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

2015 Annual Report

Work conducted under LCR MSCP
Work Task D2

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

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Lower Colorado River Multi-Species Conservation Program

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

2015 Annual Report

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Multi-Species Conservation Program
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ACRONYMS AND ABBREVIATIONS

AIC	Akaike's information criterion
AIC_c	Akaike's information criterion for small sample sizes
ALAM	Alamo Lake study area
AR1	first-order autoregressive
ARMA (1,1)	first-order autoregressive moving average
ARMA (2,0)	second-order autoregressive
BA	biological assessment
BIWI	Bill Williams study area
BO	biological opinion
CD	compact disc
CIBO	Cibola study area
cfs	cubic feet per second
cm	centimeter(s)
CS	compound-symmetric
CVCA	Cibola Valley Conservation Area
EHRE	Ehrenberg study area
FR	Federal Register
GLMM	generalized linear mixed model
GPS	Global Positioning System
GRCA	Grand Canyon study area
h	hour
HCP	habitat conservation plan
IMPE	Imperial study area
KEPI	Key Pittman study area
km	kilometer(s)
LB	lower bound
LCR	lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
LIFI	Littlefield study area
LMM	linear mixed model

m	meter(s)
MESQ	Mesquite study area
MITT	Mittry Lake study area
mm	millimeter(s)
MOME	Mormon Mesa study area
MSP	Mayfield survival probability
MUDD	Muddy River study area
MVWA	Meadow Valley Wash study area
NAD	North American Datum
NDOW	Nevada Department of Wildlife
Pa	Pascal(s)
PAHR	Pahranagat study area
PVER	Palo Verde Ecological Reserve
Reclamation	Bureau of Reclamation
RH	relative humidity
RIRA	River Ranch study area
SE	standard error
sp.	species
SWCA	SWCA Environmental Consultants
T	temperature
TES	threatened, endangered, and sensitive
TOGO	Topock Gorge study area
TOPO	Topock Marsh study area
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VP	vapor pressure
WMA	Wildlife Management Area
WMSP	Warm Springs study area
YUMA	Yuma study area

Symbols

≈	approximately
x	by
Δ	change in
°	degree(s)
°C	degrees Celsius
=	equal to
>	greater than
≥	greater than or equal to
~	is modeled as a function of
<	less than
≤	less than or equal to
#	number
%	percent
–	to
^	to the power of

CONTENTS

Page

Executive Summary ES-1

Chapter 1 – Introduction 1
Species Introduction 1
Bureau of Reclamation Project History 3
Related Studies 5
Purpose and Description of Studies 5

Chapter 2 – Presence/Absence Surveys and Site Descriptions 9
Introduction 9
Methods 10
Site Selection 10
Additional Site Evaluation 12
Broadcast Surveys 12
Covered Species 13
Incidental, Passive Detections 13
Yellow-billed Cuckoo Broadcast Surveys 14
Site Descriptions 14
Results 14
Flycatcher Broadcast Surveys 14
Key Pittman, Nevada 15
River Ranch, Nevada 26
Pahranagat, Nevada 28
Meadow Valley Wash, Nevada 32
Muddy River, Nevada 35
Warm Springs, Nevada 37
Topock Marsh, Arizona 39
Topock Gorge, Arizona 47
Bill Williams, Arizona 48
Alamo Lake, Arizona 57
Palo Verde Ecological Reserve, California 66
Ehrenberg, Arizona 73
Cibola, Arizona and California 74
Imperial, Arizona and California 79
Mittry Lake, California 82
Yuma, Arizona 83
Yellow-billed Cuckoo Broadcast Surveys 87
River Ranch, Nevada 87
Pahranagat, Nevada 88
Warm Springs, Nevada 88
Discussion 88

Page

Chapter 3 – Color Banding and Resighting 97
Introduction.....97
Methods.....97
Color Banding.....97
Resighting 98
Data Analyses 99
Movement 99
Results.....100
All Study Areas.....100
Individual Study Areas 100
Key Pittman, Nevada 100
River Ranch, Nevada 117
Pahranagat, Nevada.....117
Meadow Valley Wash, Nevada.....117
Muddy River, Nevada.....118
Warm Springs, Nevada 118
Topock Marsh, Arizona 118
Bill Williams, Arizona.....118
Alamo Lake, Arizona.....119
Palo Verde Ecological Reserve, California 119
Non-Monitoring Sites 119
St. George, Utah.....120
Mesquite, Nevada 121
Mormon Mesa, Nevada.....121
Adult Between-Year Return and Dispersal.....121
Juvenile Between-Year Return and Dispersal 122
Within-Year, Between-Study-Area Movement 122
Discussion.....122
Color-Banding Effort.....122
Adult and Juvenile Between-Year Dispersal 124
Within-Year, Between-Study-Area Movement 127
Adult and Juvenile Survivorship.....127

Chapter 4 – Nest Monitoring 129
Introduction.....129
Methods.....129
Results.....131
Nest Monitoring.....131
Nest Failure.....134
Brood Parasitism.....135
Cowbird Egg Addling.....136
Mayfield Nest Success and Nest Productivity.....136
Discussion.....136
Number of Breeding Flycatchers.....136
Nest Success.....139

Page

Nest Failure 142
Brood Parasitism 143
Cowbird Egg Addling 144

Chapter 5 – Nest Site Characteristics 147
Introduction 147
Methods 147
Surface Hydrology 147
Vegetation 148
Temperature and Humidity 149
Statistical Analyses 149
Results 150
Surface Hydrology 150
Vegetation 154
Temperature and Humidity 154
Discussion 157
Surface Hydrology 157
Vegetation 171
Temperature and Humidity 172

Chapter 6 – Habitat and Threats Monitoring 175
Introduction 175
Methods 175
Beetle Monitoring and Vegetation Measurements 176
Calibration 177
Temperature and Humidity Measurements 178
Comparison of HOBOs to iButtons 178
Light Intensity Measurements 178
Statistical Analyses 179
Comparison of HOBOs and iButtons 180
Results 183
Beetle Monitoring and Vegetation Measurements 183
Calibration 183
Beetle Monitoring and Vegetation Measurements 191
Temperature and Humidity Measurements 194
Comparison of HOBOs and iButtons 199
Light Intensity Measurements 204
Discussion 206
Beetle Monitoring and Vegetation Measurement 206
Calibration 206
Vegetation Measurements 207
Temperature and Humidity 208
Comparison of HOBOs to iButtons 208
Light Intensity 210

Page

Relationships Among Vegetation, Microclimate, and Light 211
Recommendations.....211

Chapter 7 – Management and Study Design Recommendations 213
Broadcast Surveys and Site Assessment.....213
Habitat Improvement 214
Nest Predators 215
Cowbird Control 215
Habitat Threats and Monitoring.....216

Literature Cited 219

Acknowledgments.....229

Tables

Table Page

2-1 Adult willow flycatchers detected during survey and monitoring activities, 2015 16
2-2 Passive detections of yellow-billed cuckoos, 2015....20
2-3 Passive detections of Yuma clapper rails, 2015....21
2-4 Summary of hydrologic conditions by survey site, 2015 22
3-1 Summary of southwestern willow flycatchers and willow flycatchers detected during the 2015 breeding season....101
3-2 Summary of resident adult southwestern willow flycatchers detected during the 2015 breeding season 104
3-3 Details of willow flycatchers detected at study areas where resident flycatchers were observed during the 2015 breeding season....107
3-4 Banded southwestern willow flycatchers detected at non-monitoring sites, 2015 120
3-5 Resident adult southwestern willow flycatcher annual return from 2014 to 2015....121
3-6 Adult southwestern willow flycatcher between-year movements for all individuals identified in a previous year and recaptured or resighted at a different study area in 2015....122
3-7 Juvenile southwestern willow flycatchers banded as hatch year birds in a prior year and identified as adults for the first time in 2015....123
3-8 Adult southwestern willow flycatcher within-year movements for all individuals identified at two different study areas in 2015....123
4-1 Summary of southwestern willow flycatcher nest monitoring results at all study areas, 2015 132
4-2 Southwestern willow flycatcher percent apparent nest success recorded at all study areas, 1996–2015....133
4-3 Summary of causes of southwestern willow flycatcher nest failure at all study areas, 2015 134
4-4 Fates of southwestern willow flycatcher nests parasitized by cowbirds at all study areas, 2015 135
4-5 Daily survival rates and Mayfield survival probability (MSP) for southwestern willow flycatcher nest stages at all study areas, 2015....137
4-6 Southwestern willow flycatcher nest productivity (young fledged per nest) and fecundity (young fledged per female) at all study areas, 2015....138

Tables (continued)

Table Page

5-1 Tally of nests by nest substrate and percentage of tamarisk at southwestern willow flycatcher nests by vegetation type in all study areas, 2015.....156

6-1 Maximum observer variation by vegetation variable and type during the initial and final calibration exercises at Muddy River, Topock Marsh, and Bill Williams, 2015 185

6-2 Top models ($\Delta AIC_c < 10$) used to predict the difference in maximum daily temperature, minimum nightly temperature, diurnal vapor pressure, and nocturnal vapor pressure between HOBO and iButton data loggers over 2 years at 33 beetle monitoring points at Topock Marsh and Bill Williams, 2014 and 2015.....200

Figures

Figure Page

1-1 Breeding range distribution of the subspecies of the willow flycatcher (*Empidonax traillii*). 1

2-1 Locations of southwestern willow flycatcher study areas along the LCR and its tributaries, 2015. 11

2-2 Number of resident southwestern willow flycatchers at Topock Marsh, 2003–15. 93

2-3 Marsh elevation (feet above sea level) measured at the South Dike at Topock Marsh, 1997–2015. 93

2-4 Monthly average streamflow (cfs) recorded at the Bill Williams River near Parker, Arizona (USGS Station #09426620), 2002–15. 94

4-1 Number of pairs of southwestern willow flycatchers detected at Key Pittman (KEPI), Pahranagat (PAHR), Muddy River (MUDD), Topock Marsh (TOPO), and Bill Williams (BIWI) during years of intensive nest monitoring.....138

4-2 Annual apparent nest success and fecundity (number of young produced per adult female) at Key Pittman (KEPI) and Pahranagat (PAHR), 2003–15. 140

4-3 Annual percent apparent nest success at Muddy River (MUDD), Topock Marsh (TOPO), Bill Williams (BIWI), and Alamo Lake (ALAM), 2003–15. 141

Figures (continued)

Figure Page

4-4 Annual fecundity at Muddy River (MUDD), Topock Marsh (TOPO), Bill Williams (BIWI), and Alamo Lake (ALAM), 2003–15.....141

5-1 Soil moisture characteristics at southwestern willow flycatcher nests in Key Pittman and Pahranagat, 2015.....151

5-2 Soil moisture characteristics at southwestern willow flycatcher nests in River Ranch and Meadow Valley Wash, 2015.....152

5-3 Soil moisture characteristics at southwestern willow flycatcher nests in Muddy River, 2015.....153

5-4 Soil moisture characteristics at southwestern willow flycatcher nests in Topock Marsh and Bill Williams, 2015.....155

5-5 Median maximum daily temperature at southwestern willow flycatcher nests by study area and vegetation type, 2015.....158

5-6 Mean maximum daily temperature and 95% confidence intervals over 2-week periods at southwestern willow flycatcher nests by study area, 2015.....159

5-7 Median minimum daily temperature at southwestern willow flycatcher nests by study area and vegetation type, 2015.....160

5-8 Median daily temperature range at southwestern willow flycatcher nests by study area and vegetation type, 2015.....161

5-9 Median diurnal vapor pressure at southwestern willow flycatcher nests by study area and vegetation type, 2015.....162

5-10 Mean diurnal vapor pressure and 95% confidence intervals over 2-week periods at southwestern willow flycatcher nests by study area, 2015.....163

5-11 Median nocturnal vapor pressure at southwestern willow flycatcher nests by study area and vegetation type, 2015.....164

5-12 Median maximum daily temperature at southwestern willow flycatcher nests and beetle monitoring points by study area, 2015.....165

5-13 Median minimum daily temperature at southwestern willow flycatcher nests and beetle monitoring points by study area, 2015.....166

5-14 Median daily temperature range at southwestern willow flycatcher nests and beetle monitoring points by study area, 2015.....167

5-15 Median diurnal vapor pressure at southwestern willow flycatcher nests and beetle monitoring points by study area, 2015.....168

Figures (continued)

Figure Page

5-16 Median nocturnal vapor pressure at southwestern willow flycatcher nests and beetle monitoring points by study area, 2015.....169

5-17 Alamo Lake level (feet above mean sea level), 1990–2015. 170

5-18 Mean maximum daily temperatures and 95% confidence intervals at flycatcher nests by study area, 2014 and 2015.....173

5-19 Mean diurnal vapor pressures and 95% confidence intervals at flycatcher nests by study area, 2014 and 2015. 173

6-1 Calibration data by observer and vegetation type for percent foliage that was green during the initial and final calibration exercises at monitoring points, 2015. 186

6-2 Calibration data by observer and vegetation type for percent leafless stems during the initial and final calibration exercises at monitoring points, 2015. 187

6-3 Calibration data by observer and vegetation type for percent canopy closure during the initial and final calibration exercises at monitoring points, 2015. 188

6-4 Calibration data by observer and vegetation type for percent of vegetation that was tamarisk within 2 m of the monitoring point during the initial and final calibration exercises, 2015. 189

6-5 Calibration data by observer and vegetation type for percent of vegetation that was tamarisk within 5 m of the monitoring point during the initial and final calibration exercises, 2015. 190

6-6 Median percentage of beetle points at which beetle larvae were detected and percentage of foliage color at beetle monitoring points, 2015. 191

6-7 Median percentage of leafless stems by vegetation type at beetle monitoring points, 2015. 193

6-8 Median percent canopy closure by vegetation type at beetle monitoring points, 2015. 193

6-9 Median maximum and minimum daily temperature and daily temperature range (°C) recorded by original iButtons at beetle monitoring points, 2015. 195

6-10 Median diurnal and nocturnal vapor pressure (Pa) recorded by original iButtons at beetle monitoring points, 2015.....196

Figures (continued)

Figure Page

6-11 Median maximum and minimum daily temperature (°C) at beetle monitoring points within tamarisk (TAMSPP, n = 10) and Goodding's willow overstory with tamarisk understory (SALGOO_TAMSPP, n = 10) at Muddy River (MUDD) as compared to maximum and minimum daily temperature recorded at the Overton weather station, 2015. 197

6-12 Median maximum and minimum daily temperature (°C) at beetle monitoring points within tamarisk (TAMSPP; n = 5) and tamarisk with emergent Goodding's willow (TAMSPP_SALGOO, n = 7) at Topock Marsh (TOPO) and Goodding's willow overstory with tamarisk understory (SALGOO_TAMSPP, n = 15) at Bill Williams (BIWI) as compared to maximum and minimum daily temperature recorded at the Needles weather station, 2015. 198

6-13 Regression and 95% prediction intervals (based on regular model standard errors) for difference in maximum daily temperature (top left), minimum nightly temperature (top right), daily mean vapor pressure (bottom left), and nightly mean vapor pressure (bottom right) recorded by HOBO and iButton data loggers plotted against values recorded by HOBO loggers at beetle monitoring points, Topock Marsh and Bill Williams, May 15 – July 31, 2014, (black) and May 15 – August 7, 2015 (red).....201

6-14 Difference in maximum daily temperature (top left), minimum nightly temperature (top right), daily mean vapor pressure (bottom left), and nightly mean vapor pressure (bottom right) recorded by HOBO data loggers at original and comparison microsites plotted against values recorded by HOBO loggers at original microsites at beetle monitoring points at Muddy River, Topock Marsh, and Bill Williams, May 15 – August 7, 2015.....202

6-15 Difference in maximum daily temperature (top left), minimum nightly temperature (top right), daily mean vapor pressure (bottom left), and nightly mean vapor pressure (bottom right) recorded by iButton data loggers at original and comparison microsites plotted against values recorded by iButton loggers at original microsites at beetle monitoring points at Muddy River, Topock Marsh, and Bill Williams, May 15 – August 7, 2015.....203

6-16 Median daily illuminance (lux) between 0900 and 1500 hours at control points at Muddy River (MUDD), Topock Marsh (TOPO), and Bill Williams (BIWI), 2015. 205

6-17 Median percent daily illuminance between 0900 and 1500 hours at all monitoring points, 2015. 205

Attachments

Attachment

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

2 Field Data Forms

3 Orthophotos Showing Study Sites

4 Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Dates for Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2015

5 Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Results for Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2015

6 Detections of Special Concern Species Within Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2015

7 Orthophotos Showing Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) Survey Sites

8 All Willow Flycatchers (*Empidonax traillii*) Color Banded and/or Resighted, 2010–2015

9 Temperature and Humidity at Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Nests at Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2015

10 Temperature and Humidity at Beetle Points at Muddy River, Topock Marsh, and Bill Williams, 2015

11 Model Results for HOBO-iButton Comparison

12 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. 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).

Flycatcher studies 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. SWCA Environmental Consultants (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 2015. Studies in 2015 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 2015, and effort that would have been spent on the Virgin River was redirected to Alamo Lake and Meadow Valley Wash and to supplement effort in the Pahranagat Valley.

SWCA was also retained by the Nevada Department of Wildlife in 2015 to conduct flycatcher surveys, site descriptions, nest monitoring, and color banding in the Pahranagat Valley at the Key Pittman (KEPI) study area in the Key Pittman Wildlife Management Area, at the River Ranch (RIRA) study area, and at the Pahranagat (PAHR) study area in the Pahranagat National Wildlife Refuge, and by the Southern Nevada Water Authority to conduct similar work at the Warm

[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*.

Springs (WMSP) study area in the Warm Springs Natural Area. Broadcast surveys were also completed for yellow-billed cuckoos (*Coccyzus americanus occidentalis*) at RIRA, PAHR, and WMSP.

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. SWCA searched for nests in all areas occupied in 2015 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.

Recorded broadcasts of flycatcher song and calls were used to elicit willow flycatcher responses at 97 of 116 sites, ranging in size from < 1 to 41 hectares, along the LCR and its tributaries from Caliente, Nevada, south to Yuma, Arizona, between May 15 and July 17, 2015. Willow flycatchers were detected on at least one occasion at 56 of the 97 sites. In addition to the 97 surveyed sites, 19 sites were occupied by flycatchers throughout the breeding season and were monitored via territory and nest visits. Breeding or resident flycatchers were detected at 41 sites within the following study areas: KEPI, PAHR, Meadow Valley Wash (MVWA), Muddy River (MUDD), and WMSP, Nevada; Topock Marsh (TOPO), Bill Williams (BIWI), and Alamo Lake (ALAM), Arizona; and Palo Verde Ecological Reserve (PVER), California. The detection at PVER was the first detection of a territorial (i.e., engaging in lengthy, unsolicited song), resident (i.e., one detected for a week or more) flycatcher south of Parker Dam since SWCA began monitoring flycatchers along the LCR in 2003. The flycatcher defended a territory for 2 weeks, from late May until mid-June, at the edge of one of the cottonwood-willow blocks planted as part of the LCR MSCP. Almost 2 weeks after the resident flycatcher left, a second individual (as determined through resighting; see chapter 3) was detected for a day (June 27) in the same area. This second individual also vocalized unsolicited for lengthy periods of time but was not as responsive to playback as the resident individual. An additional 116 flycatcher detections were recorded south of Parker Dam between May 15 and June 11. Subsequent surveys and behavioral observations suggest these willow flycatchers were not resident, breeding individuals but were most likely spring migrants.

Broadcast surveys were completed for yellow-billed cuckoos at RIRA, PAHR, and WMSP. One silent yellow-billed cuckoo was detected in Pahranagat North during a survey on June 28. No yellow-billed cuckoos were detected during surveys at either RIRA or WMSP, but an incidental, passive detection of a cuckoo was recorded at WMSP on June 18.

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. Each individual was banded with a single, numbered U.S. Federal aluminum band on one leg and one pinstriped, aluminum 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. At some sites in Nevada, a digital camera (Canon PowerShot SX50 HS) was also used to take pictures of flycatchers; these photos supplemented any resight data.

A total of 288 adult flycatchers and willow flycatchers were detected in all study areas in 2015. Of the 288 adults, 142 were resident adult flycatchers and 146 were willow flycatchers that were not determined to be residents. By the end of the breeding season, 34% of the 288 adult flycatchers and willow flycatchers and 65% of the resident flycatchers detected in the project area were known to be color banded. Across all study areas, 30 adult willow flycatchers were newly color banded and 5 were recaptured.[2] An additional 58 adults were identified to individual via resighting, and 6 adults were resighted but did not have their color combinations confirmed. Of the adults identified in 2015, 17 were identified for the first time since they were banded as nestlings. One hundred four adult willow flycatchers remained unbanded, and banding status was undetermined (i.e., it could not be determined if these individuals were banded) for 85 adults. Seventy-five nestlings from 34 nests were banded, and 32 unbanded fledglings were resighted from an additional 17 nests plus 1 unbanded fledging from a nest where its nest mates were banded; 1 of the unbanded fledglings was captured and banded.

In 2014, 100 adult, resident flycatchers were individually identified at study areas that were monitored by SWCA in both 2014 and 2015. Of these 100 flycatchers, 49% were detected in 2015, with 5 of the 49 returning flycatchers (10%) being detected at a different study area than where they were resident in 2014. One within-year, between-study-area movement was detected in 2015.

In 2014, 65 nestlings and 3 fledglings were banded at all study areas monitored by SWCA. Seven of the nestlings were known or suspected to have died before fledging. Of the 61 remaining juveniles, 13 (22%) were identified in 2015. Four individuals originally banded as nestlings in 2013 were also identified for the first time in 2015. Of the 17 returning nestlings identified in 2015, 8 (47%) dispersed away from their natal study area. The median dispersal distance for all returning juvenile flycatchers in 2015 was 3.8 kilometers (km).

Eighty-five territories were recorded at all monitored study areas. Of these, 67 (79%) consisted of breeding flycatchers, 2 (2%) consisted of pairs for which no nest could be found, and 16 (19%) consisted of unpaired individuals. Eight breeding males were each polygynous with two females, two males were each

[2] Capture efforts targeted *E. t. extimus*, but migrant individuals of other subspecies may also have been captured.

polygynous with three females, and one female bred consecutively with two different males. One unpaired male moved, displacing a male in a breeding territory, and was subsequently paired for the rest of the season.

At all monitored study areas, 93 flycatcher nesting attempts were documented, 85 of which contained flycatcher eggs and were used in calculating nest success and productivity. Forty-four (52%) nests were successful and fledged young, 37 (43%) failed, and 4 (5%) had an unknown fate. Apparent nest success ranged from 11% at KEPI to 100% at MVWA and WMSP. Depredation was the major cause of nest failure for all study areas combined, accounting for 44% (20 of 45) of all failed nests and 54% of nests that failed after flycatcher eggs were laid.

Nine of 77 nests (12%) with flycatcher eggs and known parasitism status were brood parasitized by cowbirds, and 1 flycatcher nest was abandoned with a cowbird egg. Brood parasitism ranged from 0 to 40% and was highest at TOPO. Cowbird eggs were addled via vigorous shaking at all easily accessible flycatcher nests; of the four nests where the cowbird egg was addled, three were incubated long enough for the cowbird egg to hatch; all three hatched. Prior to 2015, the hatch rate of cowbird eggs that were incubated for a minimum of 10 days and were not shaken was 68% (36 of 53 eggs) across all years and study areas. In contrast, only 12% (2 of 16 eggs) of the cowbird eggs that were shaken hatched after a minimum of 10 days of incubation, and it was apparent that addling cowbird eggs significantly reduced the cowbird hatch rate. As noted in the past, field personnel varied in their ability to disrupt the internal structure of an egg without breaking the shell. Replacing cowbird eggs with dummy eggs would eliminate the possibility of cowbird eggs hatching and would also reduce disturbance at the nest. Replacing cowbird eggs with dummy eggs should be implemented in the future.

Soil moisture conditions were described up to 4 times during the season at 90 flycatcher nests in KEPI, RIRA, PAHR, MVWA, MUDD, WMSP, TOPO, BIWI, and ALAM. Descriptions included conditions of soil moisture at the nest (inundated, saturated, damp, or dry), depth of water (if any) at the nest, distance to water from the nest, and the percent of the area within 20 and 50 meters (m) of the nest that contained inundated or saturated soils (hereafter wet soils). Soil moisture conditions were known at the time the nest site was selected by a flycatcher for 67 of the 90 nests. Of the 67 nests, 28 (42%) were built within 5 m of standing water or saturated soil, 7 nests (10%) were within 30 m of water, and 32 (48%) were built more than 50 m from wet soils. Of the 32 nests built more than 50 m from wet soils, 31 were in study areas with unusually dry conditions (ALAM and BIWI) and 1 was at TOPO, after marsh levels had dropped from the peak in May. Site fidelity or lack of alternate available habitat likely influenced nest site selection in these areas.

Surface hydrology data indicate that soil around nests at PAHR, RIRA, WMSP, TOPO, and BIWI experienced a gradual drying trend through the flycatcher breeding season. Conditions near nests at KEPI, MVWA, MUDD, and ALAM did not change through the season.

Field personnel recorded the species of tree or shrub in which a nest was placed, as well as a visual estimate of the percentage of vegetation volume that consisted of tamarisk (*Tamarix* spp.) within 2 and 5 m of the nest, at 90 flycatcher nests. Twenty-eight percent of the nests were built in tamarisk trees, and 54% of the nests had tamarisk within 5 m of the nest. No tamarisk foliage was present in the vicinity of any nest at KEPI, PAHR, or RIRA. The purpose of quantifying the amount of tamarisk in the vicinity of each nest is to determine the potential impact of defoliation, but defoliation has been observed at only a very small number of active nests for which these data have been recorded. It is therefore difficult to determine a threshold percentage of tamarisk foliage at which adverse effects on nest success might occur during a defoliation event.

A temperature/humidity data logger was deployed at a subset of flycatcher nests that were confirmed to be in the incubation 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 each of 3 flycatcher nests at MUDD, 4 nests at TOPO, 6 nests at BIWI, and 10 nests at ALAM. The maximum daily temperatures at nests at ALAM were approximately 4 degrees Celsius higher than at nests at either BIWI or TOPO, while maximum daily temperatures at MUDD were intermediate between those at ALAM and the other two study areas. Minimum temperatures were less variable among study areas and were typically highest at TOPO, while the daily temperature range followed the same pattern as maximum daily temperature. Both diurnal and nocturnal vapor pressure were markedly lower at MUDD than at the other three study areas, and vapor pressure at ALAM was intermediate between MUDD and the other two study areas.

Tamarisk beetles (*Diorhabda* spp.) defoliate tamarisk plants during the flycatcher's breeding season, likely exposing flycatcher nests to adverse microclimate conditions and increased risk of depredation and parasitism. 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 has expanded downstream annually since then, encompassing the entire stretch of the Virgin River to Lake Mead by the end of the breeding season in 2011. Tamarisk beetles continued spreading downstream along the LCR in 2012 and 2013, and by the fall of the 2013 breeding season were found approximately 11 km downstream from Lake Mohave. No movement was documented in 2014, but by August 2015, beetles were detected approximately 11 km south of Big Bend. In 2015, the MUDD, TOPO, and BIWI study areas were formally monitored for the presence and effect of tamarisk beetles.

All monitoring data at TOPO and BIWI were collected at permanent monitoring points established in 2013 in recently occupied flycatcher habitat. At MUDD, all monitoring data were collected at monitoring points established in 2015 in mostly unsuitable habitat outside of currently occupied habitat. A temperature/humidity data logger and a light logger were deployed at each monitoring point, and each point was visited at intervals throughout the breeding season to record visual estimates of foliar color, the percentage of leafless stems, and the number of beetle eggs, larvae, and adults. At each visit, percent total canopy closure was also recorded. At each study area, a control light logger was also deployed in a sunny location. Extended exposure to sunlight causes the logger housing to become cloudy, so the housing of the control logger was changed monthly.

A calibration protocol was implemented, with the goal of quantifying and reducing observer variation and identifying any individual observer drift through the season. At the beginning of the season, all observers visited three monitoring points in each vegetation type within each study area as a group. Each observer independently recorded the beetle and vegetation data at a given monitoring point. The results for that monitoring point were then discussed before the group proceeded to the next monitoring point. A training point was included at the very beginning of the calibration exercise. At the end of the season, all observers returned to the same monitoring points from the beginning of the season. This time, each observer independently recorded the beetle and vegetation data, but the results were not discussed.

The calibration exercise was successful in quantifying overall observer variation; however, as in 2014, a progressive reduction in observer variation was not seen after the initial training point. Despite the calibration exercise not reducing overall observer variation, the maximum observer variation recorded within each vegetation type can be used as a benchmark for discerning whether or not an observed change in a particular variable during the season is likely attributable to observer variation or reflects a real change in the vegetation. Evidence of observer drift was identified for multiple observers for percentage of green foliage and percentage of leafless stems.

Beetles were not detected in 2015 at TOPO or BIWI, but they were detected for the fifth year in a row at MUDD. Defoliation was patchy and localized, and no clear effects of defoliation on vegetation, microclimate, or light levels could be identified. Conditions of vegetation, microclimate, and light levels at these study areas in 2015 are summarized in the body of this report and are considered baseline at TOPO and BIWI.

In 2003–12, all temperature and relative humidity data were collected using HOBO H8 Pro temperature/humidity data loggers. In 2013, the use of the aging and increasingly unreliable HOBOs was stopped and iButtons were deployed instead. Therefore, SWCA wanted to compare the readings collected by HOBO loggers to those collected by iButtons as a prerequisite to any future analyses that

might include both HOBO and iButton data. A formal comparison of iButtons and HOBOs at beetle monitoring points at TOPO and BIWI in 2014 showed no significant effect of canopy closure on maximum daily temperature readings, but the sample points had a high percentage of and low variation in canopy closure. The HOBO and iButton comparison was used to generate equations predicting iButton readings from HOBO readings, and it was speculated that some of the variation between the readings collected by each logger type could be caused by very local effects of logger location.

To address the questions of the effect of lower canopy closure and the effect of small changes in logger location, side-by-side comparisons of iButtons and HOBOs were again done in 2015. Beetle monitoring points at MUDD were established, and some areas where the vegetation was not as dense as at TOPO and BIWI were intentionally selected. A HOBO H8 Pro logger was hung next to the iButton at each beetle monitoring point to form an "original" pair of loggers. A second HOBO was hung approximately 1 m away from the first HOBO at all monitoring points except for two points at BIWI; this was termed the "comparison" location. At all points at MUDD, 14 points at TOPO, and 7 points at BIWI, a second iButton was also hung within approximately 30 centimeters of the comparison HOBO.

In 2015, models were run of how bias in data logger measurements varied with reference method measurements (i.e., those measurements by the HOBO data logger in each HOBO-iButton data logger pair), using 2 years of data from two study areas (TOPO and BIWI). Models were compared using Akaike's information criterion for small sample size (AIC_c). For models of bias in maximum daily temperature and minimum nightly temperature, AIC_c was lowest for a model without any fixed effects of year in which bias depended only on the reference method measurement. For measured bias in mean daily vapor pressure and mean nightly vapor pressure, models with the lowest AIC_c had additive but not interactive fixed effects of year and measurements from the same sites treated as correlated within seasons and independent between years. The measurement error for these variables was insignificant for virtually the entire range of daily maximum and nightly minimum temperatures, between ≈1,250–2,750 Pascals for mean nightly vapor pressure and between ≈1,760–3,000 Pascals for daily vapor pressure as measured by HOBO data loggers.

In 2015, the effect of microsite on bias in data logger measurements was examined using 1 year of data with two HOBO/iButton pairs per site (the "original" and "comparison" pairs) in three study areas. The difference in measurements ($HOBO_{orig} – HOBO_{comp}$; $iButton_{orig} – iButton_{comp}$) was modeled against the measurements by the data logger at the original location ($HOBO_{orig}$ or $iButton_{orig}$). It was found that 95% prediction intervals for the relationship between measurement error in a pair of data loggers and the data logger at the original location included zero for all points within the range of data logger measurements at the original location. Far more instances of large biases were

observed in vapor pressure than in temperature when HOBO data at original and comparison microsites were compared. Drift in humidity readings is acknowledged by the manufacturer as a potential problem with the humidity sensors, and the sensors likely have less power to detect changes in humidity (e.g., among study areas or pre-beetle versus post-beetle) than they do changes in temperature. The iButton loggers currently have fewer problems with drift in humidity readings since the units are 10 years younger than the HOBOs.

In 2014, SWCA measured the relationship between canopy cover (as measured by a densiometer) and bias in maximum daily temperature, predicting that measurement error would be higher at sites with lower canopy cover and greater maximum daily temperatures as measured by HOBO data loggers. Meaningful effects of canopy cover on bias were not found in 2014; this may have been because of the small number of measurements, low variation in canopy cover among sites, and observer biases in measuring canopy cover with a densiometer. In 2015, this analysis was repeated using mean daily light-level measurements taken by light loggers at each site as an inverse measure of canopy cover. Light loggers were used because their measurements were less prone to observer bias and provided a larger sample size and more statistical power to detect an effect of canopy cover. Light data were limited to cloudless days, as determined by visual inspection of the light graphs from the control logger at each study area. Measurement error in maximum daily temperatures measured by HOBO and iButton data loggers was not meaningfully influenced by light levels, although measurement error increased with maximum daily temperatures measured by HOBO data loggers.

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).

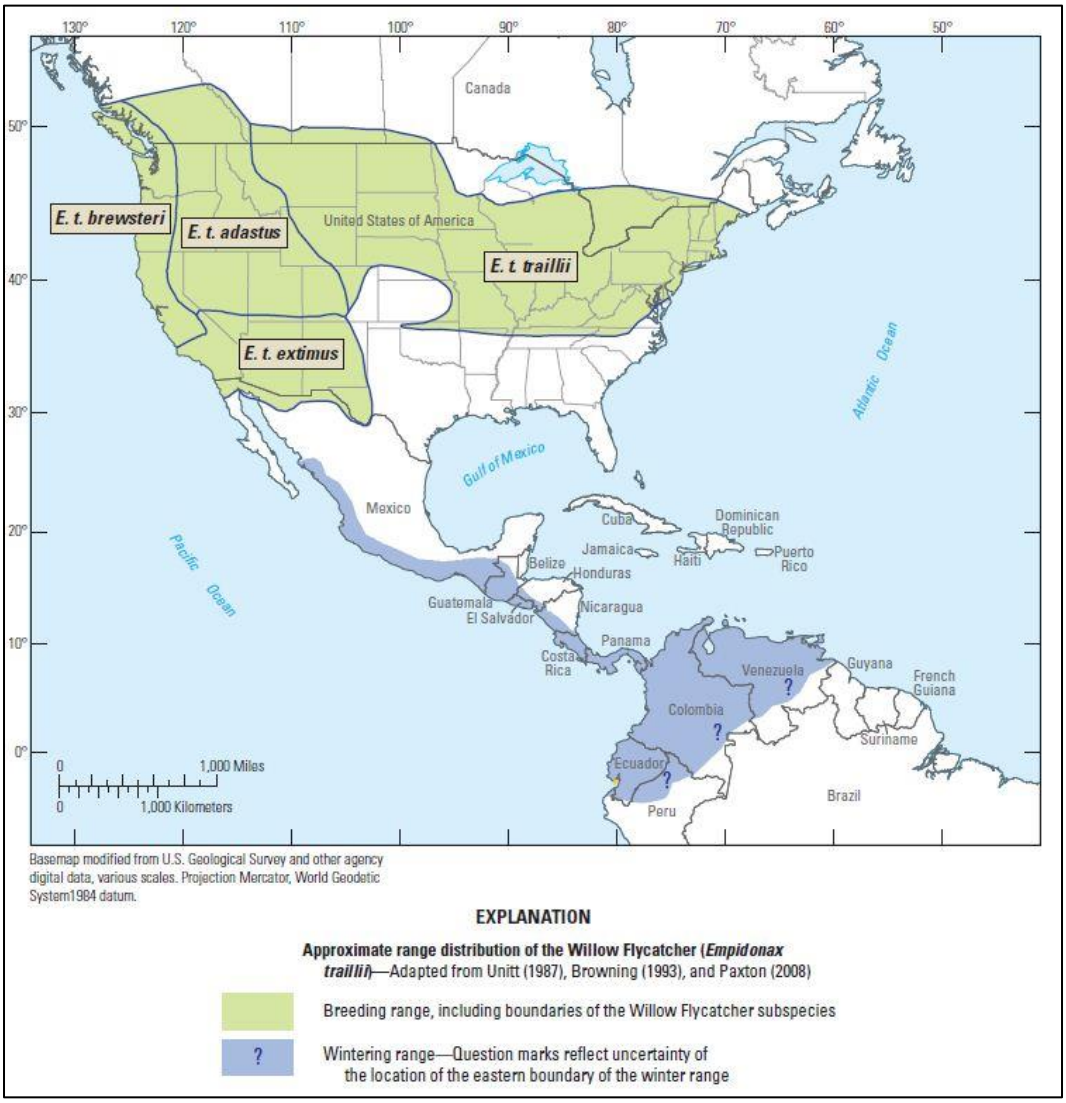

Figure 1-1.—Breeding range distribution of the subspecies of the willow flycatcher (*Empidonax traillii*).
From Sogge et al. (2010).

In the Southwest, most flycatcher[3] 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 willow flycatchers spend the non-breeding season in portions of southern Mexico, Central America, and northwestern South America (Stiles and Skutch 1989; Ridgely and Tudor 1994; Howell and Webb 1995; Unitt 1997), with wintering ground habitat similar to their 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 (Stiles and Skutch 1989; Howell and Webb 1995), 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 extreme southern stretches of the lower Colorado River (LCR) region (Unitt 1987). However, no nests have been located south of the Bill Williams River, Arizona, in over 65 years (Unitt 1987), though northbound and southbound migrant willow flycatchers use the riparian corridor (Phillips et al. 1964; Brown et al. 1987; McKernan and Braden 2002; McLeod et al. 2008; McLeod and Pellegrini 2013, 2014, this document). Factors contributing to the decline of flycatchers on their breeding grounds include loss, degradation, and/or fragmentation of riparian habitat; invasion of riparian habitat by non-native plants; and brood parasitism by brown-headed cowbirds (*Molothrus ater*) (hereafter cowbirds) (U.S. Fish and Wildlife Service [USFWS] 1995, Marshall and Stoleson 2000). Because of low population numbers range-wide, identifying and conserving flycatcher breeding sites is thought to be crucial to the recovery of the species (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 risk of depredation and parasitism. 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 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 (T. Dudley 2012, personal communication). By the fall of 2013, tamarisk beetles were detected approximately 11 kilometers (km)

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

south of Lake Mohave at Big Bend State Park (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). Tamarisk beetles (*D. carinulata* and *D. sublineata*) are also present on the Rio Grande in Texas and New Mexico and are expected to arrive at breeding areas that support large numbers of flycatchers in the next several years.

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, status of breeding pairs, flycatcher nest success, the biotic and abiotic characteristics of occupied flycatcher sites, and cowbird brood parasitism rates. In 2002, Reclamation reinitiated consultation with the USFWS on the effects of continued dam operations and maintenance on 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 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 of existing, occupied flycatcher habitat between Parker and Imperial Dams. Annual monitoring of groundwater levels, vegetation, soil moisture, temperature, and humidity was completed in 2005–2012 (McLeod and Pellegrini 2013).

The LCR MSCP is a 50-year program that seeks to protect 26 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), 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 2003–15 by SWCA Environmental Consultants (SWCA). Prior to 2015, breeding flycatchers were 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 Colorado River, 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, 2014, 2015). 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 PVER 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 around Mittry Lake, 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 2014, willow flycatchers, including two banded migrant flycatchers (Koronkiewicz et al. 2006a; McLeod and Pellegrini 2012), were detected during the breeding season at several sites along the Colorado River south of the Bill Williams River to the Mexico border, but no nesting activity was confirmed.

Following the breeding season of 2008, the USFWS and Reclamation initiated discussions regarding the declining number of flycatcher territories at TOPO in 2004–08. A plan was developed to pump water into a portion of the flycatcher breeding habitat at TOPO and to monitor vegetation, hydrology, and microclimate, as well as flycatcher occupancy, in the target area. This study was completed in 2009–12 (McLeod and Pellegrini 2013). Water delivery did not appear to have any effects on vegetation that would influence flycatcher occupancy. Delivery of water did shift hydrology and microclimate conditions toward those favored by flycatchers, increasing the extent and duration of surface water present in the target area as well as increasing humidity and decreasing the daily temperature range in flooded areas versus non-flooded areas. Water delivery did not, however, result in increased occupancy by flycatchers.

Related Studies

Prior to 2010, the Nevada Department of Wildlife (NDOW) completed nest monitoring at the Key Pittman (KEPI) study area at the Key Pittman Wildlife Management Area, and SWCA banded flycatcher nestlings and adults opportunistically in 2003–09 in cooperation with the 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 (WMSP) study area in the Warm Springs Natural Area near the headwaters of the Muddy River. This work was expanded in 2011 to include River Ranch (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. SWCA completed flycatcher monitoring at all four study areas in 2015, as well as broadcast surveys for yellow-billed cuckoos (*Coccyzus americanus occidentalis*) at RIRA, PAHR, and WMSP.

The Utah Division of Wildlife Resources monitored breeding flycatchers annually in St. George, Utah, from 2008 through 2015, and SWCA banded adults and nestling flycatchers opportunistically in cooperation with these monitoring efforts.

Purpose and Description of Studies

The purpose of the 2015 studies was to continue surveys, monitoring, and demographic and ecological studies of the flycatcher in suitable and/or historical riparian and wetland habitats throughout the LCR and Virgin River regions. The lower Grand Canyon was not monitored in 2009–15 as part of Reclamation's study 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.[4] At Reclamation's direction, SWCA did not visit sites on the Virgin River in 2015 out of safety concerns related to the management of trespass cattle. Effort was redirected to Meadow Valley Wash in Nevada and Alamo Lake in Arizona as well as to supplementing survey and monitoring efforts in the Pahranagat Valley at study areas covered under the NDOW contract. These projects currently encompass three types of studies: (1) presence/absence surveys, including site descriptions, at preselected sites along the LCR and portions of major tributaries, (2) intensive studies at all study areas where breeding flycatchers are located to assess flycatcher demographics and productivity, and (3) monitoring of habitat and microclimate conditions, including the presence and effects of tamarisk beetles, at selected study areas. Specific components of the 2015 study include:

Presence/Absence Surveys. At pre-selected survey sites along the LCR, conduct presence/absence surveys, following a five-survey protocol (per USFWS 2000). A portion of the sites are surveyed every 3 years, and these were surveyed in 2015.

Site Descriptions. Provide a general site description, including major types of vegetation and hydrological conditions, for each survey site at least three times during the survey season.

Banding and Resighting. Band as many adult and juvenile flycatchers as possible at sites with territorial flycatchers and resight banded flycatchers to determine their identity.

Nest Monitoring. Search for nests in all areas occupied by territorial flycatchers and monitor all nests to determine nest fate, brood parasitism, and causes of nest failure.

Nest Microclimate Studies. Collect data on surface hydrology at all nest locations and collect data on microclimate at nests that proceeded to the incubation phase at selected study areas.

Habitat and Threats Monitoring. Monitor vegetation and microclimate to determine the timing and effects of tamarisk beetle defoliation in occupied flycatcher habitat at MUDD, TOPO, and BIWI.

These components are addressed in chapters of this report as follows:

Chapter 2 – Presence/Absence Surveys and Site Descriptions. This chapter presents the methodology and results for presence/absence surveys and gives a general description for each survey site.

[4] Surveys completed in 2010–12 by the Grand Canyon National Park personnel 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).

Chapter 3 – Color Banding and Resighting. This chapter presents the details of banding activities and resightings of previously banded flycatchers as well as discussions of within- and between-year movement of individual flycatchers.

Chapter 4 – Nest Monitoring. This chapter summarizes nesting attempts, nest fates, and productivity for all flycatcher nesting activity.

Chapter 5 – Nest Site Characteristics. This chapter summarizes the conditions of vegetation type, soil moisture, temperature, and humidity recorded at nest sites.

Chapter 6 – Habitat and Threats Monitoring. This chapter summarizes any threats to flycatcher habitat that were noted during the breeding season and reports the results of the monitoring of the presence and effects of tamarisk beetles at MUDD, TOPO, and BIWI.

Chapter 7 – Management and Study Design Recommendations. This chapter summarizes the recommendations from all previous report chapters for ease of reference.

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* 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 as cited in Unitt 1987), 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 the 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), Colorado River (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 habitats (Young 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 2015, as part of SWCA's contract with Reclamation, multiple broadcast surveys were completed at sites in 12 study areas[5] (hereafter Reclamation study

[5] Each study area consists of 1–17 survey sites that are grouped geographically (see table 2-1).

areas) along the LCR and its tributaries to detect both migrant willow flycatchers and resident flycatchers (figure 2-1). Surveys were completed in three additional study areas (hereafter NDOW study areas) as part of the contract with the NDOW and in one additional study area as part of the contract with the Southern Nevada Water Authority. Per Reclamation's direction, no surveys were conducted in any study area along the Virgin River in 2015, 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 at all NDOW study areas.

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) and reconnaissance on foot prior to and during the 2015 survey period. Sites consisting of mature native or exotic woody riparian vegetation ≥ 4.5 meters (m) in height with high canopy closure (≥ 85%), dense vegetation between 2 and 4 m above the ground, and standing water or saturated soil under or adjacent to the vegetation were considered the most suitable habitats for flycatchers (see McLeod and Pellegrini 2013 for a summary of habitat conditions documented in flycatcher territories along the LCR). The branching structure in the understory needs to be dense enough to provide cover, with enough twig structure to provide locations for nest building, while not being so dense as to impede flight. Early successional stands of young riparian vegetation > 3 m in height in proximity to surface water or saturated soil were also considered potentially suitable flycatcher habitat. Riparian vegetation contiguous with suitable habitat was often included as part of the survey areas. Reclamation biologist, Chris Dodge, guided and approved survey site selection at the 12 Reclamation study areas.

In 2013, a three-tiered geographic naming convention was instituted under the LCR MSCP that designates area, site, and section, with area covering the largest extent and section the smallest. The 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 new LCR MSCP area and site classifications to the existing 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 old name is noted in parentheses.

Figure 2-1.—Locations of southwestern willow flycatcher study areas along the LCR and its tributaries, 2015.
(Note: Study area labels represent the approximate center of multiple sites within that region; see table 2-1.)

Many survey sites located south of Parker Dam are currently surveyed every 3 years. The conservation areas, however, are surveyed annually. Survey sites in the TOGO and BIWI study areas that were previously placed on a biennial survey schedule (McLeod and Pellegrini 2013) are also surveyed every 3 years. Sites scheduled for surveys every 3 years were surveyed in 2015. All sites that are surveyed every 3 years are ones at which resident flycatchers (i.e., those detected for a week or more) have not been detected in recent years and at which vegetation and hydrology are unlikely to change without a major flood event.

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 to include potential flycatcher habitat actually present, new boundaries were delineated based on Universal Transverse Mercator (UTM) coordinates obtained in the field. All UTM coordinates were obtained using Trimble® TerraSync™ 5.61 on a Trimble Juno 3B and were in NAD 83 to comply with Federal Geographic Data Committee standards.

Additional Site Evaluation

During the survey season, on-the-ground habitat reconnaissance and evaluation were conducted to locate additional potentially suitable flycatcher habitat and to reevaluate areas visited in previous years and noted as having the potential to become suitable habitat. Field personnel were provided high-resolution, georeferenced aerial imagery overlain with a potential site boundary to aide with navigation and the identification of potentially suitable flycatcher habitat. Personnel focused habitat reconnaissance and evaluation in areas that contained or were adjacent to standing water or saturated soils, and that appeared, from visual estimation, to have vegetation characteristics similar to those of flycatcher breeding sites (i.e., canopy height $\geq$ 4.5 m, dense vegetation within 2–4 m of the ground, and high canopy closure) or that had the potential to develop those characteristics. Broadcast surveys were conducted opportunistically during ground reconnaissance. Field personnel formulated qualitative site descriptions of all evaluated areas.

Broadcast Surveys

To elicit responses from nearby willow flycatchers, conspecific vocalizations previously recorded throughout the Southwest from 1996 to 1998 were broadcast. All flycatcher surveys were conducted according to the methods described in Sogge et al. (2010), and a five-survey protocol was followed, as recommended by the USFWS (2000). The five-survey protocol calls for one survey between May 15 and 31, two surveys between June 1 and 24, and two additional surveys

between June 25 and July 17. The surveys were separated by a minimum of 5 days whenever logistically possible. Field personnel surveyed within the habitat wherever possible using a Sansa® ClipMP3 player coupled to a Radio Shack 277-1008C mini amplified speaker. Surveyors stopped every 30–40 m and broadcast flycatcher primary song (*fitz-bew*) and calls (*breets*). Field personnel watched for 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. All survey data, including survey locations, start and stop times, the number of special concern species detected at each survey point, and the location(s) and behavior of all willow flycatchers detected, were collected in TerraSync 5.61 on a Trimble Juno 3B, allowing a spatial representation of each survey area to be created. Field personnel also recorded the presence of cowbirds and livestock, 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). Survey data were exported from TerraSync to a Microsoft Access database and were summarized on the standard flycatcher survey form (see attachment 2).

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). In study areas where breeding activity was previously documented (KEPI, RIRA, PAHR, MVWA, 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 behavior during the initial detection. If no activity was detected after three visits in the vicinity of the original detection, monitoring visits stopped and surveys resumed. In study areas where no breeding activity had been detected in any year from 2003 to 2014, (PVER, EHRE, CIBO, IMPE, MITT, and YUMA), willow flycatcher detections were followed up with monitoring visits only if territorial behavior was observed.

Covered Species

Incidental, Passive Detections

The Yuma clapper rail (*Rallus longirostris 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 the 12 Reclamation study areas, but all incidental detections were recorded. Field personnel also recorded incidental detections of two additional avian species, gilded flicker (*Colaptes chrysoides*) and vermilion flycatcher (*Pyrocephalus rubinus*), which are both covered species under the LCR MSCP. Specific locations and behavioral data for the Yuma clapper rail and yellow-billed cuckoo were recorded in TerraSync 5.61 on a Trimble Juno 3B. Field personnel also recorded all incidental detections of these four species at the three NDOW study areas and at WMSP.

Yellow-billed Cuckoo Broadcast Surveys

Broadcast presence/absence surveys were completed for yellow-billed cuckoos at PAHR, RIRA, and WMSP. Field personnel completed three broadcast surveys at PAHR and RIRA at 2-week intervals from late June through July and four broadcast surveys at WMSP from late June to early August, following methods described in Halterman et al. (2015).

Site Descriptions

Because vegetation structure and soil moisture conditions within riparian habitats are seasonally dynamic, field personnel completed site description forms (attachment 2) for each survey site at least three times throughout the survey season: early season (mid-May), mid-season (mid-June), and late season (mid-July). 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/introduced, (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/introduced. Information from the site description forms was used in conjunction with habitat photographs and comments in field notebooks and on survey forms to formulate qualitative site descriptions.

RESULTS

Flycatcher Broadcast Surveys

Field personnel spent 475.0 observer-hours conducting flycatcher broadcast surveys at 97 of 116 sites across all study areas. In the Pahranagat Valley, 10.5 observer-hours were spent conducting flycatcher broadcast surveys at 10 of 23 sites at the NDOW study areas. The remaining 13 sites were not surveyed because they were occupied by resident flycatchers. At WMSP, field

personnel surveyed two sites for a total of 2.9 observer-hours. Personnel spent 461.5 observer-hours conducting flycatcher broadcast surveys at 85 of 91 sites[6] at Reclamation study areas. Flycatcher survey and monitoring results are summarized in table 2-1 and are presented below along with site descriptions. Details of occupancy, pairing, color banding, and breeding are presented in chapters 3 and 4. The boundaries of survey sites and occupancy in 2015 are shown on orthophotos in attachment 3, along with historically occupied habitat.[7] Each site that was not occupied by territorial flycatchers was formally surveyed three to five times,[8] except at Alamo Lake, where effort focused on monitoring known territories and no site was surveyed more than once. A list of survey dates is given in attachment 4, and a summary of flycatcher survey effort and survey site occupancy status are presented in attachment 5. Passive, incidental detections of yellow-billed cuckoos and Yuma clapper rails are listed in tables 2-2 and 2-3, respectively. Several incidental detections of yellow-billed cuckoos were recorded during the season at survey sites that are monitored for cuckoos as part of another LCR MSCP project (Parametrix, Inc., and Southern Sierra Research Station, in prep.); numbers or locations of those detections are not reported in this chapter. Overall numbers of passive detections of all covered species are listed in attachment 6. Hydrologic characteristics of each survey site are summarized in table 2-4.

Key Pittman, Nevada

The KEPI study area is located 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 small patches of coyote willows (*Salix exigua*) along the western edge of Nesbitt Lake. The land west of the survey sites is periodically grazed, but the sites have been fenced on the upland side to exclude cattle.

[6] The survey season started with 88 Reclamation sites scheduled for surveys. One site at TOPO, one site at BIWI, and one site at ALAM were added following site evaluation. One site at TOPO, one site at BIWI, and four sites at ALAM were not surveyed because they were occupied by flycatchers the entire season. Surveys at one site at CIBO were discontinued after the first survey because of poor habitat quality.

[7] 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. Historically occupied habitat is depicted as the maximum extent of the survey site in any year(s) it was occupied in 2003–14.

[8] Surveys were discontinued for the season after one survey at three sites at BIWI because of the lack of surface water and at three sites in YUMA because of the need for additional permits.

Table 2-1.—Adult willow flycatchers detected during survey and monitoring activities, 2015*

Study area[1]	Survey site	Area (ha)	Number detected (date[s] of detection)[2,3,4]
KEPI	Nesbitt Forest	0.2	ND
	Patch 00	0.03	3 (May 14 – August 5)[5]
	Patch 01	0.1	2 (June 17 – August 5)[5]
	Patch 02	0.1	2 (May 14 – August 5)
	Patch 03	0.1	ND
	Patch 04	0.1	3 (May 26 – August 1)[6], 1 (July 13)[7]
	Patch 04.5	0.04	1 (May 26), 1 (June 1–5)[8], 1 (June 9–11)
	Patch 05	0.1	1 (June 1–15)[6]
	Patch 06	0.2	2 (May 13 – July 29), 1 (June 22–27)[8]
	Patch 07	0.1	2 (May 13 – July 21), 1 (May 13)
	Patch 08	0.1	ND
	Patch 09	0.3	5 (May 13 – August 3)
	Patch 10	0.1	2 (May 13 – July 28)
	Patch 10.5	0.02	ND
	Patch 11	0.1	2 (May 13 – August 5)
	Patch 12	0.1	2 (May 26 – August 1)
RIRA	East Side	0.4	4 (June 5 – August 10), 1 (June 5)
	West Side	0.3	2 (June 9 – August 3)
	Smalls	0.2	1 (June 29 – July 3)
	River Ranch[9]	–	2 (August 4)
PAHR	Pahranagat North	3.2	14 (May 12 – August 6)
	Pahranagat West	1.3	2 (June 2 – July 28)
	Pahranagat MAPS (MAPS)	0.2	5 (May 15 – July 25)[7], 1 (May 21)
	Pahranagat South	1.4	ND
MVWA	Etna	0.5	ND
	Dog Leg	10.3	5 (May 20 – August 13), 1 (July 24)
	Ford	1.8	ND
	Kyle	0.8	ND
	Cottonwood Canyon	1.3	2 (May 25)
MUDD	Overton WMA Pond	0.7	ND
	Overton WMA	7.8	3 (May 16 – August 4), 3 (May 23), 1 (June 16)
WMSP	Muddy Mac	0.5	ND
	Muddy Stringer 01	0.8	2 (May 23 – August 4)

Table 2-1.—Adult willow flycatchers detected during survey and monitoring activities, 2015*

Study area[1]	Survey site	Area (ha)	Number detected (date[s] of detection)[2,3,4]
TOPO	Pipes 01	5.2	ND
	Pipes 03	5.7	1 (June 3)
	The Wallows	0.7	2 (June 3 – August 7), 1 (June 18), 1 (July 21)[10]
	PC 6-1	4.8	1 (May 19)
	Pig Hole	2.4	ND
	In Between	7.7	ND
	800M	4.7	1 (June 2–30)[10]
	Pierced Egg	6.7	3 (June 10 – July 11), 1 (May 20), 1 (June 2)
	Swine Paradise	1.0	2 (May 13 – July 16), 1 (May 17 – June 9), 1 (May 13 – June 11), 1 (May 17), 1 (July 1)[10]
	Platform	1.9	ND
	250M	1.9	ND
	Hell Bird	5.8	1 (June 11–24), 1 (June 11 – July 1), 1 (June 20)
	Glory Hole	5.0	2 (June 2 – July 15)
	Farm Ditch Road (formerly Spaghetti)	5.4	ND
	CPhase 05 (formerly Beal Lake)	11.4	1 (June 24)
	Lost Lake	3.3	1 (June 11–24)
TOGO	Blankenship North	19.0	ND
	Blankenship South	11.8	ND
BIWI	Bill Willow	1.6	2 (May 16)
	Wispy Willow	1.3	4 (May 16 – August 6)
	Site 01	2.4	2 (May 26 – July 14), 1 (June 5–24)
	Burn Edge	4.1	ND
	Site 04	9.9	ND
	Site 03	12.9	2 (June 4 – July 16)
	Last Gasp[11]	2.1	ND
	Guinness[11]	3.4	ND
	Site 05	6.8	ND
	Black Rail[11]	1.2	ND
	Beaver Pond North (formerly Mineral Wash)	19.0	ND
	Beaver Pond	21.5	ND
	Site 08	12.1	2 (July 1–24)
	Upstream from Site 08	1.5	ND

Table 2-1.—Adult willow flycatchers detected during survey and monitoring activities, 2015*

Study area[1]	Survey site	Area (ha)	Number detected (date[s] of detection)[2,3,4]
ALAM[12]	Sidebar 01	1.7	2 (June 6 – July 27), 1 (July 20)
	Edgewater 01	10.4	2 (June 6 – July 27)
	Camp 01	0.7	ND
	Camp 04	0.3	ND
	Camp 02	0.3	ND
	Camp 03	1.9	ND
	Middle Earth 01	6.1	7 (May 9 – August 3), 1 (June 6–14)
	Middle Earth 02	6.7	15 (May 7 – August 3), 1 (May 13)
	Prospect 01	1.1	ND
	Burro Wash 01	3.9	ND
	Burro Wash 02	6.8	4 (May 11 – August 2), 1 (June 7–13)
	Motherlode 01	3.3	14 (May 10 – July 25), 1 (May 24 – June 13)
	Motherlode 02	21.6	ND
	Motherlode 03	12.6	4 (June 7 – August 10)
	Motherlode 04	0.5	2 (June 14 – July 8)
	Santa Maria South 01	30.2	ND
	Santa Maria North 01	29.5	4 (June 15 – August 13)
PVER	Phase 02	21.4	3 (May 15), 3 (May 30)
	Phase 03	21.4	1 (May 15)
	Phase 04 Block 01	7.7	1 (May 16)
	Phase 04 Block 02	4.0	1 (May 16)
	Phase 04 Block 03	23.7	1 (May 31 – June 14), 4 (May 16), 1 (June 27)
	Phase 05 Block 01	15.9	11 (May 17), 1 (June 6)
	Phase 05 Block 02	23.6	3 (May 17)
	Phase 05 Block 03	29.6	3 (May 22)
	Phase 06 Block 01	38.7	ND
	Phase 06 Block 02	37.6	ND
	Phase 07 Block 01	36.8	11 (May 16), 2 (May 17)
	Phase 07 Block 02	40.6	5 (May 17), 2 (June 1)
EHRE	Ehrenberg	4.7	ND
CIBO	Phase 01	26.2	2 (May 27)
	Phase 02	25.5	2 (May 27)
	Phase 03	38.4	2 (May 27), 2 (June 3)
	Nature Trail	13.7	3 (June 2)
	C2729	6.0	9 (May 23), 3 (June 2)
	Cibola Site 01	7.7	2 (May 28)
	Cibola Lake North[13]	9.0	1 (May 26)
	Walker Lake	4.6	ND

Table 2-1.—Adult willow flycatchers detected during survey and monitoring activities, 2015*

Study area[1]	Survey site	Area (ha)	Number detected (date[s] of detection)[2,3,4]
IMPE	Imperial NW (formerly Nursery NW)	14.2	ND
	Imperial Nursery	1.4	ND
	Ferguson Lake	21.1	6 (May 21)
	Great Blue Heron	7.1	1 (May 30)
	Powerline	1.0	ND
	Martinez Lake	4.6	4 (May 20), 3 (June 11)
MITT	Mittry West	4.4	2 (May 20), 1 (June 11)
YUMA	J (LCR MSCP Section: C4703)[14]	8.4	1 (May 19)
	South AC (LCR MSCP Section: C4711)[14]	0.9	5 (May 19)
	I (LCR MSCP Section: C4102)[14]	6.4	4 (May 19)
	Gila Confluence North	2.2	3 (May 19)
	Gila River Site 02	2.9	2 (May 18)
	Fortuna Site 01	3.2	4 (May 18)
	Fortuna North	3.8	2 (May 18), 1 (June 10)

* This table includes only sites where regular surveys were scheduled or where flycatchers were detected and does not include sites where habitat reconnaissance or opportunistic surveys were conducted and no flycatchers were detected.

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, 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] ND = No willow flycatchers were detected, and NS = no surveys were completed.
[3] See chapter 3 for details on territories, residency, pairing, and color banding; see chapter 4 for details on nesting activity.
[4] Flycatchers in territories that were occupied throughout the breeding season are shown as being present throughout the season. Flycatchers detected on a single occasion or for a short period of time are listed separately.
[5] The male was polygynous with two females; one of these had nesting attempts in both KEPI Patch 00 and KEPI Patch 01.
[6] One individual was detected in KEPI Patch 05 from June 1 to 15 and in KEPI Patch 04 from June 17 to August 1.
[7] One individual was detected in PAHR Pahranagat MAPS from May 17 to July 2 and in KEPI Patch 04 on July 13.
[8] One individual was detected in KEPI Patch 04.5 from June 1 to 5 and in KEPI Patch 06 from June 22 to 27.
[9] Not a regular survey site. Flycatchers detected during a survey for yellow-billed cuckoos.
[10] One individual was detected in TOPO 800M through June 20, in TOPO Swine Paradise on July 1, and in TOPO The Wallows on July 21.
[11] Surveys discontinued for the season because of poor habitat quality.
[12] No site was surveyed more than once at Alamo Lake, and monitoring visits were less frequent than at the other study areas.
[13] Surveys discontinued because of poor habitat quality.
[14] After the first survey, surveys at Yuma East Wetlands were completed by Reclamation personnel. Results of those surveys are not included here.

Table 2-2.—Passive detections of yellow-billed cuckoos, 2015*

Study area[1]	Survey site	Date(s)	Behavioral observations
WMSP	Muddy Stringer 01	June 18	One individual heard (kuk-kowlp)
TOPO	In Between	June 24	One individual heard (kuk)
	Hell Bird	July 15	One individual heard (coo and kuk)
	Lost Lake	June 22	One silent individual seen foraging
ALAM	Burro Wash 01	June 12	One individual heard (kuk-kowlp)
	Burro Wash 02	July 18	One individual heard (coo)
		July 25	Three or more individuals heard (no notes on vocal type)
	Motherlode 01	June 28	One individual heard (no notes on vocal type)
		July 25	One or two individuals heard (no notes on vocal type)
	Santa Maria North 01	August 1	Two individuals seen (coo and kuk)
IMPE	Imperial NW	July 9	One individual heard (kuk)

* 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 cuckoos as part of another LCR MSCP project are not included.

[1] WMSP = Warm Springs, TOPO = Topock Marsh, ALAM = Alamo Lake, and IMPE = Imperial.

Table 2-3.—Passive detections of Yuma clapper rails, 2015*

Study area[1]	Survey site	Date(s)	Behavioral observations
MVWA	Dog Leg	June 4	One individual heard (kek-kek-kek)
MUDD	Overton WMA Pond	May 19	One individual heard (kek-kek-kek)
		June 12	One individual heard (kek-kek-kek)
		June 27	One individual heard (kek-kek-kek)
TOPO	Swine Paradise	June 16	One individual heard (kek-kek-kek)
	Platform	May 21	One individual heard (kek-kek-kek)
		June 4	One individual heard (kek-kek-kek)
		July 11	One individual heard (kek-kek-kek)
	Hell Bird	May 25	One individual heard (kek-kek-kek)
		July 5	Three individuals heard (kek-kek-kek)
	Lost Lake	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)
TOGO	Blankenship North	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)
BIWI	Bill Willow	May 16	One individual heard (kek-kek-kek)
	Beaver Pond	May 18	One individual seen foraging
IMPE	Ferguson Lake	June 12	Two individuals heard (kek-kek-kek); one individual heard (clatter)
YUMA	YEW South AC	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.

Table 2-4.—Summary of hydrologic conditions by survey site, 2015*

Study area[1]	Survey site	% site inundated[2]	Depth (centimeters) of surface water[2]	% site with saturated soil[2,3]	Distance (m) to surface water or saturated soil[2]
KEPI	Patches 00-12[4] and Nesbitt Forest[5]	25/20/20	50/12/30	10/20/30	0/0/0
RIRA	East Side	5/20/0	2/15/0	75/30/10	0/0/0
	West Side	75/20/0	5/15/0	25/30/30	0/0/0
	Smalls	100/50/50	12/8/5	0/50/50	0/0/0
PAHR	Pahranagat North[4]	60/55/30	75/40/15	25/5/30	0/0/0
	Pahranagat West[4]	–/40/10	–/30/6	–/10/10	–/0/0
	Pahranagat MAPS[4] (MAPS)	100/60/30	50/30/30	0/15/30	0/0/0
	Pahranagat South	60/15/25	10/30/30	5/70/25	0/0/0
MVWA	Etna	20/8/20	30/10/8	5/4/2	0/0/0
	Dog Leg	45/25/20	30/25/20	10/35/5	0/0/0
	Ford	40/10/35	50/12/45	0/5/5	0/0/0
	Kyle	5/25/8	75/25/40	3/10/12	0/0/0
	Cottonwood Canyon	10/25/20	30/30/50	0/10/20	0/0/0
MUDD	Overton WMA Pond	40/15/0	20/6/0	10/5/0	0/0/10
	Overton WMA	5/4/4	70/80/50	2/2/2	0/0/0
WMSP	Muddy Mac	25/5/0	15/10/0	10/2/0	0/0/10
	Muddy Stringer 01	15/0/0	10/0/0	5/10/0	0/0/100
TOPO	Pipes 01	0/0/0	0/0/0	0/0/0	40/40/40
	Pipes 03	1/1[6]/0	15/10/0	2/< 5/0	0/0/37
	The Wallows	25/1[6]/0	30/10/0	15/9/0	0/0/80
	PC 6-1	33/1[6]/0	20/2/0	33/20/0	0/0/32
	Pig Hole	< 10/0/0	10/0/0	5/0/0	0/120/120
	In Between[4]	0/0/0	0/0/0	0/0/0	0/20/45
	800M	10/0/0	3/0/0	15/20/0	0/0/79
	Pierced Egg	< 1[6]/0/< 1[6]	60/0/15	0/1/0	0/0/0
	Swine Paradise[4]	10/10/10	20/20/15	5/0/5	0/0/0
	Platform[4]	5/0/1	5/0/1	0/0/1	0/0/0
	250M[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Hell Bird[4]	20/50/28	15/50/40	20/0/27	0/0/0
	Glory Hole[4]	30/30/20	20/50/40	10/10/10	0/0/0
	Farm Ditch Road[5] (formerly Spaghetti)	10/–/–	20/–/–	1/–/–	0/0/0
	CPhase 05[7] (Beal Lake)	0/0/0	0/0/0	0/0/0	15/15/15
	Lost Lake[4]	0/2/0	0/3/0	50/5/0	0/0/0

Table 2-4.—Summary of hydrologic conditions by survey site, 2015*

Study area[1]	Survey site	% site inundated[2]	Depth (centimeters) of surface water[2]	% site with saturated soil[2,3]	Distance (m) to surface water or saturated soil[2]
TOGO	Blankenship North[4] (Blankenship Bend North)	50/30/25	20/20/20	30/20/10	0/0/0
	Blankenship South[4] (Blankenship Bend South)	40/25/–	50/100/–	20/15/–	0/0/0
BIWI	Bill Willow	100/100/70	30/16/5	0/0/30	0/0/0
	Wispy Willow[5]	75/90/5	25/20/12	25/10/5	0/0/0
	Site 01[5]	55/55/30	10/20/15	25/25/40	0/0/0
	Burn Edge	0/< 1/1	0/5/30	0/0/0	436/0/0
	Site 04[5]	2/< 5/2	15/5/10	0/0/1	0/0/0
	Site 03	0/0/0	0/0/0	1/0/0	0/71/71
	Last Gasp[8]	0/–/–	0/–/–	< 1/–/–	0/–/–
	Guinness[8]	0/–/–	0/–/–	0/–/–	968/–/–
	Site 05	2/<5/1	50/10/30	1/0/0	0/0/0
	Black Rail[8]	0/–/–	0/–/–	0/–/–	640/–/–
	Beaver Pond North (Mineral Wash)	5/< 1/< 1	40/15/2	2/0/0	0/0/0
	Beaver Pond	5/5/< 5	50/40/40	1/2/< 5	0/0/0
	Site 08	6/6/6	75/30/35	4/5/5	0/0/0
	Upstream from Site 08[4]	< 5/0/1	5/0/2	< 5/0/2	0/0/0
ALAM	Sidebar 01	–/0/0	–/0/0	–/0/0	–/275/> 275
	Edgewater 01	–/–/0	–/–/0	–/–/0	–/–/300
	Camp 01	0/–/0	0/–/0	0/–/0	9/–/15
	Camp 04	1/–/0	5/–/0	2/–/0	0/–/10
	Camp 02	0/–/0	0/–/0	0/–/0	28/–/30
	Camp 03[5]	0/–/< 1	0/–/5	0/–/10	55/–/0
	Middle Earth 01	0/0/–	0/0/–	0/0/–	640/640/–
	Middle Earth 02	0/0/0	0/0/0	0/0/0	850/850/850
	Prospect 01	–/0/–	–/0/–	–/0/–	–/1120/–
	Burro Wash 01	–/0/–	–/0/–	–/0/–	–/506/–
	Burro Wash 02	–/0/0	–/0/0	–/0/0	–/900/900
	Motherlode 01	0/–/0	0/–/0	0/–/0	755/–/755
	Motherlode 02	–/0/–	–/0/–	–/0/–	–/1380/–
	Motherlode 03	–/0/–	–/0/–	–/0/–	–/1860/–
	Motherlode 04	0/0/0	0/0/0	0/0/0	2109/2109/2109
	Santa Maria South 01	–/0/–	–/0/–	–/0/–	–/5/–
	Santa Maria North 01	–/0/0	–/0/0	–/0/0	–/80/80

Table 2-4.—Summary of hydrologic conditions by survey site, 2015*

Study area[1]	Survey site	% site inundated[2]	Depth (centimeters) of surface water[2]	% site with saturated soil[2,3]	Distance (m) to surface water or saturated soil[2]
PVER	Phase 02[7]	0/0/0	0/0/0	0/0/0	25/5/10
	Phase 03[7]	0/30/0	0/12/0	0/10/0	20/0/5
	Phase 04 Block 01[7]	0/95/0	0/10/0	0/1/0	50/0/50
	Phase 04 Block 02[7]	0/0/0	0/0/0	0/0/0	20/20/5
	Phase 04 Block 03[7]	0/0/35	0/0/10	1/0/5	0/150/0
	Phase 05 Block 01[7]	0/0/65	0/0/12	0/0/10	30/30/0
	Phase 05 Block 02[7]	0/0/0	0/0/0	0/0/0	35/35/35
	Phase 05 Block 03[7]	8/0/0	5/0/0	0/0/7	0/100/0
	Phase 06 Block 01[7]	15/0/35	5/0/8	15/0/10	0/10/0
	Phase 06 Block 02[7]	0/0/0	0/0/0	< 1/0/0	0/30/30
	Phase 07 Block 01[7]	60/0/0	5/0/0	10/0/0	0/115/115
	Phase 07 Block 02[7]	0/0/0	0/0/0	0/0/0	5/120/120
EHRE	Ehrenberg	0/0/0	0/0/0	0/0/0	15/15/15
CIBO	Phase 01[7]	0/0/0	0/0/0	0/0/0	10/100/5
	Phase 02[7]	0/0/0	0/0/0	0/0/0	70/460/5
	Phase 03[7]	0/0/0	0/0/0	0/0/0	400/400/6
	Cibola Nature Trail[7]	5/0/2	2/0/4	5/< 1/3	0/0/0
	C2729[7]	0/0/45	0/0/20	0/0/3	5/270/0
	Cibola Site 01	0/0/3	0/0/20	0/0/10	20/20/0
	Cibola Lake North[9]	0/–/–	0/–/–	2/–/–	0/–/–
	Walker Lake	0/0/0	0/0/0	0/0/1	2/2/0
IMPE	Imperial NW[4] (Nursery NW)	< 1/10/5	10/3/13	15/10/15	0/0/0
	Imperial Nursery[7]	0/0/30	0/0/10	0/0/20	50/50/0
	Ferguson Lake[5]	0/< 1/20	0/–/5	10/5/5	0/0/0
	Great Blue Heron[4]	0/0/0	0/0/0	0/0/0	130/130/130
	Powerline[4]	0/0/2	0/0/4	0/0/5	0/0/0
	Martinez Lake[4]	0/0/0	0/0/0	0/0/0	0/0/0
MITT	Mittry West	5/0/0	–/0/0	30/1/0	0/0/81

Table 2-4.—Summary of hydrologic conditions by survey site, 2015*

Study area[1]	Survey site	% site inundated[2]	Depth (centimeters) of surface water[2]	% site with saturated soil[2,3]	Distance (m) to surface water or saturated soil[2]
YUMA	J[7,10]	< 1/–/–	25/–/–	2/–/–	0/–/–
	South AC[4,10]	55/–/–	–/–/–	30/–/–	0/–/–
	I[7,10]	0/–/–	0/–/–	0/–/–	50/–/–
	Gila Confluence North[5]	5/0/0	40/0/0	15/0/0	0/0/0
	Gila River Site 02[5]	0/0/0	0/0/0	0/0/0	0/0/0
	Fortuna Site 01[5]	< 1/3/–	–/20/–	70/1/–	0/0/–
	Fortuna North[5]	5/< 1/1	50/25/12	1/< 1/1	0/0/0

* Values are given for each site as recorded in mid-May, mid-June, and mid-July.

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, 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] Saturated soil or water was present only in pig wallows.
[7] Site is irrigated as part of restoration efforts; amount of standing water highly variable throughout survey season.
[8] Surveys discontinued for the season because of the lack of surface water at the site.
[9] Surveys discontinued because of poor habitat quality.
[10] Surveys discontinued because of permitting issues.

Patches 00–12 and Nesbitt Forest

Area: 1.5 ha Elevation: 1171 m

This study area is divided into 15 small stands (Patches 00–12) of coyote willows plus a small stand (Nesbitt Forest) of Fremont cottonwood (*Populus fremontii*, hereafter cottonwood). The coyote willow stands form a strip of habitat between bulrush (*Schoenoplectus californicus*) marsh to the east and dry upland scrub dominated by saltbush (*Atriplex* sp.) and grasses to the west. Most of the stands are separate from each other, but four stands (Patches 06–09) have grown together, forming a larger contiguous stand. Each coyote willow stand is characterized by very dense, large-diameter stems. Some areas have fallen or leaning stems with wispy growth in the lower 2 m, making traversing those areas difficult. Canopy height within the coyote willows ranges from 4 to 8 m, with the taller stems occurring in the center of each stand, creating a rounded look. Several stands have large gaps in the canopy, and canopy closure varies from 50 to 90%. The cottonwood stand is at the very southern end of the study area, along the southern end of Nesbitt Lake, and contains 18-m-tall trees planted on either side of an entrance road. The trees form a stand of vegetation roughly

30 x 60 m in size with 90% canopy closure and little understory. Surface water and saturated soils were present along the eastern edge of the willow stands during all visits, with little change in water levels noted during the season.

Twenty-three breeding flycatchers were located across 10 of the 16 sites. Five individuals were also detected for which residency status could not be confirmed. Four of the 16 stands were either unoccupied or were occupied for only a portion of the season; these stands were surveyed up to three times each, totaling 0.7 observer-hour. Cowbirds were noted during two surveys and throughout the season during nest monitoring activities. Deer were present within the sites but do not appear to heavily impact the vegetation structure. Overall habitat suitability is high at KEPI. Vegetation with dense canopy (≥ 90%), wet soils, and suitable branching structure is present throughout most of the patches. The gaps that have developed in several of the patches reduce the availability of nesting habitat but increase foraging habitat. The suitability of the three smallest patches (00, 04.5, and 10.5) is improved by proximity to the rest of the patches, with the study area forming a matrix of habitat. Nesbitt Forest has the lowest habitat suitability. Soils beneath the trees are dry, and while canopy closure is suitably dense, there is no understory, and the cottonwoods do not provide much suitable branching structure for nesting. In addition, limbs with suitable branching structure are exposed, increasing chances of depredation.

River Ranch, Nevada

River Ranch is in the Pahranagat Valley, approximately 12 km south of KEPI, and consists of several isolated patches of vegetation. Each patch is surrounded on all sides by grazed, irrigated cattle pasture, and signs of cattle were noted in each site. While the study area does provide suitable flycatcher habitat, the small areal extent of the patches (< 1 ha total), combined with its location in a cattle pasture and its relative isolation from other breeding populations in the valley, likely limits the overall suitability of this study area.

East Side

Area: 0.4 ha Elevation: 1101 m

This survey site is composed primarily of dense, large-diameter coyote willows 4–6 m in height. Tree height is shorter at the perimeter, giving the site a rounded appearance. Russian olive (*Eleagnus angustifolia*) and emergent velvet ash (*Fraxinus velutina*) trees are scattered throughout the site. One large, 15-m-tall cottonwood dominates the northeastern corner of the site. There are numerous piles of deadfall scattered throughout the site. Little to no understory is present, except where the willows are able to regenerate, and also in some small clearings where herbaceous vegetation dominates. Some wild grape (*Vitis* sp.) also grows in the northwestern corner, creating extremely dense habitat. Canopy closure is

primarily 70–90%, except in a few scattered clearings where it decreases to 50%. Standing water was recorded in the site in May and June. By July, only saturated soils were noted within the site.

East Side was occupied by four breeding flycatchers and one individual for which residency status could not be confirmed. The site was surveyed once, totaling 0.3 observer hour. No cowbirds were detected during the survey. This site has many of the same habitat components as the KEPI patches. Canopy closure is a little thin in places, but there are suitably dense locations with good branching structure for nesting. Wet soils can exist within this site, though it is typically the first of the three RIRA survey sites to dry out. Several gaps exist where cattle can access the interior of the site. A browse line has been noted in some years, though no browse line was noted in 2015.

West Side

Area: 0.3 ha Elevation: 1101 m

This survey site is composed primarily of dense, large-diameter coyote willows 4–6 m in height. Tree height is shorter at the perimeter, giving the site a rounded appearance. A gap 3–5 m wide runs diagonally through the site from the northwestern to the southeastern corner. Some Russian olive trees are scattered along the perimeter of this gap and along the eastern perimeter of the site. There is little to no understory throughout most of the site, except in the northeastern corner, where an extensive patch of wild grape is growing on the bases of the trees. In the gap, no understory is present, but grasses and other herbaceous plants provide groundcover. The coyote willows in this northeastern corner are noticeably stressed compared to the rest of the site, with many dead leaves, dead branches, and reduced canopy closure. Canopy closure is 80–90% throughout the southern two-thirds of the site and is 75% in the northern third. Areas of deadfall up to 1 m deep are scattered throughout the site, making travel difficult in places. Standing water or saturated soils were detected within the site throughout the season. Maximum water extent included ankle-deep water in 75% of the site in May, with the rest of the site containing saturated soils. By mid-July, the site had dried out considerably, with no standing water noted, and only 30% of the site containing saturated soils.

West Side was occupied by two breeding flycatchers. The site was surveyed twice, totaling 0.2 observer-hour. Cowbirds were detected during one survey. Canopy closure in the northern end of the site is too sparse to attract nesting flycatchers. Areas of suitably dense vegetation with wet soils and good branching structure exist in the southern end of the site but are limited in extent. Several gaps exist in the vegetation where cattle can access the interior of the site. A browse line has been noted in some years, though no browse line was noted in 2015.

Smalls

Area: 0.2 ha Elevation: 1099 m

This survey site is composed primarily of coyote willows 5–6 m tall. There is little understory except sparse, regenerating willows in the densely vegetated areas. A large gap in the woody vegetation, totaling approximately 25% of the site, dominates the northern half. This gap is dominated by herbaceous vegetation and is ringed on the western, northern, and eastern sides by a stand of coyote willows approximately 4–5 m in height and 4 m wide. Canopy closure averages 80–90% in the southern half of the site and 65–80% the shorter stands of willows in the northern half. Deadfall is scattered throughout the site but typically does not occur in piles as it does in East Side and West Side. The site contained wet soils throughout the season, with no less than one-half of the site covered in standing water.

One willow flycatcher was detected from June 29 to July 3, and this site is considered occupied in 2015. The site was surveyed three times, totaling 0.3 observer-hour. Cowbirds were detected during two surveys. This site is the smallest and wettest of the three. While suitably dense vegetation with wet soils and good branching structure do exist within the site, they are very limited in extent in the southern portion. Cattle can access the site through gaps in the northern and southern end of the site, and the large gap in the northern half often shows a significant browse line, though no browse line was noted in 2015.

Pahranagat, Nevada

The PAHR study area is located around Upper Pahranagat Lake at the northern end of the Pahranagat National Wildlife Refuge, approximately 27 km south of KEPI. Patches of primarily native vegetation exist at the inflow and outflow of Upper Pahranagat Lake and along the lakeshore. Prior to the 2008 survey season, the majority of the riparian vegetation along the northern side of the upper lake (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, resulting in a limited amount of inundation in May 2010 and in May of each subsequent year. The lake levels in 2013–2015 were the highest recorded since the dam was repaired but were still not as high as they had been before 2008. The lake levels in 2015 did not decline much during the season, unlike in previous years, and levels in July were the highest noted in that month since 2006. From 2003 to 2007, no cattle were observed within any of the survey sites. Starting in 2008, cattle from the neighboring ranch began to wander

into the northern portion of the lake and adjacent sites (Pahranagat North and Pahranagat West) as lake levels dropped during the season. This was the first year since cattle began wandering in 2008 that no cattle were observed in the survey sites during the breeding season.

Pahranagat North

Area: 3.2 ha Elevation: 1020 m

Pahranagat North is a stand of large-diameter Goodding's willows (*Salix gooddingii*) at the inflow of Upper Pahranagat Lake. Cottonwoods line the northern, upland edge of the site and extends in narrow stringers around the edge of the lakebed. Canopy height within the patch is around 20 m under the willows and 22 m under the cottonwoods. Many of the large trees in the northeastern section of the site are dead or dying. Scattered cottonwoods have fallen throughout the site, creating multiple small clearings. Canopy closure varies from as little as 50% in some of the clearings to as high as 90% under some of the denser trees. A dense understory of Indian hemp (*Apocynum cannabinum*) up to 2 m in height is present in the northern third of the site. Very little herbaceous vegetation is present in the understory in the southern two thirds 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. 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. Standing water was present in both inflow channels throughout the season as well as in the center and southern edge of the site.

Pahranagat North was occupied by 12 breeding flycatchers and 2 resident, unpaired males. Unoccupied portions of the site were surveyed five times, totaling 0.9 observer-hour. Cowbirds were detected during one survey and were also noted several times during monitoring activities. This site has high habitat suitability. The very shallow slope along the lake edge means that wet soils 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 branching structure. While several trees have fallen in recent years, many pockets of good habitat exist, especially in the southern end of the site. The northern border of the site, which has a higher prevalence of cottonwoods, tends to lack a woody understory and wet soils, which reduces its suitability.

Pahranagat West

Area: 1.3 ha Elevation: 1023 m

This native survey site consists of a stringer of cottonwoods, one-to-three trees wide and 20 m in height, on the western edge of Upper Pahranagat Lake. A few Goodding's willows 10 m in height are present in the northern half of the site, creating a distinct layer beneath the main canopy. The rest of the site has no significant understory vegetation, and canopy closure varies from < 50 to 90%. The eastern edge of the site is vegetated with bulrush, which extends into the lakebed. The western edge of the site is vegetated in yerba mansa (*Anemopsis californica*), which transitions into dry, upland desert. Throughout the survey season, the upland side of the site was dry, but surface water or saturated soil was present in the lakebed adjacent to the tree trunks.

Two breeding flycatchers were detected. Unoccupied portions of the site were surveyed five times, totaling 3.3 observer-hours. Cowbirds were detected during three surveys. Some signs of cattle use were noted, but it is unclear if the signs were from this year. Habitat suitability is low in most of the site because of the lack of understory, the narrow extent of woody vegetation, and a relatively steep slope along the lake edge that prevents water from encompassing the trees. The combination of these factors creates habitat that lacks cover and good branching structure for nesting. In the northern portion of the site, the presence of Goodding's willows in the understory creates habitat with good branching structure, good cover, and a lower canopy that extends over the lakebed. The slope of the lakebed is also shallower, creating suitable soil moisture conditions when lake levels are high enough.

Pahranagat MAPS

Area: 0.2 ha Elevation: 1022 m

Pahranagat MAPS consists of five distinct patches of dense, mostly small-diameter cottonwoods located on tiny hummocks of land in the marsh along the southwestern edge of Upper Pahranagat Lake. The patches range in size from 11 x 15 m to 20 x 40 m and are 70 to 240 m apart. Each patch of cottonwoods contains trees 8–15 m in height and one large-diameter, 20-m-tall snag. Canopy closure ranges from 60 to 90% and varies inversely with canopy height. Each patch was completely inundated in May, but standing water was present only on the eastern side of each patch, with each hummock exposed by July.

Pahranagat MAPS was occupied by two breeding flycatchers and three resident, unpaired males. Field personnel also detected one individual for which residency could not be determined. Unoccupied portions of the site were surveyed three times, totaling 2.4 observer-hours. Cowbirds were detected during two surveys. No signs of livestock were noted. The patches at Pahranagat MAPS vary in

suitability. All patches have suitable soil moisture conditions, given their location in the lakebed. The smallest patches have the shortest and densest vegetation, with the best branching structure for nesting. The largest patches have a taller canopy that is more open, and the lower canopy closure reduces suitability for nesting.

Pahranagat South

Area: 1.4 ha Elevation: 1025 m

Vegetation within this survey site consists of a stringer of 20-m-tall cottonwoods along a human-made channel that carries the outflow from Upper Pahranagat Lake. Canopy closure within the cottonwood stringer ranges from 40% in the very southern end of the site up to 75% in the center of the site. The understory contains mostly Indian hemp, yerba mansa, rabbitbrush (*Ericameria nauseosa*), cattails (*Typha* sp.), and bulrush. Some coyote willows are scattered through the understory as single, small-diameter stems along the channel. 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 > 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 80%. The channel held water throughout the season, and soils immediately adjacent to the channel were saturated. In addition, soils on the western edge of the site, including in the northern coyote willow patch, held either inundated or saturated soils throughout the season. Soils in the remainder of the site were dry.

No willow flycatchers were detected. The site was surveyed five times, totaling 2.5 observer-hours. Cowbirds were detected during three surveys. No signs of livestock use were noted. Habitat suitability is very low in this site because of a lack of understory. The understory has been slowly growing back following a fire in 2010, but most of the species present will not develop into an understory suitable for flycatchers. Some 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 willow is present on the northern end of the site, but it has yet to develop suitably dense canopy closure. The other factor limiting suitability is the distribution of wet soils within the site. In many years since 2008, surface water has been limited to the human-made channel that runs through the site, which has likely influenced the slow rate of regeneration of a woody understory. Water has intermittently been present in the field to the west of the site, and in some years, this field was an open marsh. Surface water was again noted in this field in 2015, increasing the areal extent of wet soils within the site.

Meadow Valley Wash, Nevada

The MVWA study area is located in Meadow Valley Wash, which extends south from Caliente, Nevada, through a narrow valley known as Rainbow Canyon, and past Elgin, Nevada. Habitat within the valley consists of narrow bands of native vegetation along a perennial stream. The water is ponded in several places due to beaver activity and is also subsurface in several locations. Habitat within the wash is dynamic, as scouring floods occur regularly. A tree-like willow species that did not resemble a Goodding's willow was noted in several survey sites but was not identified to species. This willow species had leaves that were proportionately wider, with a glossier dark green upper surface and noticeably more glabrous underside than those of a Goodding's willow; twigs were also noticeably redder. A researcher not associated with this project collected a sample of willow in 2014 within 1 km of Etna and identified it as red willow (*Salix laevigata* Bebb) (Southwest Environmental Information Network 2014).

Etna

Area: 0.5 ha Elevation: 1282 m

Etna is located approximately 7 km downstream from Caliente, Nevada. This survey site consists of a narrow patch of habitat approximately 25 m wide and 200 m long. The dominant overstory of the site consists of an unidentified tree-like willow species 7–9 m in height and cottonwoods 5–6 m in height. Coyote willows are present in several small clumps 3–4 m in height in both the understory and as independent stands. Some 3-m-tall tamarisk are scattered in the understory as well. Canopy closure reaches 80–90% in willow-dominated areas. A shallow stream 2–5 m wide runs through the site and held flowing water throughout the season. The banks of this stream are incised to a depth of 1 to 1.5 m, and most soils away from the stream were dry.

No willow flycatchers were detected. The site was surveyed five times, totaling 1.6 observer-hours. One cowbird was detected during one survey. Signs of cattle were noted on two visits, and signs of horses were noted on four visits. While suitable canopy height, density, and branching structure are present in this site, the lack of wet soils beneath woody vegetation limits overall suitability.

Dog Leg

Area: 10.3 ha Elevation: 1207 m

This survey site is located approximately 8 km downstream from Etna. Coyote willows 3–6 m in height are present throughout a majority of the site. In some places, they form the main overstory. In other places, they form the understory beneath an overstory of either cottonwoods 8–12 m in height or an unidentified willow species 8–10 m in height. Cottonwoods are more abundant in the northern

portion of the site, while the willow species is more abundant in the central and southern portions. Some velvet ash and tamarisk 5 m in height are scattered throughout the site as well. Canopy closure ranges from 40 to 80% and varies directly with canopy height. The lowest canopy closure is found in areas vegetated with only coyote willows. Standing water was present throughout the survey season in the form of a narrow stream that was braided in places and flowed through a small cattail marsh and several small beaver ponds. Soils away from the stream were damp to dry.

Dog Leg was occupied by five breeding flycatchers, and one additional female willow flycatcher was captured for which residency could not be confirmed. Unoccupied portions of the site were surveyed five times, totaling 9.1 observer-hours. One cowbird was detected on one visit. Signs of horses were observed during four visits, and signs of cattle were observed during one visit. A large portion of this site has low habitat suitability because of a lack of wet soils and low canopy closure. Areas with the best suitability are located around 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. The areas with surface water and saturated soils also tend to have the densest canopy closure.

Ford

Area: 1.8 ha Elevation: 1119 m

Ford is located approximately 7 km downstream from Dog Leg. Vegetation within the site consists primarily of 10–12-m-tall cottonwoods with an 8–10-m-tall willow species mixed in throughout the site. The understory is dominated by coyote willows 3–5 m in height, and some patches of velvet ash of similar height are present as well. Some seep willows (*Baccharis salicifolia*) are scattered in the understory, and yerba mansa forms a dense ground cover in areas lacking a woody understory. Canopy closure is variable and ranges from 60 to 90%, with the densest canopy closure found in some areas of cottonwoods. Standing water was present throughout the season in the form of a flowing stream with several beaver ponds up to 15 m wide. Soils away from the stream were largely dry and sandy.

No willow flycatchers were detected. The site was surveyed five times, totaling 1.9 observer-hours. No cowbirds were detected, but signs of cattle were observed on two visits. Habitat suitability in this site is low because of the lack of wet soils under woody vegetation and because areas with suitably dense canopy closure are limited in areal extent.

Kyle

Area: 0.8 ha Elevation: 971 m

Kyle is located approximately 13 km downstream from Ford. This survey site consists primarily of cottonwoods and velvet ash 10–15 m in height with scattered patches of coyote willows 3–4 m in height in the understory. Some unidentified willow trees up to 10 m in height were scattered throughout the site. A stream 1–4 m wide bisects the site from east to west; on the eastern side of the site, a beaver dam creates a 10-m-wide pool. North of the stream, very little understory is present. South of the stream, coyote willows are more prevalent in the understory. Canopy closure is variable, ranging from 60 to 85%, and is denser north of the stream under the taller cottonwoods. Surface water was present in the stream throughout the season. Soils away from the stream were largely dry and sandy.

