territory

[1] Conservation areas include CPhase 05 at TOPO, Site 03 upstream to Beaver Pond at BIWI, Planet Ranch at BIWI, and all sites at PVER, CIBO, MITT, and YUMA.

contained a single male flycatcher or a flycatcher pair. A territory was considered to be present wherever (1) a flycatcher was detected during the "non-migrant" period (i.e., June 25 through July 20), (2) a flycatcher exhibited extended, unsolicited song during the first and second surveys and was still present during the third survey, and/or (3) a flycatcher pair was present at any point during the season. A pair was considered to be present if any of the following were observed (per Sogge et al. 2010): (1) another, unchallenged flycatcher in the immediate vicinity of where a male was engaging in extended, unsolicited song, (2) *whitt* calls between nearby flycatchers in the immediate vicinity of where a male had engaged in extended, unsolicited song, (3) interaction twitter calls between nearby flycatchers, (4) physical aggression by flycatchers against cowbirds, (5) flycatchers copulating, or (6) evidence of an active nesting attempt, including: (a) a flycatcher carrying nest material, (b) a flycatcher carrying food or a fecal sac, (c) a flycatcher sitting or standing on a nest, (d) a nest containing flycatcher eggs, or (e) recently fledged flycatcher young.

During the initial territory monitoring visit, the observer spent approximately 30 minutes in the vicinity, recording multiple locations of the flycatcher(s), locations of countersinging flycatchers, and behavioral observations. On subsequent visits, the observer spent up to 30 minutes in the area, recording flycatcher locations and behavioral observations. If no flycatcher activity was detected within 20 minutes, the observer played brief broadcasts of flycatcher vocalizations, if this could be done without disturbing nearby flycatchers, to try to elicit a response. Locations where no activity was detected were visited briefly once more on the next survey round, and if there was still no activity, broadcast surveys resumed at that location, provided it was at least 50 m from any other flycatcher territory. Once a territory was confirmed to contain a pair, subsequent visits focused on determining if the territory was still active and mapping the locations of adjacent flycatchers to determine if additional flycatchers had arrived. If an active nest was located during territory monitoring, the nest location was recorded and the nest was observed through binoculars, but no attempt was made to view the contents of the nest with a mirror pole.

At sites that were within TOPO and BIWI but were outside of conservation areas, all willow flycatcher detections were followed with intensive monitoring, with the intention of finding and monitoring all flycatcher nests. Monitoring visits at these sites were more frequent than at ALAM and conservation areas, with single flycatchers monitored approximately every 4 days and pairs monitored every 2 days until a nest was found. Nests were visited according to the nest monitoring protocol (see chapter 5). If no activity was detected during the first 30 minutes of a monitoring visit, the observer played brief broadcasts of flycatcher vocalizations if this could be done without disturbing nearby flycatchers. If no activity was detected near the original detection during any of three subsequent visits, each spaced at least 4 days apart, monitoring visits stopped, and surveys resumed.

At all sites where monitoring visits were completed in accordance with the survey schedule (i.e., visits were approximately 2 weeks apart), willow flycatchers that were detected in a given vicinity on consecutive visits were considered different individuals if no territorial behaviors were observed on any visit. At sites where

monitoring visits occurred at 4-day intervals, individuals detected in a given location on multiple, consecutive visits were assumed to be the same individual. If a flycatcher was detected on multiple visits but one or more intervening visits failed to detect a flycatcher, the detections were considered different individuals in the absence of behavioral observations that indicated the flycatcher was actively defending a territory or was a member of a breeding pair.

Other Covered Species

The Yuma clapper rail (*Rallus longirostris yumanensis* [also known as Yuma Ridgway's rail = *R. obsoletus yumanensis*]) is listed as federally endangered by the USFWS, and the western population of the yellow-billed cuckoo (*Coccyzus americanus*) is listed as threatened. Both species occur along the LCR and its tributaries and are of concern to managing agencies. Surveys were not conducted specifically for either of these species, but all incidental detections were recorded at survey sites that were not within LCR MSCP conservation areas. Field personnel also recorded incidental detections of the gilded flicker (*Colaptes chrysoides*) and vermilion flycatcher (*Pyrocephalus rubinus*), both of which are covered species under the LCR MSCP, at survey sites that were not within LCR MSCP conservation areas.

Data Collection

All spatial data were recorded in Collector for ArcGIS on a Panasonic FZ-B2 Toughpad tablet running an Android operating system. Several feature services were published to ArcGIS Online for use in Collector. These included site boundaries, trails, a feature service to record real-time locations of the surveyor at regular intervals (i.e., surveyor "tracks"), a 50- x 50-m grid, and feature services for field data. Field data included point locations of survey points, willow flycatcher detections (e.g., territorial male, territory center, pair, female, or family group), and detections of other covered species; line features to show the relationship between any two willow flycatcher detection locations (e.g., same bird, different bird, countersinging males, or possible pair); and a polygon feature to delineate the approximate boundaries of a flycatcher territory. High-resolution aerial imagery of all survey sites was loaded directly onto the tablets for use in Collector. All data collected in the field were recorded into an offline copy of the feature services, which the observer downloaded onto his/her tablet. In addition to survey point and detection locations, surveyors also recorded the presence of cowbirds at each survey point and the overall signs of livestock and tamarisk leaf beetles. Cowbirds may affect flycatcher populations by decreasing flycatcher productivity, while livestock may substantially alter the vegetation in an area (USFWS 2002).

Each observer had an individual user account for ArcGIS Online and an individual Microsoft OneNote notebook, which was used on the tablet to record survey start

and stop times, behavioral observations, and any other pertinent information. At the end of each field day, each observer synchronized the Collector data with ArcGIS Online and also synchronized the OneNote notebook with an online copy. The observer then viewed the spatial data from ArcGIS Online in a custom online web application view created by SWCA and hosted on SWCA servers. If necessary, the observer edited the data using the web application to ensure that each feature was correctly labeled and all necessary fields were filled in. Using the web application, the observer linked flycatcher detection locations as child features to their respective polygons and linked survey points to their respective survey start point.

Summary information for each territory visit (time in and out of the territory, territory stage [e.g., single male, pair, or no activity], and behavioral comments) was entered in a form in Survey123 for ArcGIS. Each form was a child feature linked to its respective territory center point. In a few instances, an observer monitored multiple adjacent territories concurrently either by listening for activity in both territories from a common point or by going back and forth between the territories in the process of determining which flycatchers belonged to which territory. In these cases, a form was entered for each territory that was monitored, and the time in and out of the territory was the same on each form, resulting in a slight over-estimate of the total monitoring effort.

RESULTS

Flycatcher Broadcast Surveys and Territory Monitoring

SWCA spent 569.2 observer-hours conducting flycatcher broadcast surveys at the 67 sites that were visited in accordance with the five-survey protocol across all study areas (see orthophotos in attachment 3 for boundaries of survey sites and occupancy[2] in 2019). SWCA spent an additional 11.8 observer-hours conducting broadcast surveys at six sites (Coyote Crossing, Bill Willow, Burn Edge, and Black Rail at BIWI and South Camp and Sidebar at ALAM) as part of habitat evaluation. In addition, Reclamation spent 4.0 observer-hours completing three broadcast surveys at Hunters Hole in accordance with the three-survey protocol, which calls for one survey between May 15 and 31, one survey between June 1 and 24, and one survey between June 25 and July 17.

Areas that were known or suspected to be occupied by flycatchers were monitored via territory visits rather than broadcast surveys, with 384.8 observer-hours spent on territory monitoring. An additional 97.7 observer-hours were spent at TOPO on intensive nest monitoring after nests were found; nest monitoring results are detailed in chapter 5. Each site or portion of a site that did not contain any flycatcher territories was formally surveyed two to five times (table 3-1 and attachment 4).

[2] Occupied flycatcher habitat was defined as survey sites where at least one flycatcher territory was present.

SWCA detected 158 flycatchers from 95 territories at TOPO, BIWI, and ALAM (table 3-1). Seventy of the territories contained pairs, and 25 contained unpaired flycatchers. An additional 105 willow flycatchers that did not occupy territories were detected across all study areas.

Individual Study Areas

Topock Marsh, Arizona

Field personnel spent 68.5 observer-hours on broadcast surveys and 191.6 observer-hours on territory monitoring activities (table 3-1). Eight territories were detected; six were occupied by breeding flycatcher pairs (see chapter 5 for nest monitoring results), and two consisted of unpaired flycatchers. An additional 14 willow flycatchers were detected on or before June 6; most of these were detected only on a single occasion and responded weakly to the survey broadcast.

Bill Williams, Arizona

Field personnel spent 99.1 observer-hours on broadcast surveys and 26.9 observer-hours on territory monitoring activities. Of the time spent surveying, 9.9 observer-hours were spent at sites visited only during habitat evaluation. One territory, consisting of an unpaired flycatcher, was detected. Six additional willow flycatchers were detected; four of these were each detected for a single day on or before June 18, one was detected May 17–23, and one was detected May 21–28 (table 3-1). Most of these detections consisted of a weak response to the survey broadcast.

Alamo Lake, Arizona

Field personnel spent 66.9 observer-hours on broadcast surveys and 264.1 observer-hours on territory monitoring activities. Of the time spent surveying, 2.0 observer-hours were spent at sites visited only as part of habitat evaluation. A total of 145 territorial flycatchers, comprising 86 territories, were detected. Sixty-four territories contained flycatcher pairs. Nests were found incidentally during territory monitoring in 51 of those territories. The remaining 22 territories consisted of unpaired flycatchers. An additional 11 willow flycatchers were recorded at ALAM; 6 of these were each detected on a single occasion, and the remaining 5 were detected for periods ranging from 4 days to 3 weeks (table 3-1).

Table 3-1.—Summary of survey and monitoring effort and number of adult southwestern willow flycatchers and adult willow flycatchers detected during survey and monitoring activities, 2019*

Study area	Survey site	Elevation (m)	Area (ha)	Number of surveys	Survey hours[1]	Monitoring hours[2]	Territorial adult southwestern willow flycatchers					Adult willow flycatchers not occupying a territory[7]	
							All adults	Territories[3]	Pairs[4]	Unpaired adults[5]			
										#	Dates of detection (n)[6]	#	Dates of detection (n)[6]
Topock Marsh	The Wallows	140	0.3	5	1.2	0.0	0	0	0	0	–	0	–
	PC6-1	140	0.4	5	1.3	0.0	0	0	0	0	–	0	–
	800M	140	1.3	5	3.9	0.0	0	0	0	0	–	0	–
	Swine Paradise	140	1.2	5	2.4	7.7	1	1	0	1	June 14 – July 2 (1)	1	May 29 (1)
	Platform	140	1.9	5	2.9	3.4	0	0	0	0	–	0	–
	250M	140	1.6	5	5.1	4.8	0	0	0	0	–	2	May 20 (1), May 28 (1)
	Hell Bird	140	6.3	5	11.2	60.8	5	3	2	1	June 2–30 (1)	5	May 20 (1), May 23 (1), May 20–23 (1), June 2 (1), June 2–4 (1)
	Glory Hole	140	6.4	5	11.4	58.3	3	2	2	0	–	4	May 20 (1), May 23 (2), June 4–6 (1)
	Farm Ditch Road	140	4.4	5	4.5	0.0	0	0	0	0	–	0	–
	CPhase 05	140	11.4	5	15.2	0.7	0	0	0	0	–	0	–
	Lost Lake	140	0.2	4	0.8	0.0	0	0	0	0	–	0	–
	Lost Lake Slough 02	140	0.9	5	4.5	0.0	0	0	0	0	–	0	–
	Lost Lake Slough 03	140	0.6	4	2.1	49.1	3	2	2	0	--	0	–
	Lost Lake Slough 04	140	0.5	5	2.1	0.0	0	0	0	0	–	0	–
	Near Glory Hole[8]	140	--	0	0.0	6.8	0	0	0	0	–	2	May 20–28 (1), May 20 – June 2 (1)
	Study area total	**--**	**37.2**	**--**	**68.5**	**191.6**	**12**	**8**	**6**	**2**	**–**	**14**	**–**
Bill Williams	Coyote Crossing[9]	137	2.1	3	5.3	0.0	0	0	0	0	–	0	–
	Bill Willow[9]	137	1.6	3	3.9	0.0	0	0	0	0	–	0	–
	Wispy Willow	137	1.3	5	6.7	5.7	0	0	0	0	–	2	May 17–23 (1), June 18 (1)
	Site 01	138	2.4	5	3.3	5.6	1	1	0	1	May 29 – June 17 (1)	0	–
	Burn Edge[9]	143	3.2	1	0.3	0.0	0	0	0	0	–	0	–
	Site 04	146	9.9	5	17.5	1.7	0	0	0	0	–	0	–
	Site 03	146	12.9	5	27.6	0.0	0	0	0	0	–	0	–
	Last Gasp	146	2.1	5	5.9	0.0	0	0	0	0	–	0	–
	Guinness	148	3.4	5	3.7	0.0	0	0	0	0	–	0	–
	Site 05	146	6.8	5	8.6	0.0	0	0	0	0	–	0	–
	Black Rail[9]	146	1.2	1	0.3	0.0	0	0	0	0	–	0	–
	Site 08	167	4.5	5	9.4	13.9	0	0	0	0	–	4	May 21 (1), May 21–28 (1), May 28 (1), June 12 (1)
	Upstream Site 08	170	1.1	5	2.2	0.0	0	0	0	0	–	0	–
	Planet Ranch Road	171	2.2	5	4.4	0.0	0	0	0	0	–	0	–
	Study area total	**--**	**54.7**	**--**	**99.1**	**26.9**	**1**	**1**	**0**	**1**	**–**	**6**	**–**

Table 3-1.—Summary of survey and monitoring effort and number of adult southwestern willow flycatchers and adult willow flycatchers detected during survey and monitoring activities, 2019*

Study area	Survey site	Elevation (m)	Area (ha)	Number of surveys	Survey hours[1]	Monitoring hours[2]	Territorial adult southwestern willow flycatchers					Adult willow flycatchers not occupying a territory[7]	
							All adults	Territories[3]	Pairs[4]	Unpaired adults[5] #	Unpaired adults[5] Dates of detection (n)[6]	#	Dates of detection (n)[6]
Alamo Lake	Bullard Wash	335	1.4	5	9.3	0.0	0	0	0	0	–	0	–
	South Camp[9]	335	1.4	2	1.1	0.0	0	0	0	0	–	0	–
	Sidebar 01[9]	335	1.0	1	0.8	0.0	0	0	0	0	–	0	–
	Camp 01	337	0.6	5	3.9	0.9	0	0	0	0	--	1	June 13 (1)
	Camp 02	337	0.3	5	2.0	0.0	0	0	0	0	–	0	–
	Camp 03	337	1.2	5	3.2	5.1	1	1	0	1	May 19 – June 13 (1)	1	May 20 (1)
	Middle Earth 01	337	1.7	5	2.1	10.3	7	4	3	1	May 16 – July 14 (1)	0	–
	Middle Earth 02	338	7.9	4	5.4	65.4	33	18	16	2	May 10 – July 13 (1) June 5 – July 12 (1)	2	May 10–31 (1), May 16 (1)
	Prospect 01	338	1.9	2	0.5	28.5	14	9	7	2	May 10 – July 15 (1), May 15 – June 20 (1)	1	May 10–30 (1)
	Burro Wash 01	338	11.6	4	8.0	47.7	21	14	7	7	May 15 – July 8 (3), May 19 – July 8 (1) May 19 – July 9 (1) May 16 – June 17 (1) May 15 – June 26 (1)	2	May 15–19 (1), June 3–13 (1)
	Burro Wash 02	338	11.7	5	3.3	72.1	51	29	23	6	May 22 – June 28 (1), May 29 – July 10 (1), June 4 – July 9 (1), June 16–28 (1) June 4–28 (1) June 28–29 (1)	1	June 4 (1)
	Motherlode 01	340	5.2	5	2.0	29.9	14	9	6	3	May 21 – July 11 (1) May 21 – June 29 (1) June 16 – July 12	2	May 22 (1), May 3–14 (1)
	Motherlode 02	340	6.1	2	2.2	1.8	4	2	2	0	–		
	Prospect 02	342	0.3	2	0.4	1.5	0	0	0	0	–	1	June 12 (1)
	Motherlode 04	343	0.2	5	2.3	0.0	0	0	0	0	–	0	–
	Santa Maria North 01	347	31.4	5	20.4	1.0	0	0	0	0	–	0	–
	Study area total	**--**	**83.7**		**66.9**	**264.2**	**145**	**86**	**64**	**22**	**–**	**11**	**–**

Table 3-1.—Summary of survey and monitoring effort and number of adult southwestern willow flycatchers and adult willow flycatchers detected during survey and monitoring activities, 2019*

