Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Southwestern Willow Flycatcher Surveys, Demography, and Ecology Along the Lower Colorado River and Tributaries

2013–2017 Summary Report

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BUREAU OF RECLAMATION

May 2019

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National Park Service
Bureau of Land Management
Bureau of Indian Affairs
Western Area Power Administration

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Ducks Unlimited
Lower Colorado River RC&D Area, Inc.
The Nature Conservancy

Lower Colorado River Multi-Species Conservation Program

Southwestern Willow Flycatcher Surveys, Demography, and Ecology Along the Lower Colorado River and Tributaries

2013–2017 Summary Report

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ACRONYMS AND ABBREVIATIONS

AICc	small-sample-size corrected Akaike's information criterion
ALAM	Alamo Lake study area
ANOVA	analysis of variance
BA	biological assessment
BBIRD	Breeding Biology Research and Monitoring Database
BO	biological opinion
BIWI	Bill Williams study area
CI	confidence interval
cfs	cubic feet per second
CIBO	Cibola study area
CJS	Cormack-Jolly-Seber
cm	centimeter(s)
cont.	continued
cottonwood-willow	Fremont cottonwood(s) (*Populus fremontii*)-Goodding's willow(s) (*Salix gooddingii*)
cowbird	brown-headed cowbird(s) (*Molothrus ater*)
CVCA	Cibola Valley Conservation Area
DSR	daily survival rate
EHRE	Ehrenberg study area
FR	Federal Register
GOF	goodness of fit
GPS	Global Positioning System
GRCA	Grand Canyon study area
ha	hectare(s)
HCP	Habitat Conservation Plan
IMPE	Imperial study area
KEPI	Key Pittman study area
km	kilometer(s)
LCI	lower confidence interval
LCR	lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
LIFI	Littlefield study area
LVWA	Las Vegas Wash study area
m	meter(s)
MESQ	Mesquite study area
MITT	Mittry Lake study area
MLE	mean life expectancy
MOME	Mormon Mesa study area
mm	millimeter(s)
MSP	Mayfield survival probability
MUDD	Muddy River study area

MVWA	Meadow Valley Wash study area
n	sample size
NDOW	Nevada Department of Wildlife
OR	odds ratio
p	detection probability(ies)
Pa	Pascal(s)
PAHR	Pahranagat study area
PVER	Palo Verde Ecological Reserve study area
QAICc	quasi-likelihood adjusted AICc
Reclamation	Bureau of Reclamation
RH	relative humidity
RIRA	River Ranch study area
SE	standard error
SNWA	Southern Nevada Water Authority
sp.	single unidentified species
spp.	unidentified multiple species in a genus
STGE	St. George study area
SWCA	SWCA Environmental Consultants
T	temperature
TES	threatened, endangered, and sensitive
TOGO	Topock Gorge study area
TOPO	Topock Marsh study area
UCI	upper confidence interval
UDWR	Utah Division of Wildlife Resources
USFWS	U.S. Fish and Wildlife Service
UTM	Universal Transverse Mercator
VP	vapor pressure
WE	willow flycatcher egg
wet soils	inundated or saturated soils
WMSP	Warm Springs study area
YUMA	Yuma study area

Symbols

~	approximately
x	by
°C	degrees Celsius
Δ	difference
=	equal to
>	greater than
≥	greater than or equal to
λ	lambda; annual per capita rate of population change
<	less than
<<	much less than
≤	less than or equal to
#	number
%	percent
φ	survival probability(ies)
–	to
^	to the power of

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Attachments

Attachment

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

2 Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Results for Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2013–2017

3 Orthophotos Showing Study Sites

4 Summary of Hydrologic Conditions by Survey Site, 2013–2017

5 Orthophotos Showing Reconnaissance Sites, 2013–2017

6 Detections of Covered Species Within Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2013–2017

7 Orthophotos of Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) Survey Sites, 2013–2017

8 All Willow Flycatchers (*Empidonax traillii*) Color Banded and/or Resighted, 2013–2017

9 Candidate Model Sets Considered in Program MARK in Nest Survival Analysis

10 Contributing Personnel

EXECUTIVE SUMMARY

The southwestern willow flycatcher (*Empidonax traillii extimus*),[1] listed as federally endangered in 1995, 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 (Unitt 1987). Historical breeding records and museum collections indicate a sizable population of flycatchers may have existed along the extreme southern stretches of the lower Colorado River (LCR) region. 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). Tamarisk beetles (*Diorhabda* spp.) pose an additional threat to flycatchers. Tamarisk beetles defoliate tamarisk (*Tamarix* spp.) plants during flycatcher breeding season, likely exposing flycatcher nests to adverse microclimate conditions and increased risk of depredation and parasitism.

Flycatcher studies, including surveys, nest monitoring, and banding, have been conducted along the LCR and its tributaries annually since 1996 in compliance with requirements set forth by the U.S. Fish and Wildlife Service regarding Bureau of Reclamation (Reclamation) routine operations and maintenance along the LCR. Biological assessments and the resulting biological opinions on operations and maintenance were prepared as steps in developing a Lower Colorado River Multi-Species Conservation Program (LCR MSCP) for long-term endangered species compliance and management in the historical flood plain of the LCR. The documents for the LCR MSCP were signed in April 2005, and implementation of the program began in October 2005. The LCR MSCP calls for continued surveys and monitoring of flycatchers along the LCR.

Annual flycatcher studies were completed in 1996–2002 by the San Bernardino County Museum and in 2003–12 by SWCA Environmental Consultants (SWCA). SWCA was contracted by Reclamation to continue surveys, monitoring, and demographic and ecological studies of flycatchers in suitable and/or historical riparian and wetland habitats throughout the LCR region and along its tributaries in 2013–17. Studies in 2014–17 were originally intended to include the Virgin River, but per Reclamation's direction, no surveys were conducted in any study area along the Virgin River in those years, and effort that would have been spent on the Virgin River was redirected to the Alamo Lake study area (ALAM), Arizona, and the Meadow Valley Wash study area (MVWA), Nevada, and to supplement other survey and monitoring efforts in the Pahranagat Valley and in St. George, Utah.

[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*.

SWCA was retained by the Nevada Department of Wildlife (NDOW) in 2013–16 to conduct flycatcher broadcast surveys, site descriptions, nest monitoring, and color banding in the Pahranagat Valley at the Key Pittman study area (KEPI) in the Key Pittman Wildlife Management Area, the River Ranch study area (RIRA), and the Pahranagat study area (PAHR) in the Pahranagat National Wildlife Refuge. The Southern Nevada Water Authority retained SWCA to conduct similar work at the Warm Springs study area (WMSP) in the Warm Springs Natural Area in 2013–17. Broadcast surveys were also completed for yellow-billed cuckoos (*Coccyzus americanus occidentalis*) at RIRA, PAHR, and WMSP.

The NDOW monitored flycatchers at MVWA in 2013, at KEPI and RIRA in 2017, and at the Mesquite study area (MESQ) and the Mormon Mesa study area (MOME) along the Virgin River in 2015–17. SWCA personnel volunteered for the NDOW to assist in these efforts via occasional territory visits, which included resighting, nest monitoring, and banding, and reviewing resight and nest record data. Data collected by and in cooperation with the NDOW are reported here to provide a more continuous dataset for these study areas.

Approximately 100 sites are included in the Reclamation study of flycatchers along the Virgin and lower Colorado Rivers, but starting in 2013, a portion of the sites were surveyed triennially rather than annually. Sites on the triennial schedule were surveyed in 2015. In each year in 2013–17, SWCA searched for nests in all areas known to be occupied by territorial flycatchers; monitored flycatcher nests to document nest fate, brood parasitism, and causes of nest failure; and color banded and resighted as many willow flycatchers as possible to determine the breeding status of territorial flycatchers and to document movement and recruitment.

Across all contracts in 2013–17, SWCA surveyed and/or monitored 68 to 116 sites in each year along the Virgin and lower Colorado Rivers and tributaries, from Caliente, Nevada, south to Yuma, Arizona, with a total of 136 sites in 18 study areas across all years. Recorded broadcasts of flycatcher song and calls were used to elicit willow flycatcher responses at all sites, or portions of sites, that were not known to be occupied by flycatchers at the time of the survey. Broadcast surveys were conducted in 52 to 97 sites in 11 to 16 study areas in each year. Field personnel spent 390.0 to 479.8 observer-hours conducting the flycatcher broadcast surveys in each season. An additional 3 to 19 sites were entirely encompassed by active flycatcher territories throughout a given survey season, and field personnel completed territory and nest monitoring but no broadcast surveys at those sites in that year. Breeding flycatchers were detected within the following study areas: KEPI, RIRA, PAHR, MVWA, MESQ, MOME, Muddy River (MUDD), and WMSP, Nevada; and Topock Marsh (TOPO), Bill Williams (BIWI), and ALAM, Arizona. Two resident (i.e., detected for at least 7 days) but non-breeding flycatchers were detected at the Palo Verde Ecological Reserve (PVER) study area, California: one in 2015 and one in 2016.

Many additional willow flycatcher detections were recorded south of Parker Dam in each year, but behavioral observations and subsequent surveys suggest these willow flycatchers were not resident individuals but were most likely spring migrants.

The number of flycatcher and willow flycatcher adults detected annually in 2013–17 ranged from 172 in 2013 to 300 in 2015. The study areas and sites included in surveys and monitoring varied among years, and this affected the numbers of flycatchers and willow flycatchers detected. The total number of resident, adult flycatchers detected in each year ranged from 99 in 2013 to 200 in 2017 and was strongly influenced by the addition of ALAM in 2014. Of the study areas where resident flycatchers were detected during every monitoring year, PAHR had the most stable population and BIWI had the least stable population. The number of resident, adult flycatchers detected annually declined steadily at KEPI and MOME and increased steadily at MVWA and MESQ. The number of resident flycatchers detected at ALAM in 2017, when most of the study area was flooded, was 50–100% greater than the number detected in each of the three previous seasons when all sites had dry soils. The primary influence on the number of resident flycatchers detected annually within each study area in 2013–17 appeared to be habitat quantity and quality.

Broadcast surveys were completed for yellow-billed cuckoos at RIRA, PAHR, and WMSP. Yellow-billed cuckoos were detected on one occasion at RIRA and on multiple occasions at PAHR and WMSP. In 2016, a yellow-billed cuckoo was recorded on multiple occasions in the same general area at WMSP, and these detections qualified as a probable breeding territory, per the guidelines in the yellow-billed cuckoo survey protocol. No probable breeding territories were confirmed in any other study area in any other year.

Targeted mist net and passive netting techniques were used to capture and uniquely color band adult and fledgling flycatchers at all sites where resident flycatchers were detected. Nestlings were banded between 7 and 10 days of age. Individuals were banded with a single, numbered U.S. Federal band on one leg and one metal color band on the other. 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.

From 2013 to 2017, field personnel captured and banded 143 flycatcher and willow flycatcher adults and 297 flycatcher juveniles, 33 of which were known or suspected to have died before fledging. The proportion of resident adult flycatchers that were known to be banded varied among study areas. More than 80% of resident adults at KEPI, RIRA, PAHR, MVWA, MUDD, WMSP, and PVER had bands in most years, while a much smaller proportion of the resident, adult population was banded at MESQ, MOME, TOPO, BIWI, and ALAM.

Differences among study areas in the percentage of resident flycatchers that were banded were typically related to vegetation density and structure, which affect the ability of field personnel to capture flycatchers. The proportion of juveniles that were banded at most study areas was dictated largely by the accessibility of nests.

In 2013–17, 278 between-year returns were detected for adult flycatchers. The majority (90%) of these were of flycatchers returning to the same study area where they were last detected in a previous year. Of the 27 returns that resulted in movements between study areas, 25 were by flycatchers that had failed to produce young in the previous year. The distance moved between years for all adult flycatchers ranged from 0.001 to 213.71 kilometers (km) (median = 0.04 km). In 2013–17, 73 flycatchers were detected for the first time since they were banded as juveniles. Of these, 39 (53%) returned to their natal study area and 34 (47%) dispersed to a different study area. Except for one dispersal from ALAM to PAHR, all juvenile dispersal distances were < 60 km. The median dispersal distance for all returning juvenile flycatchers was 3.8 km and was greater than the median between-year movement distance for adult flycatchers (0.04 km; Kruskal-Wallis test, $P < 0.001$). Field personnel detected within-year, between-study-area movements from 13 adult flycatchers in 2013–17. Eight of the movements were by flycatchers leaving either RIRA or KEPI and going to PAHR. Six of the 13 flycatchers were detected in a subsequent year, and all were detected at the study area (PAHR) where they had been last seen in the previous year.

Flycatcher survival rates between 1997 and 2017 were estimated using Cormack-Jolly-Seber (CJS) live encounter models, which were analyzed using a maximum likelihood method within Program MARK. A candidate list of 45 *a priori* models were compared using small-sample-size corrected Akaike information criterion (AICc) values generated in Program MARK. These models allowed survival probabilities (φ) to vary by a combination of age and year, while detection probabilities (p) were allowed to vary by different combinations of age, year, marking cohort, and resight period. Gender was not included in these models because data are too sparse. Age was divided into two categories: juveniles (flycatchers banded in the nest or as recently fledged young) and adults. Year was included to allow survival and detection probabilities to vary through time. The marking cohort variable was included to account for differences in methodology across the 21 years of this analysis. This was done by constraining detection probabilities into three cohorts of banded individuals, corresponding to three contract periods using differing marking methodologies: 1997–2002, 2003–07, and 2008–17. Resight period was included to account for differences in resighting effort between 2014 and 2017 at study areas within the Virgin Valley and at ALAM. This analysis gives a global overview of flycatcher survival along the LCR and its tributary watersheds. Estimates of annual survival for adult and juvenile flycatchers were used to calculate mean life expectancy.

Probability of survival varied by age, with annual adult survival probability (59.5%) being significantly higher than that of juveniles (30.3%). The mean life expectancy for flycatchers, calculated from survival probabilities, was 1.17 years. Probability of detection varied by age, resight period, and marking cohort. The detection probability for adults was significantly higher than that for juveniles in all cohort-by-resight-period combinations. The detection probability of each age class was higher in the most recent cohort compared with the first two cohorts, indicating that marking methodologies may have a strong effect on detectability. The highest detection probabilities were obtained when adults were marked with metal color bands (rather than plastic bands) and when juveniles were marked with a full color combination rather than with just a Federal band. There was no significant difference in detectability between the two resight periods for adults in cohort three.

Survival analysis models were also created for three local geographic regions to explore differences among these regions and to provide survival estimates for use in calculating the annual per capita rate of population change (i.e., lambda [λ]). A constant project area size is needed to calculate λ, and changes to the project area extent occurred in 2014 and again in 2017. Survival analysis models by region were therefore limited to the following: the Pahranagat Valley (PAHR, RIRA, and KEPI) in 2011–16, PAHR in 1998–2017, and the Havasu region (TOPO and BIWI) in 1998–2017. The Pahranagat Valley had the highest survival probabilities, with juvenile survival of 30–42% (95% confidence interval [CI] 18–55%) and adult survival of 60–71% (95% CI 47–82%). PAHR had lower survival probabilities, with 20% juvenile survival (95% CI 15–26%) and 59% adult survival (95% CI 54–64%). Juvenile survival was 23% in the Havasu region (95% CI 14–35%), while adult survival was 48% (95% CI 41–55%).

A reduced dataset, consisting of all individuals that had a known gender and were detected as adults, was used to test whether one gender had higher survival than the other. A relatively simple model set of four models was created, using gender as a grouping variable within Program MARK. Survival probabilities were held constant or allowed to differ by gender, and detection probabilities were held constant or allowed to vary by the full interaction between cohort and resight period. These models revealed little difference between male and female survival.

The effects of fledge date, length of the nestling stage (as a proxy for fledgling mass), and local drainage on juvenile survival were examined using a reduced dataset consisting only of individuals banded as nestlings or recently fledged young. Survival probability in each of the top four models varied by fledge date, whereas there was inconsistent support for effects of drainage and nestling stage length. Survival probability decreased with increasing fledge date, corresponding to a 21% reduction in survival probability between June 30 and August 1. The mean fledge date across all years was July 17, which corresponded to a survival probability of 30%.

Estimates of recruitment were generated from Pradel models in Program MARK, and λ was calculated using the adult and juvenile survivorship estimates from Program MARK CJS models, seasonal fecundity estimates obtained from nest monitoring, and the recruitment estimates. Population trends were also calculated for comparison with λ estimates. The top Pradel model in each geographic region indicated that recruitment was constant across time. Recruitment in the Pahranagat Valley from 2011 to 2016 was 0.37, at PAHR between 1998 and 2017 was 0.39, and in the Havasu region between 1997 and 2017 was 0.54. The Pahranagat Valley showed a slightly increasing population trend with overall λ of 1.031. PAHR showed a slight population decline (λ = 0.982), and Havasu showed a slightly increasing trend (λ = 1.018). Immigration into the Havasu region was 2.4–3.7 times higher than in the other regions and accounted for 42% of the annual rate of population change. Immigration in the other two regions accounted for 11–18 % of the annual rate of population change.

The results of linear regressions indicated a small annual rate of change (-1.007%) and a weak, non-significant trend ($r^2 = 0.080$, $P = 0.228$) at PAHR from 1998 to 2017. The entire Pahranagat Valley had an annual rate of change of -3.440% from 2011 to 2016 and a moderate, non-significant trend ($r^2 = 0.315$, $P = 0.246$). Declines in the Pahranagat Valley may be driven by a declining population at KEPI. Results in the Havasu region from 1998 to 2017 also indicated a declining population, with an annual rate of change of -5.588% and a significant moderate trend ($r^2 = 0.381$, $P = 0.004$). Given the arrival of tamarisk beetles at TOPO and BIWI, coupled with habitat declines as the result of fires at TOPO and lack of streamflow at BIWI, the declining population trend in the Havasu region seems unlikely to reverse in the near future.

The λ estimates appear to be overestimating the rate of population growth in comparison to the annual number of resident adults documented in each region. One explanation may be the difference between the observed number of resident adults and the data used by Program MARK to calculate recruitment rates. Pradel models rely on the number of "newly marked" adults on a given occasion (year) to determine the rate of recruitment from one occasion to the next. Newly marked adults can consist of newly captured (i.e., previously unbanded) adults or returning juveniles identified for the first time as adults. The between-year change in number of newly marked individuals does not always reflect the corresponding change in the total number of resident adults, particularly in areas where many adults are unbanded. The λ estimates, as calculated through methods such as Pradel models, have also been demonstrated to have a significant positive bias at small sample sizes (< 100 individuals) with low survival probability (≤ 50%). Although the Pradel models may overestimate λ, they also help inform a greater understanding of the underlying demographic processes driving rates of population change.

A total of 466 flycatcher nesting attempts were documented by SWCA and the NDOW at KEPI, RIRA, PAHR, MESQ, MOME, MVWA, MUDD, TOPO, BIWI,

and ALAM in 2013–17; 417 of these nests were known to contain flycatcher eggs and were used in calculating nest success and productivity. A total of 189 (45%) nests were successful and fledged young, 193 (47%) failed, and 35 (8%) had an unknown fate. At all study areas in 2013–17, 401 nestlings were confirmed to have fledged from 382 nests of known outcome. Average fecundity in 2013–17 was < 1.0 at KEPI, MESQ, MOME, MUDD, and TOPO; ≥ 1.0 but < 2.0 at RIRA, PAHR, BIWI, and ALAM; and ≥ 2.0 at MVWA and WMSP.

Of all the study areas monitored for over 5 years, PAHR was the most consistently productive, with annual fecundity never dropping below 1.33 in 2003–17. MVWA was monitored only during 2013–17 and had far fewer flycatcher pairs than PAHR but had similar fecundity. KEPI showed a strong and relatively consistent decline in fecundity over the 2010–17 monitoring period, particularly in 2013–16. The number of young produced per female flycatcher at MESQ was typically between 1.0 and 2.0 in 2003–08 and then declined to 0.0 in 2012 and 2013 before recovering somewhat to values ≤ 1.0 in 2015–17. Fecundity at MOME was consistently > 1.0 but < 2.0 in 2008–11 but then dropped to 0.14 in 2013. In 2015–17, fecundity at MOME varied from 0.0 to 2.0. Fecundity was < 1.0 in most years at MUDD and was highly variable at WMSP. TOPO showed highly variable fecundity, particularly in 2009–17 when very few flycatcher pairs were detected. No flycatcher young were produced at TOPO in 2011–13 or 2016–17. Fecundity at BIWI varied generally between 0.5 and 1.5, although no young were produced in 2012–13 or 2017. No long-term nest monitoring data were available for ALAM, but fecundity varied from 0.42 in 2014 to approximately 1.5 in 2015 and 2017.

The effects of several covariates on nest survival were modeled in Program MARK. Of the individual covariates used to model nest survival, nest substrate, along with age of the nest and year, were the most important. Despite the tendency of flycatchers to nest close to water, the amount of saturated or inundated soils (hereafter wet soils) within 50 meters (m) of the nest did not have a strong influence on nest survival. The significance of nest substrate in the model may in part be attributable to correlations between this variable and the vegetation and environment of the local area. Nest survival varied with year but did not show a steady trend in one direction. Nest age, however, played a steady role in nest survival, with survival decreasing with increasing nest age. Depredation was the leading cause of nest failure, and decreasing survival over time may indicate that flycatcher nests become more obvious to predators as the young grow older.

Fifty-two (14%) of 359 nests with flycatcher eggs and known parasitism status were brood parasitized by cowbirds. Parasitism rates were 0% at MVWA and WMSP, < 10% at PAHR and ALAM, > 10% but < 25% at KEPI and BIWI, and > 25% at RIRA, MESQ, MOME, MUDD, and TOPO. Between 2013 and 2017, unparasitized nests were more likely than parasitized nests to fledge flycatcher young. SWCA attempted to addle cowbird eggs, via vigorous shaking, in easily

accessible flycatcher nests at all study areas in 2013–15 and at study areas in Nevada in 2016–17. At Arizona study areas in 2016–17, cowbird eggs were either addled or replaced with artificial cowbird eggs. Field personnel shook 1 cowbird egg in each of 22 nests in 2013–17. Cowbird eggs that were shaken were less likely to hatch than those that were not, but despite reducing the hatch rate of cowbird eggs, addling did not have any significant effect on apparent nest success. Nearly 40% of nests where cowbird eggs were shaken were ultimately depredated, and high depredation rates may obscure any positive effects of addling cowbird eggs.

Defoliation of tamarisk by tamarisk beetles, and in some cases the subsequent dieback of the tamarisk, has been observed at multiple study areas where flycatchers nest in stands with a significant tamarisk component. Defoliation is expected to have adverse effects on nesting flycatchers, and other riparian obligate birds, via increased solar radiation at nests, increased visibility of nests that leads to depredation or parasitism, and increased nest abandonment and desertion. In 2013–17, in tamarisk-dominated sites at TOPO, BIWI, and ALAM, nests at which defoliation occurred during building, laying, and/or incubation were less likely to fledge young (0 of 13 nests) than were nests at which defoliation did not occur during these nest stages (22 of 38 nests).

Soil moisture characteristics were recorded at 405 nests in 2013–17 at KEPI (88 nests), RIRA (8 nests), PAHR (64 nests), MVWA (17 nests), MUDD (24 nests), WMSP (3 nests), TOPO (18 nests), BIWI (22 nests), and ALAM (161 nests). Descriptions included conditions of soil moisture at the nest (inundated, saturated, damp, or dry), depth of water (if any) at the nest, distance to wet soil from the nest, and the percent of the area within 20 and 50 m of the nest that contained wet soils. Average soil moisture characteristics across all years at the KEPI, RIRA, PAHR, and MVWA study areas all showed general drying trends between May 15 and August 15. At KEPI and PAHR, the strong seasonal trends in surface hydrology observed at nests corresponded with seasonal trends in surface hydrology observed within the study area in general. At MUDD, the only strong variation noted was a seasonal increase in average water depth from 0 centimeters (cm) in late May to 70 cm in early August and an increase in the proportion of nests over standing water, suggesting that nests that were active in late June and early July were directly over the river channel, whereas some nests earlier in the season were in vegetation adjacent to the channel. At TOPO, no seasonal trends in surface hydrology were apparent in the data, although marsh levels declined gradually over each breeding season. Weak seasonal trends in surface hydrology were apparent at BIWI, with slight increases in distance to wet soils and slight decreases in the percentage of wet soils. Almost all nests at BIWI in 2013–17 were in sites where water levels depend on the level of Lake Havasu, which fluctuated but showed no trend during the summer months of each year. ALAM was the driest study area with breeding flycatchers in 2014–16, with no

wet soils within 50 m of any nest. In 2017, ALAM was the wettest study area with breeding flycatchers, with most nests being over standing water throughout the breeding season.

Soil moisture conditions were described at 161 nests found during building at KEPI, RIRA, PAHR, MVWA, MUDD, WMSP, TOPO, and BIWI in 2013–17. Data were collected within 7 days of the nests being found. Of these nests, 72% were located over wet soils, 25% were located > 0 m and < 30 m from wet soils, 2% were 30–60 m from wet soils, and 2% were > 100 m from wet soils. The mean percentage of wet soils within 20 and 50 m of a nest was lower in early July than earlier in the breeding season, but the distance to wet soils did not change significantly through the season. These results suggest that proximity to wet soils may be more important than abundance of wet soils for nest site selection.

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 within 2 and 5 m of the nest, was recorded at 383 flycatcher nests in 2013–17. Nests were built in coyote willows (*Salix exigua*) (26%), Goodding's willows (*S. gooddingii*) (40%), Fremont cottonwoods (*Populus fremontii*) (3%), tamarisk (30%), velvet ash (*Fraxinus velutina*) (1%), Indian hemp (*Apocynum cannabinum*) (< 1%), palms (*Washingtonia* sp.) (< 1%), and downed branches (< 1%). The three most common vegetation types at nests in 2013–17 were > 75% Goodding's willow (37% of nests), > 75% coyote willow (22% of nests), and > 75% tamarisk (12% of nests). In vegetation types with a mix of tamarisk and coyote and/or Goodding's willow, 75% of nests were located in a tamarisk substrate. No tamarisk vegetation was present within 5 m of any nest at RIRA or PAHR in any year. Of the study areas with tamarisk present near a nest location, KEPI, MVWA, WMSP, and ALAM had low median percentages of tamarisk within 5 m of flycatcher nests (0, 10, 10, and 5%, respectively) while MUDD, TOPO, and BIWI had higher median percentages of tamarisk within 5 m of nests (60, 80, and 100%, respectively).

A temperature/humidity data logger was deployed at a subset of flycatcher nests that were confirmed to have progressed beyond the laying phase. These loggers recorded data every 30 minutes and remained in place until the end of the breeding season. Temperature and humidity were recorded at 4 nests at MOME, 6 nests at MUDD, 11 nests at TOPO, 17 nests at BIWI, and 112 nests at ALAM. The rise of Alamo Lake between the breeding seasons of 2016 and 2017 had a clear effect on the microclimate at flycatcher nests in sites that were dry in 2016 but inundated in 2017. Both diurnal and nocturnal vapor pressure were approximately 500 Pascals higher in 2017 than in 2016. Minimum nocturnal temperatures were approximately 5 degrees Celsius (°C) higher in 2017 than in 2016, likely because of the moderating thermal influence of the lake water, which was quite warm.

Across all study areas, the average maximum diurnal temperatures at flycatcher nests in the second half of June and in July, when many nests were in the incubation stage, approached the temperature (41 °C) above which eggs may experience embryonic mortality, even for short exposure periods. At TOPO, BIWI, and ALAM, maximum diurnal temperatures were markedly higher, in respect to those recorded at nearby weather stations, during periods of defoliation than in years prior to the arrival of tamarisk beetles. These data suggest that defoliation resulted in increases in maximum temperatures at flycatcher nests.

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).

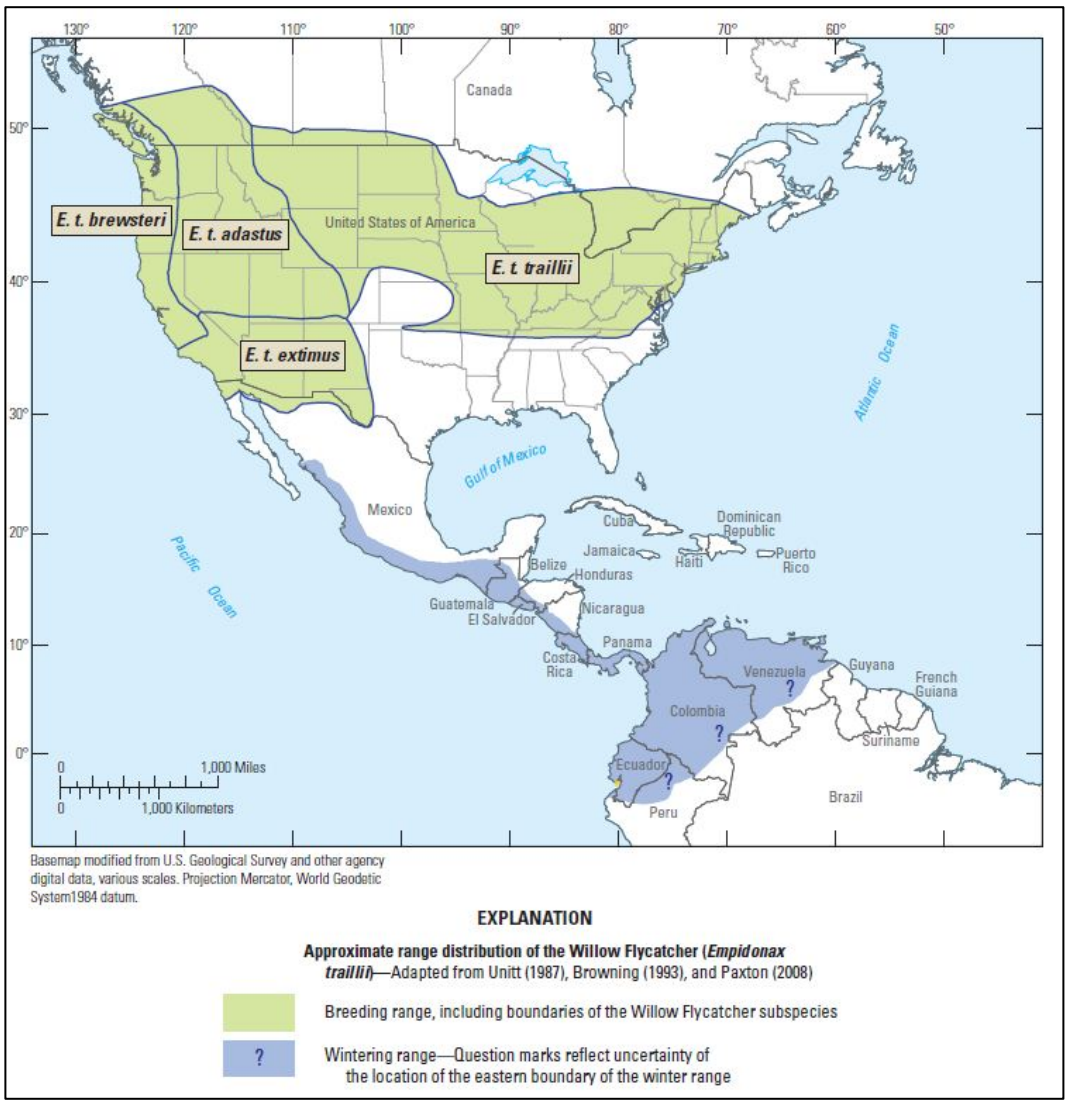

Figure 1-1.—Breeding range distribution of the subspecies of the willow flycatcher (*Empidonax traillii*).
From Sogge et al. (2010).

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. 2006b).

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). However, no nests have been located along the LCR south of the Bill Williams River, Arizona, in over 65 years (Unitt 1987), though northbound and southbound migrant willow flycatchers use the riparian corridor (Brown et al. 1987; McKernan and Braden 2002; McLeod et al. 2008; McLeod and Pellegrini 2013; this document; Phillips et al. 1964). 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 rangewide, identifying and conserving flycatcher breeding sites is thought to be crucial to the recovery of the subspecies (USFWS 2002).

Tamarisk beetles (*Diorhabda* spp.) pose an additional threat to flycatchers. Tamarisk beetles defoliate tamarisk (*Tamarix* spp.) plants during flycatcher breeding season, likely exposing flycatcher nests to adverse microclimate conditions and increased risks of depredation and parasitism. 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,

[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*.

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 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 (M.A. McLeod, personal observation; L. Harter 2016, personal communication; 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. 2018). Tamarisk beetles (*D. carinulata* and *D. sublineata*) are also present on the Rio Grande in Texas and New Mexico, and in 2016, beetles arrived at breeding areas that support large numbers of flycatchers at Elephant Butte Reservoir, New Mexico (D. Moore 2016, 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 flood plain 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, the breeding status of pairs, nest success, 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 to 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 BO also required implementation of a study to evaluate the effectiveness of cowbird trapping for conservation of the flycatcher.

Trapping was completed at several study areas in 2003–07 (McLeod et al. 2008), and post-trapping monitoring continued through 2012 (McLeod and Pellegrini 2013).

Reclamation and the USFWS completed a separate consultation on the potential effects to threatened and endangered species from implementation of surplus guidelines (i.e., water management actions in years when water supply exceeds consumptive use requirements) through 2016 and an annual change in the point of diversion for up to 400,000 acre-feet of water for 75 years. A Biological Opinion for Interim Surplus Criteria, Secretarial Implementation Agreements, and Conservation Measures was issued in January 2001. It required monitoring of 150.5 hectares (ha) of existing, occupied flycatcher habitat between Parker and Imperial Dams. Annual monitoring of groundwater levels, vegetation, soil moisture, temperature, and humidity was completed in 2005–12 (McLeod and Pellegrini 2013).

The LCR MSCP is a 50-year program that seeks to protect 27 species, most of which are 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 2003–17 by SWCA Environmental Consultants (SWCA). Breeding flycatchers have been documented in at least 1 year at 10 study areas along the Virgin and lower Colorado Rivers and tributaries: (1) Pahranagat (PAHR), in the Pahranagat Valley, Nevada; (2) Meadow Valley Wash (MVWA), between Caliente and Carp, Nevada; (3) Littlefield (LIFI), along Beaver Dam Wash near Littlefield, Arizona; (4) Mesquite (MESQ) and (5) Mormon Mesa (MOME), on the Virgin River, Nevada; (6) Muddy River (MUDD), along the Muddy River near Overton, Nevada; (7) Grand Canyon (GRCA), on the LCR between Separation Canyon and Lake Mead, Arizona; (8) Topock Marsh (TOPO), on the LCR, Havasu National Wildlife Refuge, Arizona; (9) Bill Williams (BIWI), along the Bill Williams River, Arizona; and (10) Alamo Lake (ALAM), Arizona (Braden and McKernan 2006; McLeod et al. 2008; McLeod and Pellegrini 2013; this document). The flycatcher studies also included presence/absence broadcast surveys in

several other study areas: Topock Gorge (TOGO), along the LCR between Topock Marsh and Lake Havasu, Arizona and California; Palo Verde Ecological Reserve (PVER), within the Palo Verde Ecological Reserve conservation area north of Blythe, California; Ehrenberg (EHRE), along the LCR south of Ehrenberg, Arizona; Cibola (CIBO), along the LCR in and around the Cibola National Wildlife Refuge, Arizona and California; Imperial (IMPE), along the LCR in and around the Imperial National Wildlife Refuge, Arizona and California; Mittry Lake (MITT), along the LCR north of Yuma, Arizona and California; and Yuma (YUMA), along the LCR between Yuma and the Southerly International Boundary with Mexico and along the Gila River between Yuma and Dome, Arizona. From 1997 to 2017, willow flycatchers, including two banded migrant flycatchers (Koronkiewicz et al. 2006a; McLeod and Pellegrini 2012) and two resident flycatchers (i.e., flycatchers that were detected for at least 7 days; McLeod and Pellegrini 2017a, 2017b), were detected during the breeding season at sites along the LCR between the Bill Williams River and the Mexico border, but no nesting activity was confirmed.

The lower Grand Canyon was not monitored as part of Reclamation's study after 2008 because the declining level of Lake Mead dramatically reduced the amount of potential flycatcher habitat, and the formation of rapids at Pearce Ferry and Iceberg Canyon made access difficult and dangerous.[2] At Reclamation's direction, SWCA did not visit sites on the Virgin River in 2014–17 because of safety concerns related to the management of trespass cattle. SWCA's effort was redirected to MVWA and ALAM as well as to supplementing other monitoring efforts in the Pahranagat Valley (see "Related Studies," below).

In 2013–15, the flycatcher studies included monitoring for the presence and effects of tamarisk beetles at sampling points at selected study areas. Beetle monitoring originally included sampling points at MESQ, MOME, TOPO, and BIWI. No sampling occurred along the Virgin River at MESQ or MOME after 2014, and the vegetation at all the sampling points at TOPO was consumed in a fire in August 2015. Reclamation then decided to discontinue beetle monitoring after the 2015 field season. Results of beetle monitoring can be found in the annual reports (McLeod and Pellegrini 2014, 2015, 2017a) and are not included in this document.

RELATED STUDIES

Prior to 2010, the Nevada Department of Wildlife (NDOW) completed nest monitoring at the Key Pittman study area (KEPI) at the Key Pittman Wildlife Management Area, and SWCA banded flycatcher nestlings and adults

[2] Surveys completed in 2010–12 by the Grand Canyon National Park between Diamond Creek and Pearce Ferry resulted in the detection of two flycatchers at River Mile 275 on June 24, 2010. Neither flycatcher was detected on subsequent surveys (Stroud-Settles et al. 2013).

opportunistically in 2003–09 in cooperation with these monitoring efforts. In 2010, the NDOW retained SWCA to conduct surveys, site descriptions, nest monitoring, and banding at flycatcher breeding areas at KEPI and at the Warm Springs study area (WMSP) in the Warm Springs Natural Area near the headwaters of the Muddy River. This work was expanded in 2011 to include the River Ranch study area (RIRA) in the Pahranagat Valley. PAHR, which had previously been monitored under SWCA's contract with Reclamation, was added in 2013 to the list of study areas monitored under the contract with the NDOW. Starting in 2014, WMSP was monitored under SWCA's contract with the Southern Nevada Water Authority (SNWA). Broadcast surveys for yellow-billed cuckoos (*Coccyzus americanus occidentalis*) were also completed at KEPI, RIRA, PAHR, and WMSP under the NDOW and SNWA contracts.

In 2017, funding was not available for the NDOW to hire a contractor for flycatcher studies. PAHR was monitored by SWCA under the contract with Reclamation, and KEPI and RIRA were monitored by the NDOW, with SWCA banding flycatchers opportunistically at KEPI and RIRA in conjunction with these efforts. The NDOW also monitored MESQ and MOME in 2015–17. The Utah Division of Wildlife Resources (UDWR) monitored breeding flycatchers annually in St. George, Utah, from 2008 through 2017. SWCA banded adult and nestling flycatchers opportunistically in cooperation with the monitoring efforts at the St. George study area (STGE). Data from SWCA's contracts with the NDOW and SNWA, as well as monitoring data collected by the NDOW in 2013–17 and banding and resight data from STGE, are included in this report to provide a more complete assessment of the regional flycatcher population.

PURPOSE AND DESCRIPTION OF STUDIES

The purpose of the 2013–17 study was to continue surveys, monitoring, and demographic and ecological studies of the flycatcher in suitable and/or historical riparian and wetland habitats throughout the lower Colorado and Virgin River regions. Specific components of the study, and the chapters in which they are addressed, are as follows:

Chapter 2 – Presence/Absence Surveys and Site Descriptions.
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, and these were last surveyed in 2015. All sites that are surveyed triennially are ones at which no resident flycatchers (i.e., those detected for a week or more) have been detected in recent years and at which vegetation and hydrology are unlikely to change without a major flood event. 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 presents the methodology and results of surveys, gives a general description of each survey site, and discusses habitat quality and changes in habitat quality.

Chapter 3 – Color Banding and Resighting. Adult and juvenile flycatchers were color banded at sites with territorial flycatchers, and previously banded flycatchers were resighted to determine their identity. This chapter summarizes banding and resighting activities, presents the numbers of flycatchers detected at each study area in each year, summarizes movement and dispersal of flycatchers, and presents an analysis of flycatcher demographics.

Chapter 4 – Nest Monitoring. All areas occupied by territorial flycatchers were searched for nests, and nests were monitored to determine nest fate, brood parasitism, and causes of nest failure. This chapter summarizes nesting attempts, nest success, nest fates, and productivity for all flycatcher nesting activity.

Chapter 5 – Nest Site Characteristics. Data on surface hydrology were collected at all nest locations, and data on microclimate at nests were collected at selected study areas. This chapter summarizes the conditions of vegetation type, soil moisture, temperature, and humidity recorded at nest sites.

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

Chapter 2 – Presence/Absence Surveys and Site Descriptions

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 residency 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 2013–17, as part of SWCA's contract with Reclamation, multiple broadcast surveys were completed at sites in 15 study areas[1] (hereafter Reclamation study areas) along the LCR and its tributaries to detect both migrant willow flycatchers and resident flycatchers (figure 2-1). In 2013–16, surveys were completed in three additional study areas as part of the contract with the NDOW. A fourth additional study area was surveyed in 2013 under the contract with the NDOW and in 2014–17 as part of the contract with the SNWA. Per Reclamation's direction, no surveys were conducted in any study area along the Virgin River in 2014–17, and effort that would have been spent on the Virgin River was redirected to MVWA and ALAM as well as to supplementing survey and monitoring efforts in the Pahranagat Valley.

METHODS

Site Selection

Survey sites were selected based on locations surveyed during previous years of flycatcher studies along the LCR (McLeod and Pellegrini 2013, 2014, 2015, 2017a, 2017b) and reconnaissance on foot during each survey season. Many survey sites located south of Parker Dam were placed on a triennial survey schedule in 2013. The sites within conservation areas, however, were surveyed annually. Survey sites at TOGO and BIWI that were previously on a biennial survey schedule (McLeod and Pellegrini 2013) were also placed on the triennial schedule starting in 2013. Sites scheduled for surveys every 3 years were surveyed in 2015. All sites that were surveyed every 3 years were ones at which no resident flycatchers (i.e., those detected for a week or more) had been detected in recent years and at which vegetation and hydrology were unlikely to change without a major flood event. Reclamation biologist Chris Dodge guided and approved survey site selection at the 15 Reclamation study areas.

Field personnel were provided with high-resolution hard copy and/or digital aerial photographs of all survey sites. Aerial imagery was georeferenced and overlain with an outline of the proposed survey area. If the boundary of a survey site was refined during the season, new boundaries were delineated based on Universal Transverse Mercator (UTM) coordinates obtained in the field. All coordinates were obtained using Trimble® TerraSync™ 5.61 on a Trimble Juno 3B and were in North American Datum 83 to comply with Federal Geographic Data Committee standards.

[1] Each study area consists of 2–21 survey sites that are grouped geographically (see attachment 1).

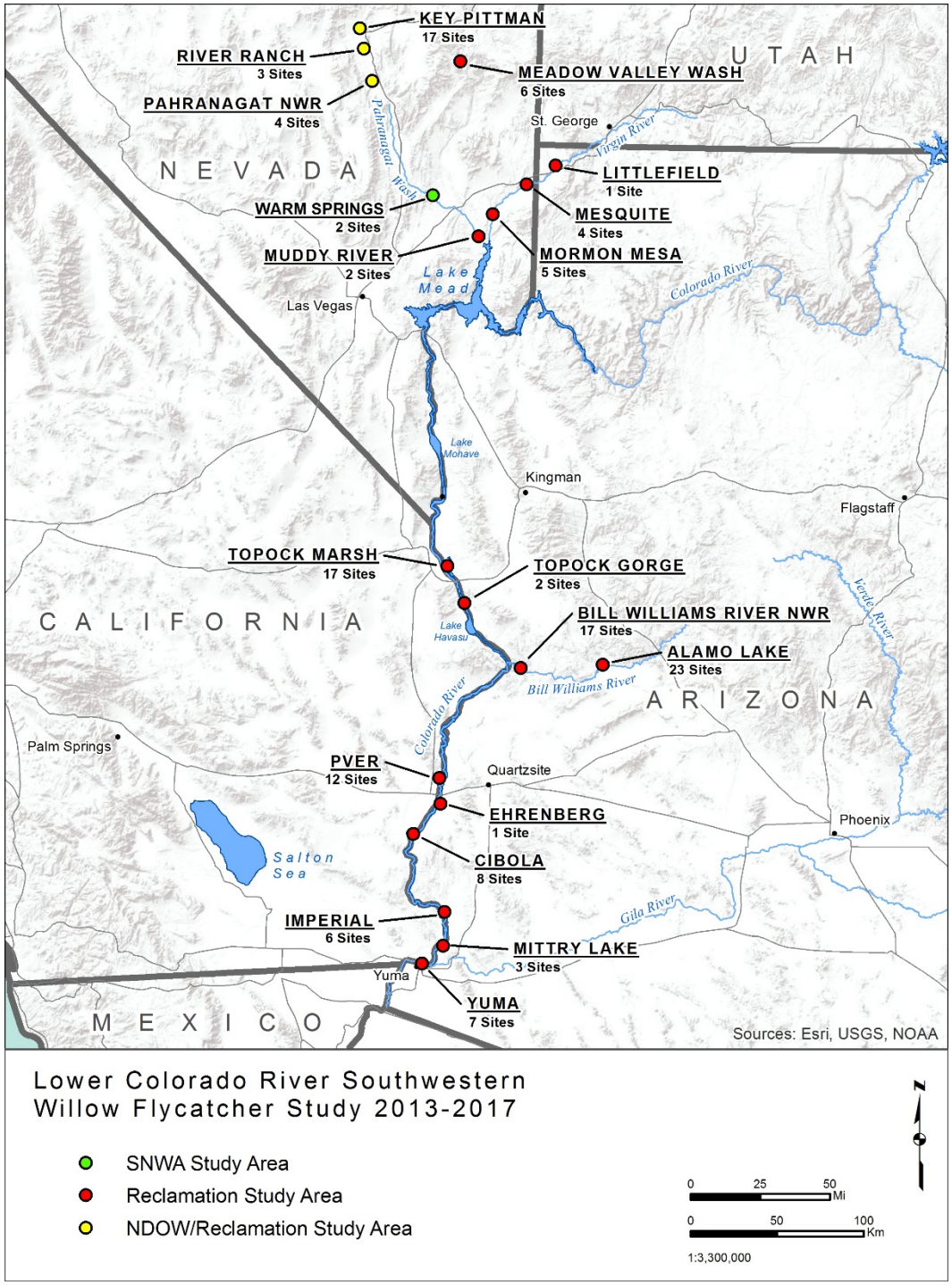

Figure 2-1.—Locations of southwestern willow flycatcher study areas along the LCR and its tributaries, 2013–17.
(Note: Study area labels represent the approximate center of multiple survey sites within that region; see attachment 1. The number of sites in each study area is indicated below each study area name.)

Site Names

In 2013, the LCR MSCP instituted a three-tiered geographic naming convention 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. Throughout the history of this project, survey sites have been grouped into "study areas." A study area does not always correspond to an 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 previous 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. For most sites surveyed in previous years, original survey site names were retained; in the few instances in which names were changed, the original name is noted in attachment 1.

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 et al. 2008; McLeod and Pellegrini 2013) 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 were evaluated based on data recorded during site descriptions (see "Site Descriptions," below).

Flycatcher Broadcast Surveys

To elicit responses from nearby willow flycatchers, field personnel broadcast conspecific vocalizations previously recorded throughout the Southwest from 1996 to 1998. All flycatcher surveys were conducted according to the methods described in Sogge et al. (2010), and surveys at most sites 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. At the study areas monitored under the NDOW contract, surveys followed the three-survey protocol described in Sogge et al. (2010), 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. Field work at ALAM was a lower priority than surveying and monitoring according to protocol at TOPO, BIWI, and

Table 2-1.—Habitat suitability criteria for suitable and preferred habitat for southwestern willow flycatchers 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 capable of providing cover for nests	Dense layer of vegetation capable of providing 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] Standing water or saturated soil is required to maintain suitable vegetation structure. Suitable vegetation structure may persist for a few years without nearby wet soils.

the conservation areas. It was not anticipated that field personnel would be able to follow a standard survey protocol at ALAM, and they were instructed to follow the three-survey protocol as closely as possible, while prioritizing the monitoring of known territories. 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. Surveyors stopped every 30–40 meters (m) and broadcast flycatcher primary song (*fitz-bew*) and calls (*breets*). 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. In 2013, field personnel used Garmin eTrex 30 Global Positioning System (GPS) units to gather UTM coordinates of start, stop, and intermediate survey points, which allowed a spatial representation of each survey area to be created. All survey data, including all UTM coordinates, start and stop times, the number of detections of LCR MSCP covered species at each survey point, and the location(s) and behavior of all willow flycatchers detected were recorded in field notebooks. In 2014–17, these

survey data were collected in TerraSync 5.61 on a Trimble Juno 3B. Field personnel also recorded the presence of cowbirds and livestock in all years, as requested by the Arizona Game and Fish Department. Cowbirds may affect flycatcher populations by decreasing flycatcher productivity (see chapter 4), while livestock may substantially alter the vegetation in an area (USFWS 2002).

Wherever territorial flycatchers were detected, personnel discontinued broadcast surveys within a radius of 50 m of territories and commenced territory and nest monitoring, which involved more frequent visits (see chapter 4). At study areas where breeding activity was previously documented (KEPI, RIRA, PAHR, MVWA, LIFI, MESQ, MOME, MUDD, WMSP, TOPO, BIWI, and ALAM), all detections of willow flycatchers were assigned a unique alphanumeric code and monitored to determine residency status regardless of the flycatcher's behavior during the initial detection. A flycatcher was considered resident at a site if it was detected for at least 7 days. If no activity was detected near the original detection during any of three subsequent visits, monitoring visits stopped and surveys resumed. At study areas where no breeding activity had been detected in any year from 2003 to 2017 (TOGO, PVER, EHRE, CIBO, IMPE, MITT, and YUMA), willow flycatcher detections were followed up with monitoring visits only if territorial behavior was observed.

Other Covered Species

Incidental, Passive Detections

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 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 at any Reclamation study area, but all incidental detections were recorded. 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. Specific locations and behavioral data for incidental detections of the Yuma clapper rail and yellow-billed cuckoo were recorded using the same methods (i.e., either using a Garmin eTrex 30 and a field notebook or using TerraSync 5.61 on a Trimble Juno 3B) as employed in flycatcher surveys in any given year. All incidental detections of these four species were also recorded at study areas in the Pahranagat Valley and at WMSP.

Yellow-billed Cuckoo Broadcast Surveys

Broadcast presence/absence surveys were completed for yellow-billed cuckoos in 2013–16 following methods described in Halterman et al. (2015). Yellow-billed cuckoo surveys were completed at PAHR and WMSP in 2013–16 and at RIRA in

2014–16. Field personnel completed three broadcast surveys at PAHR and RIRA at 2-week intervals between late June and early August in all survey years and at WMSP in 2013. Four broadcast surveys were conducted at WMSP from late June to early August in 2014–16.

Site Descriptions

Because vegetation structure and surface soil moisture conditions within riparian habitats are seasonally dynamic, field personnel completed site description forms (McLeod and Pellegrini 2014, 2015, 2017a, 2017b; McLeod et al. 2018) 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), understory height (to the nearest meter), canopy closure (to the nearest 5%), whether wet soils were present within that vegetation type, and the percentage of the site occupied by that vegetation type. Field personnel also recorded various metrics of surface hydrology for the site as a whole: percentage of soil within the site that was inundated, saturated, damp, or dry (to the nearest 5%, unless one category was only 1 or 2% of the site); depth of any standing water (to the nearest centimeter [cm] or nearest 5 cm if > 5 cm); and distance (to the nearest meter) to saturated or inundated soil (hereafter wet soils) if no wet soils were 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). In 2017, field personnel also recorded information on the presence or absence of tamarisk beetles at the site and the condition (green, brown, defoliated, or refoliating) 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 each field season, information from the site description forms was used in conjunction with habitat photographs and comments in field notebooks and on survey forms to formulate a comprehensive, qualitative description for each site and to assess habitat suitability. Unless otherwise noted, the site descriptions in this chapter represent the conditions observed in 2017.

RESULTS

Flycatcher Broadcast Surveys

All Contracts

Across all contracts in 2013–17, SWCA field personnel surveyed or monitored 68 to 116 sites in each year along the Virgin and lower Colorado Rivers and tributaries, with a total of 136 sites in 18 study areas across all years. Flycatcher broadcast surveys were conducted at sites that were either unoccupied, partially occupied, or occupied for only part of the season, with 52 to 97 sites in 11 to 16 study areas surveyed in each year. Field personnel spent 390.0 to 479.8 observer-hours conducting the flycatcher broadcast surveys in each season. An additional 3 to 19 sites were entirely encompassed by active flycatcher territories throughout a given survey season and were therefore not surveyed in that season but were monitored via territory and nest visits. Each site that was not occupied by flycatchers was formally surveyed three to six times, except at ALAM, where effort focused on monitoring known territories, and sites with no known territories were surveyed one to four times. A summary of flycatcher survey effort and survey site occupancy status is presented in attachment 2. The boundaries of survey sites and their occupancy status in 2003–17 are shown on orthophotos in attachment 3 along with historically occupied habitat.[2] Site descriptions were recorded one to three times each season for each site. A summary of hydrological conditions recorded as part of site descriptions is presented in attachment 4. Survey results from Hunters Hole (a conservation area), where Reclamation completed surveys in 2016 and 2017, are also included in this report.

Field personnel spent an additional 1.2 to 16.9 observer-hours completing habitat evaluation and opportunistic surveys in 1 to 13 reconnaissance sites in each year

[2] Occupied flycatcher habitat was defined as survey sites where willow flycatchers were detected after June 24 and before July 20, or where resident or breeding flycatchers were detected regardless of time of year, in any year since 2003. If none of the detections in a site matched these criteria, the site was considered unoccupied.

in 2013, 2014, 2016, and 2017. The results of reconnaissance for each study area are presented below following the results for regularly surveyed sites. The boundaries of reconnaissance sites are show on orthophotos in attachment 5.

Willow flycatchers were detected after June 24 and before July 20 in several sites where residency or breeding was not confirmed in the year of the detection. Only two of the detections were south of Parker Dam, and one of those individuals displayed territorial behavior but was detected for only 1 day. Behavioral observations for these detections are summarized in table 2-2.

Table 2-2.—Detections of willow flycatchers recorded after June 24 and before July 20 at survey sites where breeding or residency was not confirmed in the year of the detection, 2013–17

Year	Study area[1]	Site	Date	Comments
2013	RIRA	West Side	July 6–9	Singing spontaneously (*fitz-bew*) in circuit around territory boundary
			July 9	Recaptured via passive netting; not detected before or after capture
2014	TOPO	The Wallows	July 16	Occasional unsolicited vocalizations (*wheeo*); not very responsive to broadcast
	PVER	Phase 06 Block 02	July 7	Few spontaneous vocalizations (*fitz-bew*); unresponsive to broadcast
2015	RIRA	Smalls	June 29 – July 3	Singing spontaneously (*fitz-bew*) in circuit around territory boundary
2016	TOPO	Glory Hole	July 14	Flew in silently to broadcast; eventually vocalized briefly (*wheeo*)
		CPhase 05	June 28	Occasional vocalizations (*fitz-bew* and *wheeo*); somewhat responsive to broadcast
2017	PAHR	Pahranagat MAPS	June 26	Flew in silently to broadcast; eventually vocalized briefly (*wheep*, *fitz-bew*)
	MITT	C4911	June 27	Responded to broadcast and continued to vocalize (*fitz-bew*) in territorial manner for at least the following hour
				Responded to other individual in the site with 3–4 vocalizations (*fitz-bew*)

[1] MITT = Mittry Lake, PAHR = Pahranagat, PVER = Palo Verde Ecological Reserve, RIRA = River Ranch, and TOPO = Topock Marsh.

Reclamation Contract

From 2013 to 2017, field personnel surveyed or monitored 47 to 91 sites in each year along the Virgin and lower Colorado Rivers and tributaries, with a total of 114 sites in 15 study areas across all years. Flycatcher broadcast surveys were

conducted at sites that were either unoccupied, partially occupied, or occupied for only part of the season, with 46 to 85 sites in 7 to 12 study areas surveyed in each year. Field personnel spent 377.7 to 475.2 observer-hours conducting the flycatcher broadcast surveys in each year. An additional one to six sites were occupied throughout a given survey season and were not surveyed but were monitored via territory and nest visits. Each site that was not occupied by flycatchers was formally surveyed three to six times, except at ALAM, where effort focused on monitoring known territories, and sites with no known territories were surveyed one to four times.

Field personnel spent an additional 1.2 to 16.0 observer-hours completing habitat reconnaissance and opportunistic surveys in 1 to 11 reconnaissance sites in 2013, 2014, 2016, and 2017. The results of reconnaissance for each study area are presented below following the results and site descriptions for regularly surveyed sites.

Willow flycatchers were detected after June 24 and before July 20 in 2014, 2016, and 2017 in several sites where residency or breeding was not confirmed in the year of the detection. Only two of the detections were south of Parker Dam, and one of those individuals displayed territorial behavior but was detected for only 1 day (see table 2-2).

NDOW Contract

From 2013 to 2016, field personnel surveyed or monitored 21 to 23 sites in each year in the Pahranagat Valley and along the Muddy River, with a total of 25 sites in 4 study areas across all years. Flycatcher broadcast surveys were conducted at sites that were either unoccupied, partially occupied, or occupied for only part of the season, with 6 to 21 sites in 3 to 4 study areas surveyed in each year. Field personnel spent 4.0 to 15.6 observer-hours conducting the flycatcher broadcast surveys. An additional 2 to 15 sites were occupied throughout a given survey season and were not surveyed but were monitored via territory and nest visits. Each site that was not occupied by flycatchers was formally surveyed three to five times.

Field personnel spent an additional 0.9 observer-hour completing habitat reconnaissance and opportunistic surveys in two reconnaissance sites in 2013. The results of reconnaissance for each study area are presented below following the results and site descriptions for regularly surveyed sites.

Willow flycatchers were detected after June 24 and before July 20 in 2013 and 2015 in sites where residency or breeding was not confirmed. One individual in each year displayed territorial behavior (see table 2-2) but was not detected for long enough to be considered resident.

SNWA Contract

From 2014 to 2017, field personnel surveyed or monitored two sites in each year along the Muddy River at the Warm Springs Natural Area. Field personnel spent 2.5 to 5.2 observer-hours conducting flycatcher broadcast surveys at the two sites in each year. Each site was formally surveyed five times if not occupied by flycatchers for any portion of the season. No habitat reconnaissance or opportunistic surveys were conducted as part of this contract. No willow flycatchers were detected after June 24 in sites where residency or breeding was not confirmed.

Covered Species

All incidental, passive detections of covered species, along with behavioral observations for yellow-billed cuckoos and Yuma clapper rails, are presented in attachment 6. No confirmed detections of gilded flickers were recorded in any year in 2013–17. Multiple detections of vermilion flycatchers, yellow-billed cuckoos, and Yuma clapper rails were recorded in each year in 2013–17. Several incidental detections of yellow-billed cuckoos were recorded each season at survey sites where yellow-billed cuckoo surveys are conducted as part of another LCR MSCP project (McNeil and Tracy 2013; Parametrix, Inc., and Southern Sierra Research Station 2015, 2016a, 2016b, 2018); numbers, locations, and behavioral observations of those detections are not presented in this report.

Key Pittman, Nevada

KEPI is in the Key Pittman Wildlife Management Area, near the town of Hiko, Nevada, at the northern end of the Pahranagat Valley approximately 150 km north of Las Vegas, Nevada. It consists of a series of narrow strips of riparian habitat along the edges of Nesbitt and Frenchy Lakes. Both lakes are located within the historic area of the Hiko Spring outflow stream and are currently managed for waterfowl. Nesbitt Lake is also managed for fishing and is supplemented with water from Hiko Spring during the summer months. Water levels in both lakes decline gradually during the flycatcher breeding season; the rate of decline varies from year to year. The land around each lake is periodically grazed, but the survey sites along Nesbitt Lake have been fenced on the upland side to exclude cattle. Habitat along Nesbitt Lake was monitored for flycatchers by the NDOW prior to 2010. SWCA monitored the study area from 2010 to 2016 as part of a contract with the NDOW. The NDOW resumed monitoring in 2017.

Patches 00–12 and Nesbitt Forest

Area: 1.8 ha Elevation: 1169 m

The survey sites along Nesbitt Lake consist of 15 small patches (Patches 00–12) of coyote willows (*Salix exigua*) plus a small patch (Nesbitt Forest) of Fremont

cottonwoods (*Populus fremontii*) (hereafter cottonwoods). SWCA surveyed and/or monitored Patches 00–12 in 2010–16 and Nesbitt Forest in 2014–16. The coyote willow patches form a strip of habitat along the western edge of the lake between bulrush (*Schoenoplectus californicus*) marsh to the east and dry alkali desert scrub dominated by saltbush (*Atriplex* sp.) and grasses to the west. Lake levels were noticeably higher at the beginning of the breeding season in 2016 than they had been in previous years, and high levels persisted much longer into the season. This resulted in areas of bulrush thinning out in the deeper water. Most of the patches are separate from each other, but four patches (Patches 06–09) have grown together, forming a larger contiguous stand. Each coyote willow patch is characterized by very dense, large-diameter stems. Some areas have fallen or leaning stems with wispy growth in the lower 2 m, and traversing those areas is difficult. In 2016, canopy height within each coyote willow patch ranged from 4 to 8 m, with the shorter stems occurring around the edges of each stand, creating a rounded look. Large gaps in the canopy occurred in the center of several patches, and canopy closure varied from 65 to 95%. Since 2010, some of the canopy gaps have become larger, and two patches (Patches 02 and 03) have started to grow together. No other major changes in vegetation structure have occurred.

The cottonwood patch (Nesbitt Forest) is at the very southern end of Nesbitt Lake and, in 2016, contained 18-m-tall trees planted on either side of an entrance road. The trees formed a stand of vegetation roughly 30 x 60 m in size with 85% canopy closure and little understory. No changes in species composition or vegetation structure were noted between 2014 and 2016 at this site.

Wet soils were present along the lakeside edge of the coyote willow stands when site descriptions were recorded in May, June, and July of each year in 2013–16. A noticeable decrease in water levels was noted on the July site descriptions in most years. A similar pattern in surface hydrology was noted in 2010–12 (McLeod and Pellegrini 2013; NDOW, unpublished data). Although formal site descriptions were completed only three times each season, field personnel were onsite approximately every 2 to 4 days and observed that water levels declined gradually over the season and did not fluctuate notably from day to day (C. Hines 2017, personal communication).

Eleven to 14 of the sites in Patches 00–12 were occupied in 2013–16, with 20 to 37 resident flycatchers detected annually. In 2017, the NDOW recorded 11 resident flycatchers. Patches 00–12 were also occupied in 2010–12, with 31 to 39 resident flycatchers detected annually (McLeod and Pellegrini 2013). Nesbitt Forest was occupied by two breeding flycatchers in 2014. No willow flycatchers were detected in Nesbitt Forest in 2015–17. Cowbirds were noted during nest monitoring activities throughout each season in 2013–16. Deer were present within the sites but did not appear to heavily impact the vegetation structure.

Most of the patches have all the characteristics of preferred nesting habitat (see table 2-1). The gaps that have developed in several of the patches reduce the availability of nesting habitat but increase foraging habitat. The three smallest patches (00, 04.5, and 10.5) lack the patch width of preferred nesting habitat but have all other characteristics; the probability of occupancy in these patches is improved by proximity to the rest of the patches, with the study area forming a matrix of habitat. Nesbitt Forest lacks the midstory structural components that are typical of suitable habitat.

Frenchy Lake

Area: 0.7 ha Elevation: 1158 m

The survey site known as Frenchy Lake was surveyed in 2016 and was visited by the NDOW in 2017. It is approximately 2 km south of Nesbitt Lake, on the northeastern corner of Frenchy Lake. The site is bordered by bulrush marsh to the west and yerba mansa (*Anemopsis californica*) transitioning to dry alkali desert scrub to the east. In 2016, vegetation within the site consisted primarily of a stringer of 20–25-m-tall cottonwoods and 15–18-m-tall Goodding's willows (*Salix gooddingii*) with two disjunct patches of 4–6-m-tall coyote willows in the understory. Canopy closure was variable and reached 90% in the middle of the stringer, with less dense vegetation toward the edges. The overall site was approximately 10 m wide at ground level, with the canopy covering an area no more than 25–30 m wide.

Wet soils were present along the western edge of the site when site descriptions were recorded in May, June, and July 2016, with a decrease in water levels noted on the July site description. Although formal site descriptions were completed only three times, field personnel were onsite approximately every 2 to 4 days and observed that water levels declined gradually over the season and did not fluctuate notably from day to day (C. Hines 2017, personal communication).

Frenchy Lake was occupied in 2016 by two breeding flycatchers, and one flycatcher, which subsequently established a territory at KEPI Patch 01, was also detected for 4 days. In 2017, the NDOW detected a flycatcher at Frenchy Lake on a single occasion, and the same individual subsequently established a territory at PAHR. Cowbirds were detected during one survey as well as during nest monitoring activities. Signs of shod horses were observed on the road adjacent to the site on one visit. Cattle grazed this unit for part of summer and had access to the habitat, but no signs of them using the site were observed.

This site has the canopy height, canopy closure, midstory structural elements, and wet soils typical of preferred nesting habitat (see table 2-1), but patch width barely meets the criterion for suitable habitat. The upland area is steeply sloped away from the lake, and this limits the expansion of suitable vegetation.

River Ranch, Nevada

RIRA is on a cattle ranch near the town of Ash Springs in the Pahranagat Valley, approximately 9 km south of KEPI. It consists of several isolated patches of riparian vegetation, each surrounded by grazed, irrigated cattle pasture, as well as a linear swath of trees along the outflow stream from Ash Springs. SWCA monitored the study area from 2011 to 2016 as part of a contract with the NDOW, and the NDOW monitored the site in 2017. When SWCA began monitoring in 2011, the pasture was irrigated periodically to grow grass and then dried out while the cattle grazed (A. Pellegrini, personal observation). By 2015, the pasture was flooded for longer periods of time, and grazing frequency decreased; this pattern continued in 2016. By 2016, the vegetation in the frequently flooded area between West Side and Smalls had changed from grass and *Juncus* sp. to an unidentified sedge-like species that grew to approximately 2 m in height by July. Although the isolated patches of vegetation do provide suitable flycatcher habitat, overall habitat suitability at RIRA is fair. The small areal extent of these patches (< 1 ha total), in combination with their location in a cattle pasture and relative isolation from other breeding sites in the valley, limits the overall suitability of this study area. In each site, several access points for cattle are present, and signs of cattle were noted in each year. An obvious browse line was noted in 2013 but not during subsequent seasons.

East Side

Area: 0.4 ha Elevation: 1100 m

East Side was surveyed by SWCA from 2011 to 2016 and visited by the NDOW in 2017. In 2016, the site was composed primarily of dense, large-diameter coyote willows 4–7 m in height. Tree height was shorter at the perimeter, giving the site a rounded appearance. A couple of Russian olive (*Eleagnus angustifolia*) and emergent velvet ash (*Fraxinus velutina*) trees were present in the site. One large, 10-m-tall cottonwood dominated the northeastern corner of the site, though half of the tree had fallen over and died as of 2016. There were numerous piles of deadfall scattered throughout the site. Little to no understory was present, except where the coyote willows were regenerating and in small clearings where herbaceous vegetation dominated. Wild grape (*Vitis* sp.) also grew in the northwestern corner, creating extremely dense habitat. Canopy closure was primarily 70–90%, with lower canopy closure found in a few scattered clearings throughout the site. No changes in vegetation structure or species composition were noted between 2011 and 2016.

Standing water was present in the site when site descriptions were recorded in May of each year in 2013–16. Wet soils were present when the June site descriptions were recorded in 2015 and 2016. A small amount of saturated soil was noted in July 2015, and soils were damp or dry when the July site descriptions were recorded in other years. In 2011 and 2012, water levels

fluctuated according to irrigation activity on the property, with a similar range in both years in the ratio of wet to dry soils (McLeod and Pellegrini 2013). This site is located on the edge of the area typically affected by irrigation activities and is usually the first of the three RIRA survey sites to dry out.

East Side was occupied by two to four resident flycatchers in 2013, 2015, and 2016. No willow flycatchers were detected in 2014. The NDOW recorded two resident flycatchers in 2017. The site was also considered occupied in both 2011 and 2012 (McLeod and Pellegrini 2013). Cowbirds were detected at the site in all years except 2014.

This site contains all the characteristics of preferred nesting habitat (see table 2-1), although portions of the site with > 85% canopy closure are limited in areal extent.

West Side

Area: 0.3 ha Elevation: 1100 m

This survey site known as West Side was surveyed by SWCA from 2011 to 2016 and was visited in 2017 by the NDOW. In 2016, the site was composed primarily of dense, large-diameter coyote willows 4–6 m in height. Canopy height was shorter at the perimeter, giving the site a rounded appearance. A couple of corridors in the vegetation ran from the exterior of the site into the interior, creating gaps in the canopy. Russian olive trees were scattered along the perimeter of these corridors and along the eastern perimeter of the site. There was little to no understory throughout most of the site, except in the northeastern corner, where an extensive patch of wild grape was growing on the trees. In the corridors, no understory was present, but grasses and other herbaceous plants provided groundcover. The coyote willows in the northeastern corner were noticeably stressed compared to the rest of the site, with many dead leaves, dead branches, and reduced canopy closure. A couple of 10- x 10-m patches of dead coyote willows were present along the northwestern and eastern edges of the site. Canopy closure was 80–90% throughout the southern two-thirds of the site and 75% in the northern third. Areas of deadfall up to 1 m deep were scattered throughout the site, making travel difficult in places. Canopy height had not changed since surveys began in 2011, and the only major change in species composition was the growth of the wild grape in the northeastern corner of the site. Canopy closure was 90% throughout the site from 2011 through 2014 and decreased noticeably in the northern third of the site in 2015–16.

Wet soils were noted in 20–100% of the site when site descriptions were recorded in May, June, and July in 2014–16. In 2013, standing water covered 100% of the site when the May site description was recorded, but no wet soils were recorded in June or July. Water levels were variable in 2011 and 2012, depending on irrigation activity (McLeod and Pellegrini 2013). Unlike in 2013–16 when up to

100% of the site was inundated, the maximum extent of wet soils in 2011 and 2012 was saturated soil in no more than 10% of the site. This site is in the middle of an area directly affected by irrigation activities. Water levels within the site fluctuate with the amount of irrigation water being released into the area, and soil moisture conditions could fluctuate from day to day.

West Side was considered occupied in 2013, 2015, and 2017. In 2013, two individuals were detected in early July for no more than 3 days each. One individual displayed territorial behavior during two visits but was not detected on any of three subsequent monitoring visits. The other individual was passively captured and was not detected before or after capture during monitoring visits and surveys. The site was occupied in 2015 by a pair of breeding flycatchers. In 2014, two willow flycatchers were each detected for less than 7 days prior to June 24, and the site was unoccupied. In 2016, one willow flycatcher, which later occupied a territory in another study area, was detected for less than 7 days prior to June 24, and the site was unoccupied. In 2017, the NDOW detected one breeding pair of flycatchers and one resident, unpaired male. The site was also occupied in 2011 (McLeod and Pellegrini 2013). Cowbirds were detected on at least one survey in each year in 2014–16.

All the characteristics of preferred nesting habitat (see table 2-1) were present in the southern two-thirds of this site in 2016. Vegetation condition in the northern third of the site in 2016 was noticeably poorer than it was when SWCA first began monitoring in 2011 (figures 2-2 and 2-3), and this portion of the site did not have adequate canopy closure to meet the criterion for suitable habitat.

Figure 2-2.—View of the eastern edge of West Side in the River Ranch study area, July 2012.

Figure 2-3.—View of the eastern edge of West Side in the River Ranch study area, May 2015.

Smalls

Area: 0.2 ha Elevation: 1100 m

Smalls is the smallest and wettest of the three survey sites in the RIRA study area and was surveyed by SWCA from 2011 to 2016 and visited by the NDOW in 2017. In 2016, it was composed primarily of coyote willows 3–6 m tall. There was little understory except sparse, regenerating coyote willows in the densely vegetated areas. A large gap, approximately 8 x 15 m in size, dominated the northern half of the site. This gap was vegetated by herbaceous plants and was ringed on the western, northern, and eastern sides by a stand of coyote willows approximately 3–5 m in height and 4 m wide with 80–85% canopy closure. Vegetation health in this narrow strip of coyote willows declined between 2011 and 2016, and in 2016, tree mortality was apparent. The southern half of the site was more homogenous in structure with coyote willows 5–6 m in height and canopy closure averaging 85–90%. Deadfall was scattered throughout the site but typically did not occur in piles as it did in East Side and West Side. Other than the increase in tree mortality, no major changes in vegetation structure or species composition were noted between 2011 and 2016.

Standing water was present in the site when each site description was recorded in 2013–16, except in June 2013, when water was noted immediately adjacent to the site. The site was completely inundated during at least one site description in each year in 2013–16. Water levels were variable in 2011 and 2012, depending on irrigation activity (McLeod and Pellegrini 2013). Unlike in 2013–16 when up to 100% of the site was inundated, the maximum extent of surface water in 2011 and 2012 was no more than 50% of the site. This site is in the middle of an area directly affected by irrigation activities. Water levels within the site fluctuate with the amount of irrigation water being released into the area, and soil moisture conditions could fluctuate from day to day.

Smalls was considered occupied in 2015 with the detection of a single willow flycatcher from June 29 to July 3. This individual demonstrated territorial behavior but was detected at the site for less than 7 days and, thus, is not considered resident. One willow flycatcher was detected in 2014 on May 21 and 25. This individual was not detected on any subsequent monitoring visits or surveys, and the site was unoccupied in 2014. No willow flycatchers were detected in 2013 or 2016. In 2017, the NDOW detected one resident, unpaired male flycatcher from June 7 to 26. The site was occupied in 2011 but not 2012 (McLeod and Pellegrini 2013). Cowbirds were detected in all years.

All characteristics of preferred nesting habitat exist within the site but are limited to an area approximately 30 x 35 m in size in the southern portion.

Pahranagat, Nevada

PAHR is located around the perimeter of Upper Pahranagat Lake at the northern end of the Pahranagat National Wildlife Refuge. Patches of primarily native vegetation exist at the inflow and outflow of Upper Pahranagat Lake and along the lakeshore. Upper Pahranagat Lake is divided into two units by a levee, with the northern portion known as the North Marsh unit. Water flows between the two portions of the lake via a water control structure. Prior to the 2008 breeding season, most of the riparian vegetation along the northern side of the North Marsh unit (Pahranagat North) was inundated annually with up to 1 m of water, with the highest water levels occurring in May. Major structural problems with the dam that impounds the upper lake resulted in the upper lake being drained in early 2008, and the riparian vegetation at the northern end of the lake was not flooded during the 2008 or 2009 breeding seasons. The dam was repaired prior to the 2010 breeding season, and a portion of Pahranagat North was inundated in May 2010 and in May of each subsequent year. The lake levels in 2013–17 were the highest recorded since the dam was repaired but were still not as high as they had been before 2008. From 2003 to 2007, no cattle were observed within any of the survey sites. From 2008 to 2014, cattle from the neighboring ranch began to wander into the North Marsh unit and adjacent sites (Pahranagat North and Pahranagat West) as lake levels dropped during the season. Cattle were not observed in the southern sites (Pahranagat MAPS and Pahranagat South) during these years. No cattle were observed in the survey sites during the breeding seasons of 2015–17.

Pahranagat North

Area: 3.2 ha Elevation: 1019 m

The survey site known as Pahranagat North was surveyed from 2003 to 2017. It consists of a stand of large-diameter Goodding's willows at the inflow of Upper Pahranagat Lake. Cottonwoods line the northern, upland edge of the site and extend in narrow stringers around the edge of the lakebed. Canopy height within the site is around 20 m in the Goodding's willows and 25 m in the cottonwoods. In 2003–07, no major changes in vegetation structure or species composition were noted within the site, and canopy closure was consistently > 90%. Since 2008, tree mortality has been noted, particularly in the northeastern section of the site, where many of the large trees are dead or dying. Scattered cottonwoods have fallen throughout the site, creating multiple small clearings. Canopy closure under the Goodding's willows now varies from as little as 60% in some of the clearings to as high as 95% under the denser trees. Canopy closure in the cottonwood-dominated portions of the site is less variable and not quite as dense at 70–90%. Dense Indian hemp (*Apocynum cannabinum*) up to 2 m in height has covered varying portions of the site depending on lake levels. In 2003–07, the Indian hemp was limited primarily to the dry northern edge of the site because inundation prevented the plants from sprouting until waters receded from the northern half of the site in July. In 2008–12, the Indian hemp formed a dense

understory layer throughout the site by mid-June. In 2013–17, the Indian hemp was only present in the non-inundated portions of the site, which was either the northern half or northern third of the site, depending on lake levels. Very little herbaceous vegetation was present in the remainder of the site due to inundation. Many Goodding's willows or portions of the trees have fallen over but continue to grow, creating a distinct understory layer of woody vegetation.

One-half to three-quarters of the site contained wet soils when the May site descriptions were recorded in 2013–17, with average water depths ranging from 0.3 to 0.75 m. Water levels declined during each survey season, and 2–70% of the site contained wet soils when the July site descriptions were recorded. The highest water levels in the site in 2013–17 were noted in 2015 and 2016. Two inflow channels are present in or near the site. One channel flows through the western arm of the site and into the center of the site. The other channel is located north of the site and starts at the very western edge of the site, flows east, and drains into the lake along the eastern edge of the site. Surface water was present in the northern inflow channel during all site descriptions. The interior channel contained standing water when each site description was recorded in 2015 and 2016 and when the May and June site descriptions were recorded in 2017 but was dry in 2013 and 2014. The pattern of seasonal drying between May and July was also noted in 2003–12, though the portion of the site with wet soils in May varied among years (McLeod and Pellegrini 2013). In 2003–07, 80–100% of the site contained wet soils in May, with average water depths of 0.5–1.0 m. In 2008–12, the site was drier, with no more than 30% of the site containing wet soils in May.

Pahranagat North was occupied in 2013–17, with 14–24 resident flycatchers detected annually. The site was also occupied in 2003–12, with 18–26 resident flycatchers detected annually (McLeod and Pellegrini 2013). Cowbirds were detected during zero to two surveys and were also noted several times during monitoring activities in each year in 2013–17.

All characteristics of preferred nesting habitat (see table 2-1) are present in most of Pahranagat North. The very shallow slope along the lake edge allows wet soils to persist within the site throughout most of the breeding season in years when lake levels are high enough. The Goodding's willows provide suitably dense cover and good midstory structure. The northern edge of the site, where cottonwoods are common, tends to lack the wet soils needed for preferred habitat and the midstory structural components needed for suitable habitat.

Pahranagat West

Area: 1.3 ha Elevation: 1023 m

Pahranagat West was surveyed from 2004 to 2017. Vegetation in the site is native and consists of a stringer of cottonwoods, one-to-three trees wide and 20 m in height, on the northwestern edge of Upper Pahranagat Lake. A few

Goodding's willows 8–12 m in height are present in the northern half of the site, creating a distinct layer beneath the main canopy. The Goodding's willows have increased noticeably in height since 2004. The rest of the site has no significant understory or midstory vegetation. Canopy closure is 15–65% in portions of the site lacking a midstory and 60–85% in the area with Goodding's willows. The eastern edge of the site is vegetated with bulrush, which extends into the lakebed. The western edge of the site is vegetated with yerba mansa, which transitions into dry, alkali desert scrub. Other than the increase in height of the Goodding's willows, no major changes in vegetation structure or species composition have been noted since 2004.

When site descriptions were recorded in 2013–17, the upland side of the site was dry, but wet soils were present in the lakebed adjacent to the tree trunks. Similar patterns in surface hydrology were noted in 2004–12 (McLeod and Pellegrini 2013), though the distance to wet soils was > 0 m when each site description was recorded in 2008, 2009, 2011, and 2012.

Pahranagat West was occupied by two breeding flycatchers in 2013 and 2015–17. No willow flycatchers were detected in 2014. The site was occupied in 2004–12 (McLeod and Pellegrini 2013). Cowbirds were detected during one to two surveys annually in 2013–17.

Most of the site lacks the midstory structural components, patch width, and canopy closure needed for suitable flycatcher habitat (see table 2-1). The northern portion of the site—where Goodding's willows are present in the understory, canopy closure reaches 85%, and the shallow slope of the lakebed creates a wide area of wet soils when lake levels are high enough—has all the characteristics of suitable flycatcher habitat and one of the four characteristics that distinguish preferred habitat from suitable habitat.

Pahranagat MAPS

Area: 0.3 ha Elevation: 1022 m

Pahranagat MAPS was surveyed in 2006–10 and 2014–17. Surveys were not conducted in 2011–13 because of damage from a fire that occurred prior to the 2010 survey season. Through 2009, the site consisted of a stringer of cottonwoods on the southwestern edge of Upper Pahranagat Lake. Canopy height was 15–20 m, and canopy closure was approximately 70%. The stringer was 20 m wide at the widest point but was narrower in most places. In 2006 and 2007, tamarisk and Russian olive formed a very sparse understory. From 2008 to 2010, no woody vegetation was noted in the understory, and bulrush lined the eastern edge of the tree line and extended into the lakebed.

Since 2014, the site has consisted of distinct patches of dense, mostly small-diameter cottonwoods 70–240 m apart, which have changed in structure and areal extent between 2014 and 2017. Five of the patches are located on tiny hummocks of land in the marsh along the southwestern edge of Upper Pahranagat Lake, adjacent to the original survey area. A sixth patch was added in 2016 and is located just south of the lake on the edge of a large marshy area. In 2017, the patches ranged in size from 20 x 25 m (three patches) to 20 x 45 m. The three smaller patches were 15 x 15 m in size in 2014. Canopy height in the five patches along the southwestern edge of the lake increased from 5 m in 2014 to 10–18 m in 2017. Canopy closure in these patches decreased from 85–95% in 2014 to 60–85%, with an average of 75%, in 2017. Large gaps are now present in the canopy of each of the five patches, where large snags that were present in the center of each patch blew over in 2016. In the patch south of the lake, canopy closure is 90%, and canopy height is 8–10 m.

Each patch was mostly or completely inundated when the May and June site descriptions were recorded in 2015–17, with small exposed islands of land in the middle of each. When the July site description was recorded in 2015 and 2016, standing water was present on the eastern side of each patch, with isolated pools scattered on the western side. In 2017, standing water was present in only two of the six patches, with most soils being damp to dry when the July site description was recorded. Surface hydrology was not described in 2014.

Pahranagat MAPS was occupied by three to four resident flycatchers annually in 2014–16. In 2017, the site was considered occupied because of a detection on June 26 of a banded flycatcher. This individual was not detected on any subsequent monitoring visits or surveys and was not considered resident in the site. Pahranagat MAPS was occupied in 2006 by one resident flycatcher, and no willow flycatchers were detected in 2007–10 (McLeod and Pellegrini 2013). Cowbirds were detected during two to five surveys in 2015–17 and during nest monitoring activities in 2014–17.

Habitat suitability within the site is variable. The patch south of the lake has all the characteristics of preferred nesting habitat (see table 2-1), although patch width barely exceeds 20 m. In the portions of the remainder of the site where canopy closure reaches 85%, all components of suitable habitat are present, and the canopy height and wet soils typical of preferred nesting habitat are also present. All areas where canopy closure is < 85% lack the canopy closure typical of suitable flycatcher habitat. Canopy closure has decreased while canopy height has increased over the years in the patches in the marsh, and habitat suitability has declined with the decrease in canopy closure.

Pahranagat South

Area: 1.4 ha Elevation: 1021 m

This survey site was surveyed in 2003–10 and 2014–17. Ground reconnaissance was conducted at Pahranagat South in 2013. Surveys were not conducted in 2011–13 because of damage from a fire that occurred prior to the 2010 survey season. Through 2009, the site consisted of a relatively small stringer of Goodding's willows, coyote willows, and cottonwoods lining a human-made channel that carried the outflow from Upper Pahranagat Lake. The cottonwoods were approximately 20 m in height, while the willows were generally less than 10 m tall. Tamarisk and Russian olive formed a sparse understory through 2007. In 2003–07, the site was bordered to the west by an open marsh, which dried out into an open field in 2008–10. In 2005, dense coyote willows were noted as increasing on the western side of the site; this area of willows had very sparse canopy in 2006 and 2007 and was almost completely dead by 2008. The 2010 fire removed all understory vegetation and charred the trunks and lower branches of overstory trees. No Goodding's willows have been noted in the site since the fire. The understory in 2010 contained Indian hemp and small patches of coyote willows 3 m in height. Average canopy closure was 50% from 2003 to 2010.

Since 2013, this site has been vegetated by a 20-m-tall cottonwood stringer. Canopy closure within the cottonwood stringer ranges from 10 to 80% and varies depending on the width of the stringer and abundance of standing snags. The understory contains mostly Indian hemp, yerba mansa, rabbitbrush (*Ericameria nauseosa*), cattails (*Typha* sp.), and bulrush. Coyote willows are scattered through the understory as single, small-diameter stems along the channel and were first noted in 2015. In addition to the scattered stems, two small (10 x 40 m) patches of coyote willows 3–4 m in height are present near the center of the site. Canopy closure within these patches is 85–90%, and stem density is extremely high, creating very tangled vegetation. A third patch of coyote willows 10 x 30 m in size and 4 m in height is present at the northern end of the site. This patch contains young, small-diameter stems, and canopy closure does not exceed 75%. No major changes in vegetation structure have been noted in any of the coyote willow patches since 2013.

The channel held water, and soils immediately adjacent to the channel were saturated, when site descriptions were recorded in May, June, and July of each year in 2013–17. Wet soils were present outside the channel along the western edge of the site when all three site descriptions were recorded in 2015, when the May and June site descriptions were recorded in 2016, and when the May site description was recorded in 2017. All other soils were dry. The soil moisture conditions observed in 2013–17 were similar to those observed in 2003–10, with wet soils noted along the western edge of the site in 2003–06 but not in 2008–10 (McLeod and Pellegrini 2013). Factors influencing water levels along the western side of the site are unknown, and it is possible that fluctuations in water levels occurred between site descriptions.

No willow flycatchers were detected in 2014–17. Site occupancy was unknown in 2013, as only one survey was conducted during the reconnaissance effort, but one willow flycatcher was detected on August 2 during a yellow-billed cuckoo survey. This individual did not display territorial behavior and was not considered resident. The site was occupied by breeding flycatchers annually in 2003–06 and by an unpaired, resident male flycatcher in 2007 (McLeod and Pellegrini 2013). Cowbirds were detected during two to five surveys in each year in 2014–17.

This site currently lacks the midstory structural components and canopy closure typical of suitable flycatcher habitat (see table 2-1). The understory has been slowly growing back following a fire in 2010, but most of the species present will not develop into structure suitable for flycatchers. Coyote willows are present, but two of the three patches are too small and too dense and have not increased in extent since the fire. A promising patch of coyote willows is present on the northern end of the site, but it has yet to develop suitably dense canopy closure.

Meadow Valley Wash, Nevada

MVWA is in Meadow Valley Wash, which extends south from Caliente, Nevada, through a narrow canyon known as Rainbow Canyon and past Elgin, Nevada. Surveys were originally conducted in this study area in 2003 but were discontinued at the end of the 2003 season after it was determined that there was no suitable habitat in the study area. Breeding flycatchers were discovered in the study area (at the Dog Leg site) in 2013 by the NDOW. SWCA resumed surveys and reconnaissance in the study area in 2014. Habitat within the canyon consists of narrow bands of native vegetation along a perennial stream. Streamflow is typically minimal during the flycatcher breeding season (figure 2-4), but scouring floods do occur regularly, and habitat within the wash is therefore dynamic. Water within the study area is ponded in several places by beaver activity and is also subsurface in several locations. A tree-like willow species that has redder twigs and leaves that are proportionately wider, with a glossier dark green upper surface and a noticeably more glabrous underside, than those of a Goodding's willow is present in the study area. A researcher not associated with this project collected a sample of willow in 2014 within 1 km of Etna, Nevada, and identified it as red willow (*Salix laevigata* Bebb) (Southwest Environmental Information Network 2014). It is likely that the tree-like willow is red willow, but its identity was never confirmed, and it is referred to throughout this section as an unidentified willow.

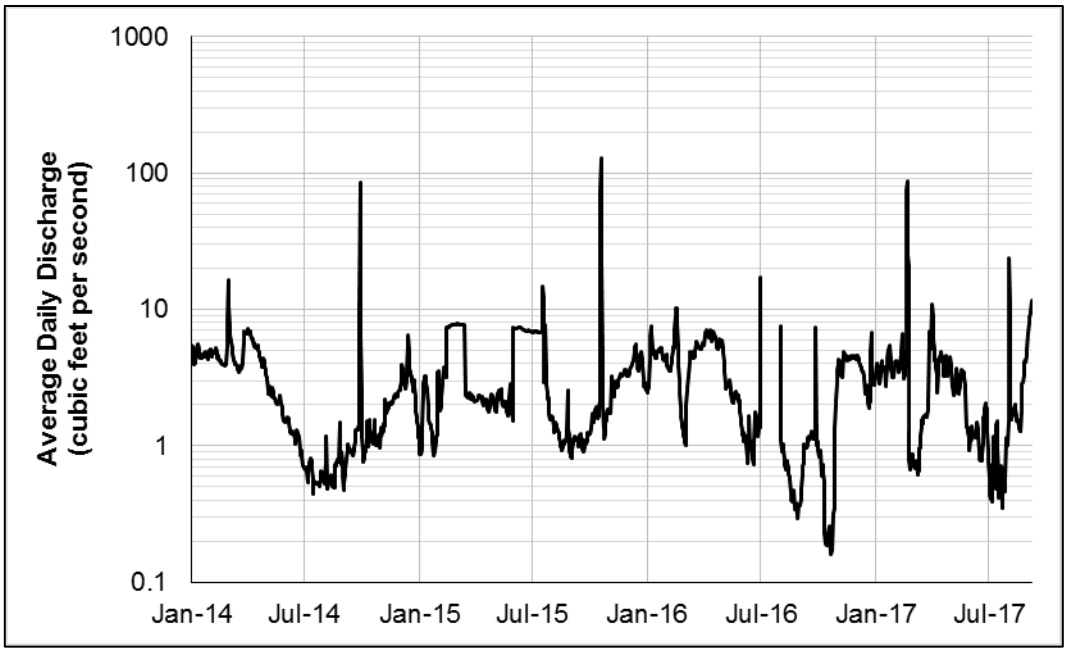

Figure 2-4.—Average daily discharge recorded in Meadow Valley Wash at Caliente, Nevada (U.S. Geological Survey Station #09418500), 2014–17.

Etna

Area: 0.5 ha Elevation: 1280 m

The survey site known as Etna was surveyed in 2014 and 2015. The site is approximately 7 km downstream from Caliente, Nevada, and consists of a strip of riparian vegetation approximately 25 m wide and 200 m long. In 2015, the dominant overstory consisted of an unidentified tree-like willow species 7–9 m in height and cottonwoods 5–6 m in height. Coyote willows were present in several small clumps 3–4 m in height both in the understory and as independent stands. Some 3-m-tall tamarisk were scattered in the understory. Canopy closure reached 90% in willow-dominated areas but was typically 80–85% and sometimes as low as 75%. No changes in vegetation structure or species composition were noted between 2014 and 2015.

A shallow stream 2–5 m wide ran through the site and contained surface water when each site description was recorded in both years. The banks of this stream were incised 1–1.5 m, and most soils away from the stream were dry. Given that water levels in Meadow Valley Wash did not fluctuate widely during the 2014 and 2015 breeding seasons (see figure 2-4), it is unlikely that soil moisture conditions fluctuated substantially from day to day.

No willow flycatchers were detected in 2014 or 2015. One cowbird was detected during one survey in both 2014 and 2015. Signs of horses were noted on four surveys in each year, and signs of cattle were noted during two surveys in 2015.

All the characteristics of preferred nesting habitat were present within small pockets in the site, but canopy closure in most of the site was lower than the criterion for suitable habitat (see table 2-1). Surveys were not conducted in 2016 or 2017 because effort was instead directed toward monitoring at Alamo Lake, Arizona.

Rock Springs Canyon

Area: 0.3 ha Elevation: 1218 m

The survey site known as Rock Springs Canyon was surveyed or monitored in 2016 and 2017. This site is approximately 7.9 km downstream from Etna and consists of a patch of habitat approximately 50 x 60 m in size. The dominant overstory of the site consists of coyote willows 3–6 m in height. Emergent 6–10-m-tall cottonwoods are present in the western side of the site, and some unidentified willow trees 4–6 m in height are found in the southern end. The stem diameter of all the trees is small, and very little deadfall was noted, indicating that this is a very young site. Canopy closure is typically 80–95% but is as low as 40% in the southern third of the site, where the coyote willows are less dense. No major changes in vegetation structure or species composition were noted between 2016 and 2017.

The site was not discovered until late June 2016, and surface water conditions at the site prior to its discovery are unknown. Several streams of varying depths meandered through various portions of the site when site descriptions were recorded in July 2016 and May, June, and July 2017. The streams were ponded in several places by beavers to a depth of 40 cm in 2016 and 70 cm in 2017. Soils away from the streams and ponds were damp to dry in both years. Water levels in this site are dependent upon both streamflow in Meadow Valley Wash, which did not fluctuate substantially during the 2017 survey season (see figure 2-4), and local beaver activity. Based on this, it is unlikely that soil moisture conditions changed substantially from day to day in 2017.

Rock Springs Canyon was occupied by two breeding flycatchers in 2016. No willow flycatchers were detected in 2017. No cowbirds were noted during either nest monitoring activities or surveys in either year. Signs of horses were noted during one visit in each year.

The northern two-thirds of the site has all the characteristics of preferred flycatcher nesting habitat (see table 2-1), whereas canopy closure in the southern third of the site does not reach levels typical of suitable flycatcher habitat. Examination of aerial imagery on Google Earth suggests vegetation within the site is less than 10 years old, and the site may increase in areal extent and density.

Dog Leg

Area: 10.3 ha Elevation: 1207 m

Dog Leg was surveyed from 2014 to 2017. The site is approximately 400 m downstream from Rock Springs Canyon and consists of a complex mosaic of vegetation types and hydrological conditions. Coyote willows 4–6 m in height are present throughout a majority of the site and form the main overstory in some places. Canopy closure within the coyote willows is typically 80–95% where wet soils are also present. In areas with predominantly dry soils, many of the coyote willows are either dead or dying, and canopy closure is as low as 50%. Tamarisk 5 m in height and averaging 85% canopy closure is sporadically mixed with the coyote willows throughout the site. Less than 5% of the tamarisk had yellow foliage in 2017 when the June site description was recorded, and no other signs of tamarisk beetles were recorded. Taller tree species, including cottonwood, velvet ash, and an unidentified willow species, are also present throughout the site. In some places, these trees are present as scattered, emergent individuals in larger coyote willow patches. In other places, these three tree species form an overstory 8–20 m in height, typically with 60–80% canopy closure. In places where soils are dry, the overstory is patchy and there is little to no understory. In wetter areas of the site where the taller tree species form an overstory, coyote willows and tamarisk are often present in the understory, and canopy closure reaches 95%. Wet soils are prevalent along the western border of the site, and dry soils are more prevalent along the eastern border. Dry soils vary in composition from clay to loose gravel bars. In areas where gravel is more dominant, tree stem density is lower, the proportion of snags is higher, and overall canopy closure is lower. In areas adjacent to standing water, canopy closure and tree stem density are higher. No major changes in vegetation structure or species composition were noted between 2014 and 2017.

Surface water was present when site descriptions were recorded in May, June, and July in 2014–17 in the form of a narrow stream that was braided in places and flowed through a small cattail marsh and several beaver ponds. The extent of the surface water varied among and within years, seemingly due to beaver activity, with 7 to 55% of the site containing wet soils. Water levels were higher during 2017 than in previous years. Soils away from the streams and beaver ponds were damp to dry when each site description was recorded.

Dog Leg was occupied by four to nine resident flycatchers annually in 2014–17. The NDOW detected two resident flycatchers in 2013. Cowbirds were detected during one to two surveys annually. Signs of horses were observed during three to five visits, and signs of cattle were observed during one to two visits in each year.

All the components of preferred nesting habitat (see table 2-1) are present in portions of the site with wet soils and dense canopy closure. Although the amount of wet soils has increased over the years with continued beaver dam

construction, a large portion of this site lacks the wet soils typical of preferred nesting habitat and the canopy closure needed for suitable habitat. Patches with all the components of preferred nesting habitat occur along the stream that flows through the site, especially in areas where the stream is braided and beaver ponds increase the amount of surface water within the woody vegetation.

Ford

Area: 1.8 ha Elevation: 1121 m

The survey site known as Ford is approximately 7 km downstream from Dog Leg and was surveyed in 2014 and 2015. In 2015, vegetation within the site consisted of an overstory of 10–12-m-tall cottonwoods and 8–10-m-tall willows (*Salix* sp.). The understory was dominated by coyote willows 3–5 m in height with a few scattered patches of velvet ash with similar height. A few mule-fat (*Baccharis salicifolia*) were scattered in the understory, and yerba mansa formed a dense groundcover in areas lacking a woody understory. Canopy closure was variable and ranged from 60 to 90%, with the densest canopy closure found in some areas of cottonwoods. No changes in vegetation structure or species composition were noted between 2014 and 2015.

A stream with several beaver ponds up to 15 m wide flows through the site. Surface water was noted in the stream and ponds when each site description was recorded in both years. Soils away from the stream were largely dry and sandy. Given that water levels in Meadow Valley Wash did not fluctuate widely during the 2014 and 2015 breeding seasons (see figure 2-4), it is unlikely that soil moisture conditions varied substantially from day to day.

No willow flycatchers were detected in 2014 or 2015. No cowbirds were detected in either year. Signs of cattle were observed during two surveys in 2015.

All the characteristics of preferred nesting habitat were present within small pockets in the site, but canopy closure in most of the site was lower than the criterion for suitable habitat (see table 2-1). Surveys were not conducted in 2016 or 2017 because effort was instead directed toward monitoring at Alamo Lake, Arizona.

Kyle

Area: 0.8 ha Elevation: 970 m

The survey site known as Kyle is approximately 13 km downstream from Ford and was surveyed in 2014 and 2015. In 2015, vegetation in the site consisted of an overstory of cottonwoods and velvet ash 10–15 m in height with an understory of scattered patches of coyote willows 3–4 m in height. Unidentified willow trees

up to 10 m in height were scattered throughout the site. A stream 1–4 m wide bisected the site from east to west; on the eastern side of the site, a beaver dam created a 10-m-wide pool. North of the stream, very little understory was present. South of the stream, coyote willows were more prevalent than elsewhere in the site and formed a distinct understory. Canopy closure was variable, ranging from 60 to 85%, and was densest north of the stream under taller cottonwoods. No changes in vegetation structure or species composition were noted between 2014 and 2015.

Surface water was noted in the stream when each site description was recorded in both years. Soils away from the stream were largely dry and sandy. Given that water levels in Meadow Valley Wash did not fluctuate widely during the 2014 and 2015 breeding seasons (see figure 2-4), it is unlikely that soil moisture conditions varied substantially from day to day.

No willow flycatchers were detected in 2014 or 2015. A cowbird was detected during one survey in 2014. Old signs of cattle were noted during two visits in 2014, and newer signs were noted during four surveys in 2015.

Although this site contained each element of suitable habitat (see table 2-1), there was no portion of the site where dense canopy closure and midstory structural components co-occurred. Surveys were not conducted in 2016 or 2017 because effort was instead directed toward monitoring at Alamo Lake, Arizona.

Cottonwood Canyon

Area: 1.3 ha Elevation: 939 m

The survey site known as Cottonwood Canyon was surveyed in 2014 and 2015. It is approximately 2.5 km downstream from Kyle, near the confluence of Meadow Valley Wash and Cottonwood Canyon. In 2015, a flowing stream bisected the site, and beaver dams formed several ponds. Cottonwoods 10–12 m in height, velvet ash 8–10 m in height, and an unknown willow species 8 m in height were scattered on either site of the stream, forming a loose canopy. Mule-fat and tamarisk up to 2 m in height formed the understory. Canopy closure under the cottonwoods and velvet ash was 50–90%. The very southwestern corner of the site was dominated by 5–6-m-tall tamarisk with 80–90% canopy closure. The far eastern portion of the site was dominated by very small-diameter, wispy coyote willows 3–5 m in height with up to 50% canopy closure. A steep, 3-m-tall bank bordered one of the beaver ponds on the northwestern edge of the site. Vegetation on top of the embankment included honey mesquite (*Prosopis glandulosa*) and arrowweed (*Pluchea sericea*). No changes in vegetation structure or species composition were noted between 2014 and 2015.

The stream held water when each site description was recorded in both years, but soils away from the channel were dry and sandy. Given that water levels in

Meadow Valley Wash did not fluctuate widely during the 2014 and 2015 breeding seasons (see figure 2-4), it is unlikely that soil moisture conditions varied substantially from day to day.

Cottonwood Canyon was unoccupied in both 2014 and 2015. No willow flycatchers were detected in 2014. In 2015, two willow flycatchers were detected on May 25. Neither of these individuals was detected during three subsequent monitoring visits or any subsequent surveys, and both were determined not to be resident. No cowbirds were detected in either year. Signs of cattle were noted during several surveys in both years. Signs of horses were noted during one survey in 2015.

Although each component of preferred nesting habitat occurred in places within the site, they tended not to co-occur. The area of coyote willows on the eastern end of the site has the greatest potential for developing into breeding habitat if both vegetation height and canopy closure increase. Surveys were not conducted in 2016 or 2017 because effort was instead directed toward monitoring at Alamo Lake, Arizona.

Ground Reconnaissance Results

East Stine

In 2014, a potential survey site known as East Stine was designated approximately 1.5 km upstream of Dog Leg. Vegetation within the area consisted of a 15–18-m-tall stand of cottonwoods and unidentified willows. Coyote willows up to 7 m in height were present in the understory in the western half of the site. Most of the coyote willows as well as parts of the overstory in the western half of the area were dead. Canopy closure varied from 70% in the western half of the site to 90% in the eastern half. All soils within the site were completely dry, and the nearest water was in an incised channel approximately 35 m away.

No willow flycatchers were detected during the survey in May 2014.

Although each structural component of preferred nesting habitat (see table 2-1) occurred in places within the site, they did not co-occur because the portions of the site with the highest canopy closure lacked any type of midstory structure. Habitat suitability did not seem likely to improve given the lack of surface water within the area, and no further visits were scheduled.

West Stine

In 2014, a potential survey site known as West Stine was designated 150 m west of East Stine. Vegetation in the area consisted of a 12-m-tall overstory of cottonwoods and unidentified willows with patches of coyote willows 7 m in

height in the understory. Overall, the vegetation structure looked suitable despite the coyote willows being mostly dead or very spindly. Canopy closure ranged from 80 to 90%. Soils were very dry with a loose, sandy texture during a visit in May. The nearest water was in an incised channel approximately 100 m to the east.

No willow flycatchers were detected during the survey in May 2014.

Much of the site had all the elements of suitable habitat, and portions of the site where canopy closure reached 90% had the structural elements of preferred nesting habitat but lacked wet soils (see table 2-1). The condition of the vegetation appeared to be declining, with many dead coyote willows. Vegetation health seemed unlikely to improve given the lack of wet soils, and the area was not scheduled for further visits.

Littlefield, Arizona

From 2003 to 2007, surveys were conducted at two adjacent sites near Littlefield, Arizona, on the Virgin River (McLeod and Pellegrini 2013). Both sites were completely scoured by floods during the 2004–05 winter, and surveys were discontinued in both sites by 2007. Starting in 2007, survey and monitoring activities focused on Beaver Dam Wash near the Highway 91 Bridge at the site known as Littlefield Poles. Prior to the 2010 survey season, a second patch of potentially suitable habitat, known as Pioneer Road, was identified upstream of Littlefield Poles. In December 2010, a flood (figure 2-5) scoured much of the area and changed the hydrology through sediment deposition. Both Littlefield Poles and Pioneer Road were evaluated at the beginning of subsequent seasons through 2013. At Reclamation's direction, SWCA did not visit the study area after 2013 due to safety concerns along the Virgin River.

Ground Reconnaissance Results

Littlefield Poles

Littlefield Poles was surveyed from 2007 to 2010. The site is on Beaver Dam Wash, approximately 1.2 km upstream of the confluence with the Virgin River. Prior to 2010, the site extended on both sides of the Highway 91 Bridge, but surveys were discontinued in the downstream portion of the site in 2010 because landowner permission could not be obtained to access the area. In December 2010, a flood (figure 2-5) scoured much of the wash. Sediments deposited by the flood shifted surface water from within the site to a channel about 40 m away. Canopy closure was also reduced to approximately 25% within the site (McLeod and Pellegrini 2013). The site was evaluated at the beginning of 2011 and 2012, but dense vegetation and wet soils were still lacking. The site was re-evaluated in 2013 to determine whether hydrology or vegetation structure had changed.

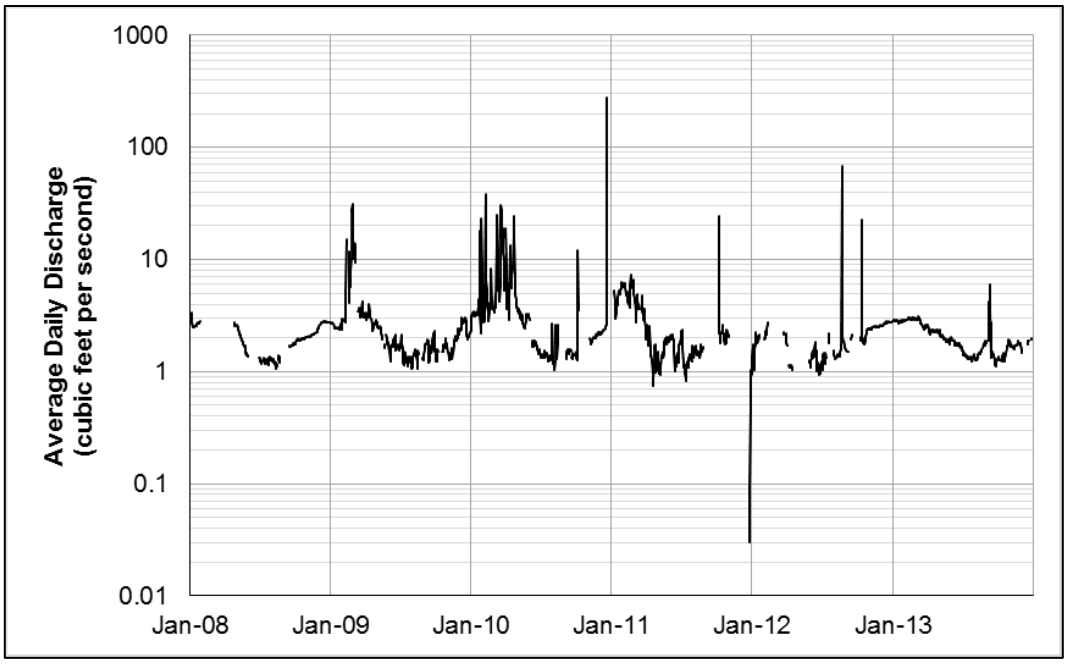

Figure 2-5.—Average daily discharge recorded in Beaver Dam Wash at Beaver Dam, Arizona (U.S. Geological Survey Station #09414900), 2008–13.

In 2013, vegetation along the northern edge of the site consisted of a scattered overstory of cottonwoods averaging 25 m in height. The southern portion of the site consisted of stands of coyote willows, young Goodding's willows, and cottonwoods 5 m in height. Two sandy, open areas were present along the length of the site near its center and southern edge. Canopy closure ranged from 50% in the sandy areas to 85% in areas of denser vegetation. No surface water was present when the May site description was recorded, and the nearest standing water was restricted to a channel in Beaver Dam Wash, about 40 m from the site. No significant change in flow within Beaver Dam Wash occurred during 2013 (see figure 2-5), and it is unlikely that soil moisture conditions changed during the flycatcher breeding season following the May site description.

No willow flycatchers were detected in 2013 during a visit to evaluate the habitat, but no broadcast surveys were conducted during the visit. Littlefield Poles was occupied in 3 years between 2007 and 2010 (McLeod and Pellegrini 2013). No willow flycatchers were detected in 2011 or 2012. No data on the presence of cowbirds or livestock sign were recorded during the visit in 2013.

Canopy closure increased noticeably between 2011 and 2013. In places where canopy closure reached 85%, all elements of suitable habitat were present (see table 2-1), but the wet soils typical of preferred nesting habitat were lacking. If survey efforts resume along Beaver Dam Wash in the future, a habitat assessment at this site would reduce the chance that suitable flycatcher habitat is overlooked.

Pioneer Road

A potential survey site known as Pioneer Road was visited in 2010 and 2012 for habitat reconnaissance and opportunistic surveys. The area is on Beaver Dam Wash approximately 1.2 km upstream of Littlefield Poles. Vegetation in the area was native in composition. In 2010, strips of dense coyote willows 3–4 m tall and 4 m wide bordered both sides of a stream that ran through the site. Away from the stream, soils were very dry, and vegetation consisted of scattered cottonwoods up to 15 m tall. Canopy closure was between 50 and 70%. In 2012, no surface water was noted within the site, and the nearest surface water was in Beaver Dam Wash, adjacent to a portion of the southern edge of the site. Vegetation still consisted of cottonwoods up to 15 m in height and coyote willows 3–5 m in height. Canopy closure had increased to 70–90%. Habitat reconnaissance was scheduled for 2013 to determine if surface hydrology had changed.

Vegetation in 2013 consisted of cottonwoods 5–7 m in height and coyote willows 4–6 m in height. Taller stands of cottonwoods up to 15 m in height were scattered around the wash. Canopy closure was continuous across the area at > 90%. One small cattail marsh held saturated soils and a small amount of standing water when the May site description was recorded. Soils were dry throughout the rest of the area, and dry leaves were noted covering the ground. A cut bank approximately 1 m in height existed along much of the western side of the area. No significant change in flow within Beaver Dam Wash occurred in 2013 (see figure 2-5), and it is unlikely that soil moisture conditions changed during the flycatcher breeding season following the May site description.

No willow flycatchers were detected in 2013 during a visit to evaluate the habitat, but no broadcast surveys were conducted during the visit. No willow flycatchers were detected in 2010 or 2012. No data on the presence of cowbirds or livestock sign were recorded during the visit in 2013.

All structural elements of preferred flycatcher habitat (see table 2-1) were present in 2013, but wet soils were lacking. Because of the lack of surface water, it was determined in 2013 that the area did not resemble typical occupied flycatcher breeding habitat, and formal surveys were not scheduled. If survey efforts resume along Beaver Dam Wash in the future, a habitat assessment at this site would reduce the chance that suitable flycatcher habitat is overlooked.

Mesquite, Nevada

MESQ is in the flood plain of the Virgin River near Mesquite and Bunkerville, Nevada. All sites at MESQ experienced flooding, scouring, and/or sediment deposition over the 2004–05 winter (figure 2-6). The study area experienced flooding again in December 2010, and although sediment deposition was minimal, scouring occurred in areas immediately adjacent to the main river channel. The study area has been defoliated annually by tamarisk leaf beetles

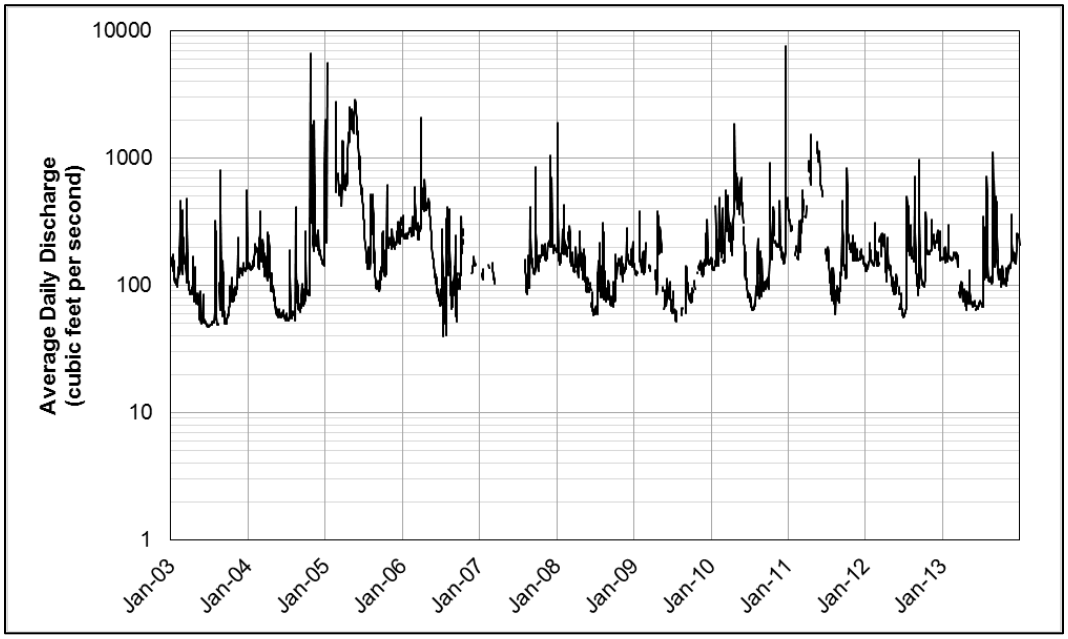

Figure 2-6.—Average daily discharge (cubic feet per second) recorded at the Virgin River at Littlefield, Arizona (U.S. Geological Survey Station #09415000), 2003–13.

since 2010, and as of 2013, the tamarisk had been damaged extensively by repeated defoliation. Surveys in 2013 were therefore limited to sites with native vegetation. At Reclamation's direction, no survey or monitoring activities were conducted at MESQ by SWCA after 2013 due to safety concerns along the Virgin River. The NDOW began monitoring flycatchers at MESQ in 2015.

Hafen Lane 01

Area: 2.1 ha Elevation: 475 m

The survey site known as Hafen Lane 01 in the city of Mesquite, Nevada, was surveyed opportunistically in 2006 and formally surveyed from 2010 to 2013. The site is bordered by Hafen Lane to the north and the active river channel to the south. Two drainage ditches pass under Hafen Lane and flow into the site. In 2013, vegetation in the site was mixed-exotic. The eastern inflow supported a dense stand of cottonwoods 8–12 m in height and Goodding's willows 6–8 m in height, with coyote willows 5 m in height in the understory. The western inflow supported a stringer of coyote willows 5–6 m in height with scattered, emergent Goodding's willows 12–15 m in height. The coyote willows at the very southern end of the western stringer had died. A few cottonwoods up to 25 m in height were scattered along both drainage ditches. *Baccharis* sp. were present in the understory at both inflows. Canopy closure reached 85% along the eastern inflow and 70% along the western inflow. Between the stringers, the site was vegetated by 6-m-tall tamarisk, much of which was over half dead, with 45–65%

canopy closure. The only changes in vegetation structure noted between 2010 and 2013 were a reduction in canopy closure within the tamarisk and mortality of some of the native vegetation.

Standing water was present within the eastern drainage ditch when two site descriptions were recorded in 2013. Wet soils were present when all three site descriptions were recorded in 2010 and 2012, and soils were dry in 2011 (McLeod and Pellegrini 2013). The source of water flowing into the drainage ditches is unknown, and the likelihood of water levels fluctuating from day to day is also unknown.

No willow flycatchers were detected in 2013. Hafen Lane 01 was occupied in 2010 and 2011, with two to three resident flycatchers recorded in each year (McLeod and Pellegrini 2013). Cowbirds were detected during all surveys in 2013. No signs of livestock were recorded. This site was not monitored after 2013.

All characteristics of suitable flycatcher habitat were present along the eastern inflow in 2013, but the rest of the site had canopy closure << 85% and thus did not meet all the criteria for suitable habitat (see table 2-1).

Dumb Luck Bridge

Area: 1.1 ha Elevation: 475 m

Dumb Luck Bridge is a mixed-native survey site near the city of Mesquite, Nevada. The site was discovered with breeding flycatchers mid-season in 2012 and was surveyed in 2013. The site is immediately upstream of the Riverside Road Bridge and is bordered to the south by a terrace. Vegetation on the terrace burned between 2008 and 2010 and had not yet recovered in 2013. The active channel of the Virgin River was approximately 100 m north of the site. In 2013, the site was dominated by 6-m-tall coyote willows with 75% canopy closure, which had declined from 70–90% in 2012. Clumps of emergent Goodding's willows 20 m in height were scattered throughout the site. Tamarisk were present throughout the site but were most abundant along the site edges. A few emergent cottonwoods were present along the northern edge of the western side of the site. An old road bisects the site north to south, and a drainage ditch from an irrigation canal flowed into an area of dense coyote and Goodding's willows just east of the road. By July 2013, many of the coyote willows along the southern edge of the site were dead or dying. Other than the mortality observed in the coyote willows, no changes in species composition or vegetation structure were observed between 2012 and 2013.

A small portion of the site (5%) was inundated when the May 2013 site description was recorded, but all other soils were dry and sandy. No wet soils

were noted when the June and July site descriptions were recorded in 2013. In 2012, up to 20% of the site contained wet soils, but soils in the remainder of the site were very dry and sandy (McLeod and Pellegrini 2013). The only source of surface water at the site was the outflow from the irrigation canal. Flow patterns in the canal are unknown, and it is therefore unknown whether soil moisture conditions at the site fluctuated from day to day.

No willow flycatchers were detected in 2013. The site was occupied by two breeding flycatchers in 2012 (McLeod and Pellegrini 2013). Cowbirds were detected during all surveys in 2013. No signs of livestock were recorded. No surveys or monitoring were conducted at this site after 2013.

Canopy closure did not exceed 75% in 2013, and the site thus did not meet all the criteria for suitable habitat (see table 2-1). Vegetation components with the potential to develop suitable structure given increased soil moisture remained in the site. If survey efforts resume along the Virgin River in the future, a habitat assessment at this site would determine whether conditions have improved and would reduce the chance that suitable flycatcher habitat is overlooked.

Mesquite West 01

Area: 11.7 ha Elevation: 470 m

Mesquite West 01 is a mixed-native survey site in the city of Mesquite, Nevada, that was surveyed from 2003 to 2013. The site is approximately 1 km downstream from the Riverside Road Bridge. The site is bordered by golf courses and housing developments to the north and by the Virgin River to the south. In 2013, vegetation within the site consisted of dense coyote willows 4–7 m in height with interspersed tamarisk. The eastern portion of the site was vegetated primarily with coyote willows, while the western portion contained a mix of coyote willows and tamarisk. Several small areas of dead coyote willows were present in the eastern and central portions of the site. Vegetation along the southern edge of the site was dominated by tamarisk with an understory of willow baccharis (*Baccharis salicina*) and occasional patches of common reed (*Phragmites australis*). Several emergent Russian olive, screwbean mesquite (*Prosopis pubescens*), and velvet ash trees were scattered throughout this portion of the site. Several areas of cattails and bulrush were present within the site and contained brown, dead vegetation during the 2013 season. These marshes occupied 3.7 ha in 2004 but decreased in size to 1.6 ha by 2013, with young coyote willows filling in the margins of the formerly open marshes. Canopy closure ranged from 30% in the areas of dead coyote willows to > 90% in areas of healthy coyote willows. In 2003–08, canopy closure varied from 50 to > 90%. Water availability became less consistent starting in 2009, and by 2012, canopy closure was the same as that observed in 2013 (McLeod and Pellegrini 2013).

Soils within the site were completely dry when the May, June, and July site descriptions were recorded in 2013. Soil moisture conditions at the site are influenced by irrigation return flows and by human manipulation of the channel that carries the return flows. From 2003 to 2008, wet soils were documented in the site throughout each flycatcher breeding season. In 2009, irrigation return flows were not present until the last week of June. When return flows resumed, they were present for 1 day at a time at roughly weekly intervals for the rest of the season, and only the eastern portion of the site was inundated. Soil moisture conditions in 2010 were similar to those noted in 2003–08. In June 2011, the channel that carries the return flows was dredged, resulting in all return flows bypassing the site. The site remained dry until April 2012, when a berm was constructed in the channel to direct flow into the northeastern corner of the site. The site was intermittently inundated throughout the 2012 survey season. When surface water was present, it only reached a portion of the area that had been inundated in previous years. During the 2013 survey season, the channel had become incised sufficiently to allow all water to bypass the site.

Mesquite West 01 was occupied by two breeding flycatchers in 2013. Breeding flycatchers were documented by the NDOW in each year in 2015–17, with the number of breeding flycatchers increasing from 3 in 2015 to 12 in 2017. In 2003–12, 6–30 resident adults were detected annually. Cowbirds were detected during all surveys in 2013. Old signs of cattle were observed but were limited to the southern and western edges of the site.

In 2013, all the structural characteristics of preferred nesting habitat were present within portions of the site, but wet soils were lacking (see table 2-1). In 2015–17, habitat suitability improved as wet soils were present intermittently and coyote willows continued to fill the marshes (M.A. McLeod and A. Pellegrini, personal observation).

Electric Avenue Pond

Area: 1.7 ha Elevation: 464 m

Electric Avenue Pond was opportunistically surveyed in 2012 and formally surveyed in 2013. The site is approximately 2 km downstream from Mesquite West 01, near Bunkerville, Nevada. It is bordered to the north by riparian vegetation and to the south by agricultural fields. In 2013, vegetation within the site was composed primarily of coyote willows 4–6 m in height. Several small cattail patches formed a mosaic with the coyote willows, and cattails were present in the understory in many places. Several emergent cottonwoods were also scattered along the southern edge of the site. Overall canopy closure was 85–90%. This was a young site, and the coyote willows increased noticeably in height and density between 2012 and 2013.

When the May and July site descriptions were recorded in 2013, 90–100% of the site contained wet soils. Soil moisture conditions were not recorded in June. Similar surface hydrology was noted during opportunistic surveys in 2012 (McLeod and Pellegrini 2013). Hydrology at this site is influenced by agricultural return flows, and water levels fluctuated through the 2013 season. Soil moisture conditions could have varied from day to day between site descriptions, but it is likely that some portion of the site contained at least saturated soils throughout the season.

Electric Avenue Pond was occupied in 2013 by one resident, unpaired male flycatcher. Two to five breeding and/or resident flycatchers were documented by the NDOW annually in 2015–17. No willow flycatchers were detected in 2012 (McLeod and Pellegrini 2013). Many cowbirds were detected in 2013. Signs of cattle were noted throughout the site.

All the elements of preferred nesting habitat (see table 2-1) were present in 2013 and in 2015–17 (M.A. McLeod and A. Pellegrini, personal observation).

Ground Reconnaissance Results

Ball Park

Habitat reconnaissance was completed in 2012 at a potential survey site known as Ball Park. The area is approximately 200 m upstream of Hafen Lane 01. It is bordered by a park and housing developments to the north and patchy riparian vegetation in the active flood plain to the south. In 2012, patches of habitat with suitable structure and density were < 10 m wide, and no surface water was present in or near the area. Further reconnaissance was scheduled in 2013 to determine if the areal extent of suitable vegetation had increased and if surface hydrology had improved.

In 2013, vegetation in the area was mixed-exotic in composition. The area was dominated by 6-m-tall tamarisk that were mostly dead, with an emergent overstory of 12–15-m-tall Goodding's willows and scattered 18–20-m-tall cottonwoods. Several small (10 x 20 m) patches of coyote willows 3–6 m in height with 75–85% canopy closure were scattered throughout the site. Canopy closure throughout the rest of the site averaged 60% and in places was below 50%. Dense patches of 2-m-tall cattails were also present in the understory. Most of the tamarisk were brown and leafless during reconnaissance in May 2013.

A shallow, 1–3-m-wide stream meandered through the area during a visit in May 2013. There was no obvious source for the water, and the active river channel was more than 300 m to the south. There are springs in the area (J. Willis 2016, personal communication), and one of these springs could be the water source.

No broadcast surveys were conducted during habitat evaluations in 2012 and 2013, and no flycatchers were detected.