No willow flycatchers were detected. The site was surveyed five times, totaling 2.3 observer-hours. No cowbirds were detected, but signs of cattle were noted during four visits. Habitat suitability at this site is low. Areas with dense enough canopy closure lack an understory with suitable branching structure and wet soils. Areas with wet soils and suitable branching structure are not dense enough or large enough in areal extent to attract nesting flycatchers.

Cottonwood Canyon

Area: 1.3 ha Elevation: 940 m

Cottonwood Canyon is located approximately 2.5 km downstream from Kyle, near the confluence of Meadow Valley Wash and Cottonwood Canyon. This site is bisected by a flowing stream that is ponded by a beaver dam on the western end of the site. Cottonwoods 10–12 m in height, 8–10-m-tall velvet ash, and an unknown willow species 8 m in height are scattered on either side of the stream, forming a loose canopy. Seep willows and some tamarisk up to 2 m in height form the understory. Canopy closure under the cottonwoods and velvet ash is 50–90%. The very southwestern corner of the site is dominated by 5–6-m-tall tamarisk with 80–90% canopy closure. The far eastern portion of the site is 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 borders one of the beaver ponds on the northwestern edge of the site. Vegetation on top of the embankment includes some honey mesquite (*Prosopis glandulosa*) and arrowweed (*Pluchea sericea*). The stream held water throughout the season, but soils away from the channel were dry and sandy.

Two willow flycatchers were detected on May 25, and this site is not considered occupied in 2015. The site was surveyed five times, totaling 2.6 observer-hours. No cowbirds were detected, but signs of cattle were noted on all visits as well as

signs of horses on one visit. Overall habitat suitability at this site is low. Areas with suitably dense canopy closure lack wet soils and occasionally lack an understory with suitable branching structure. Many areas lack sufficiently dense canopy closure. The area of coyote willows on the eastern end of the site has the greatest potential for developing into breeding habitat if the willows grow a few meters taller and canopy closure increases.

Muddy River, Nevada

The MUDD study area is located along the Muddy River in the Overton Wildlife Management Area near Overton, Nevada. Tamarisk in this study area was defoliated throughout the summer of 2012, and a reduction in live tamarisk canopy has been evident in some areas since 2013. Some tamarisk beetle larvae were noted in mid-May 2015, and spotty defoliation was noted during the season in the southern portion of the site.

Overton WMA Pond

Area: 0.7 ha Elevation: 380 m

This survey site 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 bisects the site from north to south and carries outflow from the reservoir. The dominant vegetation consists of Goodding's willows 15–20 m in height with a 5–7-m-tall tamarisk understory. Arrowweed and common reed (*Phragmites australis*) are present in scattered, dense patches within and along the edges of the site. Some cattails are present along the channel. Canopy closure is variable, ranging from 70% by the channel up to 90% elsewhere. Yerba mansa cover the ground in areas with lower canopy closure. Standing water was present in the channel and near the eastern and western edges of the site in May and June. By July, no wet soils remained.

No willow flycatchers were detected. The site was surveyed five times, totaling 2.7 observer-hours. Cowbirds were detected during four surveys, and no sign of livestock use was observed. Areas where suitable canopy closure, branching structure, and wet soils occur together are limited in areal extent in this site, which limits habitat suitability. Many areas lack dense canopy closure, lack an understory with woody vegetation, or have an understory too thickly vegetated with arrowweed or common reed.

Overton WMA

Area: 7.8 ha Elevation: 375 m

This mixed-exotic survey site lies along the Muddy River approximately 600 m south of Overton WMA Pond and consists of two disjunct polygons. The northern portion of the site consists of an 80-m-wide strip of riparian vegetation along both sides of an 850-m stretch of the Muddy River. The southern portion consists of a 125- x 275-m stand of mixed exotic vegetation along an old channel of the river. The site is bordered to the southwest by open agricultural fields and to the northeast by sparser areas of riparian vegetation. The northern portion of the site is dominated by very dense tamarisk 3–7 m in height with canopy closure ranging from 70 to 90%. Tamarisk are tallest on the eastern bank of the river channel, with height, density, and canopy closure decreasing with distance from the channel. Additionally, much of the tamarisk in this portion of the site is heavily damaged from previous years' defoliation, with the amount of dieback increasing with distance from the river channel. Several small patches of coyote willows 5–6 m in height with 70–90% canopy closure are present on the eastern bank of the river near the center of this portion of the site. Two stretches of the channel of the Muddy River within this portion of the site 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 vegetated with quailbush (*Atriplex lentiformis*), Emory baccharis (*Baccharis salicina*), and tamarisk 2–3 m in height. Canopy closure in this area is as low as 30%. The river channel in the northern portion of the site is incised 1–2 m below the surrounding land surface and contained flowing water throughout the survey season. Soils outside the channel were dry throughout the survey season.

The southern portion of the site consists primarily of a stand of Goodding's willows 10–15 m in height with an understory of 3–5-m-tall tamarisk. Many of the Goodding's willows have fallen over or lost limbs, creating gaps in the canopy. 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 this portion of the site. Some Emory baccharis is present in the southwestern corner of this portion of the site. A 25- x 5-m patch of coyote willows up to 6 m in height with 90% canopy closure is present near the center of this portion of the site. The densest, most suitable vegetation in the southern portion of the site is located between the center, near the coyote willows, and the southern edge of the site. The far eastern end of this portion of the site is primarily 4-m-tall tamarisk that shows signs of damage from tamarisk beetle defoliation and has 70% canopy closure. The channel of the Muddy River flows into the northern end of this portion of the site and then splits into two channels, one of which runs through the site and another that skirts the southwestern edge of the site. In 2005, the channel through the site was dredged, and approximately 0.3 ha was bulldozed as part of the efforts at the Overton Wildlife Management Area to repair flood damage to their water control system. This dredged channel carried water through the southern part of the site in subsequent years but slowly

filled in with sediment and cattails. Since 2013, water has flowed only in the channel along the southwestern boundary of the site. This channel is incised, and all soils outside of the channel were dry throughout the season.

This survey site was occupied by three breeding flycatchers in the northern portion of the site. Field personnel also detected four individuals for which residency status could not be confirmed in the southern portion. Portions of this site not known to be occupied by flycatchers were surveyed five times, totaling 16.3 observer-hours. No signs of livestock were observed, but cowbirds were detected during most surveys. While suitable habitat does exist within this survey site, it is limited in areal extent. The best habitat is along a 150-m stretch of river in the northern portion of the site, within 10–15 m of the river. There is also a patch of vegetation approximately 50 x 50 m in size with suitably dense canopy closure in the south-central portion of the southern portion of the site, but soils here are dry. Habitat elsewhere in the site is too open and too dry and sometimes too short. The lack of suitably dense canopy closure is exacerbated by damage from tamarisk beetle defoliation.

Warm Springs, Nevada

The WMSP study area is located in the Warm Springs Natural Area at the northern end of the Moapa Valley, at the headwaters of the Muddy River. On July 1, 2010, a wildfire burned at least part of every survey site at WMSP. Due to 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.

Muddy Mac

Area: 0.5 ha Elevation: 536 m

This native survey site lies near the head of Apcar Stream. It is bordered by a grassy field to the west and a small cattail marsh to the east and south. The northern portion of the original site was heavily damaged in the 2010 fire, with the overstory being completely killed. Dense basal regeneration of velvet ash has occurred, and live vegetation is now at least 5 m in height with 95% canopy closure. The eastern half of the current survey area is characterized by a very dense velvet ash stand 4–7 m in height with no understory and 85–95% canopy closure. Canopy closure in the eastern half is less dense along the southern edge and increases to the north, near the border with the burned area. The western half of the current survey area is dominated by sparse velvet ash approximately 12 m in height with 50–60% canopy closure. The understory in the western half of the site consists of sparsely distributed regenerating 4–5-m-tall velvet ash, with thick grasses and yerba mansa forming a dense ground cover 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 very southern portion of the site in May, but by July only damp soils remained, even in the cattail marsh that borders the site to the east.

No willow flycatchers were detected. The site was surveyed five times, totaling 2.0 observer-hours. Cowbirds were detected during three surveys. No evidence of livestock was observed. The burned area was surveyed once in 2015, and it is recommended that it be added to surveys in 2016. Habitat suitability is good within the site, though the western half of the current survey area lacks suitably dense canopy cover. Suitability would be improved if wet soils covered a larger areal extent and were present for a longer portion of the season.

Muddy Stringer 01

Area: 0.8 ha Elevation: 532 m

Muddy Stringer 01 is located approximately 100 m north of the North Fork of the Muddy River and contains two distinct portions: a narrow, linear northern arm and a bulbous southern end. A narrow stringer of 10–12-m-tall palm trees (*Washingtonia* sp.) 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 scattered clumps less than 5 x 5 m in size of tamarisk or velvet ash no more than 2 m tall. Where woody vegetation occurs in the northern arm, it covers an area no more than 5 m wide. Areas lacking woody vegetation are covered by dense yerba mansa. Near the northern end of the site is a small patch of coyote willows approximately 5 x 20 m in size, reaching 4 m in height and 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 85–90% canopy closure. The eastern half of the southern end is vegetated in a more heterogeneous mix of 6-m-tall velvet ash and 5-m-tall tamarisk on either side of the palm tree stringer. Some honey mesquite and cattails are also scattered throughout the eastern half. Canopy closure in the eastern half of the southern end ranges from 70 to 95%. Standing water was present in the channel in May and along the very eastern edge of the site, but by July all soils were damp or dry.

This site was occupied by two breeding flycatchers. The site was surveyed five times, totaling 1.0 observer-hour. Cowbirds were detected during three surveys, and no evidence of livestock was noted. Most of the northern arm of this site is completely unsuitable, lacking any type of closed canopy or understory, though 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 should be discontinued in this portion of the site, but the coyote willow patch should continue to be checked at the beginning of future seasons to determine if it has

improved in suitability. Habitat suitability in the southern portion of the site would be improved if canopy closure within the coyote willows increased in density 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. The TOPO study area is located in this large expanse of riparian vegetation, which is primarily monotypic tamarisk with isolated patches of tall Goodding's willows. Seasonally wet, low-lying areas are interspersed throughout the riparian area. Marsh elevation data collected at the South Dike gaging station show that water levels within Topock Marsh were approximately 0.1–0.3 m lower throughout the 2015 breeding season than they were on the corresponding day in 2014. While tamarisk beetles have not yet reached Topock Marsh, the tamarisk in several survey sites was noted as being very brown at some point during the field season, and it is assumed to be the result of tamarisk weevils. Feral pigs are present throughout the Topock Marsh study area, and evidence of pigs was observed in most survey sites. On August 8, 2015, a wildfire burned through Topock Marsh north of the Firebreak Canal, completely consuming Pipes 01, Pipes 03, The Wallows, PC 6-1, Pig Hole, In Between, and Pierced Egg, leaving only charred stems. Parts of 800M were also consumed, but some unburned tamarisk remained in the marsh in the interior of the site. An assessment of habitat suitability for these sites is not given, as suitability is no longer applicable. The fire burned into the northern edge of Swine Paradise but did not cross the Firebreak Canal.

Pipes 01

Area: 5.2 ha Elevation: 140 m

This exotic survey site is bordered to the east by the refuge road and consisted primarily of monotypic tamarisk 6–8 m in height. Arrowweed occurred in dense patches within 50 m of the refuge road. Tamarisk were densest and tallest within 100 m of the refuge road; vegetation was 7–8 m in height, and canopy closure was 80–95%. Tamarisk became 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 within this site were completely dry throughout the season.

No willow flycatchers were detected. The site was surveyed five times, totaling 7.7 observer-hours. Cowbirds were detected during all surveys.

Pipes 03

Area: 5.7 ha Elevation: 139 m

This survey site is 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. The southern portion of the site had a few emergent Goodding's willows up to 15 m in height and open areas with Emory baccharis and some bulrush. A few honey mesquite were scattered throughout the site.

Canopy closure ranged from 60 to 90% and was lowest under some of the willows. Standing water was noted in a few isolated pig wallows in May and June, with all other soils dry. By July, no wet soils remained within the site.

One willow flycatcher was detected on June 3, and this site is not considered occupied in 2015. The site was surveyed five times, totaling 7.9 observer-hours. Cowbirds were detected during all surveys.

The Wallows

Area: 0.7 ha Elevation: 139 m

The Wallows was primarily vegetated by tamarisk 5–7 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 dominated the southwestern corner. The eastern side was dry and graded from 2-m-tall arrowweed along the refuge road to tamarisk in the center of the site. Overall canopy closure ranged from 50% in the marshy area to 90% in the tamarisk. The open marsh was widely covered in standing water in May, but by mid-June the only standing water noted was in a small pig wallow on the eastern edge of the marsh. By July, all soils within the marsh were damp. Soils away from the marsh and under the tamarisk were dry all season.

The Wallows was occupied by two breeding flycatchers. In addition, field personnel detected one willow flycatcher for which residency status could not be confirmed on June 18 and another on July 21. The flycatcher detected on July 21 occupied a territory in 800M during June and was detected in Swine Paradise on July 1. The site was surveyed once, totaling 0.5 observer-hour. No cowbirds were detected during the survey, but they were observed frequently during monitoring activities.

PC 6-1

Area: 4.8 ha Elevation: 139 m

PC 6-1 was a mixed-exotic survey site. Most of the site was vegetated with tamarisk 6 m in height. Emergent Goodding's willows 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 two-thirds of the site, primarily along the western, southern, and eastern borders. Canopy closure in the interior of the site averaged 90%, while canopy closure on the periphery of the site near the refuge road was approximately 50%. Approximately two-thirds of the site contained wet soils in mid-May, but only saturated soils and pig wallows remained in the middle of the site by mid-June. By July, no wet soils were noted.

One willow flycatcher was detected on May 19, and PC 6-1 is not considered occupied. The site was surveyed five times, totaling 7.2 observer-hours. Cowbirds were detected during four surveys.

Pig Hole

Area: 2.4 ha Elevation: 139 m

Pig Hole consisted of monotypic 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. A few dense patches of arrowweed were present on the eastern edge. Standing water was present in scattered pig wallows and shallow puddles in May, but the site contained only damp or dry soils by mid-June.

No willow flycatchers were detected. The site was surveyed five times, totaling 4.4 observer-hours. Cowbirds were detected during four surveys.

In Between

Area: 7.7 ha Elevation: 139 m

In Between consisted of monotypic tamarisk 6–8 m in height. The lowest 3 m of the stand lacked foliage, resulting in a relatively open understory. Canopy closure was 60–90% and lowest in the eastern and southern portions of the site. The western edge of the site borders a marsh, but no wet soils were noted within the site throughout the season. Standing water or saturated soil was found throughout the season in the marsh along the western border of the site.

No willow flycatchers were detected. The site was surveyed three times, totaling 5.5 observer-hours. Cowbirds were observed on all three surveys.

800M

Area: 4.7 ha Elevation: 139 m

800M adjoins the western edge of In Between, and the eastern half of the site consisted of a cattail and bulrush marsh with clumps of tamarisk 5–7 m in height and a few 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. Canopy closure in the tamarisk was 80–90%, except on the western and northern edges of the site where it dropped to 70%. Canopy closure in the marsh was around 60%. Some standing water was present in the marsh in May, but only small pockets of saturated soils remained by June. By July, only damp soils remained in the marsh. The rest of the site was dry throughout the season

800M was occupied by one unpaired flycatcher from June 2 to 30. Unoccupied portions of the site were surveyed three times, totaling 5.0 observer-hours. Cowbirds were observed during two surveys.

Pierced Egg

Area: 6.7 ha Elevation: 140 m

This mixed-exotic survey site borders the western edge of 800M and consisted of dense tamarisk 7 m in height, with scattered emergent Goodding's willows 15 m in height. Areas with willows tended to have a more open understory with patches of cattails and bulrush. Overall canopy closure was approximately 80% throughout the majority of the site, lowering to 70% along the eastern edge. Standing water was present in several pig wallows scattered throughout the site in May, but by June saturated soils were noted only in a small bulrush marsh in the south-central portion of the site. Some pig wallows again contained standing water in mid-July. Soils elsewhere in the site were mostly dry.

Pierced Egg was occupied by three breeding flycatchers. In addition, one willow flycatcher was detected on May 20 and another on June 2. Unoccupied portions of the site were surveyed three times, totaling 4.2 observer-hours. Cowbirds were observed during two surveys.

Swine Paradise

Area: 1.0 ha Elevation: 140 m

This mixed-exotic survey site is bisected by the Firebreak Canal, with a small 30- x 40-m polygon north of the canal and a larger polygon to the south. Vegetation on the northern side of the canal consisted primarily of coyote willows 3–6 m in height bordered to the north and west by tamarisk 6–8 m in height and by cattail marsh to the east. Much of the northern polygon was burned in a fire,

which left a 10–15-m-wide swath of mixed coyote willows and tamarisk along the canal. Vegetation south of the canal consists of tamarisk 3–8 m in height and scattered, emergent Goodding's willows up to 15 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 3–6 m in height is present in the northeastern corner of the southern portion of site, adjacent to the Firebreak Canal. Large patches of arrowweed dominate the understory in the southern half of the site. Canopy closure ranges from 85 to 95% in the monotypic tamarisk and under the Goodding's willows and ranges from 70 to 90% in the coyote willows, with shorter coyote willows also being more open. The coyote willow patches on either side of the canal were inundated throughout the season, but the remainder of the site was dry.

Swine Paradise was occupied by two breeding flycatchers and two unpaired males. One additional individual was detected on May 17, and on July 1, a flycatcher was detected that had occupied a territory in 800M during June. Due to occupancy status, this site was not surveyed. Habitat suitability is highest in the portion of the site where tamarisk borders the inundated coyote willows. Tamarisk are taller in this portion, with good branching structure and dense canopy closure, and soils are at least damp and very close to standing water. Suitability within the coyote willows decreases away from the tamarisk as the canopy closure becomes too low. The southern half of the site has extremely low suitability because of dry sandy soils, canopy closure that is too low, and an understory that is too thickly vegetated to permit easy flight. Suitability in the northern polygon will likely be low in 2016 because only a narrow swath of unburned vegetation remains.

Platform

Area: 1.9 ha Elevation: 139 m

This survey site lies between the main refuge road to the west and open bulrush and cattail marsh to the east. Vegetation at the site consists of tamarisk 8 m in height with a few emergent Goodding's willows. Most of the site lacks a distinct understory layer, though the tamarisk are very dense and covered with a thick layer of duff in many areas. A few screwbean mesquite trees (*Prosopis pubescens*) are present along the northwestern edge and in the center of the site. A 5-m-wide strip of 5-m-tall coyote willows runs along a portion of the eastern edge of the site adjacent to the marsh. These coyote willows are expanding at the northern end of their extent and now cover an area approximately 30 x 40 m. Overall canopy closure reaches 95%. The very eastern edge of the site bordering the marsh had inundated or saturated soils throughout the season, but the remainder of the site was very dry.

No willow flycatchers were detected. The site was surveyed five times, totaling 1.9 observer-hours. Cowbirds were detected during four surveys. Habitat suitability is low in most of this site because soils are dry and vegetation structure in the understory is too thick. Some suitable habitat is present along the marsh edges but is extremely limited in areal extent.

250M

Area: 1.9 ha Elevation: 139 m

This survey site lies between the main refuge road to the northwest and open marsh to the northeast and southeast. Vegetation composition and structure varies with distance from the marsh. Closest to the refuge road, the site is dominated by mesquite trees (*Prosopis* sp.) with an understory of arrowweed. The center of the site is dominated by tamarisk ranging from 3 to 4 m in height near the refuge road to 6 to 7 m in height near the marsh. A few emergent Goodding's willows approximately 12 m in height are present near the marsh. A patch of coyote willows 45 x 90 m in size is present along the northeastern edge of the site. Canopy closure ranges from 60 to 90% and is most dense on the marsh side of the site. Some damp soils were noted near the marsh in May, but otherwise, all soils were dry.

No willow flycatchers were detected. The site was surveyed five times, totaling 3.3 observer-hours. Cowbirds were detected during two surveys. Most of this site contains dry soils and low canopy closure and therefore has low habitat suitability for nesting flycatchers. The eastern side of the site closest to the marsh is marginally suitable with damp soils and higher canopy closure, but suitability would be improved by increased areal extent of wet soils.

Hell Bird

Area: 5.8 ha Elevation: 139 m

This mixed-exotic survey site is located on an island separated from the main riparian area by a narrow, deep channel. Vegetation composition and structure are highly variable, with the survey area vegetated primarily by a mosaic of tamarisk 6–8 m in height and Goodding's willows 15 m in height. Screwbean mesquite trees 4–6 m in height are also scattered throughout the site. Canopy closure ranges from 50 to 90%. The survey area is bordered to the north by the open channel and to the east and south by marshes. Marshes vegetated by cattails and bulrush are also interspersed throughout the site. The marshes, totaling approximately 50% of the areal extent of the site, were inundated to 50 centimeters (cm) in depth throughout the season. Adjacent soils were dry to damp.

Hell Bird was occupied by two unpaired flycatchers between June 11 and July 1. In addition, one willow flycatcher was detected on June 20. Unoccupied portions of the site were surveyed five times, totaling 6.3 observer-hours. Cowbirds were detected during four surveys. Overall habitat suitability is good. All components of suitable habitat are present in a mosaic within the site and combine into several small patches of suitable habitat within the larger matrix of the site.

Glory Hole

Area: 5.0 ha Elevation: 140 m

This mixed-exotic survey site is contiguous with Hell Bird and is located immediately to the southwest. Vegetation composition and structure are highly variable, with the survey area vegetated primarily by a mosaic of tamarisk 6–8 m in height and Goodding's willows 15 m in height. Screwbean mesquite trees 9–10 m in height are also scattered throughout the site. Canopy closure ranges from 50 to 90%. The survey area is bordered on the north by a sand dune and on other sides by a mix of woody vegetation and marshes. Marshes vegetated by cattails and bulrush are interspersed throughout the site. The marshes, totaling approximately 40% of the areal extent of Glory Hole, were inundated to 50 cm in depth throughout the season. Adjacent soils were dry to damp.

Glory Hole was occupied by two breeding flycatchers. Unoccupied portions of the site were surveyed five times, totaling 5.5 observer-hours. Cowbirds were detected during three surveys and were frequently detected during monitoring activities. Overall habitat suitability is good. All components of suitable habitat are present in a mosaic within the site and combine into several small patches of suitable habitat within the larger matrix of the site.

Farm Ditch Road (Formerly Spaghetti)

Area: 5.4 ha Elevation: 141 m

Farm Ditch Road is located on the north side of the Farm Ditch canal, about 500 m west of the boat launch to the Glory Hole/Hell Bird island. The site was surveyed from the road in past years but had not been thoroughly described from the interior of the site. The eastern half of the site was described in May. Coyote willows 3–5 m in height are present along the canal in a stringer 10–30 m wide. Canopy closure ranges from 70 to 95% in the coyote willows and varies directly with height. Some cattails and bulrush are mixed in and around narrower portions of the coyote willows. Vegetation north of the coyote willows is primarily 2–2.5-m-tall arrowweed and Emory baccharis with emergent 4–6-m-tall tamarisk, screwbean mesquite, honey mesquite, and 8–10-m-tall Goodding's willows. The trees are widely spaced and do not form a closed canopy; canopy closure north of

the coyote willows ranges from 0 to 40%. Inundated soils were noted along the canal border in May but did not extend very far into the site. Soils on the upland side of the coyote willows were dry and sandy.

No willow flycatchers were detected. The site was surveyed five times, totaling 5.8 observer-hours. Cowbirds were detected during four surveys. Habitat in the northern half of the site is unsuitable, as it contains dry, sandy soils and lacks a closed canopy. Suitable habitat is present in the coyote willows in the southern half of the site. Structure in the coyote willows reaches suitable height (≥ 4.5 m) and canopy closure (≥ 85%), with wet soils in several places.

CPhase 05 (Formerly Beal Lake)

Area: 11.4 ha Elevation: 140 m

The survey site known as CPhase 05 is within a conservation area and consists of a mosaic of cottonwoods, Goodding's willows, coyote willows, mesquite, and arrowweed, with some 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 sparse and averages 35%, reaching 95% in the cottonwood stands. The amount of standing water and saturated soil is highly variable because the site is flood irrigated. Sandy soil at the site allows the water to drain rapidly after irrigation. No wet soils were noted during visits in May, June, or July.

One willow flycatcher was detected on June 24. This individual sang for 5–10 minutes at a time with 10–20 minutes between singing bouts and covered a large area, never having more than one singing bout in a given location. No willow flycatchers were detected on any of three followup visits. This flycatcher is not considered resident because the detection was on a single occasion, and CPhase 05 is not considered occupied in 2015 because the detection was not after June 24. The site was surveyed five times, totaling 3.3 observer-hours. Cowbirds were detected during all surveys. In general, soils are too dry within the site. Vegetation in a majority of the site is too short and open, or, in the case of the cottonwoods, lacks woody vegetation in the understory and does not have good branching structure for nesting.

Lost Lake

Area: 3.3 ha Elevation: 140 m

This site consists of a narrow (< 100 m wide) strip of 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 edge of the site consists of an overstory of planted cottonwoods 10–15 m in height, with an

understory of tamarisk 5 m in height on the edge of a cattail marsh. South of the cottonwoods, the site is primarily tamarisk, 5–8 m in height, with small openings vegetated by arrowweed. Most of the tamarisk lacks a distinct understory layer, and the tamarisk are very dense and covered with a thick layer of duff in many areas. The western edge of the site is dominated by scattered mesquite trees. A 30- x 70-m patch of coyote willows 5 m in height with a dense arrowweed understory is present in the western third of the site, but the willows do not form a closed canopy. Canopy closure is 90% in the monotypic tamarisk and varies from 80 to 95% in the cottonwoods. Surface water and saturated soil were present in the marsh on the northern edge of the site in May and June. The remainder of the interior was dry to damp.

Lost Lake was occupied by one unpaired flycatcher. The site was surveyed five times, totaling 4.9 observer-hours. Cowbirds were detected during three surveys. Most of the site is dominated by tamarisk that is thickly vegetated in the understory. Most of the site contains dry, sandy soils. Soils are wettest under the cottonwood stringer, but most of the understory within the stringer is not dense enough, and the cottonwoods are too mature to provide suitable branching structure for nesting.

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. Backwater areas that support marsh and riparian vegetation were surveyed. Both survey sites in 2015 were located in Blankenship Bend, which contains riparian and marsh vegetation along the eastern bank of the Colorado River adjacent to the Blankenship Valley.

Blankenship North

Area: 19.0 ha Elevation: 139 m

Blankenship North consists of two portions: (1) a linear 100-m-wide strip of riparian vegetation along the eastern edge of the site between the upland and marsh and (2) a 200-m-wide portion of vegetation that runs east-west along the northern edge of the site between the river and the upland. Vegetation in the eastern strip of Blankenship North consists of mesquite 7 m in height at the upland edge that grades 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 is very dense. The coyote willows border a bulrush marsh, and the western edge of the marsh is also 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 consists of a mosaic of marshes, tamarisk, coyote willows, arrowweed, and mesquite. Vegetation height is typically 3–4 m and

does not exceed 5 m, and canopy closure within the woody vegetation varies between 60 and 80%. Soils were dry along the eastern border of the site, but the marshes contained surface water throughout the season.

No willow flycatchers were detected. The site was surveyed five times, totaling 7.6 observer-hours. Cowbirds were detected during three surveys, and evidence of burros was observed during four surveys. While surface water and saturated soils are present in the northern portion of the site under the woody vegetation, vegetation in this area is too short and too open to be considered suitable. Soils within the eastern portion of the site are too dry, and the understory vegetation structure is too thick. Some suitable habitat is likely present along the marsh edge but is limited in areal extent.

Blankenship South

Area: 11.8 ha Elevation: 140 m

Blankenship South consists 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 contains coyote willows 4–6 m in height, which mixes with tamarisk to the east. Vegetation structure within the tamarisk is very dense. The eastern side of the site is bordered by dry upland and is primarily vegetated by 4–6-m-tall honey mesquite and 2–3-m-tall arrowweed. The western side of the site is bordered by bulrush marsh and open water. Canopy closure is approximately 80–90%. Standing water was present throughout the survey season along the western edge of the site; soils on the eastern side of the site were dry.

No willow flycatchers were detected. The site was surveyed five times, totaling 7.4 observer-hours. Cowbirds were detected during three surveys, and signs of burros were also detected on all surveys. Soils within the eastern half of the site were too dry and vegetation was too thick in the understory to provide suitable habitat for nesting flycatchers. Some suitable habitat is likely present along the marsh edge but is limited in areal extent.

Bill Williams, Arizona

The BIWI study area 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 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 monotypic tamarisk, beaver ponds, and cattail marsh. Survey sites within the BIWI study area are listed below from west to east, moving progressively farther upstream. Signs of burros were seen between the Mineral

Wash area and the eastern border of the refuge. The extent of surface water within the study area was relatively high in 2010, intermediate and variable in 2011–13, and restricted to deep channels and beaver ponds in 2014 and 2015.

Bill Willow

Area: 1.6 ha Elevation: 140 m

Bill Willow is located along the very northwestern extent of riparian vegetation along the Bill Williams River and borders cattail marsh to the north and west. Vegetation within the site consists of 3–6-m-tall tamarisk with dead cattail stands in the understory, particularly near the northern and western borders. A few emergent Goodding's willows are present along the southern and eastern borders. Canopy closure ranges from 70 to 90% and varies directly with canopy height. Vegetation is noticeably taller and denser in the southwestern portion of the site than in the northeastern portion. Surface water covered the entire site in May and June and roughly three-quarters of the site in July.

Two willow flycatchers were detected on May 16, and this site is not considered occupied in 2015. The site was surveyed five times, totaling 6.9 observer-hours. Cowbirds were detected during three surveys. Vegetation in the southwestern portion of the site appears to be suitable, with high canopy closure, adequate canopy height, surface water within woody vegetation, a branching structure suitable for nest placement, and an understory of intermediate density. Vegetation in the northeastern portion of the site is currently too open and too short to be suitable.

Wispy Willow

Area: 1.3 ha Elevation: 140 m

This survey site is located approximately 75 m southwest of Bill Willow on the north side of the Bill Williams River. The western and southern portions of the site are vegetated primarily with 6-m-tall coyote willows. 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. Canopy closure is 80–85% within the coyote willows, 75–90% within the tamarisk, and as low as 60% within the marshy areas. Tamarisk in the northern arms of the site are less dense than the tamarisk farther south, with canopy closure averaging 75%. Standing water was present within the majority of the site in May and June but was restricted to the isolated cattail marshes by July.

Wispy Willow was occupied by four breeding flycatchers. Because of site occupancy, no surveys were conducted. Canopy closure is slightly low in some parts of the site, but overall the site is very suitable because of the extensive

presence of surface water within woody vegetation, adequate vegetation height, suitable canopy closure in a majority of the site, and an understory that is not too thick and contains good branching structure for nest placement.

Site 01

Area: 2.4 ha Elevation: 142 m

Site 01 is a mixed-native survey site just upstream of Wispy Willow, on the southern edge of an area that burned in 2006. Goodding's willows dominate the overstory at a height of 15 m but do not form a continuous canopy. Tamarisk 8 m in height are scattered in the understory throughout much of the northern half of the site. Toward the center of the site, there are patches of dense arrowweed 2–3 m in height. A stand of large-diameter coyote willows 4–6 m in height is present along the western and southern edges of the site. Canopy closure is approximately 70–90% within the coyote willows and 60–80% throughout the rest of the site. Standing water was present within the coyote willow stand throughout the season.

Site 01 was occupied by two breeding flycatchers and one unpaired flycatcher. The site was surveyed once, totaling 1.5 observer-hours. Cowbirds were detected during the survey as well as during monitoring activities. Most of the site lacks suitably dense canopy closure and wet soils. The very southern edge of the site contains the best canopy closure in combination with wet soils and good branching structure.

Burn Edge

Area: 4.1 ha Elevation: 145 m

Burn Edge is near the northern edge of the Bill Williams riparian corridor, on the eastern edge of an area that burned in 2006. Goodding's willows and cottonwoods 15–20 m in height make up the overstory, with cottonwoods being more prevalent than Goodding's willows in the eastern quarter of the site. A cattail marsh runs east-west through the center of the site. The understory immediately adjacent to the marsh ranges in height from 3 to 7 m and is dominated by a mixture of tamarisk, coyote willows, seep willows, arrowweed, and honey mesquite. Farther away from the marsh, the understory is dominated primarily by tamarisk up to 6 m in height. Canopy closure away from the marshy area reaches 90% and varies in the marshy area from around 60% at the eastern end to 25% at the western end. Standing water and saturated soils were noted in a small (3- x 9-m) pool at the western end of the marsh in June and July. Soils away from the marsh were dry in May and July but mostly damp in June.

No willow flycatchers were detected. The site was surveyed four times, totaling 3.8 observer-hours. Cowbirds were detected during three surveys. Some suitable vegetation structure does exist within the site, in the largest and densest patches of tamarisk, but soils are too dry and the current extent of surface water is too limited, which lowers overall suitability.

Site 04

Area: 9.9 ha Elevation: 145 m

Site 04 is a mixed-native survey site located on the very southern edge of the riparian area. Vegetation consists of an overstory of Goodding's willows 10–15 m in height and patches of monotypic tamarisk up to 8 m in height in the understory. Several 15–20-m-tall cottonwoods are scattered throughout the overstory. A few small patches of coyote willows 3–5 m in height are also present throughout the site as well as some scattered seep willows. Canopy closure is variable, and overall is 50–70%, but can reach as high as 90% in some of the taller, more extensive patches of tamarisk. The understory in some areas is very open, and the ground in these areas is covered with herbaceous vegetation. Many large willows and cottonwoods have fallen over the past several years, leaving large gaps in the canopy and creating patches of thick, dead, fallen woody vegetation. Surface water was present throughout the season in a deep, backwater channel on the western side of the site. In addition, some standing water was noted in a small stream channel in the middle of the site in May and June. Soils away from these channels were largely dry throughout the season.

No willow flycatchers were detected. The site was surveyed five times, totaling 11.0 observer-hours. Cowbirds were detected during three surveys. Overall habitat suitability is currently very low in this site, and has declined in recent years as trees and large limbs have fallen, decreasing canopy closure. Most of the site lacks suitably dense canopy closure and wet soils. Understory dense enough to provide suitable nesting habitat is also limited in areal extent.

Site 03

Area: 12.9 ha Elevation: 146 m

This mixed-native survey site is contiguous with Site 04 and is located immediately to the east; together Site 03 and Site 04 are known as Mosquito Flats. Vegetation consists of an overstory of Goodding's willows 15–20 m in height and patches of monotypic tamarisk up to 8 m in height. Several cottonwoods are scattered throughout the overstory, and seep willows 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 over the past several years, leaving large gaps in the canopy and creating patches of thick, dead, fallen woody vegetation. Canopy closure is variable and ranges from 50% in areas with open understory and fallen trees to 90% in areas with dense tamarisk. Several stands of dead cattails and formerly marshy areas occupy approximately 10% of the site; most of these areas contained dry soils. A small patch of saturated soil was noted in a marshy area near the southern end of the site in May, but by June all soils were dry or damp.

Site 03 was occupied by two breeding flycatchers. Portions of the site not known to be occupied were surveyed six times, totaling 15.4 observer-hours. Cowbirds were detected during four surveys. Overall habitat suitability is currently low in this site, though understory structure is slightly better than in Site 04. As in Site 04, habitat suitability has decreased in recent years. Most of the site lacks suitably dense canopy closure and wet soils, and understory dense enough to provide suitable nesting habitat is limited in areal extent. Canopy closure has decreased in recent years throughout the site and continued to decrease during the season as more trees and large limbs fell; this trend is expected to continue. The best habitat is in an extensive patch of tamarisk with a Goodding's willow overstory that surrounds a small marsh in the southern end of the site. The marsh contained some moist soils during part of the season, and habitat suitability would be improved if surface water were more widespread and persisted into June and July.

Last Gasp

Area: 2.1 ha Elevation: 146 m

Last Gasp is a narrow, mixed-native survey site along a channel on the northern edge of the Bill Williams riparian area, approximately 250 m east of Burn Edge. Due to a lack of both flycatcher detections and surface water, this site was put on a periodic survey schedule and has not been visited since 2011. Vegetation within the site consists of a broken overstory of 15–20-m-tall cottonwoods with 8–10-m-tall Goodding's willows and 5–7-m-tall tamarisk in the understory. Both the Goodding's willows and cottonwoods look stressed with many dead limbs and sparse foliage. Tamarisk are scattered in loose patches rather than forming a continuous understory, and arrowweed are present in the gaps between the tamarisk patches. Canopy closure varies from 50% in the channel to 80% under the densest cottonwood overstory. A small 1- x 1-m pool of water was noted in the middle of the site during a visit in May. All other soils in the site were dry and sandy.

No willow flycatchers were detected. The site was surveyed once, totaling 0.7 observer-hour, but occupancy status could not be determined from the limited survey effort. Cowbirds were detected during the survey. Surveys were discontinued for the remainder of the season following the initial visit due to lack of surface water within the site. This site currently lacks wet soils and vegetation

dense enough to provide suitable structure. If wet soils developed outside of the channel, the vegetation could increase in density and suitability. SWCA recommends keeping this site on the periodic survey list to determine if either the hydrology or vegetation structure improves in future years

Guinness

Area: 3.4 ha Elevation: 149 m

Guinness is a mixed-native survey site located approximately 150 m east of Site 03. Due to a lack of surface water away from a narrow, incised channel, this site was put on a periodic survey schedule and has not been surveyed since 2012. The site is dominated by a patchy overstory of Goodding's willows 10–15 m in height with an understory of 5–6-m-tall tamarisk. Some emergent cottonwoods are scattered along the northern and southern edges of the site. A few mesquite trees are scattered in the understory. Canopy closure is approximately 70%. A stream channel bisects the site, but all soils were dry during a visit in May.

No willow flycatchers were detected. The site was surveyed once, totaling 1.9 observer-hours, but occupancy status could not be determined from the limited survey effort. Cowbirds were detected during the survey. Surveys were discontinued for the remainder of the season following the initial visit due to lack of surface water within the site. This site currently lacks wet soils and a dense enough canopy, but if wet soils develop outside of the channel, vegetation could increase in density and suitability. SWCA recommends keeping this site on the periodic survey list to determine if either the hydrology or vegetation structure improves in future years.

Site 05

Area: 6.8 ha Elevation: 150 m

Site 05 is located 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. Vegetation in the site is mixed-native, with Goodding's willows 12–20 m in height and cottonwoods 15–25 m in height forming a broken overstory. Cottonwoods are more dominant in the overstory in the eastern third of the site, and Goodding's willows are more dominant in the western two-thirds of the site. The understory consists of scattered patches of tamarisk 6–8 m in height as well as some young Goodding's willows and cottonwoods. Many gaps are present in the canopy, particularly in areas dominated by Goodding's willows, where many limbs have fallen in recent years. Ground cover in portions of the site consists of thick, dead, fallen woody vegetation. Canopy closure in the site is variable, ranging from 70% in more open areas to 90% in the denser tamarisk patches. Standing water was present

throughout the survey season along the northeastern edge of the site in a series of beaver ponds. These beaver ponds have the capacity to be over 2 m deep and were noticeably shallower at the beginning of the season compared to previous years. They also grew progressively shallower during the season. Soils away from the beaver ponds were dry.

No willow flycatchers were detected. The site was surveyed three times, totaling 5.6 observer-hours. Cowbirds were detected during one survey. Habitat suitability is currently low in this site and has declined in recent years as canopy closure and the extent of wet soils have decreased.

Black Rail

Area: 1.2 ha Elevation: 153 m

This survey site is located approximately 250 m southeast of Site 05 on the eastern edge of the Bill Williams River flood plain. Vegetation in this mixed-native site contains a broken overstory of cottonwoods and Goodding's willows up to 15 m in height. Several clumps of tamarisk 4 m in height are scattered in the understory. Patches of dense, completely brown cattails and bulrush 1–2 m in height are also scattered through the interior of the site. Canopy cover in the majority of the site is 80%, reaching 90% in some denser areas. A dense stand of even-aged Goodding's willows 12–15 m in height, with a continuous canopy, is present along the southwestern edge of the site. Soils were completely dry during a visit in May.

No willow flycatchers were detected. The site was surveyed once, totaling 0.5 observer-hour, but occupancy status could not be determined from the limited survey effort. No cowbirds were detected. Surveys were discontinued for the season after one visit because soils at the site were completely dry. In addition to the lack of wet soils, most of the site lacks suitably dense canopy closure, though canopy closure could increase if wet soils were present. SWCA recommends visiting this site again in future years to determine if soil moisture conditions and vegetation structure have improved.

Beaver Pond North (Formerly Mineral Wash)

Area: 19.0 ha Elevation: 165 m

Beaver Pond North is a mixed-native survey site located approximately 2 km upstream of Black Rail. The site has been on a periodic survey schedule since 2008 because of a relative lack of resident flycatchers and wet soils away from the main river channel; it was last surveyed in 2012. The site contains two channels of the Bill Williams River, one along the southwestern edge of the site and the other through the center of the site. Areas of bulrush, cattails, and sedges as well

as several beaver ponds are present in both channels. Vegetation within 50 m of the river channel in the center of the site consists 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 changes to a mix of tamarisk, honey mesquite, and arrowweed. A few emergent cottonwoods and Goodding's willows with narrow canopies are present in this portion of the site as well but do not form a closed canopy. Vegetation more than 50 m away from the river channel in the center of the site is largely a mix of tamarisk and arrowweed. Canopy closure ranges from 60% in the more open areas with cattail marsh or sparse overstory to 90% in areas with lusher Goodding's willow overstory. In May, both river channels held standing water, though the river channel in the center of the site was dry in the northern third of the site. By June, almost all standing water was gone, with only a few isolated pools remaining near the beaver dams in the center of the site. Soils away from the channels were dry and sandy throughout the survey season.

No willow flycatchers were detected. The site was surveyed five times, totaling 7.8 observer-hours. Cowbirds were detected during all surveys. Most of the site lacks moist soils and dense canopy closure, making it largely unsuitable for nesting flycatchers. Some patches of vegetation adjacent to the river have suitably dense canopy, and continuing periodic surveys at this site is recommended because of the presence of these patches of suitable habitat.

Beaver Pond

Area: 21.5 ha Elevation: 170 m

Beaver Pond is a mixed-native survey site that is contiguous with the upstream end of Beaver Pond North. Due to a lack of resident flycatchers and a lack of suitable hydrology away from the river channel, this site was put on a periodic survey schedule; it was last surveyed in 2012. 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 50 m of the river channel in the center of the site consists 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. Some seep willows are scattered in the understory adjacent to the river channel. Vegetation more than 50 m away from the river channel in the center of the site consists of tamarisk and honey mesquite 5–7 m in height. Cattails and bulrush are present along most of the southern river channel. In the river channel in the center of the site, a series of beaver dams has created several pools with relatively little vegetation. Portions of the channel between the pools are vegetated in either cattails or sedges. Canopy closure ranges from 50% in the more open areas with beaver pools to 90% in areas with a lusher overstory. 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 southern half of the site. By July, standing

water was only present in a very deep beaver pool at the very southern end of the site. Soils away from either river channel were dry and sandy throughout the survey season.

No willow flycatchers were detected. The site was surveyed five times, totaling 8.2 observer-hours. Cowbirds were detected during four surveys. Most of the site lacks moist soils and dense canopy closure, making it largely unsuitable for nesting flycatchers. Some patches of vegetation adjacent to the river have suitably dense canopy, and continuing periodic surveys at this site is recommended because of the presence of some patches of suitable habitat.

Site 08

Area: 12.1 ha Elevation: 181 m

Site 08 is a narrow, linear, mixed-native survey site that encompasses the river channel approximately 3 km upstream of Beaver Pond, at the confluence of the Mohave Wash and the Bill Williams River. This section of the river is confined between high cliffs on both banks. Due to a lack of resident flycatchers and a lack of suitable hydrology away from the river channel, this site was put on a periodic survey schedule and had not been visited since 2010. This site was expanded at the end of the 2015 season to encompass habitat around a nest location discovered adjacent to the northeastern corner of the site. Only the original extent of the site was described. Vegetation immediately adjacent to the river channel consists of an overstory of 8–10-m-tall Goodding's willows and 12–15-m-tall cottonwoods with an understory of 2–6-m-tall tamarisk. Some 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 a mix of tamarisk, arrowweed, and honey mesquite, but in the eastern half of the site, there is also a loose overstory of cottonwoods. Canopy closure ranges from 50 to 90% but averages 70%. Standing water was present in the river channel and beaver ponds throughout the survey season, but soils beneath the vegetation were dry. Soil moisture data collected beneath the nest location as part of nest monitoring indicate the annexed portion of the site contained at least some damp soils.

Two breeding flycatchers were detected in Site 08. Unoccupied portions of the site were surveyed five times, totaling 6.6 observer-hours. Cowbirds were detected during one survey. Most of the site lacks moist soils and dense canopy closure, making it largely unsuitable for nesting flycatchers. Some suitable habitat is present in the annexed northeastern corner of the site, but total areal extent is unknown, though likely limited. The original extent of the site continues to lack wet soils outside of the river channel, and it lacks suitably dense canopy closure in most areas. Some patches of vegetation adjacent to the river in the original portions of the site have suitably dense canopy; continuing periodic

surveys in the original extent of this site is recommended because of the presence of some patches of suitable habitat. Annual surveys should be completed in the area that was occupied in 2015, and further exploration of the area between Site 08 and Upstream from Site 08 is warranted.

Upstream from Site 08

Area: 1.5 ha Elevation: 181 m

Upstream from Site 08 is located on the northern side of the riparian zone, approximately 100 m east of Site 08. Vegetation in the site consists of an overstory of 15–20-m-tall cottonwoods and 10–15-m-tall Goodding's willows with an understory of 3–5-m-tall tamarisk. Goodding's willows are more prevalent in the eastern portion of the site, and cottonwoods are more prevalent in the western portion. The northern edge of the site borders a cattail marsh. Canopy cover is variable and ranges from 60 to 80%, with an average of 70%. Standing water was present along the northern and western borders of the site in the cattail marsh. Most of the soils away from the marsh were damp throughout the season.

No willow flycatchers were detected. The site was surveyed three times, totaling 1.9 observer-hours. Cowbirds were detected during all three surveys. Overall habitat suitability is low within the site, as canopy closure is not dense enough. While most of the site lacks wet soils, they are present adjacent to the site. SWCA recommends putting this site on the periodic survey schedule to determine whether soil moisture and canopy closure improve in future years.

Alamo Lake, Arizona

The Alamo Lake study area is located along the Big Sandy and Santa Maria Rivers, near their confluence, and downstream along the Bill Williams River to the current shore 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 each year from 2012 to 2014 (Lakes Online 2014). Imagery available on Google Earth shows that Sidebar 01, Camp 01–04, Middle Earth 01–02, and Burro Wash 01–02 were still under water as of June 24, 2011. Lake levels were roughly 5 feet higher in 2015 than they were in 2014 due to a storm event in March, but no wet soils were present within the vegetation in any survey site during the breeding season. Burros and cattle were noted in and near many of the survey sites. Field effort at Alamo Lake focused on monitoring known territories. No site was surveyed more than once, and most sites were described only once or twice.

Sidebar 01

Area: 1.7 ha Elevation: 377 m

This mixed-native survey site is located on the eastern edge of the riparian area, 1 km downstream from the end of Brown's Crossing Road. Vegetation within the site consists of a 30–50-m-wide strip of Goodding's willows, 7–8 m in height, with a few cottonwoods. Tamarisk up to 2 m in height is scattered in the understory. Some arrowweed and seep willows are present in the understory and are more prevalent near the edges of the site than in the interior. There are several areas with standing snags, and the southern 100 m of the site are completely dead. Canopy closure ranges from 50% in areas with snags to 95% in the densest vegetation.

Sidebar 01 was occupied by two breeding flycatchers. In addition, one willow flycatcher for which residency status could not be determined was detected on July 20. The site was surveyed once, totaling 1.0 observer-hour. Two cowbirds were detected during the survey, and additional cowbird detections were recorded during monitoring activities. Most of the site contains very suitable vegetation structure, with good vegetation height, high canopy closure, good branching structure with many locations for nest placement, and a good density of stems.

Edgewater 01

Area: 10.4 ha Elevation: 377 m

Edgewater 01 is located 500 m northwest of Sidebar 01, in the middle of the riparian zone. This site was first visited in 2014 and was determined to consist of vegetation that was too short (< 4 m tall) to be considered suitable. In 2015, flycatchers were discovered in a 100- x 40-m patch of 8-m-tall Goodding's willows located along the western border approximately mid-way between the northern and southern ends of the site. Tamarisk 2–4 m in height dominates the understory. Canopy closure in this portion of the site reached 90%. Most of the rest of the site was not described. SWCA recommends a more thorough assessment of the rest of this site in future years to determine whether the vegetation has developed suitable structure.

Edgewater 01 was occupied by two breeding flycatchers. This site was not surveyed because of occupancy status. The occupied portion of the site has high canopy closure, good branching structure for nest placement, and an understory that is dense enough to provide concealment while still providing flyways.

Camp 01

Area: 0.7 ha Elevation: 377 m

This native survey site is located approximately 200 m northwest of Edgewater 01 on the western edge of the riparian area. The site is bordered by dry upland scrub to the northwest and the main river channel to the southeast. Dominant vegetation within the survey site consists of Goodding's willows 8–9 m in height with 75% canopy closure. An understory is lacking in much of the site, but clumps of tamarisk 2–3 m in height and arrowweed up to 2 m tall occur in more open areas. Water was present in a stream channel 10 m southeast of the site during visits in June and July, but an incised bank separates the site from the stream channel.

No willow flycatchers were detected. The site was surveyed once, totaling 0.2 observer-hour, but occupancy status could not be determined from the limited survey effort. No cowbirds were detected during the survey. Canopy closure appears to have declined since 2014, but further assessments are needed to determine the level of habitat suitability.

Camp 04

Area: 0.3 ha Elevation: 377 m

Camp 04 is located approximately 180 m northeast of Camp 01. Vegetation in this survey site consists of a narrow, linear stand of 5–8-m-tall Goodding's willows with 2–3-m-tall tamarisk in the understory and 65% canopy closure. The site is bordered to the east by a dense stand of arrowweed and to the west by the river channel. The bank of the channel is at least 1 m in height. Standing water was present in the river channel during visits in June and July.

No willow flycatchers were detected. The site was surveyed once, totaling 0.04 observer-hour, but occupancy status could not be determined from the limited survey effort. No cowbirds were detected during the survey. Canopy closure appears to have declined since 2014, but further assessments are needed to determine the level of habitat suitability.

Camp 02

Area: 0.3 ha Elevation: 377 m

Camp 02 is located 45 m northwest of Camp 04 and lies at the outflow of a small wash. It is bordered to the west, north, and south by dry upland scrub and to the east by the main river channel. Vegetation within the site consists primarily of Goodding's willows 8–9 m in height with 75% canopy closure. Tamarisk 2–3 m

in height dominates the understory, with some Emory baccharis scattered throughout. There was water in the main river channel to the east during visits in June and July. The site sits on a bench above the water.

No willow flycatchers were detected. The site was surveyed once, totaling 0.04 observer-hour, but occupancy status could not be determined from the limited survey effort. No cowbirds were detected during the survey. Canopy closure appears to have declined to low suitability levels since 2014, but further assessments are needed to determine the level of habitat suitability.

Camp 03

Area: 1.9 ha Elevation: 377 m

Camp 03 is located 150 m north of Camp 02. This survey site is located at the outflow of a wash and is bordered to the north and west by dry upland scrub and to the south and east by the river channel. The site is vegetated by a stand of dense Goodding's willows 9–10 m in height with 1–3-m-tall tamarisk scattered in the understory. Some cottonwoods are scattered in the overstory, and seep willows are present in the understory. Canopy closure averages 75%. Water was present in the river channel in July, but the banks are steeply incised to a depth of 3 m.

No willow flycatchers were detected. The site was surveyed once, totaling 0.2 observer-hour, but occupancy status could not be determined from the limited survey effort. One cowbird was detected during the survey. Canopy closure appears to have declined to low suitability levels since 2014, but further assessments are needed to determine the level of habitat suitability.

Middle Earth 01

Area: 6.1 ha Elevation: 377 m

This mixed-native survey site is located approximately 700 m southwest of the end of Brown's Crossing Road on the eastern side of the riparian zone. The site is surrounded on all sides by historic lakebed, which is patchily vegetated with 2-m-tall tamarisk and seep willows, scattered patches of arrowweed, and several herbaceous species. Vegetation within the site consists of Goodding's willows 9–10 m in height with a scattered tamarisk understory up to 5 m in height. The tamarisk are patchy and become very dense in places. Canopy closure ranges from 60 to 85%. Most of the site has a sparse understory and low (60%) canopy closure. A small area in the southeastern portion of the site has a very thick understory and 85% canopy closure. Soils within the site were damp to completely dry during visits in May and June. The distance to the nearest surface water varied between 540 and 730 m.

Middle Earth 01 was occupied by seven breeding flycatchers and one unpaired male. This site was not surveyed because monitoring of known territories was prioritized over surveying portions of the site outside the known occupied area. Low canopy closure (60%) was documented in a majority (> 75%) of the site, and this suggests a decline since 2014. Further assessments are needed to determine the extent of suitable habitat.

Middle Earth 02

Area: 6.7 ha Elevation: 377 m

This mixed-native survey site is located 75 m north of Middle Earth 01 and 400 m due west of the end of Brown's Crossing Road. It is surrounded on all sides by historic lakebed. Vegetation within the southern portion of the site consists 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 exist in the center of the site and are dominated by seep willows. Canopy closure ranges from 70% in the gaps to 90% in the denser willows. Some cottonwoods are scattered in the overstory. The northern arm of the site was not described in 2015, but in 2014, it consisted of clumps of Goodding's willows 6–8 m in height surrounded by tamarisk 2–4 m in height and seep willows up to 2 m in height. In 2015, soils were mostly damp during a visit in May and gradually dried out to be mostly dry by July. The distance to the nearest surface water varied between 160 and 700 m.

Middle Earth 02 was occupied by 15 breeding flycatchers. One flycatcher was also detected that moved on to breed in Motherlode 01. This site was not surveyed because monitoring of known territories was prioritized over surveying portions of the site outside the known occupied area. While low canopy closure was documented in areas with gaps (approximately 25% of the site), the gaps are present in a matrix with more suitable habitat. A majority of the site contains very suitable vegetation structure, with good canopy closure (90%) and good branching structure for nesting.

Prospect 01

Area: 1.1 ha Elevation: 377 m

This mixed-native survey site runs north-south along a bench 100 m west of the end of Brown's Crossing Road on the eastern edge of the riparian zone. The eastern side of the site is on top of the bench, and the western side of the site is at the bottom of the bench. Soils between the two sides slope gradually in transition, rather than being sharply incised, and in total there is an approximate 1-m difference in elevation between the two sides. Vegetation within the site consists of a 20–30-m-wide strip of Goodding's willows 7–8 m in height with 2–3-m-tall tamarisk scattered throughout the understory. Some seep willows are also

scattered throughout the understory. Tamarisk are more prevalent on top of the bench, and many of the Goodding's willows have died in this area, creating gaps with 50% canopy closure. On the western side of the site, below the bench, Goodding's willows are the dominant vegetation, with little to no tamarisk and canopy closure reaching 90%. The distance to the nearest surface water varied between 615 m and 1.2 km.

No willow flycatchers were detected. The site was surveyed once, totaling 0.9 observer-hour, but occupancy status could not be determined from the limited survey effort. One cowbird was detected during the survey. Some suitable vegetation structure is present in less than one-half the site, where canopy closure is the highest.

Burro Wash 01

Area: 3.9 ha Elevation: 377 m

This mixed-native survey site is located 350 m northwest of the upper arm of Middle Earth 02, near the western edge of the riparian zone. The site is bordered to the north by a dry cattail marsh and to the south by an open, dry river channel. Vegetation within the site consists of Goodding's willows 6–10 m in height with 2–3-m-tall tamarisk in the understory. In the western half of the site, the Goodding's willows are taller, with a sparser understory and canopy closure of 75%. In the eastern half of the site, tamarisk become dominant with scattered emergent Goodding's willows 6 m in height and canopy closure of 85%. In the very southeastern corner of the site, 7-m-tall Goodding's willows form a dense overstory with 95% canopy closure and 2-m-tall tamarisk and seep willows in the understory. The distance to the nearest surface water varied between 170 and 500 m.

No willow flycatchers were detected. The site was surveyed once, totaling 1.3 observer-hours, but occupancy status could not be determined from the limited survey effort. Two cowbirds were detected during the survey. The western half of the site has low habitat suitability because of a lack of dense canopy closure. The eastern half of the site has moderate habitat suitability, as canopy closure reaches 85%. The very southeastern corner of the site has good vegetation structure and the best habitat suitability.

Burro Wash 02

Area: 6.8 ha Elevation: 377 m

This mixed-native survey site is located approximately 100 m northeast of Burro Wash 01 and forms a strip of riparian vegetation 75–170 m wide. It is bordered to the west by dry cattail marsh, to the east by a large swath of dead and

downed trees, to the north by dry upland scrub, and to the south by live riparian forest in Motherlode 01. Vegetation within the site consists of small-diameter Goodding's willows 8–10 m in height with 2–3-m-tall tamarisk in the understory and 75–90% canopy closure. Seep willows and cattails are also present in the understory, mostly in the northern half of the site. In the southern half of the site, canopy closure is higher, and the understory is less dense and widely scattered. More gaps are present in the northern half of the site, and canopy closure is lower. The distance to the nearest surface water varied between 350 and 900 m.

Burro Wash 02 was occupied by four breeding flycatchers in the southern tip of the site, adjacent to Motherlode 01. In addition to resident adults, one willow flycatcher for which residency status could not be determined was detected in early June. The site was surveyed once, totaling 0.7 observer-hour. No cowbirds were detected during the survey. The best vegetation structure is in the southern half of the site, where canopy closure is highest. Habitat suitability decreases in the northern half of the site with decreasing canopy closure, but small patches of suitable habitat are likely still present.

Motherlode 01

Area: 3.3 ha Elevation: 377 m

This native survey site is located 20 m east of Burro Wash 01 and 25 m south of Burro Wash 02. It is 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. Vegetation within the western third of the site consists of a dense stand of small-diameter Goodding's willows 8–10 m in height with 3–5-m-tall tamarisk widely scattered in the understory. Canopy closure reaches 90% in this portion of the site. The eastern two-thirds of the site is vegetated with larger-diameter Goodding's willows 10–20 m in height. This portion of the site contains more gaps in the canopy, which are filled with deadfall and dense tamarisk 3–5 m in height; canopy closure in this section reaches 80%. Seep willows are also scattered through this portion of the site. Near the very northeastern portion of the site, the Goodding's willows are dying back, with tamarisk filling in from the understory. The distance to the nearest surface water varied between 160 and 760 m.

Motherlode 01 was occupied by 14 breeding flycatchers and 1 unpaired male, all of which were in the western third of the site. This site was not surveyed because monitoring of known territories was prioritized over surveying portions of the site outside the known occupied area. Vegetation structure is very suitable in the western third of the site because of the high canopy closure (90%), good vegetation height, and densely spaced stems with many twigs in the understory for nest locations. The eastern two-thirds of the site lack suitable canopy closure.

Motherlode 02

Area: 21.6 ha Elevation: 377 m

This mixed-native survey site is located 275 m east of Burro Wash 02. It 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. Vegetation within the site consists of Goodding's willows 7–15 m in height with significant amounts of deadfall scattered in the understory. Some tamarisk and seep willows are scattered in a narrow band around the very western and northern borders of the site. The trees are shorter (7–9 m in height) in the southern portion of the site, with wide crowns and canopy closure reaching 85%. In the northern two-thirds of the site, tree height averages 10–12 m, with a few trees reaching 15 m in height. Most tree canopies are narrow in the northern portion of the site, creating a more broken canopy than in the southern end of the site, and canopy closure varies between 70 and 85%. Several tall, large-diameter willows (> 40 cm diameter at breast height) are present within the site, but many of the ≥ 10-m-tall trees have relatively narrow diameters (< 20 cm diameter at breast height) and are starting to lean. Many of the trees in the northeastern portion of the site are dying, and several gaps with nothing but snags have formed. The distance to the nearest surface water varied from 740 m to 1.2 km.

No willow flycatchers were detected. The site was surveyed once, totaling 2.9 observer-hours, but occupancy status could not be determined from the limited survey effort. No cowbirds were detected during the survey. Most of the site lacks suitably dense canopy closure. Areas with minimally suitable canopy closure (85%) or better are very limited in extent in the southern end of the site and along the western border.

Motherlode 03

Area: 12.6 ha Elevation: 377 m

This mixed-exotic survey site is located 100 m east of Motherlode 02. 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. Vegetation within the site consists primarily of tamarisk 4–6 m in height with a scattered, non-contiguous overstory of Goodding's willows 8–12 m in height. A few cottonwoods 10–12 m in height are present along the eastern edge of the site. Many dead willows are scattered throughout the site, and several large gaps in the canopy were noted. Areas with dead willows are filling in with tamarisk. Thick deadfall is also prevalent in the understory. Canopy closure ranges from 60 to 95%. The distance to the nearest surface water varied from 1.2 to 1.5 km.

Motherlode 03 was occupied by four breeding flycatchers. The site was surveyed once, totaling 2.9 observer-hours. One cowbird was detected during the survey.

Some suitable vegetation structure is present within the site where canopy closure is highest, with the best habitat noted in the vicinity of the breeding flycatchers. The total areal extent of suitable habitat is unknown. The rest of the site is too open to be very suitable.

Motherlode 04

Area: 0.5 ha Elevation: 377 m

This site is located 200 m east of Motherlode 03 and consists of a patch of vegetation 120 x 50 m in size in the middle of the dry, open river channel. Vegetation within the site consists of dense Goodding's willows 10–12 m in height with 1–4-m-tall tamarisk in the understory. Some arrowweed 1–2 m in height and a few cottonwoods are scattered around the perimeter of the site. Canopy closure within the willows reaches 90%. The nearest known water throughout the season was approximately 1.3 km away in the river channel between the Santa Marias.

Motherlode 04 was occupied by two breeding flycatchers. The site was surveyed once, totaling 0.3 observer-hour. No cowbirds were detected during the survey. Vegetation structure within the site is very suitable because of the high canopy closure (90%) and good vegetation height. While the site is small, its overall suitability is improved by its proximity to larger swaths of riparian habitat.

Santa Maria South 01

Area: 30.2 ha Elevation: 377 m

This mixed-exotic survey site is located along the southern edge of the riparian area bordering the Santa Maria River and stretches upstream for 1.8 km from 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. Only the western third of the site was described in 2015 because the monitoring of known territories was prioritized over exploring sites not known to be occupied. Vegetation within the western third of the site consists of tamarisk 3–5 m in height with some emergent Goodding's willows and cottonwoods 10 m in height along the northern edge of the site. Canopy closure is 80% in areas dominated by cottonwoods and 60–90% in areas dominated by tamarisk. Water was present in the river channel adjacent to the western end of the site, but the site sits on a terrace, preventing water from entering the vegetation.

No flycatchers were detected. The area was surveyed once, totaling 1.1 observer-hours, but occupancy status could not be determined from the limited survey effort. No cowbirds were detected during the survey. Since the site was not

described completely, it is difficult to assess overall habitat suitability. Some components of suitable vegetation structure do exist within the site, but their areal extent is unknown.

Santa Maria North 01

Area: 29.5 ha Elevation: 377 m

This mixed-exotic survey site is located along the northern edge of the riparian area bordering the Santa Maria River and stretches upstream for 1.4 km from 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 third of the site was described in 2015 because the monitoring of known territories was prioritized over exploring portions of the site outside the known occupied areas. Vegetation within the western third of the site consists primarily of tamarisk up to 6 m in height with emergent cottonwoods and Goodding's willows up to 15 m in height. Large amounts of thick deadfall are found throughout the site, and the tamarisk become quite dense in places, both in canopy closure and stem density. Some of the willows and cottonwoods have begun to die back near the southwestern corner of the site, creating gaps in the canopy. Canopy closure ranges from 50% in areas with gaps to 90% in the densest tamarisk. 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 during visits in June and July.

This site was occupied by two breeding flycatchers and two paired flycatchers for which no nest was found. The site was surveyed once, totaling 0.8 observer-hour. No cowbirds were detected during the survey. Since the site was not described completely, it is difficult to assess overall habitat suitability. Some suitable vegetation structure does exist within the site, as evidenced by breeding activity, but total areal extent is unknown.

Palo Verde Ecological Reserve, California

The PVER is a conservation area located on the California bank of the Colorado River. All sites are periodically flood irrigated. Lands immediately to the west are dominated by agricultural fields. No evidence of livestock has been documented in or around the PVER study area.

Phase 02

Area: 21.4 ha Elevation: 86 m

The survey site known as Phase 02 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 8-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 10-m-tall cottonwoods. Height and density of the vegetation varies within and between cells of the site. Canopy closure is highly variable and is 60–85% in the Goodding's willows, 70–90% in the coyote willows, and 70–90% in the cottonwoods. Some *Baccharis* bushes were sparsely scattered in the understory of the site. No wet soils were noted in the site, but standing water was documented in adjacent irrigation channels throughout the season.

Field personnel detected three willow flycatchers on May 15 and three on May 30, and this site is not considered occupied. The site was surveyed five times, totaling 12.4 observer-hours. Many cowbirds were detected during all visits. Some suitable vegetation structure is present within the site, but few areas have both canopy closure ≥ 85% and a suitable branching structure in the understory. Overall habitat suitability is low.

Phase 03

Area: 21.4 ha Elevation: 86 m

The survey site known as Phase 03 is vegetated primarily with cottonwoods reaching 12 m in height. Rows ≤ 10 m wide of mixed Goodding's willows 5–8 m in height and small-diameter coyote willows up to 4 m in height are spaced roughly 40–50 m apart throughout the site. *Baccharis* shrubs 1.5 m in height occur occasionally along the borders between the willows and cottonwoods. The overall effect is a mosaic of vegetation types. The height and density of the vegetation vary within the site, with the vegetation taller and denser on the western side. Canopy closure under the cottonwoods reaches 85% but is as low as 60% in the coyote willows. The eastern 20% of the site is vegetated with smaller-diameter Goodding's willows reaching 10 m in height and clumps of baccharis reaching 1.5 m in height. Canopy closure here reaches 80%. Surface water was noted within the site in late June as part of active irrigation. The site contained mostly damp soils during visits in May and July, with the nearest surface water located either in the Colorado River or in an irrigation ditch immediately adjacent to the site.

One willow flycatcher was detected on May 15, and this site is not considered occupied. The site was surveyed five times, totaling 9.7 observer-hours. Cowbirds were detected during all visits. Canopy closure is too low through most of the site, and in combination with lack of consistently wet soils, habitat suitability is low.

Phase 04 Block 01

Area: 7.7 ha Elevation: 87 m

Phase 04 Block 01 is vegetated primarily by Goodding's willows up to 10 m in height. Five evenly spaced, 20-m-wide strips of cottonwoods up to 12 m in height are dispersed throughout the site. Some coyote willows 2–3 m in height are present near the cottonwood-Goodding's willow boundaries. Canopy closure was 80–90% in the cottonwoods and 60–80% in the Goodding's willows. *Baccharis* is planted on the northern edge of the survey site. A majority of the site contained surface water from active irrigation during a visit in mid-June. Soils were damp during visits in May and dry in July, with the nearest surface water located in the Colorado River.

One willow flycatcher was detected on May 16, and this site is not considered occupied. This block was surveyed five times, totaling 5.4 observer-hours. Cowbirds were detected during all visits. Although canopy closure reaches suitable density in the cottonwoods, the cottonwoods cover < 25% of the site, and the lack of understory and available branching structure for nest placement limits habitat suitability. Canopy closure is too low in the Goodding's willows, and consistently wet soils are lacking; thus, overall habitat suitability is low.

Phase 04 Block 02

Area: 4.0 ha Elevation: 87 m

Phase 04 Block 02 lies due east of Phase 04 Block 01 and is adjacent to the Colorado River. This survey site is primarily vegetated with Goodding's willow 8–10 m in height. Canopy height is shorter along the northern and southern edges. Some coyote willow 4–6 m in height is present in small clumps or strips along the northern and southern edges of the site. Cottonwoods 10–12 m in height is present in a square patch approximately 35 x 35 m in size near the center of the site. Canopy closure is 80–90% in the Goodding's willows and 85–95% in the cottonwoods. In general, canopy closure is sparser along the northern and southern edges and in the eastern half of the site. No surface water was documented within the site during any visits, and the nearest surface water was located either in the Colorado River or in an irrigation canal adjacent to the site.

One willow flycatcher was detected on May 16, and this site is not considered occupied. The site was surveyed five times, totaling 4.3 observer-hours. Cowbirds were detected during all visits. Overall vegetation structure is suitable within the site, but wet soils are lacking.

Phase 04 Block 03

Area: 23.7 ha Elevation: 87 m

Phase 04 Block 03 lies due north of Phase 04 Block 02 and is also located adjacent to the Colorado River. This survey site is vegetated with 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 10–12 m in height form the overstory for the majority of the block. Goodding's willows 7–9 m in height and spindly coyote willows 3–6 m in height occur throughout the understory. There are a few narrow (20-m-wide) strips containing only Goodding's and coyote willows. Cottonwoods are less prevalent in the north-central portion of the site, and coyote willows 4–6 m in height are the dominant woody species in the gaps between the cottonwoods. Canopy closure is 90% within the cottonwoods and as low as 55% in areas with only coyote willows. This site contained surface water during a visit in July.

One resident flycatcher was detected from May 31 to June 14, and this site is considered occupied. In addition to the resident flycatcher, four willow flycatchers were detected on May 16 and one on June 27. The resident flycatcher was actively defending a territory, engaging in lengthy, unsolicited song on each of seven territory visits. This is the first detection of a territorial, resident flycatcher south of Parker Dam since SWCA began monitoring in 2003. The individual that was detected on June 27 also engaged in lengthy, unsolicited song and was located in the same general area as the resident flycatcher. The site was surveyed five times, totaling 11.5 observer-hours. Cowbirds were detected during all visits. Vegetation structure is suitable throughout most of the site, though a lack of consistently wet soils reduces overall habitat suitability.

Phase 05 Block 01

Area: 15.9 ha Elevation: 88 m

Of the three survey sites in Phase 05, Block 01 contains the greatest proportion of grassy fields. The grassy fields dominate the center of the site. The most suitable habitat is located within 100 m of the eastern and southern edges and the northwestern corner of the site, and these were the only portions surveyed. The habitat within 100 m of the southern edge of the site is vegetated primarily with Goodding's willows 8–10 m in height and some cottonwoods up to 12 m in height, with some small clumps of coyote willows 4 m in height scattered in the understory. Canopy closure is densest along the very southern edge of the site, reaching 85–90%, and decreases to 40–60% along the northern edge of this portion of the site. Habitat within 100 m of the eastern edge is vegetated with cottonwoods 6–10 m in height and Goodding's willows 5–8 m in height, with the shorter trees being to the north and along the very eastern edge of the site. Canopy closure varies between 50 and 65% in this portion of the site. The

northwestern corner of the block contains cottonwoods and Goodding's willows 7–10 m in height with 65–75% canopy closure. Standing water was noted in the site from active irrigation during a visit in July. Soils were dry or damp during visits in May and June, and the nearest standing water was in the Colorado River.

Field personnel detected 11 willow flycatchers on May 17 and 1 on June 6, and this block is not considered occupied. The block was surveyed five times, totaling 8.1 observer-hours. Cowbirds were detected during all visits. Most of the site, with the exception of vegetation along the southern border, lacks suitably dense canopy closure. Low canopy closure in combination with a lack of consistently wet soils creates overall low habitat suitability at this site.

Phase 05 Block 02

Area: 23.6 ha Elevation: 88 m

Phase 05 Block 02 lies due east of Phase 05 Block 01 and is adjacent to the Colorado River. This survey site contains a lower percentage of open, grassy fields than Block 01. It is primarily vegetated with cottonwoods up to 10 m in height in the western half of the site and Goodding's willows up to 8–9 m in height in the eastern half. Vegetation height for all trees is shorter along the northern edge of the site, reaching only 5–6 m in height. Canopy closure averages 60–75% in the Goodding's willows and 70–80% in the cottonwoods. A few small clumps of spindly 4-m-tall coyote willows are scattered throughout the understory. No surface water was documented within the block during any visits.

Three willow flycatchers were detected on May 17, and this block is not considered occupied. The site was surveyed five times, totaling 10.7 observer-hours. Cowbirds were detected during all visits. Low canopy closure in combination with a lack of consistently wet soils creates overall low habitat suitability at this site.

Phase 05 Block 03

Area: 29.6 ha Elevation: 88 m

Phase 05 Block 03 is located due north of Block 02. It contains the smallest proportion of open grassy areas of the three survey sites in Phase 05. The site is primarily vegetated with a mix of cottonwoods and Goodding's willows. The eastern and western thirds of the site are predominantly cottonwoods up to 10 m in height, with many thin (≤10-m-wide) strips of Goodding's willows 6–8 m in height. Canopy closure ranges from 65 to 75% in these portions of the site. Open, grassy areas are more abundant in the eastern third of the site than elsewhere. The center third of the site is predominantly Goodding's willows 6–7 m in height with a dense patch of 3-m-tall coyote willows in the southern end.

Canopy closure in this portion varies from 70 to 75%. A small portion of the site was inundated during a visit in May, and some saturated soils were noted during a visit in July. Soils in June were dry.

Three willow flycatchers were detected on May 22, and this block is not considered occupied. The site was surveyed five times, totaling 11.7 observer-hours. Cowbirds were detected during all visits. Low canopy closure in combination with a lack of consistently wet soils creates overall low habitat suitability at this site.

Phase 06 Block 01

Area: 38.7 ha Elevation: 87 m

This survey site contains a few open areas but 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 up to 10 m in height, and the Goodding's willows are up to 8 m in height. Canopy closure ranges from 65% in open areas to 90% in the tallest, densest cottonwoods, but is typically 80%. Coyote willows up to 5 m in height are also present in narrow (1–5-m-wide) rows throughout the site, with canopy cover ranging from 60 to 75%. Seep willow and another *Baccharis* species are scattered throughout the understory. Surface water was noted during visits in May and July, but soils were dry or damp in June, with the nearest water in an irrigation ditch adjacent to the site.

No willow flycatchers were detected. The site was surveyed five times, totaling 14.1 observer-hours. Many cowbirds were detected during all visits. Canopy closure reaches suitable density within the cottonwoods, but there is no understory, and the trees do not provide suitable branching structure for nesting. Wet soils are also lacking, and habitat suitability is low.

Phase 06 Block 02

Area: 37.6 ha Elevation: 87 m

Phase 06 Block 02 is located between Phase 06 Block 01 and Phase 05 Block 03. This survey site is vegetated with a mosaic of Goodding's willows, cottonwoods, and coyote willows, with Goodding's willows being most prevalent and coyote willows least prevalent. Vegetation height is up to 10 m in areas with cottonwoods and 8 m in areas with Goodding's willows. Canopy closure averages 70–80%. Coyote willows vary from 2-m-tall, wispy stems that are widely spaced to 5-m-tall stands with 50% canopy closure. Seep willows are

scattered throughout the site. Soils were mostly damp, with < 1% of the site containing saturated soil during a visit in May, but were dry in June and July. The nearest standing water was in the Colorado River.

No willow flycatchers were detected. The site was surveyed five times, totaling 15.1 observer-hours. Many cowbirds were detected during all visits. Low canopy closure in combination with a lack of consistently wet soils creates overall low habitat suitability at this site.

Phase 07 Block 01

Area: 36.8 ha Elevation: 87 m

Phase 07 Block 01 is located due north of Block 02. 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 rows of coyote willows. The cottonwoods reach 8–10 m in height, and the Goodding's willows reach 4–8 m in height. Canopy closure varies directly with canopy height and is typically 70–85%. Much of the coyote willows vary from 2-m-tall, wispy stems that are widely spaced to 5-m-tall stands with 60% canopy closure. *Baccharis* is scattered throughout the site. The site was being irrigated during a visit in May, but soils were dry in June and July. The nearest standing water was in the Colorado River.

Field personnel detected 11 willow flycatchers on May 16 and two on May 17, and this site is not considered occupied. The site was surveyed five times, totaling 13.2 observer-hours. Many cowbirds were detected during all visits. Low canopy closure in combination with a lack of consistently wet soils creates overall low habitat suitability at this site.

Phase 07 Block 02

Area: 40.6 ha Elevation: 87 m

Phase 07 Block 02 is located between Phase 07 Block 01 and Phase 06 Block 01. 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 rows of coyote willows. The cottonwoods reach 8–10 m in height, and the Goodding's willows reach 4–8 m in height. Canopy closure varies directly with canopy height and is typically 70–80%. Coyote willows vary from 2-m-tall, wispy stems that are widely spaced to 5-m-tall stands with 65% canopy closure. *Baccharis* is also scattered throughout the site. Several open areas with widely spaced Goodding's and coyote willows are

present within the site. Thick stands of grass and alfalfa are present in these open areas. Soils were mostly damp during visits in May and July but were mostly dry in June. The nearest standing water was in the Colorado River.

Five willow flycatchers were detected on May 17 and two on June 1, and this site is not considered occupied. The site was surveyed five times, totaling 13.8 observer-hours. Many cowbirds were detected during all visits. Low canopy closure in combination with a lack of consistently wet soils creates overall low habitat suitability at this site.

Ehrenberg, Arizona

Ehrenberg

Area: 4.7 ha Elevation: 78 m

Ehrenberg is a mixed-native site located immediately adjacent to the Colorado River. It was put on the periodic survey schedule in 2008 and has not been visited since 2012. A stringer of primarily 20–25-m-tall cottonwoods runs north to south through the middle of the site. In the southern half of the site, the understory consists of 1–2-m-tall arrowweed, and several of the cottonwoods are dying. Canopy closure reaches 50% in this portion of the site. In the northern half of the site, the arrowweed becomes less abundant, and Emory baccharis becomes more dominant in the understory. A few large Goodding's willows are present in the stringer in this portion of the site. Canopy closure reaches 80% in this portion of the site. Two cattail marshes are present within the site, one in the eastern half of the site and the other in the northwest portion of the site, adjacent to the site border. The northwestern cattail marsh contains thin, wispy coyote willows 3–4 m in height with 75–80% canopy closure. The size and extent of the coyotes willow in this marsh have not changed significantly since 2012. The northwestern marsh is bordered to the south by an area of dead and fallen coyote willows that has been present since 2008. The eastern cattail marsh is 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 is present between the cattails and tamarisk on the western side of the marsh. Canopy closure reaches 80% on either side of the eastern marsh. The far eastern and southern portions of the site are vegetated primarily with arrowweed. The western cattail marsh was inundated during a visit in March, but both marshes contained only small amounts of damp soils during the survey season. All other soils were dry. The site is separated from the Colorado River by a levee.

No willow flycatchers were detected. The site was surveyed five times, totaling 3.7 observer-hours. Cowbirds were detected during each survey. No evidence of livestock use was observed within the site, although burros used the periphery of the site. Most of the site is dry and lacks both a closed canopy and a live understory other than arrowweed or Emory baccharis, making it unsuitable for

breeding flycatchers. The presence of coyote willows in or adjacent to cattail marsh suggests the potential for habitat suitability to improve if more surface water is present and the willows increase in density and extent. This site should be reevaluated at the beginning of future seasons to see if the hydrology and vegetation structure have improved, and surveys should be discontinued if there was no improvement.

Cibola, Arizona and California

The survey sites in this study area are a mix of conservation area sites and existing, unrestored riparian sites. The conservation area sites are located 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. The unrestored riparian sites are located in the refuge and on land immediately south of the refuge. No evidence of livestock was documented in or around any sites in the study area.

Phase 01

Area: 26.2 ha Elevation: 74 m

Phase 01 at the CVCA 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 tallest cottonwoods are 15 m in height, and the tallest Goodding's willows are around 12 m in height. Coyote willows reach 3–6 m in height. Canopy closure is 65–90% in the cottonwoods, 60–70% in the Goodding's willows, and 55–80% in the coyote willows. A lot of the coyote willows around the perimeter of the mono-specific cells have died, and canopy closure is low within these cells. A few of the cells have scattered trees in grassy fields. No surface water was documented within the site during any visits, though soils were completely damp during a visit in July. An irrigation canal adjacent to the western edge of the site held water during visits in May and July.

Two willow flycatchers were detected on May 27, and this site is not considered occupied. The site was surveyed five times, totaling 10.0 observer-hours. Large flocks of cowbirds were detected during all visits. Canopy closure is too low within most of the site. Canopy closure reaches suitably high density in portions of the cottonwoods, but good branching structure for nesting is lacking. Wet soils are also lacking, and habitat suitability is low.

Phase 02

Area: 25.5 ha Elevation: 74 m

The survey site known as Phase 02 at the CVCA is located immediately south of Phase 01. 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 7–10 m in height, with Goodding's willows up to 8 m in height. The coyote willows are 3–7 m in height. Most of the Goodding's willows are dying back, and in some areas live foliage is present only on the lower half of the tree. Vegetation within 20 m of the southern edge of the site is cottonwoods 8–9 m in height. The tallest, densest vegetation is located within 10 m of the northern edge of the site. Canopy cover ranges from 60 to 85% and varies directly with vegetation height. Many of the willows of both species are severely stressed, with some up to half dead, and canopy closure decreases as the amount of willows increases. No surface water was documented within the site during any visits, though soils were completely damp during a visit in July. An irrigation canal 80 m west of the site held surface water during a visit in May, and a canal immediately north of the site held water in July.

Two willow flycatchers were detected on May 27, and this site is not considered occupied. The site was surveyed five times, totaling 10.2 observer-hours. Large flocks of cowbirds were detected during all visits. Canopy closure is too low within most of the site. Canopy closure reaches suitable levels along the northern edge of the site, but suitable branching structure for nesting is only present within the two willow species and is therefore limited in areal extent. Wet soils are also lacking, and overall habitat suitability is low.

Phase 03

Area: 38.4 ha Elevation: 73 m

The survey site known at Phase 03 at the CVCA is located 2.5 km west of Phases 01 and 02. 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 12 m in height, Goodding's willows reach 8 m, and coyote willows reach 5 m. Many of the willows of both species are mostly dead, with only basal sprouts present. Canopy closure ranges from 50 to 80% and is lowest in the coyote willows and highest in the cottonwoods. Some damp soils were noted during a visit in July, but soils were completely dry otherwise. Standing water was present in an irrigation canal adjacent to the site in July.

Field personnel detected two willow flycatchers on May 27 and two on June 3, and this site is not considered occupied. The site was surveyed five times, totaling 13.2 observer-hours. Large flocks of cowbirds were detected during all visits. Dense canopy closure and wet soils are lacking in this site, and habitat suitability is low.

Nature Trail

Area: 13.7 ha Elevation: 71 m

The survey site known as Nature Trail is approximately 700 m west of the Cibola National Wildlife Refuge headquarters and consists of a mosaic of cottonwoods, Goodding's willows, mesquite, and Emory baccharis. Approximately one-half of the site consists of scattered screwbean and honey mesquite up to 6 m in height with a thick understory of Emory baccharis. Canopy closure is 60–80% in the mesquite. The northern half of the site contains an extensive, but sparse, stand of Goodding's willows 5–10 m in height. The interior of the willow stand contains the shorter trees with a canopy closure of < 25%, and many of the willow trees are dead. The tallest willows are present around the perimeter of the willow stand, and canopy closure reaches 70% under these trees. The southwestern corner of the site has a small stand of cottonwoods 12–18 m in height with canopy closure of 75–80%, and stringers of cottonwoods up to 18 m in height occur throughout the site. The site contained a small amount of surface water during visits in May and July, but soils were mostly dry throughout the season.

Three willow flycatchers were detected on June 2, and this site is not considered occupied. The site was surveyed five times, totaling 6.3 observer-hours. Cowbirds were detected during all surveys. Dense canopy closure and wet soils are lacking in this site, and habitat suitability is low.

C2729

Area: 6.0 ha Elevation: 70 m

The survey site known as C2729 is approximately 2 km west of the Cibola National Wildlife Refuge headquarters in the area known as Crane Roost and consists of a mosaic of cottonwoods and coyote willows. The site is bisected east to west by a road, and cottonwoods form a 10–12-m-tall overstory with a 4–6-m-tall coyote willow understory in the northern half of the site. Some tamarisk are scattered around the understory, and Goodding's willows 6–9 m in height are prevalent along the eastern edge of the site. Trees in the south-central portion of the northern half of the site are noticeably shorter and less dense than the rest of trees in this portion of the site. Canopy closure in the northern half of the site ranges from 40% in the shorter, sparser trees to 85%. The southern half of the site

is vegetated primarily with coyote willows 5–6 m in height with emergent 10–12-m-tall cottonwoods. An area of sparse 3-m-tall coyote willows is present in the southeastern portion of this half. Some tamarisk and honey mesquite are scattered throughout the southern half. Canopy closure in the southern half of the site ranges from 40 to 80%. The southern half of the site was being irrigated during a visit in July; soils were dry to damp throughout the rest of the season. Water was present in an irrigation canal on the western side of the site in May.

Field personnel detected nine willow flycatchers on May 23 and three on June 2, and this site is not considered occupied. The site was surveyed five times, totaling 7.0 observer-hours. Cowbirds were detected during all surveys. Suitably dense canopy closure and wet soils are lacking in most of this site. Some suitable vegetation structure is present in the coyote willows immediately south of the road and in the very northwestern corner of the site. If canopy closure were higher in the rest of the site, the overall vegetation structure would be good.

Cibola Site 01

Area: 7.7 ha Elevation: 66 m

Cibola Site 01 is a mixed-exotic survey site that consists of a 200-m-wide strip of riparian vegetation between the channelized Colorado River to the west and a levee road to the east. Starting in 2008, this site was put on the periodic survey schedule and was last visited in 2011. Vegetation along the eastern edge of the site consists of a mix of dry and scrubby 3–4-m-tall tamarisk with 2-m-tall arrowweed and 40–60% canopy closure. Two cattail marshes dominate the western half of the site, and the tamarisk are slightly taller and denser adjacent to the marshes. Emergent 10–12-m-tall Goodding's willows and 15-m-tall cottonwoods are scattered in a loose stringer along the eastern edge of the marshes. A small patch of 5-m-tall coyote willows is also present along the eastern edge of the marshes. Some honey mesquite is scattered throughout the site. Canopy closure beneath the cottonwoods and Goodding's willows reaches 75%. Dense vegetation inhibited observers from accessing the interior of each marsh during all visits, and it is unclear if the marshes held standing water throughout the season. Standing water was noted in the marshes during a visit in July.

Two willow flycatchers were detected on May 28, and this site is not considered occupied. The site was surveyed five times, totaling 5.9 observer-hours. Cowbirds were detected during four surveys. No major changes in vegetation structure, species composition, or hydrology were noted since the site was last visited in 2011, and this site continues to lack dense vegetation > 4 m in height. Surveys should be discontinued.

Cibola Lake North

Area: 9.0 ha Elevation: 67 m

Cibola Lake North is a mixed-exotic site that borders Cibola Lake. Starting in 2008, it was put on the periodic survey schedule and was last visited in 2012, at which time it was recommended that surveys 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 survey season. In particular, personnel were 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.

The area immediately to the north of Cibola Lake North also borders Cibola Lake. The eastern edge of the area consists 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 are present beneath the Goodding's willows. Canopy closure within the willow strip reaches 90% in the densest parts. This willow strip continues along the edge of the lake for about 200 m north of the old survey site, at which point the vegetation transitions to tamarisk. To the west of the willow strip, vegetation consists of mesquite 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.

One willow flycatcher was detected immediately north of the old survey site on May 26. The site was surveyed once, totaling 1.1 observer-hours, but occupancy status could not be determined from the limited survey effort. One cowbird was detected during the survey. Although the willow strip contained areas of dense canopy closure and surface water, the strip is narrow enough to see through and does not currently provide a wide enough area of high canopy cover to provide suitable nesting habitat for flycatchers. This area should be revisited during the next round of periodic surveys to determine if the willow area has expanded.

Walker Lake

Area: 4.6 ha Elevation: 66 m

Walker Lake is a mixed-exotic site located along the eastern edge of Walker Lake. The site was put on the periodic survey schedule starting in 2012 and was not visited again until 2015. The majority of the site consists 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 are scattered throughout the site. Walker Lake held standing water throughout the survey

season, but soils immediately adjacent to the lake were mostly damp, with only a small amount of saturated soil noted during a visit in July. Soils away from the lake were largely dry.

No willow flycatchers were detected. The site was surveyed five times, totaling 2.5 observer-hours. Cowbirds were detected during all surveys. Overall vegetation structure is good within the site, though the understory tends to be too thickly vegetated. No major changes in vegetation structure, species composition, or hydrology since 2012 were noted, and this site should be maintained on the periodic survey schedule.

Imperial, Arizona and California

The Imperial study area is composed of lands within the Imperial National Wildlife Refuge and on adjacent public lands. Several of the sites originally included in this study area burned in 2013 and have not yet recovered. No evidence of livestock use was observed, although burros were abundant in adjacent uplands.

Imperial NW (Formerly Nursery NW)

Area: 14.2 ha Elevation: 59 m

Imperial NW is a mixed-exotic survey site that lies between the Colorado River and a cattail marsh. The site was put on the periodic survey schedule in 2012 and was not visited again until 2015. The dominant vegetation is tamarisk approximately 5–7 m in height with an understory of common reed. Both screwbean and honey mesquite trees are scattered along the western edge of the site. Several emergent Goodding's willows 10–12 m in height are present along the eastern edge of the site, adjacent to the cattail marsh. Overall canopy closure is around 70%, and the densest portions of the site have canopy closure > 85%. Surface water or saturated soils were present in the marsh and the eastern edge of the site throughout the survey season. Dense vegetation inhibited access to the site interior, and hydrology within the site is unknown.

No willow flycatchers were detected. The site was surveyed five times, totaling 5.2 observer-hours. Cowbirds were detected during all surveys. While canopy height and closure reach suitable measures, the understory of the site is too thickly vegetated with common reed, and habitat suitability is low. No major changes since 2012 in vegetation structure, species composition, or hydrology were noted, and accessing the interior of this site in future years to determine vegetation structure and hydrology is recommended. Knowledge of the site interior will inform the decision of whether surveys should be continued.

Imperial Nursery

Area: 1.4 ha Elevation: 58 m

The site known as Imperial Nursery is managed by the Imperial National Wildlife Refuge. The site was put on the periodic survey schedule in 2008 and was last visited in 2012. The site is planted primarily with cottonwoods 12–14 m in height, with canopy closure of 65–75%. The understory consists 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 is present in the eastern half of the site. The edges of the site are vegetated by arrowweed and *Baccharis* sp. with a few 3–4-m-tall honey mesquite in the northwestern corner of the site. The site is bordered to the north by a patchwork of cattails, common reed, and tamarisk, and by open fields to the south. The amount of standing water and saturated soil is highly variable because the site is flood irrigated. Sandy soil at the site allows the water to drain rapidly after irrigation.

No willow flycatchers were detected. The site was surveyed five times, totaling 1.2 observer-hours. One cowbird was detected during two surveys. Canopy height has not changed noticeably since 2012, but canopy closure is noticeably lower than it had been (90% in 2012). The honey mesquite and baccharis have also increased in prevalence in the understory. Low canopy closure combined with dry soils creates low overall habitat suitability. SWCA recommends maintaining this site on the periodic survey schedule to determine if vegetation structure improves in future years.

Ferguson Lake

Area: 21.1 ha Elevation: 57 m

Ferguson Lake is a mixed-native survey site on a strip of land between Ferguson Lake and the Colorado River. The site was put on the periodic survey schedule starting in 2012 and was not visited again until 2015. Vegetation is mixed-native, with scattered, emergent Goodding's willows 10 m in height throughout the site. Tamarisk 5–6 m in height is the dominant understory species, and it forms a continuous canopy in portions of the site. The eastern edge of the site also contains patches of arrowweed and scattered screwbean and honey mesquite, with little canopy cover. Canopy closure varies from 30% along the eastern edge of the site to 90% within dense tamarisk stands. In past years, portions of the site up to 50 m from the lakeshore had saturated soils and fluctuating levels of standing water, 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 throughout the survey season.

Six willow flycatchers were detected on May 21, and this site is not considered occupied. The site was surveyed five times, totaling 11.0 observer-hours.

Cowbirds were detected during all surveys. Pockets of suitable habitat are present within the site, but due to limited access to the interior, the total areal extent of suitable habitat is unknown. No major changes in vegetation structure, species composition, or hydrology since 2012 were noted, and this site should be maintained on the periodic survey schedule. Improving access to the interior of the site in future years is recommended.