Study area	Survey site	Elevation (m)	Area (ha)	Number of surveys	Survey hours[1]	Monitoring hours[2]	Territorial adult southwestern willow flycatchers					Adult willow flycatchers not occupying a territory[7]	
							All adults	Territories[3]	Pairs[4]	Unpaired adults[5]			
										#	Dates of detection (n)[6]	#	Dates of detection (n)[6]
Palo Verde Ecological Reserve	Phase 02	85	21.4	5	16.1	0.0	0	0	0	0	–	1	June 4 (1)
	Phase 03	85	21.4	5	16.0	0.0	0	0	0	0	–	0	–
	Phase 04 Block 01	86	7.7	5	7.2	0.0	0	0	0	0	–	0	–
	Phase 04 Block 02	86	4.0	5	4.5	0.0	0	0	0	0	–	0	–
	Phase 04 Block 03	87	23.7	5	15.9	0.0	0	0	0	0	–	2	May 16 (2)
	Phase 05 Block 01	87	15.8	5	11.1	0.0	0	0	0	0	–	0	–
	Phase 05 Block 02	86	23.7	5	13.7	0.0	0	0	0	0	–	1	June 12 (1)
	Phase 05 Block 03	86	29.6	5	18.6	0.0	0	0	0	0	–	2	May 23 (2)
	Phase 06 Block 01	86	38.8	5	22.1	0.0	0	0	0	0	–	0	–
	Phase 06 Block 02	86	37.6	5	20.6	0.0	0	0	0	0	–	0	–
	Phase 07 Block 01	86	36.8	5	21.8	0.0	0	0	0	0	–	0	–
	Phase 07 Block 02	86	40.6	5	23.0	0.0	0	0	0	0	–	0	–
	Study area total	**--**	**301.2**	**--**	**190.7**	**0.0**	**0**	**0**	**0**	**0**	**–**	**6**	**–**
Cibola	Phase 01	73	26.2	5	19.4	0.0	0	0	0	0	–	3	May 20 (3)
	Phase 02	73	25.5	5	16.6	0.0	0	0	0	0	–	3	May 20 (3)
	Phase 03	72	38.5	5	21.3	0.0	0	0	0	0	–	4	May 23 (3), June 3 (1)
	Phase 08	71	16.3	5	21.5	0.0	0	0	0	0	–	18	May 21 (8), May 22 (5), June 1 (4), June 12 (1)
	Upper Hippy Fire	70	28.1	5	19.2	0.0	0	0	0	0	–	2	May 17 (2)
	Nature Trail	70	13.7	5	7.1	0.0	0	0	0	0	–	1	May 17 (1)
	Lower Hippy Fire	70	26.4	5	18.2	0.0	0	0	0	0	–	8	May 18 (8)
	C2729	70	6.0	5	5.2	0.0	0	0	0	0	–	1	May 17 (1)
	Study area total	**--**	**180.5**	**--**	**128.6**	**0.0**	**0**	**0**	**0**	**0**	**–**	**40**	**–**
Mittry Lake	C4958	49	1.0	5	2.2	0.0	0	0	0	0	–	3	May 16 (2), June 2 (1)
	C4911	49	1.0	5	2.5	0.0	0	0	0	0	–	3	May 22 (3)
	C4913	49	0.7	5	0.8	0.0	0	0	0	0	–	3	May 22 (2), June 2 (1)
	C4959	48	0.5	5	1.4	0.0	0	0	0	0	–	1	June 2 (1)
	C4960	48	4.3	5	5.0	0.0	0	0	0	0	–	4	May 16 (2), June 2 (1), June 18 (1)
	C4961	48	0.2	5	0.7	0.0	0	0	0	0	–	1	June 2 (1)
	Near C4958[8]	48	–	–	0.0	0.0	0	0	0	0	–	2	May 16 (2)
	Study area total	**--**	**7.6**	**--**	**12.7**	**0.0**	**0**	**0**	**0**	**0**	**–**	**17**	**–**

Table 3-1.—Summary of survey and monitoring effort and number of adult southwestern willow flycatchers and adult willow flycatchers detected during survey and monitoring activities, 2019*

Study area	Survey site	Elevation (m)	Area (ha)	Number of surveys	Survey hours[1]	Monitoring hours[2]	Territorial adult southwestern willow flycatchers					Adult willow flycatchers not occupying a territory[7]	
							All adults	Territories[3]	Pairs[4]	Unpaired adults[5]			
										#	Dates of detection (n)[6]	#	Dates of detection (n)[6]
Yuma	C4703	36	8.4	5	5.8	0.0	0	0	0	0	–	3	May 21 (3)
	C4711	36	0.9	5	2.3	0.0	0	0	0	0	–	3	May 21 (2), June 1 (1)
	C4702	36	6.4	5	6.5	0.0	0	0	0	0	–	3	May 21 (1), June 1 (2)
	Hunters Hole[10]	23	17.7	3	4.0	0.0	0	0	0	0	–	2	May 29 (2)
	Study area total	**--**	**33.4**	**--**	**18.5**	**0.0**	**0**	**0**	**0**	**0**	**–**	**11**	**–**
Total		**--**	**698.0**	**--**	**585.0**	**482.5**	**158**	**95**	**70**	**25**	**–**	**105**	**–**

* This table includes sites where at least one survey was completed or where willow flycatchers were detected and does not include evaluation sites where no surveys were completed and where no willow flycatchers were detected.

[1] Number of hours spent doing broadcast surveys (does not include time spent monitoring territories). Discrepancies between the total time reported and the sum of the individual times is the result of rounding error.

[2] Number of hours spent monitoring territories, monitoring nests, and following up on willow flycatcher detections (does not include time spent doing broadcast surveys). Discrepancies between the total time reported and the sum of the individual times is the result of rounding error.

[3] A territory was considered to be present wherever (1) a flycatcher was detected during the "non-migrant" period (i.e., June 25 through July 20), (2) a flycatcher exhibited extended, unsolicited song during the first and second surveys and was still present during the third survey, and/or (3) a flycatcher pair was present at any point during the season.

[4] A pair was considered to be present if any of the following were observed (per Sogge et al. 2010): (1) another, unchallenged flycatcher in the immediate vicinity of where a male was engaging in extended, unsolicited song, (2) *whitt* calls between nearby flycatchers in the immediate vicinity of where a male had engaged in extended, unsolicited song, (3) interaction twitter calls between nearby flycatchers, (4) physical aggression by flycatchers against cowbirds, (5) flycatchers copulating, or (6) evidence of an active nesting attempt, including: (a) a flycatcher carrying nest material, (b) a flycatcher carrying food or a fecal sac, (c) a flycatcher sitting or standing on a nest, (d) a nest containing flycatcher eggs, or (e) recently fledged flycatcher young.

[5] Adults were considered unpaired if they met the criteria for a territory (footnote 3), but no evidence of pairing was observed.

[6] The numbers in parentheses are the number of individuals detected on the given date(s).

[7] Non-territorial adults were all those that did not meet the criteria (footnote 3) for a territory.

[8] Not an official survey site. Willow flycatcher(s) detected incidentally.

[9] Surveys conducted during habitat evaluation.

[10] Surveyed by Reclamation.

Palo Verde Ecological Reserve, California

Field personnel spent 190.7 observer-hours on broadcast surveys. Six willow flycatchers were detected, each on a single occasion, between May 16 and June 12 (see table 3-1); none displayed territorial behavior.

Cibola, Arizona

Field personnel spent 128.6 observer-hours on broadcast surveys. Forty willow flycatchers were detected, each on a single occasion, between May 17 and June 12 (see table 3-1); none displayed territorial behavior.

Mittry Lake, Arizona and California

Field personnel spent 12.7 observer-hours on broadcast surveys. Seventeen willow flycatchers were detected, each on a single occasion, between May 16 and June 18 (see table 3-1); none displayed territorial behavior.

Yuma, Arizona

Field personnel spent 18.5 observer-hours on broadcast surveys. Eleven willow flycatchers were detected, each on a single occasion, between May 21 and June 1 (table 3-1); none displayed territorial behavior.

Other Covered Species

Detections of yellow-billed cuckoos were recorded at two sites at TOPO, one site at BIWI, and six sites at ALAM (see attachment 5 for details). Yuma clapper rails were recorded at multiple sites at TOPO and one site at BIWI, while vermilion flycatchers were recorded at two sites at ALAM. One gilded flicker was detected at PVER.

DISCUSSION

The numbers of territories (8) and resident adults (12) observed in 2019 at TOPO were near the upper end of the ranges observed in 2011–18 (2–10 territories and 2–15 resident adults). All resident adults occupied habitat that had a substantial component of native vegetation, and all pairs occupied areas where tamarisk dieback was negligible. The occupied sites (Swine Paradise, Hell Bird, Glory Hole, and Lost Lake Slough 03) all contained areas that met the criteria for suitable or preferred nesting habitat (see chapter 2). The availability of suitable habitat has decreased in recent years, first with the consumption of habitat by fires in 2015 and 2016 and then as the result of defoliation by tamarisk beetles and subsequent tamarisk dieback. Defoliation by tamarisk beetles occurred throughout TOPO during the 2017 and

2018 breeding seasons, and partial dieback affected habitat suitability in many of the unburned sites in 2019. If beetles continue to defoliate tamarisk at TOPO, or if the tamarisk continue to die back as the result of defoliation events, flycatchers at TOPO are likely to persist only in areas with a substantial component of native, woody vegetation.

As in 2018, one territory (an unpaired male) was detected at BIWI in the Bill Williams River Delta. Habitat quality has declined throughout BIWI in recent years (see chapter 2). From mid-April 2015 through mid-March 2018, average monthly discharge at the USGS gaging station (#09426620) on the Bill Williams River near Parker, Arizona, was 0.0 cfs (figure 3-1). This is the longest period of 0.0 cfs recorded at this gaging station since recording began in late 1988. The dry conditions within BIWI resulted in a decrease in canopy closure at many sites as large-diameter Goodding's willows and cottonwoods died or lost large limbs. Flycatcher occupancy shifted within the landscape accordingly, and starting in 2014, most flycatcher territories were in the Bill Williams River Delta, where water levels are influenced by the level of Lake Havasu rather than by streamflow in the Bill Williams River. The number of flycatcher territories in the delta declined from seven to eight territories in 2015–17 to one territory in 2018 and 2019. This decline corresponds with the arrival of tamarisk beetles and the associated increase in tamarisk mortality in the delta (see chapter 2).

In spring 2018, releases from Alamo Dam resulted in a sustained flow > 10 cfs that lasted through late April 2019 (figure 3-1), and surface water was present in both 2018 and 2019 in many survey sites that had been dry in previous years. In 2019, several localized areas with young cottonwoods and Goodding's willows were present along stream channels. Despite the signs of vegetation regrowth, overall vegetation density in areas dominated by Goodding's willows and cottonwoods did not improve significantly, and no flycatcher territories were detected in BIWI upstream of the Bill Williams River Delta.

The proportion of territories known to contain pairs at Alamo Lake in 2019 (74%) was similar to that in 2018 (72%) but was lower than proportions in 2014–17 (86–94%); however, it is not clear whether the proportion of pairs was truly higher in 2014–17. In 2014–17, field activities at ALAM focused on intensive territory and nest monitoring, whereas field activities in 2018–19 consisted of surveys and less intensive territory monitoring. Territory visits were less frequent and shorter in duration in 2018–19 compared to in 2014–17, and this could have resulted in the misclassification of some territories as single individuals when they contained pairs.

The level of Alamo Lake increased over 6 m between the breeding seasons of 2018 and 2019 (see figure 2-6), and almost all survey sites were inundated during the 2019 season. The distribution of flycatcher territories across the sites at ALAM was generally similar in 2017–19, although territories were discovered in 2019 around the

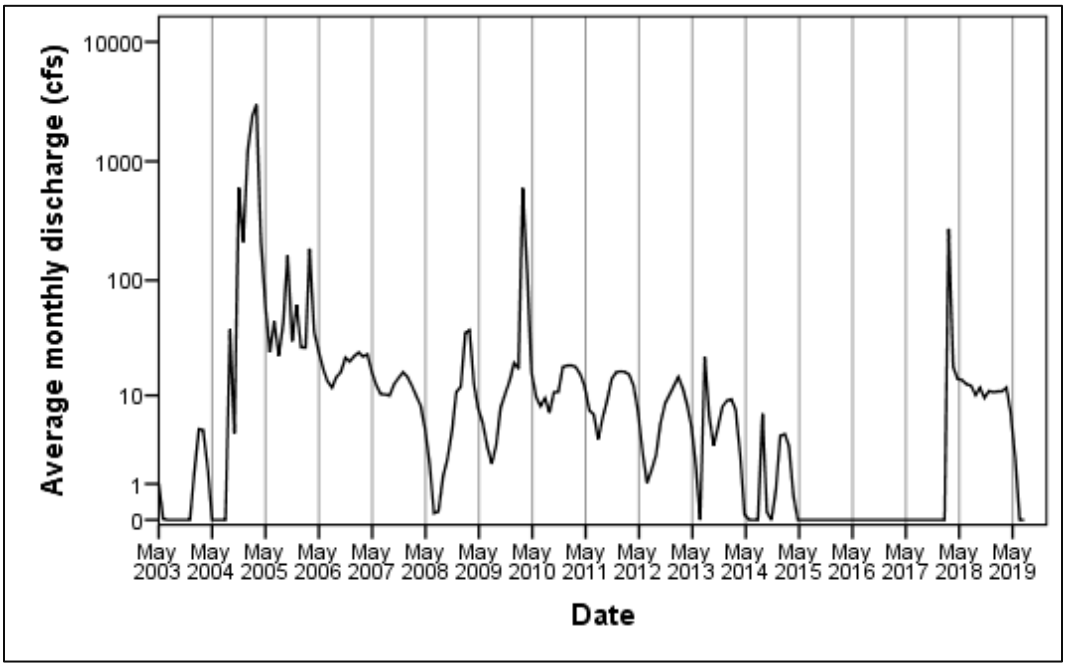

Figure 3-1.—Monthly average streamflow (cfs) recorded at the Bill Williams River near Parker, Arizona (USGS Station #09426620), 2003–19.
Data source: USGS 2019g.

periphery of sites occupied in 2017–18. Survey sites that were expanded in 2019 to encompass flycatcher territories included Prospect 01, Middle Earth 02, Burro Wash 01, Burro Wash 02, and Motherlode 01. Territories were also discovered near the former southern edge of Motherlode 02, where surveys were discontinued after 2017. Much of the site expansion occurred at sites that germinated in 2011, and occupancy of the periphery of these sites likely is the result of continued habitat maturation in combination with the presence of surface water.

The number of territories detected in Santa Maria North 01 declined between 2017 and 2019 from eight to zero. Not only were there no territories in Santa Maria North 01 in 2019, there were no willow flycatcher detections. Santa Maria North 01 was the only site at ALAM with an understory of dense, mature tamarisk that was occupied by flycatchers in 2017. During the 2017 breeding season, the tamarisk were defoliated by tamarisk beetles. In 2018, the tamarisk understory was partially dead, and portions that were not dead were defoliated. In 2019, most of the tamarisk were dead. The decline in the number of territories detected in Santa Maria North 01 is likely related to the decrease in density of the understory.

There were 74 willow flycatcher detections recorded south of the Bill Williams River in 2019, all which were before June 24. Behavioral observations (lack of territorial and aggressive behaviors exhibited toward conspecific broadcasts) and subsequent surveys at these sites suggest these flycatchers were not resident or breeding individuals but migrants. These results are consistent with those recorded in the

same survey sites in 2003–18 (McLeod and Pellegrini 2013, 2019; McLeod et al. 2008, 2018a). The presence of migrant willow flycatchers along the LCR is expected in June as multiple subspecies are known to migrate north during this portion of the breeding season (Sogge et al. 2010).

Chapter 4 – Resighting

INTRODUCTION

Long-term monitoring of flycatchers of known identity, sex, and age is the only effective way to determine demographic life history parameters such as annual survivorship of adults and young, site fidelity, seasonal and between-year movements, and population structure. Color banding was in integral part of Reclamation's flycatcher studies along the LCR in 1997–2017 (see McLeod et al. 2018a for details on banding methodologies), but banding was discontinued in 2018. Although no new flycatchers were banded in 2019, field personnel resighted as many flycatchers as possible to determine whether each individual was banded and, if it was, to identify the unique color combination on its legs.

METHODS

The identity of a color-banded flycatcher was determined by observing with binoculars, from a distance, the unique color combination on its legs. Field personnel also used digital cameras (Canon PowerShot SX50 HS or SX60 HS) to take pictures of flycatchers; these photos supplemented any resight data. Typically, territories and active nests were focal areas for resighting, but entire sites were surveyed.