Vegetation that met all the criteria of suitable habitat was present only in the coyote willow patches, which barely met the criteria for patch width and canopy closure (see table 2-1). No change in the areal extent of the coyote willow patches was noted between 2012 and 2013, but the patches could have grown in subsequent years. If survey efforts resume along the Virgin River in the future, a habitat assessment at this site would determine whether conditions have improved and would reduce the chance that suitable flycatcher habitat is overlooked.

Up Creek

A potential survey site known as Up Creek was visited in 2012 for habitat reconnaissance and opportunistic surveys. The site is near the city of Mesquite, Nevada, approximately 1 km upstream of the Riverside Road Bridge, and is bordered by the active channel of the Virgin River to the north and upland desert to the south. When the site was first assessed in 2012, it was determined that existing patches of native vegetation were too short to be considered suitable habitat and that surface water was limited to a very small portion of the site. Further reconnaissance was completed in 2013 to determine if either vegetation height or the extent of wet soils had increased.

In 2013, vegetation in the site was mixed-native in composition. Emergent, 20-m-tall cottonwoods were scattered throughout the site. In the eastern third of the site, vegetation consisted of tamarisk 4–5 m in height with 40–60% canopy closure. Several emergent Goodding's willows were scattered amongst the tamarisk. At the western edge of this portion of the site, an outflow channel from an irrigation canal bisected the site and flowed into the Virgin River. Vegetation in the center of the site consisted of a mosaic of patches of Goodding's willows and cottonwoods up to 9 m in height, tamarisk 4–7 m in height, arrowweed, and dry sandy clearings. Canopy closure ranged from < 25% in the clearings to 40–60% in the tamarisk and up to 85% in the patches of native trees. A 20- x 40-m patch of coyote willows 3–4 m in height with 70% canopy closure was present along the southern edge of the site. The western end of the site was vegetated with Goodding's willows up to 8 m in height with an understory of willow baccharis, coyote willows 2 m in height, and arrowweed. Common reed was also present.

Standing water was present in the outflow channel during two visits in 2012 and three visits in 2013. Soils throughout the rest of the site, and immediately adjacent to the channel, were dry. The outflow channel was incised as was the active river channel adjacent to the site. While river levels and outflow levels likely fluctuated during the 2012 and 2013 seasons, it is unlikely that they

increased enough to result in inundated soils within a larger portion of the site. No willow flycatchers were detected in either 2012 or 2013. Cowbirds were detected during all surveys. No signs of livestock were recorded.

All the components of suitable habitat were present in small patches within the site, but the remainder of the site had canopy closure << 85% and thus did not meet all the criteria for suitable habitat (see table 2-1). The area was not added as a formal survey site because most of it lacked suitable vegetation structure. If flood events alter the surface hydrology within the area, the areal extent of suitable vegetation structure could increase. If survey efforts resume along the Virgin River after a future flood event, a habitat assessment at this site would determine whether conditions have improved and would reduce the chance that suitable flycatcher habitat is overlooked.

Mormon Mesa, Nevada

For approximately 15 km upstream of its confluence with the Muddy River, the Virgin River flows through a 1-km-wide flood plain with a mosaic of habitats, including cattail marshes and tamarisk and willow forest. River levels are seasonally influenced by snowmelt in spring and monsoon rains in mid- and late summer, and the entire study area experienced severe flooding over the 2004–05 and 2010–11 winters (see figure 2-6). Soil moisture conditions within the survey sites are influenced by water from the Virgin River that surfaces in areas away from the main river channel. All survey sites at MOME are at least 10 km upstream of the Muddy River confluence. Tamarisk at MOME were defoliated by tamarisk beetles in July 2011 and throughout the summer of 2012 and experienced extensive dieback as the result of these defoliation events. Surveys in 2013 were therefore limited to areas with native vegetation. Cowbirds were detected during most surveys in all years from 2003 to 2013. All survey sites were used extensively by cattle. At Reclamation's direction, no activities were conducted by SWCA at MOME after 2013 due to safety concerns along the Virgin River. The NDOW monitored flycatchers at recently occupied sites at MOME in 2015–17.

Mormon Mesa South (North)

Area: 6.0 ha Elevation: 385 m

The survey site known as Mormon Mesa South (North) was surveyed from 2003 to 2013. Over that time, the areal extent of the site was reduced by three-quarters as on-the-ground reconnaissance identified areas of poor suitability. In 2013, vegetation was mixed-exotic in composition and consisted of a scattered overstory of Goodding's willows 12–15 m in height with a patchy understory of tamarisk 4–6 m in height. A few of the Goodding's willows reached 20 m in height. The willows varied in condition, with the healthiest located in the center of the site.

The rest of the willows were dead or dying. Arrowweed and dead cattails were also scattered in the understory. Overall canopy closure ranged from < 50 to 70%, depending on the health and spacing of willows and the degree of tamarisk dieback. The overall condition of willows in the site declined between 2003 and 2013, and most of the willows in formerly surveyed portions of the site died.

No wet soils were recorded in 2013, but damp soils were noted when the May and June site descriptions were recorded. Wet soils were recorded on at least one site description in 2003, 2004, and 2006 (McLeod and Pellegrini 2013). Since 2007, only damp soils have been recorded in the site. No overbank flooding occurred during the 2013 breeding season (see figure 2-6), and soil moisture conditions likely did not fluctuate substantially from day to day.

No willow flycatchers were detected in 2013, and the site was not monitored in 2014–17. Mormon Mesa South (North) was unoccupied in 2003–12 (McLeod and Pellegrini 2013).

In 2013, canopy closure throughout the site was << 85%, and the site thus did not meet all the criteria for suitable habitat (see table 2-1). An increase in soil moisture could improve the condition of the willows, but changes in soil moisture are unlikely to occur without a large flood event. If survey efforts resume along the Virgin River after a future flood event, a habitat assessment at this site would determine whether conditions have improved and would reduce the chance that suitable flycatcher habitat is overlooked.

Mormon Mesa South (South)

Area: 2.2 ha Elevation: 385 m

Mormon Mesa South (South) is contiguous with and immediately south of Mormon Mesa South (North) and was surveyed from 2003 to 2013. Over that time, the areal extent of the site was reduced by three-quarters as areas of poor suitability were identified. In 2013, vegetation within the site was mixed-exotic and consisted primarily of tamarisk 4–6 m in height, with scattered Goodding's willows 12–15 m in height along the northern and western borders. The willows varied in health, with the healthiest located on the western edge of the site. The rest of the willows were dead or dying. Overall canopy closure ranged from < 50 to 70%, depending on the health and spacing of willows and the degree of tamarisk dieback. The overall health of willows in the site declined between 2003 and 2013, and most of the willows had more dead branches and sparser canopies than the willows in Mormon Mesa South (North).

There was no surface water within the site in 2013, but damp soils were noted when the May and June site descriptions were recorded. In 2003, some inundated soils were noted when the May site description was recorded. Soils were either

damp or dry when all other site descriptions were recorded since May 2003. No overbank flooding occurred during the 2013 breeding season (see figure 2-6), and soil moisture conditions likely did not fluctuate substantially from day to day.

No willow flycatchers were detected in 2013, and the site was not monitored in 2014–17. Mormon Mesa South (South) was unoccupied in 2003–12.

In 2013, canopy closure throughout the site was << 85%, and the site thus did not meet all the criteria for suitable habitat (see table 2-1). An increase in soil moisture could improve the health of the willows, but changes in soil moisture are unlikely to occur without a large flood event. If survey efforts resume along the Virgin River after a future flood event, a habitat assessment at this site would determine whether conditions have improved and would reduce the chance that suitable flycatcher habitat is overlooked.

Virgin River 01 North

Area: 3.4 ha Elevation: 380 m

The survey site known as Virgin River 01 North was surveyed from 2003 to 2013. Over that time, the area surveyed was reduced by more than 90% from its original extent as areas of poor suitability were identified. Changes in surface hydrology have also reduced the suitability of some formerly occupied areas within the site.

Vegetation in the site is mixed-exotic and from 2003 to 2013 consisted primarily of tamarisk 4–6 m in height with areas of emergent, 10-m-tall Goodding's willows. In 2003 to 2007, the emergent willows were primarily in the eastern half of the original survey area, with another patch along the northwestern edge. By 2008, the emergent willows in the northeastern portion of the original survey area were completely dead as a result of sediment deposition during a flood over the 2004–05 winter and a corresponding shift in the distribution of surface water within the site. By 2013, two patches of emergent willows remained, with one in the central portion and one in the southwestern portion of the original survey area. The survey area in 2013 was reduced to encompass only the two emergent willow patches. Canopy closure in 2013 was 70–85% under the willows and < 50% in areas with only tamarisk.

When the 2013 site descriptions were recorded, wet soils were present in several braided channels in and near the two Goodding's willow patches, though the areal extent of wet soils was significantly smaller in July compared to earlier in the season. A seasonal reduction in areal extent of wet soils was also noted in 2003–12, though the extent and distribution of wet soils shifted among years (McLeod and Pellegrini 2013). No overbank flooding occurred during the 2013 breeding season (see figure 2-6), and soil moisture conditions likely did not fluctuate substantially from day to day.

Virgin River 01 North was occupied in 2013 by one resident, unpaired male that was detected in the southwestern corner of the site from May 23 to June 3. The NDOW monitored this site in 2015 and detected one resident flycatcher. The site was occupied during 8 years in 2003–12, with one to eight resident flycatchers detected annually during years of occupancy (McLeod and Pellegrini 2013).

In 2013, the Goodding's willow patches had canopy closure that met the minimum criterion for suitable habitat and had all the remaining characteristics of preferred nesting habitat. The remainder of the site had canopy closure that was << 85% and thus did not meet all criteria for suitable habitat.

Virgin River 01 South

Area: 5.9 ha Elevation: 380 m

Virgin River 01 South is a survey site immediately to the south of and contiguous with Virgin River 01 North. It was surveyed from 2004 to 2013, following opportunistic surveys in 2003. Over the years, the area surveyed was reduced by more than 75% from its original extent as areas of poor suitability were identified. Changes in surface hydrology have also reduced the suitability of some formerly occupied areas within the site.

From 2003 to 2006, the site was described as primarily dense, dry tamarisk 5 m in height with 80% canopy closure. A few emergent Goodding's willows were noted along the northeastern and southern portions of the original survey area. In 2007, a marsh was found in the northwestern corner of the site. The 2013 survey area encompassed only this marsh and the immediately surrounding area. Vegetation in 2013 consisted primarily of tamarisk 4–6 m in height with patches of 6-m-tall coyote willows and scattered Goodding's willows 8–12 m in height. A cattail marsh was present in the very center of the site. Canopy closure varied from > 90% in areas of dense willows to 25–50% in tamarisk and marshy openings.

Inundated soils were documented when the May and June site descriptions were recorded in all years and sometimes when July site descriptions were recorded, though the areal extent and distribution of surface water shifted among years (McLeod and Pellegrini 2013). From 2003 to 2006, surface water was documented only in the southern portion of the original survey area. Starting in 2007, inundated soils were no longer observed in the southern portion of the original survey area, and the only documented surface water was in the northwestern marsh encompassed by the most recent survey area. In 2013, wet soils were present in the cattail marsh and some of the surrounding willows when each site description was recorded. No overbank flooding occurred during the 2013 breeding season (see figure 2-6), and soil moisture conditions likely did not fluctuate substantially from day to day.

Virgin River 01 South was occupied in 2013 by 16 resident or breeding flycatchers. The NDOW monitored this site starting in 2015, and six or seven breeding and/or resident flycatchers were documented in each year in 2015–17. The site was occupied annually in 2006–12 by 3–25 breeding flycatchers (McLeod and Pellegrini 2013). No willow flycatchers were detected in 2003–05.

In 2013, the dense willow patches met all the criteria for preferred nesting habitat (see table 2-1). Areas vegetated by tamarisk had canopy closure << 85% and thus did not meet all criteria for suitable habitat. Habitat characteristics at the site in 2015–17 were similar to those present in 2013 (M.A. McLeod, personal observation).

Ground Reconnaissance Results

Virgin River 02

The survey site known as Virgin River 02 received extensive sedimentation from the flood in December 2010. The depth of new sediment ranged from 15 to 60 cm and was most extensive in the southern portion of the site. Because of the lack of standing water and overall poor habitat quality, surveys were discontinued at this site in 2012 (McLeod and Pellegrini 2013). The site was re-evaluated in 2013 to determine whether conditions had changed.

In 2013, the site consisted primarily of tamarisk 4–6 m in height with a stringer of emergent, 15-m-tall Goodding's willows along the eastern edge. Many of the Goodding's willows had dead branches, and canopy closure within the willows ranged from 60 to 85%, while closure in the tamarisk was < 50%. The Virgin River, on the eastern edge of the site, had surface water when the May site description was recorded, but a high bank prevented the water from entering the site, and soils within the site were completely dry.

No broadcast surveys were conducted during the habitat evaluation in 2013, and no flycatchers were detected. Neither soil moisture conditions nor overall habitat quality improved between 2012 and 2013.

Although canopy closure reached suitable density in the patches of Goodding's willows, these areas lacked a live understory or midstory and thus did not have the structural components typical of suitable flycatcher habitat (see table 2-1). Habitat suitability at this site is unlikely to improve without a large flood event. If survey efforts resume along the Virgin River after a future flood event, a habitat assessment at this site would determine whether conditions have improved and would reduce the chance that suitable flycatcher habitat is overlooked.

Muddy River, Nevada

MUDD is located along the Muddy River in the Overton Wildlife Management Area near Overton, Nevada. Within the study area, the Muddy River is contained within a narrow, incised channel. River levels typically fluctuate during the flycatcher breeding season but are generally not high enough to result in overbank flooding (figure 2-7), and soils away from the river channel are typically dry. Tamarisk in this study area were defoliated by tamarisk beetles throughout the breeding season of 2012, and a reduction in live tamarisk canopy has been evident in some areas since 2013. Some amount of defoliation by tamarisk beetles was noted within the study area in each year in 2013–17.

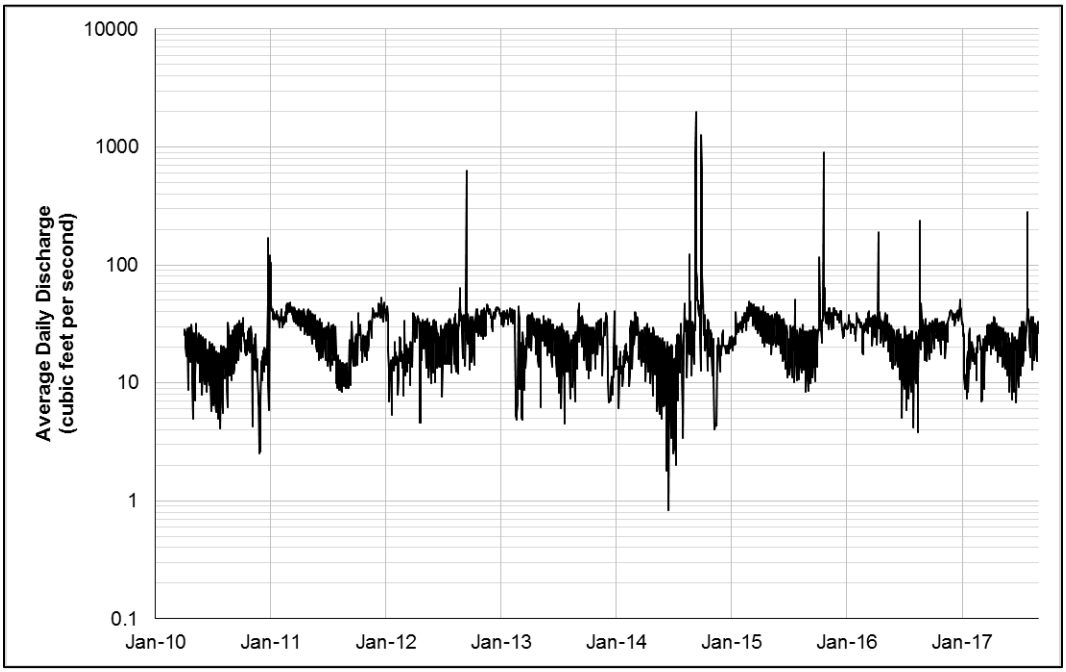

Figure 2-7.—Average daily discharge (cubic feet per second) recorded at the Muddy River at Lewis Avenue in Overton, Nevada (U.S. Geological Survey Station #09419507), 2010–17.

Overton WMA Pond

Area: 0.7 ha Elevation: 378 m

The survey site known as Overton WMA Pond was surveyed from 2007 to 2017. It consists of a patch of mixed-native vegetation approximately 150 m long and 75 m wide at the northern end of the Overton Wildlife Management Area just south of Honeybee Reservoir. A channel that was dredged prior to the 2014 survey season bisects the site from north to south and carries outflow from the reservoir. The dominant vegetation consists of Goodding's willows 10–15 m in height and 3–6-m-tall tamarisk. The two species rarely overlap, and there is only a sparse understory beneath the Goodding's willows. Arrowweed and common

reed are present in scattered, dense patches within and along the edges of the site. Common reed is also present along the channel in patches up to 4 m wide. Canopy closure is variable, ranging from 75 to 85% in the Goodding's willows and by the channel to up to 95% in the dense tamarisk patches. In areas under the Goodding's willows where there is little understory, yerba mansa forms a dense groundcover. No major changes in species composition or vegetation structure were noted between 2007 and 2017.

Surface water was present in the channel when site descriptions were recorded in May and June in 2014–17 and July in 2014 and 2016–17, with soils away from the channel being mostly dry. All soils were dry when each site description was recorded in 2013. Similar patterns in surface hydrology (i.e., surface water was intermittently present in the channel, and soils away from the channel were mostly dry) were noted in 2007–12 (McLeod and Pellegrini 2013). Water levels in the channel are dependent on releases from Honeybee Reservoir and could fluctuate. However, Honeybee Reservoir is not a large body of water, and the resulting outflow is unlikely to affect the site beyond the immediate vicinity of the channel. Overall soil moisture conditions within the site likely did not change substantially between site descriptions.

Overton WMA Pond was unoccupied in 2013–17. No willow flycatchers were detected in 2013, 2015, or 2017. Three willow flycatchers were detected before June 24 in both 2014 and 2016. Field personnel followed up on each detection with three subsequent monitoring visits, but no further detections were recorded during the monitoring visits or on subsequent surveys. None of the willow flycatchers were determined to be resident. Overton WMA Pond was occupied by a breeding pair of flycatchers in 2007 and a single, resident flycatcher in 2012 (McLeod and Pellegrini 2013). Cowbirds were detected during two to five surveys annually in 2013–17. No signs of livestock were recorded in any year.

Some portions of the site have all the characteristics of preferred nesting habitat (see table 2-1). These areas are limited in areal extent, however, and the remainder of the site lacks the dense canopy closure and midstory structural components typical of suitable habitat.

Overton WMA

Area: 5.9 ha Elevation: 375 m

The survey site known as Overton WMA was surveyed from 2004 to 2017. It is a mixed-exotic survey site that lies along the Muddy River approximately 600 m south of Overton WMA Pond and is bordered to the southwest by open agricultural fields and to the northeast by sparser areas of riparian vegetation. Since 2013, the survey area has been reduced by one-third from its original extent

as areas of poor suitability were identified. The site now consists of two disjunct polygons. The two polygons are described separately, as vegetation structure and species composition differ between them.

The northern polygon is 50–70 m wide by 550 m long and is bisected along its length by the Muddy River. This portion of the site is dominated by very dense tamarisk 6–8 m in height with canopy closure ranging from 50 to 90%. Vegetation is tallest on the eastern bank of the river channel, reaching 8 m in height. Vegetation height, density, and canopy closure decrease with increasing distance from the channel. Many of the tamarisk were noted in 2013–17 as heavily damaged from defoliation by tamarisk beetles, and the tops of many trees are dead, resulting in a ragged upper canopy with no uniform canopy height. Several small patches of coyote willows 4–5 m in height with 80–90% canopy closure are present on the eastern bank of the river near the southern end of this portion of the site. Two stretches of the Muddy River channel within the northern polygon were dredged with heavy equipment over the 2007–08 winter, resulting in a cleared swath 10–15 m wide on the western bank of the river. This swath is now thickly vegetated with quailbush (*Atriplex lentiformis*), willow baccharis, and tamarisk 2–3 m in height. Canopy closure in this area is as low as 20%. The only changes in species composition since surveys began have been in the cleared swath, but canopy closure in the tamarisk has decreased from an estimated 70–90% prior to 2013. The river channel in the northern polygon contained flowing water when site descriptions were recorded in May, June, and July in all survey years. Soils outside the channel were generally dry in all survey years, and the channel has been incised 1–2 m below the surrounding land surface since dredging. The breeding area in the northern polygon contained more braided channels with flowing water prior to dredging (McLeod and Pellegrini 2013).

The northern polygon of Overton WMA was occupied in 2013–17, with two to eight resident flycatchers detected annually. This portion of the site was also occupied in 2004–07 and 2012, with one to four resident flycatchers detected each year (McLeod and Pellegrini 2013).

The southern polygon consists of a 125- x 275-m stand of mixed-exotic vegetation along an old channel of the river. This portion of the site is dominated by a stand of Goodding's willows 8–15 m in height with a tamarisk understory 4–6 m in height. Many of the Goodding's willows have fallen over or lost limbs, creating gaps in the canopy. Within areas dominated by Goodding's willows, canopy closure ranges from 60% in areas with large gaps to 90% in the few areas of denser vegetation. Several open areas with dead cattails are scattered throughout the southern polygon, with willow baccharis present in the southwestern corner. A 25- x 20-m patch of coyote willows up to 5 m in height with 90% canopy closure is present near the center of the southern polygon. The densest, most suitable vegetation is located between the center and the southern edge of the polygon. The far eastern end of the southern polygon is primarily 3–6-m-tall tamarisk with 85–95% canopy closure. The Muddy River flows into the northern end of the southern polygon and then splits into two channels; one

channel runs through the site and the other skirts its southwestern edge. The channel that runs through the site was dredged in 2005 as part of the efforts at the Overton Wildlife Management Area to repair flood damage to the water control system. Following dredging, the channel carried water into a network of smaller, braided channels that flowed through the southern polygon, but it slowly filled in with sediment and cattails and has been dry since 2013. Since 2013, the river has flowed only in the channel along the southwestern boundary of the site. As is the case with the channel in the northern polygon, this channel is incised 1–2 m below the surrounding soil. It contained the only surface water observed in the southern polygon when site descriptions were recorded in May, June, and July in 2013–17. As noted above, river depth fluctuated regularly, but soils away from the channel were generally dry throughout the 2013–17 survey seasons.

The southern polygon was occupied in 2013 and 2016 by three and two resident flycatchers, respectively. The southern polygon was considered occupied in 2017, when one willow flycatcher was detected on July 7 but was not detected on any subsequent monitoring visits or surveys and was not considered resident in the site. No willow flycatchers were detected in the southern polygon in 2014. In 2015, four willow flycatchers were each detected for 1 day prior to June 24. The southern polygon was occupied in 2005–12, with 8–13 resident flycatchers detected annually (McLeod and Pellegrini 2013). Cowbirds were detected during all surveys in 2013–17. No signs of livestock were recorded.

All the characteristics of preferred nesting habitat are present within 10–15 m of the bank along a 150-m stretch of river in the northern polygon. A patch of vegetation approximately 50 x 50 m in size in the south-central portion of the southern polygon has all the vegetative components of preferred nesting habitat but lacks wet soils. Most of the remainder of the site has canopy closure well below 85% and thus does not meet all criteria for suitable habitat.

Ground Reconnaissance Results

Secret Marsh

In 2013, a potential survey site known as Secret Marsh was designated within the riparian zone approximately 2.8 km downstream from the Overton WMA survey site. Vegetation in 2013 was composed primarily of tamarisk 2–4 m in height with 70% canopy closure. A cattail marsh was present along the eastern side of the area. Water from the marsh extended under the tamarisk, and wet soils were present in several areas during habitat reconnaissance in late June.

No broadcast surveys were conducted during the habitat evaluation in 2013, and no willow flycatchers were detected.

In 2013, neither canopy closure nor canopy height at this site met the criteria for suitable habitat (see table 2-1). Given the widespread dieback of tamarisk along the Muddy River as the result of defoliation by tamarisk beetles, it is unlikely that habitat suitability at the site has improved.

Warm Springs, Nevada

WMSP is in the Warm Springs Natural Area at the northern end of the Moapa Valley, at the headwaters of the Muddy River. Surface water occurs in the study area in several incised stream channels and some low-lying areas. The streams are perennial, but there is an obvious seasonal drying trend in the intermittently wet, low-lying areas. On July 1, 2010, a portion of each survey site at WMSP was burned by a wildfire. Because of the severity of fire damage, surveys were discontinued after the fire at all sites except Muddy Mac. Personnel continued to monitor the recovery of vegetation at Muddy Stringer 01, and surveys resumed at this site in 2014. Tamarisk beetles were first noted near WMSP in 2011, but defoliation within the survey sites was not noted until 2017.

Muddy Mac

Area: 0.9 ha Elevation: 535 m

Muddy Mac is a native survey site near the head of Apcar Stream that is bordered by a grassy field to the west and a small cattail marsh to the east and south. It was surveyed or monitored from 2010 to 2017. The northern half of the site was heavily damaged in the 2010 fire, and the overstory was completely killed. Dense basal regeneration of velvet ash has occurred, resulting in dense clusters of stems, and this half of the site was again included in surveys starting in 2016. Most of the site is vegetated with velvet ash 5–15 m in height. In the northern half of the site, the velvet ash are 8 m in height in the middle and 5 m in height along the edges with 85–95% canopy closure. The understory structure is relatively open, despite the dense canopy closure, as each tree comprises a cluster of narrow stems spaced relatively far from the next cluster. A few emergent cottonwoods and palm trees (*Washingtonia* sp.) are scattered in this portion of the site. The southeastern quarter of the survey site consists of closely spaced, small-diameter (5–8 cm), single stems of velvet ash 6–7 m in height with no understory and 80–90% canopy closure. The close spacing of the stems creates a stand that feels very dense, yet the canopy of each tree in this portion of the site is relatively sparse, resulting in lower canopy closure than in the northern half. Canopy closure in this portion of the site has decreased slightly from > 90% in 2010–12. The southwestern quarter of the site is dominated by sparse velvet ash 12–15 m in height with 60–70% canopy closure. This portion of the site has an understory layer consisting of sparsely distributed regenerating 4–5-m-tall velvet ash,

tamarisk, and a few honey mesquite, with thick grasses and yerba mansa forming a dense groundcover in areas without an understory. The area immediately south of the site has been cleared as part of a restoration effort.

Surface water was present in the southern portion of the site when each May site description was recorded, though the extent of wet soils varied among years, with 50% in 2013 and 15–35% in 2014–17. Soils quickly dried out during each year in 2013–17, and < 10% of the site contained wet soils when the June site description was recorded in both in 2013 and 2015, the July site description was recorded in 2014, and the June and July site descriptions were recorded in 2017. Soils were otherwise dry or damp, and the adjacent cattail marsh also lacked wet soils in some years. Similar seasonal drying trends were noted in 2010–12, though a majority of the site contained wet soils in May, and the adjacent cattail marsh contained standing water throughout the survey season in each of those years (McLeod and Pellegrini 2013). This site is not directly connected to any of the perennially flowing streams in the study area. It is unlikely that any substantial day-to-day fluctuations in soil moisture conditions occurred.

Muddy Mac was occupied in 2014 and 2017 by one resident, unpaired male flycatcher and two breeding flycatchers, respectively. No willow flycatchers were detected in 2013, 2015, or 2016. The site was occupied in 2010–12, with two to three resident flycatchers detected annually (McLeod and Pellegrini 2013). Occupancy in 2011, 2012, and 2014 was limited to the unburned southeastern portion of the site. The breeding pair in 2017 was in the regenerated northern portion of the site. Cowbirds were detected during two to five surveys annually in 2013–17. No signs of livestock were recorded in any year.

The northeastern three-quarters of the site contains all the vegetation characteristics of preferred nesting habitat (see table 2-1), but wet soils were present only in a very small portion of this area. Habitat suitability would be improved if wet soils covered a larger areal extent and persisted at least through June. The southwestern quarter of the site had canopy closure ≤ 70% and thus did not meet all criteria for suitable habitat.

Muddy Stringer 01

Area: 0.8 ha Elevation: 530 m

The survey site known as Muddy Stringer 01 was surveyed or monitored in 2010 and 2014–17. Surveys were not conducted in 2011–13 because of damage from the July 1, 2010, fire. The site is approximately 100 m north of the main stem of the Muddy River and contains two distinct portions: a narrow, linear northern arm and a bulbous southern end. A narrow stringer of 10–15-m-tall palm trees runs the entire length of the site along an irrigation canal. The northern arm of the site is dominated by the palm tree stringer, which consists of widely spaced single trees. The understory of the northern arm contains several stands of arrowweed

and scattered clumps of tamarisk or velvet ash that are 5 x 5 m in size and no more than 2 m tall. Areas in the northern arm lacking woody vegetation are covered by dense yerba mansa. Canopy closure in the northern stringer reaches 25%. Near the very northern end of the site is a small patch of coyote willows approximately 5 x 20 m in size, reaching 5 m in height and 60–80% canopy closure. The southern end of the site is vegetated with two distinct vegetation types. The western half of the southern end is vegetated with 4–6-m-tall coyote willows with 80–95% canopy closure, a dense groundcover of yerba mansa, and a relatively open midstory. The eastern half of the southern end is vegetated in a more heterogeneous mix of 5–8-m-tall velvet ash and 5-m-tall tamarisk on either side of the palm tree stringer. Honey mesquite and cattails are also scattered throughout the eastern half. Canopy closure in the eastern half of the southern end ranges from 40 to 95%. Approximately 5% of the tamarisk within the site were yellow in July 2017, although all the tamarisk in the surrounding area were yellow or defoliated. No changes in vegetation structure or species composition have been noted since 2014.

Standing water was present in the channel when site descriptions were recorded in May of 2014–17. Wet soils were present in the channel when the June site descriptions were recorded in 2015–17. Almost all soils were dry when the July site descriptions were recorded in 2014–17. A similar seasonal drying trend was noted in 2010 (McLeod and Pellegrini 2013). This site is not directly connected to any of the perennially flowing streams in the study area, and water levels are subject to seasonal drying trends.

Muddy Stringer 01 was occupied in 2014–17, with one to three resident flycatchers detected annually. The site was also occupied in 2010 by three resident flycatchers (McLeod and Pellegrini 2013). Cowbirds were detected during surveys in all years. No signs of livestock were recorded in 2014–17.

The northern arm of this site does not provide the patch width, canopy closure, or midstory structure typical of suitable flycatcher habitat (see table 2-1). The small coyote willow patch at the northern end of the site could develop into suitable habitat if it increased in areal extent and density. Surveys could be discontinued in the northern arm of the site without the possibility of overlooking resident flycatchers because of the current lack of suitable habitat. Evaluating the coyote willow patch at the beginning of future seasons to determine whether it has developed into suitable habitat, and resuming surveys if it has, would ensure that no suitable habitat is overlooked. The eastern half of the southern end of the site contains all the characteristics of preferred nesting habitat, although wet soils were restricted to the channel in 2014–17. The western half of the southern end of the site lacks the midstory structural elements typical of suitable habitat, and canopy closure in some areas is < 85%. Habitat suitability would be improved if canopy closure within the coyote willows increased and a dense midstory vegetation layer developed, and if the areal extent of wet soils increased within the site.

Topock Marsh, Arizona

Topock Marsh lies within the Havasu National Wildlife Refuge and encompasses over 3,000 ha of open water, cattail and bulrush marsh, and riparian vegetation. A large expanse (over 2,000 ha) of riparian vegetation occupies the Colorado River flood plain between the Colorado River on the western edge of the flood plain and the open water of Topock Marsh on the eastern edge of the flood plain. TOPO is in this large expanse of riparian vegetation, which is primarily tamarisk with isolated patches of tall Goodding's willows. Seasonally wet, low-lying areas are interspersed throughout the riparian area. Marsh elevation data recorded at the South Dike gaging station show that marsh levels were lowered starting in 2010 in preparation for construction of the Firebreak Canal, a new water delivery channel. Construction was completed between the 2011 and 2012 breeding seasons, and water levels within Topock Marsh were noticeably higher starting at the beginning of the 2012 season than they were in 2011 (figure 2-8). In August 2015, a wildfire burned through TOPO north of the Firebreak Canal, consuming all or most of each survey site within the burned area. Habitat within the burned area began to regenerate in 2016 but is still completely unsuitable for flycatchers, and only sites south of the Firebreak Canal were surveyed or monitored in 2016–17. Tamarisk beetles had not yet reached TOPO by the end of the 2016 flycatcher breeding season, but beetles were detected in August 2016 on the eastern side of Topock Marsh, near the community of Golden Shores. In May 2017, tamarisk beetles were noted in TOPO, and the first full defoliation occurred by mid-June. Cowbirds were detected throughout the study area in all survey years. Feral pigs are present throughout the TOPO study area, and signs of pigs were observed in most survey sites in 2003–16. In 2017, signs of pigs were recorded only in the Glory Hole and Hell Bird survey sites.

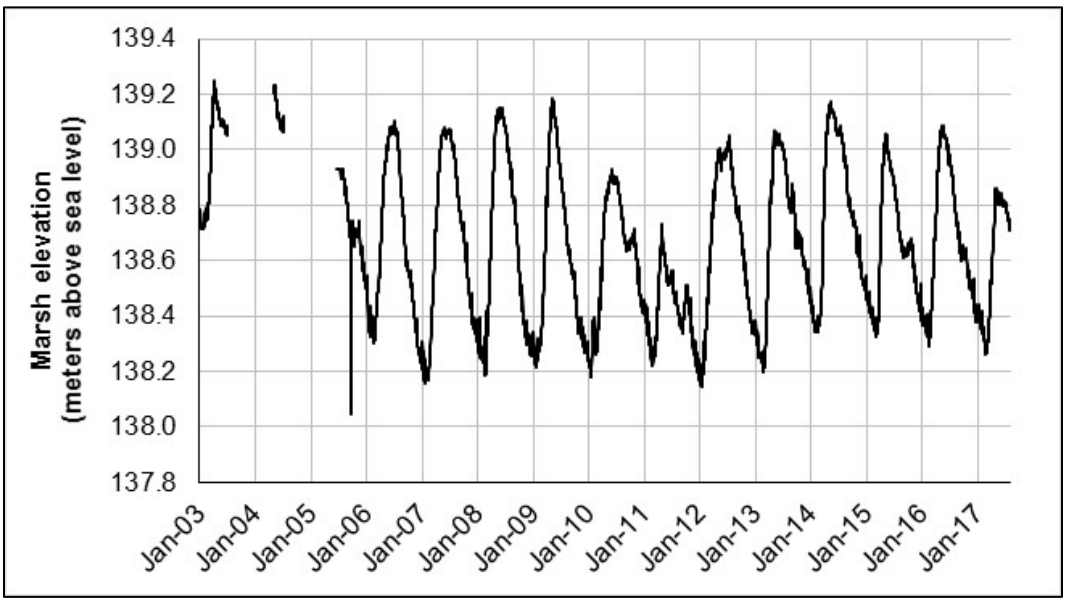

Figure 2-8.—Daily marsh elevation (meters above sea level) measured at the South Dike at Topock Marsh, 2003–17.

Pipes 01

Area: 5.2 ha Elevation: 140 m

Pipes 01 was a survey site consisting of exotic vegetation that was surveyed from 2003 to 2015. Surveys were discontinued after the August 2015 fire, when the site was completely consumed. No major changes in vegetation structure or species composition were recorded during the years prior to the August 2015 fire. The site was bordered to the east by the refuge road and consisted primarily of tamarisk 6–8 m in height. Arrowweed occurred in dense patches within 50 m of the refuge road. The tamarisk were densest and tallest within 100 m of the refuge road, with vegetation reaching 7–8 m in height and canopy closure reaching 80–95%. The tamarisk were shorter (6–7 m tall) and more open (70–85% canopy closure) toward the western edge of the site. Deadfall was scattered throughout the understory in clumpy patches.

Soils were dry in 2013 and 2015 when each site description was recorded. In 2014, soils were dry when site descriptions were recorded in May and June but saturated in July as the result of recent rain events. Wet soils were recorded on one site description in each year in 2003–07, and only dry soils were recorded in 2008–12 (McLeod and Pellegrini 2013). Water levels within the site are dependent on the elevation of Topock Marsh, which did not fluctuate widely during any flycatcher breeding season in 2003–15, though a seasonal decrease in marsh elevation was evident in each year (see figure 2-8). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

No willow flycatchers were detected in 2013–15. The site was considered occupied in 2 years between 2003 and 2012 (McLeod and Pellegrini 2013). Though no formal assessment was conducted in 2017, a quick examination of the area indicated that vegetation at the site lacked all structural characteristics of suitable flycatcher habitat (see table 2-1).

Pipes 03

Area: 5.7 ha Elevation: 140 m

Pipes 03 was a survey site consisting of mixed-exotic vegetation that was surveyed from 2003 to 2015. Surveys were discontinued after the August 2015 fire, when the site was completely consumed. No major changes in vegetation structure or species composition were recorded during the years prior to the fire. This site was bordered to the east by the refuge road. Arrowweed occurred in dense patches within 50 m of the road. Most of the site was vegetated by tamarisk 5–7 m in height. A few emergent Goodding's willows up to 15 m in height and open areas with willow baccharis and bulrush were present in the southern portion of the site. Canopy closure ranged from 70 to 90% in most of the site but was as low as 60% in the open areas surrounding the willows.

Wet soils were present in the southern portion of the site near the Goodding's willows when site descriptions were recorded in May and June in 2013–15. The amount of wet soils documented when the July site descriptions were recorded varied from 15% of the site in 2013 to 0% in 2015. Wet soils were recorded on at least one site description annually in 2003–10 and 2012, but all soils were dry in 2011 (McLeod and Pellegrini 2013). Water levels within the site are dependent on the elevation of Topock Marsh, which did not fluctuate widely during any flycatcher breeding season in 2003–15, though a seasonal decrease in marsh elevation was evident in each year (see figure 2-8). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

Pipes 03 was unoccupied in 2013–15. No willow flycatchers were detected in 2013, and detections of a single willow flycatcher on a single day prior to June 24 were recorded in 2014 and 2015. These individuals were determined not to be resident, as there were no further detections recorded on any of three subsequent monitoring visits or on subsequent surveys. The site was occupied in 8 years between 2003 and 2012 (McLeod and Pellegrini 2013).

Though no formal assessment was conducted in 2017, a quick examination of the area indicated that vegetation at the site lacked all structural characteristics of suitable flycatcher habitat (see table 2-1).

The Wallows

Area: 0.7 ha Elevation: 140 m

The survey site known as The Wallows was surveyed from 2005, when it was discovered with breeding flycatchers, to 2015. Surveys were discontinued after the August 2015 fire, when the site was completely consumed. No major changes in vegetation structure or species composition were recorded during the years prior to the fire. This site was located 30 m west of the refuge road, and the eastern edge of the site was dry and dominated by 2-m-tall arrowweed. Vegetation in the rest of the site was predominately tamarisk 5–8 m in height with emergent Goodding's willows in the western half of the site. The Goodding's willows surrounded an open cattail marsh, which was a dominant feature in the southwestern corner of the site. Overall canopy closure ranged from 50% in the marshy area to 90% in the tamarisk.

Wet soils were present within the cattail marsh when each site description was recorded in 2013–15, except in July 2015. Soils away from the marsh were primarily dry. Wet soils were also present in the cattail marsh when each site description was recorded in every year from 2005 to 2012 except 2011 (McLeod and Pellegrini 2013). Water levels within the site are dependent on the elevation of Topock Marsh, which did not fluctuate widely during any flycatcher breeding

season in 2003–15, though a seasonal decrease in marsh elevation was evident in each year (see figure 2-8). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

The Wallows was occupied in 2013–15. Breeding flycatchers were detected in 2015, and one resident, unpaired male flycatcher was detected in 2013. In 2014, no resident flycatchers were detected, but the site was considered occupied because of the detection of a willow flycatcher on July 16. No further detections were recorded on any of three subsequent monitoring visits or on subsequent surveys, and this individual was determined not to be resident. The site was occupied in 5 years between 2005 and 2012 (McLeod and Pellegrini 2013).

Though no formal assessment was conducted in 2017, a quick examination of the area indicated that vegetation at the site lacked all structural characteristics of suitable flycatcher habitat (see table 2-1).

PC 6-1

Area: 4.8 ha Elevation: 140 m

The survey site known as PC 6-1 was opportunistically surveyed in 2003 and formally surveyed from 2004 to 2015. Surveys were discontinued after the August 2015 fire, when the site was completely consumed. No major changes in vegetation structure or species composition were recorded during the years prior to the fire. This mixed-exotic site was bordered to the east by the refuge road, and thick stands of arrowweed occurred within 50 m of the road. Most of the site was vegetated with tamarisk 5–6 m in height. Emergent Goodding's willows approximately 10–15 m in height were scattered throughout the southern two-thirds of the site. Several large patches of arrowweed 1–2 m in height were also present in the southern portion of the site, along the southern and western borders. Canopy closure in the interior of the site averaged 90%, while canopy closure on the eastern side of the site near the refuge road was approximately 50%.

Wet soils were present when each site description was recorded in 2013–15, except in July 2015. Soil moisture conditions within the site largely did not vary from this pattern in 2003–12, except in 2005 and 2011, when no wet soils were recorded, and in 2010, when water was recorded only in a few pig wallows that quickly dried out (McLeod and Pellegrini 2013). Water levels within the site are dependent on the elevation of Topock Marsh, which did not fluctuate widely during any flycatcher breeding season in 2003–15, though a seasonal decrease in marsh elevation was evident in each year (see figure 2-8). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

PC 6-1 was unoccupied in 2013–15. One willow flycatcher was detected for 1 day in late May of 2014 and 2015. No further detections were recorded on any of three subsequent monitoring visits or on subsequent surveys, and these

individuals were determined not to be resident. No willow flycatchers were detected in 2013. The site was occupied in 3 years between 2003 and 2012 (McLeod and Pellegrini 2013).

Though no formal assessment was conducted in 2017, a quick examination of the area indicated that vegetation at the site lacked all structural characteristics of suitable flycatcher habitat (see table 2-1).

Pig Hole

Area: 2.4 ha Elevation: 140 m

Pig Hole was surveyed in 2004–11 and 2013–15. Surveys were discontinued after the August 2015 fire, when the site was completely consumed. No major changes in vegetation structure or species composition were recorded during the years prior to the fire. The site was discovered during the 2004 breeding season with breeding flycatchers. The site was not surveyed in 2012 in favor of hydrology monitoring elsewhere in the study area. During the survey years, the site consisted of tamarisk 6–8 m in height with canopy closure ranging from 70 to 90%. Tamarisk along the northern edge of the site had many wispy branches and smaller-diameter stems than in the rest of the site. The northern portion of the site also had the highest stem density, and the center of the site, where flycatchers were detected, was less dense. A few dense patches of arrowweed were present on the eastern edge of the site, which was within 50 m of the refuge road.

Inundated soils were present when the May site description was recorded in 2013–15 but not when the June or July site descriptions were recorded. Some amount of wet soils was noted in 2004 and 2007–09, but the site was mostly dry or damp in other years (McLeod and Pellegrini 2013). Water levels within the site are dependent on the elevation of Topock Marsh, which did not fluctuate widely during any flycatcher breeding season in 2003–15, though a seasonal decrease in marsh elevation was evident in each year (see figure 2-8). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

No willow flycatchers were detected in Pig Hole in 2013–15. The site was occupied in 2 years between 2004 and 2011 (McLeod and Pellegrini 2013).

Though no formal assessment was conducted in 2017, a quick examination of the area indicated that vegetation at the site lacked all structural characteristics of suitable flycatcher habitat (see table 2-1).

In Between

Area: 7.7 ha Elevation: 140 m

The survey site known as In Between was surveyed from 2003 to 2015. Surveys were discontinued after the fire, when the site was completely consumed. The site consisted of tamarisk 6–8 m in height. The lowest 3 m of the stand generally lacked foliage, resulting in a relatively open understory. Canopy closure was 70–90% in most years, but in 2015, canopy closure was 60–90%, and the percentage of the site with 90% canopy closure was lower than in previous years.

The western edge of the site bordered a marsh. Some wet soils were present when the May site description was recorded in 2013 and 2014; soils were damp or dry when all other site descriptions were recorded in 2013–15. Some amount of wet soils was noted on at least one site description in previous years, except in 2010 (McLeod and Pellegrini 2013). The site was artificially flooded in 2011 in an attempt to improve habitat suitability. In other years, water levels within the site were dependent on the elevation of Topock Marsh, which did not fluctuate widely during any flycatcher breeding season in 2003–15, though a seasonal decrease in marsh elevation was evident in each year (see figure 2-8). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

No willow flycatchers were detected in 2013–15. The site was occupied in 2003–08 and unoccupied in 2009–12 (McLeod and Pellegrini 2013).

Though no formal assessment was conducted in 2017, a quick examination of the area indicated that vegetation at the site lacked all structural characteristics of suitable flycatcher habitat (see table 2-1).

800M

Area: 4.7 ha Elevation: 140 m

The survey site known as 800M was surveyed from 2003 to 2015. Surveys were discontinued after the August 2015 fire, when the site was almost completely consumed. The site was bordered to the east by In Between, to the west by Pierced Egg, and to the south by the refuge road. The eastern half of the site consisted of a cattail and bulrush marsh with clumps of tamarisk 5–7 m in height and scattered, emergent Goodding's willows. The remainder of the site was vegetated by tamarisk 4–7 m in height, with the shortest tamarisk in the northern portion of the site. Canopy closure in the tamarisk was 80–90% throughout most of the site, except where it dropped to 70% along the western and northern edges. Canopy closure in the marsh was around 60%. Until the fire, a reduction in canopy closure along the western and northern edges of the site was the only major change in vegetation structure since 2012.

Wet soils were present when each site description was recorded in 2013–15, except in July 2015. Wet soils were also present in at least part of the season in all years in 2003–12 except for 2010 (McLeod and Pellegrini 2013). In 2011, 800M received supplemental water, and the cattail and bulrush marsh contained varying amounts of wet soils through early July. In other years, water levels within the site were dependent on the elevation of Topock Marsh, which did not fluctuate widely during any flycatcher breeding season in 2003–15, though a seasonal decrease in marsh elevation was evident in each year (see figure 2-8). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

800M was occupied in 2015 by one resident, unpaired male flycatcher. No willow flycatchers were detected in 2013 or 2014. The site was occupied during 8 years between 2003 and 2012 (McLeod and Pellegrini 2013).

Though no formal assessment was conducted in 2017, a quick examination of the area indicated that vegetation at the site lacked all structural characteristics of suitable flycatcher habitat (see table 2-1).

Pierced Egg

Area: 6.7 ha Elevation: 140 m

Pierced Egg was surveyed from 2003 to 2015. Surveys were discontinued after the August 2015 fire, when the site was completely consumed. The site was bordered by 800M to the east and the refuge road to the south. Vegetation was mixed-exotic and consisted of dense tamarisk 7 m in height, with a scattered overstory of Goodding's willows 15 m in height. Areas with willows tended to have a more open understory and contained patches of cattails and bulrush. Overall canopy closure was approximately 80% but was as low as 70% along the eastern edge.

Some amount of wet soils was present when each site description was recorded in 2013–15, though wet soils were confined to deep pig wallows when the July 2015 site description was recorded. Similar patterns in soil moisture conditions were recorded in 2003–12 (McLeod and Pellegrini 2013). Water levels within the site are dependent on the elevation of Topock Marsh, which did not fluctuate widely during any flycatcher breeding season in 2003–15, though a seasonal decrease in marsh elevation was evident in each year (see figure 2-8). Soil moisture conditions therefore likely did not fluctuate substantially from day to day.

Pierced Egg was occupied in 2015 by a pair of breeding flycatchers. The site was unoccupied in 2013 and 2014, though one and three willow flycatchers were detected in each year, respectively, before June 24. No further detections were recorded on any of three subsequent monitoring visits or on subsequent surveys, and these individuals were determined not to be resident. Pierced Egg was

occupied by resident flycatchers in 7 years between 2003 and 2012 and was considered occupied in an 8th year because of the detection of a flycatcher after June 24 (McLeod and Pellegrini 2013).

Though no formal assessment was conducted in 2017, a quick examination of the area indicated that vegetation at the site lacked all structural characteristics of suitable flycatcher habitat (see table 2-1).

Swine Paradise

Area: 0.9 ha Elevation: 140 m

Swine Paradise is a mixed-exotic survey site adjacent to the Firebreak Canal and was surveyed annually from 2003 to 2017. In 2011, a 40-m-wide section of habitat was bulldozed through the northern end of the site in preparation for construction of the Firebreak Canal. The site consisted of two disjunct polygons on either side of the canal until the fire in 2015, which burned most of the polygon on the northern side of the canal. Vegetation in the southern polygon consists 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 are significantly shorter in the very southern quarter of the site, with no woody vegetation exceeding 8 m in height. A dense, 25- x 60-m patch of coyote willows 4–7 m in height is present in the northeastern corner of the site, adjacent to the Firebreak Canal, with the shorter trees in this range adjacent to the marsh. Examination of Google Earth imagery suggests that the coyote willows expanded in areal extent starting in 2010. Large patches of arrowweed dominate the understory in the southern half of the site. Canopy closure is 70–80% under the Goodding's willows and 85–90% in the coyote willows. At the beginning of the 2017 season, canopy closure in the tamarisk was 90% in the northern half of the site and 80% in the southern half. Canopy closure decreased later in the season as the tamarisk became defoliated. Tamarisk were beginning to turn yellow in a small portion of the site in May, were mostly yellow or brown in early June, and were defoliated in mid-June and early July.

The coyote willow patch was inundated in 2013–16 when site descriptions were recorded in May, June, and July and contained wet soils in 2017. The remainder of the site was dry during all visits. Wet soils were present when site descriptions were recorded in May and June 2004; May 2007; May, June, and July 2008; and June and July 2012 (McLeod and Pellegrini 2013). Soils were otherwise dry within the site. Swine Paradise borders the open water of Topock Marsh, and water levels within the site vary directly with those in the marsh (see figure 2-8); therefore, water levels did not fluctuate substantially from day to day.

Swine Paradise was occupied in 2013–16, with two to five resident flycatchers detected annually. In 2017, four willow flycatchers were detected, each for 1 day prior to June 24, and the site was unoccupied. None of these individuals were

detected during subsequent monitoring visits or surveys, and none were determined to be resident. Swine Paradise was occupied in 2004 but not in any other year in 2003–12 (McLeod and Pellegrini 2013).

The coyote willows in the northeastern corner of the site provide the canopy closure of suitable flycatcher habitat and all other elements of preferred nesting habitat (see table 2-1). Tamarisk in the northern half of the site provided all the characteristics of preferred nesting habitat at the beginning of the 2017 season, but canopy closure dropped below suitable levels when the tamarisk became defoliated. The southern half of the site lacks flight paths in the midstory and has canopy closure ≤ 80% and thus does not meet all criteria for suitable habitat.

Platform

Area: 1.9 ha Elevation: 140 m

The survey site known as Platform was surveyed from 2003 to 2017. In 2010, the extent of the site was expanded when a pair of breeding flycatchers was discovered south of the original survey area. The site lies between the main refuge road to the west and open bulrush and cattail marsh to the east. Vegetation at the site is exotic and consists primarily of tamarisk 8–10 m in height with a few emergent Goodding's willows 15–18 m in height. A few screwbean and honey mesquite trees are present along the western edge of the site. Two disjunct patches of coyote willows up to 5 m in height are present along the eastern edge of the site, adjacent to the marsh. The northern patch is approximately 60 m long and 5–10 m wide, though scattered coyote willows extend into the site up to 30 m from the eastern edge. This patch was noted as expanding in areal extent starting in 2013. The southern coyote willow patch is approximately 35 x 60 m in size. Before 2017, canopy closure was 90% in the tamarisk and 70% in the coyote willows. Canopy closure in the tamarisk declined to 60–85% during the 2017 survey season as the tamarisk became defoliated. Tamarisk within the site were completely green when the May site description was recorded, all yellow or brown when the June site description was recorded, and defoliated in July. Other than the expansion in areal extent of the coyote willows and the reduction of canopy closure following defoliation, no changes in vegetation structure or species composition have been noted since 2003.

Wet soils along the very eastern edge of the site bordering the marsh were recorded on two to three site descriptions annually in 2013–16. In 2017, wet soils were noted along the eastern edge only in May. The remainder of the site was very dry in all years. Similar patterns of wet soils along the marsh edge and dry soils in the interior were noted in 2003–12 (McLeod and Pellegrini 2013). Platform borders the open water of Topock Marsh, and water levels within the site vary directly with those in the marsh (see figure 2-8); therefore, water levels did not fluctuate substantially from day to day.

Platform was occupied in 2016 by one resident, unpaired male flycatcher. One and three willow flycatchers were each detected for 1 day before June 24 in 2013 and 2014, respectively, and the site was unoccupied. No willow flycatchers were detected in 2015 or 2017. Platform was occupied in 2010 and 2011 by one to two resident flycatchers but was unoccupied in all other years in 2003–12 (McLeod and Pellegrini 2013).

Prior to defoliation, all components of preferred nesting habitat (see table 2-1) were present in a narrow strip along the edge of the marsh. During defoliation, however, canopy closure did not exceed 85% anywhere in the site and was much lower than 85% in many places. The interior of the site has an extremely dense midstory and lacks the flight paths typical of suitable and preferred habitat.

250M

Area: 1.6 ha Elevation: 140 m

The survey site known as 250M was surveyed from 2003 to 2017. The site lies between the main refuge road to the northwest and open marsh to the southeast. Vegetation is mixed-exotic, and both composition and structure vary with distance from the road. Most of the site is vegetated with tamarisk 4–8 m in height. A few emergent Goodding's willows approximately 12–15 m in height are present near the marsh. Honey mesquite 9 m in height are also scattered throughout the site. A patch of coyote willows 45 x 90 m in size and 5–7 m in height is present along the northern edge of the site. Canopy closure is 70% in areas with Goodding's willows but was not thoroughly described in the coyote willows. Prior to defoliation by tamarisk beetles, canopy closure in the tamarisk was 60–95% and averaged 85%, but it declined to 60–70% when the tamarisk became defoliated in 2017. Tamarisk were all green when the May site description was recorded and defoliated when the June and July site descriptions were recorded. Other than the decline in canopy closure, no major changes in vegetation structure or species composition were noted between 2003 and 2017. The extent of the survey area was changed prior to the 2016 survey season, when the western border was redrawn, removing a portion of the site with tamarisk 3–4 m in height from the survey area, and the northern border was redrawn to completely include the coyote willow patch.

Only dry or damp soils were noted on site descriptions in 2013–17. Wet soils were recorded on at least one site description in each year in 2003–04 and 2006–09 (McLeod and Pellegrini 2013). The highest water levels were noted in May of 2003 and 2004, with 30–40% of the site containing wet soils. 250M borders the open water of Topock Marsh, and water levels within the site vary directly with those in the marsh (see figure 2-8); therefore, water levels did not fluctuate substantially from day to day.

250M was occupied in 2017 by a pair of breeding flycatchers. In 2016, one willow flycatcher was detected on 1 day prior to June 24, and the site was unoccupied. No willow flycatchers were detected in 2013–15. 250M was occupied in 2004–06 by one to two resident flycatchers and was considered occupied in 2009 because of the detection of a willow flycatcher on June 25 (McLeod and Pellegrini 2013). This individual was not detected on any subsequent monitoring visit or survey and was not considered resident in the site.

Prior to defoliation, all characteristics of preferred nesting habitat (see table 2-1) were present in patches near the marsh edge of the site. The interior of the site lacked the wet soils typical of preferred habitat and the flight paths in the understory typical of suitable habitat. Portions of the site also lacked dense canopy closure. During defoliation, all areas dominated by tamarisk had canopy closure that was too low to meet the criterion for suitable habitat. Canopy closure in the coyote willows at the northern end of the site was not recorded on any site description, but all other characteristics of preferred nesting habitat were present in the coyote willows throughout the season.

Hell Bird

Area: 5.8 ha Elevation: 142 m

The survey site known as Hell Bird was surveyed from 2003 to 2017. The site is on an island separated from the main riparian area by a narrow, deep channel. It is bordered to the north by the open channel and to the east and south by marshes. Vegetation within the site is mixed-exotic, and vegetation composition and structure are highly variable. The site is vegetated with a mosaic of tamarisk 6–8 m in height and Goodding's willows 12–15 m in height. Screwbean mesquite trees 4–6 m in height and arrowweed are scattered throughout the site. Marshes vegetated by cattails and bulrush are also interspersed throughout the site, totaling approximately 50% of the areal extent of the site. In areas with emergent Goodding's willows, canopy closure is 50–90%, with an average of 75%. Canopy closure was 70–85% at the beginning of the 2017 season in areas dominated by tamarisk but declined to 50% when the tamarisk became defoliated in June and July. Other than the tamarisk defoliation in 2017, no major changes in species composition or vegetation structure have been noted since 2003.

The marshes were inundated up to 80 cm in depth when site descriptions were recorded in May, June, and July in 2013–16. In 2017, no more than 30% of the site contained wet soils when any site description was recorded, and water depth was 14–40 cm. Adjacent soils were dry to damp in 2013–17. Similar patterns in surface hydrology were noted in 2003–12 (McLeod and Pellegrini 2013). The marshes in the site are connected to Topock Marsh, and water levels within the site vary directly with those in Topock Marsh; therefore, water levels did not fluctuate substantially from day to day.

Hell Bird was occupied by one to three resident flycatchers in 2013, 2015, and 2017. One willow flycatcher was detected in 2016 on July 25. No detections were recorded on three subsequent monitoring visits, and this individual was determined not to be resident. Because the detection was after July 20, this site was considered unoccupied in 2016. No willow flycatchers were detected in 2017. Hell Bird was occupied in 3 years between 2003–12 by one to seven resident flycatchers (McLeod and Pellegrini 2013).

All components of preferred nesting habitat (see table 2-1) are present in several small patches distributed within the larger matrix of the site. These patches are generally areas where Goodding's willows are present. Canopy closure in some tamarisk-dominated areas met the criterion for suitable habitat prior to tamarisk defoliation in 2017 but was too low to meet the suitability criterion during defoliation.

Glory Hole

Area: 6.4 ha Elevation: 143 m

The survey site known as Glory Hole was surveyed from 2003 to 2017. It 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 within the site is mixed-exotic, and both vegetation composition and structure are highly variable. The site is vegetated primarily by a mosaic of tamarisk 6–8 m in height and Goodding's willows 12–15 m in height. Screwbean mesquite trees 9–10 m in height are scattered throughout the site. Marshes vegetated by cattails and bulrush are also interspersed throughout the site. In areas with Goodding's willows, canopy closure is 30–90%, averaging 60%. Canopy closure in areas dominated by tamarisk was 75–80% at the beginning of the 2017 season but declined when the tamarisk became defoliated in June and July. Other than the tamarisk defoliation in 2017, no major changes in species composition or vegetation structure have been noted since 2003. The survey area was expanded prior to the 2016 survey season to include potentially suitable habitat to the east.

The marshes, totaling approximately 40% of the areal extent of Glory Hole, were inundated to 20–80 cm in depth when site descriptions were recorded in May, June, and July in 2013–17. Adjacent soils were dry to damp in all years. Similar patterns in surface hydrology were noted in 2003–12 (McLeod and Pellegrini 2013). The marshes in the site are connected to Topock Marsh, and water levels within the site vary directly with those in Topock Marsh; therefore, water levels did not fluctuate substantially from day to day.

Glory Hole was occupied in 2013 and 2015 by three and two resident flycatchers, respectively. The site was considered occupied in 2016 because of the detection of a willow flycatcher on July 14. This individual was not detected on any

subsequent monitoring visits and was determined not to be resident. Two and one willow flycatchers were detected in 2014 and 2017, respectively, each for 1 day prior to June 24, and the site was unoccupied in those years. Glory Hole was occupied in 9 years between 2003 and 2012, with 1–10 resident flycatchers detected each year (McLeod and Pellegrini 2013).

All components of preferred nesting habitat (see table 2-1) are present in several small patches distributed within the larger matrix of the site. These patches are generally areas where Goodding's willows are present. Canopy closure in some tamarisk-dominated areas met the criterion for suitable habitat prior to tamarisk defoliation in 2017 but was too low to meet the suitability criterion during defoliation.

Farm Ditch Road

Area: 4.4 ha Elevation: 140 m

The survey site known as Farm Ditch Road was opportunistically surveyed in 2010 and 2014 and formally surveyed in 2011 and 2015–17. It is located on the northern side of the Farm Ditch, about 500 m west of the boat launch to Glory Hole and Hell Bird. The interior of the site was described in 2015, at which time suitable habitat was noted along the Farm Ditch, and the site was added to the annual survey list. Because all suitable habitat is located adjacent to the Farm Ditch, it was determined that surveys would be conducted from the road, which is on the south side of the Farm Ditch. Because the site was surveyed from the road in 2016–17, a thorough assessment of vegetation structure and hydrology is not available. The southern edge of the site consists of a mosaic of coyote willows and tamarisk 5–7 m in height, with canopy closure that appears to be approximately 90% in the coyote willows. Canopy closure was estimated at 90% in the tamarisk when the May site description was recorded in 2017 but declined to 50–60% when the tamarisk became defoliated. Cattails and bulrush are present along the very southern edge of the site and occasionally extend into the site. In 2015, vegetation north of the coyote willows was primarily 2–2.5-m-tall arrowweed and willow baccharis with emergent 4–6-m-tall tamarisk, screwbean and honey mesquite, and 8–10-m-tall Goodding's willows. The trees were widely spaced and did not form a closed canopy; canopy closure north of the coyote willows ranged from 0 to 40%.

Inundated soils were present along the canal border in May 2015 but did not extend very far into the site. Soils on the upland side of the coyote willows were dry and sandy. The extent of inundated soils within the site in 2016–17 is unknown, but it is surmised that some wet soils exist given the presence of marsh vegetation extending into the site.

Farm Ditch Road was unoccupied in 2015–17. Up to two willow flycatchers were

detected in each of those years, each for 1 day prior to June 24. None of these individuals were detected on any subsequent monitoring visits or surveys. The site was also unoccupied in 2011 (McLeod and Pellegrini 2013)

Habitat suitability was not thoroughly assessed in 2017, as surveys were conducted from outside the site. The area with the coyote willows along the southern edge of the site appears to meet the criteria for preferred nesting habitat (see table 2-1). However, suitable habitat within the site is limited in areal extent.

CPhase 05

Area: 11.4 ha Elevation: 140 m

The survey site known as CPhase 05 was surveyed from 2006 to 2017. The site is 1.8 km south of Glory Hole within the Beal Lake Conservation Area. Vegetation within the site consists of a mosaic of cottonwoods, Goodding's willows, coyote willows, honey mesquite, screwbean mesquite, and arrowweed, with tamarisk scattered throughout the site. Canopy height is highly variable and averages approximately 3–4 m over most of the site and up to 15 m in the cottonwood stands. Canopy closure is 10–30% in areas dominated by either of the mesquite species and arrowweed. Canopy closure is 95% in areas with coyote willows and 75–85% in the cottonwood stands. Canopy height has increased across the site from an average of 4 m in 2006–07. Canopy closure has also increased from an average of 25% in 2006–07. No major changes in species composition have been noted since 2006. Prior to the 2015 survey season, the boundaries of the site were redrawn to eliminate areas dominated by 2-m-tall arrowweed or 3–4-m-tall mesquite, thereby reducing the extent of the survey area.

Standing water was recorded on one to two site descriptions in 2013, 2014, and 2016. Standing water was present when all three site descriptions were recorded in 2017, and no wet soils were noted in 2015. No more than 25% of the site contained wet soils when any site description was recorded. The amount of wet soils is highly variable because the site is flood irrigated, and sandy soil allows the water to drain rapidly after irrigation.

CPhase 05 was considered occupied in 2013, 2014, and 2016. The individual in 2013 was detected June 10–20. In 2014, one willow flycatcher was detected in the same general area on three consecutive visits between May 21 and June 2. No territorial behaviors or bands were observed during any detection, making it impossible to confirm that each detection was of the same individual. However, because the detections were in the same area over three consecutive visits, with the same type of behavior observed each time, the detections were assumed to be of one individual. In 2016, a willow flycatcher was detected on June 28. This individual vocalized in response to playback at a few survey points and then sang at a slow rate for about 20 minutes following cessation of playback; the overall determination was that this individual was not highly territorial. No

willow flycatchers were detected on any of three subsequent monitoring visits, and this individual was determined not to be resident. One willow flycatcher was detected in each year in 2015 and 2017 for 1 day prior to June 24, and the site was unoccupied. CPhase 05 was also considered occupied in 2009 and 2012 (McLeod and Pellegrini 2013). In 2009, one flycatcher was detected May 15–23. This individual did not display extensive territorial behavior but was responsive to broadcast and was detected in the same general area over three consecutive visits. In 2012, one resident, unpaired male flycatcher was detected from May 23 to July 9.

Almost all of the site is missing at least one characteristic of suitable habitat (see table 2-1). Areas dominated by either of the mesquite species and/or arrowweed lack all characteristics of suitable habitat. Stands of Goodding's willows have sufficient canopy height but lack canopy closure. Canopy height and sometimes canopy closure reach suitable levels in cottonwood stands, but these lack the midstory components of dense vegetation and twig structure for nest placement. The most suitable vegetation structure within the site is in very small patches of coyote willows, where all vegetative components of preferred nesting habitat are present, but the consistent presence of wet soils is lacking.

Lost Lake

Area: 3.3 ha Elevation: 140 m

The survey site known as Lost Lake was surveyed from 2003 to 2015. Surveys were discontinued after a fire in early 2016, when a majority of the site was completely consumed. Reconnaissance was conducted in 2016 and 2017 to assess how the remaining vegetation was recovering. The unburned area consists of a narrow (< 40 m wide) strip of mixed-native riparian vegetation separated from the Colorado River to the southwest by a low ridge of barren sand dunes and bordered to the northeast by marshy areas. The northern portion of the unburned area consists 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. Half of the cottonwoods are dead, and none of the canopies are interlocking; canopy closure is 70% in this portion of the site. Southeast of the cottonwood stringer, there is a 10-m-wide strip of tamarisk 5–8 m in height. The tamarisk had 75% canopy closure when the site was visited in May 2017. Further southeast, there is a narrow, 5-m-wide strip of coyote willows 5–6 m in height with 85% canopy closure. Within the remainder of the original site boundary, vegetation is starting to regenerate. In the northwestern portion of the original site, clumps of 2–3-m-tall coyote willows are starting to grow in a patch approximately 75 x 30 m in size. Arrowweed and screwbean mesquite are scattered in the patch as well. A majority of the rest of the site contains 1.5-m-tall tamarisk, though there is some 2–3-m-tall screwbean mesquite at the far northern end of the site and 1.5-m-tall willow baccharis at the far southern end. Canopy closure in this portion of the site is still 0%.

Wet soils were present along the eastern edge of the site, adjacent to the marsh, when each site description was recorded, with up to 15% of the site containing standing water. Soils in the remainder of the site were mostly dry. Similar patterns in surface hydrology were noted in 2003–12 (McLeod and Pellegrini 2013). The unburned portion of the site is quite flat and immediately adjacent to a marsh, and water levels in this portion of the site fluctuate with those in the marsh.

Lost Lake was occupied in 2014 and 2015 by one resident flycatcher. Two willow flycatchers were detected in 2013 prior to June 24 for 1–3 days each, and the site was unoccupied. Lost Lake was also occupied by one resident flycatcher in 2004 (McLeod and Pellegrini 2013).

Elements of suitable habitat still exist at this site, but no portion of the site contains both suitable canopy closure and suitable patch width (see table 2-1). Surveys were discontinued in 2017. With the rate of growth in the most heavily damaged portion of the site, vegetation might reach suitable structure in 2–3 years. Re-examination of the site in 2–3 years would determine if the extent of suitable habitat has increased and would reduce the chance that suitable habitat is overlooked.

Ground Reconnaissance Results

Lost Slough

Lost Slough was surveyed from 2007 to 2009. The site is approximately 1.6 km northwest of Lost Lake. Surveys were discontinued after 2009 because vegetation lacked the right combination of height and density required for suitable habitat (i.e., vegetation of a suitable height lacked suitable density, and areas with suitable density were too short). No changes in vegetation structure were noted between 2007 and 2009. The site was re-evaluated in 2013 to determine if vegetation structure had improved.

In 2013, vegetation was mixed-exotic in composition and consisted of tamarisk 6–8 m in height with a few emergent Goodding's willows and scattered screwbean mesquite trees. There were also patches of coyote willows 6 m in height with low foliage density, despite high stem density. Arrowweed up to 2 m in height made up the understory vegetation. Canopy closure at the site was variable, with open areas toward the edges of the site and over 70% closure in areas with thick vegetation.

Inundated soils were present in a low-lying area in the center of the site when the June 2013 site description was recorded. Similar surface hydrology was noted during survey years, with wet soils confined to a small marshy area in the center of the site (McLeod and Pellegrini 2013).

No willow flycatchers were detected in 2013 or in any year from 2007 to 2009.

Examination of Google Earth imagery from June 2017 suggests that this site was completely consumed in the fire that affected Lost Lake early in 2016. Prior to the fire, vegetation at the site did not meet all the criteria for suitable habitat, and it seems unlikely for suitable structure to develop at this site. Future evaluations of this site could be canceled with minimal risk of overlooking potentially suitable habitat.

Lost Lake Slough #1

In 2009, a potential survey site approximately 100 m south of the bridge on South Dike Road and known as Lost Lake Slough #1 was designated after aerial reconnaissance in the area. This area was visited several times in 2009 and 2010, and it was determined that while vegetation structure appeared suitable, the areal extent was too limited to support resident flycatchers. The site was re-evaluated in 2013.

In 2010, Lost Lake Slough #1 consisted of a 25- x 50-m patch of 6-m-tall tamarisk. A few mesquite were scattered through the area. The area was surrounded by marsh, and a finger of the marsh extended into the center of the site. Water extended under the woody vegetation at the marsh edges when the May and June site descriptions were recorded. In 2013, the interior of the area was not accessed. No obvious change in vegetation height was evident from the perimeter of the area. Surface hydrology was not assessed in 2013.

No willow flycatchers were detected in any year in which the area was visited.

Although the site was not thoroughly described in 2013, it is likely that this site contained all the elements of preferred nesting habitat, but the small size of the site limited the likelihood that it would be occupied by flycatchers. Woody vegetation at the site consists primarily of tamarisk, and given the arrival of tamarisk beetles in the area in 2016, suitability of this site is likely to decline. Another evaluation could be conducted at this site to assess the condition of the vegetation and to reduce the chance of suitable flycatcher habitat being overlooked.

Lost Lake Slough #2

In 2009, a potential survey site known as Lost Lake Slough #2 was designated approximately 200 m south-southeast of Lost Lake Slough #1. Habitat reconnaissance and opportunistic surveys were conducted at Lost Lake Slough #2 in 2009 and 2010. In 2010, it was determined that canopy height was too short

and canopy closure was too low (McLeod and Pellegrini 2013) for the area to provide suitable flycatcher habitat. The area was re-evaluated in 2013 to determine if vegetation structure had improved.

In 2010, the area consisted of a 100- x 50-m patch of coyote willows 4 m in height, surrounded by open marsh. Large stem diameter indicated that the stand was not young, and it was speculated that growth to a more suitable height was unlikely. Canopy closure in the coyote willows was approximately 80%. The interior of the area was not accessed in 2013 due to the presence of dense cattail marsh surrounding the coyote willow patch. No obvious change in vegetation height was noted from the perimeter of the area. The site was completely inundated in May of both 2009 and 2010 and saturated or inundated in mid-June. Though surface hydrology could not be assessed in 2013, conditions were likely similar to those observed in earlier years.

No flycatchers were detected in 2009, 2010, or 2013.

In 2010, the site lacked the canopy height and canopy closure of suitable habitat (see table 2-1). Habitat suitability could improve if the vegetation increases in height and canopy closure. Examination of June 2017 Google Earth imagery indicated that the coyote willow patch had increased in extent since 2010, reaching 130 x 90 m in size. Another evaluation could be conducted to reduce the chance of suitable flycatcher habitat being overlooked.

Lost Lake Slough #3

In 2009, a potential survey site known as Lost Lake Slough #3 was designated between Lost Lake Slough #2 and new South Dike Road. Habitat reconnaissance and opportunistic surveys were conducted in the area in 2009 and 2010. In 2010, it was determined that habitat suitability was poor, and the site was not scheduled for formal surveys (McLeod and Pellegrini 2013). The area was re-evaluated in 2013 to determine if habitat suitability had improved.

In 2013, the site was bordered to the north by marsh and to the south by dry uplands adjacent to the road. Vegetation within the site was a mix of coyote willows and tamarisk. The tamarisk averaged 6 m in height and was the dominant cover species. The coyote willows reached 5 m in height and formed a strip that was generally ≤ 10 m wide along the edge of the marsh. The center of the site was dominated by 2-m-tall arrowweed patches that extended to the west. A few screwbean mesquite up to 5 m in height were present near the southern edge of the site. Canopy closure ranged from approximately 80–90% in the tamarisk and coyote willows to as low as 40% in the arrowweed. When the site description was recorded in late June, surface water was present only along the edge of the site adjacent to the marsh.

No willow flycatchers were detected in 2009, 2010, or 2013.

In 2013, no portion of the site contained all the elements of suitable flycatcher habitat (see table 2-1) because dense canopy closure occurred only in the strip of coyote willows, which was too narrow to be suitable. It was determined that future assessments of the area could be postponed until aerial imagery suggested that the patch of coyote willows had increased in areal extent. Examination of June 2017 Google Earth imagery indicated that the coyote willow patch is now up to 30 m wide. The imagery also shows that the portions of the site dominated by tamarisk and arrowweed were consumed in the fire in early 2016 that also affected Lost Lake. Another evaluation could be conducted to reduce the chance of suitable flycatcher habitat being overlooked.

Lost Lake Slough #4

In 2009, a potential survey site known as Lost Lake Slough #4 was designated approximately 85 m southwest of Lost Lake Slough #3. Habitat reconnaissance and opportunistic surveys were conducted in 2009 and 2010. The site was not scheduled for formal surveys after assessments determined that vegetation structure did not meet the criteria for suitable habitat. The area was re-evaluated in 2013.

The site was bordered by a marsh to the north and dry uplands to the south. In 2013, vegetation was primarily coyote willows with bulrush along the northern border of the site. The southern border was dominated by a mix of tamarisk and arrowweed. Canopy height was 2–4 m, and canopy closure was around 90%.

No willow flycatchers were detected in 2009, 2010, or 2013.

In 2013, canopy height at the site was too short to meet the criterion for suitable habitat (see table 2-1). As no change in structure was noted between 2010 and 2013, it was determined that the existing vegetation was unlikely to develop into suitable habitat. Examination of June 2017 Google Earth imagery showed that the southern border of the site was burned in the fire in early 2016, and there was no obvious increase in the aerial extent of the coyote willows. If imagery taken in future years shows an increase in the areal extent of the site, assessments could be conducted to reduce the chance that suitable flycatcher habitat is overlooked.

Topock Gorge, Arizona

Between Topock Marsh and Lake Havasu, the Colorado River winds through Topock Gorge. Throughout the gorge, the river is confined between steep cliffs and high bluffs, and little vegetation grows along the river. Starting in 2013, survey sites in the study area were put on a triennial survey schedule, and surveys were conducted in 2015. Both survey sites in 2015 were in Blankenship Bend, which contains riparian and marsh vegetation along the eastern bank of the Colorado River adjacent to Blankenship Valley.

Blankenship North

Area: 19.0 ha Elevation: 138 m

Blankenship North was surveyed from 2003 to 2010 and in 2015. The site is shaped like an inverted "L," with a linear, 100-m-wide strip of riparian vegetation along the eastern edge of the site, and a 200-m-wide portion of vegetation that runs east-west along the northern edge of the site. In 2015, vegetation in the eastern strip of the site consisted of honey mesquite 7 m in height at the upland edge that graded to tamarisk and then to a narrow strip of coyote willows 5 m in height, with canopy closure averaging 90%. Vegetation structure within the tamarisk was very dense. The coyote willows bordered a narrow bulrush marsh 5–70 m in width, and the western edge of the marsh was vegetated by a narrow (5–10 m wide) strip of coyote willows as well as several emergent Goodding's willows 12 m in height. The northern portion of the site consisted of a mosaic of marshes, tamarisk, coyote willows, arrowweed, and honey mesquite. Vegetation height was typically 3–4 m and did not exceed 5 m. Canopy closure within the woody vegetation varied between 60 and 80%. No major changes in vegetation structure were noted between 2003 and 2015. Because water levels within the site are directly influenced by those in the Colorado River, the site contained varying amounts of wet soils throughout each survey season, though soils were always dry along the upland border of the site.

No willow flycatchers were detected in 2015. The site was unoccupied each year in 2003–10 (McLeod and Pellegrini 2013). Cowbirds were detected in all survey years. Both feral pigs and burros (*Equus asinus*) were observed in and around the site in 2003–10, but only signs of burros were noted in 2015.

Canopy closure and canopy height in the northern portion of the site did not meet the criteria for suitable habitat (see table 2-1). The eastern portion of the site had sufficient canopy height and canopy closure, but few flyways were present in the thick midstory vegetation. Vegetation with suitable height, canopy closure, and midstory structure was present in a strip of willows along the western edge of the marsh, but this strip was too narrow to meet the patch width criterion for suitable habitat. If this strip of vegetation expands in areal extent, habitat suitability would improve. Defoliation of the tamarisk by tamarisk beetles has likely reduced canopy closure at this site since 2015. Maintaining this site on the triennial survey schedule will ensure that any changes in habitat suitability will be noted in a timely manner.

Blankenship South

Area: 11.8 ha Elevation: 138 m

The survey site known as Blankenship South was surveyed from 2003 to 2010 and in 2015. In 2015, the site consisted of a 100-m-wide strip of tamarisk up to

6 m in height with clumps of emergent Goodding's willows up to 12 m in height. The western edge of the site contained coyote willows 4–6 m in height, which mixed with tamarisk to the east. Vegetation structure within the tamarisk was very dense. The eastern side of the site was bordered by dry upland and was primarily vegetated by 4–6-m-tall honey mesquite and 2–3-m-tall arrowweed. The western side of the site was bordered by bulrush marsh and open water. Canopy closure was approximately 80–90%. No major changes in vegetation structure or species composition were noted between 2003 and 2015. Because water levels within the site are directly influenced by those in the Colorado River, the site contained varying amounts of wet soils throughout each survey season, with up to 30% of the site inundated, though soils were always dry along the upland border of the site.

No willow flycatchers were detected in 2015. The site was unoccupied in 2003–10 (McLeod and Pellegrini 2013). Cowbirds were detected in all survey years. Signs of both feral pigs and burros were observed in and around the site in 2003–10, but only signs of burros were noted in 2015.

Canopy height and canopy closure met the criteria for suitable habitat, but few flyways were present in the thick midstory vegetation. Though no changes in vegetation structure were noted over the years, there is the potential for woody vegetation along the marsh edge to expand in areal extent. Defoliation of the tamarisk by tamarisk beetles has likely reduced canopy closure at this site since 2015. Maintaining this site on the triennial survey schedule will ensure that any changes in habitat suitability will be noted in a timely manner.

Bill Williams, Arizona

BIWI encompasses the Bill Williams River National Wildlife Refuge and the adjacent Planet Ranch property. 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 ha along the Bill Williams River upstream of its mouth at Lake Havasu and contains a mixture of native forest, stands of tamarisk, beaver ponds, and cattail marsh. The Planet Ranch property is located adjacent to the upstream portion of the refuge and changed ownership prior to the 2013 season. Access to the property was not granted in 2013 and 2014. It was incorporated into the LCR MSCP in 2015, and surveys resumed in 2017. Survey sites within BIWI are listed below from west to east, moving progressively farther upstream. Signs of burros were seen between the Mohave Wash area and the eastern border of the refuge. Tamarisk beetles were detected in the Bill Williams River Delta in July 2016, immediately south and west of the farthest downstream survey sites. In 2017, beetles were present throughout the study area during the entire season.

The extent of surface water within BIWI was relatively high in 2010, intermediate and variable in 2011–13, and restricted to deep channels and beaver ponds in 2014–17. Water levels within survey sites in the Bill Williams River Delta in 2014–17 varied with the level of Lake Havasu (figure 2-9). The rate of discharge from the Bill Williams River (U.S. Geological Survey Station #09426620, which is between Site 05 and Beaver Pond North) was 0.0 cubic foot per second (cfs) throughout the 2014–17 flycatcher breeding seasons (figure 2-10).

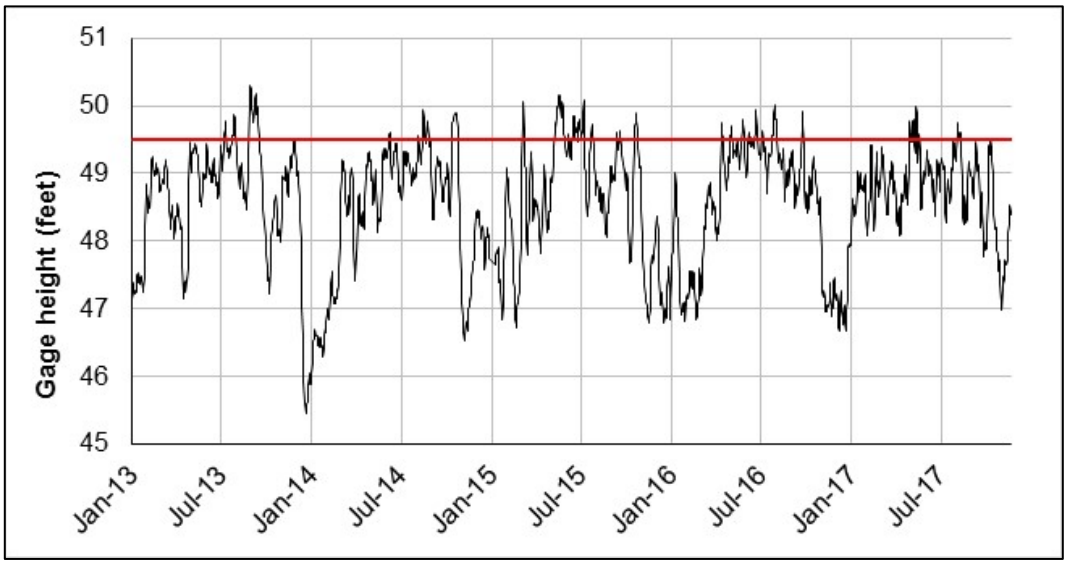

Figure 2-9.—Daily average gage height (feet) recorded at Lake Havasu near Parker Dam, Arizona (U.S. Geological Survey Station #09427500), 2013–17.
The red line at 49.5 feet is a reference line above which 100% of Bill Willow is inundated.

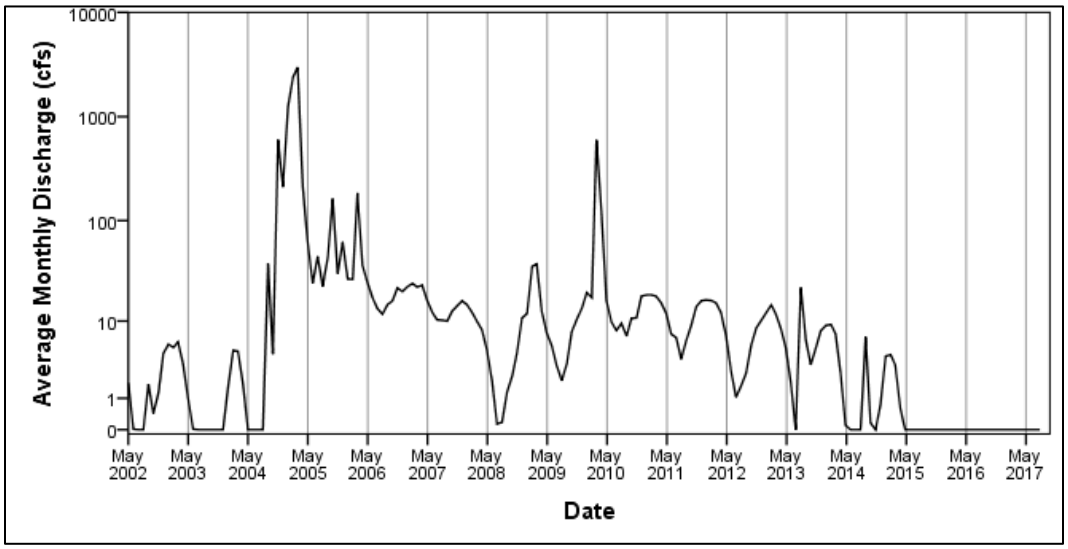

Figure 2-10.—Monthly average streamflow (cfs) recorded at the Bill Williams River near Parker, Arizona (U.S. Geological Survey Station #09426620), 2002–17.

Coyote Crossing
Area: 2.1 ha Elevation: 137 m

Coyote Crossing was surveyed or monitored in 2016 and 2017. The site forms a strip of riparian habitat in the very southwestern extent of riparian vegetation along the Bill Williams River. It is bordered by cattail marsh to the north, south, and west and by the river to the east. Vegetation consists of 3–7-m-tall tamarisk with cattails around the periphery of the site. Canopy height is shortest near the southern and western edges where the tamarisk mixes with cattails and is tallest along the northeastern edge near the river. In 2016, canopy closure ranged from 30 to 90% and varied directly with canopy height. In 2017, tamarisk within the site were completely defoliated in May and mostly defoliated, but with some regrowth, in mid-July. Canopy closure in 2017 did not exceed 80%.

Wet soils were present when each site description was recorded, with 5–90% of the site containing wet soils. This site is located within the Bill Williams River Delta, and water levels within the site vary with those in Lake Havasu (see figure 2-9).

Coyote Crossing was occupied by one resident flycatcher in 2016. No willow flycatchers were detected in 2017. Cowbirds were detected during two to three surveys in each year.

In 2016, prior to defoliation, all components of preferred nesting habitat (see table 2-1) were present in the tall, dense tamarisk along the northeastern edge of the site. Vegetation in the southwestern portion of the site, however, lacked the canopy height and closure necessary to meet all the criteria for suitable habitat.

During defoliation in 2017, canopy closure throughout the site failed to meet the criterion for suitable habitat, although the other components of preferred nesting habitat were still present along the northeastern edge of the site.

Bill Willow

Area: 1.6 ha Elevation: 137 m

The Bill Willow survey site was explored as part of reconnaissance in 2014 and formally surveyed in 2015–17. It is 250 m northeast of Coyote Crossing, at the very northwestern extent of riparian vegetation along the Bill Williams River and on the northern edge of an area that burned in 2006. It is bordered by cattail marsh to the north, east, and west and by riparian vegetation to the south. Vegetation within the site consists of 4–8-m-tall tamarisk with cattail stands in the understory, particularly near the northern and western borders. A few emergent, 9–15-m-tall Goodding's willows are present along the southern and eastern borders. Vegetation is noticeably taller and denser in the southwestern two-thirds of the site than in the northeastern third. Prior to the arrival of tamarisk beetles,

canopy closure was 80–90% in areas with Goodding's willows and 90% in the tamarisk. In 2017, tamarisk within the site were mostly to completely defoliated when the site descriptions were recorded in May and June, and about 30% of the tamarisk were refoliating in July. Canopy closure in the tamarisk did not exceed 80% in 2017. Other than this reduction in canopy closure, no major changes in species composition or vegetation structure have been noted since 2015.

Wet soils were detected when each site description was recorded, except in June and July 2017. The site was recorded as completely inundated on at least one site description in 2015 and 2016. This site is located within the Bill Williams River Delta, and water levels within the site vary with those in Lake Havasu (see figure 2-9).

Bill Willow was occupied by five resident flycatchers in each year in 2016 and 2017. Two willow flycatchers were detected in 2015, each for 1 day prior to June 24. Cowbirds were detected during two to three surveys in each year.

Prior to the arrival of tamarisk beetles, the entirety of this site had all the characteristics of preferred nesting habitat (see table 2-1). During defoliation in 2017, only the isolated Goodding's willows provided canopy closure that met the criterion for suitable or preferred nesting habitat.

Wispy Willow

Area: 1.3 ha Elevation: 137 m

Wispy Willow was opportunistically surveyed in 2010–11 and formally surveyed in 2012–17. The site is approximately 75 m southwest of Bill Willow and 60 m east of Coyote Crossing on the northern side of the Bill Williams River and on the western edge of an area that burned in 2006. Vegetation composition within the site is mixed-native. The western and southern portions of the site are vegetated primarily with 5–7-m-tall coyote willows, occasionally mixed with tamarisk. Tamarisk 5–7 m in height dominate the northern arms and eastern side of the site and are scattered along the southern border. Small cattail marshes are scattered within the site along the western and northern borders. Prior to the arrival of tamarisk beetles, canopy closure was 80–90% within the coyote willows and tamarisk and as low as 60% within the marshy areas. In 2017, tamarisk within the site were mostly or completely defoliated when the May and June site descriptions were recorded and were all refoliating when the July site description was recorded. Canopy closure in the tamarisk did not exceed 70%. Vegetation is generally shorter and less dense along the western edge of the site and taller and denser along the northern and eastern edges. Canopy height and stem diameter have increased slightly since 2012, and canopy closure in tamarisk was lower in 2017 than in previous years due to the tamarisk being defoliated most of the season. No other major changes in species composition or vegetation structure have been noted.

Standing water was present in some portion of the site when each site description was recorded in 2013–17. The proportion of the site with wet soils varied from a minimum of 10%, with wet soils confined to the isolated cattail marshes, to a maximum of 100%, with 90% of the site inundated. Similar variations in surface hydrology were observed prior to 2013 (McLeod and Pellegrini 2013). This site is located within the Bill Williams River Delta, and water levels within the site vary with those in Lake Havasu (see figure 2-9).

Wispy Willow was occupied in 2014–17, with two to five resident adults detected annually. The site was unoccupied in 2013, when one willow flycatcher was detected May 28 – June 1 but not on any subsequent monitoring visits or surveys and was determined not to be resident. Cowbirds were detected in all years except 2014.

Prior to the arrival of tamarisk beetles, most of this site had all the characteristics of preferred nesting habitat (see table 2-1). During defoliation in 2017, canopy closure in the tamarisk-dominated portions of the site did not reach the values typical of suitable habitat, but some portions dominated by coyote willows still retained all characteristics of preferred nesting habitat.

Site 01

Area: 2.4 ha Elevation: 138 m

The survey site known as Site 01 was surveyed in 2003–06, 2010, and 2012–17. Opportunistic surveys were conducted in 2011. Surveys were discontinued between 2006 and 2010 due to damage from a fire that occurred in late summer 2006. The site is 60 m southeast of Wispy Willow and 200 m south of Bill Willow on the southern edge of the area that burned in 2006. The site is bordered to the west and south by cattail marsh along the main Bill Williams River channel and a side channel. Vegetation within the site is mixed-native and consists of a mosaic of Goodding's willows, coyote willows, and tamarisk. Coyote willows 4–6 m in height form a dense stand along the southern, western, and northwestern borders of the site. The trees are larger in diameter along the southern edge of the site than along the northern edge. Several emergent Goodding's willows 12–15 m in height are scattered throughout the site, while dense clumps of tamarisk 4–8 m in height are scattered throughout much of the central and eastern portions. Dense patches of arrowweed 2–3 m in height are also present in the center of the site. Canopy closure is approximately 80–90% within the coyote willows and 85% under the Goodding's willows. Prior to the arrival of tamarisk beetles, canopy closure in the remainder of the site was as high as 80%. In 2017, tamarisk within the site were completely defoliated when the May site description was recorded, refoliating in June, and a mixture of defoliated and green when the July site description was recorded. Canopy closure in 2017 in

areas with tamarisk was 60–75%. Other than the reduction of canopy closure in tamarisk in 2017 due to defoliation, no major changes in species composition or vegetation structure have been noted since 2012.

Standing water was present when each site description was recorded in 2013–17. The proportion of the site with wet soils varied from a minimum of 10%, with wet soils present only in the cattail marshes along the site perimeter, to a maximum of 80%, with 55% of the site being inundated. Similar variations in surface hydrology were observed prior to 2013 (McLeod and Pellegrini 2013). This site is located within the Bill Williams River Delta, and water levels within the site vary with those in Lake Havasu (see figure 2-9).

Site 01 was occupied in 2015–17, with one to three resident flycatchers detected annually. The site was unoccupied in 2013 and 2014, when two and three willow flycatchers, respectively, were detected, each for less than 7 days prior to June 24. Each detection was followed by three subsequent monitoring visits, none of which resulted in further detections, and these willow flycatchers were determined not to be resident. Site 01 was also occupied in 2003, 2004, and 2012 (McLeod and Pellegrini 2013). Cowbirds were detected in all survey years.

In places where canopy closure reaches 90%, the strip of coyote willows along the southern edge of the site has all the characteristics of preferred nesting habitat (see table 2-1). Emergent Goodding's willows provide pockets of vegetation that meet all the criteria of suitable habitat. Most of the interior of the site lacks the dense canopy closure typical of suitable habitat and lacks the wet soils typical of preferred nesting habitat.

Burn Edge

Area: 3.2 ha Elevation: 143 m

Burn Edge is a survey site 675 m southeast of Site 01, near the northern edge of the Bill Williams riparian corridor and on the eastern edge of an area that burned in 2006. It was opportunistically surveyed in 2008 and formally surveyed in 2009–17. Vegetation within the site is mixed-native and consists of an overstory of 12–15-m-tall Goodding's willows and 20-m-tall cottonwoods with an understory of 5–8-m-tall tamarisk. Vegetation in both the over- and understory is denser in the western half of the site. Several open areas with deadfall and little understory are present in the eastern half of the site, and an open area that was once a cattail marsh runs east-west through the center of the site. Coyote willows, willow baccharis, mule-fat, arrowweed, and honey mesquite are present in low abundance in the understory throughout the site. Prior to the arrival of tamarisk beetles, canopy closure reached 90% in areas of dense tamarisk in the western half of the site. In 2017, tamarisk within the site were completely defoliated when the May site description was recorded and refoliating when the June and July site descriptions were recorded. Canopy closure in 2017 was 70–85% in the western

half of the site and 55–65% in the eastern half. The original survey area was reduced after the 2016 survey season to exclude the eastern 200 m of the site, where canopy closure and understory density had declined to the point where habitat was no longer suitable and seemed unlikely to recover quickly. Vegetation structure and species composition in the remaining survey area have remained largely unchanged since 2009, though cattails are no longer as prevalent as they once were, and canopy closure in areas dominated by tamarisk was lower in 2017 due to defoliation.

Wet soils were present in a small (3 x 9 m) pool at the western end of the old marsh when each site description was recorded in 2014–17. This pool decreased in areal extent during each survey season and was slightly smaller at the start of the 2017 survey season than in previous years. In some years, damp soils were noted in the western portion of the site when the May site description was recorded, but otherwise all soils away from the small pool were completely dry. In 2013, up to 25% of the site contained wet soils when the May site description was recorded, but only the small pool remained by July. Up to 50% of the site contained wet soils in 2009–12 (McLeod and Pellegrini 2013). Water levels within the site were primarily influenced by the water table during the 2013–17 breeding seasons and therefore were not likely to fluctuate substantially day to day between site descriptions.

Burn Edge was unoccupied in 2013–17. No willow flycatchers were detected in 2013–15 or 2017. In 2016, three willow flycatchers were detected on June 8. No further detections were recorded on any of three subsequent monitoring visits or on subsequent surveys, and all three individuals were determined not to be resident. Burn Edge was considered occupied in 2010 and 2011 (McLeod and Pellegrini 2013). Cowbirds were detected in all survey years.

The eastern half of the site has canopy closure that is well below the values typical of suitable habitat and also lacks midstory structural components (see table 2-1). Pockets of vegetation that meet all the criteria for suitable habitat are present in the western half of the site in the densest patches of tamarisk with an overstory of cottonwoods and Goodding's willows. Canopy closure does not reach the levels typical of preferred nesting habitat, and only a very small portion of the site is near surface water. Habitat suitability would be improved if surface water covered a wider extent and canopy closure were higher.

Site 04

Area: 9.9 ha Elevation: 146 m

The survey site known as Site 04 was surveyed from 2003 to 2017. It is approximately 400 m south of Burn Edge on the very southern edge of the riparian area. Vegetation within the site is mixed-native and consists of an overstory of Goodding's willows 15–20 m in height with patches of tamarisk

3–7 m in height in the understory. Several 20-m-tall cottonwoods are scattered throughout the overstory as single trees or very small stands. A few small patches of coyote willows 3–5 m in height and scattered mule-fat and yerba mansa are also present throughout the site. Vegetation structure within the site is highly variable. In much of the center of the site and along the eastern edge there are big gaps (30–40 m across) in the canopy with thick piles of deadfall below. Small, patches of tamarisk spaced widely (> 20 m) apart are scattered in the understory in this portion of the site. Canopy closure in these areas is 50–70%. The Goodding's willows and tamarisk are denser around the northern, western, and southern edges of the site, with canopy closure reaching 80% in many places. The best habitat is immediately adjacent to a deep, incised backwater channel on the western side of the site, with the tamarisk reaching 6–7 m in height and canopy closure of 80–90%. In 2017, tamarisk within the site were completely defoliated in May, green with up to 40% yellow in mid-June, and refoliating in mid-July. Between 2003 and 2012, cattails and marshy areas occupied approximately 10% of Site 04 (McLeod and Pellegrini 2013). By 2017, cattails were only present in small patches in the western portion of the site. Canopy closure was estimated at 50% overall throughout the site in 2003–12 because of the number of gaps present. Since 2012, the gaps have increased, and the proportion of the site with dense canopy closure has decreased.

Surface water was present in the deep, backwater channel on the western side of the site when each site description was recorded in 2013–17 and was noted in a small stream channel in the middle of the site on most site descriptions, with all other soils noted as mostly dry. In 2003–12, surface water was noted in the same areas, as well as in a small network of braided channels in the southern portion of the site (McLeod and Pellegrini 2013). 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 2-9). Given that neither lake nor river levels fluctuated strongly during the 2013–17 seasons, it is unlikely that surface soil moisture conditions varied substantially from day to day.

Site 04 was unoccupied in 2013–17. One willow flycatcher was detected in 2017 for 1 day prior to June 24. No willow flycatchers were detected in 2013–16. Site 04 was occupied in 4 years between 2003 and 2012 by one to four resident flycatchers (McLeod and Pellegrini 2013). Cowbirds were detected in all years.

Most of the site lacks the midstory structural components and dense canopy closure typical of suitable habitat (see table 2-1) and lacks the proximity to surface water that is typical of preferred nesting habitat. Dense tamarisk stands along the deep backwater channel had all the elements of preferred nesting habitat when the tamarisk were green. Habitat suitability would be improved if the tamarisk had green leaves throughout the season. Overall habitat suitability in the site has declined in recent years as trees and large limbs have fallen, decreasing overall canopy closure.

Site 03

Area: 12.9 ha Elevation: 146 m

Site 03 is contiguous with and immediately to the east of Site 04; together Site 03 and Site 04 are known as Mosquito Flats. Site 03 was surveyed from 2003 to 2017. Vegetation is mixed-native and consists of an overstory of Goodding's willows 15–25 m in height and patches of tamarisk 3–7 m in height. In 2017, tamarisk within the site were all yellow or brown in mid-May and mid-June and a mix of defoliated and refoliating in mid-July. Several cottonwoods are scattered throughout the overstory, and mule-fat are scattered throughout the understory. The eastern half of the site has a small patch where velvet ash dominate the overstory. The understory in some areas is very open, and the ground in these areas is covered with thick yerba mansa. Many large willows and cottonwoods have fallen in recent years, leaving large gaps in the canopy and creating patches of thick, dead, fallen woody vegetation. Canopy closure is variable and ranges from 40% in areas with open understory and large gaps in the overstory to 90% in areas with dense tamarisk. Canopy closure does not exceed 80% in areas without a dense tamarisk understory. Several stands of dead cattails and formerly marshy areas are present primarily along the northern and southern edges of the site.

The marsh in the southeastern corner of the site contained standing water in May 2013 and saturated soils in May of 2014 and 2015. All other soils were damp or dry. Given that neither lake nor river levels fluctuated strongly during the 2013–17 seasons, it is unlikely that surface soil moisture conditions were variable from day to day. In 2003–12, wet soils were recorded on all but four site descriptions (McLeod and Pellegrini 2013), and as much as 100% of the site contained wet soils.

Site 03 was occupied in 2014 and 2015, with two resident flycatchers detected in each year, but was unoccupied in 2013, 2016, and 2017. One willow flycatcher was detected in 2013 and three willow flycatchers were detected in 2016, all prior to June 24. No further detections were recorded on three subsequent monitoring visits or subsequent surveys, and these individuals were determined not to be resident. No willow flycatchers were detected in 2017. Site 03 was occupied in 2003–12, with 2–12 resident adults detected annually (McLeod and Pellegrini 2013). Cowbirds were detected in all years.

Most of the site lacks the midstory structural components and dense canopy closure typical of suitable habitat (see table 2-1), and the entire site lacks the proximity to surface water that is typical of preferred nesting habitat. As in Site 04, canopy closure has decreased in recent years. A patch of tamarisk with a Goodding's willow overstory that surrounds a formerly marshy area in the southern end of the site contains all the elements of suitable habitat. Habitat suitability would be improved if the tamarisk had green leaves throughout the season and if surface water were present.

Last Gasp

Area: 2.1 ha Elevation: 146 m

The survey site known as Last Gasp is a narrow, mixed-native survey site along a channel on the northern edge of the Bill Williams River riparian area, approximately 375 m southeast of Burn Edge. Due to a lack of both flycatcher detections and high-quality habitat, this site was put on a periodic survey schedule after 2011. It was opportunistically surveyed in 2008, formally surveyed in 2009–11, and opportunistically surveyed in 2015–16. In 2016, vegetation within the site consisted of a broken overstory of 15-m-tall cottonwoods and 8–10-m-tall Goodding's willows. Tamarisk, 3–5 m tall, dominated the understory. Both the Goodding's willows and cottonwoods looked stressed with many dead limbs and sparse foliage. Tamarisk were scattered in loose patches rather than forming a continuous understory, and arrowweed and honey mesquite were present in the gaps between the tamarisk patches. Canopy closure varied from 40% in the channel to 60% under the densest cottonwood overstory. Except for a reduction in canopy closure, which was as high as 80–90% in earlier years, no major changes in species composition or vegetation structure have been noted since 2011.

All soils in the site were dry and sandy during the May survey in 2016. A small 1- x 1-m pool of water was noted in May 2015, and all other soils were dry. As much as 15% of the site contained wet soils in 2009–11, and inundated soils were noted when each site description was recorded, except in July of 2009 and 2011 (McLeod and Pellegrini 2013). Water levels in the site are dependent on river levels and likely did not increase following the May surveys in 2015 and 2016, as riverflow was 0.0 cfs throughout both seasons (see figure 2-10).

No willow flycatchers were detected during the one survey in 2015 and in 2016, and occupancy status was undetermined in both years due to limited survey effort. No willow flycatchers were detected in 2008–11 (McLeod and Pellegrini 2013). Cowbirds were detected in all survey years.

Surveys were discontinued for the remainder of the 2015 and 2016 seasons following the initial visit due to poor overall habitat quality. Canopy closure was << 85%, and this site thus 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. If flow in the Bill Williams River increases strongly in future years, re-evaluation of the site would reduce the chance that suitable habitat is overlooked.

Guinness

Area: 3.4 ha Elevation: 148 m

The survey site known as Guinness is approximately 150 m east of Site 03. Due to a lack of surface water away from the narrow, incised channel that bisects the site, this site was put on the triennial survey schedule in 2012. The site was surveyed in 2012 and opportunistically surveyed at the beginning of 2015 and 2016. In 2016, vegetation in the site was mixed-native and was dominated by a patchy overstory of Goodding's willows 10–15 m in height with an understory of 5–7-m-tall tamarisk. Emergent cottonwoods were scattered along the northern and southern edges of the site. Canopy closure was approximately 70%, occasionally reaching 90% in some of the denser tamarisk. No major changes in vegetation structure or species composition were noted between 2012 and 2016. A stream channel bisects the site, but all soils were dry during the survey in May in 2015 and 2016. The channel held standing water in 2012 (McLeod and Pellegrini 2013).

No willow flycatchers were detected during the one survey in each year in 2015 and 2016, and occupancy status was undetermined in both years due to limited survey effort. Cowbirds were detected in each year. Guinness was unoccupied in 2012 (McLeod and Pellegrini 2013).

Surveys were discontinued for the remainder of the 2015 and 2016 seasons following the initial visit due to poor overall habitat quality. Canopy closure in most of the site was too low to be considered suitable (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. If flow in the Bill Williams River increases strongly in future years, re-evaluation of the site would reduce the chance that suitable habitat is overlooked.

Site 05

Area: 6.8 ha Elevation: 146 m

Site 05 was surveyed from 2003 to 2016 and assessed in 2017. The site is on the northern edge of the Bill Williams River flood plain, approximately 1 km southeast of Guinness, and is bordered to the northeast by steep cliffs and to the southwest by a dry river channel. The survey area changed significantly in size and shape prior to 2009 (McLeod and Pellegrini 2013). Vegetation in the site is mixed-native, with Goodding's willows 10–18 m in height and cottonwoods 15–25 m in height forming a broken overstory. The overstory is predominantly Goodding's willows in the western two-thirds of the site, with the willows transitioning from widely scattered and emergent near the western edge to a broken overstory in the center of the site. Cottonwoods are more dominant in the overstory in the eastern third of the site. The understory consists of scattered

patches of tamarisk 3–8 m in height, which are taller and denser in the western third and shorter and more widely scattered in the eastern third of the site, as well as young Goodding's willows and cottonwoods. Many gaps are present in the canopy, particularly in areas dominated by Goodding's willows. Many of the willows have dead tops, dead limbs, and sparse leaves. Most of the groundcover in the site consists of thick piles of fallen, woody vegetation. Canopy closure is 50–70% in a majority of the site. A small patch of Goodding's willows near the south-facing wall of the cliff have fewer dead branches than do trees elsewhere in the site; canopy closure here is 80%. Through 2015, canopy closure reached 90% in the site. The areal extent of this level of canopy closure has decreased over the years as the canopies in both the Goodding's willows and cottonwoods have thinned out with continued loss of limbs. During the visit in May 2017, the tamarisk were refoliating on the eastern side of the site and were brown and just starting to resprout on the western side. No other major changes in vegetation structure or species composition have been noted since 2003.

Standing water was present along the northeastern edge of the site in a series of isolated beaver ponds when each site description was recorded in 2013–16, and all other soils were dry. These beaver ponds have the capacity to be over 2 m deep and were noticeably shallower at the beginning of each season than they had been in the previous year. Estimated depth was > 100 cm in May 2013 and only 20 cm in May 2017. The pools also grew progressively shallower during each season. Between 2009 and 2012, up to 20% of the site contained wet soils (McLeod and Pellegrini 2013). Given that river levels did not fluctuate strongly during any season 2013–17 (see figure 2-10), it is unlikely that surface soil moisture conditions varied substantially from day to day.

No willow flycatchers were detected in 2013–17. Site 05 was occupied only in 2009, when one resident, unpaired male flycatcher was detected June 5–16 (McLeod and Pellegrini 2013). Cowbirds were detected in all survey years.

Surveys were discontinued in 2017 because of poor habitat quality. No portion of this site has canopy closure that reaches 85%; therefore, the site does not meet all the criteria for suitable habitat. Habitat suitability could improve in future years if wet soils are again present at the site and vegetation density increases. If flow in the Bill Williams River increases strongly in future years, re-evaluation of the site would reduce the chance that suitable habitat is overlooked.

Black Rail

Area: 1.2 ha Elevation: 146 m

This survey site known as Black Rail was assessed in 2006, at which time it was determined that canopy height was too short to be suitable. The site was formally surveyed in 2010 and 2012–14 and opportunistically surveyed in 2015–16. The site is approximately 250 m southeast of Site 05 on the eastern edge of the

Bill Williams River flood plain. In 2016, vegetation was mixed-native and was showing signs of stress due to lack of water. The overstory consisted of cottonwoods 15–20 m tall with a layer of Goodding's willows 10–12 m tall. The cottonwoods were slightly more predominant in the northeastern portion of the site, while the Goodding's willows were slightly more predominant in the southwestern portion. Most of the Goodding's willows beneath the cottonwoods were almost completely dead, with basal sprouts as the only live foliage. Where the Goodding's willows were more predominant, each tree was ≥ 50% dead. Tamarisk 3–4 m in height were loosely scattered in the understory. Patches of dense, completely brown cattails and bulrush 1–2 m in height were also scattered through the interior of the site. These patches were green and up to 3 m in height through 2012. Canopy closure in most of the site was 60–80% but was only 40–75% in the southwestern portion, where the Goodding's willows were more predominant. Due to the stressed nature of the trees, the canopy was very thin, and the entire site felt open and sunny despite the occasionally dense canopy closure. Through 2014, canopy closure reached 80% in a majority of the site, with 90% canopy closure in an even-aged stand of Goodding's willows and cottonwoods along the southwestern edge of the site.

Soils were completely dry when each site description was recorded in 2013–16. Given that river levels did not fluctuate strongly during any season in 2013–16 (see figure 2-10), it is unlikely that surface soil moisture conditions varied substantially from day to day. Wet soils were present when each site description was recorded in 2010 and were noted on the May site description in 2012 (McLeod and Pellegrini 2013). Up to 90% of the site contained wet soils in 2010 and 2012.

No willow flycatchers were detected in any survey year. No cowbirds were detected on any survey in 2013–16 but were detected in 2010 and 2012.

Surveys were discontinued for the remainder of the 2015 and 2016 seasons following the initial survey because canopy closure was too low to meet the suitability criterion (see table 2-1). As water levels have decreased over the years, canopy closure has decreased, and some trees have died. If wet soils were once again present in the site, the trees might recover and canopy closure could improve. If flow in the Bill Williams River increases strongly in future years, re-evaluation of the site would reduce the chance that suitable habitat is overlooked.

Cougar Point

Area: 1.3 ha Elevation: 157 m

Cougar Point is a survey site approximately 1.6 km east of Black Rail along a channel of the Bill Williams River. It was surveyed or monitored in 2011–14. In 2012, vegetation in the site was native and consisted of dense, even-age stands of

Goodding's willows and cottonwoods 6–8 m in height. Mule-fat were present in the understory but appeared to be dying back as it became shaded by the taller cottonwoods and willows. Cattail marshes were present within and around the site. Canopy closure within the woody vegetation exceeded 80%. In May 2014, vegetation within the site appeared stressed, and several small, dead willows were noted. By July 2014, the entire site was dead or dying, and less than 10% of the woody vegetation had green leaves. Most of the trees were leafless, though some brown leaves remained on some of the Goodding's willows. Canopy closure within the woody vegetation averaged 60% during the last visit in July and was as high as 80% in the densest areas with brown leaves.

Wet soils were present when the May and June site descriptions were recorded in 2013, with up to 30% of the site containing wet soils. No wet soils were noted in 2014. Given that river levels did not fluctuate strongly during the 2013 and 2014 seasons (see figure 2-10), it is unlikely that surface soil moisture conditions varied substantially from day to day. In 2011, surface hydrology was described only in July, at which time 95% of the site contained wet soils (McLeod and Pellegrini 2013). In 2012, standing water was present only in the river channel and marshes when each site description was recorded, and no more than 20% of the site contained wet soils.

Cougar Point was unoccupied in 2013 and 2014. Three willow flycatchers were detected for 1 day before June 24 in 2013, and no willow flycatchers were detected in 2014. Cougar Point was occupied in 2011 by a pair of breeding flycatchers. No willow flycatchers were detected in 2012. Cowbirds were detected in all survey years. Surveys were discontinued in the site after the 2014 survey season due to the lack of live woody vegetation.

Beaver Pond North

Area: 19.0 ha Elevation: 158 m

The survey site known as Beaver Pond North is approximately 150 m upstream of Cougar Point. This site has been on a periodic survey schedule since 2008 because of a lack both of resident flycatchers and of wet soils away from the main river channel. It was formally surveyed in 2003–08, 2010, 2012, and 2015, and opportunistically surveyed in 2011 and 2016. Two channels of the Bill Williams River are present in the site; one channel runs along the southern border of the site and the other through the center. Vegetation within the site is mixed-native. Within 50 m of the river channel in the center of the site, vegetation in 2016 consisted of an overstory of 8–12-m-tall Goodding's willows and 12–15-m-tall cottonwoods with an understory of tamarisk averaging 5 m in height. In the northern third of the site, the vegetation changed to a mix of tamarisk, honey mesquite, and arrowweed. A few emergent cottonwoods and Goodding's willows with narrow canopies were present in this portion of the site but did not form a closed canopy. Vegetation more than 50 m from the river channel in the center of

the site was largely a mix of tamarisk and arrowweed. Canopy closure over the river channel in the center of the site reached 65% in 2016. In 2015, canopy closure ranged from 60% in the river channel to 90% in areas with lusher Goodding's willow overstory. Sedges and grasses, as well as dead or dying cattails, were noted in several places within the river channels. Through 2012, all vegetation in the river channels was mostly bulrush and cattails that were green and lush. Other than the change in herbaceous vegetation in the river channels, no major changes in vegetation structure or species composition have been noted since 2003.

In 2015, standing water was present in both river channels in the southern two-thirds of the site when the May site description was recorded. Only isolated pools were present when the June and July site descriptions were recorded. All other soils were dry and sandy. In 2016, no wet soils were noted during the survey in May. Given that river levels did not fluctuate strongly during the 2015 and 2016 seasons (see figure 2-10), it is unlikely that surface soil moisture conditions varied substantially from day to day. From 2003 to 2007, the main river channel was flowing in May annually but dried to a few puddles in July (McLeod and Pellegrini 2013). In 2008, 2010, and 2012, both channels of the Bill Williams River contained surface water when each site description was recorded. Soils away from the channels were dry and sandy throughout the survey seasons.

No willow flycatchers were detected in 2015 or 2016. Beaver Pond North was considered occupied in 2007, with the detection of a flycatcher from May 30 to June 6, but not in any other survey year. Cowbirds were detected in all survey years.

Surveys were discontinued for the remainder of the 2016 season following the initial visit because canopy closure within the site did not meet the criterion for suitable habitat (see table 2-1). Some patches of vegetation adjacent to the river had suitably dense canopy closure in previous years, and this could again be the case if wet soils were present and resulted in increased vegetation density. Maintaining this site on the triennial survey schedule will ensure that any changes in habitat suitability will be noted in a timely manner.

Beaver Pond

Area: 21.5 ha Elevation: 160 m

Beaver Pond is contiguous with the upstream end of Beaver Pond North. This site was put on a periodic survey schedule starting in 2008 due to a lack of resident flycatchers and of wet soils away from the river channel. It was surveyed formally in 2003–08, 2010, 2012, and 2015 and opportunistically in 2011 and 2016. Two channels of the Bill Williams River are present at the site; one channel runs along the southern border of the site and the other through the center. Vegetation within the site is mixed-native. Within 50 m of the river channel in the center of

the site, vegetation in 2016 consisted of an overstory of 8–12-m-tall Goodding's willows and 12–14-m-tall cottonwoods with an understory of tamarisk 5–7 m in height. Willow baccharis, mule-fat, screwbean mesquite, and honey mesquite were scattered in the understory adjacent to the river channel. Vegetation more than 50 m from the river channel in the center of the site consisted of tamarisk and honey mesquite 5–7 m in height. Cattails and bulrush were present along most of the southern river channel. In the river channel in the center of the site, a series of beaver dams created several pools with relatively little vegetation. Portions of the channel between the pools were vegetated in either cattails or sedges, which were dying at the northeastern end of the site in 2016. Canopy closure over the river channel in the center of the site reached 60% in 2016. In 2015, canopy closure ranged from 50% in open areas in the river channel to 90% in areas with lusher Goodding's willow overstory. No major changes in vegetation structure or species composition have been noted since 2003.

In 2015, both river channels held standing water for the entire length of the site in May. By June, standing water was present in both channels in the upstream half of the site. By July, standing water was only present in a very deep beaver pool at the very upstream end of the site. Soils away from the river channels were dry and sandy throughout the 2015 survey season. In 2016, three small puddles with surrounding saturated soils were present in the river channel in the center of the site when the May site description was recorded; all other soils were dry. Given that river levels did not fluctuate strongly during the 2015 or 2016 seasons (see figure 2-10), it is unlikely that surface soil moisture conditions varied substantially from day to day. From 2003 to 2012, standing water was present in both channels throughout each survey season, either as flowing water or in beaver ponds (McLeod and Pellegrini 2013). Soils away from the river channels were dry and sandy in each survey year in 2003–12.

Beaver Pond was unoccupied in 2015 and 2016. No willow flycatchers were detected in 2015. Three willow flycatchers were detected for 1 day prior to June 24 in 2016; none of these individuals were detected on any of three subsequent monitoring visits. Beaver Pond was unoccupied in all survey years in 2003–12 (McLeod and Pellegrini 2013). Cowbirds were detected in all survey years.

Surveys were discontinued for the remainder of the 2016 season following the initial visit because canopy closure within the site did not meet the criterion for suitable habitat (see table 2-1). Some patches of vegetation adjacent to the river had suitably dense canopy in previous years, and this could again be the case if wet soils were present and resulted in increased vegetation density. Maintaining this site on the triennial survey schedule will ensure that any changes in habitat suitability will be noted in a timely manner.

Site 08

Area: 6.0 ha Elevation: 167 m

The survey site known as Site 08 is immediately upstream of the confluence of the Mohave Wash and the Bill Williams River and 3 km upstream of Beaver Pond. The flood plain on this stretch of river is confined to the north and south by high cliffs, creating a 150-m-wide riparian zone of mixed-native vegetation. Site 08 was surveyed in 2003–08, 2010, and 2015–17. No surveys were conducted between 2010 and 2015 because the site had been placed on the periodic survey schedule due to a lack of resident flycatchers and of wet soils away from the river channel. In 2015, breeding flycatchers were discovered just upstream of the original survey area, and the site boundary was revised to incorporate this area. Vegetation immediately adjacent to the river channel consists of an overstory of 10–12-m-tall Goodding's willows and 12–15-m-tall cottonwoods with an understory of 2–6-m-tall tamarisk. Young Goodding's willows, cottonwoods, and coyote willows are scattered in the understory immediately adjacent to the river channel. Vegetation away from the river channel is dominated by 5–6-m-tall tamarisk with some arrowweed and honey mesquite and a loose overstory of 10–12-m-tall cottonwoods and a few Goodding's willows. In 2017, many of the cottonwoods and Goodding's willows were dead or severely stressed with few leaves, and thick deadfall was present throughout the site. The healthiest overstory trees were in the very eastern portion of the site, on either side of the Bill Williams River channel. The proportion of overstory trees showing signs of stress increased from east to west through the site, with roughly 50% of the trees being dead on the western side. This pattern was also noted in the tamarisk, with live trees present in the eastern portion of the site near the river channel and dead trees away from the channel. The live tamarisk were mostly defoliated when each site description was recorded in 2017. Through 2015, canopy closure ranged from 50 to 90%, with an average of 70%. In 2017, canopy closure reached 85% under the healthiest cottonwoods and 40–60% in the remainder of the site. Other than the tree mortality and decrease in canopy closure noted in 2017, no major changes in vegetation structure or species composition have occurred since 2003.

The Bill Williams River bisects the site, and in 2015 and 2016, water was present in a series of deep, stagnant beaver ponds on the eastern side of the site and as a small, flowing stream on the western side when site descriptions were recorded in May, June, and July. All other soils were dry. In 2017, water levels in the beaver ponds were noticeably lower than in previous years, and the areal extent of water within the site was much smaller. Given that river levels did not fluctuate strongly during the season in 2015–17 (see figure 2-10), it is unlikely that surface soil moisture conditions were variable from day to day. In survey years in 2003–10, flowing water was present in the river channel throughout each survey season, while soils beneath the vegetation were dry (McLeod and Pellegrini 2013).

Site 08 was occupied in 2015 and 2016, with one to two resident flycatchers detected in each year. No willow flycatchers were detected in 2017. Site 08 was unoccupied in all survey years in 2003–10 (McLeod and Pellegrini 2013). Cowbirds were detected in all survey years.

A small patch of trees in the northwestern corner of the site has most of the elements of preferred nesting habitat, but canopy closure in this area does not exceed the minimum value for suitable habitat. The remainder of the site has canopy closure < 85% and thus does not meet all the criteria for suitable habitat. Discontinuing surveys in portions of the site with poor habitat quality would result in minimal risk of missing flycatcher territories. Habitat suitability at the site could improve in future years if wet soils increase in extent and canopy closure becomes denser. If flow in the Bill Williams River increases strongly in future years, re-evaluation of the site would reduce the chance that suitable habitat is overlooked.

Upstream Site 08

Area: 1.1 ha Elevation: 170 m

The survey site known as Upstream Site 08 was opportunistically surveyed in 2008 and formally surveyed in 2009–17. It is approximately 100 m east of Site 08 on the northern side of the riparian zone. Vegetation in the site consists of a broken overstory of 15–20-m-tall cottonwoods and 10–15-m-tall Goodding's willows with an understory of 3–7-m-tall tamarisk. The tamarisk had yellow or brown leaves when each site description was recorded in 2017. The northern and western edges of the site border a cattail marsh. Vegetation is healthiest near the western edge of the site and becomes increasingly stressed with many dead or partially dead Goodding's willows on the eastern side. Very few cottonwoods remain in the site compared to previous years. Canopy closure has decreased in recent years from a range of 60 to 80% and an average of 70% in 2015 to a range of 30 to 85% with an average of 55% in 2017. Canopy closure is highest in areas with thick tamarisk.

Standing water was present in the very western portion of the site and along the northern border in the cattail marsh when site descriptions were recorded in 2013–17. The eastern half of the site contained dry to damp soils when each site description was recorded. Given that river levels did not fluctuate strongly during the season in 2013–17 (see figure 2-10), it is unlikely that surface soil moisture conditions varied substantially from day to day.

In 2008–12, the site contained surface water throughout the survey season annually, but the percentage of the site that was inundated decreased from 40–60% in 2008 to 2–5% in 2012 (McLeod and Pellegrini 2013). In 2012, only the western portion of the site contained surface water throughout the breeding season, with dry soils throughout the rest of the site.

Upstream Site 08 was unoccupied in 2013–17. One willow flycatcher was detected for 1 day prior to June 24 in 2013 but was not detected on subsequent monitoring visits or surveys. No willow flycatchers were detected in 2014–17. Upstream Site 08 was occupied in 2009 by a pair of breeding flycatchers (McLeod and Pellegrini 2013). Cowbirds were detected in all survey years.

Patches of dense tamarisk in the western portion of the site have most of the elements of preferred nesting habitat, but canopy closure does not exceed the minimum value for suitable habitat (see table 2-1). The remainder of the site has canopy closure << 85% and thus does not meet all the criteria for suitable habitat. If defoliation occurs in future years and the condition of the tamarisk declines, habitat suitability would also decline. If the site is evaluated at the beginning of the next survey season and determined not to have improved in quality, surveys could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

Planet Ranch Road

Area: 4.0 ha Elevation: 171 m

The survey site known as Planet Ranch Road was surveyed annually from 2009 to 2011. The site is on the Planet Ranch property, just south of the refuge boundary; a majority of the site is within 20 m of the refuge boundary. After the 2011 survey season, ownership of the property changed, and surveys were conducted from the refuge boundary in 2012 and 2013. Surveys were discontinued after the first two survey periods in 2013 when it was discovered that surveys were being conducted on the property by another organization. The property changed ownership again in 2016, and the site was surveyed in 2017.

Planet Ranch Road is approximately 350 m south of Upstream Site 08 along the southern edge of the riparian area. The site is bisected along its 700-m length by the Bill Williams River channel. The river channel dominates the site, and in the western three-quarters, vegetation within the site boundary is no more than 25 m wide on either side of the channel. Vegetation in the site is mixed-native and in the western three-quarters of the site consists primarily of tamarisk 4–6 m in height with some cottonwoods and Goodding's willows up to 12 m in height. The cottonwoods and Goodding's willows are present as either emergent trees or as a broken overstory. Several of the cottonwoods and willows are dead. In 2017, the tamarisk were mostly brown in May; a mixture of brown, leafless, and refoliating in June; and just beginning to refoliate when the July site description was recorded. Canopy closure in the western three-quarters of the site ranges from 50% near the edges of the ponds to 85% in pockets of thick tamarisk and averages 75%. The primary change since 2011 in vegetation structure in the western three-quarters of the site has been in the increased presence of dead trees. In 2010, the survey area was expanded to include the eastern quarter of the site. In the eastern quarter of the site, vegetation covers the width of the site and consists of

cottonwoods and Goodding's willows up to 10 m in height with an understory of arrowweed and3-m-tall tamarisk. Many of the Goodding's willows have dead tops with live vegetation only to 7 m in height. Canopy closure ranges from 30 to 80% in this portion of the site and is typically 40–50%. Canopy height has not increased noticeably since 2011 (6–10 m in height in 2011), and canopy closure has decreased noticeably (> 90% in 2011).