Great Blue Heron

Area: 7.1 ha Elevation: 57 m

Great Blue Heron is a mixed exotic survey site located on the eastern shore of Martinez Lake. The site was put on the periodic survey schedule in 2012 and was not visited again until 2015. Several scattered emergent Goodding's willows up to 10 m in height are present near the shore of Martinez Lake. Many of the willows appear stressed and dying. The understory beneath the willows is thick with tamarisk, common reed, and giant reed (*Arundo* sp.). Canopy closure in this area reaches 80%. Portions of the site contain thickets of willow deadfall. Farther from the lake, the site is vegetated by scattered arrowweed and tamarisk 6 m in height. Canopy closure is typically 55–60% but reaches 75% in some denser areas. Soils within the site were almost completely dry throughout the survey season, though areas adjacent to Martinez Lake occasionally held standing water or saturated soils.

One willow flycatcher was detected on May 30, and this site is not considered occupied. The site was surveyed five times, totaling 9.3 observer-hours. Cowbirds were detected during all surveys. No major changes in vegetation structure, species composition, or hydrology since 2012 were noted, and habitat suitability within the site is low due to a lack of wet soils and suitably dense canopy closure. Aerial photos suggest there may be habitat with greater suitability immediately west of the site. This area should be assessed in future years, and surveys should be discontinued within the current extent of the site.

Powerline

Area: 1.0 ha Elevation: 58 m

Powerline is a mixed-native survey site located south of Great Blue Heron along the eastern shore of Martinez Lake. It was put on the periodic survey schedule starting in 2008 and was last visited in 2011. Vegetation within the site consists of a broken stringer up to 20 m wide of Goodding's willows and cottonwoods up to 12 m in height along the border of a cattail marsh. The understory beneath the cottonwoods and Goodding's willows is primarily tamarisk 3–4 m in height. Canopy closure varies from 45 to 80% in this area. Vegetation along the upland

edge of the site is dominated by tamarisk and arrowweed up to 3 m in height. Soils within the site were primarily dry throughout the season, with standing water and saturated soils noted along the marsh edge in July.

No willow flycatchers were detected. The site was surveyed five times, totaling 2.3 observer-hours. Cowbirds were detected during all surveys. No major changes in vegetation structure, species composition, or hydrology since 2011 were noted. While some patches of dense vegetation exist within the site, canopy closure within the site continues to be too low to resemble that of occupied habitat, and surveys should be discontinued.

Martinez Lake

Area: 4.6 ha Elevation: 58 m

Martinez Lake is a mixed-native survey site that borders the eastern shore of Martinez Lake and is adjacent to and south of the Powerline site. This site was put on the periodic survey schedule in 2008 and was last visited in 2011. Goodding's willows < 10 m in height and cottonwoods up to 15 m in height form 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 forms the understory, and canopy closure is 70–80%. The eastern edge of the site, adjacent to the upland, is dominated by arrowweed. Some scattered tamarisk and a few emergent Goodding's willows and cottonwoods are also present along the eastern edge of the site. Canopy closure is 45–65% in this area. The interior of the site was dry throughout the survey season, and only damp soils were noted along the marsh edge.

Field personnel detected four willow flycatchers on May 20 and three on June 11, and this site is not considered occupied. The site was surveyed five times, totaling 7.0 observer-hours. Cowbirds were detected during all surveys. No major changes since 2011 in vegetation structure, species composition, or hydrology were noted. Because the interior of the site is dry and canopy closure is sparse in many areas, habitat suitability is low; therefore, surveys at this site should be discontinued.

Mittry Lake, California

Mittry West

Area: 4.4 ha Elevation: 49 m

Mittry West is a mixed-native survey site located approximately 3 km downstream from Imperial Dam on the LCR. The site was put on the periodic survey schedule in 2012 and was not visited again until 2015. The center of the site is dominated by Goodding's willows 12 m in height with a dense understory

of arrowweed and tamarisk. Deadfall is common throughout the site, and canopy closure varies from 30% in clearings to 70% under the willows and up to 90% within dense tamarisk patches. Honey and screwbean mesquite are scattered throughout the site but are more common near the periphery. A sparse clump of 4–5-m-tall coyote willows approximately 50 m in diameter is present in the northeastern corner of the site, and a small bulrush marsh is present in the southeastern corner of the site. Emory baccharis are most abundant along the northern border of the site. Approximately half of the site contained saturated soil in May, but by July only damp or dry soils remained.

Field personnel detected two willow flycatchers on May 20 and one on June 11, and this site is not considered occupied. The site was surveyed five times, totaling 6.0 observer-hours. Cowbirds were detected during all surveys. No major changes in vegetation structure, species composition, or hydrology were noted since the site was visited last in 2012. Some patches with suitable vegetation structure are present within the site, primarily within the densest tamarisk, and wet soils are also periodically present. Overall habitat suitability is good. This site should be maintained on the periodic survey schedule.

Yuma, Arizona

The Yuma study area is located along the Colorado and Gila Rivers, starting at Yuma East Wetlands approximately 4 km downstream from the confluence and moving 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. All survey sites within the study area are located within a matrix of agricultural lands. Surveys were discontinued at Yuma East Wetlands after the first visit due to permitting issues. Cowbirds are widespread throughout the study area and were detected during all surveys. No evidence of livestock was noted within or around any of the survey sites.

J (LCR MSCP Section: C4703)

Area: 8.4 ha Elevation: 38 m

The survey site known as J is located in Yuma East Wetlands 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 with a 2-m-tall understory of Emory baccharis, honey mesquite, and screwbean mesquite. The cottonwoods are taller and the understory less prevalent on the northern side of the site. Canopy closure averages 80% throughout the cottonwoods. A stand of 4–6-m-tall coyote willows 60 x 120 m in size is present along the western edge of the site. Canopy closure was not described for this portion of the site. Standing water was noted in small puddles at the irrigation canal outlets during a visit in May.

One willow flycatcher was detected on May 19. The site was surveyed once, totaling 1.3 observer-hours, and occupancy status could not be determined. Most of the site lacks suitably dense canopy closure with good branching structure in the understory; therefore, habitat suitability is low. The stand of coyote willows on the western side of the site has good vegetation height, and if canopy closure is dense enough (≥ 85%), vegetation structure would be suitable.

South AC (LCR MSCP Section: C4711)

Area: 0.9 ha Elevation: 37 m

The survey site known as South AC is located in Yuma East Wetlands immediately south of the Colorado River and consists of a stringer of cottonwoods and Goodding's willows 7–15 m in height along the northern edge of a cattail/bulrush marsh. The site is bisected by an open water channel extending north from the marsh. East of the channel, the stringer is only one tree wide, and the trees are scattered with canopy closure averaging 75%. Honey mesquite is scattered in low density in the understory. West of the channel, the stringer widens slightly and canopy closure increases to 80%. Seep willows, Emory baccharis, and honey mesquite form a dense understory. The very western end of the stringer is bordered to the south by a dense stand of coyote willows 3–5 m in height with 80% canopy closure. Standing water was documented within the coyote willows and some of the cottonwoods and Goodding's willows in May.

Five willow flycatchers were detected on May 19. The site was surveyed once, totaling 1.4 observer-hours, and occupancy status could not be determined. Canopy closure within the site is not dense enough, and overall site suitability is low. The potential for good suitability exists if the coyote willows grow a little taller and denser.

I (LCR MSCP Section: C4702)

Area: 6.4 ha Elevation: 38 m

The survey site known as I is located in Yuma East Wetlands and consists primarily of cottonwoods 7–12 m in height with an understory of 2-m-tall Emory baccharis and 4–6-m-tall honey mesquite. The habitat is divided into cells that are separated by dirt roads, and vegetation density varies by cell, ranging from 50 to 70%. 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% canopy closure and no understory. This cottonwood stand is bordered to the west by a stand of coyote willow 2–5 m in height with 70% canopy cover that

covers an area roughly 70 x 50 m in size. Soils were damp or dry during a visit in May. Standing water was noted in an isolated pool immediately south of the site. Four willow flycatchers were detected on May 19. The site was surveyed once, totaling 2.1 observer-hours, and occupancy status could not be determined. Canopy closure within the site is not dense enough, and overall site suitability is low. Vegetation structure would be suitable if both height and canopy closure increased in the coyote willows.

Gila Confluence North

Area: 2.2 ha Elevation: 37 m

Gila Confluence North is a mixed-native survey site that borders the northern side of the Colorado River at the confluence of the Gila and Colorado Rivers. This site was put on the periodic survey schedule in 2008 and was last visited in 2012. Stringers of 8–12-m-tall Goodding's willows and 12–14-m-tall cottonwoods form a broken overstory in the western half of the site and along the northern border with Emory baccharis in the understory. These stringers surround a cattail marsh near the northern side of the site. Common reed is present between the site and the river and extends into the understory along the southern border. Areas away from the cottonwood and Goodding's willow stringers, including the eastern half of the site, are dominated by arrowweed, with scattered Emory baccharis, screwbean mesquite, and tamarisk. Canopy closure is variable and ranges from 45 to 65%. Standing water was present in the northern cattail marsh in May, and all other soils were damp during this visit. All soils within the site were completely dry during visits in June and July.

Three willow flycatchers were detected on May 19, and this site is not considered occupied. The site was surveyed five times, totaling 3.0 observer hours. No major changes in vegetation structure or hydrology were noted since the site was visited in 2012; however, common reed appears to be more prevalent along the southern boundary. It was recommended in 2012 that surveys be discontinued because the site lacked wet soils and dense vegetation and did not provide suitable habitat for nesting flycatchers. The vegetation has not changed substantially since then, and surveys at this site could be discontinued.

Gila River Site 02

Area: 2.9 ha Elevation: 45 m

Gila River Site 02 is a mixed-native survey site located approximately 7 km upstream of Gila Confluence North on the north side of the Gila River. The site is bordered to the north by agricultural fields and to the south by an open, sandy area vegetated by arrowweed. This site was put on the periodic survey schedule in

2008 and was last visited in 2011. Vegetation within the site consists 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 is 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 are present around the perimeter of the site and mixed with arrowweed. The very northern end of the site has been cleared for pasture. Canopy closure ranges from 50 to 70%. No standing water was observed within the site during the survey season, but the northwestern edge of the site bordered a marsh, which did hold water throughout the survey season.

Two willow flycatchers were detected on May 18, and this site is not considered occupied. The site was surveyed five times, totaling 2.6 observer-hours. No major changes in vegetation structure, species composition, or hydrology were noted since the site was visited in 2011. The site continues to lack canopy closure dense enough to resemble currently occupied habitat along the LCR and its tributaries, as well as any type of surface water or wet soils within the site interior, though wet soils are present adjacent to the site. Surveys should be discontinued.

Fortuna Site 01

Area: 3.2 ha Elevation: 47 m

Fortuna Site 01 is a mixed-native survey site located approximately 750 m upstream of Gila River Site 02 on the north side of the Gila River. The site is bordered to the north by agricultural fields and to the south by a cattail and common reed marsh and the Gila River. It was put on the periodic survey schedule in 2008 and was last visited in 2011. Vegetation in the site consists primarily 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 with 75% canopy closure is present in the center of the site. Within the densest cottonwood-willow areas, there is little understory but a lot of deadfall. The interior of the site was mostly dry throughout the survey season, but the adjoining marsh contained surface water.

Four willow flycatchers were detected on May 18, and this site is not considered occupied. The site was surveyed five times, totaling 3.9 observer-hours. No major changes in vegetation structure, species composition, or hydrology were noted since the site was visited in 2011. This site continues to lack the dense canopy closure typical of occupied habitat along the LCR and its tributaries, and surveys should be discontinued.

Fortuna North

Area: 3.8 ha Elevation: 47 m

Fortuna North is located 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. It was put on the periodic survey schedule in 2008 and was last visited in 2011. This site is vegetated primarily by mature tamarisk 3–7 m in height. Dense arrowweed are 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 is 70–85%. Surface water was limited to the river; all other soils were dry.

Field personnel detected two willow flycatchers on May 18 and one on June 10, and this site is not considered occupied. The site was surveyed five times, totaling 6.1 observer-hours. Prior to the site being bulldozed in June, no major changes in vegetation structure, species composition, or hydrology were noted. The remaining vegetation in the majority of site continues to lack canopy closure dense enough to be considered suitable, and surveys should be discontinued.

Yellow-billed Cuckoo Broadcast Surveys

Field personnel spent 18.9 observer-hours conducting yellow-billed cuckoo broadcast surveys at RIRA, PAHR, and WMSP. The results of the surveys and site descriptions are summarized below. Some surveys were conducted at sites also surveyed for flycatchers, and site descriptions for those sites can be found earlier in this chapter. The boundaries of survey areas at each study area are shown on orthophotos in attachment 7.

River Ranch, Nevada

Surveys were conducted in a portion of a linear patch of trees located southeast of the RIRA flycatcher survey sites. The cuckoo survey area begins approximately 175 m east of Smalls and extends south for 1 km. Vegetation within this stringer consists primarily of 8–10-m-tall velvet ash growing on either side of the stream outflow from Ash Springs. The width of the stringer varies from 30 to 170 m. Approximately 10% of the site contains cottonwoods 15–20 m in height. Some 6–8-m-tall Russian olive and some dense patches of grape vine are also scattered throughout the site. Canopy closure varies 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 present on the eastern side of the site throughout the season.

Three surveys were completed in July and early August, totaling 5.3 observer-hours. No yellow-billed cuckoos were detected during surveys.

Pahranagat, Nevada

Yellow-billed cuckoo surveys were conducted at Pahranagat North, Pahranagat West, and Pahranagat South, and descriptions of these sites can be found earlier in this chapter. In addition to flycatcher sites, two stringers of habitat 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. Vegetation within this stringer consists of 10–15-m-tall cottonwoods that covers an area 15–30 m wide. Canopy closure reaches 90%. The stringer on the western side of the lake is located immediately south of the levee. It consists of cottonwoods 15 m in height, one to three trees wide with several gaps. Canopy closure reaches 70% in the widest part of the stringer, which is approximately 40 m wide. Soils beneath both stringers were damp to inundated, depending on lake levels.

Three surveys were completed in late June and in July, totaling 10.2 observer-hours. One silent yellow-billed cuckoo was detected in Pahranagat North during a survey on June 28.

Warm Springs, Nevada

Yellow-billed cuckoo surveys were conducted 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. The trees reach 10–12 m in height, and canopy closure reaches 80–90%. This patch was added after the incidental, passive detection of a cuckoo in the vicinity (see below).

Four surveys were completed, totaling 3.4 observer-hours. No yellow-billed cuckoos were detected during surveys, but an incidental, passive detection was recorded on June 18 (see table 2-2).

DISCUSSION

Six of the 10 study areas occupied in 2015 by resident or breeding flycatchers (KEPI, PAHR, MUDD, TOPO, BIWI, and ALAM) held resident or breeding flycatchers in each year they were surveyed (Braden and McKernan 2006; McLeod et al. 2008; McLeod and Pellegrini 2013, 2014, 2015); details of residency and breeding in 2015 are presented in chapters 3 and 4 of this

document). While resident flycatchers were detected in all of the typically occupied study areas, breeding and resident flycatchers were detected in new locations within BIWI. Of the other four occupied study areas, three (RIRA, WMSP, and MVWA) have been intermittently occupied over the years, and one (PVER) was occupied for the first time since surveys began in 2009. Each study area is discussed in detail below.

As was the case in each year (2010–15) that KEPI was surveyed, resident and breeding flycatchers were found in the patches of coyote willows surrounding Nesbitt Lake. The number of resident flycatchers detected was the lowest since monitoring began in 2010, but no obvious changes in vegetation structure or overall habitat suitability have been documented. This was the first season where the number of resident adults varied noticeably from other years, and further monitoring would be necessary to determine if this is a temporary fluctuation or the beginning of a trend.

RIRA was occupied by three pairs of breeding flycatchers in 2015. Occupancy at RIRA has been intermittent since SWCA began monitoring in 2011, with some amount of habitat occupied in 4 out of 5 years of monitoring. Occupancy has also been variable, ranging from a single flycatcher detected for 1 day up to several pairs of breeding flycatchers. Vegetation structure in 2015 was not noticeably different from previous years, with highly suitable structure patchily distributed within each site. Soil moisture was noticeably higher than in previous years, with wet soils documented in each site throughout the season. Since monitoring began in 2011, all but one banded flycatcher identified at this study area have been second-year birds. Second-year birds of many species are known to disperse greater distances than returning adults (Gill 1995), and they frequently colonize new habitats. The best habitats are typically occupied by older individuals, who may be more competitive or arrive sooner on the breeding grounds, leaving habitat of lesser quality for younger birds (Hill 1988; Holmes et al. 1996). Habitat at RIRA was established many years prior to 2011, and the continued presence of young flycatchers indicates suboptimal habitat conditions. Several within-season dispersal events from RIRA to other breeding areas in the Pahranagat Valley have been observed and are suggestive of suboptimal habitat conditions at RIRA. Intermittent occupancy could also be indicative of suboptimal habitat conditions.

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 standing water and saturated soil 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 and 2009 flycatcher breeding seasons. The dam was repaired prior to

the 2010 breeding season, and although lake levels have been higher since this repair, they have not returned to the levels maintained prior to dam failure. Lake levels in 2015 were at their highest since the repairs, and up to 85% of the riparian vegetation at the northern end of the lake contained standing water and saturated soils at the beginning of the breeding season. While the number of resident flycatchers at Pahranagat North has not changed since 2003, the distribution of breeding pairs has shifted away from the center of the site toward the lakeside edge. This distribution persisted in 2015, with every nest located within the maximum extent of water documented within the site in May (SWCA, unpublished data).

Resident, breeding flycatchers were again documented at Pahranagat West. Occupancy has been documented in this site in only one other year (2013) since SWCA began monitoring in 2003. As in 2013, the pair occupied the only portion of the site that has any type of understory, which occurs in the form of two 10-m-tall Goodding's willows. The lakebed extends under the canopy of these two trees, and standing water or saturated soil was present up to the base of the trees throughout the season, creating a small area of dense canopy cover with wet soils. Occupancy at this site is likely intermittent because of the extremely limited areal extent of suitable habitat.

Breeding flycatchers were documented at Pahranagat MAPS for the second year in a row. No resident flycatchers were documented at this site from 2007 to 2013. The original survey site was heavily damaged by a fire in 2010, and the burned area remained unoccupied in 2014 and 2015. The currently occupied portion of the site consists of three small (15- x 15-m) patches of small-diameter, regenerating cottonwoods and two slightly larger patches of larger-diameter cottonwoods adjacent to the original survey site. Despite their small size, each regenerating patch contained suitable structure and hydrology, and each was occupied. Canopy closure in the larger patches was slightly less dense than the smaller patches, with reduced understory structure, and only one of these patches was occupied. Habitat suitability is likely to diminish as the cottonwoods mature, self-thin, and lose the understory structure and density typically used by flycatchers along the LCR and its tributaries.

Breeding flycatchers were again documented in MVWA, which has been intermittently occupied over the years. Sites within MVWA were surveyed in 1998–2001, and flycatchers were detected only in 1998 (Braden and McKernan 2006). The study area was first monitored by SWCA in 2003. It was unoccupied in that year, and surveys were discontinued for a lack of suitable habitat. NDOW biologists located breeding flycatchers in the study area in 2013 (C. Klinger 2013, personal communication), and MVWA was added to the survey areas in 2014 because of that discovery. The breeding area in MVWA is located in the largest swath of riparian habitat in the canyon (approximately 120 x 950 m). Hydrology within the breeding area consists of a series of beaver ponds and shallow, braided streams within the woody vegetation. Within a majority of the rest of the study

area, surface water and saturated soils are limited to an incised streambed and a series of beaver ponds, and woody vegetation occurs in intermittent patches. Meadow Valley Wash is a narrow canyon, and the width of the riparian vegetation rarely exceeds 100 m. This is considerably narrower than the wide expanses of riparian habitat found in other systems like the Virgin River, Topock Marsh, Bill Williams River, or Alamo Lake, and Meadow Valley Wash is therefore unlikely to support a large flycatcher population. In addition, the canyon is subject to periodic scouring floods, and the amount and quality of riparian habitat thus fluctuates between years. 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). All these factors contribute to MVWA being periodically occupied by small numbers of flycatchers.

Breeding flycatchers have been documented at MUDD in the Overton WMA survey site annually since 2005, though varying portions of the site have been occupied. In 2005–07, the Overton WMA survey site had two distinct breeding areas approximately 800 m apart. Over the 2007–08 winter, the Muddy River was dredged immediately upstream 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. Resident flycatchers were not documented in the northern breeding area from 2008 to 2011, and all breeding flycatchers were located in the very southern end of the site. Over the 2012 and 2013 breeding seasons, breeding activity again transitioned between the two breeding areas, with progressively fewer flycatchers in the southern area and more in the northern area. In 2014 and 2015, all nesting attempts and resident flycatchers were detected in the northern breeding area, and the southern breeding area was unoccupied. The return of flycatchers to the northern breeding area coincided with the gradual drying of the southern end of the site as the channel that supplied water was slowly filled with sediment. Since 2013, no wet soils have been documented outside of the main river channel in the southern breeding area, and the unusually dry conditions probably influenced flycatchers to occupy an alternate location. In 2015, the number of resident flycatchers (3) was the lowest recorded in the study area since breeding was first documented in 2005 (2005–14 range: 8–15 resident adults; median: 11.5). The current extent of suitable habitat within the study area is very limited, both as a result of factors mentioned above and an extensive reduction in the areal extent of suitably dense canopy closure as a result of damage from tamarisk beetle defoliation. The limited extent of suitable habitat combined with poor reproductive success in 2014 likely influenced both site fidelity and recruitment. Recruitment into the study area is further limited by low productivity along the Virgin River in recent years (McLeod and Pellegrini 2013, 2014).

WMSP was again occupied by a breeding pair of flycatchers. Occupancy at WMSP has been intermittent since SWCA began monitoring in 2010, with some amount of habitat occupied in 5 out of 6 years of monitoring. Occupancy has also

been variable, ranging from a single unpaired male up to several pairs of breeding flycatchers. Occupancy was affected by the reduction in available habitat following the 2010 fire, but one of the heavily damaged breeding sites has now recovered enough to attract resident and breeding flycatchers. While the total amount of available habitat has increased since the fire, surface water within the sites is limited, with wet soils usually only present in a portion of each site through May in any given year. Occupancy has also been primarily the result of a male who has held a territory at WMSP every year since 2010 except 2013. In 2013, this male bred at TOPO, and no flycatchers were detected at WMSP. WMSP is > 30 km from the nearest flycatcher population at MUDD, and this distance likely limits recruitment as available habitat increases. The small amount of available habitat and the relative isolation of the study area contribute to WMSP being intermittently occupied by small numbers of flycatchers.

The number of resident flycatchers (15) detected at TOPO in 2015 was the highest number recorded since 2008 (figure 2-2). Breeding was documented in several sites, including Pierced Egg and The Wallows, where breeding has not been documented since 2008 and 2009, respectively. Breeding flycatchers were also documented in Swine Paradise and Glory Hole, which have been occupied by breeding flycatchers in more recent years. Unpaired male flycatchers were documented in both Hell Bird and Lost Lake, which have been occupied by unpaired flycatchers in recent years, as well as in 800M, which was last occupied in 2011. No changes in vegetation structure or species composition were noted in the sites that had not been occupied in several years. Marsh elevations at Topock Marsh on any given day during the breeding season of 2015 were 0.36–1.02 feet lower than on the same day in 2014 and 0.01–0.70 foot lower than on the same day in 2013 (figure 2-3). These lower marsh elevations were reflected in noticeably reduced areal extent of wet soils within the survey sites in June, compared to 2014. The increase in number of resident flycatchers, despite the apparent absence of improvement in habitat suitability, may be due to population dynamics from another population outside of those along the LCR. The number of juvenile flycatchers available for recruitment from TOPO and BIWI is too low to account for the increase in the number of resident flycatchers (see chapter 3).

Tamarisk-dominated habitat at TOPO between the North Dike and Firebreak Canal burned in August 2015 in the Willow Fire, including areas currently and historically occupied by flycatchers. The fire provides an opportunity to create willow-dominated habitat through restoration activities in areas that have recently had surface water conditions suitable for attracting nesting flycatchers. An examination of water levels within Topock Marsh shows that after 2004, water peaked at lower levels, high water levels were of shorter duration, and over-winter lows were lower than was the case prior to 2004 (figure 2-3). Current management of marsh levels should be considered when selecting restoration sites so as to ensure that adequate water levels would be present both for supporting native vegetation and for attracting flycatchers.

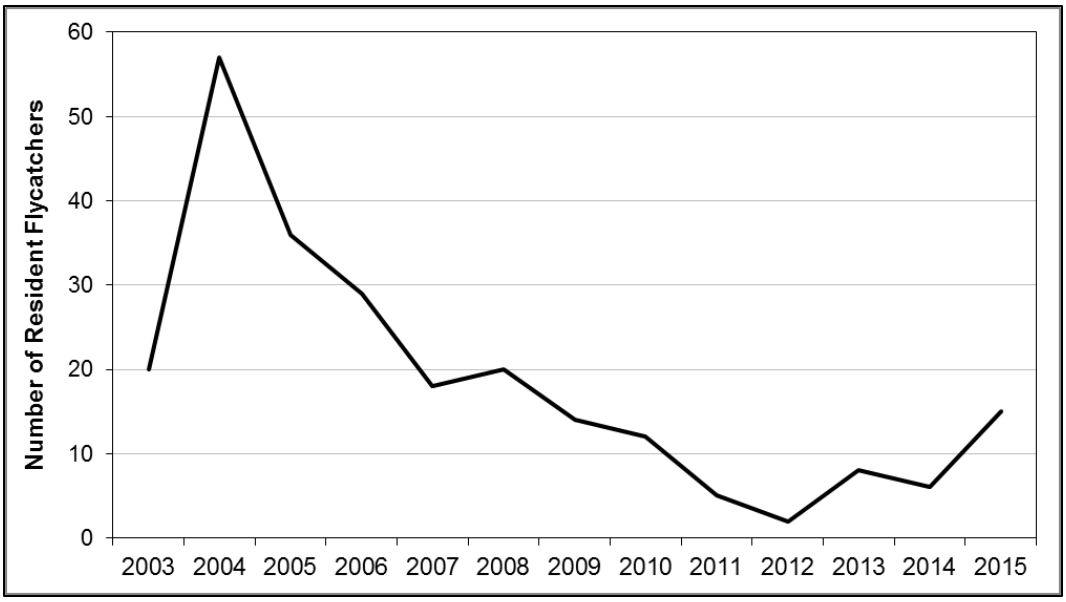

Figure 2-2.—Number of resident southwestern willow flycatchers at Topock Marsh, 2003–15.

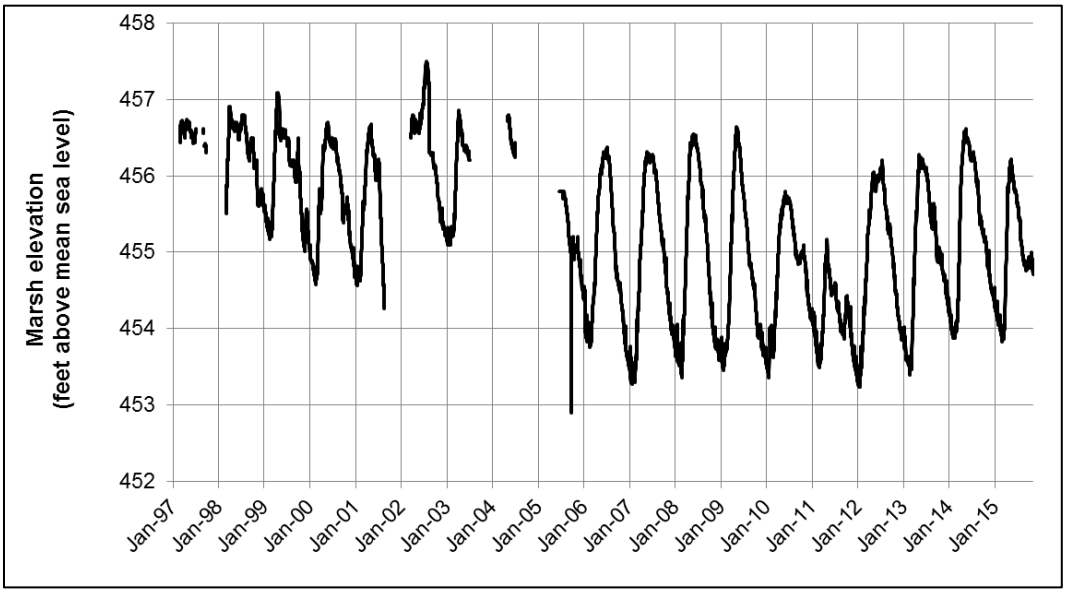

Figure 2-3.—Marsh elevation (feet above sea level) measured at the South Dike at Topock Marsh, 1997–2015.

The number of resident flycatchers at BIWI (11) was the highest recorded since 2009, and among the highest recorded since SWCA began monitoring in 2003 (2003–14 range: 1–13 resident adults; median: 6.5). In contrast with the increased number of resident flycatchers, streamflow was extremely low throughout the breeding season (figure 2-4). Daily discharge in 2015 at the

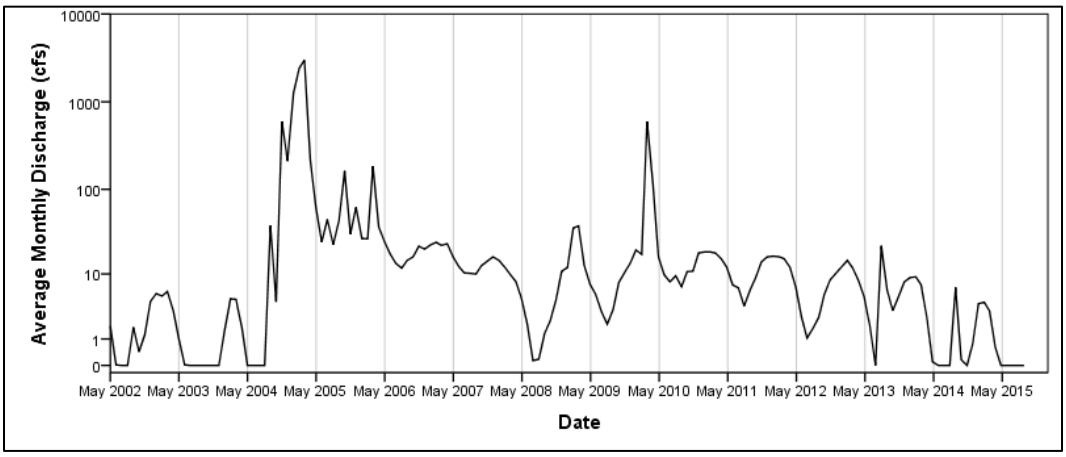

Figure 2-4.—Monthly average streamflow (cfs) recorded at the Bill Williams River near Parker, Arizona (USGS Station #09426620), 2002–15.

U.S. Geological Survey gaging station (#09426620) on the Bill Williams River near Parker, Arizona, was 0.0 cubic feet per second (cfs) from April 5 through September 30. This is the longest period of 0.0 cfs recorded at this gaging station since a 7-month dry period in 2003. At the beginning of the season, water was present only in the main river channel and in marsh vegetation surrounding the main stem of the river. As the season progressed, shallow stretches of the river dried up, leaving water only in the deepest channels, and the depth in isolated pools grew shallower. As the dry conditions continue within the study area, canopy closure appears to be decreasing in several formerly occupied areas with large-diameter Goodding's willows or cottonwoods as large limbs or whole trees fall. Some previously occupied stands of young riparian vegetation have died completely, such as the survey site at Cougar Point. Occupancy has shifted within the landscape as habitat quality declines in formerly occupied areas.

The currently occupied areas are in sites that have the dense vegetation structure preferred by flycatchers, provided by substantial stands of tamarisk or coyote willows. The flycatchers are also in sites closest to the current perennial extent of water, or areas with at least damp soils. These sites include Wispy Willow, Site 01, the most frequently occupied area in Mosquito Flats, and an area that was added to the northeastern edge of Site 08. This was the first year since SWCA began monitoring in 2003 that breeding was documented in either Site 01 or Site 08. Breeding flycatchers occupied the dense stand of coyote willows along the southern edge of Site 01, which was inundated throughout the breeding season. In Site 08, flycatchers occupied a dense patch of tamarisk northeast of the original extent of the site and adjacent to a large beaver pond. Soils were damp beneath the nest in July, but standing water was present within 30 m to both the north and south. Wispy Willow consists of coyote willows that have been slowly filling in an inundated cattail marsh over several years, surrounded by dense tamarisk. The most frequently occupied territory in Mosquito Flats consists of an extensive stand of dense tamarisk with a Goodding's willow overstory surrounding a small

cattail marsh. This marsh contained mostly damp soils with a small patch of saturated soil in May. In all locations, the flycatchers likely responded to the co-occurrence of suitable vegetation structure with moist or inundated soils. As is the case with TOPO, the increase in the number of resident flycatchers may be due to population dynamics from another population outside of those along the LCR. The number of juvenile flycatchers available for recruitment from TOPO and BIWI is too low to account for the increase in the number of resident flycatchers (see chapter 3).

ALAM was not surveyed as part of this project until 2014, but it was known to be occupied annually from 1996 to 2006, with 5–24 territories, of which 1–19 were pairs, documented in each year (Ellis et al. 2008). Thirty-two territories, of which 28 were pairs, were documented in 2015; this is the same as the number of territories in 2014 (31 territories, of which 28 were pairs). Though the total number of territories did not change, areas of occupancy did. The study area at Alamo Lake consists of a wide (> 1 km) riparian area on the Bill Williams River that transitions into the lake. As lake levels have dropped from the recent peak in 2010 (see chapter 5), a 2-km stretch of sediment within the riparian zone has been slowly exposed. Several patches of woody mixed-native vegetation have grown on the exposed sediments and have since been colonized. Vegetation in the occupied portions of all the new sites consists primarily of relatively small-diameter, even-aged Goodding's willows that was no more than 4 years old in 2015. The colonization of young habitat that emerges on recently exposed sediment has also been documented at Roosevelt Lake, Arizona, where new habitats were colonized when they were 2.5–3.5 years old (Paxton et al. 2007) and occupancy declined at older sites as they became farther from water (Ellis et al. 2008). This pattern is being observed in areas of occupancy at ALAM. In 2014, 17 of the 28 pairs (61%) were in the new sites that lacked any type of woody vegetation in June 2011, as shown in aerial imagery on Google Earth, either because of inundation by Alamo Lake or recent scouring. The remaining pairs were in older, long-established habitat farther away from the current lake extent. In 2015, the proportion of pairs that were in the new sites increased to 23 of the 28 pairs (82%), while the proportion of pairs in older sites decreased. While surface water conditions at ALAM do not resemble that of typical occupied flycatcher habitat along the LCR and its tributaries, microclimate was similar to that of TOPO and BIWI in 2015 (see chapter 5). It appears that the combination of suitable microclimate with very suitable, young vegetation structure was enough to support occupancy of habitat by a relatively large flycatcher population despite the fact that all occupied habitat was several hundred meters from standing water in 2015. In 2015, several areas were noted within the new sites where canopy closure density had decreased, or where trees had died completely, possibly in response to the extremely low lake levels in 2014. If lake levels remain steady or decline, flycatcher occupancy will likely continue to shift around the landscape as additional habitat grows closer to the lake and some of the trees in the currently occupied sites die back.

For the first time since SWCA began monitoring flycatchers along the LCR in 2003, a territorial, resident flycatcher was detected south of Parker Dam. The individual was located in the PVER conservation area. This individual defended a territory on the edge of one of the cottonwood-willow blocks and used habitat in both the cottonwood-willow block as well as the adjacent mesquite block. No evidence of pair behavior was observed, and the individual left 2 weeks after arriving. The habitat occupied by this flycatcher was not typical of occupied habitats along the LCR and its tributaries because of the significant component of mesquite. The atypical habitat composition, combined with the early dates and short window of occupancy, suggest that this individual might have been prospecting for potential habitat (Paxton et al. 2007) during its northbound migration. Almost 2 weeks after the resident flycatcher left, a second individual (as determined through resighting; see chapter 3) was detected for a day in the same area. This second individual also vocalized unsolicited for lengthy periods of time but was not as responsive to playback as the resident individual. Three other flycatchers were detected in habitat south of Parker Dam in very late June or early July that have been no more than mildly responsive to playback and have not remained for longer than two visits (PVER Phase 06 Block 01, 2014; Walker Lake, 2005; and Hoge Ranch, 2003). While all four individuals have been detected within the window of time considered outside of migration (between June 24 and July 20), their behavior suggests that they were either very late migrants or possibly non-territorial residents prospecting for potential habitat.

There were an additional 116 flycatcher detections recorded south of the Bill Williams River in 2015, all before June 24. Monitoring results and behavioral observations (lack of territorial and aggressive behaviors exhibited toward conspecific broadcasts) at these sites suggest these flycatchers were not resident or breeding individuals but migrants. These results are consistent with those recorded in the same survey sites in 2003–14 (McLeod et al. 2008; McLeod and Pellegrini 2013, 2014, 2015). Given that willow flycatchers are one of the last long-distance neotropical migrant passerines to arrive in the Southwest in spring, the occurrence of northbound, migrant flycatchers along the Colorado River until late June is not surprising.

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 SWCA's studies, personnel captured and uniquely color banded as many flycatchers as possible, 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. This was SWCA's 13th consecutive year of color-banding studies, which build upon color banding initiated at these sites in 1997 (McKernan and Braden 1998).

METHODS

Color Banding

From mid-May through mid-August, 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 and remote speakers to lure territorial flycatchers into the nets. In addition, "passive netting" was used whereby several mist nets were erected and periodically checked, with no broadcast of conspecific vocalizations. Each adult willow flycatcher was banded with a single, numbered U.S. Federal aluminum band on one leg and a colored metal band on the other. The aluminum Federal bands are either standard silver or anodized in one of several colors. All color combinations were coordinated with the Federal Bird Banding Laboratory and all other flycatcher banding projects to minimize duplication of color combinations. For each color-banded bird recaptured, the legs were visually inspected, and any evidence of irritation or injury that may be related to the presence of leg bands was noted.

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 (Whitfield 1990; Paxton et al. 1997). 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. Nestlings were also banded with a single, numbered Federal band (standard silver or anodized) on one leg and a metal color band on the other leg.

For each captured adult willow flycatcher, morphological measurements, including culmen, tail, wing, fat level, and molt, were recorded onto standardized data forms (attachment 2). Sex was determined based on the presence of a cloacal protuberance (for males) or brood patch and/or egg(s) in the oviduct (for females). Captured flycatchers lacking breeding characteristics or diagnostic wing chord (female ≤ 66 millimeters [mm]; male ≥ 71 mm), and not observed engaging in male advertising song (see below), were sexed as unknown. Flycatchers 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. At some sites in Nevada, a digital camera (Canon PowerShot SX50 HS) was also used to take pictures of flycatchers, which supplemented any resight data. Typically, 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 banding, monitoring, and survey field personnel coordinated resighting efforts and recorded observations of color-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-band combinations, territory number, site, standardized confidence levels of the resight, and behavioral observations were recorded. 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.

Prior to July 15, inactive territories were visited at least three times (each visit 4 days apart) before territory visits stopped. After July 15, inactive territories were visited at least two times (each visit 4 days apart) before the territory was deemed closed for the season. All territories were assigned a unique alphanumeric code and were plotted onto high-resolution aerial photographs, thus producing a spatial representation of the flycatcher population at each study location. If multiple females were paired with a single male, each female received a unique territory number. Flycatchers were determined to be unpaired if none of the following breeding behaviors were observed: presence of another unchallenged flycatcher in the immediate vicinity, counter calling (*whitts*) with a nearby flycatcher, interaction twitter calls (*churr/kitters*) with a nearby flycatcher, a flycatcher in the immediate vicinity carrying nesting material, a flycatcher in the immediate vicinity carrying food or fecal sac, or adult flycatchers feeding young (per Sogge et al. 2010).

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.

Data Analyses

Movement

All movements were defined as the straight-line distance between two known locations of activity. Activity can include breeding, defense of a territory, or the brief (< 7 days) detection of an individual in a particular area. Adult movements can either occur between years or within season but are always between study areas; movements within a study area or survey site are not described. All adult between-year movement distances were calculated from the last known location in one study area in a given year (year t) and the first known location in another study area in a subsequent year (year t + 1). Years are not always consecutive. For juvenile dispersal, the last known location is always the nest location even if the juvenile was detected as a fledgling elsewhere. The distance between the nest location and the first known location of the juvenile in a subsequent year is always calculated even if the individual returned to its natal survey site. All known movements were summarized as described above and presented as the median, minimum, and maximum movement distances for all adult between-year movements and juvenile dispersal.

RESULTS

All Study Areas

Field personnel color banded 30 new adult flycatchers and recaptured 5 adults. An additional 58 adults were identified to individual via resighting, while 6 individuals were resighted but did not have their color combinations confirmed. Eighty-two adult flycatchers remained unbanded, and banding status was undetermined (i.e., personnel were unable to determine if these individuals were banded) for 42 adults. Overall, 45% of the adult flycatchers detected at the monitoring sites were known to be color banded by the end of the breeding season (table 3-1). Of the adults that were identified in 2015, 17 were identified for the first time since they were banded in their hatch year (see "Juvenile Between-Year Return and Dispersal," below). Seventy-five nestlings were banded from 34 nests, and 32 unbanded fledglings were resighted from an additional 17 nests plus 1 unbanded fledging from a nest where its nest mates were banded; personnel captured and banded 1 of the unbanded fledglings. Of the 223 adult flycatchers detected in all study areas, 142 were resident; 65% of the resident adult flycatchers were known to be color banded by the end of the breeding season (table 3-2). For details on all banded flycatchers detected at the study areas from 2010 to 2015, see attachment 8. Details on all banded flycatchers detected at the study areas from 2003 to 2012 can be found in McLeod and Pellegrini (2013).

Individual Study Areas

Key Pittman, Nevada

Twenty-three resident, adult flycatchers were detected from 13 territories at KEPI. In addition to resident adults, five willow flycatchers were detected for which residency could not be determined; one of these individuals held a territory at PAHR earlier in the season (table 3-3). Of the 13 territories at KEPI, 12 consisted of breeding individuals, and 1 consisted of an unpaired male. The unpaired male moved, displacing a male in a breeding territory, and was subsequently paired for the rest of the season. Two males were each polygynous with two females.

Field personnel captured and color banded two new adults. Twenty-two adults were resighted and identified, and two additional adults were known to be banded, but their band combinations could not be confirmed. Of the adults identified in 2015, four were identified for the first time since their hatch year. Two adults remained unbanded. Nine nestlings from five nests were banded; three banded nestlings from three nests were known to have died before fledging.

Table 3-1.—Summary of southwestern willow flycatchers and willow flycatchers detected during the 2015 breeding season*

Study area	Survey site	Adults									Juveniles			
					Resighted									
		Total adults detected	New captured	Recaptured	Color combination confirmed	Banded (color combinations unconfirmed)	Unbanded	Band status undetermined	% of all adults resident	% of all adults banded	Nestlings banded (# nests)	Fledglings captured (# nests)	Unbanded fledglings (# nests)	% of all fledglings banded[1] (# fledglings)
KEPI	Patch 00	3[2]	0	0	3[2]	0	0	0	100	100	0	0	0	--
	Patch 01	2[2]	0	0	2[2]	0	0	0	100	100	1 (1)	0	0	-- (0)
	Patch 02	2	1	0	1	0	0	0	100	100	0	0	0	--
	Patch 04	4[3,4]	0	0	3[3,4]	1	0	0	75	100	0	0	0	--
	Patch 04.5	3[5]	1[5]	0	0	0	2	0	0	33	0	0	0	--
	Patch 05	1[3]	0	0	1[3]	0	0	0	100	100	0	0	0	--
	Patch 06	3[5]	0	0	3[5]	0	0	0	67	100	1 (1)	0	0	-- (0)
	Patch 07	3	0	0	2	1	0	0	67	100	0	0	0	--
	Patch 09	5	0	0	5	0	0	0	100	100	1 (1)	0	0	-- (0)
	Patch 10	2	0	0	2	0	0	0	100	100	3 (1)	0	0	100 (3)
	Patch 11	2	0	0	2	0	0	0	100	100	0	0	0	--
	Patch 12	2	0	0	2	0	0	0	100	100	3 (1)	0	0	100 (3)
	Study area total	**28[2,3,5]**	**2**	**0**	**22[2,3,5]**	**2**	**2**	**0**	**82**	**93**	**9 (5)**	**0**	**0**	**100 (6)**
RIRA	East Side	5	0	1	2	0	1	1	80	60	2 (1)	0	0	100 (2)
	West Side	2	1	1	0	0	0	0	100	100	3 (1)	0	0	100 (3)
	Smalls	1	1	0	0	0	0	0	0	100	0	0	0	--
	River Ranch[6]	2	0	0	0	0	0	2	0	0	0	0	0	--
	Study area total	**10**	**2**	**2**	**2**	**0**	**1**	**3**	**60**	**60**	**5 (2)**	**0**	**0**	**100 (5)**
PAHR	Pahranagat North	14	0	1	13	0	0	0	100	100	9 (5)	1 (1)	1 (1)	91 (11)
	Pahranagat West	2	0	0	2	0	0	0	100	100	3 (1)	0	0	100 (3)
	Pahranagat MAPS	6[4]	1[4]	0	4	0	1	0	83	83	3 (1)	0	0	100 (3)
	Study area total	**22**	**1**	**1**	**19**	**0**	**1**	**0**	**95**	**95**	**15 (7)**	**1 (1)**	**1 (1)**	**94 (17)**
MVWA	Dog Leg	6	3	0	3	0	0	0	83	100	10 (4)	0	0	100 (10)
	Cottonwood Canyon	2	0	0	0	0	1	1	0	0	0	0	0	--
	Study area total	**8**	**3**	**0**	**3**	**0**	**1**	**1**	**63**	**75**	**10 (4)**	**0**	**0**	**100 (10)**
MUDD	Overton WMA	7	1	1	1	0	1	3	43	43	3 (2)	0	0	100 (2)
	Study area total	**7**	**1**	**1**	**1**	**0**	**1**	**3**	**43**	**43**	**3 (2)**	**0**	**0**	**100 (2)**
WMSP	Muddy Stringer 01	2	1	0	1	0	0	0	100	100	1 (1)	0	0	100 (1)
	Study area total	**2**	**1**	**0**	**1**	**0**	**0**	**0**	**100**	**100**	**1 (1)**	**0**	**0**	**100 (1)**
TOPO	Pipes 03	1	0	0	0	0	0	1	0	0	0	0	0	--
	The Wallows	4[7]	2	0	1[7]	0	1	0	50	75	2 (1)	0	0	-- (0)
	PC 6-1	1	0	0	0	0	0	1	0	0	0	0	0	--
	800M	1[7]	1[7]	0	0	0	0	0	100	100	0	0	0	--
	Pierced Egg	5	1	0	0	1	1	2	60	40	0	0	0	--
	Swine Paradise	6[7]	1	0	1[7]	0	3	1	67	33	0	0	1 (1)	0 (1)
	Hell Bird	3	2	0	0	0	1	0	67	67	0	0	0	--
	Glory Hole	2	0	0	2	0	0	0	100	100	0	0	0	--
	CPhase 05	1	0	0	0	0	0	1	0	0	0	0	0	--
	Lost Lake	1	1	0	0	0	0	0	100	100	0	0	0	--
	Study area total	**23[7]**	**8**	**0**	**2[7]**	**1**	**6**	**6**	**65**	**48**	**2 (1)**	**0**	**1 (1)**	**0 (1)**

Table 3-1.—Summary of southwestern willow flycatchers and willow flycatchers detected during the 2015 breeding season*

		Adults									Juveniles			
					Resighted									
Study area	Survey site	Total adults detected	New captured	Recaptured	Color combination confirmed	Banded (color combinations unconfirmed)	Unbanded	Band status undetermined	% of all adults resident	% of all adults banded	Nestlings banded (# nests)	Fledglings captured (# nests)	Unbanded fledglings (# nests)	% of all fledglings banded[1] (# fledglings)
BIWI	Bill Willow	2	0	0	0	0	0	2	0	0	0	0	0	--
	Wispy Willow	4	1	0	2	0	1	0	100	75	5 (2)	0	2 (1)	50 (4)
	Site 01	3	1	0	1	0	0	1	100	67	0	0	1 (1)	0 (1)
	Site 03	2	0	0	0	0	2	0	100	0	0	0	0	--
	Site 08	2	2	0	0	0	0	0	100	100	2 (1)	0	0	100 (1)
	Study area total	**13**	**4**	**0**	**3**	**0**	**3**	**3**	**85**	**54**	**7 (3)**	**0**	**3 (2)**	**50 (6)**
ALAM	Sidebar 01	3	0	0	0	0	3	0	67	0	0	0	1 (1)	0 (1)
	Edgewater 01	2	0	0	0	0	1	1	100	0	0	0	1 (1)	0 (1)
	Middle Earth 01	8	0	0	1	0	5	2	100	13	9 (3)	0	3 (1)	63 (8)
	Middle Earth 02	16[8]	3[8]	0	1	2	10	0	100	35	4 (2)	0	8 (5)[9]	33 (12)
	Burro Wash 02	5	0	0	1	1	3	0	80	40	3 (1)	0	3 (1)	50 (6)
	Motherlode 01	15[8]	4	1	4[8]	0	5	1	100	60	7 (3)	0	7 (3)	46 (13)
	Motherlode 03	4	0	0	0	0	2	2	100	0	0	0	1 (1)	0 (1)
	Motherlode 04	2	0	0	0	0	1	1	100	0	0	0	0	--
	Santa Maria North 01	4	0	0	0	0	4	0	100	0	0	0	3 (1)	0 (3)
	Study area total	**58[8]**	**7**	**1**	**6[8]**	**3**	**34**	**7**	**97**	**29**	**23 (9)**	**0**	**27 (14)**	**40 (45)**
PVER	Phase 02	6	0	0	0	0	4	2	0	0	0	0	0	--
	Phase 03	1	0	0	0	0	0	1	0	0	0	0	0	--
	Phase 04 Block 01	1	0	0	0	0	0	1	0	0	0	0	0	--
	Phase 04 Block 02	1	0	0	0	0	1	0	0	0	0	0	0	--
	Phase 04 Block 03	6	1	0	0	0	3	2	17	17	0	0	0	--
	Phase 05 Block 01	12	0	0	0	0	7	5	0	0	0	0	0	--
	Phase 05 Block 02	3	0	0	0	0	2	1	0	0	0	0	0	--
	Phase 05 Block 03	3	0	0	0	0	2	1	0	0	0	0	0	--
	Phase 07 Block 01	13	0	0	0	0	9	4	0	0	0	0	0	--
	Phase 07 Block 02	7	0	0	0	0	5	2	0	0	0	0	0	--
	Study area total	**53**	**1**	**0**	**0**	**0**	**33**	**19**	**2**	**2**	**0**	**0**	**0**	**--**
CIBO	Phase 01	2	0	0	0	0	2	0	0	0	0	0	0	--
	Phase 02	2	0	0	0	0	0	2	0	0	0	0	0	--
	Phase 03	4	0	0	0	0	0	4	0	0	0	0	0	--
	Nature Trail	3	0	0	0	0	2	1	0	0	0	0	0	--
	C2729	12	0	0	0	0	5	7	0	0	0	0	0	--
	Cibola Site 01	2	0	0	0	0	0	2	0	0	0	0	0	--
	Cibola Lake North	1	0	0	0	0	0	1	0	0	0	0	0	--
	Study area total	**26**	**0**	**0**	**0**	**0**	**9**	**17**	**0**	**0**	**0**	**0**	**0**	**--**
IMPE	Ferguson Lake	6	0	0	0	0	1	5	0	0	0	0	0	--
	Great Blue Heron	1	0	0	0	0	0	1	0	0	0	0	0	--
	Martinez Lake	7	0	0	0	0	1	6	0	0	0	0	0	--
	Study area total	**14**	**0**	**0**	**0**	**0**	**2**	**12**	**0**	**0**	**0**	**0**	**0**	**--**

Table 3-1.—Summary of southwestern willow flycatchers and willow flycatchers detected during the 2015 breeding season*

		Adults									Juveniles			
					Resighted									
Study area	Survey site	Total adults detected	New captured	Recaptured	Color combination confirmed	Banded (color combinations unconfirmed)	Unbanded	Band status undetermined	% of all adults resident	% of all adults banded	Nestlings banded (# nests)	Fledglings captured (# nests)	Unbanded fledglings (# nests)	% of all fledglings banded[1] (# fledglings)
MITT	Mittry West	3	0	0	0	0	1	2	0	0	0	0	0	--
	Study area total	**3**	**0**	**0**	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**--**
YUMA	J	1	0	0	0	0	0	1	0	0	0	0	0	--
	South AC	5	0	0	0	0	4	1	0	0	0	0	0	--
	I	4	0	0	0	0	3	1	0	0	0	0	0	--
	Gila Confluence North	3	0	0	0	0	0	3	0	0	0	0	0	--
	Gila River Site 02	2	0	0	0	0	0	2	0	0	0	0	0	--
	Fortuna Site 01	4	0	0	0	0	3	1	0	0	0	0	0	--
	Fortuna North	3	0	0	0	0	0	3	0	0	0	0	0	--
	Study area total	**22**	**0**	**0**	**0**	**0**	**10**	**12**	**0**	**0**	**0**	**0**	**0**	**--**
Total		**288[4]**	**30**	**5**	**58[4]**	**6**	**104**	**85**	**49**	**34**	**75 (34)**	**1 (1)**	**32 (18)[9]**	**66 (93)**

* Adults are identified as new captures (previously unbanded), recaptures of previously banded birds, resightings of banded birds for which band combinations were confirmed, birds known to be unbanded, birds for which band status could not be determined, and resightings of banded birds for which band combinations were undetermined. The total numbers of adults detected, percent of adults that were resident, and percent of all adults banded are included. Juveniles are identified as banded in the nest, banded as fledglings, or unbanded. The percent of all fledglings banded is included. For breeding and/or residency status of adults and fledging status of nestlings, see table 3-3.

[1] 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 and not known or suspected to have died before fledging.
[2] Two individuals were detected in both Patch 00 and Patch 01 and are tallied only once in the study area total.
[3] One individual was detected in both Patch 04 and Patch 05 and is tallied only once in the study area total.
[4] One individual was detected in both Key Pittman Patch 04 and Pahranagat MAPS and is tallied only once in the overall total.
[5] One individual was detected in both Patch 04.5 and Patch 06 and is tallied only once in the study area total.
[6] Not a flycatcher survey site. Flycatchers detected during a survey for yellow-billed cuckoos.
[7] One individual was detected in 800M, Swine Paradise, and The Wallows and is tallied only once in the study area total.
[8] One individual was captured in Middle Earth 02 and then detected in Motherlode 01 and is tallied only once, as a new capture, in the study area total.
[9] One unbanded fledgling was from a nest that also had banded nestlings.

Table 3-2.—Summary of resident adult southwestern willow flycatchers detected during the 2015 breeding season*

Study area	Survey site	Total resident adults detected	New captured	Recaptured	Resighted				% of all resident adults banded
					Color combination confirmed	Banded (color combinations unconfirmed)	Unbanded	Band status undetermined	
KEPI	Patch 00	3[1]	0	0	3[1]	0	0	0	100
	Patch 01	2[1]	0	0	2[1]	0	0	0	100
	Patch 02	2	1	0	1	0	0	0	100
	Patch 04	3[2]	0	0	2[2]	1	0	0	100
	Patch 05	1[2]	0	0	1[2]	0	0	0	100
	Patch 06	2	0	0	2	0	0	0	100
	Patch 07	2	0	0	2	0	0	0	100
	Patch 09	5	0	0	5	0	0	0	100
	Patch 10	2	0	0	2	0	0	0	100
	Patch 11	2	0	0	2	0	0	0	100
	Patch 12	2	0	0	2	0	0	0	100
	Study area total	**23[1,2]**	**1**	**0**	**21[1,2]**	**1**	**0**	**0**	**100**
RIRA	East Side	4	0	1	2	0	1	0	75
	West Side	2	1	1	0	0	0	0	100
	Study area total	**6**	**1**	**2**	**2**	**0**	**1**	**0**	**83**
PAHR	Pahranagat North	14	0	1	13	0	0	0	100
	Pahranagat West	2	0	0	2	0	0	0	100
	Pahranagat MAPS	5	1	0	4	0	0	0	100
	Study area total	21	1	1	19	0	0	0	100
MVWA	Dog Leg	5	2	0	3	0	0	0	100
	Study area total	**5**	**2**	**0**	**3**	**0**	**0**	**0**	**100**
MUDD	Overton WMA	3	1	1	1	0	0	0	100
	Study area total	**3**	**1**	**1**	**1**	**0**	**0**	**0**	**100**

Table 3-2.—Summary of resident adult southwestern willow flycatchers detected during the 2015 breeding season*

Study area	Survey site	Total resident adults detected	New captured	Recaptured	Resighted				% of all resident adults banded
					Color combination confirmed	Banded (color combinations unconfirmed)	Unbanded	Band status undetermined	
WMSP	Muddy Stringer 01	2	1	0	1	0	0	0	100
	Study area total	**2**	**1**	**0**	**1**	**0**	**0**	**0**	**100**
TOPO	The Wallows	2	1	0	0	0	1	0	50
	800M	1	1	0	0	0	0	0	100
	Pierced Egg	3	1	0	0	1	1	0	67
	Swine Paradise	4	1	0	0	0	3	0	25
	Hell Bird	2	2	0	0	0	0	0	100
	Glory Hole	2	0	0	2	0	0	0	100
	Lost Lake	1	1	0	0	0	0	0	100
	Study area total	**15**	**7**	**0**	**2**	**1**	**5**	**0**	**67**
BIWI	Wispy Willow	4	1	0	2	0	1	0	75
	Site 01	3	1	0	1	0	0	1	67
	Site 03	2	0	0	0	0	2	0	0
	Site 08	2	2	0	0	0	0	0	100
	Study area total	**11**	**4**	**0**	**3**	**0**	**3**	**1**	**64**

Table 3-2.—Summary of resident adult southwestern willow flycatchers detected during the 2015 breeding season*

Study area	Survey site	Total resident adults detected	New captured	Recaptured	Resighted				% of all resident adults banded
					Color combination confirmed	Banded (color combinations unconfirmed)	Unbanded	Band status undetermined	
ALAM	Sidebar 01	2	0	0	0	0	2	0	0
	Edgewater 01	2	0	0	0	0	1	1	0
	Middle Earth 01	8	0	0	1	0	5	2	13
	Middle Earth 02	15	2	0	1	2	10	0	31
	Burro Wash 02	4	0	0	1	1	2	0	50
	Motherlode 01	15	5[3]	1	3	0	5	1	60
	Motherlode 03	4	0	0	0	0	2	2	0
	Motherlode 04	2	0	0	0	0	1	1	0
	Santa Maria North 01	4	0	0	0	0	4	0	0
	Study area total	**56**	**7**	**1**	**6**	**3**	**32**	**7**	**30**
PVER	Phase 04 Block 03	1	1	0	0	0	0	0	100
	Study area total	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**100**
Total		**142**	**25**	**5**	**58**	**5**	**41**	**8**	**65**

* Adults are identified as new captures (previously unbanded), recaptures of previously banded birds, resightings of banded birds for which band combinations were confirmed, birds known to be unbanded, birds for which band status could not be determined, and resightings of banded birds for which band combinations were undetermined. Included are total numbers of resident adults detected and percent of all resident adults banded. For breeding status of resident adults, see table 3-3.

[1] Two individuals were detected in both Patch 00 and Patch 01 and are tallied only once in the study area total.
[2] One individual was detected in both Patch 04 and Patch 05 and is tallied only once in the study area total.
[3] One individual was captured in Middle Earth 02 but resident in Motherlode 01.

Table 3-3.—Details of willow flycatchers detected at study areas where resident flycatchers were observed during the 2015 breeding season

Study area[1]	Survey site	Date banded[2]	Federal band #[2]	Color combination[3]	Age[4]	Sex[5]	Territory or location[6]	Observation status[7]
KEPI	Patch 00	June 28, 2014	2540-58138	TQ:VK(M)	SY	F	41	RS
		June 4, 2014	9999-99999[8]	YG(M):UB	A3Y	M	41, 24	RS
	Patch 01	July 5, 2014	2660-23077	WYW(M):VI	SY	F	24	RS; A attempt in Patch 01, B attempt in Patch 00
		July 11, 2015	2660-23107	VB(M):VI	L	U	24	N; died before fledging
	Patch 02	July 1, 2015	2660-23101	VI:KD(M)	SY	F	04	N
		July 2, 2009	2370-40024	PU:BV(M)	7Y	M	04	RS
	Patch 04	July 13, 2013	2540-58270	TQ:WGW(M)	4Y	F	43	RS
		INA	INA	banded	AHY	M	43	RS; displaced by WVW(M):XX
		June 29, 2014	2590-53175	WVW(M):XX	SY	M	43, T51	RS; detected June 1–15 at T51 in Patch 05
		May 29, 2015	2660-23054	BB(M):VI	AHY	M	F81	RS; detected July 13; detected May 15 – July 2 at T52 in PAHR Pahranagat MAPS
	Patch 04.5	June 2, 2015	2660-23133	OK(M):VI	SY	M	F44, F25	N; detected June 1–5; detected June 22–27 at F25 in Patch 06
		N/A	N/A	UB:UB	AHY	U	F90	RS; detected May 26
		N/A	N/A	UB:UB	AHY	U	F91	RS; detected June 9–11
	Patch 06	July 17, 2013	2540-58281	VDV(M):TQ	A4Y	F	29	RS
		June 8, 2010	2430-61088	XX:BKB(M)	A7Y	M	29	RS
		July 29, 2015	2660-23115	VI:OG(M)	L	U	29	N; died before fledging
	Patch 07	July 1, 2012	2540-58320	KO(M):TQ	4Y	F	21	RS
		July 28, 2010	2540-58202	TQ:BB(M)	7Y	M	21	RS
		INA	INA	Banded	AHY	M	F79	RS; detected May 13
	Patch 09	July 5, 2011	2590-53121	XX:WRW(M)	A6Y	F	22	RS
		July 8, 2011	2590-53101	XX:DOD(M)	5Y	M	22	RS
		July 30, 2015	2660-23116	WV(M):VI	L	U	22	N; died before fledging
		June 29, 2014	2660-23038	VI:BG(M)	SY	F	45	RS
		June 30, 2010	2540-58239	RD(M):TQ	6Y	M	45, 71	RS
		July 14, 2009	2430-61279	XX:DW(M)	7Y	F	71	RS
	Patch 10	July 6, 2011	2540-58177	TQ:KRK(M)	A6Y	F	03	RS
		July 16, 2009	2430-61158	RB(M):XX	A8Y	M	03	RS
		July 1, 2015	2660-23136	BR(M):VI	L	U	03	N
		July 1, 2015	2660-23137	YK(M):VI	L	U	03	N
		July 1, 2015	2660-23138	ODO(M):VI	L	U	03	N

Table 3-3.—Details of willow flycatchers detected at study areas where resident flycatchers were observed during the 2015 breeding season

Study area[1]	Survey site	Date banded[2]	Federal band #[2]	Color combination[3]	Age[4]	Sex[5]	Territory or location[6]	Observation status[7]
KEPI (cont.)	Patch 11	June 27, 2011	2590-53171	XX:ORO(M)	6Y	F	02	RS
		June 22, 2014	2660-23067	VI:WKW(M)	A3Y	M	02	RS
	Patch 12	July 3, 2011	2540-58114	YDY(M):TQ	5Y	F	23	RS
		June 13, 2011	2540-58245	TQ:KYK(M)	6Y	M	23	RS
		July 6, 2015	2660-23238	OB(M):VI	L	U	23	N
		July 6, 2015	2660-23239	VI:BYB(M)	L	U	23	N
		July 6, 2015	2540-58367	BKB(M):TQ	L	U	23	N
RIRA	East Side	N/A	N/A	UB:UB	AHY	F	02	RS
		July 13, 2014	2660-23048	VI:KYK(M)	SY	M	02	R July 21
		July 1, 2014	2660-23045	DVD(M):VI	SY	F	22	RS
		July 3, 2014	2540-58332	RGR(M):TQ	SY	M	22	RS
		August 5, 2015	2660-23144	VI:RG(M)	L	U	22	N
		August 5, 2015	2540-58372	TQ:BKB(M)	L	U	22	N
		INA	INA	Undetermined	AHY	M	F21	Detected June 5
	West Side	July 21, 2015	2660-23111	VI:OK(M)	SY	F	01	N
		July 1, 2014	2660-23044	VI:KB(M)	SY	M	01	R July 21
		July 21, 2015	2540-58383	TQ:OBO(M)	L	U	01	N
		July 21, 2015	2590-53176	XX:DVD(M)	L	U	01	N
		July 21, 2015	2540-58381	WBW(M):TQ	L	U	01	N
	Smalls	June 29, 2015	2660-23134	VI:YD(M)	SY	M	F51	N; detected June 29 – July 3
	River Ranch[9]	INA	INA	Undetermined	AHY	U	F98	Detected August 4
		INA	INA	Undetermined	AHY	U	F99	Detected August 4
PAHR	Pahranagat North	July 3, 2011	2430-61220	RGR(M):XX	5Y	F	01	RS
		June 27, 2011	2540-58246	BR(M):TQ	6Y	M	01	R July 16
		N/A	N/A	UB:UB	HY	U	01	RS
		July 16, 2015	2660-23142	VI:KG(M)	HY	U	01	N
		July 20, 2013	2660-23042	VI:YB(M)	3Y	F	21	RS
		July 7, 2011	2540-58179	GK(M):TQ	5Y	M	21	RS
		July 5, 2015	2540-58364	RG(M):TQ	L	U	21	N
		July 5, 2015	2660-23237	VI:WYW(M)	L	U	21	N
		July 30, 2010	2540-58238	TQ:GOG(M)	6Y	F	23	RS
		July 17, 2012	2540-58262	OG(M):TQ	4Y	M	23	RS
		July 4, 2015	2660-23235	DG(M):VI	L	U	23	N

Table 3-3.—Details of willow flycatchers detected at study areas where resident flycatchers were observed during the 2015 breeding season

Study area[1]	Survey site	Date banded[2]	Federal band #[2]	Color combination[3]	Age[4]	Sex[5]	Territory or location[6]	Observation status[7]
PAHR (cont.)	Pahranagat North (cont.)	July 4, 2015	2660-23234	VI:YO(M)	L	U	23	N
		July 31, 2012	2540-58269	KVK(M):TQ	A5Y	F	27	RS
		June 21, 2010	2370-40088	PU:VG(M)	7Y	M	27	RS
		June 30, 2015	2660-23097	DV(M):VI	L	U	27	N
		July 19, 2014	2540-58361	TQ:GRG(M)	SY	F	30	RS
		July 7, 2012	2540-58259	ORO(M):TQ	4Y	M	30	RS
		July 7, 2015	2660-23135	RR(M):VI	L	U	30	N
		July 7, 2015	2660-23139	VI:YK(M)	L	U	30	N
		August 6, 2013	2540-58309	TQ:GDG(M)	3Y	F	42	RS
		July 21, 2010	2540-58201[10]	No foot:BO(M)	6Y	M	42	RS
		June 30, 2015	2660-23084	BO(M):VI	L	U	42	N
		June 30, 2015	2660-23088	DW(M):VI	L	U	42	N
		July 24, 2008	2430-61083	XX:YR(M)	9Y	M	T22	RS; detected May 12 – July 25
		July 8, 2010	2540-58158	RB(M):TQ	6Y	M	T28	RS; detected May 25 – July 29
	Pahranagat West	July 28, 2014	2660-23053	VI:RGR(M)	A3Y	F	29	RS
		July 16, 2014	2540-58311	DOD(M):TQ	SY	M	29	RS
		July 20, 2015	2540-58369	TQ:BWB(M)	L	U	29	N
		July 20, 2015	2660-23243	VI:DK(M)	L	U	29	N
		July 20, 2015	2660-23242	YBY(M):VI	L	U	29	N
	Pahranagat MAPS	July 4, 2012	2430-61298	KGK(M):XX	5Y	F	26	RS
		July 3, 2013	2540-58250	KRK(M):TQ	3Y	M	26	RS
		July 12, 2015	2540-58379	YBY(M):TQ	L	U	26	N
		July 12, 2015	2660-23140	VI:GD(M)	L	U	26	N
		July 12, 2015	2660-23141	VK(M):VI	L	U	26	N
		July 8, 2010	2540-58157	OY(M):TQ	6Y	M	T24	RS; detected May 15 – July 6
		July 13, 2013	2660-23031	VI:YR(M)	3Y	M	T25	RS; detected May 15 – June 30
		May 29, 2015	2660-23054	BB(M):VI	AHY	M	T52	N; detected May 15 – July 2; detected July 13 at F81 in KEPI Patch 04
		N/A	N/A	UB:UB	AHY	M	F41	RS; detected May 21
MVWA	Dog Leg	June 30, 2014	2660-23039	RB(M):VI	SY	F	01	RS
		July 2, 2015	2660-23103	VI:GY(M)	AHY	M	01	N
		July 30, 2015	2540-58371	TQ:DV(M)	L	U	01	N
		July 30, 2015	2660-23143	VI:OW(M)	L	U	01	N

Table 3-3.—Details of willow flycatchers detected at study areas where resident flycatchers were observed during the 2015 breeding season

Study area[1]	Survey site	Date banded[2]	Federal band #[2]	Color combination[3]	Age[4]	Sex[5]	Territory or location[6]	Observation status[7]
MVWA (cont.)	Dog Leg (cont.)	June 25, 2015	2660-23056	VI:BD(M)	SY	F	21	N
		June 18, 2014	2370-40077	PU:OGO(M)	3Y	M	21, 41	RS
		July 10, 2015	2540-58380	KBK(M):TQ	L	U	21	N
		July 10, 2015	2660-23104	VI:RB(M)	L	U	21	N
		July 10, 2015	2660-23105	WO(M):VI	L	U	21	N
		June 30, 2014	2540-58140	TQ:DWD(M)	A3Y	F	41	RS
		June 25, 2015	2660-23057	GK(M):VI	L	U	41	N
		June 25, 2015	2660-23058	KR(M):VI	L	U	41	N
		June 25, 2015	2660-23059	RD(M):VI	L	U	41	N
		August 6, 2015	2540-58313	OW(M):TQ	L	U	41	N
		August 6, 2015	2660-23145	DV(M):VI	L	U	41	N
		July 24, 2015	2660-23114	VI:VY(M)	SY	F	F42	N; detected July 24
	Cottonwood Canyon	N/A	N/A	UB:UB	AHY	U	F72	RS; detected May 25
		INA	INA	Undetermined	AHY	U	F73	Detected May 25
MUDD	Overton WMA	July 10, 2014	2660-23083	VI:OYO(M)	3Y	F	21	RS
		June 6, 2013	2660-23017	VI:DYD(M)	4Y	M	21,41	R July 26
		July 22, 2015	2660-23106	VI:VK(M)	L	U	21	N
		July 22, 2015	2660-23112	GRG(M):VI	L	U	21	N
		July 26, 2015	2540-58336	WYW(M):TQ	SY	F	41	N
		July 22, 2015	2660-23113	VI:RKR(M)	L	U	41	N; not confirmed as fledged
		N/A	N/A	UB:UB	AHY	M	F51	RS; detected June 16
		INA	INA	Undetermined	AHY	U	F90	Detected May 23
		INA	INA	Undetermined	AHY	U	F91	Detected May 23
		INA	INA	Undetermined	AHY	U	F92	Detected May 23
WMSP	Muddy Stringer 01	June 18, 2015	2660-23055	VI:BW(M)	SY	F	01	N
		May 20, 2008	2540-58234	KD(M):TQ	A9Y	M	01	RS
		July 5, 2015	2660-23236	VI:GV(M)	L	U	01	N
TOPO	Pipes 03	INA	INA	Undetermined	AHY	U	F23	Detected June 3
	The Wallows	August 4, 2015	2660-23224	ORO(M):VI	SY	F	24	N
		N/A	N/A	UB:UB	AHY	M	24	RS
		August 7, 2015	2660-23225	RKR(M):VI	L	U	24	N; died before fledging
		August 7, 2015	2660-23226	VI:WYW(M)	L	U	24	N; died before fledging
		June 18, 2015	2660-23209	VI:VD(M)	SY	M	F98	N; detected June 18

Table 3-3.—Details of willow flycatchers detected at study areas where resident flycatchers were observed during the 2015 breeding season

Study area[1]	Survey site	Date banded[2]	Federal band #[2]	Color combination[3]	Age[4]	Sex[5]	Territory or location[6]	Observation status[7]
TOPO (cont.)	PC 6-1	INA	INA	Undetermined	AHY	U	F99	Detected May 19
	800M	June 16, 2015	2660-23178	VI:KY(M)	AHY	M	T22, F70, F71	N; detected June 2–30; detected July 1 at F70 in Swine Paradise; detected July 21 at F71 in The Wallows
	Pierced Egg	N/A	N/A	UB:UB	AHY	F	11	RS
		June 23, 2015	2660-23210	VI:WB(M)	SY	M	11	N; displaced by a different, banded male
		INA	INA	Banded	AHY	M	11	RS
		INA	INA	Undetermined	AHY	M	F51	Detected May 20
		N/A	N/A	Undetermined	AHY	U	F80	Detected June 2
	Swine Paradise	June 27, 2015	2660-23211	GY(M):VI	AHY	F	21	N
		N/A	N/A	UB:UB	AHY	M	21	RS
		N/A	N/A	UB:UB	HY	U	21	RS
		N/A	N/A	UB:UB	AHY	M	T08	RS; detected May 17 – June 9
		N/A	N/A	UB:UB	AHY	M	T50	RS; detected May 13 – June 11
		INA	INA	Undetermined	AHY	M	F09	Detected May 17
	Hell Bird	June 24, 2015	2660-23190	VI:RVR(M)	SY	M	T33	N; detected June11–24
		June 20, 2015	2660-23231	KWK(M):VI	AHY	M	T36	N; detected June 11 – July 1
		N/A	N/A	UB:UB	AHY	M	F64	RS; detected June 20
	Glory Hole	June 29, 2010	2540-58231	TQ:GR(M)	7Y	F	48	RS
		July 16, 2014	2590-53168	YOY(M):XX	3Y	M	48	RS
	CPhase 05	INA	INA	Undetermined	AHY	M	F12	Detected June 24
	Lost Lake	June 16, 2015	2660-23208	VI:OO(M)	SY	M	T40	N; detected June 11–24
BIWI	Bill Willow	INA	INA	Undetermined	AHY	U	F61	Detected May 16
		INA	INA	Undetermined	AHY	U	F62	Detected May 16
	Wispy Willow	July 11, 2014	2540-58340	GKG(M):TQ	SY	F	40	RS
		N/A	N/A	UB:UB	AHY	M	40,60,96	RS
		July 16, 2015	2540-58359	RVR(M):TQ	L	U	40	N; not confirmed as fledged
		July 16, 2015	2660-23214	VI:YV(M)	L	U	40	N; not confirmed as fledged
		July 28, 2015	2660-23193	VRV(M):VI	SY	F	60	N
		July 31, 2015	2660-23194	VW(M):VI	L	U	60	N
		July 31, 2015	2660-23195	VI:GK(M)	L	U	60	N
		July 31, 2015	2540-58345	TQ:DOD(M)	L	U	60	N; not confirmed as fledged
		July 17, 2014	2540-58356	DGD(M):TQ	3Y	F	96	RS
		N/A	N/A	UB:UB	HY	U	96	RS
		N/A	N/A	UB:UB	HY	U	96	RS

Table 3-3.—Details of willow flycatchers detected at study areas where resident flycatchers were observed during the 2015 breeding season

Study area[1]	Survey site	Date banded[2]	Federal band #[2]	Color combination[3]	Age[4]	Sex[5]	Territory or location[6]	Observation status[7]
BIWI (cont.)	Site 01	July 12, 2014	2540-58352	GRG(M):TQ	SY	F	10	RS
		June 25, 2015	2660-23191	KB(M):VI	AHY	M	10	N
		N/A	N/A	UB:UB	HY	U	10	RS
		INA	INA	Undetermined	AHY	M	T50	Detected June 5–24
	Site 03	N/A	N/A	UB:UB	AHY	F	55	RS
		N/A	N/A	UB:UB	AHY	M	55	RS
	Site 08	July 22, 2015	2660-23217	VI:GRG(M)	SY	F	13	N
	Site 08	July 22, 2015	2660-23218	YO(M):VI	AHY	M	13	N
		July 18, 2015	2660-23215	RW(M):VI	L	U	13	N; not confirmed as fledged
		July 18, 2015	2660-23216	VI:DOD(M)	L	U	13	N
ALAM	Sidebar 01	N/A	N/A	UB:UB	AHY	F	61	RS
		N/A	N/A	UB:UB	AHY	M	61	RS
		N/A	N/A	UB:UB	HY	U	61	RS
		N/A	N/A	UB:UB	AHY	M	F90	RS; detected July 20
	Edgewater 01	INA	INA	Undetermined	AHY	F	62	
		N/A	N/A	UB:UB	AHY	M	62	RS
		N/A	N/A	UB:UB	HY	U	62	RS
	Middle Earth 01	N/A	N/A	UB:UB	AHY	F	02	RS
		July 11, 2014	2540-58341	OYO(M):TQ	A3Y	M	02	RS
		June 20, 2015	2540-58346	VGV(M):TQ	L	U	02	N
		June 20, 2015	2660-23182	VI:KRK(M)	L	U	02	N; not confirmed as fledged
		June 20, 2015	2660-23183	VI:WG(M)	L	U	02	N
		June 20, 2015	2660-23184	OR(M):VI	L	U	02	N
		INA	INA	Undetermined	AHY	F	21	
		INA	INA	Undetermined	AHY	M	21	
		N/A	N/A	UB:UB	AHY	F	53	RS
		N/A	N/A	UB:UB	AHY	M	53,54	RS
		N/A	N/A	UB:UB	HY	U	53	RS
		N/A	N/A	UB:UB	HY	U	53	RS
		N/A	N/A	UB:UB	HY	U	53	RS
		N/A	N/A	UB:UB	AHY	F	54	RS
		June 20, 2015	2660-23179	VI:OB(M)	L	U	54	N; not confirmed as fledged

Table 3-3.—Details of willow flycatchers detected at study areas where resident flycatchers were observed during the 2015 breeding season

Study area[1]	Survey site	Date banded[2]	Federal band #[2]	Color combination[3]	Age[4]	Sex[5]	Territory or location[6]	Observation status[7]
ALAM (cont.)	Middle Earth 01 (cont.)	June 20, 2015	2660-23181	DK(M):VI	L	U	54	N; not confirmed as fledged
		June 20, 2015	2660-23181	VI:GWG(M)	L	U	54	N; not confirmed as fledged
		July 27, 2015	2660-23222	GVG(M):VI	L	U	54	N
		July 27, 2015	2660-23223	VI:VDV(M)	L	U	54	N
		N/A	N/A	UB:UB	AHY	M	T50	RS; detected June 6–14
	Middle Earth 02	N/A	N/A	UB:UB	AHY	F	01	RS
		N/A	N/A	UB:UB	AHY	M	01	RS
		N/A	N/A	UB:UB	HY	U	01	RS
		N/A	N/A	UB:UB	HY	U	01	RS
		N/A	N/A	UB:UB	HY	U	01	RS
		June 4, 2014	2540-58316	TQ:WRW(M)	A3Y	F	08	RS
		INA	INA	banded	AHY	M	08,12	RS
		N/A	N/A	UB:UB	AHY	F	10	RS
		July 8, 2015	2660-23192	WDW(M):VI	SY	M	10	N
		June 21, 2015	2660-23186	VI:VG(M)	L	U	10	N
		June 21, 2015	2660-23187	KOK(M):VI	L	U	10	N
		N/A	N/A	UB:UB	AHY	F	11	RS
		INA	INA	banded	AHY	M	11	RS
		N/A	N/A	UB:UB	HY	U	11	RS
		N/A	N/A	UB:UB	AHY	F	12	RS
		N/A	N/A	UB:UB	AHY	F	30	RS
		May 13, 2015	2660-23174	VI:DW(M)	AHY	M	30,35	N
		N/A	N/A	UB:UB	HY	U	30	RS
		N/A	N/A	UB:UB	HY	U	30	RS
		N/A	N/A	UB:UB	AHY	F	32	RS
		N/A	N/A	UB:UB	AHY	M	32,43	RS
		N/A	N/A	UB:UB	AHY	F	35	RS
		N/A	N/A	UB:UB	HY	U	35	RS
		N/A	N/A	UB:UB	AHY	F	43	RS
		June 21, 2015	2660-23185	VI:OGO(M)	L	U	43	N
		June21, 2015	2660-23188	GYG(M):VI	L	U	43	N
		N/A	N/A	UB:UB	HY	U	43	RS

Table 3-3.—Details of willow flycatchers detected at study areas where resident flycatchers were observed during the 2015 breeding season

Study area[1]	Survey site	Date banded[2]	Federal band #[2]	Color combination[3]	Age[4]	Sex[5]	Territory or location[6]	Observation status[7]
ALAM (cont.)	Burro Wash 02	July 11, 2014	2540-58353	VWV(M):TQ	AHY	F	07	RS
		N/A	N/A	UB:UB	AHY	M	07	RS
		N/A	N/A	UB:UB	HY	U	07	RS
		N/A	N/A	UB:UB	HY	U	07	RS
		N/A	N/A	UB:UB	HY	U	07	RS
		July 27, 2015	2660-23219	DGD(M):VI	L	U	07	N
		July 27, 2015	2660-23220	VI:KWK(M)	L	U	07	N
		July 27, 2015	2660-23221	VI:ODO(M)	L	U	07	N
		INA	INA	banded	AHY	F	09	RS
		N/A	N/A	UB:UB	AHY	M	09	RS
		N/A	N/A	UB:UB	AHY	M	F44	RS; detected June 7–13
	Motherlode 01	N/A	N/A	UB:UB	AHY	F	03	RS
		June 6, 2014	2660-23066	VI:VR(M)	A3Y	M	03	RS
		June 14, 2015	2660-23204	VI:GB(M)	L	U	03	N
		June 14, 2015	2660-23205	DR(M):VI	L	U	03	N
		June 14, 2015	2540-58355	TQ:KW(M)	L	U	03	N
		N/A	N/A	UB:UB	AHY	F	04	RS
		June 6, 2014	2540-58329	TQ:RDR(M)	AHY	M	04,42,45	RS
		May 22, 2015	2660-23176	VI:BR(M)	AHY	F	05	N
		May 24, 2015	2660-23177	BG(M):VI	AHY	M	05	N
		June 28, 2015	2660-23212	KV(M):VI	L	U	05	N; not confirmed as fledged
		June 28, 2015	2660-23213	OG(M):VI	L	U	05	N
		June 28, 2015	2540-58357	YG(M):TQ	L	U	05	N
		N/A	N/A	UB:UB	AHY	F	06	RS
		June 5, 2014	2590-53129	DG(M):XX	A3Y	M	06	R May 24
		N/A	N/A	UB:UB	HY	U	06	RS
		N/A	N/A	UB:UB	HY	U	06	RS
		N/A	N/A	UB:UB	HY	U	06	RS
		June 4, 2014	2660-23063	GR(M):VI	A3Y	F	40	RS
		N/A	N/A	UB:UB	AHY	M	40	RS
		June 15, 2015	2660-23206	BD(M):VI	L	U	40	N
		May 13, 2015	2660-23175	RY(M):VI	AHY	F	42	RS; N at 08 in Middle Earth 02
		N/A	N/A	UB:UB	HY	U	42	RS
		INA	INA	undetermined	AHY	F	45	

Table 3-3.—Details of willow flycatchers detected at study areas where resident flycatchers were observed during the 2015 breeding season

Study area[1]	Survey site	Date banded[2]	Federal band #[2]	Color combination[3]	Age[4]	Sex[5]	Territory or location[6]	Observation status[7]
ALAM (cont.)	Motherlode 01 (cont.)	N/A	N/A	UB:UB	AHY	F	52	RS
		June 15, 2015	2660-23207	VI:KR(M)	AHY	M	52	N
		N/A	N/A	UB:UB	HY	U	52	RS
		N/A	N/A	UB:UB	HY	U	52	RS
		N/A	N/A	UB:UB	HY	U	52	RS
		June 13, 2015	2660-23203	VI:DO(M)	AHY	M	T46	N; detected May 24 – June 13
	Motherlode 03	INA	INA	Undetermined	AHY	F	51	
		N/A	N/A	UB:UB	AHY	M	51	RS
		N/A	N/A	UB:UB	AHY	F	55	RS
		INA	INA	Undetermined	AHY	M	55	
		N/A	N/A	UB:UB	HY	U	55	RS
	Motherlode 04	N/A	N/A	UB:UB	AHY	F	58	RS
		INA	INA	Undetermined	AHY	M	58	
	Santa Maria North 01	N/A	N/A	UB:UB	AHY	F	22	RS
		N/A	N/A	UB:UB	AHY	M	22	RS
	Santa Maria North 01	N/A	N/A	UB:UB	AHY	F	59	RS
		N/A	N/A	UB:UB	AHY	M	59	RS
		N/A	N/A	UB:UB	HY	U	59	RS
		N/A	N/A	UB:UB	HY	U	59	RS
		N/A	N/A	UB:UB	HY	U	59	RS

Table 3-3.—Details of willow flycatchers detected at study areas where resident flycatchers were observed during the 2015 breeding season

Study area[1]	Survey site	Date banded[2]	Federal band #[2]	Color combination[3]	Age[4]	Sex[5]	Territory or location[6]	Observation status[7]
PVER[11]	Phase 04 Block 03	June 2, 2015	2540-58365	YRY(M):TQ	AHY	M	T01	N; detected May 31 – June 14
		N/A	N/A	UB:UB	AHY	M	F02	RS; detected June 27

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, ALAM = Alamo Lake, and PVER = Palo Verde Ecological Reserve.

[2] N/A = not applicable, and INA = information not available.

[3] **Color-band codes**: PU = pumpkin Federal band, XX = standard silver Federal band, TQ = turquoise Federal band, VI = violet Federal band, (M) = metal pinstriped band, UB = unbanded, R = red, O = orange, Y = yellow, G = green, D = dark blue, B = light blue, V = violet, W = white, K = black, banded = bird was banded but combination could not be determined, and undetermined = presence of bands 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.

[4] **Age in 2015**: L = nestling, HY = hatch year, SY = 2 years, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = 4 years, A4Y = 4 years or older, etc.

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

[6] **Territory or location code**: Number without an alphacode indicates a flycatcher pair, T = territorial individual detected for at least 7 days, and F = individual detected for less than 7 days. Number indicates unique location.

[7] **Observation status codes**: N = new capture, R = recapture followed by date recaptured, and RS = resight. Banded nestlings are confirmed to have fledged unless noted otherwise.

[8] Captured with pre-existing leg injury. No Federal band applied. Band number tracked internally as 9999-99999.

[9] Not a flycatcher survey site. Willow flycatchers detected during a survey for yellow-billed cuckoos.

[10] Original Federal band number.

[11] For this study area, only flycatchers that were resident or singing insistently are included. An additional 32 unbanded flycatchers and 19 flycatchers with undetermined band status were detected at the PVER study area between May 15 and June 6. None of these individuals responded strongly to broadcast or engaged in extensive, unsolicited song and were likely migrants.

River Ranch, Nevada

Six resident, adult flycatchers were detected from three territories at RIRA. In addition to resident adults, four willow flycatchers were detected for which residency could not be determined (see table 3-3). All three territories at RIRA consisted of breeding individuals.

Field personnel captured and color banded two new adults and recaptured two adult flycatchers. Two additional adults were resighted and identified. All four of the returning flycatchers identified in 2015 were identified for the first time since their hatch year. One adult remained unbanded, and band status could not be determined for three adults. Five nestlings were banded from two nests.

Pahranagat, Nevada

Twenty-one resident, adult flycatchers were detected from 13 territories at PAHR. In addition to resident adults, one willow flycatcher was detected for which residency could not be determined (table 3-3). Of the 13 territories recorded at PAHR, 8 consisted of breeding pairs, and 5 consisted of unpaired males. One unpaired male was detected briefly at KEPI after vacating his territory at PAHR.

Field personnel captured and color banded one new adult and recaptured one adult flycatcher. An additional 19 adults were resighted and identified. One adult remained unbanded. Of the adults identified in 2015, two were identified for the first time since their hatch year. Fifteen nestlings were banded from seven nests. Two unbanded fledglings from one additional nest were resighted; one of these fledglings was captured and banded.

Meadow Valley Wash, Nevada

Five resident, adult flycatchers were detected from three territories at MVWA. In addition to resident adults, three individuals were detected for which residency could not be confirmed (see table 3-3). All three territories consisted of breeding individuals, and one breeding male was polygynous with two females.

Field personnel captured and color banded three new adult flycatchers. Three other adults were resighted and identified, one of which was identified for the first time since its hatch year. One adult remained unbanded, and the band status of one adult could not be determined. Ten nestlings from four nests were banded.

Muddy River, Nevada

Three resident, adult flycatchers were detected from two territories at MUDD. In addition to resident adults, four individuals were detected for which residency could not be confirmed (see table 3-3). Both territories consisted of breeding pairs, and the breeding male was polygynous with two females.

Field personnel captured and color banded one new adult flycatcher and recaptured one adult flycatcher. One other adult was resighted and identified. One additional adult remained unbanded, and band status could not be determined for three adults. Three nestlings from two nests were banded.

Warm Springs, Nevada

Two resident, adult flycatchers were detected from one territory at WMSP (see table 3-3).

Field personnel captured and color banded one new adult flycatcher and resighted and identified the other adult. One nestling was banded.

Topock Marsh, Arizona

Fifteen resident, adult flycatchers were detected from 10 territories at TOPO. In addition to resident adults, eight individuals were detected for which residency could not be confirmed (see table 3-3). Four of the territories recorded at TOPO consisted of breeding pairs, and six consisted of unpaired males. One female was paired consecutively with two males.

Field personnel captured and color banded eight new adult flycatchers. Two adults were resighted and identified to individual, and one additional adult was known to be banded, but its band combination could not be confirmed. Six adults remained unbanded, and the band status of six individuals could not be determined. Two nestlings from one nest were banded; both were known to have died before fledging. One unbanded fledgling from one additional nest was resighted.

Bill Williams, Arizona

Eleven resident, adult flycatchers were detected from seven territories at BIWI. In addition to resident adults, two individuals were detected for which residency could not be confirmed (see table 3-3). Six of the territories consisted of breeding individuals, and one consisted of an unpaired male. One male was polygynous with three females.

Field personnel captured and color banded four new adult flycatchers. Three additional adults, two of which were identified for the first time since their hatch year, were resighted and identified to individual. Three adults remained unbanded, and band status could not be determined for three adults. Seven nestlings from three nests were banded, and three unbanded fledglings from two additional nests were resighted.

Alamo Lake, Arizona

Fifty-six resident, adult flycatchers were detected from 32 territories at ALAM. In addition to resident adults, two individuals were detected for which residency could not be confirmed (see table 3-3). Of the 32 territories recorded at ALAM, 28 consisted of breeding pairs, 2 consisted of pairs for which no nest could be found, and 2 consisted of an unpaired male. Four males were each polygynous with two females, and one male was polygynous with three females.

Field personnel captured and color banded seven new adult flycatchers and recaptured one previously banded flycatcher. Six adults were resighted and identified, and three additional adults were known to be banded, but their band combinations could not be confirmed. Thirty-four adults remained unbanded, and band status could not be determined for seven adults. Twenty-three nestlings from 9 nests were banded, and 26 unbanded fledglings from 13 additional nests were resighted, plus 1 unbanded fledgling from a nest where its nest mates were banded.

Palo Verde Ecological Reserve, California

One resident, adult flycatcher was detected. An additional 52 adult flycatchers were detected for which residency could not be confirmed. One of these was detected on June 27 and sang insistently and spontaneously. The other 51 flycatchers were detected between May 15 and June 6, responded weakly to broadcasts, and were likely migrants.

Field personnel captured and color banded the resident flycatcher. Thirty-three adults remained unbanded, and band status could not be determined for 19 adults.

Non-Monitoring Sites

These study areas were monitored by other agencies, and here only banded flycatchers that were captured or resighted are reported. Unbanded individuals or those with unknown band status are not included.

St. George, Utah

Personnel from the Utah Division of Wildlife Resources resighted and identified seven adult flycatchers and resighted an additional three banded flycatchers that could not be definitively identified (table 3-4). Of the seven identified adults, three were identified for the first time since their hatch year. Field personnel banded five nestlings from three nests.