Data Collection

Observers recorded all resight information in their OneNote notebooks on their tablets. Multiple observations of an individual bird could be recorded during a single visit. Information recorded for each observation included band status (i.e., was each leg banded or unbanded), the colors and band type (Federal band or metal color band) observed on each leg, standardized confidence level of the resight (i.e., A = saw full color combination with 100% confidence at least twice, B = saw full color combination with 100% confidence once, C = saw full color combination with 95–99% confidence, N = less than 95% confidence, and P = used broadcast to obtain the resight), and gender of the flycatcher. Flycatchers observed engaging in lengthy, primary song from high perches (male advertising song) were sexed as male, and flycatchers observed carrying nest material or constructing or incubating a nest were sexed as female. Individuals not observed engaging in one of these diagnostic activities were sexed as unknown. One clear photograph was considered an "A" resight.

Summary information for each individual resighted on a given day (i.e., a single "best guess" of the color combination, overall confidence level, gender determination, and comments explaining any uncertainty in the resight or gender) was entered in a form in Survey123 for ArcGIS. Each form was a child feature linked to its respective territory center or nest flag point. If photographs were taken, they were transferred from the camera to a field computer.

Data Analyses

After the conclusion of the field season, all resight data were exported to a Microsoft Excel spreadsheet where they were sorted by study area, territory, and date. All resights of an individual flycatcher were evaluated as a group to determine whether the identity of the bird could be confirmed. Identities were confirmed for all birds that had two "A" resights or three "B" resights. Identities were also confirmed in instances where fewer resights or resights with lower confidence levels were available, but the color combination was consistent with an individual that was likely to be in that location (e.g., an adult that held a territory in that location in the previous year). All confirmed resights were entered in a form in Survey123 for ArcGIS. Each form was a child feature linked to its respective territory polygon.

Movement

All movements were defined as the straight-line distance between two known locations of activity. Activity could include breeding, defense of a territory, or the brief detection of an individual. Adult movements could occur either between years or within season but were always between study areas; movements within a study area are not described. All adult between-year movement distances were calculated from the last known location in one study area in a given year (year t) and the first known location in another study area in a subsequent year (year t + 1). Years are not always consecutive. For juvenile dispersal, the last known location was always the nest location even if the juvenile was detected elsewhere as a fledgling. The distance between the nest location and the first known location of the juvenile in a subsequent year was always calculated even if the individual returned to its natal survey site.

RESULTS

Overall, 263 adult flycatchers and willow flycatchers were detected in the project area. Of these, nine (3%) were known to be banded, and six of the nine were individually identified. A total of 107 adults were known to be unbanded, and band status was undetermined for 147 adults (table 4-1). Banded flycatchers were detected only at TOPO (3 individuals) and ALAM (6 individuals).

Table 4-1.—Summary of adult southwestern willow flycatchers and willow flycatchers detected during the 2019 breeding season*

Study area	Total adults detected	Identity confirmed	Banded (identity unknown)	Unbanded	Band status unknown
Topock Marsh	26	2	1	10	13
Bill Williams	**7**	**0**	**0**	**3**	**4**
Alamo Lake	156	4	2	82	68
Palo Verde Ecological Reserve	6	0	0	2	4
Cibola	40	0	0	6	34
Mittry Lake	17	0	0	4	13
Yuma	11	0	0	0	11
Total	**263**	**6**	**3**	**107**	**147**

Two flycatchers at TOPO and four flycatchers at ALAM were individually identified, and an additional one flycatcher at TOPO and two flycatchers at ALAM were known to be banded, but resights were insufficient to determine their identity (table 4-2).

Table 4-2.—Banded southwestern willow flycatchers detected during the 2019 breeding season

Study area[1]	Survey site	Date banded[2]	Federal band #[2]	Color combination[3]	Age[4]	Sex[5]
TOPO	Hell Bird	June 28, 2017	2660-23198	VI:MW(M)	A4Y	F
		July 06, 2017	2660-23278	GB(M):VI	A4Y	M
		INA	INA	Banded	AHY	M
ALAM	Middle Earth 02	May 30, 2012	2430-61286	XX:VD(M)	A9Y	M
	Prospect 01	June 25, 2008	2430-61209	GY(M):XX	A13Y	M
	Burro Wash 01	June 15, 2016	2540-58389	TQ:WBW(M)	5Y	M
	Burro Wash 02	May 22, 2015	2660-23176	VI:BR(M)	A6Y	F
		INA	INA	Banded	AHY	M
		INA	INA	Banded	AHY	U

[1] TOPO = Topock Marsh, and ALAM = Alamo Lake.

[2] INA = information not available.

[3] **Color-band codes**: B = light blue, Banded = bird was banded but combination could not be determined, D = dark blue, G = green, M = mulberry, (M) = metal pinstriped band, R = red, TQ = turquoise Federal band, V = violet, VI = violet Federal band, W = white, XX = silver Federal band, and Y = yellow. Color combinations are read as the bird's left leg and right leg, top to bottom; two or three letters designate every band; color-band designations for left and right legs are separated with a colon.

[4] **Age in 2019**: AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = 4 years, A4Y = 4 years or older, etc.

[5] **Sex codes**: F = female, M = male, and U = unknown.

Returns and Movements

In 2018, 10 adult flycatchers (1 at BIWI and 9 at ALAM) were individually identified at study areas that were monitored by SWCA in both 2018 and 2019. Of these 10 flycatchers, 3 (30%; 1 from BIWI and 2 from ALAM) were detected in 2019. The two from ALAM returned to ALAM in 2019, while the third flycatcher moved 69.2 km from BIWI Wispy Willow to TOPO Hell Bird. Two between-year movements were detected for flycatchers that were most recently identified prior to 2018. One flycatcher that was last detected along the Virgin River in southern Nevada in 2013 was at ALAM Middle Earth 02 in 2019, a dispersal distance of 268.1 km. This individual had lost one of the pinstripes on its color band and was identified via numerous photographs that allowed the Federal band number to be determined. The second flycatcher was last detected along the Muddy River in southern Nevada in 2009 and was at ALAM Prospect 01 in 2019, a dispersal distance of 259.4 km.

No within-year, between-study-area movements or juvenile dispersals were detected in 2019.

DISCUSSION

The number of banded flycatchers detected has declined each year as banded adults die and no flycatchers are newly banded. From 2017 to 2019, the number of banded adult flycatchers detected at TOPO, BIWI, and ALAM declined an average of 50% each year, from 33 in 2017 to 9 in 2019. The number of banded flycatchers is expected to continue declining at a similar rate over the coming years.

It is not surprising that no juvenile dispersals were detected in 2019. No juvenile flycatchers were banded in 2018, and only two were banded at TOPO, BIWI, and ALAM in 2017. Most returning juveniles are detected within 2 years of their hatch year, and it is unlikely that any juvenile dispersals will be detected in future years if no additional juveniles are banded.

Despite there being few banded flycatchers, three adult between-year, between-study-area movements were detected in 2019. Two of these were long-distance movements of > 250 km. Adult movements of this magnitude are relatively uncommon, with only two other adult between-year movements of > 250 km and five movements of 200–250 km recorded during the Reclamation study in 2003–18. All these movements were between southern Nevada and either TOPO or BIWI.

Neither of the long-distance movements documented in 2019 would have been detected without the use of cameras to photograph the bands. One individual,

originally banded at Las Vegas Wash in 2008 and last seen along the Muddy River in 2009, was photographed and resighted via binoculars at ALAM in 2019. Although the flycatcher's color combination was resighted correctly via binoculars on one occasion, this resight would not have been sufficient to confirm the identity of the flycatcher, given the rarity of long-distance movements and the bird's age. This individual was at least 13 years old in 2019, tying the longevity record for flycatchers banded during Reclamation's study. The photographs of the individual were, however, unequivocal.

The second individual that displayed a long-distance movement was resighted via binoculars at ALAM in 2019, but the color combination observed was that of a flycatcher that would have been 17 years old and was originally banded approximately 350 km away in the Pahranagat Valley in southern Nevada, making it very unlikely that the color combination was observed correctly. This same color combination had been observed on a flycatcher at ALAM in 2018, but the identity of the individual was not confirmed in that year because of the unlikelihood of the resighted combination being correct. Because of skepticism that the observed color combination could be correct, field personnel revisited the banded flycatcher and took numerous photographs, from which the Federal band number could be discerned. The Federal band number identified the flycatcher as an individual originally banded along the Virgin River in 2012 and most recently identified there in 2013. One of the pinstripes on the color band had come off, revealing the color of the base band and making it impossible to discern the bird's identity via binoculars. This is only the second instance of a missing pinstripe that has been observed out of over 300 flycatchers with pinstriped bands that have been detected over multiple years during the Reclamation study, suggesting that this is an infrequent occurrence.

Chapter 5 – Nest Monitoring and Nest Site Characteristics

INTRODUCTION

In 2019, SWCA conducted intensive nest searches and nest monitoring at sites at TOPO and BIWI that were not within LCR MSCP conservation areas. Specific objectives of nest monitoring included determining which sites supported breeding flycatchers, calculating nest success and failure, documenting causes of nest failure (e.g., abandonment, desertion, depredation, and brood parasitism), and calculating nest productivity. Although no formal nest monitoring was completed at ALAM, nests were sometimes found during territory monitoring activities. No special attempt was made to determine the success of these nests, but fledglings were recorded if they were observed during territory monitoring activities.

It is apparent that flycatchers along the LCR and its tributaries typically select territories and nest sites that are close to surface water (McLeod and Pellegrini 2013). This preference for surface water has been demonstrated with flycatcher populations in the Cliff-Gila Valley (Stoleson and Finch 2003) and along the Gila and San Pedro Rivers (Paradzick 2005). Paradzick and Woodward (2003) also found that most occupied sites in Arizona from 1993 to 2000 were less than 50 m from water. Despite the general knowledge that flycatchers are drawn to surface water, relatively few data are available regarding the persistence of water at occupied areas throughout the breeding season, though Whitfield and Enos (1996) noted that most breeding areas dried up before young fledged. To broaden the understanding of the patterns of inundation throughout the breeding season, surface water conditions were documented periodically throughout the nesting cycle for each flycatcher nest that was formally monitored. General information on each nest was gathered, such as nesting substrate and percentage of the vegetation around the nest that consisted of tamarisk. This percentage estimate provides a qualitative assessment of the potential impact of tamarisk defoliation on each nesting attempt. In addition, temperature and humidity were measured via data loggers at all monitored nests. These data will add to the database describing conditions in occupied flycatcher territories.

METHODS

Nest Monitoring

Upon confirming or suspecting a pair of flycatchers was present, field personnel conducted intensive nest searches following the methods of Rourke et al. (1999).

Nest monitoring followed a modification of the methods described by Rourke et al. (1999) and the Breeding Biology Research and Monitoring Database (BBIRD) protocol by Martin et al. (1997).

Nests were located primarily by observing adult flycatchers return to a nest or by systematically searching suspected nest sites. Nests were typically monitored every 4 days after nest building was complete and incubation was confirmed. During incubation and after hatching, nest contents were observed directly whenever possible using a telescoping mirror pole to determine nest contents and transition dates. Nest monitoring during nest building and egg-laying stages was limited to reduce the chance of abandonment during these periods. To reduce the risk of premature fledging of young (Rourke et al. 1999), nests were observed from a distance, using binoculars, once nestlings were 8 days of age. If no activity was observed at a previously occupied nest, the nest was checked directly to determine nest contents and condition. If no activity was observed at a nest close to or on the estimated fledge date, field personnel conducted a systematic search of the area to locate possible fledglings.

Per instructions from Reclamation biologists, a flycatcher nest was considered successful only if fledglings were observed near the nest or in surrounding areas. The number of young fledged from each nest was counted as the number of fledglings that were visually confirmed. This method of determining success produces a conservative estimate of both nest success rate and number of fledges and differs from methods recommended by some nest monitoring protocols (e.g., Martin et al. 1997; Rourke et al. 1999) that consider a nest as successful if chicks are observed in the nest within 2 days of the estimated fledge date.

A nest was considered to have failed if (1) the nest was abandoned prior to egg laying (abandoned), (2) the nest was deserted with flycatcher eggs or young remaining (deserted), (3) the nest was found empty or destroyed 2 days or more prior to the estimated fledge date (depredated), (4) nestlings died in the nest despite being tended by the adults (nestlings died in nest), or (5) the entire clutch was incubated for an excess of 20 days (addled). If a nest was visited on the anticipated fledge date and the nest was empty but the adults were clearly not feeding fledglings, the nest was assumed to have been depredated. For nests containing flycatcher eggs, parasitism was considered the cause of nest failure if (1) cowbird young outlived any flycatcher eggs or young or (2) the disappearance of all flycatcher eggs coincided with the appearance of cowbird eggs.

For each nest check, field personnel recorded the date and time of the visit, monitoring method (observation via binoculars or mirror pole), nesting stage, nest contents, and the number and behavior of adults and/or fledges present. These data were recorded in a OneNote notebook on a tablet and then entered in a form in Survey123 for ArcGIS at the end of the field day. Each form was a child feature linked to its respective nest flag point. Flycatcher nest success was calculated using apparent nesting success (number of successful nests/total number of nests

containing at least one flycatcher egg), while fecundity was calculated as the number of young produced per female over the breeding season. Parasitism rates were calculated as the percentage of nests with known contents that included at least one flycatcher egg and one cowbird egg.

Flycatcher nests that are parasitized by cowbirds and in which the cowbird egg hatches produce fewer flycatcher young than nests in which the cowbird egg does not hatch (McLeod and Pellegrini 2013); therefore, the nest monitoring protocol included replacing cowbird eggs in easily accessible flycatcher nests with artificial cowbird eggs. Three-dimensional printed cowbird eggs were obtained from Shapeways (http://www.shapeways.com/shops/VN, per Igic et al. 2015) and painted with BEHR PREMIUM PLUS ULTRA® interior paint to resemble cowbird eggs (figure 4-1). If the nest was accessible without a ladder, the cowbird egg was replaced as soon as it was discovered. If a ladder was required, the cowbird egg was replaced on the next regularly scheduled nest visit. Cowbird eggs were replaced only if a direct view of the nest contents could be obtained from a secure location either on the ground or on a ladder. The cowbird egg was replaced so as not to mimic a partial depredation event, which might result in nest desertion. If a nest was found with a cowbird nestling already in the nest, the cowbird nestling was removed from the nest.

Figure 5-1.—Artificial cowbird eggs used to replace cowbird eggs in easily accessible southwestern willow flycatcher nests.

Surface Hydrology

Soil moisture conditions were described near all monitored nests one to three times during the life of each nest. Descriptions included conditions of soil moisture at the nest (inundated, saturated, damp, or dry), depth of water at the nest (if any, to the nearest centimeter or nearest 5 cm if > 5 cm), distance from the nest to wet soils (inundated or saturated soil, to the nearest meter), and the percent of the area within 20 and 50 m of the nest that contained wet soils (to the nearest 5%). As described in chapter 2, soil moisture categories were qualitatively determined as follows: inundated soils were those that had water visible on the surface; soils were considered saturated if compression of the soil (e.g., by stepping on it) caused water to be expressed; soils were considered dry if squeezing a handful of soil did not result in the soil sticking together; and damp soils were any that did not have surface water and did not meet the criteria for either saturated or dry (i.e., compressing a handful of soil caused the soil to stick together, but no water was expressed). Estimates of distance to wet soils were determined by one of three methods: (1) a visual estimate in the field (if wet soils were visible from the nest), (2) using Collector for ArcGIS on a tablet in the field (finding the nearest wet soil, and using the measure tool to measure the distance between the observer's location and the nest location, thus displaying distance from wet soils back to the nest), or (3) by measuring on a georeferenced aerial photograph in an ArcGIS Online web application. The percentages of the area within 20 and 50 m of the nest that contained wet soils were estimated either visually in the field or, more often, by using on-the-ground knowledge of surface hydrology coupled with an aerial photograph to help with visualizing the area encompassed within a 20- or 50-m-radius circle around the nest. These data were scheduled to be collected when the nest was found, at the nest check before the estimated hatch day (or, if estimated hatch day was unknown, the nest check when nestlings were first detected), and again at fledge or failure. If a nest failed during laying or incubation or was found with nestlings, only two measurements of surface hydrology were collected.

Vegetation

Nest height was recorded up to three times for each nest: (1) if the nest was found during building and was not approached on the day it was found, a visual estimate was obtained; (2) the first time the nest was observed with a mirror pole, the pole (each section of which is 90 cm) was used to obtain an estimate of nest height; and (3) nest height was measured with a stadia rod after the nest was vacated. Each time nest height was estimated or measured, the observer also recorded the species of tree or shrub in which the nest was placed (nest substrate) as well as a visual estimate of the percentage of vegetation volume that consisted of tamarisk within a 2-m-radius cylinder and a 5-m-radius cylinder centered on the nest.