Standing water was present in the river channel as a series of deep beaver ponds when the May, June, and July site descriptions were recorded in 2017. Soils away from the river channel and beaver ponds were dry. Similar surface hydrology was noted in 2009–12 (McLeod and Pellegrini 2013). In this reach, surface water is affected by riverflow but not by water levels in Lake Havasu. Given that daily outflow from Alamo Dam increased only slightly during the 2017 breeding season and river levels downstream from Site 08 remained unchanged, it is unlikely that surface soil moisture conditions varied substantially from day to day.

No willow flycatchers were detected in 2017. The site was occupied in 2 years between 2009 and 2012, when breeding flycatchers were documented in the eastern quarter of the site (McLeod and Pellegrini 2013). The site was also occupied in 2013 when a flycatcher was detected from the property line on June 5–12. This individual was in the same location during both surveys and was demonstrating territorial behavior. It is unknown if the flycatcher remained in the area, as surveys ceased after June 12. Cowbirds were detected in all survey years.

Small pockets of dense tamarisk in the western end of the site have most of the characteristics of preferred nesting habitat, but canopy closure does not exceed the minimum value for suitable habitat (see table 2-1). Most of the site has canopy closure << 85% and thus does not meet all the criteria for suitable habitat. The cottonwoods and Goodding's willows at this site no longer provide a dense, continuous overstory as they did in earlier years. Discontinuing surveys at a site in this condition would result in minimal risk of missing flycatcher territories. Habitat suitability at the site could improve in future years if the beaver ponds are washed out by high-flow events and new vegetation emerges. Re-evaluation of the site in the years after a high-flow event would reduce the chance that suitable flycatcher 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 level of Alamo Lake rose early in 2010 following a large rain event but declined over the next 5 years, falling over 5 feet during each year from 2012 to 2014 (figure 2-11). Imagery available on Google Earth shows that South Camp, Over the Edge, Sidebar 01, Edgewater 01, Camp 01–04, Middle Earth 01–02, and Burro Wash 01–02 were still under water as of June 24, 2011. Imagery also shows that as of November 2, 2013, South Camp was still partially

Figure 2-11.—Alamo Lake daily elevation (meters above mean sea level), 2010–17. Data sourced from Lakes Online (2017).

under water, and Over the Edge had only recently been exposed. Lake levels fluctuated between 2014 and 2016, but no wet soils were documented within any of the sites during those years (McLeod and Pellegrini 2015, 2017a, 2017b). Storm events over the 2016–17 winter increased the level of Alamo Lake, which peaked in March 2017 at 10.4 m higher than on the corresponding day in 2016. Standing water was present in most survey sites in 2017, with water levels gradually decreasing by 1.3 m over the breeding season (see figure 2-11). Three sites surveyed in previous seasons (Over the Edge, Edgewater 01, and Camp 04) were entirely under water and were not surveyed in 2017. Burros and cattle were noted in and near several of the sites in each year, and elk (*Cervus elaphus*) were occasionally observed. Tamarisk beetles were first seen in the study area in 2017, primarily within sites that were not inundated and around the perimeter of the lake. Effort at Alamo Lake in 2014–17 focused on monitoring territories, and sites were not surveyed on the schedule recommended in the survey protocol. No site was surveyed more than four times in any year, and most sites were described only once or twice per year. Occupancy status remained undetermined in several sites where no willow flycatchers were detected and survey effort did not meet the three-survey protocol.

Bullard Wash

Area: 1.4 ha Elevation: 335 m

The survey site known as Bullard Wash is a mixed-native survey site located on the eastern edge of the riparian area at the outflow of Bullard Wash at the end of Wickenburg Road. It was surveyed in 2016 and 2017. In 2016, a large portion of

the site consisted of Goodding's willows 10–12 m in height with no understory and 80% canopy closure. The Goodding's willows were surrounded by honey mesquite and tamarisk 3–5 m in height with 0–40% canopy closure. In 2017, most of the site consisted of Goodding's willows with the upper 5–8 m of the trees exposed above the surface of the water. Canopy closure was 60–80% across most of the site. Tamarisk 1–2 m in height above the water were present in the understory along the southern and eastern edges of the site. The tamarisk were in poor condition, with many dead leaves. No tamarisk beetles were noted on any site description, and the condition of the tamarisk was likely the result of prolonged inundation.

Soils were completely dry in 2016 when the site description was recorded in July, and the nearest water was 280 m away in Alamo Lake. In 2017, the site was completely inundated when site descriptions were recorded in May, early July, and late July, with water depth exceeding 3 m. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

No willow flycatchers were detected in 2016 or 2017. Occupancy status could not be determined in either year because of limited survey effort, with only one survey conducted in 2016 and no surveys in June 2017. Cowbirds were detected in both years.

Canopy closure in this site is < 85%; therefore, the site does not meet all the criteria for suitable habitat (see table 2-1). If the Goodding's willows increase in density, habitat suitability could improve.

South Camp

Area: 1.8 ha Elevation: 335 m

South Camp is a mixed-native survey site consisting of two disjunct polygons on the western edge of the riparian area, approximately 2 km due north of Bullard Wash. It was surveyed in 2016 and 2017. In 2016, vegetation within the site consisted of Goodding's willows 6–10 m in height with tamarisk 2–3 m in height scattered in the understory. Some arrowweed and mule-fat were present in the understory and were more prevalent near the edges of the site than in the interior. Some young, 4–6-m-tall Goodding's willows were present in the southwestern portion of the site. Canopy closure ranged from 30% in the shortest and sparsest Goodding's willows to 70–90% in the tallest vegetation. In 2017, the southern polygon was completely submerged. Vegetation in the northern polygon consisted entirely of Goodding's willows, with only 3–6 m of the upper canopy of the trees emerging from Alamo Lake. Most of the trees were on the short end of this height range, and the increase in canopy height as lake levels decreased was very noticeable. No understory vegetation was visible during the season.

Canopy closure ranged from 40% in the southern end of the northern polygon, where the Goodding's willows were short and sparse, to 75% in the northern end, where the Goodding's willows were tallest and densest.

Soils were dry in 2016 when site descriptions were recorded in June and July, but a shallow flowing stream was present adjacent to the site. The site was inundated in 2017 to a depth greater than 2 m when site descriptions were recorded in May, June, and July. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

South Camp was occupied in 2016 by two breeding flycatchers. No willow flycatchers were detected in 2017. The site was surveyed according to the three-survey protocol in 2017 and was considered unoccupied in that year. Cowbirds were detected in 2016 but not in 2017.

Overall habitat suitability in the site in 2017 was poor, as canopy closure was low (see table 2-1). Only the upper canopy was exposed in 2017, creating the effect of scattered shrubs in areas with the lowest canopy closure. This site was first surveyed in 2016 and was noted as being young. The age assessment is supported by Google Earth imagery, which does not show the Goodding's willows as being visible in November 2013. Habitat suitability may improve if lake levels decrease and more of the midstory is exposed. Habitat suitability would also improve if the trees mature and the canopy becomes taller and more continuous.

Over the Edge

Area: 2.1 ha Elevation: 335 m

Over the Edge is a mixed-native survey site located in the middle of the riparian area, approximately 500 m southeast of South Camp. It was surveyed in 2016, but it was completely submerged and therefore not surveyed in 2017. In 2016, vegetation within most of the site consisted of 7–8-m-tall Goodding's willows with tamarisk 3–5 m in height in the understory. Canopy closure averaged 80–90% at the beginning of the season and decreased to a range of 50–80% and an average of 70% by the end of the season. The northwestern arm of the site was 6-m-tall tamarisk with 70–80% canopy closure. Cattle used the site extensively and had trampled much of the herbaceous groundcover.

Soils were completely dry when site descriptions were recorded in May and July of 2016. Willows within the site had slight early leaf abscission in late July. Soil moisture conditions at the site did not fluctuate through the 2016 season, aside from temporarily damp soils caused by seasonal rains (D. Blood 2017, personal communication).

Over the Edge was occupied in 2016 by four breeding flycatchers. No surveys were conducted due to occupancy status, and the presence of cowbirds is unknown.

Sidebar 01

Area: 1.1 ha Elevation: 335 m

Sidebar 01 is a mixed-native survey site on the eastern edge of the riparian area, 1 km downstream from the end of Brown's Crossing Road. It was surveyed in 2014–17. Through 2016, vegetation within the site consisted of a 30–50-m-wide strip of Goodding's willows, 10–12 m in height, with a few cottonwoods. Tamarisk 2–4 m in height were scattered in the understory. Some arrowweed and mule-fat were present in the understory and were more prevalent near the edges of the site than in the interior. There were several areas with standing snags, and trees in the southern 25 m of the site were completely dead. The areal extent of the survey area was reduced after 2015, as trees in the southern 100 m of the original survey area were completely dead. Canopy closure in 2016 varied with tree health and declined during the season. At the beginning of the 2016 season, canopy closure varied from 30% in areas with snags to 90% in the densest vegetation. At the end of the season, many of the Goodding's willows in the northern third and along the western edge of the site became leafless, with 30–40% canopy closure. Canopy closure in the remaining Goodding's willows was 60–70% in the center portion of the site and 70–80% in the southern portion. Between 2014 and 2016, canopy height increased from 8 m, and overall canopy closure decreased from 95%.

In 2017, vegetation within the site was native and consisted of Goodding's willows with the upper 6–10 m of the trees exposed above the surface of the lake. A few tamarisk emerged less than 2 m out of the lake and appeared stressed. Several pockets of dead Goodding's willows were present in the site, notably at the far northern and southern ends and in the middle. Examination of Google Earth imagery from October 2016 suggests that some tree mortality had already occurred by that time. The extent of mortality observed in 2017 is greater than what is visible in Google Earth, especially in the middle of the site. Canopy closure varied directly with the proportion of healthy trees and ranged from 40 to 90% and was typically 70–80% in areas with the healthiest trees. In the areas with many dead trees, canopy closure was 40–60%.

Soils were completely dry when site descriptions were recorded in 2014–16. In 2017, the site was completely inundated to a depth greater than 3 m when site descriptions were recorded. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

Sidebar 01 was occupied in 2015 and 2016, with two and four resident flycatchers detected, respectively. No willow flycatchers were detected in 2014 or 2017, but

occupancy status could not be determined in either year because of limited survey effort, with only one survey conducted in 2014 and no surveys in June 2017. Cowbirds were detected in 2014, 2015, and 2017.

Small pockets of habitat with all the characteristics of preferred nesting habitat (see table 2-1) are present in this site. However, most of the site has canopy closure << 85% and therefore does not meet all the criteria for suitable habitat. Habitat suitability could improve if the crowns of the Goodding's willows increase in size or density or if the lake recedes and new trees grow.

Edgewater 01

Area: 0.9 ha Elevation: 335 m

Edgewater 01 is 100 m northeast of Over the Edge, in the middle of the riparian zone. The site was assessed in 2014, at which time canopy height was too short (< 4 m) to be suitable for flycatchers. The site was surveyed in 2015 and 2016, but it was completely submerged and not surveyed in 2017. In 2016, vegetation in the site consisted of Goodding's willows 7–8 m in height with an understory of 1–4-m-tall tamarisk. The Goodding's willows were surrounded by 3–4-m-tall tamarisk with 50–70% canopy closure. Canopy closure under the Goodding's willows was 80–90% at the beginning of the 2016 season but decreased to 70% during the season as many of the Goodding's willows lost up to half of their leaves.

Soils were dry when site descriptions were recorded in 2015 and 2016. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

Edgewater 01 was occupied in 2015 and 2016, with two and four resident flycatchers detected, respectively. Because the site was occupied both years, it was not surveyed. The presence of cowbirds is unknown.

Camp 01

Area: 0.6 ha Elevation: 337 m

The survey site known as Camp 01 was surveyed in 2014–17. It is approximately 200 m northwest of Edgewater 01 on the western edge of the riparian area. The site occupies two inlets along the edge of the riparian area and the space between them, creating a "U" shape, and is bordered to the northwest by dry, upland vegetation. Vegetation in the site is native in composition. In 2016, dominant vegetation within the survey site consisted of Goodding's willows 10–12 m in height with 80–90% canopy closure. Much of the site lacked an understory, but clumps of tamarisk 2–3 m in height and arrowweed up to 2 m tall occurred along the edges of the site. Between 2014 and 2016, canopy height increased from 8 m,

and canopy closure decreased from 95% overall. In 2017, dominant vegetation within the site consisted of Goodding's willows emerging 6–8 m above the lake with a few cottonwoods mixed in on the eastern side. A few clumps of tamarisk up to 2 m in height above the water level were present along the edges of the site. Canopy closure at the mouth of each inlet and along the eastern side of the site was 60–80%. Vegetation at the head of each inlet consisted of 5-m-tall Goodding's willows that were either dead or had very sparse canopies. Canopy closure in these areas reached 40%, and this portion of the site was not surveyed in 2017. Examination of Google Earth imagery from October 2016 suggests that mortality occurred prior to the site being inundated.

Water was present in a stream channel southeast of and adjacent to the site when site descriptions were recorded in 2014–16, but an incised, 2-m-tall bank separated the site from the stream channel. Soils within the site in 2014–16 were dry when each site description was recorded. In 2017, the site was completely inundated to a depth of over 2 m when all site descriptions were recorded. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

Camp 01 was occupied in 2014 and 2016, with two resident flycatchers detected in each year. No willow flycatchers were detected in 2015 or 2017. Site occupancy status is unknown for 2015, as only one survey was conducted. The site was considered unoccupied in 2017, as surveys were conducted according to the three-survey protocol. Cowbirds were detected only in 2017.

Canopy closure throughout this site was < 85% in 2017, and the site therefore did not meet all the criteria for suitable habitat (see table 2-1). Low canopy closure was largely the result of tree mortality that occurred prior to the 2017 field season. Habitat suitability could improve if the crowns of the Goodding's willows increase in size or density or if the lake recedes and new trees grow.

Camp 04

Area: 0.2 ha Elevation: 335 m

Camp 04 was surveyed in 2014–16 but was completely submerged and not surveyed in 2017. The site is approximately 180 m northeast of Camp 01. In 2016, vegetation in this survey site consisted of a narrow, linear stand of 7–8-m-tall Goodding's willows with 3–4-m-tall tamarisk in the understory. Canopy closure was typically 90%, except in a few small gaps, where it was 70%. In 2016, the site was bordered to the east by a dense stand of arrowweed and to the west by the river channel. The bank of the channel was at least 1 m in height.

Soils were dry when each site description was recorded in 2014–16, though standing water was present in the river channel. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

Camp 04 was occupied in 2014 and 2016, with one and three resident flycatchers detected, respectively. No willow flycatchers were detected in 2015, but only one survey was conducted, and site occupancy status is unknown. No cowbirds were detected during survey years.

Camp 02

Area: 0.3 ha Elevation: 337 m

Camp 02, a site 45 m northwest of Camp 04 at the outflow of a small wash on the western edge of the riparian area, was surveyed in 2014–17. In 2016, vegetation within the site consisted primarily of Goodding's willows 10–12 m in height with 90% canopy closure. Tamarisk 3–4 m in height was present around the site periphery and dominated the western 15% of the site, with some emergent cottonwoods. Canopy closure was 60–70% in the western end of the site. In 2017, vegetation within the site consisted primarily of Goodding's willows with the upper 5–8 m of the trees exposed above the lake. Some cottonwoods were scattered through the site and made up a significant portion of the canopy in the western half. By June 2017, the cottonwoods looked stressed with low canopy closure. Canopy closure varied from 40% in the western half of the site to 80% in the eastern half. Tamarisk 2–3 m in height above the water were present around the site periphery, and the western 15% of the site was dominated by tamarisk that emerged 1–2 m above the lake. Canopy closure in this area was 15%, and this portion of the site was not surveyed in 2017. No tamarisk beetles were noted when the site descriptions were recorded, but the tamarisk had sparse green and brown foliage and appeared stressed by prolonged inundation.

Soils were dry when site descriptions were recorded in 2014–16, though there was water in the main river channel to the east of the site. The site sits on a bench that was 1 m above the water in 2014–16. In 2017, the site was inundated to a depth of at least 2 m when all site descriptions were recorded. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

No willow flycatchers were detected in 2014–17. Survey effort in 2014–16 was insufficient to determine occupancy, with one to two surveys in each year. In 2017, surveys were conducted according to the three-survey protocol, and the site is considered unoccupied in that year. No cowbirds were detected during any surveys.

Canopy closure throughout this site was < 85% in 2017; therefore, the site did not meet all the criteria for suitable habitat (see table 2-1). Habitat suitability could improve if the crowns of the Goodding's willows increase in size or density or if the lake recedes and new trees grow.

Camp 03

Area: 1.2 ha Elevation: 337 m

The survey site known as Camp 03 was surveyed in 2014–17. It is 150 m north of Camp 02, along the western edge of the riparian area at the outflow of a wash and is bordered to the north and west by dry upland scrub. Vegetation in the site is native in composition. In 2016, the site was primarily vegetated by Goodding's willows 10–12 m in height with 3–4-m-tall tamarisk scattered in the understory. Some cottonwoods 12–18 m in height were scattered in the overstory and were most prevalent in the northwestern portion of the site. Mule-fat were also present in the understory. Canopy closure averaged 80% but ranged from 70 to 90%. Some of the Goodding's willows began to die in July 2016, and canopy closure was as low as 40–50% in the area with stressed trees. Between 2014 and 2016, canopy height increased from 6–8 m to 10–12 m, though canopy closure did not change. Stem density in portions of the site with both cottonwoods and Goodding's willows was noted in 2014 as being lower than in areas with only Goodding's willows. Prior to the 2015 survey season, the eastern part of the site was washed away in a spring storm, leaving a cut bank up to 3 m tall along the eastern site border.

In 2017, vegetation consisted of Goodding's willows with the upper 6–9 m of the trees exposed above the lake. Cottonwoods emerging 8–9 m in height above the water were scattered along the northern edge of the site and were most prevalent in the northwestern portion. Stem density of the Goodding's willows and cottonwoods was lower than what is typically present elsewhere in the study area (G. Cummins 2017, personal observation). Tamarisk emerging up to 1 m in height above the lake were scattered in the understory and reached 2 m in height along the upland edge of the site. No tamarisk beetles were noted when the site descriptions were recorded, but the tamarisk were leafless or had very sparse leaves, likely as the result of prolonged inundation. The condition of the cottonwoods declined noticeably during the season. Many of the cottonwoods looked stressed in mid-June, and by late July 99% of the cottonwoods were completely dead, with many having fallen over. Canopy closure was 75–90% in May but decreased to 40–75% in late July. The lowest percentages of canopy closure were recorded in the northern end and very northwestern tip of the site, where all the trees were dead.

Soils were completely dry when site descriptions were recorded in 2014–16. The site sits on a bench that was 3 m above the adjacent wash, which held water in 2014 and 2015. The nearest standing water in 2016 was adjacent to Camp 02.

In 2017, the site was completely inundated to a depth of at least 2 m throughout the season. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

Camp 03 was occupied in 2014 by two resident flycatchers. No willow flycatchers were detected in 2015–17. Site occupancy status is unknown for 2015 and 2016, as only one or two surveys were conducted in each year. In 2017, the site was surveyed according to the three-survey protocol and is considered unoccupied in that year. Cowbirds were detected during surveys in 2015 and 2017.

At the beginning of the 2017 season, portions of the site with the highest canopy closure met all the criteria for preferred nesting habitat, but by the end of the season, the entire site had canopy closure << 85% and thus did not meet all the criteria for suitable habitat (see table 2-1). Low canopy closure in much of the site is due to cottonwood mortality that occurred during the 2017 field season. Some Goodding's willow mortality was noted toward the end of the 2016 survey season (McLeod and Pellegrini 2017b), and this likely contributed to low canopy closure in areas dominated by Goodding's willows. Habitat suitability could improve in future years if the crowns of the Goodding's willows increase in size or density or if the lake recedes and new trees grow.

Middle Earth 01

Area: 1.8 ha Elevation: 337 m

Middle Earth 01 is a mixed-native survey site consisting of two disjunct polygons approximately 700 m southwest of the end of Brown's Crossing Road on the eastern side of the riparian zone. It was surveyed in 2014–17. Through 2016, the site was surrounded by historical lakebed, which was patchily vegetated with 2-m-tall tamarisk and mule-fat, scattered patches of arrowweed, and several herbaceous species. In 2016, vegetation within the site consisted of tamarisk up to 5 m in height with several disjunct patches of Goodding's willows 7–12 m in height. Where Goodding's willows were present, they formed an overstory above the tamarisk. The tamarisk were patchy but very dense in places. About 50% of the tamarisk were dead or dying in May 2016, and areas dominated by this vegetation were removed from the survey area after the 2016 survey season. Canopy closure ranged from 50 to 70% in the tamarisk and reached 70–80% in areas with Goodding's willows. In 2016, canopy height was slightly higher than that (maximum height 10 m) recorded in 2014, and canopy closure was slightly lower than that (60–95%) observed in 2014.

In 2017, vegetation in both polygons consisted of Goodding's willows, with the upper 9–12 m of the trees emerging above the water level, and an understory of tamarisk 1–2 m in height above the lake. A few cottonwoods were also present in the southern polygon, and small Goodding's willow snags were scattered in the

understory. In the southern polygon, there were a few patches of tamarisk that had no willow overstory. No tamarisk beetles were noted when the site descriptions were recorded, but the tamarisk had brown leaves or very sparse green leaves throughout the season, likely as the result of prolonged inundation. Areas dominated by dead Goodding's willows were present on the southeastern and northwestern borders of the southern polygon. Canopy closure averaged 70% in the northern polygon. In the southern polygon, canopy closure was typically 70–90%, depending on overstory health and density, but was as low as 10% in the gaps dominated by tamarisk. The highest canopy closure was in the center of the southern polygon.

Soils within the site were damp or completely dry when site descriptions were recorded in 2014–16. In 2017, the site was completely inundated to a depth of at least 2 m when site descriptions were recorded in May and July. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

Middle Earth 01 was occupied in 2014–17, with two to nine resident flycatchers detected annually. A cowbird was detected during one survey in 2017.

The center of the southern polygon, where canopy closure is highest, has all the characteristics of preferred nesting habitat (see table 2-1). The remainder of the southern polygon and all of the northern polygon lack the canopy closure needed for suitable habitat.

Middle Earth 02

Area: 5.0 ha Elevation: 338 m

The mixed-native survey site known as Middle Earth 02 was surveyed in 2014–17. It is 75 m north of Middle Earth 01 and 400 m west of the end of Brown's Crossing Road, in the middle of the riparian zone. In 2016, vegetation within most of the site consisted of Goodding's willows 10–12 m in height, with clumpy tamarisk 3–5 m in height in the understory. Several gaps in the overstory existed in the center of the site and were dominated by mule-fat. Canopy closure averaged 70–80% but reached 90% in the denser willows. The Goodding's willows in the west-central portion of the site, just northeast of the road, showed signs of stress in May 2016, with new deadfall and thin canopies resulting from loss of leaves. Canopy height in 2016 was higher than that (7–9 m) recorded in 2014, and canopy closure was lower than that (95%) observed in 2014. In 2014, the northern arm of the site consisted of clumps of Goodding's willows 6–8 m in height, surrounded by tamarisk 2–4 m in height and mule-fat up to 2 m in height. In 2016, most of the willows in the northern arm were completely dead and the remainder were obviously stressed. A significant portion of the tamarisk in the northern arm was brown, and the densest canopy closure was 30–50%. This portion of the site was not visited again after May 2016.

In 2017, vegetation consisted of Goodding's willows with the upper 12–14 m of the trees emerging above the water, with patches of tamarisk 2 m in height above the lake scattered in the understory. The eastern half of the site was primarily Goodding's willows with little to no tamarisk in the understory. Tamarisk were more prevalent in the western half of the site. There were also several gaps in the overstory where only tamarisk 2–4 m in height above the water occurred. No tamarisk beetles were noted when the site descriptions were recorded, but many of the tamarisk were either dead or turning brown, likely the result of prolonged inundation. Canopy closure was 90% in areas with a Goodding's willow overstory and 50% in areas with only tamarisk.

Soils throughout the site were damp to dry when site descriptions were recorded in 2014–16. The site was completely inundated to a depth of at least 2 m when site descriptions were recorded in May and July of 2017. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

Middle Earth 02 was occupied in 2014–17, with 14–21 resident flycatchers detected annually. Cowbirds were detected during a survey in 2014. Most of this site contains all the characteristics of preferred nesting habitat (see table 2-1). Pockets within the site that are vegetated only with tamarisk lack the canopy closure and canopy height of suitable habitat.

Prospect 01

Area: 1.4 ha Elevation: 338 m

Prospect 01 is a mixed-native survey site extending north-south along a bench 100 m west of the end of Brown's Crossing Road on the eastern edge of the riparian zone. It was surveyed in 2014–17. The eastern side of the site is on the top of the bench, while the western side is at the bottom. The ground surface slopes gradually between the two sides, rather than being sharply incised, and there is an approximate 1-m difference in ground elevation between the two sides. In 2016, vegetation within the site consisted of a 20–30-m-wide strip of Goodding's willows 10–12 m in height with 2–3-m-tall tamarisk and some mule-fat scattered throughout the understory. Tamarisk were more prevalent on top of the bench, and many of the Goodding's willows had died in this area, creating gaps with 50% canopy closure. On the western side of the site, below the bench, Goodding's willows were the dominant vegetation, with canopy closure averaging 70% and little to no tamarisk. Many of the Goodding's willows throughout the site were stressed and dying.

In 2017, vegetation within the site consisted of a 20–40-m-wide strip of Goodding's willows, with the upper 8–15 m of the trees emerging above the lake, and a scattered understory of tamarisk emerging 3 m above the lake. The Goodding's willows were generally shorter (8–9 m) in the southern end of the site

and taller (10–15 m) in the northern end. A 20-m-wide strip of dead Goodding's willows was present in the southern half of the site along the eastern edge; these trees were noted as being dead during the 2016 breeding season. In the northern half of the site, a strip of tamarisk 4–5 m in height was present along the eastern site edge. No tamarisk beetles were noted when the site descriptions were recorded, but many of the tamarisk were sparsely foliated, likely the result of prolonged inundation. Canopy closure was typically 80–90% in areas dominated by Goodding's willows but as low as 15% in the area with high tree mortality. In areas dominated by tamarisk, canopy closure varied from 10 to 80% but was typically 40%.

Soils were completely dry when site descriptions were recorded in 2014–16. In 2017, the site was completely inundated to a depth of at least 1.5 m when site descriptions were recorded in May and July. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

Prospect 01 was occupied in 2017 by nine resident flycatchers. No willow flycatchers were detected in 2014–16, but this site was only surveyed once or twice in each year, and occupancy status could not be formally determined. However, field personnel traversed the site regularly en route to other sites and did not detect any flycatchers. Cowbirds were detected in 2014 and 2015.

Portions of the site dominated by live Goodding's willows have all the characteristics of preferred nesting habitat (see table 2-1). Areas dominated by dead Goodding's willows and/or tamarisk lack the canopy closure needed for suitable habitat.

Burro Wash 01

Area: 5.8 ha Elevation: 338 m

Burro Wash 01 is a mixed-native site that was surveyed in 2014–17. It is 480 m northwest of Middle Earth 02 and 350 m northeast of Camp 03, near the western edge of the riparian zone. Through 2016, the site was bordered to the north by a dry cattail marsh and to the south by open, dry river channel. In 2016, the western half of the site was vegetated with Goodding's willows 10–12 m in height in the overstory and 2–4-m-tall tamarisk and mule-fat in the understory. Canopy closure in this portion of the site was 85%. In the east-central portion of the site, vegetation transitioned to 10–15-m-tall cottonwoods with tamarisk understory and 70% canopy closure. The very southeastern corner of the site was vegetated with 3–5-m-tall tamarisk with 70–80% canopy closure. In 2016, canopy height was taller and canopy closure was slightly lower than that recorded in 2014 (6–8 m and 80–95%, respectively).

In 2017, vegetation in the site consisted primarily of Goodding's willows, with the upper 10–12 m of the trees emerging above the lake, and an understory of tamarisk emerging 2 m above the lake. Cottonwoods up to 12 m in height above the water were mixed in with the Goodding's willows in a band approximately 50 m wide in the eastern portion of the site. About half of the cottonwoods had fallen but were still alive in June. In July, only one standing cottonwood was noted, and the rest had fallen over. Several Goodding's willows had also fallen over by mid-July after high wind events. Two areas of tamarisk without a Goodding's willow or cottonwood overstory were present along the southern and eastern borders. Tamarisk within the site had brown leaves or were leafless throughout the survey season. No tamarisk beetles were observed within the site, and the condition of the tamarisk was likely the result of prolonged inundation. Canopy closure in late June was 85–90% in a majority of the site with patches of 70% canopy closure along the western and southwestern edges and 60% canopy closure in areas dominated by tamarisk. Canopy closure within the areas dominated by Goodding's willows decreased as cottonwoods and willows fell over and was 75–80% by late July. The survey area was increased in 2017, as patches of trees adjacent to the original survey area had matured and were occupied during the season.

Soils were completely dry when site descriptions were recorded in 2014–16. The site was completely inundated to a depth of at least 2.5 m when site descriptions were recorded in June and July of 2017. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

Burro Wash 01 was occupied in 2016 and 2017, with 5 and 21 resident flycatchers detected in each year, respectively. No willow flycatchers were detected in 2014 or 2015, but the site was surveyed only once in each year, and site occupancy status was undetermined. Cowbirds were detected in all survey years.

At the beginning of the 2017 season, most of the site had all the characteristics of preferred nesting habitat (see table 2-1). Canopy closure declined as the season progressed, and by the end of the season canopy closure did not meet the criterion for suitable habitat, although all other characteristics of preferred nesting habitat remained.

Burro Wash 02

Area: 8.6 ha Elevation: 338 m

The survey site known as Burro Wash 02 was surveyed in 2014–17. It is approximately 40 m northeast of Burro Wash 01 and forms a long strip of mixed-native riparian vegetation 75–170 m wide that is oriented north-south. The site is bordered to the north by dry upland scrub and to the south by live riparian forest in Motherlode 01. Through 2016, it was bordered to the west by dry cattail marsh

and to the east by a large swath of dead and downed trees. In 2016, vegetation within the site consisted of small-diameter Goodding's willows 10–14 m in height with 2–4-m-tall tamarisk in the understory and 70–85% canopy closure. Mule-fat and cattails were also present in the understory, mostly in the middle section of the site. In the southern third of the site, canopy closure was higher, trees were taller, and the understory was less dense and widely scattered. More gaps were present in the northern half of the site, and canopy closure was lower. Between 2014 and 2016, canopy height increased from 6–8 m and canopy closure decreased slightly from 80–95%.

In 2017, vegetation within the site consisted of Goodding's willows, with the upper 12–15 m of the trees emerging above the lake. Tamarisk 2 m in height above the water were scattered in the understory and were more prevalent along the western edge of the site than in the interior. The tamarisk had brown leaves and appeared to be dying. No tamarisk beetles were detected at the site, and the condition of the tamarisk was likely the result of prolonged inundation. Canopy closure throughout a majority of the site was 85–90%. A swath of dead and/or dying Goodding's willows approximately 100 m across was present in the southern half of the site. Canopy closure in this area was approximately 70%. Several small pockets of 70% canopy closure were also scattered throughout the site.

Soils were damp to dry when site descriptions were recorded in 2014–16. In 2017, the site was completely inundated to a depth of at least 1.75 m when site descriptions were recorded in June and July. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

Burro Wash 02 was occupied in 2015–17, with 4–30 resident flycatchers detected annually. No willow flycatchers were detected in 2014, but the site was surveyed only once, and occupancy status could not be determined. Cowbirds were detected in 2014, 2016, and 2017.

Most of this site contains all the characteristics of preferred nesting habitat (see table 2-1). The swath of dead and dying Goodding's willows in the southern half of the site lacks the canopy closure and midstory structural elements of suitable habitat.

Motherlode 01

Area: 4.2 ha Elevation: 340 m

The survey site known as Motherlode 01 was surveyed in 2014–17. It is east of Burro Wash 01 and south of Burro Wash 02 and is contiguous with both sites. Through 2016, it was bordered to the south by open, dry river channel, to the north by a large swath of dead and downed trees, and to the east by sparse riparian

forest. In 2016, vegetation within the western third of the site consisted of a dense stand of small-diameter Goodding's willows 8–12 m in height with 1–6-m-tall tamarisk widely scattered in the understory. Canopy closure reached 90% in this portion of the site. The eastern two-thirds of the site was vegetated with tamarisk 3–5 m in height, with larger-diameter, emergent Goodding's willows 10–20 m in height. This portion of the site contained canopy gaps that were filled with deadfall; canopy closure in this section reached 75%. Mule-fat were also scattered through this portion of the site.

In 2017, vegetation within the western two-thirds of the site consisted of a dense stand of Goodding's willows emerging 8–12 m in height above the lake, with tamarisk 1–4 m in height above the water widely scattered in the understory. A 50-m-wide swath of dead or dying Goodding's willows ran north-south through the western third of the site. Tree health was highest along the very western and southern borders of this portion of the site. Canopy closure varied from 10% in areas dominated by dead trees to 90% in areas with healthy trees. Most of the eastern third of the site was vegetated with tamarisk 3–5 m in height and emergent Goodding's willows 10 m in height. Mule-fat were also scattered through this portion of the site, and deadfall occurred in thick piles. A strip of 8-m-tall Goodding's willows was present along the southern boundary of this portion of the site, and a stand of Goodding's willows with a tamarisk understory was present at the northern border. Canopy closure in the middle of the eastern third of the site was approximately 60%. Canopy closure along the northern and southern borders was much higher than 60% but was not thoroughly described. Examination of Google Earth imagery indicated that much of the tree mortality throughout the site had occurred by October 2016.

Soils were completely dry when site descriptions were recorded in 2014–16. In 2017, most of the western half of the site was inundated to a depth of at least 1.5 m when it was described in May and July. The eastern half of the site was described in July, at which time 20% of it contained wet soils and most of the remainder had damp soils. Water levels at the site vary in accordance with the level of Alamo Lake and thus did not fluctuate substantially from day to day.

Motherlode 01 was occupied in 2014–17, with two to nine resident flycatchers detected annually. This site was not surveyed in 2015–17 due to occupancy status, and cowbirds were noted only in 2014. Cattle were noted in the eastern lobe of the site in 2017.

Portions of the site with the healthiest trees and highest canopy closure have all the characteristics of preferred nesting habitat (see table 2-1), whereas portions of the site with canopy closure < 85% do not meet all the criteria for suitable habitat. Portions of the site with dead and dying trees also lack the midstory structural elements of suitable habitat.

Motherlode 02

Area: 4.9 ha Elevation: 343 m

Motherlode 02 is a mixed-native survey site 350 m east of Burro Wash 02 and is bordered to the north by dry upland scrub, to the east and south by a matrix of live riparian forest and pockets of deadfall, and to the west by a large swath of dead and downed trees. It was surveyed in 2014–17. In 2016, vegetation within the site was mixed-native and consisted of Goodding's willows 12–18 m in height with significant amounts of deadfall scattered in the understory. Some tamarisk and mule-fat were scattered in a narrow band around the southern, western, and northern borders of the site. There was little to no understory in the interior of the site, which was thick with deadfall. The trees were shorter (12–15 m in height) in the southern portion of the site, with wide crowns and canopy closure reaching 80%. In the northern two-thirds of the site, tree height averaged 15–18 m, canopy closure varied between 40 and 80%, and most tree canopies were narrow, creating a more broken canopy than in the southern end of the site. Several tall, large-diameter willows (> 40 cm diameter at breast height) were present within the site, but many of the trees had relatively narrow diameters (< 20 cm diameter at breast height) and were starting to lean. By July 2016, the Goodding's willows were starting to lose leaves.

In 2017, examination of Google Earth imagery showed that most of the original extent of the survey area appeared to have died as of October 2016. This was confirmed during the survey season, and only the southern quarter of the original area was surveyed in 2017. The 2017 survey area is bordered to the north and east by mostly dead riparian vegetation, to the south by a matrix of live riparian forest and pockets of deadfall, and to the west by a large swath of dead and downed trees. Vegetation is mixed-native in composition and consists of Goodding's willows up to 15 m in height, with some 1–7-m-tall tamarisk scattered around the southern border of the site. There is little to no understory in the interior of the site, which is thick with large amounts of deadfall. Canopy closure ranges from 50 to 75%, with the highest cover occurring in areas with tamarisk. Tamarisk beetle larvae were noted in June, and some of the tamarisk were turning brown. In July, most of the tamarisk were refoliating.

Soils were completely dry when site descriptions were recorded in 2014–16. In 2017, small amounts of wet soils were present when the June site description was recorded, with most of the site being completely dry. In July 2017, most of the site was damp, though a small amount of saturated soil was present where the inundated soils had previously been located. The extensive presence of damp soil was likely the result of recent wet weather. The site was not adjacent to the maximum extent of the lake during the survey season, and any changes in soil moisture would likely 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 in the Santa Maria River during any breeding season in 2014–17 (figure 2-12). Small flow events generally occurred in the Big Sandy River in

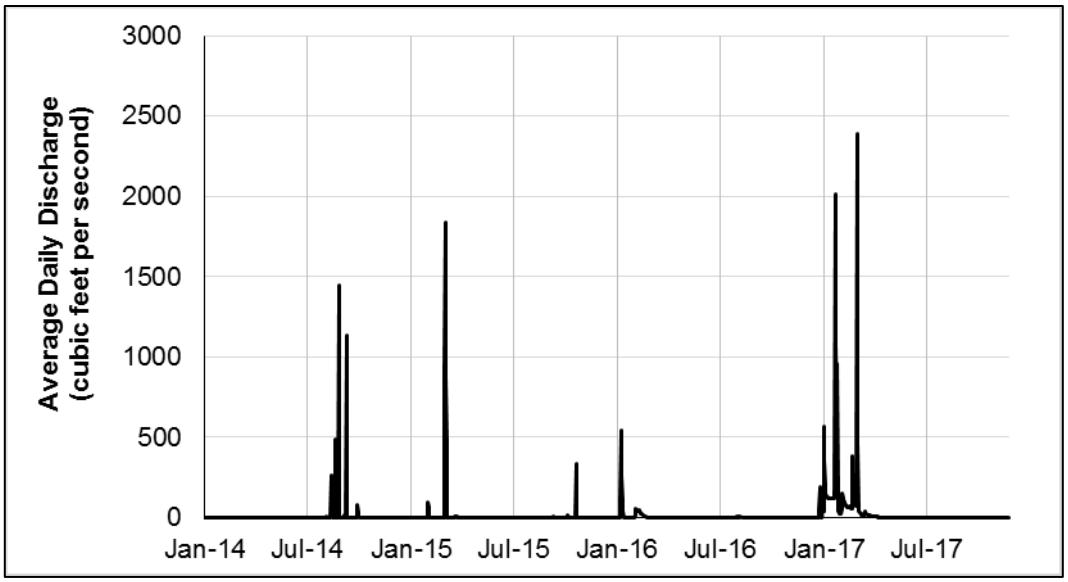

Figure 2-12.—Average daily discharge (cfs) recorded at the Santa Maria River near Bagdad, Arizona (U.S. Geological Survey Station #09424900), 2014–17.

July and August of each year (figure 2-13). It is possible that more water was present adjacent to the site during these flow events, though water levels were unlikely to have increased sufficiently to result in overbank flooding.

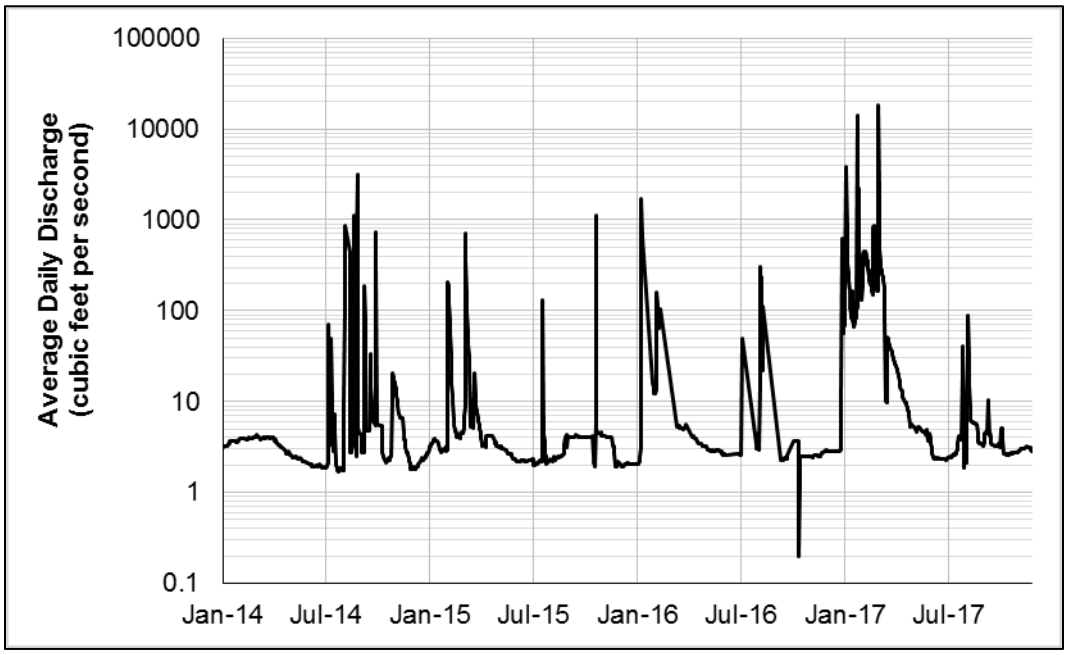

Figure 2-13.—Average daily discharge (cfs) recorded at the Big Sandy River near Wikieup, Arizona (U.S. Geological Survey Station #09424450), 2014–17.

Motherlode 02 was occupied in 2014 and 2016, with four resident flycatchers detected in each year. No willow flycatchers were detected in 2015 or 2017, but the site was surveyed only once in each of these years, and site occupancy status could not be determined. A cowbird was detected during the 2017 survey.

No portion of this site has all the elements of suitable habitat (see table 2-1) because canopy closure is too low and most of the site lacks dense twig structure in the midstory. Vegetation health at this site has been declining steadily since 2014 and did not improve in 2017 despite an increase in wet soils in part of the site. Vegetation condition seems likely to continue to decline, and surveys could be discontinued at this site with minimal risk of overlooking suitable flycatcher habitat.

Motherlode 03

Area: 5.3 ha Elevation: 345 m

The survey site known as Motherlode 03 was surveyed in 2014–17. It is a mixed-exotic survey site 200 m northeast of Motherlode 02 that consists of two disjunct polygons. It is bordered to the east by open, dry river channel, to the west and south by a matrix of live riparian forest and dead trees, and to the north by dry upland scrub. Sections of both polygons were washed away by flooding over the 2016–17 winter. Vegetation in the northern polygon consists of tamarisk 6–8 m in height with some emergent Goodding's willows 12–15 m in height. Many of the Goodding's willows are dead and fallen, as are several of the tamarisk, with the effect that vegetation occurs in clumps. Deadfall is thick throughout the understory. Canopy closure reaches 30% in the northern polygon. The southern polygon is primarily tamarisk 6–8 m in height with two isolated patches of emergent Goodding's willows and cottonwoods 12–15 m in height. Many of the tamarisk have fallen in this polygon as well, creating thick piles of deadfall, and canopy closure within the tamarisk reaches 45%. The cottonwoods and Goodding's willows in the southern polygon are the healthiest in the site, although many have leafless or downed limbs, and canopy closure reaches 60% in these small patches. The live tamarisk in both polygons were in varying stages of defoliation and refoliation during June and late July of 2017. Since 2014, the amount of dead cottonwoods and Goodding's willows and the amount of dead branches within the remaining live trees have increased, as has the amount of deadfall. Canopy closure has decreased since 2014, when it was 75–90%. The areal extent of the survey area has also decreased due both to flood activity and to areas of unsuitable habitat being removed from the survey area.

Soils were damp to dry when site descriptions were recorded in 2014–17. The site was not adjacent to the maximum extent of the lake during the 2017 survey season. Any changes in soil moisture during survey years would likely 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 in the Santa Maria

River during any breeding season in 2014–17 (see figure 2-12). Small flow events generally occurred in the Big Sandy River in July and August of each year (see figure 2-13). It is possible that more water was present adjacent to the site during these flow events, though water levels were unlikely to have increased sufficiently to result in overbank flooding.

Motherlode 03 was occupied in 2014–16, with 3–10 resident flycatchers detected annually. No willow flycatchers were detected in 2017, but the site was surveyed only once, and site occupancy status could not be determined. Cowbirds were detected in 2015 and 2016.

No portion of this site has canopy closure that meets the criterion for suitable habitat (see table 2-1), and most of the site also lacks dense twig structure in the midstory. A large amount of tree mortality has occurred since 2014, and live vegetation within the site is patchy. Surveys could be discontinued at this site with minimal risk of overlooking suitable flycatcher habitat.

Motherlode 04

Area: 0.4 ha Elevation: 343 m

The survey site known as Motherlode 04 was surveyed in 2014–17. It is located 200 m east of Motherlode 03 and consists of a patch of vegetation 100 x 50 m in size in the middle of the dry, open river channel. Approximately 20 m of the southern end of the original survey area was washed away during the 2016–17 winter floods. Vegetation within the northern half of the remaining survey area consists of Goodding's willows 10–12 m in height with 1–3-m-tall tamarisk in the understory. Mule-fat 1–2 m in height and a few cottonwoods are scattered around the perimeter of the site. Many of the trees were dead or dying in late July 2017 and were showing signs of stress at the end of 2016. In July 2017, 90% of the trees were either dead or had dropped most of their leaves. Canopy closure in the northern half of the site was 90% in June 2017 but had decreased to 50–65% by late July. Canopy closure throughout the site in 2014 and 2015 was 90%. Vegetation in the southern half of the remaining survey area is now mostly dead snags with the occasional live cottonwood or tamarisk. Tamarisk in the site were defoliated in mid-June of 2017.

Soils were dry to damp when site descriptions were recorded in 2014–17. The site was not adjacent to the maximum extent of the lake during the 2017 survey season. Any changes in soil moisture during survey years would likely 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 in the Santa Maria River during any breeding season in 2014–17 (see figure 2-12). Small flow events generally occurred in the Big Sandy River in July and August of each year

(see figure 2-13). It is possible that water was present adjacent to the site during these flow events, though water levels were unlikely to have increased sufficiently to result in overbank flooding.

Motherlode 04 was occupied in 2014 and 2015, with two resident flycatchers detected in each year. No willow flycatchers were detected in 2016 or 2017. In 2016, the site was surveyed according to the three-survey protocol and is considered unoccupied. Site occupancy status is unknown for 2017, as only one survey was conducted. Cowbirds were detected in 2015 and 2016.

At the beginning of the 2017 season, the northern half of the site had all the structural elements of preferred nesting habitat (see table 2-1) but did not have wet soils. By late July, canopy closure in this portion of the site had declined to << 85%, and the site thus did not meet all the criteria for suitable habitat. The southern half of the site lacked the canopy closure and midstory structural elements needed for suitable habitat throughout the 2017 season. Habitat suitability at this site has been declining over the last several years as trees have died. The condition of the vegetation did not improve with the rise in lake levels in 2017, and it seems unlikely to improve in future years without another significant rise in water levels. Surveys at this site could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

Confluence 02

Area: 9.8 ha Elevation: 350 m

The mixed-exotic survey site known as Confluence 02 was surveyed in 2014 and 2016. It is located along the eastern edge of the riparian zone and extends south from the confluence of the Big Sandy and Santa Maria Rivers for 1.3 km. The site sits on a terrace several meters above the river channel and is bordered by dry upland scrub to the east and open river channel to the west. In 2016, two-thirds of the site was vegetated with scattered emergent Goodding's willows and cottonwoods 15–18 m in height, with tamarisk 3–7 m in height in the understory. Many of the emergent trees looked stressed with dead branches, and many had already fallen, creating large piles of deadfall throughout the site. The remaining third of the site was vegetated with tamarisk 5–12 m in height. The tallest tamarisk were of enormous proportions, having stems > 30 cm diameter at breast height and emerging above the rest of the tamarisk. Canopy closure throughout the site was quite variable, ranging from 50 to 90%. No major changes in vegetation structure or species composition were noted between 2014 and 2016.

Soils were dry when site descriptions were recorded in 2014 and 2016. Any changes in soil moisture during survey years would likely 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 in the Santa Maria River during any breeding season in 2014–17 (see figure 2-12). Small flow events

generally occurred in the Big Sandy River in July and August of each year (see figure 2-13). It is possible that water was present adjacent to the site during these flow events, though water levels were unlikely to have increased sufficiently to result in overbank flooding.

No willow flycatchers were detected in 2016. One willow flycatcher was detected for 1 day prior to June 24 in 2014. No more than two surveys were conducted in either year, and site occupancy status was undetermined. Cowbirds were detected in 2014.

Surveys were discontinued at this site in 2016 after the initial visit, as SWCA concluded that habitat conditions were poor overall and unlikely to improve. Small pockets of tamarisk had all the components of suitable habitat, but the remainder of the site had canopy closure << 85%.

Confluence 01

Area: 5.3 ha Elevation: 350 m

The survey site known as Confluence 01 was surveyed in 2014 and assessed in 2017. It is 90 m northeast of Confluence 02 at the confluence of the Big Sandy and Santa Maria Rivers. It is bordered to the north by dry upland scrub and on all other sides by open river channels. Vegetation within the site is mixed-exotic and consists largely of tamarisk 2–5 m in height. Goodding's willows and cottonwoods 10–12 m in height form an overstory along the southern and western edges of the site. There is a significant amount of standing and fallen deadwood scattered throughout the site. Canopy closure ranges from 10% in very open areas with short vegetation to 60% in areas with cottonwoods and Goodding's willows. The tamarisk were completely defoliated and brown during the visit in mid-July of 2017. No change in species composition was noted between 2014 and 2017, but canopy closure in 2017 was considerably lower than the maximum of 95% recorded in the densest tamarisk in 2014.

Soils were completely dry when site descriptions were recorded in 2014 and 2017. There was water flowing in the Santa Maria River adjacent to the southern edge of the site in 2017. The site sits on a terrace 2–3 m above both riverbeds and would not be inundated except during a high-flow event.

No willow flycatchers were detected in 2014 and 2017, although no broadcast surveys were completed in 2017. Only two surveys were completed in 2014, and occupancy status could not be determined. Field personnel passed along the southern edge of this site regularly in each year in 2014–17 en route to other sites, but no willow flycatchers were detected.

No portion of the site has canopy closure that approaches 85%; therefore, the site does not meet all criteria for suitable habitat (see table 2-1). Portions of the site

also do not have sufficient canopy height to meet the suitability criterion. Habitat quality is unlikely to improve without a significant change in surface soil moisture conditions, and surveys could be discontinued at this site with minimal risk of overlooking suitable flycatcher habitat.

Sandy South 01

Area: 14.9 ha Elevation: 347 m

The survey site known as Sandy South 01 was surveyed in 2014 and 2017. It extends north from the confluence of the Big Sandy and Santa Maria Rivers for 1 km along the western edge of the riparian zone on the Big Sandy River. The site is bordered by dry upland scrub to the west and open river channel to the east. Vegetation is mixed-exotic and consists of tamarisk 6–8 m in height with scattered, emergent Goodding's willows and cottonwoods 12–18 m in height. Honey mesquite 6–8 m in height are scattered along the northwestern edge of the site. Most of the tamarisk in the southern quarter of the site were brown or defoliated during the survey in May 2017. Canopy closure during this survey ranged from 60% in defoliated areas to 85% under the emergent trees and averaged 75% overall. No major changes in species composition or vegetation structure were recorded between 2014 and 2017.

Soils were dry when site descriptions were recorded in 2014 and 2017. The site sits on a terrace 2–3 m above the riverbed and would not be inundated except during a high-flow event.

No willow flycatchers were detected in 2014. One willow flycatcher was detected for 1 day prior to June 24 in 2017 but was not detected on a subsequent monitoring visit. No more than two surveys were conducted in either year, and site occupancy is undetermined. Cowbirds were detected in 2014.

Vegetation with all the elements of suitable habitat (see table 2-1) was limited to the scattered, emergent cottonwoods and Goodding's willows. Canopy closure elsewhere was too low to meet the suitability criterion. Because suitable habitat was so limited and the condition of the vegetation was likely to decline with further tamarisk defoliation, surveys were discontinued at this site in 2017 after the initial visit. This site could be omitted from future years of surveys with minimal risk of overlooking suitable flycatcher habitat.

Santa Maria South 01

Area: 25.6 ha Elevation: 347 m

The survey site known as Santa Maria South 01 was surveyed in 2014–16. It stretches along the southern edge of the riparian area bordering the Santa Maria

River for 1.8 km upstream of the confluence with the Big Sandy River. The site is bordered to the south by dry upland scrub and to the north by a mixture of riparian forest and open river channel. Vegetation within the site is mixed-exotic. In 2016, vegetation consisted primarily of tamarisk 4–7 m in height with 35–90% canopy closure. The areas with the highest canopy closure were only 4 m tall and contained piles of downed, woody debris. Emergent cottonwoods 25 m in height were present along the northern edge of the site. In the northeastern corner of the site, Goodding's willows and cottonwoods were present, generally as emergent trees, and canopy closure under these trees was 70–85%. In 2014, a 20-x 300-m patch of 5-m-tall Goodding's willows and cottonwoods with 95% canopy closure was noted along the very northwestern edge of the site, adjacent to the river. This patch of trees was not recorded in 2015 or 2016. No other major changes in species composition or vegetation structure were noted between 2014 and 2016.

Soils were dry when site descriptions were recorded in 2014–16. Water was present in the river channel adjacent to the western end of the site in all survey years, but the site sits on a terrace, preventing water from entering the vegetation. Any changes in soil moisture would likely be caused by local weather events or fluctuations in daily discharge in the Santa Maria River. Daily discharge levels did not change in the Santa Maria River during any breeding season in 2014–17 (see figure 2-12).

Santa Maria South 01 was occupied in 2014 by a pair of flycatchers for which no nest was found. This pair was present along the edge of the river channel in the portion of the site that was described in 2014 but not in 2015 or 2016. No flycatchers were detected in 2015 or 2016, but no more than two surveys were completed in each year, and site occupancy status could not be determined. Cowbirds were detected in 2014 and 2016.

Surveys were discontinued after the 2016 survey season. Although each suitable habitat component (see table 2-1) was present within the site, dense canopy closure did not typically occur in areas with sufficient vegetation height.

Santa Maria North 01

Area: 27.7 ha Elevation: 347 m

The survey site known as Santa Maria North 01 was surveyed in 2014–17. It stretches along the northern edge of the riparian area bordering the Santa Maria River for 1.4 km upstream of the confluence with the Big Sandy River. The site is bordered by open river channel to the south and dry upland scrub to the north. Only the western half of the site was visited in 2014–16. Vegetation within the site is mixed-native and consists primarily of cottonwoods and Goodding's willows 15–25 m in height with tamarisk 1–8 m in height in the understory. The density of both the overstory and understory is highly variable. In some places, the cottonwoods and Goodding's willows occur as emergent trees, rather than as a

continuous or broken overstory. Large amounts of deadfall are found throughout the site. Where the deadfall is thickest, the understory is sparse. Where there is not as much deadfall, the tamarisk can be quite dense, both in canopy closure and stem density. In areas dominated by tamarisk, canopy closure ranges from 60 to 85%. In areas with a robust cottonwood-willow overstory, canopy closure varies with stem density and ranges between 30 and 85%. Tamarisk beetle larvae were noted in the middle section of the site in May 2017, and some of the tamarisk had foliage that was beginning to turn yellow. In July, most of the tamarisk in the site were brown or defoliated. Other than the tamarisk defoliation, no major changes in species composition or vegetation structure were noted between 2014 and 2017.

The southern edge of the site has a steep bank 1–2 m in height that separates the vegetation from the river channel. The river channel held water throughout the 2015–17 seasons; all surface soils within the site were dry or damp when site descriptions were recorded in 2014–17. Any changes in soil moisture would likely be caused by local weather events or fluctuations in daily discharge in the Santa Maria River. Daily discharge levels did not change in the Santa Maria River during any breeding season in 2014–17 (see figure 2-12).

Santa Maria North 01 was occupied in 2014–17, with 4–13 resident flycatchers detected annually. Cowbirds were detected in 2014, 2016, and 2017.

Prior to the tamarisk at the site being defoliated by tamarisk beetles, portions of the site where the tamarisk were dense enough to have suitable canopy closure but not so dense as to impede flight had all the elements of suitable habitat and the patch width and canopy height of preferred nesting habitat (see table 2-1). In areas where the cottonwoods or Goodding's willows provided sufficient canopy closure, suitable midstory components were sometimes absent. During defoliation, canopy closure in tamarisk-dominated portions of the site did not meet the criterion for suitable habitat, and this site lacks the continuous presence of wet soils that is typical of preferred nesting habitat.

Ground Reconnaissance Results

Bullard Wash North

In 2016, field personnel evaluated a potential survey site known as Bullard Wash North on the eastern edge of the riparian area, 400 m downstream from Sidebar 01. Vegetation was native and consisted of a stringer of Goodding's willows two to three trees wide with a broken canopy. Arrowweed and mule-fat were present in the understory. Soils were completely dry during the visit in May 2016. Given the lack of any kind of dense vegetation and the narrow patch width, the site did not meet the habitat suitability criteria and was not visited again in 2016. This site was completely submerged in 2017.

Palo Verde Ecological Reserve, California

The Palo Verde Ecological Reserve is a conservation area located on the California bank of the Colorado River near Blythe, California. All sites at PVER 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 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. While conditions vary between sites depending on soil type and irrigation schedule, surface soils are likely dry a majority of the time within the conservation area. Lands immediately to the west are dominated by agricultural fields. Cowbirds were detected on almost all surveys in all years. No signs of livestock have been documented in or around PVER.

Phase 02

Area: 21.4 ha Elevation: 85 m

The survey site known as Phase 02 was surveyed from 2009 to 2017. It is composed of distinct cells of vegetation, each dominated by a single tree species. The northern three-quarters of the site contains alternating 30–40-m-wide swaths of 10–12-m-tall Goodding's willows and coyote willows up to 6 m in height. The southern portion of the site is dominated by two large (225 x 60 m) patches of 12–15-m-tall cottonwoods. Height and density of the vegetation vary within and between cells of the site. Vegetation height has remained the same since 2012, but canopy closure has changed. In 2012, canopy closure ranged from < 25 to 90%, having increased notably since 2009. Alfalfa (*Medicago sativa*) formed a thick groundcover throughout the site through 2012. By 2014, canopy closure had increased further and was 80–85% in the Goodding's willows, 70–90% in the coyote willows, and 85–95% in the cottonwoods. Canopy closure in 2017 was noticeably lower than in previous years and was 70–85% in the Goodding's willows, 60–70% in the coyote willows, and 80–85% in the cottonwoods. *Baccharis* sp. are sparsely scattered in the understory of the site.

Wet soils were recorded on at least one site description in each year in 2013–14 and 2016–17, with primarily dry soils recorded the rest of the time. Similarly variable surface hydrology was recorded in 2009–12 (McLeod and Pellegrini 2013). Conclusions on the frequency and duration of surface water within the 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).

Phase 02 was occupied in 2016 by one resident, unpaired male flycatcher. This individual was highly territorial on the first day it was detected and sang spontaneously for lengthy periods of time. Over the following week, this individual became less territorial and was no longer singing spontaneously shortly before it departed. It was present in roughly the same area for 9 days, and because it was detected for more than 7 days, it is considered resident. Phase 02 was unoccupied in 2013–15 or 2017. One to nine willow flycatchers were detected before June 24 during each of these years. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. Phase 02 was unoccupied in 2009–12 (McLeod and Pellegrini 2013).

The cottonwood stands have the highest canopy closure at this site but lack any type of midstory structure. Thus, although each element of suitable habitat (see table 2-1) is present in places within the site, these elements rarely co-occur. This site lacks the continuous presence of wet soils that is typical of preferred nesting habitat, and very few places within the site have the canopy closure of preferred nesting habitat.

Phase 03

Area: 21.4 ha Elevation: 85 m

The survey site known as Phase 03 was surveyed from 2010 to 2017. The western 80% of the site is vegetated with cottonwoods 15–20 m in height. Rows ≤ 10 m wide of mixed Goodding's willows 4–7 m in height and small-diameter coyote willows up to 4 m in height are spaced roughly 40–50 m apart throughout the site. The eastern 20% of the site is vegetated with Goodding's willows 10–12 m in height. *Baccharis* sp. 1.5 m in height occur occasionally along the borders between the willows and cottonwoods and within the Goodding's willows on the eastern side of the site. The overall effect is a mosaic of vegetation types. Trees throughout the entire site have many dead branches, dead branch tips, and thin or oddly shaped crowns. This may be the result of past water stress because all leaves were shiny, green, and healthy looking in 2017. Canopy height has increased slightly since 2012, and canopy closure has also changed over the years. In 2012, canopy closure ranged from 50 to 90% and had increased since 2010. Canopy closure reached 95% in the western portion of the site in 2014 and decreased thereafter. In 2017, canopy closure in the western portion of the site ranged from 60% in the willow rows and in areas with a lot of deadfall and gaps in the trees to as high as 85% in more continuous canopy, though it was most commonly 70%. Canopy closure was 85% in the Goodding's willows in the eastern portion of the site.

Wet soils were recorded on one site description in each year in 2015–17. No wet soils were noted during any of the site descriptions in 2013 or 2014. Similarly variable soil moisture conditions were recorded in 2010–12 (McLeod and

Pellegrini 2013). Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation. However, if conditions are similar to those observed in Phase 02, surface water was likely present only during active irrigation (see GeoSystems Analysis, Inc. 2014).

Phase 03 was unoccupied in 2013–17. It was also unoccupied in 2010–12 (McLeod and Pellegrini 2013). One to six willow flycatchers were detected before June 24 of each year in 2013–15. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. No willow flycatchers were detected in 2016 or 2017.

Canopy closure reaches the minimum suitable level (see table 2-1) in portions of the cottonwood stands, but areas with suitable canopy closure lack any type of midstory structure. All elements of suitable habitat are present in the eastern 20% of the site, where canopy closure reaches 85%. This site lacks the continuous presence of wet soils and the canopy closure that are typical of preferred nesting habitat.

Phase 04 Block 01

Area: 7.7 ha Elevation: 86 m

The survey site known as Phase 04 Block 01 was surveyed from 2013 to 2017. It is vegetated primarily by Goodding's willows 10–12 m in height. Five 20-m-wide strips of cottonwoods up to 15 m in height are evenly spaced throughout the site. Coyote willows up to 5 m in height are present near the cottonwood-Goodding's willow boundaries. In 2017, many Goodding's willows looked stressed with dead or thin tops. Canopy closure is 80% in the cottonwoods and 70–85% in areas dominated by Goodding's willows. *Baccharis* sp. are planted on the northern edge of the survey site. The only notable change in vegetation structure since 2013 is the stressed appearance of the Goodding's willows. No substantial changes in vegetation height or canopy closure have been recorded over the years.

Wet soils were recorded on one site description in each year in 2015–17. No wet soils were noted when site descriptions were recorded in 2013 and 2014. Conclusions on the presence of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation. However, if conditions are similar to those observed in Phase 02, surface water was likely present only during active irrigation (see GeoSystems Analysis, Inc. 2014).

Phase 04 Block 01 was unoccupied in 2013–17. One willow flycatcher was detected in each year in 2014–17 before June 24. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. No willow flycatchers were detected in 2013.

Although canopy closure reaches suitable density (see table 2-1) in a few places within the Goodding's willows, most of the site lacks the canopy closure typical of suitable habitat. This site lacks the continuous presence of wet soils that is typical of preferred nesting habitat.

Phase 04 Block 02

Area: 4.0 ha Elevation: 86 m

The survey site known as Phase 04 Block 02 was surveyed from 2013 to 2017. Most of vegetation within the site is Goodding's willows 12–15 m in height. Coyote willows 3–6 m in height are present in small clumps in the understory or in strips along the perimeter of the site. Where the coyote willows extend into the site, most of the stems are dead. Cottonwoods 15–20 m in height are present in a square patch approximately 35 x 35 m in size near the center of the site. Canopy closure in the Goodding's willows ranges from 60% on the eastern side of the site to 90% on the western side; in the cottonwoods it is 85–90%. Since 2013, canopy height has increased and canopy closure has decreased slightly (from 85–95%). The coyote willows have also declined in health since 2013.

Wet soils were recorded on one site description in each year in 2015–17. No wet soils were noted when site descriptions were recorded in 2013 and 2014. Conclusions on the presence of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation. However, if conditions are similar to those observed in Phase 02, surface water was likely present only during active irrigation (see GeoSystems Analysis, Inc. 2014).

Phase 04 Block 02 was unoccupied in 2013–17. One to four willow flycatchers were detected before June 24 of each year in 2014–17. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. No willow flycatchers were detected in 2013.

The eastern side of the site has canopy closure << 85% and thus does not meet all the criteria for suitable habitat (see table 2-1). Canopy closure within the remainder of the site meets the criterion for suitable habitat, and in some places reaches the minimum value for preferred nesting habitat, but midstory structural elements are missing from most of the site. This site lacks the continuous presence of wet soils that is typical of preferred nesting habitat.

Phase 04 Block 03

Area: 23.7 ha Elevation: 87 m

The survey site known as Phase 04 Block 03 was surveyed from 2013 to 2017. Vegetation within the site consists of cottonwoods, Goodding's willows, and coyote willows that occur in a much more heterogeneous mix than in the other two blocks in Phase 04. Cottonwoods 12–18 m in height and Goodding's willows 8–12 m in height form the overstory. Spindly coyote willows 3–5 m in height occur throughout the understory. There are a few narrow (20-m-wide) strips containing only Goodding's and coyote willows. A few gaps in the cottonwood canopy are present along the north-central portion of the site, and coyote willows 3–5 m in height are the dominant woody species in these gaps. Canopy closure is mostly 70–80% throughout the site and varies directly with canopy height. Canopy closure is as high as 90% in a few places and as low as 60% in areas with only coyote willows. Between 2013 and 2017, vegetation height remained largely unchanged and canopy closure decreased slightly.

Wet soils were recorded on one site description in each year in 2013–17. Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation. However, if conditions are similar to those observed in Phase 02, surface water was likely present only during active irrigation (see GeoSystems Analysis, Inc. 2014).

Phase 04 Block 03 was considered occupied in 2015 but was unoccupied in 2013–14 and 2016–17. In 2015, one resident, unpaired male flycatcher was detected from May 31 to June 14. This individual was actively defending a territory, engaging in lengthy, unsolicited song on each of seven territory visits. In addition to the resident flycatcher, four willow flycatchers were each detected for 1 day before June 24, and one was detected on June 27. The individual that was detected on June 27 also engaged in lengthy, unsolicited song and was in the same general area as the resident flycatcher. It was determined not to be resident, as there were no further detections recorded on any of three subsequent monitoring visits or on subsequent surveys. One willow flycatcher was detected before June 24 of each year in 2016 and 2017. Neither of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. No willow flycatchers were detected in 2013 or 2014.

Although canopy closure reaches preferred density (see table 2-1) in a few places, areas with dense canopy closure lack any type of midstory structure. Thus, although all elements of suitable habitat are present in places within the site, these elements rarely co-occur. Most of the site lacks the canopy closure typical of suitable habitat, and the continuous presence of wet soils that is typical of preferred nesting habitat is also missing.

Phase 05 Block 01

Area: 15.8 ha Elevation: 87 m

The survey site known as Phase 05 Block 01 was surveyed from 2013 to 2017. The site consists of two disjunct polygons encompassing the eastern and southern edges and the northwestern corner of a rectangular block. Grassy fields dominate the center of the block between the two polygons. The site is vegetated by a mosaic of cottonwoods 8–15 m in height, Goodding's willows 6–10 m in height, and coyote willows 2–3 m in height. Cottonwood is the dominant woody species, with interspersed small patches and rows of Goodding's willows. Small coyote willow patches are present along the northern and southern borders of the site. Canopy closure is 65–75% throughout most of the site but is as low as 30% in the northeastern corner where the Goodding's willows are stressed and the top half of each tree is dead. Since 2013, parts of the grassy fields have filled in noticeably with woody vegetation, and the size of the area surveyed has increased accordingly. Canopy closure has also decreased slightly in a majority of the site. Goodding's willows in various parts of the site have shown signs of stress since 2013. In 2014, the Goodding's willows in the southwestern portion of the site were stressed but appeared to recover in subsequent years. Stressed willows were noted in the northeastern corner of the site for the first time in 2017.

No wet soils were recorded when each site description was recorded in 2013–14 and 2017. Wet soils were present in some portion of the site and recorded on at least one site description in 2015–16. Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation. However, if conditions are similar to those observed in Phase 02, surface water was likely present only during active irrigation (see GeoSystems Analysis, Inc. 2014).

Phase 05 Block 01 was unoccupied in 2013–17. One to 12 willow flycatchers were detected prior to June 24 of each year in 2013–16. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. No willow flycatchers were detected in 2017.

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

Phase 05 Block 02

Area: 23.6 ha Elevation: 86 m

The survey site known as Phase 05 Block 02 was surveyed from 2013 to 2017. It is vegetated primarily with cottonwoods 12–16 m in height in the western two-thirds of the site and Goodding's willows up to 8–10 m in height in the eastern third. Some Goodding's willows are mixed in under the cottonwoods as well. In

2016, the Goodding's willows under the taller cottonwoods appeared stressed or dead. Vegetation height is generally shorter on the northern side of the site and taller on the southern side. Canopy closure ranges from 60 to 85% and varies directly with vegetation height. A few large, open areas dominated by grass and shrubs run diagonally through the center of the site from the northeast to the southwest. Other than the declining condition of some of the Goodding's willows, the only notable change in vegetation structure over the years has been a slight decrease in canopy closure.

No wet soils were noted when site descriptions were recorded in May, June, or July in any year in 2013–17, though damp soils were noted at times. Conclusions on the presence of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation. However, if conditions are similar to those observed in Phase 02, surface water was likely present only during active irrigation (see GeoSystems Analysis, Inc. 2014).

Phase 05 Block 02 was unoccupied in 2013–17. Two and three willow flycatchers were detected before June 24 in 2015 and 2017, respectively. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. No willow flycatchers were detected in 2013–14 or 2016.

Though suitably dense canopy closure exists within a small portion of the site, it rarely co-occurs with all midstory structural components needed for suitable flycatcher habitat (see table 2-1). The continuous presence of wet soils that is typical of preferred nesting habitat is also missing.

Phase 05 Block 03

Area: 29.6 ha Elevation: 86 m

The survey site known as Phase 05 Block 03 was surveyed in 2013–17. This site is primarily vegetated with a mix of cottonwoods and Goodding's willows. The eastern and western portions of the site are predominantly cottonwoods 12–15 m in height. Many narrow (≤ 10 m wide) rows of Goodding's willows are interspersed throughout the cottonwoods. Most of the Goodding's willows are 7–8 m in height and mostly dead. In areas where the cottonwoods are less prevalent, the Goodding's willows are healthier and taller, reaching 10 m in height. Several open areas dominated by grass are present and are more abundant in the eastern portion of the site than elsewhere. Canopy closure in the cottonwood-dominated portion of the site ranges from 60 to 85% and is typically 80–85%. Canopy closure at the low end of this range occurs in the western 50 m of the site where the cottonwoods have dead tops and canopy closure does not exceed 70%. The center quarter of the site is predominantly Goodding's willows 8–15 m in height with 30–90% canopy closure. The Goodding's willows are taller in the northern 100 m of the site, and canopy closure varies directly with

vegetation height. Near the southern border of the site, the Goodding's willows reach 10 m in height, but the top two-thirds of each tree is dead and leafless. A few patches of 2–5-m-tall coyote willows and *Baccharis* spp. are scattered in the understory throughout the site. Trees within the site have increased in height slightly since 2013, but no other major changes in vegetation structure have been noted other than the declining health of the trees. In 2014, the Goodding's willows in the eastern portion of the site were stressed but appeared to recover in subsequent years. Stressed willows were noted in the south-central portion of the site for the first time in 2017.

Wet soils were recorded on at least one site description in 2014–16. Soils were either damp or dry when site descriptions were recorded in 2013 and 2017. Conclusions on the presence of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation. However, if conditions are similar to those observed in Phase 02, surface water was likely present only during active irrigation (see GeoSystems Analysis, Inc. 2014).

Phase 05 Block 03 was unoccupied in 2013–17. Two to six willow flycatchers were detected before June 24 of each year in 2015–17. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. No willow flycatchers were detected in 2013 or 2014. The northernmost 100 m of the stand of Goodding's willows has all the structural characteristics of preferred nesting habitat (see table 2-1) but lacks wet soils. Most of the rest of the site lacks the canopy closure needed for suitable habitat.

Phase 06 Block 01

Area: 38.7 ha Elevation: 86 m

The survey site known as Phase 06 Block 01 was surveyed from 2014 to 2017. It is vegetated primarily with a mosaic of cottonwoods and Goodding's willows. The two species occasionally occur in monotypic strips but more often occur together in mixed strips. The cottonwoods are 10–15 m in height, and the Goodding's willows are 10–12 m in height. Canopy closure ranges from 60% in open areas to 90% in the tallest, densest cottonwoods and is typically 75–80%. Coyote willows up to 5 m in height are also present in narrow (1–5 m wide) rows spaced at even intervals from east to west throughout the site. Canopy cover is 40–60% in areas dominated by coyote willows. Mule-fat and *Baccharis* sp. are scattered throughout the understory. Canopy height has increased noticeably since 2014, but overall canopy closure has remained the same. No other changes in vegetation structure were noted.

Wet soils were recorded on at least one site description in 2014–17. Conclusions on the presence of surface water within the site could not be drawn because of

the high variability in water levels associated with flood irrigation. However, if conditions are similar to those observed in Phase 02, surface water was likely present only during active irrigation (see GeoSystems Analysis, Inc. 2014).

Phase 06 Block 01 was unoccupied in 2014–17. Two to five willow flycatchers were detected before June 24 annually in 2014 and 2016–17. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. No willow flycatchers were detected in 2015.

Although canopy closure reaches suitable density (see table 2-1) in the densest cottonwoods, areas with suitable canopy closure lack any type of midstory structure. Thus, although all elements of suitable habitat are present in places within the site, these elements do not co-occur.

Phase 06 Block 02

Area: 37.6 ha Elevation: 86 m

The survey site known as Phase 06 Block 02 was surveyed from 2014 to 2017. This survey site is vegetated with a mosaic of Goodding's willows, cottonwoods, and coyote willows. The cottonwoods are 10–15-m-tall, and the Goodding's willows are 8–12-m-tall. Most of the Goodding's willows appear stressed, with dead leaves, sparse foliage, and dead/dying canopy tops. Several large, open areas vegetated primarily with grass are present in the southeastern portion of the site. Canopy closure varies from 70 to 85%, with no discernable pattern across most of the site, but is as low as 30% in open areas. Coyote willows 3–5 m in height are widely scattered in small patches (5 x 10 m in size) throughout the site. Mule-fat are also scattered widely throughout the site. Both the mule-fat and coyote willow patches are so widely scattered that they do not form an understory layer. Canopy height has increased noticeably since 2014, but overall canopy closure has remained the same.

Wet soils were recorded on at least one site description in 2014, 2015, and 2017 but not in 2016. Conclusions on the presence of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation. However, if conditions are similar to those observed in Phase 02, surface water was likely present only during active irrigation (see GeoSystems Analysis, Inc. 2014).

Phase 06 Block 02 was considered occupied in 2014 but not in 2015–17. In 2014, one willow flycatcher was detected on July 7. This individual was heard briefly from a distance at the beginning of the survey, prior to any playback. Field personnel attempted to get closer to the individual, but it was unresponsive to playback and could not be located. No willow flycatchers were detected during a subsequent survey on July 14. No followup monitoring visits were scheduled

because the individual did not display territorial behavior. Five additional willow flycatchers were detected before June 24 of each year in 2014, 2016, and 2017. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. No willow flycatchers were detected in 2015.

All the characteristics of suitable habitat (see table 2-1) are present in small portions of this site, but canopy closure in most of the site is below suitable levels, and midstory structural elements occur only in patches.

Phase 07 Block 01

Area: 36.8 ha Elevation: 86 m

The survey site known as Phase 07 Block 01 was surveyed from 2015 to 2017. This survey site is vegetated with a mosaic of cottonwoods, Goodding's willows, and coyote willows, with cottonwoods being most prevalent and coyote willows least prevalent. The cottonwoods and Goodding's willows tend to be planted together, alternating with narrow rows of coyote willows. The effect is of a scattered understory of coyote willows. The cottonwoods reach 10–15 m in height, and the Goodding's willows reach 6–10 m in height. Canopy closure is 70–85% in a majority of the site. The coyote willows vary from 3-m-tall, widely spaced wispy stems to 5-m-tall stands with 85–95% canopy closure. *Baccharis* sp. are scattered throughout the site. Vegetation height has increased slightly since 2015, but overall canopy closure has remained the same.

The presence of wet soils was recorded on one site description in both 2015 and 2017, with a majority of the site holding wet soils in 2015 and only a small portion holding wet soils in 2017. No wet soils were documented when each site description was recorded in 2016. When no wet soils were present, the nearest standing water was either in the irrigation canal immediately to the south or in the Colorado River. Conclusions on the presence of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation. However, if conditions are similar to those observed in Phase 02, surface water was likely present only during active irrigation (see GeoSystems Analysis, Inc. 2014).

Phase 07 Block 01 was unoccupied in 2015–17. Three to 13 willow flycatchers were detected prior to June 24 of each year. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled.

All characteristics of suitable habitat are present within small patches, and canopy closure, but not canopy height, reaches levels typical of preferred nesting habitat (see table 2-1) in stands of coyote willows. Most of the site, however, has canopy closure that does not reach suitable levels. This is one of the youngest sites surveyed by SWCA; vegetation structure may continue to develop in future years.

Phase 07 Block 02

Area: 40.6 ha Elevation: 86 m

The survey site known as Phase 07 Block 02 was surveyed from 2015 to 2017. It is vegetated with a mosaic of cottonwoods, Goodding's willows, and coyote willows, with cottonwoods being most prevalent and coyote willows least prevalent. The cottonwoods and Goodding's willows tend to be planted together, alternating with narrow rows of coyote willows. The cottonwoods reach 10–12 m in height, and the Goodding's willows reach 8–10 m in height. Canopy closure is 70–90% throughout a majority of the site. Coyote willows vary from 2-m-tall, widely spaced wispy stems to 5-m-tall stands with 40–60% canopy closure. *Baccharis* sp. are also scattered throughout the site. Several open areas with widely spaced Goodding's and coyote willows are present within the site, and canopy closure is as low as 60% in these locations. Both vegetation height and canopy closure have increased since 2015.

Wet soils were present in a majority of the site when one site description was recorded in 2016. In 2017, wet soils were present in a majority of the site when one site description was recorded and in a small portion of the site when another site description was recorded. No wet soils were documented when site descriptions were recorded in 2015. Conclusions on the presence of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation. However, if conditions are similar to those observed in Phase 02, surface water was likely present only during active irrigation (see GeoSystems Analysis, Inc. 2014).

Phase 07 Block 02 was unoccupied in 2015–17. Five to seven willow flycatchers were detected prior to June 24 of each year. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled.

All the structural characteristics of preferred nesting habitat (see table 2-1) are present in portions of the site, but the consistently wet soils that are typical of preferred nesting habitat are lacking.

Ehrenberg, Arizona

Ehrenberg

Area: 4.7 ha Elevation: 78 m

The survey site known as Ehrenberg was surveyed annually from 2003 to 2008. In 2008, it was put on a biennial survey schedule and was surveyed again in 2010 and 2012. In 2013, this site was placed on a triennial survey schedule and was surveyed in 2015. In 2015, vegetation in the site was mixed-native in composition. A stringer of primarily 20–25-m-tall cottonwoods ran north to south through the middle of the site. In the southern half of the site, the understory consisted of 1–2-m-tall arrowweed, and several of the cottonwoods were dying. Canopy closure reached 50% in the southern half of the site. In the northern half of the site, the arrowweed was less abundant, and willow baccharis dominated the understory. A few large Goodding's willows were present in the stringer in this portion of the site, and canopy closure reached 80%. Two cattail marshes were present within the site, one in the eastern half of the site and the other in the northwestern portion of the site, adjacent to the site border. The northwestern cattail marsh contained thin, wispy coyote willows 3–4 m in height with 75–80% canopy closure. The size and extent of the coyote willows in this marsh did not change significantly between 2012 and 2015. The northwestern marsh was bordered to the south by an area of dead and fallen coyote willows that had been present since 2008. The eastern cattail marsh was bordered on either side by a strip up to 10 m wide of tamarisk and honey mesquite 6–7 m in height. A narrow strip of 5-m-tall coyote willows was present between the cattails and tamarisk on the western side of the marsh. Canopy closure reached 80% on either side of the eastern marsh. The far eastern and southern portions of the site were vegetated primarily with arrowweed.

The western cattail marsh was inundated during a visit in March 2015, but both marshes contained only small amounts of damp soils when the May, June, and July site descriptions were recorded. All other soils were dry. The presence of wet soils in a small portion of the site (≤ 15%) was recorded on least one site description in each previous survey year (McLeod and Pellegrini 2013). The site is separated from the Colorado River by a levee. Soil moisture conditions in the site are influenced by groundwater levels, which likely fluctuate with the level of the Colorado River.

No willow flycatchers were detected in 2015. The site was unoccupied in all survey years in 2003–12 (McLeod and Pellegrini 2013). Cowbirds were detected in all survey years. No signs of livestock have been observed within the site, although burros used the periphery of the site.

No portion of this site had canopy closure that reached 85% in 2015, and the site thus did not meet all the criteria for suitable habitat (see table 2-1). The southern half of the site also lacked any type of midstory structure. The presence of coyote

willows in or adjacent to the cattail marshes suggests the potential for habitat suitability to improve if more surface water is present and the willows increase in density and extent. If no improvements in vegetation structure are noted on future visits to the site, surveys could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

Cibola, Arizona and California

The survey sites in CIBO are a mix of conservation area sites and existing, unrestored riparian sites. The existing, unrestored riparian sites were placed on a triennial survey schedule in 2013 and were each surveyed in 2015. The conservation area sites are in the Cibola Valley Conservation Area (CVCA) and in the Cibola National Wildlife Refuge near the headquarters. All sites within the conservation areas are periodically flood irrigated and typically become dry between irrigation bouts. The CVCA sites are surrounded by agricultural fields. No signs of livestock were documented in or around any sites in CIBO in any year, though signs of burros were abundant in upland areas adjacent to many sites.

Cibola Valley Conservation Area

Phase 01

Area: 26.2 ha Elevation: 73 m

Phase 01 at the CVCA was surveyed from 2008 to 2017. The site consists of a mosaic of rectangular cells of cottonwoods, Goodding's willows, and coyote willows of varying sizes and densities. Each cell generally contains a single species and age class, though some emergent Goodding's willows are present in the coyote willow cells. The cottonwoods are 15–18 m in height, and the Goodding's willows are 10–15 m in height. Coyote willows reach 2–5 m in height. Canopy closure is 70–85% in the cottonwoods and 60–80% in the Goodding's willows. Most of the coyote willows are dead or nearly dead, though one patch of 5-m-tall coyote willows with 80% canopy closure is present along the northern border of the site. In some places, the Goodding's willows are half dead, with leaves only in the bottom half of each stem. A few of the cells have scattered trees in grassy fields. Overall vegetation height has increased slightly in the cottonwoods since 2012 but has not changed in the Goodding's or coyote willows. Canopy closure has remained unchanged in the cottonwoods and Goodding's willows but has decreased noticeably in the coyote willows as the trees have died. The only other noticeable change in vegetation structure is the dieback in the Goodding's willow crowns in some portions of the site. Signs of stress were first noted in both willow species in 2015.

A small amount of wet soils (< 5% of the site) was noted when the July site description was recorded in 2016. No wet soils were recorded on any other site description in 2013–17. The presence of wet soils in ≥ 10% of the site were

recorded on at least one site description in each year in 2008 and 2010–12 (McLeod and Pellegrini 2013). Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation.

Phase 01 at the CVCA was unoccupied in 2013–17. It was also unoccupied in 2008–12 (McLeod and Pellegrini 2013). Two to six willow flycatchers were detected prior to June 24 of each year in 2013–15 and 2017. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. No willow flycatchers were detected in 2016. Large flocks of cowbirds were detected during all surveys in all years.

Portions of the cottonwood stands have canopy closure that meets the criterion for suitable habitat (see table 2-1), but the cottonwood stands are lacking in midstory structural components, and there is no portion of the site where all the elements of suitable habitat co-occur.

Phase 02

Area: 25.5 ha Elevation: 73 m

The survey site known as Phase 02 at the CVCA is immediately south of Phase 01 and was surveyed from 2010 to 2017. It consists of rectangular cells of mixed cottonwoods and Goodding's willows alternating with cells of coyote willows with emergent cottonwoods. The mixed cottonwood-Goodding's willow cells consist of cottonwoods 15–18 m in height with Goodding's willows up to 10–12 m in height. The coyote willows are 2–6 m in height. The Goodding's willows are dying back in some places, with live foliage present only on the lower half of the trees. Canopy cover ranges from 40 to 90% and varies inversely with the proportion of coyote willows, many of which are severely stressed or completely dead. The healthiest vegetation is in the very center of the site, where canopy closure reaches 90%. Overall vegetation height has increased slightly since 2012 in the cottonwoods but not in the Goodding's or coyote willows. Canopy closure has decreased across the entire site and has decreased most noticeably in the coyote willows as many of the trees have died. The only other noticeable change in vegetation structure is the dieback in the Goodding's willow crowns in some portions of the site. Signs of stress were first noted in both willow species in 2014.

A small amount of wet soils (10% of the site) was noted when the June site description was recorded in 2017. No wet soils were recorded on any other site description in 2013–17. Similarly dry conditions were noted in 2010–12 (McLeod and Pellegrini 2013). Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation.

Phase 02 in the CVCA was unoccupied in 2013–17. The site was also unoccupied in or 2010–12 (McLeod and Pellegrini 2013). One to four willow flycatchers were detected prior to June 24 of each year in 2013–15 and 2017. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. No willow flycatchers were detected in 2016. Large flocks of cowbirds were detected in all years.

The center of the site, where canopy closure is the highest and branching structure is good, has all the structural elements but lacks the consistently wet soils of preferred nesting habitat (see table 2-1). The rest of the site lacks the canopy closure needed to meet the criterion for suitable habitat.

Phase 03

Area: 38.4 ha Elevation: 72 m

The survey site known at Phase 03 at the CVCA is located 2.5 km west of Phases 01 and 02 and was surveyed from 2009 to 2017. It consists of a mosaic of rectangular cells of cottonwoods, Goodding's willows, and coyote willows of varying sizes and densities. Each cell generally contains one species and age class, though some emergent cottonwoods and Goodding's willows are present in the coyote willow cells. The tallest cottonwoods reach approximately 18–20 m in height but are 10–14 m in height throughout much of the site. Canopy closure in the cottonwoods ranges from 65 to 90% and varies inversely with vegetation height. Many of the willows of both species are mostly dead, with only basal sprouts present. The Goodding's willows are 9 m in height where they are the healthiest and are 5–6 m in height where they are stressed. Canopy closure in cells dominated by Goodding's willows ranges from 40 to 80% and varies directly with vegetation height. The coyote willows reach 3 m in height. Canopy closure ranges from 30 to 70% depending on how many of the coyote willows are dead and how many emergent cottonwoods and Goodding's willows are present. Overall vegetation height has increased slightly since 2012 in the cottonwoods but not in the Goodding's or coyote willows. The range in canopy closure has not changed since 2012, but canopy closure is low in more areas than it was in 2012, as both the Goodding's and coyote willows have died. Signs of stress were first noted in both willow species in 2014.

The presence of wet soils in ≥ 20% of the site was recorded on at least one site description in each year in 2013–14 and 2016–17. No wet soils were noted when each site description was recorded in 2015. Similarly variable soil moisture conditions were noted in 2009–12 (McLeod and Pellegrini 2013). Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation.

Phase 03 in the CVCA was unoccupied in 2013–17. It was also unoccupied in 2009–12 (McLeod and Pellegrini 2013). One to 10 willow flycatchers were

detected prior to June 24 of each year in 2013–17. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. Large flocks of cowbirds were detected during all surveys in all years.

Portions of the cottonwood stands have canopy closure that meets the criterion for suitable or preferred nesting habitat (see table 2-1), but the cottonwood stands are lacking in midstory structural components, and there is no portion of the site where all the elements of suitable habitat co-occur. In most of the site, canopy closure it too low to meet the criterion for suitable habitat.

Nature Trail

Area: 13.7 ha Elevation: 70 m

The survey site known as Nature Trail was surveyed from 2006 to 2017. It is approximately 700 m west of the Cibola National Wildlife Refuge headquarters and consists of a mosaic of cottonwoods, Goodding's willows, honey and screwbean mesquite, and willow baccharis. Approximately half of the site consists of scattered screwbean and honey mesquite 5–7 m in height, with a thick understory of willow baccharis. Canopy closure in areas dominated by mesquite spp. and willow baccharis is 10–90% and varies in direct proportion with the amount of mesquite spp. present. The northern half of the site contains a cell of Goodding's willows approximately 100 x 275 m in size. The majority of the Goodding's willows (> 90%) are mostly dead and reach 4–6 m in height with 10% canopy closure. There is a 5–10-m-wide band of Goodding's willows along the southern edge of the cell that are 8–10 m in height with 90% canopy closure. Cottonwoods 20 m in height with 85% canopy closure are present in the southwestern corner of the site and in narrow stringers along the pathways throughout the site. There is a very sparse understory of willow baccharis 1.5 m in height in the southwestern corner of the site. Vegetation height and species composition have remained unchanged since 2006. Canopy closure has increased overall in areas dominated by willow baccharis and mesquite spp. In the Goodding's willows, canopy closure has decreased in the center of the cell and increased under the healthy trees around the perimeter.

The amount of wet soils was highly variable across all site descriptions and years. Wet soils were recorded on at least one site description in each year in 2013–17, with up to 70% of the site containing wet soils. Similarly variable soil moisture conditions were noted in 2006–12 (McLeod and Pellegrini 2013). Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation.

Nature Trail was considered unoccupied in 2013–17. It was considered also unoccupied in 2006–12 (McLeod and Pellegrini 2013). Three to nine willow flycatchers were detected prior to June 24 of each year in 2014–16. None of these

willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. No willow flycatchers were detected in 2013 or 2017. Cowbirds were detected during all surveys in all years.

Canopy closure that meets the criterion for suitable habitat is present under the cottonwoods, but midstory structural components are lacking (see table 2-1). Dense canopy closure is also present in a stringer of Goodding's willows, but the widest portion of the stringer barely meets the criterion for minimum patch width for suitable habitat. Canopy closure also reaches suitable density under the tallest mesquite spp., but these areas are small and patchily distributed.

C2729

Area: 6.0 ha Elevation: 70 m

The survey site known as C2729 was surveyed from 2015 to 2017. It is approximately 2 km west of the Cibola National Wildlife Refuge headquarters in the LCR MSCP site known as Crane Roost. The site is bisected east to west by a road and consists of a mosaic of cottonwoods and coyote willows. The northern half of the site is vegetated with a cottonwood overstory and a coyote willow understory. The cottonwoods are 12–15 m in height around the perimeter of the northern half and 6–10 m in height in the center. The coyote willows are 4–6 m in height, with the taller trees occurring around the perimeter of the northern half. Canopy closure in the northern half of the site ranges from 75% in the center to 90% in the tallest cottonwoods around the perimeter. Many of the coyote willows in the northern half of the site were stressed and mostly leafless at the end of the 2017 survey season. The entirety of the southern half of the site is vegetated with coyote willows with some cottonwoods 15–20 m in height along the southern edge of the site. The coyote willows in the northwestern 75% of the southern half are 9 m in height with large diameters (8 cm) and 90% canopy closure. An area of sparse 3-m-tall coyote willows with 10% canopy closure is present in the southeastern quarter of the southern half of the site. Where the cottonwoods occur along the southern border, the coyote willows reach 5 m in height but are half dead. Canopy closure reaches 75% under the cottonwoods. Some tamarisk, honey mesquite, and willow baccharis are scattered throughout both halves of the site. Other than a decline in the health of the coyote willows, no major changes in species composition or vegetation structure were noted between 2015 and 2017.

The amount of wet soils was highly variable across all site descriptions and years. The presence of standing water in up to half of the site was recorded on one site description in each year in 2015 and 2016. No wet soils were noted when each site description was recorded in 2017. Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation.

C2729 was considered unoccupied in 2015–17. Four to 12 willow flycatchers were detected before June 24 of each year. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. Cowbirds were detected during all surveys in each year.

The coyote willows immediately south of the road and the cottonwoods in the very northwestern corner of the site have all the structural elements of preferred nesting habitat (see table 2-1) but lack a consistent presence of wet soils. Canopy closure in the remainder of the site does meet the criterion for suitable habitat.

Cibola Site 01

Area: 7.7 ha Elevation: 65 m

The survey site known as Cibola Site 01 was surveyed annually from 2003 to 2007 and then in 2009, 2011, and 2015. The site consists of a 200-m-wide strip of mixed-exotic riparian vegetation between the channelized Colorado River to the west and a levee road to the east. In 2015, vegetation along the eastern edge of the site consisted of a mix of dry and scrubby 3–4-m-tall tamarisk and 2-m-tall arrowweed with 40–60% canopy closure. Two cattail marshes dominated the western half of the site, and tamarisk were slightly taller and denser adjacent to the marshes. Emergent 10–12-m-tall Goodding's willows and 15-m-tall cottonwoods were scattered in a loose stringer along the eastern edge of the marshes. A small patch of 5-m-tall coyote willows was also present along the eastern edge of the marshes. Some honey mesquite was scattered throughout the site. Canopy closure beneath the cottonwoods and Goodding's willows reached 75%. No major changes in vegetation structure or species composition were noted between 2003 and 2015.

As in many previous years, dense vegetation inhibited observers from accessing the interior of each marsh during some surveys in 2015. Access was gained when the July 2015 site description was recorded, at which time standing water was noted in the marshes. All other soils in the site were noted as dry or damp when each site description was recorded, as was the case in previous years (McLeod and Pellegrini 2013). Soil moisture conditions in the site are dependent upon groundwater levels, which likely fluctuate with the water level in the Colorado River.

In 2015, the site was considered unoccupied with the detection of two willow flycatchers on May 28. Neither of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. The site was considered unoccupied in all survey years in 2003–11 (McLeod and Pellegrini 2013). Cowbirds were detected on almost all surveys in all years.

Canopy closure throughout the site was << 85%; therefore, the site did not meet all the criteria for suitable habitat (see table 2-1). Most of the site also had

vegetation that was too short to meet the canopy height criterion for suitable habitat. Surveys could be discontinued at this site with no minimal risk of overlooking suitable habitat, as habitat suitability is poor and has remained unchanged since 2003.

Cibola Lake North

Area: 9.0 ha Elevation: 64 m

The survey site known as Cibola Lake North, on the western edge of Cibola Lake, was surveyed annually from 2003 to 2008 and then in 2010, 2012, and 2015. In 2012, it was noted that surveys could be discontinued because of sparse canopy closure and very dry soils in the interior of the site. The site was not visited during a reconnaissance trip in March 2015, so it was evaluated at the beginning of the 2015 survey season. Personnel were particularly interested in assessing the northern edge of the site and adjacent areas where marshy openings and patches of coyote willows had been noted in 2012.

In 2015, the original survey site of Cibola Lake North was assessed from the perimeter. No obvious changes in vegetation structure were noted. Surveys were discontinued within the original survey site after this assessment.

The area immediately to the north of Cibola Lake North was also assessed. The eastern edge of this area bordered Cibola Lake and consisted of a 10-m-wide strip of coyote willows 6 m in height with scattered, emergent Goodding's willows 12 m in height. Heaps of deadfall were present beneath the Goodding's willows. Canopy closure within the willow strip reached 90% in the densest parts. This willow strip continued along the edge of the lake for about 200 m north of the old survey site, at which point the vegetation transitioned to tamarisk. To the west of the willow strip, vegetation consisted of mesquite spp. and tamarisk < 6 m in height. During the survey in May, water from Cibola Lake extended into the willow strip, where soils were inundated or saturated, but soils in the interior of the site were dry.

In 2015, one willow flycatcher was detected on May 26, immediately north of the original survey site. This individual did not demonstrate territorial behavior, and no subsequent monitoring visits were scheduled. Occupancy status of the area remained unknown in 2015 due to limited, opportunistic survey effort. One cowbird was detected during the survey in May.

The coyote willow strip had most of the characteristics of preferred nesting habitat but was barely wide enough to meet the patch width criterion of suitable habitat (see table 2-1). Suitability of this strip could improve if it increases in width. This area could be assessed in future years to reduce the chance that suitable flycatcher habitat is overlooked.

Walker Lake

Area: 4.6 ha Elevation: 64 m

The survey site known as Walker Lake was surveyed annually from 2003 to 2012 and then in 2015. The site is an area of mixed-exotic riparian vegetation along the eastern edge of Walker Lake. In 2015, most of the site consisted of very dense tamarisk 4–6 m in height with 80–90% canopy closure. A few emergent Goodding's willows and cottonwoods up to 20 m in height were scattered throughout the site. No major changes in vegetation structure or species composition were noted between 2003 and 2015.

Walker Lake held standing water when each site description was recorded in 2015, but soils immediately adjacent to the lake were mostly damp, with only a small amount of saturated soil noted when the July site description was recorded. Soils away from the lake were largely dry when each site description was recorded. Similar patterns in surface hydrology were noted in 2003–12 (McLeod and Pellegrini 2013). Soil moisture conditions in the site are dependent on water levels in Walker Lake. It is unlikely that soil moisture conditions fluctuated widely from day to day.

No willow flycatchers were detected in 2015. The site was considered occupied in 2005 because of the detection of a willow flycatcher on July 6, but it was considered unoccupied in all other years in 2003–04 or 2006–12 (McLeod and Pellegrini 2013). Cowbirds were detected in all survey years.

Much of the site has the canopy closure and canopy height of suitable habitat, and portions of the site have canopy closure and canopy height that meet the criteria for preferred nesting habitat (see table 2-1). Most of the site, however, has vegetation that is so dense that it does not provide the flyways needed for both suitable and preferred habitat. No major changes in vegetation structure, species composition, or hydrology were noted between 2012 and 2015. An evaluation at the beginning of future survey seasons would determine whether this site contains suitable habitat.

Imperial, Arizona and California

IMPE is primarily composed of existing, unrestored lands within the Imperial National Wildlife Refuge and on adjacent public lands. All the sites within the study area were placed on the triennial survey schedule in 2013 and were surveyed in 2015. Several of the sites (i.e., Hoge Ranch, Adobe Lake, and Rattlesnake) originally included in this study area burned in 2013 and had not yet recovered when the area was assessed in March 2015. Cowbirds are widespread through the study area and were seen in all sites in all survey years, sometimes in large flocks. No signs of livestock were observed within the sites, although burros were abundant in adjacent uplands.

Imperial NW (Formerly Nursery NW)

Area: 14.2 ha Elevation: 58 m

The survey site known as Imperial NW was surveyed annually from 2006 to 2012 and then in 2015. The site is bordered by the Colorado River to the west and a cattail marsh to the east. In 2015, vegetation in the site was mixed-exotic in composition, and the dominant vegetation was tamarisk approximately 5–7 m in height with an understory of common reed. Both screwbean and honey mesquite were scattered along the western edge of the site. Several emergent Goodding's willows 10–12 m in height were present along the eastern edge of the site, adjacent to the cattail marsh. Overall canopy closure was around 70%, and the densest portions of the site had canopy closure > 85%. No major changes in vegetation structure or species composition were recorded from 2006 to 2015. Wet soils were present in the marsh and the eastern edge of the site throughout each survey season. Dense vegetation inhibited access to the site interior in 2015, and hydrology within the site is unknown.

No willow flycatchers were detected in 2015. The site was considered unoccupied in all survey years in 2006–12 (McLeod and Pellegrini 2013).

Portions of the site that were assessed in 2015 had canopy height and canopy closure that met the criteria for suitable habitat, but the midstory was thickly vegetated with common reed and lacked flyways (see table 2-1). Access into the interior of the site would allow a better assessment of surface hydrology and vegetation structure within the site. If an assessment of the interior of the site resulted in a determination that no portion of the site met all the criteria for suitable habitat, surveys at this site could be discontinued.

Imperial Nursery

Area: 1.4 ha Elevation: 58 m

The survey site known as Imperial Nursery is a restoration site managed by the Imperial National Wildlife Refuge. It was surveyed annually from 2003 to 2008 and was then put on a biennial survey schedule in 2008. It was surveyed in 2010 and 2012 and then in 2015 following placement on the triennial survey schedule. The site is bordered to the north by a patchwork of cattails, common reed, and tamarisk and to the south by open fields. The site was planted primarily with cottonwoods. In 2015, the cottonwoods were 12–14 m in height with canopy closure of 65–75%. The understory consisted of scattered 2-m-tall honey mesquite and some scattered *Baccharis* sp. A 20- x 30-m patch of 6-m-tall Goodding's willows with 50% canopy closure was present in the eastern half of the site. The edges of the site were vegetated by arrowweed and *Baccharis* sp. with a few 3–4-m-tall honey mesquite in the northwestern corner of the site. From 2003 to 2012, vegetation height was noted as increasing, while canopy closure remained

constant (McLeod and Pellegrini 2013). Since 2012, vegetation height has not changed, but canopy closure in 2015 was noticeably lower than it had been (90% in 2012). The honey mesquite and *Baccharis* sp. increased in prevalence in the understory between 2012 and 2015.

The site is flood irrigated. In 2015, 50% of the site had wet soils when the July site description was recorded. Soils in the remainder of the site were damp, and all soils were dry when the May and June site descriptions were recorded. From 2003 to 2008, the presence of wet soils was recorded on one or two site descriptions in each year, with 7–90% of the site containing wet soils (McLeod and Pellegrini 2013). In 2010 and 2012, no wet soils were observed when each site description was recorded. Sandy soil at the site allows the water to drain rapidly after irrigation. Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation.

No willow flycatchers were detected in 2015. The site was considered unoccupied in all survey years in 2003–12 (McLeod and Pellegrini 2013).

In 2015, no portion of the site had canopy closure that met the criterion for suitable habitat (see table 2-1). If canopy closure increases, habitat suitability would improve. Maintaining this site on the triennial survey schedule will ensure that any changes in habitat suitability will be noted in a timely manner.

Ferguson Lake

Area: 21.1 ha Elevation: 57 m

The survey site known as Ferguson Lake was surveyed annually from 2003 to 2012 and then in 2015 following placement on the triennial survey schedule. It is on a strip of land between Ferguson Lake to the west and the Colorado River to the east. In 2015, vegetation was mixed-native, with scattered, emergent Goodding's willows 10 m in height throughout the site. Tamarisk 5–6 m in height was the dominant understory species, and it formed a continuous canopy in portions of the site. The eastern edge of the site also contained patches of arrowweed and scattered screwbean and honey mesquite, with little canopy cover. In 2012, areas of 3-m-tall coyote willows were noted in the northeastern corner of the site, but this portion of the site was not accessed in 2015. Canopy closure varied from 30% along the eastern edge of the site to 90% within dense tamarisk stands. No major changes in vegetation structure or species composition were recorded from 2003 to 2015.

Up to 25% of observed soils were inundated or saturated when each site description was recorded in 2015. In past years, portions of the site up to 50 m from the lakeshore had saturated soils and fluctuating levels of standing water

(McLeod and Pellegrini 2013), but personnel were unable to determine if these conditions were present in 2015. Soils along the eastern side of the site were dry to damp when each site description was recorded.

Six willow flycatchers were detected on May 21. None of these individuals demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. The site was considered unoccupied in 2015. It was also considered unoccupied in all survey years in 2003–12 (McLeod and Pellegrini 2013).

All the characteristics of preferred nesting habitat (see table 2-1) were present in portions of the site in 2015. Improving access to the interior of the site in future years would allow for a more thorough assessment of the extent of suitable and preferred nesting habitat.

Great Blue Heron

Area: 7.1 ha Elevation: 58 m

Great Blue Heron is a survey site on the eastern shore of Martinez Lake and is bordered by marsh to the west and scrubby tamarisk to the east. It was surveyed annually from 2003 to 2012 and again in 2015 after it was placed on the triennial survey schedule. In 2015, vegetation was mixed-native with several scattered emergent Goodding's willows up to 10 m in height present near the shore of Martinez Lake. Many of the willows appeared stressed and dying, and examination of photos taken in the site in 2010 indicated that the trees were stressed in 2010 as well. The understory beneath the willows was thick with tamarisk, common reed, and giant reed (*Arundo* sp.). Canopy closure reached 80% in the willow-dominated areas. Portions of the site contained thickets of willow deadfall. Farther from the lake, the site was vegetated by scattered arrowweed and tamarisk 6 m in height. Canopy closure was typically 55–60% but reached 75% in some denser areas. Overall, no major changes in vegetation structure or species composition were recorded from 2003 to 2015.

When each site description was recorded in 2015, observed soils were almost completely dry, with only a small amount of damp soil noted. Similar patterns in surface hydrology were noted in 2003–12, though occasionally some wet soils were observed near the western edge of the site (McLeod and Pellegrini 2013). Soil moisture conditions in the site are dependent on water levels in Martinez Lake, and it is unlikely that soil moisture fluctuated widely from day to day.

One willow flycatcher was detected on May 30 in 2015. This individual did not demonstrate territorial behavior, and no subsequent monitoring visits were scheduled. The site was considered unoccupied in 2015. It was also considered unoccupied in all survey years in2003–12 (McLeod and Pellegrini 2013).

No portion of the site had canopy closure that reached 85%; therefore, the site did not meet all the criteria for suitable habitat (see table 2-1). Surveys could be discontinued with minimal risk of overlooking suitable flycatcher habitat. Aerial imagery suggests that a band of coyote willows is present between the site and the open water of Martinez Lake, and this area could be assessed in future years.

Powerline

Area: 1.0 ha Elevation: 58 m

The survey site known as Powerline was surveyed annually from 2003 to 2007 and then in 2009, 2011, and 2015. The site is bordered by cattail marsh to the west and dry upland to the east, and it is near the eastern shore of Martinez Lake. In 2015, vegetation was mixed-native and consisted of a broken stringer up to 20 m wide and 12 m tall of Goodding's willows and cottonwoods. The understory beneath the cottonwoods and Goodding's willows was primarily tamarisk 3–4 m in height. Canopy closure varied from 45 to 80% in this area. Vegetation along the upland edge of the site was dominated by tamarisk and arrowweed up to 3 m in height. No major changes in vegetation structure or species composition were noted between 2003 and 2015.

Wet soils were noted near the marsh edge in < 10% of the site when the July 2015 site description was recorded. The majority of soils observed when each site description was recorded were dry. Surface hydrology was similar in previous years, with wet soils recorded on at least one site description in each year in 2005–07, 2009, and 2011 in up to 15% of the site (McLeod and Pellegrini 2013). No wet soils were observed in 2003 or 2004. Soil moisture conditions in the site are influenced by water levels in Martinez Lake, and it is unlikely that soil moisture fluctuated widely from day to day.

No willow flycatchers were detected in 2015. The site was considered unoccupied in all survey years in 2003–11 (McLeod and Pellegrini 2013).

No portion of the site had canopy closure that reached 85%; therefore, the site did not meet all the criteria for suitable habitat (see table 2-1). Surveys could be discontinued without risk of overlooking suitable flycatcher habitat.

Martinez Lake

Area: 4.6 ha Elevation: 58 m

The survey site known as Martinez Lake was surveyed annually from 2003 to 2007 and then in 2009, 2011, and 2015. The site is adjacent to and south of Powerline and is bordered to the west by cattail marsh on the eastern shore of Martinez Lake and to the east by scrubby upland vegetation. In 2015, vegetation

was mixed-native. Goodding's willows < 10 m in height and cottonwoods up to 15 m in height formed a broken stringer up to 30 m wide on the western edge of the site, adjacent to cattails and common reed along the lakeshore. Tamarisk 3–4 m in height formed the understory, and canopy closure was 70–80%. The eastern edge of the site, adjacent to the upland, was dominated by arrowweed. Some scattered tamarisk and a few emergent Goodding's willows and cottonwoods were also present along the eastern edge of the site. Canopy closure was 45–65% in this area. No major changes in vegetation structure or species composition were noted between 2003 and 2015.

No wet soils were noted when each site description was recorded in 2015. Soils were almost completely dry, except for some damp soils along the marsh edge. Wet soils were recorded on one or two site descriptions in 2004, 2005, 2007, and 2011 in 2–25% of the site (McLeod and Pellegrini 2013). Wet soils were not noted when each site description was recorded in 2003, 2006, or 2009. Soil moisture conditions in the site are influenced by water levels in Martinez Lake, and it is unlikely that soil moisture fluctuated widely from day to day.

The site was unoccupied in 2015. Four willow flycatchers were detected on May 20 and three on June 11 in 2015. None of these individuals demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. The site was also unoccupied in all survey years in 2003–11 (McLeod and Pellegrini 2013).

No portion of the site had canopy closure that reached 85%; therefore, the site did not meet all the criteria for suitable habitat (see table 2-1). Surveys could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

Mittry Lake, Arizona and California

MITT is located north of Mittry Lake and west of the Mittry Lake Wildlife Area. The survey sites in this study area are a mix of conservation area sites and existing, unrestored riparian sites. The conservation area sites are in the Laguna Division Conservation Area. Irrigation within the Laguna Division Conservation Area is driven by water levels in the central channel that bisects the area. Water levels are regulated by a series of water control structures, and when water levels are high, the effect is like overbank flooding. Cowbirds are widespread around the lake and were detected in every survey year. No signs of livestock were recorded within or around any of the survey sites, though burros use the surrounding uplands.

Mittry West

Area: 4.4 ha Elevation: 48 m

The survey site known as Mittry West was surveyed annually from 2003 to 2012 and then in 2015. It is approximately 3 km downstream from Imperial Dam on the California side of the LCR. In 2015, vegetation in the site was mixed-native. The center of the site was dominated by Goodding's willows 12 m in height with a dense understory of arrowweed and tamarisk. Deadfall was common throughout the site, and canopy closure varied from 30% in clearings to 70% under the willows and up to 90% within dense tamarisk patches. Honey and screwbean mesquite were scattered throughout the site but were more common near the periphery. A sparse clump of 4–5-m-tall coyote willows approximately 50 m in diameter was present in the northeastern corner of the site, and a small bulrush marsh was present in the southeastern corner of the site. Willow baccharis was most abundant along the northern border of the site. No major changes in vegetation structure or species composition were noted between 2003 and 2015.

In 2015, approximately one-third of the site contained wet soils when the May site description was recorded. Only a very small amount of saturated soil was noted when the June site description was recorded, and by the July site description, only damp or dry soils remained. In 2003–12, wet soils were recorded on at least one site description in each year in 5–100% of the site (McLeod and Pellegrini 2013). In 2003, 2004, 2008, and 2012, wet soils were noted when each site description was recorded. Soil moisture conditions are influenced by groundwater levels, and soil moisture likely did not fluctuate widely from day to day.

Two willow flycatchers were detected on May 20 and one on June 11 in 2015. None of these individuals demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. This site was unoccupied in 2015. It was also unoccupied in all survey years in 2003–12 (McLeod and Pellegrini 2013).

Portions of this site contain all the elements of preferred nesting habitat (see table 2-1). Surveys could be continued at this site on the triennial survey schedule.

C4911

Area: 1.0 ha Elevation: 49 m

The survey site known as C4911 at the Laguna Division Conservation Area was surveyed in 2017. It consists of a mosaic of cottonwoods, Goodding's willows, and coyote willows. The very western edge of the site is vegetated with dense arrowweed 2 m in height. Adjacent to the arrowweed is a 10-m-wide strip of Goodding's willows and cottonwoods 8 m in height with 90% canopy closure.

East of this strip, vegetation is a mix of Goodding's willows, cottonwoods, and coyote willows 4–6 m in height, with bulrush scattered in the understory. Canopy closure in this portion is 60–85%. In the very northeastern corner of the site is a patch of coyote willows 6 m in height with 80% canopy closure. The very southwestern corner of the site contains a mix of Goodding's willows, cottonwoods, and honey mesquite 4–5 m in height with some arrowweed mixed in and 70% canopy closure. In general, vegetation is taller and denser at the northern end of the site.

All soils were damp when the May site description was recorded, and 75% of the site contained damp soils when the July site description was recorded. All soils were completely dry when the June site description was recorded. The nearest standing water was in the central channel that bisects the conservation area, due east of the site. Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation. This is evidenced by the observation that 40% of the site contained wet soils during a territory monitoring visit in late June.

Two willow flycatchers were detected on June 27, and the site was considered occupied in 2017 based on the date of the detections. One of these individuals displayed territorial behavior at the time of detection and was noted singing continuously for up to 1 hour. This individual is not considered resident, however, as it was not detected the following day or on either of two subsequent monitoring visits. The second individual did not display any territorial behavior and was not detected on any of three followup visits.

The strip of cottonwoods and Goodding's willows on the western side of the site has the canopy height, canopy closure, and midstory structural components of preferred nesting habitat (see table 2-1), but the strip is only 10 m wide and lacks a consistent presence of wet soils and, thus, does not have all the characteristics of preferred nesting habitat. Most of the remainder of the site lacks the canopy closure needed for suitable habitat. This is a relatively young site that is still growing, and it is likely that canopy closure and overall structure will improve as the site matures.

C4913

Area: 0.7 ha Elevation: 49 m

The survey site known as C4913 at the Laguna Division Conservation Area was surveyed in 2017. It consists of a mosaic of cottonwoods, Goodding's willows, and coyote willows. The northeastern third of the site is vegetated primarily with 2–3-m-tall coyote willows with 50% canopy closure. The southwestern two-thirds of the site is vegetated with a mix of cottonwoods 5–8 m in height and Goodding's willows 3–4 m in height with a scattered understory of honey and screwbean mesquite, arrowweed, and coyote willows. Vegetation height is

primarily 5 m throughout this portion of the site, but there is a small stand of cottonwoods 6–8 m in height near the southeastern corner of the site. Canopy closure in the cottonwood-dominated area ranges from 55 to 65% and varies directly with vegetation height.

Soils were completely dry when the May and July site descriptions were recorded, and 20% of soils were damp when the June site description was recorded. The nearest standing water was in the central channel that bisects the conservation area, due east of the site. Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation.

One willow flycatcher was detected on May 24 and two were detected on June 8. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. This site was unoccupied in 2017.

No portion of this site has canopy closure that is high enough to meet the criterion for suitable habitat, and the northeastern third of the site is too short to be suitable (see table 2-1). This is a relatively young site that is still growing, and it is likely that canopy closure and overall structure will improve as the site matures.

Yuma, Arizona

YUMA is located along the Colorado and Gila Rivers. The survey sites in this study area are a mix of conservation area sites and existing, unrestored riparian sites. The existing, unrestored riparian sites were placed on a triennial survey schedule in 2013 and were each surveyed in 2015. The conservation area sites are in Yuma East Wetlands, which is on the far western side of the study area, approximately 4 km downstream from the confluence of the Colorado and Gila Rivers. The remainder of the survey sites are farther upstream along the Gila River. Yuma East Wetlands is a flood-irrigated conservation area located on either side of the Colorado River and is bordered by urban landscape to the west. Flood-irrigated sites within the conservation area are typically dry between irrigation bouts. All survey sites within the study area are located within a matrix of agricultural lands. Cowbirds are widespread throughout the study area and were detected during all surveys. No signs of livestock were recorded within or around any of the survey sites.

J

Area: 8.4 ha Elevation: 36 m

The survey site known as J at Yuma East Wetlands was surveyed from 2014 to 2017. The site is on the northern side of the Colorado River and is bisected by a dirt road and irrigation channel. Vegetation within the site consists primarily of

cottonwoods 8–10 m in height, occasionally reaching 10–12 m in height. The understory is composed of 2-m-tall willow baccharis and 2–6-m-tall honey and screwbean mesquite. The cottonwoods are tallest in the northwestern portion of the site and shortest in the very eastern portion. The understory is more prevalent on the southern side of the site. Canopy closure varies from 70 to 85%. A stand of 4–6-m-tall coyote willows 60 x 120 m in size with up to 90% canopy closure is present along the western edge of the site. Most of the coyote willows on the northern side of the road in this patch were mostly leafless in May 2017. The only changes in vegetation structure noted since 2014 have been an increase in canopy height, which was 3–7 m in 2014, and the decline in the health of the coyote willows in 2017. No major changes in species composition have been noted since 2014.

Wet soils were recorded on at least one site description in each year, with the percentage of the site containing wet soils ranging from 3 to 35%. Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation.

This site was unoccupied in 2014 and 2016–17. Occupancy status was not determined in 2015 because access to the site could not be obtained after the initial survey in May. One to six willow flycatchers were detected prior to June 24 in each year. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled.

Most of the site lacks the canopy closure and/or the midstory structure of suitable habitat (see table 2-1). Portions of the stand of coyote willows on the western side of the site have suitable canopy height and closure, but the stems are wispy and closely spaced, providing few flyways. Structure may improve as the stand matures.

C (formerly South AC)

Area: 0.9 ha Elevation: 36 m

The survey site known as C at Yuma East Wetlands was surveyed from 2014 to 2017. It consists of a stringer of cottonwoods and Goodding's willows along the northern edge of a cattail and bulrush marsh. The site is bisected by an open water channel extending north from the marsh. East of the channel, the stringer consists of 5–10-m-tall cottonwoods with a few Goodding's willows and is rarely more than one tree wide. The shorter trees are near the channel. Canopy closure ranges from 60 to 80% and varies inversely with canopy height. Honey mesquite is scattered in low density in the understory east of the channel. West of the channel, the stringer widens slightly and consists of 8–10-m-tall Goodding's willows and 15-m-tall cottonwoods. Mule-fat, willow baccharis, and honey mesquite form a dense understory. Canopy closure varies from 75 to 90%. There

is also a small cattail and bulrush marsh surrounded by coyote willows along the southern edge of this portion of the site. The very western end of the stringer is bordered to the south by a dense stand of coyote willows approximately 80 x 10 m in size and 4–5 m in height with 90% canopy closure. The only major change in vegetation structure noted since 2014 has been an increase in canopy height, which was 5–7 m in 2014. No major changes in species composition have been noted since 2014.

When standing water was documented, it was within the channel and in the coyote willows along the southwestern edge of the site. The channel held standing water when each site description was recorded in all years in 2014–17. Standing water was documented within the coyote willows when the May site description was recorded in 2014–16 and when the June site descriptions were recorded in 2014 and 2016. Soils elsewhere in the site were generally dry.

This site was unoccupied in 2014 and 2016–17. Occupancy status was not determined in 2015 because access to the site could not be obtained after the initial survey in May. One to five willow flycatchers were detected prior to June 24 of each year. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled.

The coyote willow patch on the western side of the site has suitable canopy height, canopy closure, and midstory structure but is barely wide enough to be considered suitable flycatcher habitat (see table 2-1). Canopy closure within most of the remainder of the site is too low to meet the criterion for suitable habitat. Where canopy closure does reach suitable levels in the cottonwoods and Goodding's willows, midstory structural components are lacking.

I

Area: 6.4 ha Elevation: 36 m

The survey site known as I at Yuma East Wetlands was surveyed from 2014 to 2017. It consists 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 is divided into cells that are separated by dirt roads, and vegetation density varies by cell, with canopy closure ranging from 60 to 85%. Areas with lower canopy closure are characterized by more widely spaced trees and a more dominant understory. One cell on the western side of the site contains a 20-m-wide, dense stand of cottonwoods 10–12 m in height with 80–95% canopy closure and no understory. This cottonwood stand is bordered to the west by a stand of coyote willows roughly 70 x 50 m in size and 3–5 m in height with 95% canopy closure. The only major change in vegetation structure noted since 2014 has been an increase in canopy height, which was 5–8 m in 2014. No major changes in species composition have been noted since 2014.

Standing water was recorded on at least one site description in 2014 and 2016 in a small portion of the cottonwoods. Standing water was also recorded on at least one site description each year in 2016 and 2017 but only in culverts under the roads. All soils away from standing water were dry. Conclusions on the frequency and duration of surface water within the site could not be drawn because of the high variability in water levels associated with flood irrigation.

This site was unoccupied in 2014 and 2016–17. Occupancy status was not determined in 2015 because access to the site could not be obtained after the initial survey in May. Two to 14 willow flycatchers were detected before June 24 of each year. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled.

The coyote willow patch on the western side of the site has all the characteristics of suitable habitat and has the canopy closure of preferred nesting habitat (see table 2-1). The dense stand of cottonwoods near the western end of the site has suitable canopy closure but lacks midstory structural components. The remainder of the site generally lacks the canopy closure needed for suitable habitat. In areas where vegetation structure is good, habitat suitability would be improved by a more consistent presence of wet soils.

Gila Confluence North

Area: 2.2 ha Elevation: 40 m

The survey site known as Gila Confluence North was surveyed annually from 2003 to 2008 and then in 2010, 2012, and 2015. The site borders the northern side of the Colorado River at the confluence of the Gila and Colorado Rivers. Prior to the 2007 survey season, a fire burned through the western half of the site (McLeod and Pellegrini 2013). Vegetation in this portion of the original survey area never recovered, and surveys have been conducted in the unburned eastern half of the original survey area since 2007.

In 2015, vegetation was mixed-native. In the western half and along the northern border of the site, stringers of 8–12-m-tall Goodding's willows and 12–14-m-tall cottonwoods formed a broken overstory with willow baccharis in the understory. These stringers surrounded a cattail marsh near the northern side of the site. Common reed was present between the site and the river and extended into the understory along the southern border. The areal extent of the common reed increased between 2007 and 2015. Areas away from the cottonwood and Goodding's willow stringers were dominated by arrowweed, with scattered willow baccharis, screwbean mesquite, and tamarisk. Canopy closure was variable and ranged from 45 to 65%. Other than the increased prevalence of common reed in the site, no major changes in vegetation structure or species composition were noted between 2007 and 2015.

In 2015, wet soils were present in the northern cattail marsh when the May site description was recorded, and all other soils were damp during this visit. All soils within the site were completely dry when the June and July site descriptions were recorded. Similar patterns of hydrology were noted in previous years; when wet soils were present, they were in the northern cattail marsh and all other soils were dry (McLeod and Pellegrini 2013). Soil moisture conditions are dependent on groundwater levels, which likely fluctuate with the water level in the Colorado River.

In 2015, three willow flycatchers were detected on May 19. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. The site was unoccupied in 2015. It was also unoccupied in all survey years in 2003–12. This site had been previously reported as occupied in 2006 (McLeod and Pellegrini 2013), but the detection (on July 28) was after July 20, which is the date before which detected willow flycatchers are considered likely to belong to the southwestern subspecies (Sogge et al. 2010).

Canopy closure at this site was << 85%; therefore, the site did not meet all the criteria for suitable habitat (see table 2-1). Portions of the site where common reed was present also lacked flyways in the midstory. Surveys could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

Gila River Site 02

Area: 2.9 ha Elevation: 45 m

The survey site known as Gila River Site 02 was surveyed annually from 2003 to 2007 and then in 2009, 2011, and 2015. The site is on the north side of the Gila River, approximately 7 km upstream of the confluence of the Gila River and the LCR. It is bordered to the north by agricultural fields and to the south by an open, sandy area vegetated by arrowweed. In 2015, vegetation was mixed-native and consisted primarily of a broken overstory of 6–8-m-tall Goodding's willows with an understory of tamarisk 5–7 m in height. Emergent cottonwoods up to 15 m in height were scattered throughout the site, with the highest concentration of trees in the southern half of the site. Shorter cottonwoods up to 6 m in height were present around the perimeter of the site and were mixed with arrowweed. Prior to the 2015 survey season, the northern tip of the site was cleared for pasture. Canopy closure ranged from 50 to 70%. No changes in vegetation structure or species composition were noted between 2003 and 2015.