Table 3-4.—Banded southwestern willow flycatchers detected at non-monitoring sites, 2015

Study area[1]	Survey site	Date banded	Federal band #	Color combination[2]	Age[3]	Sex[4]	Observation status[5]
STGE	Y-Drain	July 22, 2013	2540-58124	TQ:DGD(M)	3Y	F	RS
		INA	INA	banded	AHY	M	RS
		July 22, 2013	2540-58125	TQ:GKG(M)	3Y	M	RS
	Seegmiller Marsh	July 17, 2013	2660-23015	VYV(M):VI	3Y	F	RS
		July 9, 2010	2540-58160	DD(M):TQ	6Y	M	RS
		June 29, 2015	2660-23233	OYO(M):VI	L	U	N
		INA	INA	banded	AHY	F	RS
		July 17, 2013	2660-23010	VI:KVK(M)	3Y	F	RS
		July 7, 2015	2540-58368	TQ:KBK(M)	L	U	N
		July 7, 2015	2660-23240	VI:WBW(M)	L	U	N
		July 7, 2015	2660-23241	VY(M):VI	L	U	N
	Riverside Marsh	July 14, 2009	2540-58217	TQ:BR(M)	8Y	M	RS
		July 17, 2013	2660-23007	RG(M):VI	3Y	M	RS
		INA	INA	banded	AHY	M	RS
		June 29, 2015	2660-23232	VI:RWR(M)	L	U	N
MESQ	Mesquite West	August 8, 2013	2540-58133	TQ:VGV(M)	3Y	F	RS
		June 29, 2013	2590-53177	OWO(M):XX	A4Y	M	RS
		July 16, 2015	2660-23110	VI:KW(M)	L	U	N
	Electric Avenue Pond	July 16, 2015	2660-23109	VI:KO(M)	SY	M	N
MOME	Virgin River 01 South	May 28, 2012	2430-61282	XX:YGY(M)	A5Y	M	RS
		June 3, 2010	2540-58192	TQ:BG(M)	A7Y	M	RS
		August 5, 2015	2660-23118	WD(M):VI	AHY	F	N
		August 5, 2015	2660-23117	VI:GOG(M)	HY	U	N

[1] STGE = St. George, MESQ = Mesquite, and MOME = Mormon Mesa
[2] **Color-band codes**: TQ = turquoise Federal band, XX = standard silver Federal band, VI = violet Federal band, (M) = metal pinstriped band, R = red, O = orange, Y = yellow, G = green, B = light blue, D = dark blue, V = violet, K = black, W = white, and banded = bird was banded but combination 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] **Age in 2015**: L = nestling, HY = hatch year, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = 4 years, A4Y = 4 years or older, etc.
[4] **Sex codes**: M = male, F = female, and U = unknown.
[5] **Observation status codes**: N = new capture, and RS = resight.

Mesquite, Nevada

Personnel from the NDOW captured and banded one adult flycatcher and banded one nestling flycatcher. An additional two adult flycatchers were resighted and identified (see table 3-4). One of these was identified for the first time since its hatch year.

Mormon Mesa, Nevada

Personnel from the NDOW captured and banded one adult and one fledgling flycatcher. An additional two adult flycatchers were resighted and identified (see table 3-4).

Adult Between-Year Return and Dispersal

In 2014, 100 adult, resident flycatchers were individually identified at study areas that were monitored in both 2014 and 2015. Of these 100 flycatchers, 49 (49%) were detected in 2015, with 5 (10%) being detected at a different study area than where they were resident in 2014 (table 3-5). Of all the adult flycatchers identified in 2015, three were detected at a different study area than where they were last detected in a previous year (table 3-6). The median dispersal distance for all returning adult flycatchers exhibiting between-year movements in 2015 was 30.1 km (minimum = 29.8 km, maximum = 30.2 km).

Table 3-5.—Resident adult southwestern willow flycatcher annual return from 2014 to 2015

Study area	# identified in 2014	# of 2014 birds detected in 2015	% return	% return to same study area
Key Pittman	34	20	59	80
Pahranagat	28	15	54	93
Meadow Valley Wash	2	2	100	100
Muddy River	8	2	25	100
Warm Springs	1	1	100	100
Topock Marsh	3	1	33	100
Bill Williams	2	1	50	100
Alamo Lake	21	7	33	100
Total	100	49	49	90

Table 3-6.—Adult southwestern willow flycatcher between-year movements for all individuals identified in a previous year and recaptured or resighted at a different study area in 2015

Study area/survey site/year detected[1]	Study area/survey site detected 2015[1]	Distance moved (km)	Federal band #	Color combination[2]	Sex[3]
PAHR/North/2014	KEPI/Patch 12	30.2	2540-58114	YDY(M):TQ	F
KEPI/Patch 06/2014	PAHR/North	30.1	2660-23042	VI:YB(M)	F
KEPI/Patch 02/2014	PAHR/West	29.8	2660-23053	VI:RGR(M)	F

[1] KEPI = Key Pittman and PAHR = Pahranagat.
[2] **Color-band codes**: TQ = turquoise Federal band, VI = violet Federal band, (M) = metal pinstriped band, R = red, Y = yellow, G = green, B = light blue, and D = dark blue. Color combinations are read as the bird's left leg and right leg, top to bottom; two letters designate every band; color-band designations for right and left legs are separated with a colon.
[3] **Sex codes**: F = female.

Juvenile Between-Year Return and Dispersal

In 2014, 65 nestlings and 3 fledglings were banded at all study areas. Seven of the nestlings were known or suspected to have died before fledging. Of the 61 remaining juveniles, 13 (22%) were identified in 2015 (table 3-7). Four individuals originally banded as nestlings in 2013 were also identified for the first time in 2015. Of the 17 returning nestlings identified in 2015, 8 (47%) dispersed away from their natal study area. The median dispersal distance for all returning juvenile flycatchers in 2015 was 3.8 km (minimum = 0.05 km, maximum = 49.3 km).

Within-Year, Between-Study-Area Movement

One within-year, between-study area movement was detected in 2015 (table 3-8). One unpaired male was at Pahranagat MAPS from May 17 through July 2 and was then was resighted on July 13 in KEPI Patch 04.

DISCUSSION

Color-Banding Effort

The proportion of all detected adults that were known to be banded varied widely among study areas, ranging from 2% at PVER to 100% at 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 willow flycatchers are unbanded

Table 3-7.—Juvenile southwestern willow flycatchers banded as hatch year birds in a prior year and identified as adults for the first time in 2015

Study area/survey site banded[1]	Year hatched	Study area/survey site detected 2015[1]	Distance moved (km)	Federal band #	Color combination[2]	Sex[3]
ALAM/Middle Earth 02	2014	BIWI/Wispy Willow	49.3	2540-58340	GKG(M):TQ	F
MUDD/Overton WMA	2013	MESQ/Mesquite West	40.8	2540-58133	TQ:VGV(M)	F
PAHR/Pahranagat North	2014	KEPI/Patch 09	30.2	2660-23038	VI:BG(M)	F
PAHR/Pahranagat North	2014	KEPI/Patch 05	30.0	2590-53175	WVW(M):XX	M
PAHR/Pahranagat MAPS	2014	RIRA/East Side	20.3	2540-58332	RGR(M):TQ	M
PAHR/Pahranagat North	2014	RIRA/East Side	18.2	2660-23048	VI:KYK(M)	M
PAHR/Pahranagat North	2014	RIRA/East Side	18.2	2660-23045	DVD(M):VI	F
PAHR/Pahranagat North	2014	RIRA/West Side	18.2	2660-23044	VI:KB(M)	M
STGE/Riverside Marsh	2013	STGE/Y-Drain	3.8	2540-58124	TQ:DGD(M)	F
STGE/Riverside Marsh	2013	STGE/Y-Drain	3.7	2540-58125	TQ:GKG(M)	M
KEPI/Patch 10	2014	KEPI/Patch 00	0.8	2540-58138	TQ:VK(M)	F
KEPI/Patch 09	2014	KEPI/Patch 01	0.7	2660-23077	WYW(M):VI	F
STGE/Y-Drain	2013	STGE/Seegmiller Marsh	0.6	2660-23015	VYV(M):VI	F
MVWA/Dog Leg	2014	MVWA/Dog Leg	0.5	2660-23039	RB(M):VI	F
PAHR/Pahranagat North	2014	PAHR/Pahranagat West	0.4	2540-58311	DOD(M):TQ	M
BIWI/Wispy Willow	2014	BIWI/Site 01	0.4	2540-58352	GRG(M):TQ	F
PAHR/Pahranagat North	2014	PAHR/Pahranagat North	0.05	2540-58361	TQ:GRG(M)	F

[1] ALAM = Alamo Lake, BIWI = Bill Williams, MUDD = Muddy River, MESQ = Mesquite, PAHR = Pahranagat, KEPI = Key Pittman, RIRA = River Ranch, STGE = St. George, and MVWA = Meadow Valley Wash.
[2] **Color-band codes**: XX = standard silver Federal band, TQ = turquoise Federal band, VI = violet Federal band, (M) = metal pinstriped band, R = red, O = orange, Y = yellow, G = green, B = light blue, D = dark blue, V = violet, W = white, and K = black. 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] **Sex codes**: F = female, and M = male.

Table 3-8.—Adult southwestern willow flycatcher within-year movements for all individuals identified at two different study areas in 2015

Start study area/survey site[1]	End study area/survey site[1]	Distance moved (km)	Federal band #	Color combination[2]	Sex[3]
PAHR/Pahranagat North	KEPI/Patch 04	31.7	2660-23054	BB(M):VI	M

[1] PAHR = Pahranagat and KEPI = Key Pittman.
[2] **Color-band codes**: VI = violet Federal band, (M) = metal pinstriped band, and B = light blue. Color combinations are read as the bird's left leg and right leg, top to bottom; two letters designate every band; color-band designations for right and left legs are separated with a colon.
[3] **Sex codes**: M = male.

or have an undetermined band status, and study areas such as PVER that had a low proportion of resident adults (2%) also had low proportions of banded adults (2%). Over the years, higher numbers of non-resident willow flycatchers have typically been detected in study areas along the main stem of the LCR, such as TOPO and BIWI, than at the other study areas, with the lowest number of non-resident willow flycatchers being detected at PAHR and KEPI. The majority 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, ranging from 30% at ALAM to 100% at KEPI, PAHR, MVWA, MUDD, and WMSP. Differences among study areas in the percentage of resident individuals that are banded are typically related to vegetation density and overall structure, which affect the ability of field personnel to capture flycatchers. At RIRA, TOPO, and BIWI, where the proportion of banded resident adults was less than 100%, dense vegetation was the limiting factor in capture rate. The low proportion of banded resident adults at ALAM is due to multiple factors. The Alamo Lake study area was new to this project in 2014, and the entire population at ALAM was unmarked at the beginning of the 2014 breeding season. ALAM also had the highest number of resident flycatchers of any of the study areas in both 2014 and 2015, and the amount of field time and personnel available to capture adult flycatchers were insufficient to band a majority of the population in either year.

Adult and Juvenile Between-Year Dispersal

Adult and juvenile dispersal data for the 2015 field season show overall high site fidelity exhibited by adult flycatchers (90%) and lower natal site fidelity exhibited by juveniles (53%), with juveniles dispersing among study areas. These dispersal data are consistent with the patterns observed at all study areas from 1998 to 2015, over which period 90% of adult returns were to the same study area, while only 50% of all juvenile returns were to the natal study area (McLeod and Pellegrini 2013, 2014, 2015). These dispersal data are also consistent with range-wide data (Paxton et al. 2007), which show adult flycatchers exhibiting high site fidelity to breeding areas. Juvenile dispersal within the southern Nevada/LCR population(s) is largely limited to this region, and while reciprocal juvenile movements among geographically isolated flycatcher populations of the greater Southwest do occur, they are rare. Only three instances of flycatcher immigration from sites outside the southern Nevada/LCR region have been recorded since 1997 (McKernan and Braden, unpublished data; McLeod et al. 2008), with two

males originally banded as nestlings in 2003 at Roosevelt Lake recaptured in 2005 at MUDD and TOPO, and one male banded as a nestling in 1999 at Roosevelt Lake recaptured in 2002 in GRCA. Although movements of this magnitude are infrequent, other instances of dispersal distances greater than 140 km have been reported for the flycatcher (Paxton et al. 2007) and have been noted within the southern Nevada/LCR population (McLeod and Pellegrini 2013, 2014, 2015). Banding studies at Roosevelt Lake and along the San Pedro River were discontinued after 2005, so immigration of juveniles produced in those areas after 2005 would have gone undetected. The observed dispersal patterns fit well with the tenets of contemporary metapopulation theory (Hanski and Simberloff 1997), suggesting the southern Nevada/LCR population may be a panmictic subpopulation of a greater metapopulation. 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 Reclamation's conservation areas at the PVER and CVCA to be colonized. For the first time since surveys began at the CVCA in 2008 and at the PVER in 2009, a resident, territorial male flycatcher was detected at one of these conservation areas. This individual was detected over a 2-week period in the first half of June at PVER Phase 04; no other flycatchers were detected in the vicinity during that period, and the bird appeared to be unpaired. This bird was unbanded when it arrived, and its origin is unknown. It was captured and banded; it did not have any retained feathers and thus was aged as after hatch year. It was not detected, either at PVER or at any other study area, after June 14. A different willow flycatcher was detected in the same area of PVER Phase 04 on a single occasion on June 27. This individual sang consistently for 45 minutes, which suggests it was not a passing migrant. This individual was also unbanded, and its origin is unknown. The likelihood of either individual returning to the PVER in a future year is unknown, but given that site fidelity is strongly linked to successful reproduction (McLeod and Pellegrini 2013) and neither bird was paired, neither individual is expected to return to the same location.

The known breeding sites that are closest to the PVER and CVCA, and thus the most likely to be sources for flycatchers that colonize these areas, are at BIWI, TOPO, and ALAM; each is approximately 75–150 km from the PVER and CVCA and within the range of dispersal distances (0.02–203.0 km for juveniles, 0.001–258.6 km for adults) recorded within the southern Nevada/LCR population (McLeod and Pellegrini 2013). Given the observed patterns of adult and juvenile dispersal, returning juveniles from these breeding sites are also 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. Observations of returning juveniles from 2008 to 2015 indicate

that 97% of returning juveniles are detected by the time they are 3 years old. For the coming breeding season (2016), the likely pool of returning juveniles would be drawn from all nestlings not known or suspected to have died before fledging in 2014 and 2015 at TOPO (7 nestlings), BIWI (15 nestlings), and ALAM (75 nestlings). After accounting for typical annual survival at TOPO and BIWI (13–34% for juveniles, 46% for adults; McLeod and Pellegrini 2013), the number of returning juveniles from 2014 and 2015 available for dispersal and colonization would be around 16 individuals, with ALAM being the most likely source.

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). Although such long-distance movements are relatively infrequent, multiple instances of adult and juvenile dispersal between the Virgin River, TOPO, and BIWI have been documented in recent years (McLeod and Pellegrini 2013, 2014, 2015). The likelihood of an individual from the Virgin or Muddy Rivers colonizing the conservation areas is limited, however, by low productivity on the Virgin and Muddy Rivers in recent years (McLeod and Pellegrini 2015; this document; NDOW, unpublished data), and flycatcher breeding areas at Roosevelt Lake (300–330 km from the PVER) might provide a more likely population source.

The likelihood of flycatchers colonizing conservation areas might be improved by broadcasting conspecific vocalizations in the sites. Territorial songbirds use song to defend territories and attract mates, but song may also attract other males to settle in an area. The use of playback during territory establishment in spring was shown to attract the target species in multiple studies, in some cases inducing them to settle in apparently suitable but previously unoccupied habitat (black-capped vireo, Ward and Schlossberg 2004; Baird's sparrow, Ahlering et al. 2006; American redstarts, Hahn and Silverman 2006; black-throated blue warblers, Hahn and Silverman 2007). Although playback often increased the number of territorial males, these males did not always succeed in attracting a mate, and few studies examined whether breeding pairs were successful in producing young. None of these studies attempted to attract birds to settle in an area that was far from an established population, and it is unclear whether this technique would successfully attract flycatchers to the conservation areas. These sites also lack the constant presence of surface water that is typical of flycatcher territories during the first half of the breeding season, which may affect whether flycatchers would settle there. Flycatchers that settle at the PVER or CVCA sites may be unable to attract a mate, as was the case for the unpaired male detected in 2015, or may be unable to reproduce successfully. Many factors can influence reproductive success, but both areas have large numbers of cowbirds, and parasitism reduces flycatcher nest success (see chapter 4). Care should be taken to ensure that adequate habitat is present if experimenting with this method, as flycatchers that are drawn in may attempt to nest and could fail if habitat is not suitable.

Within-Year, Between-Study-Area Movement

In 2015, one within-year, between-study-area movement was detected. This is similar to the annual number of movements in 2003–14, when between zero and seven (median = 2) movements were detected per year. The within-year, between-study-area movement in 2015 consisted of an unpaired male detected briefly as a non-territorial adult in a second study area near the end of the breeding season. Of the 27 within-year, between-study-area movements detected in 2003–14, 11 (41%) were of individuals detected as non-territorial adults at the end of the breeding season after breeding or defending a territory elsewhere. Of these 11 individuals, 9 returned in a subsequent year, and 7 of the 9 (78%) returned to the same survey site where they were last detected. These individuals were likely prospecting for potential breeding sites, a life history trait that 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).

Adult and Juvenile Survivorship

Annual survivorship is defined as the number of individuals that survive from one year to the next, and accurate estimates depend on year-to-year detection of uniquely marked birds. Forty-nine percent of the adult, resident flycatchers identified in 2014 were detected again in 2015, while of the 61 juveniles banded in monitored sites in 2014 and not known or suspected to have died before fledging, only 13 (22%) were identified in 2015. Thus, minimum estimated adult and juvenile survival from 2014 to 2015 at all monitored sites was 49 and 22%, respectively. These estimates are similar to those recorded in previous years (median adult annual survivorship in 2004–14 = 55% [range = 39–74%]; median juvenile annual survivorship in 2009–14 = 22% [range = 13–29%]). The annual adult survivorship estimates at MUDD (25%), TOPO (33%), and ALAM (33%) were below the overall 2015 annual return rate of 49%. Both TOPO and MUDD had small starting sample sizes (three and eight individuals, respectively), and survivorship estimates would thus be strongly affected by the fate of one or two individuals. In addition, any flycatcher from MUDD that dispersed to another study area would be most likely to go to the Virgin River, which was not intensively monitored in 2015. At ALAM, personnel were unable to devote the amount of field effort necessary to identify all individuals, and of the 56 resident adults detected in 2015, 3 were known to be banded but were not identified to individual, and the band status of 7 adults remained undetermined at the end of the season. Thus, the survival estimate for ALAM in 2015 is likely below the actual rate of survival. These simple annual percent survivorship calculations assume that all living flycatchers are detected in a given year, and individuals not detected are assumed to have died, unless detected elsewhere. To provide more robust estimates of annual survival, demographic data acquired from 2013 to 2017

will be combined with data collected during 1997–2012. Survival and detection probabilities will be estimated using program MARK (White and Burnham 1999) and presented in a summary report in 2017.

Chapter 4 – Nest Monitoring

INTRODUCTION

Documentation of nest success and productivity is critical to understanding local population status and demographic patterns of the flycatcher. In 2015, at all sites where flycatcher breeding activity was suspected, SWCA personnel conducted intensive nest searches and nest monitoring. Specific objectives of nest monitoring included identifying breeding individuals (see chapter 3, "Color Banding and Resighting"), calculating nest success and failure, documenting causes of nest failure (e.g., abandonment, desertion, depredation, and brood parasitism), and calculating nest productivity. Nest monitoring results from 2015 were compared with those at the study areas from 1996 to 2014 (Braden and McKernan unpublished data; McLeod et al. 2008; McLeod and Pellegrini 2013, 2014, 2015). Although aspects of willow flycatcher breeding ecology can vary widely across the species' broad geographical and elevational ranges throughout the Southwest (Whitfield et al. 2003), personnel 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

Upon locating territorial flycatchers, regardless of whether a possible mate was observed, field personnel conducted intensive nest searches following the methods of Rourke et al. (1999). Nest monitoring followed a modification of the methods described by Rourke et al. (1999) and the Breeding Biology Research and Monitoring Database (BBIRD) protocol by Martin et al. (1997).

Nests were located primarily by observing adult flycatchers return to a nest or by systematically searching suspected nest sites. Nests were 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 10 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 depredation (Martin et al. 1997), brood parasitism by cowbirds, and premature fledging of young (Rourke et al. 1999), field personnel observed nests from a distance, using binoculars, once the number and age of nestlings were confirmed. If no activity was observed at a previously

occupied nest, the nest was checked directly to determine nest contents and cause of failure. If no activity was observed at a nest close to or on the estimated fledge date, a systematic search of the area was conducted to locate possible fledglings.

Per instructions from Reclamation biologists, a flycatcher nest was considered successful only if fledglings were observed near the nest or in surrounding areas. The number of young fledged from each nest was counted based on the number of fledglings actually observed. This method of determining success differs from that 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. The method followed produces a conservative estimate of both nest success rate and number of fledges.

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.

For each nest check, field personnel recorded the date and time of the visit, observer initials, monitoring method (observation via binoculars or mirror pole), nesting stage, nest contents, and number and behavior of adults and/or fledges present into an electronic (Microsoft Word) form that included the nest or territory number and UTM coordinates. Flycatcher nest success was calculated using both apparent nesting success (number of successful nests/total number of nests containing at least one flycatcher egg) and the Mayfield method (Mayfield 1961, 1975), which calculates daily nest survival to account for nests that failed before they were found. The assumption was 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 Mayfield survival probabilities (MSPs), SWCA used the average length of each nest stage (2.15, 12.90, and 13.73 days for laying, incubation, and nestling stages, respectively) as observed in this study in 2003–15 for nests with known transition dates. 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 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.

SWCA personnel attempted to addle cowbird eggs in easily accessible flycatcher nests at all study areas. If the nest was accessible without a ladder, the cowbird egg was addled as soon as it was discovered. If a ladder was required, the cowbird egg was addled on the next regularly scheduled nest visit. Cowbird eggs were addled only if a direct view of the nest contents could be obtained from a secure location either on the ground or on a ladder. The cowbird egg was carefully removed from the nest and placed 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.

Summary statistics were calculated using IBM ® SPSS ® v. 22.0. One-sided confidence intervals around differences in proportions followed Agresti and Caffo 2000 (formula provided by Reclamation staff).

RESULTS

Nest Monitoring

Ninety-three flycatcher nesting attempts were documented at KEPI, RIRA, PAHR, MVWA, MUDD, WMSP, TOPO, BIWI, and ALAM; 85 of these nests were known to contain flycatcher eggs and were used in calculating nest success and productivity. Forty-four (52%) nests were successful and fledged young, 37 (43%) failed, and 4 (5%) had an unknown fate. Nest success ranged from 11% at KEPI to 100% at MVWA and WMSP (table 4-1). For a comparison of apparent nest success at all monitoring sites from 1997 to 2015, see table 4-2.

Table 4-1.—Summary of southwestern willow flycatcher nest monitoring results at all study areas, 2015

Study area[1]	Survey site	Pairs	Nests	Nests with 1+ WE[2]	Successful nests[3]	Failed nests[3]	Nests with unknown fate	Parasitized nests[4]
KEPI	***Patch 00***	2[5]	3	1	0	1 (100)	0	1 (100)
	Patch 01	1[5]	1	1	0	1 (100)	0	0
	Patch 02	1	1	1	0	1 (100)	0	0
	Patch 04	1	2	2	0	2 (100)	0	0
	Patch 06	1	2	2	0	2 (100)	0	0
	Patch 07	1	2	2	0	2 (100)	0	0
	Patch 09	3	5	5	0	5 (100)	0	0
	Patch 10	1	1	1	1 (100)	0	0	0
	Patch 11	1	2	1	0	1 (100)	0	0
	Patch 12	1	2	2	1 (50)	1 (50)	0	0
	Total	*12*	*21*	*18*	*2 (11)*	*16 (89)*	*0*	*1 (6)*
RIRA	East Side	2	3	3	1 (33)	2 (67)	0	1 (33)
	West Side	1	2	1	1 (100)	0	0	0
	Total	*3*	*5*	*4*	*2 (50)*	*2 (50)*	*0*	*1 (25)*
PAHR	Pahranagat North	6	6	6	6 (100)	0	0	0
	Pahranagat West	1	1	1	1 (100)	0	0	0
	Pahranagat MAPS	1	2	2	1 (50)	1 (50)	0	0
	Total	*8*	*9*	*9*	*8 (89)*	*1 (11)*	*0*	*0*
MVWA	Dog Leg	3	4	4	4 (100)	0	0	0
	Total	*3*	*4*	*4*	*4 (100)*	*0*	*0*	*0*
MUDD	Overton WMA	2	3	2	1 (50)	0	1 (50)	0
	Total	*2*	*3*	*2*	*1 (50)*	*0*	*1 (50)*	*0*
WMSP	Muddy Stringer 01	1	1	1	1 (100)	0	0	0
	Total	*1*	*1*	*1*	*1 (100)*	*0*	*0*	*0*
TOPO	The Wallows	1	2	2	0	2 (100)	0	2 (100)
	Pierced Egg	1	2	1	0	1 (100)	0	0
	Swine Paradise	1	1	1	1 (100)	0	0	0
	Glory Hole	1	1	1	0	1 (100)	0	0
	Total	*4*	*6*	*5*	*1 (20)*	*4 (80)*	*0*	*2 (40)*
BIWI	Wispy Willow	3	4	4	2 (50)	1 (25)	1 (25)	1 (33)
	Site 01	1	2	2	1 (50)	1 (50)	0	1 (50)
	Site 03	1	1	1	0	1 (100)	0	0
	Site 08	1	1	1	1 (100)	0	0	0
	Total	*6*	*8*	*8*	*4 (50)*	*3 (37)*	*1 (12)*	*2 (29)*
ALAM	Sidebar 01	1	1	1	1 (100)	0	0	0
	Edgewater 01	1	1	1	1 (100)	0	0	0
	Middle Earth 01	4	5	5	3 (60)	1 (20)	1 (20)	1 (20)
	Middle Earth 02	9	13	12	6 (50)	5 (42)	1 (8)	0
	Burro Wash 02	2	3	3	2 (67)	1 (33)	0	0
	Motherlode 01	8	8	7	6 (86)	1 (14)	0	0
	Motherlode 03	2	3	3	1 (33)	2 (67)	0	1 (100)
	Motherlode 04	1	1	1	0	1 (100)	0	1 (100)
	Santa Maria North 01	2	1	1	1 (100)	0	0	0
	Total	*30*	*36*	*34*	*21 (62)*	*11 (32)*	*2 (6)*	*3 (11)*
Overall total		**69**	**93**	**85**	**44 (52)**	**37 (43)**	**4 (5)**	**9 (12)**

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.
[2] WE = 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 include only nests with at least one flycatcher egg and for which parasitism status could be determined.
[5] One female nested in both Patch 00 and 01 and is counted only once in the study area total.

Table 4-2.—Southwestern willow flycatcher percent apparent nest success recorded at all study areas, 1996–2015*

Year	Key Pittman[1]	River Ranch[1]	Pahranagat	Meadow Valley Wash	Littlefield	Mesquite	Mormon Mesa[2]	Muddy River	Warm Springs	Grand Canyon	Topock Marsh	Bill Williams	Alamo Lake[1]
1996	–	–	Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nc	Nc	Nm	–
1997	–	–	Nm	Nm	Nd	67 (3)	42 (12)	Nc	Nm	Nc	Nc	Nd	–
1998	–	–	47 (19)	0 (2)	Nd	0 (7)	70 (10)	Nm	Nm	Nc	53 (15)	Nd	–
1999	–	–	60 (15)	Nd	Nm	Nd	45 (11)	Nm	Nm	Nc	38 (16)	100 (1)	–
2000	–	–	63 (16)	Nd	Nd	50 (8)	38 (13)	100 (1)	Nm	Nc	36 (11)	100 (1)	–
2001	–	–	50 (18)	Nd	Nd	53 (17)	54 (13)	Nc	Nm	Nc	36 (14)	50 (4)	–
2002	–	–	33 (12)	Nm	Nd	59 (17)	0 (9)	Nd	Nm	Nd	50 (6)	78 (9)	–
2003	–	–	91 (11)	Nd	Nd	44 (18)	0 (10)	Nd	Nm	Nd	78 (9)	100 (2)	–
2004	–	–	76 (17)	Nm	50 (2)	24 (17)	50 (6)	Nd	Nm	0 (1)[3]	45 (38)	Nd	–
2005	–	–	58 (19)	Nm	Nd	42 (12)	17 (6)	38 (8)	Nm	Nd	24 (34)	100 (2)	–
2006	–	–	60 (15)	Nm	Nd	55 (20)	50 (8)	44 (9)	Nm	0 (3)	23 (17)[4]	20 (5)	–
2007	–	–	67 (12)	Nm	Nd	57 (14)	27 (11)	0 (6)	Nm	0 (1)	75 (8)	25 (8)	Nm
2008	–	–	80 (10)	Nm	Nd	82 (11)	62 (13)	25 (8)	Nm	Nd	13 (8)[3]	40 (5)[3]	Nm
2009	–	–	47 (17)[3]	Nm	0 (1)	21 (14)[3]	53 (17)	0 (8)	Nm	Nm	50 (2)	33 (6)	Nm
2010	50 (30)	–	59 (17)	Nm	50 (2)	31 (13)	42 (12)	100 (3)	0 (3)	Nm	50 (2)	18 (11)	Nm
2011	45 (31)	0 (4)	100 (7)	Nm	Nd	29 (7)	39 (18)[5]	0 (5)[3]	100 (1)	Nm	0 (1)	40 (5)	Nm
2012	41 (27)	Nd	71 (14)	Nm	Nd	0 (5)	38 (13)	25 (4)	0 (2)	Nm	Nd	0 (2)	Nm
2013	35 (23)[6]	0 (2)	86 (7)	Nm	Nd	0 (0)	20 (5)	25 (4)	Nd	Nm	0 (2)	Nd	Nm
2014	44 (18)[7]	Nd	65 (17)	100 (2)	Nm	Nm	Nm	20 (5)[8]	Nd	Nm	100 (3)	50 (4)	25 (24)[5]
2015	11 (18)	50 (4)	89 (9)	100 (4)	Nm	Nm	Nm	50 (2)[3]	100 (1)	Nm	20 (5)	50 (8)[3]	62 (34)[8]

* Data from 1997 to 2002 are from Braden and McKernan (unpublished data); these numbers have been verified with the raw data and may differ from those presented in earlier annual reports. Data from 2003 to 2007 are from McLeod et al. 2008; data from 2008 to 2012 are from McLeod and Pellegrini 2013; data from 2013 and 2014 are from McLeod and Pellegrini 2014 and 2015, respectively. The total number of nests containing at least one flycatcher egg is indicated in parentheses. Nm = not monitored, Nd = study area surveyed, no breeding documented, and Nc = breeding confirmed, nest success not calculated.

[1] Data are included only for years when monitoring was completed by SWCA.
[2] Study area includes the Virgin River Delta at Lake Mead.
[3] Fate of one nest was unknown.
[4] An additional three nests (18%) were suspected to have fledged, but fledglings were not visually confirmed.
[5] Fate of four nests was unknown.
[6] One additional nest (4%) was suspected to have fledged, but fledglings were not visually confirmed.
[7] Fate of three nests was unknown.
[8] Fate of two nests was unknown.

Sixty-six nesting females, of which 65 were known to have produced at least 1 egg, were followed through all of their nesting attempts. Of these 66 females, 40 had 1 nesting attempt and 26 had 2 nesting attempts. Twenty-two of the 26 females with multiple nesting attempts renested after failed nests, 3 renested after a successful nest, and 1 renested after a nest attempt of unknown fate. One additional female at BIWI was found feeding fledglings, but the nest was never located. An additional two females for which no nest was found were detected at ALAM.

Nest Failure

Depredation was the major cause of nest failure for all study areas combined, accounting for 44% (20 of 45) of all failed nests (table 4-3). Eight nests (18%) were abandoned before flycatcher eggs were laid. Of the 37 nests that failed after flycatcher eggs were laid, depredation accounted for 54% of failures, while parasitism caused failure at 2 (5%) of these nests. Eggs were determined to be addled in 4 (9%) of all the failed nests, 9 (20%) nests were deserted, and 1 nest failed in a fire. The cause of failure was unknown at one nest where the contents could not be determined.

Table 4-3.—Summary of causes of southwestern willow flycatcher nest failure at all study areas, 2015*

Study area[1]	Total # nests	All failed nests	Abandoned	Deserted	Depredated	Parasitized	Addled	Fire	Cause of failure unknown
KEPI	21	19	3 (16)	2 (11)	12 (63)	1 (5)	1 (5)	0	0
RIRA	5	3	1 (33)	0	1 (33)	0	1 (33)	0	0
PAHR	9	1	0	1 (100)	0	0	0	0	0
MVWA	4	0	0	0	0	0	0	0	0
MUDD	3	1	1 (100)	0	0	0	0	0	0
WMSP	1	0	0	0	0	0	0	0	0
TOPO	6	5	1 (20)	0	2 (40)	0	1 (20)	1 (20)	0
BIWI	8	3	0	3 (100)	0	0	0	0	0
ALAM	36	13	2 (15)	3 (23)	5 (38)	1 (8)	1 (8)	0	1 (8)
Total	**93**	**45**	**8 (18)**	**9 (20)**	**20 (44)**	**2 (4)**	**4 (9)**	**1 (2)**	**1 (2)**

* 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; parasitized = cowbird young outlived any flycatcher young or appearance of cowbird egg(s) coincided with disappearance of all flycatcher eggs; and addled = entire clutch incubated > 20 days.

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.

Brood Parasitism

Nine of 77 nests (12%) with flycatcher eggs and known parasitism status were brood parasitized by cowbirds, and 1 flycatcher nest was abandoned with a cowbird egg (table 4-4). Brood parasitism ranged from 0 to 40% and was highest at Topock Marsh (see table 4-1). For nests containing flycatcher eggs, parasitism likely contributed to the failure of two nests that were deserted shortly after being parasitized, and two nests ultimately failed because of parasitism. None of the five remaining parasitized nests fledged a flycatcher; however, nest failure was attributed to other causes. In 2015, 38 of 64 (59.4%) unparasitized nests were successful, whereas 0 of 9 (0%) parasitized nests were successful (one-sided Fisher's exact test, $P = 0.001$; difference in proportions = 0.58, 95% lower bound [LB] = 0.33).

Table 4-4.—Fates of southwestern willow flycatcher nests parasitized by cowbirds at all study areas, 2015*

Study area[1]	Nest ID code	Outcome[2]
KEPI	24B	All WE depredated before hatching; CE addled but still hatched; CN removed.
RIRA	01A	Nest abandoned with one CE.
	22A	Nest parasitized ≈7 days into incubation; CE addled but still hatched; CN removed. WEs never hatched despite 20 days incubation.
TOPO	24A	Two WE depredated, and one WE never hatched; CE was not addled and hatched; CN removed.
	24B	WN died in fire; CE addled but still hatched; CN removed.
BIWI	10A	Deserted during incubation; CE addled but not incubated long enough to hatch.
	60A	Deserted with one WE and two CE shortly after parasitism event.
ALAM	21A	Deserted with two WE and one CE shortly after parasitism event.
	51A	Nest not poled during incubation; one CN documented in the nest, but the nest was too high to reach; unknown if CN fledged.
	58A	Cause of failure unknown. Unclear if the parasitism event caused nest failure or if the CE was laid after the nest had already failed.

* All nesting attempts are included.

[1] KEPI = Key Pittman, RIRA = River Ranch, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.

[2] WE = flycatcher egg(s), CE = cowbird egg(s), WN = flycatcher nestling(s), and CN = cowbird nestling(s).

Cowbird Egg Addling

Field personnel attempted to addle cowbird eggs at four of the nine parasitized nests that contained flycatcher eggs. Of the five nests where the cowbird eggs were not shaken, three were deserted soon after the parasitism event, and the cowbird eggs were not incubated long enough to hatch. One additional nest was not mirror-poled until after it had failed, at which point it contained one cowbird egg. The remaining nest was not mirror-poled until the nestling phase, when it was found to contain a cowbird nestling. Of the four nests where the cowbird eggs were shaken, three were incubated long enough for the cowbird egg to hatch; all three cowbird eggs hatched.

Mayfield Nest Success and Nest Productivity

MSP ranged from 0.174 at KEPI to 1.000 at MVWA, MUDD, and WMSP, and it was 0.534 for all study areas combined (table 4-5). At all sites, 93 nestlings were confirmed to have fledged from 81 nests of known outcome (mean number of fledglings/nest = 1.15, standard error [SE] = 0.14). Fecundity across study areas ranged from 0.25 to 3.33 young per female and averaged 1.41 (SE = 0.17) (table 4-6).

DISCUSSION

Number of Breeding Flycatchers

In 2015, breeding was documented in nine study areas (KEPI, RIRA, PAHR, MVWA, MUDD, WMSP, TOPO, BIWI, and ALAM). Breeding has been documented in each of these study areas in previous years (McLeod and Pellegrini 2013, 2015). The number of flycatcher pairs (12) detected at KEPI was less than the number detected (17–18 pairs) in the other 5 years the study area has been intensively monitored (figure 4-1). Future monitoring would be necessary to determine whether this decline is part of a trend or is a temporary fluctuation. Annual fluctuations appear to be the norm at PAHR, where 8 pairs were detected in 2015 (range in 2003–14 = 6–15 pairs, median = 10 pairs; see figure 4-1).

The number of flycatcher pairs (2) recorded at MUDD was the lowest recorded in any year since breeding was first recorded in 2005 (range 2005–14 = 4–8 pairs; median = 5.5 pairs; figure 4-1). As in 2014, all of the breeding activity occurred in the central portion of the site rather than at the southern end where it was concentrated in previous years. This shift in distribution was likely the result of the majority of the southern end of the site being dry in 2012–15 (see chapter 2). Habitat quality at MUDD has also been affected by tamarisk beetles, which have been defoliating tamarisk at the site annually since 2012.

Table 4-5.—Daily survival rates and MSP for southwestern willow flycatcher nest stages at all study areas, 2015*

Study area	Nest stage[1]	Nest losses/ observation days	Daily survival rate	MSP
Key Pittman	1	0/34	1.000	1.000
	2	5/225	0.978	0.748
	3	11/109	0.899	0.232
	All stages			0.174
River Ranch	1	0/6	1.000	1.000
	2	1/61	0.984	0.808
	3	1/29	0.966	0.618
	All stages			0.499
Pahranagat	1	0/15	1.000	1.000
	2	1/111	0.991	0.890
	3	0/106	1.000	1.000
	All stages			0.890
Meadow Valley Wash	1	0/6	1.000	1.000
	2	0/40	1.000	1.000
	3	0/49.5	1.000	1.000
	All stages			1.000
Muddy River	1	0/1	1.000	1.000
	2	0/19	1.000	1.000
	3	0/22.5	1.000	1.000
	All stages			1.000
Warm Springs	1	0/2	1.000	1.000
	2	0/15	1.000	1.000
	3	0/14	1.000	1.000
	All stages			1.000
Topock Marsh	1	0/8	1.000	1.000
	2	2/64	0.969	0.664
	3	2/34.5	0.942	0.441
	All stages			0.292
Bill Williams	1	0/10	1.000	1.000
	2	3/67.5	0.956	0.556
	3	0/46.5	1.000	1.000
	All stages			0.556
Alamo Lake	1	1/40	0.975	0.947
	2	7/307	0.977	0.743
	3	3/286	0.990	0.865
	All stages			0.608
Total	**1**	**1/122**	**0.992**	**0.982**
	2	**19/909.5**	**0.979**	**0.762**
	3	**17/697**	**0.976**	**0.713**
	All stages			**0.534**

* MSP was calculated using 2.15-day egg laying, 12.90-day incubation, and 13.73-day nestling stages.
[1] 1 = egg laying, 2 = incubation, and 3 = nestling.

Table 4-6.—Southwestern willow flycatcher nest productivity (young fledged per nest) and fecundity (young fledged per female) at all study areas, 2015*

Study area	# young fledged	# nests with known outcome	Productivity mean (SE)	# females with known outcome	Fecundity mean (SE)
Key Pittman	6	18	0.33 (0.23)	12	0.50 (0.34)
River Ranch	5	4	1.25 (0.75)	3	1.67 (0.88)
Pahranagat	17	9	1.89 (0.31)	8	2.13 (0.23)
Meadow Valley Wash	10	4	2.50 (0.29)	3	3.33 (0.88)
Muddy River	2	1	2.00	1	2.00
Warm Springs	1	1	1.00	1	1.00
Topock Marsh	1	5	0.20 (0.20)	4	0.25 (0.25)
Bill Williams	6	7	0.86 (0.34)	5	1.20 (0.37)
Alamo Lake	45	32	1.41 (0.22)	29	1.55 (0.27)
Total	**93**	**81**	**1.15 (0.14)**	**66**	**1.41 (0.17)**

* Productivity calculations include nests that contained flycatcher eggs and had a known outcome. Fecundity calculations include all females for which nest outcomes were known.

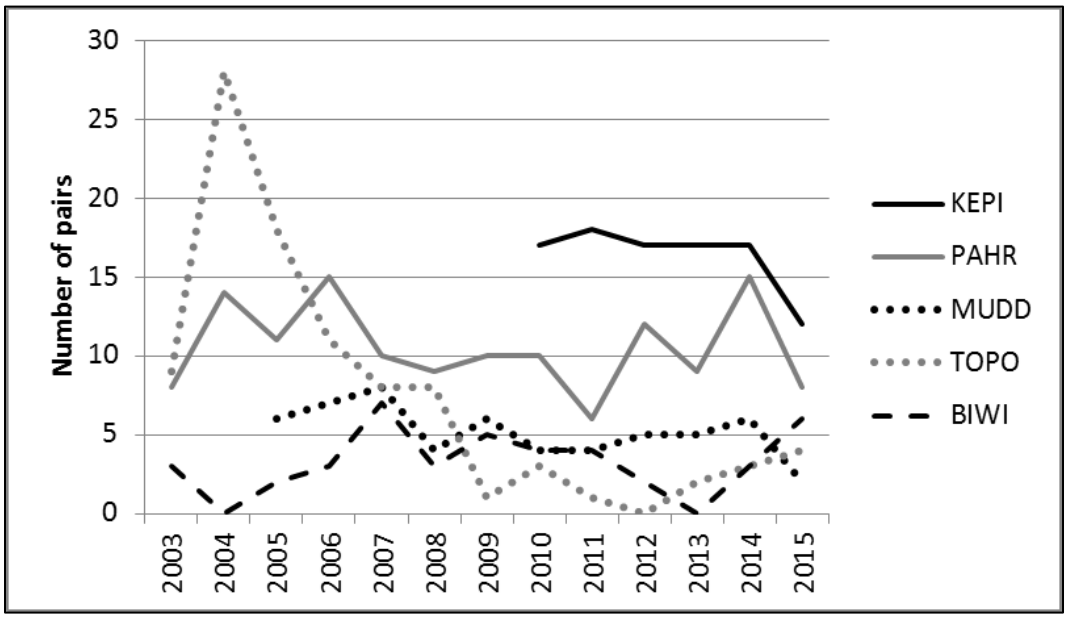

Figure 4-1.—Number of pairs of southwestern willow flycatchers detected at Key Pittman (KEPI), Pahranagat (PAHR), Muddy River (MUDD), Topock Marsh (TOPO), and Bill Williams (BIWI) during years of intensive nest monitoring.

Breeding flycatchers were once again detected at WMSP, with one pair nesting in Muddy Stringer 01, which had been heavily damaged in a fire in 2010. Coyote willows at the site have grown back since the fire, and they are now 4–6 m in height. The flycatcher nest, however, was placed in the dead, hanging fronds of a palm tree; this may be the first recorded instance of flycatchers using a palm as a nest substrate. Selection of the palm as the nest tree may have been influenced by the presence of surface water within 2 m of the palm when the nest was built.

Four breeding pairs were detected at TOPO in 2015, which is the most in any year since 2008. The number of flycatcher pairs at TOPO declined sharply from 2004 to 2012 (see figure 4-1); fluctuations in marsh levels are likely to have influenced the number of breeding flycatchers detected over those years, just as they appear to have influenced the number of resident flycatchers (see chapter 2 for discussion). The slight increase in 2015 in the number of breeding pairs did not appear to be related to marsh levels, however, which were lower in 2015 than in 2014 (see chapter 2), and may be the result of random fluctuations in the small, local population or may be influenced by regional flycatcher populations.

Six pairs of breeding flycatchers were detected at BIWI, the most detected in any year 2003–14 except for in 2007, when seven pairs were found (see figure 4-1). Half of the breeding pairs were in Wispy Willow, which was first occupied by breeding flycatchers in 2014. For the first year since SWCA began monitoring in 2003, breeding flycatchers were found in Site 01 and adjacent to Site 08, which was expanded to encompass the breeding area. Only one pair was found in Mosquito Flats (Sites 03 and 04). Flow in the Bill Williams River was 0.0 cfs in May – July (see chapter 2), and the pattern of flycatcher occupancy was likely affected by the lack of surface water in many areas, with most breeding flycatchers being found either adjacent to a beaver pond (Site 08) or adjacent to an arm of Lake Havasu (Site 01 and Wispy Willow). Given that southwestern riparian ecosystems experience dynamic change and are not ecologically static (Periman and Kelly 2000), flycatcher occupancy and nesting are likely to be affected by changes in habitat suitability, with breeding flycatchers detected at a given site in one year and not in another.

Nest Success

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 percent nest success and MSP, success of a subsequent nesting attempt 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.

After the breeding season of 2014, fecundity at KEPI was noted to have been declining since SWCA began monitoring in 2010. In 2015, both fecundity and productivity declined sharply from the levels recorded in previous years (figure 4-2). The leading cause of nest failure at KEPI was depredation, with 10 of 12 depredation events occurring in the nestling stage (see discussion on nest failure below).

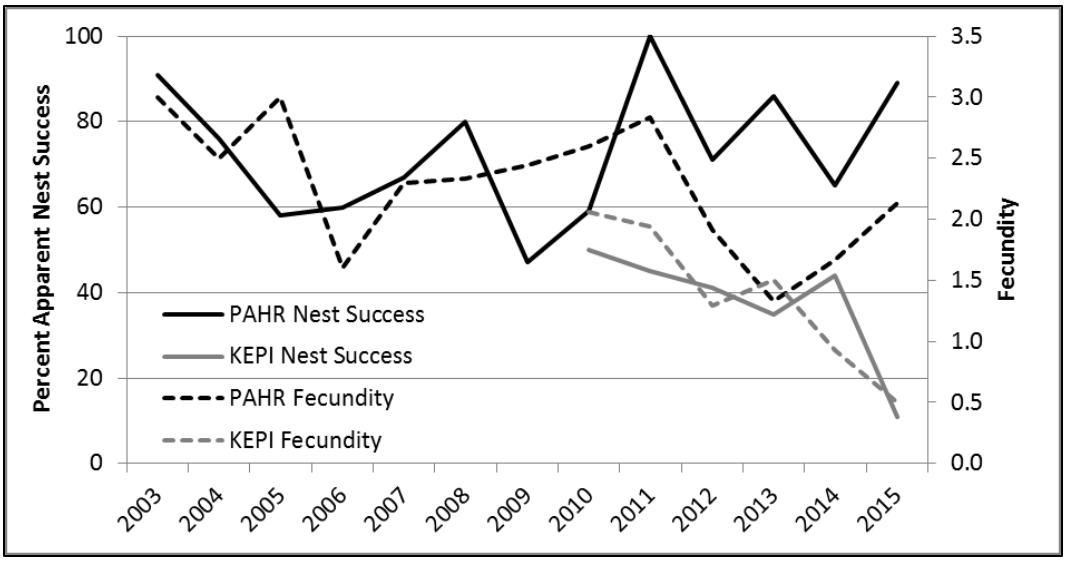

Figure 4-2.—Annual apparent nest success and fecundity (number of young produced per adult female) at Key Pittman (KEPI) and Pahranagat (PAHR), 2003–15.

Although relatively few flycatcher pairs were detected at PAHR, nest success was high, and fecundity was > 2.0 young/female for the first time since 2011.

At MUDD, both nest success and fecundity were among the highest recorded since monitoring began in 2005 (figures 4-3and 4-4); however, sample size was very low, with only two nests and one female having a known outcome. Therefore, the improvement in productivity is likely the result of variation inherent with small sample sizes and not an indication of improved conditions at MUDD. At TOPO, nest success and fecundity were among the lowest recorded in any year 2003–15, with only one fledgling produced. One nest, which was anticipated to produce two fledglings, failed just before the fledge date due to the Willow fire (see chapter 2). TOPO also has low sample sizes, and large interannual fluctuations in productivity are expected. Despite low sample size, nest success and fecundity at BIWI were essentially unchanged from 2014.

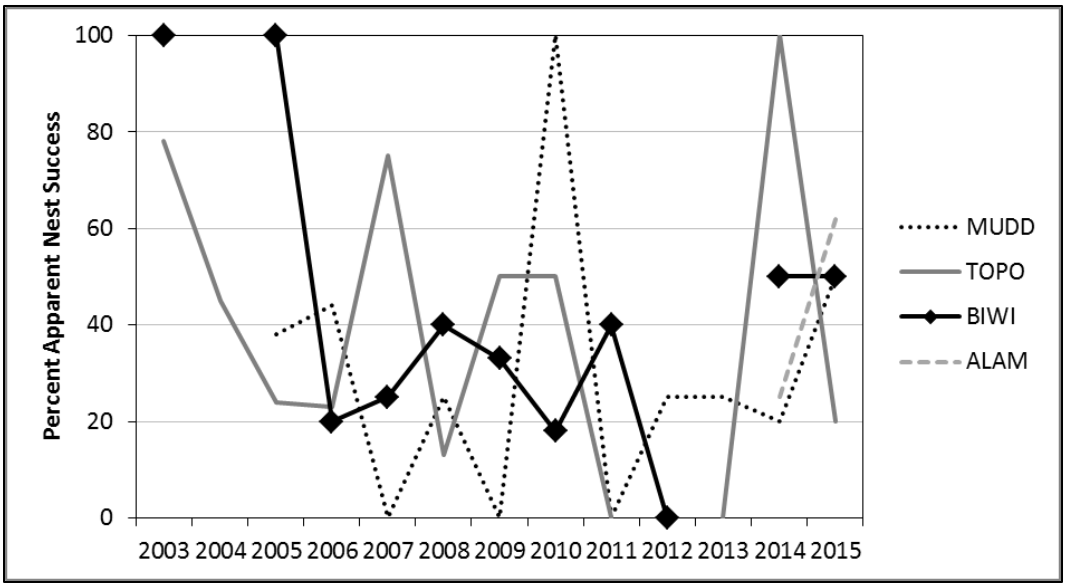

Figure 4-3.—Annual percent apparent nest success at Muddy River (MUDD), Topock Marsh (TOPO), Bill Williams (BIWI), and Alamo Lake (ALAM), 2003–15.

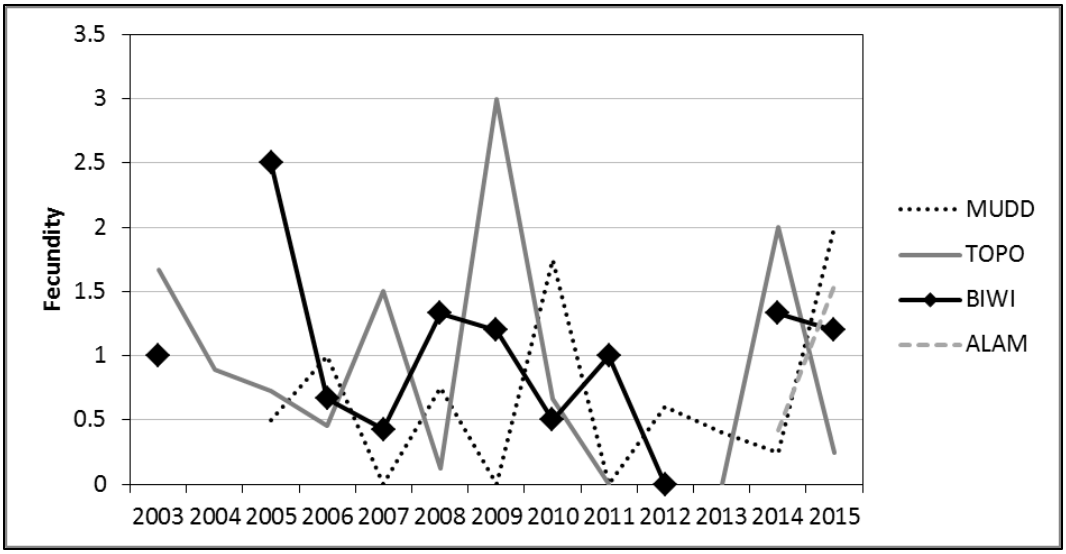

Figure 4-4.—Annual fecundity at Muddy River (MUDD), Topock Marsh (TOPO), Bill Williams (BIWI), and Alamo Lake (ALAM), 2003–15.

In 2014, ALAM had low nest success (25%) and fecundity (0.42 young/ female), which was suspected to be due to poor habitat conditions. There were very dry soils throughout the study area, median maximum daily temperatures at flycatcher nests at ALAM were approximately 7–10 °C hotter than at either BIWI or TOPO, and vapor pressure was typically 500–1,000 Pascals (Pa) lower than at BIWI and TOPO (McLeod and Pellegrini 2015). In 2015, nest success (62%) and fecundity (1.55 young/female) at ALAM were much higher than in 2014. ALAM was still the driest of all the study areas in 2015, though damp soils were present in nesting areas in 2015 (see chapter 5), unlike in 2014. Although median maximum daily temperatures were still higher at ALAM than at TOPO or BIWI, the difference between ALAM and the other study areas was on the order of 2–4 °C, while vapor pressure at ALAM was 200–400 Pa lower than at the other two study areas (see chapter 5). Damp soils, cooler temperatures, and higher humidity likely contributed to improved nest success at ALAM.

Nest Failure

Depredation was the leading cause of nest failure in 2015, as has been the case in previous years; this is consistent with the results reported in other studies at sites across Arizona (Graber et al. 2007; Ellis et al. 2008; Graber and Koronkiewicz 2009). Depredation rates were highest at KEPI, where depredation accounted for 63% of all failed nests. Ten of the 12 depredation events (83%) at KEPI occurred during the nestling phase; this is a continuation of the trend seen over the last several years, with an increasing proportion of nests that were depredated at KEPI having failed during the nestling stage. Across the other study areas in 2003–15, 34% of depredated nests failed during the nestling phase (SWCA, unpublished data). Likely predators of nestling flycatchers at KEPI in recent years include a pair of nesting Cooper's hawks, 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 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 (Wiens 1989; Robinson 1992; Howlett and Stutchbury 1996). If productivity at KEPI continues to be low, with depredation during the nestling phase being a primary cause of nest failure, inspection of the Cooper's hawk nest and plucking posts to search for flycatcher remains and leg bands might provide evidence to implicate the Cooper's hawks as a predator of flycatcher nestlings.

Brood Parasitism

The overall parasitism rate observed in 2015 (12%) was higher than those reported at other monitored sites across Arizona in 1996–2006, which were less than 10% at most sites in most years (Graber et al. 2007; Ellis et al. 2008), but was the lowest recorded in this study since monitoring began in 1997 (median 1997–2014 = 18.7%, range = 14.8–35.7%). The relatively low parasitism rate observed in 2015 probably does not indicate a change in the abundance or activities of cowbirds but rather reflects shifts in which study areas were monitored and the relative abundance of flycatchers at each site. The Mesquite study area on the Virgin River was not monitored in 2015; this study area typically had high parasitism rates, averaging 41.4% in 1997–2012. There were very few (2) flycatcher nests at MUDD, which has also typically had a very high parasitism rate, averaging 43.0% in 2005–14, while ALAM, which had a low parasitism rate (6.3% in 2014 and 10.7% in 2015), accounted for 38% of all flycatcher nests with known parasitism status in 2015.

Only two instances of nest failure in 2015 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. 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 as cited in Woodward and Stoleson 2002). 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, only cowbirds were 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 many depredation events on eggs and nestlings are attributable to cowbirds.

Parasitism does not invariably cause nest failure, but the success rate (16%) for parasitized nests at all study areas in 2003–15 was one-third that of unparasitized nests (50%; one-sided Fisher's exact test, $P < 0.001$). Similar results were recorded for willow flycatchers in Oregon, with parasitism resulting in a 50% decrease in success rates compared to unparasitized nests (Sedgwick and Iko 1999) and at other sites in Arizona, where in 1996–2005, 20% of parasitized 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 2003–14 produced on average fewer young (1.3 young/nest) than did unparasitized nests (2.2 young/nest; $F_{1,340} = 25.27$, $P < 0.001$). 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 2015, 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 (Paxton et al. 2007; McLeod and Pellegrini 2013), 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

Prior to 2015, the hatch rate of cowbird eggs that were incubated for a minimum of 10 days and that were not shaken was 68% (36 of 53 eggs) across all years and study areas. In contrast, only 12% (2 of 16 eggs) of the cowbird eggs that were shaken hatched after a minimum of 10 days of incubation, and it was apparent that addling cowbird eggs significantly reduced the cowbird hatch rate (Fisher's exact test, $P < 0.001$; difference in proportions = 0.55, 95% LB = 0.29). Egg addling in 2015 was ineffective, however, with all three cowbird eggs that SWCA personnel attempted to addle, and that were subsequently incubated for at least 10 days, ultimately hatching. Addling is less effective for eggs that have already been incubated for several days, but none of the eggs addled in 2015 had been incubated for more than a few days. As noted in the past, field personnel vary in their ability to disrupt the internal structure of an egg without breaking the shell. Replacing cowbird eggs with dummy eggs would eliminate the possibility of cowbird eggs hatching and would also reduce disturbance at the nest. Addling an egg requires accessing the nest twice in one visit, once to remove the egg and the other to replace the egg after it has been shaken, and then possibly requires another visit to remove the cowbird nestling if the egg hatches. Substituting a dummy egg for the cowbird egg would require accessing the nest only once and would be guaranteed to be effective regardless of how many days the egg had

been incubated or the field personnel performing the task. Cowbird eggs should be replaced with dummy eggs in the future. This procedure has been used at other study areas with no detrimental effects to flycatchers (M. Whitfield 2012, personal communication).

Chapter 5 – Nest Site Characteristics

INTRODUCTION

It is apparent that flycatchers along the LCR and its tributaries select territories and nest sites that are in close proximity 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 the majority of 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 little 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 latter 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 that progressed to the incubation phase at MUDD, TOPO, BIWI, and ALAM. These data will add to the database describing conditions in occupied flycatcher territories and also provide measures of temperature and humidity with which data collected concurrently at the conservation areas can be compared.

METHODS

Surface Hydrology

Surface hydrology was described near all active nests two to three times during the life of each nest. Descriptions included conditions of soil moisture at the nest (inundated, saturated, damp, or dry), depth of water (if any) at the nest, distance to water from the nest, and the percent of the area within 20 and 50 m of the nest that was inundated or saturated. 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 water were determined by one of three methods: a visual estimate in the field (if water

was visible from the nest); using a Global Positioning System (GPS) unit in the field (finding the nearest water, recording the GPS location, and setting the GPS unit to navigate back to the nest, thus displaying distance from water back to the nest); or by measuring on a georeferenced aerial photograph (either on a hardcopy 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 were inundated or saturated were estimated either visually in the field or, more often, by using on-the-ground knowledge of surface hydrology coupled with an aerial photograph to help with visualizing the area encompassed within a 20- or 50-m-radius circle around the nest. These data were scheduled to be collected when the nest was found, at the nest check before the estimated hatch day (or, if estimated hatch day was unknown, the nest check when nestlings were first detected), and again at fledge or failure. If a nest failed during laying or incubation or was found with nestlings, only two measurements of surface hydrology were collected.

At MUDD, wet soils have been confined to the river channel itself in recent years, and the linear distribution of these soils seems to lead observers to overestimate their presence in the vicinity of the nest. A shapefile of the river channel was generated using aerial imagery 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. Field estimates were compared with the water mapping estimates, and in instances in which the difference between the two was more than 10%, the water mapping estimate was selected for inclusion in the final dataset.

Vegetation

At each nest, the species of tree or shrub in which the nest was placed (nest substrate) was recorded 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

A Hygrochron iButton (Maxim Integrated, San Jose, California) was deployed at the first 10 flycatcher nests that were confirmed to be in the incubation phase at MUDD, TOPO, BIWI, and ALAM. 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 loggers recorded temperature and relative humidity every 30 minutes and remained in place until the end of the breeding season.

Statistical Analyses

Temperature and humidity data were truncated to the midnight after the logger was deployed and midnight before the logger was removed so that only full 24-hour periods were represented. Temperature (T, °C) and relative humidity (RH) were converted to vapor pressure[9] (VP, Pascals) as follows:

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

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

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

For vapor pressure calculations, times from 0530 to 2000 hours were assigned as day and all others as night. Each variable was summarized over 2-week periods by study area and by vegetation type within each study area. Standard error for each 2-week period was calculated using each daily measurement from each

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

logger as an independent observation. Nest data were plotted with data obtained at beetle monitoring points (see chapter 6) within the same study area. A cursory examination of temperature and humidity data collected at beetle monitoring points showed that daily summary data were not always normally distributed. It was presumed that data collected at nest sites were likely also non-normal, and median data were presented in graphs showing daily summary data. Analyses of temperature and humidity and summary of vegetation data were completed in IBM ® SPSS ® v. 22.0.

RESULTS

Surface Hydrology

Soil moisture conditions were described up to 4 times during the season at 90 flycatcher nests in 9 study areas: KEPI (21 nests), RIRA (5 nests), PAHR (9 nests), MVWA (4 nests), MUDD (3 nests), WMSP (1 nest), TOPO (6 nests), BIWI (7 nests), and ALAM (34 nests). Although personnel had intended to describe soil moisture conditions up to three times (when the nest was found, at hatch, and at fail or fledge), soil moisture conditions were sometimes described four times when duplicate estimates were accidently recorded for a particular nest stage. Soil moisture conditions were described at 84 of the 90 nests within 1 week of the nest being found; 51 were found during building, 11 were found during laying, 18 were found during incubation, and 4 were found with nestlings.

No trend was observed at KEPI for any measure of surface hydrology, and at least 10% of the soils within 50 m of each nesting attempt were inundated or saturated throughout the life of the nest (figure 5-1). Of the 54 estimates of soil condition at nests in KEPI, 32 (59%) were of saturated or inundated soils, 21 (39%) were of damp soils, and 1 (2%) noted dry soils. At PAHR, a slight drying trend was observed through the season in all measures of surface hydrology, though at least 20% of the soils within 50 m of each nesting attempt were inundated or saturated throughout the life of the nest (figure 5-1). Of the 25 estimates of soil condition at nests in PAHR, 20 (80%) were of saturated or inundated soils, and 5 (20%) were of damp soils. At RIRA, a drying trend was noted, with noticeably smaller percentages of wet soils within 20 and 50 m of active nests at the end of the season (figure 5-2). By August, no wet soils were noted within 50 m of the remaining active nest. Of the 14 estimates of soil condition at nests in RIRA, 2 (14%) were of saturated soils, 9 (64%) were of damp soils, and 3 (21%) were of dry soils. At MVWA, each nest was located over standing water throughout the season, and the only noticeable trend was a slight decrease in water depth (figure 5-2).

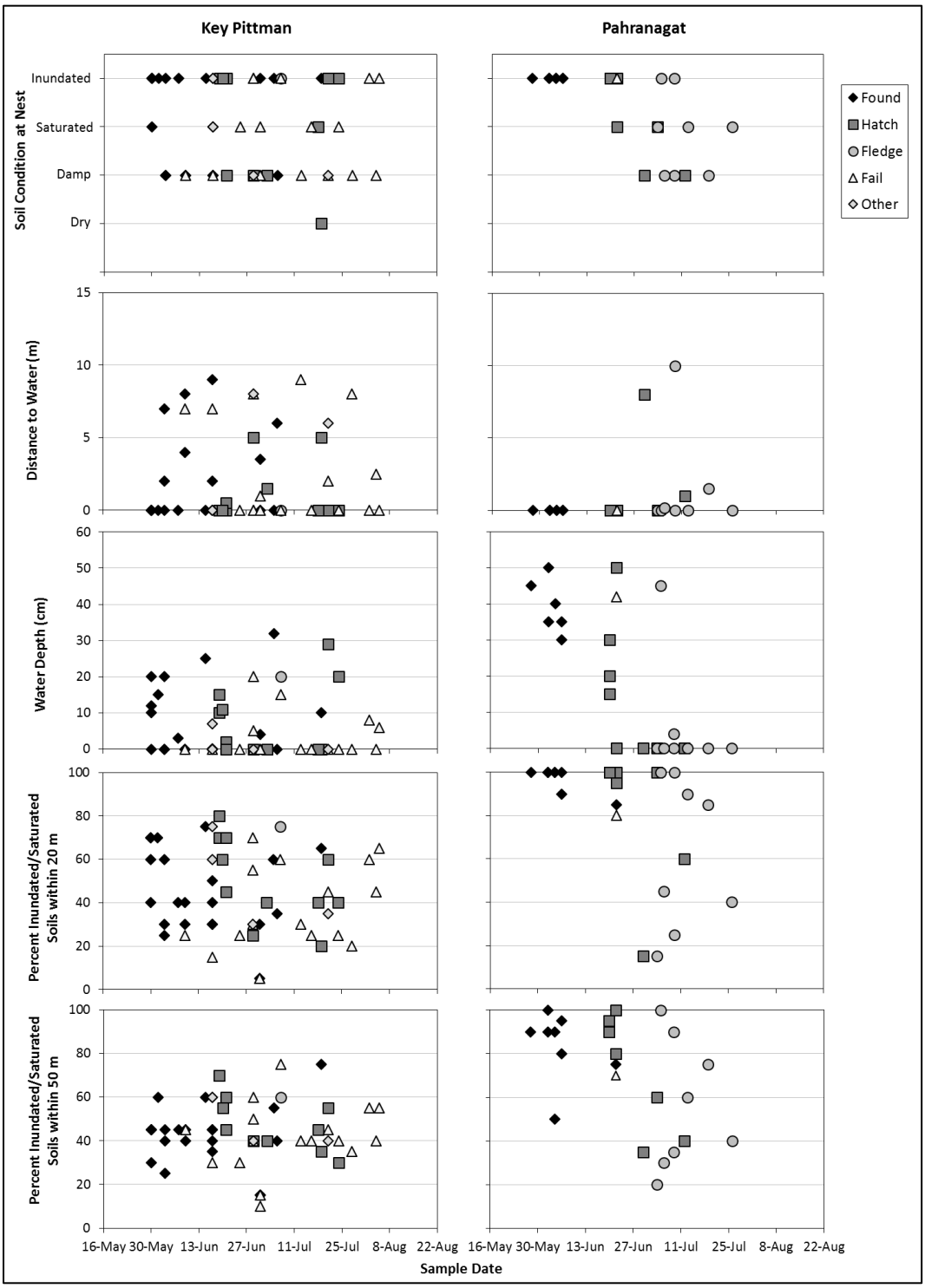

Figure 5-1.—Soil moisture characteristics at southwestern willow flycatcher nests in Key Pittman and Pahranagat, 2015.

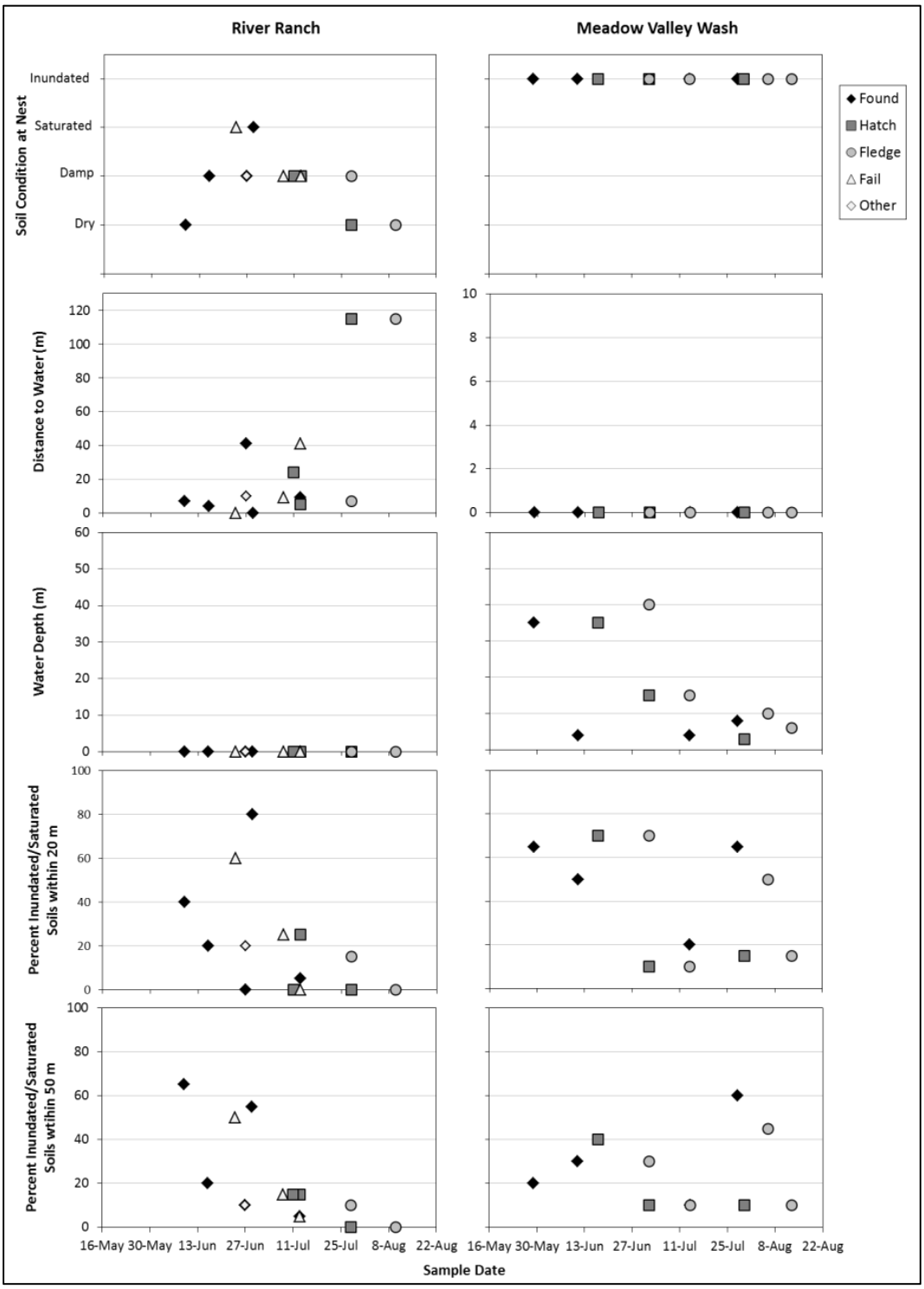

Figure 5-2.—Soil moisture characteristics at southwestern willow flycatcher nests in River Ranch and Meadow Valley Wash, 2015.

At MUDD, nearly all field observations resulted in an overestimate of wet soil extent, though some observers were able to estimate wet soil extent to within 10% of the water mapping values. Of the 16 estimates, 6 (38%) were generated from water mapping. Areal extent of water did not change through the season at MUDD, as all surface water and saturated soils were contained in the narrow river channel. Consequently, even though each nest at MUDD was located over surface water throughout the season, the extent of wet soils in the vicinity of each nest was small (figure 5-3). Depth of surface water below each nest varied in accordance with river depth (figure 5-3). A drying trend was noticed around the nest at WMSP. The nest was over damp soils in June and dry soils in July. Distance to wet soils increased from 2 m in early June to 18 m in late June and 156 m in mid-July. In early June, 10% of the soils within 20 m and 5% of the soils within 50 m were either inundated or saturated. In late June, 5% of the soils within 20 m and 15% of the soils within 50 m were either inundated or saturated. By mid-July, none of the soils within 50 m were wet. Because of the limited sample size, the data are not presented graphically.

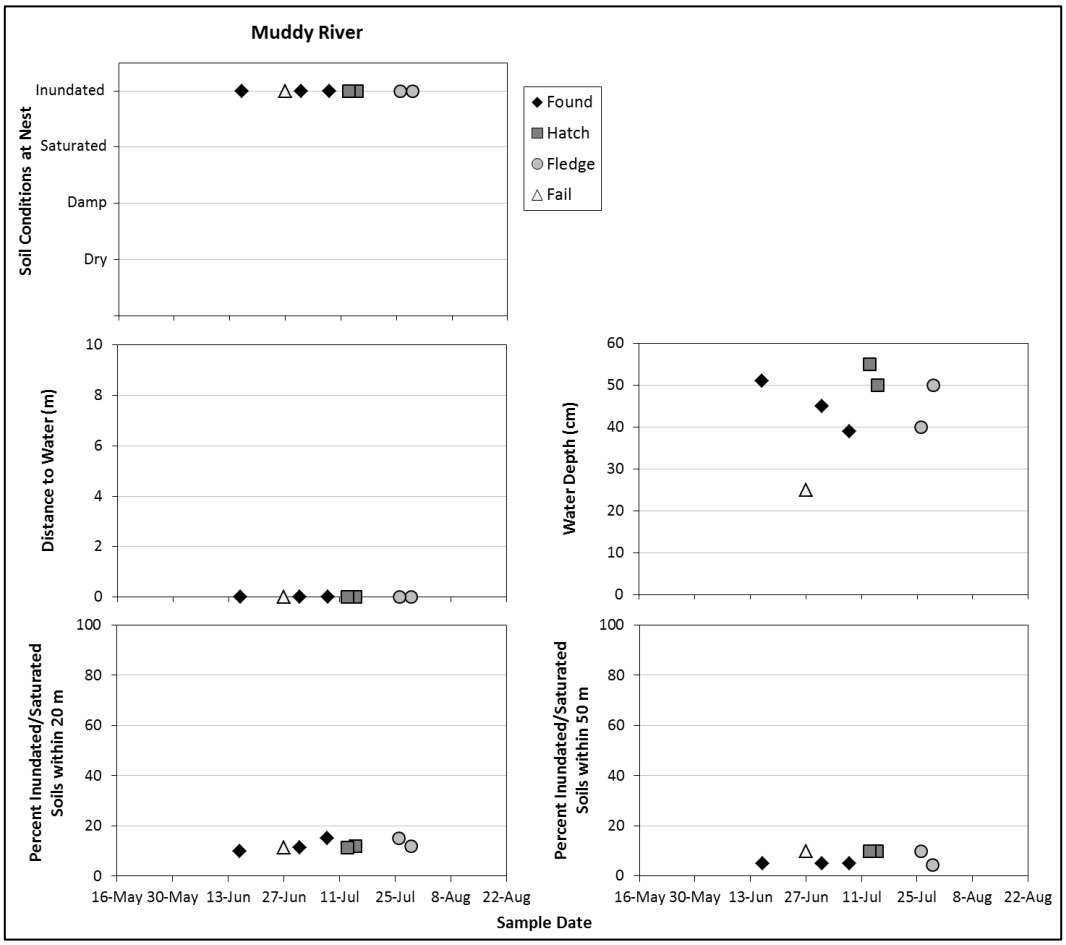

Figure 5-3.—Soil moisture characteristics at southwestern willow flycatcher nests in Muddy River, 2015.

At TOPO, no nests were located over wet soils, and a slight drying trend was apparent with increasing distance to water and decreasing percentages of wet soils within 50 m of active nests (figure 5-4). Of the 13 estimates of soil condition at a nest collected in TOPO, 8 (62%) were of damp soils, and 5 (38%) were of dry soils. Surface water and wet soils were largely confined to deep channels at BIWI, and a drying trend was noted in soil conditions at nests and in the amount of wet soils within 20 and 50 m of each nest (figure 5-4). ALAM was the driest study area with breeding flycatchers in 2015, with only 26 of the 85 estimates (31%) noting damp soils beneath nests and all other estimates noting dry soils. Distance to known standing water varied from 204 m at one nest up to 2 km. The median distance to water for all nests was 923 m and did not vary through the breeding season. Because of the extremely dry conditions in this study area, the data are not presented graphically.

Vegetation

Vegetation characteristics were recorded at 90 flycatcher nests (21 at KEPI, 5 at RIRA, 9 at PAHR, 4 at MVWA, 3 at MUDD, 1 at WMSP, 6 at TOPO, 7 at BIWI, and 34 at ALAM; table 5-1). Nests were built in coyote willows (33%), Goodding's willows (34%), cottonwoods (2%), tamarisk (28%), velvet ash (1%), and palms (1%). No tamarisk foliage was present within 5 m of any nest at KEPI, RIRA, or PAHR. Tamarisk foliage was present to some extent within 5 m of each nest location at MUDD (range = 60–70%), TOPO (range = 10–100%), and WMSP (10%). At MVWA, some tamarisk foliage was present within 5 m of two of the four nests (range = 10–15%), while tamarisk foliage was present within 5 m of six of the seven nests at BIWI (range = 50–100%). At ALAM, some tamarisk foliage was present within 5 m of 31 of the 34 nests (range = 5–100%). Of the study areas with tamarisk present in the vicinity of a nest location, MVWA, WMSP, and ALAM had low median percentages of tamarisk within 5 m of flycatcher nests (5, 10, and 10%, respectively) while MUDD, TOPO, and BIWI had higher percentages of tamarisk within 5 m of nests (60, 90, and 95%, respectively; table 5-1).

Temperature and Humidity

An iButton was deployed at each of 3 flycatcher nests at MUDD, 4 nests at TOPO, 6 nests at BIWI, and 10 nests at ALAM. The loggers were deployed between late May and mid-July and remained in place until late July or early August. Two iButtons at ALAM were taken down in error in mid-June and were redeployed a week later. Three iButtons at TOPO were not removed until mid-October because the refuge was closed after a fire in August. Data from one of the three iButtons could not be retrieved because the logger was damaged in the fire; all other iButtons functioned properly.

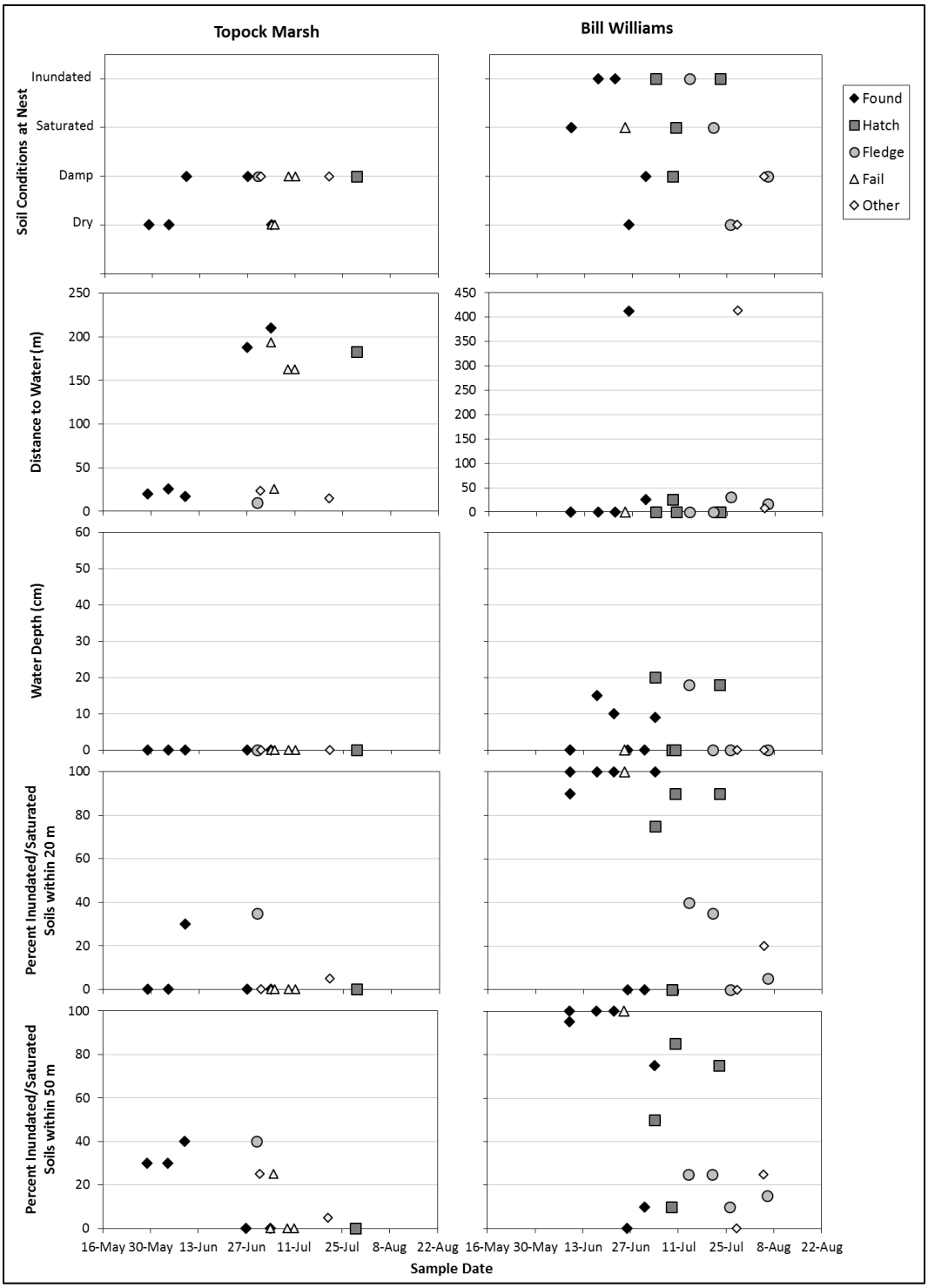

Figure 5-4.—Soil moisture characteristics at southwestern willow flycatcher nests in Topock Marsh and Bill Williams, 2015.

Table 5-1.—Tally of nests by nest substrate and percentage of tamarisk at southwestern willow flycatcher nests by vegetation type in all study areas, 2015

		Nest substrate					% TAMSPP within 2 m		% TAMSPP within 5 m	
Study area[1]	**Vegetation type[2]**	**SALEXI**	**SALGOO**	**POPFRE**	**TAMSPP**	**OTHER**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**
KEPI	SALEXI (n = 21)	21	0	0	0	0	0.0 (0.0–0.0)	0.0 (0.0)	0.0 (0.0–0.0)	0.0 (0.0)
RIRA	SALEXI (n = 5)	5	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	SALGOO (n = 6)	0	6	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 = 2)	0	0	2	0	0	0.0 (0.0–0.0)	0.0 (0.0)	0.0 (0.0–0.0)	0.0 (0.0)
	POPFRE_SALGOO (n = 1)	0	1	0	0	0	0.0	0.0	0.0	0.0
	Total	**0**	**7**	**2**	**0**	**0**	**0.0 (0.0–0.0)**	**0.0 (0.0)**	**0.0 (0.0–0.0)**	**0.0 (0.0)**
MVWA	SALEXI (n = 3)	3	0	0	0	0	0.0 (0.0–5.0)	1.7 (1.7)	0.0 (0.0–15.0)	5.0 (5.0)
	OTHER[3] (n = 1)	0	0	0	0	1[4]	5.0	5.0	10.0	10.0
	Total	**3**	**0**	**0**	**0**	**1**	**2.5 (0.0–5.0)**	**2.5 (1.4)**	**5.0 (0.0–12.5)**	**6.3 (3.8)**
MUDD	TAMSPP_SALEXI (n = 3)	0	0	0	3	0	80.0 (40.0–90.0)	70.0 (15.3)	60.0 (60.0–70.0)	63.3 (3.3)
WMSP	OTHER[5] (n = 1)	0	0	0	0	1[6]	5.0	5.0	10.0	10.0
TOPO	SALGOO_TAMPSPP (n = 1)	0	0	0	1	0	25.0	25.0	10.0	10.0
	TAMSPP (n = 4)	0	0	0	4	0	100.0 (97.5–100.0)	98.8 (1.3)	97.5 (90.0–100.0)	95.0 (3.5)
	TAMSPP_SALGOO (n = 1)	0	0	0	1	0	80.0 (100.0-100.0)	80.0 (0.0)	60.0 (95.0-100.0)	60.0 (4.9)
	Total	**0**	**0**	**0**	**4**	**0**	**97.5 (80.0-100.0)**	**83.3 (12.1)**	**90.0 (60.0-100.0)**	**75.0 (14.3)**
BIWI	SALEXI (n = 1)	1	0	0	0	0	0.0	0.0	0.0	0.0
	TAMSPP (n = 5)	0	0	0	5	0	100.0 (100.0-100.0)	100.0 (0.0)	100.0 (95.0-100.0)	94.0 (4.9)
	TAMSPP_SALEXI (n = 1)	0	0	0	1	0	90.0	90.0	50.0	50.0
	Total	**1**	**0**	**0**	**6**	**0**	**100.0 (90.0-100.0)**	**84.3 (14.1)**	**95.0 (50.0-100.0)**	**74.3 (14.2)**
ALAM	SALGOO (n = 17)	0	16	0	1	0	0.0 (0.0-5.0)	4.1 (1.8)	5.0 (5.0-10.0)	7.1 (1.6)
	SALGOO_TAMSPP (n = 11)	0	8	0	3	0	12.5 (10.0-25.0)	18.0 (4.4)	15.0 (10.0-20.0)	15.5 (2.5)
	TAMSPP (n = 2)	0	0	0	2	0	100.0 (100.0-100.0)	100.0 (0.0)	95.0 (90.0-100.0)	95.0 (5.0)
	TAMSPP_SALGOO (n = 4)	0	0	0	4	0	37.5 (35.0-50.0)	42.5 (6.0)	50.0 (42.5-60.0)	51.3 (7.1)
	Total	**0**	**24**	**0**	**10**	**0**	**5.0 (0.0-30.0)**	**18.8 (5.0)**	**10.0 (5.0-25.0)**	**20.3 (4.4)**

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, MUDD = Muddy River, WMSP = Warm Springs, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.

[2] SALEXI = > 75% coyote willow; SALGOO = > 75% Goodding's willow; POPFRE = > 75% Fremont cottonwood; TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%; OTHER = a vegetation type that does not fit one of the above descriptions; SALGOO_POPFRE = Goodding's willow and Fremont cottonwood mix, neither > 75%; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory; TAMSPP_SALGOO = tamarisk with emergent Goodding's willow; and TAMSPP = > 75% tamarisk.

[3] Coyote willow with tamarisk, velvet ash, and Fremont cottonwood.

[4] Velvet ash.

[5] Palm overstory with coyote willow, velvet ash, and tamarisk understory.

[6] Palm.

Maximum daily temperatures at nests at ALAM were approximately 4 °C higher than at nests at either BIWI or TOPO, while maximum daily temperatures at MUDD were intermediate between those at ALAM and the other two study areas (attachment 9 and figures 5-5 and 5-6). Minimum temperatures were less variable among study areas and were typically highest at TOPO (attachment 9 and figure 5-7), while the daily temperature range followed the same pattern as maximum daily temperature (attachment 9 and figure 5-8). Both diurnal and nocturnal vapor pressure were markedly lower at MUDD than at the other three study areas, and vapor pressure at ALAM was intermediate between MUDD and the other two study areas (attachment 9 and figures 5-9 to 5-11).

Although nest sample sizes were too small to permit a formal comparison between nests and beetle monitoring points (see chapter 6), simple visual comparisons show that flycatcher nest locations at MUDD had median maximum daily temperatures that were approximately 5 °C cooler than at beetle monitoring points, while vapor pressure was slightly (approximately 100 Pa) but consistently higher at nests than at beetle points (figures 5-12 to 5-16). At TOPO, median maximum daily temperature differed very little between nests and beetle points; minimum temperatures, however, were typically higher at nests than at beetle points, and the daily temperature range was consequently smaller at nests than at beetle points. Vapor pressure at TOPO did not differ between nests and beetle points. At BIWI, maximum daily temperatures tended to be lower at nest sites than at beetle points, and nocturnal vapor pressure tended to be higher at nests than at beetle points.

DISCUSSION

Surface Hydrology

Soil moisture conditions that were recorded within a week of a nest being found in the building stage closely represent the conditions present when the nest location was selected by the flycatcher. This was the case for 51 of 90 nests in all study areas. Soil moisture conditions were described for 16 additional nests at ALAM that were found after they were already built. Hydrological conditions remained constant through the season at ALAM (see chapter 2), and the data recorded at these additional nests are thus representative of the conditions that were present when the nest site was selected. Of these 67 nests, 28 (42%) were built within 5 m of standing water or saturated soil, and an additional 7 nests (10%) were within 30 m of water. Flycatchers are known for their propensity to nest near surface water (Sogge and Marshall 2000; McLeod and Pellegrini 2013), which affects vegetation density, food availability (Iwata et al. 2003, Peterson et al. *in press*), and microclimate (McLeod and Pellegrini 2013).

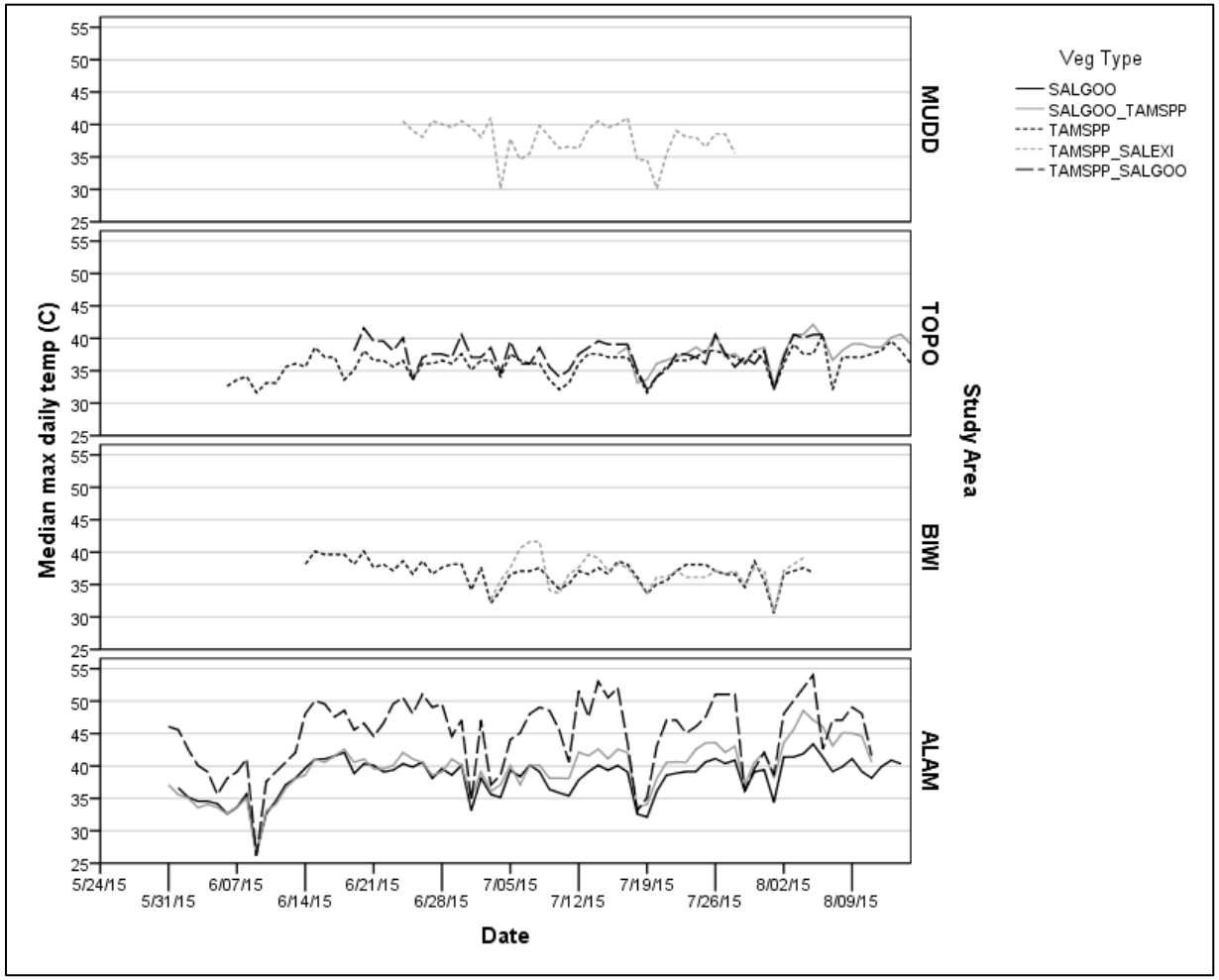

Figure 5-5.—Median maximum daily temperature at southwestern willow flycatcher nests by study area and vegetation type, 2015.

Muddy River (MUDD; TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%; n = 3), Topock Marsh (TOPO; TAMSPP = > 75% tamarisk, n = 1; and TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, n =1), Bill Williams (BIWI; TAMSPP n = 5 and TAMSPP_SALEXI n = 1), and Alamo Lake (ALAM; SALGOO = > 75% Goodding's willow, n = 6; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory, n = 3; and TAMSPP_SALGOO n = 1).