These two distances were chosen to try to assess, in the event of defoliation by tamarisk beetles, whether the level of defoliation in the immediate vicinity of the nest (2 m) or in the more general vicinity (5 m) had a greater influence on nest success and microclimate. It is typically not possible to see more than 5 m, so the percentage of tamarisk was not estimated at distances > 5 m. One of the following vegetation types was also assigned to each nest based on the foliage volume of the plant species present within 5 m of the nest:

TAMSPP = > 75% tamarisk

SALGOO = > 75% Goodding's willow

SALEXI = > 75% coyote willow

POPFRE = > 75% cottonwood

TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%

SALGOO_POPFRE = Goodding's willow and cottonwood mix, neither > 75%

TAMSPP_SALGOO = tamarisk with emergent Goodding's willow

SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory

OTHER = a vegetation type that does not fit one of the above descriptions

Each time soil moisture conditions at the nest were recorded, the observer also made note of whether signs of tamarisk beetles (either beetles themselves or evidence of defoliation) were present anywhere within the survey site and whether beetles or defoliation were present within 5 m of the nest. The observer recorded the condition of the tamarisk within 5 m of the nest (green, yellow/brown, defoliated, refoliating, or dead) as well as the percentage of the tamarisk within the site that was affected by beetles.

Data Analyses

Nest height and the percentage of tamarisk within 2 and 5 m of the nest were summarized for each vegetation type in each study area. Although up to three sets of estimates for nest height and tamarisk percentages were recorded for each nest, the only set included in the final dataset was the one that came from the visit when the most accurate method of measuring nest height was used.

Temperature and Humidity

A Hygrochron iButton (Maxim Integrated, San Jose, California) was deployed at each monitored flycatcher nest after the nest was confirmed to be in the incubation phase, or after it was vacated if it failed before reaching incubation. The iButton was mounted on a key fob and hung in an inconspicuous location, no higher than 2 m

above the ground or water surface but below nest height, and within 2 m horizontal distance of the nest. The loggers recorded temperature and relative humidity every 30 minutes and remained in place until the end of the breeding season.

Data Analyses

Temperature and humidity data were truncated to the midnight after the logger was deployed and the midnight before the logger was removed so that only full 24-hour periods were represented. Temperature (T, degrees Celsius [°C]) and relative humidity (RH) were converted to vapor pressure[1] (VP, Pascals [Pa]) as follows:

$$VP = RH*(610.7*10^{((7.5*T)/(237.3+T))})/100$$

The following temperature and humidity variables were calculated for each logger:

- Maximum diurnal temperature
- Minimum nocturnal temperature
- Daily temperature range (diurnal maximum minus nocturnal minimum)
- Mean diurnal vapor pressure
- Mean nocturnal vapor pressure

Times from 0530 to 2000 hours were assigned as day and all others as night. Each variable was summarized over 2-week periods by study area and by vegetation type within each study area. Box plots summarizing the data over 2-week periods show the distribution of daily measurements from each logger as independent observations. Box plots illustrate the interquartile range (the ends of the box) and median (line within the box), with "whiskers" extending up to 1.5x the interquartile range beyond the box and outliers beyond the whiskers plotted as individual points. Outliers that are more than 3x the interquartile range beyond the box are denoted with an asterisk.

Hourly temperature and relative humidity data were obtained from the weather station at the Needles airport near Needles, California (station ID WBAN23179). These data were summarized as described for the iButton data. For each temperature and humidity variable, the daily value recorded by the iButton was subtracted from the value recorded at the weather station to obtain the difference in readings between the logger and the weather station. These differences were summarized with box plots over 2-week periods. Analyses of temperature and humidity and a summary of vegetation data were completed in IBM® SPSS® v. 22.0.

[1] Vapor pressure, unlike relative humidity, is not influenced by ambient temperature and may be a more biologically meaningful measure of water content of the air (e.g., the relative vapor pressure inside and outside an egg determines whether the egg loses moisture).

RESULTS

Nest Monitoring

Nine flycatcher nesting attempts were documented at TOPO. No flycatcher pairs were documented at BIWI. Seven nests were known to contain flycatcher eggs and were used in calculating nest success and productivity (table 5-1). Five (71%) of the seven nests fledged flycatcher young, and the remaining two nests failed. Of the two nests that failed after flycatcher eggs were laid, one was deserted after at least 14 days of incubation, and one failed when it was parasitized during incubation, with the parasitism event resulting in the disappearance of all flycatcher eggs and desertion of the nest. No other nests were parasitized, and no cowbird eggs were addled or replaced in 2019.

Table 5-1.—Southwestern willow flycatcher nest monitoring results, Topock Marsh, 2019

Survey site	Pairs	Nests	Nests with 1+ WE[1]	Successful nests[2]	Failed nests[2]	Nests with unknown fate	Nests with 1+ WE[1] and known parasitism status	Parasitized nests[3]
Hell Bird	2	4	3	2 (67)	1 (33)	0	3	0
Glory Hole	2	3	3	2 (67)	1 (33)	0	3	1 (33)
Lost Lake Slough 03	2	2	1	1 (100)	0	0	1	0
Total	***6***	***9***	***7***	***5 (71)***	***2 (29)***	***0***	***7***	***1 (14)***

[1] WE = willow flycatcher egg.
[2] Only nests with at least one flycatcher egg were used in tallies and percentage calculations. Percentages are given in parentheses.
[3] Parasitized nests include all nests that contained at least one flycatcher egg and one cowbird egg. Percentages in parentheses include only nests with at least one flycatcher egg and for which parasitism status could be determined.

Nests were located for six females, five of which were known to have produced at least one egg. Two nesting attempts were located for each of three of the females, while a single nesting attempt was located for each of the other three females. Two of the females with multiple nesting attempts renested after failed nests. One female renested after a successful nest and reused the same nest structure. Twelve flycatcher fledglings were produced at TOPO, resulting in mean nest productivity of 1.71 (standard error [SE] = 0.52) and mean fecundity of 2.0 (SE = 0.52).

Surface Hydrology

Soil moisture conditions were described up to four times at each of the nine nesting attempts at TOPO. Although the intention was to record these data up to three times,

soil moisture data were collected four times at one nest when estimates were recorded on two different days for the same nest stage. When this occurred, the estimate farther from the transition date was removed from the dataset.

Soil moisture conditions were described at eight nests within 4 days of the nest being found; two were found during building, two were found during laying, and four were found during incubation. All nests were within 30 m of wet soils when they were found. A slight drying trend was apparent from mid-June to mid-August, with a decrease in the presence of wet soils beneath nests and in the nest vicinity and a corresponding increase in the distance to wet soils, which reached 50 m at one nest by mid-August (figure 5-2). Soil moisture conditions recorded during building and laying likely represent the conditions that were present when the female flycatcher selected the nest site. All four nests that were found during building or laying were within 2 m of wet soil when they were found.

Vegetation

Vegetation characteristics were recorded at all nine flycatcher nesting attempts at TOPO. Seven nesting attempts were in areas where vegetation was > 75% tamarisk, one was in a mix of tamarisk and coyote willow, and one was in an area that was > 75% Goodding's willow (table 5-2). Eight nesting attempts were in nest structures placed in tamarisk and one was in a Goodding's willow. Nest height across all vegetation types ranged from 2.1 to 4.0 m (average = 2.9, SE = 0.2). Tamarisk was a substantial component of the vegetation surrounding eight of the nine nests. The tamarisk within 5 m of each nest were green until mid- or late July, when the tamarisk foliage turned brown as the result of tamarisk beetle activity.

Temperature and Humidity

An iButton was deployed at each of seven nest structures at TOPO. No logger was deployed at the eighth nest structure, which disappeared soon after it was found. The loggers were deployed between mid-June and mid-July and were in place until mid-August. The branch on which one iButton was hung had fallen by the time iButtons were retrieved in August, and the iButton could not be found. Data from two of the remaining six iButtons could not be downloaded because the batteries had ceased functioning during iButton deployment. The remaining four iButtons functioned normally. One had been set to collect data every 10 minutes, which resulted in the memory being full 1 month before the loggers were retrieved in August.

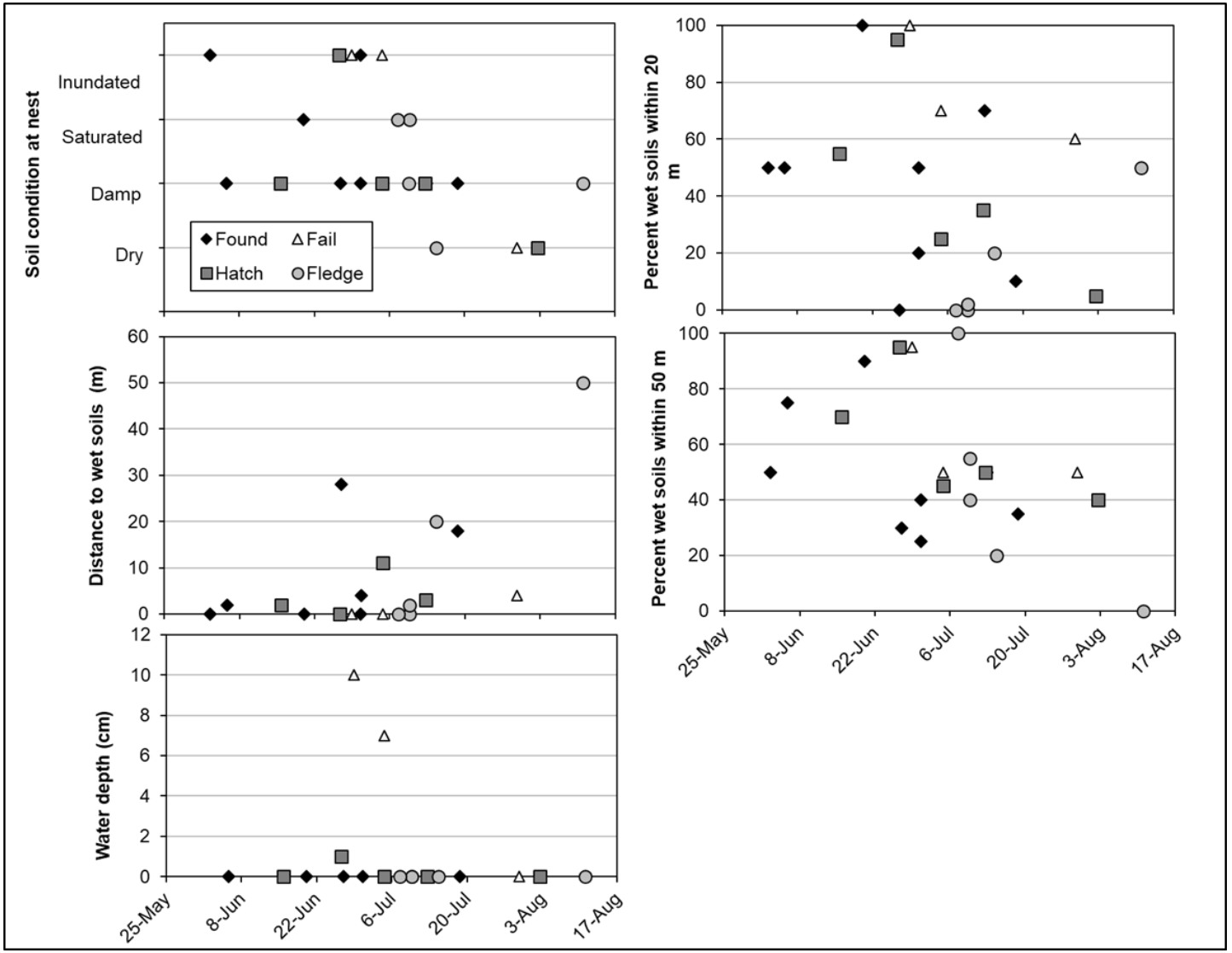

Figure 5-2.—Soil moisture characteristics at southwestern willow flycatcher nests at Topock Marsh (n = 9), 2019.

Table 5-2.—Vegetation characteristics at southwestern willow flycatcher nests at Topock Marsh, 2019

	Nest height		Nest substrate		% tamarisk within 2 m		% tamarisk within 5 m	
Vegetation type[1]	**Median (25th–75th percentile)**	**Mean (SE)**	**TAMSPP**	**SALGOO**	**Median (25th–75th percentile)**	**Mean (SE)**	**Median (25th–75th percentile)**	**Mean (SE)**
SALGOO (n = 1)	2.7	2.7	0	1	0.0	0.0	25.0	25.0
TAMSPP (n = 7)	3.0 (2.4–3.8)	3.0 (0.3)	7	0	100.0 (100.0–100.0)	98.6 (1.4)	80 (80.0–90.0)	82.1 (2.1)
TAMSPP_SALEXI (n = 1)	2.5	2.5	1	0	80	80	70	70
Total	**2.7 (2.5–3.5)**	**2.9 (0.2)**	**8**	**1**	**100 (90.0–100.0)**	**85.6 (10.9)**	**80.0 (75.0–80.0)**	**74.4 (6.5)**

[1] SALGOO = > 75% Goodding's willow; TAMSPP = > 75% tamarisk; TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%.

Median and mean maximum daily temperatures at flycatcher nests over 2-week periods from early June to mid-August were between 38.1 and 43.1 °C (table 5-3, figure 5-3). Median and mean minimum nocturnal temperatures were between 18.6 and 24.8 °C, while the median and mean daily temperature ranges were between 14.2 and 21.5 °C. Both diurnal and nocturnal vapor pressure increased from early June to mid-August (table 5-4, figure 5-3).

The maximum diurnal temperatures recorded at flycatcher nests were typically 1–4 °C cooler than those recorded at the Needles weather station, while nocturnal minimum temperatures were typically 3–10 °C cooler at flycatcher nests than at the weather station (figure 5-4). Both diurnal and nocturnal vapor pressures were invariably higher at flycatcher nests than at the weather station.

DISCUSSION

Six flycatcher pairs were detected at TOPO in 2019, which represents a three-fold increase over the number of pairs detected in both 2017 and 2018 (McLeod and Pellegrini 2019) and is the highest number of pairs detected since 2008 (McLeod and Pellegrini 2013). Flycatcher pairs at TOPO successfully fledged young for the first time since 2015, and the number of young (12) produced in 2019 equals the number of young fledged at TOPO over the previous decade combined. Habitat quantity and quality at TOPO have been adversely affected by several factors in recent years: low water levels in 2010–11, a large fire in 2015, and tamarisk beetles in 2017 and 2018. Tamarisk beetles were present in 2019, but defoliation did not occur until the second half of July, by which time four of the five successful nests had fledged. In addition, flycatcher nests at TOPO in 2019 were in areas where the tamarisk, in contrast to much of the rest of TOPO, showed very little dieback from the previous 2 years of beetle activity.