No wet soils were observed when each site description was recorded in 2015, but the northwestern edge of the site bordered a marsh, which held water during each visit. Similar surface hydrology was noted in previous years (McLeod and Pellegrini 2013). Soil moisture conditions are dependent on groundwater levels and likely did not fluctuate widely from day to day.

Two willow flycatchers were detected on May 18 in 2015. Neither of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. This site was unoccupied in 2015. It was also unoccupied in all survey years in 2003–11 (McLeod and Pellegrini 2013).

Canopy closure at this site was << 85%; therefore, the site did not meet all the criteria for suitable habitat (see table 2-1). Vegetation at the site has remained unchanged since SWCA began surveying in 2003, and surveys could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

Fortuna Site 01

Area: 3.2 ha Elevation: 45 m

Fortuna Site 01 is a mixed-native survey site approximately 750 m upstream of Gila River Site 02 on the north side of the Gila River. It is bordered to the north by agricultural fields and to the south by a cattail and common reed marsh. It was surveyed annually from 2004 to 2007 and then in 2009, 2011, and 2015. In 2015, most of the vegetation consisted of 3–5-m-tall tamarisk with scattered patches of arrowweed along the perimeter of the site. A narrow stringer of emergent 12–15-m-tall cottonwoods and 10–12-m-tall Goodding's willows was present in the center of the site. Canopy closure beneath the stringer was 75%. Within the densest cottonwood-willow areas, there was little understory but a lot of deadfall. No major changes in vegetation structure or species composition were noted between 2004 and 2015.

In 2015, a majority of the site contained saturated soils when the May site description was recorded, but most soils were dry when the June site description was recorded. The site was not described in July. Inundated soils were noted near the adjoining marsh, which contained surface water during each visit. Some wet soils were recorded on one or two site descriptions in 2004, 2009, and 2011 near the marsh (McLeod and Pellegrini 2013). No wet soils were observed in any other survey year. Soil moisture conditions are influenced by levels in the adjacent marsh and likely did not fluctuate widely from day to day.

Four willow flycatchers were detected on May 18 in 2015. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. The site was unoccupied in 2015. It was also unoccupied in all survey years in 2004–11 (McLeod and Pellegrini 2013).

Canopy closure at the site did not exceed 75%; therefore, the site did not meet all the criteria for suitable habitat (see table 2-1). Vegetation has remained unchanged since 2004, and surveys could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

Fortuna North

Area: 3.8 ha Elevation: 46 m

The survey site known as Fortuna North was surveyed annually from 2003 to 2007 and then in 2009, 2011, and 2015. It is approximately 2.5 km upstream of Fortuna Site 01 on the eastern side of the Gila River, which runs along the western edge and through the northwestern corner of the site. In 2015, the site was vegetated primarily by mature tamarisk 3–7 m in height. Dense arrowweed was present along the eastern border of the site. A few 10-m-tall Goodding's willows and some common reed were present in the northern end of the site in May. By mid-June, the northern 100 m of the site had been cleared of all vegetation. Canopy closure in the vegetated portion of the site was 70–85%. Other than the cleared vegetation at the northern end of the site, no major changes in vegetation structure or composition were noted between 2003 and 2015.

Wet soils were noted when each site description was recorded in 2015 but were limited to the river channel, and all other soils were dry. Similar patterns of surface hydrology were noted during survey years in 2003–11 (McLeod and Pellegrini 2013). Soil moisture conditions in the site are influenced by the Gila River and likely did not fluctuate widely from day to day.

In 2015, two willow flycatchers were detected on May 18, and one willow flycatcher was detected on June 10. None of these willow flycatchers demonstrated territorial behavior, and no subsequent monitoring visits were scheduled. The site was considered unoccupied in 2015. It was also considered unoccupied in all survey years in 2003–11.

All the elements of suitable habitat (see table 2-1) were present in the portions of the site where canopy closure reached 85% (see table 2-1). This site could be evaluated before future surveys to determine whether all elements of suitable habitat are still present.

Hunters Hole

Area: 17.8 ha Elevation: 23 m

The survey site known as Hunters Hole was surveyed annually by SWCA from 2003 to 2007. In those years, the site consisted of two patches of Goodding's willows separated by a pond surrounded by cattail and common reed. The southern willow patch consisted of stringers of trees 10 m in height surrounding an oxbow. The northern patch was a mixture of Goodding's willows and cottonwoods in stringers along channels and small ponds. Canopy closure along the stringers was around 50%. Between the stringers, vegetation was a mix of tamarisk and arrowweed. Varying amounts of surface water were present in the channels and ponds throughout the seasons of 2003, 2004, and 2006, but no

surface water was present during surveys in 2005 or 2007. No surveys were completed by SWCA at Hunters Hole after 2007 because of safety concerns related to the site's location on the border between the United States and Mexico.

The site was incorporated into the LCR MSCP as a conservation area and planted with cottonwoods, Goodding's and coyote willows, honey and screwbean mesquite, and several types of native grasses. Planting was completed in 2013, and the site was surveyed for flycatchers by Reclamation in 2016 and 2017, at which time the tallest trees were in the center of the site and reached 6–8 m in height. No data on surface hydrology were recorded during surveys in 2016 or 2017.

Surveys in 2016 and 2017 followed the three-survey protocol. Fourteen willow flycatchers were detected on May 17 in 2016, and five willow flycatchers were detected on May 25 in 2017. None of these willow flycatchers demonstrated territorial behavior, and all were suspected to be migrants. Habitat suitability at the site was not assessed.

Yellow-billed Cuckoo Broadcast Surveys

Field personnel spent 79.4 observer-hours conducting yellow-billed cuckoo broadcast surveys at RIRA, PAHR, and WMSP in 2013–2017. No followup (e.g., nest searching) was conducted for any detection. Results of the surveys and site descriptions are summarized below. Sites that were also surveyed for flycatchers are described earlier in this chapter. The boundaries of survey areas are shown on orthophotos in attachment 7.

River Ranch, Nevada

Surveys were conducted in 2014–16 in a portion of a linear patch of trees located due south of the RIRA flycatcher survey sites. The cuckoo survey site begins approximately 275 m southeast of Smalls and extends south for 900 m. In 2016, vegetation within this linear patch consisted primarily of 6–10-m-tall velvet ash growing on either side of the stream flowing from Ash Springs, with the shorter trees at the northern end of the site. The width of the linear patch varied from 30 to 170 m. Approximately 10% of the site contained cottonwoods 10–15 m in height. Some 2–6-m-tall Russian olive and some dense patches of grape vine were also scattered throughout the site. Canopy closure varied from 80 to 90%. The stream channel held flowing water throughout the season, but soils away from the channel were dry to damp, with crunchy leaves covering the ground. Most of this site is surrounded by grazed cattle pasture, and some cattle were intermittently present in each survey year.

One yellow-billed cuckoo was detected on July 13, 2014. This individual was not detected during one subsequent survey, and residency status is unknown. No yellow-billed cuckoos were detected during surveys in 2015 or 2016. Three surveys were conducted in each year in 2014–16 between either late June and late July or early July and early August, for a total of 15.2 observer-hours. Surveys were conducted around the flycatcher sites in 2011 and 2012, and no yellow-billed cuckoos were detected in those years (McLeod and Pellegrini 2013).

Pahranagat, Nevada

Yellow-billed cuckoo surveys were conducted in 2013–16 at all four flycatcher survey sites. In addition to flycatcher sites, two stringers of cottonwoods on either side of Upper Pahranagat Lake were surveyed. The stringer on the eastern side of the lake starts 220 m north of the eastern terminus of the levee that bisects the lake and continues 210 m south of the levee. In 2016, the cottonwoods within this stringer were 10–15-m-tall and covered an area 15–30 m wide. Canopy closure reached 90%. The stringer on the western side of the lake is immediately south of the levee. In 2016, it was one to three trees wide and 15 m in height, with several gaps. Canopy closure reached 70% in the widest part of the stringer, which was approximately 40 m wide. Soils beneath both stringers were damp to inundated in each survey year, depending on lake levels.

At least one yellow-billed cuckoo detection was recorded during surveys in each year in 2013–16. In 2013, one yellow-billed cuckoo was detected at Pahranagat South on July 19. In 2014, one yellow-billed cuckoo was detected in the eastern stringer on July 11, and one was detected at Pahranagat South on July 24. In 2015, one silent yellow-billed cuckoo was detected at Pahranagat North on June 28. In 2016, one yellow-billed cuckoo was visually and aurally detected at Pahranagat MAPS during a survey on July 6. Residency status of each individual is unknown. In addition to detections during surveys, several incidental, passive detections were recorded during flycatcher monitoring activities in 2013–17 (see attachment 6). Three surveys were completed in each year in 2013–16 between either late June and late July or early July and early August, for a total of 47.1 observer-hours. SWCA did not conduct yellow-billed cuckoo surveys at PAHR prior to 2013.

Warm Springs, Nevada

Yellow-billed cuckoo surveys were conducted in 2013–17 at Muddy Mac, Muddy Stringer 01, and a small (70 x 20 m) patch of velvet ash located approximately 150 m south of Muddy Stringer 01. This patch of velvet ash trees is located 10 m south of the north fork of the Muddy River and approximately 45 m west of the end of a dirt road that dead-ends at the river. It consists of a stringer bisected by the dirt road and is surrounded by a matrix of quailbush and mesquite spp. The trees reach 10–12 m in height, and canopy closure reaches 80–90%.

No yellow-billed cuckoos were detected during surveys in 2013–15 or 2017. In 2016, a yellow-billed cuckoo was recorded during surveys in the same general area of Muddy Mac on June 22, July 5, and July 19. A second detection was noted on July 19, but it was unclear if the detection was of a second individual. According to the yellow-billed cuckoo survey protocol (Halterman et al. 2015), "three or more total detections in an area during at least three survey periods and at least 10 days between each detection" qualifies as a probable breeding territory. The Muddy Mac survey site was therefore determined to have a probable breeding territory, though breeding activity was not positively confirmed. According to protocol for the LCR MSCP, this territory would be classified as a possible breeding territory since there was no confirmation of the presence of a pair, nest building, or food carrying. Several incidental, passive detections of yellow-billed cuckoos were also recorded during flycatcher monitoring activities (see attachment 6). Three surveys were conducted in 2013 and four surveys were completed in each year in 2014–17, totaling 17.1 observer-hours. Surveys were also conducted in 2010 and 2012, and no yellow-billed cuckoos were detected during these surveys (McLeod and Pellegrini 2013).

DISCUSSION

Site Discovery and Loss

Between 2013 and 2017, 51 survey sites were added, compared with 61 in 2004–12 (McLeod and Pellegrini 2013). Of the 51 added survey sites, 24 (47%) were added in 2014 when effort shifted away from the Virgin River, 11 (22%) were added when previously unsurveyed sites were identified within existing study areas, and 16 (31%) were added as habitat within conservation areas matured or additional conservation areas were incorporated into the LCR MSCP. More sites were added in 2013–17 due to maturation of conservation areas than in 2004–12 (10% of added sites), whereas far fewer sites were added in 2013–17 than in 2004–12 (90% of new sites) because of additional sites being identified within existing study areas. Relatively few new sites were identified in 2013–17 because of increased familiarity with the project area and because habitat along the main stem of the LCR is relatively stable, as water is well regulated within the system. The lack of scouring floods and dynamic shifting of water on the landscape limits how much new habitat can develop within the project area. Of the 11 new sites added within existing study areas, 7 consisted of young habitat. These sites were in MVWA, MESQ, BIWI, and ALAM, which have more dynamic water regimes than do many other study areas.

Between 2013 and 2017, surveys at a total of 43 sites were discontinued or could be discontinued with minimal risk of overlooking suitable flycatcher habitat. Reasons surveys at a site were discontinued fell into one of five categories: poor habitat quality that did not improve over the years (35% of discontinued sites),

fire (26%), the site dried up and vegetation died completely or became too sparse to be suitable (23%), safety (9%), and the site was completely submerged (7%). As was the case in 2003–12, the top three reasons for discontinuing surveys at a site were poor habitat, fire, and changes in hydrology. All sites where surveys were discontinued due to a lack of surface water and reduction of habitat suitability were in study areas (MESQ, MOME, BIWI, and ALAM) with more dynamic water regimes. The only novel reason for discontinuing surveys was a site being completely submerged. All submerged sites were at Alamo Lake, which is unique among study areas surveyed in 2013–17 in that the lake is a reservoir that is supplied by undammed rivers.

Surface Water and Habitat Suitability

Flycatcher habitat suitability is driven by both vegetation structure and the presence of wet soils (Sogge et al. 2010). The presence of wet soils is often required to maintain suitable vegetation structure. As noted in the previous section, shifts in hydrology have been responsible for a large portion of habitat degradation and new site creation in the last 5 years. Here, changes in hydrology along various river segments within the project area are summarized along with the corresponding changes in habitat suitability and flycatcher occupancy.

River Ranch

The study area is flood irrigated as part of pasture management for grazing. Between 2014 and 2015, the irrigation regime changed from intermittent flooding to relatively continual irrigation during the breeding season. Observations of occupied habitat along the LCR and tributaries have indicated that high soil moisture is usually associated with the highest habitat quality (McLeod and Pellegrini 2013). At RIRA, however, there has been a noticeable decline in vegetation health in the two most heavily irrigated sites (West Side and Smalls) following the change in irrigation regime. Many trees have died in West Side, and the vegetation in the eastern third of the site no longer meets the suitability criteria. In Smalls, some mortality has occurred but is primarily limited to a narrow band of trees on the very northern edge of the site.

Habitat in RIRA that meets all the criteria for suitability has been limited in extent since SWCA began monitoring in 2011. In early years, the presence of cattle within each site was sufficient to affect understory structure. In recent years, increasing tree mortality has reduced the area of continuous, suitably dense canopy closure within some sites. The relatively small size of each habitat patch, the distance between habitat patches (each is 50–150 m away from the next patch), and the relative isolation of RIRA from the other study areas in the valley also reduce the probability of site occupancy. Occupancy at RIRA has been intermittent since SWCA began monitoring in 2011, with some portion of the

study area being occupied in 5 out of 6 years of monitoring. Occupancy has also been variable, ranging from a single flycatcher detected for 1 day up to several pairs of breeding flycatchers. So long as suitable habitat remains in the study area, this pattern of occupancy is likely to continue.

Pahranagat

From the start of flycatcher monitoring at PAHR in 1997 through 2007, occupied flycatcher habitat at Pahranagat North, near the inflow to Upper Pahranagat Lake, was inundated annually, with up to 1 m of water recorded under the vegetation in mid-May. From 2003 to 2007, as much as 100% of the site contained standing water in mid-May, and as much as 95% of the site contained wet soils until mid-July. Major structural problems with the dam that impounds the upper lake resulted in the upper lake being drained in early 2008, and the riparian vegetation at the northern end of the lake was not flooded during the 2008 or 2009 flycatcher breeding seasons. The dam was repaired prior to the 2010 breeding season, and lake levels in each year since 2013 have been slightly below the levels maintained prior to dam failure. The change in water levels has not corresponded with any change in the number of resident flycatchers at Pahranagat North, but the distribution of breeding pairs has shifted away from the center of the site toward the lakeside edge. This distribution shift began shortly after the dam was repaired and has persisted through 2017, with all nests located within the maximum extent of water documented within the site in May (SWCA, unpublished data).

Pahranagat MAPS was surveyed annually in 2006–10, but only one resident flycatcher was documented. The original survey site was heavily damaged by a fire in 2010, and surveys were discontinued thereafter. The drop in lake levels between 2008 and 2012 allowed new habitat adjacent to the original survey area in Pahranagat MAPS to germinate and grow. Surveys were reinitiated in the new habitat in 2014, when resident flycatchers were discovered by another field crew. Habitat occupied in 2014–16 consisted of three small (no larger than 25 x 30 m) patches of small-diameter, regenerating cottonwoods and two patches of larger-diameter cottonwoods adjacent to the original survey site, plus one additional small regenerating patch just south of the lake. Vegetation structure has changed noticeably since 2014, with height increasing from 5 m to 10–18 m and canopy closure decreasing from 85–95% to 60–85%, and habitat suitability has declined with the decrease in canopy closure. No resident flycatchers were detected in the site in 2017, though the site was considered occupied because of the detection of a banded flycatcher on June 26. Habitat suitability is likely to continue to diminish as the cottonwoods mature, self-thin, and lose the midstory structure and density typically used by flycatchers along the LCR and its tributaries.

Meadow Valley Wash

Meadow Valley Wash is a narrow canyon, rarely exceeding 100 m in width. Throughout most of the canyon, wet soils are limited to an incised streambed and a series of beaver ponds, and woody vegetation occurs in intermittent patches. The canyon is subject to periodic scouring floods, and the amount and quality of riparian habitat thus fluctuates between years, and flycatcher occupancy has been intermittent. Sites within MVWA were surveyed in 1998–2001, and flycatchers were detected only in 1998 (Braden and McKernan 2006). SWCA first monitored the study area in 2003, at which time it was unoccupied, and surveys were discontinued because of poor habitat quality.

The most recent scouring floods in MVWA occurred in 2010. The NDOW located breeding flycatchers in 2013 in the largest swath of riparian habitat present in the canyon (approximately 120 x 950 m). Aerial imagery indicates that habitat within the site was not scoured during the 2010 floods but that surface hydrology changed shortly thereafter. The main breeding site currently contains a series of beaver ponds and shallow, braided streams within the woody vegetation. The extent of suitable vegetation has increased as the extent of surface water within the site has increased with beaver activity. MVWA was surveyed again by SWCA starting in 2014, and the number of resident flycatchers has grown steadily since 2013 as the amount of suitable habitat has increased. The 2010 flood did scour habitat just north of the main breeding site, and vegetation in the Rock Springs Canyon site has grown since 2011. Breeding flycatchers were first discovered in that site in 2016. MVWA is > 50 km from the nearest flycatcher population in the Pahranagat Valley, and this distance likely results in the study area not being rapidly recolonized once vegetation has recovered after a flood event (Paxton et al. 2007). Limited and intermittent habitat availability in an area relatively isolated from other flycatcher populations results in MVWA being periodically occupied by small numbers of flycatchers.

Muddy River

Breeding flycatchers have been documented at MUDD annually since 2005, primarily in the survey site known as Overton WMA, in which there are two distinct breeding areas approximately 800 m apart. Both areas have been periodically occupied since 2005, with the local population shifting between the two areas. This shifting has been primarily driven by the extent of surface water in combination with suitable vegetation structure. In 2005–07, both areas were occupied by breeding flycatchers. Over the 2007–08 winter, the Muddy River was dredged immediately upstream of and downstream from the northern breeding area. Dredging activities resulted in a cleared swath 10–15 m wide on the western bank of the river and a reduced number of braided channels in the northern breeding area. In 2008–11, resident flycatchers were only detected in the southern breeding area, which still had an extensive network of braided channels flowing through an area of suitable vegetation 40–80 m wide. After 2010, the

channel where water entered the southern breeding area began to fill with sediment, and in 2013–17, no wet soils were observed in the site outside of the main river channel. Starting in 2013, the northern breeding area had a relatively greater availability of suitable vegetation adjacent to surface water compared to what remained in the southern breeding area, though the area of suitable habitat was generally only 20 m wide, and the majority of breeding activity shifted back to the northern breeding area. The change in hydrology in the southern breeding area resulted in a reduction of vegetation density as many limbs fell from the Goodding's willows.

Tamarisk beetles have been present in the study area since 2012, and many of the tamarisk have reduced foliage density as the result of several seasons of defoliation. This has impacted habitat suitability, particularly in the northern breeding area, which consists of a narrow band of native vegetation surrounded by tamarisk. The combined effect of tamarisk beetle defoliation and a reduction in surface water has been a significant reduction in the extent of suitable habitat in the study area. The number of resident flycatchers has declined accordingly, and the number detected in 2015–17 was no more than half that detected in 2005–14. If surface water remains confined to the river channel, the amount of available habitat is unlikely to increase, and the flycatcher population at MUDD is likely to remain small.

Topock Marsh

Water levels within the sites at TOPO are directly related to marsh elevations, which are heavily managed (see figure 2-8). While marsh elevation levels do change within the flycatcher breeding season, they do not fluctuate from day to day and have been similar in most years since 2005. In 2010 and 2011, marsh elevation levels were lowered to allow for the construction of a new water delivery canal. Conditions were very dry within the survey sites in 2010 and 2011, and the number of resident flycatchers dropped in each subsequent year. The number of resident flycatchers increased again starting in 2013, in the second year of a return to near-normal marsh elevations. The lag effect in response to changing conditions is not unexpected, as site fidelity has been shown to decrease following a year of poor reproductive success, such as in 2010 and 2011 (McLeod and Pellegrini 2013). Flycatchers are also known to prospect for new habitat, often occupying habitat in which they were briefly detected at the end of the previous year (see chapter 3). The drop in marsh elevation levels resulted in the growth of new coyote willow habitat in Swine Paradise, which was then occupied in 2013–16. Increases in the extent of suitable habitat are unusual in the TOPO study area because water is relatively stable within the area (i.e., no scouring floods or major shifts in location of surface water within the landscape).

A majority of available habitat in TOPO was consumed in the Willow Fire in August 2015. All the remaining suitable habitat within TOPO contains a high proportion of tamarisk. In late July 2016, tamarisk beetles were detected due

east of the remaining unburned survey sites, by the town of Golden Shores. Defoliation by tamarisk beetles occurred throughout TOPO during the 2017 breeding season, and habitat suitability throughout the study area declined sharply as the result of defoliation. Without an increase in native vegetation at TOPO, the study area may become unoccupied.

Bill Williams

Water levels in the Bill Williams River are dependent on releases from Alamo Dam. The dam is capable of a maximum release of 7,000 cfs, and when this outflow is delivered, shifts in surface hydrology within the river flood plain in BIWI are noted afterward. Flood events can shift gravel bars around the landscape, scour vegetation, and shift where the river will surface within the flood plain. Two large flood events occurred within the study area between 2003 and 2017, one in the winter of 2004–05 and the other in spring 2010. In both cases, new areas became inundated while other areas became more channelized after beaver dams were washed out. Beavers are common within the study area and were able to rebuild sizeable dams within a couple of years after each flood, inundating new areas. Examination of Google Earth imagery shows growth of some areas of vegetation between 2007 and 2010, and several sites were added after reconnaissance in 2008 and 2009 and again in 2011 and 2012.

Daily discharge at the U.S. Geological Survey gaging station (#09426620) on the Bill Williams River near Parker declined after 2010 (see figure 2-10). In 2013, daily discharge was 0.0 cfs for the first time since 2004. This discharge rate lasted for just under 2 months, between July 9 and August 29. Water levels reached 0.0 cfs again in 2014, this time from May 15 to September 8. Since May 2015, average monthly discharge has been 0.0 cfs. This is the longest period of 0.0 cfs recorded at this gaging station since SWCA began monitoring in 2003 and since the U.S. Geological Survey began recording in late 1988. At the beginning of the 2014–17 survey seasons, water was present only in the main river channel and in marsh vegetation surrounding the main stem of the river. As each season progressed, shallow stretches of the river dried up, leaving water only in the deepest channels, and the depth in isolated pools grew shallower.

Native vegetation appears to have been affected by the prolonged dry conditions within the study area. Native tree mortality was first noted during this project in 2014 at Cougar Point. It has since been noted both in young and older stands of native riparian habitat and appears to be spreading both upstream of and downstream from the Cougar Point area. In stands with large-diameter Goodding's willows or cottonwoods that have not yet died, canopy closure is decreasing as many large limbs and trees fall. Some of the decrease in canopy closure has occurred within formerly occupied areas, resulting in reduced habitat quality, and flycatcher occupancy in the study area has shifted accordingly within the landscape. Annually in 2003–09, most or all resident flycatchers in BIWI were in the Mosquito Flats area (Sites 03 and 04). Starting in 2010, at least half

of the resident flycatchers in the study area were detected in other sites. In 2016 and 2017, Mosquito Flats was unoccupied, and most of the resident flycatchers were in sites in the Bill Williams River Delta. Occupied habitat in these sites is characterized by the typically dense vegetation structure preferred by flycatchers, which is provided by substantial stands of tamarisk or coyote willows, often combined with standing water within woody vegetation, depending on water levels in Lake Havasu. All occupied sites in BIWI in 2017 have a significant tamarisk component. Toward the end of the 2016 season, tamarisk beetles were detected in the Bill Williams River Delta. In 2017, defoliation was documented in all occupied sites at the beginning of the breeding season, and sites were completely defoliated by mid-June. Some of the tamarisk were refoliating by mid-July. Defoliation reduced habitat suitability at these sites, and flycatcher occupancy is likely to decline in future years if defoliation continues or if the condition of the tamarisk declines because of defoliation.

Alamo Lake

ALAM consists of a wide (> 1 km) riparian area above the upstream edge of Alamo Lake. Lake levels dropped from the recent peak in 2010 to a low in 2016 not recorded since 1978 (figure 2-14). As lake levels dropped, a 3-km stretch of sediment within the riparian zone was slowly exposed. Several patches of woody native or mixed-native vegetation grew on the exposed sediments and have been colonized by flycatchers. In each survey site that developed as lake levels receded, vegetation in the occupied portion consists primarily of relatively small-diameter, even-aged Goodding's willows that were no more than 3–4 years old when resident flycatchers were first detected. The colonization of young habitat that emerges on recently exposed sediment has also been documented in other locations, including at Roosevelt Lake, Arizona. There, new habitats were colonized when they were 2.5–3.5 years old (Paxton et al. 2007), and occupancy declined at older sites as the distance from water increased (Ellis et al. 2008). This same pattern is being observed at ALAM. Several new sites were colonized in 2016, while occupancy in several older sites declined as habitat quality declined. By the end of 2016, many trees had died within the study area, and surveys in several of the oldest sites (Motherlodes 02, 03, and 04) were discontinued in 2017 due to widespread tree mortality.

Occupied flycatcher sites at ALAM in 2014–16 had predominantly dry soils, unlike typical occupied flycatcher habitat along the LCR and its tributaries. The dynamic nature of the availability of vegetation with suitable structure likely allowed the local flycatcher population to persist despite the lack of wet soils; that is, vegetation developed as the lake level receded, eventually reaching suitable canopy height (see table 2-1). By that time, however, the lake had receded to the point where surface soils under the vegetation were dry. Given the degree of tree mortality observed at the end of the 2016 season, it appeared that the lake had declined to a level too low to support portions of the native riparian forest, particularly at the sites farthest from the lake.

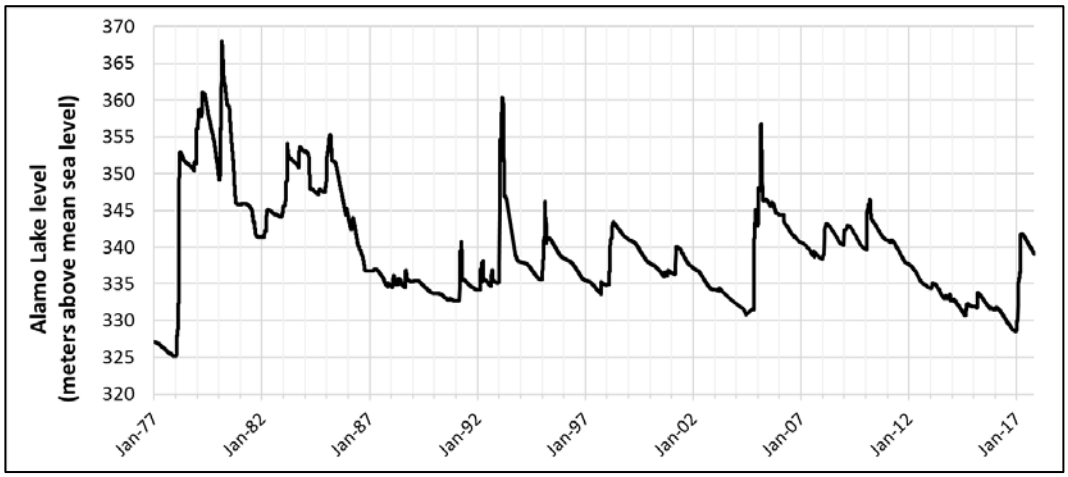

Figure 2-14.—Alamo Lake elevation (meters above sea level), 1977–2017.
Data sourced from Lakes Online (2017) and Arizona Game and Fish Department, unpublished data.

ALAM was not surveyed as part of this project until 2014, but it was known to be occupied annually in 1996–2006, with 5–24 territories, of which 1–19 consisted of pairs, documented in each year (Ellis et al. 2008). In 2014 and 2015, 56 resident flycatchers were detected annually at the study area. In 2016, the number of detected resident adults increased to 76 despite the continuing decline in lake levels. This apparent increase in the size of the resident flycatcher population in 2016 is likely partially the result of an overestimate of the number of individual flycatchers. Relatively few flycatchers at ALAM were banded (36% of resident adults; see chapter 3), and the high proportion of unbanded individuals meant that mid-season movements could go undetected. During the breeding season of 2016, field personnel documented a decline in habitat suitability at several sites where trees either lost most of their leaves or died outright. Signs of water stress in the trees became very apparent in late June, and it was at about this time that several pairs abandoned their territories. Several pairs were initially detected in early July in other portions of the study area with heathier vegetation. These were counted as separate individuals but could have been individuals that had vacated sites elsewhere in the study area.

In 2017, lake levels rose, and many sites were inundated throughout the season. Vegetation in the sites farthest downstream was either mostly or completely submerged. The presence of water within sites farther upstream improved habitat suitability, and many sites were occupied, including one (Prospect 01) that was unoccupied in 2014–16. A higher number of resident flycatchers (112) were detected in 2017 compared to previous years. Prolonged inundation affected the vegetation, however. Within the inundated sites, many of the tamarisk looked stressed, though no tamarisk beetles were noted; most of the cottonwoods died during the season and many fell over; and many otherwise healthy Goodding's willows were blown over during windstorms in early July. Tamarisk beetles were

noted in portions of the study area that were not inundated, and defoliation occurred in the middle of the breeding season within one of the occupied sites (Santa Maria North 01). Occupancy in this site is likely to decline with future seasons of defoliation.

South of Parker Dam

Between 2003 and 2017, SWCA detected two resident flycatchers south of Parker Dam that displayed territorial behavior. Both individuals were detected in the Palo Verde Ecological Reserve, with one in 2015 and the other in 2016. Both individuals defended territories on the edge of a cottonwood-willow block adjacent to mesquite spp., with each in a separate phase within the conservation area. No evidence of pair behavior was observed in either year, and detections for each individual spanned no more than 2 weeks. While the 2015 individual displayed territorial behavior on all observation dates, the 2016 individual became increasingly less territorial as time progressed, and it was not actively defending its territory toward the end of its stay. The early dates and short window of occupancy, combined with declining territorial behavior for the 2016 individual, suggest that these individuals might have been prospecting for potential habitat (Paxton et al. 2007) during their northbound migration.

Water levels in the LCR south of Parker Dam are regulated by releases from a series of dams. Habitat outside of conservation areas is relatively stable unless a stochastic event like a fire occurs. The stable nature of surface hydrology within this stretch of the river limits the capacity to replace aging vegetation with younger vegetation that could have more suitable structure. The only new sites added along this stretch of river in 2013–17 were in conservation areas, all of which are flood irrigated.

Livestock

The presence of livestock has been identified as a potential threat to flycatcher habitat primarily because of the detrimental effects of overgrazing. Overgrazing by livestock has the potential to degrade riparian habitat through trampling of young vegetation, erosion of streambanks, and compaction of soils (Bureau of Land Management 1991). Three types of livestock were noted during surveys in 2013–17: cattle, feral pigs, and feral burros. Feral burros were primarily observed at the periphery of survey sites between TOGO and YUMA. Habitat along the edge of the riparian zone in these areas is often vegetated with scrubby tamarisk, scattered mesquite spp., palo verde (*Parkinsonia* spp.), and ironwood (*Olneya tesota*) with an open understory, which creates shady habitat that is easy to move through. There is no evidence of negative impacts by burros to flycatcher habitat along the LCR. Feral pigs were noted within flycatcher habitat primarily at TOPO. Where feral pigs are present, they create small tunnels and

trails within the bottom meter of vegetation. Feral pigs will also disturb the ground, rooting for food, and will create large wallows. In some cases, the wallows provided the only wet soil that persisted within the site into July. The ground disturbance and trails noted within the TOPO study area in 2013–17 did not appear to have any negative impact on habitat suitability for flycatchers.

Cattle were observed along the Virgin River in 2013, at RIRA in 2013–16, and at PAHR in 2013 and 2014. Documented effects of cattle presence on habitat within the project area include the creation of many tunnel-like "trails" within the lower 2 m of the vegetation and grazing of wet meadows and other herbaceous vegetation. At RIRA, grazing pressure can be sufficient to create a "browse-line" in the lower 2 m of the sites, though this was not observed in 2015 or 2016. RIRA is in pasture that is intensively managed for grazing. In areas like the Virgin River and PAHR, cattle density and grazing pressure have been insufficient to create a "browse-line" in broad-leaf trees. A study of light to moderate grazing pressure in flycatcher habitat along the Rio Grande found no detrimental effects to the habitat (Ahlers et al. 2009). Cattle will travel directly adjacent to flycatcher nesting areas, but no nest failure directly due to cattle (i.e., knocking over the nest or nest tree, or eating nest contents) has been documented in this study in any year in 2003–17. While the presence of cattle has not obviously affected flycatcher nest success in this study, cattle likely inhibit the natural expansion of native vegetation through selective browsing or trampling of young seedlings. Native vegetation is an important component of flycatcher habitat, and it may provide the only remaining suitable habitat in areas affected by tamarisk beetles.

Chapter 3 – Color Banding and 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. Thus, as an integral part of flycatcher studies along the LCR and its tributaries, personnel captured and uniquely color banded as many flycatchers as possible at all study areas monitored by SWCA during each year from 2003 to 2017, allowing field personnel to resight individuals throughout the breeding season, as well as in subsequent years. Resighting consisted of using binoculars to determine the identity of a color-banded flycatcher by observing, from a distance, the unique color combination on its legs. This allowed field personnel to detect and monitor individuals without recapturing each bird. Prior to 2003, color banding was done as part of the Reclamation studies at PAHR, MESQ, MOME, MUDD, GRCA, TOPO, and BIWI (McKernan and Braden 1998). SWCA color banded flycatchers opportunistically at KEPI in 2004–09 in cooperation with the NDOW, at STGE in 2008–17 in cooperation with the UDWR, and in Las Vegas Wash in 2008 and 2013 in cooperation with the SNWA. Resighting data were also compiled from the UDWR for STGE and from the NDOW for KEPI, RIRA, MESQ, and MOME in years when SWCA was not monitoring those study areas.

METHODS

Color Banding

From mid-May through mid-August of each year, personnel captured, uniquely color banded, and subsequently monitored adult and nestling flycatchers at all study areas where resident flycatchers were detected. Adult flycatchers were captured with mist nets, which provide the most effective technique for live-capture of adult songbirds (Ralph et al. 1993). A targeted capture technique was used (per Sogge et al. 2001) whereby a variety of conspecific vocalizations were broadcast from a compact disc player or MP3 player and remote speakers to lure territorial flycatchers into the nets. In addition, field personnel used passive netting, whereby several mist nets were erected and periodically checked, with no broadcast of conspecific vocalizations. Occasionally, individuals of an unknown subspecies (i.e., “willow flycatcher”) were captured, especially when passive netting was employed. These individuals were processed like known territorial flycatchers because differentiation of subspecies in the field, even when the bird is in hand, is difficult.

In 1997–2002, each adult and nestling flycatcher was banded with a single, numbered U.S. Federal aluminum band (either standard issue silver or colored epoxy enamel) and one or more celluloid plastic color bands. The enamel on the Federal band can chip, revealing the underlying silver band color, and plastic bands are susceptible to fading and band loss, causing difficulties in correct color identification through binoculars (McLeod and Pellegrini 2013). To remedy these problems, Federal bands anodized in one of several colors and colored metal bands were used starting in 2003. In 2003–07, all adults were banded with a Federal band on one leg and a metal color band on the other, while nestlings were banded only with a Federal band. This necessitated capturing any nestlings that returned in a subsequent year to determine their identity. To eliminate the need to recapture returning nestlings, all nestlings banded in 2008–17 were given a Federal band on one leg and a metal color band on the other. All color combinations were coordinated with the Federal Bird Banding Laboratory and all other flycatcher banding projects to minimize duplication of color combinations. Field personnel visually inspected the legs of each recaptured, banded flycatcher and noted any evidence of irritation or injury that might be related to the presence of leg bands.

Nestlings were banded at 7 to 10 days of age, when they were large enough to retain the leg bands, yet young enough that they would not prematurely fledge from the nest (Paxton et al. 1997; Whitfield 1990). Nestlings were banded only when the location of the nest was such that nest access and removal and replacement of the nestlings would not endanger the nest, nest plant, or nestlings.

For each captured adult willow flycatcher, morphological measurements were recorded, including culmen, tail, wing, fat level, and molt, onto standardized data forms (see McLeod et al. 2018). Sex was determined based on the presence of a cloacal protuberance in males or brood patch and/or egg(s) in the oviducts of females. Captured adults lacking breeding characteristics or a diagnostic wing chord (female ≤ 66 millimeters [mm]; male ≥ 71 mm), and not observed engaging in male advertising song (see below), were sexed as unknown. Adults with retained primary, secondary, and/or primary covert feathers (multiple-aged remiges) were aged as second-year adults, and those without (uniformly aged remiges) were aged as after hatch year (per Kenwood and Paxton 2001 and Koronkiewicz et al. 2002). Individuals in juvenile plumage (unworn flight feathers and body plumage with broad, buff-colored wing bars and fleshy gape) were aged as hatch year.

Resighting

The identity of a color-banded flycatcher was determined by observing with binoculars, from a distance, the unique color combination on its legs. In 2015–17, field personnel also used digital cameras (Canon PowerShot SX50 HS) to take

pictures of flycatchers; these photos supplemented any resight data. Territories and active nests were focal areas for resighting, but entire sites were surveyed. Field personnel typically spent the early part of each morning color banding and directed their efforts to resighting as daylight increased and flycatchers became more difficult to capture. All field personnel coordinated their resighting efforts and recorded observations of banded and unbanded flycatchers into an electronic database. For resighted flycatchers (i.e., ones for which at least one leg was seen clearly enough to determine the presence or absence of a band), color combinations, territory number, site, standardized confidence levels of the resight, and behavioral observations were recorded. Observers also recorded any evidence of leg injuries, such as obvious deformity or dysfunction of the leg.

Flycatchers for which detections spanned 1 week or longer were considered resident at a site regardless of the portion of the breeding season in which the bird was observed or whether a possible mate was observed. Flycatchers observed engaging in breeding behaviors (e.g., carrying nest material) were also considered resident regardless of the period of time over which they were observed. 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. Flycatchers not observed engaging in one of these diagnostic activities were sexed as unknown.

Unbanded flycatchers could not be identified to individual, but an unbanded flycatcher detected in a given location on multiple, consecutive visits was assumed to be the same individual. If an unbanded flycatcher or a flycatcher whose legs were not observed was detected at a given location on multiple visits, but one or more intervening visits failed to detect a flycatcher, the detections were considered to be 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.

Cooperation with Other Agencies

The NDOW monitored flycatchers at MVWA in 2013, at KEPI and RIRA in 2017, and at MESQ and MOME in 2015–17. SWCA personnel volunteered for the NDOW to assist in these efforts via occasional territory visits that included resighting, nest monitoring, and banding; and reviewing resight and nest record data. Data collected by and in cooperation with the NDOW are reported here to provide a more continuous dataset for these study areas. The UDWR monitored resident and breeding flycatchers at STGE in 2013–17. The SNWA surveyed for flycatchers at Las Vegas Wash (LVWA) in 2013–17, but a resident flycatcher was detected only in 2013. SWCA banded flycatchers opportunistically at STGE and

LVWA in conjunction with the survey and monitoring efforts and obtained resight records from the UDWR so that STGE flycatchers could be included in analyses of demography and movement.

Data Analyses

Movement

Detections of individually identified flycatchers in 2013–17 were used to examine patterns of adult between-year and within-year movement and juvenile dispersal. Individuals for which the last known detection was prior to 2013 were included in the dataset. 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 (< 7 days) detection of an individual. All adult between-year movement distances were calculated from the last known location in a given year and the first known location in a subsequent year. Years are not always consecutive. For juvenile dispersal, the last known location was always the nest location even if the juvenile was detected as a fledgling elsewhere. Data were non-normal and heavily skewed. Movement distances were compared between ages, gender, and regions using Kruskal-Wallis tests in IBM ® SPSS ® v. 22.0. Regions were defined as the Pahranagat region (KEPI, RIRA, PAHR, and MVWA), the Virgin region (STGE, MESQ, MOME, MUDD, and WMSP), and the greater Havasu region (TOPO, BIWI, and ALAM).

Demographics

Survival and Detection: Effects of Age, Year, Marking Cohort, and Resight Period

Flycatcher survival rates between 1997 and 2017 were estimated using age-structured Cormack-Jolly-Seber (CJS) live encounter models, analyzed using a maximum likelihood method within Program MARK (Version 8.2, White and Burnham 1999). A candidate list of 45 *a priori* models (full list of all candidate models is on file with Reclamation, Boulder City, Nevada) were compared using small-sample-size corrected Akaike's information criterion (AICc) values generated in Program MARK. These models allowed survival probabilities (φ) to vary by a combination of age and year, while detection probabilities (p) were allowed to vary by different combinations of age, year, marking cohort, and resight period. Gender was not included in these models, as data were too sparse. Age was divided into two categories: juveniles (flycatchers banded in the nest or as recently fledged young) and adults. Year was included to allow survival and detection probabilities to vary through time. The marking cohort variable was included to account for differences in methodology across the 21 years of data collection. This was done by constraining detection probabilities into three cohorts of banded individuals, corresponding to three contract periods that used differing marking methodologies: 1997–2002, 2003–07, and 2008–17. These

three periods varied both in the type of color bands used to mark flycatchers and in the way in which nestlings were banded. In cohort one, both adults and juveniles were banded with epoxy-enameled metal Federal bands and plastic color bands. Plastic color bands have been found to be prone to fading and have caused leg injuries in flycatchers (Koronkiewicz et al. 2005). If color bands faded or fell off an individual, it could no longer be identified by resighting, and this would lower the detection probability for individuals banded during these years. In the second cohort, adults were banded with anodized metal Federal bands and metal color bands, while juveniles were banded with anodized metal Federal bands only. For individual juveniles to be detected in future years, they had to be captured a second time to read the Federal band number, which would lower the detection probability for these individuals until they were recaptured. During the third and most recent cohort, flycatchers of all ages were banded with anodized metal Federal bands and metal color bands. Because the marking methodology for individuals originally marked as adults did not vary between cohorts two and three, the structure for all models that allowed detection probabilities to vary by marking cohort restricted detection probability not to vary between cohorts two and three for individuals banded as adults. This means that the detection probability estimates for adults encountered in cohort two are based only on individuals banded as juveniles during this cohort (i.e., in 2003–07) that survived to adulthood. The adult detection probabilities for cohorts one and three are based on individuals originally banded as both juveniles and adults. Resight period was included to account for differences in resighting effort in 2014–17 compared to earlier years at study areas within the Virgin Valley (i.e., MESQ and MOME) and at ALAM. The Virgin Valley sites were no longer monitored directly by SWCA during these years, and a regular monitoring schedule was not followed at ALAM. Resight period one included all years from 1997 to 2013, and resight period two included 2014–17.

Nestlings that were banded but did not fledge were not included in this analysis. Adult flycatchers that were captured but suspected to be migrants were also not included in this analysis. Individuals were considered migrants if they were detected for a single day prior to June 15 or after July 20. Study areas included in this analysis were KEPI, RIRA, PAHR, MOME, MESQ, MVWA, MUDD, WMSP, STGE, LIFI, LVWA, GRCA, TOPO, BIWI, and ALAM. This analysis gives a global overview of flycatcher survival along the LCR and its tributary watersheds.

To test the goodness of fit (GOF) for the general, time-dependent model, both the bootstrap and median c-hat procedures were used. For the bootstrap GOF test, 500 simulations were done to generate a distribution of expected model deviances. These were then compared with the observed deviance, and the variance inflation factor (c-hat) was calculated by dividing the observed deviance by the mean expected deviance. For the median c-hat GOF test, an upper bound of the next highest even tenth place decimal above the observed c-hat was used (i.e., with observed c-hat of 4.49, an upper bound of 4.6 was used), with

intermediate points every 0.2 and 10 repetitions per point. C-hat values of 1.0 indicate perfect fit, and those above 1.0 indicate overdispersion but are still an acceptable fit of the general model if they are below 3.0 (Lebreton et al. 1992). C-hat can be adjusted for the entire model set if GOF tests result in a value above 1.0, but structural issues in the data's fit to the model are probably present if c-hat is above 3.0. If c-hat is adjusted, then the quasi-likelihood adjusted AICc (QAICc) is used in place of AICc.

The most supported model (top model) is the one with the lowest AICc score (Burnham and Anderson 2002). Competing models are those with a difference in AICc (ΔAICc) of < 2 and are all considered to have strong support. Models with a ΔAICc of 2–7 are considered to have some support. If multiple models were supported (i.e., AICc < 7), all candidate models are averaged using their Akaike weights (relative likelihood of a model compared to other models) to obtain parameter estimates.

Estimates of annual survival for adult and juvenile flycatchers were used to calculate mean life expectancy as follows (Brownie et al. 1985; Dinsmore et al. 2003):

$$\text{mean life expectancy} = 1/-\ln(\varphi_j) + \varphi_j/-\ln(\varphi_a) + \varphi_j/\ln(\varphi_j)$$

where: φ_j = juvenile survival
φ_a = adult survival.

Geographic Regions

Survival analysis models were also created for three local geographic regions to explore differences between these regions and to provide survival estimates for the calculation of the annual per capita growth rate of a population (i.e., lambda [λ]). A constant project area size is needed to calculate λ, and changes to the project area extent occurred in 2014 and again in 2017. Survival analysis models by region were therefore limited to the following: the Pahranagat Valley (PAHR, RIRA, and KEPI) in 2011–16, PAHR in 1998–2017, and Havasu (TOPO and BIWI) in 1998–2017. A separate model set was considered for each of the three geographic regions. For all three regions, age and year plus their interaction were considered as factors affecting survival probabilities. For Havasu and PAHR, age and marking cohort plus their interaction were included as factors affecting detection probabilities. For the Pahranagat Valley, only age was considered as a factor for detection probability, along with constant survival and detection probabilities. Resight period was not included as a factor for detection probabilities for these three regional models because effort did not change within these regions over time. Marking cohort was not included in the Pahranagat Valley models because the cohort did not differ between the years of 2011 and 2016. Year was not included as a factor for detection probabilities of these three regional models because models including year could not estimate parameters

with the available data. Year was not found to be important in the detection probabilities of the global model, which lends support to its deletion here. This resulted in a candidate model list of 16 models for Havasu and PAHR, and 10 models for the Pahranagat Valley.

Adult Survival: Effect of Gender

A reduced dataset was used to test the question of whether one gender had higher survival than the other. This dataset consisted of all individuals from the global dataset that had a known gender and were detected as adults. The first encounter (i.e., the year the bird was banded) was deleted from the encounter history for all individuals banded as juveniles to allow these individuals to be used in this known-gender dataset. No juveniles were used because most juveniles are banded as nestlings, for which gender is unknown. Therefore, for an individual to have a known gender and be banded as a juvenile, it must survive at least its first year. If these individuals were left in the known-gender dataset, it would artificially increase the survival rate. As the question was only related to whether one sex had higher survival than the other, a relatively simple model set of four models was created, using gender as a grouping variable within Program MARK. Survival probabilities were either held constant or allowed to differ by gender, and detection probabilities were either held constant or allowed the full interaction between marking cohort and resight period.

Juvenile Survival: Effects of Fledge Date, Nestling Stage Length, and Drainage

Post-fledging survival probability tends to be very low, often because of high depredation rates (Naef-Daenzer and Gruebler 2016). Factors that can influence depredation rates include fledgling mass and fledging date. The effects of fledge date, length of the nestling stage (as a proxy for fledgling mass), and local drainage on juvenile survival were examined using a reduced dataset consisting only of individuals banded as nestlings or recently fledged young. Data from KEPI, RIRA, PAHR, MVWA, LIFI, MESQ, MOME, MUDD, WMSP, GRCA, TOPO, BIWI, and ALAM between 1997 and 2017 were included. The study areas were grouped into the following drainages: the Pahranagat region (KEPI, RIRA, PAHR, and MVWA), the Virgin region (LIFI, MESQ, MOME, MUDD, WMSP, and GRCA), and the greater Havasu region (TOPO, BIWI, and ALAM). Banded nestlings known to have died before fledging were excluded from the dataset. Nestlings from study areas not monitored as part of this project (i.e., not monitored by SWCA or the San Bernardino County Museum) were excluded from the dataset. Nestlings for which either fledge date or nestling stage length was unknown were also excluded.

The input file was structured with each drainage included as a group and both fledge date (in Julian date format) and nestling stage length (to the nearest half

day) included as individual covariates. The candidate model set included 28 models. The model set considered the additive effects of age, drainage, fledge date, and nestling stage length on survival probability, and the additive effects of age, drainage, marking cohort (as defined above), and resight period (as defined above) were considered for detection probability. All models were run using unstandardized covariates and mean covariate values. Model selection and GOF testing were conducted as described above.

Annual Per Capita Rate of Population Growth

A constant project area size is needed for calculations of λ, estimates of recruitment into a population using Pradel models, and calculations of population trends because increases or decreases in project area size mimic large-scale immigration or emigration events. These analyses were therefore restricted to three geographic regions and time periods for which project size was constant: the Pahranagat Valley (PAHR, RIRA, and KEPI) in 2011–16, PAHR in 1998–2017, and Havasu (TOPO and BIWI) in 1998–2017. Calculations were not generated for the Virgin region because SWCA did not monitor flycatchers there after 2013. Estimates of λ for the Virgin region for 1997–2012 are presented in McLeod and Pellegrini (2013).

The annual per capita growth rate (λ) was calculated using the following equation (Pulliam 1988):

$$\lambda = \text{adult survivorship} + (\text{juvenile survivorship x seasonal fecundity}/2) + \text{immigration}$$

Lambda values at 1.0 suggest a stable population, > 1.0 a growing population, and < 1.0 a declining population.

Adult and juvenile survival estimates were obtained from survival analysis models by region (see "Geographic Regions," above). Seasonal fecundity for each geographic region was obtained from nest monitoring efforts (see chapter 4). Estimates of recruitment were generated from Pradel models in Program MARK. Pradel models use the number of newly marked individuals in an age class to estimate total annual recruitment (f) into that age class. The models were run using data from all marked adults. Local recruitment (juvenile survivorship x seasonal fecundity/2) was then subtracted from the total annual recruitment (f) to generate an estimate of immigration for each geographic region. Estimates of survival, fecundity, and immigration were entered into the equation above to obtain annual estimates of λ for each geographic region.

Pradel models used a candidate model set that included all combinations of survival probability (φ), detection probability (p), and recruitment (f). Each parameter was individually allowed to be either constant or vary with time. Currently, no GOF tests exist for Pradel models in Program MARK, and a c-hat

of 1.0 was assumed for all model sets. Selection among competing models was made using AICc as described above. The top Pradel model for each geographic region was used to obtain an estimate of overall recruitment (f) in that region.

Population trends were also calculated for comparison with λ estimates. Any individuals that were considered resident in more than one study area within a geographic region in a given year were counted only once in the total number of resident flycatchers. To generate a trend line, the number of resident adults was transformed on the natural log (ln) scale and a linear regression was applied in Microsoft Excel. The slope of the regression line was then used to calculate the average annual percent change in population size using the equation:

$$\text{average annual percent change} = (e^{slope} - 1) \times 100$$

Leg Injuries

Because leg injuries are typically identified in years after the one in which a flycatcher is initially banded, the leg injury analysis was restricted to flycatchers that were seen for at least one season after the one in which they were originally banded as either an adult or a juvenile. Individuals resighted in STGE were excluded from the analysis because SWCA did not request any information on leg injuries from the agency that monitors flycatchers in STGE. Flycatchers that had temporary injuries (i.e., were captured or resighted on one occasion with an injury and were subsequently captured or resighted with no evidence of an injury) were considered to be injured only in the year the injury was observed but were not considered to have developed a permanent injury.

RESULTS

Numbers of Flycatchers Detected

The number of flycatcher and willow flycatcher adults detected annually in 2013–17 ranged from 172 in 2013 to 300 in 2015 (table 3-1). The study areas and sites included in surveys and monitoring varied among years, and this affected the numbers of flycatchers and willow flycatchers detected. ALAM, which has a larger flycatcher population than any of the other study areas, was added to the study in 2014, and sites south of Parker Dam that were scheduled for triennial surveys were visited only in 2015. The proportion of adults that were determined to be resident flycatchers was > 80% in most years at KEPI, PAHR, MVWA, MESQ, MOME, and ALAM; 40–80% in most years at RIRA, MUDD, TOPO, and BIWI; widely variable at WMSP; and 0% or nearly so at all study areas south of Parker Dam.

The total number of resident, adult flycatchers detected in each year ranged from 99 in 2013 to 200 in 2017 (table 3-2) and was strongly influenced by the addition of ALAM in 2014. The number of resident flycatchers detected at a given study area could also vary substantially among years. Of the study areas where resident flycatchers were detected during every monitoring year, PAHR had the most stable population, with the largest population (28 individuals) being 1.5 times the smallest (18 individuals). BIWI had the least stable population, with the largest population (13 individuals) being 13 times the smallest (1 individual). The largest between-year variation in the absolute number of resident flycatchers occurred at ALAM, where the number of residents detected in 2017 (112) exceeded that detected in 2014 and 2015 by 56 individuals. The number of resident, adult flycatchers detected in each year declined steadily at KEPI (37 in 2013 to 11 in 2017) and MOME (17 in 2013 to 6 in 2017) and increased steadily at MVWA (2 in 2013 to 9 in 2017) and MESQ (3 in 2013 to 16 in 2017). Only two resident flycatchers were detected south of Parker Dam, with one individual detected at PVER in 2015 and a different individual detected at PVER in 2016.

Color Banding Effort

From 2013 to 2017, field personnel captured and banded 143 flycatcher and willow flycatcher adults (see attachment 8 for a list of all flycatchers banded and resighted in 2013–17). The vast majority of these were resident flycatchers, and the percentage of all adults that were banded by the end of the season varied directly with the proportion of the population that was resident (table 3-1). The overall percentage of resident, adult flycatchers that were banded by the end of each season declined from 79% in 2013 to 45% in 2017 (table 3-2). The percentage of resident adults that were banded by the end of each season was > 80% in most years at KEPI, RIRA, PAHR, MVWA, MUDD, WMSP, and PVER, while a much smaller proportion of the resident, adult population was banded at MESQ, MOME, TOPO, BIWI, and ALAM.

From 2013 to 2017, field personnel banded 297 juvenile flycatchers, 33 of which were known or suspected to have died before fledging. An additional 181 unbanded juveniles were confirmed to have fledged. The percentage of fledglings banded in each year declined from 82% in 2013 to 32% in 2017 (table 3-1). The percentage of juveniles banded was > 80% in most years at KEPI, RIRA, PAHR, MVWA, MUDD, and WMSP, while MESQ, MOME, TOPO, BIWI, and ALAM had lower or more widely variable percentages of banded juveniles.

Table 3-1.—Summary of southwestern willow flycatchers and willow flycatchers detected during the breeding seasons of 2013–17
(Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA.)

		Adults									Juveniles			
					Resighted									
Study area[1]	Year	Total adults detected	New captured	Recaptured	Identity confirmed	Banded (identity unknown)	Unbanded	Band status unknown	Percent of adults resident	Percent of adults banded	Nestlings banded (# of nests)	Fledglings captured (# of nests)	Unbanded fledglings (# of nests)	Percent of fledglings banded[2] (# of fledglings)
KEPI	2013	37	4	2	26	0	4	0	100	89	35 (13)	0	0	100 (21)
	2014	41	3	1	30	2	4	1	85	88	21 (10)	0	1 (1)	92 (13)
	2015	28	2	0	22	2	2	0	82	93	9 (5)	0	0	100 (6)
	2016	24	2	2	19	0	1	0	92	96	7 (4)	0	2 (1)	0 (2)
	2017	16	0	1	7	3	2	3	69	69	0	0	3 (2)	0 (3)
RIRA	2013	5	1	2	0	0	1	1	40	60	0	0	0	–
	2014	0	0	0	0	0	0	0	–	–	0	0	0	–
	2015	10	2	2	2	0	1	3	60	60	5 (2)	0	0	100 (5)
	2016	4	0	2	2	0	0	0	50	100	1 (1)	0	0	100 (1)
	2017	9	1	0	6	0	2	0	78	78	0	0	0	–
PAHR	2013	24	2	5	11	0	6	1	83	75	4 (2)	3 (3)	5 (4)	58 (12)
	2014	30	6	7	17	0	0	0	93	100	21 (7)	3 (3)	6 (4)	76 (25)
	2015	22	1	1	19	0	1	0	95	95	15 (7)	1 (1)	1 (1)	94 (17)
	2016	28	5	9	14	0	0	0	82	100	21 (7)	3 (1)	1 (1)	96 (23)
	2017	26	1	4	15	1	5	0	69	81	25 (8)	0	0	100 (18)
MVWA	2013	2	0	0	1	0	1	0	100	50	0	0	2 (1)	0 (2)
	2014	4	3	0	0	0	1	0	100	75	5 (2)	0	0	100 (4)
	2015	8	3	0	3	0	1	1	63	75	10 (4)	0	0	100 (10)
	2016	8	2	1	4	0	0	1	88	88	2 (1)	0	3 (1)	40 (5)
	2017	9	2	3	4	0	0	0	100	100	11 (4)	0	0	100 (11)
MESQ	2013	11	1	0	1	0	4	5	27	18	0	0	0	–
	2015	5	1	0	2	0	2	0	100	60	1 (1)	0	0	– (0)
	2016	14	2	0	1	4	6	1	100	50	0	0	6 (2)	0
	2017	18	6	1	2	1	4	4	89	56	7(4)	0	2 (1)	33 (3)
MOME	2013	18	1	1	12	1	0	0	94	100	1 (1)	0	0	100 (1)
	2015	7	1	0	2	1	3	0	100	57	0	1 (1)	2 (2)	33 (3)
	2016	7	1	0	1	2	2	1	86	57	0	0	2 (1)	0 (2)
	2017	6	0	0	1	1	2	2	100	33	0	0	0	–
MUDD	2013	11	2	0	6	0	1	0	91	91	2 (1)	0	0	100 (2)
	2014	11	3	0	5	0	3	0	73	73	3 (3)	0	0	100 (1)
	2015	7	1	1	1	0	1	3	43	43	3 (2)	0	0	100 (2)
	2016	8	3	0	2	0	3	0	50	63	0	0	0	–
	2017	8	2	1	0	1	4	0	38	50	1 (1)	0	0	100 (1)

Table 3-1.—Summary of southwestern willow flycatchers and willow flycatchers detected during the breeding seasons of 2013–17
(Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA.)

		Adults									Juveniles			
					Resighted									
Study area[1]	Year	Total adults detected	New captured	Recaptured	Identity confirmed	Banded (identity unknown)	Unbanded	Band status unknown	Percent of adults resident	Percent of adults banded	Nestlings banded (# of nests)	Fledglings captured (# of nests)	Unbanded fledglings (# of nests)	Percent of fledglings banded[2] (# of fledglings)
WMSP	2013	0	0	0	0	0	0	0	–	–	0	0	0	–
	2014	1	0	0	1	0	0	0	100	100	0	0	0	–
	2015	2	1	0	1	0	0	0	100	100	1 (1)	0	0	100 (1)
	2016	2	0	0	1	0	0	1	50	50	0	0	0	–
	2017	7	5	1	1	0	0	0	71	100	5 (2)	0	0	100 (5)
TOPO	2013	16	0	1	0	0	10	5	50	6	0	0	0	–
	2014	30	3	0	1	0	7	19	20	13	6 (3)	0	0	100 (6)
	2015	23	8	0	2	1	6	6	65	48	2 (1)	0	1 (1)	0 (1)
	2016	15	0	1	0	2	7	5	40	20	0	0	0	–
	2017	12	3	0	0	0	3	6	33	25	0	0	0	–
TOGO	2015	0	0	0	0	0	0	0	–	–	0	0	0	–
BIWI	2013	14	0	0	0	0	3	11	7	0	0	0	0	–
	2014	11	2	0	0	0	3	6	55	18	2 (1)	0	3 (1)	25 (4)
	2015	13	4	0	3	0	3	3	85	54	7 (3)	0	3 (2)	50 (6)
	2016	28	3	0	4	0	9	12	46	25	9 (4)	0	0	100 (7)
	2017	12	1	0	4	2	4	1	83	58	0	0	0	–
ALAM	2014	60	21	0	0	0	20	19	93	35	7 (4)	0	5 (3)	50 (10)
	2015	58	7	1	6	3	34	7	97	29	23 (9)	0	27 (14)	40 (45)
	2016	83	14	1	10	7	41	10	92	39	12 (7)	0	27 (13)	25 (36)
	2017	123	5	0	13	2	80	23	91	16	2 (1)	0	79 (36)	2 (81)
PVER	2013	16	0	0	0	0	2	14	0	0	0	0	0	–
	2014	22	0	0	0	0	10	12	0	0	0	0	0	–
	2015	53	1	0	0	0	33	19	2	2	0	0	0	–
	2016	39	1	0	0	0	15	23	3	3	0	0	0	–
	2017	21	0	0	0	0	2	19	0	0	0	0	0	–
EHRE	2015	0	0	0	0	0	0	0	–	–	0	0	0	–
CIBO	2013	20	0	0	0	0	7	13	0	0	0	0	0	–
	2014	14	0	0	0	0	3	11	0	0	0	0	0	–
	2015	26	0	0	0	0	9	17	0	0	0	0	0	–
	2016	20	0	0	0	0	7	13	0	0	0	0	0	–
–	2017	8	0	0	0	0	0	8	0	0	0	0	0	–
IMPE	2015	14	0	0	0	0	2	12	0	0	0	0	0	–
MITT	2015	3	0	0	0	0	0	3	0	0	0	0	0	–
	2017	5	0	0	0	0	1	4	0	0	0	0	0	–

Table 3-1.—Summary of southwestern willow flycatchers and willow flycatchers detected during the breeding seasons of 2013–17
(Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA.)

Study area[1]	Year	Adults									Juveniles			
		Total adults detected	New captured	Recaptured	Resighted				Percent of adults resident	Percent of adults banded	Nestlings banded (# of nests)	Fledglings captured (# of nests)	Unbanded fledglings (# of nests)	Percent of fledglings banded[2] (# of fledglings)
					Identity confirmed	Banded (identity unknown)	Unbanded	Band status unknown						
YUMA	2014	11	0	0	0	0	1	10	0	0	0	0	0	–
	2015	22	0	0	0	0	10	12	0	0	0	0	0	–
	2016	24	0	0	0	0	4	20	0	0	0	0	0	–
	2017	6	0	0	0	0	0	6	0	0	0	0	0	–
All study areas[3]	**2013**	**172**	**11**	**11**	**55**	**1**	**38**	**50**	**58**	**45**	**42 (17)**	**3 (3)**	**7 (5)**	**82 (38)**
	2014	**233**	**41**	**8**	**52**	**2**	**52**	**78**	**62**	**44**	**65 (30)**	**3 (3)**	**15 (9)**	**77 (63)**
	2015	**300**	**32**	**5**	**62**	**7**	**108**	**86**	**51**	**35**	**76 (35)**	**2 (2)**	**34 (20)**	**65 (96)**
	2016	**298**	**33**	**16**	**52**	**15**	**95**	**87**	**58**	**39**	**52 (24)**	**3 (1)**	**41 (19)**	**50 (82)**
	2017	**283**	**26**	**11**	**50**	**11**	**109**	**76**	**71**	**35**	**51 (20)**	**0**	**84 (39)**	**32 (120)**

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, TOGO = Topock Gorge, BIWI = Bill Williams, ALAM = Alamo Lake, PVER = Palo Verde Ecological Reserve, EHRE = Ehrenberg, CIBO = Cibola, IMPE = Imperial, MITT = Mittry Lake and YUMA = Yuma.
[2] Percentage calculated based on birds confirmed to have fledged; total number of fledglings in parentheses represents the total number of nestlings confirmed to have fledged.
[3] Annual totals do not always equal the sum of the study area totals because individuals that moved between study areas are tallied only once in the total.

Table 3-2.—Summary of resident adult southwestern willow flycatchers detected during the 2013–17 breeding seasons

Study area[1]	Year	Total resident adults detected	New captured	Recaptured	Resighted				Percent of resident adults banded
					Identity confirmed	Banded (identity unknown)	Unbanded	Band status unknown	
KEPI	2013	37	4	2	26	1	4	0	89
	2014	35	3	1	30	1	0	0	100
	2015	23	1	0	21	1	0	0	100
	2016	22	0	2	19	0	1	0	95
	2017	11	0	0	6	3	1	1	82
RIRA	2013	2	0	1	0	0	1	0	50
	2014	0	0	0	0	0	0	0	–
	2015	6	1	2	2	0	1	0	83
	2016	2	0	1	1	0	0	0	100
	2017	7	1	0	6	0	0	0	100
PAHR	2013	20	1	3	11	0	4	1	75
	2014	28	6	7	15	0	0	0	100
	2015	21	1	1	19	0	0	0	100
	2016	23	4	5	14	0	0	0	100
	2017	18	0	3	13	0	2	0	89
MVWA	2013	2	0	0	1	0	1	0	50
	2014	4	3	0	0	0	1	0	75
	2015	5	2	0	3	0	0	0	100
	2016	7	1	1	4	0	0	1	86
	2017	9	2	3	4	0	0	0	100
MESQ	2013	3	1	0	1	0	1	0	67
	2015	5	1	0	2	0	2	0	60
	2016	14	2	0	1	4	6	1	50
	2017	16	6	1	2	1	3	3	56

Table 3-2.—Summary of resident adult southwestern willow flycatchers detected during the 2013–17 breeding seasons

Study area[1]	Year	Total resident adults detected	New captured	Recaptured	Resighted				Percent of resident adults banded
					Identity confirmed	Banded (identity unknown)	Unbanded	Band status unknown	
MOME	2013	17	0	1	12	4	0	0	100
	2015	7	1	0	2	1	3	0	57
	2016	6	1	0	1	1	2	1	50
	2017	6	0	0	1	1	2	2	33
MUDD	2013	10	2	0	6	1	1	0	90
	2014	8	3	0	5	0	0	0	100
	2015	3	1	1	1	0	0	0	100
	2016	4	2	0	2	0	0	0	100
	2017	3	2	1	0	0	0	0	100
WMSP	2013	0	0	0	0	0	0	0	–
	2014	1	0	0	1	0	0	0	100
	2015	2	1	0	1	0	0	0	100
	2016	1	0	0	1	0	0	0	100
	2017	5	3	1	1	0	0	0	100
TOPO	2013	8	0	1	0	0	7	0	13
	2014	6	2	0	1	0	3	0	50
	2015	15	7	0	2	1	5	0	67
	2016	6	0	1	0	1	3	1	33
	2017	4	3	0	0	0	1	0	75
BIWI	2013	1	0	0	0	0	0	1	0
	2014	6	2	0	0	0	3	1	33
	2015	11	4	0	3	0	3	1	64
	2016	13	3	0	4	0	5	1	54
	2017	10	1	0	4	2	3	0	70

Table 3-2.—Summary of resident adult southwestern willow flycatchers detected during the 2013–17 breeding seasons

Study area[1]	Year	Total resident adults detected	New captured	Recaptured	Resighted				Percent of resident adults banded
					Identity confirmed	Banded (identity unknown)	Unbanded	Band status unknown	
ALAM	2014	56	21	0	0	0	18	17	38
	2015	56	7	1	6	3	32	7	30
	2016	75	11	1	10	5	39	9	36
	2017	112	5	0	13	2	75	17	18
PVER	2015	1	1	0	0	0	0	0	100
	2016	1	1	0	0	0	0	0	100
All study areas[2]	**2013**	**99**	**8**	**8**	**56**	**6**	**19**	**2**	**79**
	2014	**144**	**40**	**8**	**52**	**1**	**25**	**18**	**70**
	2015	**154**	**27**	**5**	**62**	**6**	**46**	**8**	**65**
	2016	**173**	**25**	**11**	**56**	**11**	**56**	**14**	**60**
	2017	**200**	**23**	**9**	**49**	**9**	**87**	**23**	**45**

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, ALAM = Alamo Lake, and PVER = Palo Verde Ecological Reserve.

[2] Annual totals do not always equal the sum of the study area totals because individuals that moved between study areas are tallied only once in the total.

Cooperation with Other Agencies

One adult was newly captured at LVWA, and 21 nestling flycatchers were newly captured and banded at STGE (table 3-3). Additional adults were resighted and identified at STGE in each year. Only banded flycatchers with confirmed identities are reported below. Banded individuals that could not be identified, unbanded individuals, and those with unknown band status are not included. Additional data on flycatchers at STGE are housed in the Washington County Field Office of the UDWR.

Table 3-3.—Summary of southwestern willow flycatchers of known identity captured or resighted in Las Vegas Wash and St. George, 2013–17

Study area[1]	Year	Adults			Juveniles banded (# of nests)
		New captured	Recaptured	Resighted	
STGE	2013	0	0	2	13 (4)
	2014	0	0	5	0
	2015	0	0	7	5 (3)
	2016	0	0	5	0
	2017	0	0	6	3 (2)
LVWA	2013	1	0	0	0

[1] STGE = St. George and LVWA = Las Vegas Wash.

Leg Injuries

From 2013 to 2017, 18 banded and 2 unbanded adults were observed to have leg injuries (table 3-4). One of the two unbanded adults with leg injuries was captured and banded on its uninjured leg. Leg injuries were observed on banded flycatchers only in years after the one in which they were initially banded; no injuries were observed in the season in which the bird was initially banded. Two of the banded individuals were known to have leg injuries prior to 2013. Of the 18 injured, banded adults, 9 (50%) had an injury on the leg with the Federal band, 8 (44%) had an injury on the leg with a metal color band, and 1 (5%) could not be resighted well enough to determine what type of band was on the injured leg. Sixteen of the injured, banded flycatchers were individually identified. For all birds individually identified in 2013–17, injuries on the leg with the Federal band occurred in 4.8% (8 of 166) of individuals that carried a Federal band for multiple years, and injuries on the leg with a metal band occurred in 3.6% (6 of 167) of individuals that carried a metal band for multiple years.

Table 3-4.—Leg injuries or deformities observed on southwestern willow flycatchers, 2013–17

Year(s) observed	Study area[1]	Original Federal band #	Original; color combination[2]	Gender[3]	Age[4]	Injury
Injuries on leg with Federal band						
2011–16	PAHR	2540-58201	TQ:BO(M)	M	SY	In 2011, foot swollen; bird could not grip branch. In 2012, leg appeared broken; portion of leg below break came off during recapture.
2012–13	MOME	2360-59788	BO(M):EE	F	8Y	In 2012, leg appeared twisted but fully functional, with no swelling. In 2013, the tarsometatarsus was swollen, toes would not open or close, and bird did not use leg when perched.
2013	KEPI	2430-61124	OY(M):XX	F	6Y	Foot and band missing.
2013–14	KEPI	2540-58175	TQ:WO(M)	F	A4Y	Foot and band missing.
2016	KEPI	2540-58245	TQ:KYK(M)	M	7Y	Bird did not use leg when perched. Resighted again 2 weeks later with no sign of injury.
2016	KEPI	2540-58320	KO(M):TQ	F	5Y	Leg swollen; bird did not use it when perched.
2016	KEPI	2590-53101	XX:DOD(M)	M	6Y	Bird holding leg to belly on August 13. Bird resighted 3 days earlier and appeared uninjured.
2017	MVWA	2660-23039	RB(M):VI	F	4Y	Small protrusion at base of tarsometatarsus; bird had difficulty closing the foot. Captured and rebanded BW(M):UB.
2017	PAHR	2660-23053	VI:RGR(M)	F	A5Y	Foot and band missing.
Injuries on leg with metal color band						
2013–14	PAHR	2540-58286	TQ:DYD (M)	F	3Y	Leg swollen, foot twisted, toes completely immobile; bird did not use leg when perching. Foot came off during 2013 season. Bird captured in 2014 and rebanded KY(M):UB.
2013	KEPI	2540-58304	VK(M):TQ	F	SY	Foot immobile. Foot came off during recapture. Rebanded UB:OKO(M).
2014	KEPI	2540-58305	VR(M):TQ	F	SY	Leg and foot swollen; bird did not use foot to perch.
2014	KEPI	2430-61088	XX:BKB(M)	M	A6Y	Toes extended and immobile when bird seen in late May; bird did not use foot to perch. Starting in mid-June, bird had no sign of an injury. Bird resighted in 2015–17 with no sign of injury.
2016	PAHR	2430-61298	KGK(M):XX	F	6Y	Foot gnarled and twisted. Captured and rebanded UB:WB(M).
2016	RIRA	2660-23045	DVD(M):VI	F	3Y	Foot and band missing. Captured and rebanded UB:VW(M).
2016	MESQ	Unknown	??(M):XX	F	AHY	Bird perched with leg tucked against body.
2017	PAHR	2660-23121	GWG(M):VI	M	SY	Leg appeared lacerated and swollen just above the foot; bird could not grip with its toes. Captured and rebanded UB:DR(M).

Table 3-4.—Leg injuries or deformities observed on southwestern willow flycatchers, 2013–17

Year(s) observed	Study area[1]	Original Federal band #	Original; color combination[2]	Gender[3]	Age[4]	Injury
Injuries on a banded leg						
2017	MUDD	Unknown	Banded	U	AHY	Bird perched with leg tucked against body. Band appeared to be very high on the leg.
Injuries unrelated to bands						
2014	KEPI	None	YG(M):UB	M	AHY	Bulge near top of tarsometatarsus, as if leg had been broken and then healed. Captured; no band applied to injured leg. Bird appeared to use leg normally. Bird seen with no sign of injury in 2015–16.
2014	ALAM	None	UB:UB	M	AHY	Bird did not use leg when perching.

[1] ALAM = Alamo Lake, KEPI = Key Pittman, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, MVWA = Meadow Valley Wash, PAHR = Pahranagat, and RIRA = River Ranch.

[2] **Color band codes**: B = light blue, banded = bird was banded but combination could not be determined, D = dark blue, EE = electric yellow Federal band, G = green, K = black, (M) = metal pinstriped band, O = orange, R = red, TQ = turquoise Federal band, UB = unbanded, V = violet, VI = violet Federal band, W = white, XX = standard silver Federal band, Y = yellow, and ? = color could not be determined. 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 right and left legs are separated with a colon.

[3] F = female, M = male, and U = unknown

[4] Age when injury was first seen. SY = second year, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = four years, etc.

Of the 18 banded adults with injuries, 12 (67%) were female, 5 (28%) were male, and 1 (5%) was of unknown gender. The injuries in six females and one male caused the individual to lose the foot on the injured leg. Two of the males appeared to have temporary injuries. One was seen holding a leg up when it perched, and another had extended and immobile toes on one foot. Both individuals were seen perching normally 2 weeks after the apparent injuries were observed. Of the 162 adults with known identity and known gender and that were detected in at least one year after the one in which they were initially banded, a higher proportion of females (11 of 75) than males (3 of 87) had apparently permanent leg injuries (Fisher's exact test $P = 0.022$; difference in proportions = 0.112, 95% lower bound = 0.019).

Of the two unbanded adults observed with leg injuries, one adult had a bulge at the top of the tarsometatarsus on one leg, and the other adult did not use one leg when it perched.

In 2013–17, the proportion of breeding, banded, leg-injured flycatchers that fledged at least one young in a given breeding season did not differ from that of breeding, banded, non-injured flycatchers for either females (Fisher's exact test, $P = 0.755$; difference in proportions = 0.062, 95% lower bound = -0.213) or males (Fisher's exact test, $P = 1.000$; difference in proportions = 0.082, 95% lower bound = -0.385). The proportion of banded flycatchers that were detected in a

given year from 2013 to 2016 and returned in a subsequent year also did not appear to be affected by injury status (Fisher's exact test *P* = 0.226; difference in proportions = 0.166, 95% lower bound = -0.066).

Leg injuries sometimes took several years to develop, with injuries first noted 1 to 6 years (median = 2.5 years) after the flycatcher was banded. Of the banded flycatchers that were detected for multiple seasons, individuals with leg injuries tended to be older than their uninjured counterparts (figure 3-1). The majority (15 of 18) of the banded, leg-injured flycatchers that were detected in 2013–17 were found in the higher-elevation, native-dominated study areas of the Pahranagat region. However, this region also had the majority (107 of 167) of banded flycatchers. The proportion of leg-injured flycatchers in the Pahranagat region did not differ from that in the Virgin region (Fisher's exact test P = 0.299; difference in proportions = 0.086, 95% lower bound = -0.047). The proportion of leg-injured flycatchers in the Pahranagat region did differ from that in the greater Havasu region (Fisher's exact test P = 0.039; difference in proportions = 0.121, 95% lower bound = 0.014), but the higher-elevation sites also had many more flycatchers that were detected for more than 2 years after they were initially banded (figure 3-2).

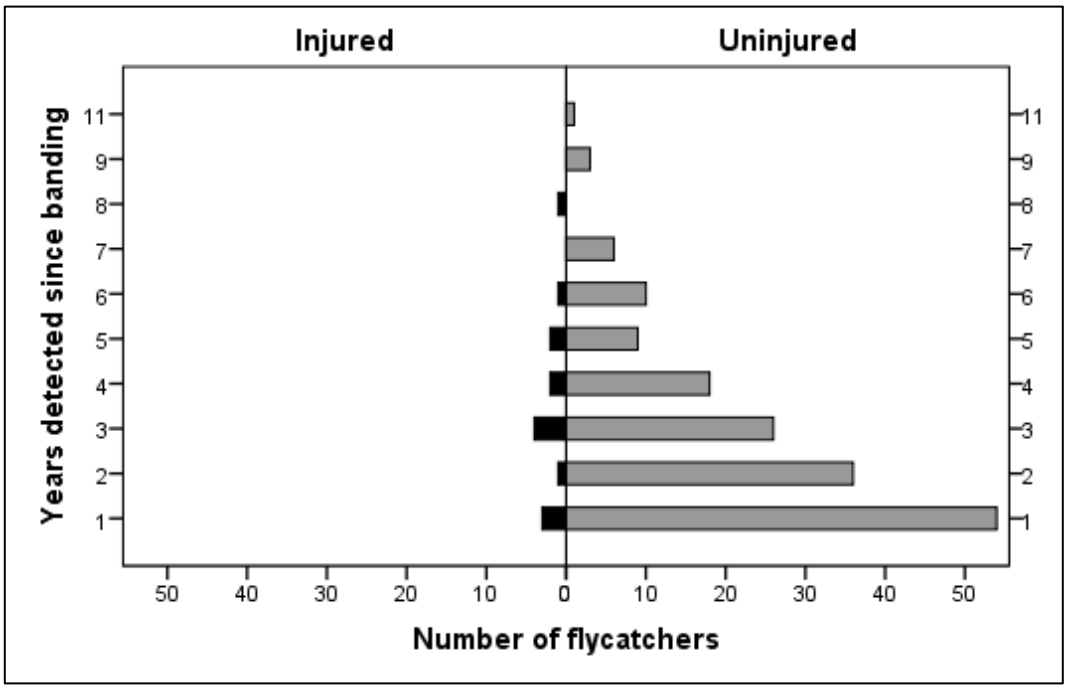

Figure 3-1.—The number of years each southwestern willow flycatcher was detected after it was initially banded, leg-injured versus uninjured individuals, 2013–17.
Only flycatchers that were detected in multiple years are included.

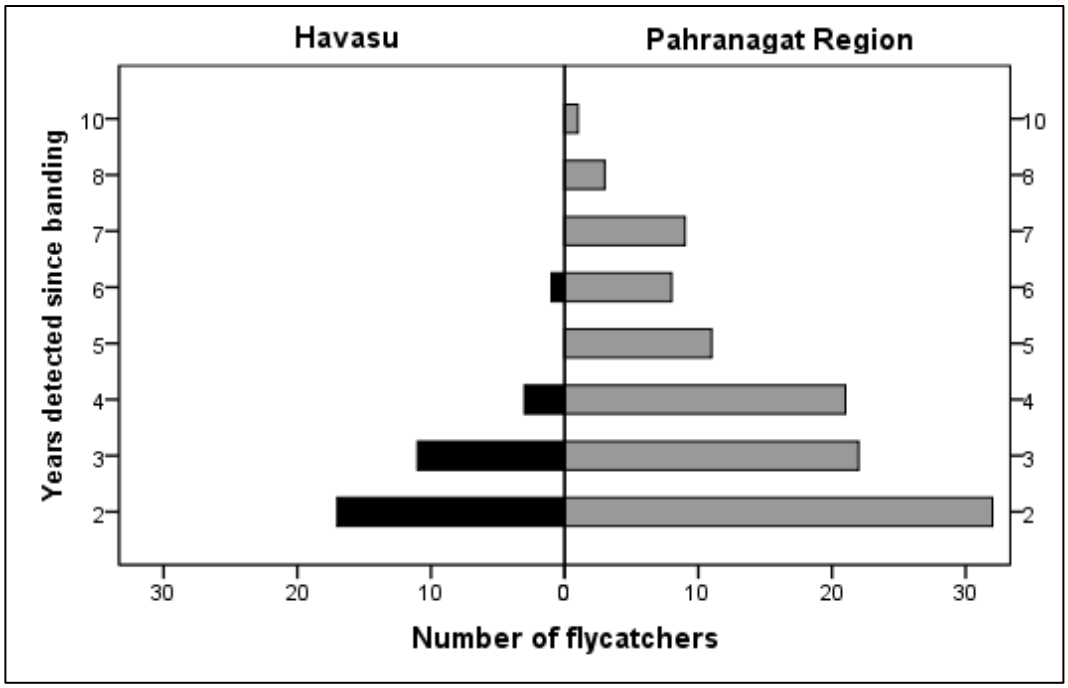

Figure 3-2.—The number of years each southwestern willow flycatcher was detected after it was initially banded in the greater Havasu region (Topock, Bill Williams, and Alamo Lake study areas) versus the higher-elevation study areas in the Pahranagat region (Key Pittman, River Ranch, Pahranagat, and Meadow Valley Wash), 2013–17.
Only flycatchers that were detected in multiple years are included.

Adult Between-Year Return and Dispersal

In 2013–17, 278 between-year returns were detected for adult flycatchers (table 3-5). The majority (90%) of these were of flycatchers returning to the same study area where they were last detected in a previous year. Of the 27 returns that resulted in movements between study areas, 25 were by flycatchers that had failed to produce young in the previous year. RIRA had the highest rate of flycatchers dispersing to other study areas, with seven of nine returns resulting in movements to another study area. The distance moved between years for all flycatchers ranged from 0.001 to 213.71 km (median = 0.04 km) (figure 3-3). The median distance of between-year movements did not differ between males and females (Kruskal-Wallis test, $P = 0.524$). The median distance of movements in the Pahranagat region (0.02 km) was smaller than that in the Virgin region (0.07 km) (Kruskal-Wallis test, $P = 0.001$) and the greater Havasu region (0.07 km) (Kruskal-Wallis test, $P = 0.028$), which did not differ from one another (Kruskal-Wallis test, $P = 0.118$).

Table 3-5.—Between-year movements of adult southwestern willow flycatchers, 2013–17

Study area subsequently detected[1]	Study area detected[1]												
	KEPI	**RIRA**	**PAHR**	**MVWA**	**STGE**	**MESQ**	**MOME**	**MUDD**	**WMSP**	**TOPO**	**BIWI**	**ALAM**	**Total**
KEPI	77	5	2										**84**
RIRA		2											**2**
PAHR	8	2	67				1	1					**79**
MVWA				12									**12**
STGE					17								**17**
MESQ						6	1						**7**
MOME							19	1					**20**
MUDD								12	1				**13**
WMSP								1	3	1			**5**
TOPO							1		1	3			**5**
BIWI										1	7		**8**
ALAM												26	**26**
Total	**85**	**9**	**69**	**12**	**17**	**6**	**22**	**15**	**5**	**5**	**7**	**26**	**278**

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, STGE = St. George, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.

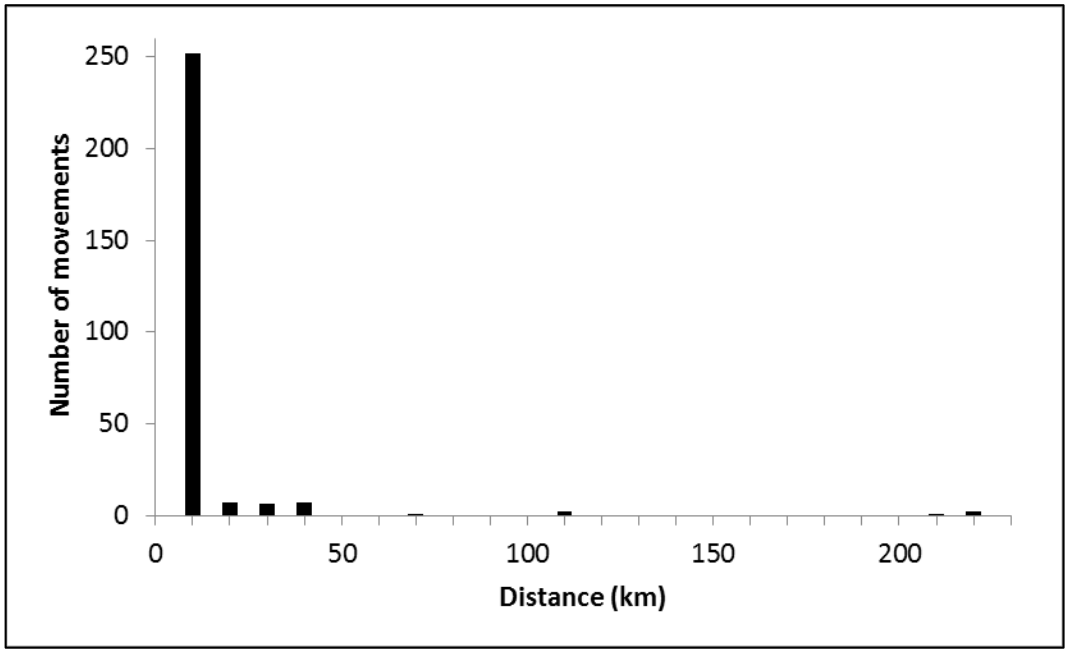

Figure 3-3.—Between-year movements detected in 2013–17 for adult southwestern willow flycatchers at all study areas.

Juvenile Between-Year Return and Dispersal

In 2013–17, 73 flycatchers were detected for the first time since they were banded as juveniles (table 3-6). Of these, 39 (53%) returned to their natal study area and 34 (47%) dispersed to a different study area. Except for one dispersal from ALAM to PAHR, all dispersal distances were < 60 km (figure 3-4). The median dispersal distance for all returning juvenile flycatchers was 3.8 km (minimum = 0.05 km, maximum = 364.6 km) and was greater than the median between-year movement distance for adult flycatchers (0.04 km; Kruskal-Wallis test, $P < 0.001$).

Table 3-6.—Between-year return and movements of juvenile southwestern willow flycatchers first detected as adults in 2013–17

Study area subsequently detected[1]	Natal study area[1]									
	KEPI	**RIRA**	**PAHR**	**MVWA**	**STGE**	**MOME**	**MUDD**	**BIWI**	**ALAM**	**Total**
KEPI	14		8	1						**23**
RIRA	2		11							**13**
PAHR	5	1	8						1	**15**
MVWA			1	3						**4**
STGE					8					**8**
MESQ							1			**1**
MUDD						2				**2**
BIWI								1	1	**2**
ALAM									5	**5**
Total	**21**	**1**	**28**	**4**	**8**	**2**	**1**	**1**	**7**	**73**

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, STGE = St. George, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, BIWI = Bill Williams, and ALAM = Alamo Lake.

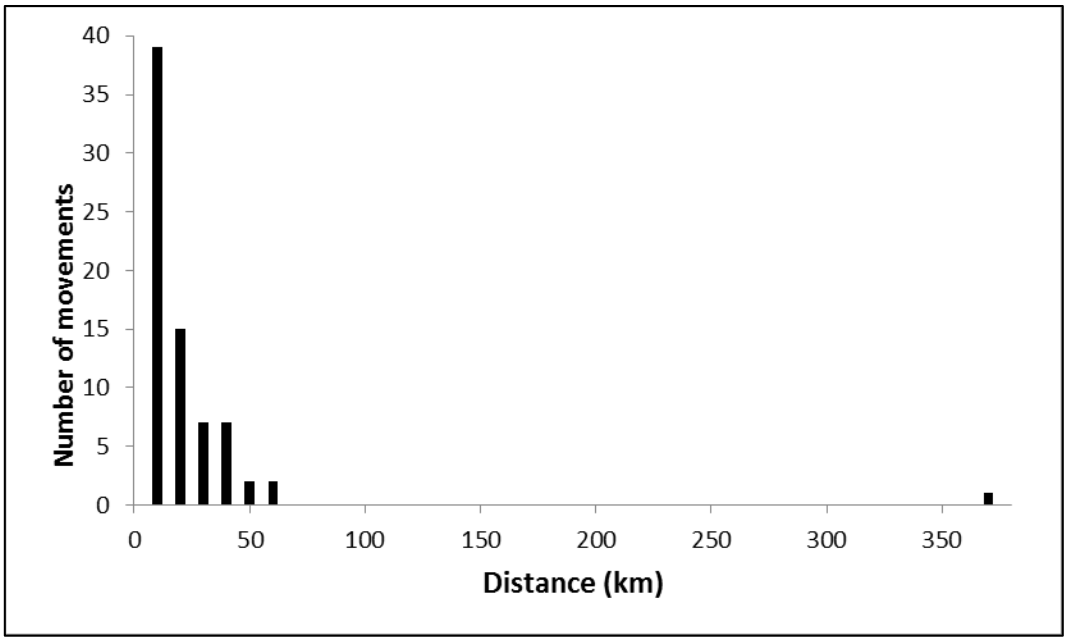

Figure 3-4.—Dispersal distances for juvenile southwestern willow flycatchers first detected as adults at all study areas in 2013–17.

Within-Year, Between-Study-Area Movements

Field personnel detected within-year, between-study-area movements from 13 adult flycatchers in 2013–17 (table 3-7). Eight of the movements were by flycatchers leaving either RIRA or KEPI and going to PAHR. Six of the 13 flycatchers were detected in a subsequent year, and all were detected at the study area (PAHR) where they had been last seen in the previous year. The median distance moved was 30.0 km (minimum = 12.0 km, maximum = 48.8 km) (figure 3-5). Of the 13 within-year movements, 12 were by flycatchers that either were not breeding or had failed in their breeding attempts. One within-year movement was by a male flycatcher that deserted its breeding territory after two failed nests but while its mate was still tending the third nesting attempt, which was ultimately successful.

Demographics

Survival and Detection: Effects of Age, Year, Marking Cohort, and Resight Period

A total of 1,755 individual encounter histories were used in modeling the effects of age, year, marking cohort, and resight period. GOF testing using both the bootstrap and median c-hat method revealed no evidence for overdispersion (bootstrap c-hat = 1.12, median c-hat = 1.05). Comparing the bootstrap

Table 3-7.—Adult flycatcher within-year movements for all individuals identified at two or more study areas in a given year, 2013–17

End study area[1]	Start study area[1]					
	KEPI	RIRA	PAHR	MESQ	ALAM	Total
KEPI		1	1			**2**
RIRA			1			**1**
PAHR	5	3[2]				**8**
MUDD				1		**1**
BIWI					1	**1**
Total	**5**	**4**	**2**	**1**	**1**	**13**

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MESQ = Mesquite, MUDD = Muddy River, BIWI = Bill Williams, and ALAM = Alamo Lake.
[2] One individual moved from RIRA to KEPI to RIRA to PAHR.

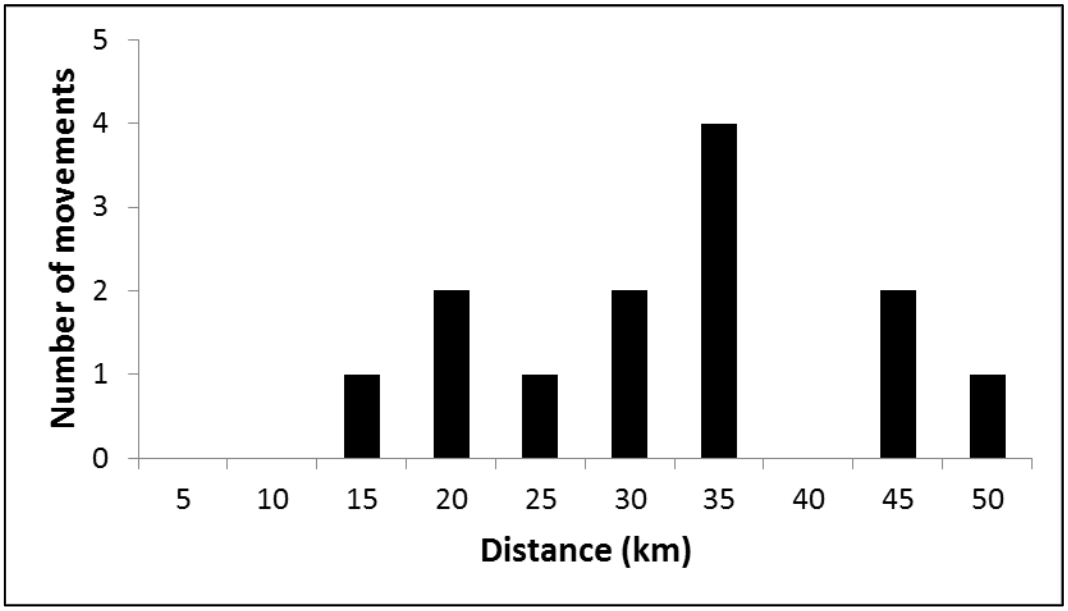

Figure 3-5.—Distances of within-year, between-study-area movements for adult southwestern willow flycatchers at all study areas, 2013–17.

expected deviances with the observed model deviance yielded p = 0.934 (meaning 93% of the simulations resulted in lower deviances than the observed value), indicating no issues with fit. C-hat was therefore not adjusted for the models and was left at 1.0.

Probability of survival and detection varied by age, as indicated by the top seven CJS live encounter models, which have 100% of the AICc weight, including age as a covariate in both survival and detection (table 3-8). Probability of detection

Table 3-8.—Model selection results for CJS live encounter models with probability of survival (φ) and probability of detection (p) for juvenile and adult southwestern willow flycatchers across all study areas from 1997 to 2017

The top five models are shown, and models with ΔAICc < 2.0 are considered equivalent. Models included main effects of age and year for survival probabilities and the main effects and interactions of age, marking cohort, and resight period for detection probabilities.

Model	AICc	ΔAICc	AICc weights	Model likelihood	# of parameters	Deviance
φ(age) p(age+cohort)	4462.56	0	0.51247	1	6	868.7801
φ(age) p(age+cohort+resight period)	4463.115	0.5541	0.38846	0.758	7	867.3239
φ(age) p(age*cohort*resight period)	4465.908	3.3472	0.09612	0.1876	12	860.0436
φ(age+year) p(age+cohort)	4474.56	11.9995	0.00127	0.0025	25	842.3315
φ(age+year) p(age+cohort+resight period)	4474.848	12.2874	0.0011	0.0021	26	840.5809

also varied by resight period and marking cohort. The top two models were separated by only 0.51 ΔAICc, so model averaging was used to estimate survival and detection probabilities.

The top three models, which hold 99.7% of the weight, include only age for the survival probability (see table 3-8). Likewise, model averaging results show no variation in survival through time (range in juvenile survival probability is 30.30 – 30.35% and adult survival probability is 59.49 – 59.55%), and survival estimates obtained from model averaging were averaged across years to obtain a single estimate. The 95% confidence intervals (CIs) were obtained by averaging the variances on the logit scale and back transforming the resulting CIs to the real probability scale. The results are almost identical to those obtained using a variance components approach with the highest ranked time dependent model. Annual adult survival probability (59.5%; 95% CI 57.0–62.0) was significantly higher than that of juveniles (30.3%; 95% CI 26.9–34.0). The mean life expectancy (MLE) for flycatchers, calculated from survival probabilities, was 1.17 years.

The top two models (only the second model had ΔAICc < 2.0) allowed the probability of detection to vary additively by age, marking cohort, and resight period. The detection probability for adults was significantly higher than that for juveniles in all cohort-by-year periods (non-overlapping 95% CI) (table 3-9). The detection probability of both age classes increased in the most recent cohort (corresponding to contract period 2008–17) compared with the first two cohorts. Estimates of adult detection jumped from 67 to 69% in the first two cohorts to 86–88% in the most recent, and juvenile detection increased from 39% to 64–68%.

Table 3-9.—Probability of detection estimates (p) from model averaging results for juvenile and adult southwestern willow flycatchers for each marking cohort and resight period across all study areas from 1997 to 2017

Resight period	Marking cohort[1]	Age	Estimate	Lower 95% CI	Upper 95% CI
1997–2013	1997–2002	Adult	67.2	59.9	73.8
		Juvenile	38.6	29.4	48.7
	2003–07	Adult	68.9	60.0	76.5
		Juvenile	39.5	30.4	49.4
	2003–17	Adult	85.8	82.0	89.0
	2008–17	Juvenile	63.8	54.5	72.2
2014–17[2]	1997–2002	Adult	—[3]	—[3]	—[3]
	2003–07	Adult	—[3]	—[3]	—[3]
	2003–17	Adult	87.5	81.8	91.5
	2008–17	Juvenile	67.7	56.3	77.3

[1] All individuals banded as adults in 2003–17 were banded with the same methodology and were analyzed as a single marking cohort. Juveniles were banded differently in all three cohorts. All adults in cohort two are individuals originally banded as juveniles in cohort two that were later encountered and captured again.

[2] No juveniles were banded as part of the first two cohorts in resight period two, so there is no detection probability for their age class.

[3] Not estimable from the data due to lack of individuals from the first two cohorts surviving into resight period two.

Geographic Regions

A total of 299 individual encounter histories were used in the analysis for the Pahranagat Valley, 477 for PAHR, and 347 for Havasu. The c-hat for all three regional model sets was close to 1.0, and no adjustments were made. The top survival models (ΔAICc < 2.0) for the Pahranagat Valley included age and year (table 3-10), while the top models for PAHR and Havasu held survival constant across time (tables 3-11 and 3-12). Age and marking cohort were both factors for the detection probabilities in the top models for PAHR and Havasu, as was the case with the global model results. Pahranagat Valley models did not consider cohort, as this did not vary in 2011–16.

Of the three regional model sets, the Pahranagat Valley had the highest survival probabilities, with annual juvenile survival of 30–42% (95% CI 18–44% and 29–55%, respectively) and annual adult survival of 60–71% (95% CI 47–71% and 57–82%, respectively). PAHR had 20% juvenile survival (95% CI 15–26%) and 59% adult survival (95% CI 54–64%), while Havasu had juvenile survival of 23% (95% CI 14–35%) and adult survival of 48% (95% CI 41–55%). Estimates for PAHR and Havasu were obtained from averaging model-averaged estimates of survival and variance across time, as the range of these estimates was less than 0.001.

Table 3-10.—Model selection results for CJS live encounter models with probability of survival (φ) and probability of detection (p) for southwestern willow flycatchers in the Pahranagat Valley, 2011–16

The top five models are shown, and models with ΔAICc < 2.0 are considered equivalent.

Model	AICc	ΔAICc	AICc weights	Model likelihood	# of parameters	Deviance
φ(age+time) p(age)	658.8057	0	0.53401	1	8	59.1722
φ(age) p(age)	660.2491	1.4434	0.25949	0.4859	4	68.8511
φ(age*time) p(age)	662.6506	3.8449	0.0781	0.1463	12	54.6314
φ(age+time) p(.)	662.7465	3.9408	0.07444	0.1394	7	65.1857
φ(age) p(.)	664.0567	5.251	0.03866	0.0724	3	74.6947

Table 3-11.—Model selection results for CJS live encounter models with probability of survival (φ) and probability of detection (p) for southwestern willow flycatchers at the Pahranagat study area, 1997–2017

The top five models are shown, and models with ΔAICc < 2.0 are considered equivalent.

Model	AICc	ΔAICc	AICc weights	Model likelihood	# of parameters	Deviance
φ(age) p(age+cohort)	953.5397	0	0.76188	1	6	318.3156
φ(age) p(age*cohort)	955.9433	2.4036	0.22906	0.3007	8	316.6317
φ(age) p(cohort)	962.4115	8.8718	0.00902	0.0118	5	329.2224
φ(age+year) p(age+cohort)	974.2591	20.7194	0.00002	0	25	299.2194
φ(age+year) p(age*cohort)	976.7598	23.2201	0.00001	0	27	297.3973

Table 3-12.—Model selection results for CJS live encounter models with probability of survival (φ) and probability of detection (p) for southwestern willow flycatchers at Havasu, 1997–2017
The top five models are shown, and models with ΔAICc < 2.0 are considered equivalent.

Model	AICc	ΔAICc	AICc weights	Model likelihood	# of parameters	Deviance
φ(age) p(age*cohort)	619.1835	0	0.48059	1	8	218.9244
φ(age) p(age)	620.1832	0.9997	0.29153	0.6066	4	228.1597
φ(age) p(age+cohort)	621.2647	2.0812	0.16976	0.3532	6	225.1419
φ(age) p(cohort)	623.4138	4.2303	0.05797	0.1206	5	229.3452
φ(age+year) p(age)	637.4194	18.2359	0.00005	0.0001	23	204.9059

Adult Survival: Effect of Gender

Known-gender models revealed little support for differences between male and female survival (table 3-13). A total of 806 individual encounter histories were included in this analysis. Testing for GOF revealed a good fit to the data, and c-hat was not altered. Models with and without gender had equal support, and model-averaged results give male survival as 60% (95% CI 57–63%) and female survival as 58% (95% CI 54–62%).

Table 3-13.—Model selection results for known-gender CJS live encounter models with probability of survival (φ) and probability of detection (p) for adult southwestern willow flycatchers across all study areas from 1997 to 2017
Survival probabilities were either held constant (.) or allowed to differ by gender. Detection probabilities were either constant or included the main effects and interactions of marking cohort and resight period.

Model	AICc	ΔAICc	AICc weights	Model likelihood	# of parameters	Deviance
φ(.) p(cohort*resight period)	2735.397	0	0.39297	1	5	613.8914
φ(gender) p(cohort*resight period)	2735.463	0.0657	0.38027	0.9677	6	611.9419
φ(.) p(.)	2737.792	2.3954	0.11863	0.3019	2	622.3172
φ(gender) p(.)	2737.978	2.5808	0.10813	0.2752	3	620.495

Juvenile Survival: Effects of Fledge Date, Nestling Stage Length, and Drainage

A total of 944 individual encounter histories were included in this analysis, with 411 from the Pahranagat region, 320 from the Virgin region, and 213 from the greater Havasu region. Goodness-of-fit testing using both the bootstrap and median c-hat method revealed no evidence for overdispersion (bootstrap c-hat = 1.10, median c-hat = 1.07), and c-hat was not adjusted.

There was strong support for the top four models, all of which had ΔAICc < 2.0 (table 3-14). Survival probability in each of the top four models varied by fledge date, whereas there was inconsistent support for effects of drainage and nestling stage length. Across the entire model set, models containing fledge date accounted for > 99.9% of the weight, whereas models containing drainage and nestling stage length accounted for less weight (50.0% and 67.4%, respectively). Survival estimates were obtained for each value of fledge date by model averaging and generating an individual covariate plot in Program MARK (figure 3-6). Survival probability decreased with increasing fledge date, corresponding to a 21% reduction in survival probability between June 30 and August 1. The mean fledge date across all years was July 17, which corresponds to a survival probability of 30%.

Table 3-14—Model selection results for CJS live encounter models with probability of survival (φ) and probability of detection (p) for juvenile southwestern willow flycatchers across all study areas from 1997 to 2017

The top five models are shown, and models with ΔAICc < 2.0 are considered equivalent. Models included main effects of age and drainage for survival probabilities with fledge date (FD) and nestling stage length (SL) as covariates and the main effects of age, drainage, marking cohort, and resight period (RP) for detection probabilities.

Model	AICc	ΔAICc	AICc weights	Model likelihood	# of parameters	Deviance
φ(age+FD+SL) p(age+drainage+cohort+RP)	2097.400	0	0.34764	1	11	2075.2035
φ(age+draiange+FD+SL) p(age+drainage+cohort+RP)	2097.570	0.1698	0.31935	0.9186	13	2071.2984
φ(age+drainage+FD) p(age+drainage+cohort+RP)	2098.827	1.4270	0.17032	0.4899	12	2074.5946
φ(age+FD) p(age+drainage+cohort+RP)	2099.065	1.6650	0.15121	0.4350	10	2078.9015
φ(age+drainage+FD+SL) p(age+cohort+RP)	2105.433	8.0324	0.00626	0.0180	11	2083.2359

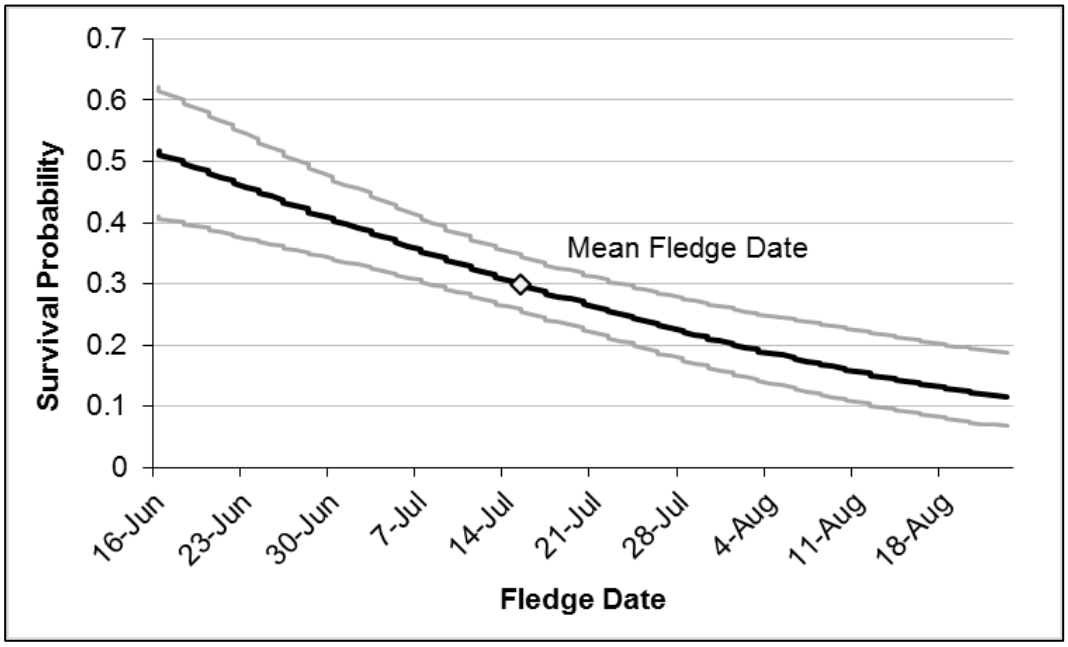

Figure 3-6.—Estimates of survival probability for juvenile southwestern willow flycatchers by fledge date across all study areas, 1997–2017.
Upper and lower 95% CIs shown in gray.

Annual Per Capita Rate of Population Change

Lambda and Pradel Models

The top Pradel model in each geographic region indicated that recruitment (f) was constant across time (tables 3-15, 3-16, and 3-17). There was some model uncertainty (ΔAICc = 1.1424) in the Pahranagat Valley in whether recruitment varied with time (see table 3-8), although the top model held recruitment constant and carried 59% of the AICc weights.

Table 3-15.—AICc model selection results for Pradel models with survival probability (φ), detection probability (p), and recruitment (f) for southwestern willow flycatchers in the Pahranagat Valley, 2011–16*

Models either varied with time (t) or were constant across time (.).

Model	AICc	ΔAICc	AICc weights	# of parameters	Deviance
φ(.) p(.) f(.)	910.1984	0.0000	0.5879	3	35.0754
φ(.) p(.) f(t)	911.3408	1.1424	0.3321	7	27.9445
φ(.) p(t) f(.)	915.7791	5.5807	0.0361	8	30.2822
φ(t) p(.) f(.)	916.8218	6.6234	0.0214	7	33.4254
φ(t) p(.) f(t)	918.0903	7.8919	0.0114	11	26.2131
φ(t) p(t) f(t)	925.9407	15.7423	0.0002	16	23.1586

* The top five models are shown, as well as the general, fully time-dependent model.

Table 3-16.—AICc model selection results for Pradel models with survival probability (φ), detection probability (p), and recruitment (f) for southwestern willow flycatchers at the Pahranagat study area, 1998–2017*

Models either varied with time (t) or were constant across time (.).

Model	AICc	ΔAICc	AICc Weights	# of parameters	Deviance
φ(.) p(t) f(.)	1753.3334	0.0000	0.8236	22	215.4662
φ(t) p(.) f(.)	1756.5538	3.2204	0.1646	21	220.9202
φ(t) p(t) f(.)	1762.2526	8.9192	0.0095	39	184.5680
φ(t) p(.) f(t)	1766.4888	13.1554	0.0012	39	188.8042
φ(.) p(.) f(t)	1767.5110	14.1776	0.0007	21	231.8774
φ(t) p(t) f(t)	1786.6736	33.3402	0.0000	57	162.6373

* The top five models are shown, as well as the general, fully time-dependent model.

Table 3-17.—AICc model selection results for Pradel models with survival probability (φ), detection probability (p), and recruitment (f) for southwestern willow flycatchers at Havasu, 1997–2017*

Models either varied with time (t) or were constant across time (.).

Model	AICc	ΔAICc	AICc Weights	# of parameters	Deviance
φ(t) p(.) f(.)	1392.1970	0.0000	0.6290	22	139.1563
φ(.) p(t) f(.)	1393.3068	1.1098	0.3611	23	137.8472
φ(.) p(.) f(t)	1401.7826	9.5856	0.0052	22	148.7420
φ(t) p(t) f(.)	1402.3134	10.1164	0.0040	41	99.4084
φ(.) p(.) f(.)	1406.3399	14.1429	0.0005	3	195.5842
φ(t) p(t) f(t)	1443.1550	50.9580	0.0000	60	80.5680

* The top five models are shown, as well as the general, fully time-dependent model.

The top Pradel model for each geographic region was used to obtain an estimate of overall recruitment in that region. Recruitment in the Pahranagat Valley from 2011 to 2016 was 0.37, at PAHR between 1998 and 2017 was 0.39, and in the Havasu region between 1997 and 2017 was 0.54.

Lambda was calculated from the recruitment estimates obtained from the Pradel models, the survival estimates obtained from the CJS live encounter models, and fecundity estimates obtained from nest monitoring. The Pahranagat Valley showed a slightly increasing population trend with overall λ of 1.031 (table 3-18). PAHR showed a slight population decline (λ = 0.982), and Havasu showed a slightly increasing population trend (λ = 1.018) (table 3-19). Immigration into Havasu was 2.4–3.7 times higher than in the other regions and accounted for 42% of the annual rate of population change. Immigration in the other two regions accounted for 11–18 % of the annual rate of population change.

Table 3-18.—Estimates of survival, recruitment, immigration, and lambda for southwestern willow flycatchers in the Pahranagat Valley, 2011–16

Year	Adult survival	Recruitment	Juvenile survival	Seasonal fecundity/2	Local recruitment	Immigration	Lambda
2011–12	0.709	0.373	0.419	0.940	0.394	-0.021	1.082
2012–13	0.597	0.373	0.296	0.776	0.230	0.143	0.970
2013–14	0.711	0.373	0.395	0.688	0.271	0.102	1.084
2014–15	0.600	0.373	0.296	0.655	0.194	0.179	0.973
2015–16	0.673	0.373	0.348	0.609	0.212	0.161	1.045
Average	**0.658**	**0.373**	**0.350**	**0.735**	**0.257**	**0.115**	**1.031**

Table 3-19.—Estimates of survival, recruitment, immigration, and lambda for southwestern willow flycatchers at the Pahranagat study area and at Havasu, 1997–2017

Region	Adult survival	Recruitment	Juvenile survival	Seasonal fecundity/2	Local recruitment	Immigration	Lambda
PAHR[1]	0.588	0.394	0.200	1.08	0.216	0.179	0.982
Havasu[2]	0.481	0.537	0.225	0.48	0.108	0.429	1.018

[1] Pahranagat study area.
[2] Topock Marsh and Bill Williams study areas.

Population Trends

The results of linear regressions indicated a small annual rate of change (-1.007%) (table 3-20, figure 3-7) and a weak, non-significant declining trend ($r^2 = 0.080$, $P = 0.228$) at PAHR from 1998 to 2017. Results from the Pahranagat Valley in 2011–16 indicated a declining population, with an annual rate of change of -3.440% and a moderate, non-significant trend ($r^2 = 0.315$, $P = 0.246$). Results from Havasu in 1998–2017 also indicated a declining population, with an annual rate of change of -5.588% and a significant moderate trend ($r^2 = 0.381$, $P = 0.004$).

Table 3-20.—Annual rate of change in adult southwestern willow flycatcher populations, 1998–2017

Region	Annual percent change	Coefficient of determination (r^2)	Degrees of freedom
Pahranagat Valley[1]	-3.440	0.315	1
PAHR[2]	-1.007	0.080	1
Havasu[3]	-5.588	0.381	1

[1] Key Pittman, River Ranch, and Pahranagat study areas in 2011–16.
[2] Pahranagat study area, 1998–2017.
[3] Topock Marsh and Bill Williams study areas, 1998–2017.

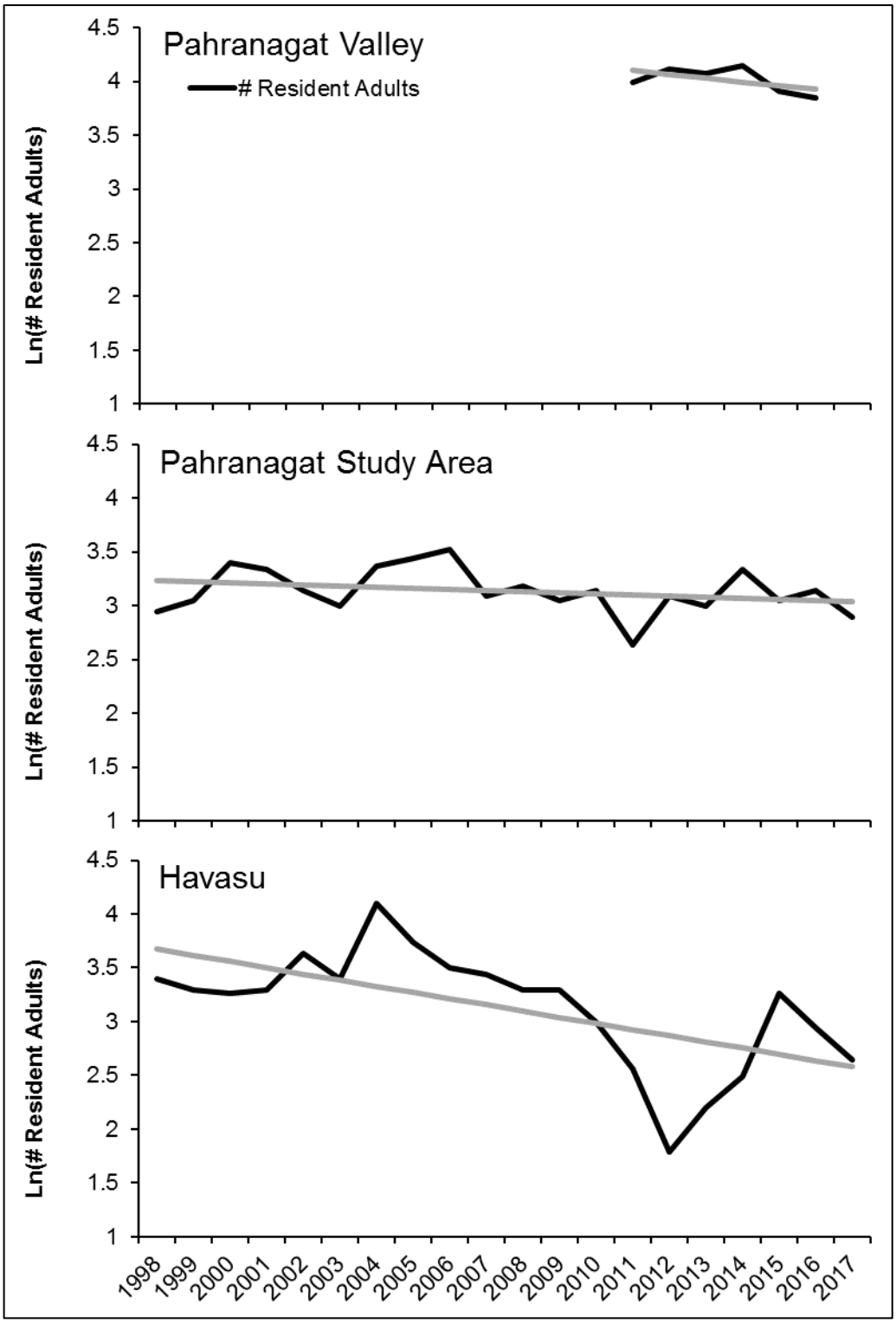

Figure 3-7.—Number of resident adult southwestern willow flycatchers (natural log scale) with linear regression line by geographic region, 1998–2017.
Linear regression (trend) line shown in gray.

DISCUSSION

Numbers of Flycatchers Detected

The total number of flycatchers and willow flycatchers detected in each year was influenced by fluctuations in the numbers of both resident and non-resident adults. The highest number of non-resident adults was detected in 2015, when triennial surveys were completed at many sites south of Parker Dam where no resident flycatchers have been detected in any year since SWCA began surveys in 2003. At sites south of Parker Dam that were surveyed annually, the number of willow flycatchers detected sometimes varied strongly between years, depending on whether a survey happened to coincide with a large migratory fallout.

The primary influence on trends in the numbers of resident flycatchers detected annually within each study area in 2013–17 appeared to be habitat quantity and quality (see chapter 2 for detailed descriptions of habitat changes within each site). The number of resident flycatchers increased steadily at MESQ, and this was concurrent with an increase in the extent of coyote willows in the eastern portion of the Mesquite West 01 site and an increase in the extent and size of coyote willows at the Electric Avenue Pond site (M.A. McLeod, personal observation). The number of resident flycatchers also increased steadily at MVWA, concurrent with an increase in the extent of surface water within the site (see chapter 2). The number of resident flycatchers detected at ALAM in 2017, when most of the study area was flooded, was 50–100% greater than the numbers detected in each of the three previous seasons when all sites had dry soils. The amount of field effort devoted to ALAM in 2017 was not greater than that in 2016, and the increase in the number of flycatchers detected is thus not the result of increased effort.

The numbers of resident flycatchers at both MOME and MUDD were lower in 2013 than in 2012 (see McLeod and Pellegrini 2013) and continued to decline over the 2013–17 period. Habitat quality at MOME declined dramatically between 2011 and 2013 as the result of defoliation by tamarisk beetles and dieback and mortality of the tamarisk (McLeod and Pellegrini 2014). Habitat quality has not improved in subsequent years (M.A. McLeod, personal observation), and the number of resident flycatchers at MOME was consistently low (6–7 individuals) in 2015–17, with territories centered in the few remaining patches of willows (NDOW, unpublished data). Habitat quality at MUDD declined in 2013–17 as the result of tamarisk defoliation and mortality as well as a reduction in the amount of surface water (see chapter 2).

KEPI was the only study area where a marked change in the number of resident flycatchers did not appear to be related to vegetation structure or the presence of surface water. The number of resident flycatchers detected declined sharply in 2015 and again in 2017. Fecundity at KEPI was lower in 2014 than in any of the

previous 4 years and continued to decline in 2015 and 2016 (see chapter 4). The number of resident adults at KEPI may have been affected by nest failure, which often results in flycatchers moving to a different area in subsequent years (McLeod and Pellegrini 2013; Paxton et al. 2007) and likely resulted in fewer juvenile flycatchers available to settle at KEPI. In addition, fewer personnel-hours were expended on monitoring at KEPI in 2017 than in previous years, and some flycatchers may have been overlooked.

Color-Banding Effort

The proportion of all detected adults that were known to be banded varied widely among study areas, ranging from 0% or nearly so at all study areas south of Parker Dam in each year in 2013–17 to > 80% in most years at KEPI, PAHR, and WMSP. These percentages include non-resident willow flycatchers, which are typically detected only once and do not exhibit territorial behaviors, making them difficult to capture. Consequently, almost all non-resident individuals are unbanded or have an undetermined band status, and study areas that had a low proportion of resident adults also had low proportions of banded adults. Among the study areas that consistently had breeding flycatchers, higher numbers of non-resident individuals have been typically detected in study areas along the main stem of the LCR, such as TOPO and BIWI, than at the other study areas. Most of these detections occur prior to the middle of June, suggesting that these individuals are migrants. Lowland riparian areas throughout the desert Southwest are heavily used by many migrant birds (Skagen et al. 2005), and the LCR likely provides a major migratory pathway. It is therefore not surprising that a higher number of migrant willow flycatchers would be detected at study areas on or near the main stem of the river.

The proportion of resident adult flycatchers that were known to be banded also varied among study areas. More than 80% of resident adults at KEPI, RIRA, PAHR, MVWA, MUDD, WMSP, and PVER had bands in most years, while a much smaller proportion of the resident, adult population was banded at MESQ, MOME, TOPO, BIWI, and ALAM. Differences among study areas in the percentage of resident flycatchers that were banded were typically related to vegetation density and structure, which affect the ability of field personnel to capture flycatchers. TOPO and BIWI had relatively low proportions of resident adults that were banded, and dense, tangled vegetation at these study areas limits captures of unbanded adults. At ALAM, vegetation structure is generally more conducive to capture than at TOPO and BIWI, but the amount of field effort available to band adult flycatchers was insufficient to band a majority of the population in any year. In 2017, deep water at most sites at ALAM precluded any banding efforts, and only 18% of the resident flycatchers were known to be

banded by the end of the season. MESQ and MOME were monitored by the NDOW in 2015–17, and banding opportunities were limited to occasions when SWCA personnel were available to assist.

The proportion of juveniles that were banded at most study areas was dictated largely by the accessibility of nests. Nests that were too high to be reached occurred more frequently at study areas with tall vegetation (e.g., PAHR, BIWI, and ALAM). Deep water at ALAM in 2017 precluded banding nestlings at most sites, and available field effort in earlier years at ALAM was insufficient to band a majority of the juvenile flycatchers.

Individual marking of a majority of the local adult flycatcher population allows for a more accurate assessment of population size than can be obtained with an unmarked population. Within-year movements cannot be tracked with an unmarked population; all flycatchers that appear mid-season would be assumed to be new individuals when they could be individuals that had already been detected elsewhere. Conversely, territory holders can change during the season, and these changes would be undetected if the individuals were unbanded. Some instances of polygyny would also go undetected if flycatchers were not individually marked. Color banding nestlings allows a more accurate estimate of productivity than can be obtained with an unbanded population. Fledglings can be highly mobile and difficult to track in dense vegetation. Resighting the individual color combinations of the fledglings is sometimes the only way to confirm how many nestlings fledged. Demographic analyses, including assessments of age structure, survival, immigration, population connectivity, and population growth, are possible only with a marked population.