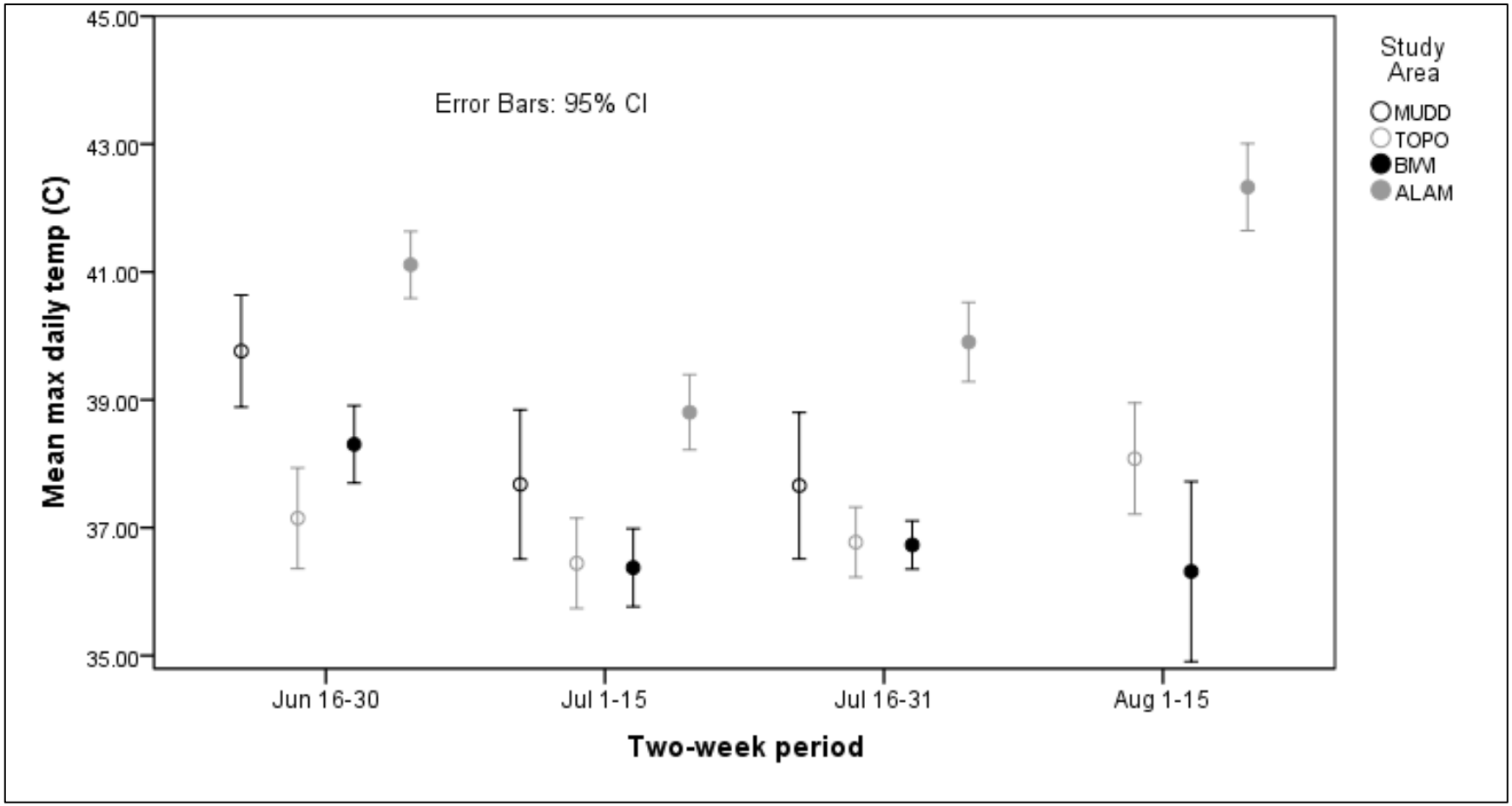

Figure 5-6.—Mean maximum daily temperature and 95% confidence intervals over 2-week periods at southwestern willow flycatcher nests by study area, 2015.
Muddy River (MUDD, n = 3), Topock Marsh (TOPO, n = 3), Bill Williams (BIWI, n = 6), and Alamo Lake (ALAM, n = 10).

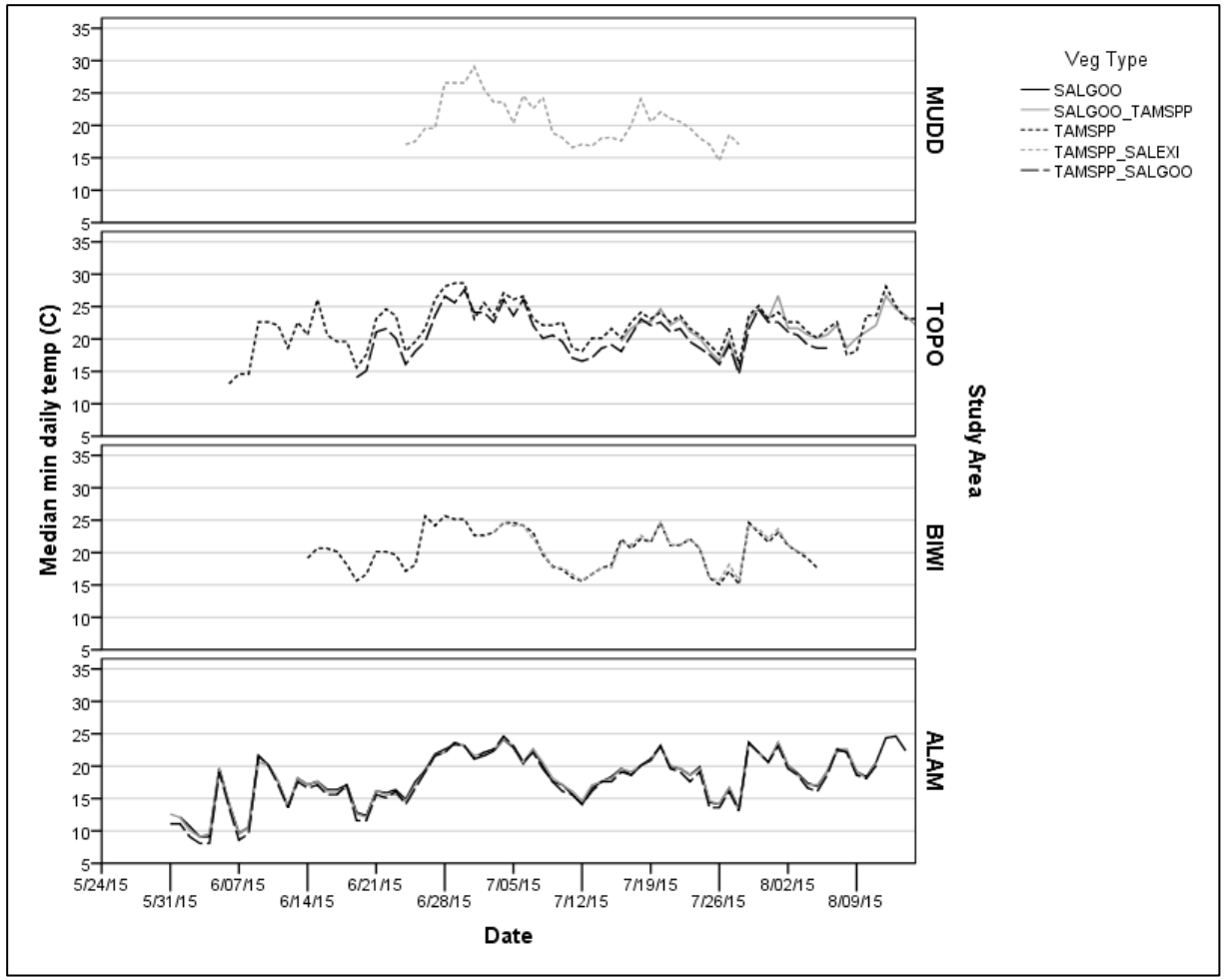

Figure 5-7.—Median minimum daily temperature at southwestern willow flycatcher nests by study area and vegetation type, 2015.
Muddy River (MUDD; TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%; n = 3), Topock Marsh (TOPO; TAMSPP = > 75% tamarisk, n = 1; and TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, n =1), Bill Williams (BIWI; TAMSPP n = 5 and TAMSPP_SALEXI n = 1), and Alamo Lake (ALAM; SALGOO = > 75% Goodding's willow, n = 6; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory, n = 3; and TAMSPP_SALGOO n = 1).

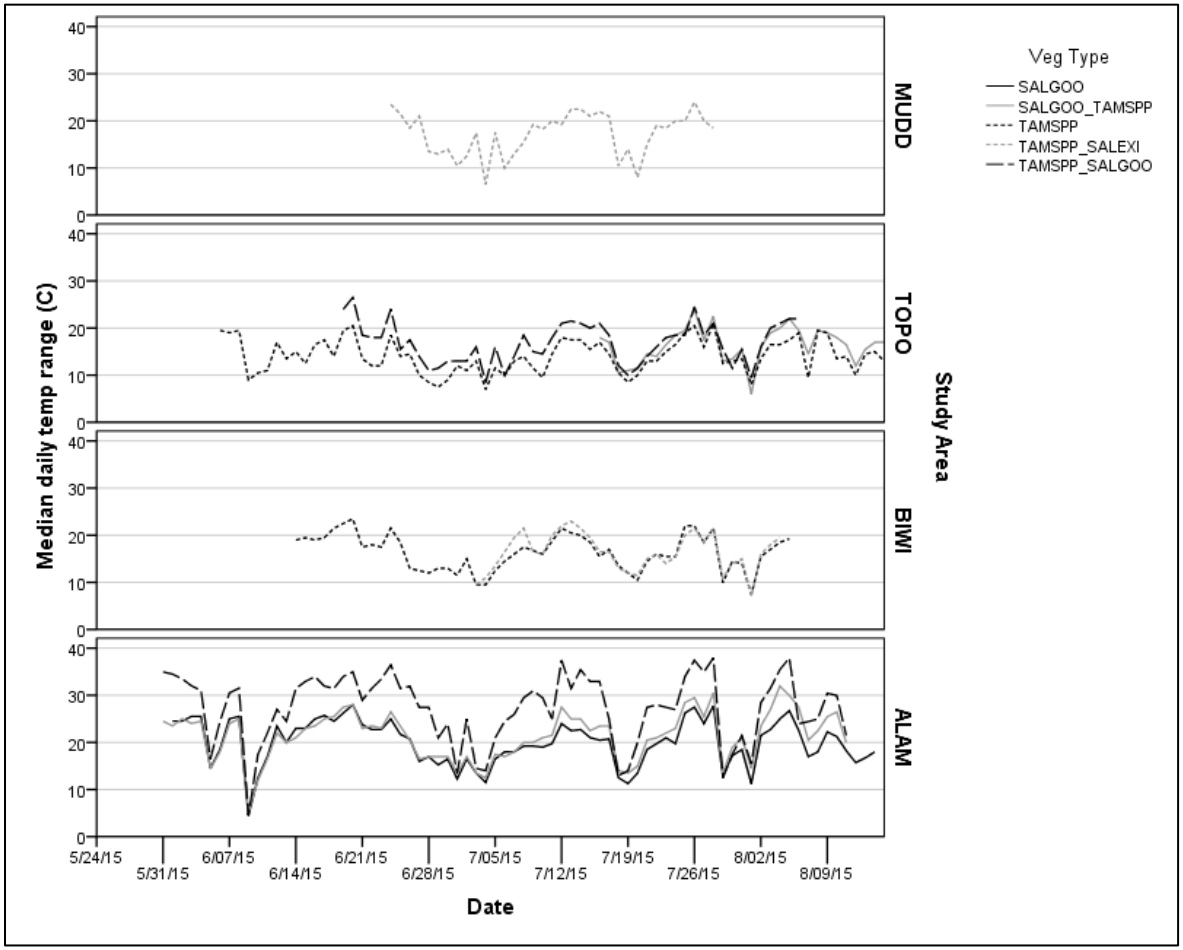

Figure 5-8.—Median daily temperature range at southwestern willow flycatcher nests by study area and vegetation type, 2015.
Muddy River (MUDD; TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%; n = 3), Topock Marsh (TOPO; TAMSPP = > 75% tamarisk, n = 1; and TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, n =1), Bill Williams (BIWI; TAMSPP n = 5 and TAMSPP_SALEXI n = 1), and Alamo Lake (ALAM; SALGOO = > 75% Goodding's willow, n = 6; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory, n = 3; and TAMSPP_SALGOO n = 1).

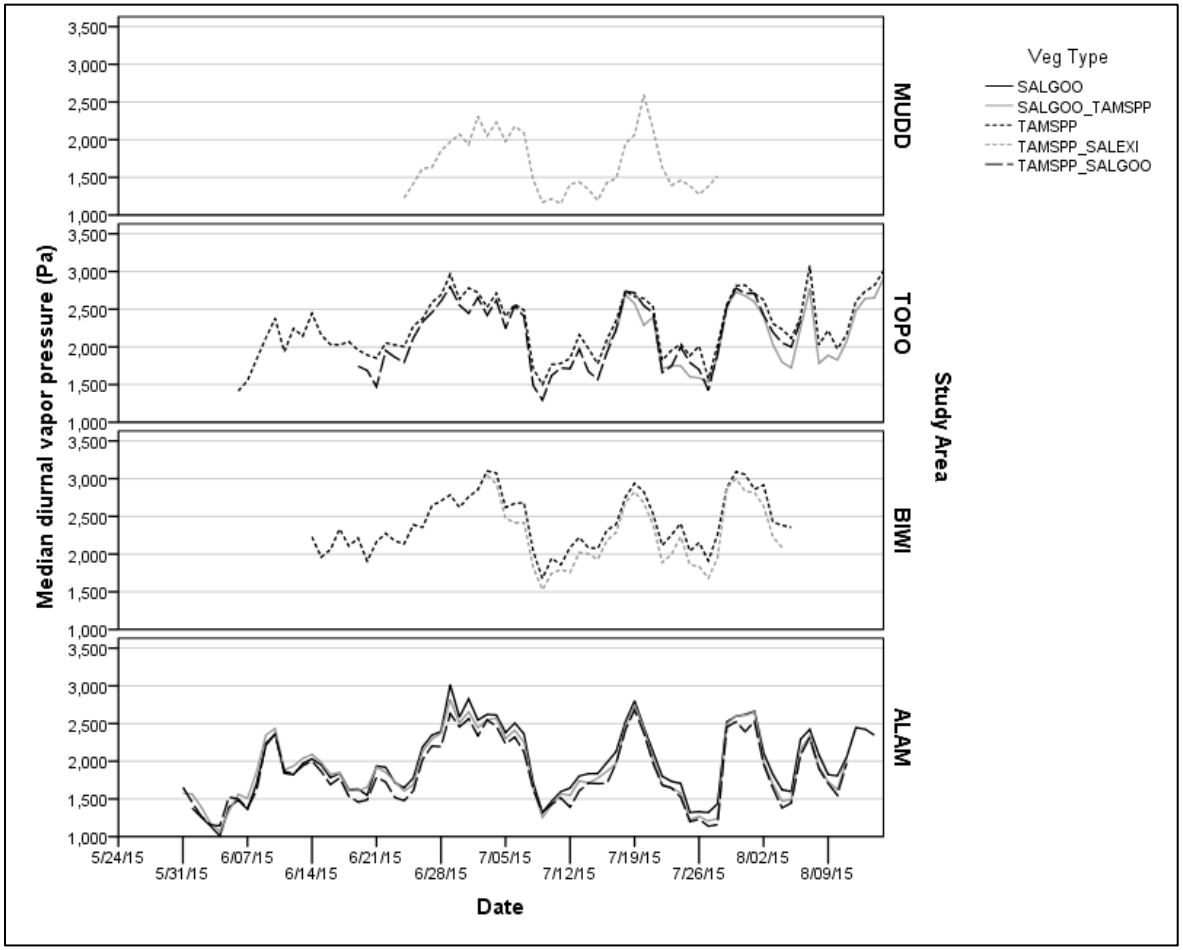

Figure 5-9.—Median diurnal vapor pressure at southwestern willow flycatcher nests by study area and vegetation type, 2015.
Muddy River (MUDD; TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%; n = 3), Topock Marsh (TOPO; TAMSPP = > 75% tamarisk, n = 1; and TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, n =1), Bill Williams (BIWI; TAMSPP n = 5 and TAMSPP_SALEXI n = 1), and Alamo Lake (ALAM; SALGOO = > 75% Goodding's willow, n = 6; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory, n = 3; and TAMSPP_SALGOO n = 1).

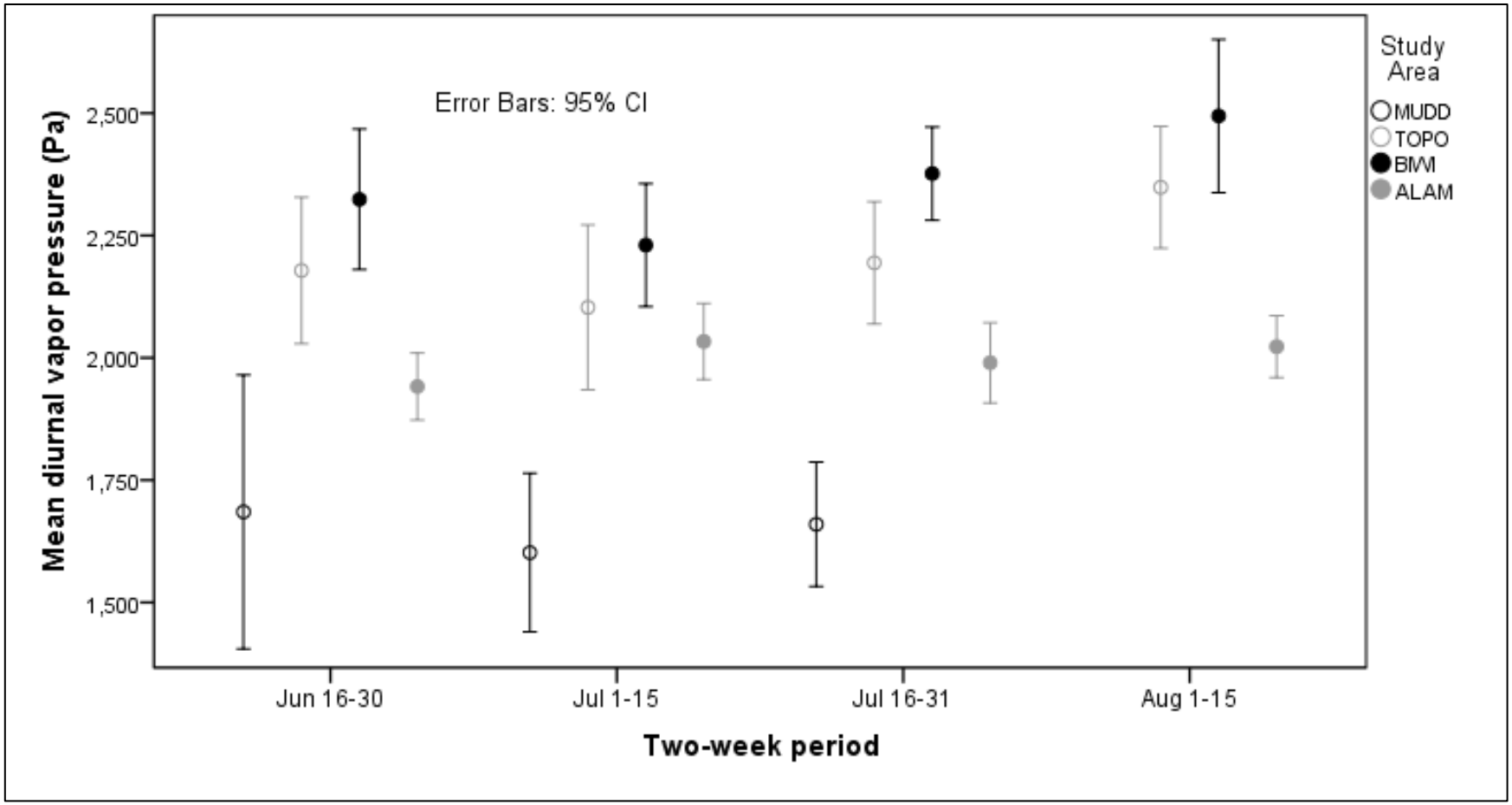

Figure 5-10.—Mean diurnal vapor pressure and 95% confidence intervals over 2-week periods at southwestern willow flycatcher nests by study area, 2015.
Muddy River (MUDD, n = 3), Topock Marsh (TOPO, n = 3), Bill Williams (BIWI, n = 6), and Alamo Lake (ALAM, n = 10).

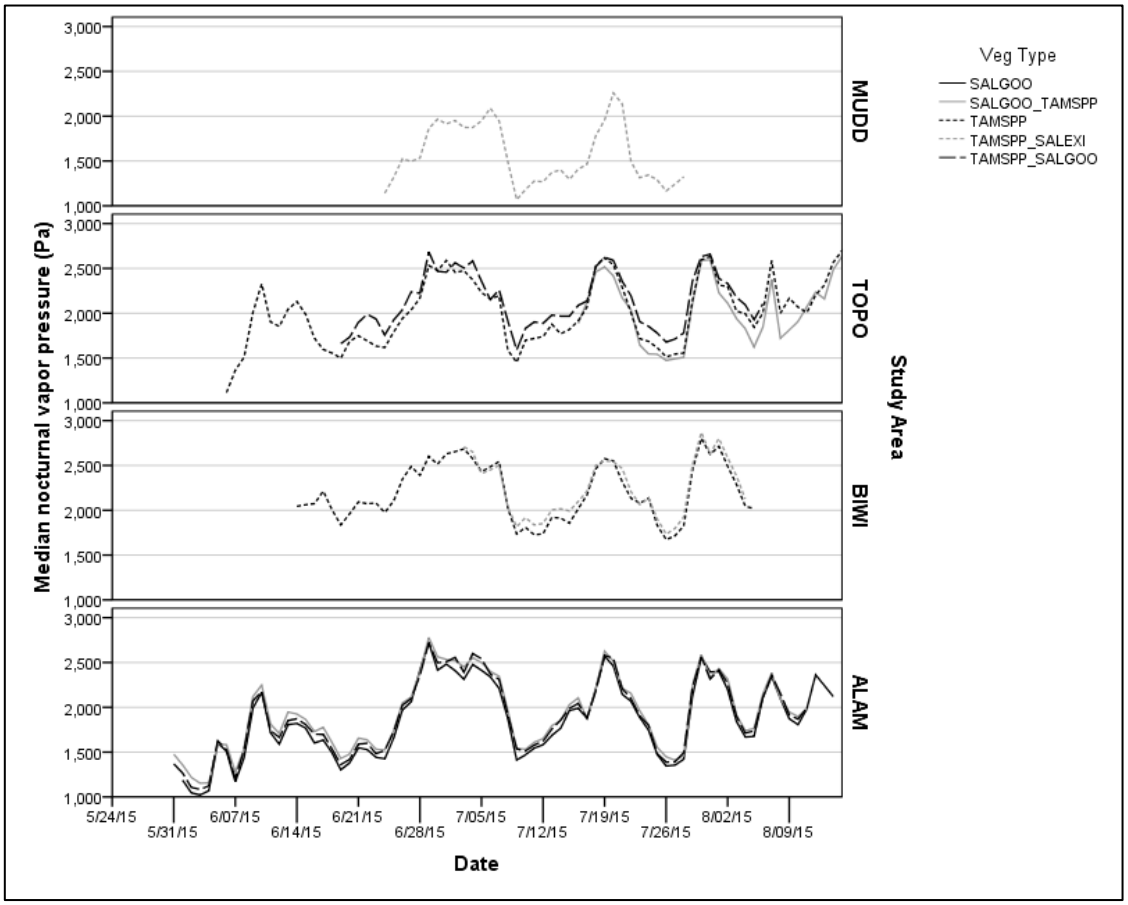

Figure 5-11.—Median nocturnal vapor pressure at southwestern willow flycatcher nests by study area and vegetation type, 2015.
Muddy River (MUDD; TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%; n = 3), Topock Marsh (TOPO; TAMSPP = > 75% tamarisk, n = 1; and TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, n = 1), Bill Williams (BIWI; TAMSPP n = 5 and TAMSPP_SALEXI n = 1), and Alamo Lake (ALAM; SALGOO = > 75% Goodding's willow, n = 6; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory, n = 3; and TAMSPP_SALGOO n = 1).

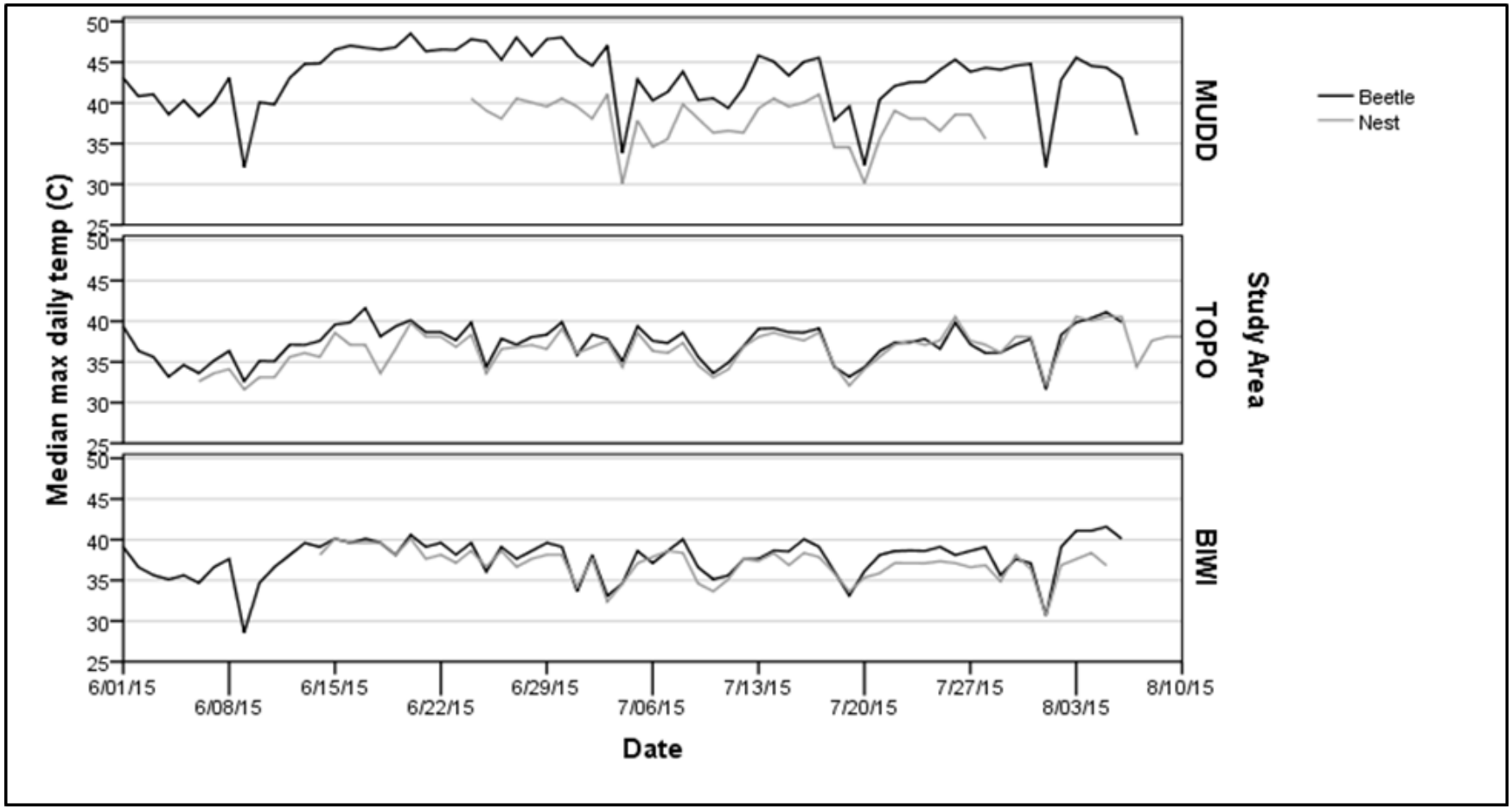

Figure 5-12.—Median maximum daily temperature at southwestern willow flycatcher nests and beetle monitoring points by study area, 2015.

Muddy River (MUDD; n = 3), Topock Marsh (TOPO; n = 3), Bill Williams (BIWI; n = 6), and beetle monitoring points at those study areas (n = 20, 12, and 15, respectively).

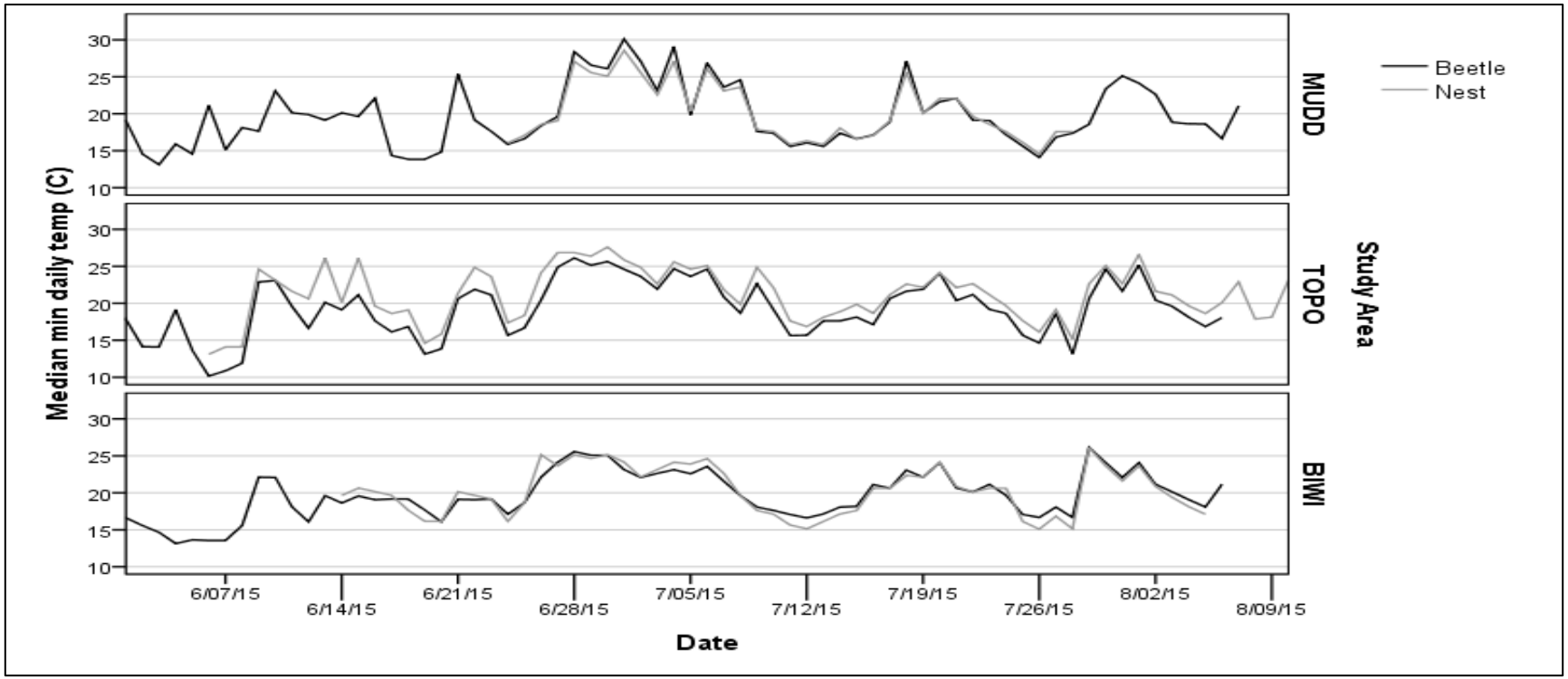

Figure 5-13.—Median minimum daily temperature at southwestern willow flycatcher nests and beetle monitoring points by study area, 2015.

Muddy River (MUDD; n = 3), Topock Marsh (TOPO; n = 3), Bill Williams (BIWI; n = 6), and beetle monitoring points at those study areas (n = 20, 12, and 15, respectively).

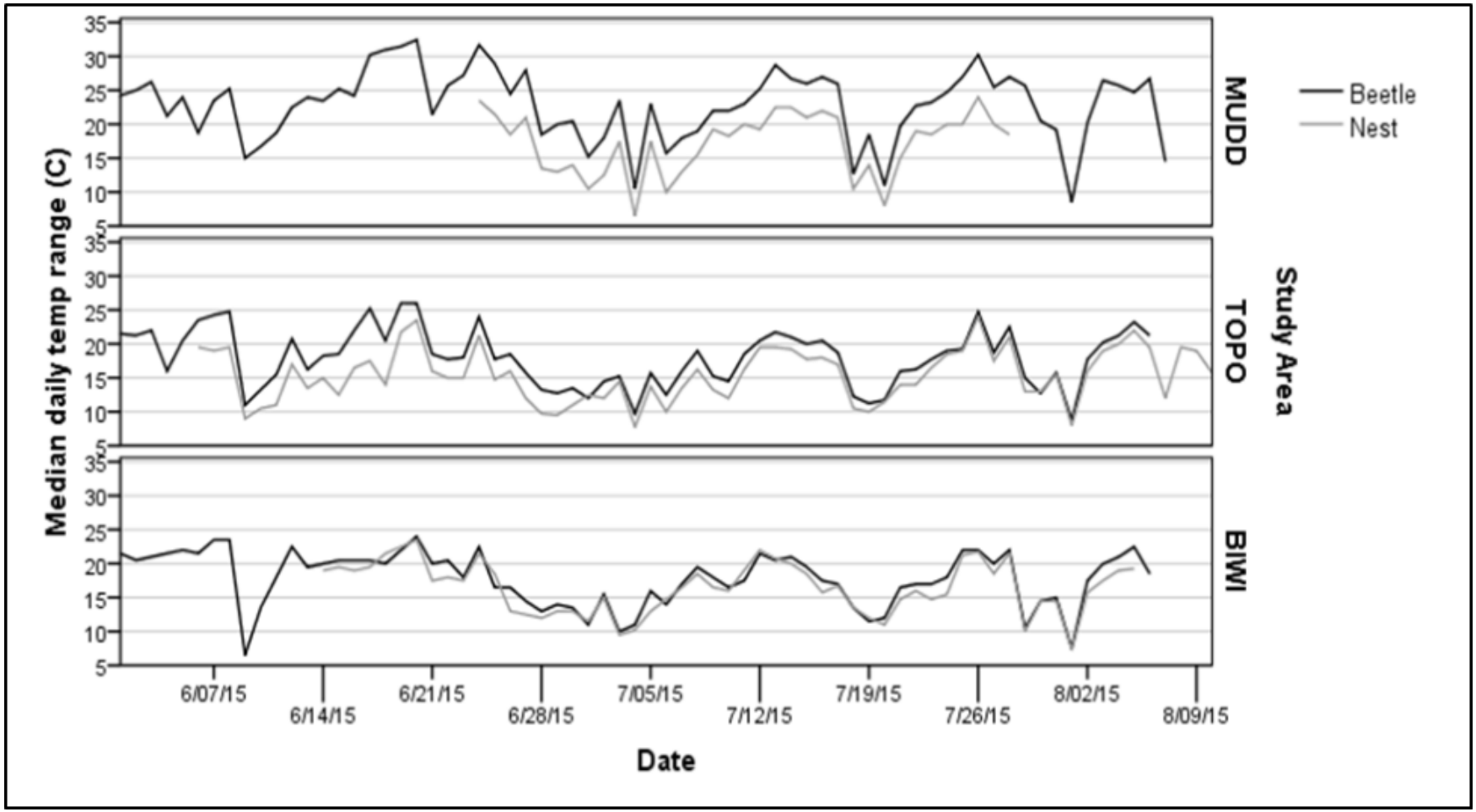

Figure 5-14.—Median daily temperature range at southwestern willow flycatcher nests and beetle monitoring points by study area, 2015. Muddy River (MUDD; n = 3), Topock Marsh (TOPO; n = 3), Bill Williams (BIWI; n = 6), and beetle monitoring points at those study areas (n = 20, 12, and 15, respectively).

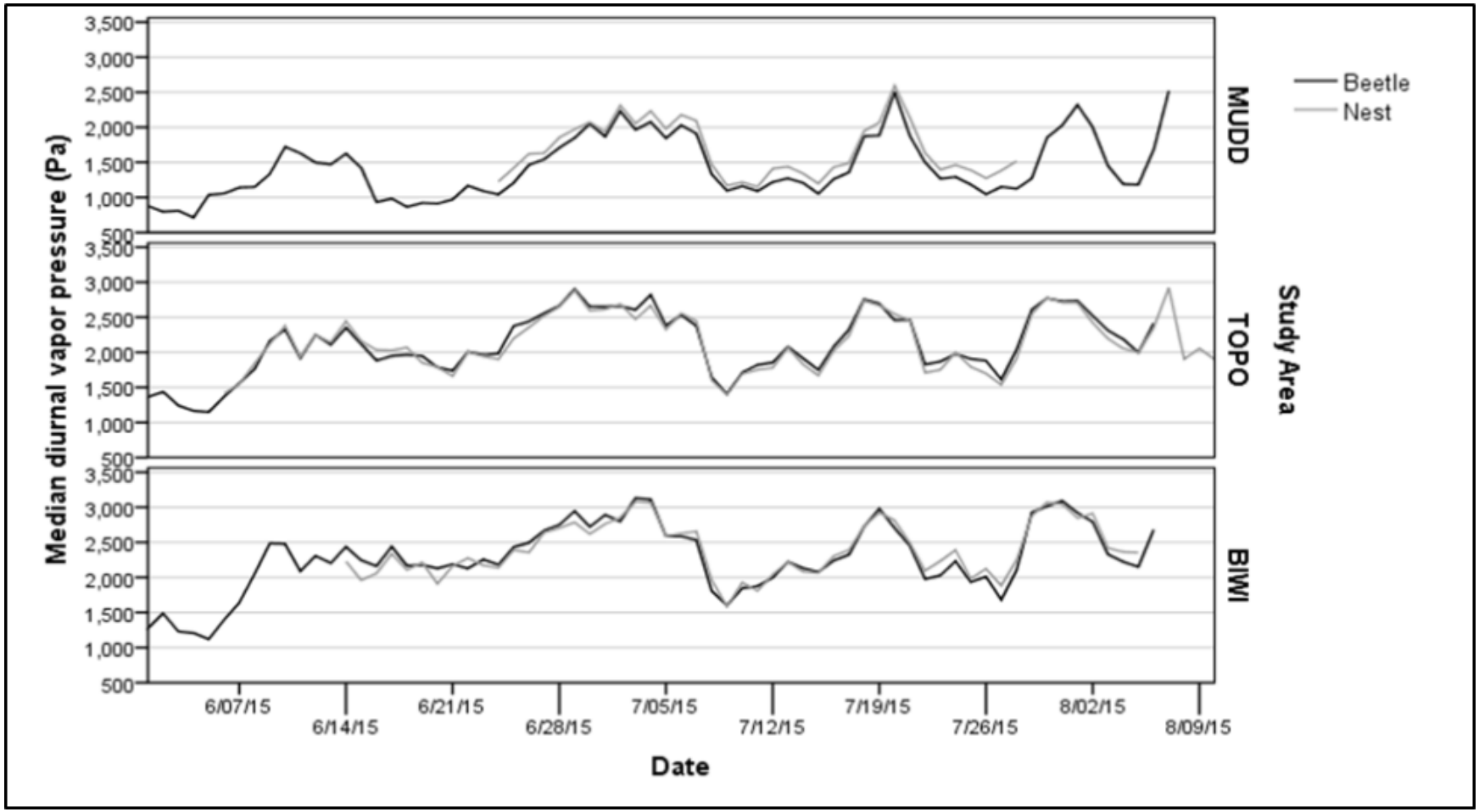

Figure 5-15.—Median diurnal vapor pressure at southwestern willow flycatcher nests and beetle monitoring points by study area, 2015. Muddy River (MUDD; n = 3), Topock Marsh (TOPO; n = 3), Bill Williams (BIWI; n = 6), and beetle monitoring points at those study areas (n = 20, 12, and 15, respectively).

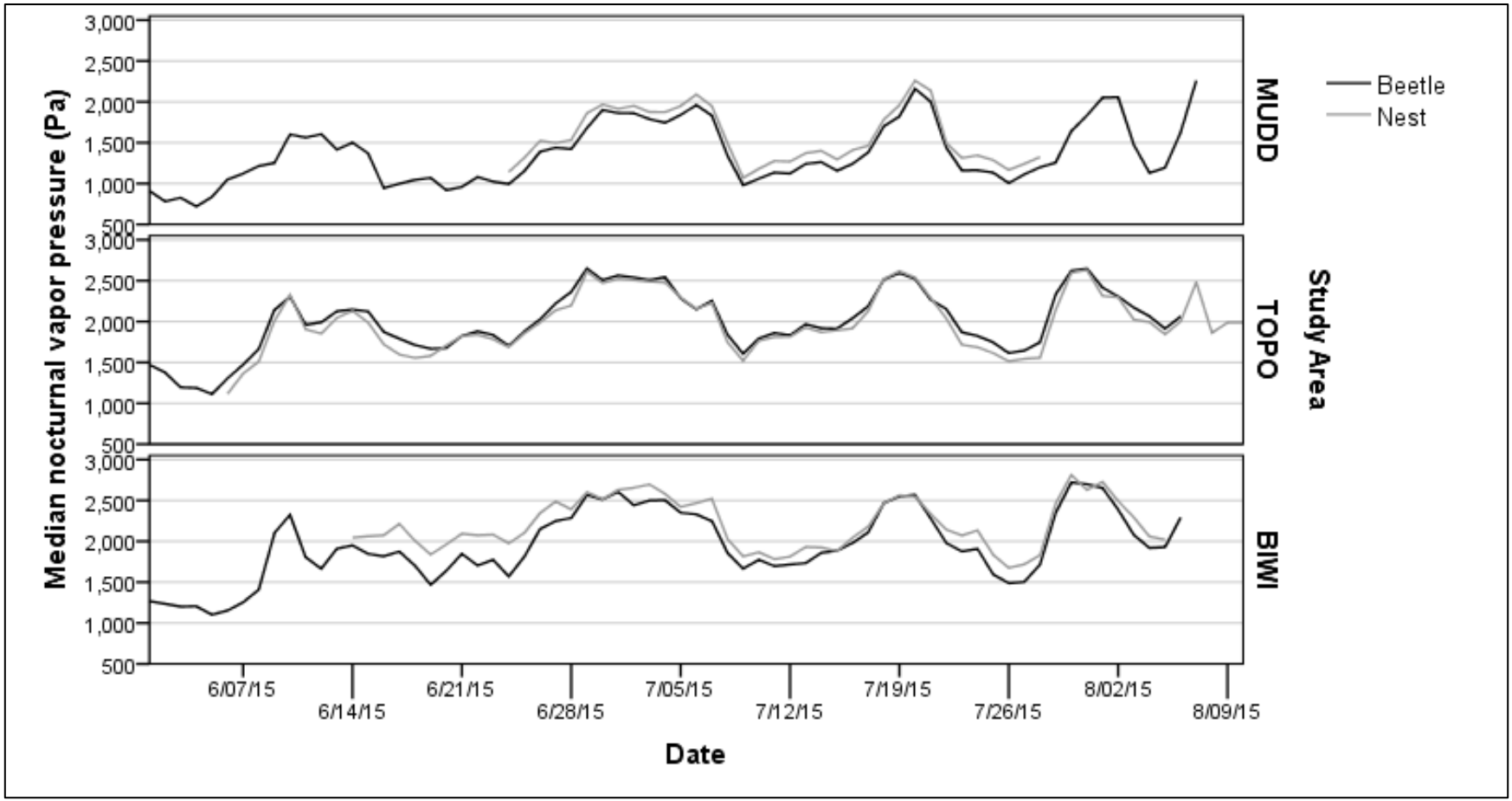

Figure 5-16.—Median nocturnal vapor pressure at southwestern willow flycatcher nests and beetle monitoring points by study area, 2015.
Muddy River (MUDD; n = 3), Topock Marsh (TOPO; n = 3), Bill Williams (BIWI; n = 6), and beetle monitoring points at those study areas (n = 20, 12, and 15, respectively).

Of the 32 nests that were not within 30 m of water, 30 were at ALAM, where the vast majority of suitable riparian vegetation was much greater than 30 m from water. Flycatchers at ALAM either had to nest at a distance from surface water or leave the study area to search for nesting sites elsewhere. Hydrological conditions can vary dramatically between years, particularly at sites influenced by reservoir levels (Sogge and Marshall 2000). This was evident at ALAM, where many of the currently occupied nesting areas were underwater as recently as 2011 but in 2014 and 2015 had the driest soil conditions of any breeding site in the project area. The drop in lake levels over the last several years (figure 5-17) has resulted in the growth of large areas of suitable habitat on exposed sediment (see chapter 2), and the continued decline of lake levels left these sites with extremely dry soils in 2014, when lake levels were at their lowest since 2004. Dry soils and a hot, dry microclimate may have contributed to the low nest success observed in the study area in 2014 (McLeod and Pellegrini 2015). Despite low nest success in 2014 and continued relatively dry conditions in 2015, a reduction in the number of resident adults was not found in 2015 (see chapter 2) although a higher proportion of nesting flycatchers was detected in younger sites closer to the lake shore. In 2015, every nest was at least 200 m from surface water or saturated soil, but soil moisture was higher than in 2014, with approximately one-third of the estimates of soil condition noting damp soils beneath nests in 2015, whereas only dry soils were noted beneath nests in 2014. The majority of documented nesting attempts were successful in 2015 (see chapter 4); nest success could have been influenced by the slightly increased soil moisture combined with an extra year of growth of the vegetation (see chapter 2), which likely helped to improve microclimate within the occupied sites (see discussion below).

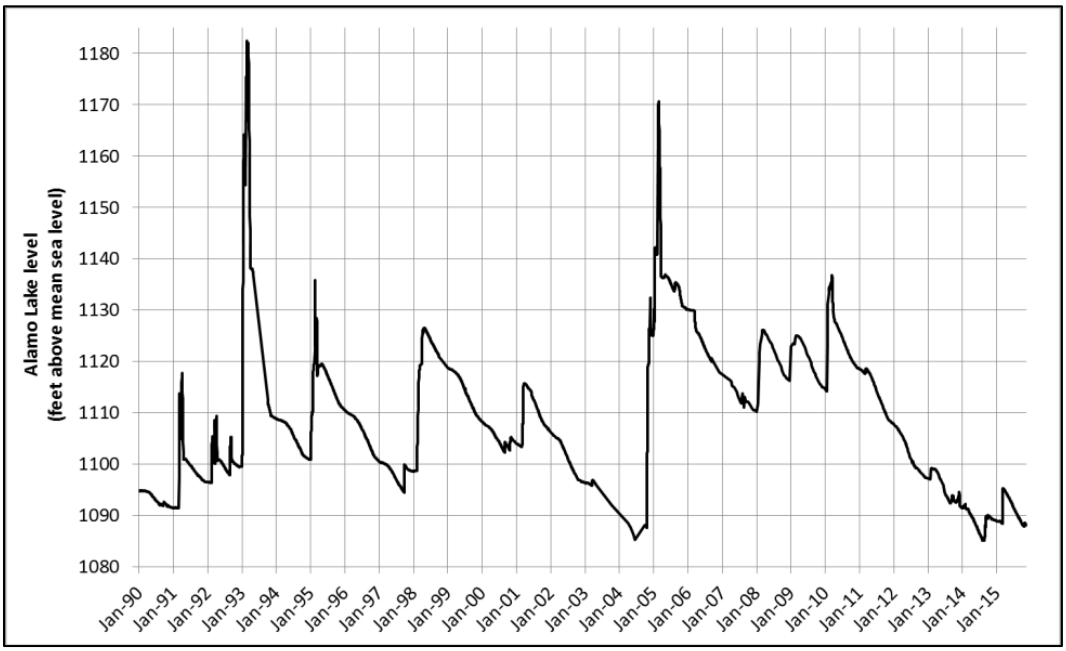

Figure 5-17.—Alamo Lake level (feet above mean sea level), 1990–2015.

Although flycatchers nested successfully at ALAM in areas up to 1 km from surface water, this is atypical of study areas in the LCR project area. In reservoir systems, the growth of large areas of new vegetation as water levels recede is common (e.g., Roosevelt Lake, Arizona; and Elephant Butte Reservoir, New Mexico), and flycatchers appear to prefer younger habitat and will colonize it rapidly if it is near an established population (Paxton et al. 2007). In other study areas, however (e.g., Mesquite, Mormon Mesa, MUDD), shifts in streamflow or irrigation patterns that caused the desiccation of breeding areas also rapidly resulted in reduced canopy density and tree mortality within those areas. Over the history of this project, there have been several instances in which flycatchers, which typically have high site fidelity (see chapter 3), nested in previously occupied areas that were wet when they were initially occupied but had since gone dry (McLeod and Pellegrini 2013). Nest success in the dry year(s) was typically low, and site fidelity in the year following dry conditions was low; if sites remained dry they became unoccupied. If the level of Alamo Lake continues to drop, a similar pattern may emerge there, with flycatchers abandoning areas that decline in vegetation vigor as the water table drops. This may well have already happened over the last several years at Alamo Lake, but no flycatcher monitoring occurred between 2006 and 2014, and patterns of flycatcher occupancy as reservoir levels changed during that period have not been documented. The presence and successful reproduction of flycatchers in habitats that are at a distance from surface water at Alamo Lake should not be construed as evidence that moist soils are not important for flycatcher occupancy and successful breeding.

Vegetation

Overall, tamarisk foliage was present near 54% of the nests monitored in 2015, though the percentage of the vegetation that consisted of tamarisk ranged from 5 to 100%. The majority (52%) of nests with tamarisk present in the vicinity were located in tamarisk trees, which is likely because young tamarisk tends to have a very suitable branching structure. While the purpose of quantifying the amount of tamarisk in the vicinity of each nest is to determine the potential impact of defoliation, defoliation was noted only at MUDD in 2015. Only patchy defoliation was noted in the study area (see chapter 2), with no extensive defoliation in the breeding area. It is therefore difficult to determine a threshold percentage of tamarisk foliage at which adverse effects on nest success might occur during a defoliation event.

Temperature and Humidity

Too few nests were sampled in 2015 to permit robust comparisons at most study areas between conditions recorded at nests and those recorded in similar vegetation but at non-nest locations, between nests monitored in 2015 and those from other years, or between nests and conservation areas. Despite small sample sizes, a few trends were apparent. At MUDD, beetle points, which were placed outside the area that was anticipated to be occupied by flycatchers, had higher maximum daily temperatures, smaller daily temperature ranges, and lower vapor pressures than did nest sites. Microclimate studies completed in 2003–07 also showed that nest sites at multiple study areas were cooler and more humid than sites outside flycatcher territories; these differences were of a similar magnitude to the differences observed between nest sites and beetle points at MUDD in 2015 (McLeod et al. 2008). Beetle points at both TOPO and BIWI were placed in areas that had been recently occupied by flycatchers. At these study areas, temperature and humidity were more similar between beetle points and flycatcher nests than at MUDD. Humidity variables, in particular, differed little between nest and non-nest locations at TOPO and BIWI. Microclimate studies completed in 2003–07 showed that nest sites were cooler than non-nests sites within the territory but that vapor pressure did not always differ between nests and within-territory points (McLeod et al. 2008).

In 2014, it was noted that nests at ALAM had markedly lower vapor pressures and markedly higher maximum daily temperatures and daily temperature ranges than nests at either TOPO or BIWI, though the temperatures and vapor pressures recorded at ALAM were not outside the range of conditions recorded within flycatcher territories at other study areas in earlier years. It was also speculated that microclimate variables at ALAM might resemble those in other occupied study areas if wet soils had been present in flycatcher territories. Soils at ALAM in 2015 were more moist than they had been in 2014 (see chapter 2 and discussion above), though they were still the driest observed in any study area. The maximum daily temperature and humidity at nests at ALAM differed less from conditions at TOPO and BIWI in 2015, when some damp soils were present at ALAM, than they did in 2014, when soils were very dry (figures 5-18 and 5-19). Modeling of the effects of vegetation and soil moisture variables on temperature and humidity showed that an increase in soil moisture resulted in a microclimate that had lower maximum temperatures and higher humidity (McLeod and Pellegrini 2013).

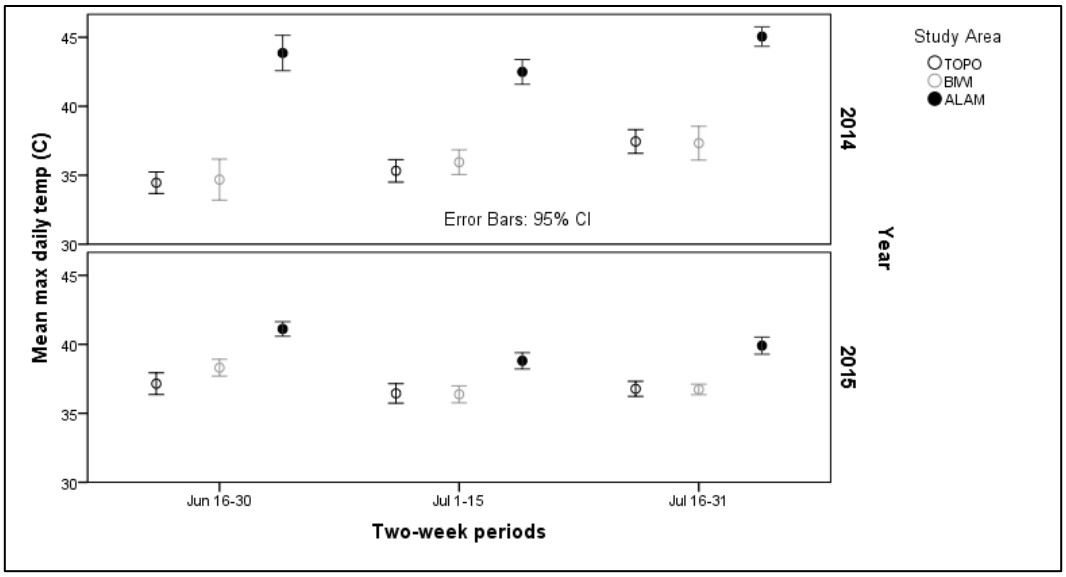

Figure 5-18.—Mean maximum daily temperatures and 95% confidence intervals at flycatcher nests by study area, 2014 and 2015.
Topock Marsh (TOPO), Bill Williams (BIWI), and Alamo Lake (ALAM).

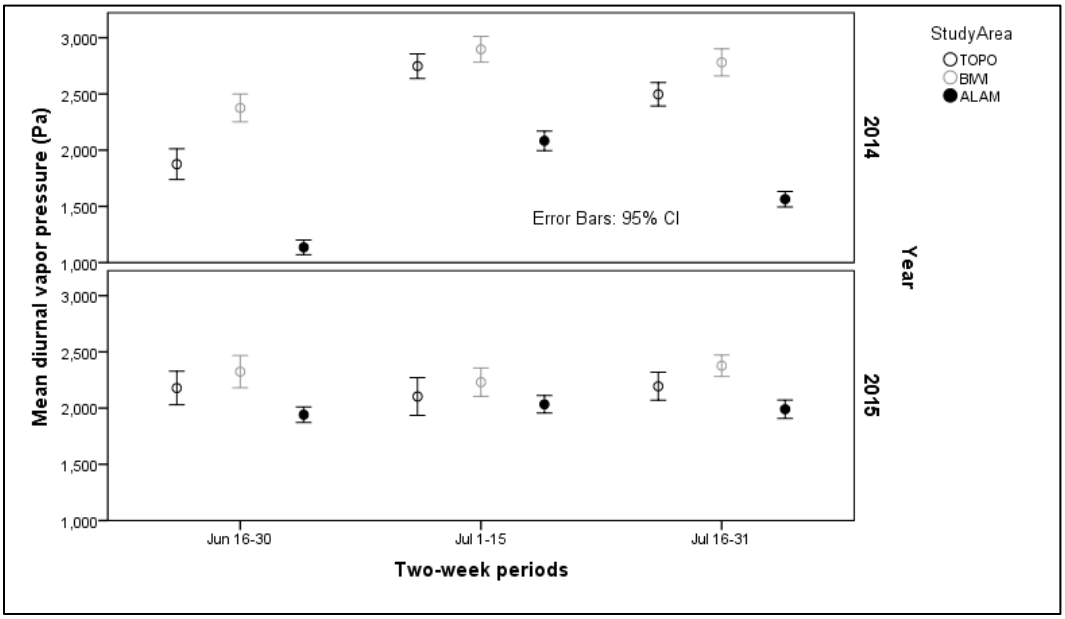

Figure 5-19.—Mean diurnal vapor pressures and 95% confidence intervals at flycatcher nests by study area, 2014 and 2015.
Topock Marsh (TOPO), Bill Williams (BIWI), and Alamo Lake (ALAM).

Chapter 6 – Habitat and Threats Monitoring

INTRODUCTION

Flycatcher breeding habitat faces several threats, including loss of habitat as the result of floods, fire, desiccation, and defoliation by tamarisk leaf beetles. All survey sites were monitored for the presence of threats to habitat integrity; any general changes in habitat suitability, including changes in soil moisture, are noted in chapter 2 under the individual site descriptions. In addition to this general monitoring, the MUDD, TOPO, and BIWI study areas were specifically monitored for the presence and effects of tamarisk beetles. The Mesquite and Mormon Mesa study areas were not monitored in 2015 due to access restrictions on the Virgin River. Beetle monitoring entailed repeated visits to established monitoring points to make ocular estimates of beetle abundance and foliar condition. Light intensity, temperature, and humidity were recorded at each sample point by data loggers.

The beetle monitoring points were also used to compare two types of data loggers: one (HOBO H8 Pro) used in 2003–12 to record conditions at flycatcher territories and nests and the other (iButton) used at nests and beetle monitoring points in 2013–14. A brief experiment conducted in 2013 suggested that the degree of canopy closure might affect the comparability of data between the two logger types, with a HOBO logger that was in a sunny location recording a higher maximum daily temperature than an iButton in the same location (McLeod and Pellegrini 2014). Therefore, personnel wanted to compare the readings collected by HOBO loggers to those collected by iButtons as a prerequisite to any future analyses that might include both HOBO and iButton data (e.g., comparing pre-beetle data on the Virgin River to post-beetle data collected in 2013). A formal comparison of iButtons and HOBOs at beetle monitoring points at TOPO and BIWI in 2014 showed no significant effect of canopy closure on maximum daily temperature readings, but the sample points had a high percentage of and low variation in canopy closure (McLeod and Pellegrini 2015). The HOBO and iButton comparison was used to generate equations predicting iButton readings from HOBO readings, and it was speculated that some of the variation between the readings collected by each logger type could be caused by very local effects of logger location. To address these questions of the effect of lower canopy closure and the effect of small changes in logger location, a side-by-side comparison was made of iButtons and HOBOs in 2015.

METHODS

All tamarisk beetle monitoring at the TOPO and BIWI study areas was conducted at permanent monitoring and photo points that were established in 2013 in sites

that had been occupied within the previous 5 years (McLeod and Pellegrini 2013, 2014). Each monitoring and photo point was marked with flagging and a piece of rebar to facilitate relocation between visits and between years. The monitoring points are distributed among the available vegetation types at each study area as follows:

- TOPO: Tamarisk (10 points), tamarisk with emergent Goodding's willow (10 points)

- BIWI: Goodding's willow overstory with tamarisk understory (15 points)

In 2015, monitoring and photo points were established at MUDD. MUDD was selected because it afforded opportunities to compare iButton and HOBO loggers in areas that were not as densely vegetated as the points in the other study areas, and it also provided an opportunity to evaluate the monitoring protocol in an area that was likely to experience beetle defoliation. At MUDD, some areas that had sparser canopy cover than did the monitoring points at the other study areas and that resembled areas that would have been considered a "non-use" site in analyses completed in 2003–07 were deliberately selected (McLeod et al. 2008). Ten points were placed in tamarisk and 10 points were placed in Goodding's willow overstory with tamarisk understory. Point locations were selected in the field to represent a range of canopy closures within each vegetation type.

Field personnel established five photo points at both TOPO and BIWI in 2013 and two at MUDD in 2015. These points were placed strategically in locations that afforded a view of the surrounding vegetation. Photos were taken at each visit at a specific height and compass bearing. A monopod, a level, and a compass were used to help align the camera and ensure that the same view was captured at each visit.

All data were collected in the field using Trimble® Terrasync™ 5.61 on a Juno 3B. Each monitoring point and photo point was visited approximately every 2 weeks.

Beetle Monitoring and Vegetation Measurements

Visual estimates of foliar color and leafless stems were recorded at each monitoring point. The observer faced outward from the rebar that marked the monitoring point and estimated, to the nearest 5%, the percentage of all foliage visible from eye level and above in each of four 90° quadrants (45º left and right of each cardinal direction) that was green, yellow, and brown. The percentage of visible stems that were leafless were also estimated in a similar manner. Main

branches that would be expected to be leafless were not included in the estimate of leafless stems. Percent total canopy closure in each cardinal direction was measured using a Model-A spherical densiometer.

The number of all beetles visible was estimated within each 90° quadrant by life stage (adults, larvae, and egg clusters). The total time spent facing each cardinal direction did not exceed 30 seconds. Adult beetles were counted first and then personnel moved closer to the vegetation if necessary to count the number of larvae and egg clusters. Counts were recorded in the following categories:

Category 0: 0
Category 1: 1–10
Category 2: 11–100
Category 3: 101–1,000
Category 4: > 1,000

The percentage of the vegetation that consisted of tamarisk within 2 m and within 5 m of the monitoring point was also estimated, as described in chapter 5. This measurement is not directly related to beetle monitoring, but repeated visits to beetle monitoring points afforded a convenient way to assess the reliability of these estimates by quantifying variation between visits and among observers.

Calibration

In 2013, personnel identified the differences among observers as a source of variation in the visual estimates of foliar color, percent leafless stems, and canopy closure. In 2014, a calibration protocol was implemented with the goal of quantifying and reducing observer variation and identifying any individual observer drift through the season. At the beginning of the season, all observers visited a series of monitoring points as a group. Each observer independently recorded the beetle and vegetation data at a given monitoring point. The results for that monitoring point were then discussed before the group proceeded to the next monitoring point. At the end of the season, all observers returned to the same series of monitoring points. This time, each observer independently recorded the beetle and vegetation data, but the results were not discussed. As a result of calibration in 2014, personnel learned that each observer's ability to precisely estimate the vegetation variables varied by vegetation type and that the largest amount of observer variation was at the initial training point. In 2015, the calibration exercise was repeated but included three monitoring points from each available vegetation type in each study area. Training all observers in data collection at a separate point prior to the first calibration point is also planned. The initial calibration exercise was conducted prior to the collection of the first round of data in each study area.

Temperature and Humidity Measurements

A Hygrochron iButton (Maxim Integrated, San Jose, California) was used to record temperature and relative humidity on every hour and half hour at each monitoring point. The iButton was mounted on a key fob and hung in a shaded location 1.5–2.0 m above the ground and as close to the monitoring point as possible (i.e., within 2 m). An iButton was deployed when each monitoring point was established and was removed after the final round of monitoring at the end of the flycatcher breeding season. In all cases where the flagging marking the iButton location from 2014 was still present, the iButton was hung in the same location that had been used in the prior year. Daily maximum and minimum temperatures were obtained from weather stations at Needles Airport, California (Station ID USW00023179) and Overton, Nevada (Station ID USC00265846).

Comparison of HOBOs to iButtons

In 2003–12, all temperature and relative humidity data were collected using HOBO H8 Pro (Onset Computer Corporation, Pocasset, Massachusetts) temperature/humidity data loggers. In 2013, use of the aging and increasingly unreliable HOBOs was stopped, and SWCA switched to iButtons. In 2015, a HOBO H8 Pro logger was hung next to (i.e., within ≈30 cm of) the iButton at each beetle monitoring point to form an "original" pair of loggers. A second HOBO was hung approximately 1 m away from the first HOBO at all monitoring points except for two points at BIWI; this was termed the "comparison" location. At all points at MUDD, 14 points at TOPO, and 7 points at BIWI, a second iButton was also hung within ≈30 cm of the comparison HOBO. Each HOBO logger collected data on every hour and quarter hour. All HOBO loggers were camouflaged by placing them in an inverted small, plastic container coated with spray adhesive and local vegetation. The opening at the bottom was covered with shadecloth, allowing free air circulation around the logger.

Light Intensity Measurements

A HOBO Pendant® temperature/light data logger (Onset Computer Corporation, Pocasset, Massachusetts) was used to measure light intensity (lux) every 15 minutes at each sampling point. The data logger was attached to a rebar safety cap and then the cap was placed on the rebar that marked the sample point location. An experiment conducted in 2014 showed that slight deviations from horizontal had a strong influence on logger readings; therefore, a level was used to ensure that the light sensor was pointing directly up, and a compass was used to orient the top of the logger to the north. A light logger was also placed at a control location in full sun at each study area. In 2013, personnel discovered that the plastic housing of the loggers gradually became opaque when exposed to intense sunlight; because of this, the housing of each control logger was changed

at monthly intervals. All light loggers were programmed to log a data point on the hour and every quarter hour. Observers were instructed to clean the housing of each logger during beetle monitoring visits and to note whether the logger had accumulated dirt or debris. After light loggers were retrieved at the end of field season, the cleanliness of each logger was noted as clean, appearing clean but having a film of dirt or sap that could be felt, visibly dirty, or visibly dirty even from a distance; and the cloudiness of the housing was noted as clear, slightly cloudy when compared to a new housing, or obviously cloudy.

Statistical Analyses

For each of the five vegetation variables, the four readings, one from each cardinal direction, were averaged to obtain a single estimate for each monitoring point during each visit. Each densiometer reading was converted to percent canopy closure before averaging.

Any observer who collected data during calibration but subsequently collected little (i.e., ≤ 2 points at MUDD or TOPO and ≤ 3 points at BIWI) or no data in a particular vegetation type at a given study area was excluded from the calibration analysis for that vegetation type at that study area. For each calibration point, observer variation for each variable was calculated as the range in estimates among observers. Within each vegetation type, the largest observer variation recorded at any point for a given vegetation variable during either the initial or final calibration exercise was used as the benchmark for determining whether an observed change represented an actual change in the vegetation. Observed changes between initial and final calibration that were unidirectional across all observers and all calibration points were also considered as evidence of actual change in the vegetation. Observer variation was considered to have changed significantly between the initial and final calibration exercises for a given vegetation variable if the maximum range in estimates differed by an absolute value > 10. This value was chosen because it was deemed representative of an actual difference in how a variable was visualized rather than a difference in rounding to the nearest 5%.

To assess whether individual observers drifted in their estimates for a given vegetation variable over the course of the season, the difference was calculated between each observer's estimate (x) and the mean across observers ($\overline{x}$) at each point for both the initial (i) and final (f) calibration exercises, and the change in these differences (i.e., $\left|(x_i - \overline{x}_i) - \left(x_f - \bar{x}_f\right)\right|$) was examined. Any unidirectional change in these differences averaging > 10% was considered an indication of observer drift.

Data were grouped by sampling round (i.e., the day or pair of days on which all points within a study area were visited) and, for each sampling round, vegetation and beetle data were summarized for each vegetation type within each study area and for each study area as a whole. Data collection often spanned several days within a given sampling week for all three study areas combined, and the data are presented by the week during which the sampling round occurred. The date at the beginning of each sample week is presented. Data were not normally distributed for any of the vegetation variables, and median data are presented.

Temperature and humidity data from the iButtons were summarized as described in chapter 5. Light 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. The percentage of available light that was recorded at each sampling point was calculated by dividing each sample point reading by the reading taken on the same date and time at the control logger and multiplying the result by 100. In 2013, the analysis of light data was restricted to times between 0900 and 1500 hours to avoid the effects of early morning or late afternoon shadows at the control loggers. The logger locations used in 2014 and 2015 did not have shadows after 0800 hours, but the data were truncated to 0900 and 1500 hours so as to be comparable to data collected in 2013. Both luminance and percent light had non-normal distributions, and median data are presented. Data were summarized by vegetation type within each study area and for each study area as a whole. Summary statistics for temperature, humidity, and light were completed in IBM® SPSS® v. 22.0.

Comparison of HOBOs and iButtons

The readings collected on quarter-hours were removed from the data collected by HOBOs, and the remaining data were summarized as was done for the iButton data. The difference between and average of each pair of measurements of maximum daily temperature, minimum daily temperature, mean diurnal vapor pressure, and mean nocturnal vapor pressure was calculated. Vapor pressure was calculated from relative humidity (see chapter 5).

Analyses in 2014

The analysis in 2014 had three objectives: (1) to calculate the bias and measurement error between HOBO and iButton data loggers for maximum daily temperature, minimum daily temperature, mean diurnal vapor pressure, and mean nocturnal vapor pressure to determine whether current data from iButtons and earlier data from HOBOs can be used in the same analyses; (2) in the event that there is acceptable agreement between iButton readings and HOBO readings, to determine how the bias in maximum daily temperature readings between HOBO and iButton data loggers is affected by canopy cover; and (3) in the event that there is acceptable agreement between iButton readings and HOBO readings, to

generate a model for predicting the iButton measurements from HOBO data logger measurements for each of the four microclimate variables. The analysis in 2015 revisited the first two objectives using an additional year of data.

To measure how the amount of measurement bias varied with the actual values of temperature and humidity measured by data loggers in 2014, plots of bias in data logger measurements (HOBO – iButton) versus reference method measurements (i.e., those measurements by the HOBO data logger in each HOBO-iButton data logger pair) were generated, similar to the ones recommended by Fernandez and Fernandez (2009). Unlike Fernandez and Fernandez (2009), who used ordinary least-squares regression, linear mixed models (LMMs) with an identity link function were used because there were repeated paired measurements per site (**lme** function, *nlme* package: Pinheiro et al. 2014). The mixed models specified a correlation structure (AR1) and random effects (site-specific intercept + slope), and thus did not use the heteroscedastic-consistent standard errors used by Fernandez and Fernandez (2009). Regression lines and 95% prediction intervals were generated for the generalized linear mixed models (GLMMs) that were used to calculate limits of agreement for each variable (*ggplot2* package [Wickham 2009] or **plot** function).

Analyses in 2015

In 2015, similar models of how bias in data logger measurements varied with reference method measurements (i.e., those measurements by the HOBO data logger in each HOBO-iButton data logger pair) were rerun, except additive and interactive effects of year were included as model predictors to determine if the relationship between bias and reference method measurement was the same or different in different years. Two years of data from two study areas (TOPO and BIWI) were used in this analysis.

For each variable tested (bias in maximum daily temperature, minimum nightly temperature, mean daily vapor pressure, and mean nightly vapor pressure) the explanatory power of at least three LMMs were compared in which the fixed effects were (1) reference method measurement alone (no year effects), (2) year + reference method measurement (additive year effect), and (3) year + reference method measurement + year*reference method measurement (interactive year effect). Akaike's information criterion for small sample size (AIC_c) (Burnham and Anderson 2002) was used to evaluate relative model fit. Standard errors that were used to generate prediction intervals for the amount of bias were generated from the best LMM (smallest AIC_c, highest Akaike weight) for each dependent variable (**predict**, **model.matrix**, and **diag** functions in *nlme* package; *ggplot2* package). These standard errors were calculated for the Best Linear Unbiased Predictor (predicted values calculated by the LMM) and were a function of the fixed effects in the model, random effects (either site or site-year, usually site-year), and the correlation structure specified by the best LMM (AR1, ARMA, CS, or none; usually AR1 or ARMA).

Scatter plots suggested that bias in mean daily vapor pressure and bias in mean nightly vapor pressure were better fit by a quadratic or cubic function of reference method measurements. For bias in mean daily vapor pressure and bias in mean nightly vapor pressure, three LMMs were also run in which the fixed effects included a quadratic function of reference method measurements and the interaction term, and three LMMs in which the fixed effects included a cubic function of reference method measurements and the interaction term; however, the data were inadequate to support models with quadratic or cubic terms, and the models were overfitted.

As 2 years of seasonal data were available, the set of models was run for each dependent variable eight times, with a different random effect-correlation structure combination specified in each run. For random effects, model runs were tested in which data from the same site in different years were treated as correlated (random effect = "site") and in which data from the same site were treated as correlated within a season and independent in different years (random effect = "site-year"). The correlation structures that were tested for all dependent variables were (1) no time-dependent correlation structure at all, (2) first-order autoregressive (AR1), (3) first-order autoregressive moving-average (ARMA 1,1), and (4) compound-symmetric. For bias in maximum daily temperature, second-order autoregressive correlation structure (AR2 or ARMA 2,0) was also tested because a semio-variogram suggested that correlations between measurements > 2 days apart did not decline as rapidly as correlations for repeated measurements of other dependent variables at each site. AIC_c was used to evaluate relative model fit.

In 2015, the effect of microsite on bias in data logger measurements was also examined using 1 year of data with two HOBO/iButton pairs per site (the "original" and "comparison" pairs) in three study areas. An effect of microsite on bias in data logger measurements from the same brand of data logger was tested by modeling the difference in measurements ($HOBO_{orig} – HOBO_{comp}$; $iButton_{orig} – iButton_{comp}$) against the measurements by the data logger at the original location ($HOBO_{orig}$ or $iButton_{orig}$). It was concluded that a significant microsite effect existed if a 95% prediction interval for the relationship excluded zero at any point within the range of data logger measurements at the original location.

Influence of Light Level on Bias in Maximum Daily Temperature

In 2014, the relationship between canopy cover as measured by a densiometer and bias in maximum daily temperature was measured, with the prediction that measurement error would be higher at sites with lower canopy cover and greater maximum daily temperatures as measured by HOBO data loggers. Meaningful effects of canopy cover on bias in 2014 were not found, but this may have been because of the small number of measurements at sites that had low variation in canopy cover and because of observer biases in measuring canopy cover with a densiometer.

In 2015, this analysis was repeated using mean daily light-level measurements taken by light loggers at each site as an inverse measure of canopy cover. Light logger measurements were less prone to observer bias and provided a larger sample size and more statistical power to detect an effect of canopy cover. Light data were limited to cloudless days, as determined by visual inspection of the light graphs from the control logger at each study area.

SWCA used LMMs with an identity link function, random intercept and slope effects for each site (i.e., observations from same site were correlated), and a first-order autoregressive correlation structure to investigate whether light levels had an effect on the differences between HOBOs and iButtons in maximum daily temperature. Using just the measurements of maximum temperature from cloudless days with light level measurements, the following LMMs, including a model with an interaction between light level and mean daily maximum temperature, were run:

Difference (HOBO-iButton) ~ Mean daily maximum temperature
Difference (HOBO-iButton) ~ Canopy cover (as measured by light meter)
Difference (HOBO-iButton) ~ Mean daily maximum temperature + light level
Difference (HOBO-iButton) ~ Mean daily maximum temperature + light level + interaction (T*light).

AIC_c was used to select the preferred model.

RESULTS

Beetle Monitoring and Vegetation Measurements

Calibration

At TOPO, training was conducted at a point in tamarisk with emergent Goodding's willow (TM-14), and then three points in tamarisk with emergent Goodding's willow (TM-16, TM-15, and TM-12) and three points in tamarisk (TM-18, TM-07, and TM-06) were used for calibration. At BIWI, three points in Goodding's willow overstory with tamarisk understory (BW-01, BW-13, and BW-20) were used for calibration. At MUDD, training was conducted at a point in tamarisk (MD-02) and then two points in tamarisk (MD-03 and MD-01) and three points in Goodding's willow overstory with tamarisk understory (MD-11, MD-12, and MD-13) were used for calibration. Calibration data are presented in the order the points were visited during the initial calibration exercise, as described above. The initial training points are included with the calibration data for comparison. Observer 2 did not collect data in tamarisk at MUDD after the initial calibration; therefore, the data from observer 2 were excluded from the analysis of calibration in tamarisk at MUDD. Observer 6 collected data at only one point in tamarisk at TOPO, and observer 7 did not collect any data in TOPO after the initial calibration exercise; both are excluded from the analysis of the corresponding calibration data from TOPO. Observer 10 did not participate in the

final calibration exercise at TOPO and BIWI. Low proportions of yellow foliage (< 13%) were noted during both calibration events in all three study areas, and data are presented for percent green foliage only.

Observer variation at MUDD was highest at the training point for estimates of canopy closure and was higher at one or more subsequent calibration points for all other vegetation measures (table 6-1; figures 6-1 to 6-5). At TOPO and BIWI, observer variation was highest at the training point compared to the nine calibration points only for percentage of tamarisk within 2 m. Observer variation was higher at one or more calibration points than at the training point for all other variables.

Maximum observer variation increased between the initial and final calibration exercises in seven instances: at MUDD in Goodding's willow with tamarisk understory for percent green foliage, percent tamarisk within 2 m, and percent tamarisk within 5 m; at TOPO in tamarisk for percent green foliage and percent leafless stems and in tamarisk with emergent Goodding's willow for percent leafless stems; and at BIWI for percent green foliage (table 6-1). Maximum observer variation was exceptionally high during the final calibration exercise at MUDD in Goodding's willow with tamarisk understory for percent tamarisk within 2 m and within 5 m, at 70 and 50%, respectively. Maximum observer variation decreased between the initial and final calibration exercise in three instances: at MUDD in tamarisk for percent tamarisk within 5 m; and at TOPO in tamarisk with Goodding's willow overstory for percent tamarisk within 2 and 5 m.

Evidence of observer drift was identified at MUDD for percent green foliage in tamarisk and percent tamarisk within 2 and 5 m in Goodding's willow with tamarisk overstory. For percent green foliage in tamarisk, observer 4 drifted lower during the season in comparison to the mean across observers (change in difference from the mean of 11–14%) while observer 3 drifted higher (8–13%; figure 6-1). For percent tamarisk within 2 m in Goodding's willow with tamarisk understory, both observer 1 and observer 2 drifted higher (change in difference from the mean ranged from 6 to 49%), and observer 3 and observer 4 both drifted lower (change in difference from the mean ranged from -11 to -56%; figure 6-4). Observer 1 drifted higher in estimates of percent tamarisk within 5 m in Goodding's willow with tamarisk understory (change in difference from the mean ranged from 5 to 36%), while observer 4 drifted lower (change in difference from the mean ranged from -5 to -29%; figure 6-5).

Evidence of observer drift was identified for percent leafless stems in both vegetation types at TOPO. Observer 5 drifted higher during the season compared to the overall mean both in tamarisk (28–40%) and in tamarisk with Goodding's willow overstory (8–36%), while observer 8 drifted lower at calibration points in tamarisk (17–52%; figure 6-2). No evidence of observer drift was observed at BIWI.

Table 6-1.—Maximum observer variation by vegetation variable and type during the initial and final calibration exercises at Muddy River, Topock Marsh, and Bill Williams, 2015

Study area[1]	Vegetation type[2]	% green foliage		% leafless stems		% canopy closure		% TAMSPP within 2 m		% TAMSPP within 5 m	
		Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
MUDD	Training Point (TAMSPP)	8	–	8	–	45	–	0	–	5	–
	TAMSPP	18	16	19	14	6	9	5	5	25	10
	SALGOO_TAMSPP	14	26	23	19	3	3	35	70	20	50
TOPO	Training Point (TAMSPP_SALGOO)	21	–	15	–	9	–	50	–	45	–
	TAMSPP	4	35	35	63	7	6	0	0	0	0
	TAMSPP_SALGOO	8	11	25	51	6	7	35	20	50	35
BIWI	SALGOO_TAMSPP	4	15	11	14	13	10	20	15	20	10

[1] MUDD = Muddy River, TOPO = Topock Marsh, and BIWI = Bill Williams.
[2] TAMSPP = > 75% tamarisk, SALGOO_TAMSPP = Goodding's willow with tamarisk understory, and TAMSPP_SALGOO = tamarisk with emergent Goodding's willow.

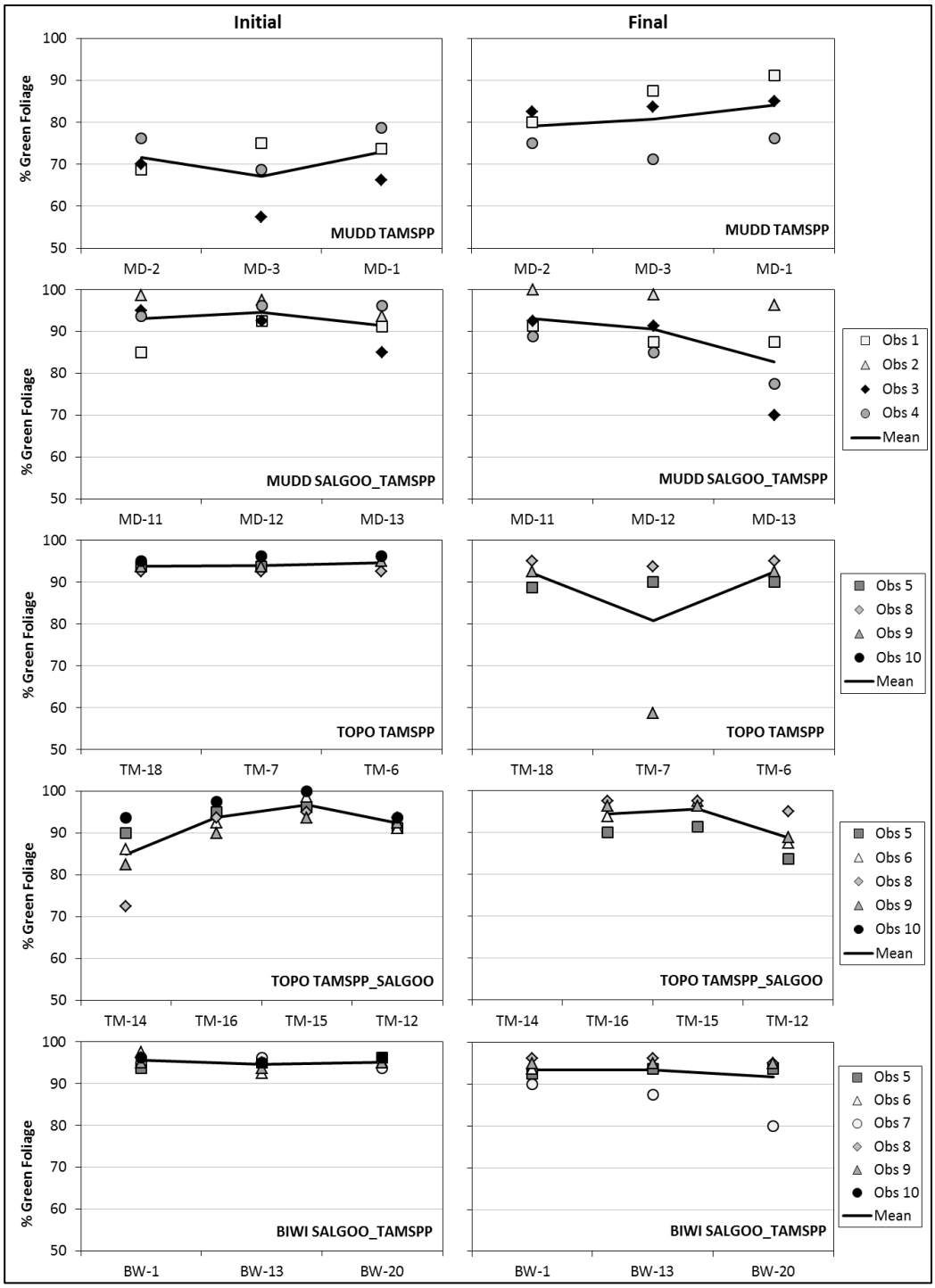

Figure 6-1.—Calibration data by observer and vegetation type for percent foliage that was green during the initial and final calibration exercises at monitoring points, 2015.

Muddy River (MUDD), Topock Marsh (TOPO), and Bill Williams (BIWI). Vegetation types are TAMSPP = > 75% tamarisk, TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, and SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory.

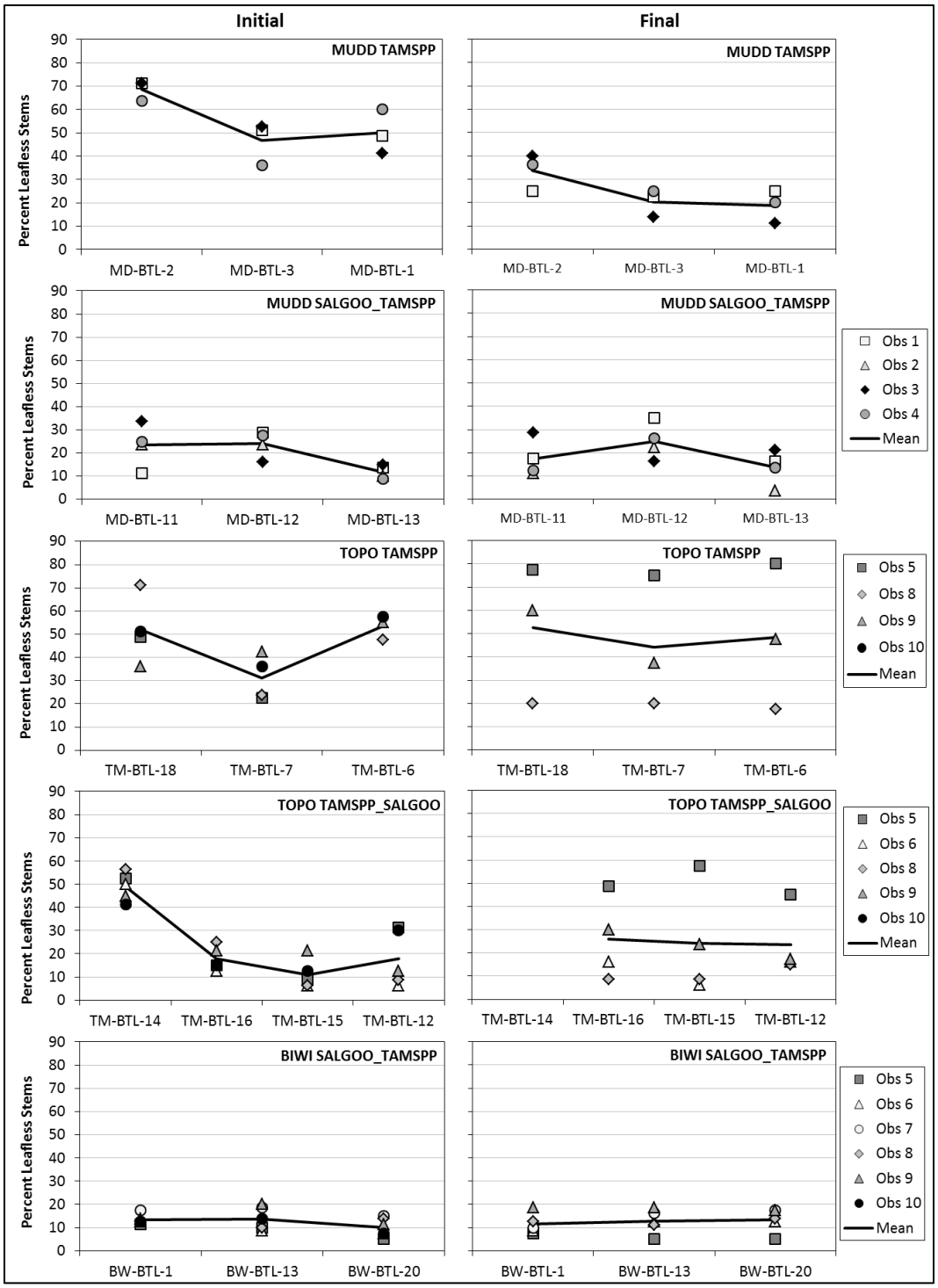

Figure 6-2.—Calibration data by observer and vegetation type for percent leafless stems during the initial and final calibration exercises at monitoring points, 2015. Muddy River (MUDD), Topock Marsh (TOPO), and Bill Williams (BIWI). Vegetation types are TAMSPP = > 75% tamarisk, TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, and SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory.

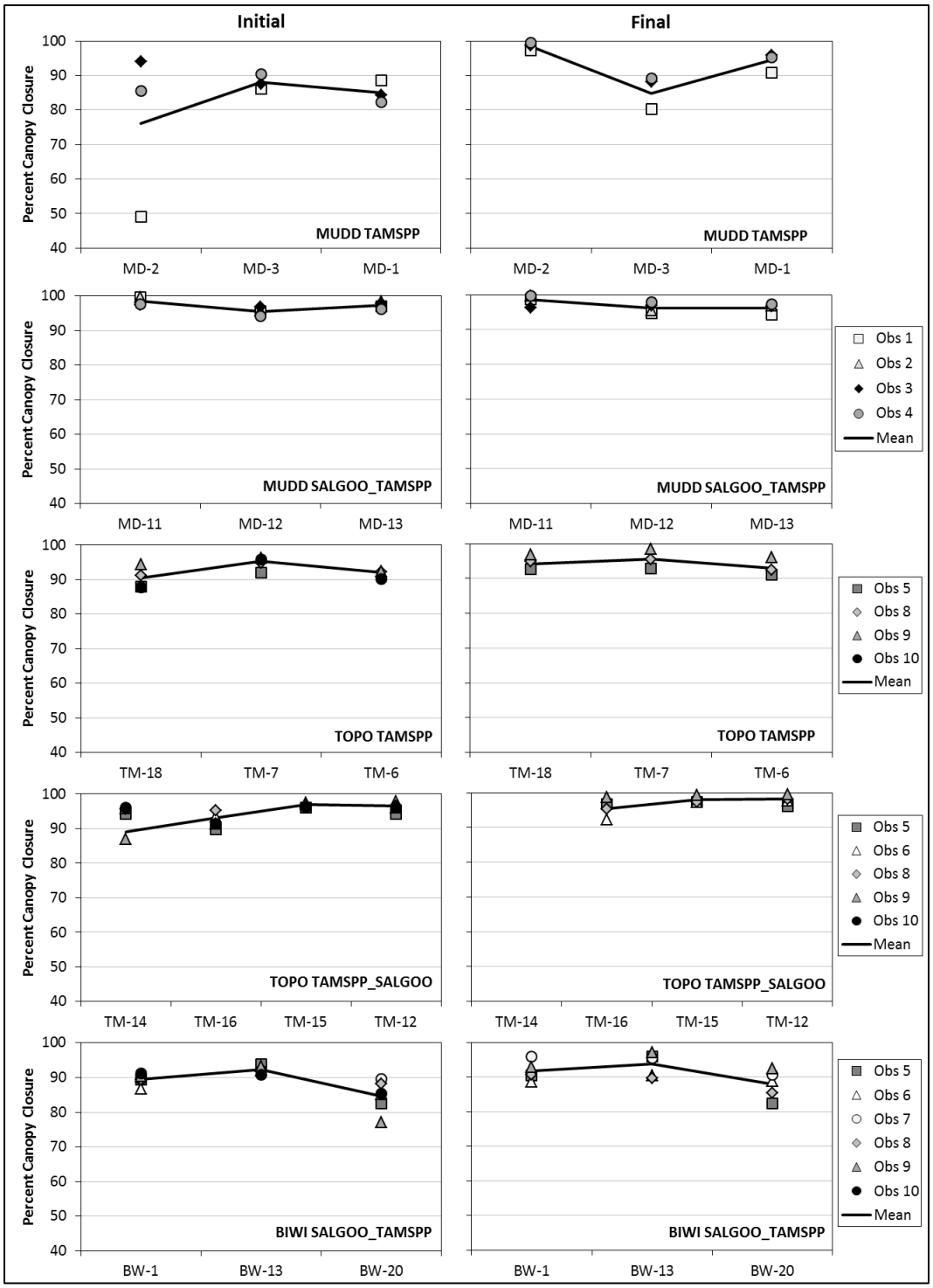

Figure 6-3.—Calibration data by observer and vegetation type for percent canopy closure during the initial and final calibration exercises at monitoring points, 2015. Muddy River (MUDD), Topock Marsh (TOPO), and Bill Williams (BIWI). Vegetation types are TAMSPP = > 75% tamarisk, TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, and SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory.