Table 5-3.—Maximum diurnal temperature, minimum nocturnal temperature, and daily temperature range (°C) at southwestern willow flycatcher nests at Topock Marsh, 2019

Vegetation type[1]	June 1–15		June 16–30		July 1–15		July 16–31		Aug 1–15	
	Median (25th–75th percentile)	**Mean (SE)**	**Median (25th–75th percentile)**	**Mean (SE)**	**Median (25th–75th percentile)**	**Mean (SE)**	**Median (25th–75th percentile)**	**Mean (SE)**	**Median (25th–75th percentile)**	**Mean (SE)**
Maximum diurnal temperature										
TAMSPP (n=3)	N/A[2]	N/A	N/A	N/A	41.6 (39.6–42.6)	41.0 (0.4)	40.6 (39.6–42.6)	41.3 (0.3)	43.1 (41.0–44.5)	42.7 (0.4)
TAMSPP_SALEXI (n = 1)	39.1 (38.6–39.6)	39.1 (0.5)	38.1 (37.6–39.1)	38.1 (0.2)	39.1 (38.3–39.8)	39.2 (0.4)	N/A	N/A	N/A	N/A
Overall	**39.1 (38.6–39.6)**	**39.1 (0.5)**	**38.1 (37.6–39.1)**	**38.1 (0.2)**	**41.4 (38.6–42.1)**	**40.6 (0.3)**	**40.6 (39.6–42.6)**	**41.3 (0.3)**	**43.1 (41.0–44.5)**	**42.7 (0.4)**
Minimum nocturnal temperature										
TAMSPP (n=3)	N/A	N/A	N/A	N/A	18.6 (17.1–22.6)	19.7 (0.7)	23.6 (21.6–24.6)	23.7 (0.5)	23.1 (22.1–25.1)	23.6 (0.5)
TAMSPP_SALEXI (n = 1)	24.8 (24.1–25.6)	24.8 (0.8)	21.1 (19.1–23.6)	21.2 (0.9)	21.6 (20.6–23.3)	21.8 (0.7)	N/A	N/A	N/A	N/A
Overall	**24.8 (24.1–25.6)**	**24.8 (0.8)**	**21.1 (19.1–23.6)**	**21.2 (0.9)**	**18.9 (17.6–23.1)**	**20.2 (0.6)**	**23.6 (21.6–24.6)**	**23.7 (0.5)**	**23.1 (22.1–25.1)**	**23.6 (0.5)**
Daily temperature range										
TAMSPP (n=3)	N/A	N/A	N/A	N/A	21.5 (20.0–23.5)	21.3 (05)	18.0 (15.0–20.5)	17.7 (0.6)	19.5 (17.0–21.5)	19.0 (0.6)
TAMSPP_SALEXI (n = 1)	14.2 (14.0–14.5)	14.2 (0.3)	16.5 (14.0–19.0)	16.9 (1.0)	17.5 (15.0–19.7)	17.4 (1.0)	N/A	N/A	N/A	N/A
Overall	**14.2 (14.0–14.5)**	**14.2 (0.3)**	**16.5 (14.0–19.0)**	**16.9 (1.0)**	**20.5 (18.5–23.0)**	**20.4 (0.5)**	**18.0 (15.0–20.5)**	**17.7 (0.6)**	**19.5 (17.0–21.5)**	**19.0 (0.6)**

[1] TAMSPP = > 75% tamarisk; TAMSPP_SALEXI = tamarisk and coyote willow mix, neither >75%; and n = number of nests.

[2] N/A = data not available.

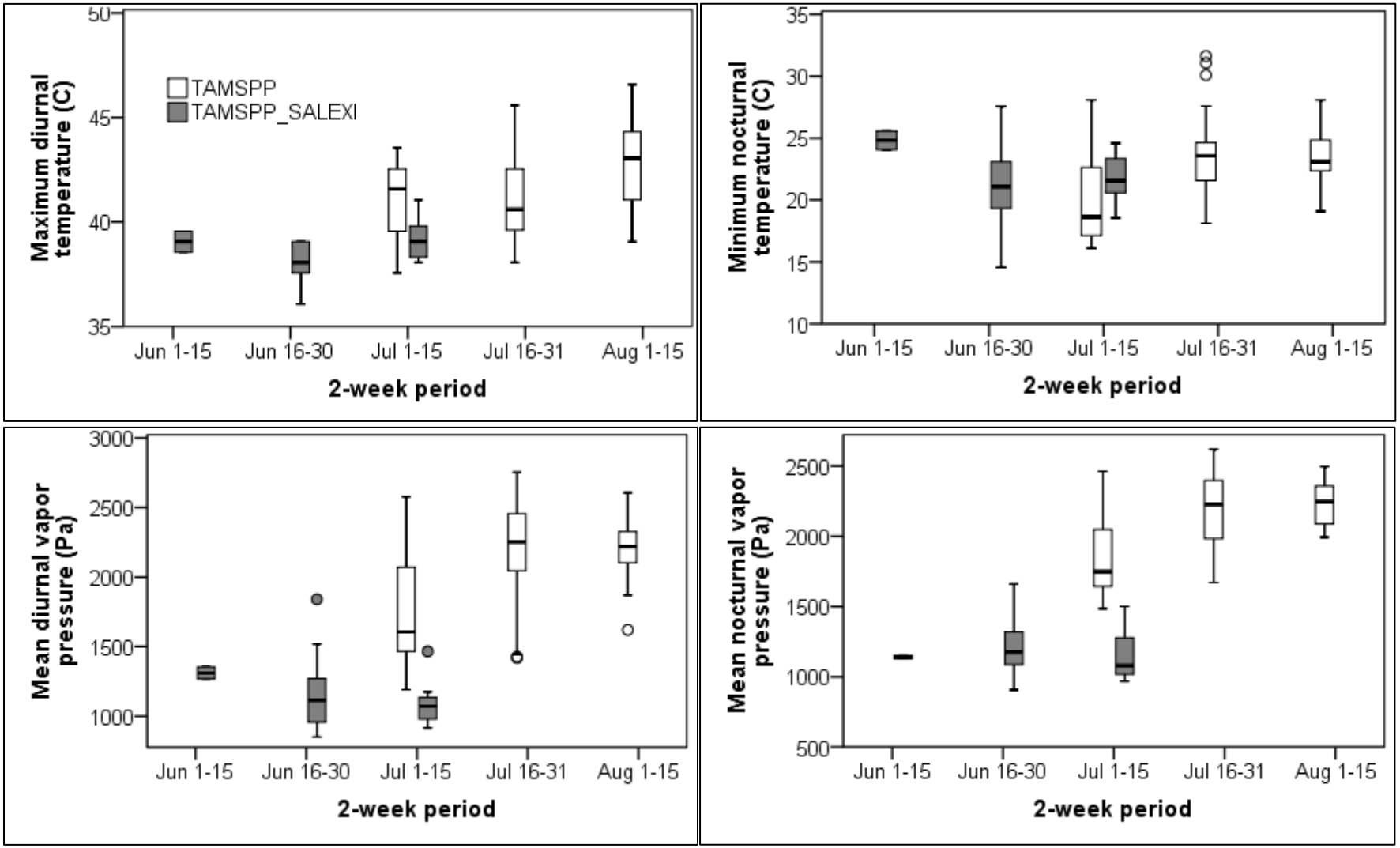

Figure 5-3.—Box plots of maximum diurnal and minimum nocturnal temperature (°C) and mean diurnal and nocturnal vapor pressure (Pa) at southwestern willow flycatcher nests in tamarisk (TAMSPP) (n = 3) and mixed tamarisk and coyote willow (TAMSPP_SALEXI) (n = 1) at Topock Marsh, 2019.

Table 5-4.—Mean diurnal vapor pressure and mean nocturnal vapor pressure (Pa) at southwestern willow flycatcher nests at Topock Marsh, 2019

Vegetation type[1]	June 1–15		June 16–30		July 1–15		July 16–31		Aug 1–15	
	Median (25th–75th percentile)	**Mean (SE)**	**Median (25th–75th percentile)**	**Mean (SE)**	**Median (25th–75th percentile)**	**Mean (SE)**	**Median (25th–75th percentile)**	**Mean (SE)**	**Median (25th–75th percentile)**	**Mean (SE)**
Mean diurnal vapor pressure										
TAMSPP (n=3)	N/A[2]	N/A	N/A	N/A	1,606 (1,467–2,070)	1,743 (75)	2,252 (2,046–2,456)	2,206 (58)	2,219 (2,071–2,330)	2,202 (44)
TAMSPP_SALEXI (n = 1)	1,311 (1,267–1,354)	1,311 (44)	1,114 (949–1,276)	1,161 (69)	1,071 (980–1,134)	1,094 (60)	N/A	N/A	N/A	N/A
Overall	**1,311 (1,267–1,354)**	**1,311 (44)**	**1,114 (949–1,276)**	**1,161 (69)**	**1,505 (1,300–1,907)**	**1,591 (76)**	**2,252 (2,046–2,456)**	**2,206 (58)**	**2,219 (2,071–2,330)**	**2,202 (44)**
Mean nocturnal vapor pressure										
TAMSPP (n=3)	N/A	N/A	N/A	N/A	1,749 (1,645–2,049)	1,841 (53)	2,226 (1,984–2,398)	2,185 (43)	2,247 (2,077–2,360)	2,230 (31)
TAMSPP_SALEXI (n = 1)	1,141 (1,130–1,152)	1,141 (11)	1,175 (1,072–1,323)	1,235 (55)	1,080 (1,019–1,277)	1,153 (72)	N/A	N/A	N/A	N/A
Overall	**1,141 (1,130–1,152)**	**1,141 (11)**	**1,175 (1,072–1,323)**	**1,235 (55)**	**1,696 (1,487–1,985)**	**1,679 (67)**	**2,226 (1,984–2,398)**	**2,185 (43)**	**2,247 (2,077–2,360)**	**2,230 (31)**

[1] TAMSPP = > 75% tamarisk; TAMSPP_SALEXI = tamarisk and coyote willow mix, neither >75%; and n = number of nests.
[2] N/A = data not available.

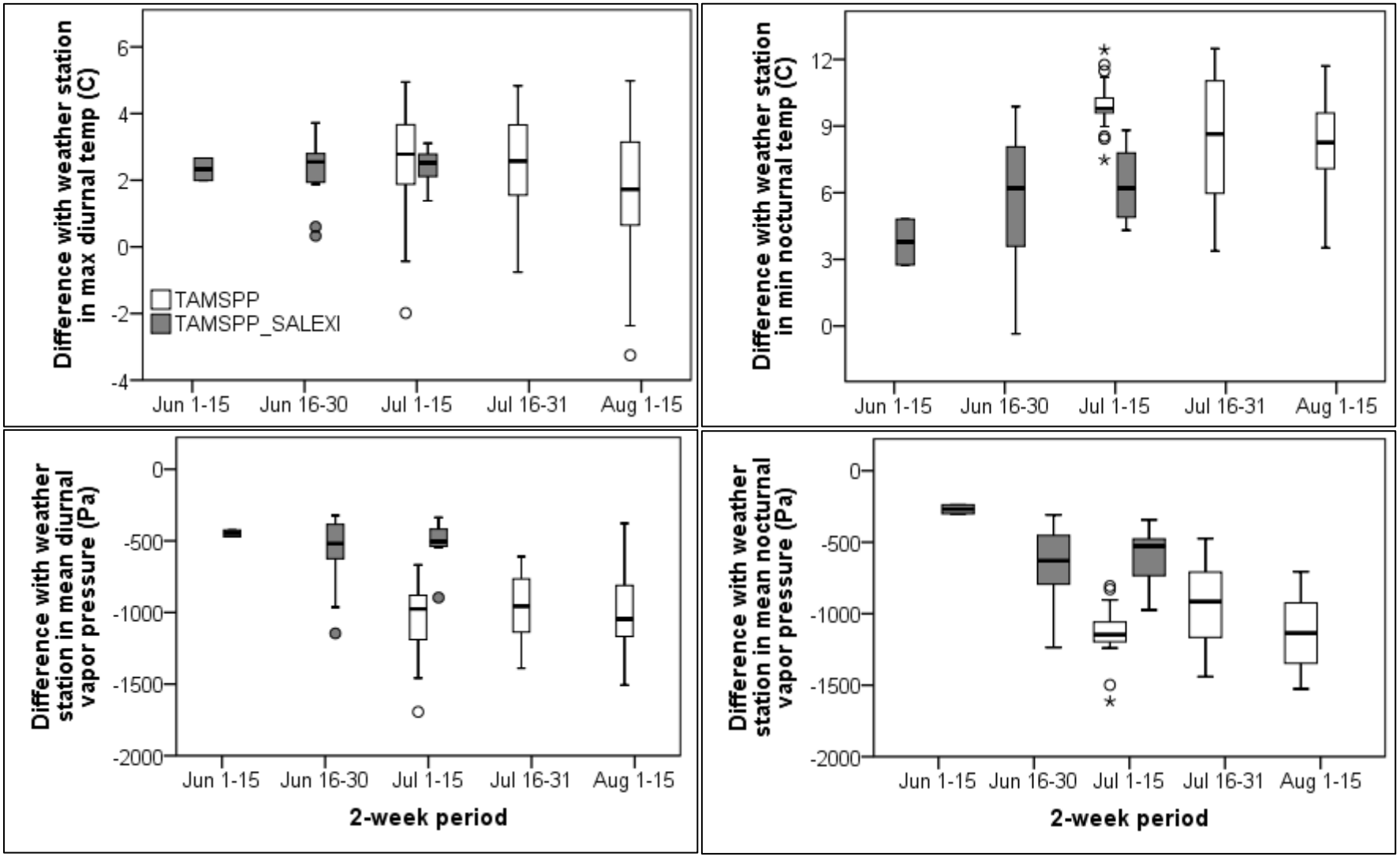

Figure 5-4.—Box plots of the differences in maximum diurnal and minimum nocturnal temperature (°C) and mean diurnal and nocturnal vapor pressure (Pa) between the Needles weather station and southwestern willow flycatcher nests in tamarisk (TAMSPP) (n = 3) and mixed tamarisk and coyote willow (TAMSPP_SALEXI) (n = 1) at Topock Marsh, 2019.

Although depredation is typically the primary cause of flycatcher nest failure at sites along the LCR (McLeod et al. 2018a) and at other sites across Arizona (Ellis et al. 2008;Graber and Koronkiewicz 2009; Graber et al. 2007), no depredation events were documented in 2019. Nest depredation rates can vary substantially from year to year (Howlett and Stutchbury 1996; Robinson 1992; Wiens 1989), and this is particularly true when sample sizes are low. Future years of monitoring would be needed to determine whether the high nest success rates observed at TOPO in 2019 are anomalous or are part of a trend of increased flycatcher productivity at TOPO.

Flycatchers are known for their propensity to nest near surface water (McLeod and Pellegrini 2013; Sogge and Marshall 2000; Sogge et al. 2010), which affects vegetation density, food availability (Iwata et al. 2003; Peterson et al. 2015), and microclimate (McLeod and Pellegrini 2013). Four flycatcher nests were found during the building or laying stages in 2019, and the soil conditions recorded when the nest was found likely represent those that existed when the female flycatcher selected the nest site. All four of these nests were within 2 m of wet soils when they were found. The slight drying trend observed through the season around the flycatcher nests is consistent with marsh level data recorded at the South Dike at Topock Marsh, which show that water levels peaked in mid-June and gradually declined thereafter (see figure 2-1).

Small sample sizes precluded meaningful comparisons between microclimate conditions observed in 2019 and those observed in other years, and between microclimate conditions in multiple vegetation types. Two of the six iButton data loggers that were retrieved at the end of the field season could not be downloaded because the batteries had ceased functioning. It is apparent that the iButtons, which were purchased in 2013, are no longer reliable and should be replaced.

Chapter 6 – Summary of Study Design Discussions

For ease of reference, this chapter summarizes all study design discussions from previous chapters.

BROADCAST SURVEYS AND SITE ASSESSMENT

The habitat conditions at the following sites were assessed and may warrant having the survey area adjusted and/or the frequency of surveys changed if monitoring is continued within those portions of the LCR system in future years.

Pipes 01, Pipes 03, Pig Hole, and In Between at TOPO were assessed at the beginning of the season to determine the extent to which vegetation had recovered following a fire in 2015. None of these sites had canopy closure that approached suitable levels. Re-evaluation of these sites in several years would ensure that no suitable habitat is overlooked.

Pierced Egg at TOPO was also burned in a fire in 2015, and the tallest patch of tamarisk had suitable canopy height, but canopy closure and patch size did not meet the suitability criteria. Evaluating this site again at the beginning of the next breeding season would ensure that no suitable habitat is overlooked.

Lost Lake Slough 01 at TOPO was visited to assess an area on the southwestern edge of the site that had been identified from aerial photography as possibly containing coyote willows. This portion of the site consisted of arrowweed and did not meet the criteria for suitable habitat. Surveys could be discontinued with minimal risk of overlooking suitable habitat.

Much of the woody vegetation in Coyote Crossing and Bill Willow at BIWI was dead, and surveys at these sites were discontinued partway through the season. Re-evaluation of these sites in several years would ensure that no suitable habitat is overlooked.

Canopy closure was much lower than 85% in Burn Edge, Last Gasp, and Guinness, and no new growth was observed at these sites. Re-evaluation of these sites in several years or after a high flow event would ensure that no suitable habitat is overlooked. In the meantime, surveys could be discontinued with minimal risk of overlooking suitable habitat.

Localized regenerative growth of cottonwoods and Goodding's willows was documented in Black Rail, Beaver Pond North, and Beaver Pond at BIWI. Substantial regrowth is needed before the sites could meet the suitability criteria. Re-evaluation of these sites in future years would ensure that no suitable habitat is overlooked.

Tree mortality has increased steadily over the past few years at Sidebar 01 at ALAM, and portions of South Camp were also dead. Re-evaluation of these sites in future years would ensure that no suitable habitat is overlooked.

NEST MONITORING

Data from two of the six iButton data loggers that were retrieved at the end of the field season could not be downloaded because the batteries had ceased functioning. Replacement of the existing iButtons with new ones would minimize the chance of losing data in future years.