A successful target-netting attempt requires approximately an hour of field time for equipment setup and take down, and processing the captured bird. Subsequent resighting can require considerably more time. Multiple visits to a territory are often needed before a complete resight can be obtained. Field personnel vary in their ability to accurately identify color combinations, and resights by multiple observers are helpful in confirming the identity of each flycatcher. Resights are often obtained during other monitoring activities such as nest searching, but resighting can be time consuming. SWCA began using cameras to obtain photographs of leg bands in 2015 and expanded their use in 2016 and 2017. A single, clear photograph provides unequivocal identification and obviates the need for multiple binocular resights to confer confidence on the accuracy of the resights. A photograph of the band combination could also be obtained in many situations where a binocular resight was not possible, such as when a bird was high in the canopy or when it was making very brief trips to feed nestlings or fledglings. Overall, resight photographs allowed for more accurate resights with less effort in comparison to resighting with binoculars alone.

Leg Injuries

Leg injury rates observed in 2013–17 for Federal bands (4.8%) did not differ significantly from those observed in 2003–12 (2.9%) (difference in proportions = 0.019, 95% lower bound = -0.018). Leg injury rates for metal bands likewise did not differ significantly between 2013–17 (3.6%) and 2003–12 (4.6%) (difference in proportions = 0.010, 95% lower bound = -0.032). Leg injuries in 2013–17 did not appear to affect either reproductive output or the likelihood that an individual would return in a subsequent year, and these results are consistent with those observed in 2003–12 (McLeod and Pellegrini 2013).

Adult and Juvenile Between-Year Dispersal

Adult flycatchers exhibited strong between-year site fidelity, with 90% of returns being to the same study area and half of all between-year returns resulting in movements of 40 m or less. Other studies have also shown that adult flycatchers are likely to exhibit high site fidelity to breeding areas (Kenwood and Paxton 2001; Koronkiewicz et al. 2002; Newell et al. 2005). Although the median distance moved between years was statistically greater in the Pahranagat region (0.02 km) than in the Virgin or greater Havasu regions (0.07 km), this difference is not likely to be biologically meaningful. From 2013 to 2017, 5 of 278 (1.8%) adult between-year returns resulted in movement between geographic regions. This is the same as the rate of movement between these geographic regions that was documented in the previous 15 years (1.9%) (McLeod and Pellegrini 2013). Site fidelity was strongly linked to successful reproduction in the LCR study in 1997–2012 (McLeod and Pellegrini 2013), and this was again the case in 2013–17, with 93% of between-study-area movements following a year in which the individual failed to produce young.

The median dispersal distance for juvenile flycatchers in 2013–17 (3.8 km) was higher than that for adults, and only 53% of returns were to the natal study area. Paxton et al. (2007) also found that natal dispersal distances were greater than the between-year movements exhibited by adults. The percentage of juvenile returns that resulted in movement to a different study area (47%) is comparable to that (50%) recorded in the LCR study in 1998–2012 (McLeod and Pellegrini 2013) (difference in proportions = 0.034, 95% lower bound = -0.100). Only 1 of 73 juvenile dispersal events (1.4%) resulted in dispersal outside the natal geographic region, which is lower than the rate (10.0%) recorded in 1998–2012 (difference in proportions = 0.086, 95% lower bound = 0.021). In 1998–2012, however, all the juvenile movements between geographic regions were between the Virgin region and one of the other two regions. Very few juveniles were banded in the Virgin region in recent years, and fewer adults have been identified, both because of habitat changes that resulted in fewer flycatchers at some sites and because of less intense monitoring at MESQ and MOME after 2013.

Therefore, it is not surprising that the rate of juvenile movements detected between geographic regions was lower in 2013–17 than in prior years. Occasional juvenile dispersal between subpopulations is likely an important population variable in terms of gene flow, with movements contributing to an understanding of the observed patterns of high genetic diversity within, and low genetic isolation among, flycatcher populations (Busch et al. 2000).

Dispersal by juveniles or adults is required for the colonization of new breeding sites, and long-distance movements are required for colonization of sites in Reclamation's conservation areas south of Parker Dam. Since surveys began in 2008, two resident, territorial male flycatchers have been detected at the conservation areas: one in 2015 and one in 2016. Both individuals were unbanded upon arrival and were captured and banded. Both remained on territory for 15 days or less and were not detected at any study area later in the same breeding season or in subsequent years. Site fidelity is strongly linked to successful reproduction (McLeod and Pellegrini 2013; Paxton et al. 2007), and because these individuals were not paired, they were not expected to return to the same location.

The known breeding sites that are closest to the conservation areas south of Parker Dam, and thus the most likely to be sources for flycatchers that colonize these areas, are at BIWI, TOPO, and ALAM; each is approximately 75–230 km from the conservation areas and within the range of dispersal distances (0.02–364.6 km for juveniles, 0.001–258.6 km for adults) recorded within the southern Nevada/LCR population (McLeod and Pellegrini 2013; this report). Given the observed patterns of adult and juvenile dispersal, returning juveniles from these breeding sites are more likely than returning adults to colonize new areas, and the likelihood of future colonization of the conservation areas is thus linked to flycatcher productivity at established breeding sites. It is also possible, though less likely, that the conservation areas could be colonized by individuals from more distant breeding areas, such as those along the Muddy and Virgin Rivers (300–350 km from the PVER) or at Roosevelt Lake (300–330 km from the PVER).

Within-Year, Between-Study-Area Movement

As with between-year movements, within-year movements between study areas in 2013–17 appeared to be influenced by breeding success, with all 13 within-year being made by flycatchers that had not yet successfully produced young that season. These individuals were likely prospecting for potential breeding sites, and indeed all the flycatchers that were detected in a subsequent year were at the study area where they had been last detected in the previous year. This life

history trait may benefit the flycatcher given the ephemeral, dynamic nature of riparian habitats (i.e., riparian vegetation and hydrology changing from one year to the next).

Demographics

Survival and Detection

Survivorship differed between age classes, but estimates of survival for juveniles (30.3%) and adults (59.5%) were similar to estimates found across the flycatcher's range (15–40% for juveniles and 55–65% for adults, summarized in Sogge et al. 2010). The estimate of MLE calculated in this study (1.17 years) is much lower than the 1.9 years reported in Paxton et al. (2007) from central Arizona, but a different formula was used. Using the formula from Brownie et al. (1985) with the survival estimates from Paxton et al. (2007) of 34% juvenile survival and 64% adult survival, life expectancy is calculated as 1.37 years. The summary report from 2008–12 (McLeod and Pellegrini 2013) also used an incorrect formula, resulting in higher MLE estimates than reported here. Despite these low estimates of MLE, the longevity record for these study areas is of a male flycatcher that was at least 13 years old, recorded breeding along the Virgin River.

MLE estimates suggest that many flycatchers (just under half) do not live long enough to return to the breeding grounds. A study of survival across the annual cycle for flycatchers in central Arizona found that 62% of the annual mortality occurred during migration (Paxton et al. 2017). In another neotropical migrant, the black-throated blue warbler (*Setophaga caerulescens*), it was estimated that 85% of apparent annual mortality occurred during migration (Sillett and Holmes 2002). As the migration period seems to be the source of most of the mortality for flycatchers and other passerines, and there are decreasing trends in the extent and quality of riparian habitat (Jones et al. 2010; Nguyen et al. 2015; Perry et al. 2012), habitat along the flycatcher's migration route may play a key role in annual survival.

Marking cohort affected the probability of detection of both adults and juveniles, with the highest detection probabilities resulting from using metal rather than plastic color bands and marking juveniles with full color combinations rather than just a Federal band. In the first cohort, when juveniles were marked with plastic color bands, their detection estimates were at least 25% lower than in the most recent cohort, when all juveniles were banded with metal color bands. Adults banded with plastic color bands in cohort one also had lower detection estimates than those banded with metal color bands in cohort three. As explained above in "Methods," plastic color bands can lead to lower detection due to fading, falling off, and a higher prevalence of leg injuries. In cohort two, when juveniles were banded only with anodized Federal bands and no color bands and thus had to be recaptured to be identified, the detection probability was 24% lower than in the

most recent cohort, when juveniles were marked with full color combinations and could be identified via resighting. All adults in cohort two were individuals banded as juveniles in cohort two that survived to adulthood. These adults therefore also have a lower detection probability than those in the most recent cohort, as some individuals were not recaptured for many years and could not be individually identified until that time. Marking methodologies that lead to higher detections rates should also lead to more precise survival estimates.

There was no difference in detectability for juveniles or adults in cohort three between the two resight periods, suggesting that overall detection rates across all study areas were not significantly affected by there being fewer territory visits along the Virgin River and at ALAM in 2014–17 than at other study areas and in earlier years. There were relatively few banded flycatchers on the Virgin River and at ALAM in 2014–17 in comparison to other regions, however, and any decreases in detectability could have been masked by data from the other study areas, particularly because the use of resight cameras could have increased detectability in the Pahranagat region in 2015–17.

Geographic Regions

The difference in both adult and juvenile survival estimates between the Pahranagat Valley (average annual survival estimates of 73% for adults and 35% for juveniles) and PAHR (59% for adults and 20% for juveniles) is likely the result of emigration from PAHR to other study areas in the Pahranagat Valley. Movements of both adults and juveniles were commonly documented between study areas in the Pahranagat Valley. Because the CJS models are unable to distinguish between death and permanent emigration, a model that encompasses multiple study areas among which movement is known to occur would be expected to produce higher survival estimates than a model that includes only a subset of those study areas. It is not known whether the relatively low survival estimates from Havasu (48% for adults and 23% for juveniles) reflect a lower survival rate or are the result of emigration to areas that were not monitored as part of this study.

Adult Survival: Effect of Gender

The separate gender analysis did not reveal any differences in survival between adult male and female flycatchers. Male survival was slightly higher (60% versus 58%), but CIs for this estimate greatly overlapped. Furthermore, AICc model selection revealed no strong support for including gender in survival probabilities. Earlier analyses of these same areas had ambiguous results regarding the significance of gender (McLeod and Pellegrini 2013), and no gender differences were found in adult survival of flycatchers at Roosevelt Lake (Paxton et al. 2007). Any differences between genders in survival for migratory passerines would likely occur during migration since that is the period of highest mortality. Gender

differences have been reported for some migratory passerines (e.g., black-throated blue warbler, Sillett and Holmes 2002; yellow warbler [*Setophaga petechia*], Cilimburg et al. 2002), but not others (e.g., saltmarsh sharp-tailed sparrow [*Ammodrammus caudacutus*], DiQuinzio et al. 2001), and it is unclear what aspects of migration may be influencing differences between genders in survival.

Juvenile Survival: Effects of Fledge Date, Nestling Stage Length, and Drainage

The time between fledging and migration for altricial bird species is especially important for survival and is a period of low survival for many bird species including flycatchers (Naef-Daenzer and Gruebler 2016; Vormwald et al. 2011). Juvenile survival was lower than adult survival during the 21 years of this project, but survival between fledging and migration was not considered separately. Studies show that juvenile mortality is highest in the first couple of weeks post-fledging, with predation being the primary cause of mortality (Naef-Daenzer and Gruebler 2016). Results of modeling did not support a difference in juvenile survival by geographic region, suggesting there is no difference in predation pressure between the three geographic regions. There was also no support for nestling stage length as an effect on juvenile survival, suggesting that the ultimate development of a nestling when it finally leaves a nest does not influence its survival. Juvenile survival was found to vary by fledge date, with survival probability decreasing across the season by 40%. This rate of decrease in survival probability is similar to that found in central Arizona (Paxton et al. 2007) and suggests that the post-fledging period is also important as a preparatory period prior to migration. This potentially risky post-fledging period combined with the rigors of migration for an inexperienced juvenile may explain their lower survival relative to adults. Increasing riparian habitat quality along migration corridors may be an important aspect for habitat management to potentially increase survival in this listed species.

Annual Per Capita Rate of Population Change

Lambda values calculated using data through 2012 (McLeod and Pellegrini 2013) were higher than those calculated using data through 2017 for both the Pahranagat Valley (λ = 1.12 vs. 1.03) and Havasu (λ = 1.06 vs. 1.02). For the Pahranagat Valley, a difference in fecundity estimates was the primary driver of the difference in λ. Declining fecundity at KEPI in recent years (see chapter 4) was the main contributor to declining fecundity in the Pahranagat Valley. For Havasu, the decline in the λ estimate was influenced by a decline in immigration. No λ value was calculated for PAHR in McLeod and Pellegrini (2013).

The Pahranagat Valley and Havasu had very similar λ estimates, but the relative contributions of local recruitment, adult survival, and immigration differed between regions. Adult survival and local recruitment were the primary

contributors to λ in the Pahranagat Valley, whereas immigration made up a substantial portion of the λ estimate for Havasu. ALAM, which is ~48 km upstream of the delta area of BIWI, is a likely source of flycatchers immigrating to Havasu, and juvenile dispersal from ALAM to BIWI as well as adult movement have been documented. No flycatchers at ALAM were banded until 2014, and the percentages of the adult and juvenile population that were banded in each year in 2014–17 were relatively low. Therefore, immigration from ALAM was likely to go undetected.

The λ estimates appear to be overestimating the rate of population growth in comparison to the annual number of resident adults documented in each geographic area. Although λ calculations indicated a slightly increasing population in Havasu and the Pahranagat Valley, linear regression of the number of resident flycatchers detected showed a declining but non-significant trend for the Pahranagat Valley and a significantly declining population for Havasu. The non-significance of the linear trend in the Pahranagat Valley may be the result of low statistical power with only 5 years of data versus 19 years in the other two regions. This same pattern of apparently overestimated λ occurred in previous analyses (McLeod and Pellegrini 2013). One explanation may be the difference between the observed number of resident adults and the data used by Program MARK to calculate recruitment rates. Pradel models rely on the number of "newly marked" adults on a given occasion (year) to determine the rate of recruitment from one occasion to the next. Newly marked adults can consist of newly captured (i.e., previously unbanded) adults or returning juveniles identified for the first time as adults. The between-year change in number of newly marked individuals does not always reflect the corresponding change in the total number of resident adults, particularly in areas where many adults are unbanded. Lambda estimates, as calculated through methods such as Pradel models, have also been demonstrated to have a significant positive bias at small sample sizes (< 100 individuals) with low survival probability (≤ 50%) (Fiske et al. 2008). Although the Pradel models may overestimate λ, they also help inform a greater understanding of the underlying demographic processes driving population growth rates. Having a population that is reliant on immigration rather than local recruitment may indicate a need for management actions to improve local recruitment.

In recent years, all flycatchers at Havasu were in sites where the vegetation is dominated by tamarisk. In 2017, tamarisk at both TOPO and BIWI were defoliated by tamarisk beetles during the flycatcher breeding season, and no successful nests were documented at either study area (see chapter 4). Given the arrival of beetles at flycatcher breeding sites at Havasu, coupled with habitat declines as the result of fires and lack of streamflow (see chapter 2), the declining population trend seems unlikely to reverse in the near future.

Chapter 4 – Nest Monitoring

INTRODUCTION

Documentation of nest success and productivity is critical to understanding local population status and demographic patterns of the flycatcher. From 2013 to 2017, at all sites where flycatcher breeding activity was suspected, SWCA conducted intensive nest searches and nest monitoring. Specific objectives of nest monitoring included identifying breeding individuals (see chapter 3), calculating nest success and failure, documenting causes of nest failure (e.g., abandonment, desertion, depredation, and brood parasitism by cowbirds), modeling nest survival with relevant covariates, and calculating nest productivity. Nest monitoring results were compared across all study areas from 1996 to 2017 (Braden and McKernan, unpublished data; McLeod et al. 2008; McLeod and Pellegrini 2013). Although aspects of willow flycatcher breeding ecology can vary widely across the species' broad geographical and elevational ranges (Whitfield et al. 2003), SWCA compared monitoring results with range-wide data to identify specific variables that may contribute to the characterization of flycatcher breeding ecology throughout the LCR and its tributaries.

METHODS

Field Methods

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. A nest structure was verified as a flycatcher nest by observing a flycatcher land on the nest or by observing flycatcher eggs in the nest. Nest structures that did not meet those criteria were not counted as flycatcher nests. Nests were typically monitored every 2 to 4 days after nest building was complete and incubation was confirmed. Nests at Alamo Lake were monitored less frequently, sometimes with 6 or more days between visits. 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.

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 number and behavior of adults and/or fledges present. These data were recorded in a field journal and then entered in TerraSync 5.70 on a computer at the end of the field day.

Cowbird Egg Addling and Replacement

Field personnel attempted to addle cowbird eggs in easily accessible flycatcher nests at selected sites starting in 2010 and at all study areas starting in 2013. At Arizona study areas in 2016–17, cowbird eggs were either addled or replaced 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 addled or replaced as soon as it was discovered. If a ladder was required, the cowbird egg was addled or replaced on the next regularly scheduled nest visit. Cowbird eggs were addled or 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.

Figure 4-1.—Artificial cowbird eggs used to replace cowbird eggs in easily accessible southwestern willow flycatcher nests at study areas in Arizona during 2016 and 2017.

To addle a cowbird egg, field personnel carefully removed the cowbird egg from the nest and placed it in a padded film canister. Field personnel then shook the canister vigorously for about 1 minute, incorporating sharp, jerky movements, and returned the egg to the nest. The cowbird egg was not permanently removed from the nest 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, or if a shaken cowbird egg still hatched, the cowbird nestling was removed from the nest. All field personnel practiced egg addling with several button quail (*Coturnix chinensis*) eggs at the start of the field season to determine how vigorously they could shake an egg without breaking it. Button quail eggs are slightly larger than cowbird eggs (19 x 25 mm versus 16 x 21 mm) but provide a reasonable and easily available substitute. Shaken eggs were carefully opened to determine whether any damage to the internal structure of the egg was apparent. Field personnel varied in their ability to shake an egg to the point of causing internal damage without breaking the shell.

Nest Monitoring by Other Agencies

The NDOW followed the same general nest monitoring methods described above, but nests and territories were visited less frequently, sometimes with 2 weeks or more between visits. SWCA personnel occasionally volunteered for the NDOW to assist with nest monitoring activities and to review and process nest monitoring data. The NDOW monitored nests at KEPI, RIRA, MVWA, MESQ, and MOME in most years when those study areas were not monitored by SWCA, and those data are reported here to provide a more continous dataset than would be available just from the data SWCA collected. The UDWR also completed nest monitoring in STGE. Those data are not reported here but are housed in the Washington County Field Office of the UDWR.

Data Analysis

Per instructions from Reclamation, 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 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), which 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 more than 2 days 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 (infertile/addled). 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.

Nest productivity was calculated as the number of young fledged per nesting attempt that produced at least one flycatcher egg and had a known outcome. 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. Summary statistics were calculated using IBM ® SPSS ® v. 22.0. Productivity and fecundity were compared across study areas using analysis of variance (ANOVA) and Tukey's Honest Significant Difference in IBM ® SPSS ® v. 22.0. One-sided CIs around differences in proportions followed Agresti and Caffo (2000) (formula provided by Reclamation staff).

Nest Success

Flycatcher nest success was calculated three ways. First, simple apparent nesting success was calculated as the number of successful nests divided by the total number of nests containing at least one flycatcher egg. Second, the Mayfield method (Mayfield 1961, 1975), which calculates daily nest survival to account for nests that failed before they were found, was used to calculate the Mayfield survival probability (MSP). Third, nest success was calculated with Program MARK (Version 8.2, White and Burnham 1999), which calculates daily survival rate (DSR) of nests using a maximum likelihood method and allows covariates to be included in models of DSR (Dinsmore et al. 2002). Because covariate data were not collected during monitoring completed by the NDOW, MARK analyses were completed only with data collected by SWCA. Data collected by the NDOW were also omitted from the Mayfield analysis to ensure that the population sample was consistent and comparable with that used in the MARK analyses.

Apparent nest success is the easiest to calculate, but can give a biased estimate of nest success, since there may be an observer bias in finding more nests later in the nesting cycle. This method does not account for nests that fail prior to being found. The Mayfield method (Mayfield 1961, 1975) was created to account for this bias by calculating nest survival based on the number of exposure days (days the nest was active and therefore "exposed" to the potential of failing). This method is slightly more cumbersome to calculate than basic apparent nest survival but, in theory, it provides a less biased estimate of nest survival. Building on this idea, modeling nest survival using a maximum likelihood method with linear models (i.e., Program MARK) allows for the ability to include time and environmental covariates in models of nest survival. Not only can various factors be tested against each other to determine which have the strongest influence on

nest survival, but estimates of their effect on nest survival are also generated. Estimates of the beta terms of the linear models created within Program MARK can be obtained and used to compare the effects of different levels of covariates. Beta estimates for categorical variables are offsets from the reference group (intercept) estimate. These estimates show both the direction and magnitude of the difference between survival for nests within that group compared with the reference group. Negative values indicate lower nest survival for nests within that group compared to the reference group, while positive values indicate the opposite. Nest survival at given levels of different variables can then be calculated, although using a model to predict nest survival beyond the scope of the input data is not recommended. Model selection finds the model that best fits the data, and competing models can be averaged to obtain survival estimates that account for any uncertainty as to which variables should be included. This method in general is limited by small sample sizes and is more complex to implement; however, the benefits in finding biologically meaningful results far outweigh the costs.

For the Mayfield analysis, SWCA calculated transition dates by assuming that one egg was laid per day, and incubation was considered to start the day the last egg was laid (per Martin et al. 1997). The nestling period was considered to start the day the first egg hatched and end the day the first nestling fledged. If exact transition dates or dates of depredation events were unknown, the transition date was estimated as halfway between observations. For nests for which fate was unknown, the last known date of activity was used to determine the number of observation days. To calculate MSPs, SWCA used the average length of each nest stage (2.17, 12.90, and 13.71 days for laying, incubation, and nestling stages, respectively) as observed in this study in 2003–17 for nests with known transition dates. The MSP for each nesting stage was calculated by raising the DSR to the power of the length of the nesting stage. The MSP for all stages combined was calculated by raising the DSR to the power of the length of the entire nesting period (i.e., the sum of the lengths of each stage). This method of calculating MSP for all stages combined allows overall MSP to be calculated for study areas that had no nests in one or more nesting stages, and it differs from the method used in 2003–16, where the MSPs of each individual stage were multiplied to get an estimate of MSP for the entire nesting period.

Three dates are used to calculate DSR for analysis of nest survival with Program MARK. The first is the date the nest was found or, if the nest was found during building, the date the first egg was laid. For failed nests, the second date is the date the nest was last checked and found to be still active, and the third is the first date the nest was checked and found to be failed. In the case of successful nests, the second and third date are the same and are the date the nest fledged. SWCA used several covariates for modeling DSR (table 4-1). Some nests were excluded from this analysis due to having unknown fate or incomplete covariate data, or if the nest was the only nest within a given category of a variable. To determine which variables best predicted DSR, models were ranked using the AICc values

created within Program MARK. Starting with the full model that included additive effects of all covariates, backward stepwise selection was manually performed to find the highest-ranking model. Interactions were not considered because they either were not biologically meaningful or because data did not exist within all levels of each covariate (e.g., a year by study area interaction in which some study areas did not have nests in every year). Backward stepwise selection involves removing each variable in a separate iteration from the starting model and finding which model of these iterations has the lowest AICc. This model then becomes the starting model, and the process of removing each variable separately is repeated to see if any iteration of removing a second variable will decrease the AICc further. After the first two repetitions of this process, variables that were taken out are added back in, again separately, to see if any previously untested combinations of variables result in lower AICc values. The final top model is the model for which the AICc is not reduced by adding or removing any single variable. Models for which the difference in AICc (ΔAICc) is < 2.0 are considered equally supported. If many models have low ΔAICc or AICc weights, this indicates little support for any one model. Model averaging was used within Program MARK to generate a weighted average of DSR across all models using their AICc weights. These estimates of DSR were then exponentiated to the length of the entire nesting period, similar to calculating MSP in the Mayfield method.

Table 4-1.—Covariates used for modeling nest survival in Program MARK, 2013–17

Covariate	Definition
Age	Age of the nest in days beginning from the day the first egg was laid
Date	Day of the breeding season, with day 1 being the earliest date out of all 5 years combined that a nest with eggs was monitored, and extending to the latest date of monitoring (93 days in total)
Year	Year the nest was monitored
Sarea	Study area in which the nest was located
Substrate	Tree species in which the nest was placed
Tasp5	Percentage of the vegetation within 5 m of the nest that consisted of tamarisk
Sat50	Percentage of the soil within 50 m of the nest that was saturated or inundated
Height	Height (m) of the nest above the ground or the surface of standing water if water was present

ALAM had over twice as many nests as any other study area (see “Results”; table 4-3) and thus may drive the model selection results when all study areas are analyzed together. To determine the effect of ALAM on model selection results, this study area was modeled separately. These analyses were done using the same backward selection methodology as for the original overall model set, starting from a global model including nest age, date, year, nest substrate, nest height, the

percentage of tamarisk within 5 m of the nest, and the amount of wet soils within 50 m of the nest. Only two nest substrates were found at ALAM (Goodding's willow and tamarisk), and tamarisk was used as the reference level. Monitoring began in 2014 at ALAM, so 2014 was used as the reference level for the year covariate.

RESULTS

Flycatcher nesting was documented every year from 2013 to 2017 at KEPI, PAHR, MVWA, MUDD, and TOPO. ALAM was monitored beginning in 2014, and nesting flycatchers were documented in each year in 2014–17. Nesting flycatchers were documented in 4 of the 5 years at RIRA (2013 and 2015–17) and BIWI (2014–17). At WMSP, nesting was documented in 2 of the 5 years (2015 and 2017).

Number of Flycatcher Pairs

The number of flycatcher pairs varied widely among study areas and also among years at some study areas. The number of pairs at PAHR varied between 15 and 7 in 2013–17, and this was similar to the range in the number of pairs observed in the previous 10 years (figure 4-2). The number of flycatcher pairs at RIRA varied between zero and three in 2011–17. No long-term trends in the number of flycatcher pairs were apparent at either PAHR or RIRA. KEPI showed a strongly decreasing trend in the number of pairs over the most recent 5 years, with 17 pairs recorded in 2013 and 2014 but only 4 pairs documented in 2017. This decline followed 5 years in which the number of pairs was essentially constant (figure 4-2). Conversely, the number of flycatcher pairs at MVWA increased steadily from one in 2013 to five in 2017.

The number of flycatcher pairs at MESQ increased steadily from one to nine over the 2013-17 period, while the number of pairs at MOME decreased from seven in 2013 to two or three in 2015–17 (figure 4-3). The data from 2003 to 2012 show that the number of pairs at MESQ declined fairly steadily from 15 pairs in 2006 to 1 in 2013, before rising again over the past 5 years. The number of flycatcher pairs at MOME fluctuated between 10 and 14 in 2007–12 before declining. Recent declines in flycatcher numbers were also apparent at MUDD, where there were four to six pairs in each year in 2008–14 but only two pairs annually in 2015–17. Flycatcher numbers were low in all years at WMSP, with four pairs in 2010 and no more than two pairs in any year in 2011–17.

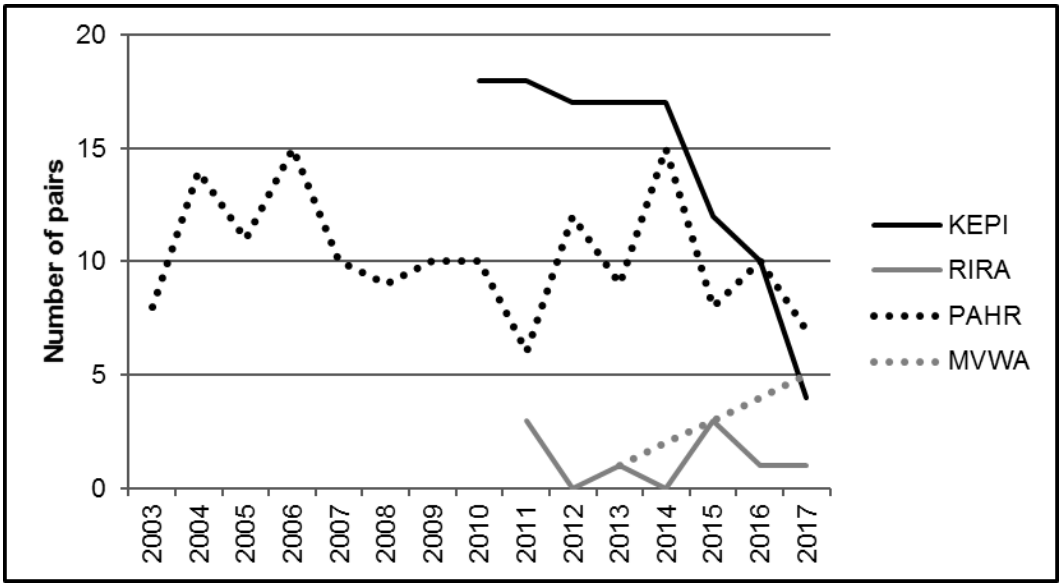

Figure 4-2.—Number of pairs of southwestern willow flycatchers detected at study areas in the Pahranagat Valley and Meadow Valley Wash, 2003–17.
KEPI = Key Pittman, RIRA = River Ranch, PAHR = PAHR, and MVWA = Meadow Valley Wash. Monitoring at KEPI and RIRA in 2017 and at MVWA in 2013 was completed by the NDOW. All other monitoring was completed by SWCA.

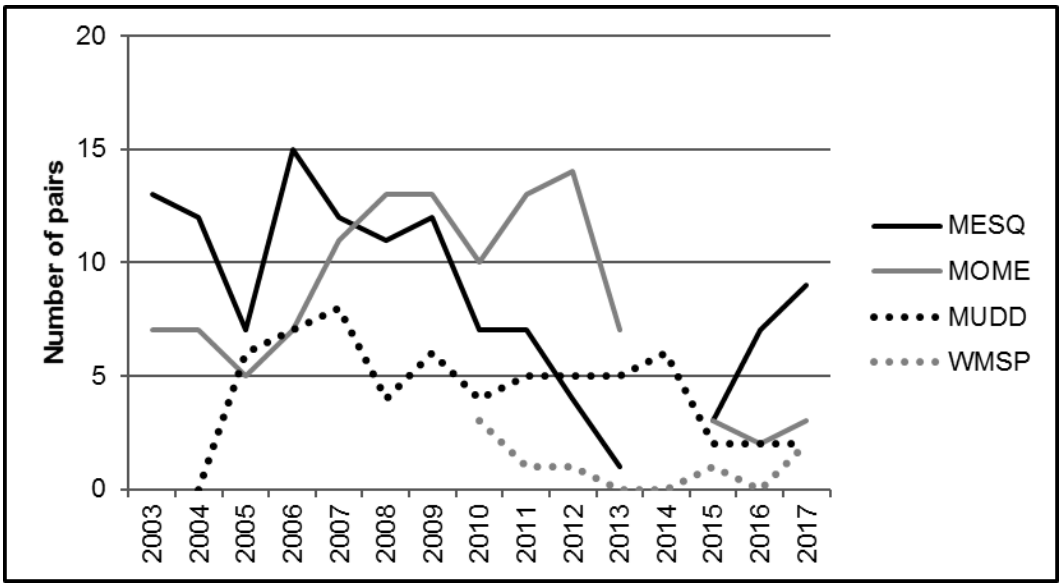

Figure 4-3.—Number of pairs of southwestern willow flycatchers detected at study areas along the Virgin and Muddy Rivers, 2003–17.
MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, and WMSP = Warm Spring. Monitoring at MESQ and MOME in 2015–17 was completed by the NDOW. All other monitoring was completed by SWCA.

TOPO had two to four flycatcher pairs annually over the past 5 years, which is comparable to the number of pairs (zero to three) detected annually in 2009–12 (figure 4-4). Prior to 2009, the number of flycatcher pairs at TOPO had declined from a high of 29 in 2004 to 9 in 2008. The number of flycatcher pairs at BIWI in 2013–17 was comparable to what was observed over the previous 10 years, when the number of flycatcher pairs fluctuated between zero and seven. The number of flycatcher pairs detected at ALAM increased from 28 pairs in 2014 to 61 pairs in 2017 and in each year was 1.6 to 6.8 times more pairs than in any other study area in the given year.

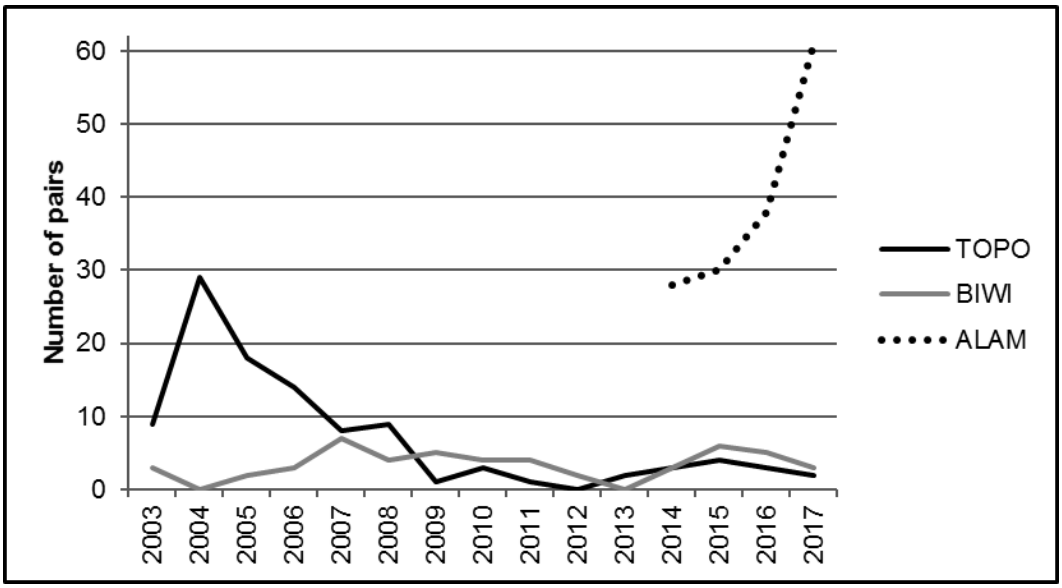

Figure 4-4.—Number of pairs of southwestern willow flycatchers detected at study areas along the lower Colorado and Bill Williams Rivers, 2003–17.
TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.

Nest Monitoring

A total of 466 flycatcher nesting attempts were documented by SWCA and the NDOW at KEPI, RIRA, PAHR, MESQ, MOME, MVWA, MUDD, TOPO, BIWI, and ALAM in 2013–17; 417 of these nests were known to contain flycatcher eggs and were used in calculating nest success and productivity (table 4-2). A total of 189 (45%) nests were successful and fledged young, 193 (47%) failed, and 35 (8%) had an unknown fate. Overall percent nest success in 2013–17 was < 35% at KEPI, RIRA, MESQ, MOME, MUDD, and TOPO; approximately 50% at BIWI and ALAM; and > 65% at PAHR, MVWA, and WMSP.

Table 4-2.—Summary of southwestern willow flycatcher nest monitoring results at all study areas, 2013–17
Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA. MESQ and MOME were not monitored in 2014, and ALAM was not monitored in 2013.

Study area[1]	Year	Pairs	Nests	Nests with 1+ WE[2]	Successful nests[3]	Failed nests[3]	Nests with unknown fate	Nests with 1+ WE[2] and known parasitism status	Parasitized nests[4]
KEPI	2013	17	27	23	8 (35)	11 (48)	4 (17)	20	3 (15)
	2014	17	21	18	8 (44)	7 (39)	3 (17)	18	4 (22)
	2015	12	21	18	2 (11)	16 (89)	0	18	1 (6)
	2016	10	19	19	1 (5)	17 (90)	1 (5)	19	3 (16)
	2017	4	3	2	2 (100)	0	0	1	0
	Total	60	91	80	21 (26)	51 (64)	8 (10)	76	11 (14)
RIRA	2013	1	2	2	0	2 (100)	0	2	2 (100)
	2014	0	0	0	–	–	–	–	–
	2015	3	5	4	2 (50)	2 (50)	0	4	1 (25)
	2016	1	3	3	1 (33)	2 (67)	0	2	0
	2017	1	1	1	0	1 (100)	0	1	1 (100)
	Total	6	11	10	3 (30)	7 (70)	0	9	4 (44)
PAHR	2013	9	7	7	6 (86)	1 (14)	0	3	0
	2014	15	20	17	11 (65)	6 (35)	0	14	1 (7)
	2015	8	9	9	8 (89)	1 (11)	0	9	0
	2016	10	19	17	8 (47)	9 (53)	0	16	1 (6)
	2017	7	9	8	7 (88)	1 (12)	0	8	0
	Total	49	64	58	40 (69)	18 (31)	0	50	2 (4)
MVWA	2013	1	1	1	1 (100)	0	0	0	–
	2014	2	2	2	2 (100)	0	0	2	0
	2015	3	4	4	4 (100)	0	0	3	0
	2016	4	4	4	2 (50)	2 (50)	0	3	0
	2017	5	7	6	4 (67)	2 (33)	0	6	0
	Total	15	18	17	13 (76)	4 (24)	0	14	0

Table 4-2.—Summary of southwestern willow flycatcher nest monitoring results at all study areas, 2013–17
Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA. MESQ and MOME were not monitored in 2014, and ALAM was not monitored in 2013.

Study area[1]	Year	Pairs	Nests	Nests with 1+ WE[2]	Successful nests[3]	Failed nests[3]	Nests with unknown fate	Nests with 1+ WE[2] and known parasitism status	Parasitized nests[4]
MESQ	2013	1	2	0	–	–	–	–	–
	2015	3	4	3	0	0	3 (100)	2	1 (50)
	2016	7	8	8	2 (25)	4 (50)	2 (25)	7	3 (43)
	2017	9	11	11	2 (18)	6 (55)	3 (27)	9	5 (56)
	Total	20	25	22	4 (18)	10 (45)	8 (36)	18	9 (50)
MOME	2013	7	9	5	1 (20)	4 (80)	0	5	2 (40)
	2015	3	3	3	2 (67)	0	1 (33)	1	0
	2016	2	2	2	1 (50)	0	1 (50)	2	1 (50)
	2017	3	3	2	0	2 (100)	0	2	0
	Total	14	17	12	4 (33)	6 (50)	2 (17)	10	3 (30)
MUDD	2013	5	8	4	1 (25)	3 (75)	0	4	1 (25)
	2014	6	7	5	1 (20)	2 (40)	2 (40)	5	3 (60)
	2015	2	3	2	1 (50)	0	1 (50)	2	0
	2016	2	2	2	0	2 (100)	0	2	0
	2017	2	4	4	1 (25)	3 (75)	0	4	1 (25)
	Total	17	24	17	4 (24)	10 (59)	3 (18)	17	5 (29)
WMSP	2013	0	0	0	–	–	–	–	–
	2014	0	0	0	–	–	–	–	–
	2015	1	1	1	1 (100)	0	0	1	0
	2016	0	0	0	–	–	–	–	–
	2017	2	2	2	2 (100)	0	0	2	0
	Total	3	3	3	3 (100)	0	0	3	0
TOPO	2013	2	2	2	0	2 (100)	0	1[5]	1 (100)
	2014	3	3	3	3 (100)	0	0	3	0
	2015	4	6	5	1 (20)	4 (80)	0	5	2 (40)
	2016	3	6	3	0	3 (100)	0	2	1 (50)
	2017	2	3	2	0	2 (100)	0	2	2 (100)
	Total	14	20	15	4 (27)	11 (73)	0	13	6 (46)

Table 4-2.—Summary of southwestern willow flycatcher nest monitoring results at all study areas, 2013–17
Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA. MESQ and MOME were not monitored in 2014, and ALAM was not monitored in 2013.

Study area[1]	Year	Pairs	Nests	Nests with 1+ WE[2]	Successful nests[3]	Failed nests[3]	Nests with unknown fate	Nests with 1+ WE[2] and known parasitism status	Parasitized nests[4]
BIWI	2013	0	0	0	–	–	–	–	–
	2014	3	4	4	2 (50)	2 (50)	0	4	0
	2015	6	8	8	4 (50)	3 (37)	1 (12)	7	2 (29)
	2016	5	8	7	4 (57)	3 (43)	0	6	1 (17)
	2017	3	3	2	0	2 (100)	0	2	1 (50)
	Total	17	23	21	10 (48)	10 (48)	1 (4)	19	4 (21)
ALAM	2014	28	24	24	6 (25)	14 (58)	4 (17)	16	1 (6)
	2015	30	36	34	21 (62)	11 (32)	2 (6)	28	3 (11)
	2016	38	40	36	19 (53)	16 (44)	1 (3)	26	2 (8)
	2017	61	70	68	37 (54)	25 (37)	6 (9)	60	2 (3)
	Total	157	170	162	83 (51)	66 (41)	13 (8)	130	8 (6)
All study areas	**2013**	**43**	**58**	**44**	**17 (39)**	**23 (52)**	**4 (9)**	**35**	**9 (26)**
	2014	**74**	**81**	**73**	**33 (45)**	**31 (42)**	**9 (12)**	**62**	**9 (15)**
	2015	**75**	**100**	**91**	**46 (51)**	**37 (41)**	**8 (9)**	**80**	**10 (13)**
	2016	**82**	**111**	**101**	**38 (38)**	**58 (57)**	**5 (5)**	**85**	**12 (14)**
	2017	**99**	**116**	**108**	**55 (51)**	**44 (41)**	**9 (8)**	**97**	**12 (12)**
Overall total		**373**	**466**	**417**	**189 (45)**	**193 (47)**	**35 (8)**	**359**	**52 (14)**

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.
[2] WE = willow flycatcher egg.
[3] Only nests with at least one flycatcher egg were used in tallies and percentage calculations. Percentages are given in parentheses.
[4] Parasitized nests include all nests that contained at least one flycatcher egg and one cowbird egg regardless of nest fate. Percentages in parentheses include only nests with at least one flycatcher egg and for which parasitism status could be determined.
[5] Does not include the unlocated nest for a flycatcher pair found feeding a cowbird fledgling. This nest is presumed to have contained WEs but was not included in the calculation of parasitism rates in order to reduce bias.

At all study areas in 2013–17, 401 nestlings were confirmed to have fledged from 382 nests of known outcome (mean number of fledglings/nest = 1.05, standard error [SE] = 0.06) (table 4-3). Nest productivity was < 1.0 at KEPI, RIRA, MESQ, MOME, MUDD, TOPO, and BIWI and > 1.0 but ≤ 2.0 at PAHR, MVWA, WMSP, and ALAM. Fecundity across all study areas and years averaged 1.18 young/female (SE = 0.07) (table 4-3). Fecundity was < 1.0 at KEPI, MESQ, MOME, MUDD, and TOPO; ≥ 1.0 but < 2.0 at RIRA, PAHR, BIWI, and ALAM, and ≥ 2.0 at MVWA and WMSP (table 4-3).

Of all the study areas monitored for over 5 years, PAHR was the most consistently productive, with annual fecundity never dropping below 1.33 in 2003–17 (figure 4-5). MVWA was monitored only during 2013–17 and had far fewer flycatcher pairs than PAHR but had similar fecundity. KEPI showed a strong and relatively consistent decline in fecundity over the 2010–17 monitoring period, particularly in 2013–16 (figure 4-5). The number of young produced per female flycatcher at MESQ was typically between 1.0 and 2.0 in 2003–08 and then declined to 0.0 in 2012 and 2013 before recovering somewhat to values ≤ 1.0 in 2015–17 (figure 4-6). Fecundity at MOME was consistently > 1.0 but < 2.0 in 2008–11 but then dropped to 0.14 in 2013. In 2015–17, fecundity at MOME varied from 0.0 to 2.0. Fecundity was < 1.0 in most years at MUDD and was highly variable at WMSP (figure 4-6). TOPO showed highly variable fecundity, particularly in 2009–17, when very few flycatcher pairs were detected (figure 4-7). No flycatcher young were produced in 2011–13 or 2016–17. Fecundity at BIWI varied generally between 0.5 and 1.5, although no young were produced in 2012–13 or 2017. No long-term nest monitoring data were available for ALAM, but fecundity varied from 0.42 in 2015 to approximately 1.5 in 2015 and 2017.

Nest Failure

Depredation was the major cause of nest failure for all study areas combined, accounting for 46% (112 of 242) of all failed nests (table 4-4) and 58% (112 of 193) of nests that failed after flycatcher eggs were laid. Forty-six of the 112 failed nests (19%) were abandoned before flycatcher eggs were laid; 5 of the abandoned nests had been parasitized. Parasitism caused failure at 10 (5%) of the 193 nests that failed after flycatcher eggs were laid. Of all 242 failed nests, 54 (22%) were deserted. Seven nests (3%) were incubated for 20 days or more but never hatched, and the cause of failure was unknown at eight nests (3%).

Table 4-3.—Southwestern willow flycatcher nest productivity (young fledged per nest) and fecundity (young fledged per female) at all study areas, 2013–17
Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA. No nesting was documented at RIRA in 2014; WMSP in 2013, 2014, or 2016; or BIWI in 2013. MESQ and MOME were not monitored in 2014, and ALAM was not monitored in 2013.

Study area[1]	Year	# of young fledged	of nests with known outcome	Productivity mean (SE)[2]	of females with known outcome	Fecundity mean (SE)[3]
KEPI	2013	21	19	1.11 (0.32)	14	1.50 (0.39)
	2014	13	15	0.87 (0.26)	14	0.93 (0.27)
	2015	6	18	0.33 (0.23)	12	0.50 (0.34)
	2016	2	18	0.11 (0.11)	9	0.22 (0.22)
	2017	3	2	1.50 (0.50)	4	0.75 (0.48)
	Total	45	72	0.63 (0.13)	53	0.88 (0.16)
RIRA	2013	0	2	0.00 (0.00)	1	0.00
	2015	5	4	1.25 (0.75)	3	1.67 (0.88)
	2016	1	3	0.33 (0.33)	1	1.00
	2017	0	1	0.00	1	0.00
	Total	6	10	0.60 (0.34)	6	1.00 (0.52)
PAHR	2013	12	7	1.71 (0.36)	9	1.33 (0.37)
	2014	25	17	1.47 (0.32)	15	1.67 (0.35)
	2015	17	9	1.89 (0.31)	8	2.13 (0.23)
	2016	23	17	1.35 (0.39)	10	2.30 (0.47)
	2017	18	8	2.25 (0.45)	7	2.57 (0.57)
	Total	95	58	1.64 (0.17)	49	1.94 (0.19)
MVWA	2013	2	1	2.00	1	2.00
	2014	4	2	2.00 (0.00)	2	2.00 (0.00)
	2015	10	4	2.50 (0.29)	3	3.33 (0.88)
	2016	5	4	1.25 (0.75)	4	1.25 (0.75)
	2017	11	6	1.83 (0.65)	5	2.20 (0.66)
	Total	32	17	1.88 (0.30)	15	2.13 (0.36)

Table 4-3.—Southwestern willow flycatcher nest productivity (young fledged per nest) and fecundity (young fledged per female) at all study areas, 2013–17
Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA. No nesting was documented at RIRA in 2014; WMSP in 2013, 2014, or 2016; or BIWI in 2013. MESQ and MOME were not monitored in 2014, and ALAM was not monitored in 2013.

Study area[1]	Year	# of young fledged	of nests with known outcome	Productivity mean (SE)[2]	of females with known outcome	Fecundity mean (SE)[3]
MESQ	2013	0	0	–	1	0.00
	2015		0	–	0	–
	2016	6	6	1.00 (0.68)	6	1.00 (0.68)
	2017	3	8	0.38 (0.26)	6	0.50 (0.34)
	Total	9	14	0.64 (0.32)	13	0.69 (0.35)
MOME	2013	1	5	0.20 (0.20)	7	0.14 (0.14)
	2015	3	2	1.50 (0.50)	2	1.50 (0.50)
	2016	2	1	2.00	1	2.00
	2017	0	2	0.00 (0.00)	3	0.00 (0.00)
	Total	6	10	0.60 (0.27)	13	0.46 (0.22)
MUDD	2013	2	4	0.50 (0.50)	5	0.40 (0.40)
	2014	1	3	0.33 (0.33)	4	0.25 (0.25)
	2015	2	1	2.00	1	2.00
	2016	0	2	0.00	2	0.00
	2017	1	4	0.25 (0.25)	2	0.50 (0.50)
	Total	6	14	0.43 (0.20)	14	0.43 (0.20)
WMSP	2015	1	1	1.00	1	1.00
	2017	5	2	2.50 (0.50)	2	2.50 (0.50)
	Total	6	3	2.00 (0.58)	3	2.00 (0.58)
TOPO	2013	0	2	0.00 (0.00)	2	0.00 (0.00)
	2014	6	3	2.00 (0.58)	3	2.00 (0.58)
	2015	1	5	0.20 (0.20)	4	0.25 (0.25)
	2016	0	3	0.00	3	0.00
	2017	0	2	0.00	2	0.00
	Total	7	15	0.47 (0.24)	14	0.50 (0.25)

Table 4-3.—Southwestern willow flycatcher nest productivity (young fledged per nest) and fecundity (young fledged per female) at all study areas, 2013–17
Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA. No nesting was documented at RIRA in 2014; WMSP in 2013, 2014, or 2016; or BIWI in 2013. MESQ and MOME were not monitored in 2014, and ALAM was not monitored in 2013.

Study area[1]	Year	# of young fledged	of nests with known outcome	Productivity mean (SE)[2]	of females with known outcome	Fecundity mean (SE)[3]
BIWI	2014	4	4	1.00 (0.71)	3	1.33 (0.88)
	2015	6	7	0.86 (0.34)	5	1.20 (0.37)
	2016	7	7	1.00 (0.44)	5	1.40 (0.51)
	2017	0	2	0.00	3	0.00
	Total	17	20	0.85 (0.23)	16	1.06 (0.27)
ALAM	2014	10	20	0.50 (0.20)	24	0.42 (0.17)
	2015	45	32	1.41 (0.22)	29	1.55 (0.27)
	2016	36	35	1.03 (0.19)	37	0.97 (0.18)
	2017	81	62	1.31 (0.16)	54	1.50 (0.17)
	Total	172	149	1.15 (0.10)	144	1.19 (0.11)
All study areas	**2013**	**38**	**40**	**0.95 (0.19)**	**40**	**0.95(0.19)**
	2014	**63**	**64**	**0.98 (0.14)**	**65**	**0.97 (0.14)**
	2015	**96**	**83**	**1.16 (0.13)**	**68**	**1.41 (0.17)**
	2016	**82**	**96**	**0.85 (0.12)**	**78**	**1.05 (0.14)**
	2017	**122**	**99**	**1.23 (0.13)**	**89**	**1.37 (0.14)**
	Total	**401**	**382**	**1.05 (0.06)**	**340**	**1.18 (0.07)**

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.
[2] Productivity calculations include nests that contained flycatcher eggs and had a known outcome.
[3] Fecundity calculations include all females for which nest outcomes were known.

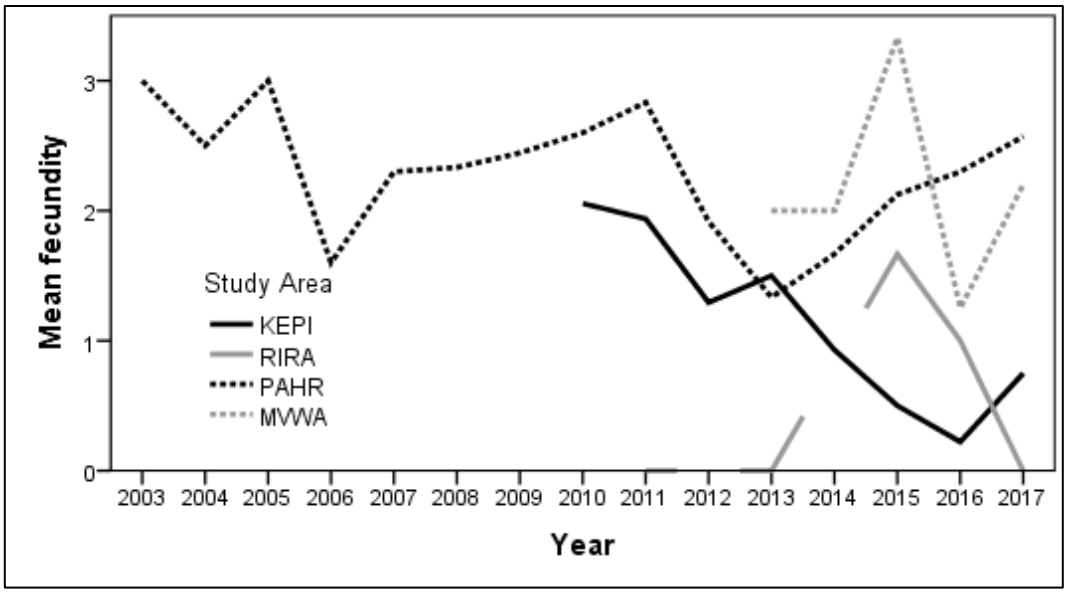

Figure 4-5.—Mean annual fecundity (young produced per female southwestern willow flycatcher) at Key Pittman (KEPI), River Ranch (RIRA), Pahranagat (PAHR), and Meadow Valley Wash (MVWA), 2003–17.
Data collected by the NDOW at KEPI and RIRA in 2017 and at MVWA in 2013. All other data collected by SWCA.

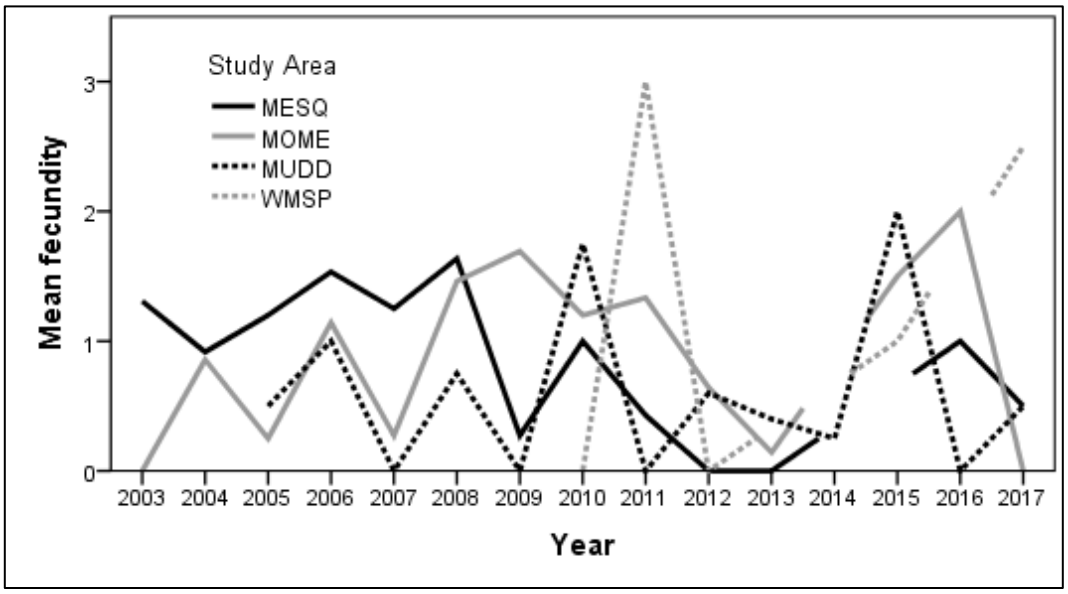

Figure 4-6.—Mean annual fecundity (young produced per female southwestern willow flycatcher) at Mesquite (MESQ), Mormon Mesa (MOME), Muddy River (MUDD), and Warm Springs (WMSP), 2003–17.
Data collected by the NDOW at MESQ and MOME in 2015–17. All other data collected by SWCA.

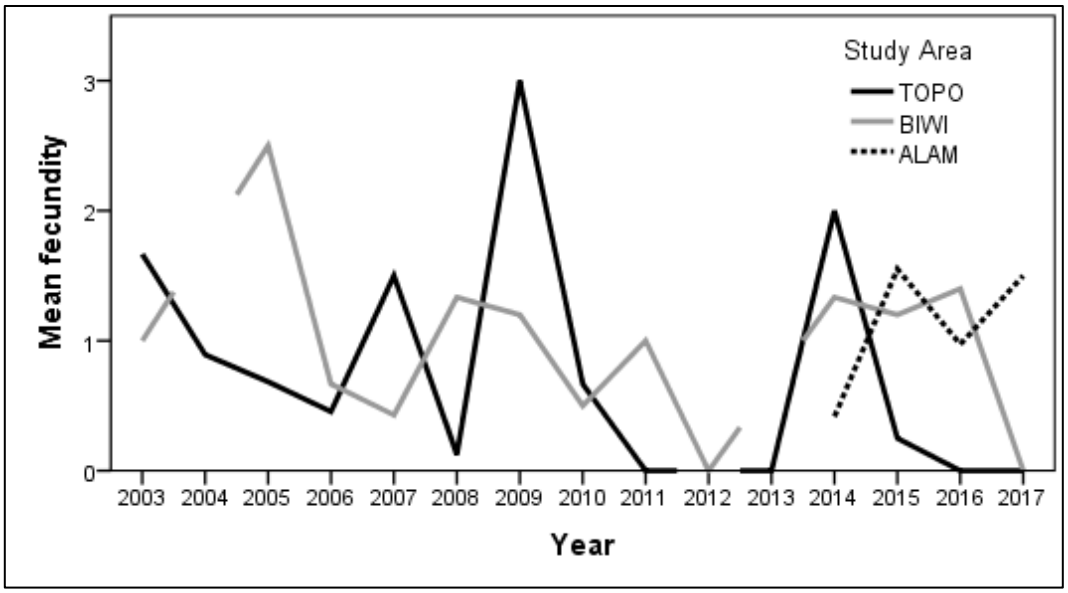

Figure 4-7.—Mean annual fecundity (young produced per female southwestern willow flycatcher) at Topock Marsh (TOPO), Bill Williams (BIWI), and Alamo Lake (ALAM), 2003–17.

Brood Parasitism

Fifty-two (14%) of 359 nests with flycatcher eggs and known parasitism status were brood parasitized by cowbirds (see table 4-2), 5 nests without flycatcher eggs were abandoned with a cowbird egg (table 4-5), 1 additional nest contained a cowbird egg but it was unknown whether flycatcher eggs had been laid, and 1 flycatcher pair was found feeding a cowbird fledgling, but the nest, which is presumed to have contained flycatcher eggs, was never located. Overall brood parasitism rates at each study area ranged from 0 to 50% (see table 4-2). Parasitism rates were 0% at MVWA and WMSP, < 10% at PAHR and ALAM, > 10% but < 25% at KEPI and BIWI, and > 25% at RIRA, MESQ, MOME, MUDD, and TOPO. Parasitism caused failure of 10 nests known or presumed to have contained flycatcher eggs. Flycatchers deserted 18 (35%) of the 52 parasitized nests known to contain flycatcher eggs. Between 2013 and 2017, unparasitized nests were more likely than parasitized nests to fledge flycatcher young. A total of 149 of 281 (53%) unparasitized nests with flycatcher eggs and known outcome were successful, whereas 1 of 49 (2%) parasitized nests with flycatcher eggs and known outcome were successful (one-sided Fisher's exact test, $P < 0.001$; difference in proportions = 0.51, 95% lower bound = 0.42).

Table 4-4.—Summary of causes of southwestern willow flycatcher nest failure at all study areas, 2013–17*

Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA. No nesting was documented at RIRA in 2014; WMSP in 2013, 2014, or 2016; or BIWI in 2013. MESQ and MOME were not monitored in 2014, and ALAM was not monitored in 2013.

Study area[1]	Year	Total # of nests	All failed nests	Abandoned	Parasitized	Deserted	Depredated	Tree fell	Nestling died in nest	Addled	Fire	Cause of failure unknown
KEPI	2013	27	15	4 (27)	0	1 (7)	9 (60)	0	0	1 (7)	0	0
	2014	21	10	3 (30)	0	4 (40)	3 (30)	0	0	0	0	0
	2015	21	19	3 (16)	1 (5)	2 (11)	12 (63)	0	0	1 (5)	0	0
	2016	19	17	0	0	2 (12)	15 (88)	0	0	0	0	0
	2017	3	1	0	0	0	0	0	0	0	0	1 (100)
	Total	91	62	10 (16)	1 (2)	9 (15)	39 (63)	0	0	2 (3)	0	1 (2)
RIRA	2013	2	2	0	1 (50)	0	1 (50)	0	0	0	0	0
	2015	5	3	1 (33)	0	0	1 (33)	0	0	1 (33)	0	0
	2016	3	2	0	0	1 (50)	1 (50)	0	0	0	0	0
	2017	1	1	0	0	0	1 (100)	0	0	0	0	0
	Total	11	8	1 (13)	1 (13)	1 (13)	4 (50)	0	0	1 (13)	0	0
PAHR	2013	7	1	0	0	0	1 (100)	0	0	0	0	0
	2014	20	9	3 (33)	1 (11)	2 (22)	3 (33)	0	0	0	0	0
	2015	9	1	0	0	1 (100)	0	0	0	0	0	0
	2016	19	11	2 (18)	0	1 (9)	7 (64)	1 (9)	0	0	0	0
	2017	9	2	1 (50)	0	0	0	0	1 (50)	0	0	0
	Total	64	24	6 (25)	1 (4)	4 (17)	11 (46)	1 (4)	1 (4)	0	0	0

Table 4-4.—Summary of causes of southwestern willow flycatcher nest failure at all study areas, 2013–17*

Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA. No nesting was documented at RIRA in 2014; WMSP in 2013, 2014, or 2016; or BIWI in 2013. MESQ and MOME were not monitored in 2014, and ALAM was not monitored in 2013.

Study area[1]	Year	Total # of nests	All failed nests	Abandoned	Parasitized	Deserted	Depredated	Tree fell	Nestling died in nest	Addled	Fire	Cause of failure unknown
MVWA	2013	1	0	0	0	0	0	0	0	0	0	0
	2014	2	0	0	0	0	0	0	0	0	0	0
	2015	4	0	0	0	0	0	0	0	0	0	0
	2016	4	2	0	0	1 (50)	1 (50)	0	0	0	0	0
	2017	7	3	1 (33)	0	1 (33)	1 (33)	0	0	0	0	0
	Total	18	5	1 (20)	0	2 (40)	2 (40)	0	0	0	0	0
MESQ	2013	2	2	2 (100)	0	0	0	0	0	0	0	0
	2015	4	1	0	0	0	0	0	0	0	0	1 (100)
	2016	8	4	0	1 (25)	2 (50)	1 (25)	0	0	0	0	0
	2017	11	6	0	0	1 (33)	3 (50)	0	0	0	0	2 (67)
	Total	25	13	2 (15)	1 (8)	3 (23)	4 (31)	0	0	0	0	3 (23)
MOME	2013	9	8	4 (50)	1 (13)	1(13)	1 (13)	0	0	1 (13)	0	0
	2015	3	0	0	0	0	0	0	0	0	0	0
	2016	2	0	0	0	0	0	0	0	0	0	0
	2017	3	3	0	0	1 (33)	1 (33)	0	0	0	0	1 (33)
	Total	17	11	4 (36)	1 (9)	2 (18)	2 (18)	0	0	1 (9)	0	1 (9)

Table 4-4.—Summary of causes of southwestern willow flycatcher nest failure at all study areas, 2013–17*

Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA. No nesting was documented at RIRA in 2014; WMSP in 2013, 2014, or 2016; or BIWI in 2013. MESQ and MOME were not monitored in 2014, and ALAM was not monitored in 2013.

Study area[1]	Year	Total # of nests	All failed nests	Abandoned	Parasitized	Deserted	Depredated	Tree fell	Nestling died in nest	Addled	Fire	Cause of failure unknown
MUDD	2013	8	7	4 (57)	0	0	3 (43)	0	0	0	0	0
	2014	7	4	2 (50)	0	0	1 (25)	0	1 (25)	0	0	0
	2015	3	1	1 (100)	0	0	0	0	0	0	0	0
	2016	2	2	0	0	1 (50)	1 (50)	0	0	0	0	0
	2017	4	3	0	0	2 (67)	1 (33)	0	0	0	0	0
	Total	24	17	7 (41)	0	3 (18)	6 (35)	0	1 (6)	0	0	0
WMSP	2015	1	0	0	0	0	0	0	0	0	0	0
	2017	2	0	0	0	0	0	0	0	0	0	0
	Total	3	0	0	0	0	0	0	0	0	0	0
TOPO	2013	2	2	0	2 (100)	0	0	0	0	0	0	0
	2014	3	0	0	0	0	0	0	0	0	0	0
	2015	6	5	1 (20)	0	0	2 (40)	0	0	1 (20)	1 (20)	0
	2016	6	6	3 (50)	0	1 (17)	1 (17)	0	0	0	0	1 (17)
	2017	3	3	1 (33)	0	1 (33)	1 (33)	0	0	0	0	0
	Total	20	16	5 (31)	2 (13)	2 (13)	4 (25)	0	0	1 (6)	1 (6)	1 (6)
BIWI	2014	4	2	0	0	2 (100)	0	0	0	0	0	0
	2015	8	3	0	0	3 (100)	0	0	0	0	0	0
	2016	8	4	1 (25)	0	1 (25)	2 (50)	0	0	0	0	0
	2017	3	3	1 (33)	0	2 (67)	0	0	0	0	0	0
	Total	23	12	2 (17)	0	8 (67)	2 (17)	0	0	0	0	0

Table 4-4.—Summary of causes of southwestern willow flycatcher nest failure at all study areas, 2013–17*

Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17. All other data collected by SWCA. No nesting was documented at RIRA in 2014; WMSP in 2013, 2014, or 2016; or BIWI in 2013. MESQ and MOME were not monitored in 2014, and ALAM was not monitored in 2013.

Study area[1]	Year	Total # of nests	All failed nests	Abandoned	Parasitized	Deserted	Depredated	Tree fell	Nestling died in nest	Addled	Fire	Cause of failure unknown
ALAM	2014	24	14	0	0	4 (29)	8 (57)	0	1 (7)	0	0	1 (7)
	2015	36	13	2 (15)	1 (8)	3 (23)	5 (38)	0	0	1 (8)	0	1 (8)
	2016	40	20	4 (20)	1 (5)	5 (25)	10 (50)	0	0	0	0	0
	2017	70	27	2 (7)	1 (4)	8 (29)	15 (56)	0	0	1 (4)	0	0
	Total	170	74	8 (11)	3 (4)	20 (27)	38 (51)	0	1 (1)	2 (3)	0	2 (3)
All study areas	**2013**	**58**	**37**	**14 (38)**	**4 (11)**	**2 (5)**	**15 (41)**	**0**	**0**	**2 (5)**	**0**	**0**
	2014	**81**	**39**	**8 (21)**	**1 (3)**	**12 (28)**	**15 (38)**	**0**	**2 (5)**	**0**	**0**	**1 (5)**
	2015	**100**	**46**	**8 (17)**	**2 (4)**	**9 (20)**	**20 (43)**	**0**	**0**	**4 (9)**	**1 (2)**	**2 (4)**
	2016	**111**	**68**	**10 (15)**	**2 (3)**	**15 (22)**	**39 (57)**	**1 (1)**	**0**	**0**	**0**	**1 (1)**
	2017	**116**	**52**	**6 (12)**	**1 (2)**	**16 (31)**	**23 (46)**	**0**	**1 (2)**	**1 (2)**	**0**	**4 (8)**
Overall total		**466**	**242**	**46 (19)**	**10 (4)**	**54 (22)**	**112 (46)**	**1 (<1)**	**3 (1)**	**7 (3)**	**1 (<1)**	**8 (3)**

* All nesting attempts (those with and without flycatcher eggs) are included. Percentage of failed nests is shown in parentheses for each cause of failure. Abandoned = no flycatcher eggs were laid; deserted = deserted with eggs or young remaining in the nest; depredated = nest empty or destroyed 2 days or more before anticipated fledge date; and parasitized = cowbird young outlived any flycatcher young or appearance of cowbird egg(s) coincided with disappearance of all flycatcher eggs.

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.

Table 4-5.—Fates of southwestern willow flycatcher nests parasitized by cowbirds, 2013–17*
Data collected by the NDOW at KEPI and RIRA in 2017, and MESQ and MOME in 2015–17. All other data collected by SWCA.

Study area[1]	Total # of nests	Abandoned	Addled	Depredated	Deserted	Fire	Nestling died in the nest	Parasitized[2]	Cause of failure unknown	Fledged	Unknown
KEPI	11	0	0	6	3	0	0	1	0	0	1
RIRA	5	1	1	2	0	0	0	1	0	0	0
PAHR	2	0	0	0	1	0	0	1	0	0	0
MESQ	9	0	0	3	3	0	0	1	1	0	1
MOME	4	0	0	0	1	0	0	1	1	0	1
MUDD	7	2	0	2	1	0	1	0	0	1	0
TOPO	7	1	1	1	2	1	0	1[3]	0	0	0
BIWI	5	1	0	0	4	0	0	0	0	0	0
ALAM	8	0	0	0	3	0	0	3	1	0	1
Total	**58**	**5**	**2**	**14**	**18**	**1**	**1**	**9**	**3**	**1**	**4**

* All parasitized nesting attempts with and without flycatcher eggs are included.

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.
[2] Parasitized nests are those where the cowbird egg or cowbird nestling outlived all flycatcher eggs or nestlings.
[3] One additional nest was never found, but the flycatcher pair was found feeding a cowbird fledgling.

Cowbird Egg Addling and Replacement

Field personnel shook one cowbird egg in each of 22 nests in 2013–17. Eleven nests where the cowbird egg was shaken were incubated long enough for it to hatch, and the cowbird did not hatch in seven (64%) of these. One of those seven nests fledged a flycatcher. A cowbird nestling was removed from nine nests, including the four nests where the cowbird egg hatched despite being shaken. Cowbird eggs that were shaken were less likely to hatch than those that were not (one-sided Fisher's exact test, $P = 0.025$; difference in proportions = 0.525, 95% lower bound = 0.14). Despite reducing the hatch rate of cowbird eggs, addling did not have any effect on apparent nest success. One of 22 nests where the cowbird egg was addled successfully fledged a flycatcher, whereas of the 31 parasitized nests where outcome was known and the egg was not addled, none fledged a flycatcher (one-sided Fisher's exact test, $P = 0.415$; difference in proportions = 0.045, 95% lower bound = -0.072).

Field personnel replaced the cowbird egg with a fake cowbird egg at two nests. One of these nests was incubated for several days after the egg was replaced but was ultimately deserted. The other nest was not observed to be active after the egg was replaced, but it is possible it was already deserted at the time of egg replacement.

Mayfield Nest Success

MSP ranged from 0.280 at RIRA to 1.0 at WMSP (though only three nests were monitored at WMSP) and was 0.473 for all study areas combined (table 4-6). Overall MSP for the incubation stage and for the nestling stage were almost identical (71%), while MSP was higher (93%) for the shorter laying stage. Apparent nest success and Mayfield survival probabilities were generally similar (range of the differences is 0–0.15) but did vary among study areas in which method provided the higher estimate (table 4-7). The Mayfield method should provide less biased estimates, but apparent nest success is included to allow comparisons with prior data and other studies.

Model Selection Results

SWCA included a total of 292 nests with known fates in the database used to model nest survival in Program MARK. WMSP had only three nests, all of which were successful, so this study area was not included in the MARK analysis. Using backward stepwise selection, 44 models were evaluated. Of the individual covariates used to model nest survival, nest substrate, age of the nest, and year proved to be the most important. These three variables together created the top

Table 4-6.—Daily survival rates and MSPs for southwestern willow flycatcher nest stages at all study areas, 2013–17

Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17 are not included.

Study area[1]	Nest stage	Nest losses/ observation days	Daily survival rate (SE)	MSP[2]
KEPI	Laying	5/140.5	0.964 (0.016)	0.924
	Incubation	17/828	0.979 (0.005)	0.765
	Nestling	29/514	0.944 (0.010)	0.451
	All stages	51/1482.5	0.966 (0.005)	0.365
RIRA	Laying	0/8	1.000 (0)	1.000
	Incubation	5/87.5	0.943 (0.025)	0.467
	Nestling	1/43.5	0.977 (0.023)	0.727
	All stages	6/139	0.957 (0.017)	0.280
PAHR	Laying	2/106.5	0.981 (0.013)	0.960
	Incubation	10/627.5	0.984 (0.005)	0.812
	Nestling	6/563.5	0.989 (0.004)	0.863
	All stages	18/1297.5	0.986 (0.003)	0.669
MVWA	Laying	2/20	0.900 (0.067)	0.796
	Incubation	2/150	0.987 (0.009)	0.841
	Nestling	0/154	1.000 (0)	1.000
	All stages	4/324	0.988 (0.006)	0.699
MOME	Laying	0/8	1.000 (0)	1.000
	Incubation	4/81	0.951 (0.024)	0.520
	Nestling	0/14	1.000 (0)	1.000
	All stages	4/103	0.961 (0.019)	0.319
MUDD	Laying	0/16	1.000 (0)	1.000
	Incubation	6/185.5	0.968 (0.013)	0.654
	Nestling	4/106.5	0.962 (0.018)	0.591
	All stages	10/308	0.968 (0.010)	0.386

Table 4-6.—Daily survival rates and MSPs for southwestern willow flycatcher nest stages at all study areas, 2013–17

Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17 are not included.

Study area[1]	Nest stage	Nest losses/ observation days	Daily survival rate (SE)	MSP[2]
WMSP	Laying	0/5	1.000 (0)	1.000
	Incubation	0/41	1.000 (0)	1.000
	Nestling	0/42.5	1.000 (0)	1.000
	All stages	0/88.5	1.000 (0)	1.000
TOPO	Laying	1/20	0.950 (0.049)	0.895
	Incubation	6/140.5	0.957 (0.017)	0.569
	Nestling	3/78	0.962 (0.022)	0.584
	All stages	10/238.5	0.958 (0.013)	0.291
BIWI	Laying	2/25.5	0.922 (0.053)	0.838
	Incubation	7/170.5	0.959 (0.015)	0.582
	Nestling	1/132.5	0.992 (0.008)	0.901
	All stages	10/328.5	0.970 (0.009)	0.410
ALAM	Laying	4/148	0.973 (0.013)	0.942
	Incubation	38/1384.5	0.973 (0.004)	0.698
	Nestling	24/1138.5	0.979 (0.004)	0.747
	All stages	66/2671	0.975 (0.003)	0.486
Total	**Laying**	**16/497.5**	**0.968 (0.008)**	**0.932**
	Incubation	**95/3696**	**0.974 (0.003)**	**0.714**
	Nestling	**68/2787**	**0.976 (0.003)**	**0.713**
	All stages	**179/6980.5**	**0.974 (0.002)**	**0.473**

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.

[2] MSP was calculated using 2.17-day egg laying, 12.93-day incubation, 13.72-day nestling stages, and the sum of all for the MSP of all stages combined.

Table 4-7.—MSP and apparent nest success at all study areas, 2013–17 (Data collected by the NDOW at KEPI and RIRA in 2017, MVWA in 2013, and MESQ and MOME in 2015–17 are not included.)

Study area[1]	MSP	Apparent nest success[2]
KEPI	0.365	0.244 (78)
RIRA	0.280	0.333 (9)
PAHR	0.669	0.690 (58)
MVWA	0.699	0.750 (16)
MOME	0.319	0.200 (5)
MUDD	0.386	0.235 (17)
WMSP	1.000	1.000 (3)
TOPO	0.291	0.267 (15)
BIWI	0.410	0.476 (21)
ALAM	0.486	0.512 (162)
All study areas	**0.473**	**0.516 (384)**

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.

[2] Apparent nest success equals the number of successful nests divided by the total number of nests (in parentheses) containing at least one flycatcher egg.

model (table 4-8). Adding further variables to this model only increased the AICc value, as did excluding any one variable. No model carried a high AICc weight (the top model only had 17%), and 15 models were within 4 AICc values of the top model (attachment 9). However, 11 of these 15 models included all 3 of these individual covariates (nest substrate, age of nest, and year), including the top 7 models. Models including all three of these covariates held 82.6% of the model weights across the entire set, whereas individual models containing nest age held 99.6% of the overall model weights, those containing year held 90%, and those containing nest substrate held 94% (attachment 9).

Beta estimates for the top model show that nest survival decreased as the nest increased in age (odds ratio [OR] 0.962, 95% CI 0.941–0.984; table 4-9). ORs greater than 1.0 show an increase in nest survival with an increase in the given variable, while ORs less than 1.0 indicate decreasing nest survival with an increase in the variable. The reference group for the year variable is 2013, and the reference for nest substrate is velvet ash. Beta estimates for year and nest substrate indicate that nest survival was greatest in 2014 (beta estimate of 0.237 is the largest among all years) and highest when the nest was placed in Goodding's willow (beta estimate of 0.217 is the largest positive effect

Table 4-8.—Models within two ΔAICc scores from the highest ranked daily nest survival model for southwestern willow flycatchers across all study areas, 2013–17

Model[1]	AICc	ΔAICc	AICc weight	Model likelihood	# of parameters	Deviance
S{Age+Year+Substrate}	870.1514	0	0.16742	1	10	850.1119
S{Age+Year+Substrate+Sat50}	871.4267	1.2753	0.08849	0.5285	11	849.3792
S{Age+Year+Substrate+Height}	871.821	1.6696	0.07266	0.434	11	849.7735
S{Age+Year+Substrate+Date}	872.0772	1.9258	0.06392	0.3818	11	850.0298
S{Age+Year+Substrate+Tasp5}	872.1183	1.9669	0.06262	0.374	11	850.0709

[1] Age = age of the nest in days, Year = calendar year, Substrate = tree species in which the nest was placed, Sat50 = percentage of the soil within 50 m of the nest that was saturated or inundated, Height = height (m) of the nest, Date = day of the breeding season, Tasp5 = percentage of the vegetation within 5 m of the nest that consisted of tamarisk.

among all nest substrates relative to velvet ash). Estimates of DSR for each year and substrate over the average length of a flycatcher nesting period show this same trend (figure 4-8). Nest age is the only variable for which the 95% CI of the OR does not bound 1.0, indicating a significant negative effect (table 4-9). All other levels of variables have CIs that bound 1.0, and no statistically significant effects between levels were found. This is not surprising, given that all models have low AICc weights, and many models are similar in their AICc values. Model averaging across all models in the set gives a range of estimates of DSR that decline across the season from 0.996 (95% CI 0.991–1.0) to 0.872 (95% CI 0.683–0.955).

Model selection for ALAM revealed a similar trend as the overall model, with the top model having nest age and substrate as factors (table 4-10 and attachment 9). Models including nest age held 74% of the weight across all models, while models including substrate held 85% of the model weights. The direction of these trends was the same for ALAM as for the overall model, with nests placed in Goodding's willow having a higher DSR than those in tamarisk, and DSR decreasing with nest age (table 4-11). However, none of these effects were significant, and there was considerable model selection uncertainty, with 12 models having ΔAICc < 2.0 and no model carrying more than 8.7% of the weight. All 12 models show the same non-significant trends of DSR decreasing with nest age and being higher in Goodding's willow. Models that included date of the season and nest height (the next most common covariate among the top 12 models) show a decrease in DSR with increases in these variables.

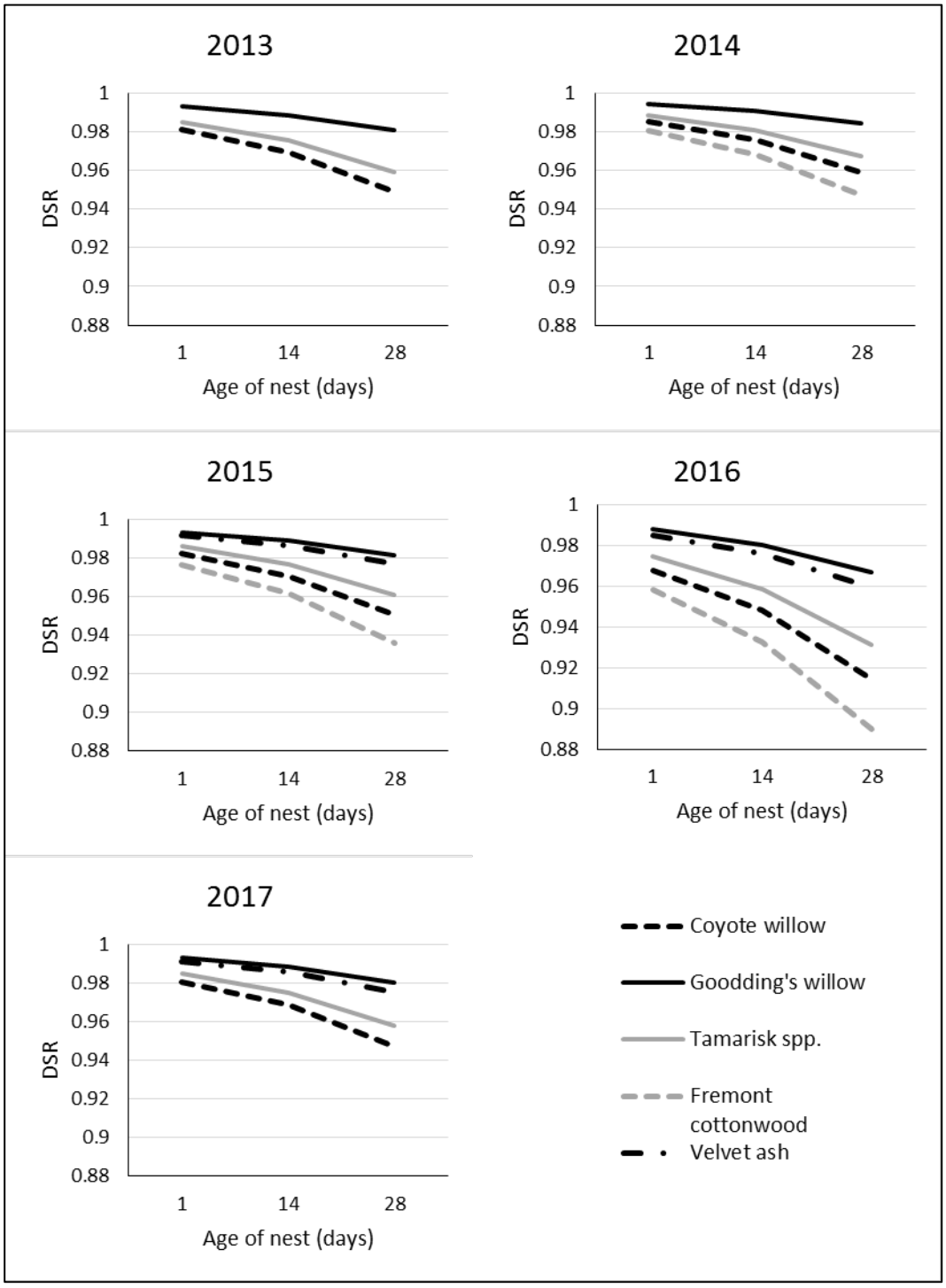

Figure 4-8.—DSR estimates for southwestern willow flycatcher nests for each substrate and year over the average nesting period of flycatchers.
Estimates for some substrates in certain years are not included, as no nests were monitored in those substrates during those years.

Table 4-9.—Beta estimates, ORs, and lower (LCI) and upper (UCI) 95% CIs for variables (nest age, year, and nest substrate) in the top model predicting daily nest survival for southwestern willow flycatchers across all study areas, 2013–17

Individual variable label	Beta[1]	SE	95% LCI	95% UCI	OR	95% LCI	95% UCI
Intercept	4.789	1.071	2.689	6.888	–	–	–
Nest age	-0.038	0.012	-0.061	-0.016	0.962	0.941	0.984
2017	-0.032	0.366	-0.749	0.684	0.968	0.473	1.982
2016	-0.555	0.320	-1.183	0.073	0.574	0.306	1.076
2015	0.038	0.332	-0.612	0.689	1.039	0.542	1.991
2014	0.237	0.362	-0.472	0.946	1.267	0.624	2.576
Coyote willow	-0.793	1.025	-2.803	1.217	0.453	0.061	3.377
Goodding's willow	0.217	1.024	-1.790	2.224	1.243	0.167	9.247
Tamarisk	-0.551	1.029	-2.567	1.465	0.577	0.077	4.329
Cottonwood	-1.068	1.090	-3.205	1.068	0.344	0.041	2.909

[1] Beta estimates for year and nest substrate variables are offsets from 2013 and velvet ash, respectively. Negative estimates indicate lower nest survival when compared with nests from 2013 or in velvet ash, and positive estimates indicate higher nest survival.

Table 4-10.—Models within two ΔAICc scores from the highest ranked daily nest survival model for southwestern willow flycatchers at Alamo Lake, 2014–17

Model[1]	AICc	ΔAICc	AICc weight	Model likelihood	# of parameters	Deviance
S{Age+Substrate}	253.8801	0	0.08735	1	3	247.8682
S{Substrate}	253.9949	0.1148	0.08248	0.9442	2	249.989
S{Age+Substrate+Height}	254.1295	0.2494	0.07711	0.8827	4	246.1096
S{Substrate+Height}	254.3331	0.453	0.06965	0.7973	3	248.3212
S{Date+Substrate+Height}	254.3794	0.4993	0.06805	0.779	4	246.3595
S{Age}	254.9104	1.0303	0.05219	0.5975	2	250.9045
S{Age+Substrate+Sat50}	255.0259	1.1458	0.04926	0.5639	4	247.0061
S{Age+Date+Substrate}	255.2594	1.3793	0.04383	0.5018	4	247.2395
S{Age+Date+Substrate+Height}	255.311	1.4309	0.04271	0.4889	5	245.2812
S{Age+Substrate+Year}	255.4762	1.5961	0.03933	0.4502	6	243.4344
S{Age+Height}	255.5642	1.6841	0.03763	0.4308	3	249.5523
S{Age+Substrate+Tasp5}	255.5982	1.7181	0.037	0.4236	4	247.5783

[1] Age = age of the nest in days, Substrate = tree species in which the nest was placed, Height = height (m) of the nest, Date = day of the breeding season, Sat50 = percentage of the soil within 50 m of the nest that was saturated or inundated, Year = calendar year, and Tasp5 = percentage of the vegetation within 5 m of the nest that consisted of tamarisk.

Table 4-11.—Beta estimates, ORs, SEs, and lower (LCI) and upper (UCI) 95% CIs for variables (nest age and nest substrate) in the top model predicting daily nest survival for Alamo Lake

Individual variable label	Beta[1]	SE	95% LCI	95% UCI	OR	95% LCI	95% UCI
Intercept	4.061	0.485	3.111	5.012	–	–	–
Nest age	-0.034	0.023	-0.079	0.012	0.967	0.924	1.012
Goodding's willow	0.670	0.367	-0.049	1.389	1.954	0.952	4.012

[1] Beta estimates for nest substrate variables are offsets from tamarisk. A positive estimate indicates higher nest survival when compared with nests in tamarisk.

Data from all study areas other than ALAM were lumped together and analyzed again. The analysis without ALAM used the same backward model selection methodology as the original model selection analysis and included the same variables and starting model. The top model included nest age, date of the season, year, study area, the percentage of tamarisk within 5 m of the nest, and the percentage of wet soils within 50 m of the nest (table 4-12). The direction of the effects on DSR of each of these covariates is the same for all models with ΔAICc < 2.0 and is similar to the results from the overall model (table 4-13 and attachment 9). The only significant effects for the top model are a decrease in DSR with increasing nest age and lower survival in 2016 than in 2013. The percentage of wet soils was nearly significant (OR lower 95% CI 1.000). Model results showed considerable model selection uncertainty, with nine models having ΔAICc < 2.0 (table 4-12).

Table 4-12.—Models within two ΔAICc scores from the highest ranked daily nest survival model for all study areas except Alamo Lake, 2013–17

Model[1]	AICc	ΔAICc	AICc weight	Model likelihood	# of parameters	Deviance
S{Age+Date+Year+Area+Tasp5+Sat50}	614.8674	0	0.15182	1	16	582.7138
S{Age+Date+Year+Substrate+Area+Sat50}	614.9895	0.1221	0.14283	0.9408	19	576.7748
S{Age+Date+Year+Area+Sat50}	615.3735	0.5061	0.11788	0.7765	15	585.238
S{Age+Year+Area+Tasp5+Sat50}	615.9093	1.0419	0.09017	0.5939	15	585.7739
S{Age+Date+Year+Substrate+Area+Tasp5+Sat50}	616.3548	1.4874	0.07217	0.4754	20	576.1174
S{Age+Date+Year+Substrate+Area+Height+Sat50}	616.3694	1.502	0.07164	0.4719	20	576.1321
S{Age+Date+Year+Substrate+Area+Tasp5}	616.4891	1.6217	0.06748	0.4445	19	578.2744
S{Age+Date+Year+Area+Tasp5}	616.518	1.6506	0.06651	0.4381	15	586.3826
S{Age+Date+Year+Area+Height+Tasp5+Sat50}	616.8064	1.939	0.05758	0.3793	17	582.6336

[1] Age = age of the nest in days, Substrate = tree species in which the nest was placed, Height = height (m) of the nest, Date = day of the breeding season, Sat50 = percentage of the soil within 50 m of the nest that was saturated or inundated, Year = calendar year, and Tasp5 = percentage of the vegetation within 5 m of the nest that consisted of tamarisk.

Table 4-13.—Beta estimates, ORs, SEs, and lower (LCI) and upper (UCI) 95% CIs for variables in the top model predicting daily nest survival for all study areas except Alamo Lake

Individual variable label[1]	Beta[2]	SE	95% LCI	95% UCI	OR	OR SE	95% LCI	95% UCI
Intercept	3.784	0.788	2.240	5.329	–	–	–	–
Age	-0.064	0.017	-0.098	-0.030	0.938	1.017	0.906	0.970
Date	0.016	0.009	-0.002	0.034	1.016	1.009	0.998	1.035
2017	-0.662	0.496	-1.634	0.310	0.516	1.642	0.195	1.363
2016	-1.373	0.387	-2.130	-0.615	0.253	1.472	0.119	0.541
2015	-0.382	0.386	-1.140	0.375	0.682	1.472	0.320	1.455
2014	0.104	0.423	-0.725	0.933	1.110	1.526	0.484	2.542
KEPI	-0.247	0.818	-1.850	1.356	0.781	2.266	0.157	3.880
RIRA	0.721	1.111	-1.457	2.899	2.056	3.038	0.233	18.157
PAHR	0.851	0.862	-0.838	2.540	2.341	2.367	0.432	12.677
MUDD	-0.777	0.866	-2.474	0.919	0.460	2.376	0.084	2.507
TOPO	-0.850	0.914	-2.642	0.942	0.427	2.495	0.071	2.565
BIWI	-0.971	1.021	-2.972	1.031	0.379	2.776	0.051	2.803
MVWA	1.523	0.996	-0.428	3.475	4.587	2.706	0.652	32.286
Tasp5	0.011	0.007	-0.002	0.024	1.011	1.007	0.998	1.024
Sat50	0.011	0.006	0.000	0.022	1.011	1.006	1.000	1.022

[1] Age = age of the nest in days, Date = day of the breeding season, KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams, MVWA = Meadow Valley Wash, Tasp5 = percentage of the vegetation within 5 m of the nest that consisted of tamarisk, and Sat50 = percentage of the soil within 50 m of the nest that was saturated or inundated.

[2] Beta estimates for year and study area variables are offsets from 2013 and Mormon Mesa. Negative estimates indicate lower nest survival when compared with nests from 2013 or at Mormon Mesa, and positive estimates indicate higher nest survival. For continuous variables, the OR should be considered.

DISCUSSION

Number of Flycatcher Pairs

The changes in the number of flycatcher pairs documented at each study area paralleled the changes in the number of resident flycatchers, which are discussed in chapter 3.

Nest Failure

Depredation was the leading cause of nest failure between 2013 and 2017, as had been the case in previous years. This is consistent with the results reported in other flycatcher studies at sites across Arizona (Ellis et al. 2008; Graber and Koronkiewicz 2009; Graber et al. 2007) and North America (Wilson and Cooper 1998), and depredation is thought to be the main driver for nest success among passerines (Martin 1995, 2015). The depredation rate was highest at KEPI, where depredation accounted for 63% of all nest failures. Although depredation was the leading cause of failure overall, abandonment was the leading cause of nest failure at MOME, MUDD, and TOPO, while desertion was the leading cause of failure at BIWI (see table 4-4). A nest must be found during the building stage in order for abandonment to be detected, and MOME, MUDD, and TOPO were the only study areas where > 75% of nests were found during the building stage. For study areas with at least five nests, linear regression of the percentage of failures that were due to abandonment with the percentage of nests found during the building stage showed that much of the variation in abandonment rates was explained by the proportion of nests found during the building stage ($R^2 = 0.64$). When only nests with flycatcher eggs were considered, depredation was the leading cause of failure at all study areas except BIWI, where desertion was the leading cause, and MVWA, where desertion and depredation occurred equally. Across all study areas, desertion was associated with parasitism, with 35% of deserted nests having been parasitized.

Of the 38 depredation events at KEPI in 2013–17 where the nesting stage was known, 26 (67%) occurred during the nestling phase. This is more than a threefold increase compared to 2010–12, when only 7 of the 35 (20%) depredation events were in the nestling phase (SWCA, unpublished data). This same trend occurred across all other study areas combined. In 2010–12, 12 (23%) of 52 depredation events where the nesting stage was known occurred during the nestling phase, compared with 32 of 64 (50%) in 2013–17 (SWCA, unpublished data). The high rate of depredation during the nestling phase likely contributes to the importance of nest age in nest survival models, where survival decreases with increasing nest age.

At KEPI, likely predators of nestling flycatchers in recent years include a pair of Cooper's hawks (*Accipiter cooperii*), which have nested at KEPI annually since 2013. Cooper's hawks may also reduce the fledgling survival rate in addition to depredating nestlings. Cooper's hawks were the primary nest predator documented in a nest camera study of flycatchers in central Arizona (Ellis et al. 2008). This study also determined that several nests were depredated late in the nesting cycle and would have been erroneously considered successful if traditional methods of determining nest success (nestlings present within 2 days of fledge date) were used. For open-cup nesting passerines, nest depredation rates can vary year to year, and sometimes substantially, with depredation of eggs and

young ultimately linked to landscape characteristics and fluctuations in predator densities, abundance, and richness (Howlett and Stutchbury 1996; Robinson 1992; Wiens 1989).

Brood Parasitism

The overall parasitism rate observed in 2013–17 (14%) was slightly higher than those reported at other monitored sites across Arizona in 1996–2006, which were less than 10% at most sites in most years (Ellis et al. 2008; Graber et al. 2007). Parasitism rates were 26% in 2013 and 12–15% in 2014–17. The relatively low parasitism rates observed in 2014–17 do not indicate a change in the abundance or activities of cowbirds but rather reflect the addition of ALAM in 2014. ALAM, which had a low parasitism rate (3.3–10.7% in 2014–17), accounted for over one- third of all flycatcher nests with known parasitism status in 2014–17.

Ten out of 242 (4%) instances of nest failure were directly attributed to cowbirds (i.e., cowbird young outlived any flycatcher eggs or young, or the disappearance of all flycatcher eggs coincided with the appearance of cowbird eggs). However, cowbirds can influence flycatcher productivity in other ways. Flycatchers may abandon or desert parasitized nests. Cowbirds often eject a host egg during the parasitism event, reducing the host clutch size. Female cowbirds are known to physically attack willow flycatcher nestlings (Woodward and Stoleson 2002), remove single eggs, and occasionally destroy entire broods after laying is complete or after hatching (Lowther 1993). In addition, cowbirds were photographed removing eggs from artificial nests during a camera study completed in 2008–10 by Northern Arizona University at sites along the LCR and in southern Nevada, and cowbirds were documented on video depredating flycatcher nests during both the incubation and nestling phases (Theimer et al. 2011). In the Virgin Valley, cowbirds were the only species documented depredating flycatcher nests. The Northern Arizona University camera study documented other avian predators at both artificial and flycatcher nests in other areas, with diversity of predators correlated to the diversity of the local avian community. While it is possible that other species, such as yellow-breasted chats (*Icteria virens*), are also responsible for some depredation events, it is likely that in study areas where cowbirds are abundant, many depredation events on eggs and nestlings are attributable to cowbirds.

Parasitism does not invariably cause nest failure, but the success rate (2%) for parasitized nests at all study areas in 2013–17 was a fraction of that of unparasitized nests (53%). The success rate of parasitized nests in 2013–17 was lower than that (18%) observed across all study areas over the previous 10 years (one-sided Fisher's exact test, $P = 0.002$). It is not clear why the success rate of parasitized nests has declined, but it is not related to efforts in recent years to addle or replace cowbird eggs in flycatcher nests (see "Cowbird Egg Addling and

Replacement," below). Other studies have shown that parasitism reduces nest success. Sedgwick and Iko (1999) recorded a 50% decrease in success rates of parasitized compared to unparasitized willow flycatcher nests in Oregon. At other sites in Arizona in 1996–2005, 20% of parasitized flycatcher nests fledged flycatcher young versus 57% of unparasitized nests (Ellis et al. 2008).

Parasitized nests that did succeed in fledging flycatcher young at all study areas in 2003–17 produced, on average, fewer young (1.3 young/nest) than did unparasitized nests (2.2 young/nest; Welch statistic $F_{1,32.4} = 57.6$, $P < 0.001$). In addition to the female cowbird ejecting eggs during the parasitism event, cowbird young also cause interspecific nestling competition, as evidenced by the presence of severely underdeveloped nestlings in some parasitized nests. For all nests monitored from 2003 to 2016, 40% of nests that fledged a cowbird also fledged flycatcher young. This is a higher rate of success than that observed in flycatchers at Kern River, California (9%) (Whitfield and Sogge 1999), but comparable to that observed at other Arizona sites (40%) (Ellis et al. 2008).

Repeated parasitism events over a female flycatcher's lifetime can reduce lifetime productivity (McLeod and Pellegrini 2013). In addition, flycatchers that fledge late in the season have been shown to have a lower survival rate than those that fledge early in the season (McLeod and Pellegrini 2013; Paxton et al. 2007; this document), suggesting additional hidden effects of parasitism and subsequent renesting on flycatcher demography. Across all study areas and all years through 2012, female flycatchers that were parasitized at least once during the season and still produced a successful nest had fledge dates that were, on average, 10 days later than successful females who were not parasitized. This 10-day delay corresponds to a reduced juvenile survival probability of approximately 6% (McLeod and Pellegrini 2013).

Cowbird Egg Addling and Replacement

While it was clear that addling cowbird eggs in 2013–17 reduced the likelihood that the egg would hatch, addling did not affect the chances of a nest successfully fledging a flycatcher. When data from all years (2010–17) of the egg addling program were considered, the results were similar: 4 (10%) of 38 nests where eggs were addled successfully fledged a flycatcher, while 1 (2%) of 44 parasitized, un-addled nests fledged a flycatcher (Fisher's exact test, $P = 0.177$; difference in proportions = 0.083, 95% lower bound = -0.037). Nearly 40% of nests where cowbird eggs were shaken were ultimately depredated, and high depredation rates may obscure any positive effects of addling cowbird eggs. Nest monitoring data collected in 2003–09 showed that parasitized nests in which the cowbird egg did not hatch produced more flycatchers per nest than did parasitized nests where the cowbird egg hatched (McLeod and Pellegrini 2013).

Replacing cowbird eggs with artificial eggs eliminates the possibility of cowbird eggs hatching, and field personnel replaced two cowbird eggs with fake eggs, one in 2016 and one in 2017. One nest was ultimately deserted, although the female flycatcher continued to incubate the nest for several days after the egg was replaced. No activity was observed at the other nest after the cowbird egg was replaced, but the nest may have already been deserted by the female prior to egg replacement. The replacement eggs are slightly larger (23 x 17 mm) than cowbird eggs within the study areas (approximately 19 x 15 mm; SWCA, unpublished data). Size is a factor that host species use when rejecting foreign eggs, although its relative importance may vary (Igic et al. 2015), and the size of a foreign egg may impact a flycatcher's decision to desert its nest. Careful observation of flycatcher nests both before and after egg replacement would help determine whether egg replacement influences nest desertion. Currently, with cowbird eggs having been replaced in only two nests, not enough data are available to determine whether egg replacement is an effective alternative to egg addling.

Nest Survival Modeling

Nest survival modeling results from all study areas combined were strongly influenced by data from ALAM, which had over half of the total number of nests. Modeling ALAM and the remaining study areas separately illustrated this influence. Despite the tendency of flycatchers to nest close to water (McLeod and Pellegrini 2013; Paradzick 2005; Paradzick and Woodward 2003; Stoleson and Finch 2003), the amount of wet soils within 50 m of the nest did not have a strong influence on nest survival for all study areas combined. When ALAM was removed from the dataset, however, the amount of wet soils was a factor in seven of the nine competing models, and the effect of wet soils was marginally significant, with nest survival increasing with an increasing percentage of wet soils. The presence of wet soils could influence flycatcher nest success by deterring terrestrial predators, promoting dense vegetation, providing a more favorable microclimate, or increasing the food supply of emergent aquatic insects. At ALAM, there was a large change in the presence of wet soils between years but little variation within years, with flycatcher breeding sites being completely dry in 2014–16 and primarily inundated in 2017. Any effect of the presence of wet soils on nest success would be confounded with the effect of year, but there was little evidence that either wet soils or year were important factors in the models for ALAM. The primary cause of nest failure in all years at ALAM was depredation, but the specific predators, and whether they would be affected by the presence of water, are unknown.

When data from all study areas were modeled together, nest survival was most influenced by nest substrate, nest age, and year. However, there was considerable model uncertainty, as evidenced by low model weights across the model set (see table 4-8 and attachment 9). This means that nest survival may be influenced by

any of the covariates tested (see table 4-1). Nevertheless, models including nest substrate, nest age, and year held 82.6% of all model weights, and all three were present in the top seven models. Nests placed in Goodding's willow had the highest survival, while nests in tamarisk had survival estimates below those in Goodding's willow and velvet ash but above those in coyote willow and cottonwood (see table 4-9). The significance of nest substrate in the model may in part be attributable to correlations between this variable and the vegetation and environment of the local area. Study areas varied in the relative abundance of each tree species, and nests placed in a given substrate were thus not distributed evenly across all study areas. The vast majority of nests in Goodding's willow occurred at PAHR and ALAM, and velvet ash occurred as a nest substrate only at MVWA and WMSP; these four study areas had the highest nest success among all the study areas.

When ALAM was excluded from the models, substrate was not as important in predicting nest survival, but study area was a factor in all competing models. This could indicate that the higher survival of nests in Goodding's willow is confounded with higher survival in study areas consisting mostly of Goodding's willow. It is also possible that nest substrate is correlated with some other variable that is a strong predictor of nest success but was not included in the model. Although substrate was a predictor of nest survival in the model set for ALAM, the effect was not significant. Nest substrate appeared to influence nest success in some years in STGE, where flycatcher nests placed in tamarisk in 2010–11 were more likely to fledge young than those placed in coyote willow (Dobbs et al. 2012).

Nest survival varied with nest age in all model sets, with survival decreasing with increasing nest age. Depredation was the leading cause of nest failure; combined with decreasing survival over time, this finding may indicate that flycatcher nests become more obvious to predators as the young grow older. Other studies have also found that nest survival decreases with age (Brawn et al. 2011; Conkling et al. 2012; Gillespie and Dinsmore 2014) and point toward an increase in activity levels at the nest as the potential reason, especially in places where the main predators are visual and diurnal (Libsch et al. 2008). SWCA and collaborators at Northern Arizona University identified almost exclusively diurnal and avian species as nest predators in a nest camera study along the Colorado and Virgin Rivers and in the Pahranagat Valley (McLeod and Pellegrini 2013). This supports the hypothesis that at least in a system with largely visual, diurnal predators, nest depredation may increase as the nest ages because parental activity at the nest may increase and nestlings become louder (Skutch 1949).

Nest survival varied by year in the overall model set and in the analysis that excluded ALAM. Yearly variation in nest survival did not show a unidirectional trend, however, with nest survival being the highest in 2014 and lowest in 2016. Some study areas did not have monitored nests in all years, so the effects of study area and year may be confounded.

In an analysis comparing flycatcher nests parasitized by cowbirds to unparasitized nests, Stumpf et al. (2012) found that parasitized nests' survival decreased throughout the season, while unparasitized nests' survival did not. All nests were lumped together in the current analysis for this study, but no support was found for a trend in nest survival related to day of the season. Parasitized nests were not compared with unparasitized nests in this study because most parasitized nests were altered by addling or replacing cowbird eggs.

Nest Success and Fecundity

Nest success alone is an incomplete measure of the production of young. Successful nests produce from one to four young, and variations in nest productivity are not reflected in nest success rates. In addition, although every failed nest attempt lowers apparent nest success and the DSR, success of a subsequent nesting attempt by the same individual may result in the same number of young produced as if the initial nesting attempt had been successful. Thus, nest productivity (young produced per nesting attempt of known outcome) and fecundity (young produced per female with known outcome) in conjunction with nest success provide additional information on the success of a given breeding season.

Nest success, whether measured by apparent success, MSP, or Program MARK, varied among study areas. WMSP had no nest failure but only had three total nests. Of the other study areas, MVWA and PAHR had the highest nest success using all three measures (see table 4-7). PAHR had similarly high nest success in years prior to 2013 (McLeod and Pellegrini 2013) and had consistently high fecundity. MVWA, like PAHR, also had high fecundity in addition to high nest success. Nest success at ALAM was the next highest as measured by all three methods, though it was 18% lower than at PAHR as measured by MSP or apparent nest success but only 6% lower as estimated in Program MARK (see table 4-7). Nest success at ALAM, PAHR, WMSP, and MVWA is likely influenced by the relatively low incidence of brood parasitism at these study areas. Fecundity at ALAM was markedly lower than at the other three study areas with high nest success. This was the result both of ALAM having somewhat lower nest success than the other study areas and of each successful female at ALAM producing fewer confirmed fledglings than those at PAHR and MVWA. The number of fledglings is more likely to be underreported at ALAM than at the other study areas, however. A lower proportion of nestlings were banded at ALAM, and not all nests could be visited on or immediately following the anticipated fledge date. Both factors make it more difficult to confirm that all nestlings have fledged, and ALAM had a higher proportion of nestlings with unknown fate than did PAHR, MVWA, and most of the other study areas.

The three methods of calculating nest success varied in how the remaining study areas were ranked, but KEPI, MUDD, and TOPO had the lowest nest success as

averaged across the three methods. Both MUDD and TOPO had high rates of parasitism, while KEPI had a high rate of depredation (see "Nest Failure," above). These three study areas also had low fecundity in 2013–17, both because fewer females had successful nests and, in the case of MUDD and TOPO, because successful females tended to have fewer fledglings than at other study areas. Unlike at ALAM, no successful nests at MUDD or TOPO had nestlings whose fate was unknown.

MESQ was not included in the MSP and nest survival analyses, but it had the lowest apparent nest success of any study area in 2013–17. However, MESQ also had the highest proportion of nests with unknown fate, and apparent nest success may be an underestimate. Fecundity at MESQ was comparable to that at MUDD and TOPO. Like MUDD and TOPO, MESQ had a high parasitism rate. The number of breeding flycatchers, nest success, and fecundity all declined strongly at MESQ in 2009–13 (McLeod and Pellegrini 2013, 2014). These declines were associated with changes in habitat quality caused by there being less surface water than in previous years. Similarly, increases in the number of breeding flycatchers and fecundity in 2015–17 have been associated with increases in surface water and the growth of woody riparian vegetation in areas that had previously been dominated by cattails (M.A. McLeod, personal observation).

Flycatcher Nesting and Tamarisk Defoliation

Defoliation of tamarisk by tamarisk beetles, and in some cases the subsequent dieback of the tamarisk, has been observed at multiple study areas where flycatchers nest in stands with a significant tamarisk component. At MOME, defoliation first occurred in flycatcher nesting areas at the end of the breeding season of 2011, after most flycatcher nesting activity had already concluded. Tamarisk at MOME were defoliated throughout the 2012 breeding season (McLeod and Pellegrini 2013). No defoliation events occurred during the flycatcher breeding season in 2013, but defoliation from the previous 2 years resulted in 84% dieback of the tamarisk at MOME (Hultine et al. 2015). As of 2017, tamarisk at MOME was still largely dead, and dense canopy closure was present only within clumps of coyote willows (M.A. McLeod, personal observation). Extensive defoliation first occurred at MUDD in mid-June of 2012 (McLeod and Pellegrini 2013). Tamarisk dieback was evident in the following year, though it was not as severe or widespread as at MOME. Defoliation events occurred at MUDD during each breeding season in 2014–17, and the tamarisk continued to exhibit dieback.

No other study areas with a significant tamarisk component were affected by tamarisk beetles until 2016. Beetles and defoliation were present near flycatcher breeding sites at both TOPO and BIWI late in the summer of 2016, but no defoliation occurred within occupied flycatcher sites during that breeding season. In 2017, however, both sites at BIWI that had breeding flycatchers were

defoliated throughout the breeding season. Tamarisk within occupied flycatcher sites at TOPO were green in mid-May 2017, turned brown in June, and were leafless by early July. Beetles arrived at ALAM during the 2017 breeding season. Santa Maria North 01, the only nesting site at ALAM where tamarisk made up a significant proportion of the vegetation, was defoliated starting in mid-June.

In the 4 years prior to 2012, the number of pairs at MOME varied between 10 and 13, and fecundity averaged 1.4 young per female. In 2012, the first year in which defoliation at MOME occurred during the height of the flycatcher breeding season, there were 14 flycatcher pairs at MOME, fecundity was 0.6 young per female, less than half of that in previous years (see figure 4-6), and half of the nests failed as the result of desertion or abandonment. In 2013, the number of flycatcher pairs at MOME had declined to seven, fecundity was only 0.1 young per female, and again half of the nests failed from desertion or abandonment. Two or three flycatcher pairs were present in each year in 2015–17, and all flycatcher activity was centered in small stands of coyote willows, which provided the only remaining dense vegetation. Hydrological conditions within the site did not appear to change over the 2008–17 period, and the low fecundity observed in 2012–13 and the subsequent decline in the number of breeding flycatchers is likely the result of tamarisk defoliation and mortality.

At MUDD, defoliation resulted in short-term reductions in canopy closure as well as long-term dieback of the tamarisk. Any effects of tamarisk defoliation on flycatchers were confounded, however, with a concurrent change in the distribution of surface water at the site (see chapter 2). Yellowing of the tamarisk near flycatcher nests at TOPO was first apparent in June 2017, and tamarisk throughout the study area was fully defoliated by early July. All three nesting attempts at TOPO in 2017 failed. However, all nests at TOPO also failed in 2016, prior to the arrival of beetles, and additional years of observation are required to assess the effects of defoliation on flycatchers. All sites that have contained nesting flycatchers at TOPO have a significant tamarisk component, and continued defoliation events and/or dieback of the tamarisk are likely to adversely affect flycatchers.

In 2015–16, almost all flycatcher nesting activity at BIWI occurred at sites near the mouth of the Bill Williams River, where tamarisk makes up a significant proportion of the vegetation. Five or six pairs were present in each year, and average fecundity was 1.3 young per female. The tamarisk within those sites were defoliated by May 2017, when flycatchers would have been settling on their territories. Only three pairs were detected in 2017, two of which were confirmed to have nesting attempts. All nesting attempts at BIWI in 2017 were either abandoned before eggs were laid or were deserted early in the incubation stage. The presence of fewer breeding pairs and nest desertion both suggest that conditions were not favorable for breeding flycatchers at BIWI in 2017.

Santa Maria North 01, the only site with a significant tamarisk component at ALAM that was occupied by breeding flycatchers in 2017, was occupied by flycatchers in each of the three previous years, over which time average fecundity was 1.75 young per female. Santa Maria North 01 was defoliated in the middle of the flycatcher breeding season in 2017. Both nests that were initiated in May successfully fledged young, while all seven nests that were initiated in June or July, and thus overlapped with the defoliated period, failed. Three of those seven nests were deserted, and a fourth was incubated for over 20 days but never hatched.

Defoliation is expected to have adverse effects on nesting flycatchers, and other riparian obligate birds, via increased solar radiation at nests, increased visibility of nests that leads to depredation or parasitism, and increased nest abandonment and desertion (Paxton et al. 2011). Unusually high rates of abandonment and desertion were observed at MOME, BIWI, and ALAM when flycatchers attempted to nest in defoliated tamarisk stands, and defoliation was also associated with higher temperatures at flycatcher nests (see chapter 5). In 2013–17, in tamarisk-dominated sites at TOPO, BIWI, and ALAM, nests at which defoliation occurred during building, laying, and/or incubation were less likely to fledge young (0 of 13 nests) than nests at which defoliation did not occur during these nest stages (22 of 38 nests; one-sided Fisher's exact test, $P < 0.001$; difference in proportions = 0.58, 95% lower bound = 0.34).

Chapter 5 – Nest Site Characteristics

INTRODUCTION

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. 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 nests at multiple study areas.

METHODS

Surface Hydrology

Surface hydrology was described near all active nests two to three times during the life of each nest in 2013–17. 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 a GPS unit in the field (finding the nearest wet soil, recording the GPS location, and setting the GPS unit to navigate back to the nest, thus displaying distance from wet soils back to the nest), or (3) by measuring on a georeferenced aerial photograph (either on a hard-copy aerial photo or by using the measuring tool in Google Earth or Pathfinder). 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 at three nest stages: (1) when the nest was found, (2) 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 (3) 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. Occasionally, data for a nest were collected on two different days for the same nest stage because an observer did not realize the data were already collected; when this occurred, only the estimate closer to the transition date was used in data summaries.

In 2013, several potential biases were identified in surface hydrology data collected at several study areas. At KEPI, the accuracy of the estimates of distance to wet soil declined as the season progressed and water receded away from the coyote willow stands and into the dense bulrush marsh. When water was not visible from the edge of the coyote willow, field personnel often used the aerial photograph to determine distance to wet soils and identified the nearest wet soil as being the open water of the lake, rather than its true location in the dense bulrush, somewhere between the edge of the coyote willows and the open water. Distance to wet soils was thus overestimated, and the percentage of wet soils within 20 and 50 m was correspondingly underestimated. Similar patterns were identified at PAHR, where wet soils were mapped twice during the 2013 breeding season. After the field season, the water mapping data were used to create shapefiles showing the extent of wet soil on the sampling dates. The field estimates of wet soil near each nest were then compared with those calculated from the shapefiles. This exercise illustrated that field estimates of the extent of wet soils declined in accuracy as the season progressed and water receded. At MUDD, wet soils have been confined to the river channel in recent years, and the linear distribution of these soils seems to lead observers to overestimate their extent.

In 2014, the location of wet soils was mapped at both KEPI and PAHR on a biweekly schedule starting in late May for use in generating more accurate estimates of the extent of wet soils near each nest. Field personnel were generally able to walk the edge of the water at PAHR. At KEPI, field personnel walked several transects perpendicular to the shoreline and out into the marsh until they encountered wet soils. The location of the water's edge was then estimated by

interpolating between each transect along the length of the shoreline. GPS data collected during water mapping in the two study areas were used to generate a series of shapefiles in ESRI® ArcMap v 10.2. These shapefiles were overlain with 20- and 50-m buffers around each nest location. The areas where the two layers intersected were extracted and the percentage of each buffer that intersected the water mapping shapefile was calculated. At KEPI and PAHR, the field estimates were compared to the corresponding water mapping estimates closest (≤ 7 days) to a nest's transition date (found, hatch, fledge, or fail). The data source closest to the transition date at a nest was used if soil condition was the same in both data sources (i.e., either saturated/inundated or damp/dry) or if there was a discrepancy in soil condition that was consistent with the site gradually drying out (i.e., the data collected later showed a drier soil condition). The field estimate was used if the discrepancy in soil condition between the two data sources was inconsistent with the site gradually drying out (i.e., the data collected later showed wetter soil conditions) and in instances where both data source were equidistant from the transition date, unless the field estimate had already been excluded as described above. In 2015, water mapping was conducted at KEPI and PAHR, but data only included the location of standing water and not saturated soil and were therefore not used in any analysis. Water mapping was not conducted in either study area in 2016 or 2017 due to limited available field effort.

At MUDD, a shapefile of the river channel was generated using aerial imagery in ESRI® ArcMap v. 10.2, and the percentage of the area within 20 and 50 m of each nest that contained wet soils was calculated as explained above. Field estimates were compared with the calculated values for each year in 2014–17. When the difference between the two was more than 10%, only the calculated value was included in the final dataset at MUDD.

Vegetation

Vegetation characteristics were recorded at each nest in 2014–17. Field personnel 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 2 and 5 m of 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

Temperature and Humidity

Temperature and humidity at flycatcher nests were measured in 2013–17 by deploying an iButton (Maxim Integrated, San Jose, California) near the nest. The iButton was mounted on a key fob and hung in an inconspicuous location, no higher than 2 m above the ground but below nest height, and within 2 m horizontal distance of the nest. The iButton was deployed after the nest was confirmed to have progressed beyond the laying stage. The loggers recorded temperature and relative humidity (RH) every 30 minutes and remained in place until late July or until all nests at the study area were nearing completion, whichever was later. IButtons were deployed at MOME, MUDD, and TOPO in 2013; TOPO, BIWI, and ALAM in 2014; MUDD, TOPO, BIWI, and ALAM in 2015; and TOPO, BIWI, and ALAM in 2016 and 2017.

Statistical Analyses

Surface Hydrology

Data were classified into 2-week intervals between May 15 and August 15. For soil condition at each nest, the frequency of occurrence of each type of soil condition (inundated, saturated, damp, and dry) was summarized for each 2-week interval. Frequencies are presented as the percentage of all data points for each 2-week interval. For distance to wet soils, water depth, and percentage of wet soils within 20 and 50 m of each nest, the data were summarized by calculating the mean for each metric by 2-week interval within each study area across all years. At KEPI, only data from 2014–16 were used, given the bias identified in the distance-to-water data from 2013.

Data on distance to wet soils, water depth, and percentage of wet soils within 20 and 50 m were summarized as described above for the subset of nests for which data were collected within 1 week of the nest being found while it was being built. Surface hydrology described within 1 week of a nest being found during building closely reflects the conditions when the nest site was selected (assuming surface hydrology does not fluctuate widely from day to day).

Data were not normally distributed for any of the variables. Variance increased with increasing date for distance to wet soils but not for the other three metrics. The shape of distributions varied among the groups for the percentage of wet soils within 20 and 50 m, and Welch's ANOVA was used to test for any difference in means among the 2-week intervals for all variables. Analyses of surface hydrology metrics at nests found during building, as well as the summary of all surface hydrology data, were completed in R v. 3.4.3.

Temperature and Humidity

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 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. 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 RH data were obtained from weather stations at the Nellis Air Force Base near Las Vegas, Nevada (station ID WBAN23112) and the Needles airport near Needles, California (station ID WBAN23179). These data were summarized as described for the iButton data. Daily maximum and minimum temperature data were obtained from weather stations in Overton, Nevada (USC00265846) and at Alamo Dam, Arizona (USC00020100). No temperature data were available from Alamo Dam for August 2017 at the time data were obtained. For each temperature and humidity variable, the daily value recorded by the iButton was subtracted from the value recorded at the nearest

[1] Vapor pressure, unlike RH, 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).

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 by study area and year to allow for comparisons among years while controlling for interannual differences in the weather. At ALAM in 2017, all nesting sites except for Santa Maria North 01 were inundated throughout the season, and Santa Maria North 01 was the only site where significant tamarisk defoliation took place (see chapter 2). Therefore, data collected at nests at Santa Maria North 01 were summarized separately for 2016 and 2017 to allow for examination of the effects of inundation and defoliation. Analyses of temperature and humidity and a summary of vegetation data were completed in IBM ® SPSS ® v. 22.0.

RESULTS

Surface Hydrology

Soil moisture characteristics were recorded at 405 nests in 2013–17 at KEPI (88 nests), RIRA (8 nests), PAHR (64 nests), MVWA (17 nests), MUDD (24 nests), WMSP (3 nests), TOPO (18 nests), BIWI (22 nests), and ALAM (161 nests). Average soil moisture characteristics across all years at KEPI, RIRA, PAHR, and MVWA all showed general drying trends between May 15 and August 15 (figures 5-1 and 5-2). The proportion of nests over wet soils declined through the season at KEPI and PAHR. Water depth was higher in late May, with an average of up to 30 cm, and lower in early August, with average water depth reaching 5 cm. Distance to wet soils also increased from 0–3 m in late May to as high as 227 m in early August (at RIRA). The average percentage of wet soils within 20 m of a nest declined from 45–92% in late May to 0–38% in early August, while the average percentage of wet soils within 50 m of a nest declined from 20–76% in late May to 0–34% in early August.

At MUDD, the only seasonal changes in soil moisture characteristics were an increase in average water depth beneath a nest from 0 cm in late May to 70 cm in early August and a strong increase in the proportion of nests over inundated soils (figures 5-3 and 5-4). The average distance to wet soils was 35 m in late May and < 5 m in each 2-week interval thereafter. The average percentage of wet soils within 20 and 50 m of a nest was relatively constant and was < 10% in each interval. At TOPO, no seasonal trends in surface hydrology were apparent in the data (figures 5-3 and 5-4), although marsh levels declined gradually over each breeding season (see figure 2-8). Weak seasonal trends in surface hydrology were apparent at BIWI, with slight increases in distance to wet soils and slight decreases in the percentage of wet soils (figure 5-4). Almost all nests at BIWI in 2013–17 were in sites where water levels depend on the level of Lake Havasu, which fluctuated but showed no trend during the summer months of each year (see figure 2-9).

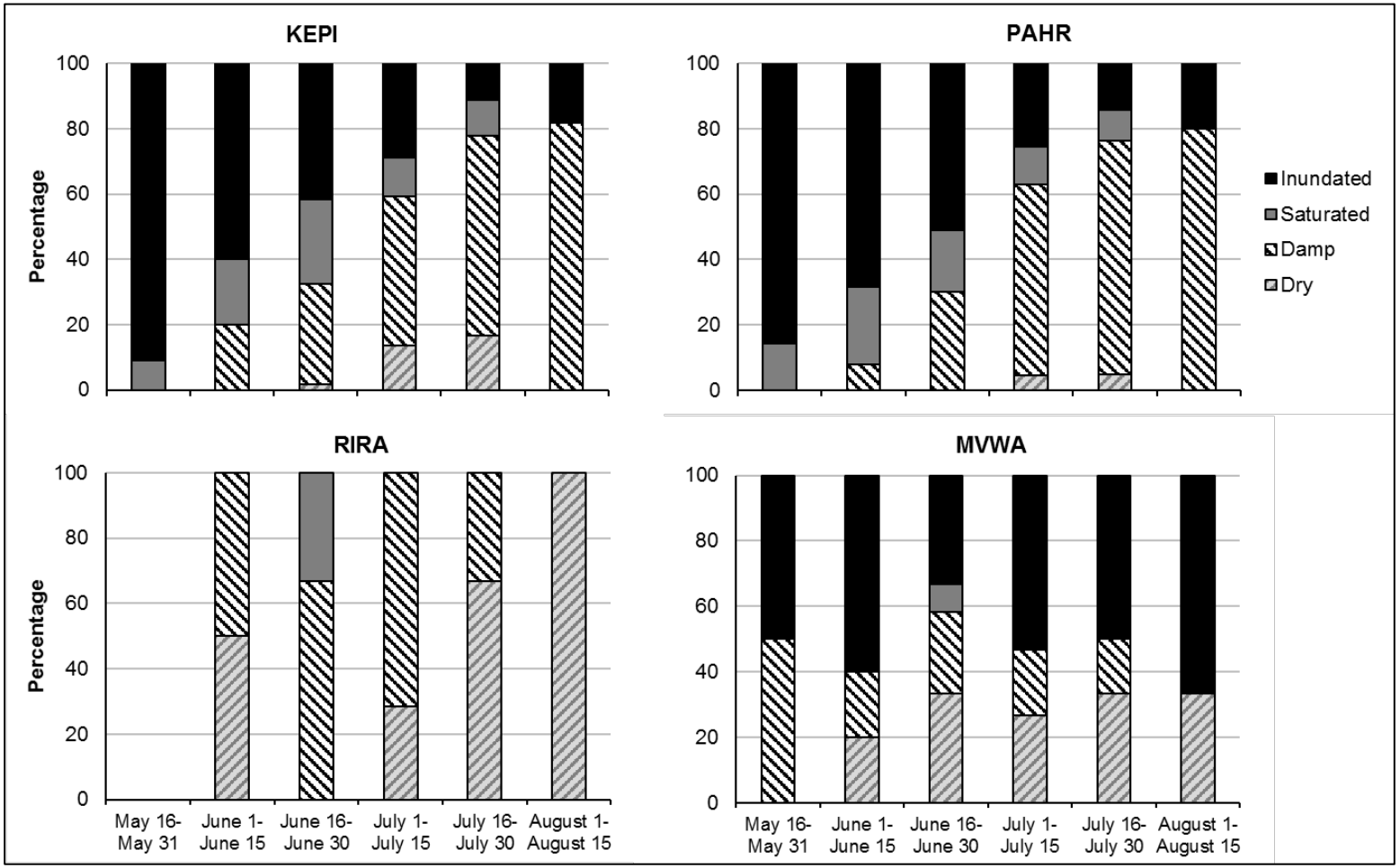

Figure 5-1.—Soil conditions at southwestern willow flycatcher nests at Key Pittman (KEPI), Pahranagat (PAHR), River Ranch (RIRA), and Meadow Valley Wash (MVWA), 2013–17.
Data represent the percentage of nests during each 2-week interval where each type of soil condition occurred.