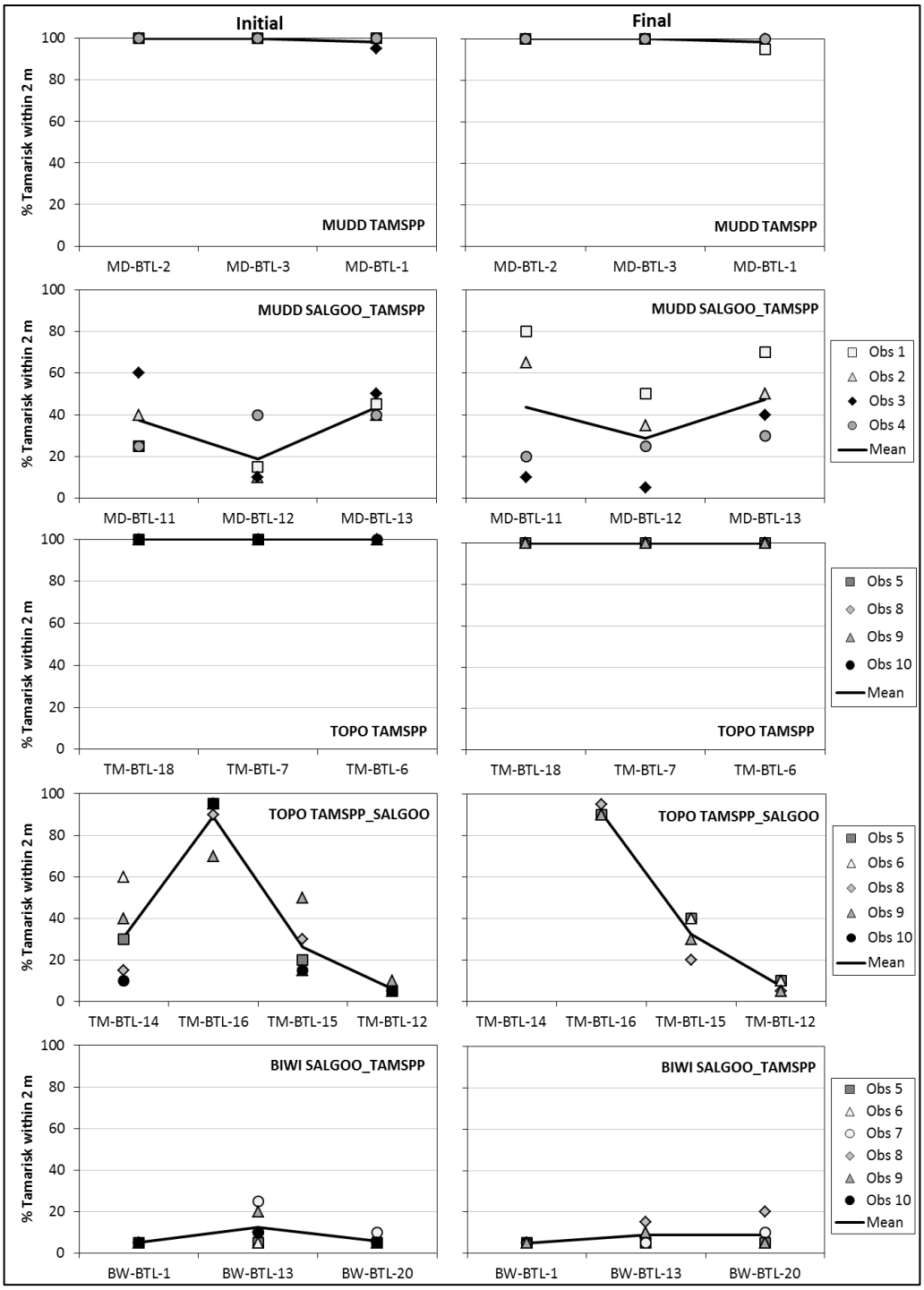

Figure 6-4.—Calibration data by observer and vegetation type for percent of vegetation that was tamarisk within 2 m of the monitoring point during the initial and final calibration exercises, 2015.

Muddy River (MUDD), Topock Marsh (TOPO), and Bill Williams (BIWI). Vegetation types are TAMSPP = > 75% tamarisk, TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, and SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory.

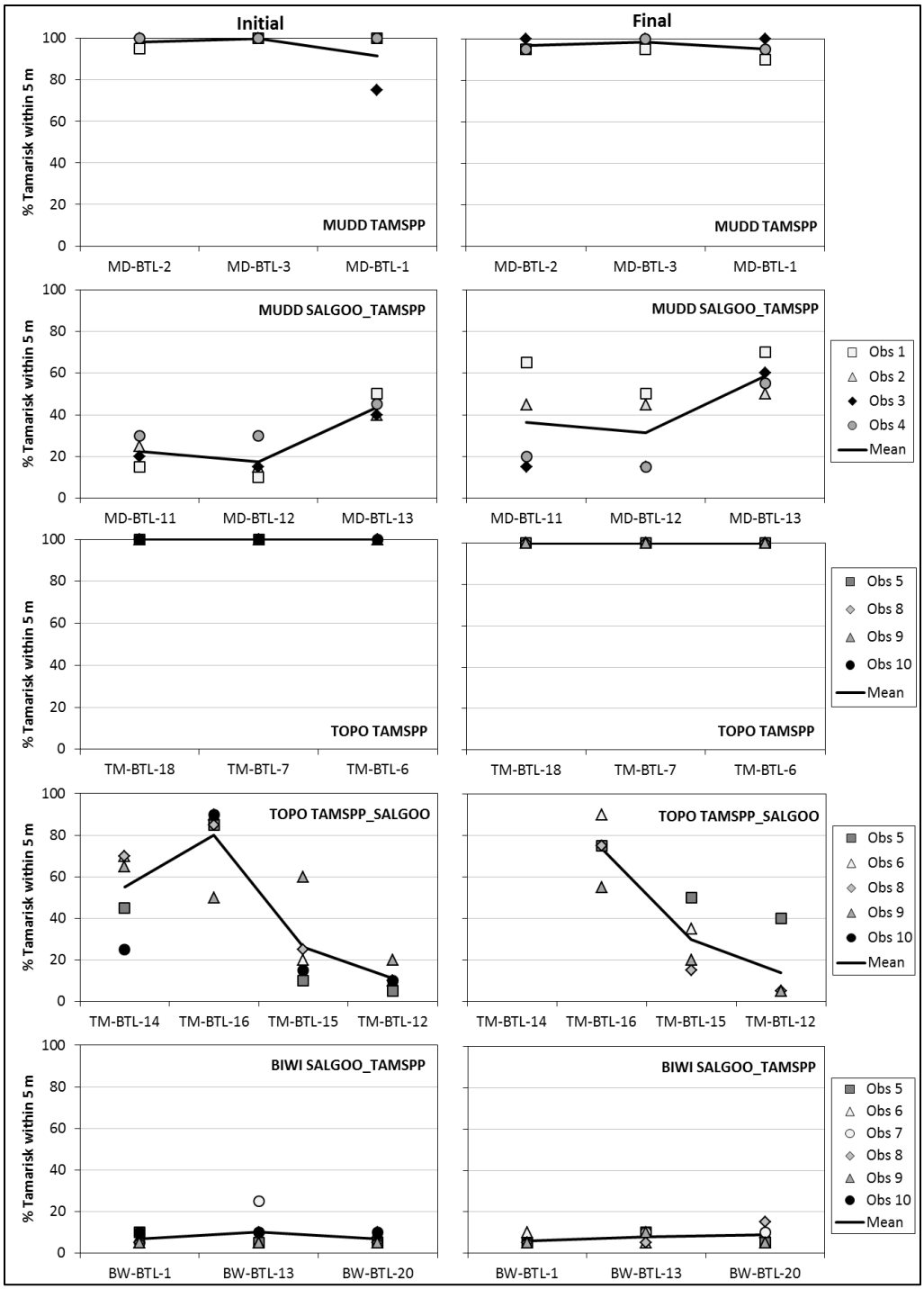

Figure 6-5.—Calibration data by observer and vegetation type for percent of vegetation that was tamarisk within 5 m of the monitoring point during the initial and final calibration exercises, 2015.
Muddy River (MUDD), Topock Marsh (TOPO), and Bill Williams (BIWI). Vegetation types are TAMSPP = > 75% tamarisk, TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, and SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory.

Beetle Monitoring and Vegetation Measurements

The monitoring points at MUDD were visited biweekly throughout the season between June 3 and July 29, with a final visit 1 week later on August 8. The monitoring points were visited biweekly throughout the season at TOPO between June 2 and July 28 and at BIWI between May 28 and July 30. Beetle larvae were detected at MUDD at one to six monitoring points in Goodding's willow with tamarisk understory during five out of the six visits and at eight monitoring points in tamarisk during the final visit (figure 6-6). The number of larvae detected did not exceed Category 2 (11–100). Adult beetles and beetle eggs were each detected during one visit at one to two monitoring points in Goodding's willow with tamarisk understory. No beetles were detected at TOPO or BIWI, though splendid tamarisk weevils (*Coniatus splendidulus*) were observed at TOPO.

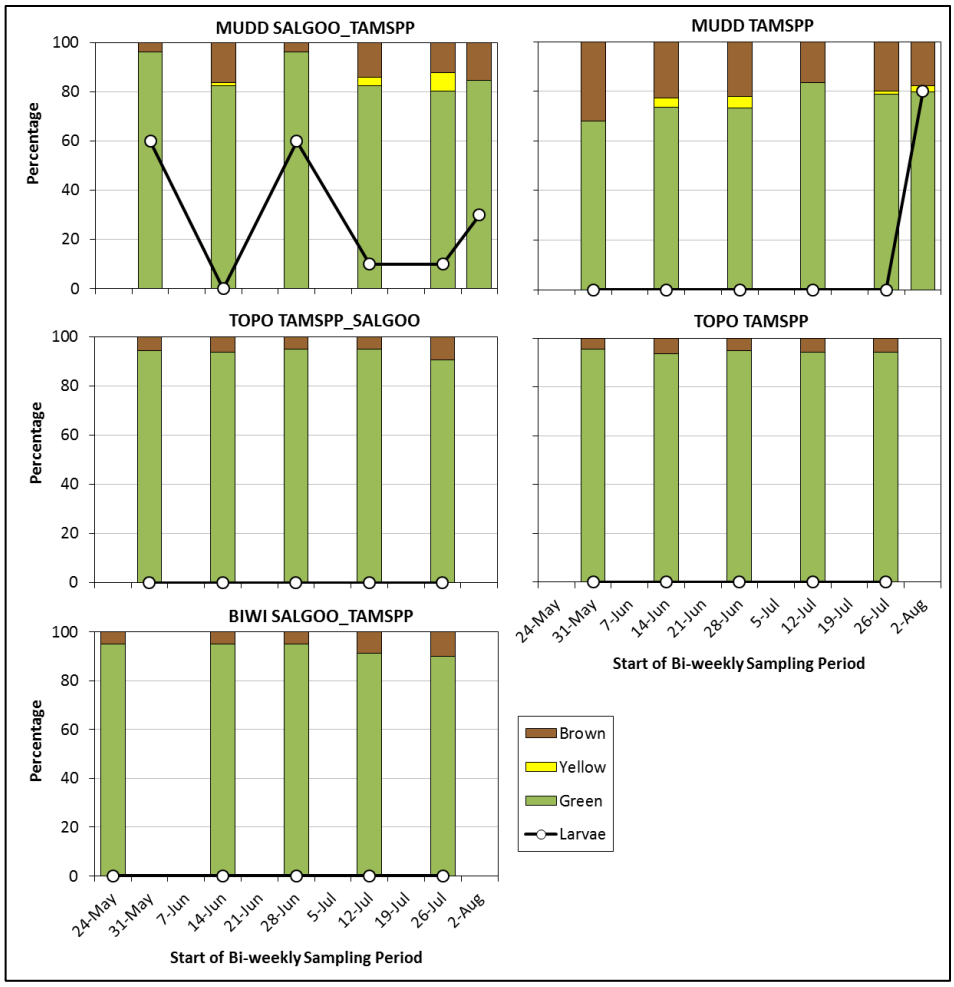

Figure 6-6.—Median percentage of beetle points at which beetle larvae were detected and percentage of foliage color at beetle monitoring points, 2015.

Muddy River (MUDD), Topock Marsh (TOPO) and Bill Williams (BIWI). Vegetation types are TAMSPP = > 75% tamarisk, TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, and SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory.

The percentage of foliage that was green at MUDD varied between 79 and 96% in Goodding's willow with tamarisk understory and 68–83% in tamarisk (see figure 6-6). The variation in both vegetation types did not exceed the maximum observer variation, which was 26 and 18%, respectively. Small amounts of yellow foliage were detected during several sampling rounds at MUDD. The percentage of foliage that was green was higher at both TOPO and BIWI than at MUDD. At TOPO, the percentage was 94–96% throughout the season in tamarisk and 90–95% in areas with Goodding's willows. At BIWI, the percentage of foliage that was green was 90–95%. None of these ranges exceeded maximum observer variation. No yellow vegetation was detected in either study area.

Overall, the percentage of leafless stems was higher in tamarisk, at both TOPO and MUDD, than in the other vegetation types (figure 6-7). At MUDD, the percentage of leafless stems in tamarisk varied between 25 and 49%, with estimates declining steadily from the first sampling round in early June through mid-July and then increasing slightly through early August. This change exceeded the maximum observer variation of 19%. In addition, all observers recorded lower estimates of percentage of leafless stems during the final calibration versus the initial calibration at points in tamarisk (see figure 6-2). The percentage of leafless stems in Goodding's willow with tamarisk understory at MUDD varied between 14 and 21%; this change did not exceed the maximum observer variation of 23%. At TOPO, the percentage of leafless stems varied between 23 and 55% in tamarisk and 14 and 28% in areas with Goodding's willows. Neither change exceeded the maximum observer variation of 63 and 51%, respectively. A majority of the data collected in both vegetation types during the sampling rounds with the highest estimates was collected by observer 5. In tamarisk, a majority of the data collected during the sampling round with the lowest estimate was collected by observer 8. At BIWI, the percentage of leafless stems varied between 11 and 20%, and this change did not exceed the maximum observer variation of 14%.

Percent canopy closure was high across all vegetation types in all study areas, ranging from 92 to 99% (figure 6-8). At MUDD, percent canopy closure varied from 92 to 99% in tamarisk and 96 to 98% in Goodding's willow with tamarisk understory. In TOPO, percent canopy closure ranged between 93 and 97% in tamarisk and 97 and 99% in areas with Goodding's willows. At BIWI, percent canopy closure varied between 93 and 97%. None of the changes exceeded the respective maximum observer variation values.

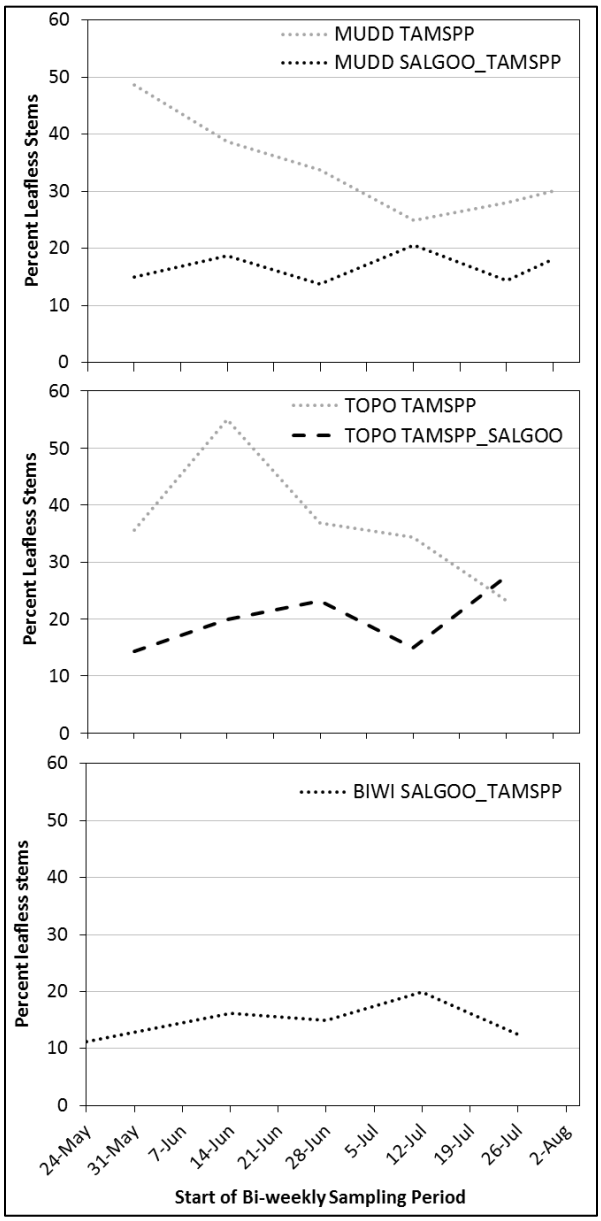

Figure 6-7.—Median percentage of leafless stems by vegetation type at beetle monitoring points, 2015.
Muddy River (MUDD), Topock Marsh (TOPO) and Bill Williams (BIWI). Vegetation types are TAMSPP = > 75% tamarisk, TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, and SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory.

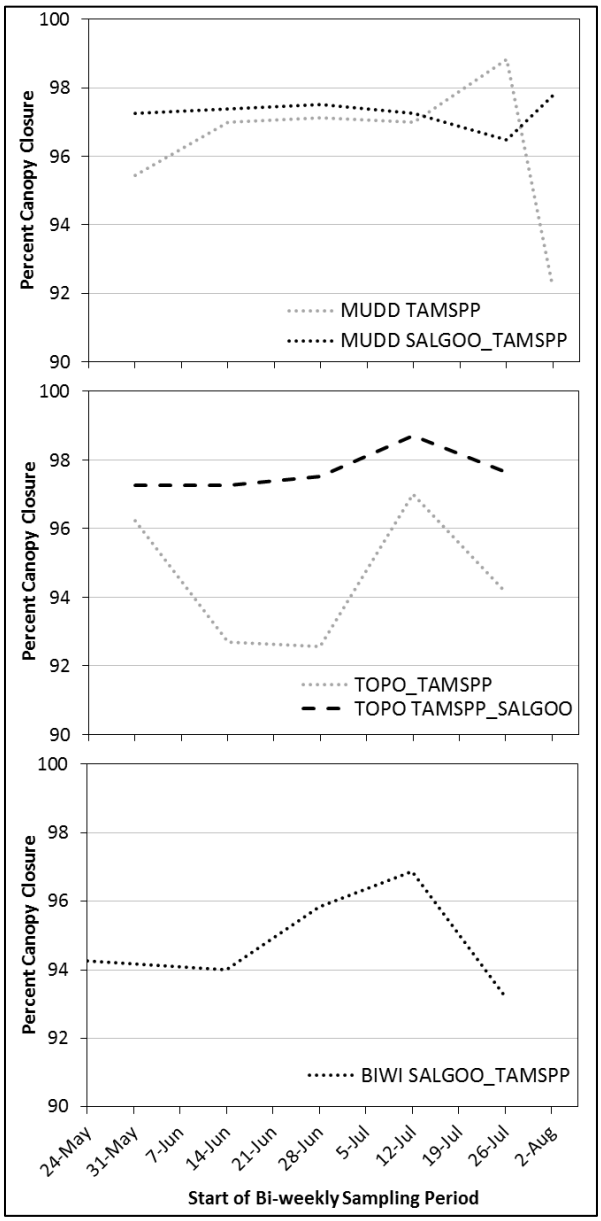

Figure 6-8.—Median percent canopy closure by vegetation type at beetle monitoring points, 2015.
Muddy River (MUDD), Topock Marsh (TOPO) and Bill Williams (BIWI). Vegetation types are TAMSPP = > 75% tamarisk, TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, and SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory.

Temperature and Humidity Measurements

HOBO and iButton loggers were deployed at MUDD between May 14 and 31, at TOPO between May 27 and June 13, and at BIWI on May 14 and 15. Loggers at all study areas were taken down between August 6 and 8. Loggers at 12 sample points at TOPO were taken down on August 7; the following day, a wildfire destroyed all loggers at the remaining 8 points; 3 points were in tamarisk with emergent Goodding's willow, and 5 points were in tamarisk. All other original iButtons functioned properly. One comparison iButton at MUDD was launched incorrectly and collected data for only 2 days. Of the original HOBOs, one at MUDD, one at TOPO, and two at BIWI failed to collect data. One comparison HOBO at MUDD failed to collect data.

Maximum daily temperature and daily temperature range were greater at MUDD than at either TOPO or BIWI (attachment 10 and figure 6-9). Overall temperatures were very similar between BIWI and TOPO; however, temperature differed between vegetation types at TOPO, with tamarisk having higher temperatures and a larger daily temperature range than tamarisk with emergent Goodding's willow. At MUDD, tamarisk had higher temperatures and a larger daily temperature range than did Goodding's willow with tamarisk understory.

Diurnal and nocturnal vapor pressures were lower at MUDD than at either BIWI or TOPO, and humidity in the tamarisk vegetation at MUDD was lower than in Goodding's willow with tamarisk understory (attachment 10 and figure 6-10). Humidity at TOPO and BIWI varied relatively little between study areas or vegetation types.

At MUDD, daytime highs in tamarisk vegetation were hotter than the high temperatures recorded at the Overton weather station, while daily high temperatures in Goodding's willow with tamarisk understory were similar to those recorded at the weather station (figure 6-11). Overnight low temperatures in both vegetation types were lower than those recorded at the weather station. At TOPO and BIWI, daytime highs and nighttime lows in all vegetation types were considerably lower than those recorded at the Needles weather station (figure 6-12). The difference in daytime highs between the Needles weather station and the beetle monitoring points tended to be larger on hot days than on cooler days.

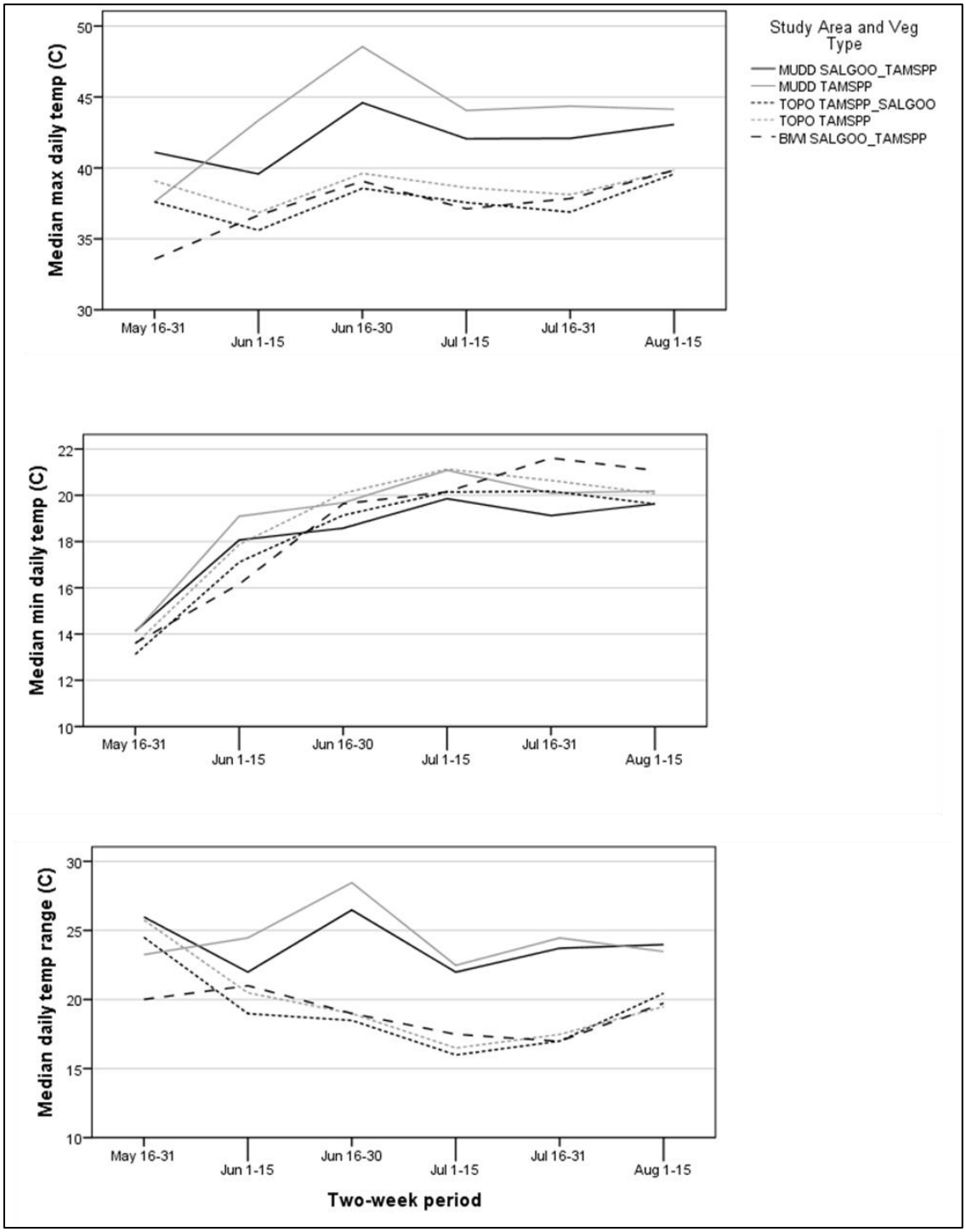

Figure 6-9.—Median maximum and minimum daily temperature and daily temperature range (°C) recorded by original iButtons at beetle monitoring points, 2015.

Muddy River (MUDD; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory, n = 10; and TAMSPP = > 75% tamarisk, n = 10), Topock Marsh (TOPO; TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, n = 7; and TAMSPP = > 75% tamarisk, n = 5), and Bill Williams (BIWI; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory, n = 15).

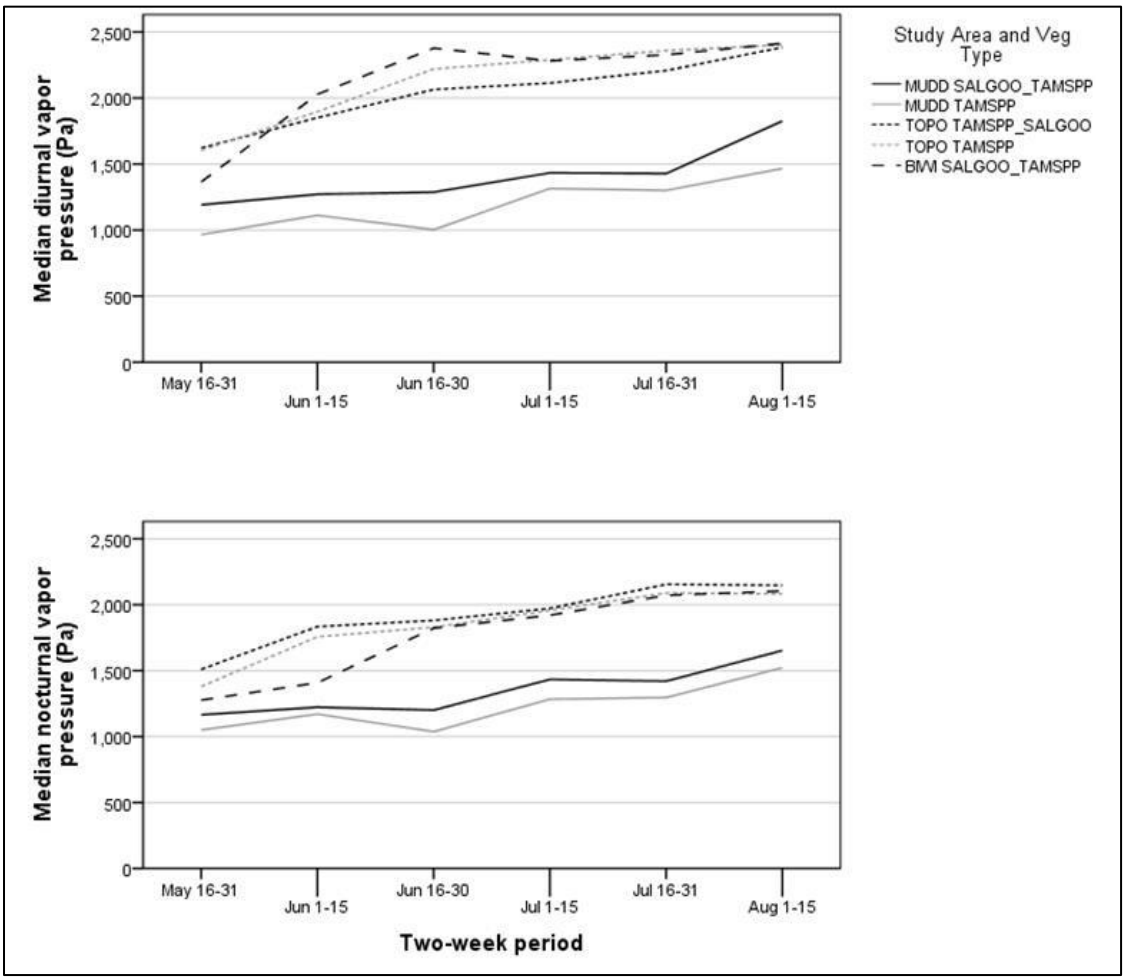

Figure 6-10.—Median diurnal and nocturnal vapor pressure (Pa) recorded by original iButtons at beetle monitoring points, 2015.
Muddy River (MUDD; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory, n = 10; and TAMSPP = > 75% tamarisk, n = 10), Topock Marsh (TOPO; TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, n = 7; and TAMSPP, n = 5), and Bill Williams (BIWI; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory, n = 15).

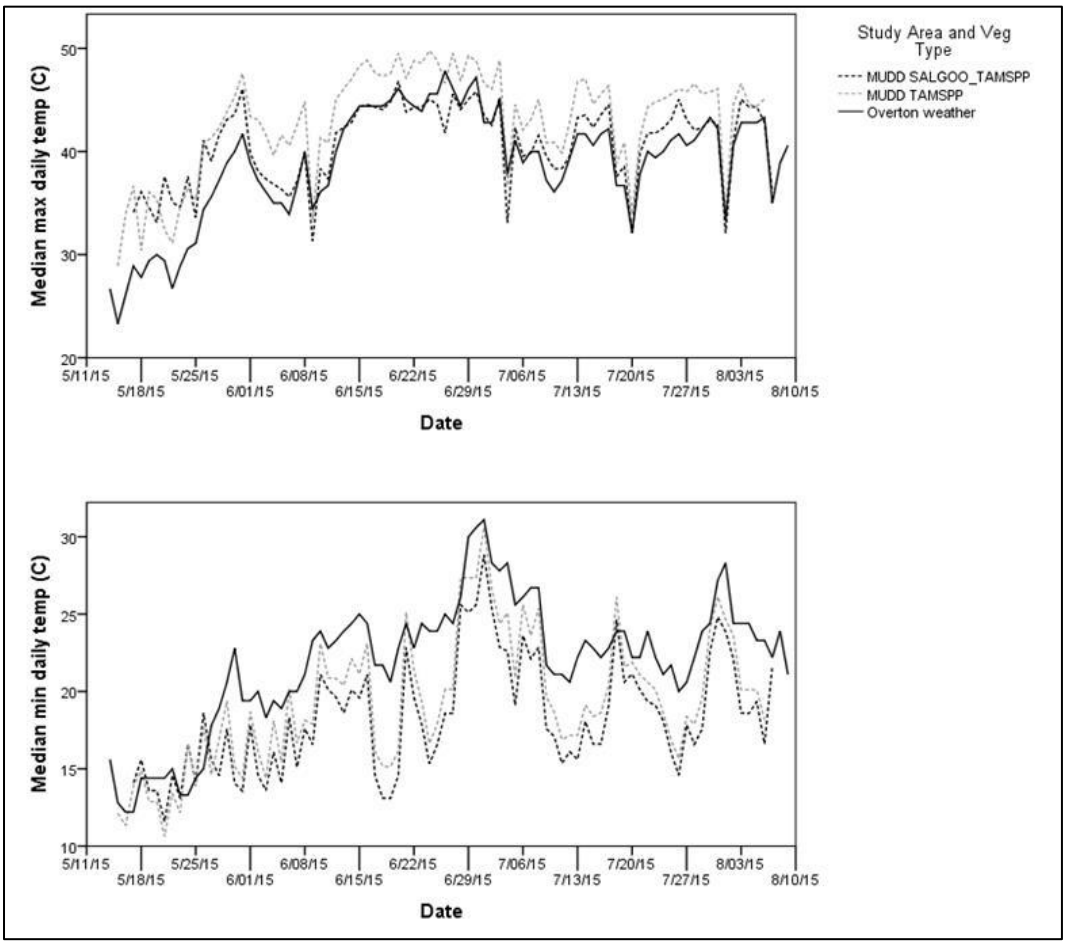

Figure 6-11.—Median maximum and minimum daily temperature (°C) at beetle monitoring points within tamarisk (TAMSPP, n = 10) and Goodding's willow overstory with tamarisk understory (SALGOO_TAMSPP, n = 10) at Muddy River (MUDD) as compared to maximum and minimum daily temperature recorded at the Overton weather station, 2015.

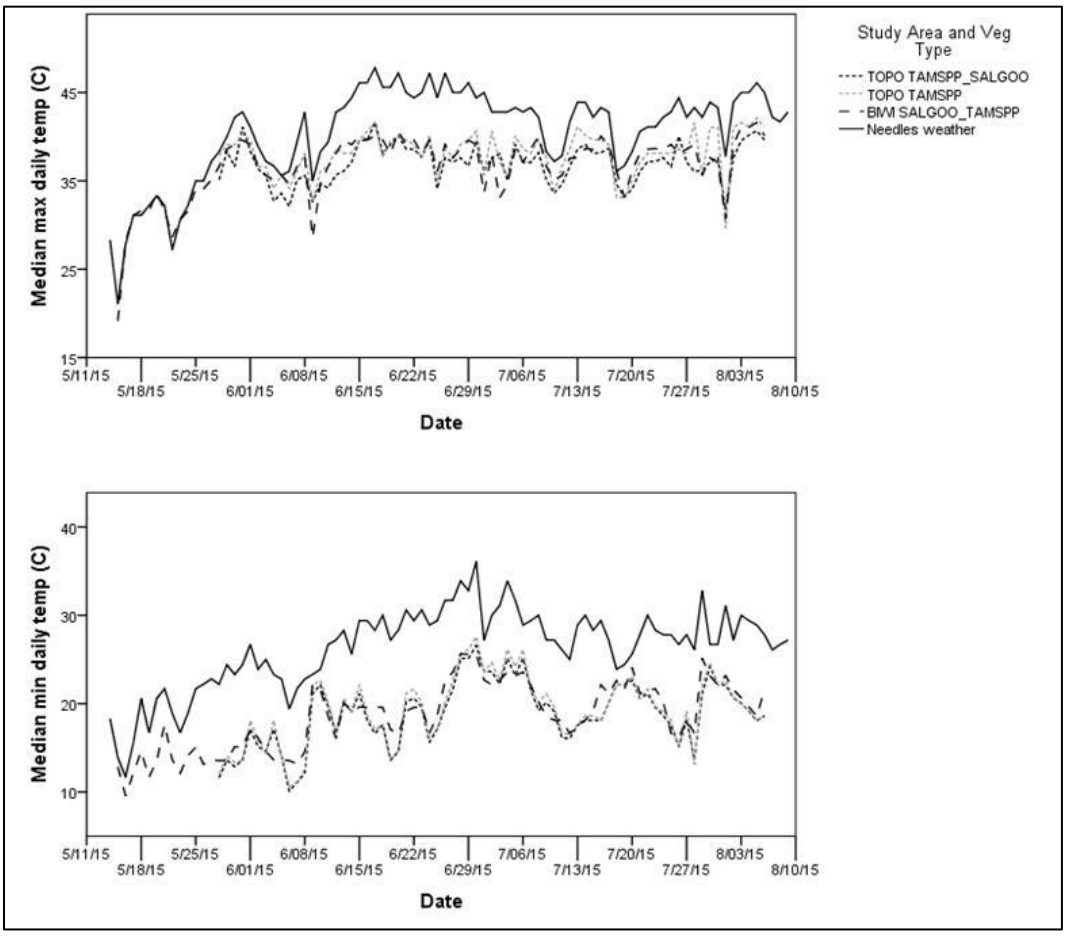

Figure 6-12.—Median maximum and minimum daily temperature (°C) at beetle monitoring points within tamarisk (TAMSPP; n = 5) and tamarisk with emergent Goodding's willow (TAMSPP_SALGOO, n = 7) at Topock Marsh (TOPO) and Goodding's willow overstory with tamarisk understory (SALGOO_TAMSPP, n = 15) at Bill Williams (BIWI) as compared to maximum and minimum daily temperature recorded at the Needles weather station, 2015.

Comparison of HOBOs and iButtons

For models of maximum daily temperature using 2 years of data from points at TOPO and BIWI, AIC_c was lowest for a model without fixed effects of year in which bias depended only on the reference method measurements for maximum daily temperature. In this model, data from the same site were correlated (AR2) within the same year but independent between years (table 6-2 and attachment 11). Measured bias in maximum daily temperature measurements (± 2.5 °C) did not significantly differ from zero, in that the 95% prediction interval for bias included zero for virtually the entire range of maximum daily temperatures measured by HOBO data loggers (figure 6-13). The predicted 2-year relationship was:

$$Bias_{\text{HOBO - iButton daily maximum T}} = -4.77 + 0.12*\text{HOBO}$$

For models of bias in minimum nightly temperature with 2 years of data from points at TOPO and BIWI, AIC_c was lowest for a model without any fixed effects of year in which bias depended only on the reference method measurements for minimum daily temperature (table 6-2 and attachment 11). In this model, data from the same site were correlated (AR1) within the same year but independent between years. Measured bias in minimum nightly temperature measurements did not significantly differ from zero, in that the 95% prediction interval for bias included zero for virtually the entire range of minimum nightly temperatures measured by HOBO data loggers (figure 6-13). The predicted 2-year relationship was:

$$Bias_{\text{HOBO - iButton nightly minimum T}} = 0.69 - 0.01*\text{HOBO}$$

For measured bias in mean daily vapor pressure and mean nightly vapor pressure, models with the lowest AIC_c had additive but not interactive fixed effects of year and measurements from the same sites treated as correlated (AR1 [mean daily vapor pressure], unspecified [mean nightly vapor pressure]) within seasons and independent between years (table 6-2 and attachment 11):

$$Bias_{\text{HOBO DVP- iButton DVP}} = -236.32 + 0.11*\text{HOBO} - 33.60*\text{Year}$$

$$Bias_{\text{HOBO NVP- iButton NVP}} = -127.09 + 0.06*\text{HOBO} - 21.00*\text{Year}$$

In other words, mean daily vapor pressure was on average 236.32 Pa lower for HOBO data loggers than iButton data loggers in 2014 and 33.60 Pa lower still in 2015. Mean nightly vapor pressure was on average 127.09 Pa lower for HOBO data loggers than iButton data loggers in 2014 and 21.00 Pa lower still in 2015.

Measurement error for these variables was insignificant (where 95% prediction intervals for bias included zero) for virtually the entire range of nightly minimum temperatures, between approximately 1,250 and 2,750 Pa for mean nightly vapor pressure, and between approximately 1,760 and 3,000 Pa for daily vapor pressure measured by HOBO data loggers (figure 6-13).

Table 6-2.—Top models (ΔAIC_c < 10) used to predict the difference in maximum daily temperature, minimum nightly temperature, diurnal vapor pressure, and nocturnal vapor pressure between HOBO and iButton data loggers over 2 years at 33 beetle monitoring points at Topock Marsh and Bill Williams, 2014 and 2015

Random effect	Correlation structure[1]	Fixed effects[2]	Intercept[3]	Y[2,4]	R[2,4]	I[2,4]	AIC_c[5]	ΔAIC_c	AIC[6] weight
Maximum daily temperature									
Site–year	ARMA (2,0)	R	-4.77 (0.50)	–	0.12 (0.02)	–	11405.73	0.00	0.88
Site–year	ARMA (2,0)	Y+R	-4.84 (0.54)	0.05 (0.14)	0.12 (0.02)	–	11409.76	4.03	0.12
Minimum nightly temperature									
Site–year	AR1	R	0.69 (0.07)	–	-0.01 (0.003)	–	1952.33	0.00	0.82
Site–year	AR1	Y+R	0.82 (0.09)	-0.09 (0.04)	-0.01 (0.003)	–	1955.60	3.27	0.16
Site–year	AR1	Y+R+I	1.08 (0.13)	-0.27 (0.08)	-0.03 (5.23E–3)	8.51E–3 (3.08E–3)	1960.40	8.07	0.01
Site–year	ARMA (1,1)	Y+R+I	1.05 (0.13)	-0.26 (0.08)	-0.02 (5.14E–3)	7.61E–3 (3.00E–3)	1961.47	9.13	0.01
Mean diurnal vapor pressure									
Site–year	AR1	Y+R	-236.32 (24.71)	-33.60 (13.97)	0.11 (0.01)	–	41937.32	0.00	1.00
Mean nocturnal vapor pressure									
Site–year	None	Y+R	-127.09 (17.82)	-21.00 (10.60)	0.06 (0.01)	–	40601.1	0.00	0.72
Site–year	CS	Y+R	-127.09 (17.82)	-21.00 (10.60)	0.06 (0.01)	–	40603.1	2.00	0.27

[1] ARMA (2,0) = second–order autoregressive, AR1 = first–order autoregressive, ARMA (1,1) = first–order autoregressive moving average, and CS = compound–symmetric.
[2] R = reference method measurement (i.e., HOBO measurement), Y = year, and I = year * reference method measurement interaction.
[3] Failed = model failed to converge in R.
[4] Coefficient followed by standard error in parentheses.
[5] AIC_c = Akaike's information criterion for small sample size.
[6] AIC = Akaike's information criterion.

When microsite effects on measurement error within the same brand of data logger ($HOBO_{orig}$ – $HOBO_{comp}$; $iButton_{orig}$ – $iButton_{comp}$) were assessed, it was found that 95% prediction intervals for the relationship between measurement error in a pair of data loggers and the data logger at the original location included zero for all points within the range of data logger measurements at the original location (figures 6-14 and 6-15).

Influence of Light Level on Bias in Maximum Daily Temperature

In 2015, measurement error in maximum daily temperatures measured by HOBO and iButton data loggers was not meaningfully influenced by light levels, although measurement error increased with maximum daily temperatures measured by HOBO data loggers (attachment 11).

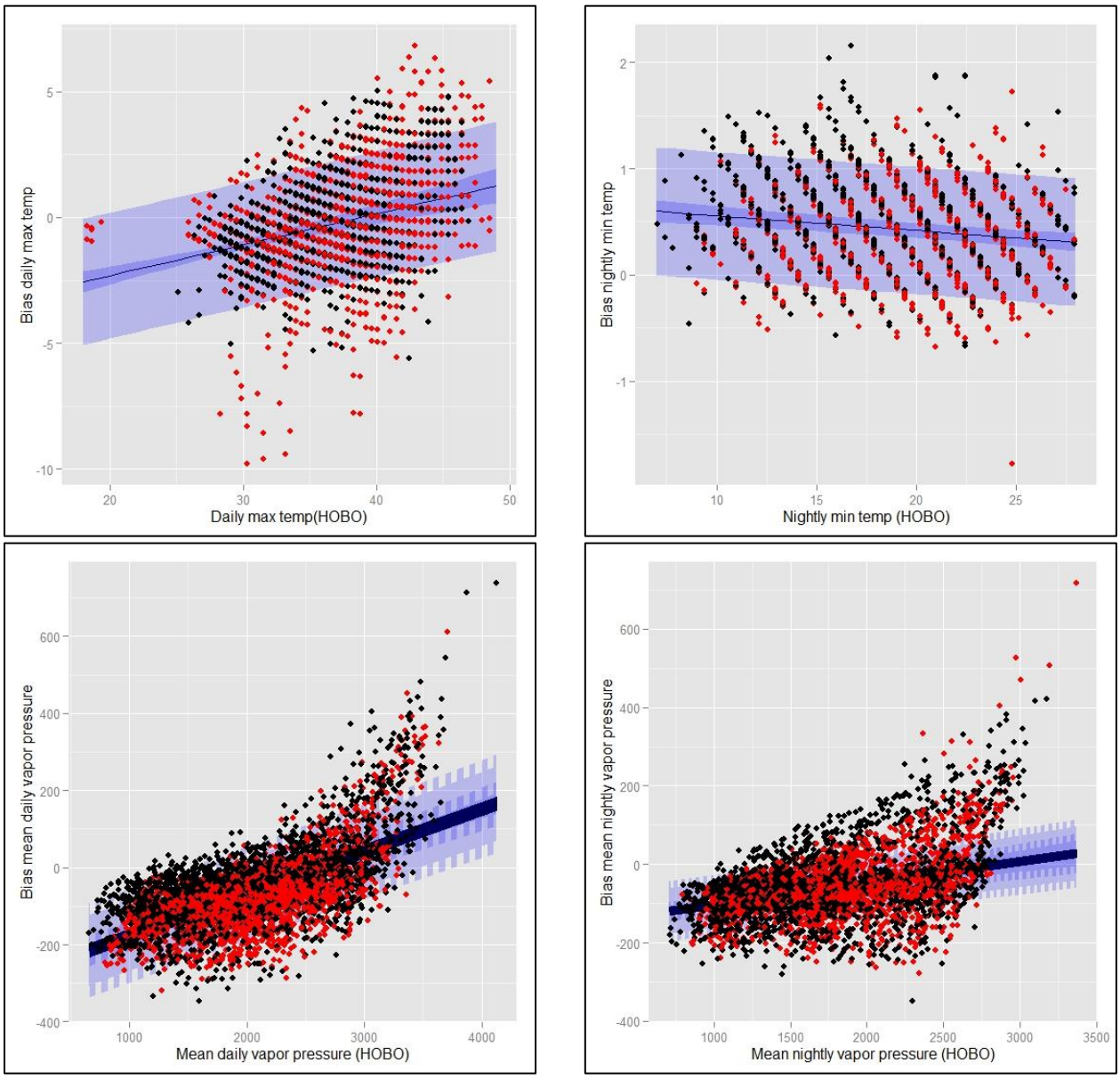

Figure 6-13.—Regression and 95% prediction intervals (based on regular model standard errors) for difference in maximum daily temperature (top left), minimum nightly temperature (top right), daily mean vapor pressure (bottom left), and nightly mean vapor pressure (bottom right) recorded by HOBO and iButton data loggers plotted against values recorded by HOBO loggers at beetle monitoring points, Topock Marsh and Bill Williams, May 15 – July 31, 2014, (black) and May 15 – August 7, 2015 (red).

Note: Prediction intervals for mean daily vapor pressure and nightly vapor pressure are based on linear functions of the HOBO data logger measurements.

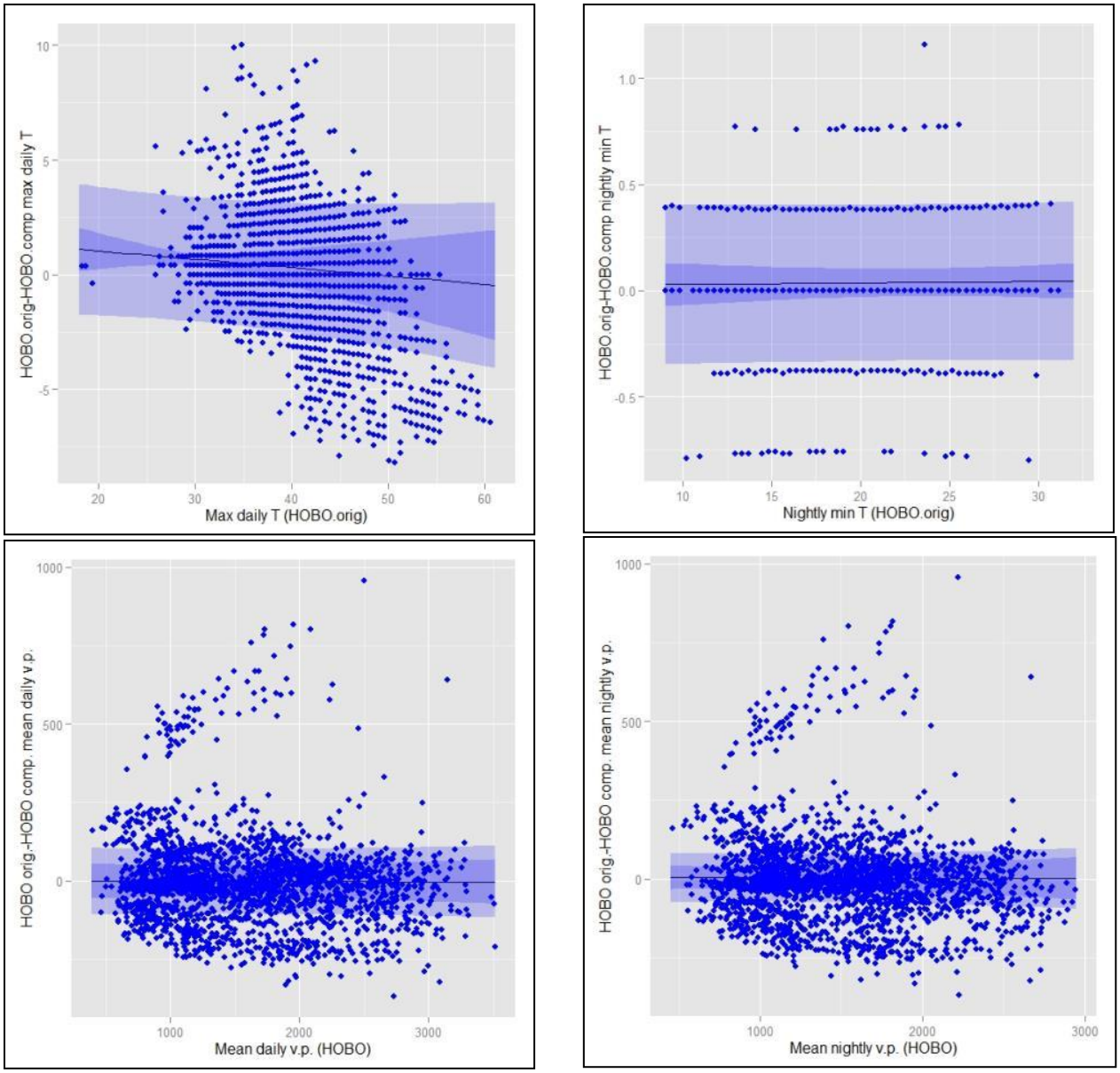

Figure 6-14.—Difference in maximum daily temperature (top left), minimum nightly temperature (top right), daily mean vapor pressure (bottom left), and nightly mean vapor pressure (bottom right) recorded by HOBO data loggers at original and comparison microsites plotted against values recorded by HOBO loggers at original microsites at beetle monitoring points at Muddy River, Topock Marsh, and Bill Williams, May 15 – August 7, 2015.

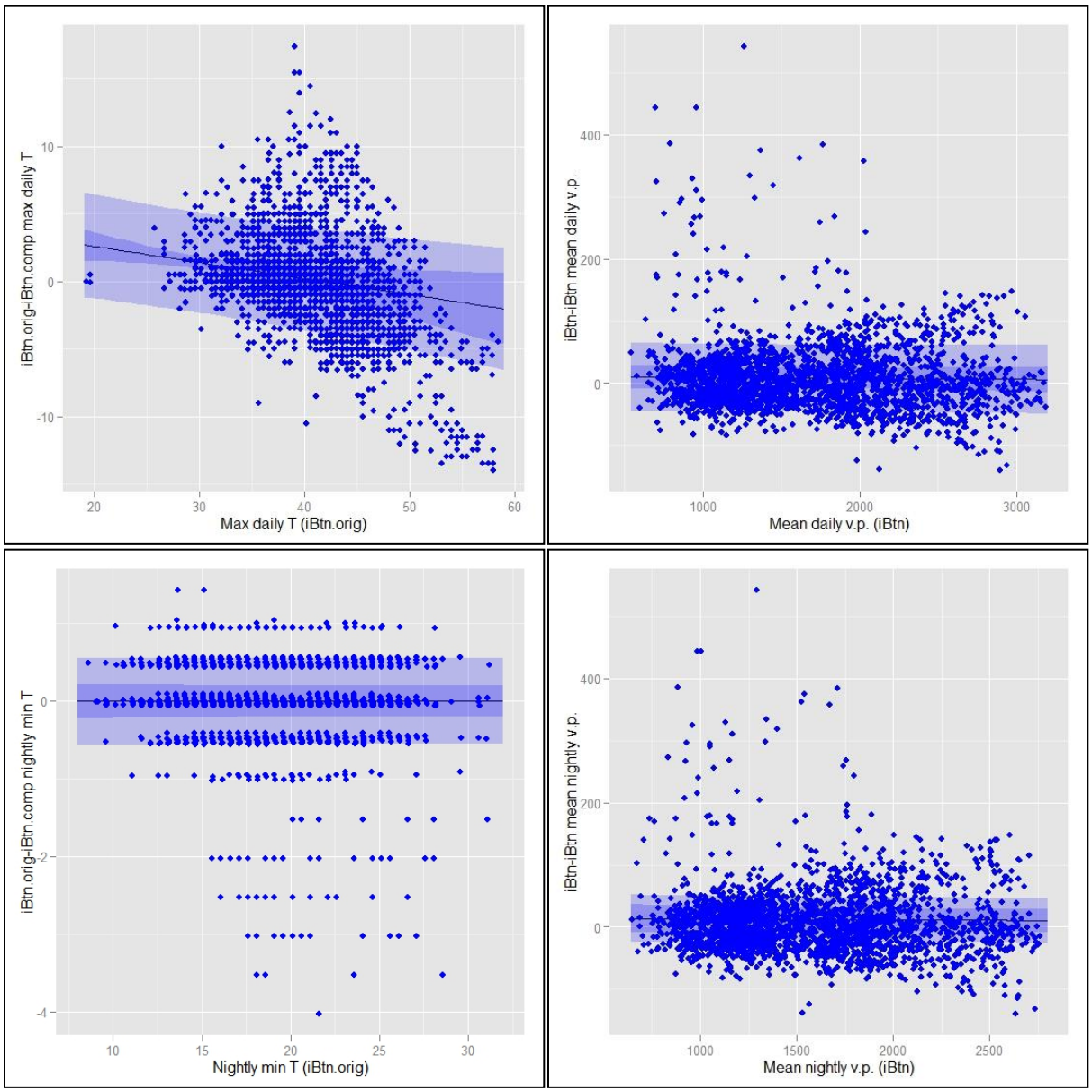

Figure 6-15.—Difference in maximum daily temperature (top left), minimum nightly temperature (top right), daily mean vapor pressure (bottom left), and nightly mean vapor pressure (bottom right) recorded by iButton data loggers at original and comparison microsites plotted against values recorded by iButton loggers at original microsites at beetle monitoring points at Muddy River, Topock Marsh, and Bill Williams, May 15 – August 7, 2015.

Light Intensity Measurements

All HOBO light loggers functioned properly. Light loggers were deployed at MUDD between May 14 and 31, at TOPO between May 27 and June 3, and at BIWI on May 14 and 15. Light loggers at all study areas were taken down between August 6 and 8. Loggers at 12 sample points at TOPO were taken down on August 7; the following day, a wildfire destroyed all loggers at the remaining 8 points; 3 points were in tamarisk with emergent Goodding's willow, and 5 points were in tamarisk. The housing of the control logger was changed at MUDD on June 16 and July15, at TOPO on July 1, and at BIWI on June 13 and July 12. However, the housing that was put on the MUDD control logger on July 15 was the same one that had been used in May and the first half of June.

All light loggers at MUDD and BIWI had a cleanliness ranking of 1 (clean) when they were retrieved at the end of the season. Of the 13 light loggers retrieved at TOPO, 4 had a cleanliness ranking of 2 (appeared clean but a film of dirt or sap could be felt), and the remainder were ranked as clean. The control logger at MUDD had a cloudiness ranking of 3 (obviously cloudy), and the control logger at TOPO had a ranking of 2 (slightly cloudy when compared to a new housing) at the end of the season. The housing of BIWI control logger was clear. Three other loggers at MUDD and one other logger at BIWI had a cloudiness ranking higher than 1; all other loggers had clear housing at the end of the season.

The control loggers at all study areas recorded daily median light levels between 0900 and 1500 hours around 225,000 lux when the loggers were first deployed (figure 6-16). Overcast days were clearly apparent as marked dips in light levels; on several days (e.g., June 9 and August 1), control data at all study areas reflected regionally cloudy conditions. Median light levels recorded on sunny days at the control loggers remained relatively constant throughout the season at BIWI but declined after mid-July at MUDD and in the first part of August at TOPO.

At all study areas, percent light readings were inversely related to luminance readings at the control loggers (i.e., a greater percentage of available light was recorded at the monitoring points on cloudy days than on sunny days) (figure 6-17). Percent light in both vegetation types at MUDD was higher than in any of the vegetation types at the other study areas. Percent light in tamarisk at MUDD declined from mid-May through mid-July, whereas percent light in Goodding's willow with tamarisk understory remained relatively constant through the season. A similar, though less pronounced, pattern was apparent at TOPO, where percent light in tamarisk with Goodding's willow overstory was relatively constant through the season, but percent light in tamarisk declined in July. Both vegetation types at TOPO had lower percent light than did Goodding's willow with tamarisk understory at BIWI.

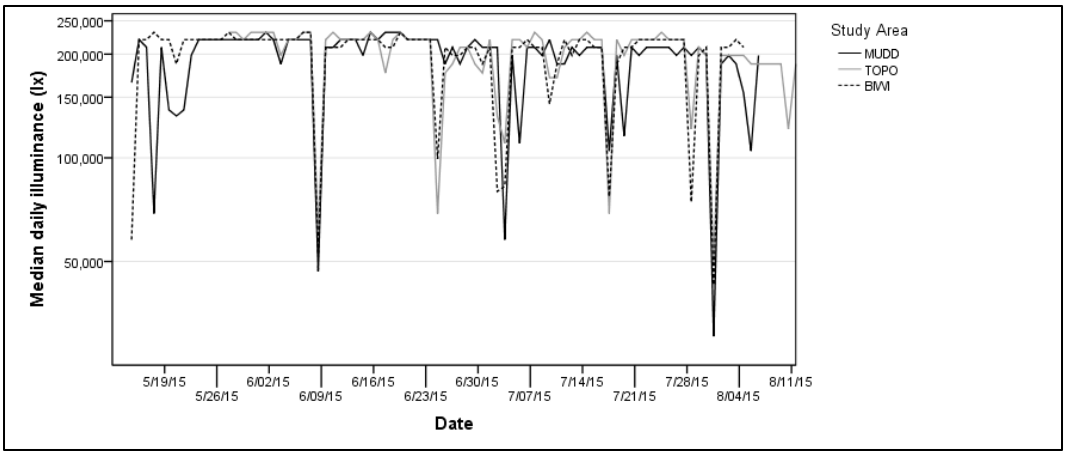

Figure 6-16.—Median daily illuminance (lux) between 0900 and 1500 hours at control points at Muddy River (MUDD), Topock Marsh (TOPO), and Bill Williams (BIWI), 2015.

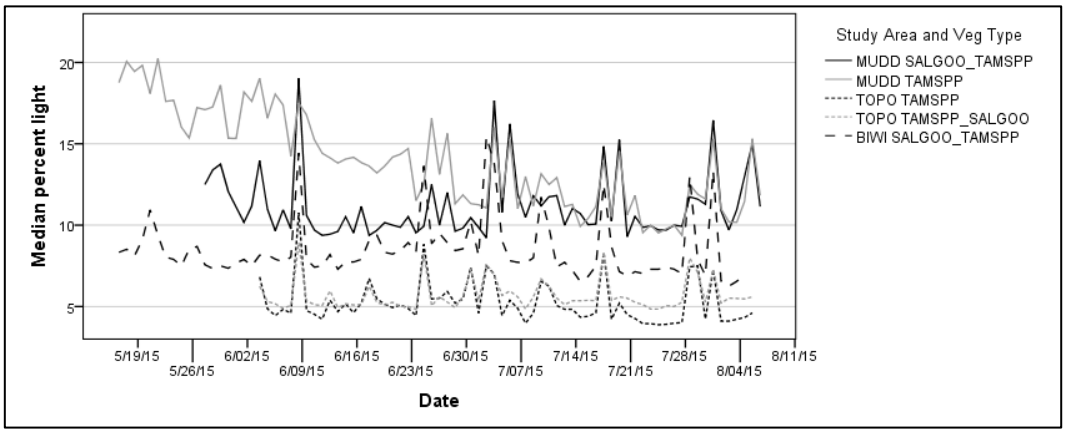

Figure 6-17.—Median percent daily illuminance between 0900 and 1500 hours at all monitoring points, 2015.

Muddy River (MUDD; SALGOO_TAMSPP = Goodding's willow with tamarisk understory, n = 10; and TAMSPP = > 75% tamarisk, n = 10), Topock Marsh (TOPO; TAMSPP, n = 5; and TAMSPP_SALGOO = tamarisk with emergent Goodding's willow, n = 7), and Bill Williams (BIWI; SALGOO_TAMSPP = Goodding's willow with tamarisk understory, n = 15).

DISCUSSION

Beetle Monitoring and Vegetation Measurement

Calibration

The calibration exercise was successful in quantifying overall observer variation. In 2014, it was noted that the largest observer variation was recorded at the initial training point, when observers were still learning the protocol. This was not the case in 2015, when observer variation was larger at one or more calibration points following the training point for all but one vegetation variable at each study area. Observers at all study areas struggled to consistently estimate the percentage of leafless stems, percent green foliage, and percent tamarisk within 2 and 5 m of the monitoring point. Observers at BIWI also struggled with percent canopy closure. Observer variation during the initial calibration tended to be larger in areas with greater heterogeneity in vegetation structure or for measures that are harder to visualize regardless of vegetation structure.

Seven instances in which maximum observer variation was higher during the final versus the initial calibration and three instances in which it was higher during the initial calibration were observed. Observer drift was identified in four of the seven instances in which observer variation was greater during final calibration, and in all four of these cases, maximum observer variation during the final calibration was ≥ 50%. The variables involved in these instances were percent tamarisk within 2 and 5 m and percent leafless stems, which were observed during the initial calibration exercise to be difficult for observers to estimate consistently. Observer drift did not always lead to increased observer variation, however. In the case of percent green foliage in tamarisk at MUDD, the estimates of observer 3 were consistently below the mean during the initial calibration and consistently above the mean during the final calibration, while the reverse was true, in equal magnitude, for observer 4. The two observers exchanged positions in the distribution of observer estimates, but the total observer variation did not change.

In most of the six other cases where maximum observer variation changed by > 10% between the initial and final calibration, a single erroneous estimate during either the initial or final calibration exercise resulted in larger maximum observer variation during the respective exercise. It is difficult to provide enough training to reduce the instance of erroneous estimates as they are not the result of a systemic error in visualizing a variable so much as the result of not assessing the vegetation carefully enough at one given location.

Estimates of percent leafless stems and percent tamarisk within 2 m and within 5 m of a location are difficult variables to estimate, as indicated by a general failure to reduce overall observer variation during the initial calibration exercise, as well as by multiple incidences of observer drift in 2015. These variables were also noted as having the highest maximum observer variation in 2014. Given the difficulty in consistently visualizing the percent tamarisk measures across

observers, this variable is likely best used as corroboration of vegetation type near a nest location, as defined in chapter 5, and is likely not useful for other possible analyses, such as examining the effect on nest success of the percentage of tamarisk near the nest. Although the percentage of leafless stems helps describe the intensity of defoliation, it can be an extremely difficult variable to visualize consistently. Observers routinely had trouble excluding stems that would not be expected to have leaves (i.e., main trunks), and the range among observers increased as the average estimate increased (up to the maximum average recorded of 53.5%). Given the problems documented with obtaining consistent estimates for a given variable across multiple observers, all observers should go through training and calibration at the beginning of future seasons when beetle monitoring is conducted, but only the most consistent observer should collect data during the field season. This observer should be selected based on the results of the calibration data, with the selected observer recording the most consistent data among the crew. Consistent data should be defined as the difference between the observer's estimates and the mean having a small magnitude. To determine if the selected observer drifted during the field season, two additional calibration exercises should be conducted at the end of the season. The first of the end-of-season exercises should include all observers except the selected observer plus a trained and experienced observer; this exercise should mimic the initial calibration exercise in methods. The second end-of-season calibration exercise should involve all observers, including the selected observer, and should follow the final calibration exercise methods described in this chapter.

Vegetation Measurements

At MUDD, beetle larvae were detected on several locations, most frequently at monitoring points in Goodding's willow with tamarisk understory. Defoliation in the study area was patchy, rather than widespread, and there were no discernable trends in the data for most vegetation variables. The only change in a vegetation variable that exceeded maximum observer variation was percent leafless stems in tamarisk, which decreased during the season. The calibration exercise also supported there having been a change in the percentage of leafless stems between the beginning and end of the season, as every observer recorded estimates that were markedly lower during the final exercise than during the initial exercise. Percent green foliage in tamarisk increased 14% from its low in early June to a high in mid-July, but this increase was not greater than the maximum inter-observer variation of 18%. However, the calibration data suggest that the percentage of green foliage might actually have increased as two of three observers recorded consistently higher estimates (13–26% higher) during the final calibration exercise compared to the initial exercise. There was no discernable trend in percent canopy closure, and no changes during the season exceeded maximum observer variation. This was surprising, as it was expected that a change in the percentage of leafless stems would be inversely related to a change in percent canopy closure. It is possible that the tamarisk branches themselves

were dense enough that canopy closure as estimated with a densiometer remained high even when the branches were partially bare, and any changes in canopy closure were obscured by observer variation.

Vegetation measures continue to represent baseline conditions at TOPO and BIWI, as no tamarisk beetles were detected in either study area in 2015. No change in any vegetation variable in either study area was larger than the maximum recorded observer variation, and all apparent changes were therefore likely due to observer variation. This was most apparent for percent leafless stems at TOPO, which had the largest difference in maximum and minimum observed estimates during the season. The calibration exercise identified that one observer drifted high in the estimates of this variable at TOPO, while a second observer drifted low. The maximum percent leafless value was recorded on a day when the observer who drifted high collected data and recorded several high estimates. The minimum estimate was recorded on a day when the observer who drifted low recorded several low estimates. Any observed pattern in these data is therefore due to erroneous estimations.

The results suggest that these methods are best suited for detecting large and significant changes in vegetation across a landscape rather than small or localized changes. Further, the calibration exercise is required to help determine which apparent changes are likely the result of observer variation.

Temperature and Humidity

In 2015, the seasonal changes recorded in maximum and minimum temperatures typically paralleled those recorded at weather stations. At both TOPO and BIWI, riparian vegetation provided a moderating effect on daily high temperatures as recorded at the weather station, whereas high temperatures at MUDD were higher than those recorded at the weather station. It was expected that defoliation would result in changes in temperature that did not mirror seasonal changes as recorded at weather stations. The comparisons with weather station data presented here provide a baseline with which to compare data from future years in which defoliation events may occur.

Comparison of HOBOs to iButtons

Measurement errors from the prediction intervals of regression are absolute values in the same units as the variables being measured by data loggers. For the flycatcher study, whether or not these values are acceptably small could be determined by what temperature or humidity difference is considered to be a biologically significant difference (e.g., between occupied and unoccupied sites or between failed and successful nests). Maximum daily temperature and mean diurnal and nocturnal vapor pressure differed significantly between occupied and

unoccupied sites (McLeod and Pellegrini 2013; table 7.18, all study sites combined), with maximum daily temperature being 2.1 °C higher on average at unoccupied sites than at occupied sites, while mean diurnal and nocturnal vapor pressures were on average 151.7 and 154.7 Pa, respectively, lower at unoccupied versus occupied sites. If these values were used as thresholds, then measurement errors between iButton and HOBO data loggers would be within these thresholds for most HOBO values.

Although 95% of measured bias appeared to be negligible for all measured reference values of daily maximum and nightly minimum temperature and higher values of mean daily and nightly vapor pressure, there are some caveats associated with the measurement error from 2 years of data. Model residuals were close to normally distributed for bias in nightly minimum temperature but not for other modelled variables. As LMMs were used rather than ordinary least-squares regression to model bias in temperature and humidity measurements, correlation structures and random effects were specified rather than transforming the dependent variables to account for heteroscedasticity in measurement error. An assumption of the LMMs was that model residuals were normally distributed; since they were not, regardless of the correlation structure and random effect used in the models, the models may be missing important, unmeasured predictors for the dependent variable, or the data may be better modeled by another distribution. Thus, the 95% prediction intervals used to represent measurement error may not be accurate. Although it is not known what these predictors are, it is known that measurement differences falling outside of the prediction band typically came from a small number of sites.

For example, most large positive biases in maximum daily temperature (where HOBO.orig > HOBO.comp) came from two sites (numbers 5 and 14) at BIWI. Large negative biases in maximum daily temperature (where HOBO.comp > HOBO.orig) came mostly from four sites at MUDD (numbers 3, 5, 15, and 17). Interestingly, MUDD site 3 had lower canopy cover than the other sites. Although canopy cover was not a significant influence on measurement error between iButtons and HOBO data loggers at the original microsite in the earlier analysis, it is possible that canopy cover might be a predictor of microsite variability within measurements.

Far more instances of large biases were observed in vapor pressure than in temperature when HOBO data were compared at original and comparison microsites, with large biases coming from MUDD sites 3, 6, 7, 13, 14, 15, 17, 19, and 20; TOPO sites 3, 12, 13, 14; and BIWI sites 1, 5, and 20. Many instances of HOBO humidity sensors drifting in their measurements over time have been observed over the years. The use of individual loggers suspected, upon cursory inspection of a graph of the data, to have unusually high or low humidity readings and that proved, upon comparison in a controlled environment with several other data loggers, to read markedly high or low, was discontinued. However, many loggers that had drifted in their humidity readings were likely overlooked. Drift

in humidity readings is acknowledged by the manufacturer as a potential problem with the humidity sensors; the user's manual states that drift is less than 1% per year in "normal operating conditions" but that there can be up to 3% additional, temporary drift when the logger is exposed to relative humidity > 70%, which can be a nightly occurrence in riparian environments. The iButton loggers have fewer problems with drift in humidity readings since the units are 10 years younger than the HOBOs (compare the vapor pressure graphs in figure 6-11 versus figure 6-12). However, the iButton manufacturer states that "absorption of contaminants can degrade [the humidity sensor's] accuracy," and iButtons should be evaluated annually in a controlled environment to allow culling of faulty units before deployment in the field. Given the drift in HOBO humidity readings, the sensors likely have less power to detect changes in humidity (e.g., among study areas or pre-beetle versus post-beetle) than they do changes in temperature.

Influence of Canopy Cover on Bias in Maximum Daily Temperature

The canopy closure recorded at TOPO and BIWI in 2014 ranged from 78.7 to 100% and from 91.9 to 100%, respectively, and it is concluded that the failure to find a significant effect of canopy closure on the differences in maximum daily temperature measured between HOBO and iButton data loggers was due to the high percentage of and low variation in canopy cover across sample points. The experiment was replicated at MUDD in 2015 with the goal of including areas that had lower canopy closure, and half the loggers were placed in tamarisk areas that clearly did not resemble occupied flycatcher habitat (the vegetation was too short and too open). Although light intensity data from 2015 showed sunnier conditions at sample points at MUDD in comparison to the other study areas, this difference was not apparent in the canopy closure data (MUDD, range = 80.2–100.0, mean = 96.3; TOPO, range = 76.0–100.0, mean = 93.7; BIWI, range = 86.7–99.7, mean = 96.2). Neither canopy closure nor light intensity had a significant effect on differences in maximum daily temperature measured by HOBO versus iButton data loggers. These results suggest that at sites with > 75% canopy closure, canopy cover does not need to be included as a factor for predicting iButton values from HOBO values from 2012 and earlier.

Light Intensity

There were no defoliation events at TOPO or BIWI in 2015, and personnel were therefore unable to determine how defoliation might affect light intensity at these study areas. Defoliation at MUDD was patchy, and personnel were also unable to determine any effect of defoliation on light intensity at this study area.

In 2013, it was noted that light levels recorded by the control loggers declined steadily from mid-June through the end of the monitoring period, and it was suspected this was caused by sun exposure causing the housing of the loggers to

become opaque. To avoid this problem in 2014 and 2015, field personnel were instructed to replace the housing of each control logger every month. At MUDD, the housing was replaced in mid-July, but it was mistakenly replaced with the same housing that had been used at the beginning of the season. A decline in the median light level recorded at the control logger on sunny days was apparent by early August, and when the logger was retrieved on 8 August, the housing was markedly cloudy. At TOPO, the logger housing was changed on July 1 but was not changed toward the end of the season; by the beginning of August, light levels recorded on sunny days began declining, and the housing was markedly cloudy when it was retrieved on August 13. These observations emphasize the need to replace the housing monthly and to discard all used housing, even if the housing still appears to be clear. The practice of wiping off the logger housing during each beetle monitoring visit was effective in preventing the accumulation of dirt and debris on the logger, and this will be continued in future years.

The most striking seasonal change in light intensity occurred in tamarisk at MUDD, where median percent light on sunny days declined steadily from around 20% in mid-May to 10% by mid-July. This suggests that shadiness at the tamarisk points increased over that period; given that loggers were cleaned biweekly, an accumulation of dirt or debris cannot account for the decrease in percent light. Shadiness at tamarisk points at TOPO also appeared to increase through the season, with percent light on sunny days declining from around 5 to 2.5%.

Relationships Among Vegetation, Microclimate, and Light

No formal analysis of the relationships among vegetation, temperature, humidity, and light intensity was completed, but one general association was apparent in the data. At MUDD in tamarisk vegetation, there was a decrease through the season in the percentage of branches that were bare and a corresponding decrease in light intensity. Given the large degree of observer variation documented in 2015 for several of the vegetation variables, light loggers likely provide a more sensitive means for detecting changes in canopy cover than do visual estimates of canopy closure or percent leafless stems.

Recommendations

In TOPO, all of the beetle monitoring points were burned in the Willow fire in August 2015. The monitoring points had been located within recently occupied habitat to help describe the potential effects of defoliation on vegetation and microclimate at flycatcher nests. Of the unburned, occupied habitat at TOPO, the largest sites are on the island in Hell Bird and Glory Hole, which primarily consist

of mixed Goodding's willows and tamarisk, and in Swine Paradise, where flycatchers have nested in the tamarisk, near emergent Goodding's willows and adjacent to a swath of coyote willows on the edge of the marsh. New monitoring points could be installed within these sites to evaluate the effects of defoliation on occupied flycatcher habitat. It is not clear when tamarisk beetles will arrive at TOPO. Over the last 2 years, beetles on the main stem of the LCR have advanced approximately 10 km, and as of August 2015, beetles were still 25 km from the nearest unburned flycatcher habitat at TOPO. If this slow pace of advance continues, beetles will not arrive at TOPO for another few years, and monitoring could be postponed until the arrival of beetles is imminent. At minimum, continuation of photo points at The Wallows and in 800M to document the regeneration of vegetation within the burned area is recommended. These two photo point locations could also serve as locations for checking for the arrival of tamarisk beetles to the study area.

Given that tamarisk beetles have not yet arrived at TOPO, it seems unlikely that they will arrive in 2016 at BIWI. With 3 years of pre-defoliation data collected, the collection of beetle monitoring data at BIWI should be discontinued, though photos should be continued at the two photo points, one in Site 04 and one in Site 03, that provide the best vantage of the tamarisk. The beetle points at MUDD were deliberately established in largely unsuitable habitat to help inform the comparison between the new and old temperature/humidity data loggers. The collection of microclimate data at these monitoring points will not help to describe the effects of defoliation on recently occupied habitat, and data collection as these points is not intended to continue.

Chapter 7 – Management and Study Design Recommendations

For ease of reference, this chapter summarizes all study design and management recommendations discussed in previous chapters.

BROADCAST SURVEYS AND SITE ASSESSMENT

The northern end of Muddy Mac in WMSP was heavily damaged in the July 1, 2010, fire and was not surveyed in 2011–14. This portion of the site was assessed in 2015 and surveyed once. Vegetation in this portion of the site has reached ≥ 5 m in height and 95% canopy closure, and surveying this area in 2016 is recommended. Surveys should be discontinued in the linear, northern arm of Muddy Stringer 01 at WMSP; this portion of the site is dominated by widely spaced palm trees with little understory. There is a patch of coyote willows at the northern tip of the site that could provide flycatcher habitat if it increased in height, density, and aerial extent; revisiting this patch in future years to assess whether suitability has improved is recommended.

Last Gasp, Guinness, Beaver Pond North, Beaver Pond, and Site 08 at BIWI are currently on a triennial survey schedule; maintaining Last Gasp, Guinness, Beaver Pond North, and Beaver Pond on this schedule is recommended because suitable habitat at these sites is limited. Breeding flycatchers were discovered adjacent to the original extent of Site 08; continuing periodic surveys in the original extent of Site 08 while completing annual surveys in the area that was occupied in 2015 is recommended. Further exploration of the area between Site 08 and Upstream from Site 08 is also warranted. Adding Upstream from Site 08 to the periodic survey list is recommended; no resident flycatchers have been detected at this site since 2009, and a majority of the site lacks dense canopy closure.

At the beginning of the 2014 field season, a site at ALAM (Edgewater), which lies in the middle of the riparian zone near the current shore of the lake, was assessed. Vegetation within this site was not tall enough in 2014 to be considered suitable flycatcher habitat. This site contained one pair of breeding flycatchers in 2015, and a thorough assessment of the site in future years to assess suitability is recommended.

Several sites that are on the periodic survey schedule were visited along the LCR south of Blythe, California. No major changes in vegetation structure, species composition, or hydrology were noted at many of the sites since they were last visited. Though limited in extent, suitable habitat can still be found at Walker Lake, Ferguson Lake, and Mittry West, and these sites should be maintained on

the periodic survey schedule. Access to a majority of the interior of Ferguson Lake is currently limited and improving trail access in future years is recommended. Vegetation structure in Imperial Nursery has declined in suitability since the site was last visited in 2012. The site should be maintained on the periodic survey schedule to determine if vegetation structure improves in future years.

At several of the sites on the periodic survey schedule, habitat suitability continues to be low or has declined, but the potential exists for suitable habitat to be present adjacent to the site or for habitat suitability to improve within the site. The current extent of Great Blue Heron continues to lack wet soils and suitably dense canopy closure, and surveys should be discontinued within the current extent of the site. Aerial photos suggest there may be habitat with greater suitability immediately west of Great Blue Heron, and this area should be assessed in future years. Surveys were discontinued at Cibola Lake North during the 2015 field season, but an area of coyote and Goodding's willows immediately north of the site was identified that contained some suitable habitat, though very limited in areal extent. This area immediately north of Cibola Lake North should be revisited during the next round of periodic surveys to determine if the willow area has expanded. Ehrenberg continues to lack suitable habitat, though the potential for habitat suitability to improve does exist. Ehrenberg should be reevaluated at the beginning of future seasons to see if hydrology and vegetation structure have improved, and surveys should be discontinued if there has been no improvement. Access into the interior of Imperial NW does not currently exist, and accessing the interior of this site in future years to determine vegetation structure and hydrology within the site is recommended. Knowledge of the interior of Imperial NW will inform the decision of whether surveys should be continued.

At many sites where no changes in vegetation structure, species composition, or hydrology were noted since the sites were last visited, habitat suitability continues to be very low. Surveys should be discontinued at Powerline, Martinez Lake, Gila Confluence North, Gila River 02, and Fortuna Site 01, as all of these sites lack canopy closure dense enough to resemble currently occupied habitat along the LCR and its tributaries, and some sites lack wet soils. Cibola Site 01 lacks dense vegetation > 4 m in height, and surveys should be discontinued. The northern end of Fortuna North was bulldozed midseason, and the remaining vegetation in the majority of the site lacks canopy closure dense enough to be considered suitable. Surveys should be discontinued at Fortuna North.

HABITAT IMPROVEMENT

Tamarisk-dominated habitat at TOPO between the North Dike and Firebreak Canal burned in August 2015 in the Willow Fire, including areas currently and

historically occupied by flycatchers. The fire provides an opportunity to create willow-dominated habitat through restoration activities in areas that have recently had surface water conditions suitable for attracting nesting flycatchers. An examination of water levels within Topock Marsh shows that after 2004, water peaked at lower levels, high water levels were of shorter duration, and over-winter lows were lower than was the case prior to 2004. Current management of marsh levels should be considered when selecting restoration sites so as to ensure that adequate water levels would be present both for supporting native vegetation and for attracting flycatchers.

NEST PREDATORS

Depredation was the leading cause of nest failure in 2015, and depredation rates were highest at KEPI, where depredation accounted for 63% of all failed nests. A majority (83%) of the depredation events at KEPI occurred during the nestling phase; this is a continuation of the trend seen over the last several years, with an increasing proportion of nests that were depredated at KEPI having failed during the nestling stage. Likely predators of nestling flycatchers at KEPI in recent years include a pair of nesting Cooper's hawks, which have nested in the area annually since 2013. Cooper's hawks may also reduce the fledgling survival rate, in addition to depredating nestlings. If productivity at KEPI continues to be low, with depredation during the nestling phase being a primary cause of nest failure, inspection of the Cooper's hawk nest and plucking posts to search for flycatcher remains and leg bands might provide evidence to implicate them as predators of flycatcher nestlings.

COWBIRD CONTROL

In 2010–14, personnel addled cowbird eggs in easily accessible flycatcher nests, which reduced the hatch rate of the cowbird eggs but did not cause desertion of any nests by the flycatchers. It is clear from nest monitoring data collected in 2003–14 that parasitized flycatcher nests in which the cowbird egg(s) never hatched produced, on average, more flycatcher fledglings than nests that had a cowbird nestling. In 2015, however, egg addling was ineffective, with all three cowbird eggs that were shaken and that were subsequently incubated for at least 10 days ultimately hatching. Replacing cowbird eggs with dummy eggs would eliminate the possibility of cowbird eggs hatching and would also reduce disturbance at the nest. Cowbird eggs should be replaced with dummy eggs in the future. This procedure has been used at other study areas with no detrimental effects to flycatchers (M. Whitfield 2012, personal communication).

HABITAT THREATS AND MONITORING

The calibration data identified the variables with the largest observer variation as the two estimates of percent tamarisk in the vicinity of a location and the percentage of leafless stems. Potential causes for the large variation included difficulty in visually estimating horizontal distance to the boundary of the sample "cylinder" for percent tamarisk and difficulty in estimating the percentage of leafless stems as the percentage increases. Because estimates of percent tamarisk are also collected at nest locations, all observers should be calibrated for this variable at the beginning of the season regardless of whether they will collect beetle data. A pole of known length, such as a mirror pole, should also be used to aid in determining the location of the 2- and 5-m sample boundaries. For beetle monitoring data, the initial calibration should be conducted with the entire crew at the beginning of the season and then the most consistent observer should be selected to be the sole observer collecting data for the rest of the season.

In TOPO, all of the beetle monitoring points were burned in the Willow fire in August 2015. The monitoring points had been located within recently occupied habitat to help describe the potential effects of defoliation on vegetation and microclimate at flycatcher nests. Of the unburned, occupied habitat at TOPO, the largest sites are on the island in Hell Bird and Glory Hole, which primarily consist of mixed Goodding's willows and tamarisk, and in Swine Paradise, where flycatchers have nested in the tamarisk, near emergent Goodding's willows and adjacent to a swath of coyote willows on the edge of the marsh. New monitoring points could be installed within these sites to evaluate the effects of defoliation on occupied flycatcher habitat. It is not clear when tamarisk beetles will arrive at TOPO. Over the last 2 years, beetles on the main stem of the LCR have advanced approximately 10 km, and as of August 2015, beetles were still 25 km from the nearest unburned flycatcher habitat at TOPO. If this slow pace of advance continues, beetles will not arrive at TOPO for another few years, and monitoring could be postponed until the arrival of beetles is imminent. At minimum, photo points at The Wallows and in 800M should be continued to document the regeneration of vegetation within the burned area. These two photo point locations could also serve as locations for checking for the arrival of tamarisk beetles to the study area.

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collection of microclimate data at these monitoring points will not help to describe the effects of defoliation on recently occupied habitat, and data collection at these points is not intended to be continued.

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ATTACHMENTS

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

2 Field Data Forms

3 Orthophotos Showing Study Sites

4 Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Dates for Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2015

5 Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Results for Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2015

6 Detections of Special Concern Species Within Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2015

7 Orthophotos Showing Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) Survey Sites

8 All Willow Flycatchers (*Empidonax traillii*) Color Banded and/or Resighted, 2010–2015

9 Temperature and Humidity at Southwestern Willow Flycatcher Nests (*Empidonax traillii extimus*) at Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2015

10 Temperature and Humidity at Beetle Points at Muddy River, Topock Marsh, and Bill Williams, 2015

11 Model Results for HOBO-iButton Comparison

12 Contributing Personnel

ATTACHMENT 1

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

Table 1-1.—Study area and survey site organization within LCR MSCP areas and sites, 2015*

Study area	LCR MSCP area	LCR MSCP site	LCR MSCP section(s) (former survey site name)
Key Pittman	Alamo	Key Pittman Wildlife Management Area	Nesbitt Forest
			Patch 00
			Patch 01
			Patch 02
			Patch 03
			Patch 04
			Patch 04.5
			Patch 05
			Patch 06
			Patch 07
			Patch 08
			Patch 09
			Patch 10
			Patch 10.5
			Patch 11
			Patch 12
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
Meadow Valley Wash	Meadow Valley Wash	Meadow Valley Wash North	Etna
		Meadow Valley Wash Middle	Dog Leg
			Ford
			Kyle
			Cottonwood Canyon
Muddy River	Muddy River	Overton Above High-Water Mark	Overton WMA Pond
		Overton Wildlife	Overton WMA
Warm Springs	Muddy River	Warm Springs	Muddy Mac
			Muddy Stringer 01

Table 1-1.—Study area and survey site organization within LCR MSCP areas and sites, 2015*

Study area	LCR MSCP area	LCR MSCP site	LCR MSCP section(s) (former survey site name)
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
			Hellbird
			Glory Hole
			Farm Ditch Road (formerly Spaghetti)
	Beal Lake Conservation Area	CPhase 05	CPhase 05 (Beal Lake)
	Topock	Topock Bay	Lost Lake
Topock Gorge	Topock Gorge South	Blankenship Valley	Blankenship North (Blankenship Bend North)
			Blankenship South (Blankenship Bend South)
Bill Williams	Bill Williams River West	North of Main Delta	Bill Willow
		North Burn	Wispy Willow
			Site 01
			Burn Edge
		Mosquito Flats	Site 04
			Site 03
		Cross River	Last Gasp
			Guinness
		Sandy Wash	Site 05
			Black Rail
	Bill Williams River East	Esquerra Ranch	Beaver Pond North (Mineral Wash)
			Beaver Pond
		Honeycomb Bend	Site 08
		Cave Wash	Upstream from Site 08

Table 1-1.—Study area and survey site organization within LCR MSCP areas and sites, 2015*

Study area	LCR MSCP area	LCR MSCP site	LCR MSCP section(s) (former survey site name)
Alamo Lake	Alamo Lake	Browns 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
			Santa Maria South 01
			Santa Maria North 01
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	Santa Fe	Ehrenberg

Table 1-1.—Study area and survey site organization within LCR MSCP areas and sites, 2015*

Study area	LCR MSCP area	LCR MSCP site	LCR MSCP section(s) (former survey site name)
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 01
			Cibola Lake North (Cibola Lake #1)
	Imperial North	Draper Ranch	Walker Lake
Imperial	Imperial South	Fishers Landing	Imperial NW (Nursery NW)
			Imperial Nursery
			Ferguson Lake
			Great Blue Heron
			Powerline
			Martinez Lake
Mittry Lake	Laguna	Laguna West	Mittry West
Yuma	Yuma East Wetlands[1]	J	C4703
		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

* 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

Field Data Forms

Willow Flycatcher (WIFL) Survey and Detection Form (revised April 2010)

Site Name State County
USGS Quad Name _____ Elevation _____ (meters)
Creek, River, Wetland, or Lake Name _____

Is copy of USGS map marked with survey area and WIFL sightings attached (as required)? Yes___ No___

Survey Coordinates: Start: E_____ N_____ UTM Datum_____(See instructions)
Stop: E_____ N_____ UTM Zone _____

If survey coordinates changed between visits, enter coordinates for each survey in comments section on back of this page.

***** Fill in additional site information on back of this page *****

Survey # / Observer(s) (Full Name)	Date (m d y) / Survey time	Number of Adult WIFLs	Estimated Number of Pairs	Estimated Number of Territories	Nest(s) Found? Y or N / If Yes, number of nests	Comments (e.g., bird behavior; evidence of pairs or breeding; potential threats [livestock, cowbirds, *Diorhabda* spp.]). If *Diorhabda* found, contact USFWS and State WIFL coordinator	GPS Coordinates for WIFL Detections (this is an optional column for documenting individuals, pairs, or groups of birds found on each survey). Include additional sheets if necessary			
Survey # 1 Observer(s)	Date						# Birds	Sex	UTM E	UTM N
	Start									
	Stop									
	Total hrs									
Survey # 2 Observer(s)	Date						# Birds	Sex	UTM E	UTM N
	Start									
	Stop									
	Total hrs									
Survey # 3 Observer(s)	Date						# Birds	Sex	UTM E	UTM N
	Start									
	Stop									
	Total hrs									
Survey # 4 Observer(s)	Date						# Birds	Sex	UTM E	UTM N
	Start									
	Stop									
	Total hrs									
Survey # 5 Observer(s)	Date						# Birds	Sex	UTM E	UTM N
	Start									
	Stop									
	Total hrs ___									
Overall Site Summary Totals do not equal the sum of each column. Include only resident adults. Do not include migrants, nestlings, and fledglings. Be careful not to double count individuals. Total Survey Hrs		Total Adult Residents	Total Pairs	Total Territories	Total Nests	Were any Willow Flycatchers color-banded? Yes___ No ___ If yes, report color combination(s) in the comments section on back of form and report to USFWS				

Reporting Individual _____ Date Report Completed_____ _____
US Fish and Wildlife Service Permit #_____State Wildlife Agency Permit #_____

<u>Submit</u> form to USFWS and State Wildlife Agency by September 1st. Retain a copy for your records.

Fill in the following information completely. Submit form by September 1st. Retain a copy for your records.

Reporting Individual _____ Phone # _____
Affiliation _____ E-mail _____
Site Name _____ Date Report Completed _____
Was this site surveyed in a previous year? Yes___ No ___ Unknown ____
Did you verify that this site name is consistent with that used in previous years? Yes No Not Applicable
If site name is different, what name(s) was used in the past? _____
If site was surveyed last year, did you survey the same general area this year? Yes ____ No ____ If no, summarize below.
Did you survey the same general area during each visit to this site this year? Yes ____ No ____ If no, summarize below.

Management Authority for Survey Area: Federal____ Municipal/County ____ State ____ Tribal ____ Private ____
Name of Management Entity or Owner (e.g., Tonto National Forest) _____

Length of area surveyed: (km)

Vegetation Characteristics: Check (only one) category that best describes the predominant tree/shrub foliar layer at this site:

_____ Native broadleaf plants (entirely or almost entirely, > 90% native)

Mixed native and exotic plants (mostly native, 50 - 90% native)

_____ Mixed native and exotic plants (mostly exotic, 50 - 90% exotic)

Exotic/introduced plants (entirely or almost entirely, > 90% exotic)

Identify the 2-3 predominant tree/shrub species in order of dominance. Use scientific names

_____

Average height of canopy (Do not include a range): _____ (meters)

Attach the following: 1) copy of USGS quad/topographical map (REQUIRED) of survey area, outlining survey site and location of WIFL detections; 2) sketch or aerial photo showing site location, patch shape, survey route, location of any detected WIFLs or their nests; 3) photos of the interior of the patch, exterior of the patch, and overall site. Describe any unique habitat features in Comments.

Comments (such as start and end coordinates of survey area if changed among surveys, supplemental visits to sites, unique habitat features. Attach additional sheets if necessary.

_____
_____
_____
_____

Territory Summary Table. Provide the following information for each verified territory at your site.

Territory Number	All Dates Detected	UTM E	UTM N	Pair Confirmed? Y or N	Nest Found? Y or N	Description of How You Confirmed Territory and Breeding Status (e.g., vocalization type, pair interactions, nesting attempts, behavior)

Attach additional sheets if necessary

SWFL General Site Description

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

Study Area: _____ **Survey Site:** _____ **Date:** _____

Observer(s): _____ **early**_____ **mid**_____ **late** _____ **other**_____

MSCP Area: _____ **MSCP Site:** _____

VEGETATION		
Vegetation Type 1	**Vegetation Type 2**	**Vegetation Type 3**
Dominant overstory sp: _____	**Dominant overstory sp:** _____	**Dominant overstory sp:** _____
Overstory ht (m): _____	**Overstory ht (m):** _____	**Overstory ht (m):** _____
Dominant understory sp: _____	**Dominant understory sp:** _____	**Dominant understory sp:** _____
Understory height (m): _____	**Understory height (m):** _____	**Understory height (m):** _____
% canopy closure: _____	**% canopy closure:** _____	**% canopy closure:** _____
Percentage of site: _____	**Percentage of site:** _____	**Percentage of site:** _____
Patch l x w (if applicable): _____	**Patch l x w** (if applicable): _____	**Patch l x w** (if applicable): _____
Inundated? Yes No	**Inundated?** Yes No	**Inundated?** Yes No

Overall vegetation at site: >90% native 50–90% native 50–90% exotic >90% exotic

Other vegetation types present (e.g., cattail)? Yes No

If yes, type of vegetation: _____ **percentage of site:**_____

type of vegetation: _____ **percentage of site:**_____

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

If INUNDATED:

Describe type of surface water (e.g., open marsh, surface water within woody vegetation, stream, etc):

_____

Average depth of surface water (cm):_____

If NO Inundated or Saturated Soils are present:

Distance (m) to Standing Water or Saturated Soil from EDGE of site: _____

How was distance determined? _____

Describe type of nearest surface water: _____

NARRATIVE and PICTORIAL DESCRIPTION

Does this description cover the entire site? Y N **If not, which portion is described?** _____

_____

On the reverse, sketch and label the locations of the major vegetation types you observed. Delineate marshes, open areas, and other habitat that may be unsuitable for flycatchers. If water was present, show its location.