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ATTACHMENTS

1 Study Area and Survey Site Organization Within Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2019

2 Field Data Forms

3 Orthophotos Showing Study Sites

4 Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Dates for Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2019

5 Detections of Covered Species Within Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2019

6 Contributing Personnel

ATTACHMENT 1

Study Area and Survey Site Organization Within Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2019

Table A1-1.—Study area and survey site organization within LCR MSCP areas and sites, 2019*

Study area	Management unit[1]	River drainage	LCR MSCP area	LCR MSCP site	LCR MSCP section
Topock Marsh	Hoover to Parker	Lower Colorado River	Topock	Topock Marsh	Pipes 01
					Pipes 03
					The Wallows
					PC6-1
					Pig Hole
					In Between
					800M
					Pierced Egg
					Swine Paradise
					Platform
					250M
					Hell Bird
					Glory Hole
					Farm Ditch Road
			Beal Lake Conservation Area	CPhase 05	CPhase 05
			Topock	Topock Bay	Lost Lake
					Lost Lake Slough 01
					Lost Lake Slough 02
					Lost Lake Slough 03
					Lost Lake Slough 04

Table A1-1.—Study area and survey site organization within LCR MSCP areas and sites, 2019*

Study area	Management unit[1]	River drainage	LCR MSCP area	LCR MSCP site	LCR MSCP section
Bill Williams	Bill Williams	Bill Williams River	Bill Williams River West	BW Delta	Coyote Crossing
				North of Main Delta	Bill Willow
				North Burn	Wispy Willow
					Site 01
					Burn Edge
				Mosquito Flats	Site 04
					Site 03
				Cross River	Last Gasp
					Guinness
				Sandy Wash	Site 05
					Black Rail
			Bill Williams River East	Esquerra Ranch	Beaver Pond North
					Beaver Pond
				Honeycomb Bend	Site 08
				Cave Wash	Upstream Site 08
			Planet Ranch	Planet Ranch West	Planet Ranch Road
Alamo Lake	Bill Williams	Bill Williams River	Alamo Lake	Lake	Bullard Wash
					South Camp
				Browns Crossing	Sidebar 01
					Camp 01
					Camp 02

Table A1-1.—Study area and survey site organization within LCR MSCP areas and sites, 2019*

Study area	Management unit[1]	River drainage	LCR MSCP area	LCR MSCP site	LCR MSCP section
Alamo Lake (cont.)	Bill Williams	Bill Williams River	Alamo Lake	Browns Crossing	Camp 03
					Middle Earth 01
					Middle Earth 02
					Prospect 01
					Burro Wash 01
					Burro Wash 02
					Motherlode 01
					Motherlode 02
					Prospect 02
					Motherlode 04
		Santa Maria River			Santa Maria North 01
Palo Verde Ecological Reserve	Parker to Southerly International Boundary	Lower Colorado River	Palo Verde Ecological Reserve	Phase 02	Phase 02
				Phase 03	Phase 03
				Phase 04	Phase 04 Block 01
					Phase 04 Block 02
					Phase 04 Block 03
				Phase 05	Phase 05 Block 01
					Phase 05 Block 02
					Phase 05 Block 03
				Phase 06	Phase 06 Block 01
					Phase 06 Block 02
				Phase 07	Phase 07 Block 01
					Phase 07 Block 02

Table A1-1.—Study area and survey site organization within LCR MSCP areas and sites, 2019*

Study area	Management unit[1]	River drainage	LCR MSCP area	LCR MSCP site	LCR MSCP section
Cibola	Parker to Southerly International Boundary	Lower Colorado River	Cibola Valley Conservation Area	Phase 01	Phase 01
				Phase 02	Phase 02
				Phase 03	Phase 03
				Phase 08	Phase 08
			Cibola National Wildlife Refuge Unit #1	Upper Hippy Fire	Upper Hippy Fire
				Nature Trail	Nature Trail
				Lower Hippy Fire	Lower Hippy Fire
				Crane Roost	C2729
Mittry Lake	Parker to Southerly International Boundary	Lower Colorado River	Laguna Division Conservation Area	Reach 01	C4958
					C4911
					C4913
				Reach 02	C4959
					C4960
					C4961
Yuma	Parker to Southerly International Boundary	Lower Colorado River	Yuma East Wetlands	J	C4703
				C	C4711
				I	C4702
			Hunters Hole Conservation Area	Hunters Hole Conservation Area	1401-01[2]

* The LCR MSCP section name corresponds to the current survey site name, though the geography of corresponding sections and survey sites may not be identical.

[1] Management units are defined in the southwestern willow flycatcher recovery plan (USFWS 2002).
[2] Data are reported under the name Hunters Hole.

ATTACHMENT 2

Field Data Forms

MSCP Area: Do Not Use **MSCP Site:** Do Not Use **Proofed by:**___ **Date:**___

SWFL General Site Description

[Complete at least 3 times during season: early (10–25 May), mid-season (10–25 June), and late season (5–20 July)]

Study Area: Study Area **Survey Site:** Survey Site **Visit:** Choose an item. **Date:** Date **Observer(s):** Observer(s)

Does this description cover the entire site? Yes / No **If not, which portion is described?** Portion of site described

VEGETATION
Overall vegetation composition at site: Choose an item.

Vegetation Type 1		Vegetation Type 2		Vegetation Type 3	
Dominant overstory:	Overstory spp	**Dominant overstory:**	Overstory spp	**Dominant overstory:**	Overstory spp
Overstory Avg ht:	Overstory average height (m)	**Overstory avg ht:**	Overstory average height (m)	**Overstory avg ht:**	Overstory average height (m)
Overstory ht range:	Overstory height range (m)	**Overstory ht range:**	Overstory height range (m)	**Overstory ht range:**	Overstory height range (m)
Dominant understory:	Understory spp	**Dominant understory:**	Understory spp	**Dominant understory:**	Understory spp
Understory avg ht:	Understory average height (m)	**Understory avg ht:**	Understory average height (m)	**Understory avg ht:**	Understory average height (m)
Understory ht range:	Understory height range (m)	**Understory ht range:**	Understory height range (m)	**Understory ht range:**	Understory height range (m)
% canopy closure:	% canopy closure	**% canopy closure:**	% canopy closure	**% canopy closure:**	% canopy closure
Percentage of site:	% of site w/ veg type 1	**Percentage of site:**	% of site w/ veg type 2	**Percentage of site:**	% of site w/ veg type 3

Other vegetation types present (e.g., cattail)? Yes / No **If yes,** **type of vegetation:** Type of vegetation **percentage of site:** % of site.
type of vegetation: Type of vegetation **percentage of site:** % of site
type of vegetation: Type of vegetation **percentage of site:** % of site

Unvegetated areas present (e.g., pond, sand dune)? Yes / No **If yes,** **Description:** Type of unvegetated area **percentage of site:** % of site.

HYDROLOGY			
% INUNDATED (% of site)	**% SATURATED Soils** (NOT including inundated areas!)	**% DAMP Soils** (NOT including inundated or saturated!)	**% DRY Soils** (NOT including moist soils!)
% Inundated	% Saturated	% Damp	% Dry

If wet soils (i.e., either INUNDATED or SATURATED) are present within the site:

Type of wet soils: Describe type of wet soils in site (e.g., open marsh, pond, stream, lake edge, high groundwater, puddles from rain, etc.)
Depth of surface water: Average depth (cm): Average water depth in site Range of depths (cm): Max and min water depth in site
Location of wet soils: Brief description of where the water is within the site (e.g., NW corner, scattered puddles, southern half, etc.)

If NO Inundated or Saturated Soils are present:

Distance (m) to surface water or saturated soil from EDGE of site: Minimum distance to wet soils if none in site
How was distance determined? Choose an item.
Type of nearest wet soils: Type of nearest wet soils if none in site
Approximate location of nearest wet soils: UTM Easting: Easting UTM Northing: Northing

¶

LIVESTOCK

Did you observe signs of livestock in or near the site? If yes, describe. Signs of livestock. Include species, type of sign, freshness of sign, and abundance of sign. ¶

TAMARISK BEETLES

Did you observe beetles in the site? If yes, describe. Life stage(s) observed and general abundance. ¶
Do any of the tamarisk appear dead? If yes, give percentage and describe. Percentage of tamarisk that appear dead. Describe! E.g., 50% dead could mean each tree is half dead, every other tree is completely dead, etc. ¶
Percent of live tamarisk currently affected by beetles: % of live tamarisk currently affected by beetles. Include tamarisk where beetles are currently present and tamarisk that show signs of beetle activity this season. ¶
Foliage condition of live tamarisk affected by beetles: Describe the condition (green, yellow/brown, defoliated, and/or refoliating) of the live tamarisk that are affected by beetles. and give the percentage of the tamarisk in each condition category. ¶

HABITAT SUITABILITY

How suitable is the habitat for flycatchers?: ☐ → ☐ → ☐ → ☐ → ☐ ¶

NARRATIVE and PICTORIAL DESCRIPTION

On the OneNote map, sketch and label the locations of the major vegetation types you observed. Delineate marshes, open areas, and other habitat that may be unsuitable for flycatchers. If water was present, show its location. Copy and paste that map and associated commentary here: ¶

¶

Give a narrative description of the site, including adjacent habitats. Use the numbers above to build your narrative. Explain any patterns present in the vegetation (e.g., shorter veg had lower canopy closure or vice versa). If you present averages above, make sure to also include the range in your narrative (as applicable) and vice versa. ¶

Additional comments on habitat quality, other notable avian species, site access, etc:

Insert and label any photos you took of the site here. Representative photos of each veg type (a lateral photo to show veg structure and a vertical photo to show canopy closure) are VERY helpful. Use as many pages as necessary.

Observed Leg Injuries

Study Area: Study Area **Survey Site:** Survey Site **Territory/Nest #:** Terr #

Date: Date **Observer(s):** Observer(s)

Color-band combination: Color combo **If captured, Federal Band #:** Prefix-Suffix

PHOTOGRAPH INFORMATION

Did you take photos? Yes / No **If yes, how many?** # of pics

After you download and name the photos, create a link to each photo:

Photo 1	
Photo 2	
Photo 3	
Photo 4	
Photo 5	
Photo 6	

NOTES

Detail all pertinent information including duration of observation, behaviors, how bird was holding its leg, whether the bird had use of the leg, etc. **Banders – describe the injury in detail. Was the band removed? If so, did the leg bleed? Was the bird stressed? Be precise, complete, and detailed.

Notes on observed leg injury

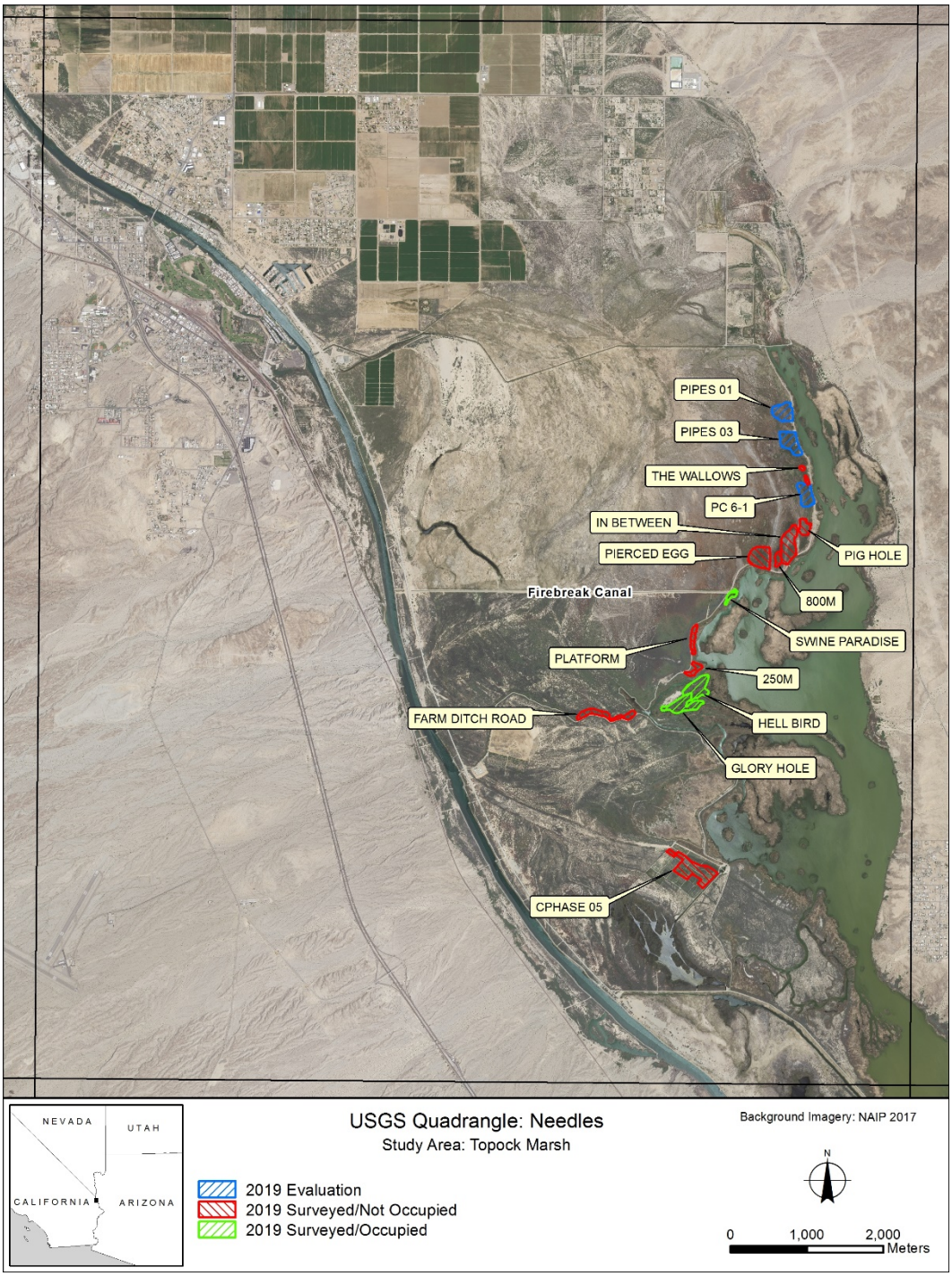
ATTACHMENT 3

Orthophotos Showing Study Sites

Definition of Survey Site Occupancy – Survey sites are considered occupied if at least one southwestern willow flycatcher (*Empidonax traillii extimus*) (hereafter flycatcher) territory is detected.

A territory was considered to be present wherever (1) a flycatcher was detected during the "non-migrant" period (i.e., June 25 through July 20), (2) a flycatcher exhibited extended, unsolicited song during the first and second surveys and was still present during the third survey, and/or (3) a flycatcher pair was present at any point during the season. A pair was considered to be present if any of the following were observed (per Sogge et al. 2010): (1) another, unchallenged flycatcher in the immediate vicinity of where a male was engaging in extended, unsolicited song, (2) *whitt* calls between nearby flycatchers in the immediate vicinity of where a male had engaged in extended, unsolicited song, (3) interaction twitter calls between nearby flycatchers, (4) physical aggression by flycatchers against cowbirds, (5) flycatchers copulating, or (6) evidence of an active nesting attempt including: (a) a flycatcher carrying nest material, (b) a flycatcher carrying food or a fecal sac, (c) a flycatcher sitting or standing on a nest, (d) a nest containing flycatcher eggs, or (e) recently fledged flycatcher young.