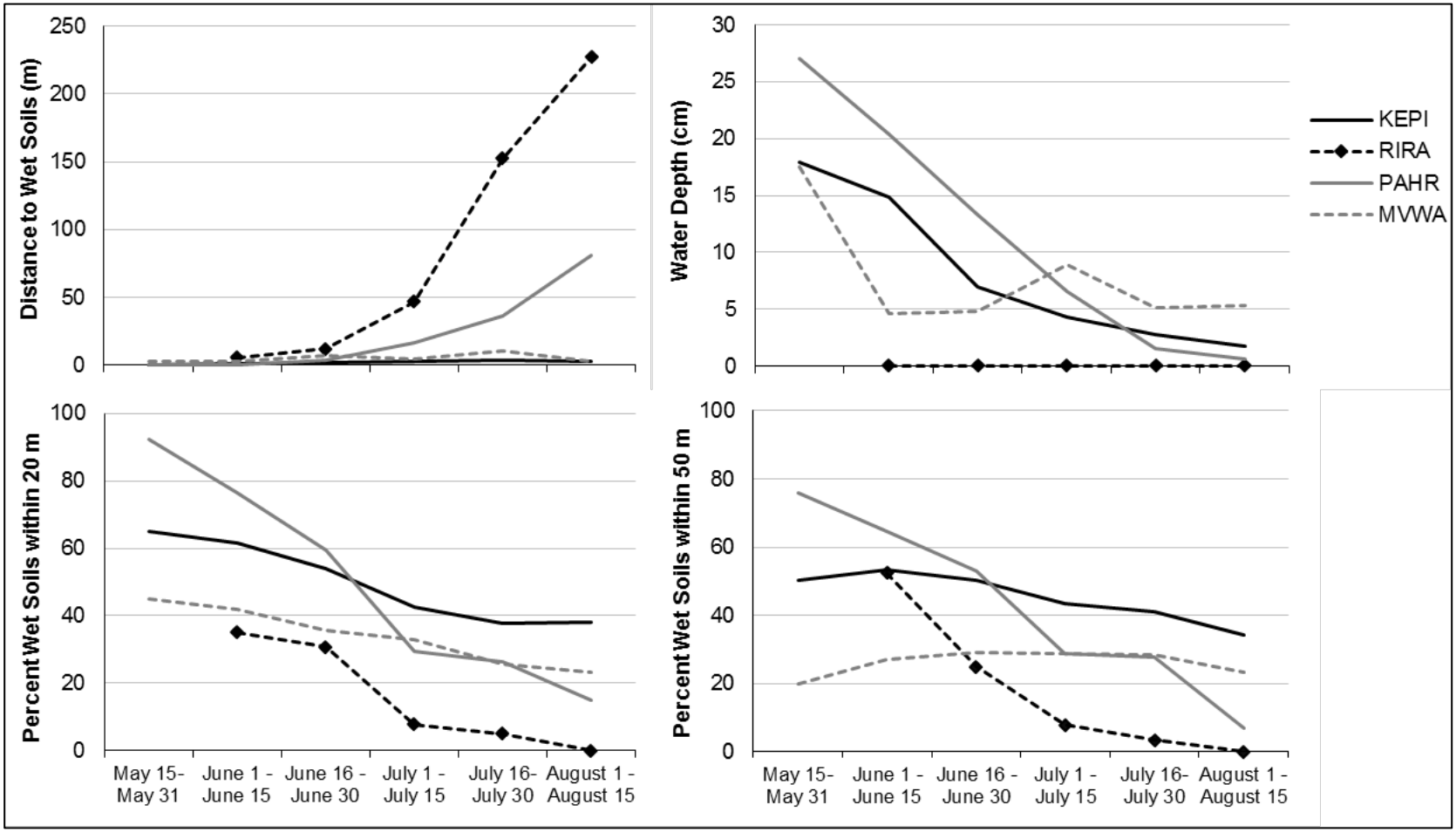

Figure 5-2.—Average soil moisture characteristics at southwestern willow flycatcher nests at Key Pittman (KEPI), Pahranagat (PAHR), River Ranch (RIRA), and Meadow Valley Wash (MVWA), 2013–17.
Wet soils include both saturated and inundated soils. Data represent the average of all data points in each 2-week period across all years by study area.

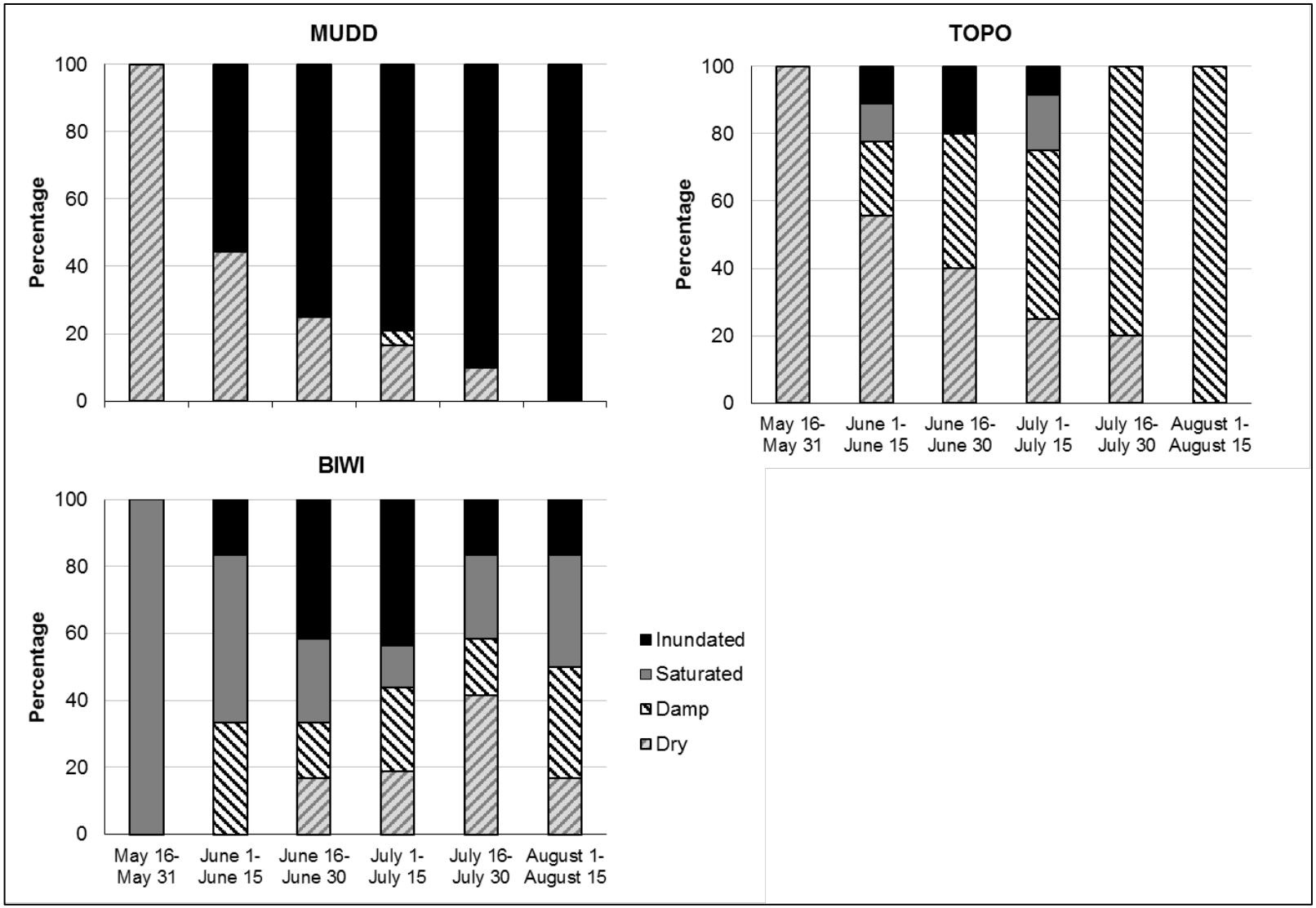

Figure 5-3.—Soil conditions at southwestern willow flycatcher nests at Muddy River (MUDD), Topock Marsh (TOPO), and Bill Williams (BIWI), 2013–17.

Data represent the percentage of nests during each 2-week interval where each type of soil condition occurred.

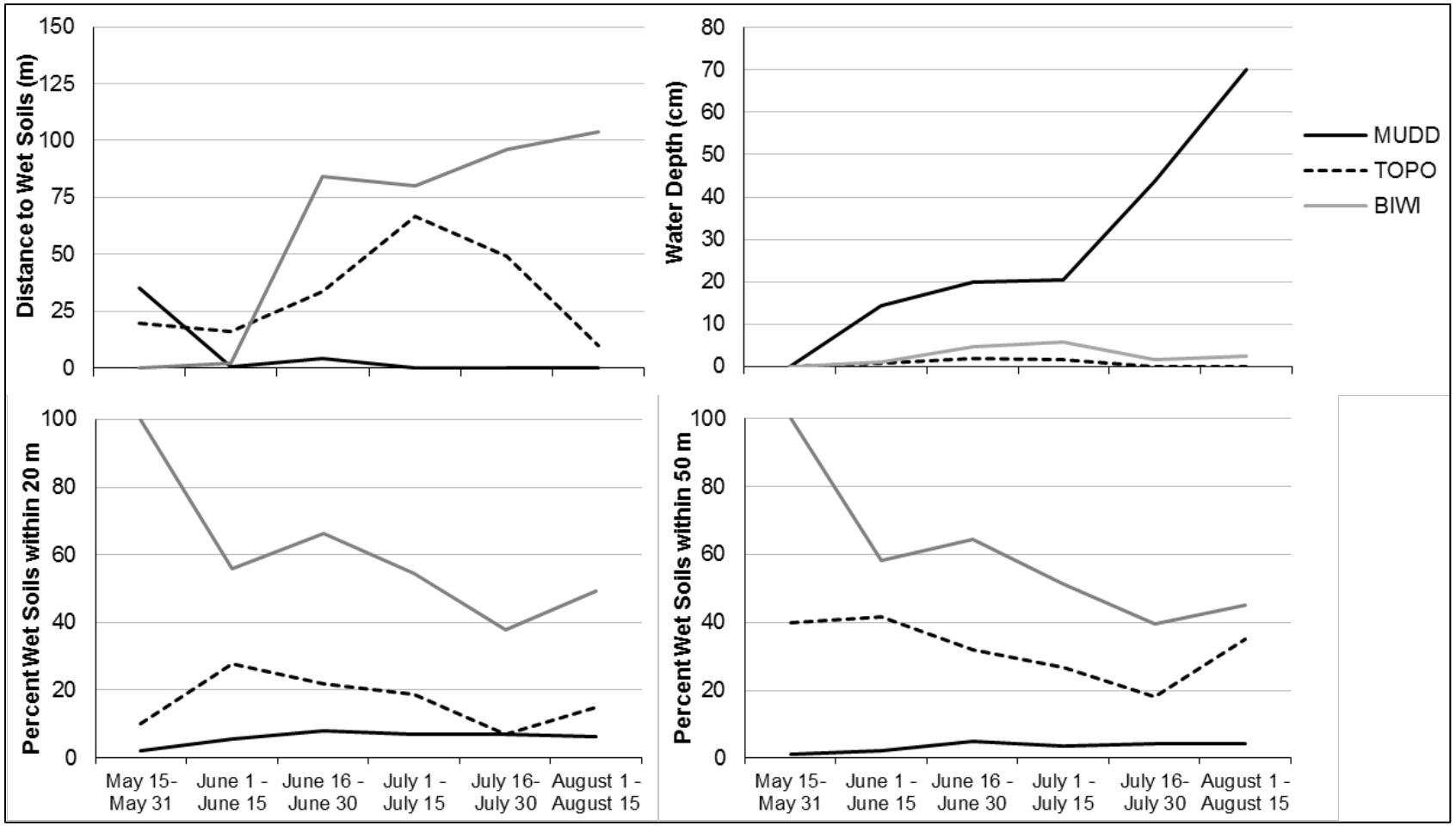

Figure 5-4.—Average soil moisture characteristics at southwestern willow flycatcher nests at Muddy River (MUDD), Topock Marsh (TOPO), and Bill Williams (BIWI), 2013–17.

Wet soils include both saturated and inundated soils. Data represent the average of all data points in each 2-week period across all years by study area.

ALAM was the driest study area with breeding flycatchers in 2014–16, with no wet soils within 50 m of any nest (figures 5-5 and 5-6). The average distance to wet soils was 600–1,000 m. Soil conditions did not fluctuate between estimates aside from temporarily damp soils caused by occasional rain (see chapter 2). In 2017, ALAM was the wettest study area with breeding flycatchers, and most nests were over inundated soils throughout the breeding season (figure 5-5). The average percentage of wet soils within 20 and 50 m was 82–95%, with no discernable trend across the season (figure 5-6). The average distance to wet soils was 11–65 m, also with no discernable trend. The average water depth did decline from a high of 192 cm in late May to 104 cm in early August.

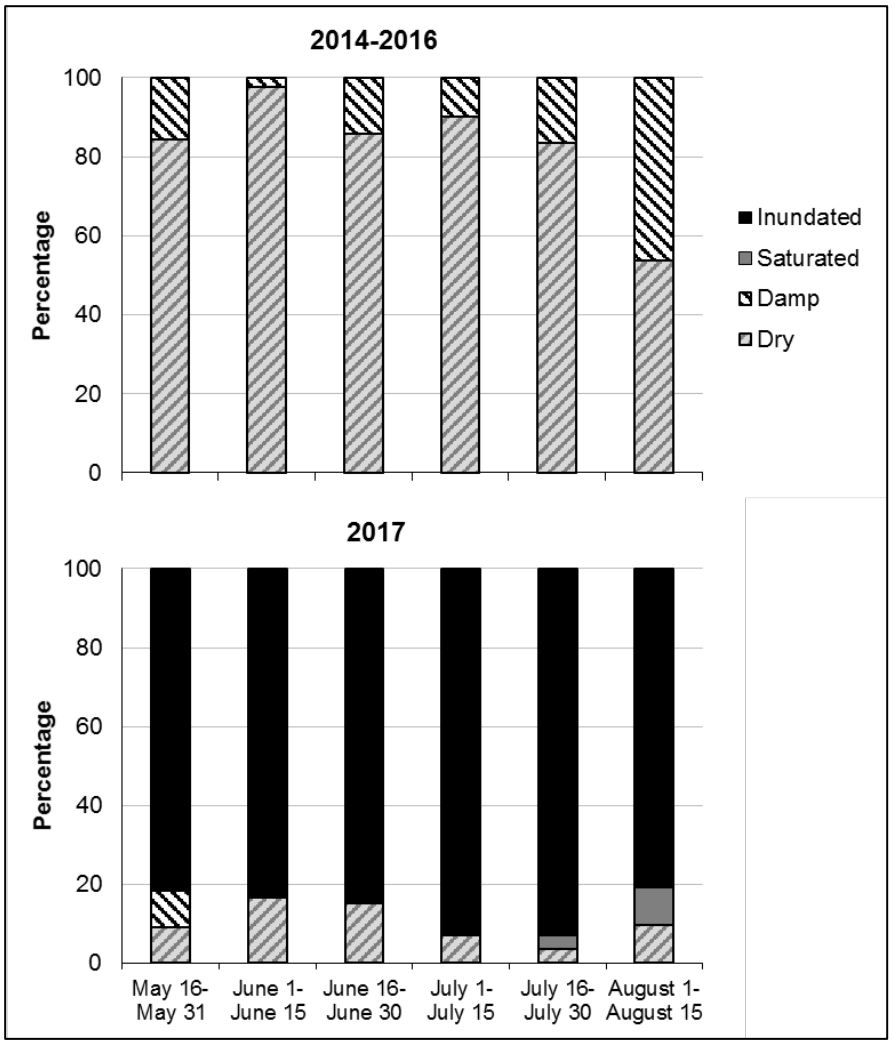

Figure 5-5.—Soil conditions at southwestern willow flycatcher nests at Alamo Lake, 2014–16 and 2017.

Data represent the percentage of nests during each 2-week interval where each type of soil condition occurred.

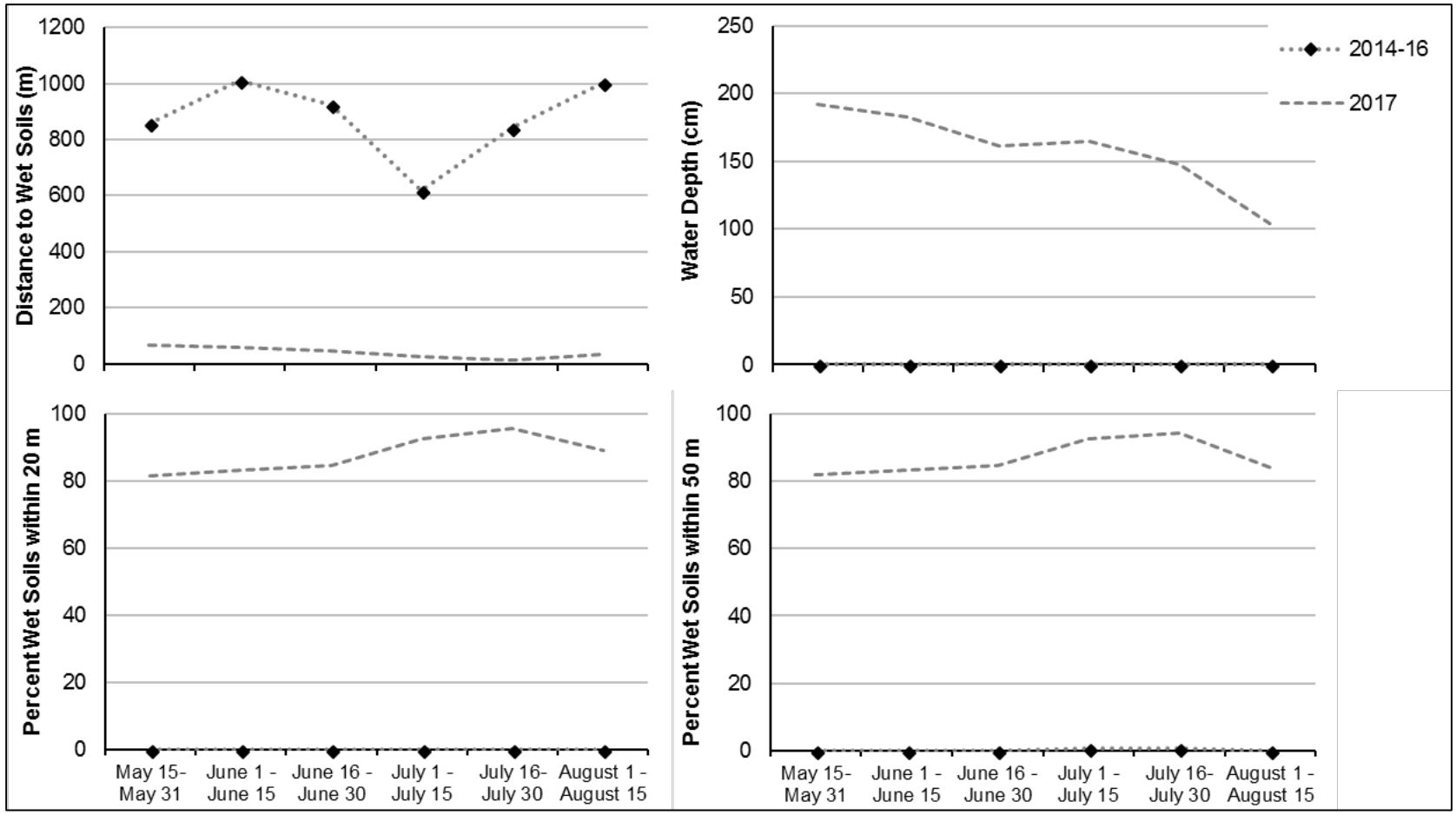

Figure 5-6.—Average soil moisture characteristics at southwestern willow flycatcher nests at Alamo Lake, 2014–16 and 2017.
Wet soils include both saturated and inundated soils. Data represent the average of all data points in each 2-week period across all years by study area.

Characteristics at Nests Found During Building

Surface hydrology was described at 161 nests within 7 days of the nests being found during building at KEPI, RIRA, PAHR, MVWA, MUDD, WMSP, TOPO, and BIWI in 2013–17. Of these nests, 72% were located over wet soil, 25% were located > 0 m and < 30 m from wet soils, 2% were 30–60 m from wet soils, and 2% were > 100 m from wet soils. The mean distance to wet soils appeared to increase between late May and early July from 3.7 to 35 m (table 5-1), but there was no significant difference among the groups (F = 1.220, df = 3, P = 0.312). The apparent increase in mean distance to wet soils was primarily driven by the presence of a few outlier data points (figure 5-7). There was no trend in mean water depth below a nest during the breeding season (F = 2.736, df = 3, P = 0.050). The mean percentage of wet soils within 20 m of a nest was lower in early July than during the previous three time intervals (F = 6.116, df = 3, P < 0.001). The same pattern occurred for the mean percentage of wet soils within 50 m of a nest (F = 6.251, df = 3, P < 0.001).

Table 5-1.—Mean soil moisture characteristics at southwestern willow flycatcher nests when nests were found during building, 2013–17*

	Distance (m) to wet soil (SE)	Water depth (cm) (SE)	Percent wet soils within 20 m (SE)	Percent wet soils within 50 m (SE)
May 16–31 n = 27	3.7 (1.8)	17.6 (3.5)	65.5 (5.9)	55.6 (4.6)
June 1–15 n = 69	2.2 (0.7)	15.0 (2.3)	57.9 (4.2)	51.1 (3.5)
June 16–30 n = 37	15.0 (11.1)	7.8 (2.0)	48.5 (5.1)	44.3 (4.4)
July 1–15 n = 28	35.0 (23.9)	11.6 (2.8)	30.1 (6.6)	26.3 (5.5)

* Study areas included are Key Pittman, River Ranch, Pahranagat, Meadow Valley Wash, Muddy River, Warm Springs, Topock Marsh, and Bill Williams.

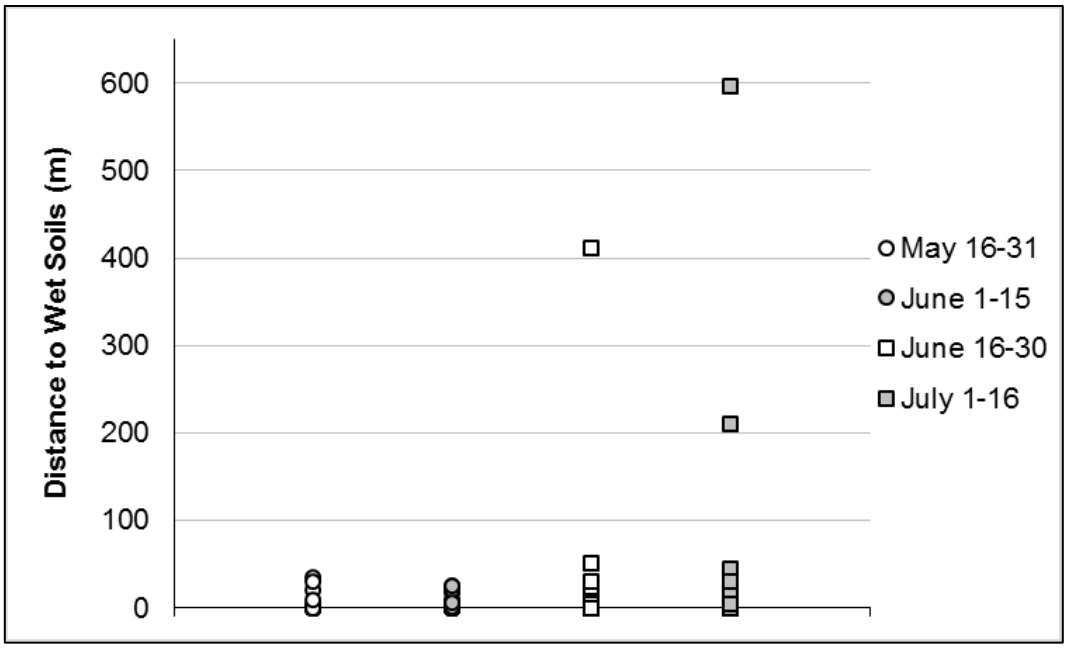

Figure 5-7.—Distance to wet soils at southwestern willow flycatcher nests when found during building, 2013–17.
Data are from the Key Pittman, River Ranch, Pahranagat, Meadow Valley Wash, Muddy River, Warm Springs, Topock Marsh, and Bill Williams study areas.

Vegetation

Between 2013 and 2017, vegetation characteristics were recorded at 383 flycatcher nests (61 at KEPI, 8 at RIRA, 57 at PAHR, 17 at MVWA, 2 at MESQ, 9 at MOME, 24 at MUDD, 3 at WMSP, 19 at TOPO, 22 at BIWI, and 161 at ALAM) (table 5-2). Nests were built in coyote willows (26%), Goodding's willows (40%), cottonwoods (3%), tamarisk (30%), velvet ash (1%), Indian hemp (< 1%), palm (< 1%), and downed branches (< 1%). The top three most prevalent vegetation types at nests in 2013–17 were > 75% Goodding's willow (37%), > 75% coyote willow (22%), and > 75% tamarisk (12%). In vegetation types with a mix of tamarisk and willow (i.e., TAMSPP_SALGOO, TAMSPP_SALEXI, and SALGOO_TAMSPP), 75% of nests were in a tamarisk substrate.

No tamarisk foliage was present within 5 m of any nest at RIRA or PAHR in any year. Of the study areas with tamarisk present near a nest location, KEPI, MVWA, WMSP, and ALAM had low median percentages of tamarisk within 5 m of flycatcher nests (0, 10, 10, and 5%, respectively), while MESQ, MOME, MUDD, TOPO, and BIWI had higher median percentages of tamarisk within 5 m of nests (55, 40, 60, 80, and 100%, respectively) (table 5-2).

Table 5-2.—Tally of nests by nest substrate and percentage of tamarisk at southwestern willow flycatcher nests by vegetation type in all study areas, 2013–17

Study area[1]	Vegetation type[2]	Nest substrate					Percent TAMSPP within 2 m		Percent TAMSPP within 5 m	
		SALEXI	SALGOO	POPFRE	TAMSPP	OTHER	Median (25th – 75th percentile)	Mean (SE)	Median (25th – 75th percentile)	Mean (SE)
KEPI	SALEXI (n = 58)	58	0	0	0	0	0.0 (0.0–0.0)	0.0 (0.0)	0.0 (0.0–0.0)	0.0 (0.0)
	POPFRE (n = 1)	0	0	1	0	0	0.0	0.0	0.0	0.0
	OTHER[3] (n = 2)	2	0	0	0	0	10.0 (0.0–20.0)	10.0 (10.0)	10.0 (0.0–20.0)	10.0 (10.0)
	Total (n = 61)	**60**	**0**	**1**	**0**	**0**	**0.0 (0.0–0.0)**	**0.3 (0.3)**	**0.0 (0.0–0.0)**	**0.3 (0.3)**
RIRA	SALEXI (n = 8)	8	0	0	0	0	0.0 (0.0–0.0)	0.0 (0.0)	0.0 (0.0–0.0)	0.0 (0.0)
	Total (n = 8)	**8**	**0**	**0**	**0**	**0**	**0.0 (0.0–0.0)**	**0.0 (0.0)**	**0.0 (0.0–0.0)**	**0.0 (0.0)**
PAHR	POPFRE (n = 10)	0	0	9	0	1[4]	0.0 (0.0–0.0)	0.0 (0.0)	0.0 (0.0–0.0)	0.0 (0.0)
	POPFRE_SALGOO (n = 2)	0	2	0	0	0	0.0 (0.0–0.0)	0.0 (0.0)	0.0 (0.0–0.0)	0.0 (0.0)
	SALGOO (n = 45)	0	44	0	0	1[5]	0.0 (0.0–0.0)	0.0 (0.0)	0.0 (0.0–0.0)	0.0 (0.0)
	Total (n = 57)	**0**	**46**	**9**	**0**	**2[4,5]**	**0.0 (0.0–0.0)**	**0.0 (0.0)**	**0.0 (0.0–0.0)**	**0.0 (0.0)**
MVWA	POPFRE (n = 1)	1	0	0	0	0	0.0	0.0	0.0	0.0
	SALEXI (n = 8)	8	0	0	0	0	0.0 (0.0–2.5)	1.9 (1.3)	0.0 (0.0–5.0)	3.1 (2.1)
	TAMSPP_SALEXI (n = 3)	1	0	0	2	0	45.0 (40.0–50.0)	45.0 (2.9)	40.0 (25.0–50.0)	38.3 (7.3)
	OTHER[6] (n = 5)	0	0	0	2	3[7]	35.0 (5.0–45.0)	34.0 (14.0)	15.0 (10.0–35.0)	24.0 (9.3)
	Total (n = 17)	**10**	**0**	**0**	**4**	**3[7]**	**5.0 (0.0–40.0)**	**18.8 (6.0)**	**10.0 (0.0–25.0)**	**15.3 (4.6)**

Table 5-2.—Tally of nests by nest substrate and percentage of tamarisk at southwestern willow flycatcher nests by vegetation type in all study areas, 2013–17

Study area[1]	Vegetation type[2]	Nest substrate					Percent TAMSPP within 2 m		Percent TAMSPP within 5 m	
		SALEXI	SALGOO	POPFRE	TAMSPP	OTHER	Median (25th – 75th percentile)	Mean (SE)	Median (25th – 75th percentile)	Mean (SE)
MESQ	TAMSPP_SALEXI (n = 2)	2	0	0	0	0	50.0 (30.0–70.0)	50.0 (20.0)	55.0 (50.0–60.0)	55.0 (5.0)
	Total (n = 2)	2	0	0	0	0	50.0 (30.0–70.0)	50.0 (20.0)	55.0 (50.0–60.0)	55.0 (5.0)
MOME	SALEXI (n = 6)	3	0	0	3	0	20.0 (1.0–30.0)	18.5 (6.4)	17.5 (2.0–40.0)	22.0 (8.9)
	TAMSPP_SALEXI (n = 1)	0	0	0	1	0	40.0	40.0	50.0	50.0
	TAMSPP_SALGOOI (n = 2)	0	0	0	2	0	60.0 (40.0–80.0)	60.0 (20.0)	45.0 (40.0–50.0)	45.0 (5.0)
	Total (n = 9)	**3**	**0**	**0**	**6**	**0**	**30.0 (20.0–40.0)**	**30.1 (8.1)**	**40.0 (15.0–50.0)**	**30.2 (7.1)**
MUDD	SALEXI (n = 2)	1	0	0	1	0	7.5 (5.0–10.0)	7.5 (2.5)	10.0 (10.0–10.0)	10.0 (0.0)
	TAMSPP (n = 3)	1	0	0	2	0	75.0 (70.0–80.0)	75.0 (2.9)	80.0 (80.0–80.0)	80.0 (0.0)
	TAMSPP_SALEXI (n = 17)	5	0	0	12	0	60.0 (15.0–80.0)	49.4 (8.5)	60.0 (20.0–70.0)	45.6 (6.9)
	TAMSPP_SALGOOI (n = 2)	0	0	0	2	0	97.5 (95.0–100.0)	97.5 (2.5)	87.5 (85.0–90.0)	87.5 (2.5)
	Total (n = 24)	**7**	**0**	**0**	**17**	**0**	**65.0 (12.5–80.0)**	**53.1 (7.3)**	**60.0 (20.0–77.5)**	**50.4 (6.3)**
WMSP	FRAVEL (n = 1)	0	0	0	0	1[7]	0.0	0.0	0.0	0.0
	OTHER[8] (n = 2)	0	0	0	0	2[7,9]	12.5 (5.0–20.0)	12.5 (7.5)	20.0 (10.0–30.0)	20.0 (10.0)
	Total (n = 3)	**0**	**0**	**0**	**0**	**3[7,9]**	**5.0 (0.0–20.0)**	**8.3 (6.0)**	**10.0 (0.0–30.0)**	**13.3 (8.8)**

Table 5-2.—Tally of nests by nest substrate and percentage of tamarisk at southwestern willow flycatcher nests by vegetation type in all study areas, 2013–17

Study area[1]	Vegetation type[2]	Nest substrate					Percent TAMSPP within 2 m		Percent TAMSPP within 5 m	
		SALEXI	SALGOO	POPFRE	TAMSPP	OTHER	Median (25th – 75th percentile)	Mean (SE)	Median (25th – 75th percentile)	Mean (SE)
TOPO	SALGOO_TAMSPP (n = 2)	0	0	0	2	0	47.5 (25.0–70.0)	47.5 (22.5)	25.0 (10.0–40.0)	25.0 (15.0)
	TAMSPP (n = 13)	0	0	0	13	0	100.0 (100.0–100.0)	99.2 (0.5)	95.0 (80.0–100.0)	88.8 (3.6)
	TAMSPP_SALGOO (n = 1)	0	0	0	1	0	80.0	80.0	60.0	60.0
	SALEXI (n = 1)	1	0	0	0	0	5.0	5.0	5.0	5.0
	TAMSPP_SALEXI (n = 2)	0	0	0	2	0	77.5 (75.0–80.0)	77.5 (2.5)	62.5 (50.0–75.0)	62.5 (12.5)
	Total (n = 19)	**1**	**0**	**0**	**18**	**0**	**100.0 (80.0–100.0)**	**84.7 (6.5)**	**80.0 (60.0–100.0)**	**74.2 (7.1)**
BIWI	TAMSPP_SALEXI (n = 3)	1	0	0	2	0	50.0 (25.0–90.0)	55.0 (18.9)	40.0 (40.0–50.0)	43.3 (3.3)
	TAMSPP (n = 17)	0	0	0	17	0	100.0 (100.0–100.0)	100.0 (0.0)	100.0 (100.0–100.0)	97.6 (1.6)
	SALEXI (n = 2)	2	0	0	0	0	0.0 (0.0–0.0)	0.0 (0.0)	0.0 (0.0–0.0)	0.0 (0.0)
	Total (n = 22)	**3**	**0**	**0**	**19**	**0**	**100.0 (100.0–100.0)**	**84.8 (7.1)**	**100.0 (75.0–100.0)**	**81.4 (7.0)**

Table 5-2.—Tally of nests by nest substrate and percentage of tamarisk at southwestern willow flycatcher nests by vegetation type in all study areas, 2013–17

Study area[1]	Vegetation type[2]	Nest substrate					Percent TAMSPP within 2 m		Percent TAMSPP within 5 m	
		SALEXI	SALGOO	POPFRE	TAMSPP	OTHER	Median (25th – 75th percentile)	Mean (SE)	Median (25th – 75th percentile)	Mean (SE)
ALAM	SALGOO (n = 98)	0	93	0	5	0	0.0 (0.0–5.0)	3.5 (1.0)	5.0 (0.0–5.0)	4.8 (1.0)
	SALGOO_TAMSPP (n = 38)	0	11	0	26	1[10]	30.0 (15.0–65.0)	40.8 (4.9)	30.0 (20.0–50.0)	35.5 (3.5)
	TAMSPP (n = 12)	0	0	0	12	0	100.0 (100.0–100.0)	99.2 (0.6)	95.0 (90.0–100.0)	93.3 (2.1)
	TAMSPP_SALGOO (n = 8)	0	0	0	8	0	50.0 (37.5–90.0)	61.3 (10.0)	62.5 (50.0–72.5)	62.5 (6.5)
	POPFRE_SALGOO (n = 3)	0	2	0	1	0	5.0 (0.0–20.0)	8.3 (6.0)	5.0 (0.0–30.0)	11.7 (9.3)
	OTHER[11] (n = 1)	0	1	0	0	0	60.0	60.0	40.0	40.0
	UNKNOWN (n = 1)	0	1	0	0	0	–	–	–	–
	Total (n = 161)	**0**	**108**	**0**	**52**	**1[10]**	**5.0 (0.0–30.0)**	**22.8 (2.7)**	**5.0 (0.0–30.0)**	**22.0 (2.4)**

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.

[2] FRAVEL = > 75% velvet ash; POPFRE = > 75% cottonwood; SALEXI = > 75% coyote willow; SALGOO = > 75% Goodding's willow; POPFRE_SALGOO = Goodding's willow and cottonwood mix, neither > 75%; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory; TAMSPP = > 75% tamarisk; TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%; TAMSPP_SALGOO = tamarisk with emergent Goodding's willow; and OTHER = a vegetation type that does not fit one of the above descriptions.

[3] Mix of coyote willow, cottonwood, and tamarisk.

[4] Downed, leafless branch.

[5] Indian hemp.

[6] Velvet ash overstory with tamarisk understory.

[7] Velvet ash.

[8] Palm overstory with coyote willow, velvet ash, and tamarisk understory.

[9] Palm.

[10] Unknown.

[11] Mix of cottonwood, Goodding's willow, and tamarisk.

Temperature and Humidity

An iButton was deployed at 4 nests at MOME, 6 nests at MUDD, 12 nests at TOPO, 18 nests at BIWI, and 115 nests at ALAM (table 5-3). One data logger at TOPO was destroyed in a fire, one logger at BIWI and one at ALAM failed to launch, one logger at ALAM collected faulty humidity data, and two loggers at ALAM could not be found at the end of the season. All other loggers functioned properly. Because loggers were deployed as nests were found but were left in place until the end of the season, the sample size increased as each season progressed. Loggers within a given study area within a given year were generally taken down over a span of 2 or 3 days, but the take-down dates were not consistent among study areas or among years, and data in the 2-week period of August 1–15 may represent the entire 2-week period or only a few days at the beginning of the period.

Table 5-3.—Number of nests at which iButton temperature and humidity data loggers were deployed in each study area, 2013–17

MOME = Mormon Mesa, MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.

	MOME	MUDD	TOPO	BIWI	ALAM	Total
2013	4	3	1	0	0	**8**
2014	0	0	3	2	9	**14**
2015	0	3	4	6	10	**23**
2016	0	0	1	7	30	**38**
2017	0	0	3	3	66	**72**
Total	**4**	**6**	**12**	**18**	**115**	**155**

Median maximum diurnal temperatures at flycatcher nests were generally between 37 and 41 °C between mid-June and early August (figure 5-8), while median minimum nocturnal temperatures during the same period were between 18 and 24 °C (figure 5-9). Median diurnal high temperatures tended to decline slightly from mid-June to early August, while median nocturnal low temperatures tended to increase over the same period, with the result that the median daily temperature range declined from mid-June through the end of July (figure 5-10). Diurnal and nocturnal vapor pressure increased markedly from early June through the end of July at most study areas (figures 5-11 and 5-12).

Maximum diurnal temperatures recorded at nests at MOME and MUDD were typically 1–3 °C cooler than those recorded at the Overton weather station (figure 5-13). Minimum nocturnal temperatures were also cooler at nests in comparison to the weather station, although the difference decreased from the beginning of June through the end of July (figure 5-14). Diurnal and nocturnal vapor pressures were much higher at nests than at the weather station at the Nellis Air Force Base (figures 5-15 and 5-16).

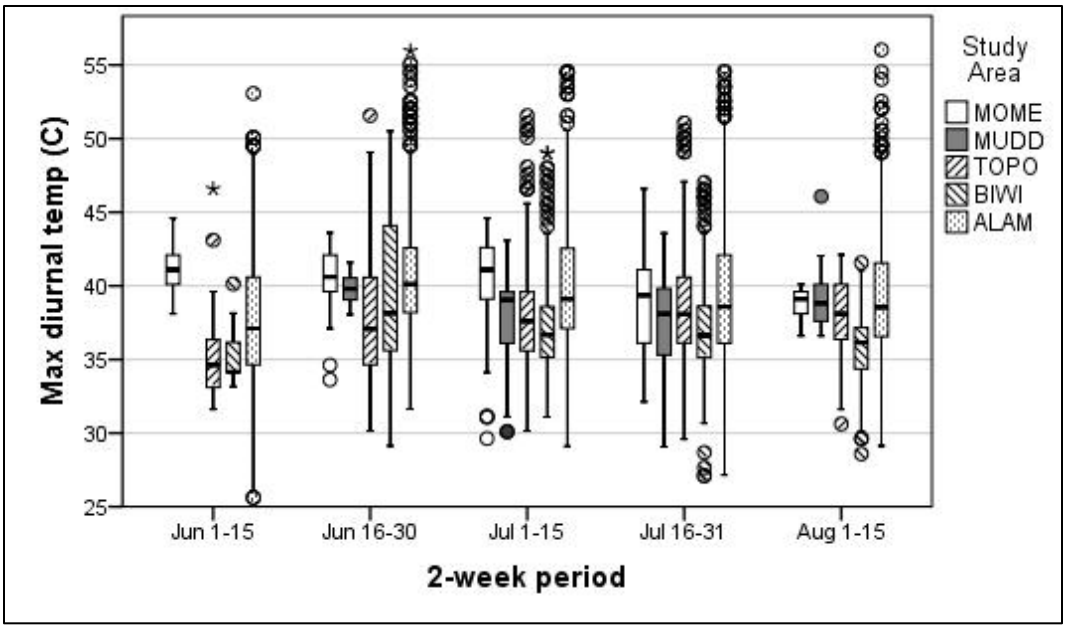

Figure 5-8.—Box plot of maximum diurnal temperature at southwestern willow flycatcher nests at Mormon Mesa, Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2013–17.
MOME = Mormon Mesa, n = 4; MUDD = Muddy River, n = 6; TOPO = Topock Marsh, n = 11; BIWI = Bill Williams, n = 17; and ALAM = Alamo Lake, n = 112.

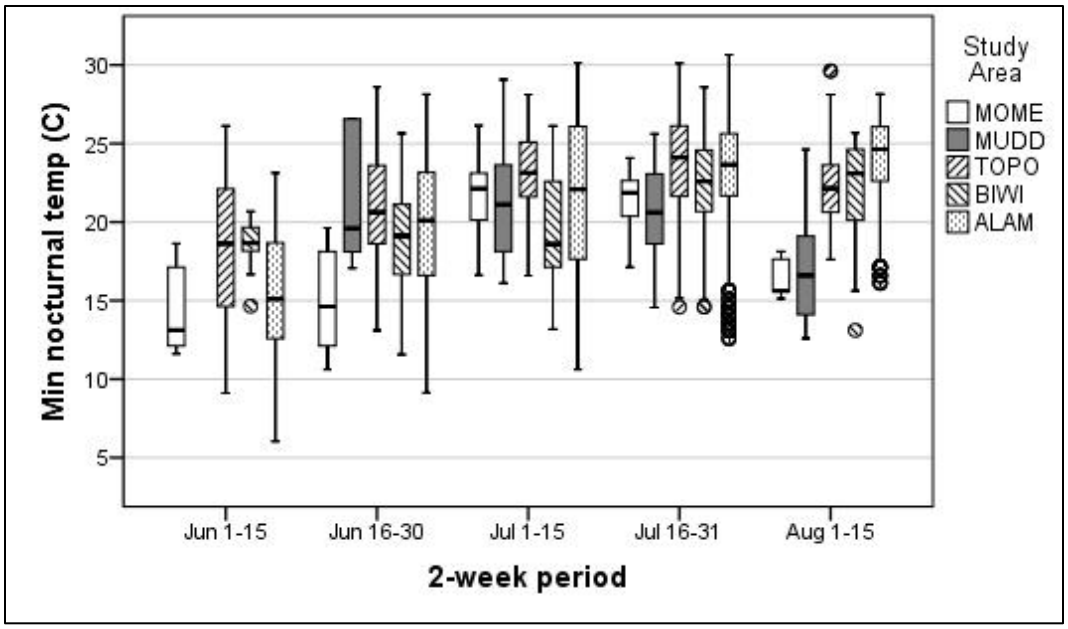

Figure 5-9.—Box plot of minimum diurnal temperature at southwestern willow flycatcher nests at Mormon Mesa, Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2013–17.
MOME = Mormon Mesa, n = 4; MUDD = Muddy River, n = 6; TOPO = Topock Marsh, n = 11; BIWI = Bill Williams, n = 17; and ALAM = Alamo Lake, n = 112.

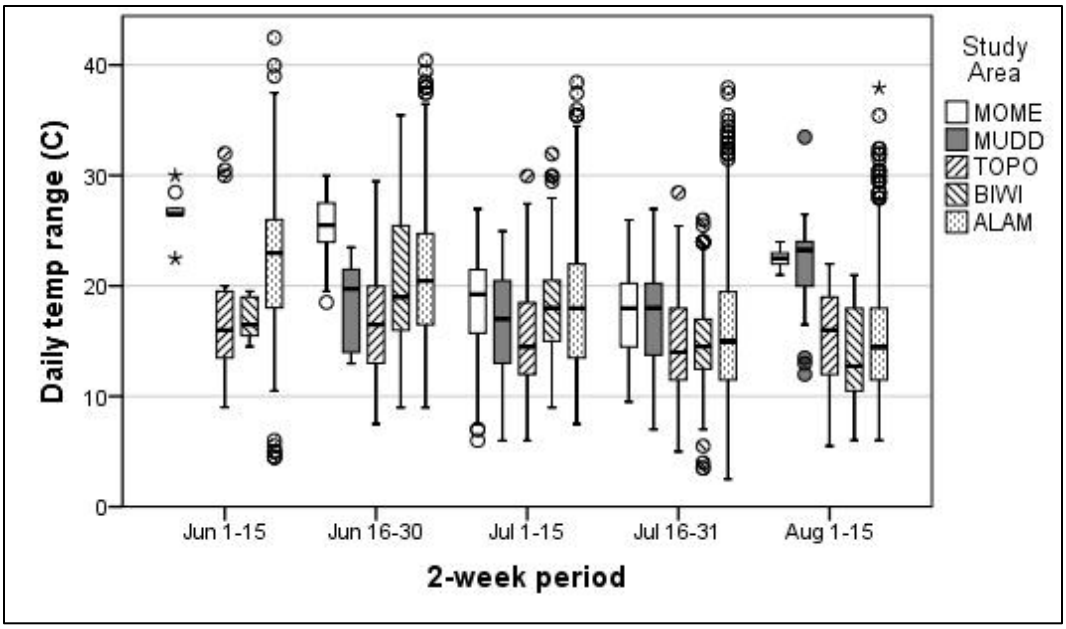

Figure 5-10.—Box plot of daily temperature range at southwestern willow flycatcher nests at Mormon Mesa, Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2013–17.
MOME = Mormon Mesa, n = 4; MUDD = Muddy River, n = 6; TOPO = Topock Marsh, n = 11; BIWI = Bill Williams, n = 17; and ALAM = Alamo Lake, n = 112.

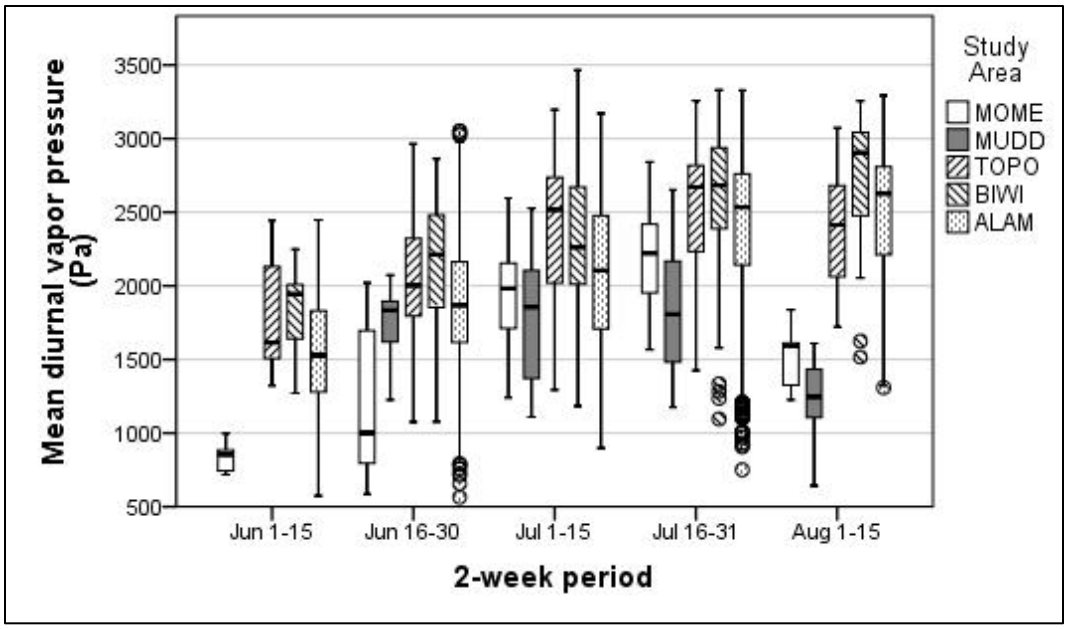

Figure 5-11.—Box plot of mean diurnal vapor pressure at southwestern willow flycatcher nests at Mormon Mesa, Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2013–17.
MOME = Mormon Mesa, n = 4; MUDD = Muddy River, n = 6; TOPO = Topock Marsh, n = 11; BIWI = Bill Williams, n = 17; and ALAM = Alamo Lake, n = 111.

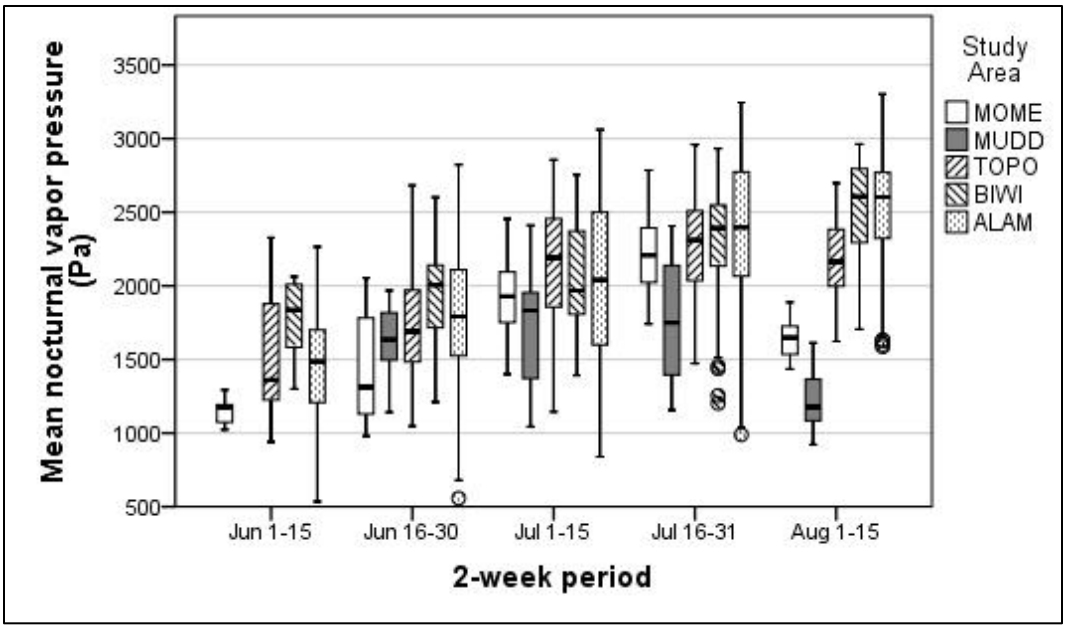

Figure 5-12.—Box plot of mean nocturnal vapor pressure at southwestern willow flycatcher nests at Mormon Mesa, Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2013–17.
MOME = Mormon Mesa, n = 4; MUDD = Muddy River, n = 6; TOPO = Topock Marsh, n = 11; BIWI = Bill Williams, n = 17; and ALAM = Alamo Lake, n = 111.

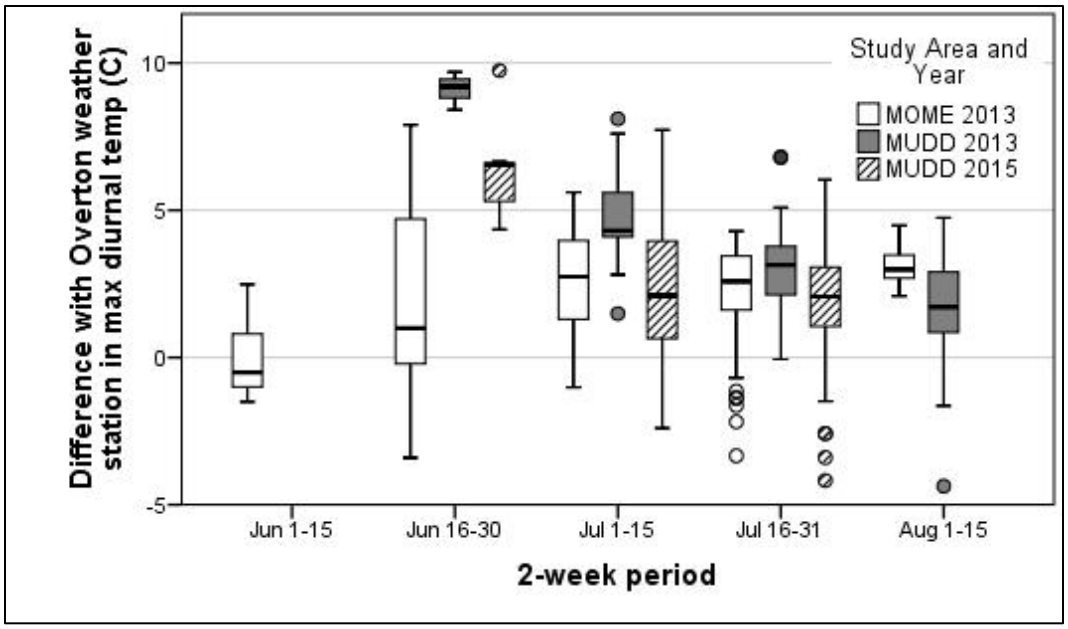

Figure 5-13.—Box plot of difference in maximum diurnal temperature between the Overton weather station and southwestern willow flycatcher nests at Mormon Mesa and Muddy River, 2013 and 2015.
MOME = Mormon Mesa, n = 4; and MUDD = Muddy River, n = 3 in 2013 and 2015.

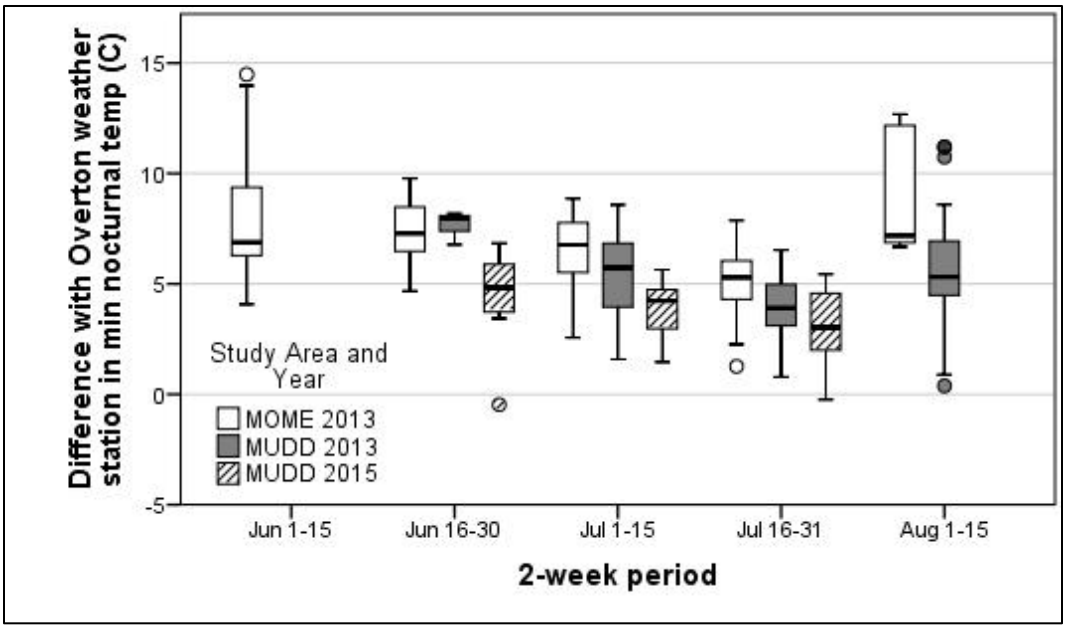

Figure 5-14.—Box plot of difference in minimum nocturnal temperature between the Overton weather station and southwestern willow flycatcher nests at Mormon Mesa and Muddy River, 2013 and 2015.
MOME = Mormon Mesa, n = 4; and MUDD = Muddy River, n = 3 in 2013 and 2015.

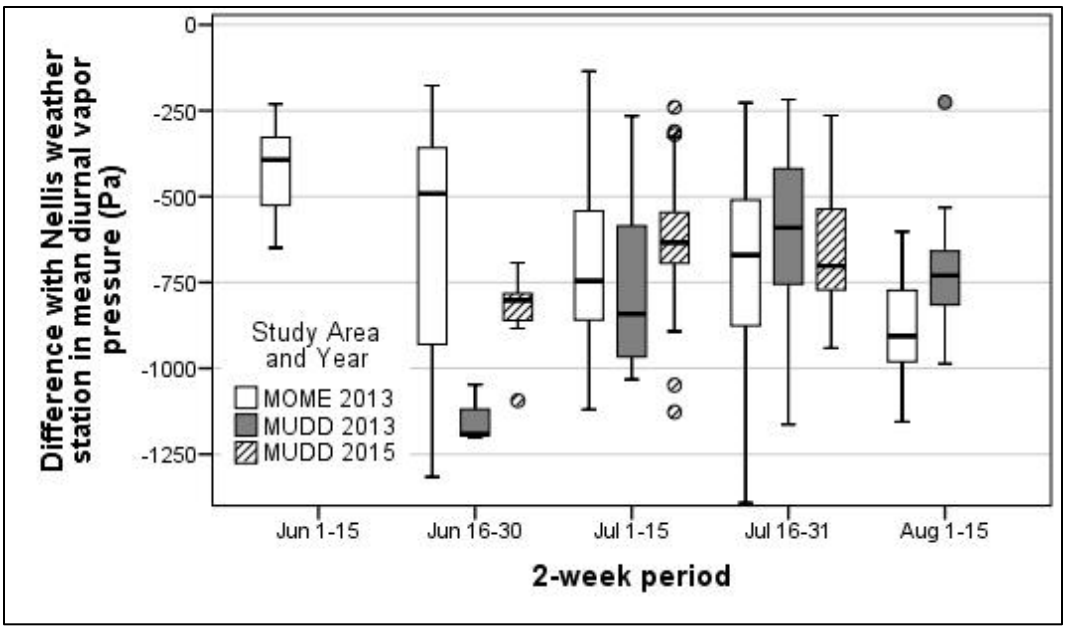

Figure 5-15.—Box plot of difference in mean diurnal vapor pressure between the Overton weather station and southwestern willow flycatcher nests at Mormon Mesa and Muddy River, 2013 and 2015.
MOME = Mormon Mesa, n =4; and MUDD = Muddy River, n = 3 in 2013 and 2015.

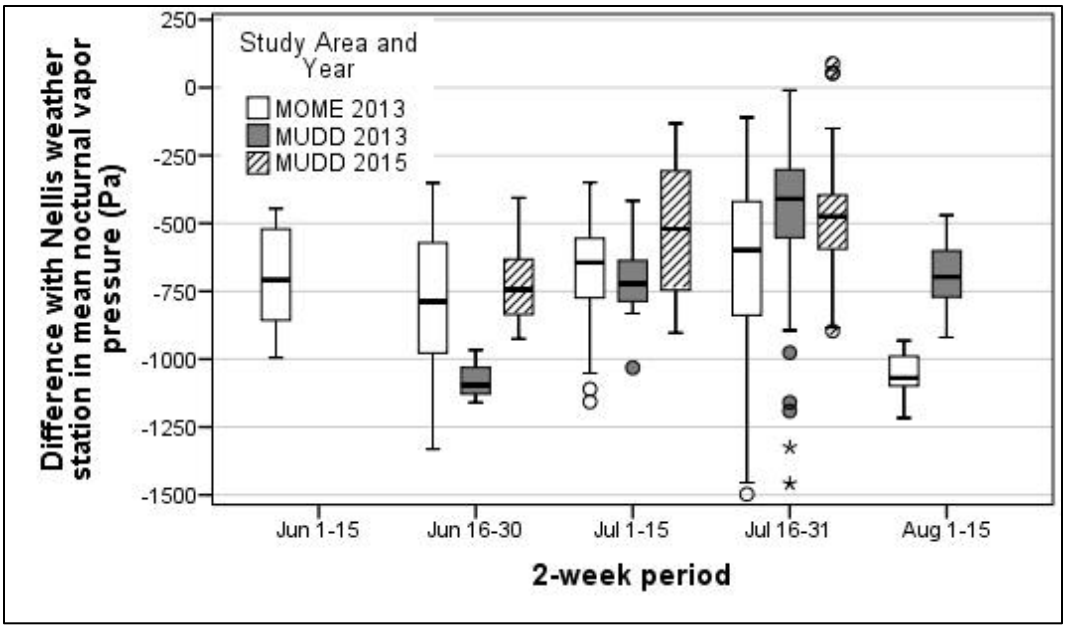

Figure 5-16.—Box plot of difference in mean nocturnal vapor pressure between the Overton weather station and southwestern willow flycatcher nests at Mormon Mesa and Muddy River, 2013 and 2015.
MOME = Mormon Mesa, n = 4; and MUDD = Muddy River, n = 3 in 2013 and 2015.

In 2013–16, maximum diurnal temperatures at flycatcher nests at TOPO were typically 4–8 °C cooler than those at the Needles weather station (figure 5-17). In 2017, however, the median differences in maximum temperatures were between 3 °C and -1 °C (i.e., maximum temperatures at nests were between 3 °C warmer and 1 °C cooler than those at the weather station). Minimum nocturnal temperatures were typically 5–10 °C cooler at nests compared to the weather station in all years in 2013–17 (figure 5-18). Mean diurnal vapor pressures were generally 1,000–1,500 Pa higher than at the weather station throughout the season in all years, while nocturnal vapor pressures were approximately 500–1,250 Pa higher than those at the weather station (figures 5-19 and 5-20).

In 2014–16 at BIWI, the median differences between maximum diurnal temperatures at flycatcher nests and those at the Needles weather station were 4–8 °C (figure 5-21). In 2017, however, the median differences were only 1–3 °C. Minimum nocturnal temperatures at nests were typically 7–12 °C cooler at nests than at the weather station, and there was no apparent change over the years in the relationship between minimum temperatures at nests and those at the weather station (figure 5-22). Mean diurnal vapor pressures at nests were generally 1,000–1,700 Pa higher than at the weather station throughout the season in all years, while nocturnal vapor pressures were approximately 600–1,200 Pa higher than those at the weather station (figures 5-23 and 5-24).

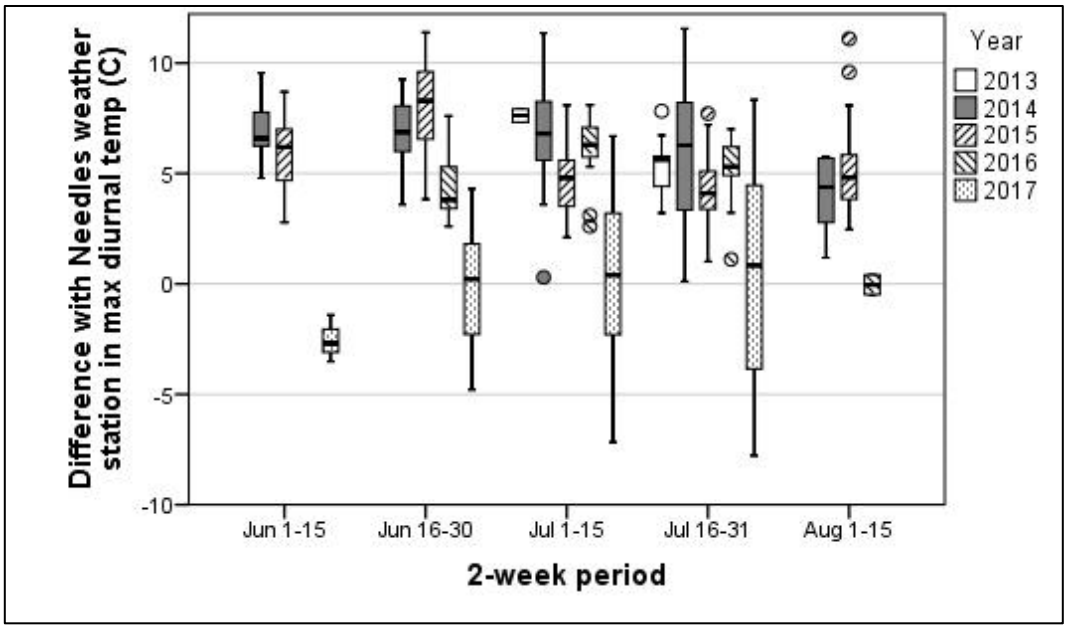

Figure 5-17.—Box plot of difference in maximum diurnal temperature between the Needles weather station and southwestern willow flycatcher nests at Topock Marsh, 2013–17.
n = 1, 3, 3, 1, and 3 in 2013, 2014, 2015, 2016, and 2017, respectively.

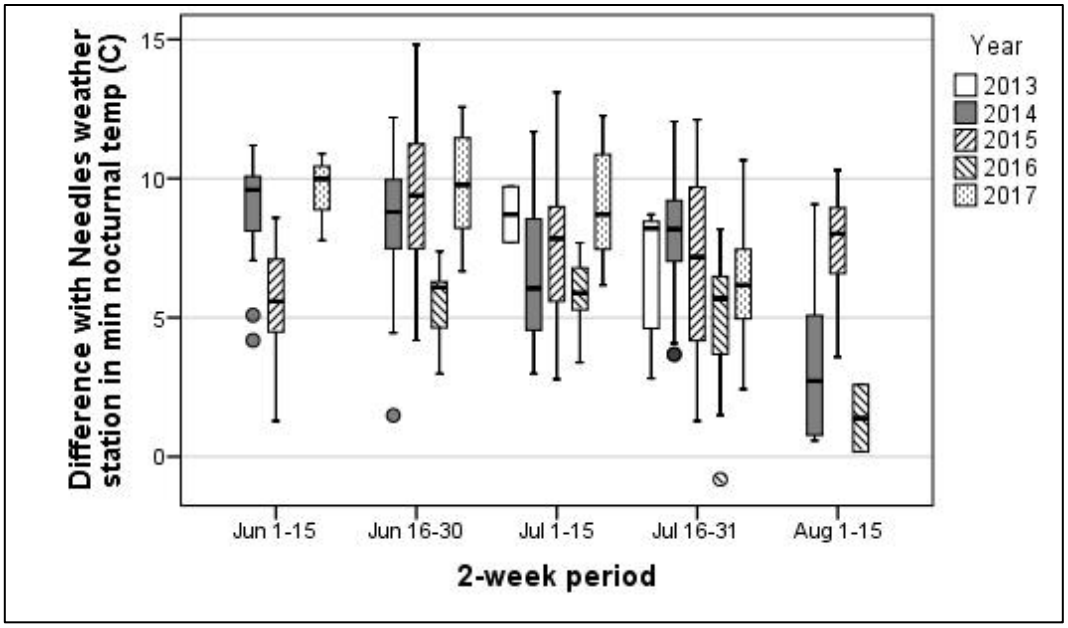

Figure 5-18.—Box plot of difference in minimum nocturnal temperature between the Needles weather station and southwestern willow flycatcher nests at Topock Marsh, 2013–17.
n = 1, 3, 3, 1, and 3 in 2013, 2014, 2015, 2016, and 2017, respectively.

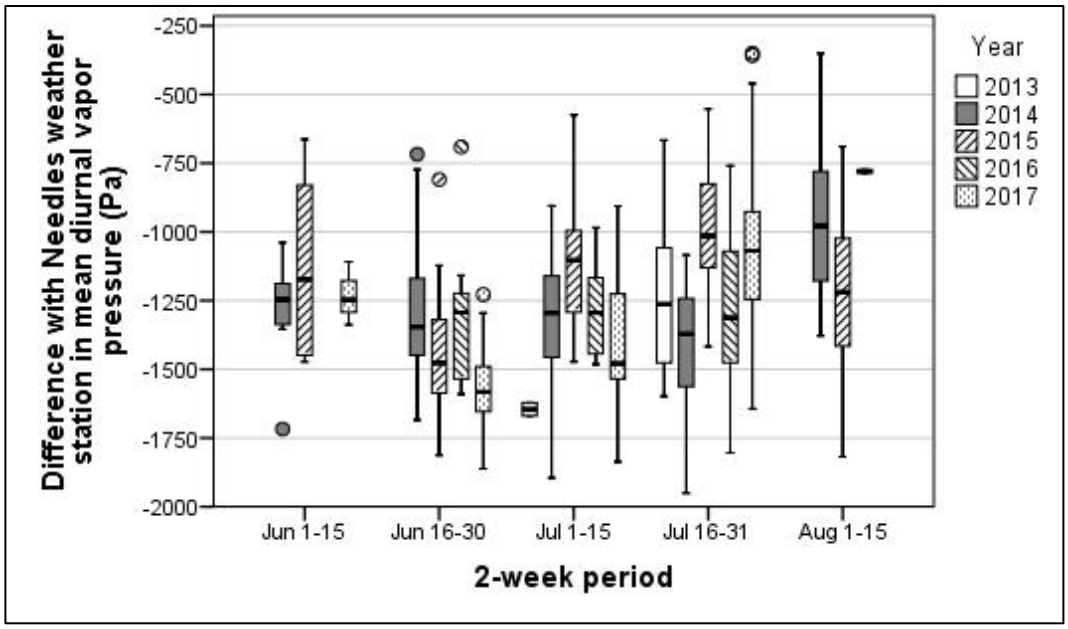

Figure 5-19.—Box plot of difference in mean diurnal vapor pressure between the Needles weather station and southwestern willow flycatcher nests at Topock Marsh, 2013–17.
n = 1, 3, 3, 1, and 3 in 2013, 2014, 2015, 2016, and 2017, respectively.

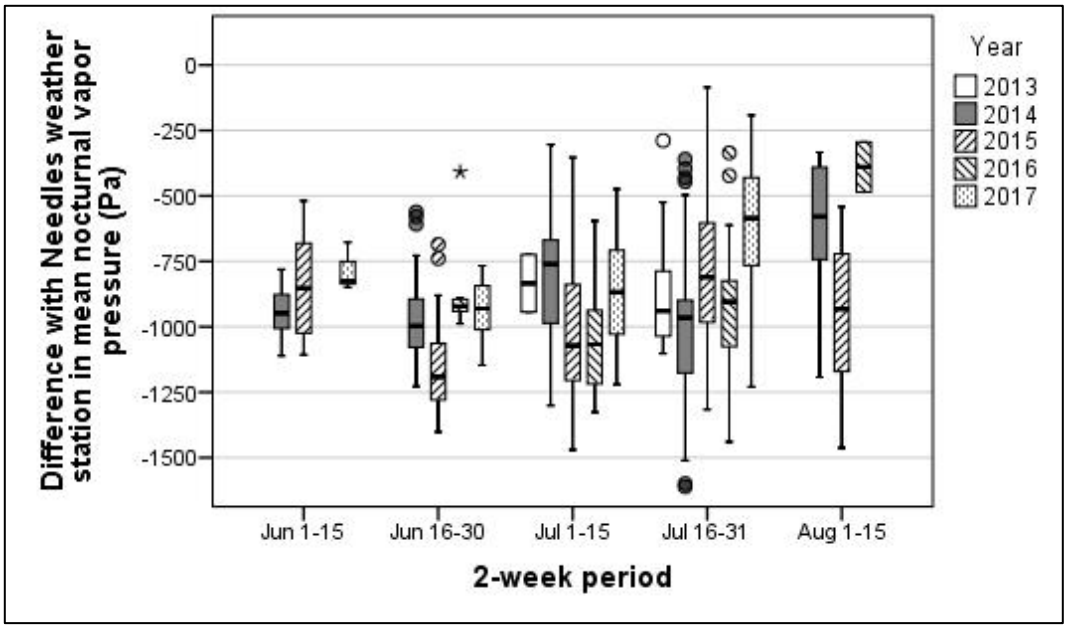

Figure 5-20.—Box plot of difference in mean nocturnal vapor pressure between the Needles weather station and southwestern willow flycatcher nests at Topock Marsh, 2013–17.
n = 1, 3, 3, 1, and 3 in 2013, 2014, 2015, 2016, and 2017, respectively.

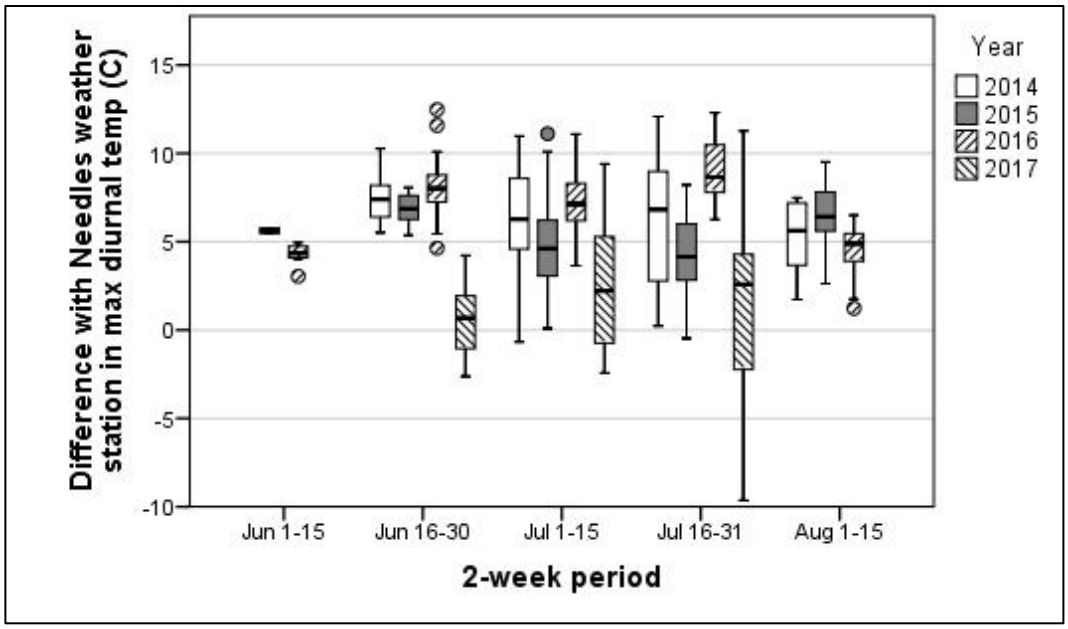

Figure 5-21.—Box plot of difference in maximum diurnal temperature between the Needles weather station and southwestern willow flycatcher nests at Bill Williams, 2014–17.
n = 2, 6, 6, and 3 in 2014, 2015, 2016, and 2017, respectively.

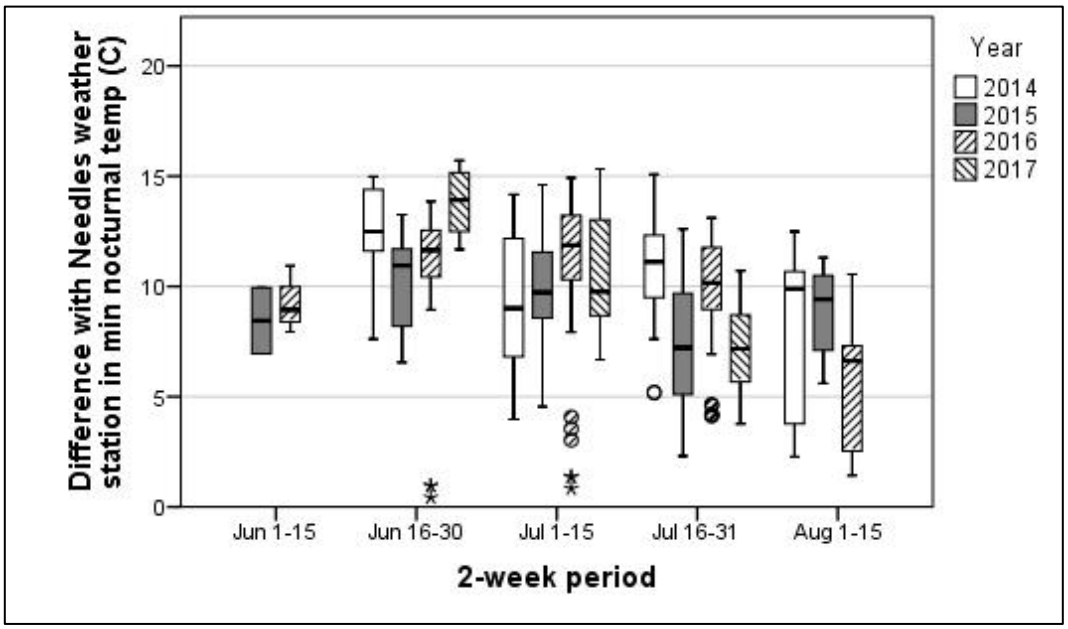

Figure 5-22.—Box plot of difference in minimum nocturnal temperature between the Needles weather station and southwestern willow flycatcher nests at Bill Williams, 2014–17.
n = 2, 6, 6, and 3 in 2014, 2015, 2016, and 2017, respectively.

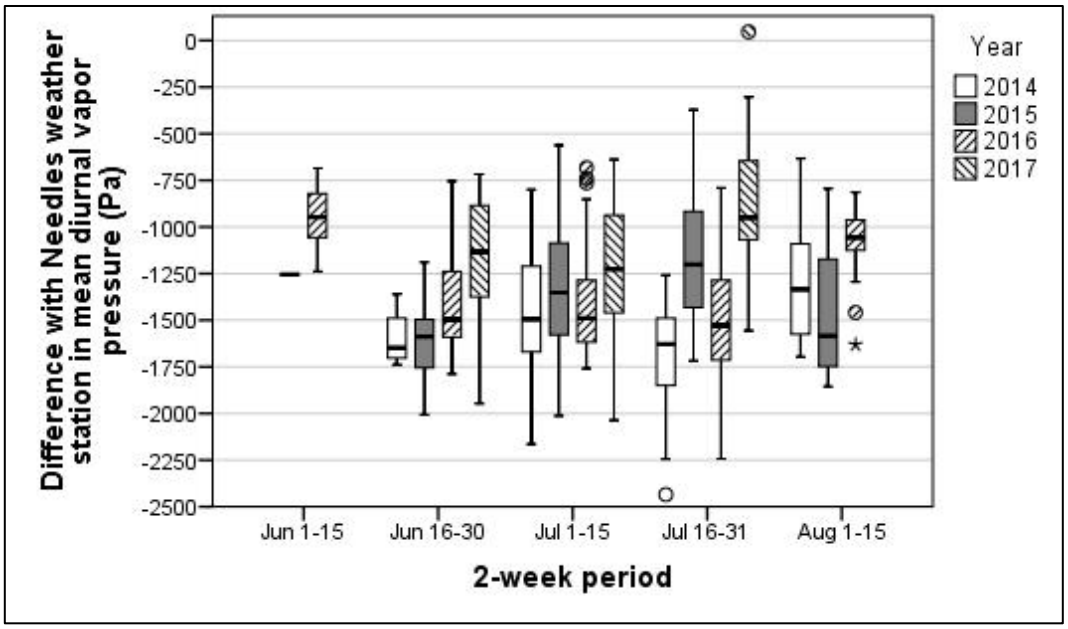

Figure 5-23.—Box plot of difference in mean diurnal vapor pressure between the Needles weather station and southwestern willow flycatcher nests at Bill Williams, 2014–17.
n = 2, 6, 6, and 3 in 2014, 2015, 2016, and 2017, respectively.

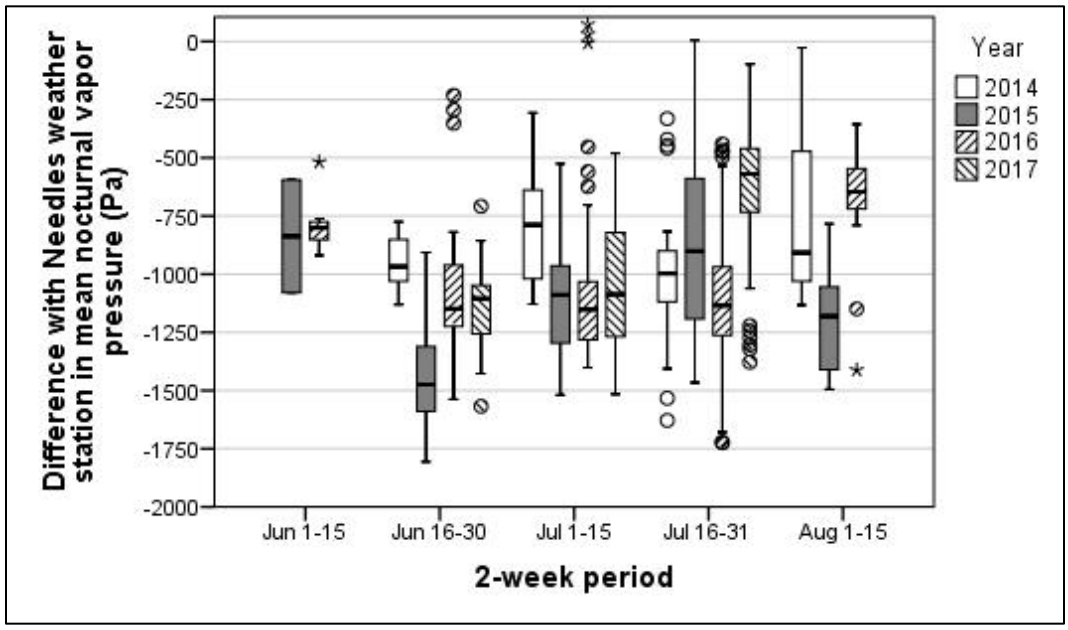

Figure 5-24.—Box plot of difference in mean nocturnal vapor pressure between the Needles weather station and southwestern willow flycatcher nests at Bill Williams, 2014–17.
n = 2, 6, 6, and 3 in 2014, 2015, 2016, and 2017, respectively.

Compared to maximum diurnal temperatures recorded at the Alamo Dam weather station, maximum temperatures at flycatcher nests at ALAM were approximately 2–3 °C warmer in 2014, 2–4 °C cooler in 2015, and 3–5 °C cooler in 2016 and 2017 (figure 5-25). In 2014–16, minimum nocturnal temperatures were warmer at the weather station than at nests, and the median difference decreased from 5–8 °C in the first half of June to 4–5 °C in the second half of July. In 2017, minimum nocturnal temperatures at nests were between 1 °C warmer and 2 °C cooler than at the weather station (figure 5-26). Both diurnal and nocturnal vapor pressures at nests at ALAM varied substantially between years in their relationship to vapor pressures recorded at the Needles weather station. In all years, vapor pressures recorded at flycatcher nests were higher than those recorded at the weather station, but median differences were the smallest (500–700 Pa) in 2014 and the largest (1,000–1,500 Pa) in 2017 (figures 5-27 and 5-28).

Maximum diurnal temperatures at nests at ALAM in sites that were dry in 2016 but inundated in 2017 were typically cooler than those at the weather station, with a median difference of approximately 5 °C in both years (figure 5-29). Minimum nocturnal temperatures at nests in these sites were cooler than those at the weather station through most of the season in 2016, with a median difference of approximately 5 °C, but were equivalent to or slightly warmer than minimum temperatures at the weather station in 2017 (figure 5-30). Both diurnal and nocturnal vapor pressures at nests in these sites were considerably higher than those at the weather station in both years, and the difference was particularly pronounced during the second half of June and the first half of July in 2017 (figures 5-31 and 5-32).

Nests at ALAM in Santa Maria North 01, the only site that was not inundated in either 2016 or 2017 but had defoliated tamarisk in 2017, had maximum diurnal temperatures in 2016 that were cooler than those at the Alamo Dam weather station (median differences of 7–8 °C). In June 2017, the median differences in maximum temperatures at nests versus the weather station were approximately 4 °C, but the median difference declined in July to approximately 0 °C (figure 5-33). Minimum nocturnal temperatures at nests in Santa Maria North 01 were cooler than those at the weather station in July of 2016 (median difference of approximately 5 °C) and July of 2017 (median difference of 0–3 °C) (figure 5-34). Diurnal vapor pressures at nests in Santa Maria North 01 in July 2016 were higher than those at the Needles weather station (median differences approximately 1,200 Pa), while the median differences in diurnal vapor pressure between nests and the weather station were only 500 Pa in the corresponding period in 2017 (figure 5-35). In June of 2017, however, the difference in mean diurnal vapor pressures between nests and the weather station were comparable to those recorded in July of 2016. The same pattern occurred for nocturnal vapor pressures, although the magnitude of the differences was smaller (figure 5-36).

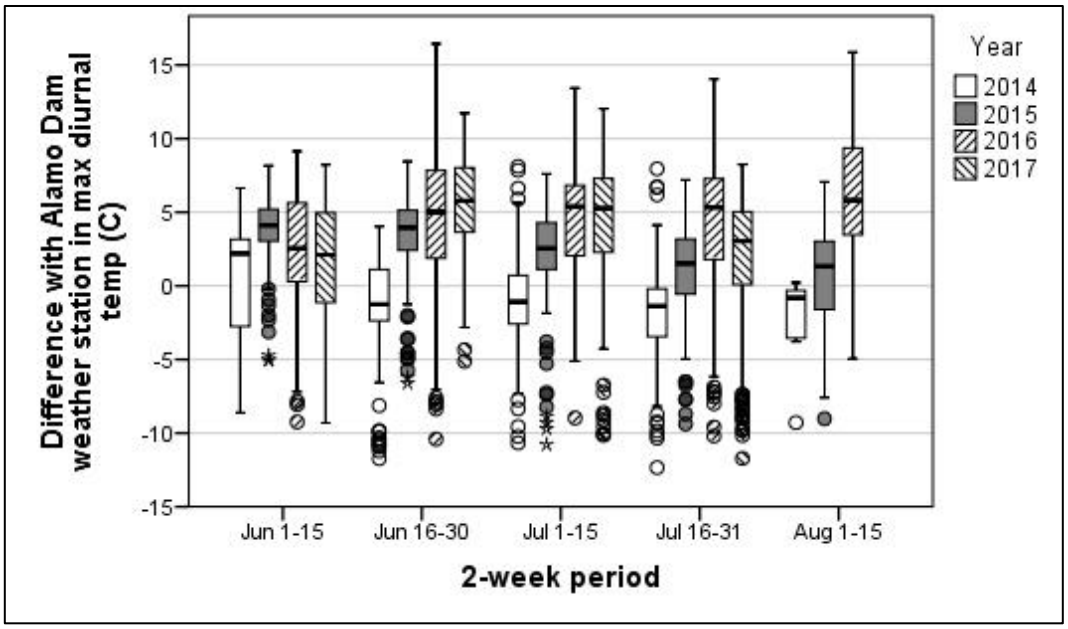

Figure 5-25.—Box plot of difference in maximum diurnal temperature between the Alamo Dam weather station and southwestern willow flycatcher nests at Alamo Lake, 2014–17.
n = 9, 10, 30, and 63 in 2014, 2015, 2016, and 2017, respectively.

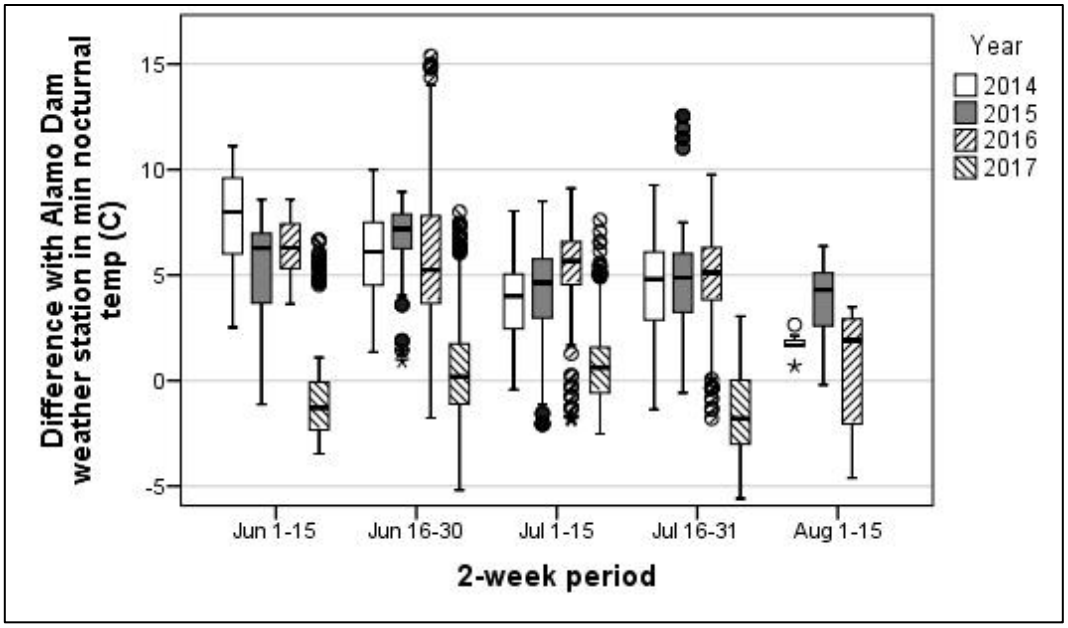

Figure 5-26.—Box plot of difference in minimum nocturnal temperature between the Alamo Dam weather station and southwestern willow flycatcher nests at Alamo Lake, 2014–17.
n = 9, 10, 30, and 63 in 2014, 2015, 2016, and 2017, respectively.

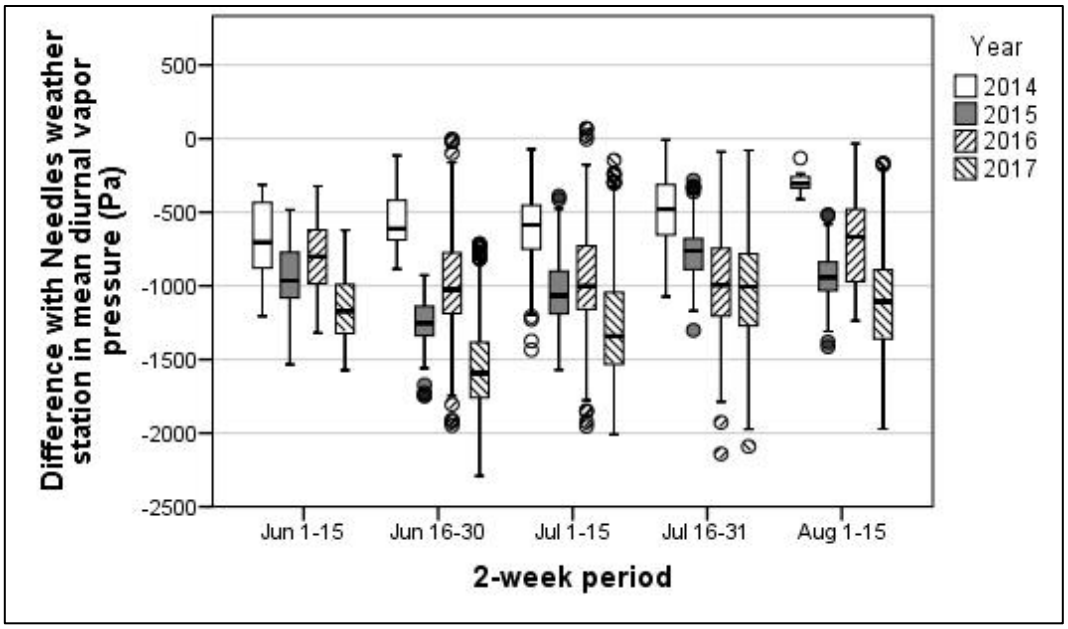

Figure 5-27.—Box plot of difference in mean diurnal vapor pressure between southwestern willow flycatcher nests at Alamo Lake and the Needles weather station, 2014–17.
n = 9, 10, 30, and 62 in 2014, 2015, 2016, and 2017, respectively.

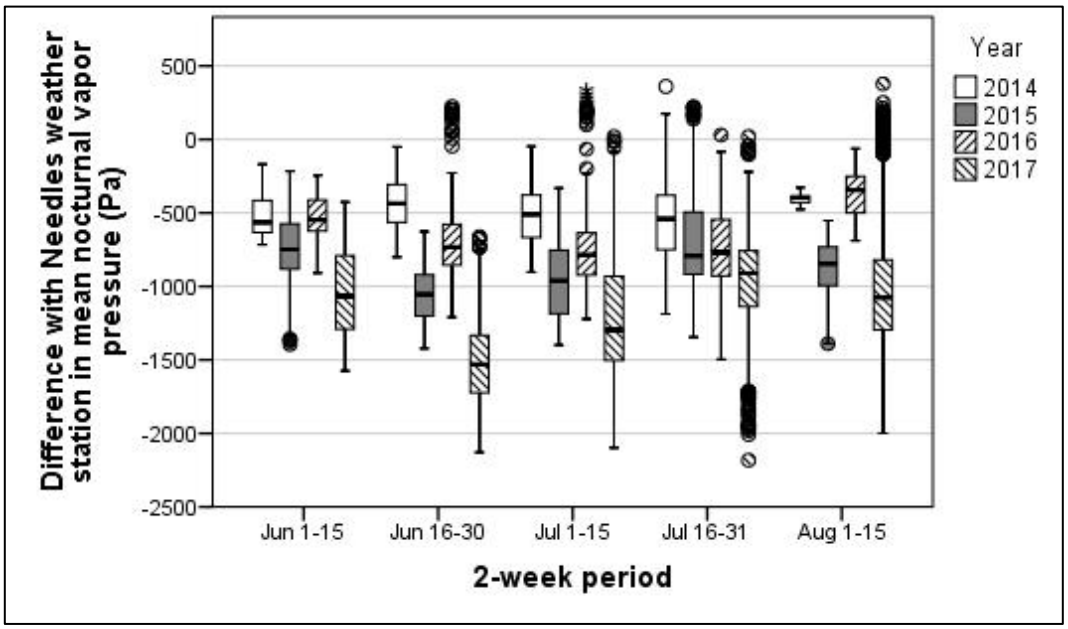

Figure 5-28.—Box plot of difference in mean nocturnal vapor pressure between southwestern willow flycatcher nests at Alamo Lake and the Needles weather station, 2014–17.
n = 9, 10, 30, and 62 in 2014, 2015, 2016, and 2017, respectively.

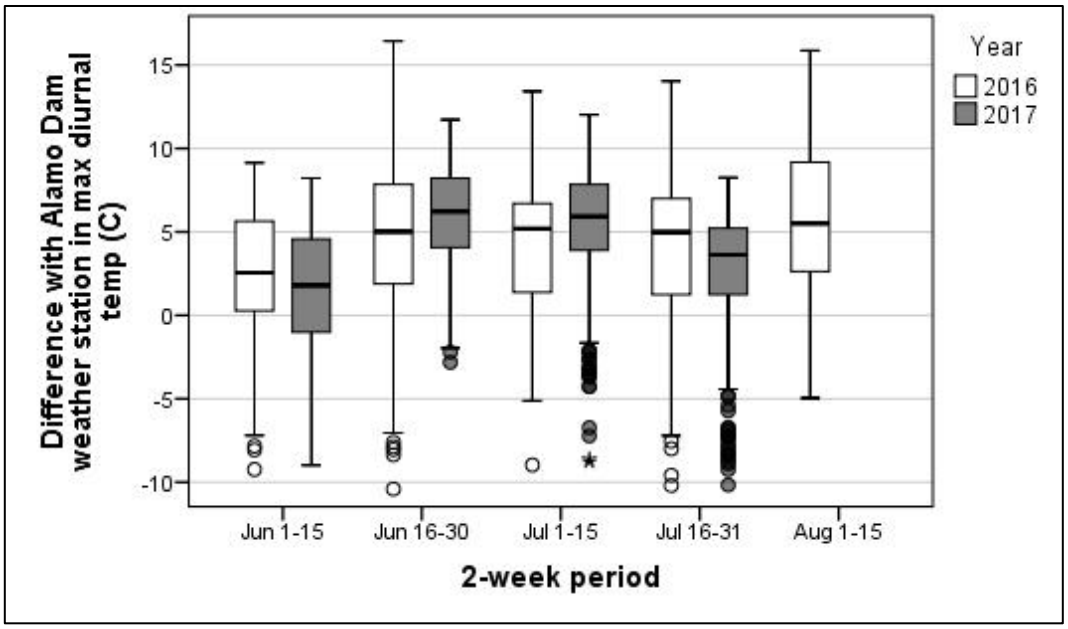

Figure 5-29.—Box plot of difference in maximum diurnal temperature between southwestern willow flycatcher nests at Alamo Lake and the Alamo Dam weather station in sites that were dry in 2016 (n = 26) but inundated in 2017 (n = 58).

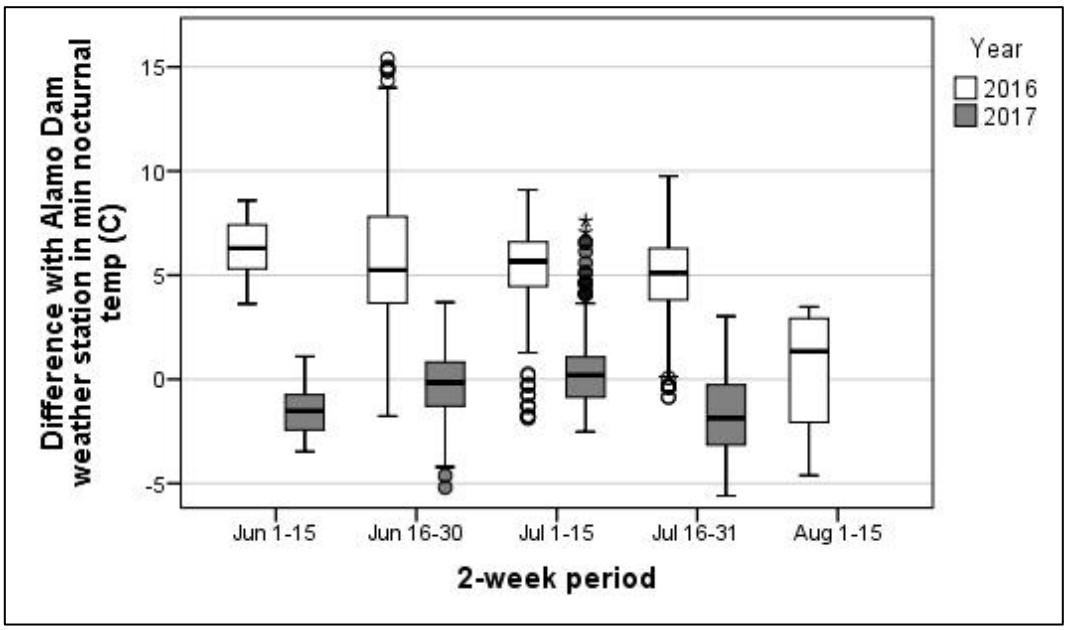

Figure 5-30.—Box plot of difference in minimum nocturnal temperature between southwestern willow flycatcher nests at Alamo Lake and the Alamo Dam weather station in sites that were dry in 2016 (n = 26) but inundated in 2017 (n = 58).

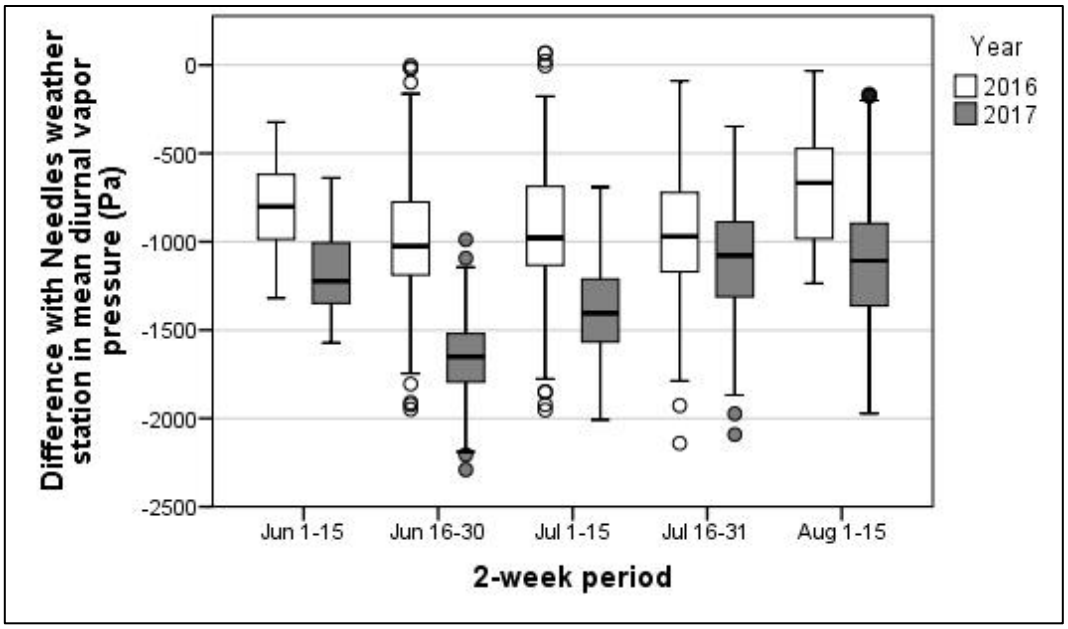

Figure 5-31.—Box plot of difference in mean diurnal vapor pressure between southwestern willow flycatcher nests at Alamo Lake and the Needles weather station in sites that were dry in 2016 (n = 26) but inundated in 2017 (n = 57).

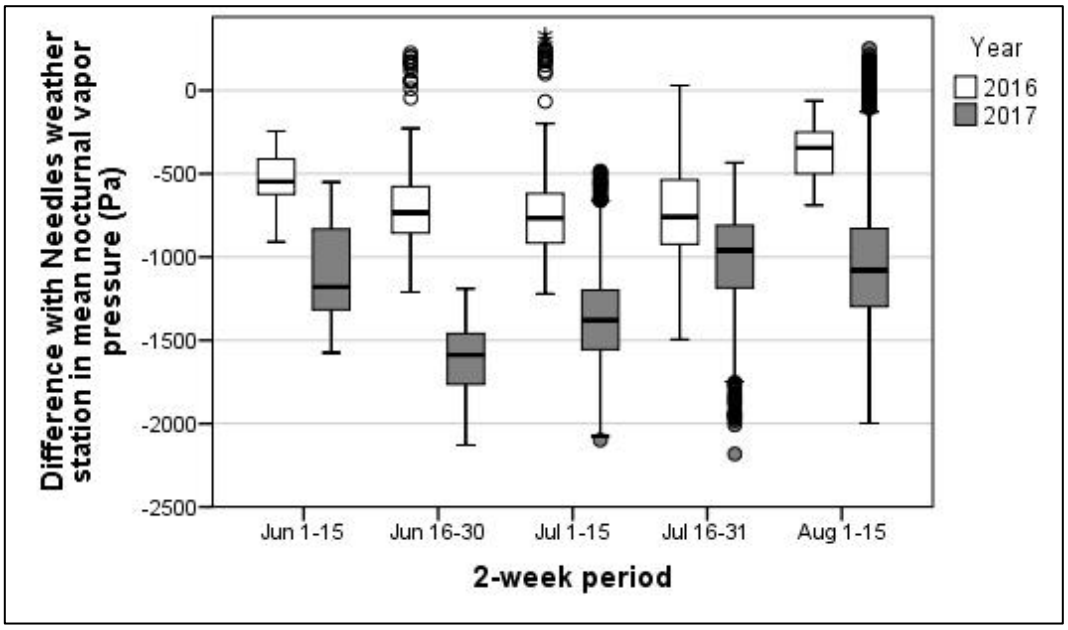

Figure 5-32.—Box plot of difference in mean nocturnal vapor pressure between southwestern willow flycatcher nests at Alamo Lake and the Needles weather station in sites that were dry in 2016 (n = 26) but inundated in 2017 (n = 57).

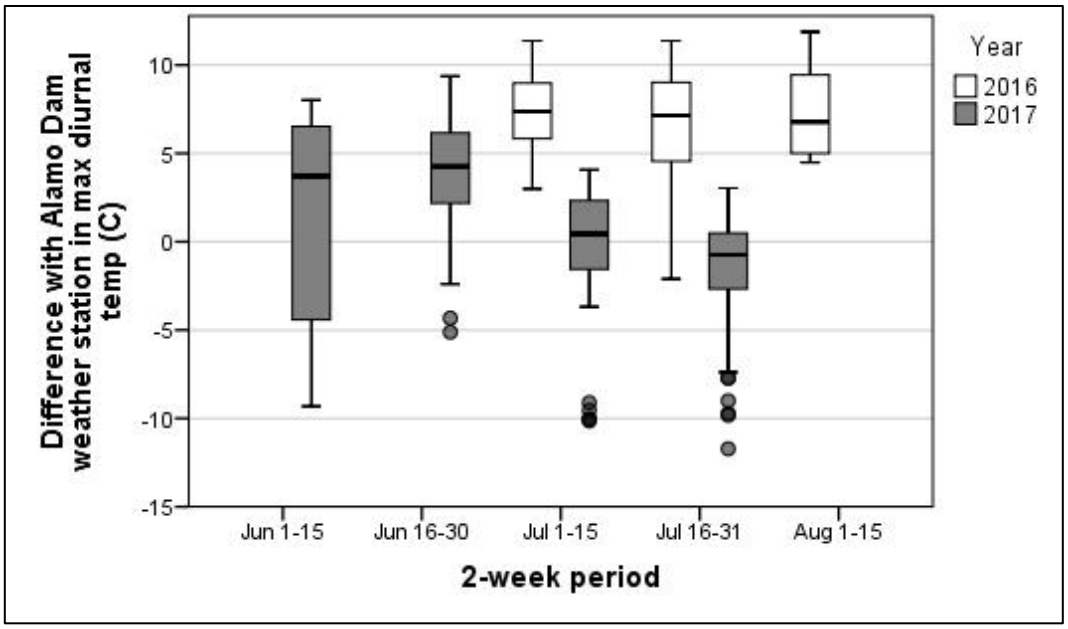

Figure 5-33.—Box plot of difference in maximum diurnal temperature between southwestern willow flycatcher nests in Santa Maria North 01 at Alamo Lake and the Alamo Dam weather station in 2016 (n = 4) and 2017 (n = 8).

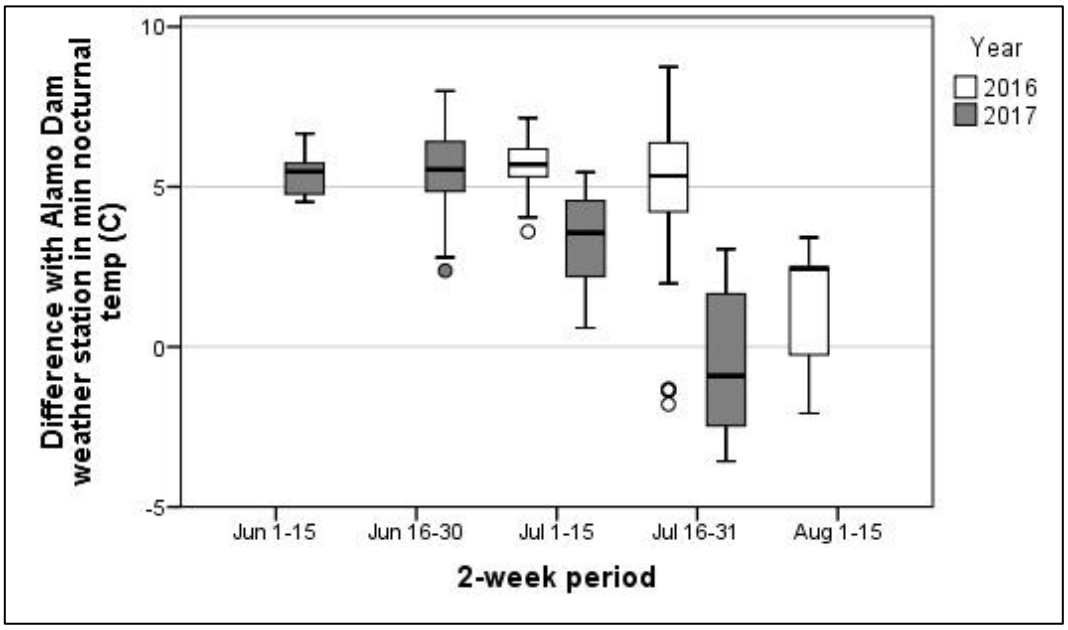

Figure 5-34.—Box plot of difference in minimum nocturnal temperature between southwestern willow flycatcher nests in Santa Maria North 01 at Alamo Lake and the Alamo Dam weather station in 2016 (n = 4) and 2017 (n = 8).

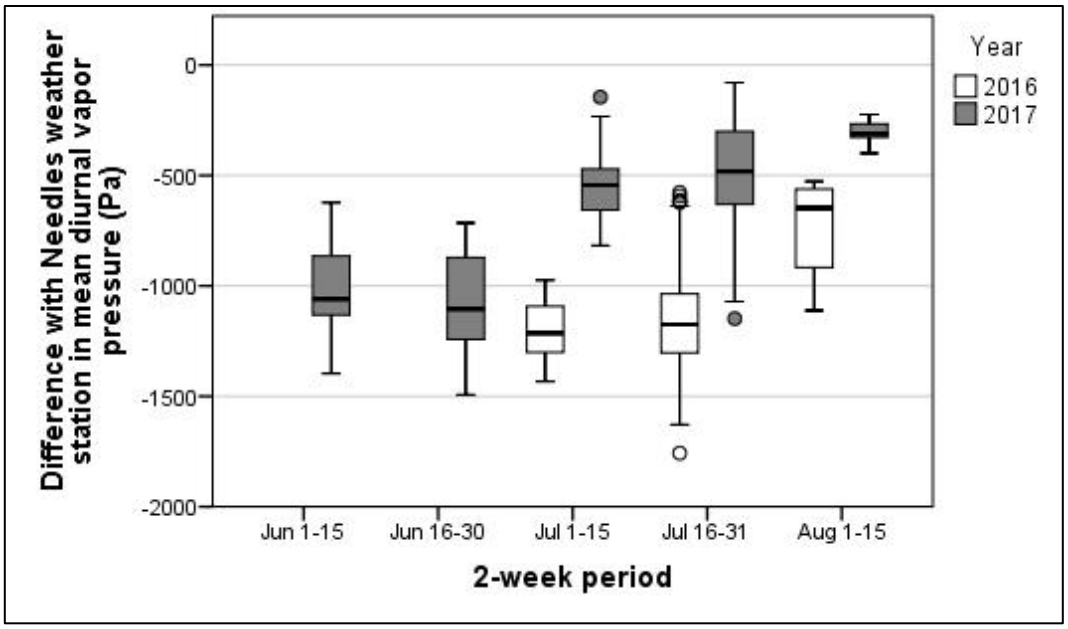

Figure 5-35.—Box plot of difference in mean diurnal vapor pressure between southwestern willow flycatcher nests in Santa Maria North 01 at Alamo Lake and the Needles weather station in 2016 (n = 4) and 2017 (n = 8).

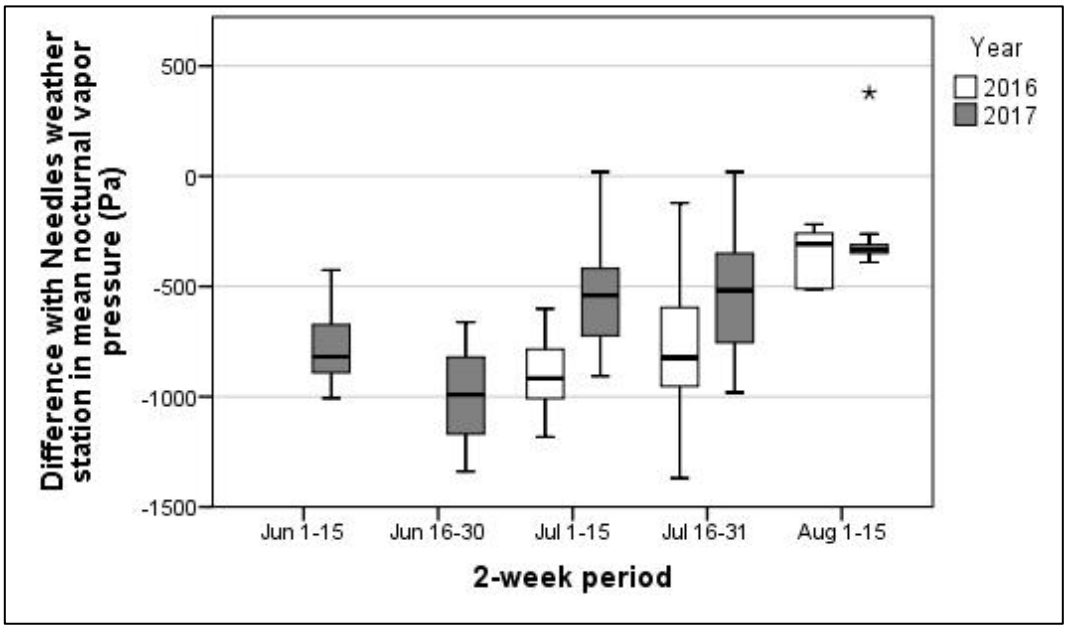

Figure 5-36.—Box plot of difference in mean nocturnal vapor pressure between southwestern willow flycatcher nests in Santa Maria North 01 at Alamo Lake and the Needles weather station in 2016 (n = 4) and 2017 (n = 8).

DISCUSSION

Surface Hydrology

Surface soil moisture conditions did not fluctuate strongly from day to day at any of the study areas where flycatcher nests were found, and some seasonal trends in soil moisture were observed (see chapter 2). In study areas like KEPI and PAHR, the strong seasonal trends in surface hydrology observed at nests correspond with seasonal trends in surface hydrology observed within the study area. At MUDD, the areal extent of wet soils remained largely unchanged during each breeding season in 2013–17. The strong trend in increase of water depth and proportion of nests over standing water as the breeding season progresses suggests that active nests at MUDD in late June and early July were directly over the river channel, whereas some nests earlier in the season were in vegetation adjacent to the channel. The shift in distribution of nest locations during the breeding season suggests that microclimate away from the river channel becomes unsuitable when regional temperatures rise. Given the lack of wet soils away from the river channel and the decrease in suitability of vegetation structure with increasing distance from the river channel (see chapter 2), a mid-season shift in the distribution of nest locations is not unexpected. At ALAM, there was a large change in surface hydrology between years but no seasonal change within years. The co-occurrence of suitable vegetation with only dry soils in the dry years and primarily inundated soils in the wet year means that flycatchers at ALAM could not select territory locations based on soil moisture conditions.

Of nests found during building at KEPI, RIRA, PAHR, MVWA, MUDD, WMSP, TOPO, and BIWI, almost all (96%) were within 30 m of wet soils when they were found. The lack of difference in mean distance to wet soils across the breeding season even though the percentage of wet soils within 20 and 50 m was significantly lower in early July compared to earlier in the breeding season suggests that proximity to wet soils may be more important than abundance of wet soils for nest site selection. 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).

Vegetation

The exact abundance of each vegetation type within the project area is not known, and no inference on preference for vegetation type can be drawn. The placement of most nests in a tamarisk substrate in vegetation types where tamarisk is not the dominant woody species does suggest a preference for tamarisk as a nest substrate. Tamarisk was most prevalent near flycatcher nests in study areas along the main stem of the LCR (i.e., TOPO and BIWI). There was only one breeding

season of active defoliation at TOPO and BIWI (2017), and the sample size of nests in defoliated areas is small. As noted in chapter 4, the amount of tamarisk within 5 m of a nest did not have much support in the model set for predicting nest survival. Given the small sample size of nests in areas with active defoliation, more data are likely needed to adequately address this question.

Temperature and Humidity

Across all study areas, the average maximum diurnal temperatures at flycatcher nests in the second half of June and in July, when many nests are in the incubation stage, approached the temperature (41 °C) above which eggs may experience embryonic mortality, even for short exposure periods (Webb 1987). Analyses of microclimate conditions within flycatcher territories along the LCR in 2003–07 showed that flycatchers place their nests in locations that have lower maximum temperatures compared to randomly selected non-nest locations within 5–10 m of the nest (McLeod et al. 2008). This suggests that high temperatures may be a limiting factor for nesting flycatchers. Analyses of relationships between vegetation and microclimate characteristics in flycatcher territories along the LCR showed that increases in canopy height, canopy closure, the density of live stems, the amount of live foliage, and soil moisture were associated with more moderate temperatures, while increases in the density of dead stems and dead foliage resulted in higher temperatures. Similarly, increases in canopy closure, the amount of live foliage, and soil moisture were associated with higher humidity (McLeod et al. 2013). Defoliation of tamarisk would thus be expected to result in higher temperatures and lower humidity at flycatcher nest sites.

The rise of Alamo Lake between the breeding seasons of 2016 and 2017 had a clear effect on the microclimate at flycatcher nests in sites that were dry in 2016 but inundated in 2017. Both diurnal and nocturnal vapor pressure were far higher in 2017 than in 2016. Minimum nocturnal temperatures were higher in 2017, likely because of the moderating thermal influence of the lake water, which was quite warm (M.A. McLeod, personal observation).

At TOPO, BIWI, and ALAM, maximum diurnal temperatures were markedly higher, in respect to those recorded at nearby weather stations, during periods of defoliation than in years prior to the arrival of tamarisk beetles. At ALAM, full defoliation did not occur at Santa Maria North until July, which coincides with the rise in high temperatures relative to those recorded at the weather station. These data suggest that defoliation resulted in increases in maximum temperatures at flycatcher nests at these study areas. Similar increases in maximum diurnal temperatures were documented as a result of defoliation along the Virgin River (Bateman et al. 2013).

The period of defoliation at ALAM was also associated with much lower diurnal vapor pressure at flycatcher nests, while nocturnal vapor pressure seemed to be less affected. Vapor pressure is affected by evapotranspiration of plants, which is greatest during the day, and defoliation markedly reduces evapotranspiration (Nagler et al. 2012). Bateman et al. (2013) also documented decreases in humidity as a result of tamarisk defoliation. Humidity at flycatcher nests at TOPO and BIWI did not seem to be affected in the same way by defoliation, likely because flycatcher nests in defoliated stands at TOPO and BIWI were near large expanses of surface water, whereas those at ALAM were not.

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

Most of the northern arm of Muddy Stringer 01 in WMSP lacks any type of closed canopy or understory and does not provide suitable habitat for breeding flycatchers. The small coyote willow patch at the northern end of the site could develop into suitable habitat if it increased in height, areal extent, and density. Surveys could be discontinued in the northern arm of the site without the possibility of overlooking resident flycatchers because of the current lack of suitable habitat. Evaluating the coyote willow patch at the beginning of future seasons to determine whether it has developed into suitable habitat, and resuming surveys if it has, would ensure that no suitable habitat is overlooked.

Surveys at Lost Slough at TOPO were discontinued after 2009 because vegetation lacked the right combination of height and density required for suitable habitat. The site was re-evaluated in 2013, and no changes in vegetation structure were noted. Examination of Google Earth imagery from June 2017 suggests that this site was completely consumed in the fire that affected Lost Lake early in 2016. Future evaluations of this site could be canceled with minimal risk of overlooking potentially suitable habitat.

If examination of aerial imagery of Lost Lake Slough #1 at TOPO shows an increase in the areal extent of the area, another evaluation could be conducted to reduce the chance of suitable flycatcher habitat being overlooked.

Examination of June 2017 Google Earth imagery of Lost Lake Slough #2 at TOPO indicated that the coyote willow patch had increased in extent since 2010, reaching 130 x 90 m in size. Another evaluation could be conducted to reduce the chance of suitable flycatcher habitat being overlooked.

Examination of June 2017 Google Earth imagery of Lost Lake Slough #3 at TOPO indicated that the coyote willows had increased in areal extent to a strip up to 30 m wide. The imagery also indicated that a majority of the area was consumed in the fire in early 2016 that also affected Lost Lake. Another evaluation could be conducted to reduce the chance of suitable flycatcher habitat being overlooked.

Examination of June 2017 Google Earth imagery of Lost Lake Slough #4 at TOPO showed that the southern border of the area was affected by the early 2016 fire, and the extent of bulrush in the area appears to have increased since 2013. If the areal extent of the area increases in future years, assessments could be conducted to reduce the chance that suitable flycatcher habitat is overlooked.

Under current conditions, surveys at Last Gasp, Guinness, Site 05, Black Rail, the downstream portion of Site 08, and Planet Ranch Road at BIWI could be discontinued with minimal risk of overlooking suitable flycatcher habitat. If flow in the Bill Williams River increases strongly in future years, re-evaluation of these sites would reduce the chance that suitable habitat is overlooked.

Maintaining Beaver Pond and Beaver Pond North at BIWI on the triennial schedule would ensure that any changes in habitat suitability would be noted in a timely manner.

If Upstream Site 08 at BIWI is evaluated at the beginning of the next survey season and determined not to have improved in quality, surveys could be discontinued with minimal risk of missing flycatcher territories.

Vegetation health at Motherlode 02, Motherlode 03, and Motherlode 04 at ALAM has been declining steadily since 2014 and seems unlikely to improve in future years without a significant rise in water levels. If lake levels do not rise about those observed in 2017, surveys at these sites could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

Sandy South 01 at ALAM could be omitted from future years of surveys with minimal risk of overlooking suitable flycatcher habitat.

If no improvements in either vegetation structure or surface hydrology are noted when surveys are next conducted at Ehrenberg at EHRE, surveys at this site could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

Surveys at Cibola Site 01 at CIBO could be discontinued with minimal risk of overlooking suitable habitat, as habitat suitability is poor and has remained unchanged since 2003.

The area immediately north of the original extent of Cibola Lake North at CIBO has the potential to develop into suitable habitat if the areal extent of coyote willows increases. This area could be assessed in future years to reduce the chance that suitable flycatcher habitat is overlooked.

If an assessment of the interior of Imperial NW at IMPE results in a determination of poor habitat suitability, surveys at this site could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

Habitat suitability at Great Blue Heron at IMPE was poor in 2015 and has not changed since SWCA began surveying in 2003. Surveys within this area could be discontinued with minimal risk of overlooking suitable flycatcher habitat. Aerial imagery suggests there may be habitat with greater suitability immediately west of the site, and this area could be assessed in future years.

Habitat suitability at Powerline and Martinez Lake at IMPE was poor in 2015 and has not changed since SWCA began surveying in 2003. Surveys could be discontinued at these sites with minimal risk of overlooking suitable flycatcher habitat.

Habitat suitability at Gila Confluence North at YUMA is poor because canopy closure is too low, and where common reed is present, the midstory is too thick. Surveys at this site could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

Habitat suitability at Gila River Site 02 and Fortuna North at YUMA was poor primarily because canopy closure was too low. Habitat suitability has remained unchanged since SWCA began surveying in 2003, and surveys could be discontinued at these sites with minimal risk of overlooking suitable flycatcher habitat.

The northern 100 m of Fortuna North at YUMA was cleared of all vegetation during the survey season in 2015, and canopy closure in a majority of the remaining vegetation was too low to constitute suitable habitat. Habitat suitability has not changed since 2004, and surveys could be discontinued with minimal risk of overlooking suitable flycatcher habitat.