Give a narrative description of the site, including adjacent habitats:

_____

_____

_____

_____

_____

_____

_____

_____

_____

Additional comments:_____

_____

_____

How suitable is the habitat for flycatchers?:

STUDY AREA: _____ UTM NAD 83 Zone 11 _____ E _____ N TERR/NEST #: _____

BANDER: _____ DATE: _____ CAPTURE TIME: _____ RELEASE TIME: _____ NBN: ____ of ____

NOTES: _____

FEDERAL BAND #	COLOR COMBO		STATUS	SEX	AGE	FECAL SAMPLE? (Y or N)	GENETIC SAMPLE? (Y or N)	# PHOTOS TAKEN
	L	R						

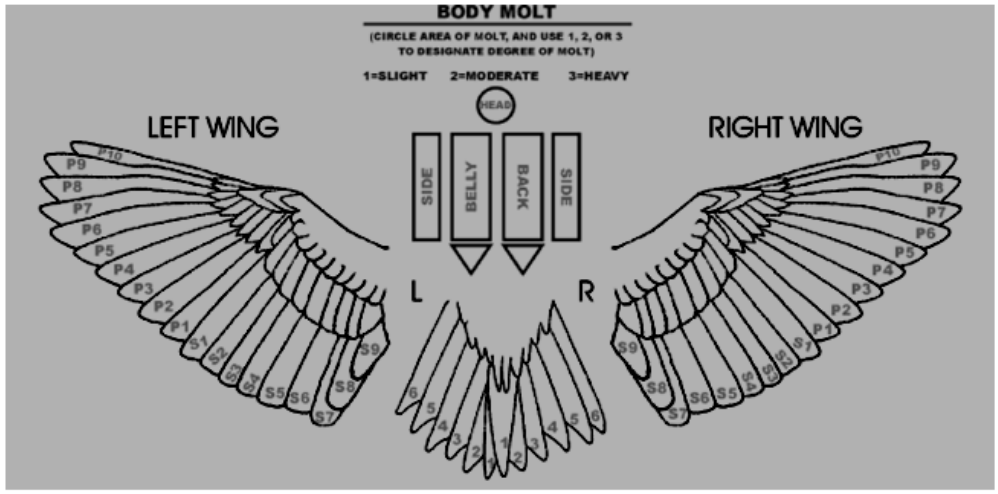
STATUS: NCP = new cap passive, NCT = new cap target, RCP = recap passive, RCT = recap target, NBN = nestling banded
SEX: U = unknown, F = female, M = male
AGE: AHY = after hatch year; SY = second year; L = nestling banded in nest; HY = hatch year/young of the year

Adults								
CP	BP	WING CHORD (mm)	TAIL (mm)	CULMEN LENGTH (mm)	CULMEN WIDTH (mm)	FAT	RETAINED FEATHERS?	ACTIVE MOLT?
							Y or N, if Y use diagram, detail in notes	

Nestlings	
Developmental Age (days)	MASS (g)

CP: 0 = non-breeding, S = partial breeding, M = full breeding
BP: 0 = none, 1 = smooth, 2 = vascularized and filled with fluid, 3 = wrinkled, 4 = molting
FAT: 0 = no fat; 1 = trace of fat in furculum, deeply concave, scattered patches, less than 5 percent filled; 2 = thin layer of fat in furculum, less than a third filled, trace of thin layer of fat in abdomen; 3 = furculum is ½ filled or more; small patches, not covering some areas, on abdomen; 4 = furculum more than 2/3 filled, level with clavicles, slightly mounded on abdomen

If a genetic sample or metric was not taken, explain why in notes



Willow Flycatcher Territory/Nest Record Form

Year: Year Study Area: Study Area Survey Site: Survey Site Territory/Nest #: Num
MSCP Area: Do Not Use MSCP Site: Do Not Use

Territory/Nest Location:
NAD 83 Zone 11:
Original Territory UTMs:
Easting: Easting
Northing: Northing
GPS Accuracy: Acc m
Territory UTMs (if moved):
Easting: Easting
Northing: Northing
GPS Accuracy: Acc m
Nest Flag UTMs (optional):
Easting: Easting
Northing: Northing
GPS Accuracy: Acc m
Nest UTMs:
Easting: Easting
Northing: Northing
GPS Accuracy: Acc m

Nest Height: Estimated: Ht m Measured: Ht m
Nest Substrate: Subst. (e.g., TAMSPP, SALGOO, SALEXI)

Distance from nest to standing water or saturated soil:
When found: Date: Date Observer: Obs
At hatch: Date: Date Observer: Obs
At fledge/fail: Date: Date Observer: Obs

% Veg Volume = TAMSPP: Date: Date Observer: Obs

Vegetation type at nest: Date: Date Observer: Obs

Nest tree double-flagged: Date: Date Observer: Obs

General comments: Comments

Confirmed color combos: Female: female combo
Male: male combo

FEMALE Color band combination: Band combo **Band Number:** Band number
MALE Color band combination: Band combo **Band Number:** Band number

JUVENILES					
Color combo: Band combo	**Band #:** Band number	**Fledged?** Y/N/U	**Color combo:** Band combo	**Band #:** Band number	**Fledged?** Y/N/U
Color combo: Band combo	**Band #:** Band number	**Fledged?** Y/N/U	**Color combo:** Band combo	**Band #:** Band number	**Fledged?** Y/N/U

Willow Flycatcher

Trans dates	Date known?	
		Found/Phase
		First egg
		Clutch completion
		Hatching
		Fledged or Failed

Willow Flycatcher

No.	Presumed	Confirmed	
			Eggs
			Nestlings
			Fledglings

Cowbird

Trans dates	
	First egg
	Hatched
	Fledged

Cowbird

No.	
	Eggs
	Nestlings
	Fledgling

Outcome: Choose an item: Description

Outcome codes:
UN= unknown; **FV**= at least one fledge visually confirmed; **PE**= probable predation, nest empty and intact; **PD**= probable predation, damage to nest structure; **AB**=nest abandoned prior to egg(s) being laid; **DE**=deserted with egg(s) or young; **PA**= parasitized, cowbird eggs or young outlived host's; **AD**= addled, no eggs hatched after >20 d inc; **OT**= failure due to other, or unknown, causes.
Mayfield success codes: **S**=successful; **D**= depredated; **U**=fate unknown; **M**= mortality other than predation; **A**=deserted with host egg(s) or young; **Z**=abandoned, no host eggs laid.

Mayfield Success		
(WIFL) Period	# Exposure days	Success
Egg Laying		
Incubation		
Nestling		

Mon Type: M=mirror, O=obs. with binocs. **Stage**: S=single bird, P = pair, B=building, L=laying, I=incubating, N=nestling, F=fledgling. **Field Tasks**: RSM=resight male, RSF=resight female, RSB=resight both, OB=observe in territory, CP=confirm pair, LN=locate nest, LRN=locate renest, PN=pole nest, CA=confirm activity or stage, VN# =verify nestling number, VF# =verify fledgling #, BN=band nestlings, AE=addle cowbird egg, GPS=GPS nest, DW=measure distance to water, PT=% TAMSPP, VT=Veg type at nest

Date	Time		Obs	Mon Type	Stage	# Ad	# WE	# CE	# WN	# CN	# WF	Age Yng	Field Tasks
	In	Out											

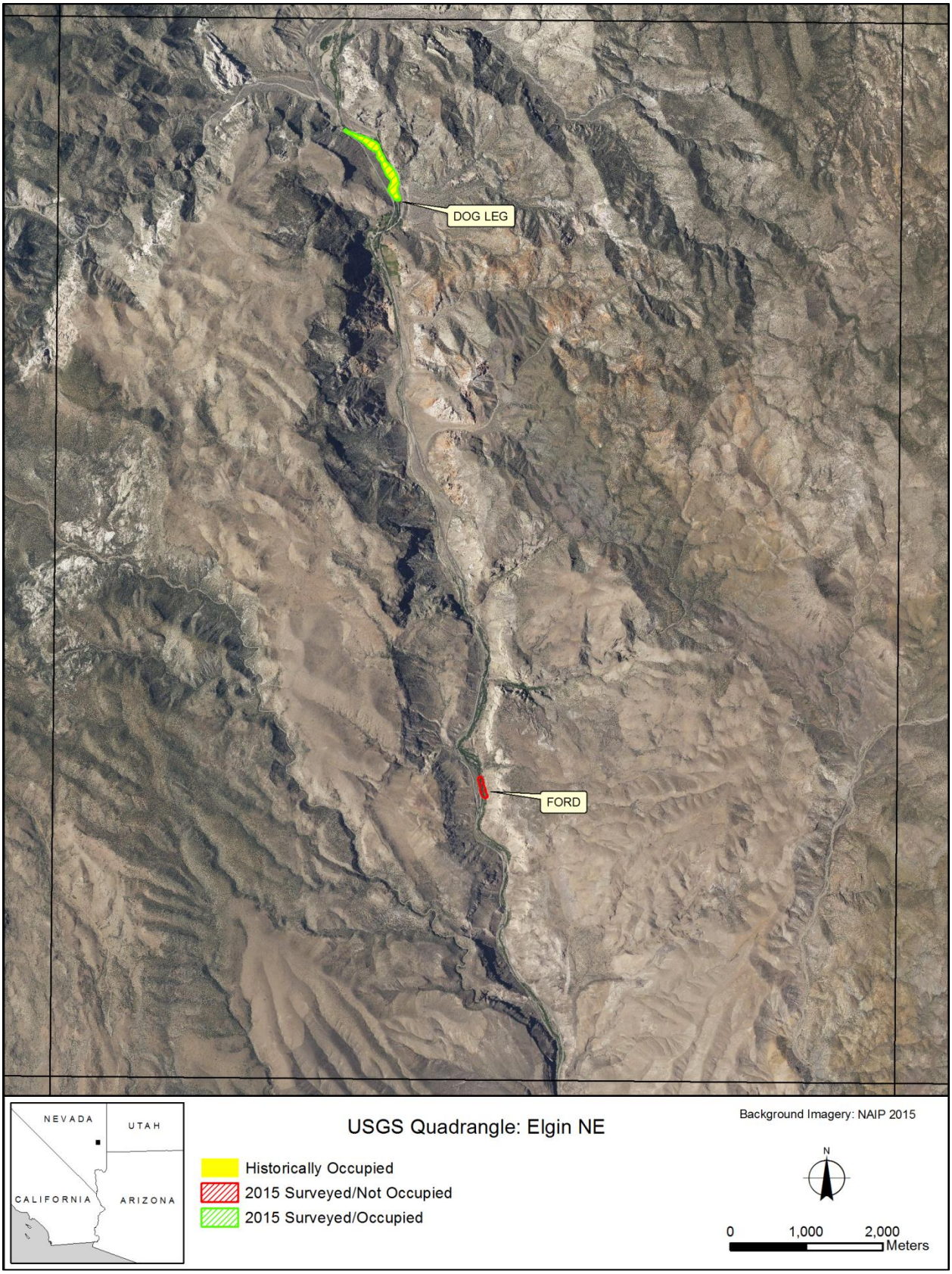
ATTACHMENT 3

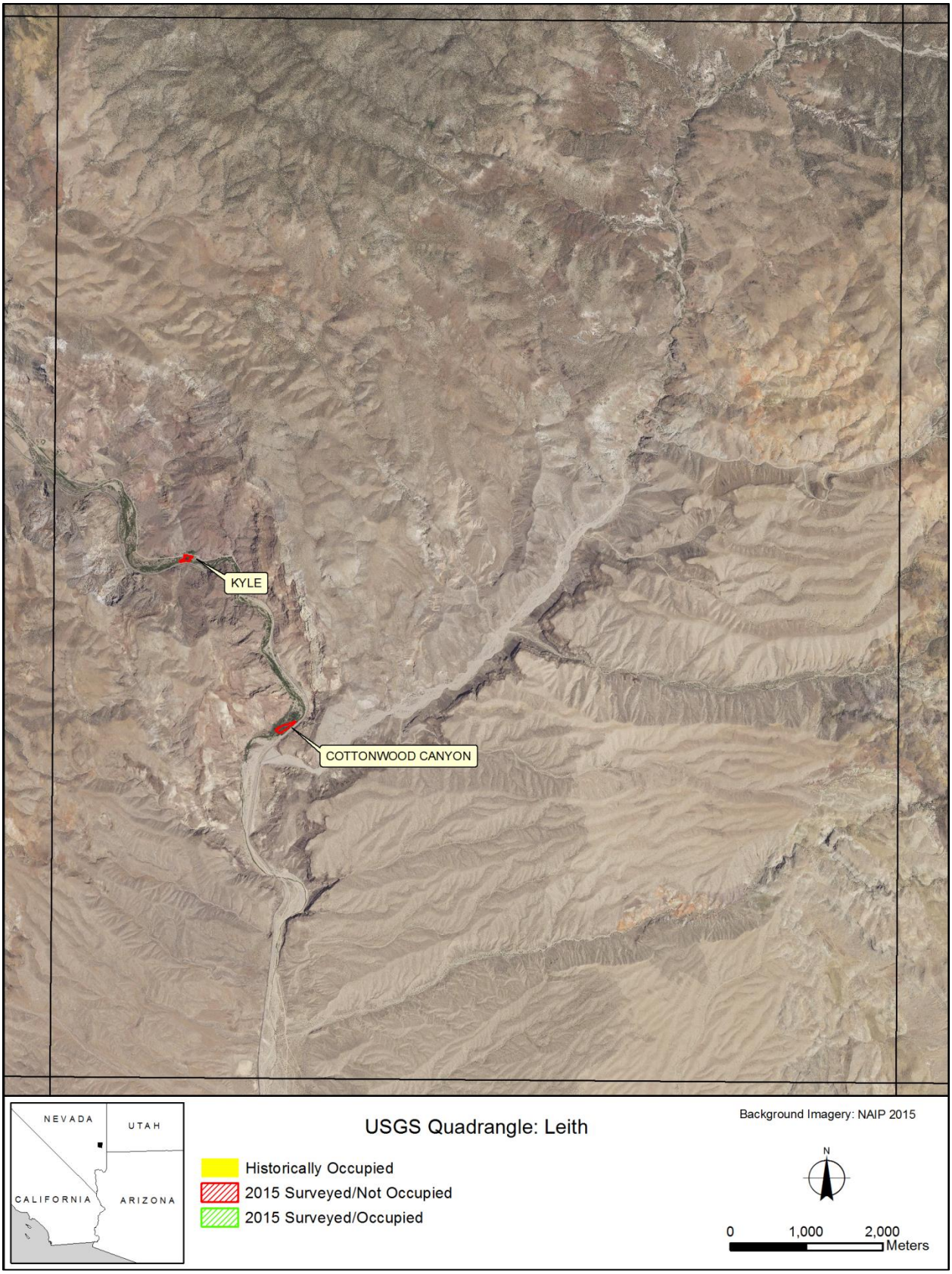
Orthophotos Showing Study Sites

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 flycatchers are detected, or if a flycatcher is detected between June 24 and July 20, regardless of residency status. A site is considered historically occupied if this criterion was met in any year 2003–14.

KEY PITTMAN PATCH 00 - 12 & NESBITT FOREST
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Hiko
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters

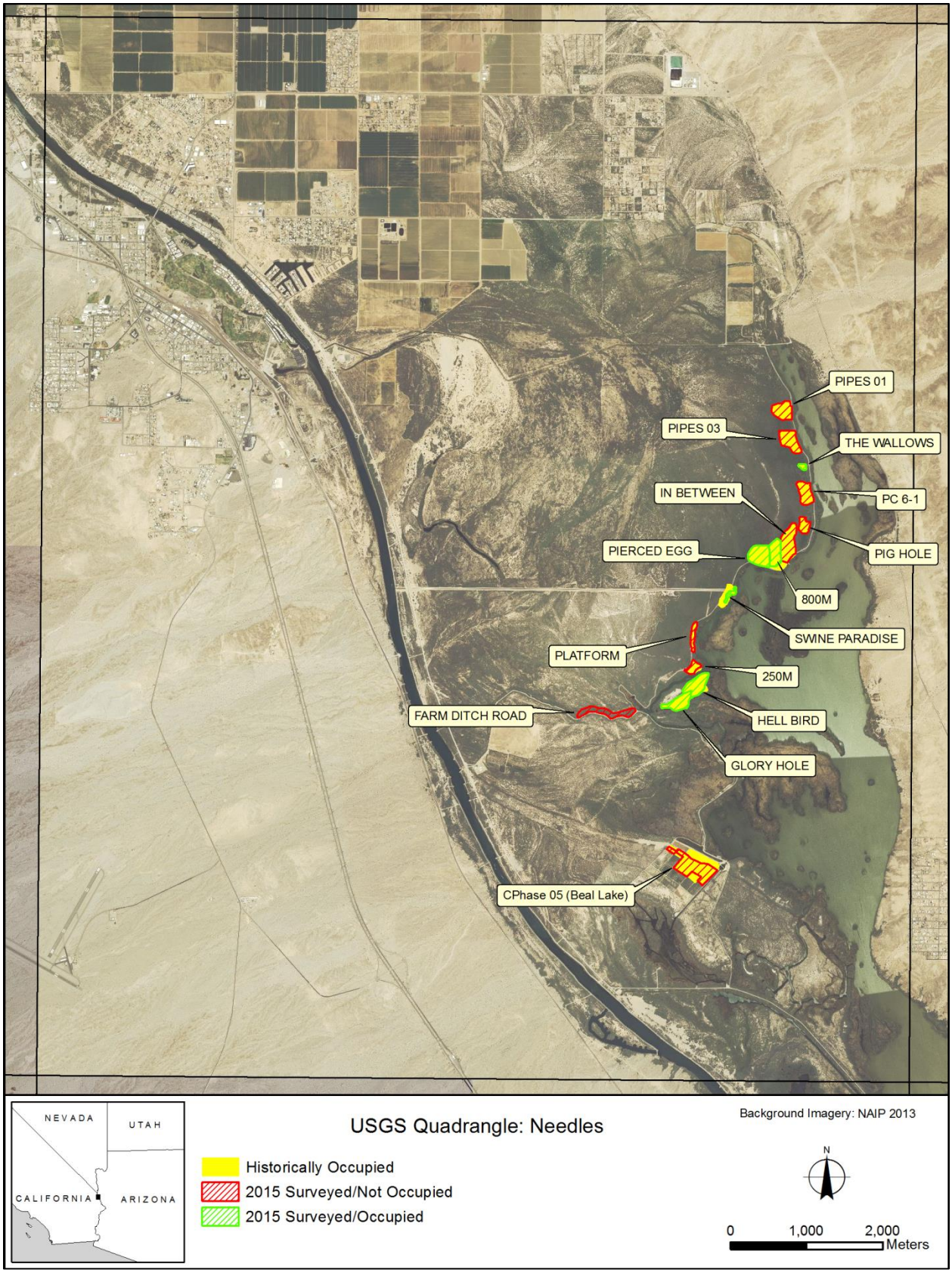
ETNA
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Caliente
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters


DOG LEG
FORD
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Elgin NE
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters

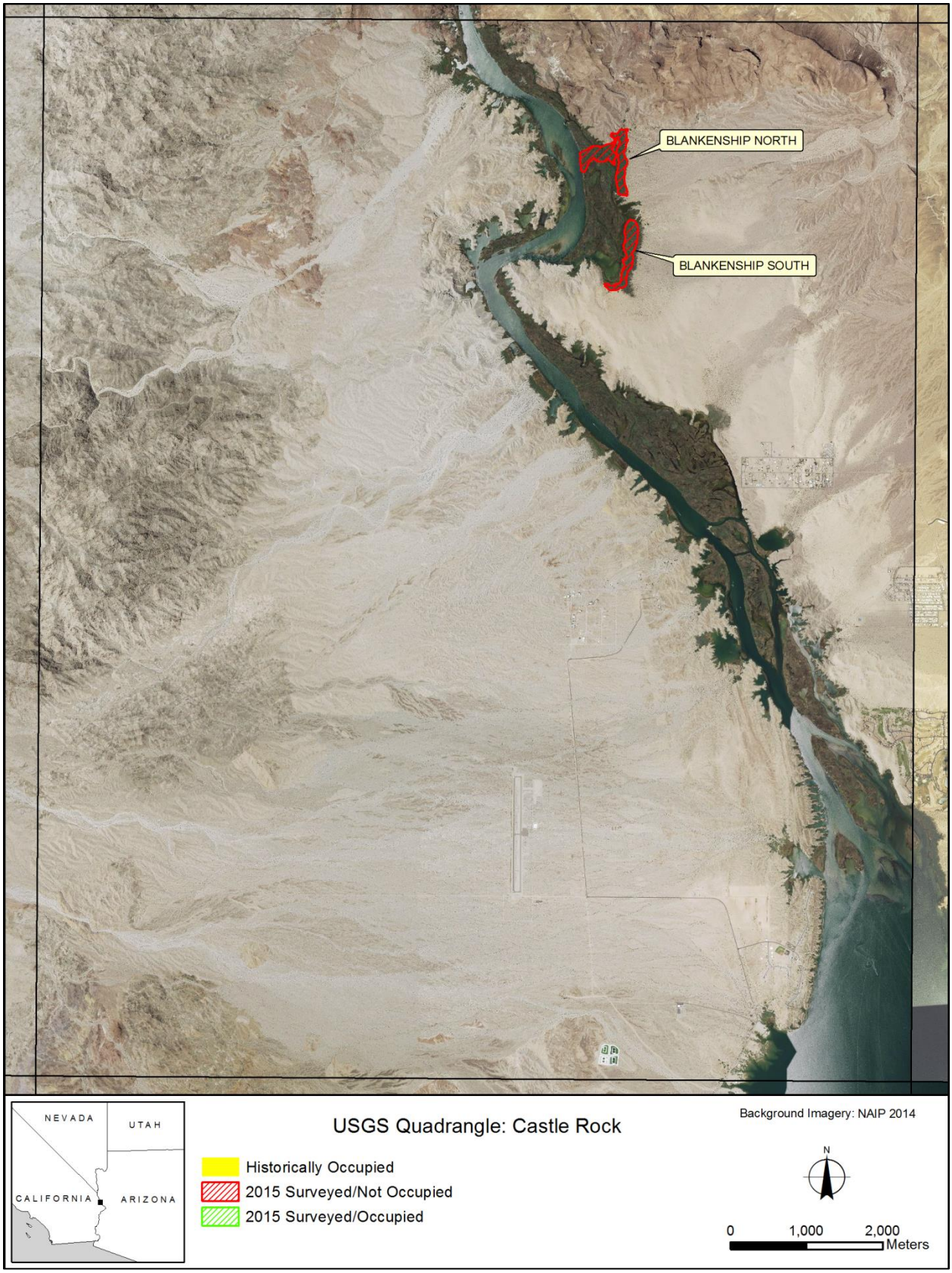

KYLE
COTTONWOOD CANYON
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Leith
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters

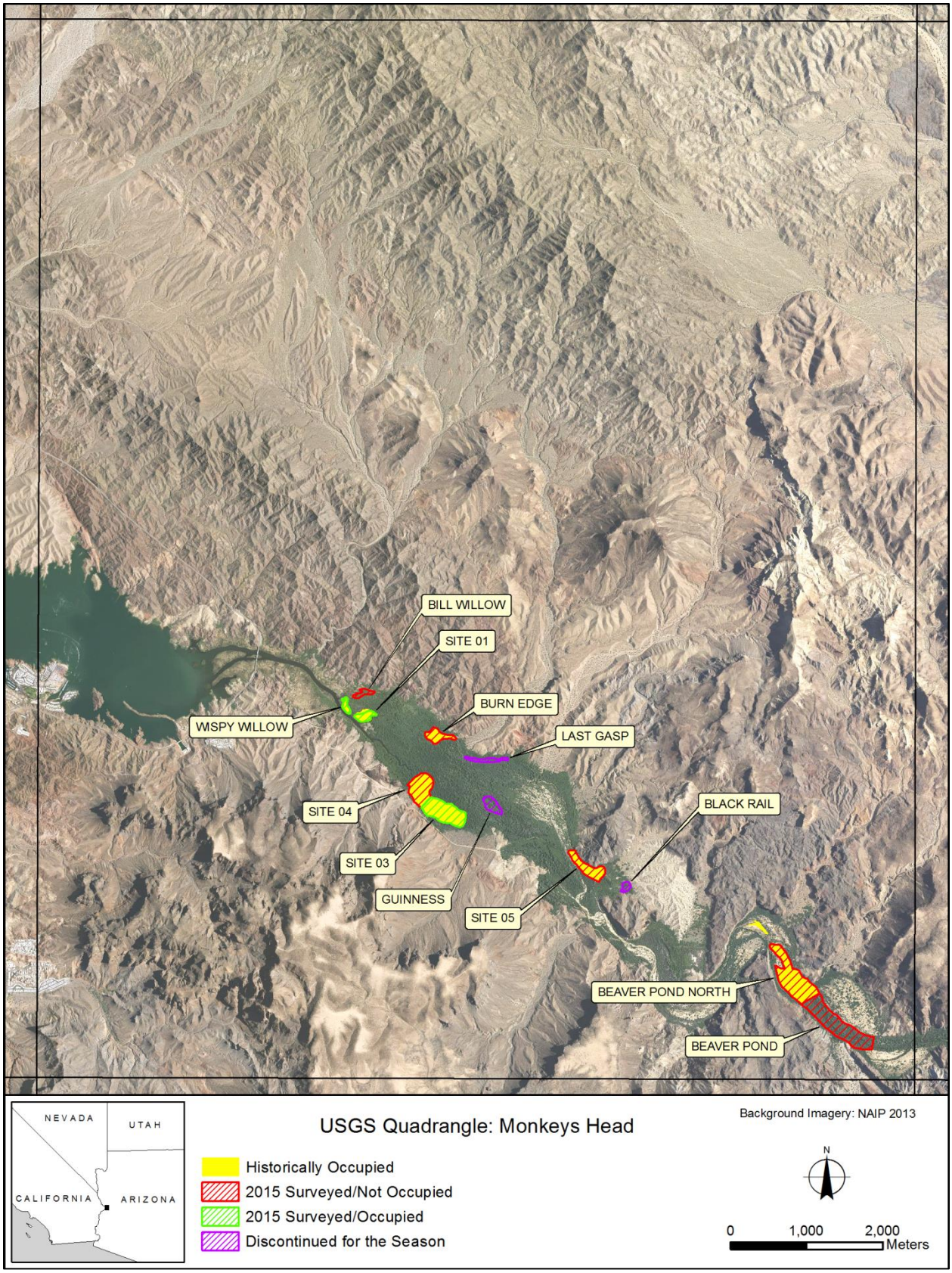
OVERTON WMA POND
OVERTON WMA
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters

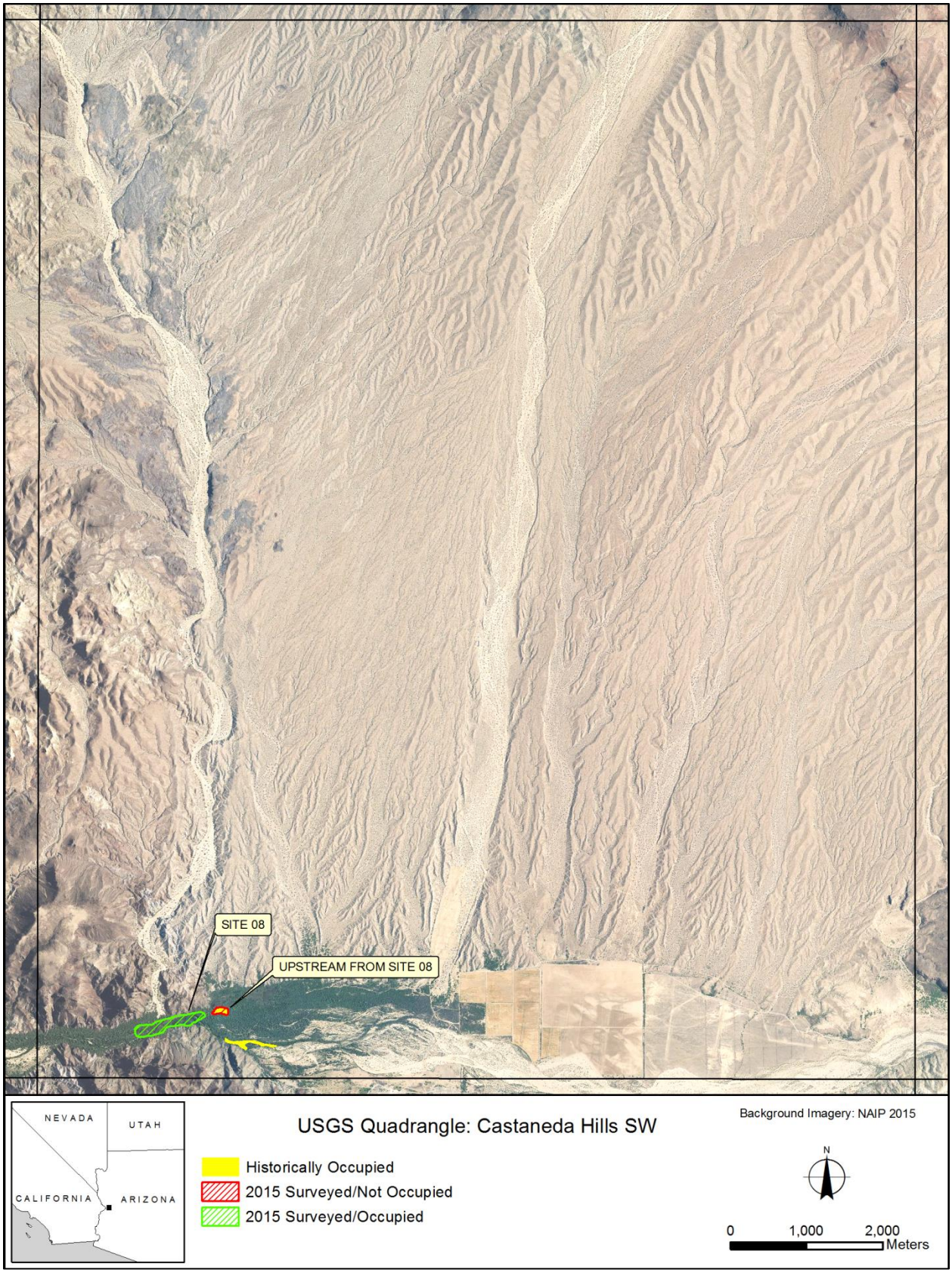
MUDDY STRINGER 01
MUDDY MAC
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Moapa West
Background Imagery: NAIP 2015
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
N
0
1,000
2,000
Meters

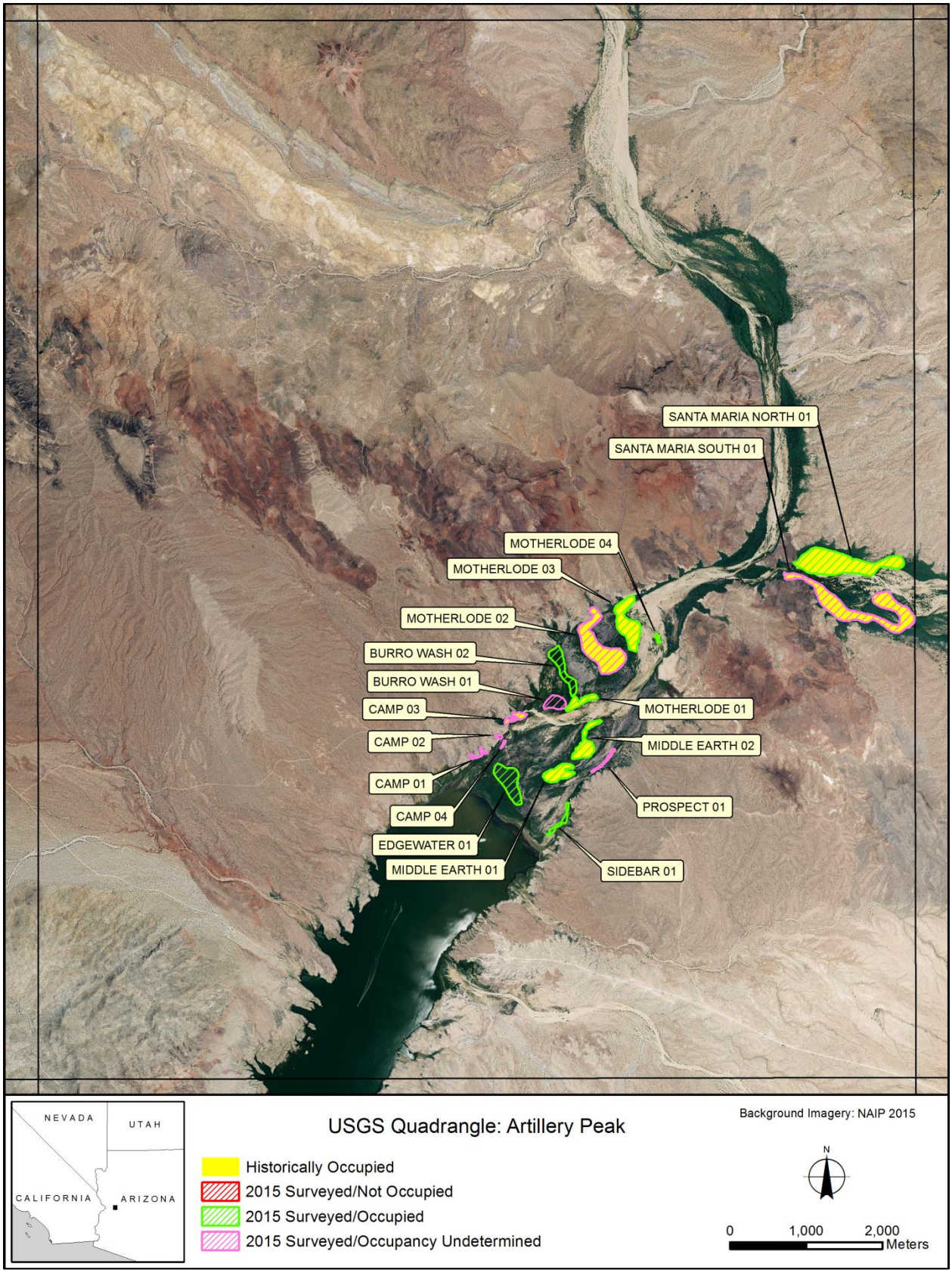

PIPES 01
PIPES 03
THE WALLOWS
IN BETWEEN
PC 6-1
PIERCED EGG
PIG HOLE
800M
SWINE PARADISE
PLATFORM
250M
FARM DITCH ROAD
HELL BIRD
GLORY HOLE
CPhase 05 (Beal Lake)
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Needles
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2013
N
0
1,000
2,000
Meters

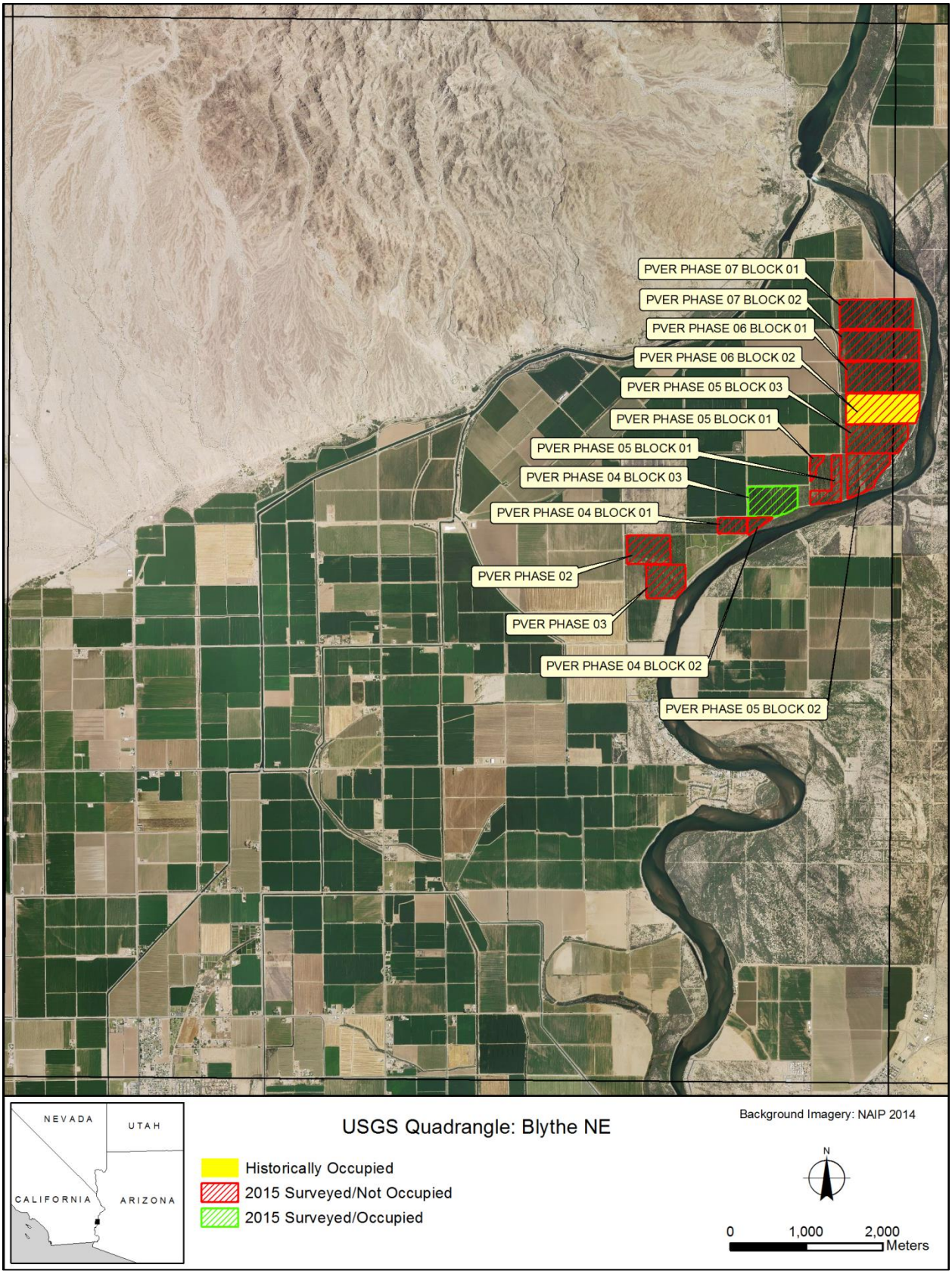
LOST LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Whale Mountain
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2014
N
0
1,000
2,000
Meters

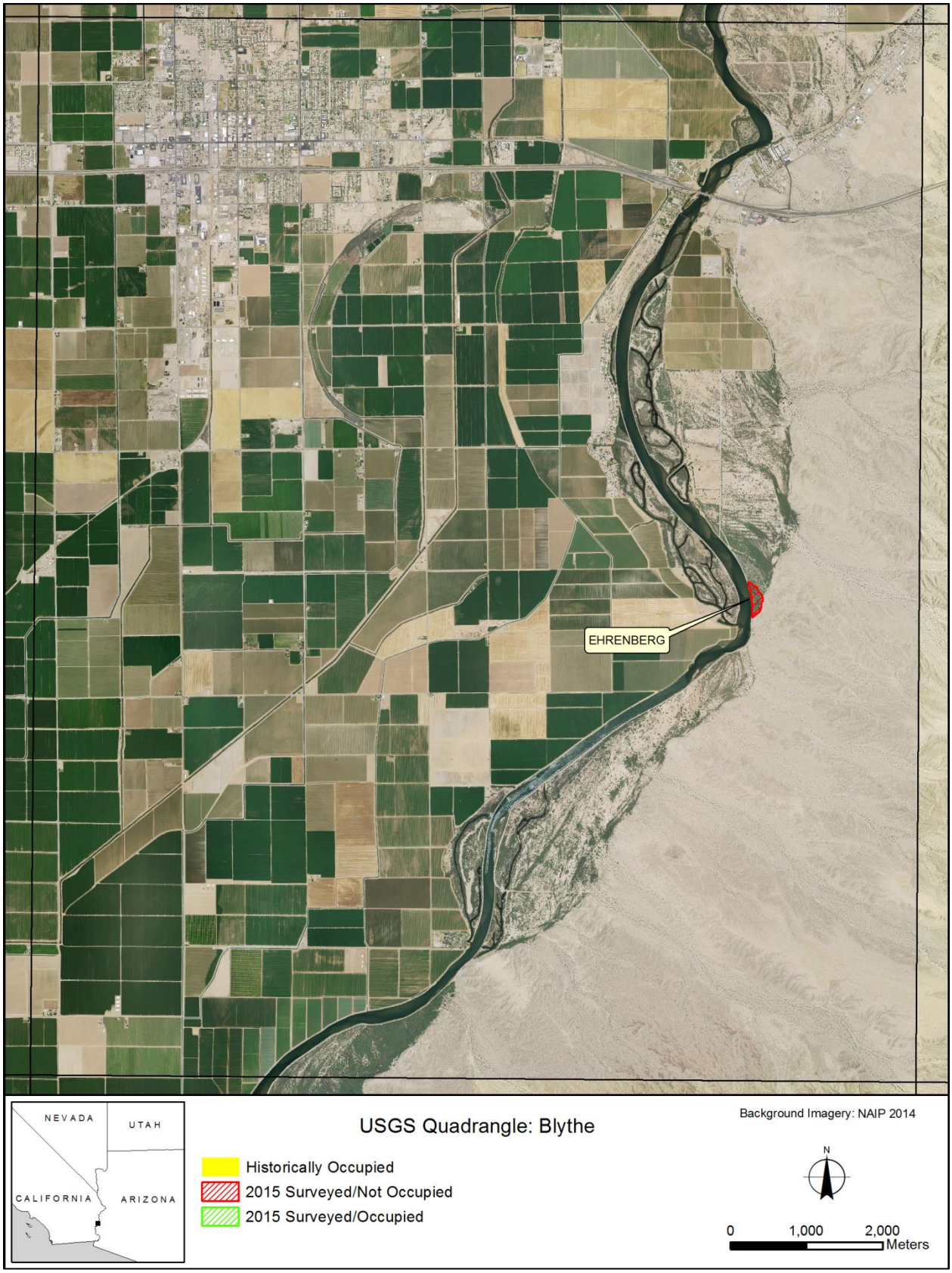

BLANKENSHIP NORTH
BLANKENSHIP SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castle Rock
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2014
N
0
1,000
2,000
Meters

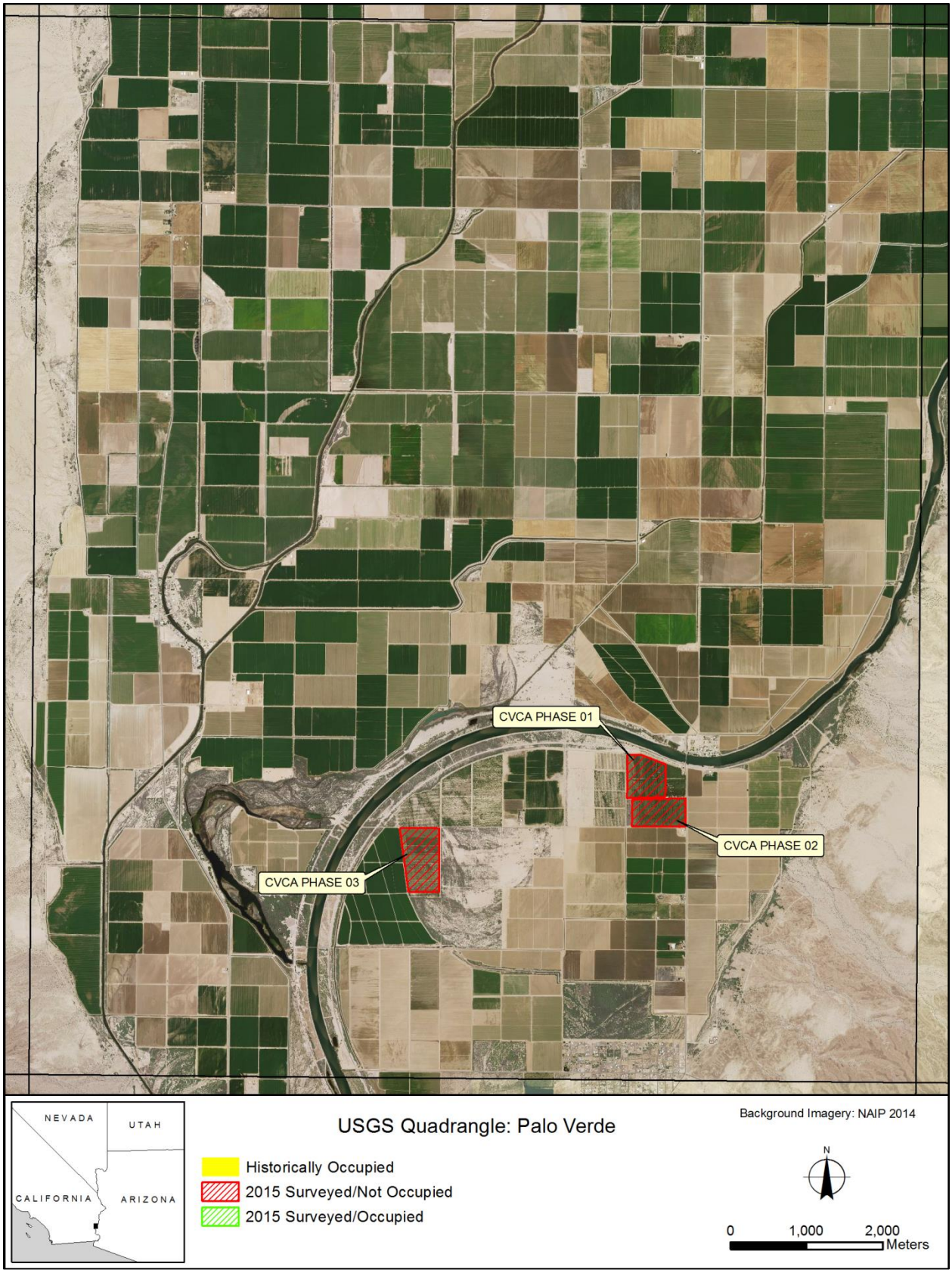

BILL WILLOW
SITE 01
BURN EDGE
WISPY WILLOW
LAST GASP
SITE 04
BLACK RAIL
SITE 03
GUINNESS
SITE 05
BEAVER POND NORTH
BEAVER POND
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Monkeys Head
Background Imagery: NAIP 2013
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Discontinued for the Season
N
0
1,000
2,000
Meters


SITE 08
UPSTREAM FROM SITE 08
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castaneda Hills SW
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2015
N
0
1,000
2,000
Meters


SANTA MARIA NORTH 01
SANTA MARIA SOUTH 01
MOTHERLODE 04
MOTHERLODE 03
MOTHERLODE 02
BURRO WASH 02
BURRO WASH 01
CAMP 03
CAMP 02
CAMP 01
CAMP 04
EDGEWATER 01
MIDDLE EARTH 01
MOTHERLODE 01
MIDDLE EARTH 02
PROSPECT 01
SIDEBAR 01
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Artillery Peak
Background Imagery: NAIP 2015
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
2015 Surveyed/Occupancy Undetermined
N
0
1,000
2,000
Meters


PVER PHASE 07 BLOCK 01
PVER PHASE 07 BLOCK 02
PVER PHASE 06 BLOCK 01
PVER PHASE 06 BLOCK 02
PVER PHASE 05 BLOCK 03
PVER PHASE 05 BLOCK 01
PVER PHASE 05 BLOCK 01
PVER PHASE 04 BLOCK 03
PVER PHASE 04 BLOCK 01
PVER PHASE 02
PVER PHASE 03
PVER PHASE 04 BLOCK 02
PVER PHASE 05 BLOCK 02
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Blythe NE
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2014
N
0
1,000
2,000
Meters


EHRENBERG
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Blythe
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2014
N
0
1,000
2,000
Meters

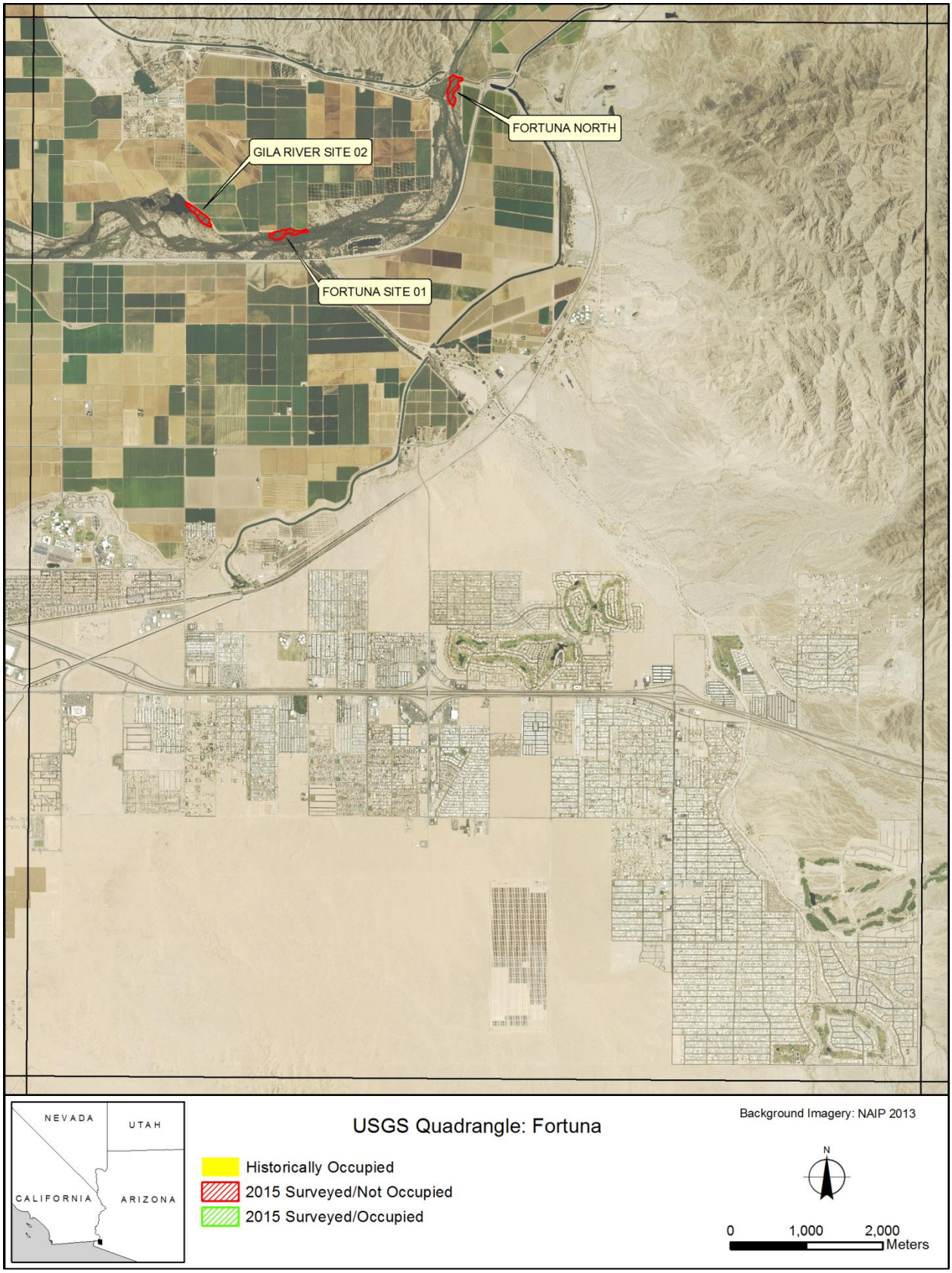

CVCA PHASE 01
CVCA PHASE 02
CVCA PHASE 03
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Palo Verde
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2014
N
0
1,000
2,000
Meters

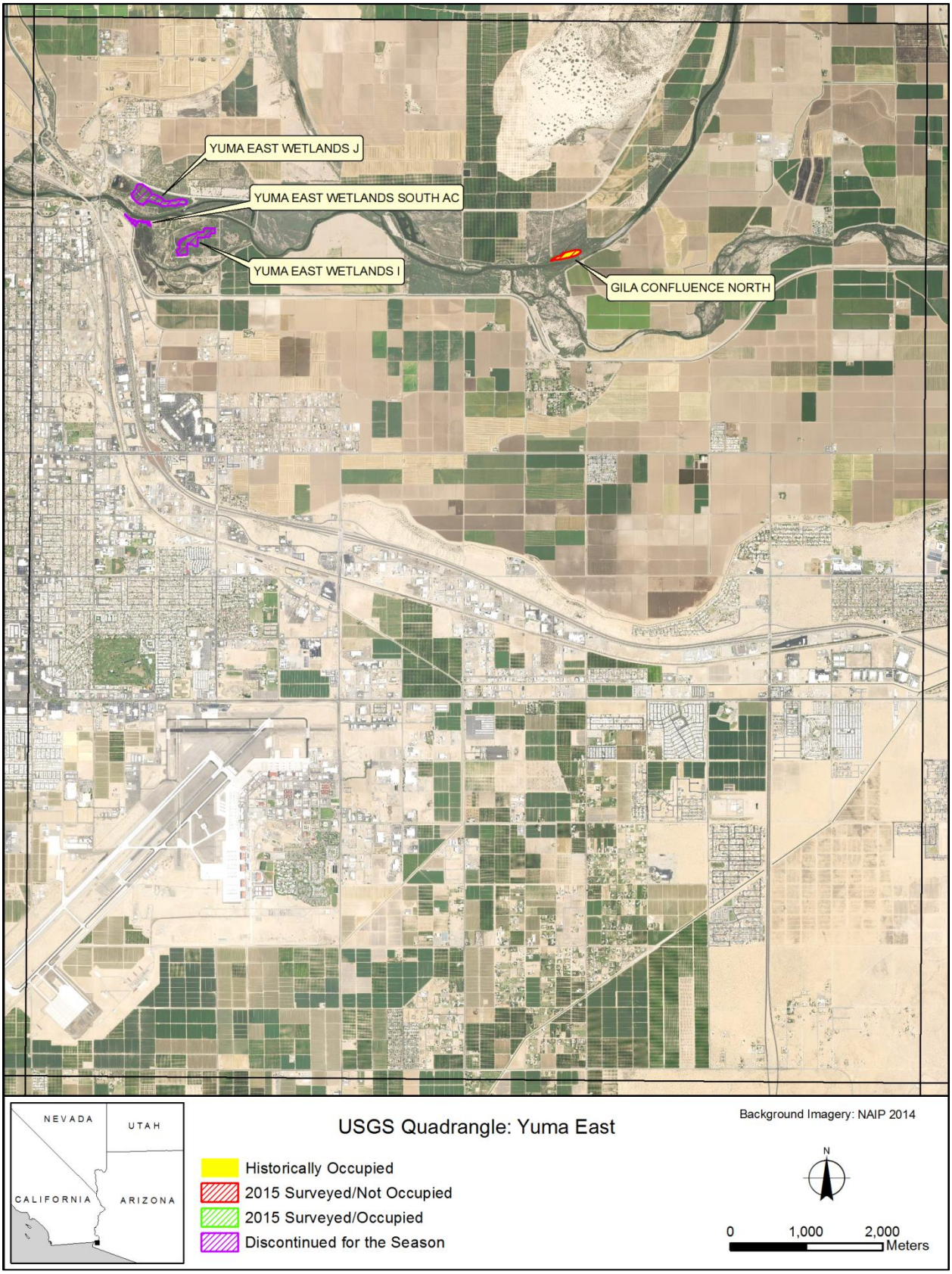
NATURE TRAIL
C2729
CIBOLA SITE 01
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Cibola
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2013
N
0
1,000
2,000
Meters

CIBOLA LAKE NORTH
WALKER LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho NW
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2014
N
0
1,000
2,000
Meters

NURSERY NW
IMPERIAL NURSERY
GREAT BLUE HERON
POWERLINE
MARTINEZ LAKE
FERGUSON LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Imperial Reservoir
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2013
N
0
1,000
2,000
Meters

MITTRY WEST
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Laguna Dam
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2013
N
0
1,000
2,000
Meters


FORTUNA NORTH
GILA RIVER SITE 02
FORTUNA SITE 01
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Fortuna
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Background Imagery: NAIP 2013
N
0
1,000
2,000
Meters


YUMA EAST WETLANDS J
YUMA EAST WETLANDS SOUTH AC
YUMA EAST WETLANDS I
GILA CONFLUENCE NORTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Yuma East
Background Imagery: NAIP 2014
Historically Occupied
2015 Surveyed/Not Occupied
2015 Surveyed/Occupied
Discontinued for the Season
N
0
1,000
2,000
Meters

ATTACHMENT 4

Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Dates for Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2015

Table 4-1.—Dates of presence/absence surveys for southwestern willow flycatchers, 2015

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Survey dates
KEPI	Alamo	Key Pittman WMA	Nesbitt Forest[2]	–
			Patches 00–04[3]	–
			Patches 04.5–05[4]	May 26, June 25, July 17
			Patches 06-10[3]	–
			Patch 10.5[2]	July 17
			Patches 11-12[3]	–
RIRA	Alamo	River Ranch	East Side[4]	May 30
			West Side[4]	May 30, June 5
			Smalls[4]	May 30, June 5, July 8
PAHR	Alamo	Pahranagat NWR	Pahranagat North	May 31, June 8, June 18, June 28, July 12
			Pahranagat West	May 15, June 2, June 18, June 28, July 14
			Pahranagat MAPS[4]	May 15, June 2, July 14
			Pahranagat South	May 15, June 4, June 18, June 27, July 7
MVWA	Meadow Valley Wash	Meadow Valley Wash North	Etna	May 21, June 8, June 19, June 30, July 14
		Meadow Valley Wash Middle	Dog Leg	May 20, June 4, June 17, June 30, July 14
			Ford	May 21, June 8, June 17, June 25, July 10
			Kyle	May 25, June 4, June 17, June 25, July 6
			Cottonwood Canyon	May 25, June 4, June 17, June 25, July 6
MUDD	Muddy River	Overton Above High-Water Mark	Overton WMA Pond	May 16, June 12, June 27, July 3, July 11
		Overton Wildlife	Overton WMA	May 23, June 7, June 23, July 1, July 8, July 12
WMSP	Muddy River	Warm Springs	Muddy Mac	May 23, June 7, June 18, June 25, July 5
			Muddy Stringer 01	May 23, June 7, June 18, June 25, July 9

Table 4-1.—Dates of presence/absence surveys for southwestern willow flycatchers, 2015

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Survey dates
TOPO	Topock	Topock Marsh	Pipes 01	May 21, June 4, June 18, June 24, July 6
			Pipes 03[4]	May 17, June 18, June 24, July 11, July 16
			The Wallows[4]	May 17
			PC 6-1	May 19, June 4, June 19, June 24, July 7
			Pig Hole	May 19, June 4, June 19, June 24, July 14
			In Between[5]	May 20, June 24, July 12
			800M[5]	May 21, June 16, July 5
			Pierced Egg[5]	May 21, June 18, June 25
			Swine Paradise[3]	–
			Platform	May 21, June 4, June 19, June 24, July 11
			250M	May 21, June 4, June 19, June 25, July 9
			Hell Bird	May 25, June 11, June 16, July 1, July 11
			Glory Hole[4]	May 19, June 2, July 7
			Farm Ditch Road (formerly Spaghetti)	May 17, June 10, June 19, June 25, July 7
	Beal Lake Conservation Area	CPhase 05	CPhase 05 (formerly Beal Lake)	May 24, June 4, June 19, June 24, July 4
	Topock	Topock Bay	Lost Lake	May 25, June 11, June 24, July 1, July 4
TOGO	Topock Gorge South	Blankenship Valley	Blankenship North	May 20, June 11, June 23, July 8, July 15
			Blankenship South	May 20, June 11, June 23, July 8, July 15

Table 4-1.—Dates of presence/absence surveys for southwestern willow flycatchers, 2015

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Survey dates
BIWI	Bill Williams River West	North Main Delta	Bill Willow	May 16, June 17, June 23, July 5, July 12
		North Burn	Wispy Willow[4]	May 20
			Site 01[4]	May 26, June 3
			Burn Edge	June 9, June 22, July 3, July 12
		Mosquito Flats	Site 04	May 16, June 10, June 20, June 26, July 14
			Site 03	May 16, June 4, June 22, June 30, July 10
		Cross River	Last Gasp[6]	May 19
			Guinness[6]	May 26
		Sandy Wash	Site 05	May 19, June 20, July 3
			Black Rail[6]	May 19
	Bill Williams River East	Esquerra Ranch	Beaver Pond North (formerly Mineral Wash)	May 18, June 21, June 25, July 1, July 13
			Beaver Pond	May 18, June 21, June 25, July 1, July 13
		Honeycomb Bend	Site 08	May 26, June 21, June 25, July 3, July 13
		Cave Wash	Upstream from Site 08	June 3, June 21, July 13
ALAM[7]	Alamo Lake	Browns Crossing	Sidebar 01	June 6
			Edgewater 01[3]	–
			Camp 01	June 1
			Camp 04	June 1
			Camp 02	June 1
			Camp 03	June 1
			Middle Earth 01[3]	–
			Middle Earth 02[3]	–
			Prospect 01	June 6
			Burro Wash 01	June 12
			Burro Wash 02	June 7
			Motherlode 01[3]	–
			Motherlode 02	June 7
			Motherlode 03	June 7
			Motherlode 04	June 14
			Santa Maria South 01	June 15
			Santa Maria North 01	June 15

Table 4-1.—Dates of presence/absence surveys for southwestern willow flycatchers, 2015

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Survey dates
PVER	Palo Verde Ecological Reserve	Phase 02	Phase 02	May 15-16, May 30–31, June 9, July 1, July 12
		Phase 03	Phase 03	May 15, May 30, June 4, June 23, July 14
		Phase 04	Phase 04 Block 01	May 16, May 31, June 18, June 30, July 14
			Phase 04 Block 02	May 16, May 31, June 9, July 1, July 11
			Phase 04 Block 03	May 16, May 31, June 6–7, June 27, July 11
		Phase 05	Phase 05 Block 01	May 17, May 31, June 6, June 27, July 11
			Phase 05 Block 02	May 17, May 31, June 7, June 23, July 12
			Phase 05 Block 03	May 22, May 31, June 9, June 27, July 12
		Phase 06	Phase 06 Block 01	May 26, June 1, June 14, July 1, July 11
			Phase 06 Block 02	May 26, May 31, June 9, June 27–28, July 5, July 7
		Phase 07	Phase 07 Block 01	May 16–17, June 1, June 14, June 28, July 7
			Phase 07 Block 02	May 17, June 1, June 14, June 28, July 7
EHRE	Palo Verde Valley	Santa Fe	Ehrenberg	May 25, June 3, June 15, June 29, July 8
CIBO	Cibola Valley Conservation Area	Phase 01	Phase 01	May 27, June 2, June 15, June 30, July 4
		Phase 02	Phase 02	May 27, June 2, June 18, June 30, July 4
		Phase 03	Phase 03	May 27–28, June 3, June 18, June 29, July 11
	Cibola National Wildlife Refuge Unit #1	Nature Trail	Nature Trail	May 23–24, June 2, June 15, June 29, July 8
		Crane Roost	C2729	May 23, June 2, June 13, June 29, July 8
	Cibola Valley South	Trigo Mountains	Cibola Site 01	May 28, June 4, June 13, June 29, July 11
			Cibola Lake North[8]	May 26
	Imperial North	Draper Ranch	Walker Lake	May 28, June 3, June 15, June 30, July 8
IMPE	Imperial South	Fishers Landing	Imperial NW (formerly Nursery NW)	May 29, June 12, June 24, July 9, July 16
			Imperial Nursery	May 29, June 12, June 24, July 9, July 16
			Ferguson Lake	May 21, June 12, June 24, July 10, July 16
			Great Blue Heron	May 30, June 13, June 24, July 9, July 15
			Powerline	May 20, June 11, June 17, June 26, July 15
			Martinez Lake	May 20, June 11, June 17, June 26, July 15

Table 4-1.—Dates of presence/absence surveys for southwestern willow flycatchers, 2015

Study area[1]	LCR MSCP area	LCR MSCP site	LCR MSCP section (survey site)	Survey dates
MITT	Laguna	Laguna West	Mittry West	May 20, June 11, June 17, June 26, July 9
YUMA	Yuma East Wetlands[9]	J	C4703 (J)	May 19
		South AC	C4711 (South AC)	May 19
		I	C4702 (I)	May 19
	Gila Valley	Gila Valley North	Gila Confluence North	May 19, June 10, June 16, June 25, July 2
			Gila River Site 02	May 18, June 10, June 16, June 25, July 2
		Gila Valley South	Fortune Site 01	May 18, June 10, June 16, June 25, July 2
			Fortuna North	May 18, June 10, June 16, June 25, July 2

[1] KEPI = Key Pittman, RIRA = River Ranch, PAHR = Pahranagat, MVWA = Meadow Valley Wash, 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] Site immediately adjacent to occupied habitat; no surveys conducted.

[3] Site occupied throughout survey season; no surveys conducted.

[4] Site occupied for a portion of the survey season; no surveys completed during occupied period.

[5] In addition to broadcast surveys, entirety of site surveyed passively every 2 weeks during beetle monitoring.

[6] Surveys discontinued for the season because of the lack of surface water at the site.

[7] Effort at Alamo Lake focused on monitoring known territories, and no site was surveyed more than once.

[8] Surveys discontinued because of poor habitat quality.

[9] Surveys discontinued because of permit requirements.

ATTACHMENT 5

Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Survey Results for Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2015

Table 5-1.—Southwestern willow flycatcher survey and monitoring results by survey site along the lower Colorado River and its tributaries, 2015*

Study area LCR MSCP area River drainage, State	LCR MSCP site	LCR MSCP section (survey site)[1]	Area (hectares)	# Surveys	Survey hours	Resident adults	Territories	Pairs	Nests	# confirmed fledges	Unknown status[2]	
											Before June 24	After June 24
Key Pittman Alamo Pahranagat Valley, Nevada	Key Pittman WMA[3]	Nesbitt Forest	0.2	0	–	0	0	0	0	0	0	0
		Patch 00	0.03	0	–	3[4]	2[4]	2[4]	3	0	0	0
		Patch 01	0.1	0	–	2[4]	1[4]	1[4]	1	0	0	0
		Patch 02	0.1	0	–	2	1	1	1	0	0	0
		Patch 03	0.1	0	–	0	0	0	0	0	0	0
		Patch 04	0.1	0	–	3[5]	1	1	2	0	0	1[6]
		Patch 04.5	0.04	3	–	0	0	0	0	0	37	0
		Patch 05	0.1	3	–	15	1	0	0	0	0	0
		Patch 06	0.2	0	–	2	1	1	2	0	0	1[7]
		Patch 07	0.1	0	–	2	1	1	2	0	1	0
		Patch 08	0.1	0	–	0	0	0	0	0	0	0
		Patch 09	0.3	0	–	5[8]	3	3	5	0	0	0
		Patch 10	0.1	0	–	2	1	1	1	3	0	0
		Patch 10.5	0.02	1	–	0	0	0	0	0	0	0
		Patch 11	0.1	0	–	2	1	1	2	0	0	0
		Patch 12	0.1	0	–	2	1	1	2	3	0	0
		Total	1.5	–	0.7	23[4,5]	13[4]	12[4]	21	6	4	2
River Ranch Alamo Pahranagat Valley, Nevada	River Ranch	East Side	0.4	1	0.3	4	2	2	3	2	1	0
		West Side	0.3	2	0.2	2	1	1	2	3	0	0
		Smalls	0.2	3	0.3	0	0	0	0	0	0	1
		River Ranch[9]	–	–	–	0	0	0	0	0	0	2
		Total	1.0	–	0.8	6	3	3	5	5	1	3
Pahranagat Alamo Pahranagat Valley, Nevada	Pahranagat NWR	Pahranagat North	3.2	5	0.9	14	8	6	6	11	0	0
		Pahranagat West	1.3	5	3.3	2	1	1	1	3	0	0
		Pahranagat MAPS	0.2	3	2.4	5[6]	4	1	2	3	1	0
		Pahranagat South	1.4	5	2.5	0	0	0	0	0	0	0
		Total	6.1	–	9.1	21	13	8	9	17	1	0

Table 5-1.—Southwestern willow flycatcher survey and monitoring results by survey site along the lower Colorado River and its tributaries, 2015*

Study area LCR MSCP area River drainage, State	LCR MSCP site	LCR MSCP section (survey site)[1]	Area (hectares)	# Surveys	Survey hours	Resident adults	Territories	Pairs	Nests	# confirmed fledges	Unknown status[2]	
											Before June 24	After June 24
Meadow Valley Wash Meadow Valley Wash Meadow Valley Wash, Nevada	Meadow Valley Wash North	Etna	0.5	5	1.6	0	0	0	0	0	0	0
	Meadow Valley Wash Middle	Dog Leg	10.3	5	9.1	5[8]	3	3	4	10	0	1
		Ford	1.8	5	1.9	0	0	0	0	0	0	0
		Kyle	0.8	5	2.3	0	0	0	0	0	0	0
		Cottonwood Canyon	1.3	5	2.6	0	0	0	0	0	2	0
		Total	14.6	–	17.5	5	3	3	4	10	0	1
Muddy River Muddy River Muddy River, Nevada	Overton Above High-Water Mark	Overton WMA Pond	0.6	5	2.7	0	0	0	0	0	0	0
	Overton Wildlife	Overton WMA	7.8	5	16.3	3[8]	2	2	3	2	4	0
		Total	8.4	–	19.0	3	2	2	3	2	4	0
Warm Springs Muddy River Muddy River, Nevada	Warm Springs	Muddy Mac	0.5	5	2.0	0	0	0	0	0	0	0
		Muddy Stringer 01	0.8	5	1.0	2	1	1	1	1	0	0
		Total	1.3	–	3.0	2	1	1	1	1	0	0
Topock Marsh Topock Colorado River, Arizona	Topock Marsh	Pipes 01	5.2	5	7.7	0	0	0	0	0	0	0
		Pipes 03	5.7	5	7.9	0	0	0	0	0	1	0
		The Wallows	0.7	1	0.4	2	1	1	2	0	1	1[10]
		PC 6-1	4.8	5	7.2	0	0	0	0	0	1	0
		Pig Hole	2.4	5	4.4	0	0	0	0	0	0	0
		In Between	7.7	3	5.5	0	0	0	0	0	0	0
		800M	4.7	3	5.0	1[10]	1	0	0	0	0	0
		Pierced Egg	6.7	3	4.2	3[11]	1	1	2	0	2	0
		Swine Paradise	1.0	0	–	4	3	1	1	1	1	1[10]
		Platform	1.9	5	1.9	0	0	0	0	0	0	0
		250M	1.9	5	3.3	0	0	0	0	0	0	0
		Hell Bird	5.8	5	6.3	2	2	0	0	0	1	0
		Glory Hole	5.0	4	5.5	2	1	1	1	0	0	0
		Farm Ditch Road (formerly Spaghetti)	5.4	5	5.8	0	0	0	0	0	0	0

Table 5-1.—Southwestern willow flycatcher survey and monitoring results by survey site along the lower Colorado River and its tributaries, 2015*

Study area LCR MSCP area River drainage, State	LCR MSCP site	LCR MSCP section (survey site)[1]	Area (hectares)	# Surveys	Survey hours	Resident adults	Territories	Pairs	Nests	# confirmed fledges	Unknown status[2]	
											Before June 24	After June 24
Topock Marsh Beal Lake Conservation Area Colorado River, Arizona	CPhase 05	CPhase 05 (Beal Lake)	11.4	5	3.3	0	0	0	0	0	1	0
Topock Marsh Topock Colorado River, Arizona	Topock Bay	Lost Lake	3.3	5	4.9	1	1	0	0	0	0	0
		Total	**73.7**	**–**	**73.3**	**15**	**10**	**4**	**6**	**1**	**8**	**1**
Topock Gorge Topock Gorge South Colorado River, Arizona	Blankenship Valley	Blankenship North (Blankenship Bend North)	19.0	5	7.6	0	0	0	0	0	0	0
		Blankenship South (Blankenship Bend South)	11.8	5	7.4	0	0	0	0	0	0	0
		Total	**30.8**	**–**	**15.0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Bill Williams Bill Williams River West Bill Williams River, Arizona	North of Main Delta	Bill Willow	1.6	5	6.9	0	0	0	0	0	2	0
	North Burn	Wispy Willow	1.3	0	–	4[12]	3	3	4	4	0	0
		Site 01	2.4	1	1.5	3	2	1	2	1	0	0
		Burn Edge	4.1	4	3.8	0	0	0	0	0	0	0
	Mosquito Flats	Site 04	9.9	5	11.0	0	0	0	0	0	0	0
		Site 03	12.9	6	15.4	2	1	1	1	0	0	0
	Cross River	Last Gasp13	2.1	1	0.7	0	0	0	0	0	0	0
		Guinness13	3.4	1	1.9	0	0	0	0	0	0	0
	Sandy Wash	Site 05	6.8	3	5.6	0	0	0	0	0	0	0
		Black Rail13	1.2	1	0.5	0	0	0	0	0	0	0
Bill Williams Bill Williams River East Bill Williams River, Arizona	Esquerra Ranch	Beaver Pond North (formerly Mineral Wash)	19.0	5	7.8	0	0	0	0	0	0	0
		Beaver Pond	21.5	5	8.2	0	0	0	0	0	0	0
	Honeycomb Bend	Site 08	12.1	5	6.6	2	1	1	1	1	0	0
	Cave Wash	Upstream from Site 08	1.5	3	1.9	0	0	0	0	0	0	0
		Total	**99.8**	**–**	**71.7**	**11**	**7**	**6**	**8**	**6**	**2**	**0**

Table 5-1.—Southwestern willow flycatcher survey and monitoring results by survey site along the lower Colorado River and its tributaries, 2015*

Study area LCR MSCP area River drainage, State	LCR MSCP site	LCR MSCP section (survey site)[1]	Area (hectares)	# Surveys	Survey hours	Resident adults	Territories	Pairs	Nests	# confirmed fledges	Unknown status[2]	
											Before June 24	After June 24
Alamo Lake[14] Alamo Lake Santa Maria River, Bill Williams River, Alamo Lake, Arizona	Browns Crossing	Sidebar 01	1.7	1	1.0	2	1	1	1	1	0	1
		Edgewater 01	10.4	0	–	2	1	1	1	1	0	0
		Camp 01	0.7	1	0.2	0	0	0	0	0	0	0
		Camp 04	0.3	1	0.04	0	0	0	0	0	0	0
		Camp 02	0.3	1	0.04	0	0	0	0	0	0	0
		Camp 03	1.9	1	0.2	0	0	0	0	0	0	0
		Middle Earth 01	6.1	0	–	8[8]	5	4	5	8	0	0
		Middle Earth 02	6.7	0	–	15[15]	9	9	13	12	1[16]	0
		Prospect 01	1.1	1	0.9	0	0	0	0	0	0	0
		Burro Wash 01	3.9	1	1.3	0	0	0	0	0	0	0
		Burro Wash 02	6.8	1	0.7	4	2	2	3	6	1	0
		Motherlode 01	3.3	0	–	15[12,16]	9	8	8	13	0	0
		Motherlode 02	21.6	1	2.9	0	0	0	0	0	0	0
		Motherlode 03	12.6	1	2.9	4	2	2	3	1	0	0
		Motherlode 04	0.5	1	0.3	2	1	1	1	0	0	0
		Santa Maria South 01	30.2	1	1.1	0	0	0	0	0	0	0
		Santa Maria North 01	29.5	1	0.8	4	2	2	1	3	0	0
		Total	**137.6**	**–**	**12.4**	**56**	**32**	**30**	**36**	**45**	**1**	**2**
Palo Verde Ecological Reserve Palo Verde Ecological Reserve Colorado River, California	Phase 02	Phase 02	21.4	5	12.4	0	0	0	0	0	6	0
	Phase 03	Phase 03	21.4	5	9.7	0	0	0	0	0	1	0
	Phase 04	Phase 04 Block 01	7.6	5	5.4	0	0	0	0	0	1	0
		Phase 04 Block 02	4.0	5	4.3	0	0	0	0	0	1	0
		Phase 04 Block 03	23.7	5	11.5	1	1	0	0	0	4	1
	Phase 05	Phase 05 Block 01	15.9	5	8.1	0	0	0	0	0	12	0
		Phase 05 Block 02	23.6	5	10.7	0	0	0	0	0	3	0
		Phase 05 Block 03	29.6	5	11.7	0	0	0	0	0	3	0
	Phase 06	Phase 06 Block 01	38.7	5	14.1	0	0	0	0	0	0	0
		Phase 06 Block 02	37.6	5	15.1	0	0	0	0	0	0	0

Table 5-1.—Southwestern willow flycatcher survey and monitoring results by survey site along the lower Colorado River and its tributaries, 2015*

Study area LCR MSCP area River drainage, State	LCR MSCP site	LCR MSCP section (survey site)[1]	Area (hectares)	# Surveys	Survey hours	Resident adults	Territories	Pairs	Nests	# confirmed fledges	Unknown status[2]	
											Before June 24	After June 24
Palo Verde Ecological Reserve Palo Verde Ecological Reserve Colorado River, California	Phase 07	Phase 07 Block 01	36.8	5	13.2	0	0	0	0	0	13	0
		Phase 07 Block 02	40.6	5	13.8	0	0	0	0	0	7	0
		Total	**300.9**	**–**	**129.8**	**1**	**1**	**0**	**0**	**0**	**51**	**1**
Ehrenberg Palo Verde Valley Colorado River, Arizona	Sante Fe	Ehrenberg	4.7	5	3.7	0	0	0	0	0	0	0
		Total	**4.7**	**–**	**3.7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cibola Cibola Valley Conservation Area Colorado River, Arizona	Phase 01	Phase 01	26.2	5	10.0	0	0	0	0	0	2	0
	Phase 02	Phase 02	25.5	5	10.2	0	0	0	0	0	2	0
	Phase 03	Phase 03	38.4	5	13.2	0	0	0	0	0	4	0
Cibola Cibola National Wildlife Refuge Unit 1 Colorado River, Arizona	Nature Trail	Nature Trail	13.7	5	6.3	0	0	0	0	0	3	0
	Crane Roost	C2729	6.0	5	7.0	0	0	0	0	0	12	0
Cibola Cibola Valley South Colorado River, Arizona	Trigo Mountains	Cibola Site 01	7.7	5	5.9	0	0	0	0	0	2	0
		Cibola Lake North (Cibola Lake #1)[17]	9.0	1	1.1	0	0	0	0	0	1	0
Cibola Imperial North Colorado River, California	Draper Ranch	Walker Lake	4.6	5	2.5	0	0	0	0	0	0	0
		Total	**131.1**	**–**	**56.3**	**0**	**0**	**0**	**0**	**0**	**26**	**0**
Imperial Imperial South Colorado River, Arizona and California	Imperial South	Imperial NW (formerly Nursery NW)	14.2	5	5.2	0	0	0	0	0	0	0
		Imperial Nursery	1.4	5	1.2	0	0	0	0	0	0	0
		Ferguson Lake	21.1	5	11.0	0	0	0	0	0	6	0
		Great Blue Heron	7.1	5	9.3	0	0	0	0	0	1	0
		Powerline	1.0	5	2.3	0	0	0	0	0	0	0
		Martinez Lake	4.6	5	7.0	0	0	0	0	0	7	0
		Total	**49.3**	**–**	**36.1**	**0**	**0**	**0**	**0**	**0**	**14**	**0**
Mittry Lake Laguna Colorado River, California	Laguna West	Mittry West	4.4	5	6.0	0	0	0	0	0	3	0
		Total	**4.4**	**–**	**6.0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**
Yuma Yuma East Wetlands[18] Colorado River, Arizona	J	C4703 (J)	8.4	1	1.3	0	0	0	0	0	1	0
	South AC	C4711 (South AC)	0.9	1	1.4	0	0	0	0	0	5	0
	I	C4702 (I)	6.4	1	2.1	0	0	0	0	0	4	0

Table 5-1.—Southwestern willow flycatcher survey and monitoring results by survey site along the lower Colorado River and its tributaries, 2015*

Study area LCR MSCP area River drainage, State	LCR MSCP site	LCR MSCP section (survey site)[1]	Area (hectares)	# Surveys	Survey hours	Resident adults	Territories	Pairs	Nests	# confirmed fledges	Unknown status[2]	
											Before June 24	After June 24
Yuma Gila Valley Gila River, Arizona	Gila Valley North	Gila Confluence North	2.2	5	3.0	0	0	0	0	0	3	0
		Gila River Site 02	2.9	5	2.6	0	0	0	0	0	2	0
	Gila Valley South	Fortuna Site 01	3.2	5	3.9	0	0	0	0	0	4	0
		Fortuna North	3.8	5	6.1	0	0	0	0	0	3	0
		Total	**Total**	**–**	**20.4**	**0**	**0**	**0**	**0**	**0**	**22**	**0**

* This table includes only sites where regular surveys were scheduled and territory monitoring was conducted. Sites where habitat reconnaissance and opportunistic surveys were conducted are not included unless a flycatcher was detected.

[1] Survey site is equivalent to the Arizona Department of Game and Fish definition of site. LCR MSCP section names correspond to those of their respective survey sites, though geographies may not be identical.

[2] Total number of individuals recorded that could not be classified as resident or migrant because of brief appearance.

[3] Survey hours not tallied by survey site; total survey hours for the study area are presented.

[4] One male was polygynous with two females: one in Key Pittman Patch 00 and one in Key Pittman Patch 01. One of the two females nested in both Key Pittman Patch 00 and Key Pittman Patch 01.

[5] One male was detected at Key Pittman Patch 05 through June 15, then displaced the male in Key Pittman Patch 04.

[6] This individual was detected at from May 15 to July 2 at Pahranagat MAPS and was then detected on July 13 at Key Pittman Patch 04.

[7] One male was detected at Key Pittman Patch 04.5 through on June 1–5 and was then detected on June 22–27 at Key Pittman Patch 06.

[8] One male was polygynous with two females.

[9] Not an official survey site. Incidental detection of two willow flycatchers recorded during a yellow-billed cuckoo survey.

[10] One individual was detected on June 2–30 in Topock Marsh 800M, then on July 1 in Topock Marsh Swine Paradise, and on July 21 in Topock Marsh The Wallows.

[11] One female was paired consecutively with two different males.

[12] One male was polygynous with three females.

[13] Surveys were discontinued for the season after the first visit due to a lack of surface water.

[14] Surveys at Alamo Lake did not follow a regular survey schedule.

[15] Three males were each polygynous with two females.

[16] One female was captured in Middle Earth 02 and subsequently nested in Motherlode 01.

[17] Surveys were discontinued at this site due to poor habitat quality.

[18] 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. Surveys were discontinued for the season at Yuma East Wetlands due to permitting issues.

ATTACHMENT 6

Detections of Special Concern Species Within Lower Colorado River Multi-Species Conservation Program (LCR MSCP) Areas and Sites, 2015

Table 6-1.—Number of detections of each special concern species recorded at each survey site, 2015*

Study area	(LCR MSCP) area	LCR MSCP site	LCR MSCP section (survey site)	Species of special concern[1]			
				CLRA	YBCU	GIFL	VEFL
Key Pittman	Alamo	Key Pittman WMA	Patches 00-12 and Nesbitt Forest	0	0	0	0
River Ranch	Alamo	River Ranch	East Side	0	0	0	0
			West Side	0	0	0	0
			Smalls	0	0	0	2
Pahranagat	Alamo	Pahranagat NWR	Pahranagat North	0	0	0	0
			Pahranagat West	0	0	0	0
			Pahranagat MAPS	0	0	0	3
			Pahranagat South	0	0	0	3
Meadow Valley Wash	Meadow Valley Wash	Meadow Valley Wash North	Etna	0	0	0	0
		Meadow Valley Wash Middle	Dog Leg	1	0	0	0
			Ford	0	0	0	0
			Kyle	0	0	0	0
			Cottonwood Canyon	0	0	0	0
Muddy River	Muddy River	Overton Above High-Water Mark	Overton WMA Pond	3	0	0	0
		Overton Wildlife	Overton WMA	0	0	0	0
Warm Springs	Muddy River	Warm Springs	Muddy Mac	0	0	0	1
			Muddy Stringer 01	0	1	0	0
Topock Marsh	Topock	Topock Marsh	Pipes 01	0	0	0	0
			Pipes 03	0	0	0	0
			The Wallows	0	0	0	0
			PC 6-1	0	0	0	0
			Pig Hole	0	0	0	0
			In Between	0	1	0	0
			800M	0	0	0	0
			Pierced Egg	0	0	0	0
			Swine Paradise[2]	1	–	–	–
			Platform	3	0	0	0
			250M	0	0	0	0
			Hell Bird	4	1	0	0
			Glory Hole	0	0	0	0
			Farm Ditch Road (formerly Spaghetti)	0	0	0	0
	Beal Lake Conservation Area	CPhase 05	CPhase 05 (Beal Lake)	0	*	0	0
	Topock	Topock Bay	Lost Lake	8	1	0	0

Table 6-1.—Number of detections of each special concern species recorded at each survey site, 2015*

Study area	(LCR MSCP) area	LCR MSCP site	LCR MSCP section (survey site)	Species of special concern[1]			
				CLRA	YBCU	GIFL	VEFL
Topock Gorge	Topock Gorge South	Blankenship Valley	Blankenship North	18	0	0	0
			Blankenship South	0	0	0	0
Bill Williams	Bill Williams River West	North of Main Delta	Bill Willow	1	0	0	0
		North Burn	Wispy Willow[2]	–	–	–	–
			Site 01	0	0	0	0
			Burn Edge	0	0	0	0
		Mosquito Flats	Site 04	0	*	0	0
			Site 03	0	*	0	0
		Cross River	Last Gasp[3]	0	0	0	0
			Guinness[3]	0	0	0	0
		Sandy Wash	Site 05	0	0	0	0
			Black Rail[3]	0	0	0	0
	Bill Williams River East	Esquerra Ranch	Beaver Pond North (formerly Mineral Wash)	0	0	0	0
			Beaver Pond	1	0	0	0
		Honeycomb Bend	Site 08	0	*	0	0
		Cave Wash	Upstream from Site 08	0	0	0	0
Alamo Lake[4]	Alamo Lake	Brown's Crossing	Sidebar 01	0	0	0	0
			Edgewater 01[2]	–	–	–	–
			Camp 01	0	0	0	0
			Camp 04	0	0	0	0
			Camp 02	0	0	0	0
			Camp 03	0	0	0	0
			Middle Earth 01[2]	–	–	–	–
			Middle Earth 02[2]	–	–	–	–
			Prospect 01	0	0	0	0
			Burro Wash 01	0	1	0	0
			Burro Wash 02	0	4	0	0
			Motherlode 01[2]	–	2	–	–
			Motherlode 02	0	0	0	1
			Motherlode 03	0	0	0	0
			Motherlode 04	0	0	0	0
			Santa Maria South 01	0	0	0	0
			Santa Maria North 01	0	2	0	0

Table 6-1.—Number of detections of each special concern species recorded at each survey site, 2015*

Study area	(LCR MSCP) area	LCR MSCP site	LCR MSCP section (survey site)	Species of special concern[1]			
				CLRA	YBCU	GIFL	VEFL
Palo Verde Ecological Reserve	Palo Verde Ecological Reserve	Phase 02	Phase 02[3]	0	*	1[5]	0
		Phase 03	Phase 03	0	*	0	1
		Phase 04	Phase 04 Block 01	0	*	0	0
			Phase 04 Block 02	0	*	0	0
			Phase 04 Block 03	0	*	0	0
		Phase 05	Phase 05 Block 01	0	*	0	0
		Phase 05	Phase 05 Block 02	0	*	0	0
			Phase 05 Block 03	0	*	0	0
		Phase 06	Phase 06 Block 01	0	*	0	0
			Phase 06 Block 02	0	*	0	0
		Phase 07	Phase 07 Block 01	0	*	0	0
			Phase 07Block 02	0	*	0	0
Ehrenberg	Palo Verde Valley	Sante Fe	Ehrenberg	0	0	0	0
Cibola	Cibola Valley Conservation Area	Phase 01	Phase 01	0	*	0	0
		Phase 02	Phase 02	0	0	1[6]	0
		Phase 03	Phase 03	0	0	0	0
	Cibola National Wildlife Refuge Unit #1	Nature Trail	Nature Trail	0	0	0	0
		Crane Roost	C2729	0	0	0	0
	Cibola Valley South	Trigo Mountains	Cibola Site 01	0	0	0	0
			Cibola Lake North[7]	0	0	0	0
Imperial	Imperial North	Draper Ranch	Walker Lake	0	0	0	0
	Imperial South	Fishers Landing	Imperial NW (Nursery NW)	0	1	0	0
			Imperial Nursery	0	0	0	0
			Ferguson Lake	3	1	0	0
			Great Blue Heron	0	0	0	0
			Powerline	0	0	0	0
			Martinez Lake	0	0	1[8]	0
Mittry Lake	Laguna	Laguna West	Mittry West	0	1	1[9]	0

Table 6-1.—Number of detections of each special concern species recorded at each survey site, 2015*

Study area	(LCR MSCP) area	LCR MSCP site	LCR MSCP section (survey site)	Species of special concern[1]			
				CLRA	YBCU	GIFL	VEFL
Yuma	Yuma East Wetlands[10]	J	C4703 (J)	0	0	0	0
		South AC	C4711 (South AC)	1	0	0	0
		I	C4702 (I)	0	0	0	0
	Gila Valley	Gila Valley North	Gila Confluence North	0	0	0	0
			Gila River Site 02	0	0	0	0
		Gila Valley South	Fortuna Site 01	0	0	0	0
			Fortuna North	0	0	0	0

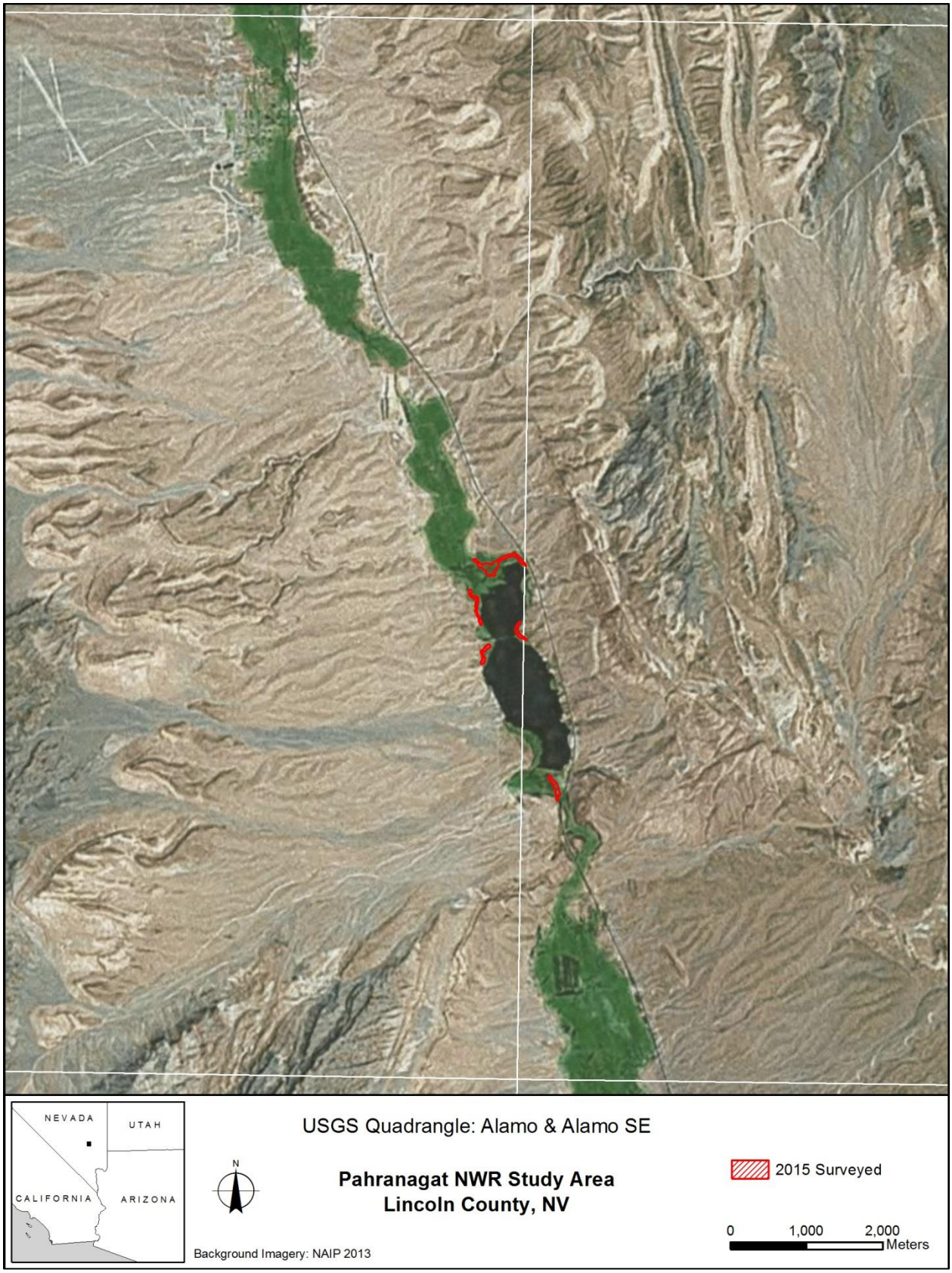
* Passive yellow-billed cuckoo detections were recorded at several survey sites monitored for yellow-billed cuckoos as part of another LCR MSCP project (see McNeil and Tracy 2015). The number of individuals detected at these sites is not recorded.