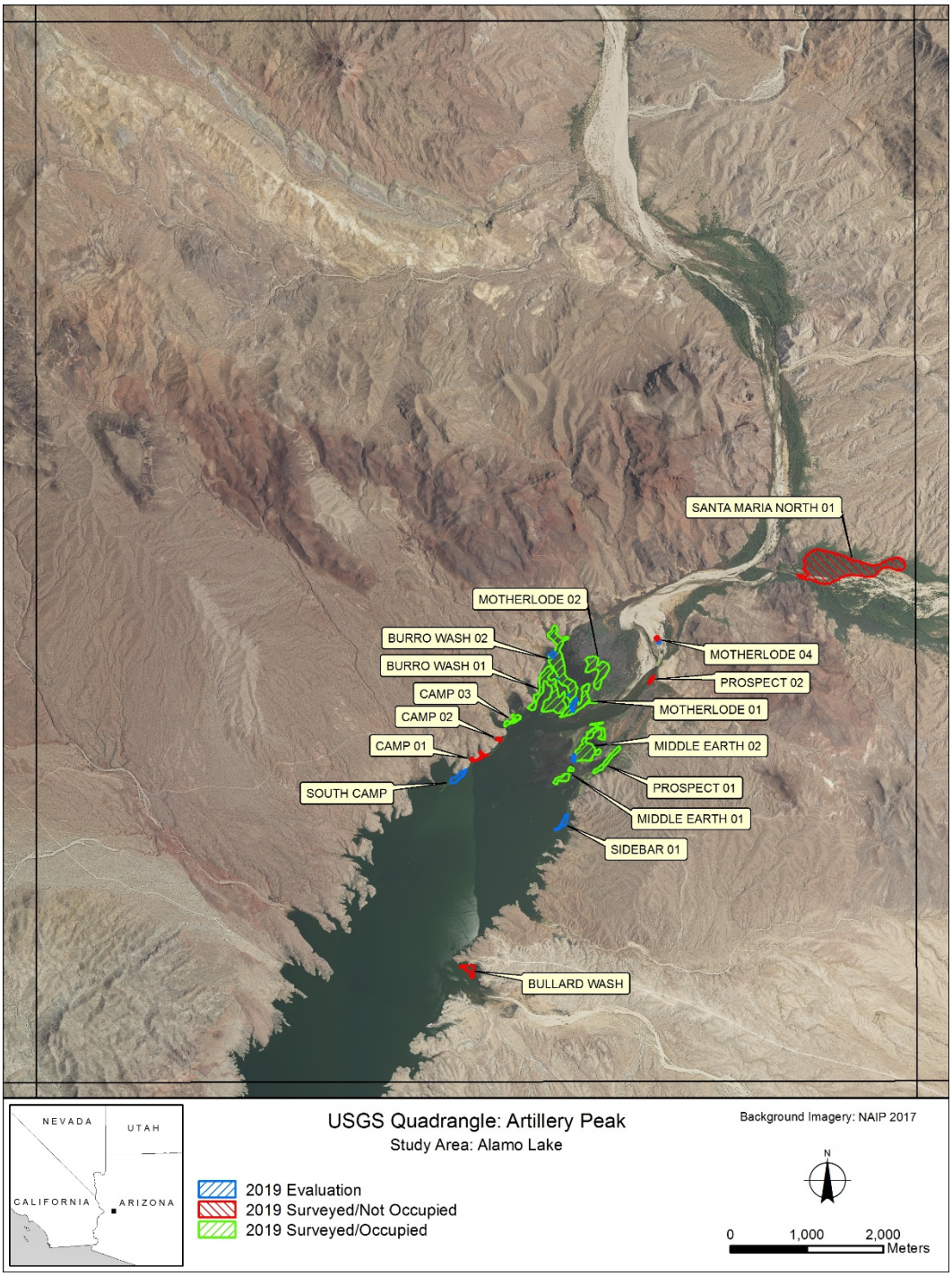
UTAH
NEVADA
St. George
Virgin River
Pahranagat Wash
Lake Mead
Colorado River
Las Vegas
Lake Mohave
Kingman
Flagstaff
TOPOCK MARSH
BILL WILLIAMS
CALIFORNIA
Lake Havasu
ALAMO LAKE
Bill Williams River
ARIZONA
Verde River
Colorado River
Palm Springs
Quartzsite
PALO VERDE ECOLOGICAL RESERVE
Salton Sea
Phoenix
CIBOLA
MITTRY LAKE
Yuma
YUMA
MEXICO
Lower Colorado River Southwestern
Willow Flycatcher Study 2019
City/Town
Study Area
River
Highway
0 25 50 Mi
0 50 100 Km
1:3,300,000
N


PIPES 01
PIPES 03
THE WALLOWS
PC 6-1
IN BETWEEN
PIERCED EGG
PIG HOLE
Firebreak Canal
800M
SWINE PARADISE
PLATFORM
250M
FARM DITCH ROAD
HELL BIRD
GLORY HOLE
CPHASE 05
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Needles
Study Area: Topock Marsh
2019 Evaluation
2019 Surveyed/Not Occupied
2019 Surveyed/Occupied
Background Imagery: NAIP 2017
N
0
1,000
2,000
Meters

LOST LAKE SLOUGH 01
LOST LAKE SLOUGH 02
LOST LAKE SLOUGH 03
LOST LAKE SLOUGH 04
LOST LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Whale Mountain & Topock
Study Area: Topock Marsh
2019 Evaluation
2019 Surveyed/Not Occupied
2019 Surveyed/Occupied
Background Imagery: NAIP 2016
N
0
1,000
2,000
Meters

BILL WILLOW
SITE 01
COYOTE CROSSING
BURN EDGE
LAST GASP
WISPY WILLOW
GUINNESS
SITE 04
SITE 03
BLACK RAIL
SITE 05
BEAVER POND NORTH
BEAVER POND
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Monkeys Head
Study Area: Bill Williams
2019 Evaluation
2019 Surveyed/Not Occupied
2019 Surveyed/Occupied
Background Imagery: NAIP 2017
N
0
1,000
2,000
Meters

SITE 08
UPSTREAM SITE 08
PLANET RANCH ROAD
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castaneda Hills SW
Study Area: Bill Williams
2019 Evaluation
2019 Surveyed/Not Occupied
Background Imagery: NAIP 2017
N
0
1,000
2,000
Meters


SANTA MARIA NORTH 01
MOTHERLODE 02
BURRO WASH 02
BURRO WASH 01
CAMP 03
CAMP 02
CAMP 01
SOUTH CAMP
MOTHERLODE 04
PROSPECT 02
MOTHERLODE 01
MIDDLE EARTH 02
PROSPECT 01
MIDDLE EARTH 01
SIDEBAR 01
BULLARD WASH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Artillery Peak
Study Area: Alamo Lake
2019 Evaluation
2019 Surveyed/Not Occupied
2019 Surveyed/Occupied
Background Imagery: NAIP 2017
N
0
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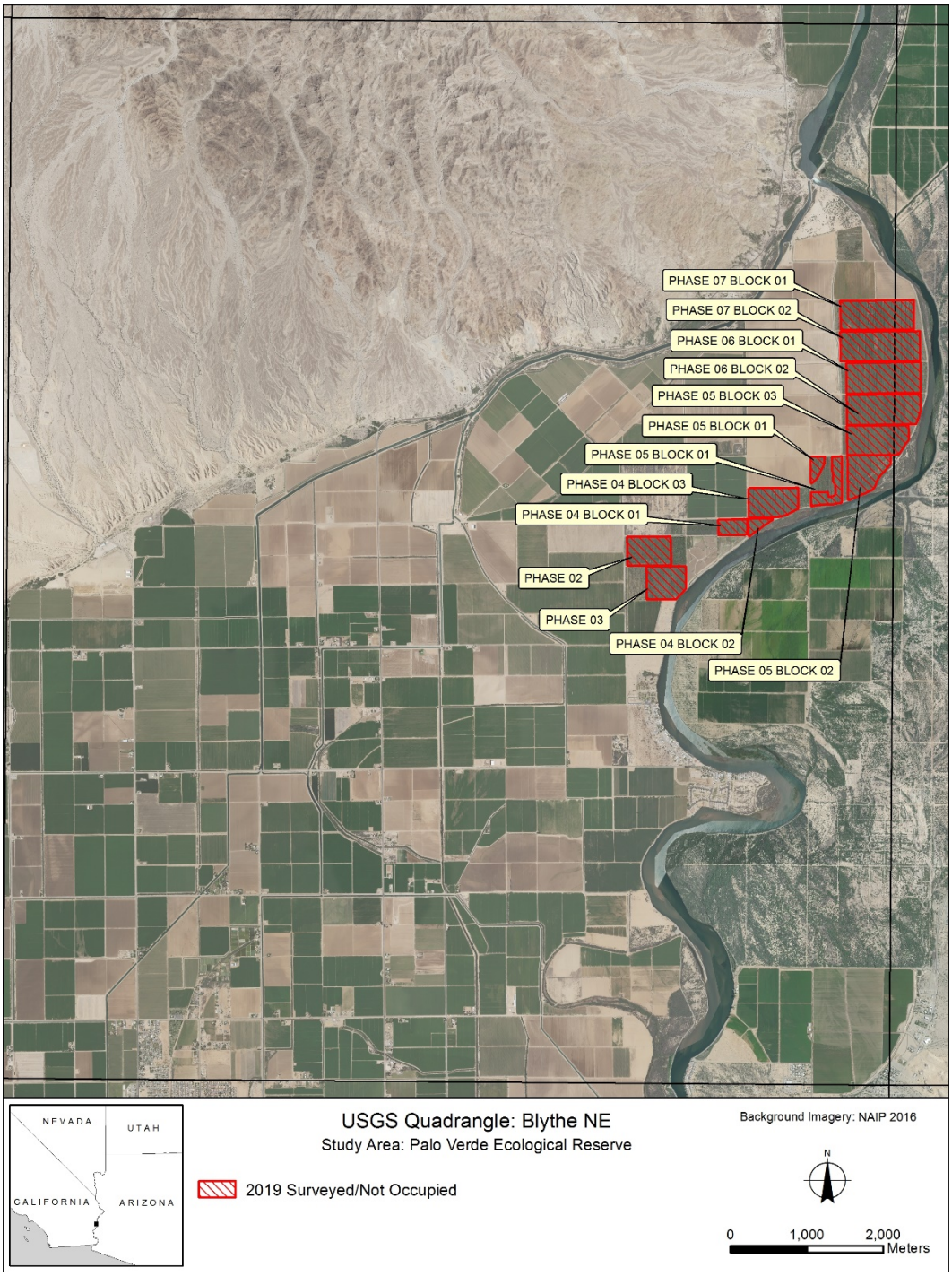
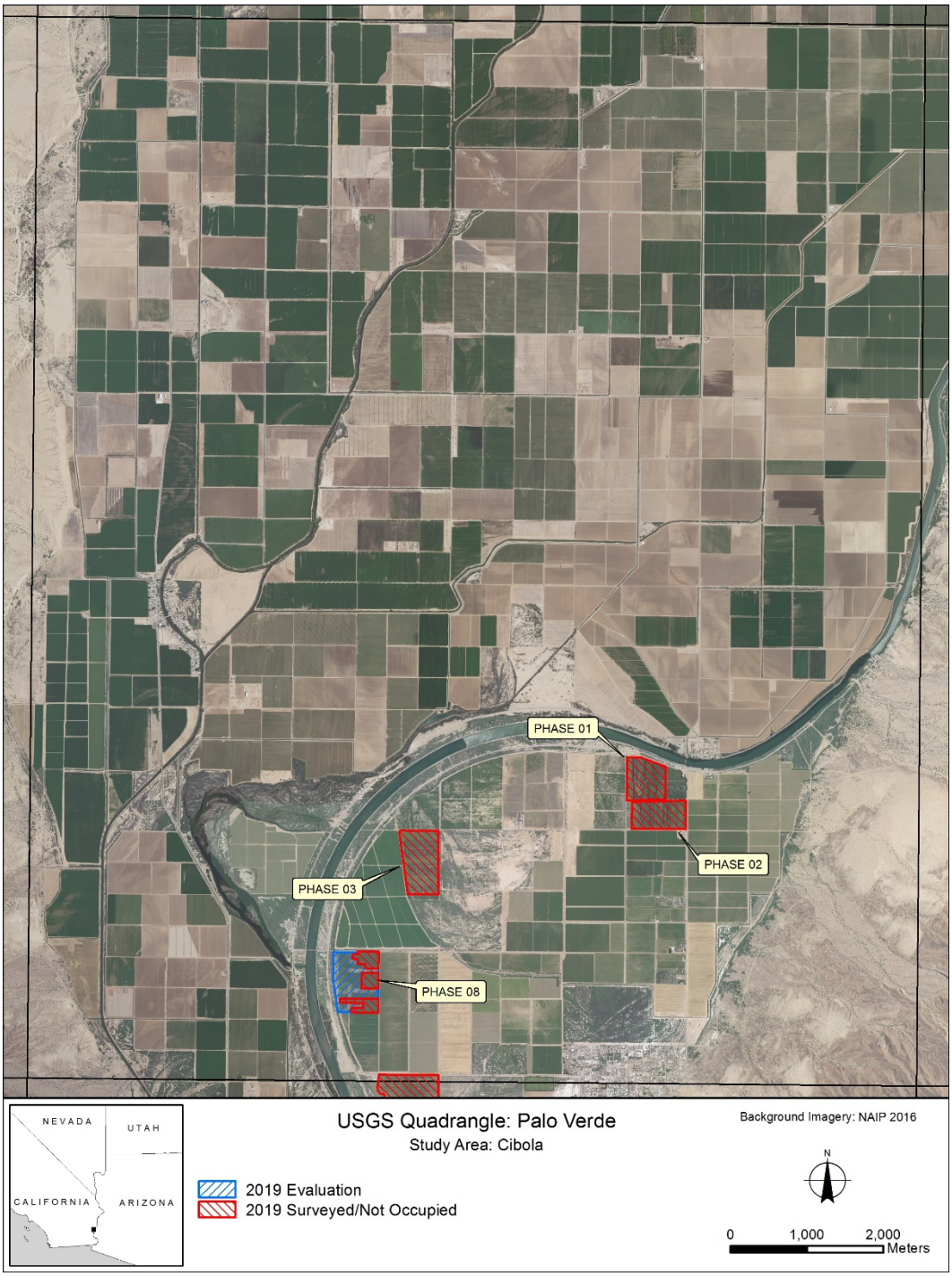
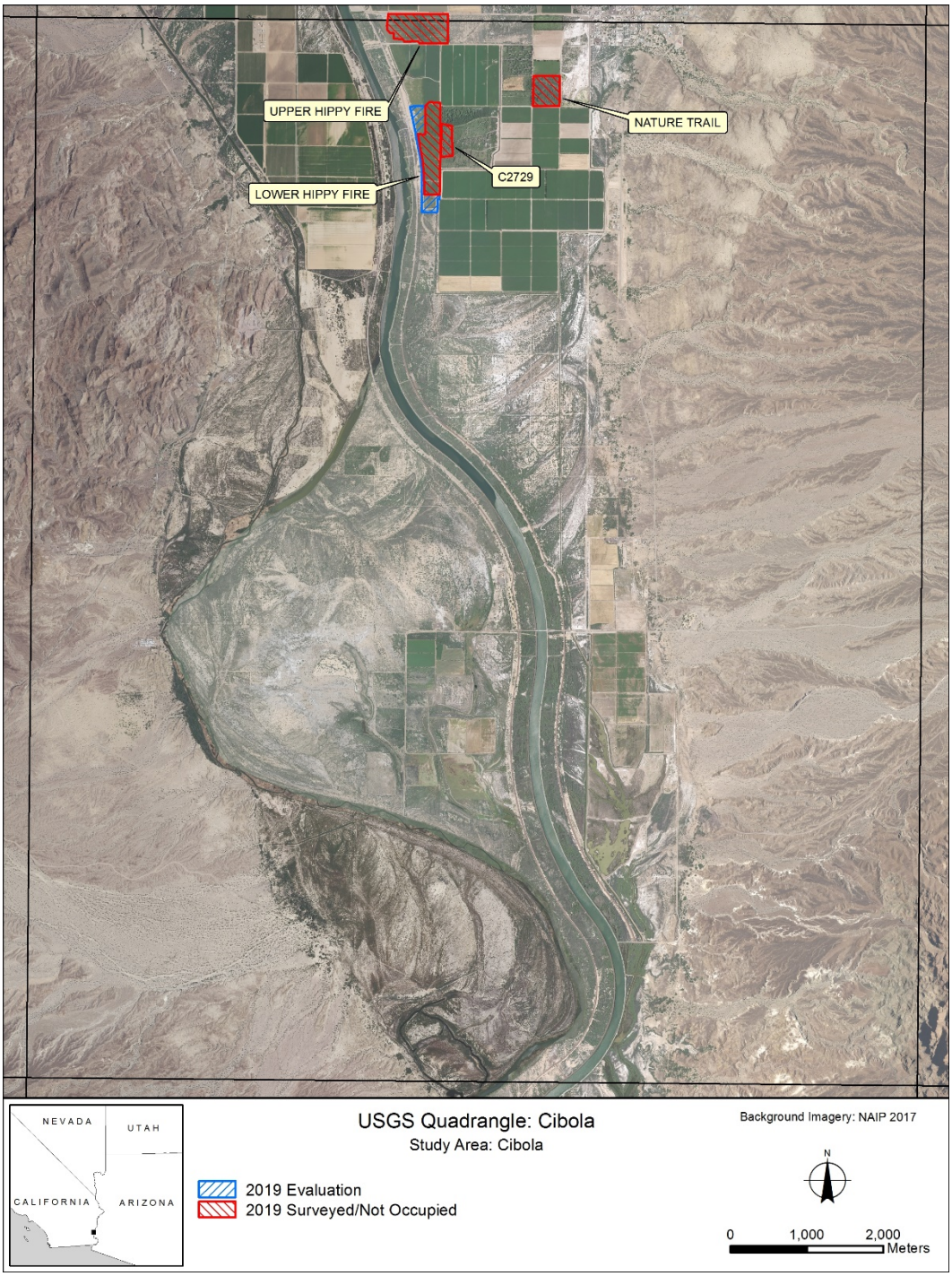
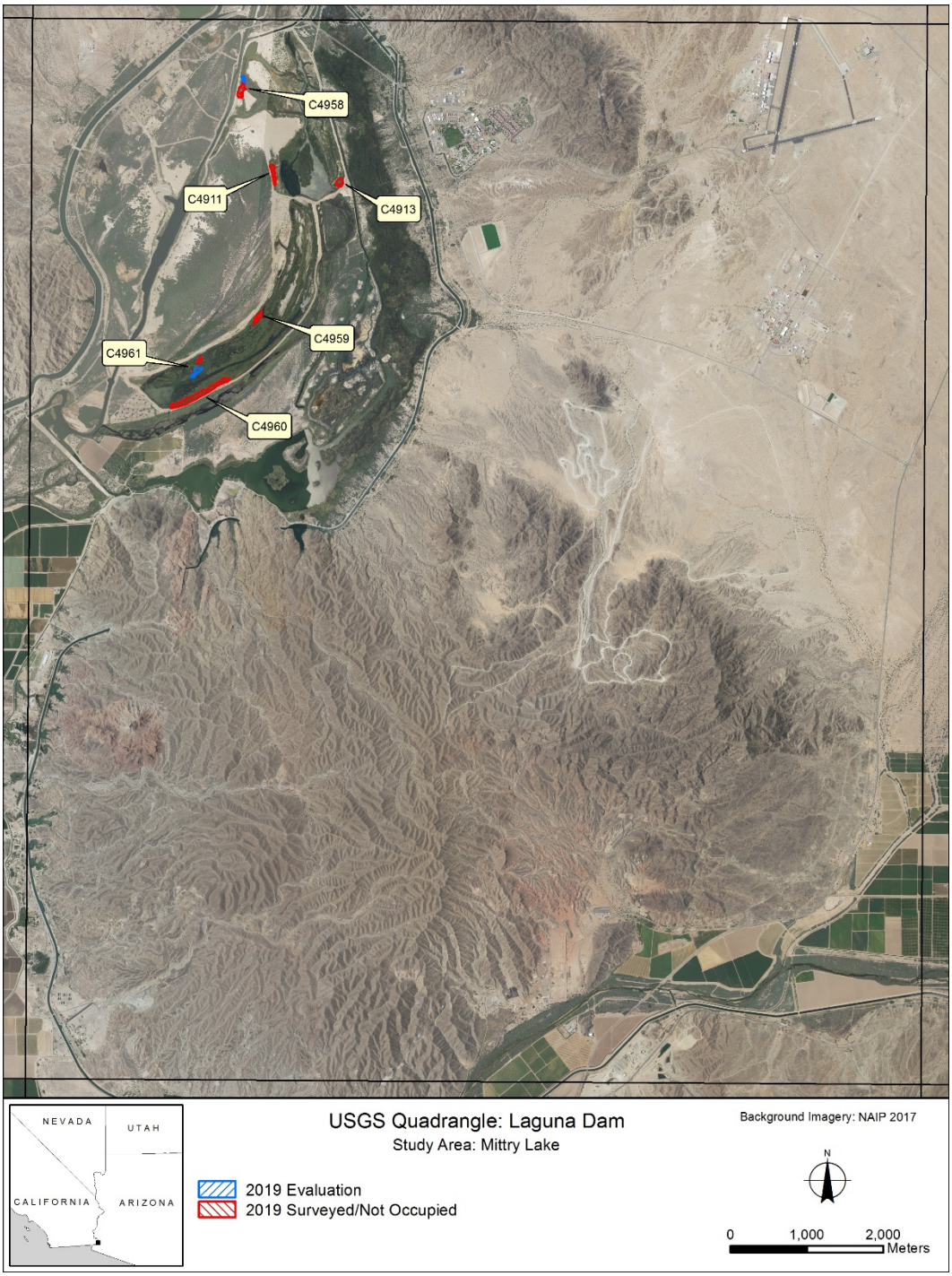
Meters