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ATTACHMENTS

Attachment

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

2 Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Results for Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2013–2017

3 Orthophotos Showing Study Sites

4 Summary of Hydrologic Conditions by Survey Site, 2013–2017

5 Orthophotos Showing Reconnaissance Sites, 2013–2017

6 Detections of Covered Species Within Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2013–2017

7 Orthophotos of Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) Survey Sites, 2013–2017

8 All Willow Flycatchers (*Empidonax traillii*) Color Banded and/or Resighted, 2013–2017

9 Candidate Model Sets Considered in Program MARK in Nest Survival Analysis

10 Contributing Personnel

ATTACHMENT 1

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

Table A1-1.—Organization of study areas, survey sites, and reconnaissance sites within LCR MSCP areas and sites, 2013–17*

Study area	LCR MSCP area	LCR MSCP site	LCR MSCP section(s) (former survey site name)
Key Pittman	Alamo	Key Pittman WMA	Patch 12
			Patch 11
			Patch 10.5
			Patch 10
			Patch 09
			Patch 08
			Patch 07
			Patch 06
			Patch 05
			Patch 04.5
			Patch 04
			Patch 03
			Patch 02
			Patch 01
			Patch 00
			Nesbitt Forest
			Frenchy Lake
River Ranch	Alamo	River Ranch	East Side
			West Side
			Smalls
Pahranagat	Alamo	Pahranagat National Wildlife Refuge	Pahranagat North
			Pahranagat West
			Pahranagat MAPS (MAPS)
			Pahranagat South

Table A1-1.—Organization of study areas, survey sites, and reconnaissance sites within LCR MSCP areas and sites, 2013–17*

Study area	LCR MSCP area	LCR MSCP site	LCR MSCP section(s) (former survey site name)
Meadow Valley Wash	Meadow Valley Wash	Meadow Valley Wash North	Etna
			East Stine
			West Stine
			Rock Springs Canyon
			Dog Leg
			Ford
			Kyle
			Cottonwood Canyon
Littlefield	Littlefield	Littlefield Bridge	Littlefield Poles
			Pioneer Road
Mesquite	Mesquite	Mesquite Ditch	Back Yard
		Hafen Lane	Ball Park
			Hafen Lane 01
		Mesquite East	Up Creek
			Dumb Luck Bridge
		Mesquite West	Mesquite West 01
			Electric Avenue Pond
Mormon Mesa	Mormon Mesa	Virgin River South	Mormon Mesa South (North)
			Mormon Mesa South (South)
			Virgin River 01 North
			Virgin River 01 South
			Virgin River 02

Table A1-1.—Organization of study areas, survey sites, and reconnaissance sites within LCR MSCP areas and sites, 2013–17*

Study area	LCR MSCP area	LCR MSCP site	LCR MSCP section(s) (former survey site name)
Muddy River	Muddy River	Overton Above High-Water Mark	Overton WMA Pond
		Overton Wildlife	Overton WMA
			Secret Marsh
Warm Springs	Muddy River	Warm Springs	Muddy Mac
			Muddy Stringer 01
Topock Marsh	Topock	Topock Marsh	Pipes 01
			Pipes 03
			The Wallows
			PC 6-1
			Pig Hole
			In Between
			800M
			Pierced Egg
			Swine Paradise
			Platform
			250M
			Hell Bird
			Glory Hole
			Farm Ditch Road (Spaghetti)
	Beal Lake Conservation Area	CPhase 05	CPhase 05 (Beal Lake)
	Topock	Topock Bay	Lost Lake

Table A1-1.—Organization of study areas, survey sites, and reconnaissance sites within LCR MSCP areas and sites, 2013–17*

Study area	LCR MSCP area	LCR MSCP site	LCR MSCP section(s) (former survey site name)
Topock Gorge	Topock Gorge South	Blankenship Valley	Blankenship North
			Blankenship South
Bill Williams	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	Cougar Point	Cougar Point
		Esquerra Ranch	Beaver Pond North
			Beaver Pond
		Honeycomb Bend	Site 08
		Cave Wash	Upstream Site 08
	Planet Ranch	Planet Ranch West	Planet Ranch Road

Table A1-1.—Organization of study areas, survey sites, and reconnaissance sites within LCR MSCP areas and sites, 2013–17*

Study area	LCR MSCP area	LCR MSCP site	LCR MSCP section(s) (former survey site name)
Alamo Lake	Alamo Lake	Lake	Bullard Wash
			South Camp
			Over the Edge
		Brown's Crossing	Sidebar 01
			Edgewater 01
			Camp 01
			Camp 04
			Camp 02
			Camp 03
			Middle Earth 01
			Middle Earth 02
			Prospect 01
			Burro Wash 01
			Burro Wash 02
			Motherlode 01
			Motherlode 02
			Motherlode 03
			Motherlode 04
			Confluence 02
			Confluence 01
			Sandy South 01
			Santa Maria South 01
			Santa Maria North 01

Table A1-1.—Organization of study areas, survey sites, and reconnaissance sites within LCR MSCP areas and sites, 2013–17*

Study area	LCR MSCP area	LCR MSCP site	LCR MSCP section(s) (former survey site name)
Palo Verde Ecological Reserve	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
Ehrenberg	Palo Verde Valley	Sante Fe	Ehrenberg
Cibola	Cibola Valley Conservation Area	Phase 01	Phase 01
		Phase 02	Phase 02
		Phase 03	Phase 03
	Cibola National Wildlife Refuge Unit #1	Nature Trail	Nature Trail
		Crane Roost	C2729
	Cibola Valley South	Trigo Mountains	Cibola Site 02
			Cibola Lake North
	Imperial North	Draper Ranch	Walker Lake

Table A1-1.—Organization of study areas, survey sites, and reconnaissance sites within LCR MSCP areas and sites, 2013–17*

Study area	LCR MSCP area	LCR MSCP site	LCR MSCP section(s) (former survey site name)
Imperial	Imperial South	Fishers Landing	Imperial NW
			Imperial Nursery
			Ferguson Lake
			Great Blue Heron
			Powerline
			Martinez Lake
Mittry Lake	Laguna	Laguna West	Mittry West
	Laguna Division Conservation Area	Reach 01	C4911
			C4913
Yuma	Yuma East Wetlands[1]	J	C4703
		C (formerly South AC)	C4711
		I	C4702
	Gila Valley	Gila Valley North	Gila Confluence North
			Gila River Site 02
		Gila Valley South	Fortuna Site 01
			Fortuna North
	Hunters Hole Conservation Area	Hunters Hole Conservation Area	1401-01

* Except where noted, 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] Data collected at Yuma East Wetlands are reported under the LCR MSCP site name; each survey site constitutes only a small portion of each LCR MSCP site.

ATTACHMENT 2

Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Results for Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2013–2017

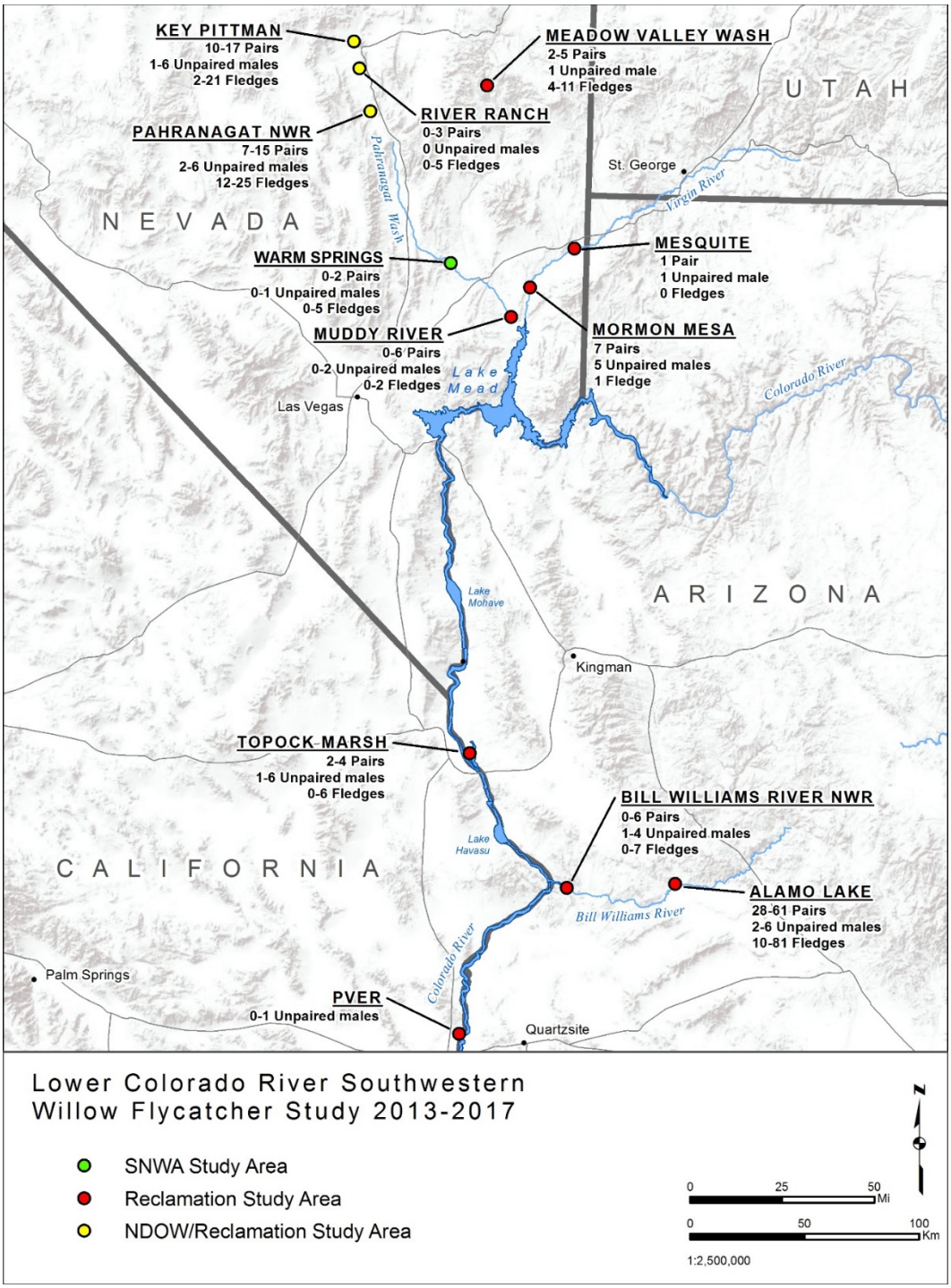
KEY PITTMAN
10-17 Pairs
1-6 Unpaired males
2-21 Fledges
MEADOW VALLEY WASH
2-5 Pairs
1 Unpaired male
4-11 Fledges
U T A H
RIVER RANCH
0-3 Pairs
0 Unpaired males
0-5 Fledges
PAHRANAGAT NWR
7-15 Pairs
2-6 Unpaired males
12-25 Fledges
Pahranagat Wash
St. George
Virgin River
N E V A D A
MESQUITE
1 Pair
1 Unpaired male
0 Fledges
WARM SPRINGS
0-2 Pairs
0-1 Unpaired males
0-5 Fledges
MUDDY RIVER
0-6 Pairs
0-2 Unpaired males
0-2 Fledges
MORMON MESA
7 Pairs
5 Unpaired males
1 Fledge
Lake Mead
Colorado River
Las Vegas
Lake Mohave
A R I Z O N A
Kingman
TOPOCK MARSH
2-4 Pairs
1-6 Unpaired males
0-6 Fledges
BILL WILLIAMS RIVER NWR
0-6 Pairs
1-4 Unpaired males
0-7 Fledges
Lake Havasu
C A L I F O R N I A
ALAMO LAKE
28-61 Pairs
2-6 Unpaired males
10-81 Fledges
Bill Williams River
Colorado River
Palm Springs
PVER
0-1 Unpaired males
Quartzsite
Lower Colorado River Southwestern
Willow Flycatcher Study 2013-2017
SNWA Study Area
Reclamation Study Area
NDOW/Reclamation Study Area
N
0 25 50 Mi
0 50 100 Km
1:2,500,000

Table A2-1.—Southwestern willow flycatcher survey and monitoring results by management unit within the Lower Colorado River Recovery Unit, 2013–17*

Management unit	Year	Area (hectares)	Survey hours	Resident adults[1]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[2]	
									Before June 24	After June 24
Pahranagat	2013	20.0	23.2[3]	71	44	33	45	37	2	2
	2014	31.3	65.7	76	51	40	50	43	10	0
	2015	33.0	50.1	60	35	29	43	41	11	3
	2016	28.5	28.5	59	39	27	47	31	6	4
	2017	28.5	43.1[3]	52	37	21	27	38	12	10
Virgin	2013	34.1	49.9	20	14	8	11	1	7	2
	2014	–	–	–	–	–	–	–	–	–
	2015	22.7	–	12	8	7	7	2	0	0
	2016	19.3	–	20	13	9	9	8	0	1
	2017	19.3	–	24	13	12	15	5	2	0
Hoover to Parker	2013	74.7	127.9	8	6	2	2	0	6	2
	2014	74.9	86.4	6	5	3	3	6	21	3
	2015	104.5	88.5	15	10	4	6	1	8	0
	2016	32.3	44.6	6	5	3	6	0	5	4
	2017	32.3	60.2	4	2	2	3	0	8	0
Bill Williams	2013	44.9	80.7	1	1	0	0	0	12	0
	2014	207.9	104.0	62	35	31	27	14	8	1
	2015	237.3	84.1	67	39	36	44	51	3	1
	2016	223.5	103.6	87	53	43	48	43	12	7
	2017	130.9	117.7	122	72	64	73	81	11	2

Table A2-1.—Southwestern willow flycatcher survey and monitoring results by management unit within the Lower Colorado River Recovery Unit, 2013–17*

Management unit	Year	Area (hectares)	Survey hours	Resident adults[1]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[2]	
									Before June 24	After June 24
Parker to Southerly International	2013	250.0	132.6	0	0	0	0	0	36	0
	2014	341.9	142.5	0	0	0	0	0	46	1
	2015	518.0	252.2	1	1	0	0	0	116	1
	2016	444.1	217.8	1	1	0	0	0	95	0
	2017	445.7	264.3	0	0	0	0	0	43	2
Project area total	**2013**	**423.7**	**414.3**	**99[4]**	**65**	**43**	**58**	**38**	**63**	**6**
	2014	**656.0**	**398.5**	**144**	**91**	**74**	**80**	**63**	**85**	**5**
	2015	**915.4**	**475.0**	**155**	**93**	**76**	**100**	**95**	**138**	**5**
	2016	**747.7**	**394.5**	**174**	**111**	**82**	**110**	**82**	**118**	**16**
	2017	**656.7**	**485.2**	**202**	**124**	**99**	**118**	**124**	**76**	**14**

* This table includes results from all sites where regular surveys were scheduled and where habitat reconnaissance and opportunistic surveys were conducted.

[1] Individuals that were resident in multiple study areas within a management unit in a given year are counted only once.
[2] Total number of individuals recorded that could not be classified as resident because of brief appearance.
[3] Survey hours do not include surveys completed by the Nevada Department of Wildlife.
[4] One individual moved between the Pahranagat and Virgin Management Units and is counted only once in the total.

Table A2-2.—Southwestern willow flycatcher survey and monitoring results by survey site within the Lower Colorado River Recovery Unit, 2013–17

"nd" indicates that no willow flycatchers were detected but survey effort was insufficient to determine that no willow flycatchers were present during some part of the season.

Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Pahranagat Key Pittman Pahranagat Valley	Patch 12 Lincoln, Nevada 1169	2013	0.08	0	0.00	4	2	2	4	4	0	0
		2014	0.09	1	–	3	2	1	2	0	1	0
		2015	0.09	0	0.00	2	1	1	2	3	0	0
		2016	0.11	0	0.00	3	2	2	3	0	0	0
		2017[4]	0.11	–	–	2	1	1	1	0	0	0
	Patch 11 Lincoln, Nevada 1169	2013	0.07	0	0.00	2	1	1	3	3	0	0
		2014	0.07	1	–	3	2	2	3	1	0	0
		2015	0.07	0	0.00	2	1	1	2	0	0	0
		2016	0.10	0	0.00	1	1	0	0	0	0	0
		2017[4]	0.10	–	–	1	1	0	0	0	0	0
	Patch 10.5 Lincoln, Nevada 1169	2013	0.02	0	0.00	1	1	0	0	0	0	0
		2014	0.02	5	–	0	0	0	0	0	0	0
		2015	0.02	1	–	0	0	0	0	0	0	0
		2016	0.05	1	0.03	0	0	0	0	0	0	0
		2017[4]	0.05	–	–	0	0	0	0	0	0	0
	Patch 10 Lincoln, Nevada 1169	2013	0.1	0	0.00	2	1	1	3	0	0	0
		2014	0.1	1	–	2	1	1	1	2	0	0
		2015	0.1	0	0.00	2	1	1	1	3	0	0
		2016	0.1	0	0.00	3	2	2	3	2	0	0
		2017[4]	0.1	–	–	1	1	0	0	0	0	0
	Patch 09 Lincoln, Nevada 1169	2013	0.29	0	0.00	7	4	4	5	5	0	0
		2014	0.29	1	–	7	4	4	4	7	0	0
		2015	0.29	0	0.00	5	3	3	5	0	0	0
		2016	0.32	0	0.00	1	1	0	0	0	0	0
		2017[4]	0.32	–	–	0	0	0	0	0	0	0

Table A2-2.—Southwestern willow flycatcher survey and monitoring results by survey site within the Lower Colorado River Recovery Unit, 2013–17

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Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Pahranagat Key Pittman Pahranagat Valley	Patch 08 Lincoln, Nevada 1169	2013	0.06	0	0.00	2	1	1	1	3	0	0
		2014	0.06	1	–	2	1	1	3	0	0	0
		2015	0.06	0	0.00	0	0	0	0	0	0	0
		2016	0.07	0	0.00	0	0	0	0	0	0	0
		2017[4]	0.07	–	–	0	0	0	0	0	0	0
	Patch 07 Lincoln, Nevada 1169	2013	0.07	0	0.00	2	1	1	1	3	0	0
		2014	0.07	1	–	2	1	1	2	1	0	0
		2015	0.07	0	0.00	2	1	1	2	0	1	0
		2016	0.10	0	0.00	2	1	1	2	0	0	0
		2017[4]	0.10	–	–	2	1	1	0	0	0	0
	Patch 06 Lincoln, Nevada 1169	2013	0.15	0	0.00	5	3	3	4	0	0	0
		2014	0.15	1	–	7	5	2	2	0	1	0
		2015	0.15	0	0.00	2	1	1	2	0	0	1
		2016	0.18	0	0.00	2	1	1	2	0	0	0
		2017[4]	0.18	–	–	2	1	1	1	2	0	1
	Patch 05 Lincoln, Nevada 1169	2013	0.11	0	0.00	3	2	2	3	0	0	0
		2014	0.11	4	–	0	0	0	0	0	4	0
		2015	0.11	3	–	1	1	0	0	0	0	0
		2016	0.12	2	0.1	0	0	0	0	0	1	0
		2017[4]	0.12	–	–	2	1	1	1	1	0	0
	Patch 04.5 Lincoln, Nevada 1169	2013	0.03	0	0.00	1	1	0	0	0	0	0
		2014	0.04	4	–	0	0	0	0	0	0	0
		2015	0.04	3	–	0	0	0	0	0	2	0
		2016	0.04	3	0.3	0	0	0	0	0	1	0
		2017[4]	0.04	–	–	0	0	0	0	0	0	0

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Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Pahranagat Key Pittman Pahranagat Valley	Patch 04 Lincoln, Nevada 1169	2013	0.06	0	0.00	1	1	0	0	0	0	0
		2014	0.06	1	–	2	1	1	1	2	0	0
		2015	0.06	0	0.00	3	1	1	2	0	0	0
		2016	0.07	1	0.01	3	1	1	2	0	0	0
		2017[4]	0.07	–	–	0	0	0	0	0	1	1
	Patch 03 Lincoln, Nevada 1169	2013	0.10	0	0.00	3	2	1	2	3	0	0
		2014	0.10	1	–	1	1	0	0	0	0	0
		2015	0.10	0	0.00	0	0	0	0	0	0	0
		2016	0.11	1	0.01	1	1	0	0	0	0	0
		2017[4]	0.11	–	–	0	0	0	0	0	0	0
	Patch 02 Lincoln, Nevada 1169	2013	0.09	0	0.00	2	1	1	1	0	0	0
		2014	0.09	1	–	3	2	2	1	0	0	0
		2015	0.09	0	0.00	2	1	1	1	0	0	0
		2016	0.11	1	0.01	1	1	0	0	0	0	0
		2017[4]	0.11	–	–	0	0	0	0	0	0	0
	Patch 01 Lincoln, Nevada 1169	2013	0.07	0	0.00	2	2	0	0	0	0	0
		2014	0.07	1	–	2	1	1	1	0	0	0
		2015	0.07	0	0.00	2	1	1	1	0	0	0
		2016	0.10	1	0.02	1	1	0	0	0	0	0
		2017[4]	0.10	–	–	0	0	0	0	0	0	0
	Patch 00 Lincoln, Nevada 1169	2013	0.03	0	0.00	0	0	0	0	0	0	0
		2014	0.03	3	–	1	1	0	0	0	0	0
		2015	0.03	0	0.00	3	2	2	3	0	0	0
		2016	0.05	1	0.02	2	1	1	2	0	0	0
		2017[4]	0.05	–	–	1	1	0	0	0	0	0

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Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Pahranagat Key Pittman Pahranagat Valley	Nesbitt Forest Lincoln, Nevada 1169	2014	0.16	0	0.00	2	1	1	1	0	0	0
		2015	0.16	0	0.00	0	0	0	0	0	0	0
		2016	0.16	1	0.02	0	0	0	0	0	0	0
		2017[4]	0.16	–	–	0	0	0	0	0	0	0
	Frenchy Lake Lincoln, Nevada 1158	2016	0.69	2	0.4	2	1	1	2	0	0	0
		2017[4]	0.69	–	–	0	0	0	0	0	2	0
	Study area total	2013	1.33	0	0.00	37	23	17	27	21	0	0
		2014	1.52	–	2.96	35	23	17	21	13	6	0
		2015	1.52	–	0.71	23	13	12	21	6	3	1
		2016	2.47	–	0.92	22	14	10	19	2	2	0
		2017[4]	2.47	–	–	11	7	4	3	3	3	2
Pahranagat River Ranch Pahranagat Valley	East Side Lincoln, Nevada 1100	2013	0.41	1	0.20	2	1	1	2	0	0	0
		2014	0.41	5	1.80	0	0	0	0	0	0	0
		2015	0.41	1	0.27	4	2	2	3	2	1	0
		2016	0.41	1	0.15	2	1	1	3	1	0	0
		2017[4]	0.41	–	–	2	1	0	0	0	0	0
	West Side Lincoln, Nevada 1100	2013	0.32	1	0.30	0	0	0	0	0	1	2
		2014	0.32	5	1.69	0	0	0	0	0	2	0
		2015	0.32	2	0.19	2	1	1	2	3	0	0
		2016	0.32	2	0.65	0	0	0	0	0	0	0
		2017[4]	0.32	–	–	3	2	1	1	0	0	0
	The Middle Lincoln, Nevada 1100	2017[4]	–	–	–	1	1	0	0	0	0	0

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											Before June 24	After June 24
Pahranagat River Ranch Pahranagat Valley	Smalls Lincoln, Nevada 1100	2013	0.23	3	0.41	0	0	0	0	0	0	0
		2014	0.23	5	0.92	0	0	0	0	0	1	0
		2015	0.23	3	0.30	0	0	0	0	0	0	1
		2016	0.23	3	0.34	0	0	0	0	0	0	0
		2017[4]	0.23	–	–	1	1	0	0	0	0	1
	Study area total	2013	0.95	–	0.91	2	1	1	2	0	0	0
		2014	0.95	–	4.41	0	0	0	0	0	1	0
		2015	0.95	–	0.76	6	3	3	5	5	1	1
		2016	0.95	–	1.13	2	1	1	3	1	0	0
		2017[4]	0.95	–	–	7	6	1	1	0	0	1
Pahranagat Pahranagat Pahranagat Valley	Pahranagat North Lincoln, Nevada 1019	2013	3.15	2	0.35	18	11	8	7	12	1	1
		2014	3.15	5	2.97	24	15	13	17	21	0	0
		2015	3.15	5	0.85	14	8	6	6	11	0	0
		2016	3.15	3	1.34	17	12	8	14	19	0	2
		2017	3.15	5	1.17	16	12	6	9	16	0	2
	Pahranagat West Lincoln, Nevada 1023	2013	1.30	2	0.45	2	1	1	0	0	0	0
		2014	1.30	5	2.44	0	0	0	0	0	0	0
		2015	1.30	5	3.28	2	1	1	1	3	0	0
		2016	1.30	3	0.63	2	1	1	2	4	0	0
		2017	1.30	5	1.82	2	1	1	1	2	2	0
	Pahranagat MAPS Lincoln, Nevada 1022	2014	0.17	0	0.0	4	3	2	3	4	0	0
		2015	0.17	3	2.41	5	4	1	2	3	1	0
		2016	0.34	2	1.01	5	4	1	3	0	0	0
		2017	0.34	5	5.78	0	0	0	0	0	3	1

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Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Pahranagat Pahranagat Pahranagat Valley	Pahranagat South Lincoln, Nevada 1021	2013	1.44	1	0.16	nd	nd	nd	nd	nd	nd	1
		2014	1.44	5	2.82	0	0	0	0	0	0	0
		2015	1.44	5	2.51	0	0	0	0	0	0	0
		2016	1.44	3	1.18	0	0	0	0	0	0	0
		2017	1.44	5	2.27	0	0	0	0	0	0	0
	Study area total	2013	5.90	–	0.96	20	12	9	7	12	1	2
		2014	6.06	–	8.23	28	18	15	20	25	0	0
		2015	6.06	–	9.05	21	13	8	9	17	1	0
		2016	6.24	–	4.15	23	17	10	19	23	0	2
		2017	6.24	–	11.05	18	13	7	10	18	5	3
Pahranagat Meadow Valley Wash Meadow Valley Wash	Etna Lincoln, Nevada 1280	2014	0.50	5	1.87	0	0	0	0	0	0	0
		2015	0.50	5	1.58	0	0	0	0	0	0	0
	Rock Springs Canyon Lincoln, Nevada 1218	2016	0.30	0	0.0	2	1	1	1	2	0	0
		2017	0.30	5	1.33	0	0	0	0	0	0	0
	Dog Leg Lincoln, Nevada 1207	2013[4]	–	–	–	2	1	1	1	2	nd	nd
		2014	8.59	5	13.63	4	3	2	2	4	0	0
		2015	10.28	5	9.13	5	3	3	4	10	0	1
		2016	10.28	5	10.24	5	3	3	3	3	1	0
		2017	10.28	5	11.57	9	6	5	7	11	0	1
	Ford Lincoln, Nevada 1121	2014	1.77	5	2.89	0	0	0	0	0	0	0
		2015	1.77	5	1.94	0	0	0	0	0	0	0
	Kyle Lincoln, Nevada 970	2014	0.75	5	2.74	0	0	0	0	0	0	0
		2015	0.75	5	2.34	0	0	0	0	0	0	0
	Cottonwood Canyon Lincoln, Nevada 939	2014	1.34	5	3.93	0	0	0	0	0	0	0
		2015	1.34	5	2.65	0	0	0	0	0	2	0

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											Before June 24	After June 24
Pahranagat Meadow Valley Wash Meadow Valley Wash	Study area total	2013[4]	–	–	–	2	1	1	1	2	nd	nd
		2014	12.95	–	25.06	4	3	2	2	4	0	0
		2015	14.64	–	17.63	5	3	3	4	10	2	1
		2016	10.58	–	10.24	7	4	4	4	5	1	0
		2017	10.58	–	12.90	9	6	5	7	11	0	1
Pahranagat Warm Springs Muddy River	Muddy Mac Clark, Nevada 535	2013	0.54	4	2.15	0	0	0	0	0	0	0
		2014	0.54	5	2.93	1	1	0	0	0	0	0
		2015	0.54	5	1.97	0	0	0	0	0	0	0
		2016	0.90	5	2.36	0	0	0	0	0	0	0
		2017	0.90	5	3.44	2	1	1	1	3	0	0
	Muddy Stringer 01 Clark, Nevada 530	2013	1.43	1	0.67	nd	nd	nd	nd	nd	nd	nd
		2014	0.81	5	2.24	1	1	0	0	0	0	0
		2015	0.81	5	0.96	2	1	1	1	1	0	0
		2016	0.81	1	0.13	1	1	0	0	0	0	1
		2017	0.81	5	1.18	3	2	1	1	2	0	2
	Study area total	2013	1.97	–	2.82	0	0	0	0	0	0	0
		2014	1.35	–	5.17	1	1	0	0	0	0	0
		2015	1.35	–	2.92	2	1	1	1	1	0	0
		2016	1.72	–	2.50	1	1	0	0	0	0	1
		2017	1.72	–	4.62	5	3	2	2	5	0	2
Pahranagat Muddy River Muddy River	Overton WMA Pond Clark, Nevada 378	2013	0.65	5	3.65	0	0	0	0	0	0	0
		2014	0.65	5	2.41	0	0	0	0	0	3	0
		2015	0.65	5	2.74	0	0	0	0	0	0	0
		2016	0.65	5	1.50	0	0	0	0	0	3	0
		2017	0.65	5	1.68	0	0	0	0	0	0	0

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											Before June 24	After June 24
Pahranagat Muddy River Muddy River	Overton WMA Clark, Nevada 375	2013	9.21	5	14.87	10	7	5	8	2	1	0
		2014	7.78	5	17.41	8	6	6	7	1	0	0
		2015	7.78	5	16.32	3	2	2	3	2	4	0
		2016	5.90	5	8.07	4	2	2	2	0	0	1
		2017	5.90	5	12.79	3	2	2	4	1	4	1
	Study area total	2013	9.86	–	18.52	10	7	5	8	2	1	0
		2014	8.43	–	19.82	8	6	6	7	1	3	0
		2015	8.43	–	19.07	3	2	2	3	2	4	0
		2016	6.55	–	9.56	4	2	2	2	0	3	1
		2017	6.55	–	14.48	3	2	2	4	1	4	1
Virgin Mesquite Virgin River	Hafen Lane 01 Clark, Nevada 475	2013	2.11	5	6.60	0	0	0	0	0	0	0
	Dumb Luck Bridge Clark, Nevada 475	2013	1.09	5	4.30	0	0	0	0	0	0	0
	Mesquite West 01 Clark, Nevada 470	2013	11.65	5	11.75	2	1	1	2	0	7	1
		2015[4]	11.65	–	–	3	2	2	2	0	0	0
		2016[4]	11.65	–	–	9	5	5	3	4	0	0
		2017[4]	11.65	–	–	14	7	7	9	3	2	0
	Electric Avenue Pond Clark, Nevada 464	2013	1.74	1	1.00	1	1	0	0	0	0	0
		2015[4]	1.74	–	–	2	1	1	2	0	0	0
		2016[4]	1.74	–	–	5	4	2	4	2	0	0
		2017[4]	1.74	–	–	4	2	2	3	2	0	0
	Study area total	2013	16.59	–	23.65	3	2	1	2	0	7	1
		2015[4]	13.39	–	–	5	3	3	4	0	0	0
		2016[4]	13.39	–	–	14	9	7	7	6	0	0
		2017[4]	13.39	–	–	18	9	9	12	5	2	0

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											Before June 24	After June 24
Virgin Mormon Mesa Virgin River	Mormon Mesa South (North) Clark, Nevada 385	2013	6.04	5	9.20	0	0	0	0	0	0	0
	Mormon Mesa South (South) Clark, Nevada 385	2013	2.23	5	5.65	0	0	0	0	0	0	0
	Virgin River 01 (North) Clark, Nevada 380	2013	3.40	5	11.38	1	1	0	0	0	0	0
		2015[4]	3.40	–	–	1	1	0	0	0	0	0
	Virgin River 01 (South) Clark, Nevada 380	2013	5.86	0	0.0	16	11	7	9	1	0	1
		2015[4]	5.86	–	–	6	4	4	3	2	0	0
		2016[4]	5.86	–	–	6	4	2	2	2	0	1
		2017[4]	5.86	–	–	6	4	3	3	0	0	0
	Study area total	2013	17.53	–	26.23	17	12	7	9	1	0	1
		2015[4]	9.26	–	–	7	5	4	3	2	0	0
		2016[4]	5.86	–	–	6	4	2	2	2	0	1
		2017[4]	5.86	–	–	6	4	3	3	0	0	0
Hoover to Parker Topock Marsh Colorado River	Pipes 01 Mohave, Arizona 140	2013	5.20	5	9.53	0	0	0	0	0	0	0
		2014	5.20	5	8.96	0	0	0	0	0	0	0
		2015	5.20	5	7.71	0	0	0	0	0	0	0
	Pipes 03 Mohave, Arizona 140	2013	5.70	5	10.00	0	0	0	0	0	0	0
		2014	5.70	5	7.33	0	0	0	0	0	1	0
		2015	5.70	5	7.88	0	0	0	0	0	1	0
	The Wallows Mohave, Arizona 140	2013	0.68	5	3.93	1	1	0	0	0	0	1
		2014	0.68	5	2.39	0	0	0	0	0	3	2
		2015	0.68	1	0.47	2	1	1	2	0	1	0
	PC 6-1 Mohave, Arizona 140	2013	4.76	5	11.36	0	0	0	0	0	0	0
		2014	4.76	5	8.30	0	0	0	0	0	1	0
		2015	4.76	5	7.20	0	0	0	0	0	1	0

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											Before June 24	After June 24
Hoover to Parker Topock Marsh Colorado River	Pig Hole Mohave, Arizona 140	2013	2.43	5	5.50	0	0	0	0	0	0	0
		2014	2.43	5	3.81	0	0	0	0	0	0	0
		2015	2.43	5	4.38	0	0	0	0	0	0	0
	In Between Mohave, Arizona 140	2013	7.75	5	11.75	0	0	0	0	0	0	0
		2014	7.75	5	8.07	0	0	0	0	0	0	0
		2015	7.75	3	5.54	0	0	0	0	0	0	0
	800M Mohave, Arizona 140	2013	4.69	5	7.78	0	0	0	0	0	0	0
		2014	4.69	5	5.64	0	0	0	0	0	0	0
		2015	4.69	3	4.95	1	1	0	0	0	0	0
	Pierced Egg Mohave, Arizona 140	2013	6.75	5	11.25	0	0	0	0	0	1	0
		2014	6.75	5	8.88	0	0	0	0	0	3	0
		2015	6.75	3	4.24	3	1	1	2	0	2	0
	Swine Paradise Mohave, Arizona 140	2013	0.75	5	4.75	2	1	1	1	0	0	0
		2014	0.99	0	0.0	4	3	3	3	6	0	1
		2015	0.99	0	0.0	4	3	1	1	1	1	0
		2016	0.89	0	0.0	5	4	3	6	0	0	1
		2017	0.89	5	5.9	0	0	0	0	0	4	0
	Platform Mohave, Arizona 140	2013	1.94	5	3.30	0	0	0	0	0	1	0
		2014	1.94	5	2.16	0	0	0	0	0	3	0
		2015	1.94	5	1.88	0	0	0	0	0	0	0
		2016	1.88	5	2.36	1	1	0	0	0	0	0
		2017	1.88	5	3.56	0	0	0	0	0	0	0
	250M Mohave, Arizona 140	2013	1.90	5	4.20	0	0	0	0	0	0	0
		2014	1.90	5	3.45	0	0	0	0	0	0	0
		2015	1.90	5	3.28	0	0	0	0	0	0	0
		2016	1.55	5	4.06	0	0	0	0	0	1	0
		2017	1.55	5	3.59	2	1	1	2	0	0	0

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Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Hoover to Parker Topock Marsh Colorado River	Hell Bird Mohave, Arizona 142	2013	5.84	5	13.75	1	1	0	0	0	2	0
		2014	5.84	5	5.49	0	0	0	0	0	0	0
		2015	5.84	5	6.33	2	2	0	0	0	1	0
		2016	5.84	5	12.08	0	0	0	0	0	0	1
		2017	5.84	5	10.29	2	1	1	1	0	0	0
	Glory Hole Mohave, Arizona 143	2013	4.97	5	7.00	3	2	1	1	0	0	1
		2014	4.97	5	6.97	0	0	0	0	0	2	0
		2015	4.97	4	5.55	2	1	1	1	0	0	0
		2016	6.37	5	8.94	0	0	0	0	0	3	1
		2017	6.37	5	16.10	0	0	0	0	0	1	0
	Farm Ditch Road Mohave, Arizona 140	2015	5.44	5	5.80	0	0	0	0	0	0	0
		2016	4.41	5	3.42	0	0	0	0	0	1	0
		2017	4.41	5	4.52	0	0	0	0	0	2	0
	CPhase05 Mohave, Arizona 140	2013	18.03	5	14.70	1	1	0	0	0	0	0
		2014	18.03	5	10.08	1	1	0	0	0	3	0
		2015	11.37	5	3.34	0	0	0	0	0	1	0
		2016	11.37	5	13.71	0	0	0	0	0	0	1
		2017	11.37	5	16.24	0	0	0	0	0	1	0
	Lost Lake Mohave, Arizona 140	2013	3.29	4	9.08	0	0	0	0	0	2	0
		2014	3.29	5	4.89	1	1	0	0	0	5	0
		2015	3.29	5	4.95	1	1	0	0	0	0	0
	Study area total	2013	74.67	–	127.88	8	6	2	2	0	6	2
		2014	74.91	–	86.39	6	5	3	3	6	21	3
		2015	73.69	–	73.49	15	10	4	6	1	8	0
		2016	32.31	–	44.56	6	5	3	6	0	5	4
		2017	32.31	–	60.18	4	2	2	3	0	8	0

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Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Hoover to Parker Topock Gorge Colorado River	Blankenship North Mohave, Arizona 138	2015	18.98	5	7.57	0	0	0	0	0	0	0
	Blankenship South Mohave, Arizona 138	2015	11.78	5	7.42	0	0	0	0	0	0	0
	Study area total	2015	30.76	–	14.99	0	0	0	0	0	0	0
Bill Williams Bill Williams Bill Williams River	Coyote Crossing La Paz, Arizona 137	2016	2.12	3	5.08	1	1	0	0	0	0	0
		2017	2.12	3	3.99	0	0	0	0	0	0	0
	Bill Willow Mohave, Arizona 137	2015	1.59	5	6.94	0	0	0	0	0	2	0
		2016	1.59	2	1.95	5	3	3	4	6	0	0
		2017	1.59	4	3.53	5	3	2	1	0	0	0
	Wispy Willow Mohave, Arizona 137	2013	0.93	5	4.25	0	0	0	0	0	1	0
		2014	1.32	2	2.07	4	3	2	2	1	2	0
		2015	1.32	0	0.0	4	3	3	4	4	0	0
		2016	1.32	1	0.81	5	3	2	4	1	0	1
		2017	1.32	2	3.38	2	2	0	0	0	0	0
	Site 01 Mohave, Arizona 138	2013	3.05	5	8.50	0	0	0	0	0	2	0
		2014	2.43	5	6.75	0	0	0	0	0	3	0
		2015	2.43	1	1.51	3	2	1	2	1	0	0
		2016	2.43	3	6.23	1	1	0	0	0	3	0
		2017	2.43	3	4.86	3	2	1	2	0	1	0
	Burn Edge Mohave, Arizona 143	2013	4.06	5	5.60	0	0	0	0	0	0	0
		2014	4.06	5	4.27	0	0	0	0	0	0	0
		2015	4.06	4	3.79	0	0	0	0	0	0	0
		2016	4.06	6	5.75	0	0	0	0	0	3	0
		2017	3.22	5	6.61	0	0	0	0	0	0	0

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Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Bill Williams Bill Williams Bill Williams River	Site 04 La Paz, Arizona 146	2013	9.87	5	17.85	0	0	0	0	0	0	0
		2014	9.89	5	8.82	0	0	0	0	0	0	0
		2015	9.89	5	10.95	0	0	0	0	0	0	0
		2016	9.89	5	14.93	0	0	0	0	0	0	0
		2017	9.89	5	17.80	0	0	0	0	0	1	0
	Site 03 La Paz, Arizona 146	2013	12.90	5	15.80	0	0	0	0	0	1	0
		2014	12.92	5	12.66	2	1	1	2	3	0	0
		2015	12.92	6	15.43	2	1	1	1	0	0	0
		2016	12.92	5	15.51	0	0	0	0	0	3	0
		2017	12.92	5	20.40	0	0	0	0	0	0	0
	Last Gasp Mohave, Arizona 146	2015[6]	2.10	1	0.70	nd	nd	nd	nd	nd	nd	nd
		2016[6]	2.10	1	0.92	nd	nd	nd	nd	nd	nd	nd
	Guinness La Paz and Mohave, Arizona 148	2015[6]	3.43	1	1.87	nd	nd	nd	nd	nd	nd	nd
		2016[6]	3.43	1	0.59	nd	nd	nd	nd	nd	nd	nd
	Site 05 Mohave, Arizona 146	2013	6.79	5	9.83	0	0	0	0	0	0	0
		2014	6.79	5	7.79	0	0	0	0	0	0	0
		2015	6.79	3	5.59	0	0	0	0	0	0	0
		2016	6.79	5	11.44	0	0	0	0	0	0	0
	Black Rail Mohave, Arizona 146	2013	1.16	5	2.75	0	0	0	0	0	0	0
		2014	1.16	5	2.46	0	0	0	0	0	0	0
		2015[6]	1.16	1	0.50	nd	nd	nd	nd	nd	nd	nd
		2016[6]	1.16	1	0.35	nd	nd	nd	nd	nd	nd	nd
	Cougar Point Mohave, Arizona 157	2013	1.34	5	6.60	0	0	0	0	0	3	0
		2014	1.34	5	3.43	0	0	0	0	0	0	0
	Beaver Pond North La Paz and Mohave, Arizona 158	2015	19.04	5	7.76	0	0	0	0	0	0	0
		2016[6]	19.04	1	2.31	nd	nd	nd	nd	nd	nd	nd

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Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Bill Williams Bill Williams Bill Williams River	Beaver Pond La Paz and Mohave, Arizona 160	2013	–	0	0.0	nd	nd	nd	nd	nd	1	nd
		2015	21.47	5	8.17	0	0	0	0	0	0	0
		2016[6]	21.47	1	2.02	nd	nd	nd	nd	nd	nd	nd
	Site 08 La Paz and Mohave, Arizona 167	2015	12.07	5	6.58	2	1	1	1	1	0	0
		2016	12.07	5	8.09	1	1	0	0	0	2	0
		2017	5.99	5	7.10	0	0	0	0	0	0	0
	Upstream Site 08 Mohave, Arizona 170	2013	1.49	5	5.25	0	0	0	0	0	1	0
		2014	1.49	4	2.91	0	0	0	0	0	0	0
		2015	1.49	3	1.90	0	0	0	0	0	0	0
		2016	1.49	5	3.46	0	0	0	0	0	0	0
		2017	1.10	5	3.99	0	0	0	0	0	0	0
	Planet Ranch Road La Paz, Arizona 171	2013[5]	3.28	3	4.25	1	1	0	0	0	4	0
		2014[5]	3.28	3	2.54	0	0	0	0	0	0	0
		2017	4.01	5	14.91	0	0	0	0	0	0	0
	Study area total	2013	44.86	–	80.68	1	1	0	0	0	12	0
		2014	44.68	–	53.69	6	4	3	4	4	5	0
		2015	99.76	–	71.69	11	7	6	8	6	2	0
		2016	101.88	–	79.45	13	9	5	8	7	11	0
		2017	44.59	–	86.57	10	7	3	3	0	2	0
Bill Williams Alamo Lake Bill Williams River	Bullard Wash La Paz, Arizona 335	2016	1.88	1	1.23	nd	nd	nd	nd	nd	nd	nd
		2017	1.40	3	2.99	nd	nd	nd	nd	nd	nd	nd
	South Camp Mohave, Arizona 335	2016	2.36	2	1.42	2	1	1	1	0	0	0
		2017	1.84	3	0.99	0	0	0	0	0	0	0
	Over the Edge Mohave, Arizona 335	2016	2.13	0	0.0	4	2	2	2	0	1	0

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Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Bill Williams Alamo Lake Bill Williams River	Sidebar 01 La Paz, Arizona 335	2014	1.66	1	0.99	nd	nd	nd	nd	nd	nd	nd
		2015	1.66	1	1.03	2	1	1	1	1	0	1
		2016	1.14	0	0.0	4	2	1	1	1	0	0
		2017	1.14	3	1.76	nd	nd	nd	nd	nd	nd	nd
	Edgewater 01 Mohave, Arizona 335	2015	10.35	0	0.0	2	1	1	1	1	0	0
		2016	0.90	0	0.0	4	2	2	2	0	0	0
	Camp 01 Mohave, Arizona 337	2014	0.71	0	0.0	2	1	1	0	0	0	0
		2015	0.71	1	0.16	nd	nd	nd	nd	nd	nd	nd
		2016	0.71	1	0.39	2	1	1	1	0	0	0
		2017	0.61	3	1.65	0	0	0	0	0	0	0
	Camp 04 Mohave, Arizona 335	2014	0.25	0	0.0	1	1	0	0	0	0	0
		2015	0.25	1	0.04	nd	nd	nd	nd	nd	nd	nd
		2016	0.17	1	0.07	3	2	2	2	1	0	1
	Camp 02 Mohave, Arizona 337	2014	0.32	1	0.20	nd	nd	nd	nd	nd	nd	nd
		2015	0.32	1	0.04	nd	nd	nd	nd	nd	nd	nd
		2016	0.32	2	0.49	nd	nd	nd	nd	nd	nd	nd
		2017	0.27	3	0.63	0	0	0	0	0	0	0
	Camp 03 Mohave, Arizona 337	2014	1.93	1	0.42	2	1	1	1	0	0	1
		2015	1.93	1	0.24	nd	nd	nd	nd	nd	nd	nd
		2016	1.27	2	1.03	nd	nd	nd	nd	nd	nd	nd
		2017	1.20	4	2.90	0	0	0	0	0	2	0
	Middle Earth 01 La Paz, Arizona 337	2014	6.12	1	1.00	9	6	5	6	1	0	0
		2015	6.12	0	0.0	8	5	4	5	8	0	0
		2016	2.23	0	0.0	2	1	1	0	0	0	0
		2017	1.82	2	2.65	3	2	1	1	2	0	0

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											Before June 24	After June 24
Bill Williams Alamo Lake Bill Williams River	Middle Earth 02 La Paz, Arizona 338	2014	6.70	1	1.20	14	8	7	6	3	1	0
		2015	6.70	0	0.0	15	9	9	13	12	0	0
		2016	4.99	0	0.0	16	10	10	12	11	0	0
		2017	4.99	0	0.0	21	12	11	14	17	1	0
	Prospect 01 Mohave, Arizona 338	2014	1.06	2	2.87	nd	nd	nd	nd	nd	nd	nd
		2015	1.06	1	0.91	nd	nd	nd	nd	nd	nd	nd
		2016	1.15	1	0.67	nd	nd	nd	nd	nd	nd	nd
		2017	1.35	0	0.0	9	6	6	6	8	2	0
	Burro Wash 01 La Paz, Arizona 338	2014	3.90	1	0.67	nd	nd	nd	nd	nd	nd	nd
		2015	3.90	1	1.34	nd	nd	nd	nd	nd	nd	nd
		2016	4.05	1	1.16	5	3	2	3	0	0	1
		2017	5.81	2	1.55	21	11	11	13	13	0	0
	Burro Wash 02 La Paz, Arizona 338	2014	6.83	1	0.75	nd	nd	nd	nd	nd	nd	nd
		2015	6.83	1	0.67	4	2	2	3	6	1	0
		2016	7.86	1	1.32	5	3	2	2	3	0	2
		2017	8.61	1	0.86	30	17	16	17	22	1	1
	Motherlode 01 La Paz, Arizona 340	2014	3.28	1	0.60	4	2	2	2	3	0	0
		2015	3.28	0	0.0	15	9	8	8	13	0	0
		2016	4.25	0	0.0	11	7	6	7	10	0	1
		2017	4.16	0	0.0	16	9	9	10	13	0	0
	Motherlode 02 La Paz, Arizona 343	2014	21.63	2	5.30	4	2	2	2	2	0	0
		2015	21.63	1	2.86	nd	nd	nd	nd	nd	nd	nd
		2016	14.19	1	2.47	4	3	2	2	0	0	0
		2017	4.87	1	2.65	nd	nd	nd	nd	nd	nd	nd

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Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Bill Williams Alamo Lake Bill Williams River	Motherlode 03 La Paz, Arizona 345	2014	12.61	1	1.55	10	5	5	3	0	1	0
		2015	12.61	1	2.93	4	2	2	3	1	0	0
		2016	8.31	2	2.32	3	2	1	0	0	0	0
		2017	5.31	1	1.88	nd	nd	nd	nd	nd	nd	nd
	Motherlode 04 La Paz, Arizona 343	2014	0.49	0	0.0	2	1	1	1	0	0	0
		2015	0.49	1	0.32	2	1	1	1	0	0	0
		2016	0.49	3	1.51	0	0	0	0	0	0	0
		2017	0.38	1	0.23	nd	nd	nd	nd	nd	nd	nd
	Confluence 02 Mohave and La Paz, Arizona 350	2014	15.82	2	5.18	nd	nd	nd	nd	nd	1	nd
		2016[6]	9.84	1	2.31	nd	nd	nd	nd	nd	nd	nd
	Confluence 01 Mohave and La Paz, Arizona 350	2014	5.34	2	2.68	nd	nd	nd	nd	nd	nd	nd
Bill Williams Alamo Lake Big Sandy River	Sandy South 01 Mohave, Arizona 347	2014	14.86	2	8.37	nd	nd	nd	nd	nd	nd	nd
		2017[6]	14.86	1	3.69	nd	nd	nd	nd	nd	1	nd
Bill Williams Alamo Lake Santa Maria River	Santa Maria South 01 La Paz, Arizona 347	2014	30.21	2	7.25	2	1	1	0	0	0	0
		2015	30.21	1	1.07	nd	nd	nd	nd	nd	nd	nd
		2016	25.64	2	5.77	nd	nd	nd	nd	nd	nd	nd
	Santa Maria North 01 Mohave, Arizona 347	2014	29.50	2	11.27	6	3	3	2	1	0	0
		2015	29.50	1	0.84	4	2	2	1	3	0	0
		2016	27.73	2	2.03	10	5	5	5	10	0	2
		2017	27.73	2	6.73	13	8	7	9	6	2	0
	Study area total	2014	163.24	–	50.31	56	31	28	23	10	3	1
		2015	137.57	–	12.45	56	32	30	36	45	1	1
		2016	121.62	–	24.18	75	44	38	40	36	1	7
		2017	86.35	–	31.17	112	65	61	70	81	9	2

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											Before June 24	After June 24
Parker to Southerly International Boundary Palo Verde Ecological Reserve Colorado River	Phase 02 Riverside, California 85	2013	21.38	5	14.75	0	0	0	0	0	9	0
		2014	21.38	5	9.32	0	0	0	0	0	3	0
		2015	21.38	5	12.37	0	0	0	0	0	6	0
		2016	21.38	5	9.64	1	1	0	0	0	3	0
		2017	21.38	5	11.00	0	0	0	0	0	1	0
	Phase 03 Riverside, California 85	2013	21.41	5	11.65	0	0	0	0	0	6	0
		2014	21.41	5	7.29	0	0	0	0	0	2	0
		2015	21.41	5	9.72	0	0	0	0	0	1	0
		2016	21.41	5	9.26	0	0	0	0	0	0	0
		2017	21.41	5	12.03	0	0	0	0	0	0	0
	Phase 04 Block 01 Riverside, California 86	2013	7.65	5	7.41	0	0	0	0	0	0	0
		2014	7.65	5	5.87	0	0	0	0	0	1	0
		2015	7.65	5	5.35	0	0	0	0	0	1	0
		2016	7.65	5	5.42	0	0	0	0	0	1	0
		2017	7.65	5	7.07	0	0	0	0	0	1	0
	Phase 04 Block 02 Riverside, California 86	2013	3.99	5	5.20	0	0	0	0	0	0	0
		2014	3.99	5	3.89	0	0	0	0	0	4	0
		2015	3.99	5	4.28	0	0	0	0	0	1	0
		2016	3.99	5	4.19	0	0	0	0	0	1	0
		2017	3.99	5	5.87	0	0	0	0	0	2	0
	Phase 04 Block 03 Riverside, California 87	2013	23.70	5	18.21	0	0	0	0	0	0	0
		2014	23.70	5	11.18	0	0	0	0	0	0	0
		2015	23.70	5	11.53	1	1	0	0	0	4	1
		2016	23.70	5	13.65	0	0	0	0	0	1	0
		2017	23.70	5	14.37	0	0	0	0	0	1	0

Table A2-2.—Southwestern willow flycatcher survey and monitoring results by survey site within the Lower Colorado River Recovery Unit, 2013–17

"nd" indicates that no willow flycatchers were detected but survey effort was insufficient to determine that no willow flycatchers were present during some part of the season.

Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Parker to Southerly International Boundary Palo Verde Ecological Reserve Colorado River	Phase 05 Block 01 Riverside, California 87	2013	14.82	5	5.41	0	0	0	0	0	1	0
		2014	14.82	5	6.44	0	0	0	0	0	1	0
		2015	15.86	5	8.07	0	0	0	0	0	12	0
		2016	15.86	5	10.05	0	0	0	0	0	4	0
		2017	15.76	5	9.97	0	0	0	0	0	0	0
	Phase 05 Block 02 Riverside, California 86	2013	23.64	5	10.91	0	0	0	0	0	0	0
		2014	23.64	5	7.91	0	0	0	0	0	0	0
		2015	23.64	5	10.70	0	0	0	0	0	3	0
		2016	23.64	5	11.07	0	0	0	0	0	0	0
		2017	23.64	5	13.98	0	0	0	0	0	2	0
	Phase 05 Block 03 Riverside, California 86	2013	29.60	5	14.45	0	0	0	0	0	0	0
		2014	29.60	5	10.11	0	0	0	0	0	0	0
		2015	29.60	5	11.66	0	0	0	0	0	3	0
		2016	29.60	5	15.94	0	0	0	0	0	6	0
		2017	29.60	5	17.54	0	0	0	0	0	2	0
	Phase 06 Block 01 Riverside, California 86	2014	38.74	5	17.60	0	0	0	0	0	5	0
		2015	38.74	5	14.08	0	0	0	0	0	0	0
		2016	38.74	5	17.47	0	0	0	0	0	2	0
		2017	38.74	5	20.14	0	0	0	0	0	4	0
	Phase 06 Block 02 Riverside, California 86	2014	37.59	5	18.54	0	0	0	0	0	5	1
		2015	37.59	5	15.07	0	0	0	0	0	0	0
		2016	37.59	5	16.74	0	0	0	0	0	5	0
		2017	37.59	5	18.56	0	0	0	0	0	0	0
	Phase 07 Block 01 Riverside, California 86	2015	36.79	5	13.20	0	0	0	0	0	13	0
		2016	36.79	5	18.47	0	0	0	0	0	7	0
		2017	36.79	5	19.66	0	0	0	0	0	3	0

Table A2-2.—Southwestern willow flycatcher survey and monitoring results by survey site within the Lower Colorado River Recovery Unit, 2013–17

"nd" indicates that no willow flycatchers were detected but survey effort was insufficient to determine that no willow flycatchers were present during some part of the season.

Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Parker to Southerly International Boundary Palo Verde Ecological Reserve Colorado River	Phase 07 Block 02 Riverside, California 86	2015	40.55	5	13.77	0	0	0	0	0	7	0
		2016	40.55	5	17.03	0	0	0	0	0	7	0
		2017	40.55	5	22.23	0	0	0	0	0	5	0
	Study area total	2013	146.19	–	87.99	0	0	0	0	0	16	0
		2014	222.52	–	98.14	0	0	0	0	0	21	1
		2015	300.90	–	129.80	1	1	0	0	0	51	1
		2016	300.90	–	148.94	1	1	0	0	0	37	0
		2017	300.80	–	172.41	0	0	0	0	0	21	0
Parker to Southerly International Boundary Ehrenberg Colorado River	Ehrenberg La Paz, Arizona 78	2015	4.68	5	3.66	0	0	0	0	0	0	0
	Study area total	2015	4.68	5	3.66	0	0	0	0	0	0	0
Parker to Southerly International Boundary Cibola Colorado River	CVCA Phase 01 La Paz, Arizona 73	2013	26.19	5	11.95	0	0	0	0	0	6	0
		2014	26.19	5	10.17	0	0	0	0	0	5	0
		2015	26.19	5	10.05	0	0	0	0	0	2	0
		2016	26.19	5	11.21	0	0	0	0	0	0	0
		2017	26.19	5	12.32	0	0	0	0	0	2	0
	CVCA Phase 02 La Paz, Arizona 73	2013	25.48	5	13.15	0	0	0	0	0	4	0
		2014	25.48	5	10.36	0	0	0	0	0	1	0
		2015	25.48	5	10.21	0	0	0	0	0	2	0
		2016	25.48	5	12.26	0	0	0	0	0	0	0
		2017	25.48	5	13.46	0	0	0	0	0	1	0
	CVCA Phase 03 La Paz, Arizona 72	2013	38.42	5	13.30	0	0	0	0	0	10	0
		2014	38.42	5	11.40	0	0	0	0	0	5	0
		2015	38.42	5	13.20	0	0	0	0	0	4	0
		2016	38.42	5	13.61	0	0	0	0	0	6	0
		2017	38.42	5	20.20	0	0	0	0	0	1	0

Table A2-2.—Southwestern willow flycatcher survey and monitoring results by survey site within the Lower Colorado River Recovery Unit, 2013–17

"nd" indicates that no willow flycatchers were detected but survey effort was insufficient to determine that no willow flycatchers were present during some part of the season.

Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Parker to Southerly International Boundary Cibola Colorado River	Nature Trail La Paz, Arizona 70	2013	13.70	5	6.24	0	0	0	0	0	0	0
		2014	13.70	5	3.73	0	0	0	0	0	3	0
		2015	13.70	5	6.30	0	0	0	0	0	3	0
		2016	13.70	5	6.04	0	0	0	0	0	9	0
		2017	13.70	5	7.55	0	0	0	0	0	0	0
	C2729 La Paz, Arizona 70	2015	5.95	5	7.04	0	0	0	0	0	12	0
		2016	5.95	5	6.83	0	0	0	0	0	5	0
		2017	5.95	5	10.64	0	0	0	0	0	4	0
	Cibola Site 01 La Paz, Arizona 65	2015	7.69	5	5.93	0	0	0	0	0	2	0
	Cibola Lake North La Paz, Arizona 64	2015[6]	8.95	1	1.15	nd	nd	nd	nd	nd	1	nd
	Walker Lake La Paz, Arizona 64	2015	4.57	5	2.46	0	0	0	0	0	0	0
	Study area total	2013	103.80	–	44.64	0	0	0	0	0	20	0
		2014	103.80	–	35.65	0	0	0	0	0	14	0
		2015	130.97	–	56.32	0	0	0	0	0	26	0
		2016	109.75	–	49.95	0	0	0	0	0	20	0
		2017	109.75	–	64.17	0	0	0	0	0	8	0
Parker to Southerly International Boundary Imperial Colorado River	Imperial NW Yuma, Arizona 58	2015	14.16	5	5.19	0	0	0	0	0	0	0
	Imperial Nursery Yuma, Arizona 58	2015	1.42	5	1.23	0	0	0	0	0	0	0
	Ferguson Lake Imperial, California 57	2015	21.06	5	11.03	0	0	0	0	0	6	0

Table A2-2.—Southwestern willow flycatcher survey and monitoring results by survey site within the Lower Colorado River Recovery Unit, 2013–17

"nd" indicates that no willow flycatchers were detected but survey effort was insufficient to determine that no willow flycatchers were present during some part of the season.

Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Parker to Southerly International Boundary Imperial Colorado River	Great Blue Heron Yuma, Arizona 58	2015	7.05	5	9.26	0	0	0	0	0	1	0
	Powerline Yuma, Arizona 58	2015	1.00	5	2.35	0	0	0	0	0	0	0
	Martinez Lake Yuma, Arizona 58	2015	4.62	5	7.03	0	0	0	0	0	7	0
	Study area total	2015	49.31	–	36.09	0	0	0	0	0	14	0
Parker to Southerly International Boundary Mittry Colorado River	Mittry West Imperial, California 48	2015	4.44	5	5.95	0	0	0	0	0	3	0
	C4911 Yuma, Arizona 49	2017	0.97	5	3.69	0	0	0	0	0	0	2
	C4913 Yuma, Arizona 49	2017	0.66	5	3.20	0	0	0	0	0	3	0
	Study area total	2015	4.4	5	5.95	0	0	0	0	0	3	0
		2017	1.63	–	6.89	0	0	0	0	0	3	2
Parker to Southerly International Boundary Yuma Colorado River	C4703 Yuma, Arizona 36	2014	8.39	5	2.97	0	0	0	0	0	4	0
		2015[7]	8.39	1	1.34	nd	nd	nd	nd	nd	1	nd
		2016	8.39	5	4.58	0	0	0	0	0	6	0
		2017	8.39	5	7.13	0	0	0	0	0	3	0
	C4711 Yuma, Arizona 36	2014	0.82	5	1.35	0	0	0	0	0	3	0
		2015[7]	0.87	1	1.39	nd	nd	nd	nd	nd	5	nd
		2016	0.87	5	2.78	0	0	0	0	0	4	0
		2017	0.87	5	2.36	0	0	0	0	0	1	0

Table A2-2.—Southwestern willow flycatcher survey and monitoring results by survey site within the Lower Colorado River Recovery Unit, 2013–17

"nd" indicates that no willow flycatchers were detected but survey effort was insufficient to determine that no willow flycatchers were present during some part of the season.

Management Unit Study area River drainage	LCR MSCP section County, State Elevation (meters)	Year	Area (hectares)	Surveys[1]	Survey hours[1]	Resident adults[2]	Territories	Pairs	Nests	Confirmed fledges	Unknown status[3]	
											Before June 24	After June 24
Parker to Southerly International Boundary Yuma Colorado River	C4702 Yuma, Arizona 36	2014	6.40	5	4.37	0	0	0	0	0	4	0
		2015[7]	6.40	1	2.08	nd	nd	nd	nd	nd	4	nd
		2016	6.40	5	7.11	0	0	0	0	0	14	0
		2017	6.40	5	5.92	0	0	0	0	0	2	0
	Gila Confluence North Yuma, Arizona 40	2015	2.21	5	2.95	0	0	0	0	0	3	0
	Gila River Site 02 Yuma, Arizona 45	2015	2.90	5	2.60	0	0	0	0	0	2	0
	Fortuna Site 01 Yuma, Arizona 45	2015	3.17	5	3.88	0	0	0	0	0	4	0
	Fortuna North Yuma, Arizona 46	2015	3.79	5	6.14	0	0	0	0	0	3	0
	1401-01 Yuma, Arizona 23	2016	17.81	3	4.45	0	0	0	0	0	14	0
		2017	17.81	3	5.40	0	0	0	0	0	5	0
	Study area total	2014	15.61	–	8.69	0	0	0	0	0	11	0
		2015	27.73	–	20.38	0	0	0	0	0	22	0
		2016	33.47	–	18.93	0	0	0	0	0	38	0
		2017	33.47	–	20.80	0	0	0	0	0	11	0

[1] Includes only formal broadcast surveys. Territory monitoring visits are not included.

[2] Individuals that were resident in multiple sites within a study area within a year are counted only once in the study area annual total. Individuals that were resident in one site but detected briefly in another, either in the same or in a different study area, are reported only in their site of residence. Individuals that were resident in multiple study areas are counted in each study area.

[3] Total number of individuals recorded that could not be classified as resident because of brief appearance.

[4] Surveys and monitoring were completed by the Nevada Department of Wildlife, and data on survey effort are on file with the Nevada Department of Wildlife, Las Vegas.

[5] Site only surveyed from property boundary of the Bill Williams River National Wildlife Refuge in 2013 and 2014, so it is possible that individuals within the site were not detected during these years.

[6] Surveys were discontinued because of poor habitat quality.

[7] Surveys discontinued after the first visit because site access could not be obtained.

ATTACHMENT 3

Orthophotos Showing Study Sites

Definition of Survey Site Occupancy – Survey sites are considered occupied if resident (i.e., detected in one location for at least 7 days) or breeding southwestern willow flycatchers (*Empidonax traillii extimus*) are detected, or if a willow flycatcher (*E. traillii*) is detected between June 24 and July 20, regardless of residency status. If none of the detections in a site matched these criteria, the site was considered unoccupied.

Lower Colorado River Southwestern Willow Flycatcher Study 2013-2017

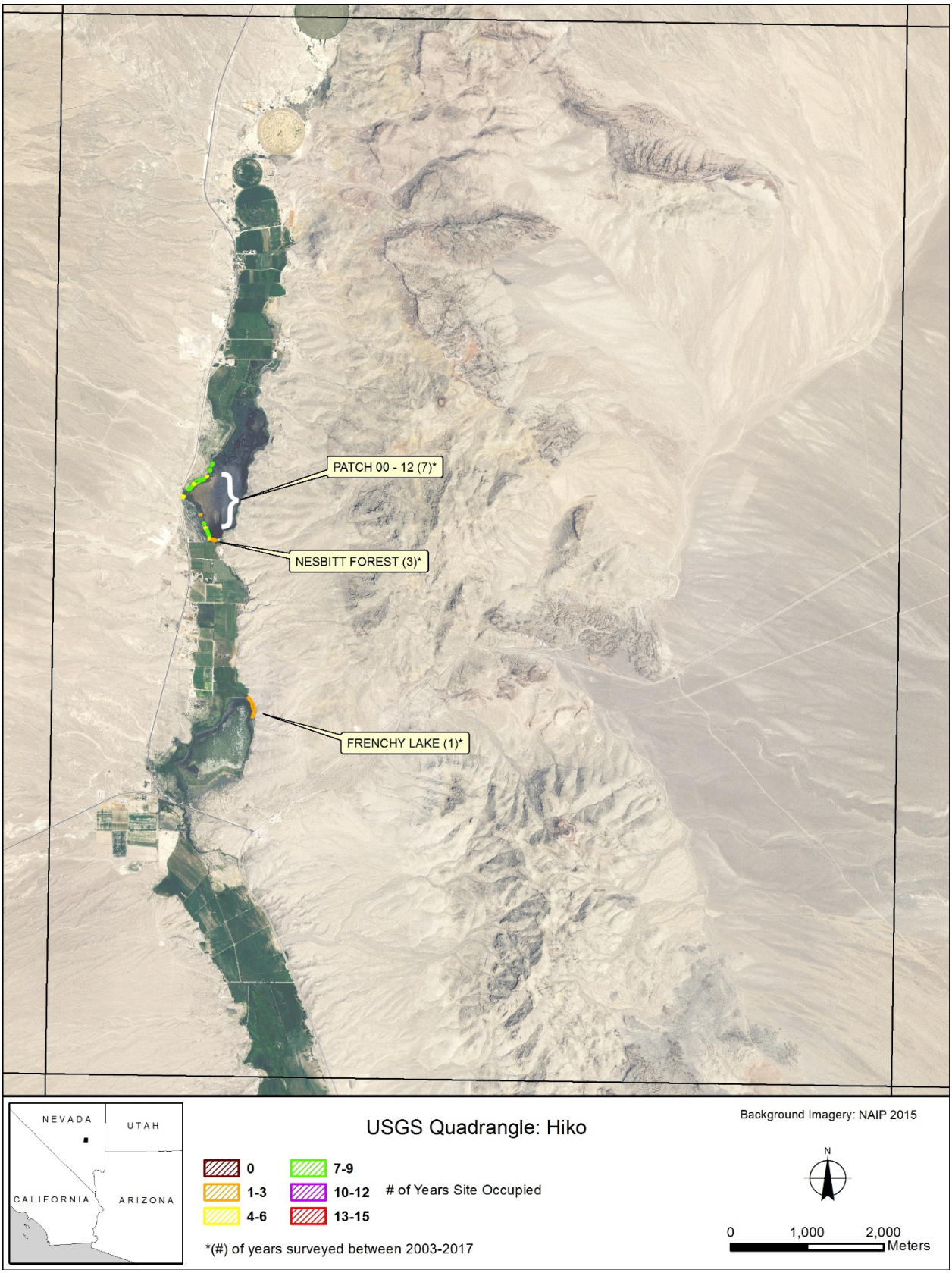
- SNWA Study Area
- Reclamation Study Area
- NDOW/Reclamation Study Area

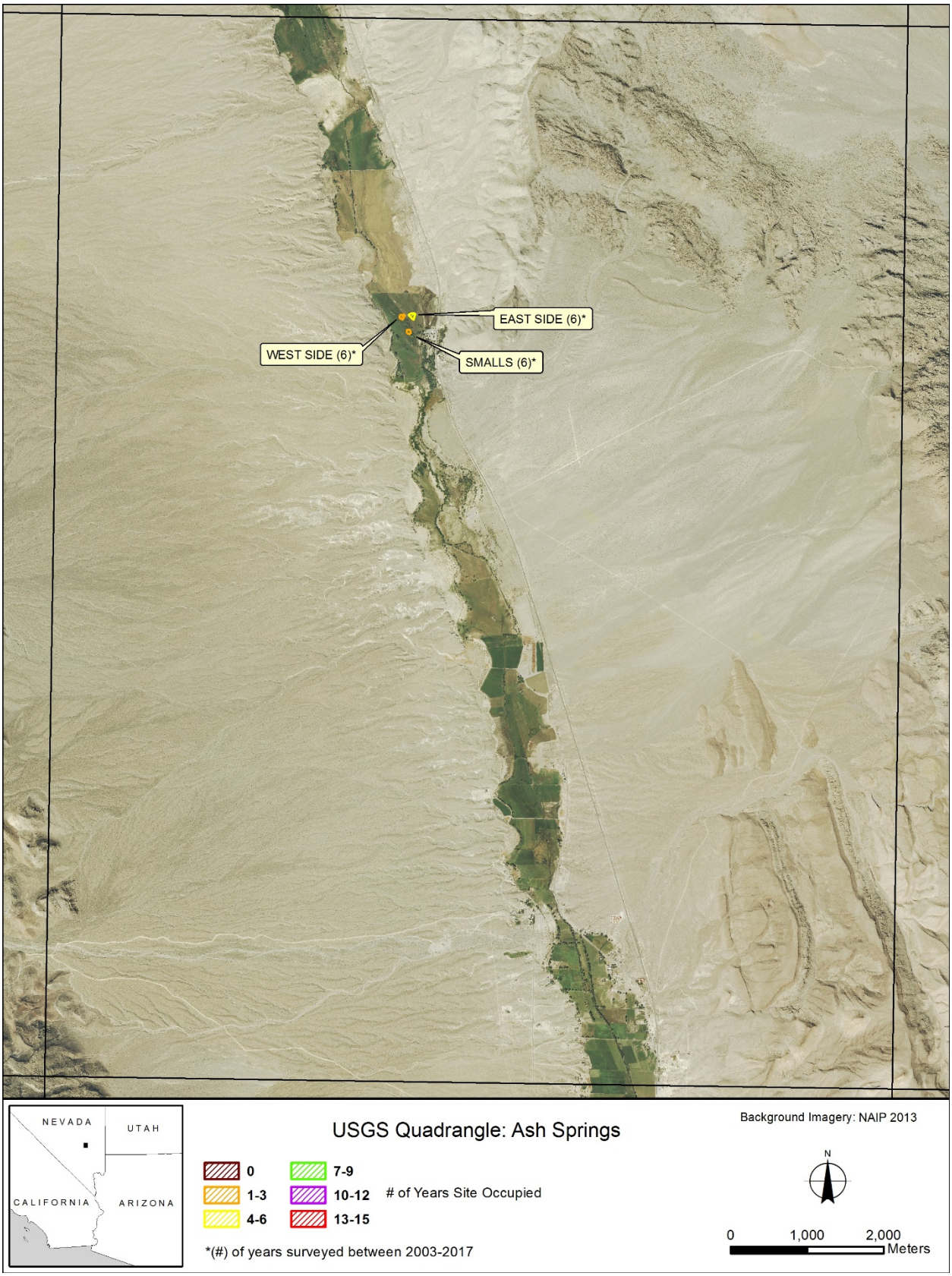
0 25 50 Mi

0 50 100 Km

1:3,300,000

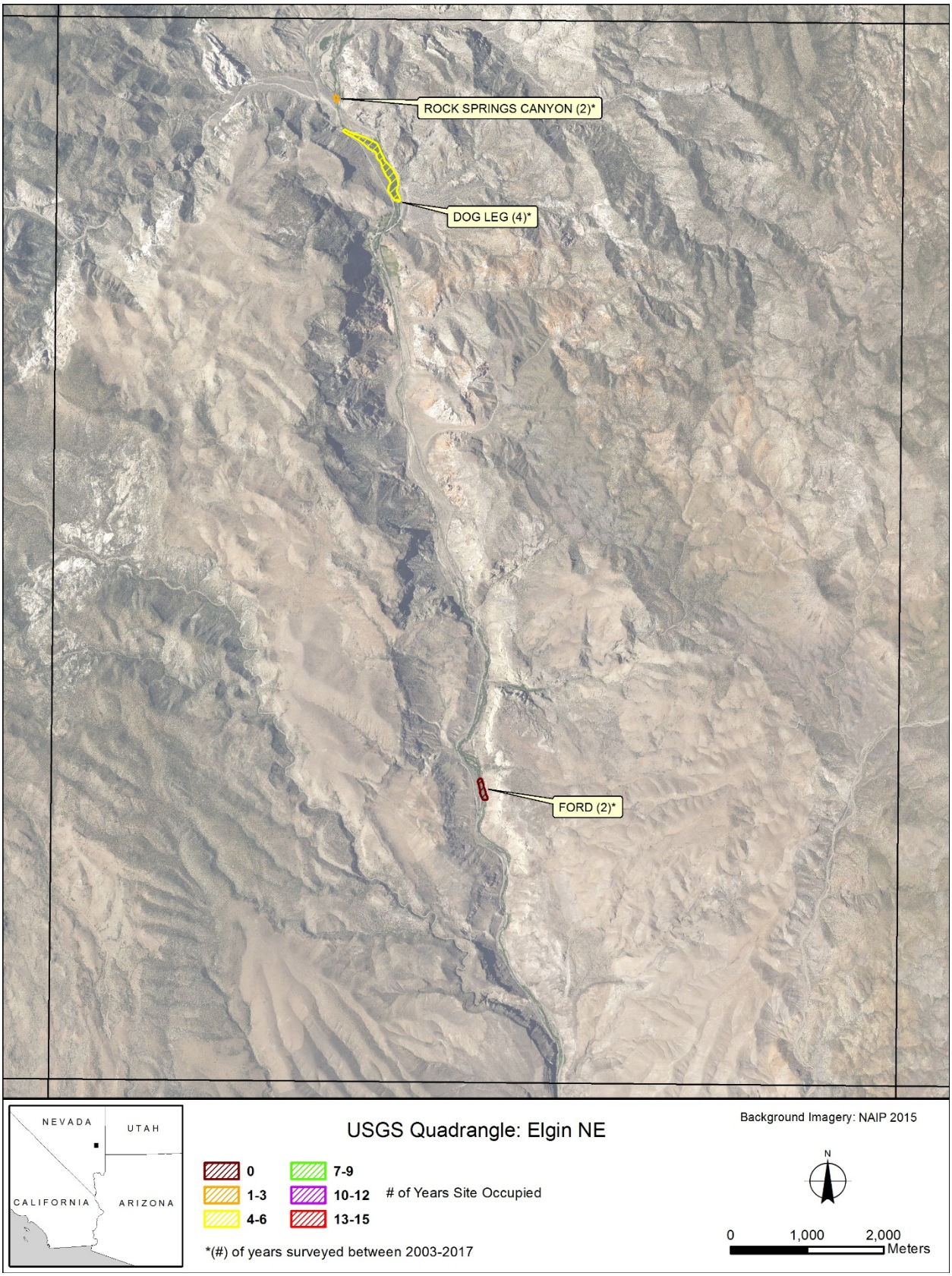
N


PATCH 00 - 12 (7)*
NESBITT FOREST (3)*
FRENCHY LAKE (1)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Hiko
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters


EAST SIDE (6)*
WEST SIDE (6)*
SMALLS (6)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Ash Springs
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2013
N
0
1,000
2,000
Meters

PAHRANAGAT NORTH (15)*
PAHRANAGAT WEST (13)*
PAHRANAGAT MAPS (9)*
PAHRANAGAT SOUTH (12)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Alamo & Alamo SE
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2013
N
0
1,000
2,000
Meters

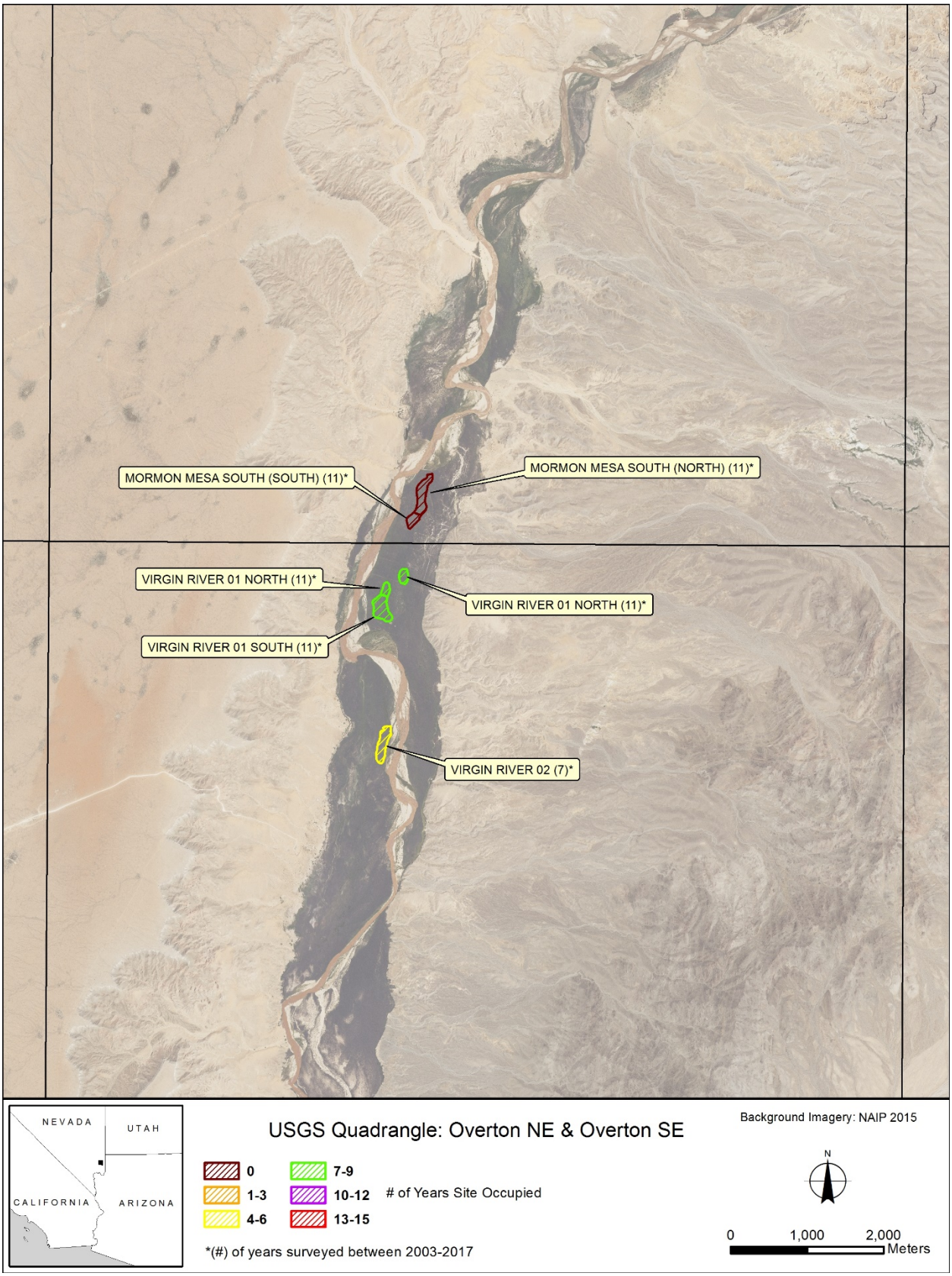
ETNA (2)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Caliente
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters


ROCK SPRINGS CANYON (2)*
DOG LEG (4)*
FORD (2)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Elgin NE
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters

KYLE (2)*
COTTONWOOD CANYON (2)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Leith
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters

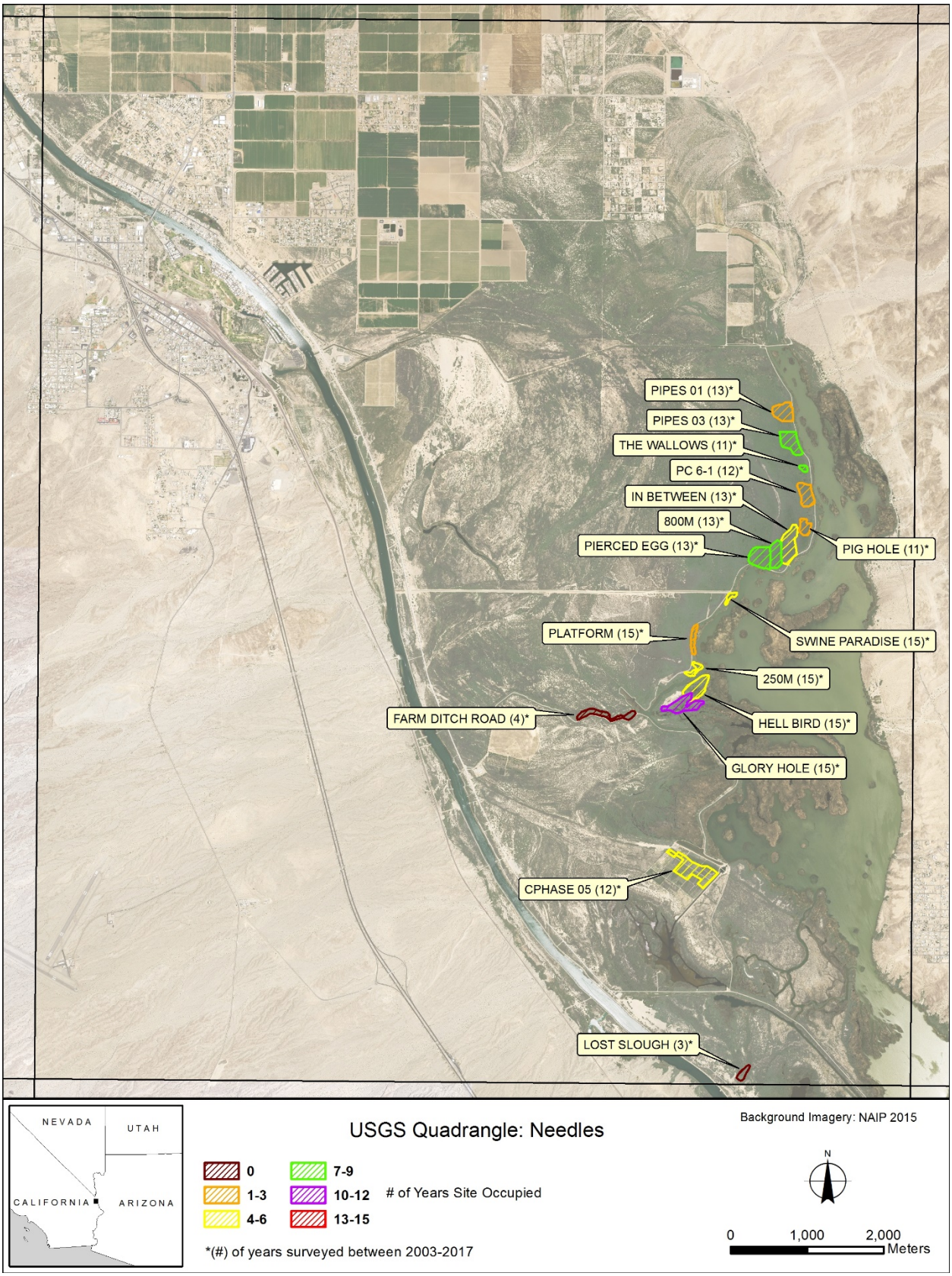
POLES (4)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Littlefield
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters

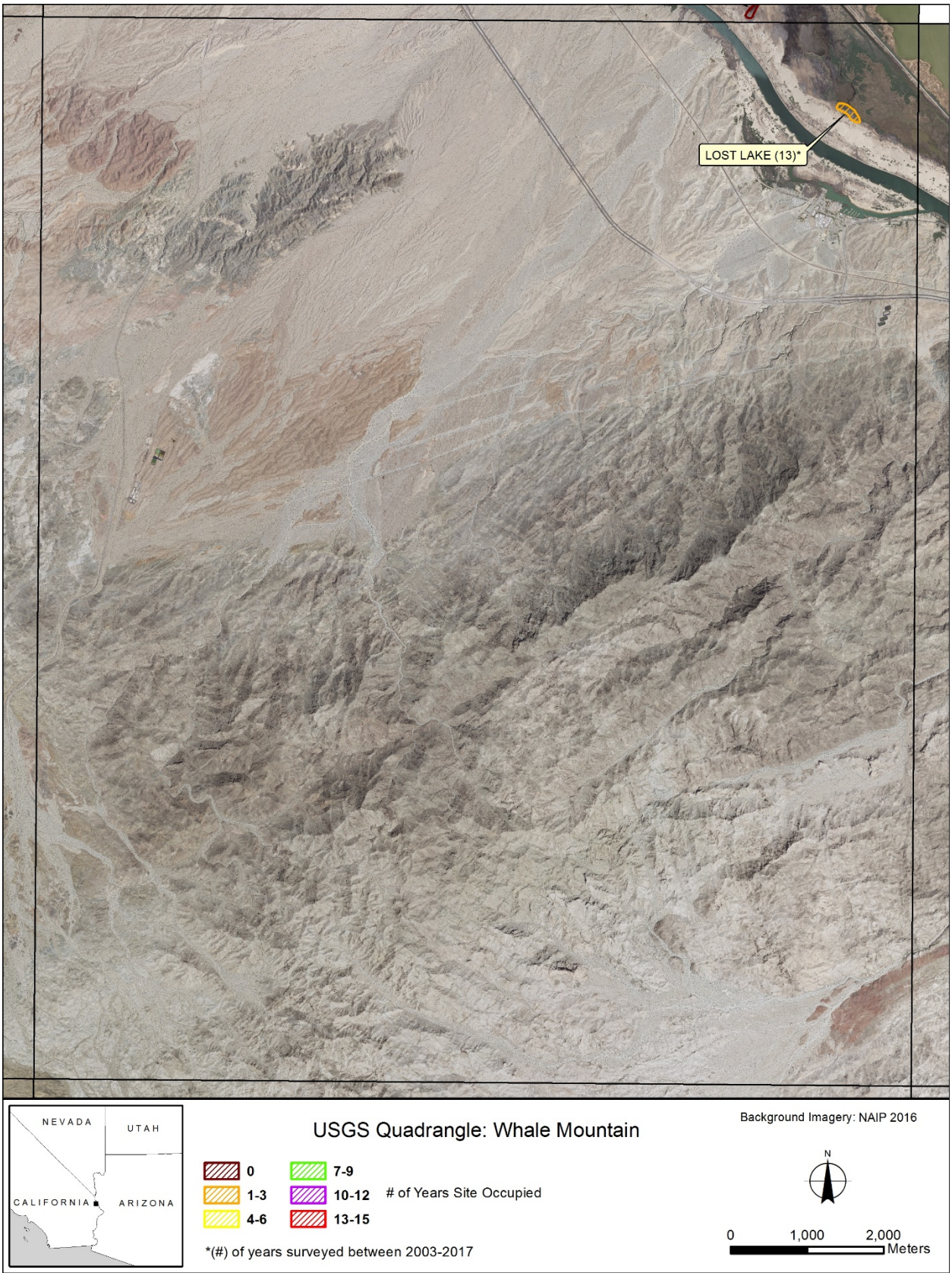
MESQUITE WEST 01 (11)*
HAFEN LANE 01 (4)*
DUMB LUCK BRIDGE (2)*
ELECTRIC AVENUE POND (1)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Mesquite & Flat Top Mesa
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters


MORMON MESA SOUTH (SOUTH) (11)*
MORMON MESA SOUTH (NORTH) (11)*
VIRGIN RIVER 01 NORTH (11)*
VIRGIN RIVER 01 NORTH (11)*
VIRGIN RIVER 01 SOUTH (11)*
VIRGIN RIVER 02 (7)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton NE & Overton SE
Background Imagery: NAIP 2015
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
N
0
1,000
2,000
Meters

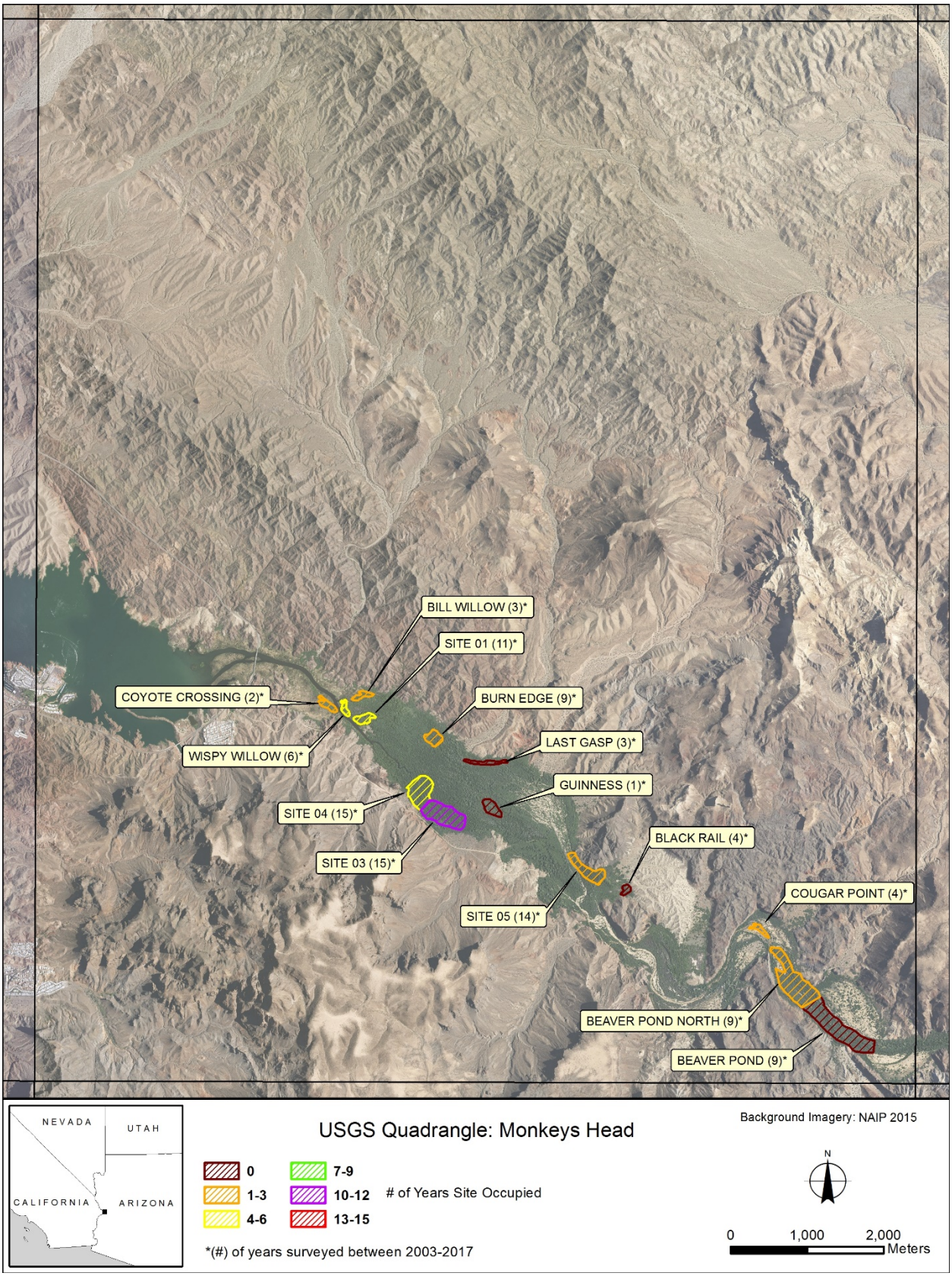
MUDDY STRINGER 01 (5)*
MUDDY MAC (8)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Moapa West
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters

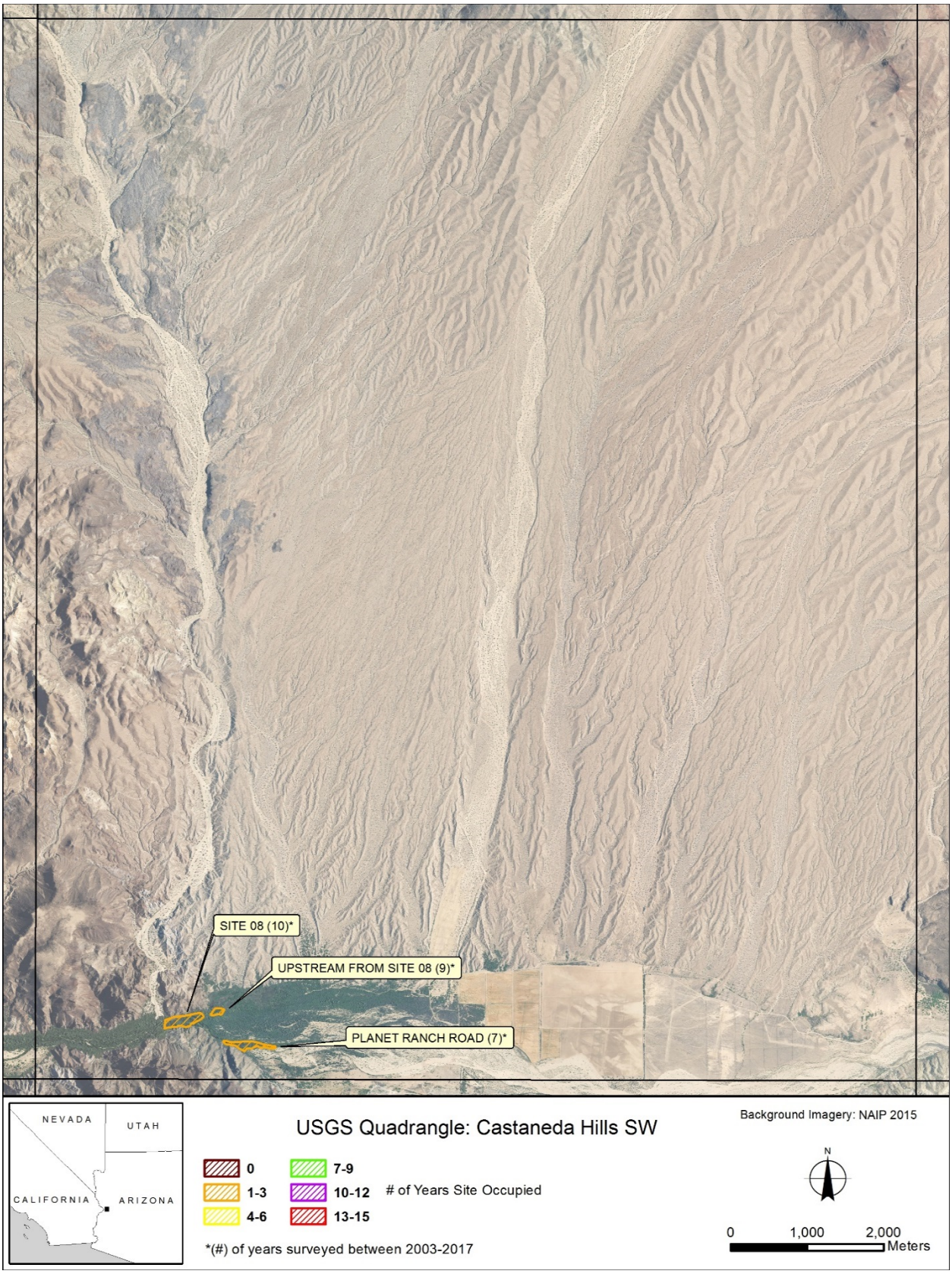
OVERTON WMA POND (11)*
OVERTON WMA (14)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters

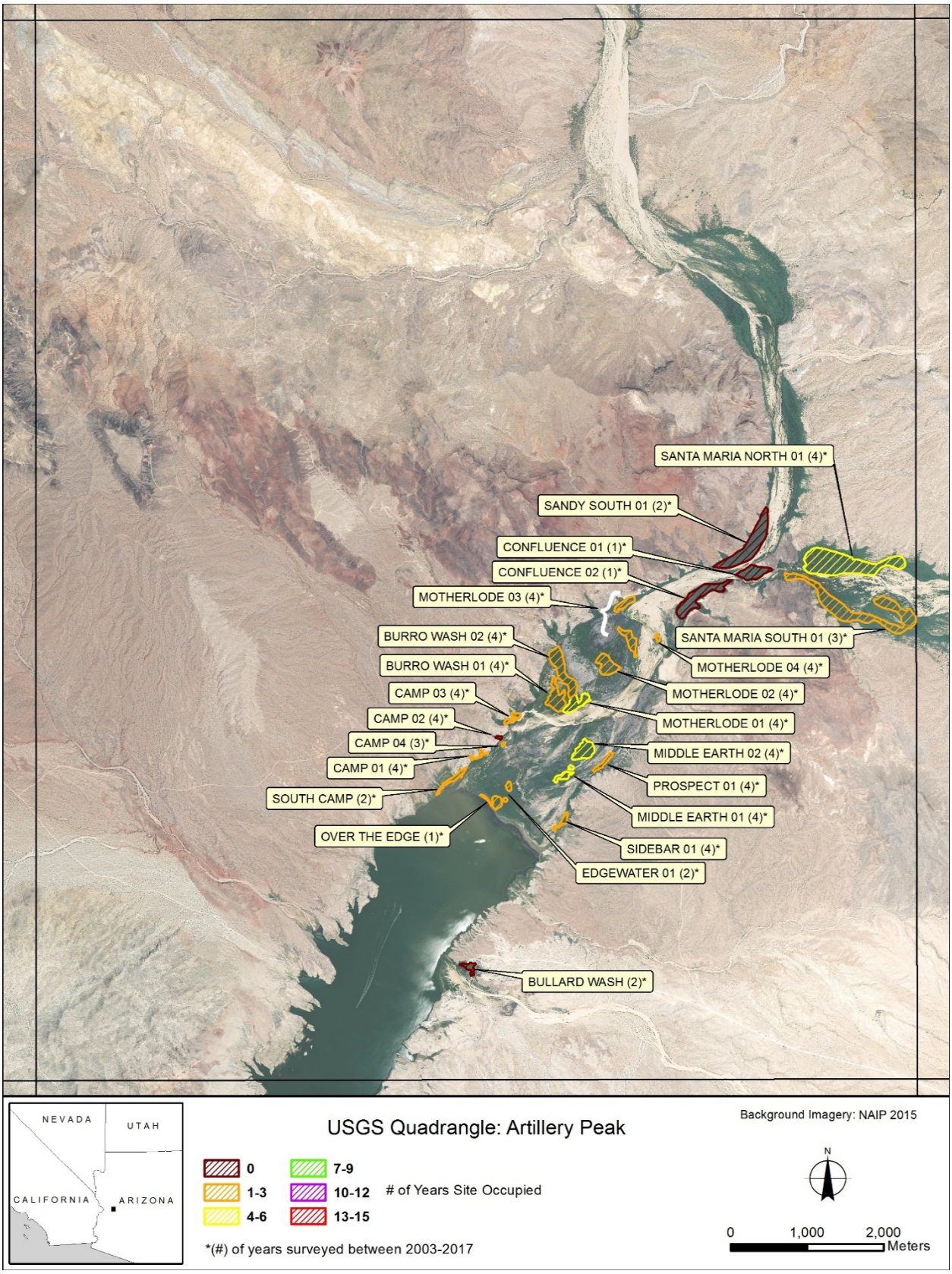

PIPES 01 (13)*
PIPES 03 (13)*
THE WALLOWS (11)*
PC 6-1 (12)*
IN BETWEEN (13)*
800M (13)*
PIERCED EGG (13)*
PIG HOLE (11)*
PLATFORM (15)*
SWINE PARADISE (15)*
250M (15)*
FARM DITCH ROAD (4)*
HELL BIRD (15)*
GLORY HOLE (15)*
CPHASE 05 (12)*
LOST SLOUGH (3)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Needles
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters

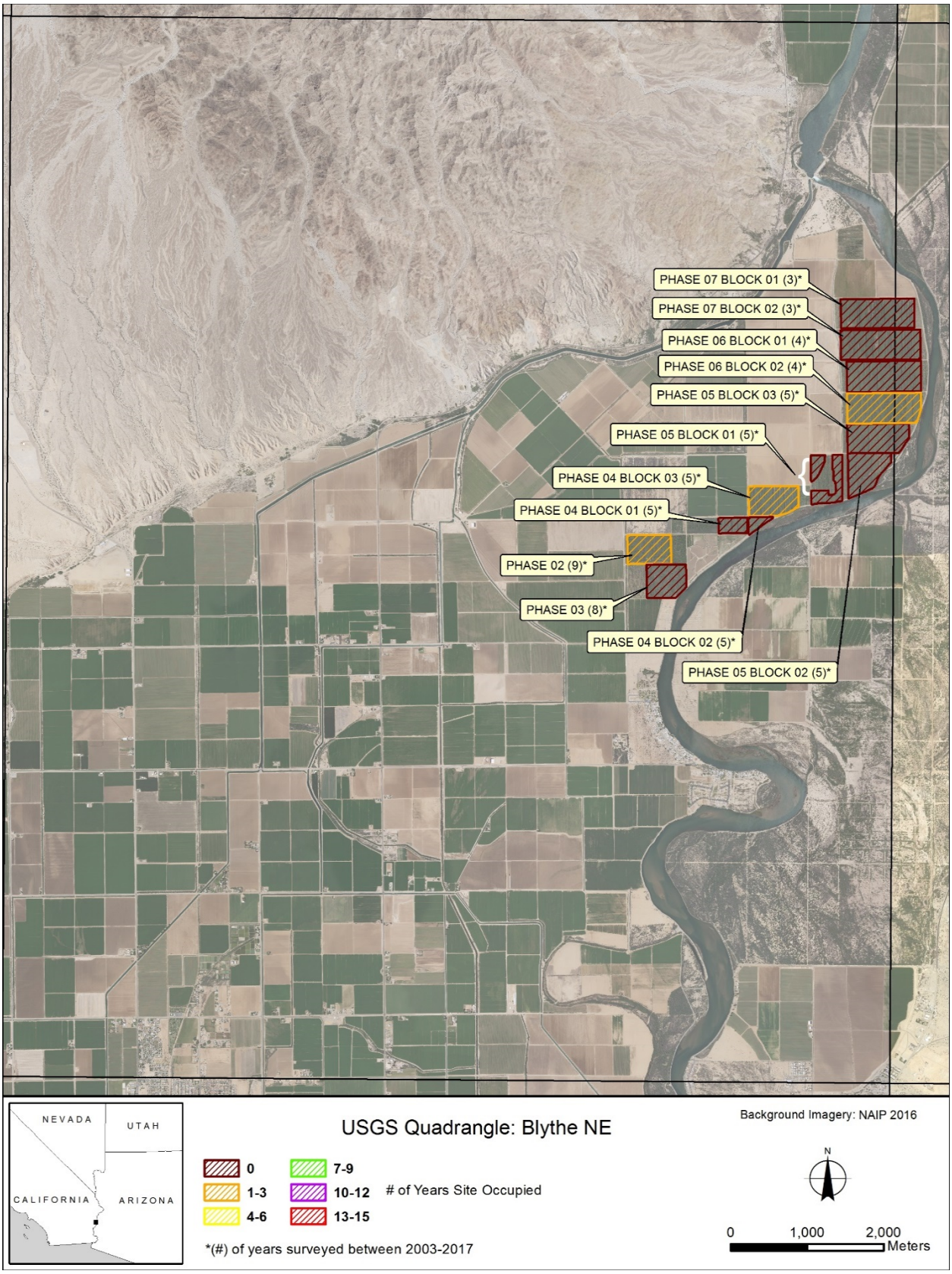

LOST LAKE (13)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Whale Mountain
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2016
N
0
1,000
2,000
Meters

BLANKENSHIP NORTH (9)*
BLANKENSHIP SOUTH (9)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castle Rock
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2016
N
0
1,000
2,000
Meters


BILL WILLOW (3)*
SITE 01 (11)*
COYOTE CROSSING (2)*
BURN EDGE (9)*
LAST GASP (3)*
WISPY WILLOW (6)*
GUINNESS (1)*
SITE 04 (15)*
BLACK RAIL (4)*
SITE 03 (15)*
COUGAR POINT (4)*
SITE 05 (14)*
BEAVER POND NORTH (9)*
BEAVER POND (9)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Monkeys Head
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters


SITE 08 (10)*
UPSTREAM FROM SITE 08 (9)*
PLANET RANCH ROAD (7)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castaneda Hills SW
Background Imagery: NAIP 2015
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
N
0
1,000
2,000
Meters


SANTA MARIA NORTH 01 (4)*
SANDY SOUTH 01 (2)*
CONFLUENCE 01 (1)*
CONFLUENCE 02 (1)*
MOTHERLODE 03 (4)*
SANTA MARIA SOUTH 01 (3)*
BURRO WASH 02 (4)*
BURRO WASH 01 (4)*
MOTHERLODE 04 (4)*
MOTHERLODE 02 (4)*
CAMP 03 (4)*
CAMP 02 (4)*
MOTHERLODE 01 (4)*
CAMP 04 (3)*
MIDDLE EARTH 02 (4)*
CAMP 01 (4)*
PROSPECT 01 (4)*
SOUTH CAMP (2)*
MIDDLE EARTH 01 (4)*
OVER THE EDGE (1)*
SIDEBAR 01 (4)*
EDGEWATER 01 (2)*
BULLARD WASH (2)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Artillery Peak
Background Imagery: NAIP 2015
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
N
0
1,000
2,000
Meters


PHASE 07 BLOCK 01 (3)*
PHASE 07 BLOCK 02 (3)*
PHASE 06 BLOCK 01 (4)*
PHASE 06 BLOCK 02 (4)*
PHASE 05 BLOCK 03 (5)*
PHASE 05 BLOCK 01 (5)*
PHASE 04 BLOCK 03 (5)*
PHASE 04 BLOCK 01 (5)*
PHASE 02 (9)*
PHASE 03 (8)*
PHASE 04 BLOCK 02 (5)*
PHASE 05 BLOCK 02 (5)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Blythe NE
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2016
N
0
1,000
2,000
Meters

USGS Quadrangle: Blythe

0
1-3
4-6
7-9
10-12
13-15

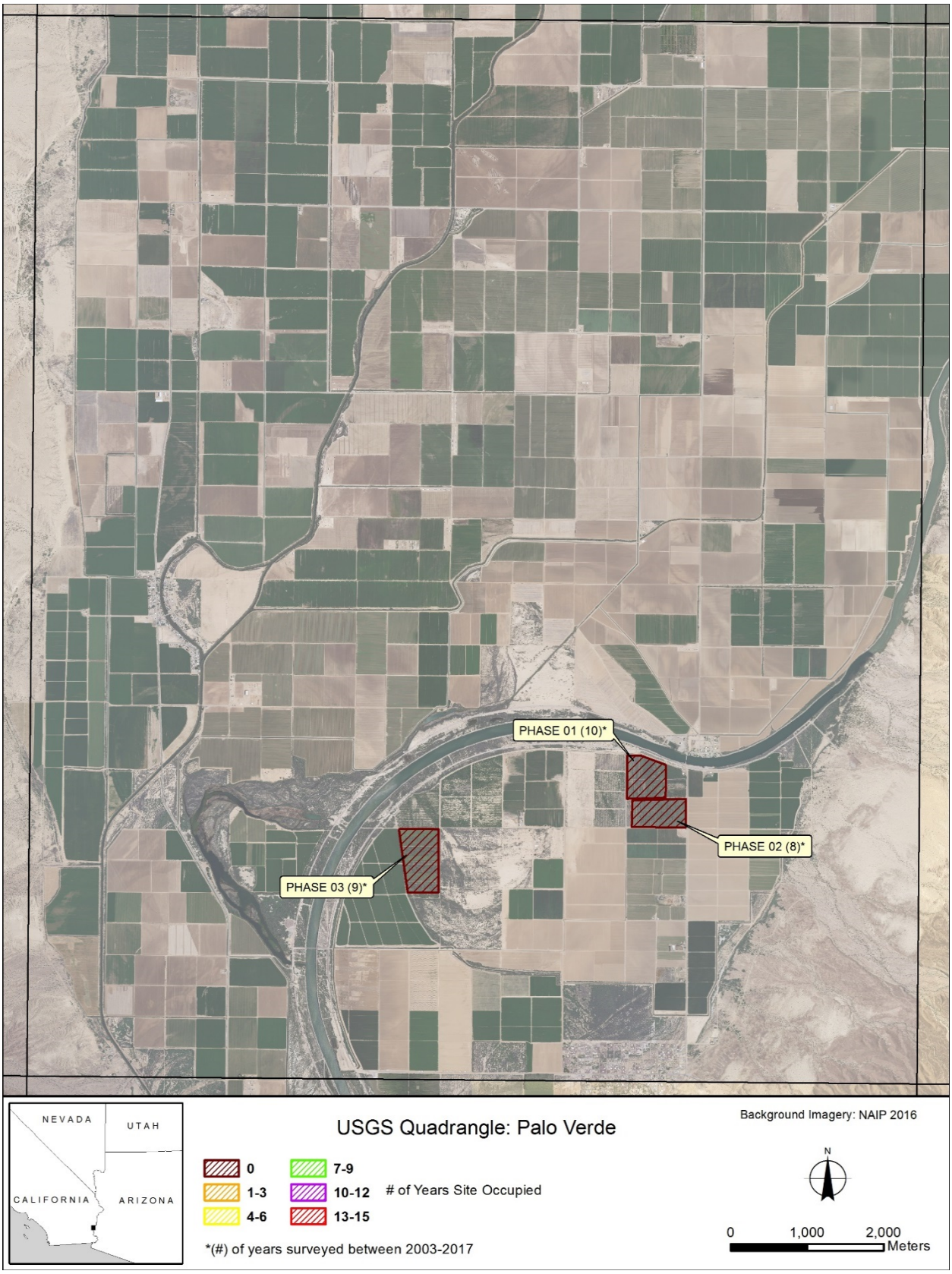
# of Years Site Occupied

*(#) of years surveyed between 2003-2017

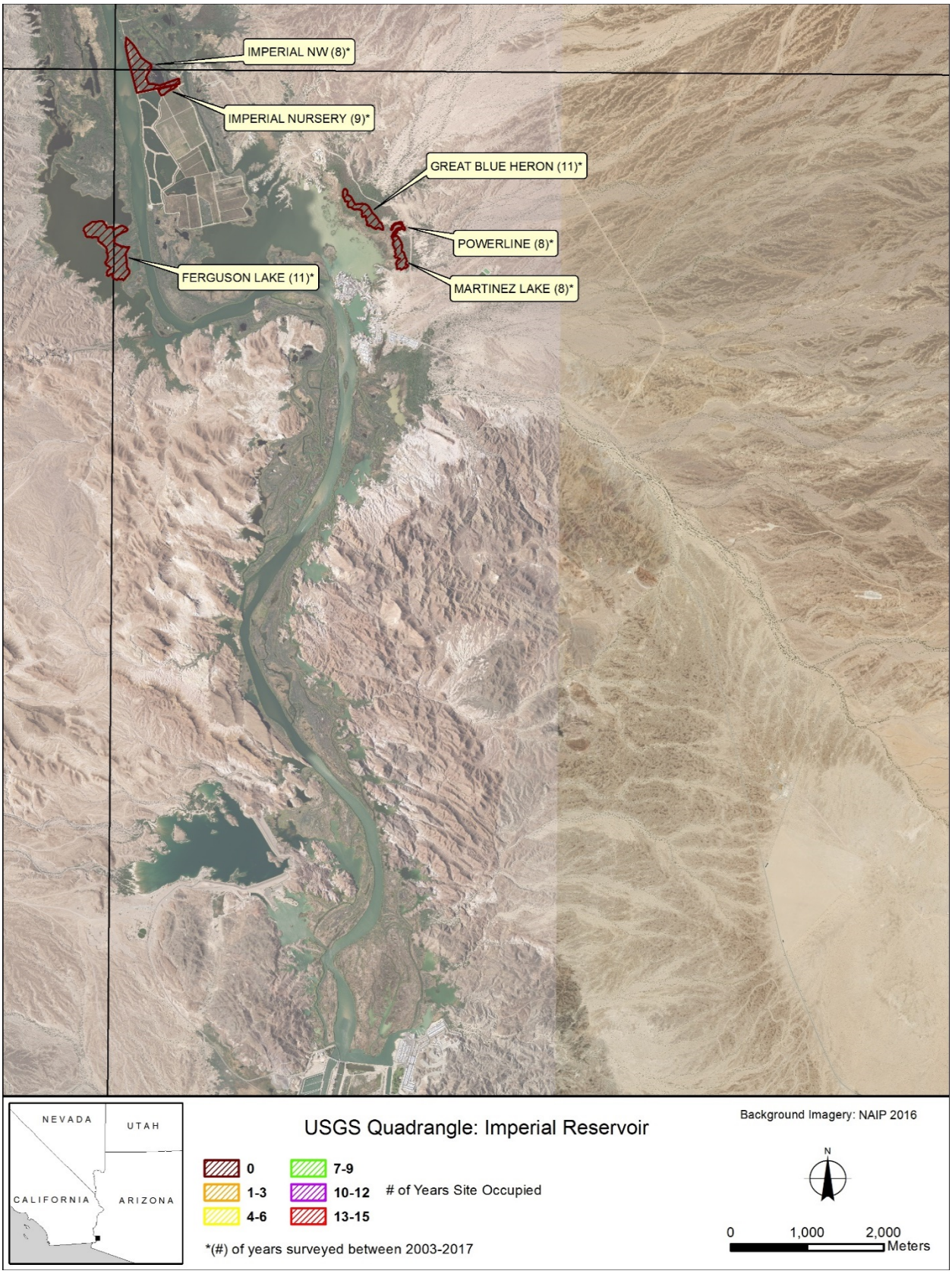
Background Imagery: NAIP 2016

N

0 1,000 2,000 Meters


PHASE 01 (10)*
PHASE 02 (8)*
PHASE 03 (9)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Palo Verde
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2016
N
0
1,000
2,000
Meters

NATURE TRAIL (12)*
C2729 (3)*
CIBOLA SITE 01 (8)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Cibola
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters


IMPERIAL NW (8)*
IMPERIAL NURSERY (9)*
GREAT BLUE HERON (11)*
POWERLINE (8)*
FERGUSON LAKE (11)*
MARTINEZ LAKE (8)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Imperial Reservoir
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2016
N
0
1,000
2,000
Meters

USGS Quadrangle: Laguna Dam

0
1-3
4-6
7-9
10-12
13-15

# of Years Site Occupied

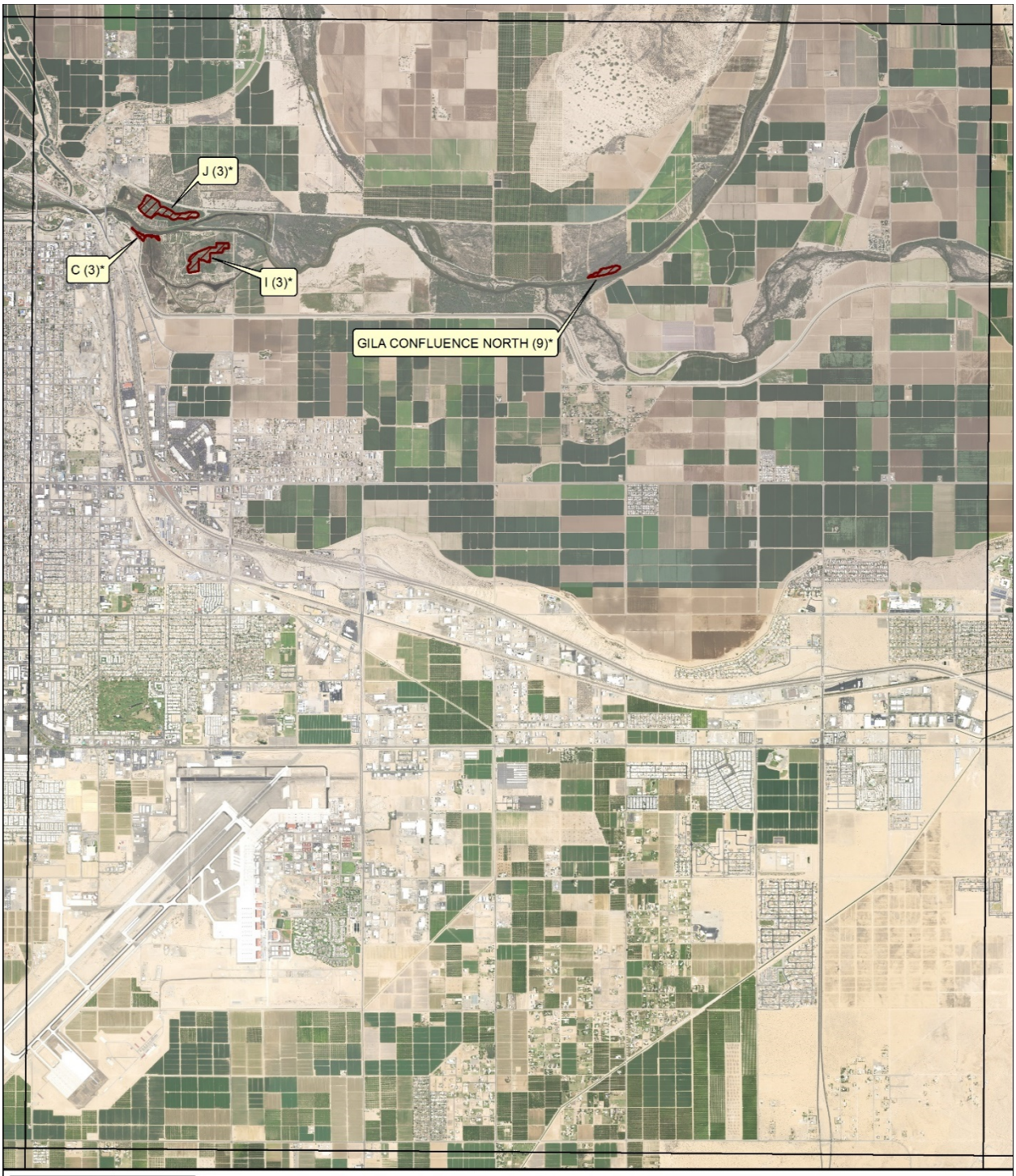
*(#) of years surveyed between 2003-2017

Background Imagery: NAIP 2015

N

0 1,000 2,000 Meters

FORTUNA NORTH (8)*
GILA RIVER SITE 02 (8)*
FORTUNA SITE 01 (6)*
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Fortuna
0
1-3
4-6
7-9
10-12
13-15
# of Years Site Occupied
*(#) of years surveyed between 2003-2017
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters



USGS Quadrangle: Yuma East

Background Imagery: NAIP 2015

0
1-3
4-6
7-9
10-12
13-15

# of Years Site Occupied

*(#) of years surveyed between 2003-2017

N

0 1,000 2,000 Meters

ATTACHMENT 4

Summary of Hydrologic Conditions by Survey Site, 2013–2017

Table A4-1.—Summary of hydrologic conditions by survey site, 2013–17
(Values are given for each site as recorded in mid-May, mid-June, and mid-July.)

Study area[1]	Survey site	Year	Percent of site inundated[2]	Depth (centimeters) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (meters) to surface water or saturated soil[2]
KEPI	Patches 00-12[4]	2013	20 / < 5 / 5	30 / – / 10	10 / 15 / 10	0 / 0 / 0
		2014	40 / 16 / 2	30 / 15 / < 5	25 / 15 / 10	0 / 0 / 0
	Patches 00–12 and Nesbitt Forest[4]	2015	25 / 20 / 20	50 / 12 / 30	10 / 20 / 30	0 / 0 / 0
		2016	80 / 38 / 30	50 / 17 / 20	13 / 9 / 20	0 / 0 / 0
	Frenchy Lake[4]	2016	45 / 70 / 5	15 / 15 / 5	10 / 5 / 5	0 / 0 / 0
RIRA	East Side	2013	45 / 0 / 0	15 / 0 / 0	0 / 0 / 0	0 / 1 / –
		2014	5 / 0 / 0	7 / 0 / 0	80 / 0 / 0	0 / 50 / 50
		2015	5 / 20 / 0	2 / 15 / 0	75 / 30 / 10	0 / 0 / 0
		2016	10 / 5 / 0	5 / 5 / 0	2 / 5 / 0	0 / 0 / 60
	West Side	2013	100 / 0 / 0	20 / 0 / 0	0 / 0 / 0	0 / 1 / –
		2014	10 / 60 / 75	4 / 5 / 7	10 / 10 / 15	0 / 0 / 0
		2015	75 / 20 / 0	5 / 15 / 0	25 / 30 / 30	0 / 0 / 0
		2016	90 / 98 / 80	10 / 15 / 7	10 / 2 / 0	0 / 0 / 0
	Smalls	2013	100 / 0 / 2	20 / 0 / 10	0 / 0 / 5	0 / 1 / 0
		2014	20 / 100 / 100	8 / 5 / 7	80 / 0 / 0	0 / 0 / 0
		2015	100 / 50 / 50	12 / 8 / 5	0 / 50 / 50	0 / 0 / 0
		2016	100 / 100 / 100	10 / 10 / 7	0 / 0 / 0	0 / 0 / 0
PAHR	Pahranagat North[4]	2013	40 / 10 / 1	30 / 10 / 50	15 / 30 / 10	0 / 0 / 0
		2014	40 / 13 / 1	24 / 15 / 3	10 / 5 / 1	0 / 0 / 0
		2015	60 / 55 / 30	75 / 40 / 15	25 / 5 / 30	0 / 0 / 0
		2016	65 / 60 / 45	40 / 30 / 20	20 / 15 / 25	0 / 0 / 0
		2017	45 / 45 / 5	30 / 15 / 5	10 / 25 / 15	0 / 0 / 0
	Pahranagat West[4]	2013	0 / 10 / 0	0 / 10 / 0	0 / 0 / 0	< 1 / 0 / 7
		2014	15 / 5 / 2	10 / – / 5	10 / 5 / 2	0 / 0 / 0
		2015	– / 40 / 10	– / 30 / 6	– / 10 / 10	– / 0 / 0
		2016	40 / 35 / 10	50 / 25 / 10	3 / 10 / 10	0 / 0 / 0
		2017	15 / 35 / 15	20 / 25 / 5	10 / 15 / 5	0 / 0 / 0
	Pahranagat MAPS[4]	2014	– / – / –	– / – / –	– / – / –	– / – / –
		2015	100 / 60 / 30	50 / 30 / 30	0 / 15 / 30	0 / 0 / 0
		2016	90 / 75 / 25	60 / 30 / 10	5 / 15 / 30	0 / 0 / 0
		2017	60 / 60 / 5	20 / 15 / 3	10 / 15 / 10	0 / 0 / 0

Table A4-1.—Summary of hydrologic conditions by survey site, 2013–17
(Values are given for each site as recorded in mid-May, mid-June, and mid-July.)

Study area[1]	Survey site	Year	Percent of site inundated[2]	Depth (centimeters) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (meters) to surface water or saturated soil[2]
PAHR (cont.)	Pahranagat South	2013	5 / < 5 / 5	50 / 10 / 30	2 / 2 / 0	0 / 0 / 0
		2014	5 / 5 / 5	10 / 30 / 15	5 / 5 / 3	0 / 0 / 0
		2015	60 / 15 / 25	10 / 30 / 30	5 / 70 / 25	0 / 0 / 0
		2016	20 / 20 / 1	60 / 15 / 20	5 / 10 / 0	0 / 0 / 0
		2017	15 / 8 / 10	40 / 60 / 30	10 / 2 / 5	0 / 0 / 0
MVWA	Etna	2014	5 / 5 / 5	10 / 15 / 10	0 / 0 / 5	0 / 0 / 0
		2015	20 / 8 / 20	30 / 10 / 8	5 / 4 / 2	0 / 0 / 0
	Rock Springs Canyon	2016	– / – / 20	– / – / 30	– / – / 10	– / – / 0
		2017	60 / 55 / 70	25 / 20 / 20	20 / 25 / 10	0 / 0 / 0
	Dog Leg	2014	5 / 20 / 15	15 / 10 / 10	2 / 10 / 10	0 / 0 / 0
		2015	45 / 25 / 20	30 / 25 / 20	10 / 35 / 5	0 / 0 / 0
		2016	35 / 5 / 10	15 / 50 / 10	15 / 5 / 10	0 / 0 / 0
		2017	35 / 40 / 30	25 / 30 / 30	15 / 10 / 15	0 / 0 / 0
	Ford	2014	10 / 15 / 15	20 / 30 / 48	5 / 0 / 0	0 / 0 / 0
		2015	40 / 10 / 35	50 / 12 / 45	0 / 5 / 5	0 / 0 / 0
	Kyle	2014	10 / 20 / 10	20 / 50 / 50	10 / 20 / 0	0 / 0 / 0
		2015	5 / 25 / 8	75 / 25 / 40	3 / 10 / 12	0 / 0 / 0
	Cottonwood Canyon	2014	15 / 30 / 35	15 / 50 / 70	5 / 10 / 3	0 / 0 / 0
		2015	10 / 25 / 20	30 / 30 / 50	0 / 10 / 20	0 / 0 / 0
MESQ	Hafen Lane 01	2013	0 / 15 / 20	0 / 30 / 10	0 / 5 / 25	5 / 0 / 0
	Dumb Luck Bridge	2013	5 / 0 / 0	15 / 0 / 0	0 / 0 / 0	0 / 55 / 55
	Mesquite West 01	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	5 / 1 / 1
	Electric Avenue Pond	2013	30 / – / 5	15 / – / 15	70 / – / 85	0 / – / 0
MOME	Mormon Mesa South (North)	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	100 / 100 / 100
	Mormon Mesa South (South)	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	170 / 170 / 170
	Virgin River 01 (North)	2013	10 / 10 / 1	20 / 10 / 3	5 / 20 / 5	0 / 0 / 0
	Virgin River 01 (South)	2013	– / – / 5	– / – / 3	– / – / 10	– / – / 0
MUDD	Overton WMA Pond	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	25 / 25 / 25
		2014	3 / 2 / 2	6 / 6 / 15	5 / 2 / 2	0 / 0 / 0
		2015	40 / 15 / 0	20 / 6 / 0	10 / 5 / 0	0 / 0 / 10
		2016	3 / 5 / 5	15 / 5 / 5	1 / 3 / 2	0 / 0 / 0
		2017	4 / 5 / 8	35 / 8 / 20	2 / 3 / 3	0 / 0 / 0

Table A4-1.—Summary of hydrologic conditions by survey site, 2013–17
(Values are given for each site as recorded in mid-May, mid-June, and mid-July.)

Study area[1]	Survey site	Year	Percent of site inundated[2]	Depth (centimeters) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (meters) to surface water or saturated soil[2]
MUDD (cont.)	Overton WMA	2013	3 / 3 / 3	70 / 70 / 70	0 / 0 / 0	0 / 0 / 0
		2014	3 / 3 / 3	25 / 20 / 60	0 / 3 / 3	0 / 0 / 0
		2015	5 / 4 / 4	70 / 80 / 50	2 / 2 / 2	0 / 0 / 0
		2016	< 5 / 4 / < 5	35 / 30 / 35	2 / 1 / 1	0 / 0 / 0
		2017	< 10 / 10 / <10	30 / 70 / 30	5 / 2 / 3	0 / 0 / 0
WMSP	Muddy Mac	2013	25 / < 10 / 0	10 / < 5 / 0	25 / 0 / 0	0 / 0 / 20
		2014	10 / 0 / 3	15 / 0 / 15	5 / 0 / 0	0 / 20 / 0
		2015	25 / 5 / 0	15 / 10 / 0	10 / 2 / 0	0 / 0 / 10
		2016	10 / 0 / 0	10 / 0 / 0	10 / 0 / 0	0 / 30 / 25
		2017	5 / 3 / 3	3 / 5 / 2	20 / 2 / 5	0 / 0 / 0
	Muddy Stringer 01	2013	0 / – / –	0 / – / –	0 / – / –	100 / – / –
		2014	5 / 0 / 0	10 / 0 / 0	5 / 0 / 0	0 / 100 / 100
		2015	15 / 0 / 0	10 / 0 / 0	5 / 10 / 0	0 / 0 / 100
		2016	5 / 5 / 0	10 / 3 / 0	5 / 5 / 0	0 / 0 / 105
		2017	5 / < 1 / 0	4 / 2 / 0	0 / 5 / 0	0 / 0 / 105
TOPO	Pipes 01	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	40 / 40 / 40
		2014	0 / 0 / 0	0 / 0 / 0	0 / 0 / 25	40 / 40 / 0
		2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	40 / 40 / 40
	Pipes 03	2013	10 / 5 / 5	10 / 10 / 5	20 / 20 / 10	0 / 0 / 0
		2014	20 / < 1[6] / 1[6]	20 / 12 / 25	20 / 0 / 0	0 / 0 / 0
		2015	1 / 1[6] / 0	15 / 10 / 0	2 / < 5 / 0	0 / 0 / 37
	The Wallows	2013	30 / 20 / 5	30 / < 5 / < 5	20 / 10 / 10	0 / 0 / 0
		2014	50 / 60 / 40	25 / 10 / 15	20 / 0 / 0	0 / 0 / 0
		2015	25 / 1[6] / 0	30 / 10 / 0	15 / 9 / 0	0 / 0 / 80
	PC6-1	2013	50 / 20 / 0	< 5 / < 5 / 0	5 / 30 / 20	0 / 0 / 0
		2014	80 / < 1[6] / 30	20 / 3 / 8	0 / 60 / 20	0 / 0 / 0
		2015	33 / 1[6] / 0	20 / 2 / 0	33 / 20 / 0	0 / 0 / 32
	Pig Hole	2013	10 / 0 / 0	< 5 / 0 / 0	5 / 0 / 0	0 / 120 / 120
		2014	70 / 0 / 0	20 / 0 / 0	5 / 0 / 0	0 / 120 / 120
		2015	< 10 / 0 / 0	10 / 0 / 0	5 / 0 / 0	0 / 120 / 120
	In Between	2013	3 / 0 / 0	5 / 0 / 0	1 / 0 / 0	0 / 0 / 0
		2014	1 / 0 / 0	3 / 0 / 0	9 / 0 / 0	0 / 20 / 10
		2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 20 / 45

Table A4-1.—Summary of hydrologic conditions by survey site, 2013–17
(Values are given for each site as recorded in mid-May, mid-June, and mid-July.)

Study area[1]	Survey site	Year	Percent of site inundated[2]	Depth (centimeters) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (meters) to surface water or saturated soil[2]
TOPO (cont.)	800M	2013	40 / 5 / 3	15 / < 5 / < 5	< 5 / 30 / 15	0 / 0 / 0
		2014	10 / 0 / 0	5 / 0 / 0	60 / 2 / 7	0 / 0 / 0
		2015	10 / 0 / 0	3 / 0 / 0	15 / 20 / 0	0 / 0 / 79
	Pierced Egg	2013	10 / 2 / 1[6]	< 5 / < 5 / 15	5 / 5 / 25	0 / 0 / 0
		2014	30 / 1[6] / < 1[6]	7 / 9 / -	0 / 5 / 3	0 / 0 / 0
		2015	< 1[6] / 0 / < 1[6]	60 / 0 / 15	0 / 1 / 0	0 / 0 / 0
	Swine Paradise[4]	2013	15 / 15 / 15	30 / 30 / 30	0 / 1 / 2	0 / 0 / 0
		2014	10 / 20 / 15	40 / 30 / 60	1 / 5 / 0	0 / 0 / 0
		2015	10 / 10 / 10	20 / 20 / 15	5 / 0 / 5	0 / 0 / 0
		2016	45 / 25 / 20	25 / 12 / 12	15 / 10 / 5	0 / 0 / 0
		2017	25 / 15 / 5	5 / 5 / 5	10 / 20 / 0	0 / 0 / 0
	Platform[4]	2013	< 1 / < 1 / < 1	– / – / –	– / – / –	0 / 0 / 0
		2014	10 / 2 / 2	15 / 12 / 10	1 / 18 / 1	0 / 0 / 0
		2015	5 / 0 / 1	5 / 0 / 1	0 / 0 / 1	0 / 0 / 0
		2016	5 / 10 / 2	10 / 5 / < 10	1 / 0 / 2	0 / 0 / 0
		2017	5 / 0 / 0	3 / 0 / 0	5 / 0 / 0	0 / 12 / 11
	250M[4]	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
		2014	0 / 0 / 0	0 / 0 / 0	1 / 0 / 0	0 / 0 / 0
		2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
		2016	– / – / 0	– / – / 0	– / – / 0	0 / 0 / 0
		2017	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	5 / 5 / 5
	Hell Bird[4]	2013	50 / 50 / 50	80 / 80 / 80	10 / 5 / 5	0 / 0 / 0
		2014	60 / 55 / 60	50 / 60 / 50	0 / 0 / 0	0 / 0 / 0
		2015	20 / 50 / 28	15 / 50 / 40	20 / 0 / 27	0 / 0 / 0
		2016	35 / 35 / 75	50 / 50 / 25	5 / 5 / 10	0 / 0 / 0
		2017	10 / 20 / 5	14 / 40 / 15	8 / 10 / 5	0 / 0 / 0
	Glory Hole[4]	2013	35 / 35 / 35	80 / 80 / 80	10 / < 3 / 2	0 / 0 / 0
		2014	45 / 40 / 40	40 / 40 / 40	0 / 0 / 0	0 / 0 / 0
		2015	30 / 30 / 20	20 / 50 / 40	10 / 10 / 10	0 / 0 / 0
		2016	30 / 50 / 30	60 / 75 / 45	5 / 5 / 5	0 / 0 / 0
		2017	25 / 50 / 20	30 / 75 / 35	10 / 5 / 5	0 / 0 / 0
	Farm Ditch Road[5]	2015	10 / – / –	20 / – / –	1 / – / –	0 / 0 / 0
		2016	– / – / –	– / – / –	– / – / –	0 / 0 / 0
		2017	– / – / –	– / – / –	– / – / –	0 / 0 / 0

Table A4-1.—Summary of hydrologic conditions by survey site, 2013–17
(Values are given for each site as recorded in mid-May, mid-June, and mid-July.)

Study area[1]	Survey site	Year	Percent of site inundated[2]	Depth (centimeters) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (meters) to surface water or saturated soil[2]
TOPO (cont.)	CPhase 05[6]	2013	0 / 0 / 15	0 / 0 / 15	< 1 / 3 / 5	0 / 0 / 0
		2014	6 / 0 / 5	15 / 0 / 3	1 / 0 / 0	0 / 20 / 0
		2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	15 / 15 / 15
		2016	0 / 20 / 0	0 / 30 / 0	0 / 5 / 0	10 / 0 / 10
		2017	2 / 15 / 20	5 / 20 / 15	0 / 5 / 5	0 / 0 / 0
	Lost Lake	2013	10 / 10 / 10	< 5 / 10 / 10	5 / 5 / 5	0 / 0 / 0
		2014	0 / 15 / < 1	0 / 30 / 2	6 / 18 / 15	0 / 0 / 0
		2015	0 / 2 / 0	0 / 3 / 0	50 / 5 / 0	0 / 0 / 0
		2016[7]	10 / – / –	5 / – / –	5 / – / –	0 / – / –
		2017[7]	0 / – / –	0 / – / –	0 / – / –	0 / – / –
TOGO	Blankenship North	2015	50 / 30 / 25	20 / 20 / 20	30 / 20 / 10	0 / 0 / 0
	Blankenship South	2015	40 / 25 / –	50 / 100 / –	20 / 15 / –	0 / 0 / 0
BIWI	Coyote Crossing[4]	2016	40 / 50 / 40	13 / 16 / 10	25 / 30 / 30	0 / 0 / 0
		2017	25 / – / 5	2 / – / 20	65 / – / 0	0 / – / 0
	Bill Willow[4]	2015	100 / 100 / 70	30 / 16 / 5	0 / 0 / 30	0 / 0 / 0
		2016	18 / 100 / 5	7 / 25 / 10	12 / 0 / 60	0 / 0 / 0
		2017	95 / 0 / 0	5 / 0 / 0	5 / 0 / 0	0 / 0 / 0
	Wispy Willow[5]	2013	30 / 30 / 40	10 / 10 / 10	20 / 30 / 5	0 / 0 / 0
		2014	30 / 25 / 30	30 / 15 / 12	30 / 10 / 0	0 / 0 / 0
		2015	75 / 90 / 5	25 / 20 / 12	25 / 10 / 5	0 / 0 / 0
		2016	90 / 70 / 30	10 / 20 / 20	10 / 20 / 35	0 / 0 / 0
		2017	95 / 10 / 2	25 / 20 / 10	0 / 10 / 45	0 / 0 / 0
	Site 01[5]	2013	7 / 5 / 5	10 / 10 / 10	5 / 5 / 5	0 / 0 / 0
		2014	10 / 50 / 30	7 / 15 / 6	5 / 0 / 10	0 / 0 / 0
		2015	55 / 55 / 30	10 / 20 / 15	25 / 25 / 40	0 / 0 / 0
		2016	10 / 15 / 15	5 / 46 / 35	30 / 25 / 35	0 / 0 / 0
		2017	20 / 10 / 5	3 / 20 / 20	40 / 10 / 35	0 / 0 / 0
	Burn Edge	2013	20 / 2 / 1	50 / 40 / 30	< 5 / < 1 / 1	0 / 0 / 0
		2014	1 / < 1 / 1	24 / 10 / 15	0 / 0 / 0	0 / 0 / 0
		2015	0 / < 1 / 1	0 / 5 / 30	0 / 0 / 0	436 / 0 / 0
		2016	1 / 1 / 1	25 / 10 / 2	0 / 0 / 1	0 / 0 / 0
		2017	1 / 1 / 1	15 / 40 / 10	0 / < 1 / < 1	0 / 0 / 0

Table A4-1.—Summary of hydrologic conditions by survey site, 2013–17
(Values are given for each site as recorded in mid-May, mid-June, and mid-July.)

Study area[1]	Survey site	Year	Percent of site inundated[2]	Depth (centimeters) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (meters) to surface water or saturated soil[2]
BIWI (cont.)	Site 04[5]	2013	< 5 / < 5 / < 5	100 / 100 / 100	5 / 2 / < 1	0 / 0 / 0
		2014	30 / 15 / 15	75 / 50 / 25	0 / 0 / 2	0 / 0 / 0
		2015	2 / < 5 / 2	15 / 5 / 10	0 / 0 / 1	0 / 0 / 0
		2016	5 / 2 / 4	40 / 65 / 30	0 / < 1 / 1	0 / 0 / 0
		2017	5 / 5 / 5	50 / 45 / 15	0 / 0 / 2	0 / 0 / 0
	Site 03	2013	5 / 0 / 0	10 / 0 / 0	< 2 / < 1 / 0	0 / 0 / 200
		2014	0 / 0 / 0	0 / 0 / 0	5 / 0 / 0	0 / 200 / 200
		2015	0 / 0 / 0	0 / 0 / 0	1 / 0 / 0	0 / 71 / 71
		2016	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	70 / 74 / 100
		2017	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	74 / 74 / 74
	Last Gasp	2015[8]	0/ – / –	0 / – / –	<1 / – / –	0 / – / –
		2016[8]	0 / – / –	0 / – / –	0 / – / –	500 / – / –
	Guinness	2015[8]	0/ – /–	0/–/–	0 / – / –	968 / – / –
		2016[8]	0 / – / –	0 / – / –	0 / – / –	820 / – / –
	Site 05	2013	5 / 3 / 3	> 100 / 60 / 60	< 1 / 3 / 3	0 / 0 / 0
		2014	3 / 3 / 3	– / – / 60	0 / 0 / 0	0 / 0 / 0
		2015	2 / < 5 / 1	50 / 10 / 30	1 / 0 / 0	0 / 0 / 0
		2016	2 / 5 / 5	50 / 70 / 70	0 / 3 / 0	0 / 0 / 0
		2017	1 / – / –	20 / – / –	0 / – / –	0 / – / –
	Black Rail	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	450 / 660 / 660
		2014	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	640 / 640 / 640
		2015[8]	0 / – / –	0 / – / –	0 / – / –	640 / – / –
		2016[8]	0 / – / –	0 / – / –	0 / – / –	640 / – / –
	Cougar Point	2013	20 / 10 / 0	40 / 15 / 0	10 / 20 / 0	0 / 0 / 25
		2014	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	180 / – / –
	Beaver Pond North	2015	5 / < 1 / < 1	40 / 15 / 2	2 / 0 / 0	0 / 0 / 0
		2016[8]	0 / – / –	0 / – / –	0 / – / –	700 / – / –
	Beaver Pond	2015	5 / 5 / < 5	50 / 40 / 40	1 / 2 / < 5	0 / 0 / 0
		2016[8]	< 1 / – / –	9 / – / –	4 / – / –	0 / – / –
	Site 08	2015	6 / 6 / 6	75 / 30 / 35	4 / 5 / 5	0 / 0 / 0
		2016	15 / 5 / 15	85 / 60 / 125	10 / 1 / 5	0 / 0 / 0
		2017	5 / 5 / 5	40 / > 21 / > 5	5 / 1 / 0	0 / 0 / 0

Table A4-1.—Summary of hydrologic conditions by survey site, 2013–17
(Values are given for each site as recorded in mid-May, mid-June, and mid-July.)

Study area[1]	Survey site	Year	Percent of site inundated[2]	Depth (centimeters) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (meters) to surface water or saturated soil[2]
BIWI (cont.)	Upstream Site 08[4]	2013	5 / 5 / 5	70 / 60 / < 5	10 / 10 / 25	0 / 0 / 0
		2014	13 / 10 / –	5 / 8 / –	5 / 0 / –	0 / 0 / –
		2015	< 5 / 0 / 1	5 / 0 / 2	< 5 / 0 / 2	0 / 0 / 0
		2016	15 / 15 / 15	20 / 30 / 12	5 / 5 / 5	0 / 0 / 0
		2017	40 / 30 / 2	40 / 30 / 3	10 / 5 / 1	0 / 0 / 0
	Planet Ranch Road	2017	45 / 25 / 50	> 100 / > 21 / 110	10 / 3 / 10	0 / 0 / 0
ALAM	Bullard Wash	2016	– / – / 0	– / – / 0	– / – / 0	– / – / 280
		2017	100 / – / 100	>300 / – / >150	0 / – / 0	0 / – / 0
	South Camp	2016	– / 0 / 0	– / 0 / 0	– / 0 / 0	– / 10 / 10
		2017	100 / 100 / 100	>200 / >200 / >200	0 / 0 / 0	0 / 0 / 0
	Over the Edge	2016	0 / – / 0	0 / – / 0	0 / – / 0	291 / – / 415
	Sidebar 01	2014	0 / – / –	0 / – / –	0 / – / –	280 / – / –
		2015	– / 0 / 0	– / 0 / 0	– / 0 / 0	– / 275 / > 275
		2016	0 / – / 0	0 / – / 0	0 / – / 0	1,093 / – / 1,118
		2017	100 / – / 100	>300 / – / >150	0 / – / 0	0 / – / 0
	Edgewater 01	2015	– / – / 0	– / – / 0	– / – / 0	– / – / 300
		2016	0 / – / 0	0 / – / 0	0 / – / 0	427 / – / 427
	Camp 01	2014	0 / – / –	0 / – / –	0 / – / –	10 / – / –
		2015	0 / – / 0	0 / – / 0	0 / – / 0	9 / – / 15
		2016	0 / – / 0	0 / – / 0	0 / – / 0	< 1 / – / < 1
		2017	100 / 100 / 100	>200 / >200 / >200	0 / 0 / 0	0 / 0 / 0
	Camp 04	2014	– / – / –	– / – / –	– / – / –	– / – / –
		2015	1 / – / 0	5 / – / 0	2 / – / 0	0 / – / 10
		2016	0 / – / 0	0 / – / 0	0 / – / 0	5 / – / 10
	Camp 02	2014	0 / – / –	0 / – / –	0 / – / –	20 / – / –
		2015	0 / – / 0	0 / – / 0	0 / – / 0	28 / – / 30
		2016	0 / – / 0	0 / – / 0	0 / – / 0	20 / – / 20
		2017	100 / 100 / 100	>200 / >200 / >200	0 / 0 / 0	0 / 0 / 0
	Camp 03	2014	0 / – / –	0 / – / –	0 / – / –	0 / – / –
		2015	0 / – / < 1	0 / – / 5	0 / – / 10	55 / – / 0
		2016	0 / – / 0	0 / – / 0	0 / – / 0	213 / – / 213
		2017	100 / 100 / 100	>200 / >200 / >200	0 / 0 / 0	0 / 0 / 0

Table A4-1.—Summary of hydrologic conditions by survey site, 2013–17
(Values are given for each site as recorded in mid-May, mid-June, and mid-July.)

Study area[1]	Survey site	Year	Percent of site inundated[2]	Depth (centimeters) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (meters) to surface water or saturated soil[2]
ALAM (cont.)	Middle Earth 01	2014	0 / – / –	0 / – / –	0 / – / –	735 / – / –
		2015	0 / 0 / –	0 / 0 / –	0 / 0 / –	640 / 640 / –
		2016	0 / – / –	0 / – / –	0 / – / –	752 / – / –
		2017	100 / – / 100	>200 / – / 200	0 / – / 0	0 / – / 0
	Middle Earth 02	2014	0 / – / –	0 / – / –	0 / – / –	735 / – / –
		2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	850 / 850 / 850
		2016	0 / – / –	0 / – / –	0 / – / –	835 / – / –
		2017	100 / – / 100	>300 / – / 200	0 / – / 0	0 / – / 0
	Prospect 01	2014	0 / 0 / –	0 / 0 / –	0 / 0 / –	1,300 / 1,300 / –
		2015	– / 0 / –	– / 0 / –	– / 0 / –	– / 1,120 / –
		2016	0 / – / –	0 / – / –	0 / – / –	1,145 / – / –
		2017	100 / – / 100	>200 / – / > 150	0 / – / 0	0 / – / 0
	Burro Wash 01	2014	0 / – / –	0 / – / –	0 / – / –	250 / – / –
		2015	– / 0 / –	– / 0 / –	– / 0 / –	– / 506 / –
		2016	0 / – / 0	0 / – / 0	0 / – / 0	674 / – / 705
		2017	– / 100 / 100	– / 300 / 250	– / 0 / 0	– / 0 / 0
	Burro Wash 02	2014	0 / – / –	0 / – / –	0 / – / –	640 / – / –
		2015	– / 0 / 0	– / 0 / 0	– / 0 / 0	– / 900 / 900
		2016	0 / – / 0	0 / – / 0	0 / – / 0	960 / – / 1,000
		2017	– / 100 / 100	– / 200 / 175	– / 0 / 0	– / 0 / 0
	Motherlode 01	2014	0 / – / –	0 / – / –	0 / – / –	522 / – / –
		2015	0 / – / 0	0 / – / 0	0 / – / 0	755 / – / 755
		2016	0 / 0 / –	0 / 0 / –	0 / 0 / –	800 / 846 / –
		2017	50 / – / 50	200 / – / 175	0 / – / 10	0 / – / 0
	Motherlode 02	2014	0 / 0 / –	0 / 0 / –	0 / 0 / –	1,120 / 1,120 / –
		2015	– / 0 / –	– / 0 / –	– / 0 / –	– / 1,380 / –
		2016	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	1,487 / 1,506 / 2,681
		2017	– / 5 / 0	– / 15 / 0	– / 10 / 3	– / 0 / 0
	Motherlode 03	2014	0 / – / –	0 / – / –	0 / – / –	1,600 / – / –
		2015	– / 0 / –	– / 0 / –	– / 0 / –	– / 1,860 / –
		2016	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	1,338 / 1,636 / 2,214
		2017	– / 0 / 5	– / 0 / 10	– / 0 / 5	– / 2 / 0

Table A4-1.—Summary of hydrologic conditions by survey site, 2013–17
(Values are given for each site as recorded in mid-May, mid-June, and mid-July.)

Study area[1]	Survey site	Year	Percent of site inundated[2]	Depth (centimeters) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (meters) to surface water or saturated soil[2]
ALAM (cont.)	Motherlode 04	2014	– / – / –	– / – / –	– / – / –	– / – / –
		2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	2,109 / 2,109 / 2,109
		2016	0 / – / 0	0 / – / 0	0 / – / 0	1,274 / – / 2,060
		2017	– / 0 / 0	– / 0 / 0	– / 0 / 2	– / 5 / 0
	Confluence 02	2014	0 / 0 / –	0 / 0 / –	0 / 0 / –	675 / 675 / –
		2016[9]	0 / – / –	0 / – / –	0 / – / –	50 / – / –
	Confluence 01	2014	0 / 0 / –	0 / 0 / –	0 / 0 / –	150 / 150 / –
		2017	– / – / 0	– / – / 0	– / – / 0	– / – / 2
	Sandy South	2014	0 / 0 / –	0 / 0 / –	0 / 0 / –	450 / 450 / –
		2017[9]	0 / – / –	0 / – / –	0 / – / –	0 / – / –
	Santa Maria South 01	2014	0 / 0 / –	0 / 0 / –	0 / 0 / –	5 / 10 / –
		2015	– / 0 / –	– / 0 / –	– / 0 / –	– / 5 / –
		2016	0 / – / 0	0 / – / 0	0 / – / 0	7 / – / 16
	Santa Maria North 01	2014	0 / 0 / –	0 / 0 / –	0 / 0 / –	10 / 25 / –
		2015	– / 0 / 0	– / 0 / 0	– / 0 / 0	– / 80 / 80
		2016	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	17 / 22 / 20
		2017	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	50 / 50 / 50
PVER	Phase 02[6]	2013	45 / 35 / 0	15 / 15 / 0	< 5 / – / 0	0 / 0 / 20
		2014	0 / 30 / 0	0 / 15 / 0	0 / 5 / 0	380 / 0 / 380
		2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	25 / 5 / 10
		2016	0 / 95 / 0	0 / 12 / 0	0 / 0 / 0	8 / 0 / 30
		2017	0 / 100 / 0	0 / 5 / 0	0 / 0 / 0	380 / 0 / 8
	Phase 03[6]	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	20 / 20 / 20
		2014	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	20 / 20 / 20
		2015	0 / 30 / 0	0 / 12 / 0	0 / 10 / 0	20 / 0 / 5
		2016	55 / 0 / 0	5 / 0 / 0	10 / 0 / 0	0 / 52 / 260
		2017	0 / 10 / 0	0 / 5 / 0	0 / 0 / 0	25 / 0 / 25
	Phase 04 Block 01[6]	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	5 / 50 / 5
		2014	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	50 / 50 / 50
		2015	0 / 95 / 0	0 / 10 / 0	0 / 1 / 0	50 / 0 / 50
		2016	0 / 0 / 5	0 / 0 / 2	0 / 0 / 0	56 / 56 / 0
		2017	0 / 40 / 0	0 / 20 / 0	0 / 30 / 0	56 / 0 / 56

Table A4-1.—Summary of hydrologic conditions by survey site, 2013–17
(Values are given for each site as recorded in mid-May, mid-June, and mid-July.)

Study area[1]	Survey site	Year	Percent of site inundated[2]	Depth (centimeters) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (meters) to surface water or saturated soil[2]
PVER (cont.)	Phase 04 Block 02[6]	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	15 / 20 / 20
		2014	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	20 / 20 / 20
		2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	20 / 20 / 5
		2016	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	10 / 20 / 9
		2017	0 / 0 / 0	0 / 0 / 0	0 / 25 / 0	20 / 0 / 20
	Phase 04 Block 03[6]	2013	30 / 0 / 0	15 / 0 / 0	0 / 0 / 0	0 / 150 / 150
		2014	2 / 0 / 0	2 / 0 / 0	0 / 0 / 0	0 / 0 / 150
		2015	0 / 0 / 35	0 / 0 / 10	1 / 0 / 5	0 / 150 / 0
		2016	25 / 0 / 50	10 / 0 / 7	3 / 0 / 10	0 / 133 / 0
		2017	2 / 0 / 0	6 / 0 / 0	0 / 0 / 0	0 / 20 / 145
	Phase 05 Block 01[6]	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	30 / 30 / 5
		2014	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	30 / 30 / 30
		2015	0 / 0 / 65	0 / 0 / 12	0 / 0 / 10	30 / 30 / 0
		2016	5 / 0 / 5	3 / 0 / 7	20 / 0 / 30	0 / 19 / 0
		2017	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	25 / 25 / 25
	Phase 05 Block 02[6]	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	35 / 35 / 35
		2014	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	35 / 35 / 35
		2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	35 / 35 / 35
		2016	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	2 / 35 / 5
		2017	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	25 / 25 / 25
	Phase 05 Block 03[6]	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	100 / 100 / 100
		2014	70 / 0 / 0	15 / 0 / 0	0 / 0 / 0	0 / 100 / 100
		2015	8 / 0 / 0	5 / 0 / 0	0 / 0 / 7	0 / 100 / 0
		2016	1 / 0 / 0	2 / 0 / 0	1 / 0 / 0	0 / 97 / 97
		2017	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	97 / 97 / 97
	Phase 06 Block 01[6]	2014	8 / 90 / 0	5 / 15 / 0	2 / 5 / 0	0 / 0 / 40
		2015	15 / 0 / 35	5 / 0 / 8	15 / 0 / 10	0 / 10 / 0
		2016	0 / 2 / 0	0 / 2 / 0	0 / 0 / 0	98 / 0 / 77
		2017	27 / 5 / 0	11 / 10 / 0	3 / 0 / 0	0 / 0 / 5
	Phase 06 Block 02[6]	2014	60 / 0 / 0	10 / 0 / 0	5 / 0 / 0	0 / 105 / 105
		2015	0 / 0 / 0	0 / 0 / 0	< 1 / 0 / 0	0 / 30 / 30
		2016	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	25 / 25 / 24
		2017	15 / 0 / 0	4 / 0 / 0	15 / 0 / 0	0 / 25 / 25

Table A4-1.—Summary of hydrologic conditions by survey site, 2013–17
(Values are given for each site as recorded in mid-May, mid-June, and mid-July.)

Study area[1]	Survey site	Year	Percent of site inundated[2]	Depth (centimeters) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (meters) to surface water or saturated soil[2]
PVER (cont.)	Phase 07 Block 01[6]	2015	60 / 0 / 0	5 / 0 / 0	10 / 0 / 0	0 / 115 / 115
		2016	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 9 / 5
		2017	0 / 0 / 0	0 / 0 / 0	3 / 0 / 0	0 / 108 / 15
	Phase 07 Block 02[6]	2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	5 / 120 / 120
		2016	1 / 60 / 0	3 / 20 / 0	1 / 10 / 0	0 / 0 / 10
		2017	65 / 0 / 0	5 / 0 / 0	30 / 0 / 0	0 / 123 / 123
EHRE	Ehrenberg	2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	15 / 15 / 15
CIBO	Phase 01[6]	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	10 / 100 / 100
		2014	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	100 / 10 / 100
		2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	10 / 100 / 5
		2016	0 / 0 / 1	0 / 0 / 3	0 / 0 / 1	10 / 7 / 0
		2017	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	95 / 12 / 10
	Phase 02[6]	2013	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	25 / 460 / 460
		2014	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	460 / 68 / 460
		2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	70 / 460 / 5
		2016	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	74 / 74 / 75
		2017	0 / 5 / 0	0 / 9 / 0	0 / 5 / 0	477 / 0 / 391
	Phase 03[6]	2013	0 / 30 / 0	0 / 15 / 0	0 / 25 / 0	400 / 0 / 400
		2014	0 / 60 / 35	0 / 25 / 15	0 / 0 / 0	400 / 0 / 0
		2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	400 / 400 / 6
		2016	0 / 15 / 0	0 / 8 / 0	0 / 5 / 0	408 / 0 / 408
		2017	0 / 30 / 0	0 / 20 / 0	0 / 10 / 0	408 / 0 / 5
	Cibola Nature Trail[6]	2013	0 / 67 / 0	0 / 15 / 0	0 / 2 / 0	60 / 0 / 1,770
		2014	1 / 0 / 0	2 / 0 / 0	0 / 0 / 0	0 / 5 / 1,770
		2015	5 / 0 / 2	2 / 0 / 4	5 / < 1 / 3	0 / 0 / 0
		2016	50 / 0 / 0	5 / 0 / 0	15 / 0 / 0	0 / 2 / 1
		2017	5 / 3 / 5	3 / 5 / 5	1 / 2 / < 1	0 / 0 / 0
	C2729[6]	2015	0 / 0 / 45	0 / 0 / 20	0 / 0 / 3	5 / 270 / 0
		2016	55 / 0 / 2	20 / 0 / 5	0 / 0 / 0	0 / 10 / 0
		2017	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	12 / 10 / 330
	Cibola Site 01	2015	0 / 0 / 3	0 / 0 / 20	0 / 0 / 10	20 / 20 / 0
	Cibola Lake North[9]	2015	0 / – / –	0 / – / –	2 / – / –	0 / – / –
	Walker Lake	2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 1	2 / 2 / 0

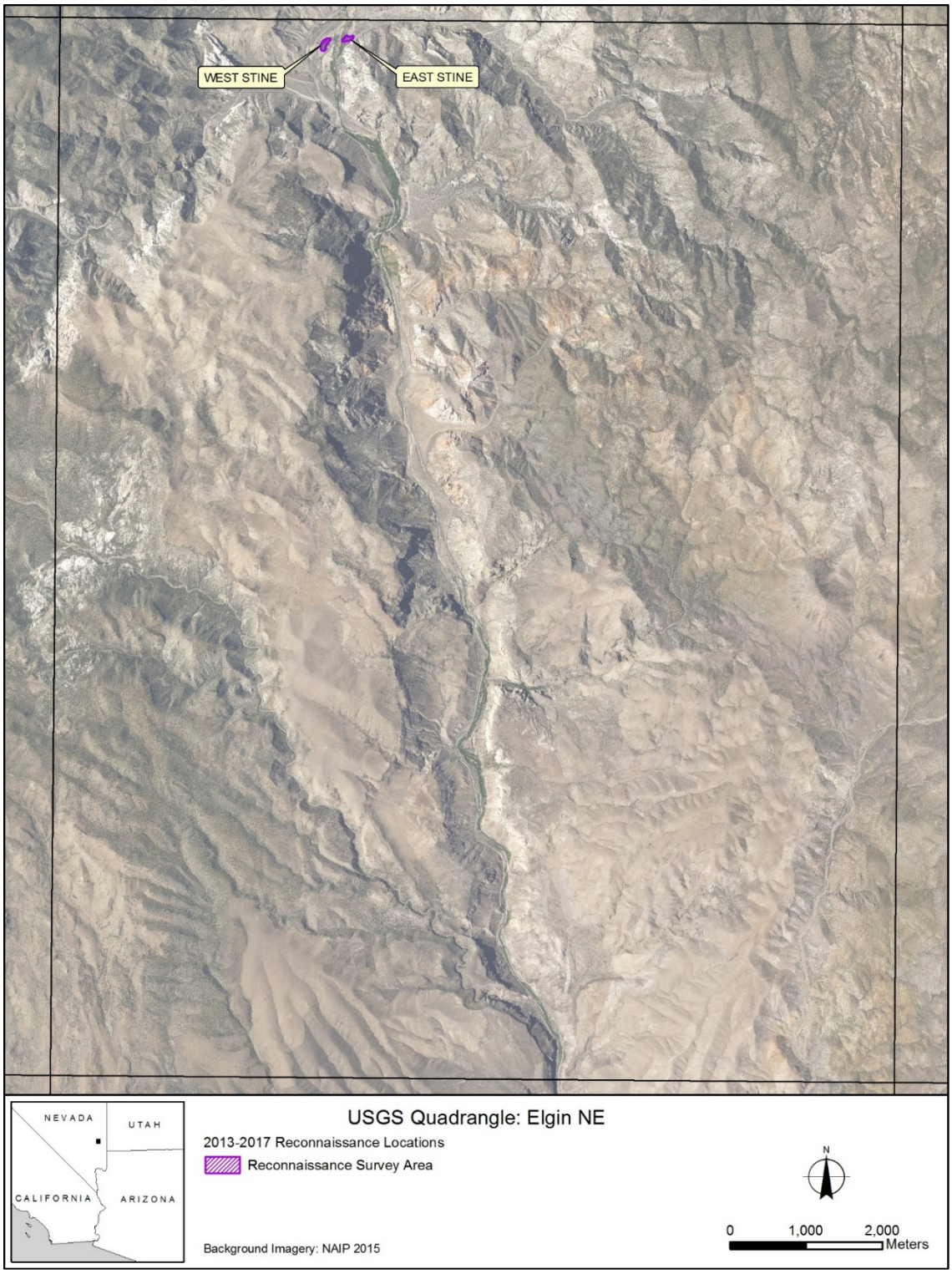
Table A4-1.—Summary of hydrologic conditions by survey site, 2013–17
(Values are given for each site as recorded in mid-May, mid-June, and mid-July.)

Study area[1]	Survey site	Year	Percent of site inundated[2]	Depth (centimeters) of surface water[2]	Percent of site with saturated soil[2,3]	Distance (meters) to surface water or saturated soil[2]
IMPE	Imperial NW	2015	< 1 / 10 / 5	10 / 3 / 13	15 / 10 / 15	0 / 0 / 0
	Imperial Nursery	2015	0 / 0 / 30	0 / 0 / 10	0 / 0 / 20	50 / 50 / 0
	Ferguson Lake	2015	0 / < 1 / 20	0 / – / 5	10 / 5 / 5	0 / 0 / 0
	Great Blue Heron	2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	130 / 130 / 130
	Powerline	2015	0 / 0 / 2	0 / 0 / 4	0 / 0 / 5	0 / 0 / 0
	Martinez Lake	2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
MITT	Mittry West	2015	5 / 0 / 0	– / 0 / 0	30 / 1 / 0	0 / 0 / 81
	C4911	2017	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	75 / 75 / 75
	C4913	2017	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	29 / 29 / 29
YUMA	J[6]	2014	35 / 5 / 0	– / 20 / 0	0 / 0 / 0	0 / 0 / 35
		2015[10]	< 1 / – / –	25 / – / –	2 / – / –	0 / – / –
		2016	3 / 5 / 5	10 / 15 / 10	0 / 0 / 5	0 / 0 / 0
		2017	5 / 0 / –	15 / 0 / –	0 / 0 / –	0 / 14 / –
	C[4] (formerly South AC)	2014	15 / 33 / 0	20 / 20 / 0	1 / 0 / 0	0 / 0 / 20
		2015[10]	55 / – / –	– / – / –	30 / – / –	0 / – / –
		2016	20 / 30 / 10	15 / 15 / 10	0 / 0 / 10	0 / 0 / 0
		2017	0 / 2 / 2	0 / 200 / 150	0 / 0 / 0	0 / 0 / 0
	I[6]	2014	33 / < 1 / 0	20 / 20 / 0	0 / 0 / 0	0 / 0 / 140
		2015[10]	0 / – / –	0 / – / –	0 / – / –	50 / – / –
		2016	0 / 7 / 0	0 / 2 / 0	0 / 3 / 0	5 / 0 / 137
		2017	< 1 / < 1 / –	150 / 100 / –	0 / 0 / –	0 / 0 / –
	Gila Confluence North	2015	5 / 0 / 0	40 / 0 / 0	15 / 0 / 0	0 / 0 / 0
	Gila River Site 02	2015	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
	Fortuna Site 01	2015	< 1 / 3 / –	– / 20 / –	70 / 1 / –	0 / 0 / –
	Fortuna North	2015	5 / < 1 / 1	50 / 25 / 12	1 / < 1 / 1	0 / 0 / 0

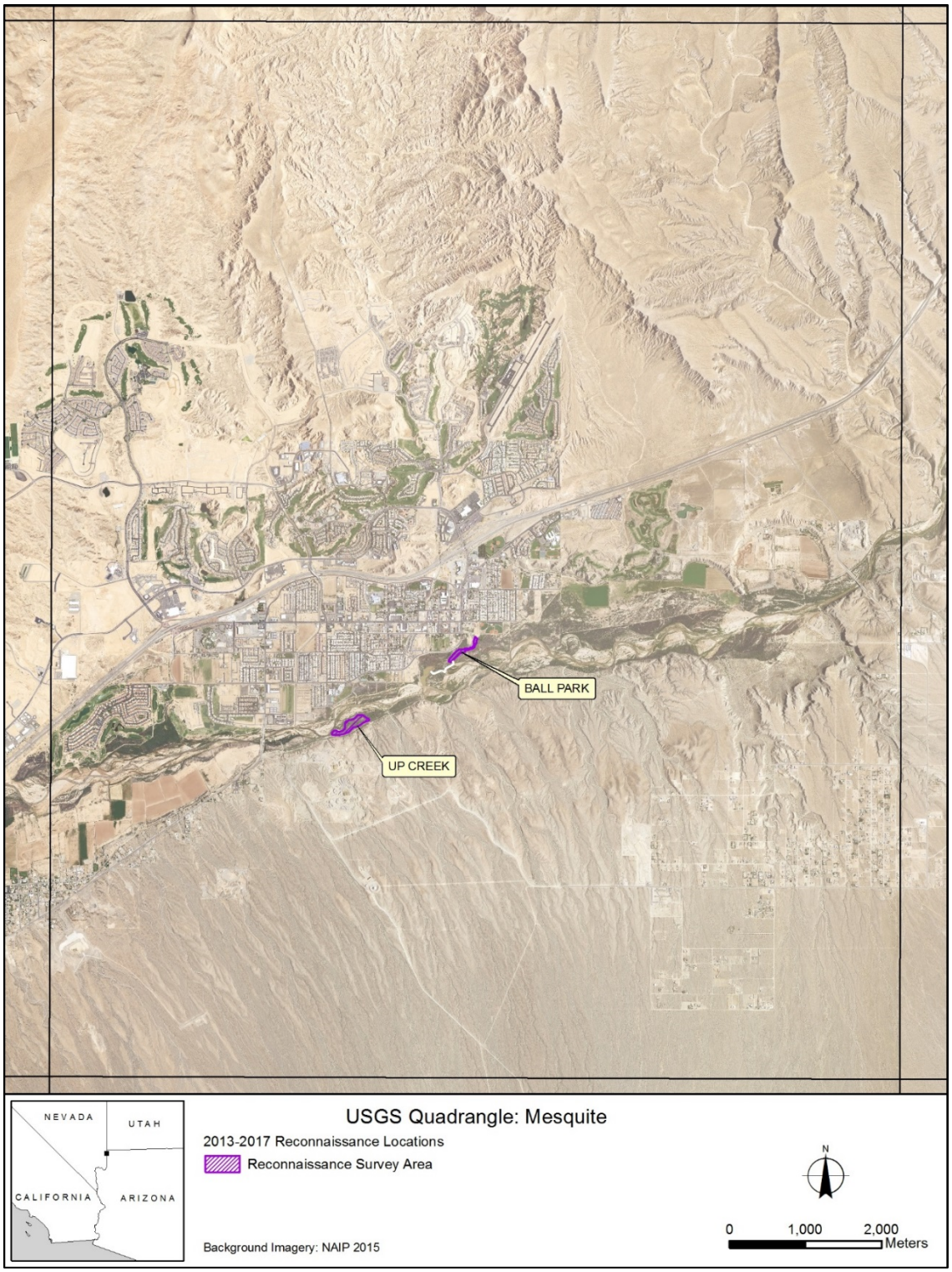
[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, TOGO = Topock Gorge, BIWI = Bill Williams, ALAM = Alamo Lake, PVER = Palo Verde Ecological Reserve, EHRE = Ehrenberg, CIBO = Cibola, IMPE = Imperial, 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.
[5] Site bordered by a river, lake, or pond.
[6] Site irrigated as part of restoration efforts; amount of standing water highly variable throughout survey season.
[7] Surveys discontinued for the season because of fire damage.
[8] Surveys discontinued for the season because of the lack of surface water.
[9] Surveys discontinued because of poor habitat quality.
[10] Surveys discontinued because access could not be obtained.

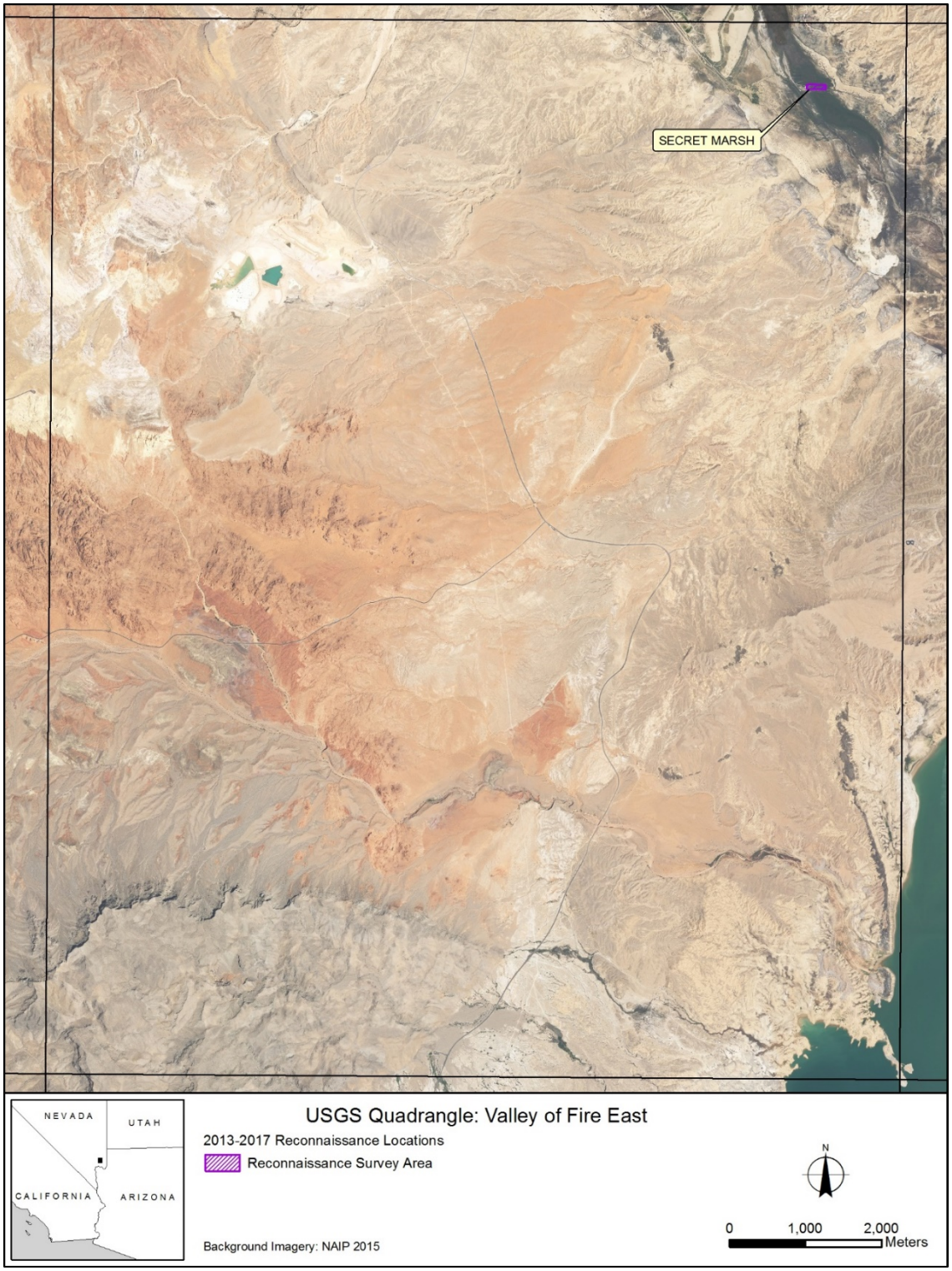
ATTACHMENT 5

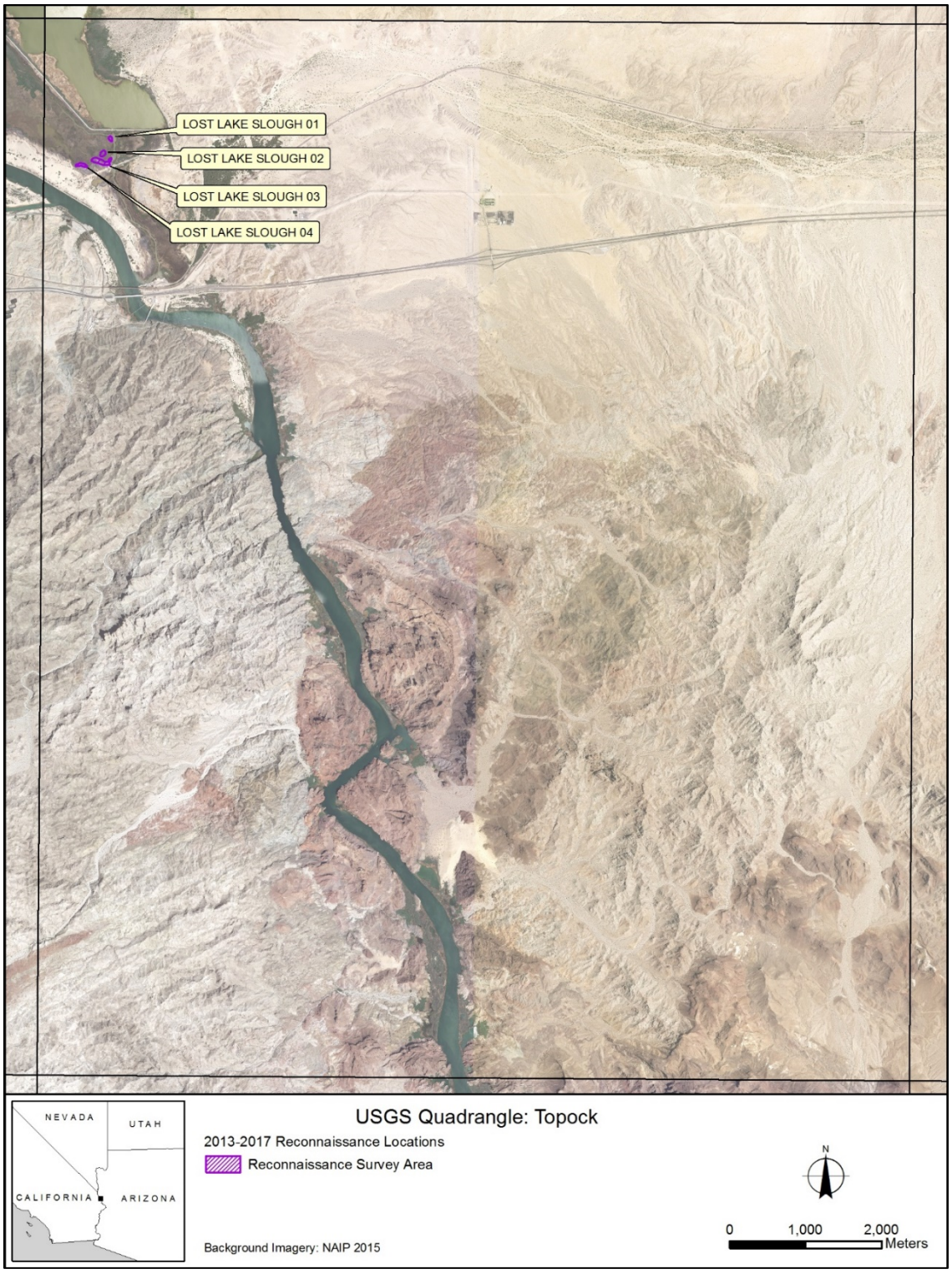
Orthophotos Showing Reconnaissance Sites, 2013–2017


WEST STINE
EAST STINE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Elgin NE
2013-2017 Reconnaissance Locations
Reconnaissance Survey Area
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters

PIONEER ROAD
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Littlefield
2013-2017 Reconnaissance Locations
Reconnaissance Survey Area
N
0
1,000
2,000
Meters
Background Imagery: NAIP 2015


BALL PARK
UP CREEK
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Mesquite
2013-2017 Reconnaissance Locations
Reconnaissance Survey Area
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters


SECRET MARSH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Valley of Fire East
2013-2017 Reconnaissance Locations
Reconnaissance Survey Area
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters


LOST LAKE SLOUGH 01
LOST LAKE SLOUGH 02
LOST LAKE SLOUGH 03
LOST LAKE SLOUGH 04
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Topock
2013-2017 Reconnaissance Locations
Reconnaissance Survey Area
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters

BULLARD WASH NORTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Artillery Peak
2013-2017 Reconnaissance Locations
Reconnaissance Survey Area
N
0
1,000
2,000
Meters
Background Imagery: NAIP 2015

ATTACHMENT 6

Detections of Covered Species Within Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2013–2017

Table A6-1.—Number of detections of each covered species recorded during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast surveys at each survey site, 2013–17*

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Year	Species[2]			
					CLRA	YBCU	GIFL	VEFL
KEPI	Alamo	Key Pittman Wildlife Management Area	Frenchy Lake	2016	0	0	0	0
			Nesbitt Forest	2014[3]	–	–	–	–
				2015[3]	0	0	0	0
				2016	0	0	0	0
			Patches 00-12	2013	–	–	–	–
				2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
RIRA	Alamo	River Ranch	East Side	2013	0	0	0	1
				2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
			West Side	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
			Smalls	2013	0	0	0	0
				2014	0	0	0	3
				2015	0	0	0	2
				2016	0	0	0	2
PAHR	Alamo	Pahranagat National Wildlife Refuge	Pahranagat North	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
				2017	0	0	0	0
			Pahranagat West	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
				2017	0	0	0	0
			Pahranagat MAPS	2014[3]	–	–	–	–
				2015[3]	0	0	0	3
				2016	0	0	0	1
				2017	0	0	0	0

Table A6-1.—Number of detections of each covered species recorded during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast surveys at each survey site, 2013–17*

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Year	Species[2]			
					CLRA	YBCU	GIFL	VEFL
PAHR (cont.)	Alamo (cont.)	Pahranagat National Wildlife Refuge (cont.)	Pahranagat South	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	0	0	3
				2016	0	0	0	0
				2017	0	0	0	1
MVWA	Meadow Valley Wash	Meadow Valley Wash North	Etna	2014	0	0	0	0
				2015	0	0	0	0
			Rock Springs Canyon	2016[3]	–	–	–	–
				2017	0	0	0	0
			Dog Leg	2014	0	0	0	0
				2015	1	0	0	0
				2016	0	0	0	0
				2017	0	0	0	0
		Meadow Valley Wash Middle	Ford	2014	0	0	0	0
				2015	0	0	0	0
			Kyle	2014	0	0	0	0
				2015	0	0	0	0
			Cottonwood Canyon	2014	0	0	0	0
				2015	0	0	0	0
MESQ	Mesquite	Hafen Lane	Hafen Lane	2013	0	0	0	0
		Mesquite East	Up the Creek[3]	2013[3]	0	0	0	0
			Dumb Luck Bridge	2013	0	0	0	0
		Mesquite West	West	2013	0	0	0	0
			Electric Avenue Pond	2013	0	0	0	0
MOME	Mormon Mesa	Virgin River South	Mormon Mesa South	2013	0	0	0	0
			Virgin River #1	2013	0	0	0	0
MUDD	Muddy River	Overton Above High-Water Mark	Overton WMA Pond	2013	0	0	0	0
				2014	0	0	0	0
				2015	3	0	0	0
				2016	0	0	0	0
				2017	1	0	0	0
		Overton Wildlife	Overton WMA	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
				2017	0	0	0	0

Table A6-1.—Number of detections of each covered species recorded during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast surveys at each survey site, 2013–17*

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Year	Species[2]			
					CLRA	YBCU	GIFL	VEFL
WMSP	Muddy River	Warm Springs	Muddy Mac	2013	0	0	0	3
				2014	0	0	0	2
				2015	0	0	0	1
				2016	0	1	0	0
				2017	0	0	0	1
			Muddy Stringer 01	2014	0	0	0	0
				2015	0	1	0	0
				2016	0	0	0	2
				2017	0	0	0	0
TOPO	Topock	Topock Marsh	Pipes 01	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
			Pipes 03	2013	0	0	0	4
				2014	0	0	0	0
				2015	0	0	0	0
			The Wallows	2013	0	0	0	0
				2014	0	0	?[4]	0
				2015	0	0	0	0
			PC 6-1	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
			Pig Hole	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
			In Between	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	1	0	0
			800M	2013	1	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
			Pierced Egg	2013	0	0	0	0
				2014	2	0	0	0
				2015	0	0	0	0
			Swine Paradise	2013	0	0	0	0
				2014	–	–	–	–
				2015[3]	1	–	–	–
				2016[3]	–	–	–	–
				2017	2	0	0	0

Table A6-1.—Number of detections of each covered species recorded during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast surveys at each survey site, 2013–17*

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Year	Species[2]			
					CLRA	YBCU	GIFL	VEFL
TOPO (cont.)	Topock (cont.)	Topock Marsh (cont.)	Platform	2013	0	0	0	0
				2014	0	0	0	0
				2015	3	0	0	0
				2016	1	0	0	0
				2017	1	0	0	0
			250M	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
				2016	3	0	0	0
				2017	0	0	0	0
			Hell Bird	2013	2	0	0	0
				2014	2	0	0	0
				2015	4	1	0	0
				2016	3	0	0	0
				2017	1	0	0	0
			Glory Hole	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
				2016	0	2	0	1
				2017	0	1	0	0
			Farm Ditch Road (formerly Spaghetti)	2013[3,4]	0	0	0	0
				2015	0	0	0	0
				2016	1	0	0	0
				2017	1	2	0	0
	Beal Lake Conservation Area	CPhase 05	CPhase 05 (Beal Lake)	2013	0	*	0	0
				2014	0	0	0	0
				2015	0	*	0	0
				2016	1	*	0	0
				2017	0	*	0	0
	Topock	Topock Bay	Lost Slough[3]	2013[3]	0	0	0	0
			Lost Lake	2013	2	0	0	0
				2014	5	0	0	0
				2015	8	1	0	0
			Lost Lake Slough #1[3]	2013[3]	0	0	0	0
			Lost Lake Slough #2[3]	2013[3]	0	0	0	0
			Lost Lake Slough #3[3]	2013[3]	0	0	0	0
			Lost Lake Slough #4[3]	2013[3]	0	0	0	0

Table A6-1.—Number of detections of each covered species recorded during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast surveys at each survey site, 2013–17*

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Year	Species[2]			
					CLRA	YBCU	GIFL	VEFL
TOGO	Topock Gorge South	Blankenship Valley	Blankenship North	2015	18	0	0	0
			Blankenship South	2015	0	0	0	0
BIWI	Bill Williams River West	BW Delta	Coyote Crossing	2016	0	0	0	0
				2017	1	0	0	0
		North of Main Delta	Bill Willow	2015	1	0	0	0
				2016	0	0	0	0
				2017	2	0	0	0
		North Burn	Wispy Willow	2013	0	0	0	0
				2014	0	0	0	0
				2015[3]	–	–	–	–
				2016[3]	0	0	0	0
				2017	1	0	0	0
			Site 01	2013	2	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	1[4]	0
				2017	0	0	0	0
			Burn Edge	2013	0	0	0	0
				2014	0	*	0	0
				2015	0	0	0	0
				2016	0	0	0	0
				2017	0	0	0	0
		Mosquito Flats	Site 04	2013	0	0	0	3
				2014	0	0	0	0
				2015	0	*	0	0
				2016	0	0	0	0
				2017	0	0	0	0
			Site 03	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	*	0	0
				2016	0	0	0	0
				2017	0	0	0	0
		Cross River	Last Gasp[5]	2015[5]	0	0	0	0
				2016[5]	0	0	0	0
			Guinness[5]	2015[5]	0	0	0	0
				2016[5]	0	0	0	0

Table A6-1.—Number of detections of each covered species recorded during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast surveys at each survey site, 2013–17*

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Year	Species[2]			
					CLRA	YBCU	GIFL	VEFL
BIWI (cont.)	Bill Williams River West (cont.)	Sandy Wash	Site 05	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
			Black Rail	2013	0	0	0	0
				2014	0	0	0	0
				2015[5]	0	0	0	0
				2016[5]	0	0	0	0
	Bill Williams River East	Cougar Point	Cougar Point	2013	0	0	0	0
				2014	0	0	0	0
		Esquerra Ranch	Beaver Pond North (Mineral Wash)	2015	0	0	0	0
				2016[5]	0	0	0	0
			Beaver Pond	2015	1	0	0	0
				2016[5]	0	0	0	0
		Honeycomb Bend	Site 08	2015	0	*	0	0
				2016	0	0	0	0
				2017	1	0	0	0
		Cave Wash	Upstream Site 08	2013[4]	0	0	0	0
				2014[4]	0	*	0	0
				2015	0	0	0	0
				2016	1	0	1[4]	0
				2017	0	0	0	0
	Planet Ranch	Planet Ranch West	Planet Ranch Road	2013	0	*	0	0
				2014	0	0	0	0
				2017	0	0	0	0
ALAM[6]	Alamo Lake	Lake	Bullard Wash	2016	0	0	0	0
				2017	0	0	0	0
			Bullard Wash North	2016	0	0	0	0
			South Camp	2016	0	0	0	0
				2017	0	0	0	0
			Over the Edge[3]	2016[3]	–	–	–	–
		Brown's Crossing	Sidebar 01	2014	0	0	0	0
				2015	0	0	0	0
				2016[3]	–	–	–	–
				2017	0	0	0	0
			Edgewater 01[2]	2015[3]	–	–	–	–
				2016[3]	–	–	–	–

Table A6-1.—Number of detections of each covered species recorded during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast surveys at each survey site, 2013–17*

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Year	Species[2]			
					CLRA	YBCU	GIFL	VEFL
ALAM[6] (cont.)	Alamo Lake (cont.)	Brown's Crossing (cont.)	Camp 01	2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
			Camp 01	2017	0	0	0	0
			Camp 04	2014[3]	–	–	–	–
				2015	0	0	0	0
				2016	0	0	0	0
			Camp 02	2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
				2017	0	0	0	0
			Camp 03	2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
				2017	0	3	0	0
			Middle Earth 01	2014	0	0	0	0
				2015[3]	–	–	–	–
				2016[3]	–	–	–	–
				2017	0	0	0	0
			Middle Earth 02	2014	0	0	0	0
				2015[3]	–	–	–	–
				2016[3]	–	–	–	–
				2017[3]	–	–	–	–
			Prospect 01	2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
				2017[3]	–	–	–	–
			Burro Wash 01	2014	0	0	0	0
				2015	0	1	0	0
				2016	0	0	0	0
				2017	0	1	0	0
			Burro Wash 02	2014	0	0	0	0
				2015	0	4	0	0
				2016	0	0	0	0
				2017	0	0	0	0

Table A6-1.—Number of detections of each covered species recorded during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast surveys at each survey site, 2013–17*

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Year	Species[2]			
					CLRA	YBCU	GIFL	VEFL
ALAM[6] (cont.)	Alamo Lake (cont.)	Brown's Crossing (cont.)	Motherlode 01	2014	0	0	0	0
				2015[3]	–	2	–	–
				2016[3]	–	–	–	–
				2017[3]	–	–	–	–
			Motherlode 02	2014	0	0	0	1
				2015	0	0	0	1
				2016	0	0	0	0
				2017[5]	0	0	0	0
			Motherlode 03	2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
				2017[5]	0	0	0	0
			Motherlode 04	2014[3]	–	–	–	–
				2015	0	0	0	0
				2016	0	0	0	0
				2017[5]	0	0	0	0
			Confluence 02	2014	0	0	0	0
				2016[5]	0	0	0	0
			Confluence 01	2014	0	0	0	0
			Sandy South 01	2014	0	0	0	0
				2017[5]	0	0	0	0
			Santa Maria South 01	2014	0	0	0	0
				2015	0	0	0	0
				2016	0	0	0	0
			Santa Maria North 01	2014	0	0	0	3
				2015	0	2	0	0
				2016	0	0	0	0
				2017	0	1	0	1
PVER	Palo Verde Ecological Reserve	Phase 02	Phase 02	2013	0	0	0	0
				2014	0	*	0	0
				2015[5]	0	*	1[4]	0
				2016[4]	0	*	0	0
				2017	0	*	0	0
		Phase 03	Phase 03	2013	0	*	0	0
				2014	0	0	0	0
				2015	0	*	0	1
				2016	0	0	0	0
				2017	0	*	0	0

Table A6-1.—Number of detections of each covered species recorded during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast surveys at each survey site, 2013–17*

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Year	Species[2]			
					CLRA	YBCU	GIFL	VEFL
PVER (cont.)	Palo Verde Ecological Reserve (cont.)	Phase 04	Phase 04 Block 01	2013	0	*	0	0
				2014	0	*	0	0
				2015	0	*	0	0
				2016	0	0	0	0
				2017	0	*	0	0
			Phase 04 Block 02	2013	0	*	0	0
				2014	0	*	0	0
				2015	0	*	0	0
				2016	0	*	0	0
				2017	0	0	0	0
			Phase 04 Block 03	2013	0	*	0	0
				2014	0	*	0	0
				2015	0	*	0	0
				2016	0	*	0	0
				2017	0	*	0	0
		Phase 05	Phase 05 Block 01	2013	0	*	0	0
				2014	0	*	0	0
				2015	0	*	0	0
				2016	0	*	0	0
				2017	0	0	0	0
			Phase 05 Block 02	2013	0	0	0	0
				2014	0	*	0	0
				2015	0	*	0	0
				2016	0	*	0	0
				2017	0	*	0	0
			Phase 05 Block 03	2013	0	*	0	0
				2014	0	*	0	0
				2015	0	*	0	0
				2016	0	*	0	0
				2017	0	*	0	0
		Phase 06	Phase 06 Block 01	2014	0	*	0	0
				2015	0	*	0	0
				2016	0	*	0	0
				2017	0	*	0	0
			Phase 06 Block 02	2014	0	*	0	0
				2015	0	*	0	0
				2016	0	*	0	0
				2017	0	*	0	0

Table A6-1.—Number of detections of each covered species recorded during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast surveys at each survey site, 2013–17*

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Year	Species[2]			
					CLRA	YBCU	GIFL	VEFL
PVER (cont.)	Palo Verde Ecological Reserve (cont.)	Phase 07	Phase 07 Block 01	2015	0	*	0	0
				2016	0	*	0	0
				2017	0	*	0	0
			Phase 07 Block 02	2015	0	*	0	0
				2016	0	*	0	0
				2017	0	*	0	0
EHRE	Palo Verde Valley	Sante Fe	Ehrenberg	2015	0	0	0	0
CIBO	Cibola Valley Conservation Area	Phase 01	Phase 01	2013	0	*	0	0
				2014	0	*	0	0
				2015	0	*	0	0
				2016	0	*	0	0
				2017	0	*	0	0
		Phase 02	Phase 02	2013	0	*	0	0
				2014	0	*	0	0
				2015	0	0	1[4]	0
				2016	0	0	0	0
				2017	0	0	0	0
		Phase 03	Phase 03	2013	0	*	0	0
				2014	0	*	0	0
				2015	0	0	0	0
				2016	0	*	0	0
				2017	0	*	0	0
	Cibola National Wildlife Refuge Unit #1	Nature Trail	Nature Trail	2013	0	0	0	0
				2014	0	0	0	0
				2015	0	0	0	0
				2016	0	*	0	2
				2017	0	0	0	0
		Crane Roost	C2729	2015	0	0	0	0
				2016	0	*	0	0
				2017	0	*	0	0
	Cibola Valley South	Trigo Mountains	Cibola Site 01	2015	0	0	0	0
			Cibola Lake North[5]	2015[5]	0	0	0	0
IMPE	Imperial North	Draper Ranch	Walker Lake	2015	0	0	0	0
	Imperial South	Fishers Landing	Imperial NW (Nursery NW)	2015	0	1	0	0
			Imperial Nursery	2015	0	0	0	0
			Ferguson Lake	2015	3	1	0	0
			Great Blue Heron	2015	0	0	0	0

Table A6-1.—Number of detections of each covered species recorded during southwestern willow flycatcher (*Empidonax traillii extimus*) broadcast surveys at each survey site, 2013–17*

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Year	Species[2]			
					CLRA	YBCU	GIFL	VEFL
IMPE (cont.)	Imperial South (cont.)	Fishers Landing (cont.)	Powerline	2015	0	0	0	0
			Martinez Lake	2015	0	0	1[4]	0
MITT	Laguna	Laguna West	Mittry West	2015	0	1	1[4]	0
	Laguna Division Conservation Area	Reach 01	C4911	2017	0	0	0	0
			C4913	2017	0	0	0	0
YUMA	Yuma East Wetlands	J	C4703 (J)	2014	0	0	0	0
				2015[5]	0	0	0	0
				2016	0	0	0	0
				2017	1	0	0	0
		C (South AC)	C4711 (C)	2014	0	0	0	0
				2015[5]	1	0	0	0
				2016	0	0	0	1
				2017	0	0	0	0
		I	C4702 (I)	2014	0	0	0	0
				2015[5]	0	0	0	0
				2016	0	0	0	0
				2017	0	0	0	0
	Gila Valley	Gila Valley North	Gila Confluence North	2015	0	0	0	0
			Gila River Site 02	2015	0	0	0	0
		Gila Valley South	Fortuna Site 01	2015	0	0	0	0
			Fortuna North	2015	0	0	0	0

* Only detections of covered species recorded during southwestern willow flycatcher broadcast surveys are reported in this table. Additional detections of both yellow-billed cuckoos (*Coccyzus americanus occidentalis*) and Yuma clapper rails (*Rallus longirostris yumanensis* [also known as Yuma Ridgway's rail = *R. obsoletus yumanensis*]) were recorded during nest monitoring activities and are reported in tables A6-2 and A6-3, respectively, in this attachment. Passive yellow-billed cuckoo detections were recorded at several survey sites monitored for yellow-billed cuckoos as part of another LCR MSCP project. The number of individuals detected at these sites is not reported.

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, TOGO = Topock Gorge, BIWI = Bill Williams, ALAM = Alamo Lake, PVER = Palo Verde Ecological Reserve, EHRE = Ehrenberg, CIBO = Cibola, IMPE = Imperial, MITT = Mittry Lake, and YUMA = Yuma.

[2] CLRA = Yuma clapper rail, YBCU = yellow-billed cuckoo, GIFL = gilded flicker (*Colaptes chrysoides*), and VEFL = vermilion flycatcher (*Pyrocephalus rubinus*).

[3] This survey site was not surveyed; site was occupied during the breeding season.

[4] At least one flicker was detected at this site, but no positive identification to species was made.

[5] Only one survey conducted

[6] Only one survey conducted in 2015, no site was surveyed more than three times in 2016, and no site was surveyed more than four times in 2017.

Table A6-2.—Details on all passive detections of yellow-billed cuckoos, 2013–17*

Study area[1]	Survey site	Year	Date	Behavioral observations[2]
KEPI	Patch 12	2014	June 8	One silent individual seen
	Patch 05	2016	June 14	One individual seen perched
PAHR	Pahranagat North	2016	June 15	One individual seen perched
			June 27	One individual heard (CON)
		2017	June 26	One individual heard (CON) then seen flying
	Pahranagat MAPS	2016	August 3	One individual heard (VO)
MUDD	Overton WMA	2016	June 11	One individual heard (ALA)
WMSP	Muddy Stringer 01	2015	June 18	One individual heard (CON)
		2017	July 7	One individual heard (COO)
	Muddy Mac	2016	July 5	One individual heard (CON); likely same individual that responded to protocol level survey 30 minutes prior
TOPO	In Between	2015	June 24	One individual heard (ALA)
	Swine Paradise	2014	June 25	One individual heard (ALA)
		2016	June 25	One individual heard (CON)
	250M	2016	July 6	One individual heard (COO)
	Hell Bird	2015	July 15	One individual heard (COO and ALA)
		2017	June 26	One individual heard (COO)
	Glory Hole	2016	July 14	Two individuals heard (CON)
	Farm Ditch Road	2017	June 26	One individual seen and heard (CON)
	CPhase 05	2016	June 21	One individual heard (CON)
			July 7	One individual heard (COO)
		2017	June 7	One individual heard (COO)
			June 21	One individual heard (CON)
	Lost Lake	2015	June 22	One silent individual seen foraging
BIWI	Wispy Willow	2016	July 28	One individual heard (COO and CON)
	Site 01	2017	July 26	One individual heard (COO)
ALAM	Sidebar 01	2016	June 14	One individual seen foraging
			June 26	One individual heard (COO)
	Camp 03	2017	July 21	Two individuals with three detections. One individual heard (COO); second individual seen flying and heard (ALA); third detection of an individual that was heard (CON)
	Prospect 01	2017	July 7	One individual heard (COO)

Table A6-2.—Details on all passive detections of yellow-billed cuckoos, 2013–17*

Study area[1]	Survey site	Year	Date	Behavioral observations[2]
ALAM (cont.)	Middle Earth 01	2014	July 10	One individual heard (ALA)
	Middle Earth 02	2017	July 7	One individual heard (COO)
			July 8	One individual heard (CON)
			July 9	One individual heard (CON) and seen perching; one individual heard only (CON and COO)
			July 10	Two detections where an individual was heard (COO)
			July 12	One individual heard (COO)
			July 23	Two detections where an individual was heard (one detection with COO, one with ALA)
			July 27	One individual heard (CON and ALA)
	Burro Wash 01	2014	July 1	One individual heard (coo)
		2015	June 12	One individual heard (CON)
		2016	July 5	One individual heard (COO)
			July 9	One individual heard (CON); individual counter-singing with detected bird at Burro Wash 02
			July 11	One individual heard (ALA)
			July 27	One individual heard (CON)
		2017	June 25	Two detections where an individual was heard (CON)
			June 28	One individual heard (CON)
			July 8	One individual heard (COO)
			July 20	One individual heard (COO) and seen flying overhead
			July 28	One individual heard (VO)
	Burro Wash 02	2016	July 9	Two individuals heard (CON); one individual was counter-singing with detected bird at Burro Wash 01
			July 19	One individual heard (CON)
		2017	July 7	One individual heard (CON) and seen foraging
			July 8	Two detections where an individual was heard (COO)
			July 10	One individual heard (CON)
			July 21	Two individuals heard (COO)
			July 26	One individual heard (COO)
	Motherlode 01	2014	July 24	One individual heard (CON)
		2015	June 28	One individual heard (no notes on vocal type)
			July 25	One or two individuals heard (no notes on vocal type)
		2016	July 11	One individual heard (ALA and COO)
		2017	July 13	One individual heard (ALA)

Table A6-2.—Details on all passive detections of yellow-billed cuckoos, 2013–17*

Study area[1]	Survey site	Year	Date	Behavioral observations[2]
ALAM (cont.)	Santa Maria North 01	2015	August 1	Two individuals seen (COO and ALA)
		2016	July 9	One individual heard (COO)
		2017	June 8	One individual heard (COO)
			June 22	One individual heard (ALA)
			July 27	One individual heard (CON)
IMPE	Imperial NW	2015	July 9	One individual heard (ALA)

* 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. Detections at sites that are monitored for yellow-billed cuckoos as part of another LCR MSCP project are not included.

[1] KEPI = Key Pitmann, PAHR = Pahranagat, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, ALAM = Alamo Lake, and IMPE = Imperial.

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

Table A6-3.—Details on all passive detections of Yuma clapper rails, 2013–17*

Study area[1]	Survey site	Year	Date	Behavioral observations
MVWA	Dog Leg	2015	June 4	One individual heard (kek-kek-kek)
MUDD	Overton WMA Pond	2015	May 19	One individual heard (kek-kek-kek)
			June 12	One individual heard (kek-kek-kek)
			June 27	One individual heard (kek-kek-kek)
		2017	May 15	One individual heard (clatter)
TOPO	800M	2013	June 5	One individual heard in 800M marsh
	Pierced Egg	2013	May 22	One individual heard
			June 20	One individual heard
			June 25	One individual heard
		2014	May 15	One individual heard in marsh south of site (kek-kek-kek)
			June 15	Two individuals counter-calling (kek-kek-kek)
	Swine Paradise	2015	June 16	One individual heard (kek-kek-kek)
		2016	May 19	One individual heard (kek-kek-kek)
			June 4	Two individuals heard (kek-kek-kek)
		2017	May 15	One individual heard (clatter)
			June 7	One individual heard (clatter)
	Platform	2015	May 21	One individual heard (kek-kek-kek)
			June 4	One individual heard (kek-kek-kek)
			July 11	One individual heard (kek-kek-kek)
		2016	June 6	One individual heard (kek-kek-kek)
		2017	May 15	One individual heard (clatter)
	250M	2016	May 16	One individual heard (kek-kek-kek)
			May 20	One individual heard (kek-kek-kek)
			May 24	One individual heard (kek-kek-kek)
			May 30	Two individuals heard (kek-kek-kek)
			June 20	Two individuals heard (kek-kek-kek)
			July 6	One individual heard (kek-kek-kek)
		2017	July 7	One individual heard (kek-kek-kek)
	Hell Bird	2013	June 2	One individual heard
			June 11	One individual heard
		2014	June 9	Two individuals heard (both using kek-burr call)
		2015	May 25	One individual heard (kek-kek-kek)
		2015	July 5	Three individuals heard (kek-kek-kek)

Table A6-3.—Details on all passive detections of Yuma clapper rails, 2013–17*

Study area[1]	Survey site	Year	Date	Behavioral observations
TOPO (cont.)	Hell Bird (cont.)	2016	May 16	One individual heard (clatter)
			June 3	Two individuals heard (kek-kek-kek)
			June 20	One individual heard (kek-kek-kek)
		2017	June 28	One individual heard (kek-kek-kek)
	Glory Hole	2016	May 15	One individual heard (kek-kek-kek)
			May 25	One individual heard (kek-kek-kek)
	Farm Ditch Road	2016	May 16	One individual heard (kek-kek-kek)
		2017	June 26	One individual heard (kek-kek-kek)
	CPhase 05	2016	May 19	One individual heard (kek-kek-kek)
	Lost Lake	2013	May 29	Two individuals heard
		2014	May 21	One individual heard (kek-bur)
			June 9	Two individuals heard (kek-kek-kek)
			June 23	One individual heard (kek-kek-kek)
			July 8	Two individuals heard (kek-kek-kek)
		2015	June 11	Two individuals heard (kek-kek-kek)
			June 22	Two individuals heard (kek-kek-kek)
			June 24	Two individuals heard (kek-kek-kek)
			July 4	Two individuals heard (kek-kek-kek)
		2016	May 16	Two individuals heard (clatter and kek-kek-kek)
		2017	May 17	One individual heard (kek-kek-kek)
TOGO	Blankenship North	2015	May 20	Seven individuals heard (kek-kek-kek)
			June 11	Four individuals heard (kek-kek-kek); one individual heard (clatter)
			June 23	Four individuals heard (kek-kek-kek)
			July 8	Two individuals heard (kek-kek-kek)

Table A6-3.—Details on all passive detections of Yuma clapper rails, 2013–17*

Study area[1]	Survey site	Year	Date	Behavioral observations
BIWI	Coyote Crossing	2017	May 20	One individual heard (kek-kek-kek)
	Bill Willow	2015	May 16	One individual heard (kek-kek-kek)
		2017	May 20	Two individuals heard (one clatter, one kek-kek-kek)
	Wispy Willow	2016	June 8	Four individuals heard (kek-kek-kek)
			June 15	One individual heard (kek-kek-kek)
		2017	May 16	One individual heard (kek-kek-kek)
	Site #1	2013	July 9	One individual heard
	Beaver Pond	2015	May 18	One individual seen foraging
	Site 08	2017	May 23	One individual heard (kek-kek-kek)
	Upstream Site 08	2016	June 2	One individual seen standing
IMPE	Ferguson Lake	2015	June 12	Two individuals heard (kek-kek-kek); one individual heard (clatter)
YUMA	Yuma East Wetlands J	2017	June 9	One individual heard (clatter)
	Yuma East Wetlands C	2015	May 19	One individual heard (kek-kek-kek)

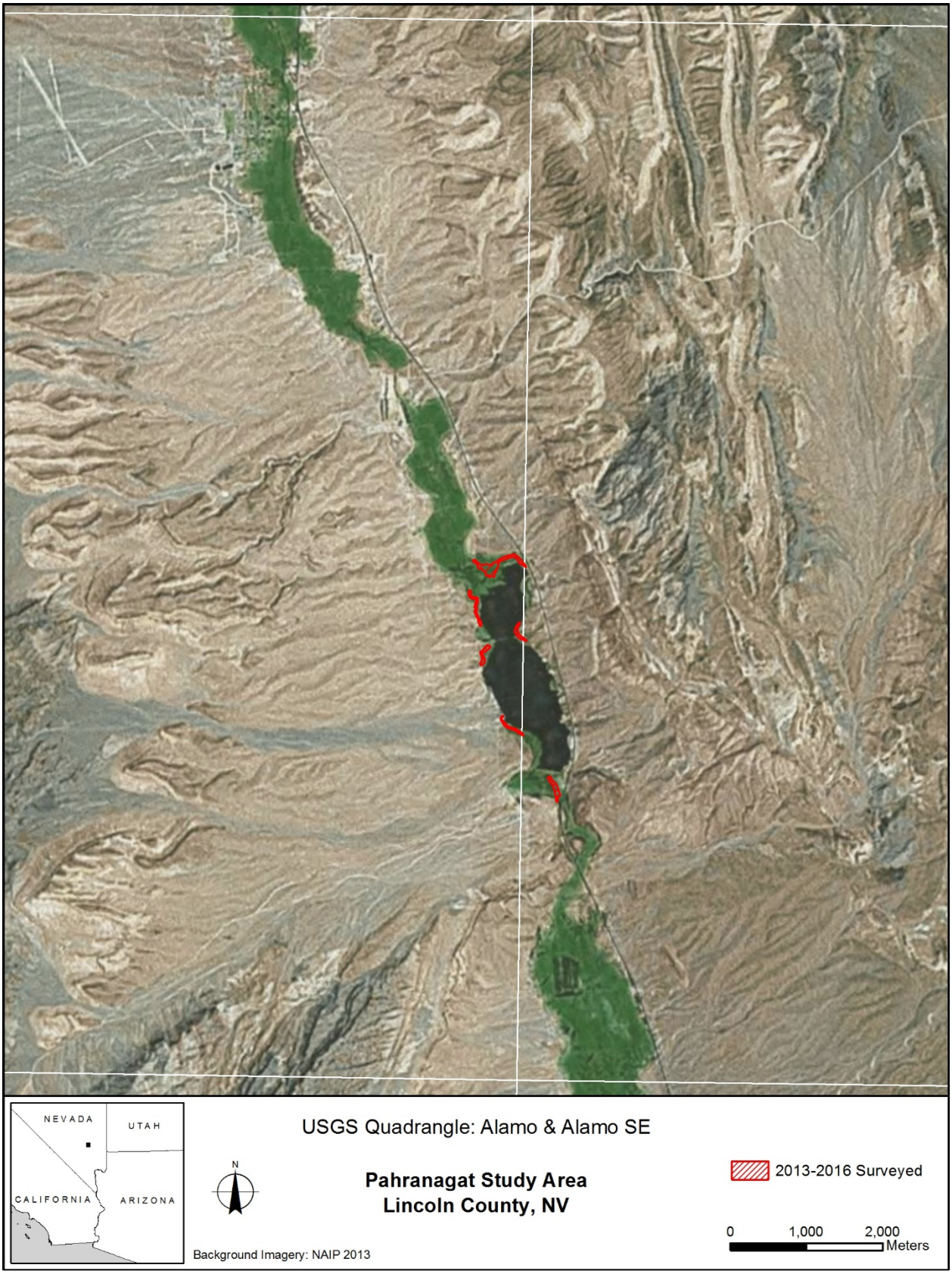
* All individuals were detected passively, and no protocol surveys were conducted. These detections indicate the presence of the species in a given location but cannot be used to estimate population size or infer absence of the species in other locations.

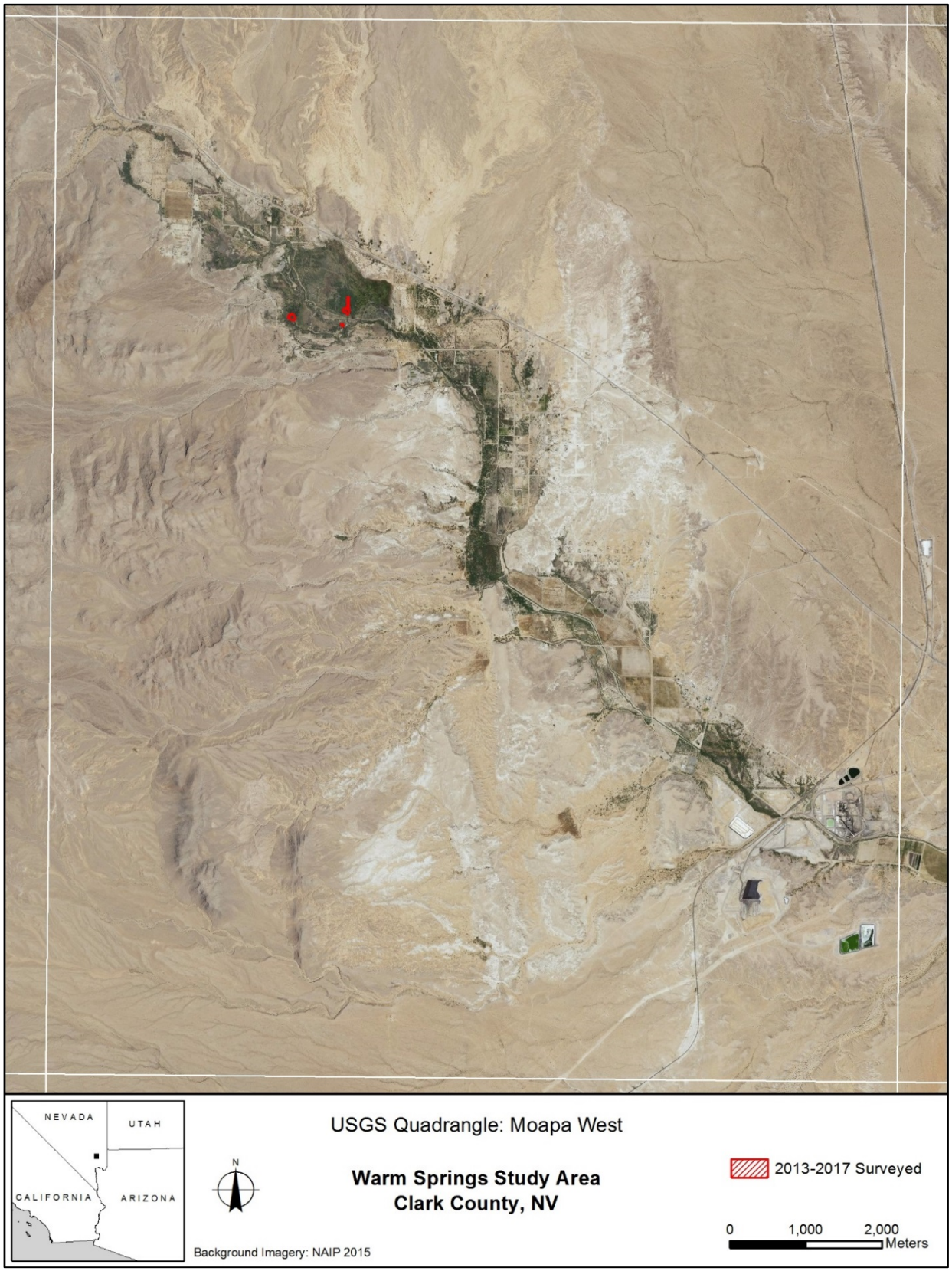
[1] MVWA = Meadow Valley Wash, MUDD = Muddy River, TOPO = Topock Marsh, TOGO = Topock Gorge, BIWI = Bill Williams, IMPE = Imperial, and YUMA = Yuma.

ATTACHMENT 7

Orthophotos of Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) Survey Sites, 2013–2017

NEVADA
UTAH
CALIFORNIA
ARIZONA
N
USGS Quadrangle: Ash Springs
River Ranch Study Area
Lincoln County, NV
2013-2016 Surveyed
0
1,000
2,000
Meters
Background Imagery: NAIP 2013


NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Alamo & Alamo SE
N
Pahranagat Study Area
Lincoln County, NV
2013-2016 Surveyed
0
1,000
2,000
Meters
Background Imagery: NAIP 2013


NEVADA
UTAH
CALIFORNIA
ARIZONA
N
USGS Quadrangle: Moapa West
Warm Springs Study Area
Clark County, NV
2013-2017 Surveyed
0
1,000
2,000
Meters
Background Imagery: NAIP 2015

ATTACHMENT 8

All Willow Flycatchers (*Empidonax traillii*) Color Banded and/or Resighted, 2013–2017

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2140-66709	M	A	Q	Q	Q		Q[4]	M	M	M	M	M	M[5]	M				
2320-31632	F	A			Q		M	M	M[6]		M	M	M	M				
2360-59788	F	J				D	D	M	M	M	M	M	M	M				
2370-39938	M	A					M	M	M	M	M	M	M	M				
2370-40000	M	A									D	D	D	D				
2370-40024	M	J								K	K	K	K	K	K	K	K	
2370-40046	M	A					G	G[7]	M	M	M	M	M	M				
2370-40077	M	A													W	W		W
2370-40088	M	A									D	D	D	P	P	P	P	
2370-40091	F	J									M	D		D				
2370-40093	M	J									M							
2370-40094	U	J													P			
2370-40175	M	J								M	Q	Q	D	D				
2370-40190	M	J						P				K	K	K				
2370-40197	M	A						M	Q	Q	M	M	M	M				
2430-61083	M	A							P	P	P	P	P	P	P	P	P	P
2430-61087	F	A								P	P	P	P	P				
2430-61088	M	A									N	D	E	K	K	K	K	K
2430-61124	F	J							P		K			K				
2430-61134	M	A							T		N	N	N	T	N	N	N	N
2430-61158	M	A								K	K	K	K	K	K	K		
2430-61159	M	J								M		K	K	K	K			
2430-61220	F	J										P	P	P	P	P	P	P

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2430-61260	M	A											D	D				
2430-61262	M	J											K	P	P			
2430-61267	F	A											P	P	P		P	
2430-61279	F	J								P	K	K	K	K	K	K		
2430-61281	M	A											M	M				
2430-61282	M	A											M	M	M	M	M	M
2430-61286	M	A											M	M				
2430-61290	M	J											P	E				
2430-61298	F	A											M	M	P	P	P	
2430-61300	F	J											P	P	K			
2540-58114	F	J										P	P	P	P	K		
2540-58121	U	J												K				
2540-58122	U	J												K				
2540-58123	U	J												K				
2540-58124	F	J												S		S	S	
2540-58125	M	J												S		S		S
2540-58126	U	J												S				
2540-58127	F	J												K	P			
2540-58128	U	J												K				
2540-58129	U	J												K				
2540-58130	U	J												D				
2540-58133	F	J												D		Q		Q
2540-58134	M	A													D			

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2540-58135	F	A													P			
2540-58136	F	A													P			
2540-58137	U	J													P			
2540-58138	F	J													K	K		
2540-58139	U	J													P			
2540-58140	F	A													W	W	W	W
2540-58153	U	J													K			
2540-58157	M	J									K	E		P	P	P	P	P
2540-58158	M	J									K	K	K	K	K[8]	P		
2540-58160	M	J									S		S	S	S	S	S	S
2540-58174	F	J										M	M[6]		M			
2540-58175	F	A										K	K	K	K			
2540-58177	F	A										K	K	K	K	K	K	
2540-58179	M	J										K	K	K	P	P	P	
2540-58182	F	J										K		K				
2540-58192	M	A									Q	Q[4]	M	M	M	M		
2540-58193	F	A									N	N	N		D			
2540-58199	M	J									K		P	P	P			
2540-58201	M	J									K	P	P	P	P	P	P	
2540-58202	M	A									K		K	K	K	K		
2540-58211	M	J										K	K	K				
2540-58215	U	J													P			
2540-58217	M	A								S	S			S	S	S		

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2540-58223	M	A									K	K	K	K	K			
2540-58224	F	J									K	K	K	K				
2540-58231	F	A									T	M	M	M	T	T		
2540-58238	F	J									K	E[9]		P	P	P	P	
2540-58239	M	J									K			K	K	K	K	
2540-58240	F	J									K	E	K	K	K			
2540-58245	M	A										P	K	K	K	K	K	K
2540-58246	M	A										E	P	P	P	P		
2540-58248	F	J												P	K			
2540-58249	U	J												P				
2540-58250	M	J												P	P	P	P	
2540-58251	U	J												P				
2540-58252	U	J												K				
2540-58253	U	J												K				
2540-58254	F	J												P	K			
2540-58255	F	A												M				
2540-58259	M	J											K	K	P	P		
2540-58262	M	J											K	E	P	P		
2540-58269	F	A											K	K[8]	P	P	P	
2540-58270	F	A												K	K	K	K	
2540-58271	F	A												P	P			
2540-58277	M	J										K	K		K			
2540-58281	F	A												K	K	K	K	

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2540-58286	F	J										P	P	P	P			
2540-58300	F	J											K	K				
2540-58301	M	J											P	W				
2540-58304	F	J											P	K				
2540-58305	F	J												K	K			
2540-58306	U	J												P				
2540-58307	U	J												K				
2540-58308	U	J												K				
2540-58309	F	J												K	P	P		
2540-58310	U	J												K				
2540-58311	M	J													P	P	P	
2540-58312	F	A													P			
2540-58313	U	J														W		
2540-58314	M	A															W	
2540-58315	U	J															P	
2540-58316	F	A													O	O		
2540-58317	M	A													O		O	O
2540-58318	F	A													O			
2540-58319	F	A													O			
2540-58320	F	J											K		K	K	K	
2540-58322	F	A											K	K				
2540-58326	M	J											K	P				
2540-58328	F	A													O			

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2540-58329	M	A													O	O	O	
2540-58330	U	J													W			
2540-58331	U	J													P			
2540-58332	M	J													P	E	E[10]	P
2540-58333	U	J													K			
2540-58334	U	J													K			
2540-58335	U	J													K			
2540-58336	F	A														D	D	
2540-58337	U	J															P	
2540-58338	U	J													O			
2540-58339	U	J													O			
2540-58340	F	J													O	B		
2540-58341	M	A													O	O		
2540-58342	F	A													O			
2540-58343	U	J													O			
2540-58344	U	J													T			
2540-58345	U	J														B		
2540-58346	F	J														O	O	
2540-58347	U	J													T			
2540-58348	U	J													T			
2540-58349	F	A													T			
2540-58350	M	A													O			
2540-58351	U	J													O			

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2540-58352	F	J													B	B		
2540-58353	F	A													O	O		O
2540-58354	U	J															P	
2540-58355	M	J														O	O	
2540-58356	F	A													B	B	B	
2540-58357	U	J														O		
2540-58358	U	J													K			
2540-58359	U	J														B		
2540-58360	U	J													D			
2540-58361	F	J													P	P	P	P
2540-58362	F	A													O		O[11]	
2540-58363	M	A													W			
2540-58364	U	J														P		
2540-58365	M	A														Z		
2540-58366	U	J															P	
2540-58367	U	J														K		
2540-58368	M	J														S		S
2540-58369	U	J														P		
2540-58370	M	A															W	
2540-58371	U	J														W		
2540-58372	U	J														E		
2540-58374	M	A												V				
2540-58375	M	A												P				

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2540-58376	M	A												E	K			
2540-58377	F	J												K	K			
2540-58379	U	J														P		
2540-58380	U	J														W		
2540-58381	M	J														E	P	P
2540-58382	M	A															K	
2540-58383	U	J														E		
2540-58384	U	A															K	
2540-58387	M	A										K	K	K	K			
2540-58388	U	J															K	
2540-58389	M	A															B	B
2540-58390	U	J															O	
2540-58391	M	A															O	
2540-58392	U	A															O	O
2540-58393	U	J															O	
2540-58394	M	A															O	
2540-58395	U	J															O	
2540-58396	F	A															O	O
2540-58397	U	J															P	
2540-58398	U	J															K	
2540-58399	F	A															O	
2540-58400	F	A															O	
2590-53101	M	J										P			K	K	K	

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2590-53106	F	J										M			D			
2590-53114	M	J										K		K				
2590-53117	M	J										M	Q	Q[12]				
2590-53120	U	J												K				
2590-53121	F	A										K	K	K	K	K	K	
2590-53128	M	A													O			
2590-53129	M	A													O	O		
2590-53130	M	A													O			
2590-53131	U	J													T			
2590-53156	F	A											M	M				
2590-53157	F	J											M	D	D			
2590-53159	U	J												S				
2590-53160	F	J												S	S			
2590-53167	M	A													T			
2590-53168	M	A													T	T		
2590-53169	U	J													K			
2590-53170	M	A															P	
2590-53171	F	A										E	K	K	K	K		
2590-53174	U	J												S				
2590-53175	M	J													P	K		
2590-53176	U	J														E		
2590-53177	M	A												Q	Q	Q	Q	Q
2590-53178	U	J												K				

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2590-53179	U	J												K				
2590-53180	U	J												K				
2590-53181	U	J												K				
2590-53183	U	J													P			
2590-53201	M	A															P	P
2590-53202	M	A															D	
2590-53203	U	J															K	
2590-53204	U	J															P	
2590-53205	U	J															P	P
2590-53206	U	J															K	
2590-53207	U	J															P	E
2590-53208	F	A															P	
2590-53209	U	J															P	E
2590-53210	U	J															W	
2590-53211	M	A																N
2590-53212	U	J																W
2590-53213	U	J																P
2590-53214	U	J																W
2590-53215	U	J																W
2590-53216	F	A																D
2590-53217	U	J																W
2590-53218	U	J																P
2590-53219	M	A															D	

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2590-53220	M	J															P	E
2590-53222	U	J															P	
2590-53223	F	J															P	E
2590-53224	M	A																N
2590-53225	U	J																P
2590-53226	U	J																P
2590-53227	M	A																W
2590-53228	F	A																Q
2590-53229	U	J																W
2590-53230	U	J																P
2590-53231	U	J																P
2590-53232	U	J																P
2590-53233	U	J																P
2590-53236	F	A															O	O
2590-53237	U	J															B	
2590-53238	U	J															B	
2590-53239	U	J															B	
2590-53240	M	A															O	
2590-53241	M	A															O	
2590-53242	U	J															O	
2590-53243	U	J															B	
2590-53252	U	A																P
2590-53253	U	J																P

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2590-53254	U	J															O	
2590-53255	U	J															O	
2590-53256	U	J															B	
2590-53257	U	J																P
2590-53258	U	J																P
2590-53259	U	J																P
2590-53260	U	J																S
2590-53261	U	J																S
2590-53262	U	J																S
2590-53263	F	A																Q
2590-53264	U	J																Q
2590-53265	U	J																Q
2590-53266	U	J																Q
2590-53267	U	A																N
2590-53268	U	J																N
2590-53269	U	J																N
2590-53270	U	J																D
2590-53271	U	J																W
2590-53272	M	A															Z	
2590-53273	M	A															Q	
2590-53275	F	A															P	
2590-53276	M	A															O	
2590-53277	F	A															B	B

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2590-53288	F	A																N
2590-53289	F	A																Q
2590-53290	F	A																Q
2590-53291	M	A																E[13]
2590-53292	U	J																P
2590-53293	U	J																P
2590-53294	U	J																P
2590-53295	U	J																P
2590-53296	U	J																N
2590-53297	U	J																N
2590-53298	F	A																W
2590-53299	U	J																Q
2590-53300	U	J																Q
2660-23001	M	A												K	K			
2660-23002	U	J												M				
2660-23003	U	J												K				
2660-23004	U	J												K				
2660-23005	U	J												K				
2660-23006	U	J													P			
2660-23007	M	J												S	S	S	S	
2660-23008	U	J												S				
2660-23009	U	J												S				
2660-23010	F	J												S	S	S	S	S

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2660-23011	U	J												S				
2660-23013	U	J												S				
2660-23015	F	J												S		S		S
2660-23016	F	A												D	D			N
2660-23017	M	A												D	D	D	D	D
2660-23018	U	J												K				
2660-23019	U	J												K				
2660-23020	U	J												K				
2660-23021	M	J												K	P			
2660-23022	U	J												K				
2660-23023	U	J												K				
2660-23025	U	J												K				
2660-23026	U	J												K				
2660-23027	U	J												K				
2660-23028	U	J												K				
2660-23029	M	A												K	K			
2660-23031	M	J												K	K[8]	P	P	
2660-23033	U	J												P				
2660-23034	U	J												K				
2660-23036	U	J													P			
2660-23037	U	J													K			
2660-23038	F	J													P	K	K	
2660-23039	F	J													W	W	W	W

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2660-23040	U	J													W			
2660-23041	U	J													K			
2660-23042	F	J												K	K	P	P	
2660-23043	U	J													K			
2660-23044	M	J													P	E	K	K
2660-23045	F	J													P	E	E	
2660-23046	U	J													K			
2660-23047	U	J													K			
2660-23048	M	J													P	E	K	
2660-23049	U	J													P			
2660-23051	U	J													P			
2660-23052	U	J													D			
2660-23053	F	A													K	P	P	P
2660-23054	M	A														P[14]		
2660-23055	F	A														N		
2660-23056	F	A														W		
2660-23057	U	J														W		
2660-23058	U	J														W		
2660-23059	U	J														W		
2660-23060	M	A													P			
2660-23061	M	A													O			
2660-23062	M	A													O			
2660-23063	F	A													O	O	O	O

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2660-23064	M	A													O			
2660-23065	F	A													P			
2660-23066	M	A													O	O	O	O
2660-23067	M	A													K	K	K	K
2660-23068	U	J													D			
2660-23069	U	J													W			
2660-23070	U	J													W			
2660-23071	U	J													P			
2660-23072	U	J													P			
2660-23073	U	J													K			
2660-23074	U	J													K			
2660-23075	U	J													K			
2660-23076	U	J													K			
2660-23077	F	J													K	K	P	P
2660-23078	U	J													K			
2660-23079	U	J													K			
2660-23080	U	J													P			
2660-23081	U	J													P			
2660-23082	F	A													D			
2660-23083	F	A													D	D		
2660-23084	F	J														P	K	K
2660-23085	U	J													O			
2660-23086	U	J													O			

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2660-23087	M	A													B			
2660-23088	U	J														P		
2660-23089	U	J													T			
2660-23090	U	J													T			
2660-23091	M	A													O			
2660-23092	U	J													B			
2660-23093	U	J													M			
2660-23094	U	J													M			
2660-23095	U	J													K			
2660-23096	U	J													K			
2660-23097	U	J														P		
2660-23098	U	J													P			
2660-23099	U	J													P			
2660-23100	F	A													P			
2660-23101	F	A														K		
2660-23102	M	A													O			
2660-23103	M	A														W	W	W
2660-23104	U	J														W		
2660-23105	U	J														W		K
2660-23106	U	J														D		
2660-23107	U	J														K		
2660-23109	M	A														Q		
2660-23110	U	J														Q		

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2660-23111	F	A														E		
2660-23112	U	J														D		
2660-23113	U	J														D		
2660-23114	M	A														W	W	W
2660-23115	U	J														K		
2660-23116	U	J														K		
2660-23117	U	J														M		
2660-23118	F	A														M		
2660-23119	M	A															O	O
2660-23120	U	J															K	
2660-23121	M	J															P	P
2660-23122	M	J															P	E
2660-23123	U	J															K	
2660-23124	U	J															P	
2660-23125	U	J															P	
2660-23126	F	A															D	
2660-23127	U	A															P	
2660-23128	F	J															W	W
2660-23129	M	A																N
2660-23130	U	J																W
2660-23131	U	J																W
2660-23132	U	J																W
2660-23133	M	A														K	P[15]	

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2660-23134	M	A														E	K	P
2660-23135	U	J														P		
2660-23136	U	J														K		
2660-23137	U	J														K		
2660-23138	F	J														K	K	
2660-23139	U	J														P		
2660-23140	U	J														P		
2660-23141	U	J														P		
2660-23142	U	J														P		
2660-23143	U	J														W		
2660-23144	U	J														E		
2660-23145	F	J														W	W	W
2660-23146	U	J																P
2660-23147	U	J																P
2660-23148	U	J																P
2660-23149	U	J																Q
2660-23150	U	J															P	E[9]
2660-23151	U	J															P	
2660-23152	U	J															P	
2660-23153	U	J															P	
2660-23154	U	J															E	
2660-23155	U	J																Q
2660-23156	U	J																W

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2660-23157	U	J																P
2660-23159	U	J																P
2660-23160	U	J																P
2660-23161	U	J																P
2660-23162	U	J																P
2660-23163	U	J																N
2660-23164	U	J																W
2660-23170	M	A															O	
2660-23171	U	J															O	
2660-23172	U	J															B	
2660-23173	U	J															O	
2660-23174	M	A														O	O	O
2660-23175	F	A														O		
2660-23176	F	A														O	O	O
2660-23177	M	A														O	O	O
2660-23178	M	A														T		
2660-23179	U	J														O		
2660-23180	U	J														O		
2660-23181	U	J														O		
2660-23182	U	J														O		
2660-23183	U	J														O		
2660-23184	U	J														O		
2660-23185	U	J														O		

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2660-23186	U	J														O		
2660-23187	M	J														O	P	P
2660-23188	U	J														O		
2660-23190	M	A														T		
2660-23191	M	A														B		
2660-23192	M	A														O		
2660-23193	F	A														B	B	
2660-23194	U	J														B		
2660-23195	U	J														B		
2660-23196	U	J															B	
2660-23197	M	A																T
2660-23198	F	A																T
2660-23203	M	A														O		
2660-23204	F	J														O	O	
2660-23205	U	J														O		O
2660-23206	U	J														O		
2660-23207	M	A														O		
2660-23208	M	A														T		B
2660-23209	M	A														T		
2660-23210	M	A														T		
2660-23211	F	A														T	T	
2660-23212	U	J														O		
2660-23213	M	J														O		O

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2660-23214	U	J														B		
2660-23215	U	J														B		
2660-23216	U	J														B		
2660-23217	F	A														B		
2660-23218	M	A														B	B	B
2660-23219	U	J														O		
2660-23220	U	J														O		
2660-23221	U	J														O		
2660-23222	U	J														O		
2660-23223	U	J														O		
2660-23224	F	A														T		
2660-23225	U	J														T		
2660-23226	U	J														T		
2660-23231	M	A														T		
2660-23232	U	J														S		
2660-23233	U	J														S		
2660-23234	U	J														P		
2660-23235	M	J														P	K	K[8]
2660-23236	U	J														N		
2660-23237	U	J														P		
2660-23238	M	J														K	E[13]	P
2660-23239	F	J														K	K[8]	P
2660-23240	U	J														S		

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2660-23241	F	J														S	S	S
2660-23242	U	J														P		
2660-23243	U	J														P		
2660-23246	M	A															B	
2660-23247	U	J															O	
2660-23248	M	A															O	
2660-23249	U	J															O	
2660-23250	U	J															O	
2660-23251	U	J															O	
2660-23252	U	J															B	
2660-23253	U	J															B	
2660-23264	F	J															P	P
2660-23266	U	J															P	
2660-23267	U	J															P	
2660-23268	U	J															P	P
2660-23269	U	J															K	
2660-23272	M	A															O	
2660-23273	M	A															M	Q
2660-23274	M	A															Q	
2660-23278	M	A																B
2660-23279	U	J																O
2660-23280	F	A																O
2660-23281	M	A																O
2660-23290	M	A																O

Table A8-1.—Detection history for willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers, 2013–17*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]															
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2660-23291	U	J																P
2660-23292	F	A																Q
2660-23301	F	A																Q
2660-23302	F	A																D
2660-23316	F	A																O
2660-23317	U	J																O
2660-23344	M	A																O
2660-23345	M	A																T
9999-99999	M	A													K	K	K	

* Table includes individuals banded at sites prior to 2012, including some individuals banded prior to 2003 (Braden and McKernan, unpublished data), and recaptured or resighted by SWCA Environmental Consultants between 2013 and 2017.

[1] B = Bill Williams, D = Muddy River, E = River Ranch, G = Grand Canyon, K = Key Pittman, M = Mormon Mesa, N = Warm Springs, O = Alamo Lake, P = Pahranagat, Q = Mesquite, S = St. George, T = Topock Marsh, V = Las Vegas Wash, W = Meadow Valley Wash, and Z = Palo Verde Ecological Reserve. Study area indicated is the study area where the individual was first detected during the given season. Within-season movements are indicated with individual footnotes.

[2] F = female, M = male, and U = unknown.

[3] A = adult, and J = juvenile.

[4] Within-season movement from Mesquite to Mormon Mesa.

[5] Within-season movement from Mormon Mesa to Mesquite, then from Mesquite back to Mormon Mesa.

[6] Within-season movement from Mormon Mesa to Muddy River.

[7] Within-season movement from the Grand Canyon to Mormon Mesa.

[8] Within-season movement from Key Pittman to Pahranagat.

[9] Within-season movement from River Ranch to Key Pittman.

[10] Within-season movement from River Ranch to Key Pittman, then from Key Pittman back to River Ranch, then from River Ranch to Pahranagat.

[11] Within-season movement from Alamo Lake to Bill Williams.

[12] Within-season movement from Mesquite to Muddy River.

[13] Within-season movement from River Ranch to Pahranagat.

[14] Within-season movement from Pahranagat to Key Pittman.

[15] Within-season movement from Pahranagat to River Ranch.

ATTACHMENT 9

Candidate Model Sets Considered in Program MARK in Nest Survival Analysis

Table A9-1.—Complete model set evaluated during backwards stepwise selection process of nest survival models for southwestern willow flycatchers at all study areas, 2013–17

Model	AICc[1]	ΔAICc	AICc[2] weight	Model likelihood	Number of parameters	Deviance
S{Age+Year+Substrate}	870.1514	0	0.16742	1	10	850.1119
S{Age+Year+Substrate+Sat50}	871.4267	1.2753	0.08849	0.5285	11	849.3792
S{Age+Year+Substrate+Height}	871.821	1.6696	0.07266	0.434	11	849.7735
S{Age+Year+Substrate+Date}	872.0772	1.9258	0.06392	0.3818	11	850.0298
S{Age+Year+Substrate+Tasp5}	872.1183	1.9669	0.06262	0.374	11	850.0709
S{Age+Year+Substrate+SArea+Sat50}	872.4527	2.3013	0.05298	0.3164	19	834.316
S{Age+Year+Substrate+SArea}	872.6116	2.4602	0.04893	0.2923	18	836.4885
S{Age+Substrate}	872.6345	2.4831	0.04837	0.2889	6	860.6195
S{Age+Year+SArea+Sat50}	873.1182	2.9668	0.03798	0.2268	15	843.0319
S{Age+Year+Substrate+Sat50+Height}	873.2742	3.1228	0.03513	0.2098	12	849.2182
S{Age+Year+Substrate+Sat50+Date}	873.3327	3.1813	0.03412	0.2038	12	849.2766
S{Age+Year+Substrate+Sat50+Tasp5}	873.3975	3.2461	0.03303	0.1973	12	849.3415
S{Age+Substrate+Sat50+Tasp5}	873.5299	3.3785	0.03092	0.1847	8	857.5041
S{Age+Year+Substrate+SArea+Sat50+Tasp5}	873.7427	3.5913	0.0278	0.166	20	833.5916
S{Age+Substrate+Sat50}	873.9386	3.7872	0.0252	0.1505	7	859.9185
S{Age+Year+Substrate+SArea+Sat50+Height}	874.1898	4.0384	0.02223	0.1328	20	834.0387
S{Age+Year+Substrate+SArea+Sat50+Date}	874.2692	4.1178	0.02136	0.1276	20	834.118
S{Age+Year+Substrate+SArea+Tasp5}	874.2798	4.1284	0.02125	0.1269	19	836.1431
S{Age+Year+SArea+Sat50+Tasp5}	875.0315	4.8801	0.01459	0.0871	16	842.9337
S{Age+Year+Substrate+Sat50+Height+Tasp5}	875.2292	5.0778	0.01322	0.079	13	849.1638
S{Age+Year+Substrate+SArea+Sat50+Height+Tasp5}	875.3812	5.2298	0.01225	0.0732	21	833.215
S{Age+Year+Substrate+SArea+Height+Tasp5}	875.4161	5.2647	0.01204	0.0719	20	835.2649
S{Age+Year+Substrate+SArea+Date+Sat50+Tasp5}	875.4648	5.3134	0.01175	0.0702	21	833.2985
S{Age+Year+Substrate+SArea+Date+Sat50+Height}	875.9692	5.8178	0.00913	0.0545	21	833.8029

Table A9-1.—Complete model set evaluated during backwards stepwise selection process of nest survival models for southwestern willow flycatchers at all study areas, 2013–17

Model	AICc[1]	ΔAICc	AICc[2] weight	Model likelihood	Number of parameters	Deviance
S{Age+Year+SArea+Sat50+Height+Tasp5}	877.0086	6.8572	0.00543	0.0324	17	842.8985
S{Age+Year+Substrate+SArea+Date+Sat50+Height+Tasp5}	877.0356	6.8842	0.00536	0.032	22	832.8534
S{Age+Year+Substrate+Date+Sat50+Height+Tasp5}	877.1249	6.9735	0.00512	0.0306	14	849.0494
S{Age+Year+Substrate+SArea+Date+Height+Tasp5}	877.1934	7.042	0.00495	0.0296	21	835.0271
S{Age+Substrate+SArea+Sat50}	877.7442	7.5928	0.00376	0.0225	15	847.6579
S{Age+Year+SArea+Date+Sat50+Height+Tasp5}	878.9447	8.7933	0.00206	0.0123	18	842.8217
S{Year+Substrate}	879.1599	9.0085	0.00185	0.011	9	861.1276
S{Age+Substrate+SArea+Sat50+Tasp5}	879.6445	9.4931	0.00145	0.0087	16	847.5467
S{Year+Substrate+Sat50}	880.2942	10.1428	0.00105	0.0063	10	860.2546
S{Age+Substrate+SArea+Sat50+Height+Tasp5}	881.5535	11.4021	0.00056	0.0033	17	847.4435
S{Year+Substrate+Sat50+Tasp5}	882.2708	12.1194	0.00039	0.0023	11	860.2234
S{Age+Substrate+SArea+Date+Sat50+Height+Tasp5}	883.5611	13.4097	0.00021	0.0013	18	847.438
S{Year+Substrate+Sarea+Sat50}	884.108	13.9566	0.00016	0.001	18	847.9849
S{Year+Substrate+Sarea+Sat50+Tasp5}	885.5647	15.4133	0.00008	0.0005	19	847.428
S{Age+Year}	886.284	16.1326	0.00005	0.0003	6	874.2689
S{Age+Year+Sat50+Tasp5}	887.0111	16.8597	0.00004	0.0002	7	872.991
S{Year+SArea+Substrate+Sat50+Height+Tasp5}	887.2047	17.0533	0.00003	0.0002	20	847.0536
S{Year+Substrate+SArea+Date+Sat50+Height+Tasp5}	887.4253	17.2739	0.00003	0.0002	21	845.259
S{Age+Year+Sat50}	887.7462	17.5948	0.00003	0.0002	7	873.7261

[1] AICc = small-sample-size corrected Akaike's information criterion.
[2] Difference in AICc.

Table A9-2.—Complete model set evaluated during the backwards stepwise selection process of nest survival models for southwestern willow flycatchers at Alamo Lake, 2014–17

Model	AICc[1]	ΔAICc[2]	AICc weight	Model likelihood	Number of parameters	Deviance
S{Age+Substrate}	253.8801	0	0.08735	1	3	247.8682
S{Substrate}	253.9949	0.1148	0.08248	0.9442	2	249.9890
S{Age+Substrate+Height}	254.1295	0.2494	0.07711	0.8827	4	246.1096
S{Substrate+Height}	254.3331	0.453	0.06965	0.7973	3	248.3212
S{Date+Substrate+Height}	254.3794	0.4993	0.06805	0.779	4	246.3595
S{Age}	254.9104	1.0303	0.05219	0.5975	2	250.9045
S{Age+Substrate+Sat50}	255.0259	1.1458	0.04926	0.5639	4	247.0061
S{Age+Date+Substrate}	255.2594	1.3793	0.04383	0.5018	4	247.2395
S{Age+Date+Substrate+Height}	255.3110	1.4309	0.04271	0.4889	5	245.2812
S{Age+Substrate+Year}	255.4762	1.5961	0.03933	0.4502	6	243.4344
S{Age+Height}	255.5642	1.6841	0.03763	0.4308	3	249.5523
S{Age+Substrate+Tasp5}	255.5982	1.7181	0.03700	0.4236	4	247.5783
S{Age+Year+Substrate+Height}	256.0075	2.1274	0.03015	0.3452	7	241.9518
S{Date+Year+Substrate+Height}	256.131	2.2509	0.02835	0.3245	7	242.0753
S{Age+Substrate+Height+Sat50}	256.131	2.2509	0.02835	0.3245	5	246.1012
S{Age+Substrate+Height+Tasp5}	256.1388	2.2587	0.02824	0.3233	5	246.1090
S{Age+Date+Height}	256.2906	2.4105	0.02617	0.2996	4	248.2708
S{Age+Date+Year+Substrate}	256.7772	2.8971	0.02052	0.2349	7	242.7215
S{Age+Date+Year+Substrate+Height}	257.1477	3.2676	0.01705	0.1952	8	241.0761
S{Age+Date+Substrate+Height+Tasp5}	257.2295	3.3494	0.01637	0.1874	6	245.1878
S{Age+Date+Substrate+Height+Sat50}	257.2503	3.3702	0.0162	0.1855	6	245.2085
S{Age+Date+Year+Height+Tasp5}	257.4216	3.5415	0.01487	0.1702	8	241.3499
S{Age+Date+Year+Height}	257.4615	3.5814	0.01457	0.1668	7	243.4058
S{Date+Year+Substrate+Height+Tasp5}	257.9558	4.0757	0.01138	0.1303	8	241.8842

[1] AICc = small-sample-size corrected Akaike's information criterion.
[2] Difference in AICc.

Table A9-3.—Complete model set evaluated during the backwards stepwise selection process of nest survival models for southwestern willow flycatchers at all study areas except Alamo Lake, 2013–17

Model	AICc[1]	ΔAICc[2]	AICc weight	Model likelihood	Number of parameters	Deviance
S{Age+Date+Year+Area+Tasp5+Sat50}	614.8674	0	0.15182	1	16	582.7138
S{Age+Date+Year+Substrate+Area+Sat50}	614.9895	0.1221	0.14283	0.9408	19	576.7748
S{Age+Date+Year+Area+Sat50}	615.3735	0.5061	0.11788	0.7765	15	585.2380
S{Age+Year+Area+Tasp5+Sat50}	615.9093	1.0419	0.09017	0.5939	15	585.7739
S{Age+Date+Year+Substrate+Area+Tasp5+Sat50}	616.3548	1.4874	0.07217	0.4754	20	576.1174
S{Age+Date+Year+Substrate+Area+Height+Sat50}	616.3694	1.5020	0.07164	0.4719	20	576.1321
S{Age+Date+Year+Substrate+Area+Tasp5}	616.4891	1.6217	0.06748	0.4445	19	578.2744
S{Age+Date+Year+Area+Tasp5}	616.5180	1.6506	0.06651	0.4381	15	586.3826
S{Age+Date+Year+Area+Height+Tasp5+Sat50}	616.8064	1.9390	0.05758	0.3793	17	582.6336
S{Age+Date+Year+Substrate+SArea+Height+Tasp5+Sat50}	617.5985	2.7311	0.03875	0.2552	21	575.3373
S{Age+Date+Year+Substrate+SArea+Height+Tasp5}	617.6173	2.7499	0.03839	0.2529	20	577.3799
S{Age+Year+Substrate+SArea+Tasp5+Sat50}	617.6690	2.8016	0.03741	0.2464	19	579.4543
S{Age+Year+Substrate+SArea+Height+Tasp5+Sat50}	619.3115	4.4441	0.01646	0.1084	20	579.0741
S{Age+Date+Date2+Year+Substrate+SArea+Height +Tasp5+Sat50}	619.4580	4.5906	0.01529	0.1007	22	575.1719
S{Age+Date+Year+Substrate+Tasp5+Sat50}	621.1694	6.3020	0.00650	0.0428	13	595.0668
S{Age+Age2+Date+Date2+Year+Substrate+SArea+Height+Tasp5+Sat50}	621.4737	6.6063	0.00558	0.0368	23	575.1615
S{Age+Date+Year+Substrate+Height+Tasp5+Sat50}	622.9173	8.0499	0.00271	0.0179	14	594.7988
S{Date+Year+SArea+Tasp5+Sat50}	626.8680	12.0006	0.00038	0.0025	15	596.7326
S{Age+Date+Year+Tasp5+Sat50}	627.9507	13.0833	0.00022	0.0014	9	609.9000
S{Date+Year+Substrate+SArea+Tasp5+Sat50}	629.5776	14.7102	0.00010	0.0007	19	591.3629
S{Age+Date+SArea+Tasp5+Sat50}	630.9800	16.1126	0.00005	0.0003	12	606.8920
S{Date+Year+Substrate+SArea+Height+Tasp5+Sat50}	631.3202	16.4528	0.00004	0.0003	20	591.0828
S{Age+Date+Substrate+SArea+Tasp5+Sat50}	631.5025	16.6351	0.00004	0.0003	16	599.3489
S{Age+Date+Substrate+SArea+Height+Tasp5+Sat50}	633.5203	18.6529	0.00001	0.0001	17	599.3475

[1] AICc = small-sample-size corrected Akaike's information criterion.
[2] Difference in AICc.

ATTACHMENT 10

Contributing Personnel

Table A10-1.–Contributing personnel from SWCA Environmental Consultants and their role(s) in 2013–17

Contributor	Year(s)	Role
Mary Anne McLeod, M.S.	2013–17	Project Manager/Scientific Investigator/Field Supervisor
Anne Pellegrini, M.S.	2013–17	Project Coordinator/Scientific Investigator/Field Supervisor
Glenn A. Dunno, M.A.	2013–17	Geographic Information System Specialist
Lionel Leston, Ph.D	2014–15	Statistician
Kimberly Proa	2013–16	Project Administrator/Data Entry
Jessica Maggio	2013	Administrative Assistant/Formatting Specialist
Jacque Muehlbauer	2017	Project Administrator
Dorothy A. House, M.A.	2013–17	Technical Editor
Thomas J. Koronkiewicz, M.S.	2013–17	Banding Lead
Sarah Nichols	2014, 2015, 2017	Field Coordinator/Bander/Surveyor/Technical Writer
George Cummins, M.S.	2017	Bander/Nest Monitor/Data Analysis/Technical Writer
Solon Morse, Ph.D.	2013	Field Coordinator/Bander
Abram Tompkins	2013	Field Coordinator/Bander
Callie Gesmundo	2014	Field Coordinator/Bander
Laura Duval	2015–17	Field Coordinator/Bander
Jerry Kreiser	2015–17	Field Coordinator/Nest Monitor
Cheyenne Szydlo, M.S.	2015, 2017	Field Coordinator/Nest Monitor
Rheanna Frasier	2013	Bander
Katie Barnes, M.S.	2014	Bander
Marissa Buschow, M.S.	2014	Bander
Darin Blood	2015–16	Bander
Chance Hines	2015–17	Bander
Jill Peiffer	2015	Bander
Thomas Thalhuber	2016	Bander
Rachelle McLaughlin	2017	Bander
Matt Boone	2013	Nest Monitor
Wanda Bruhns	2013–14	Nest Monitor
Grant Merrill	2013	Nest Monitor
Gabrielle Robinson, M.S.	2013	Nest Monitor
John Rohrback	2013	Nest Monitor
Jesse Vooz	2013	Nest Monitor
Sam Flake	2014	Nest Monitor

Table A10-1.–Contributing personnel from SWCA Environmental Consultants and their role(s) in 2013–17

Contributor	Year(s)	Role
Jazelle Mondeau	2014	Nest Monitor
Nate Turner	2014	Nest Monitor
Heath Weaver, M.S.	2014	Nest Monitor
Guillermo Alba	2015–17	Nest Monitor
Richard “Blake” Hepner	2015	Nest Monitor
John Zeiger	2015	Nest Monitor
Tasso Cocoves	2016	Nest Monitor
Tyler Walcheff	2016	Nest Monitor
Quick Yeates-Burghart, M.S.	2016–17	Nest Monitor
Kristin Kovach, M.S.	2017	Nest Monitor
Corina Anderson	2015	Surveyor
Jacob Cowan, M.S.	2015	Surveyor
Tim Hauck	2015	Surveyor