PHASE 07 BLOCK 01
PHASE 07 BLOCK 02
PHASE 06 BLOCK 01
PHASE 06 BLOCK 02
PHASE 05 BLOCK 03
PHASE 05 BLOCK 01
PHASE 05 BLOCK 01
PHASE 04 BLOCK 03
PHASE 04 BLOCK 01
PHASE 02
PHASE 03
PHASE 04 BLOCK 02
PHASE 05 BLOCK 02
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Blythe NE
Study Area: Palo Verde Ecological Reserve
2019 Surveyed/Not Occupied
Background Imagery: NAIP 2016
N
0
1,000
2,000
Meters


PHASE 01
PHASE 02
PHASE 03
PHASE 08
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Palo Verde
Study Area: Cibola
2019 Evaluation
2019 Surveyed/Not Occupied
Background Imagery: NAIP 2016
N
0
1,000
2,000
Meters


UPPER HIPPY FIRE
NATURE TRAIL
C2729
LOWER HIPPY FIRE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Cibola
Study Area: Cibola
2019 Evaluation
2019 Surveyed/Not Occupied
Background Imagery: NAIP 2017
N
0
1,000
2,000
Meters


C4958
C4911
C4913
C4959
C4961
C4960
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Laguna Dam
Study Area: Mittry Lake
2019 Evaluation
2019 Surveyed/Not Occupied
Background Imagery: NAIP 2017
N
0
1,000
2,000
Meters

C4703
C4711
C4702
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Yuma East
Study Area: Yuma
2019 Surveyed/Not Occupied
Background Imagery: NAIP 2017
N
0
1,000
2,000
Meters

Hunters Hole
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Gadsden
Study Area: Yuma
2019 Surveyed/Not Occupied
Background Imagery: NAIP 2017
N
0
1,000
2,000
Meters

ATTACHMENT 4

Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Dates for Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2019

Table A4-1.—Survey dates for southwestern willow flycatchers, 2019

Study area	Survey site	Survey dates[1]
Topock Marsh	The Wallows	May 18, June 6, June 16, July 2, July 14
	PC6-1	May 20, June 6, June 19, July 1, July 16
	800M	May 29, June 14, June 19, July 1, July 13
	Swine Paradise	May 29, June 14, June 19, July 2, July 13
	Platform	May 29, June 13, June 19, July 6, July 17
	250M	May 20/30, June 14, June 25, July 1, July 10
	Hell Bird	May 20/23, June 5/14, June 20, June 26, July 12/16
	Glory Hole	May 20/23, June 15, June 20, June 26/28, July 12/14/15
	Farm Ditch Road	May 30, June 13, June 25, July 6, July 17
	CPhase 05	May 18, June 4, June 16, June 29, July 17
	Lost Lake	June 13, June 19, July 7, July 14
	Lost Lake Slough 02	June 2, June 13, June 19, June 28, July 10
	Lost Lake Slough 03[2]	May 22, June 13, June 26, July 10
	Lost Lake Slough 04	May 22, June 13, June 19, June 28, July 10
Bill Williams	Coyote Crossing[3]	May 17, June 15, June 25
	Bill Willow[3]	May 17, June 12, June 18
	Wispy Willow	May 17/23, June 3, June 18, June 27, July 12
	Site 01	May 29, June 3, June 17, June 27, July 14
	Burn Edge[3]	May 23
	Site 04	May 15/16, June 4, June 16, June 28, July 15
	Site 03	May 15/16, June 4/5, June 18, June 28/29, July 15
	Last Gasp	May 21, June 15, June 20, July 1, July 16
	Guinness	May 19, June 5, June 20, July 1, July 16
	Site 05	May 19, June 5, June 18, June 29, July 16
	Black Rail[3]	May 19
	Site 08	May 21, June 3, June 17, June 27, July 11
	Upstream Site 08	May 21, June 3, June 17, June 27, July 11
	Planet Ranch Road	May 21, June 3, June 17, June 27, July 11
Alamo Lake[4]	Bullard Wash	May 21, June 6, June 12, July 1, July 15
	South Camp[3]	May 21, June 4
	Sidebar 01[3]	May 16
	Camp 01	May 20, June 4, June 13, July 1, July 14
	Camp 02	May 20, June 4, June 13, July 1, July 14
	Camp 03	May 20, June 6, June 13, July 1, July 14
	Middle Earth 01	May 16, June 2, June 18, June 30, July 14
	Middle Earth 02[2]	May 16/19, June 2, June 30/July 4, July 12/13/14

Table A4-1.—Survey dates for southwestern willow flycatchers, 2019

Study area	Survey site	Survey dates[1]
Alamo Lake (cont.)	Prospect 01[2]	May 16, July 15
	Burro Wash 01[2]	May 15/17, June 2/3/4, June 26/27, July 8/9
	Burro Wash 02[2]	May 29, June 5/6, June 15, June 27/28, July 10/11
	Motherlode 01	May 21, June 11, June 17, June 29, July 11
	Motherlode 02[5]	June 29, July 2
	Prospect 02[5]	July 1, July 12
	Motherlode 04	May 18, June 2, June 12, July 1, July 12
	Santa Maria North 01	May 17/18, June 1, June 19, July 3, July 16
Palo Verde Ecological Reserve	Phase 02	May 15, June 4, June 13, June 27, July 9
	Phase 03	May 15, June 4, June 13, June 26, July 10
	Phase 04 Block 01	May 16, June 5, June 14, June 29, July 11
	Phase 04 Block 02	May 16, June 3, June 14, June 28, July 11
	Phase 04 Block 03	May 16, June 5, June 14, June 28, July 12
	Phase 05 Block 01	May 29, June 5, June 12, June 25, July 4
	Phase 05 Block 02	May 30, June 5, June 12, June 25, July 4
	Phase 05 Block 03	May 23, June 3, June 12, June 25, July 4
	Phase 06 Block 01	May 28, June 11, June 18, July 3, July 17
	Phase 06 Block 02	May 28, June 11, June 19, July 1, July 17
	Phase 07 Block 01	May 19, June 9, June 16, June 30, July 13
	Phase 07 Block 02	May 19, June 10, June 17, July 2, July 16
Cibola	Phase 01	May 20, June 6, June 15, June 28, July 13
	Phase 02	May 20, June 6, June 15, June 29, July 11
	Phase 03	May 23, June 3, June 11/16, July 1, July 14
	Phase 08	May 21/22, June 1, June 12, June 29, July 15
	Upper Hippy Fire	May 17, May 31, June 11, June 26, July 9
	Nature Trail	May 17, May 31, June 11, June 27, July 10
	Lower Hippy Fire	May 18, June 2, June 13, June 30, July 12
	C2729	May 17, May 31, June 20, June 27, July 10
Mittry Lake	C4958	May 16, June 2, June 19, July 3, July 16
	C4911	May 22, June 2, June 19, July 3, July 16
	C4913	May 22, June 2, June 19, July 3, July 16
	C4959	May 16, June 2, June 18, July 3, July 15
	C4960	May 16, June 2, June 18, July 3, July 15
	C4961	May 16, June 2, June 18, July 3, July 15

Table A4-1.—Survey dates for southwestern willow flycatchers, 2019

Study area	Survey site	Survey dates[1]
Yuma	C4703	May 21, June 1, June 17, July 2, July 14
	C4711	May 21, June 1, June 17, July 2, July 14
	C4702	May 21, June 1, June 17, July 2, July 14
	Hunters Hole[6]	May 29, June 18, July 10

[1] Wherever multiple dates are separated with a slash (/), part of the site was surveyed on each date, and the dates together constitute a complete survey of the site.

[2] Site completely covered via territory monitoring for a portion of the survey season; no surveys completed during monitored period.

[3] Surveys conducted during habitat evaluation.

[4] Survey rounds at Alamo Lake consisted of both broadcast surveys and territory monitoring.

[5] Site discovered partway through breeding season with territorial flycatchers.

[6] Surveyed by Reclamation.

ATTACHMENT 5

Detections of Covered Species Within Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2019

Table A5-1.—Yellow-billed cuckoo (*Coccyzus americanus occidentalis*) detections recorded outside of LCR MSCP conservation areas during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast survey and territory monitoring activities, 2019*

Study area	Survey site	Date	Behavioral observations[1]
Topock Marsh	Glory Hole	June 20	One individual heard (CON)
		June 28	One individual heard (COO and CON; three detections)
	Lost Lake Slough 02	June 28	One individual heard (CON)
Bill Williams	Wispy Willow	June 18	One individual heard (COO)
Alamo Lake	Camp 03	July 1	One individual heard (three detections)
	Middle Earth 02	June 2	One individual heard (COO and CON; two detections)
		June 12	One individual heard (COO)
		June 14	One individual heard
	Prospect 01	June 3	One individual heard
		July 15	One individual heard
	Burro Wash 01	June 3	One individual heard
		June 14	One individual heard
		June 26	One individual heard
	Burro Wash 02	June 4	One individual heard
		June 15	One individual heard
		June 28	One individual heard
		June 29	One individual heard (two detections)
		July 9	One individual seen and heard
	Motherlode 01	June 11	One individual heard

* All individuals were detected passively, and no protocol surveys were conducted. These detections indicate the presence of the species in a given location but cannot be used to estimate population size or infer absence of the species in other locations.

[1] Vocalization codes follow those described in the standard yellow-billed cuckoo survey protocol. COO = coo call, and CON = contact call (kuk and kowlp notes).

Table A5-2.—Yuma clapper rail (*Rallus longirostris yumanensis* [also known as Yuma Ridgway's rail = *R. obsoletus yumanensis*]), detections recorded outside of LCR MSCP conservation areas during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast survey and territory monitoring activities, 2019*

Study area	Survey site	Date	Behavioral observations
Topock Marsh	250M	June 11	One individual heard (kek)
		June 25	One individual heard (kek)
	Hell Bird	June 2	One individual heard (kek)
		June 6	One individual heard (kek)
		June 11	Two individuals heard (kek)
	Glory Hole	May 23	One individual heard
		June 11	One individual heard (kek)
		June 28	One individual heard (kek)
		July 12	One individual seen
	Lost Lake Slough 02	June 13	Two individuals heard (kek)
		June 19	One individual heard (kek)
		June 28	One individual heard (kek)
	Lost Lake Slough 03	May 29	One individual heard (kek)
		June 4	One individual heard (kek)
	Near Lost Lake Slough 01[1]	May 29	Two individuals heard (kek)
			Pair heard (clatter, kek, kek-hurrah)
Bill Williams	Bill Williams River Delta[2]	May 23	One individual heard

* All individuals were detected passively, and no protocol surveys were conducted. These detections indicate the presence of the species in a given location but cannot be used to estimate population size or infer absence of the species in other locations.

[1] Detection locations north, east, and south of Lost Lake Slough 01.
[2] Detection locations along the Bill Williams River west of Wispy Willow.

Table A5-3.—Vermilion flycatcher (*Pyrocephalus rubinus*) detections recorded outside of LCR MSCP conservation areas during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast survey and territory monitoring activities, 2019*

Study area	Survey site	Date	Behavioral observations
Alamo Lake	Burro Wash 02	June 27	One adult seen
	Santa Maria North 01	May 18	One adult seen
		June 1	One male seen and heard
			Male and female seen
		June 19	One adult seen
		July 3	Male and female seen together
		July 16	Two males seen

* All individuals were detected incidentally. These detections indicate the presence of the species in a given location but cannot be used to estimate population size or infer absence of the species in other locations.

Table A5-4.—Gilded flicker (*Colaptes chrysoides*) detections recorded during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast survey and territory monitoring activities, 2019*

Study area	Survey site	Date	Behavioral observations
Palo Verde Ecological Reserve	Phase 05 Block 01	June 12	One female seen

* All individuals were detected incidentally. These detections indicate the presence of the species in a given location but cannot be used to estimate population size or infer absence of the species in other locations.

ATTACHMENT 6

Contributing Personnel

Contributor	Role
Mary Anne McLeod, M.S.	Project Manager/Scientific Investigator/Field Supervisor
Anne Pellegrini, M.S.	Project Coordinator/Scientific Investigator/Field Supervisor
Clay Donaldson	Collector, Survey123, and ArcGIS Online Specialist
Glenn A. Dunno, M.A.	Geographic Information System Specialist
Jacque Muehlbauer	Project Administrator
Dorothy A. House, M.A.	Technical Editor
George Cummins, M.S.	Roving Coordinator
Sarah Nichols	Roving Coordinator
Valarie Haworth	Site Coordinator
Alaina Lamb, M.S.	Site Coordinator
Julie Webber, M.P.A.	Site Coordinator
Cédric Duhalde	Field Technician
Zachary Emery	Field Technician
Lauren Strong	Field Technician