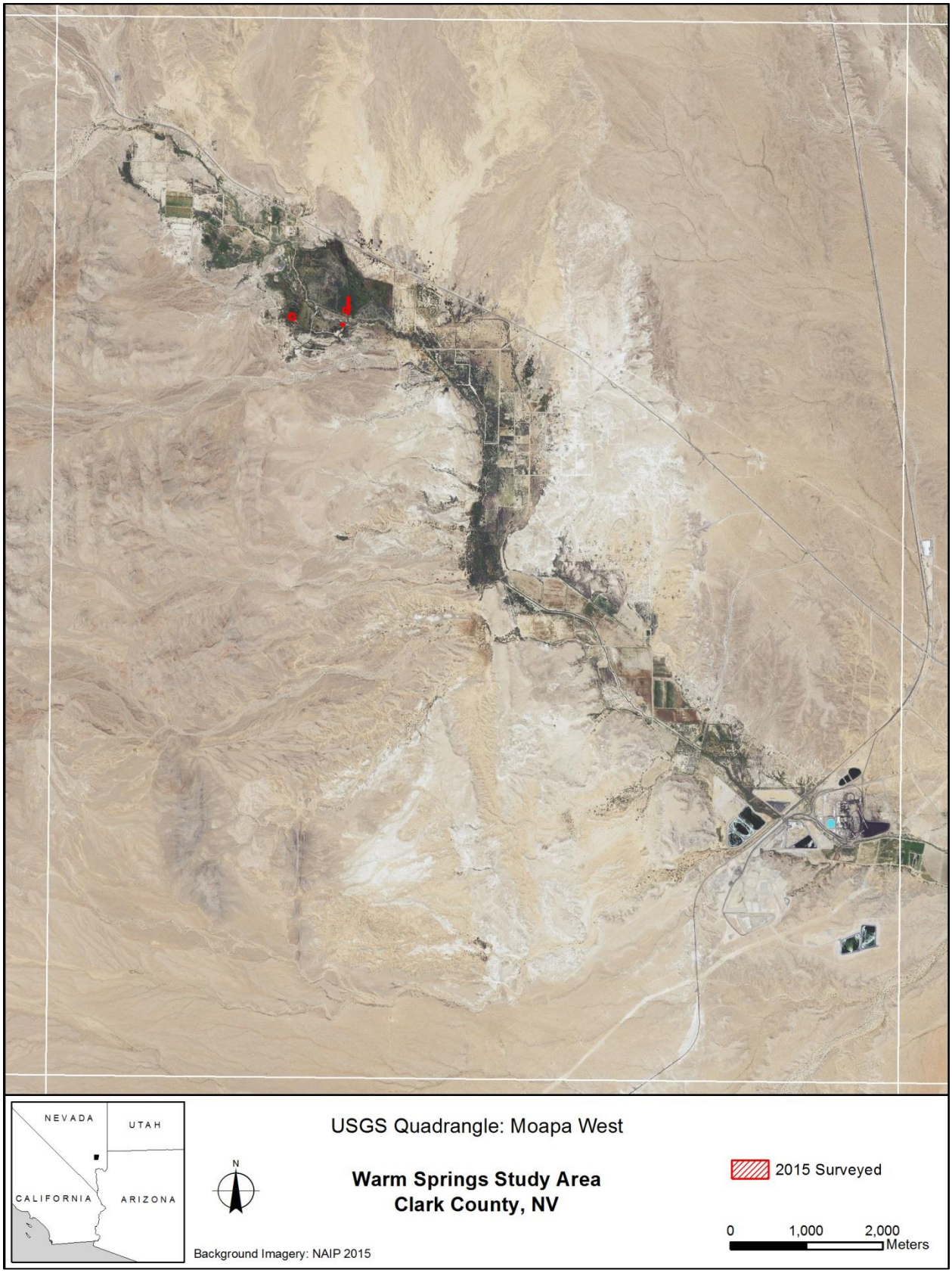
[1] CLRA = clapper rail, YBCU = yellow-billed cuckoo, GIFL = gilded flicker, and VEFL = vermilion flycatcher.
[2] This survey site was not surveyed; site was occupied during the breeding season.
[3] Only one survey conducted. Surveys were discontinued for the season due to a lack of surface water.
[4] No site was surveyed more than once.
[5] A flicker was detected at this site in early July, but no positive identification to species was made.
[6] A flicker was heard at this site in late June, but no positive identification to species was made.
[7] Surveys discontinued after the first visit due to poor habitat quality.
[8] A flicker was detected at this site in late May, but no positive identification to species was made.
[9] A flicker was heard at this site in mid-June, but no positive identification to species was made.
[10] Only one survey conducted. Surveys were discontinued for the season due to permitting issues.

ATTACHMENT 7

Orthophotos Showing Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) Survey Sites

NEVADA
UTAH
CALIFORNIA
ARIZONA
N
USGS Quadrangle: Ash Springs
River Ranch Study Area
Clark County, NV
2015 Surveyed
0
1,000
2,000
Meters
Background Imagery: NAIP 2013


NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Alamo & Alamo SE
N
Pahranagat NWR Study Area
Lincoln County, NV
2015 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
2015 Surveyed
0
1,000
2,000
Meters
Background Imagery: NAIP 2015

ATTACHMENT 8

All Willow Flycatchers (*Empidonax traillii*) Color Banded and/or Resighted, 2010–2015

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2140-66709	M	A		Q	Q	Q		Q[4]	M	M	M	M	M	M[5]	M		
2320-31445	F	A			Q	Q	Q	Q	Q	Q	Q	Q					
2320-31463	F	J			P			K	K			K					
2320-31498	F	J				M		G[6]	Q	Q	Q	Q					
2320-31562	M	J				T		T		T	T	T					
2320-31595	M	A				P	P	P	P	P	P	P	P	P			
2320-31632	F	A				Q		M	M	M[7]		M	M	M	M		
2320-31647	M	J										M					
2320-31648	M	J										M					
2320-31659	M	J				Q		D	D	D		D					
2320-31660	F	J				Q			M	S	S	S					
2320-31674	M	J						P		K	K	K					
2320-31688	M	J					Q	Q	Q	Q	Q	Q	Q	Q			
2360-59711	M	J					K			P	P	P					
2360-59712	M	J					K			P		P	P				
2360-59754	M	J						Q	Q	Q	Q	P	P				
2360-59777	F	J							Q				M	M			
2360-59782	F	J							K			M					
2360-59788	F	J					D	D	M	M	M	M	M	M	M		
2360-59799	M	J						M	D	M		M					
2370-39915	M	A					P	P	P	P[8]	P	P					
2370-39930	M	J									M	Q	D[9]				
2370-39938	M	A						M	M	M	M	M	M	M	M		
2370-39956	F	A					D	D	D			M	M	M			
2370-39968	M	A											D				
2370-39970	F	J											M				
2370-39988	M	A						G	M	M	M	M					
2370-39999	M	A										Q					
2370-40000	M	A										D	D	D	D		
2370-40001	U	J										P					
2370-40002	U	J										P					
2370-40005	U	J										S					
2370-40007	M	J										S					
2370-40008	M	J										D					
2370-40009	U	J										D					
2370-40010	M	J										D	K	K			
2370-40011	F	A										Q					
2370-40022	M	A										K					
2370-40024	M	J									K	K	K	K	K	K	K
2370-40027	F	J									P	E	K				
2370-40029	M	J									M		D				
2370-40031	M	J									K	K	K				
2370-40037	F	A						G	M		M	M	M	M			
2370-40046	M	A						G	G[10]	M	M	M	M	M	M		
2370-40047	F	A						P	P	P	P	P	P	P			

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2370-40051	M	J										K					
2370-40060	M	A						P		P	P	P	P				
2370-40072	F	J									M			Q			
2370-40073	F	A									P	P					
2370-40077	M	A														W	W
2370-40078	F	J											K				
2370-40079	U	J											K				
2370-40087	F	A							Q	Q	Q	Q	Q				
2370-40088	M	A										D	D	D	P	P	P
2370-40089	U	J										M					
2370-40090	F	J										M					
2370-40091	F	J										M	D		D		
2370-40093	M	J										M					
2370-40094	U	J														P	
2370-40097	M	J								K		K	K				
2370-40112	M	J							T			T					
2370-40141	M	A									K	K	K				
2370-40144	M	J									M	T					
2370-40148	F	J								S	S	S	S				
2370-40151	F	J									M	M					
2370-40155	M	A									L			P			
2370-40157	M	A							P		P	P					
2370-40173	M	A							M	M	M	M					
2370-40175	M	J									M	Q	Q	D	D		
2370-40177	F	J										T					
2370-40179	U	J										K					
2370-40190	M	J							P				K	K	K		
2370-40192	F	A							D			B					
2370-40193	F	A							Q	Q	Q	D					
2370-40194	F	A							P	P	P	P					
2370-40197	M	A							M	Q	Q	M	M	M	M		
2390-92434	M	J	Q	Q		Q	Q	Q	Q	Q	Q	M	M				
2430-61072	M	A								G			T				
2430-61080	M	A								P	P	P	P	P			
2430-61083	M	A								P	P	P	P	P	P	P	P
2430-61084	M	J								Q		D					
2430-61085	M	A									D	D	D	D			
2430-61087	F	A									P	P	P	P	P		
2430-61088	M	A										N	D	E	K	K	K
2430-61089	F	J										M					
2430-61090	M	J										M					
2430-61091	U	J										S					
2430-61092	F	A										S					
2430-61093	M	A										S	S				
2430-61094	M	J										D					

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2430-61095	M	A										M					
2430-61096	F	A										L					
2430-61097	M	J										P					
2430-61098	M	J										P	E[11]				
2430-61099	M	J										K	E[11]	K			
2430-61100	F	A										K	K	K			
2430-61106	M	J								P		M	M				
2430-61114	M	J								P		K	K				
2430-61118	M	J								P	M	M	K				
2430-61120	F	J								P	P	P	P	P			
2430-61123	F	J								P		P					
2430-61124	F	J								P		K			K		
2430-61134	M	A								T		N	N	N	T	N	N
2430-61135	M	A								T	T	T					
2430-61136	M	A								B	B	B	B				
2430-61137	F	A								B	B	B	B	B			
2430-61151	F	J										K					
2430-61152	M	J										P					
2430-61154	F	J									Q	S	S	S			
2430-61158	M	A									K	K	K	K	K	K	K
2430-61159	M	J									M		K	K	K	K	
2430-61163	F	A										K					
2430-61165	M	J								Q	Q	M					
2430-61167	M	A								M	M	M	M				
2430-61174	F	J								M		Q					
2430-61176	M	J								Q		P	P	P			
2430-61179	M	A								K	P	P	P	P			
2430-61180	M	A								K		K	K	K			
2430-61187	M	J								Q	L	L					
2430-61189	F	J								Q		M					
2430-61197	M	J								P		K	K	K			
2430-61206	M	J								M		M					
2430-61207	F	J								M	D	D					
2430-61213	F	J										K					
2430-61214	M	A											K				
2430-61215	F	J											P				
2430-61216	F	J											Q				
2430-61217	F	J											Q				
2430-61218	F	J											P	P			
2430-61219	U	J											M				
2430-61220	F	J											P	P	P	P	P
2430-61221	M	J										P					
2430-61226	F	J										P					
2430-61227	U	J										P					
2430-61228	F	J										K					

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2430-61229	M	J										K					
2430-61230	F	A										S	S	S			
2430-61231	U	J										S		M			
2430-61232	F	J										L					
2430-61233	M	J										L					
2430-61234	F	A										Q	Q				
2430-61235	U	J										Q					
2430-61236	M	J										K					
2430-61237	M	J											B				
2430-61257	M	A												P			
2430-61258	U	J												K			
2430-61259	M	A												M			
2430-61260	M	A												D	D		
2430-61261	M	A												D			
2430-61262	M	J												K	P	P	
2430-61263	U	J												K			
2430-61264	U	J												K			
2430-61265	U	J												M			
2430-61266	U	J												M			
2430-61267	F	A												P	P	P	
2430-61276	U	J										Q					
2430-61277	F	J									P	P					
2430-61279	F	J									P	K	K	K	K	K	K
2430-61280	M	J										M					
2430-61281	M	A												M	M		
2430-61282	M	A												M	M	M	M
2430-61286	M	A												M	M		
2430-61287	U	J												K			
2430-61288	U	J												K			
2430-61289	U	J												K			
2430-61290	M	J												P	E		
2430-61291	U	J												P			
2430-61292	U	J												P			
2430-61293	U	J												P			
2430-61294	U	J												P			
2430-61295	U	J												K			
2430-61296	U	J												D			
2430-61297	U	J												D			
2430-61298	F	A												M	M	P	P
2430-61299	U	J												M			
2430-61300	F	J												P	P	K	
2540-58101	M	J										K					
2540-58102	F	J										K					
2540-58103	M	J										K					
2540-58104	F	J										K					

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2540-58105	M	J										Q					
2540-58106	U	J										Q					
2540-58107	F	J										Q					
2540-58108	M	A											T				
2540-58109	M	A											P[12]				
2540-58110	F	A											P				
2540-58111	F	A											P	P			
2540-58112	M	J											Q				
2540-58113	U	J											M				
2540-58114	F	J											P	P	P	P	K
2540-58115	M	J											B				
2540-58116	M	J										B		T			
2540-58117	M	J										B					
2540-58118	U	J										K					
2540-58119	M	J										K					
2540-58120	F	A											B				
2540-58121	U	J													K		
2540-58122	U	J													K		
2540-58123	U	J													K		
2540-58124	F	J													S		S
2540-58125	M	J													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		
2540-58132	M	A									S	S	S	S			
2540-58133	F	J													D		Q
2540-58134	M	A														D	
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
2540-58147	F	J										B					
2540-58148	M	J										Q					
2540-58149	M	J										Q					
2540-58150	M	J										Q					
2540-58151	M	J										Q					
2540-58152	F	A											Q				
2540-58153	U	J														K	
2540-58154	M	J									M	T[13]	D[14]	M			
2540-58156	F	A										K	K	K			
2540-58157	M	J										K	E		P	P	P

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2540-58158	M	J										K	K	K	K	K[15]	P
2540-58159	F	J										K	K	K			
2540-58160	M	J										S		S	S	S	S
2540-58161	F	J										L					
2540-58162	M	J										K					
2540-58163	M	J										K					
2540-58164	M	J										K					
2540-58165	F	J										K	K				
2540-58166	M	J										K					
2540-58172	M	A											Q				
2540-58173	M	J											M	D			
2540-58174	F	J											M	M[7]		M	
2540-58175	F	A											K	K	K	K	
2540-58176	M	A											Q				
2540-58177	F	A											K	K	K	K	K
2540-58178	F	J											K	K			
2540-58179	M	J											K	K	K	P	P
2540-58180	M	J											K				
2540-58182	F	J											K		K		
2540-58183	U	J											K				
2540-58184	F	A											M	M			
2540-58187	F	A									P		K				
2540-58190	F	J										T					
2540-58191	F	J										P					
2540-58192	M	A										Q	Q[4]	M	M	M	M
2540-58193	F	A										N	N	N		D	
2540-58194	F	J										D					
2540-58195	F	J										P					
2540-58196	M	J										P					
2540-58197	M	J										P					
2540-58198	F	J										P					
2540-58199	M	J										K		P	P	P	
2540-58200	M	J										K					
2540-58201	M	J										K	P	P	P	P	P
2540-58202	M	A										K		K	K	K	K
2540-58203	F	A										K	K				
2540-58204	F	A										K					
2540-58205	F	J										K					
2540-58206	U	J										P					
2540-58207	U	J										P					
2540-58208	U	J										P					
2540-58209	F	A										P					
2540-58211	M	J											K	K	K		
2540-58212	U	J											K				
2540-58213	M	J											M				

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2540-58214	F	J											K				
2540-58215	U	J														P	
2540-58217	M	A									S	S			S	S	S
2540-58220	M	A										B	B				
2540-58221	M	A										B					
2540-58222	F	J										K					
2540-58223	M	A										K	K	K	K	K	
2540-58224	F	J										K	K	K	K		
2540-58225	F	J										K					
2540-58226	F	A										K					
2540-58227	M	A										T					
2540-58228	M	A										T	T				
2540-58229	M	A										B					
2540-58230	F	A										B	B				
2540-58231	F	A										T	M	M	M	T	T
2540-58232	F	J										T					
2540-58233	F	A										N					
2540-58235	F	J										N					
2540-58236	F	J										N					
2540-58237	F	J										K					
2540-58238	F	J										K	E[11]		P	P	P
2540-58239	M	J										K			K	K	K
2540-58240	F	J										K	E	K	K	K	
2540-58241	F	A										K	K				
2540-58242	U	J										K					
2540-58243	M	J										K					
2540-58244	M	J										K					
2540-58245	M	A											P	K	K	K	K
2540-58246	M	A											E	P	P	P	P
2540-58247	F	J											K	K			
2540-58248	F	J													P	K	
2540-58249	U	J													P		
2540-58250	M	J													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		
2540-58258	U	J												K			
2540-58259	M	J												K	K	P	P
2540-58260	U	J												M			
2540-58261	F	A												M			
2540-58262	M	J												K	E	P	P
2540-58263	U	J												K			
2540-58264	U	J												K			

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2540-58265	U	J												M			
2540-58266	U	J												P			
2540-58267	U	J												P			
2540-58268	M	A												K			
2540-58269	F	A												K	K[15]	P	P
2540-58270	F	A													K	K	K
2540-58271	F	A													P	P	
2540-58274	F	J											N				
2540-58275	M	J											N				
2540-58276	M	J											K				
2540-58277	M	J											K	K		K	
2540-58278	U	J											D				
2540-58279	U	J											D				
2540-58280	M	J											K				
2540-58281	F	A													K	K	K
2540-58282	F	J											K				
2540-58283	U	J											K				
2540-58284	F	J											P				
2540-58285	M	J											P	K			
2540-58286	F	J											P	P	P	P	
2540-58287	M	A											S	S			
2540-58288	M	J										P					
2540-58289	F	A										K					
2540-58290	M	J										K					
2540-58291	F	J										K					
2540-58292	F	J										K					
2540-58293	F	A										P	P	P			
2540-58294	F	J										P					
2540-58295	U	J										P					
2540-58296	F	J										P					
2540-58297	F	A											K				
2540-58298	M	J											K				
2540-58299	F	J											K				
2540-58300	F	J												K	K		
2540-58301	M	J												P	W		
2540-58302	U	J												P			
2540-58303	U	J												P			
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

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2540-58312	F	A														P	
2540-58313	U	J															W
2540-58316	F	A														O	O
2540-58317	M	A														O	
2540-58318	F	A														O	
2540-58319	F	A														O	
2540-58320	F	J												K		K	K
2540-58321	U	J												D			
2540-58322	F	A												K	K		
2540-58323	U	J												P			
2540-58325	U	J												K			
2540-58326	M	J												K	P		
2540-58327	U	J												K			
2540-58328	F	A														O	
2540-58329	M	A														O	O
2540-58330	U	J														W	
2540-58331	U	J														P	
2540-58332	M	J														P	E
2540-58333	U	J														K	
2540-58334	U	J														K	
2540-58335	U	J														K	
2540-58336	F	A															D
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	U	J															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	
2540-58352	F	J														B	B
2540-58353	F	A														O	O
2540-58355	U	J															O
2540-58356	F	A														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

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2540-58362	F	A														O	
2540-58363	M	A														W	
2540-58364	U	J															P
2540-58365	M	A															Z
2540-58367	U	J															K
2540-58368	U	J															S
2540-58369	U	J															P
2540-58371	U	J															W
2540-58372	U	J															E
2540-58373	U	J												M			
2540-58374	M	A													V		
2540-58375	M	A													P		
2540-58376	M	A													E	K	
2540-58377	F	J													K	K	
2540-58378	F	J											K				
2540-58379	U	J															P
2540-58380	U	J															W
2540-58381	U	J															E
2540-58383	U	J															E
2540-58385	U	J											S				
2540-58386	F	A											K				
2540-58387	M	A											K	K	K	K	
2590-53101	M	J											P			K	K
2590-53102	M	J											P				
2590-53103	F	J											P				
2590-53104	M	J											P				
2590-53105	F	A											D				
2590-53106	F	J											M			D	
2590-53107	M	J											M	Q[16]			
2590-53108	F	A											D				
2590-53109	U	J											P				
2590-53110	F	A											K				
2590-53111	U	J											K				
2590-53112	M	J											K	K			
2590-53113	F	J											K				
2590-53114	M	J											K		K		
2590-53115	M	J											M				
2590-53116	F	J											M				
2590-53117	M	J											M	Q	Q[17]		
2590-53118	M	J											K				
2590-53119	F	J											M				
2590-53120	U	J													K		
2590-53121	F	A											K	K	K	K	K
2590-53122	U	J											K				
2590-53123	U	J											K				

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2590-53124	M	A											K				
2590-53125	M	J											K				
2590-53126	F	J											D				
2590-53127	F	J											K				
2590-53128	M	A														O	
2590-53129	M	A														O	O
2590-53130	M	A														O	
2590-53131	U	J														T	
2590-53141	M	J											M				
2590-53142	M	J											M				
2590-53143	M	J											N				
2590-53144	F	J											K				
2590-53145	M	A											S				
2590-53147	U	J											D				
2590-53148	M	A											K	K			
2590-53149	M	J											K				
2590-53150	U	J											M				
2590-53151	M	J											M				
2590-53152	F	J											Q				
2590-53153	M	A												K			
2590-53154	M	J											Q				
2590-53155	U	J												M			
2590-53156	F	A												M	M		
2590-53157	F	J												M	D	D	
2590-53158	U	J												K			
2590-53159	U	J													S		
2590-53160	F	J													S	S	
2590-53162	M	A											T				
2590-53163	F	A											B				
2590-53164	M	J											B				
2590-53165	F	A												B			
2590-53166	M	A												T			
2590-53167	M	A														T	
2590-53168	M	A														T	T
2590-53169	U	J														K	
2590-53171	F	A											E	K	K	K	K
2590-53172	M	J											K				
2590-53173	F	A											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
2590-53178	U	J													K		
2590-53179	U	J													K		
2590-53180	U	J													K		

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2590-53181	U	J													K		
2590-53182	M	J											B				
2590-53183	U	J														P	
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
2660-23008	U	J													S		
2660-23009	U	J													S		
2660-23010	F	J													S	S	S
2660-23011	U	J													S		
2660-23012	U	J												K			
2660-23013	U	J													S		
2660-23014	U	J												P			
2660-23015	F	J													S		S
2660-23016	F	A													D	D	
2660-23017	M	A													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		
2660-23024	U	J												M			
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[15]	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
2660-23039	F	J														W	W
2660-23040	U	J														W	
2660-23041	U	J														K	
2660-23042	F	J													K	K	P
2660-23043	U	J														K	
2660-23044	M	J														P	E
2660-23045	F	J														P	E

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2660-23046	U	J														K	
2660-23047	U	J														K	
2660-23048	M	J														P	E
2660-23049	U	J														P	
2660-23051	U	J														P	
2660-23052	U	J														D	
2660-23053	F	A														K	P
2660-23054	M	A															P[8]
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
2660-23064	M	A														O	
2660-23065	F	A														P	
2660-23066	M	A														O	O
2660-23067	M	A														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
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	U	J															P
2660-23085	U	J														O	
2660-23086	U	J														O	
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	

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
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
2660-23104	U	J															W
2660-23105	U	J															W
2660-23106	U	J															D
2660-23107	U	J															K
2660-23109	M	A															Q
2660-23110	U	J															Q
2660-23111	F	A															E
2660-23112	U	J															D
2660-23113	U	J															D
2660-23114	F	A															W
2660-23115	U	J															K
2660-23116	U	J															K
2660-23117	U	J															M
2660-23118	F	A															M
2660-23133	M	A															K
2660-23134	M	A															E
2660-23135	U	J															P
2660-23136	U	J															K
2660-23137	U	J															K
2660-23138	U	J															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	U	J															W
2660-23174	M	A															O
2660-23175	F	A															O
2660-23176	F	A															O
2660-23177	M	A															O
2660-23178	M	A															T
2660-23179	U	J															O

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
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
2660-23186	U	J															O
2660-23187	U	J															O
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
2660-23194	U	J															B
2660-23195	U	J															B
2660-23203	M	A															O
2660-23204	U	J															O
2660-23205	U	J															O
2660-23206	U	J															O
2660-23207	M	A															O
2660-23208	M	A															T
2660-23209	M	A															T
2660-23210	M	A															T
2660-23211	F	A															T
2660-23212	U	J															O
2660-23213	U	J															O
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
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	U	J															P
2660-23236	U	J															N

Table 8-1.—Willow flycatchers banded and/or resighted by SWCA Environmental Consultants along the Virgin and lower Colorado Rivers in 2010–15*

Original Federal band number	Sex[2]	Age when banded[3]	Study area detected[1]														
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2660-23237	U	J															P
2660-23238	U	J															K
2660-23239	U	J															K
2660-23240	U	J															S
2660-23241	U	J															S
2660-23242	U	J															P
2660-23243	U	J															P
9999-99999	M	A														K	K

* Table includes individuals banded at sites prior to 2010, including some individuals banded prior to 2003 (Braden and McKernan, unpublished data), and recaptured or resighted by SWCA Environmental Consultants between 2010 and 2015.

[1] K = Key Pittman, E = River Ranch, P = Pahranagat, W = Meadow Valley Wash, S = St. George, L = Littlefield, Q = Mesquite, M = Mormon Mesa, D = Muddy River, N = Warm Springs, V = Las Vegas Wash, G = Grand Canyon, T = Topock Marsh, B = Bill Williams, O = Alamo Lake, 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] M = male, F = female, 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 the Grand Canyon to Mesquite.
[7] Within-season movement from Mormon Mesa to Muddy River.
[8] Within-season movement from Pahranagat to Key Pittman.
[9] Within-season movement from Muddy River to Mesquite.
[10] Within-season movement from Grand Canyon to Mormon Mesa.
[11] Within-season movement from River Ranch to Key Pittman.
[12] Within-season movement from Pahranagat to River Ranch.
[13] Likely within-season movement from Topock Marsh to Muddy River.
[14] Within-season movement from Muddy River to Mormon Mesa.
[15] Within-season movement from Key Pittman to Pahranagat.
[16] Within-season movement from Mesquite to Key Pittman.
[17] Within-season movement from Mesquite to Muddy River.

ATTACHMENT 9

Temperature and Humidity at Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Nests at Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2015

Table 9-1.—Maximum daily temperature (degrees Celsius) at southwestern willow flycatcher nests at Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2015*

Study area[1]	Vegetation type[2]	June 1–15		June 16–30		July 1–15		July 16–31		August 1–15	
		Median (25th–75th percentile)	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**
MUDD	TAMSPP_SALEXI (n = 3)	n/a	n/a	40.0 (39.1-40.5)	39.8 (0.4)	38.1 (36.1-39.6)	37.7 (0.6)	38.1 (35.1-40.0)	37.7 (0.6)	n/a	n/a
TOPO	SALGOO_TAMSPP (n = 1)	n/a	n/a	n/a	n/a	n/a	n/a	37.6 (36.4-38.4)	37.2 (0.5)	39.1 (38.1-40.6)	38.9 (0.6)
	TAMSPP (n = 1)	33.9 (33.1-35.6)	34.4 (0.7)	36.6 (35.6-37.1)	36.2 (0.3)	36.1 (34.1-37.1)	35.7 (0.5)	36.9 (35.9-37.4)	36.4 (0.4)	37.6 (36.1-38.1)	37.1 (0.6)
	TAMSPP_SALGOO (n = 1)	n/a	n/a	38.1 (37.3-39.8)	38.4 (0.6)	37.1 (35.6-38.6)	37.2 (0.5)	37.1 (35.3-37.8)	36.7 (0.5)	40.3 (37.1-40.6)	38.5 (1.4)
	Overall	**33.9 (33.1-35.6)**	**34.4 (0.7)**	**37.1 (36.1-38.1)**	**37.1 (0.4)**	**36.6 (35.1-37.6)**	**36.4 (0.3)**	**37.1 (36.1-37.9)**	**36.8 (0.3)**	**38.4 (37.1-40.1)**	**38.1 (0.4)**
BIWI	TAMSPP (n = 5)	39.1 (38.1-40.1)	39.1 (1.0)	38.1 (37.6-39.6)	38.3 (0.3)	36.6 (34.6-37.6)	36.1 (0.3)	36.6 (35.3-38.6)	36.8 (0.2)	36.6 (35.6-39.1)	36.3 (0.8)
	TAMSPP_SALEXI (n = 1)	n/a	n/a	n/a	n/a	37.6 (35.6-39.6)	37.5 (0.8)	36.4 (36.1-37.1)	36.5 (0.3)	37.6 (33.9-38.6)	36.3 (1.9)
	Overall	**39.1 (38.1-40.1)**	**39.1 (1.0)**	**38.1 (37.6-39.6)**	**38.3 (0.3)**	**36.6 (34.6-38.1)**	**36.4 (0.3)**	**36.6 (35.6-38.1)**	**36.7 (0.2)**	**36.9 (35.6-39.1)**	**36.3 (0.7)**
ALAM	SALGOO (n = 6)	35.1 (33.6-37.2)	35.3 (0.4)	40.1 (38.9-41.1)	40.0 (0.2)	37.6 (35.6-39.2)	37.4 (0.2)	39.1 (38.1-40.6)	38.8 (0.3)	40.9 (39.1-42.6)	40.9 (0.3)
	SALGOO_TAMSPP (n = 3)	34.1 (33.1-36.6)	34.7 (0.6)	40.6 (39.1-42.1)	40.6 (0.3)	39.1 (37.1-41.6)	39.4 (0.4)	41.1 (39.1-42.8)	40.6 (0.5)	44.6 (42.6-46.0)	44.2 (0.5)
	TAMSPP_SALGOO (n = 1)	40.1 (38.1-42.6)	40.3 (1.4)	48.1 (46.6-49.6)	47.9 (0.5)	47.1 (40.6-49.1)	45.4 (1.4)	45.6 (40.8-49.3)	44.4 (1.5)	48.1 (42.6-50.0)	47.1 (1.4)
	Overall	**35.1 (33.6-38.1)**	**35.7 (0.4)**	**40.6 (39.1-42.1)**	**41.1 (0.3)**	**38.6 (36.1-40.2)**	**38.8 (0.3)**	**40.1 (38.1-42.1)**	**39.9 (0.3)**	**41.6 (39.6-44.6)**	**42.3 (0.3)**

* n/a = data not available.

[1] MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.
[2] TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory; TAMSPP = > 75% tamarisk; TAMSPP_SALGOO = tamarisk with emergent Goodding's willow; SALGOO = > 75% Goodding's willow; and n = number of nests.

Table 9-2.—Minimum daily temperature (degrees Celsius) at southwestern willow flycatcher nests at Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2015*

Study area[1]	Vegetation type[2]	June 1–15		June 16–30		July 1–15		July 16–31		August 1–15	
		Median (25th–75th percentile)	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**
MUDD	TAMSPP_SALEXI (n = 3)	n/a	n/a	19.6 (17.6-26.6)	21.9 (1.7)	18.6 (18.1-23.6)	20.5 (0.6)	19.6 (17.6-20.6)	19.3 (0.4)	n/a	n/a
TOPO	SALGOO_TAMSPP (n = 1)	n/a	n/a	n/a	n/a	n/a	n/a	21.9 (19.6-23.2)	21.1 (0.7)	21.7 (20.7-23.7)	22.2 (0.6)
	TAMSPP (n = 1)	21.4 (14.6-22.6)	19.8 (1.4)	21.6 (19.6-26.1)	22.3 (1.1)	22.6 (20.1-25.6)	22.7 (0.7)	22.6 (20.4-23.6)	21.8 (0.6)	22.6 (21.1-23.6)	22.5 (0.7)
	TAMSPP_SALGOO (n = 1)	n/a	n/a	20.6 (17.1-24.6)	20.8 (1.3)	20.6 (18.6-24.1)	21.2 (0.8)	20.8 (18.3-22.4)	20.2 (0.7)	19.8 (18.6-21.1)	20.1 (0.7)
	Overall	**21.4 (14.6-22.6)**	**19.8 (1.4)**	**21.1 (18.1-25.6)**	**21.6 (0.8)**	**22.1 (19.6-24.1)**	**21.9 (0.6)**	**21.6 (19.4-23.1)**	**21.1 (0.4)**	**21.9 (20.4-23.4)**	**22.0 (0.4)**
BIWI	TAMSPP (n = 5)	19.9 (19.2-20.7)	19.9 (0.8)	20.2 (18.1-25.2)	20.8 (0.9)	18.1 (17.1-22.6)	19.5 (0.4)	21.2 (19.8-22.6)	20.7 (0.3)	20.6 (19.1-21.6)	20.7 (0.4)
	TAMSPP_SALEXI (n = 1)	n/a	n/a	n/a	n/a	17.6 (17.6-23.2)	19.8 (0.9)	21.4 (19.4-22.4)	20.8 (0.7)	20.7 (19.9-22.4)	21.2 (0.9)
	Overall	**19.9 (19.2-20.7)**	**19.9 (0.8)**	**20.2 (18.1-25.2)**	**20.8 (0.9)**	**18.1 (17.1-22.6)**	**19.5 (0.4)**	**21.2 (19.8-22.6)**	**20.7 (0.3)**	**20.6 (19.6-21.6)**	**20.7 (0.4)**
ALAM	SALGOO (n = 6)	15.1 (10.6-18.1)	14.8 (0.5)	16.6 (15.6-20.8)	17.5 (0.4)	20.1 (17.1-22.1)	19.4 (0.3)	19.6 (17.2-20.6)	19.0 (0.3)	19.9 (18.6-22.6)	20.4 (0.3)
	SALGOO_TAMSPP (n = 3)	15.1 (10.1-18.1)	14.8 (0.7)	16.6 (15.6-21.6)	17.6 (0.5)	20.1 (17.1-22.1)	19.7 (0.4)	19.6 (17.6-20.9)	19.1 (0.4)	19.6 (18.6-22.1)	19.9 (0.4)
	TAMSPP_SALGOO (n = 1)	13.6 (9.1-17.6)	14.1 (1.2)	16.1 (15.1-21.6)	17.2 (1)	19.6 (16.1-22.1)	19.4 (0.8)	19.1 (16.9-20.9)	18.8 (0.8)	18.6 (18.1-22.1)	19.5 (0.7)
	Overall	**15.1 (10-18.1)**	**14.7 (0.4)**	**16.6 (15.6-21.6)**	**17.5 (0.3)**	**20.1 (17.1-22.1)**	**19.5 (0.2)**	**19.6 (17.2-20.6)**	**19 (0.2)**	**19.6 (18.6-22.6)**	**20.2 (0.2)**

* n/a = data not available.

[1] MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.
[2] TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory; TAMSPP = > 75% tamarisk; TAMSPP_SALGOO = tamarisk with emergent Goodding's willow; SALGOO = > 75% Goodding's willow; and n = number of nests.

Table 9-3.—Daily temperature range (degrees Celsius) at southwestern willow flycatcher nests at Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2015*

Study area[1]	Vegetation type[2]	June 1–15		June 16–30		July 1–15		July 16–31		August 1–15	
		Median (25th–75th percentile)	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**
MUDD	TAMSPP_SALEXI (n = 3)	n/a	n/a	18.5 (13.5-21.5)	17.8 (1.6)	18.0 (13.0-21.0)	17.2 (0.9)	19.5 (15.0-22.0)	18.3 (0.8)	n/a	n/a
TOPO	SALGOO_TAMSPP (n = 1)	n/a	n/a	n/a	n/a	n/a	n/a	16.0 (13.2-18.2)	16 (1.0)	17.0 (15.5-19.5)	16.7 (1.0)
	TAMSPP (n = 1)	14.2 (11.0-19.0)	14.6 (1.2)	14.0 (10.0-17.5)	13.8 (1.1)	13.0 (11.0-15.5)	13.0 (0.8)	14.0 (12.7-16.7)	14.6 (0.9)	14.5 (13.0-17.5)	14.6 (0.9)
	TAMSPP_SALGOO (n = 1)	n/a	n/a	17.7 (13.5-21.2)	17.6 (1.5)	16.0 (13.0-20.0)	16.0 (1.0)	17.0 (13-18.5)	16.5 (1.0)	20.5 (16.0-22.0)	18.4 (2.0)
	Overall	**14.2 (11.0-19.0)**	**14.6 (1.2)**	**14.5 (12.0-18.5)**	**15.5 (0.9)**	**14.2 (11.5-17.5)**	**14.5 (0.7)**	**15.5 (13.0-18.5)**	**15.7 (0.6)**	**16.5 (13.7-19.2)**	**16.1 (0.7)**
BIWI	TAMSPP (n = 5)	19.2 (19.0-19.5)	19.2 (0.2)	18.0 (13.0-21.5)	17.5 (1.0)	17.5 (14.0-19.5)	16.6 (0.5)	15.5 (13.5-18.5)	16.1 (0.4)	17.5 (15.0-18.5)	15.7 (1.0)
	TAMSPP_SALEXI (n = 1)	n/a	n/a	n/a	n/a	19.5 (16.0-21.5)	17.7 (1.2)	15.2 (13.5-17.5)	15.7 (0.8)	17.0 (11.5-18.7)	15.1 (2.8)
	Overall	**19.2 (19.0-19.5)**	**19.2 (0.2)**	**18.0 (13.0-21.5)**	**17.5 (1.0)**	**17.5 (14.2-20.0)**	**16.8 (0.5)**	**15.5 (13.5-18.5)**	**16.0 (0.4)**	**17.5 (15.0-18.5)**	**15.6 (0.9)**
ALAM	SALGOO (n = 6)	23.0 (17.5-25.0)	20.5 (0.7)	23.5 (19.0-25.7)	22.5 (0.5)	18.7 (15.0-20.5)	18.0 (0.4)	19.5 (15.7-23.2)	19.8 (0.6)	20.5 (17.0-23.5)	20.5 (0.5)
	SALGOO_TAMSPP (n = 3)	21.5 (16.5-24.0)	19.9 (0.9)	23.5 (19.0-26.5)	23.0 (0.7)	20.0 (16.5-22.5)	19.7 (0.7)	21.5 (16.7-25.2)	21.5 (0.8)	24.5 (21.0-27.5)	24.3 (0.9)
	TAMSPP_SALGOO (n = 1)	30.5 (22.0-32.0)	26.3 (2.1)	31.5 (27.4-33.9)	30.7 (1.1)	25.9 (21.0-31.5)	26.0 (2.0)	27.2 (18.7-33.4)	25.7 (2.1)	28.4 (24.0-31.4)	27.6 (1.9)
	Overall	**23.0 (17.5-25.0)**	**21.0 (0.6)**	**24.0 (20.0-26.7)**	**23.6 (0.4)**	**19.5 (15.5-22.5)**	**19.3 (0.4)**	**20.5 (16.5-25.0)**	**20.9 (0.5)**	**22.0 (18.0-25.5)**	**22.2 (0.5)**

* n/a = data not available.

[1] MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.
[2] TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory; TAMSPP = > 75% tamarisk; TAMSPP_SALGOO = tamarisk with emergent Goodding's willow; SALGOO = > 75% Goodding's willow; and n = number of nests.

Table 9-4.—Mean diurnal vapor pressure (Pascals) at southwestern willow flycatcher nests at Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2015*

Study area[1]	Vegetation type[2]	June 1–15		June 16–30		July 1–15		July 16–31		August 1–15	
		Median (25th–75th percentile)	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**
MUDD	TAMSPP_SALEXI (n = 3)	n/a	n/a	1630 (1419-1971)	1685 (114)	1437 (1215-2051)	1602 (79)	1486 (1389-1994)	1660 (63)	n/a	n/a
TOPO	SALGOO_TAMSPP (n = 1)	n/a	n/a	n/a	n/a	n/a	n/a	2116 (1730-2560)	2121 (110)	2248 (1828-2640)	2254 (105)
	TAMSPP (n = 1)	2131 (1839-2244)	2023 (107)	2054 (2004-2590)	2230 (88)	2161 (1774-2565)	2181 (113)	2224 (1983-2655)	2283 (100)	2396 (2165-2735)	2467 (91)
	TAMSPP_SALGOO (n = 1)	n/a	n/a	2034 (1770-2503)	2115 (123)	1970 (1619-2446)	2025 (121)	2116 (1768-2627)	2179 (115)	2273 (2055-2422)	2288 (107)
	Overall	**2131 (1839-2244)**	**2023 (107)**	**2054 (1892-2553)**	**2178 (73)**	**2069 (1716-2526)**	**2103 (82)**	**2155 (1807-2608)**	**2194 (62)**	**2330 (2044-2645)**	**2348 (61)**
BIWI	TAMSPP (n = 5)	2094 (1960-2228)	2094 (134)	2274 (2136-2619)	2324 (67)	2174 (1908-2672)	2252 (72)	2389 (2134-2808)	2387 (53)	2467 (2382-2903)	2504 (86)
	TAMSPP_SALEXI (n = 1)	n/a	n/a	n/a	n/a	2002 (1794-2416)	2145 (131)	2259 (1919-2754)	2325 (109)	2432 (2157-2727)	2442 (171)
	Overall	**2094 (1960-2228)**	**2094 (134)**	**2274 (2136-2619)**	**2324 (67)**	**2151 (1890-2625)**	**2230 (63)**	**2381 (2085-2808)**	**2377 (48)**	**2467 (2343-2859)**	**2494 (76)**
ALAM	SALGOO (n = 6)	1754 (1365-1982)	1689 (47)	1803 (1655-2235)	1966 (48)	1912 (1655-2545)	2084 (51)	2059 (1551-2522)	2035 (53)	2090 (1792-2374)	2089 (38)
	SALGOO_TAMSPP (n = 3)	1831 (1391-1988)	1726 (62)	1824 (1683-2214)	1936 (59)	1776 (1569-2444)	1968 (72)	1924 (1408-2462)	1937 (78)	1872 (1667-2085)	1919 (62)
	TAMSPP_SALGOO (n = 1)	1620 (1371-1940)	1676 (97)	1724 (1518-2195)	1838 (97)	1711 (1514-2338)	1927 (117)	1841 (1378-2403)	1880 (135)	1901 (1551-2081)	1863 (109)
	Overall	**1760 (1371-1983)**	**1700 (35)**	**1792 (1653-2205)**	**1941 (35)**	**1879 (1617-2491)**	**2033 (39)**	**1980 (1534-2499)**	**1990 (42)**	**1988 (1721-2316)**	**2023 (32)**

* n/a = data not available.

[1] MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.
[2] TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory; TAMSPP = > 75% tamarisk; TAMSPP_SALGOO = tamarisk with emergent Goodding's willow; SALGOO = > 75% Goodding's willow; and n = number of nests.

Table 9-5.—Mean nocturnal vapor pressure (Pascals) at southwestern willow flycatcher nests at Muddy River, Topock Marsh, Bill Williams, and Alamo Lake, 2015*

Study area[1]	Vegetation type[2]	June 1–15		June 16–30		July 1–15		July 16–31		August 1–15	
		Median (25th–75th percentile)	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**
MUDD	TAMSPP_SALEXI (n = 3)	n/a	n/a	1523 (1316-1860)	1548 (109)	1401 (1281-1915)	1547 (63)	1410 (1288-1784)	1550 (56)	n/a	n/a
TOPO	SALGOO_TAMSPP (n = 1)	n/a	n/a	n/a	n/a	n/a	n/a	2076 (1544-2439)	2008 (107)	2072 (1828-2235)	2065 (75)
	TAMSPP (n = 1)	1946 (1511-2046)	1825 (119)	1721 (1618-2038)	1846 (83)	1876 (1719-2373)	2009 (94)	2037 (1650-2534)	2060 (107)	2167 (2002-2314)	2206 (65)
	TAMSPP_SALGOO (n = 1)	n/a	n/a	1962 (1828-2231)	2046 (89)	1979 (1904-2458)	2128 (79)	2166 (1817-2555)	2180 (90)	2141 (2093-2332)	2170 (69)
	Overall	**1946 (1511-2046)**	**1825 (119)**	**1899 (1686-2169)**	**1935 (63)**	**1973 (1819-2373)**	**2068 (61)**	**2100 (1700-2519)**	**2083 (58)**	**2108 (1968-2313)**	**2141 (43)**
BIWI	TAMSPP (n = 5)	2054 (2045-2062)	2054 (9)	2094 (2006-2391)	2184 (59)	1914 (1782-2431)	2027 (52)	2158 (1823-2473)	2141 (45)	2293 (2055-2492)	2274 (63)
	TAMSPP_SALEXI (n = 1)	n/a	n/a	n/a	n/a	2017 (1919-2450)	2169 (90)	2210 (1995-2524)	2259 (83)	2484 (2254-2693)	2474 (144)
	Overall	**2054 (2045-2062)**	**2054 (9)**	**2094 (2006-2391)**	**2184 (59)**	**1939 (1808-2441)**	**2056 (46)**	**2167 (1832-2493)**	**2161 (40)**	**2303 (2076-2502)**	**2305 (59)**
ALAM	SALGOO (n = 6)	1589 (1172-1807)	1539 (41)	1574 (1447-2023)	1744 (51)	1965 (1607-2367)	1996 (42)	2023 (1578-2253)	1975 (42)	2075 (1829-2226)	2033 (28)
	SALGOO_TAMSPP (n = 3)	1610 (1276-1871)	1623 (52)	1668 (1541-2061)	1843 (62)	2031 (1655-2450)	2061 (59)	2111 (1650-2270)	2012 (57)	1985 (1850-2209)	2041 (41)
	TAMSPP_SALGOO (n = 1)	1625 (1207-1853)	1577 (92)	1699 (1519-2097)	1822 (109)	1988 (1622-2509)	2070 (107)	2071 (1647-2271)	2006 (103)	1990 (1869-2267)	2039 (73)
	Overall	**1603 (1218-1823)**	**1571 (30)**	**1623 (1485-2052)**	**1786 (37)**	**1988 (1622-2400)**	**2023 (32)**	**2051 (1612-2259)**	**1989 (32)**	**2048 (1842-2226)**	**2036 (22)**

* n/a = data not available.

[1] MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams, and ALAM = Alamo Lake.
[2] TAMSPP_SALEXI = tamarisk and coyote willow mix, neither > 75%; SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory; TAMSPP = > 75% tamarisk; TAMSPP_SALGOO = tamarisk with emergent Goodding's willow; SALGOO = > 75% Goodding's willow; and n = number of nests.

ATTACHMENT 10

Temperature and Humidity at Beetle Points at
Muddy River, Topock Marsh, and Bill Williams, 2015

Table 10-1.—Maximum and minimum daily temperature (degrees Celsius) recorded by original iButtons at beetle monitoring points at Muddy River, Topock Marsh, and Bill Williams, 2015*

Study area[1]	Vegetation type[2]	May 16–31		June 1–15		June 16–30		July 1–15		July 16–31		August 1–15	
		Median (25th–75th percentile)	**Mean (standard error)**	**Median (25th– 75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**
Maximum daily temperature													
MUDD	SALGOO_TAMSPP (n = 10)	41.1 (37.1-44.6)	41.3 (1.0)	39.6 (36.6-42.6)	40.0 (0.4)	44.6 (43.1-47.0)	45.7 (0.3)	42.1 (39.1-44.0)	42.0 (0.4)	42.1 (40.1-45.1)	42.6 (0.4)	43.1 (38.1-44.6)	41.8 (0.7)
	TAMSPP (n = 10)	37.6 (34.1-42.6)	38.6 (0.5)	43.3 (40.1-46.5)	43.1 (0.4)	48.5(46.6-50.5)	48.8 (0.3)	44.1 (41.1-47.0)	44.0 (0.4)	44.4 (40.6-47.6)	44.0 (0.4)	44.1 (40.6-48)	43.5 (0.8)
	Overall	**38.1 (34.2-43.1)**	**39.0 (0.4)**	**41.1 (37.6-45.1)**	**41.6 (0.3)**	**47.0 (44.1-49.1)**	**47.3 (0.2)**	**42.6 (40.1-45.6)**	**43.0 (0.3)**	**43.0 (40.6-46.1)**	**43.3 (0.3)**	**43.5 (40.1-46.1)**	**42.6 (0.5)**
TOPO	TAMSPP_SALGOO (n = 7)	37.6 (36.1-40.1)	38.2 (0.7)	35.6 (33.6-37.1)	35.5 (0.2)	38.6 (36.7-40.1)	38.6 (0.2)	37.6 (35.6-38.6)	37.0 (0.2)	36.9 (35.1-38.1)	36.9 (0.2)	39.6 (36.6-40.6)	38.6 (0.7)
	TAMSPP (n = 5)	39.1 (38.1-40.1)	39.1 (0.5)	36.9 (35.1-38.8)	37.0 (0.4)	39.6 (37.6-42.5)	40.0 (0.4)	38.6 (36.1-40.6)	38.3 (0.3)	38.1 (35.4-40.6)	37.7 (0.4)	39.8 (36.1-43)	38.8 (0.9)
	Overall	**38.6 (36.6-40.1)**	**38.5 (0.5)**	**36.1 (34.1-38.1)**	**36.1 (0.2)**	**38.9 (37.6-40.9)**	**39.2 (0.2)**	**37.6 (35.6-39.1)**	**37.5 (0.2)**	**37.1 (35.1-39.1)**	**37.3 (0.2)**	**39.6 (36.1-41.6)**	**38.7 (0.5)**
BIWI	SALGOO_TAMSPP (n = 15)	33.6 (30.6-36.4)	33.7 (0.3)	36.7 (35.1-39.1)	37.1 (0.3)	39.1 (37.6-41.6)	39.7 (0.2)	37.1 (35.2-39.1)	37.6 (0.2)	37.8 (36.1-39.1)	37.9 (0.2)	39.8 (37.1-41.6)	38.7 (0.5)
Minimum daily temperature													
MUDD	SALGOO_TAMSPP (n = 10)	14.1 (13.6-16.1)	14.8 (0.4)	18.1 (15.6-19.6)	17.7 (0.2)	18.6 (15.1-22.6)	19.0 (0.4)	19.9 (17.1-23.6)	20.5 (0.3)	19.1 (17.1-21.1)	19.4 (0.2)	19.6 (18.6-22.1)	20.2 (0.3)
	TAMSPP (n = 10)	14.1 (12.6-16.1)	14.4 (0.2)	19.1 (16.6-21.1)	18.8 (0.2)	19.7 (16.6-24.7)	20.5 (0.4)	21.1 (18.1-25.2)	21.8 (0.3)	20.1 (18.2-21.6)	20.3 (0.2)	20.2 (19.1-23.6)	21.0 (0.3)
	Overall	**14.1 (12.6-16.1)**	**14.4 (0.2)**	**18.6 (16.1-20.2)**	**18.3 (0.2)**	**19.1 (16.1-23.6)**	**19.8 (0.3)**	**20.6 (17.6-24.6)**	**21.2 (0.2)**	**19.6 (17.6-21.6)**	**19.9 (0.2)**	**20.2 (18.6-22.6)**	**20.6 (0.2)**
TOPO	TAMSPP_SALGOO (n = 7)	13.1 (12.6-13.6)	13.0 (0.2)	17.1 (13.6-20.2)	16.9 (0.4)	19.1 (16.6-21.6)	19.5 (0.4)	20.1 (18.1-23.6)	20.7 (0.3)	20.2 (18.1-22.1)	19.9 (0.3)	19.6 (18.6-20.6)	19.9 (0.2)
	TAMSPP (n = 5)	13.6 (12.8-13.6)	13.3 (0.3)	17.9 (13.6-20.9)	17.2 (0.5)	20.1 (16.1-23.1)	19.8 (0.5)	21.1 (18.6-24.1)	21.1 (0.4)	20.6 (18.1-22.1)	20.1 (0.3)	20.1 (19.1-21.6)	20.1 (0.3)
	Overall	**13.3 (12.6-13.6)**	**13.1 (0.2)**	**17.1 (13.6-20.6)**	**17.0 (0.3)**	**19.6 (16.6-22.1)**	**19.6 (0.3)**	**21.1 (18.1-23.6)**	**20.9 (0.2)**	**20.6 (18.1-22.1)**	**20.0 (0.2)**	**19.7 (18.6-20.9)**	**20.0 (0.2)**
BIWI	SALGOO_TAMSPP (n = 15)	13.6 (12.6-14.6)	13.6 (0.1)	16.2 (14.1-19.6)	16.9 (0.2)	19.6 (18.6-23.1)	20.6 (0.2)	20.2 (18.1-22.7)	20.4 (0.2)	21.6 (19.3-22.6)	20.9 (0.2)	21.1 (19.6-21.6)	20.8 (0.2)

[1] MUDD = Muddy River, TOPO = Topock Marsh, and BIWI = Bill Williams.
[2] SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory, TAMSPP = > 75% tamarisk, and TAMSPP_SALGOO = tamarisk with emergent Goodding's willow.

Table 10-2.—Daily temperature range (degrees Celsius) recorded by original iButtons at beetle monitoring points at Muddy River, Topock Marsh, and Bill Williams , 2015*

Study area[1]	Vegetation type[2]	May 16–31		June 1–15		June 16–30		July 1–15		July 16–31		August 1–15	
		Median (25th–75th percentile)	**Mean (standard error)**	**Median (25th– 75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**	**Median (25th–75th percentile)**	**Mean (standard error)**
MUDD	SALGOO_TAMSPP (n = 10)	26.0 (21.0-31.5)	26.5 (1.1)	22.0 (19.5-24.5)	22.3 (0.4)	26.5 (22.5-30.5)	26.7 (0.5)	22.0 (17.5-25.5)	21.5 (0.5)	23.7 (19.5-26.7)	23.2 (0.5)	24.0 (16.5-26.5)	21.6 (0.9)
	TAMSPP (n = 10)	23.2 (20.5-27.7)	24.2 (0.4)	24.5 (20.5-27.9)	24.2 (0.4)	28.5 (23.4-31.9)	28.3 (0.5)	22.5 (18.0-26.0)	22.2 (0.5)	24.5 (19.5-28.4)	23.7 (0.5)	23.5 (20.5-27.4)	22.5 (1.0)
	Overall	**23.5 (21.0-28.0)**	**24.6 (0.4)**	**23.0 (20.0-26.9)**	**23.3 (0.3)**	**27.5 (22.9-31.4)**	**27.5 (0.4)**	**22.0 (17.5-25.9)**	**21.8 (0.3)**	**24.0 (19.5-27.0)**	**23.4 (0.4)**	**24.0 (17.5-27)**	**22.0 (0.7)**
TOPO	TAMSPP_SALGOO (n = 7)	24.5 (23.3-27.0)	25.2 (0.5)	19.0 (16.0-22.0)	18.6 (0.4)	18.5 (15.5-23.5)	19.1 (0.5)	16.0 (13.5-19.5)	16.4 (0.4)	17.0 (13.5-20.0)	17.1 (0.4)	20.4 (16.0-21.5)	18.7 (0.8)
	TAMSPP (n = 5)	25.8 (25.0-26.5)	25.8 (0.4)	20.5 (16.2-23)	19.8 (0.6)	19.0 (16.0-24.0)	20.2 (0.6)	16.5 (14.0-20.5)	17.1 (0.5)	17.5 (14.2-20.5)	17.6 (0.5)	19.5 (16.5-22.5)	18.6 (1.1)
	Overall	**25.3 (23.8-26.7)**	**25.4 (0.4)**	**19.0 (16.0-22.0)**	**19.1 (0.4)**	**18.5 (16.0-23.5)**	**19.6 (0.4)**	**16.0 (13.7-19.5)**	**16.7 (0.3)**	**17.2 (14.0-20.0)**	**17.3 (0.3)**	**20.2 (16.2-22.2)**	**18.7 (0.7)**
BIWI	SALGOO_TAMSPP (n = 15)	20.0 (17.3-23.0)	20.1 (0.2)	21.0 (18.5-23.0)	20.2 (0.3)	19.0 (15.5-22.0)	19.1 (0.3)	17.5 (14.0-20.5)	17.2 (0.3)	17.0 (13.7-20)	17.0 (0.3)	19.7 (16.0-22.0)	17.9 (0.6)

[1] MUDD = Muddy River, TOPO = Topock Marsh, and BIWI = Bill Williams.
[2] SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory, TAMSPP = > 75% tamarisk, and TAMSPP_SALGOO = tamarisk with emergent Goodding's willow.

Table 10-3.—Diurnal and nocturnal vapor pressure (Pascals) recorded by original iButtons at beetle monitoring points at Muddy River, Topock Marsh, and Bill Williams, 2015*

Study area[1]	Vegetation type[2]	May 16–31		June 1–15		June 16–30		July 1–15		July 16–31		August 1–15	
		Median (25th–75th percentile)	Mean (standard error)	Median (25th– 75th percentile)	Mean (standard error)	Median (25th–75th percentile)	Mean (standard error)	Median (25th–75th percentile)	Mean (standard error)	Median (25th–75th percentile)	Mean (standard error)	Median (25th–75th percentile)	Mean (standard error)
Diurnal vapor pressure													
MUDD	SALGOO_TAMSPP (n = 10)	1191 (930-1284)	1123 (37)	1271 (1048-1642)	1324 (27)	1288 (1144-1765)	1420 (32)	1433 (1253-2058)	1656 (37)	1428 (1213-1906)	1561 (32)	1826 (1371-2288)	1809 (58)
	TAMSPP (n = 10)	965 (879-1063)	1007 (15)	1112 (859-1427)	1156 (26)	1003 (858-1427)	1135 (30)	1315 (1100-1852)	1481 (33)	1301 (1146-1818)	1464 (34)	1466 (1180-1926)	1552 (57)
	Overall	**971 (881-1090)**	**1027 (14)**	**1224 (984-1528)**	**1240 (19)**	**1175 (946-1554)**	**1277 (23)**	**1408 (1182-1969)**	**1568 (25)**	**1393 (1189-1860)**	**1513 (23)**	**1574 (1282-2101)**	**1690 (42)**
TOPO	TAMSPP_SALGOO (n = 7)	1622 (1498-1700)	1619 (32)	1851 (1373-2168)	1782 (45)	2065 (1874-2530)	2179 (37)	2114 (1744-2548)	2130 (43)	2208 (1879-2627)	2236 (37)	2384 (2186-2535)	2372 (38)
	TAMSPP (n = 5)	1604 (1497-1669)	1584 (45)	1897 (1410-2192)	1847 (57)	2220 (1933-2598)	2285 (49)	2289 (1791-2652)	2234 (55)	2359 (1921-2730)	2329 (48)	2403 (2223-2674)	2432 (56)
	Overall	**1613 (1498-1700)**	**1608 (26)**	**1887 (1398-2179)**	**1809 (35)**	**2138 (1904-2534)**	**2223 (30)**	**2187 (1762-2586)**	**2173 (34)**	**2289 (1906-2678)**	**2275 (30)**	**2385 (2206-2612)**	**2397 (32)**
BIWI	SALGOO_TAMSPP (n = 15)	1365 (1232-1510)	1396 (13)	2028 (1366-2325)	1864 (34)	2377 (2173-2648)	2413 (19)	2281 (1951-2791)	2372 (32)	2327 (2075-2858)	2432 (28)	2414 (2230-2820)	2513 (35)
Nocturnal vapor pressure													
MUDD	SALGOO_TAMSPP (n = 10)	1165 (1045-1269)	1161 (34)	1223 (997-1538)	1262 (23)	1201 (1108-1516)	1304 (23)	1434 (1257-1923)	1566 (29)	1421 (1261-1779)	1525 (27)	1653 (1367-2101)	1739 (46)
	TAMSPP (n = 10)	1051 (918-1142)	1084 (17)	1171 (817-1400)	1144 (25)	1038 (952-1347)	1152 (22)	1284 (1099-1788)	1433 (29)	1296 (1122-1724)	1414 (28)	1522 (1163-1983)	1555 (48)
	Overall	**1058 (920-1165)**	**1097 (16)**	**1197 (958-1497)**	**1203 (17)**	**1146 (1003-1387)**	**1228 (17)**	**1383 (1171-1843)**	**1500 (21)**	**1365 (1165-1756)**	**1469 (20)**	**1603 (1314-2041)**	**1653 (34)**
TOPO	TAMSPP_SALGOO (n = 7)	1510 (1419-1556)	1482 (23)	1835 (1321-2136)	1735 (42)	1881 (1754-2139)	1980 (30)	1973 (1858-2451)	2109 (31)	2155 (1775-2513)	2141 (34)	2148 (2051-2302)	2154 (25)
	TAMSPP (n = 5)	1380 (1284-1458)	1371 (39)	1757 (1276-2098)	1687 (54)	1830 (1681-2127)	1927 (41)	1957 (1752-2407)	2056 (42)	2090 (1729-2517)	2103 (46)	2083 (1939-2283)	2108 (41)
	Overall	**1442 (1380-1533)**	**1445 (23)**	**1771 (1305-2111)**	**1715 (33)**	**1859 (1720-2129)**	**1958 (24)**	**1972 (1837-2420)**	**2087 (25)**	**2146 (1766-2517)**	**2125 (27)**	**2133 (1988-2295)**	**2135 (23)**
BIWI	SALGOO_TAMSPP (n = 15)	1277 (1198-1330)	1267 (6)	1408 (1212-1889)	1562 (26)	1822 (1695-2242)	1937 (23)	1920 (1758-2429)	2080 (23)	2071 (1790-2501)	2117 (27)	2105 (1949-2405)	2204 (32)

[1] MUDD = Muddy River, TOPO = Topock Marsh, and BIWI = Bill Williams.
[2] SALGOO_TAMSPP = Goodding's willow overstory with tamarisk understory, TAMSPP = > 75% tamarisk, and TAMSPP_SALGOO = tamarisk with emergent Goodding's willow.

ATTACHMENT 11

Model Results for HOBO-iButton Comparison

Table 11-1.—Models used to predict the difference in maximum daily temperature (degrees Celsius) between HOBO and iButton data loggers over 2 years at 33 beetle monitoring points at Topock Marsh and Bill Williams River National Wildlife Refuge, 2014 and 2015

Random effect	Correlation structure[1]	Fixed effects[2]	Intercept[3]	Y[2,4]	R[2,4]	I[2,4]	AIC_C[5]	ΔAIC_C	AIC[6] weight
Site-year	ARMA (2,0)	R	-4.77(0.50)	-	0.12(0.02)	-	11405.73	0.00	0.88
Site-year	ARMA (2,0)	Y+R	-4.84(0.54)	0.05(0.14)	0.12(0.02)	-	11409.76	4.03	0.12
Site-year	ARMA (2,0)	Y+R+I	-5.93(1.32)	0.80(0.84)	0.16(0.01)	-0.02(0.03)	11416.38	10.65	0
Site	ARMA (2,0)	R	-4.74(0.51)	-	0.12(0.02)	-	11548.22	142.49	0
Site	ARMA (2,0)	Y+R	-4.77(0.54)	0.02(0.10)	0.12(0.02)	-	11552.91	147.18	0
Site	ARMA (2,0)	Y+R+I	-5.93(0.85)	0.81(0.46)	0.16(0.03)	-0.02(0.01)	11558.83	153.10	0
Site-year	AR1	Y+R+I	-6.91(1.36)	1.40(0.87)	0.18(0.04)	-0.04(0.03)	11692.27	286.54	0
Site	AR1	R	-4.90(0.51)	-	0.13(0.02)	-	11837.57	431.84	0
Site	AR1	Y+R	-4.83(0.53)	-0.05(0.08)	0.13(0.02)	-	11842.40	436.67	0
Site	AR1	Y+R+I	-6.81(0.86)	1.30(0.47)	0.18(0.03)	-0.04(0.01)	11843.01	437.28	0
Site-year	None	R	-4.21(0.60)	-	0.11(0.02)	-	13118.10	1712.37	0
Site-year	CS	R	-4.21(0.60)	-	0.11(0.02)	-	13120.10	1714.37	0
Site-year	None	Y+R	-4.27(0.64)	0.04(0.16)	0.11(0.02)	-	13121.92	1716.19	0
Site-year	CS	Y+R	-4.27(0.64)	0.04(0.16)	0.11(0.02)	-	13123.92	1718.19	0
Site-year	None	Y+R+I	-5.32(1.76)	0.76(1.14)	0.14(0.05)	-0.02(0.03)	13128.47	1722.74	0
Site-year	CS	Y+R+I	-5.32(1.76)	0.76(1.14)	0.14(0.05)	-0.02(0.03)	13130.47	1724.74	0
Site	None	Y+R	-4.19(0.63)	-0.19(0.05)	0.12(0.02)	-	13539.95	2134.22	0
Site	CS	Y+R	-4.19(0.63)	-0.19(0.05)	0.12(0.02)	-	13541.95	2136.22	0
Site	None	Y+R+I	-3.25(0.92)	-0.83(0.45)	0.09(0.03)	0.02(0.01)	13546.96	2141.23	0
Site	CS	Y+R+I	-3.25(0.92)	-0.83(0.45)	0.09(0.03)	0.02(0.01)	13548.96	2143.23	0
Site	None	R	-4.33(0.62)	-	0.11(0.02)	-	13551.32	2145.59	0
Site	CS	R	-4.33(0.62)	-	0.11(0.02)	-	13553.32	2147.59	0
Site-year	ARMA (1,1)	R	Failed						
Site-year	ARMA (1,1)	Y+R	Failed						
Site-year	ARMA (1,1)	Y+R+I	Failed						
Site	ARMA (1,1)	R	Failed						
Site	ARMA (1,1)	Y+R	Failed						
Site	ARMA (1,1)	Y+R+I	Failed						

[1] ARMA (2,0) = second-order autoregressive, AR1 = first-order autoregressive, CS = compound-symmetric, and ARMA (1,1) = first-order autoregressive moving average.
[2] R = reference method measurement (i.e., HOBO measurement), Y = year, and I = year * reference method measurement interaction.
[3] Failed = model failed to converge in R.
[4] Coefficient followed by standard error in parentheses.
[5] AIC_c = Akaike's information criterion for small sample size.
[6] AIC = Akaike's information criterion.

Table 11-2.—Models used to predict the difference in minimum nightly temperature (degrees Celsius) between HOBO and iButton data loggers over 2 years at 33 beetle monitoring points at Topock Marsh and Bill Williams, 2014 and 2015

Random effect	Correlation structure[1]	Fixed effects[2]	Intercept[3]	Y[2,4]	R[2,4]	I[2,4]	AIC_C[5]	ΔAIC_C	AIC[6] weight
Site-year	AR1	R	0.69(0.07)	-	-0.01(0.003)	-	1952.33	0.00	0.82
Site-year	AR1	Y+R	0.82(0.09)	-0.09(0.04)	-0.01(0.003)	-	1955.60	3.27	0.16
Site-year	AR1	Y+R+I	1.08(0.13)	-0.27(0.08)	-0.03(5.23E-3)	8.51E-3(3.08E-3)	1960.40	8.07	0.01
Site-year	ARMA (1,1)	Y+R+I	1.05(0.13)	-0.26(0.08)	-0.02(5.14E-3)	7.61E-3(3.00E-3)	1961.47	9.13	0.01
Site-year	None	R	0.71(0.07)	-	-0.01(0.003)	-	1962.78	10.44	0
Site-year	CS	R	0.71(0.07)	-	-0.01(0.003)	-	1964.78	12.44	0
Site-year	None	Y+R	0.83(0.09)	-0.09(0.04)	-0.01(0.003)	-	1966.04	13.70	0
Site-year	CS	Y+R	0.83(0.09)	-0.09(0.04)	-0.01(0.003)	-	1968.04	15.70	0
Site-year	None	Y+R+I	1.10(0.13)	-0.28(0.08)	-0.03(5.31E-3)	8.77E-3(3.15E-3)	1970.69	18.36	0
Site-year	CS	Y+R+I	1.10(0.13)	-0.28(0.08)	-0.03(5.31E-2)	8.77E-3(3.15E-3)	1972.69	20.36	0
Site	AR1	Y+R	0.84(0.07)	-0.01(0.003)	-0.12(0.01)	-	2215.93	263.60	0
Site	AR1	Y+R+I	1.08(0.10)	-0.28(0.06)	-0.03(5.26E-3)	8.90E-3(3.10E-3)	2219.51	267.18	0
Site	AR1	R	0.69(0.07)	-	-0.01(0.003)	-	2285.90	333.57	0
Site	None	Y+R	0.87(0.07)	-0.11(0.01)	-0.01(0.003)	-	2305.12	352.79	0
Site	None	Y+R+I	1.12(0.10)	-0.30(0.05)	-0.03(0.005)	9.63E-2(2.80E-3)	2305.30	352.97	0
Site	CS	Y+R	0.87(0.07)	-0.11(0.01)	-0.01(0.003)	-	2307.12	354.79	0
Site	CS	Y+R+I	1.12(0.10)	-0.30(0.05)	-0.03(4.88E-3)	9.63E-3(2.80E-3)	2307.30	354.97	0
Site	None	R	0.73(0.07)	-	-0.02(0.003)	-	2401.79	449.46	0
Site	CS	R	0.73(0.07)	-	-0.01(0.003)	-	2403.79	451.46	0

Table 11-2.—Models used to predict the difference in minimum nightly temperature (degrees Celsius) between HOBO and iButton data loggers over 2 years at 33 beetle monitoring points at Topock Marsh and Bill Williams, 2014 and 2015

Random effect	Correlation structure[1]	Fixed effects[2]	Intercept[3]	Y[2,4]	R[2,4]	I[2,4]	AIC_C[5]	ΔAIC_C	AIC[6] weight
Site-year	ARMA (1,1)	R	Failed						
Site-year	ARMA (1,1)	Y+R	Failed						
Site	ARMA (1,1)	R	Failed						
Site	ARMA (1,1)	Y+R	Failed						
Site	ARMA (1,1)	Y+R+I	Failed						

[1] AR1 = first-order autoregressive, ARMA (1,1) = first-order autoregressive moving average, and CS = compound-symmetric.
[2] Y = year, R = reference method measurement (i.e., HOBO measurement), and I = year * reference method measurement interaction.
[3] Failed = model failed to converge in R.
[4] Coefficient followed by standard error in parentheses.
[5] AIC_c = Akaike's information criterion for small sample size.
[6] AIC = Akaike's information criterion.

Table 11-3.—Models used to predict difference in mean diurnal vapor pressure (Pascals) between HOBO and iButton data loggers over 2 years at 33 beetle monitoring points at Topock Marsh and Bill Williams, 2014 and 2015*

Random effect	Correlation structure[1]	Fixed effects[2]	Intercept	Y	R	R^2	R^3	I	I^2	I^3	AICc[3]	ΔAIC$_C$	AIC[4] weight
Site-year	ARMA (1,1)	Y+R+I	-3.43(25.76)	-31.95(16.85)	0.09(0.02)	2.0E-5(7.0E-6)	0(0)	0.02(0.01)	5.0E-5(5.0E-6)	0(0)	41835.87	0.00	0.54
Site-year	AR1	Y+R+I	-3.90(25.69)	-31.90(16.80)	0.09(0.02)	2.0E-5(7.0E-6)	0(0)	0.02(0.01)	5.0E-5(5.0E-6)	0(0)	41836.17	0.30	0.46
Site-year	ARMA (1,1)	Y+R	-4.00(22.62)	-31.39(14.48)	0.12(0.01)	8.4E-5(2.0E-6)	0(0)	-	-	-	41863.05	27.19	0
Site-year	AR1	Y+R	-4.66(22.59)	-31.20(14.46)	0.12(0.01)	8.5E-5(2.0E-6)	0(0)	-	-	-	41863.22	27.36	0
Site-year	ARMA (1,1)	R	-49.06(9.07)	-	0.12(0.01)	8.0E-5(2.0E-6)	0(0)	-	-	-	41872.59	36.72	0
Site-year	AR1	R	-49.43(9.04)	-	0.12(0.01)	8.5E-5(2.0E-6)	0(0)	-	-	-	41872.73	36.86	0
Site-year	ARMA (1,1)	Y+R+I	-1.60(25.23)	-29.73(16.50)	0.10(0.02)	2.5E-5(6.0E-6)	-	0.03(0.01)	3.3E-5(4.0E-6)	-	41890.26	54.40	0
Site-year	AR1	Y+R	-3.25(22.89)	-29.18(14.67)	0.14(0.01)	7.1E-5(2.0E-6)	-	-	-	-	41895.11	59.25	0
Site-year	ARMA (1,1)	Y+R	-2.37(22.93)	-29.40(14.69)	0.14(0.01)	7.0E-5(2.0E-6)	-	-	-	-	41924.84	88.97	0
Site-year	AR1	R	-45.11(9.14)	-	0.14(0.01)	7.0E-5(2.0E-6)	-	-	-	-	41928.29	92.42	0
Site-year	ARMA (1,1)	R	-38.20(8.54)	-	0.15(0.01)	7.0E-5(2.0E-6)	-	-	-	-	41933.91	98.04	0
Site-year	AR1	Y+R	-236.32(24.71)	-33.60(13.97)	0.11(0.01)	-	-	-	-	-	41937.32	101.45	0
Site	ARMA (1,1)	Y+R+I	-40.74(12.96)	-1.93(7.04)	0.10(0.01)	2.0E-5(7.0E-6)	0(0)	2.02E-2(6.05E-3)	5.0E-5(5.0E-6)	0(0)	42339.76	503.89	0
Site	ARMA (1,1)	Y+R	-66.79(12.49)	17.36(6.76)	0.13(0.01)	8.0E-5(2.0E-6)	0(0)	-	-	-	42395.92	560.06	0
Site	ARMA (1,1)	R	-43.16(8.36)	-	0.13(0.01)	8.0E-5(2.0E-6)	0(0)	-	-	-	42404.01	568.14	0
Site	ARMA (1,1)	Y+R+I	-28.06(12.86)	-6.89(6.89)	0.11(0.01)	2.2E-5(6.0E-6)	-	2.76E-2(4.96E-3)	3.4E-5(4.0E-6)	-	42437.28	601.42	0
Site-year	None	Y+R+I	-8.61(25.11)	-30.39(16.43)	0.09(0.02)	3.4E-5(0.02)	0(0)	0.02(0.01)	3.9E-5(5.0E-6)	0(0)	42442.75	606.88	0
Site-year	CS	Y+R+I	-8.61(25.04)	-30.39(16.38)	0.09(0.02)	3.4E-5(7.0E-6)	0(0)	0.02(0.01)	3.9E-5(5.0E-6)	0(0)	42444.75	608.88	0
Site-year	None	Y+R	-9.28(22.17)	-30.00(14.21)	0.12(0.01)	8.7E-5(2.0E-6)	0(0)	-	-	-	42455.41	619.55	0
Site-year	CS	Y+R	-9.33(22.14)	-29.70(14.19)	0.12(0.01)	8.7E-5(2.0E-6)	0(0)	-	-	-	42457.41	621.55	0
Site-year	None	R	-52.33(8.82)	-	0.12(0.01)	9.0E-5(2.0E-6)	0(0)	-	-	-	42464.8	628.93	0
Site-year	CS	R	-52.34(8.79)	-	0.12(0.01)	9.0E-5(2.0E-6)	0(0)	-	-	-	42466.8	630.93	0
Site	ARMA (1,1)	Y+R	-55.17(12.48)	12.42(6.59)	0.15(0.01)	7.0E-5(2.0E-6)	-	-	-	-	42472.78	636.91	0
Site	ARMA (1,1)	R	-38.20(8.54)	-	0.15(0.01)	7.0E-5(2.0E-6)	-	-	-	-	42478.79	642.92	0
Site	AR1	Y+R+I	-0.27(11.53)	-30.35(5.43)	0.11(0.01)	1.4E-5(7.0E-6)	0(0)	1.68E-2(6.55E-3)	5.4E-5(5.0E-6)	0(0)	42492.55	656.68	0
Site-year	None	Y+R+I	-5.15(25.41)	-29.01(16.64)	0.10(0.02)	3.0E-5(5.0E-6)	-	0.03(0.01)	2.7E-5(3.0E-6)	-	42512.3	676.44	0

Table 11-3.—Models used to predict difference in mean diurnal vapor pressure (Pascals) between HOBO and iButton data loggers over 2 years at 33 beetle monitoring points at Topock Marsh and Bill Williams, 2014 and 2015*

Random effect	Correlation structure[1]	Fixed effects[2]	Intercept	Y	R	R^2	R^3	I	I^2	I^3	AICc[3]	ΔAIC$_C$	AIC[4] weight
Site-year	CS	Y+R+I	-5.15(25.32)	-29.01(16.58)	0.10(0.02)	3.0E-5(5.0E-6)	-	0.03(0.01)	2.7E-5(3.0E-6)	-	42514.3	678.44	0
Site	AR1	Y+R	-14.32(11.04)	-19.93(4.93)	0.14(8.31E-3)	8.3E-5(2.0E-6)	0(0)	-	-	-	42535.45	699.59	0
Site-year	None	Y+R	-5.84(22.43)	-28.79(14.39)	0.13(0.01)	6.9E-5(2.0E-6)	-	-	-	-	42548.89	713.02	0
Site-year	CS	Y+R	-5.88(22.40)	-28.76(14.37)	0.13(0.01)	6.9E-5(2.0E-6)	-	-	-	-	42550.89	715.02	0
Site	AR1	R	-42.13(8.66)	-	0.14(8.34E-3)	8.0E-5(2.0E-6)	0(0)	-	-	-	42554.34	718.47	0
Site	AR1	Y+R+I	0.29(11.66)	-27.76(5.55)	0.12(0.01)	2.8E-5(7.0E-6)	-	2.57E-2(5.22E-3)	3.3E-5(5.0E-6)	-	42555.74	719.88	0
Site-year	None	R	-47.13(8.90)	-	0.13(0.01)	7.0E-5(2.0E-6)	-	-	-	-	42557.93	722.06	0
Site-year	CS	R	-47.13(8.88)	-	0.13(0.01)	7.0E-5(2.0E-6)	-	-	-	-	42559.93	724.06	0
Site	AR1	Y+R	-10.49(11.24)	-20.16(5.11)	0.16(0.01)	7.3E-5(2.0E-6)	-	-	-	-	42575.87	740.00	0
Site	AR1	R	-38.66(8.71)	-	0.16(0.01)	7.0E-5(2.0E-6)	-	-	-	-	42594.07	758.20	0
Site-year	ARMA (1,1)	Y+R	-250.60(25.58)	-34.86(13.40)	0.12(0.01)	-	-	-	-	-	42907.86	1071.99	0
Site-year	ARMA (1,1)	Y+R+I	-214.25(46.41)	-60.57(30.21)	0.10(0.02)	-	-	1.52E-2(1.60E-2)	-	-	42915.43	1079.56	0
Site-year	ARMA (1,1)	R	-300.80(17.24)	-	0.12(0.01)	-	-	-	-	-	42919.16	1083.30	0
Site-year	AR1	R	-282.74(15.53)	-	0.11(0.01)	-	-	-	-	-	43020.82	1184.95	0
Site	ARMA (1,1)	Y+R	-330.77(21.80)	16.78(7.33)	0.12(0.01)	-	-	-	-	-	43381.16	1545.29	0
Site	ARMA (1,1)	Y+R+I	-277.88(26.70)	-20.00(13.51)	0.10(0.01)	-	-	1.77E-2(5.44E-3)	-	-	43381.51	1545.64	0
Site	ARMA (1,1)	R	-304.12(18.11)	-	0.12(0.01)	-	-	-	-	-	43388.26	1552.40	0
Site	AR1	Y+R	-280.99(21.25)	-27.34(6.32)	0.13(0.01)	-	-	-	-	-	43471.68	1635.81	0
Site	AR1	Y+R+I	-267.58(26.57)	-36.83(13.05)	0.12(0.01)	-	-	4.63E-3(5.58E-3)	-	-	43481.54	1645.67	0
Site-year	None	Y+R	-202.21(23.09)	-32.40(13.61)	0.09(0.01)	-	-	-	-	-	44022.08	2186.21	0
Site-year	CS	Y+R	-202.26(23.00)	-32.37(13.52)	0.09(0.01)	-	-	-	-	-	44024.1	2188.23	0
Site-year	CS	Y+R+I	-193.85(38.16)	-38.22(25.16)	0.09(0.02)	-	-	3.78E-3(1.37E-2)	-	-	44032.01	2196.14	0
Site-year	None	R	-248.61(12.59)	-	0.09(0.01)	-	-	-	-	-	44032.53	2196.67	0
Site	None	Y+R+I	-19.06(10.01)	-25.60(2.86)	0.09(0.01)	4.1E-5(9.0E-6)	0(0)	1.79E-2(5.45E-3)	4.6E-5(6.0E-6)	0(0)	44952.38	3116.51	0
Site	CS	Y+R+I	-19.06(10.01)	-25.60(2.86)	0.09(0.01)	4.1E-5(9.0E-6)	0(0)	1.7E-2(5.45E-3)	4.6E-5(6.0E-6)	0(0)	44954.38	3118.51	0
Site	None	Y+R	-27.47(9.49)	-19.31(1.98)	0.12(0.01)	1.01E-4(3.0E-5)	0(0)	-	-	-	44976.04	3140.18	0

Table 11-3.—Models used to predict difference in mean diurnal vapor pressure (Pascals) between HOBO and iButton data loggers over 2 years at 33 beetle monitoring points at Topock Marsh and Bill Williams, 2014 and 2015*

Random effect	Correlation structure[1]	Fixed effects[2]	Intercept	Y	R	R^2	R^3	I	I^2	I^3	AICc[3]	ΔAIC$_C$	AIC[4] weight
Site	CS	Y+R	-27.47(9.49)	-19.31(1.98)	0.12(0.01)	1.0E-4(3.0E-6)	0(0)	-	-	-	44978.04	3142.18	0
Site	None	R	-55.39(9.17)	-	0.12(0.01)	1.0E-4(3.0E-6)	0(0)	-	-	-	45071.44	3235.57	0
Site	CS	R	-55.39(9.17)	-	0.12(0.01)	1.0E-4(3.0E-6)	0(0)	-	-	-	45073.44	3237.57	0
Site	None	Y+R+I	-14.65(9.91)	-22.77(2.63)	0.10(0.01)	4.2E-5(6.0E-6)	-	2.92E-2(4.08E-3)	2.4E-5(4.0E-6	-	45080.36	3244.50	0
Site	CS	Y+R+I	-14.65(9.91)	-22.77(2.63)	0.10(0.01)	4.2E-5(6.0E-6)	-	2.92E-2(4.08E-3)	2.4E-5(4.0E-6	-	45082.36	3246.50	0
Site	None	Y+R	-17.91(9.58)	-20.68(2.01)	0.14(0.01)	7.5E-5(2.0E-6)	-	-	-	-	45097.21	3261.34	0
Site	CS	Y+R	-17.91(9.58)	-20.68(2.01)	0.14(0.01)	7.5E-5(2.0E-6)	-	-	-	-	45099.21	3263.34	0
Site	None	R	-47.49(9.27)	-	0.14(0.01)	8.0E-5(2.0E-6)	-	-	-	-	45202.67	3366.80	0
Site	CS	R	-47.49(9.27)	-	0.14(0.01)	8.0E-5(2.0E-6)	-	-	-	-	45204.67	3368.80	0
Site	None	Y+R	-211.59(14.69)	-27.88(2.27)	0.09(0.01)	-	-	-	-	-	46092.31	4256.44	0
Site	CS	Y+R	-211.59(14.69)	-27.88(2.27)	0.09(0.01)	-	-	-	-	-	46094.31	4258.44	0
Site	None	Y+R+I	-196.82(17.80)	-38.84(7.94)	0.09(0.01)	-	-	5.32E-3(3.69E-3)	-	-	46101.61	4265.74	0
Site	CS	Y+R+I	-196.82(17.80)	-38.84(7.94)	0.09(0.01)	-	-	5.32E-3(3.69E-3)	-	-	46103.61	4267.74	0
Site	None	R	-250.39(14.95)	-	0.09(0.01)	-	-	-	-	-	46241.92	4406.06	0
Site	CS	R	-250.39(14.95)	-	0.09(0.01)	-	-	-	-	-	46243.92	4408.06	0

* Coefficients are followed by standard error in parentheses.

[1] ARMA (1,1) = first-order autoregressive moving average, AR1 = first-order autoregressive, and CS = compound-symmetric.
[2] Y = year, R = reference method measurement (i.e., HOBO measurement), and I = year * reference method measurement interaction.
[3] AIC$_c$ = Akaike's information criterion for small sample size.
[4] AIC = Akaike's information criterion.

Table 11-4.—Models used to predict difference in mean nocturnal vapor pressure (Pascals) between HOBO and iButton data loggers over 2 years at 33 beetle monitoring points at Topock Marsh and Bill Williams, 2014 and 2015*

Random effect	Correlation structure[1]	Fixed effects[2]	Intercept	Y	R	R^2	R^3	I	I^2	I^3	AIC$_C$[3]	ΔAIC$_C$	AIC[4] weight
Site-year	ARMA (1,1)	Y+R+I	-36.27(29.61)	-12.92(19.48)	0.05(0.02)	-1.0E-5(9.0E-6)	0(0)	-2.3E-4(1.47E-2)	5.0E-5(6.0E-6)	0(0)	39418.73	0.00	0.62
Site-year	AR1	Y+R+I	-36.71(29.54)	-12.84(19.43)	0.05(0.02)	-1.0E-5(9E-6)	0(0)	-5.7E-4(1.47E-2)	5.0E-5(6.0E-6)	0(0)	39420.21	1.48	0.32
Site-year	ARMA (1,1)	Y+R	-23.41(19.32)	-22.44(11.64)	0.05(0.01)	7.0E-5(3.0E-6)	0(0)	-	-	-	39438.01	19.28	0
Site-year	AR1	Y+R	-24.06(19.23)	-22.22(11.58)	0.05(0.01)	6.6E-5(3.0E-6)	0(0)	-	-	-	39439.86	21.13	0
Site-year	ARMA (1,1)	Y+R	-26.40(19.85)	-16.91(12.01)	0.08(0.01)	4.0E-5(3.0E-6)	-	-	-	-	39618.04	199.31	0
Site-year	AR1	Y+R+I	-34.81(30.17)	-11.33(19.84)	0.04(0.02)	-1.0E-5(8.0E-6)	-	0.02(0.01)	3.0E-5(5.0E-6)	-	39622.97	204.24	0
Site-year	ARMA (1,1)	R	-50.69(9.75)	-	0.08(0.01)	4.0E-5(3.0E-6)	-	-	-	-	39624.79	206.06	0
Site-year	AR1	R	-51.15(9.73)	-	0.08(0.01)	4.0E-5(3.0E-6)	-	-	-	-	39641.08	222.35	0
Site-year	CS	Y+R+I	-36.15(29.97)	-13.33(19.72)	0.04(0.02)	-2.0E-5(8.0E-6)	0(0)	8.6E-4(1.45E-2)	5.0E-5(5.0E-6)	0(0)	40168.22	749.49	0
Site	ARMA (1,1)	Y+R+I	-33.06(13.20)	-14.81(6.29)	0.07(0.01)	-1.0E-5(1E-5)	0(0)	-1.51E-2 (6.32E-3)	6.0E-5 (6.0E-6)	0(0)	40173.23	754.50	0
Site-year	None	Y+R	-26.36(18.39)	-20.48(10.86)	0.05(0.01)	5.80E-4 (3.0E-6)	0(0)	-	-	-	40201.36	782.63	0
Site-year	CS	Y+R	-25.92(18.59)	-20.69(11.01)	0.05(0.01)	5.8E-5(3.0E-6)	0(0)	-	-	-	40203.32	784.59	0
Site-year	CS	R	-55.64(9.67)	-	0.05(0.01)	6.0E-5(3.0E-6)	0(0)	-	-	-	40211.35	792.62	0
Site	ARMA (1,1)	Y+R	-45.00(12.50)	-7.86(5.63)	0.05(0.01)	7.0E-5(3.0E-6)	0(0)	-	-	-	40221.83	803.10	0
Site	ARMA (1,1)	R	-55.73(9.75)	-	0.05(0.01)	7.0E-5(3.0E-6)	0(0)	-	-	-	40227.04	808.31	0
Site-year	CS	Y+R+I	-36.20(30.47)	-10.00(20.04)	0.03(0.02)	-1.0E-5(6.0E-6)	2.31E-2 (1.51E-2)	3.0E-5 (4.0E-6)	-	-	40359.46	940.73	0
Site-year	None	Y+R	-25.63(18.78)	-17.48(11.12)	0.07(0.01)	3.2E-5(2.0E-6)	-	-	-	-	40377.34	958.61	0
Site-year	CS	Y+R	-25.29(19.01)	-17.63(11.30)	0.07(0.01)	3.2E-5(2.0E-6)	-	-	-	-	40379.3	960.57	0
Site-year	CS	R	-50.62(9.83)	-	0.07(0.01)	3.0E-5(2.0E-6)	-	-	-	-	40386.37	967.64	0
Site	ARMA (1,1)	Y+R+I	-16.63(13.51)	-23.74(6.43)	0.07(0.01)	-2.0E-5(9.0E-6)	7.50E-4 (4.94E-3)	4.6E-5 (6.0E-6)	-	-	40405.86	987.13	0
Site	ARMA (1,1)	Y+R	-45.99(12.73)	-3.61(5.77)	0.08(0.01)	4.0E-5(3.0E-6)	-	-	-	-	40433.08	1014.35	0
Site	ARMA (1,1)	R	-50.94(9.91)	-	0.08(0.01)	4.0E-5(3.0E-6)	-	-	-	-	40436.81	1018.08	0
Site	AR1	Y+R+I	-33.13(12.21)	-15.84(5.29)	0.08(0.01)	1.0E-5(1.1E-5)	0(0)	-0.01(0.01)	5.0E-5(7.0E-6)	0(0)	40446.38	1027.65	0
Site	AR1	Y+R	-41.57(11.54)	-11.11(4.54)	0.06(0.01)	8.0E-5(3.0E-6)	0(0)	-	-	-	40471.35	1052.62	0

Table 11-4.—Models used to predict difference in mean nocturnal vapor pressure (Pascals) between HOBO and iButton data loggers over 2 years at 33 beetle monitoring points at Topock Marsh and Bill Williams, 2014 and 2015*

Random effect	Correlation structure[1]	Fixed effects[2]	Intercept	Y	R	R^2	R^3	I	I^2	I^3	AIC*c*[3]	ΔAIC*C*	AIC[4] weight
Site	AR1	R	-56.74(9.58)	-	0.06(0.01)	8.0E-5(3.0E-6)	0(0)	-	-	-	40479.99	1061.26	0
Site-year	None	Y+R	-127.09(17.82)	-21.00(10.60)	0.06(0.01)	-	-	-	-	-	40601.1	1182.37	0
Site-year	CS	Y+R	-127.09(17.82)	-21.00(10.60)	0.06(0.01)	-	-	-	-	-	40603.1	1184.37	0
Site-year	CS	Y+R+I	-106.70(28.69)	-35.21(18.91)	0.03(0.02)	-	-	0.01(0.01)	-	-	40610.67	1191.94	0
Site-year	CS	R	-157.12(9.59)	-	0.06(0.01)	-	-	-	-	-	40611.44	1192.71	0
Site	ARMA (1,1)	R	-186.39(0.07)	-	12.92(0.01)	-	-	-	-	-	40645.22	1226.49	0
Site	AR1	Y+R+I	-19.64(12.49)	-23.05(5.44)	0.08(0.01)	-6.0E-6(1.0E-5)	-	1.26E-2(5.72E-3)	4.5E-5(7.0E-6)	-	40683.5	1264.77	0
Site	AR1	Y+R	-39.42(11.77)	-9.46(4.70)	0.09(0.01)	6.0E-5(3.0E-6)	-	-	-	-	40694.48	1275.75	0
Site	AR1	R	-52.38(9.74)	-	0.09(0.01)	6.0E-5(3.0E-6)	-	-	-	-	40701.32	1282.59	0
Site	AR1	Y+R	-175.77(17.48)	-20.32(6.03)	0.08(0.01)	-	-	-	-	-	40815.2	1396.47	0
Site	AR1	Y+R+I	-159.50(22.55)	-31.71(11.74)	0.07(0.01)	-	-	6.51E-3(5.78E-3)	-	-	40824.4	1405.67	0
Site	AR1	R	-204.87(15.55)	-	0.08(0.01)	-	-	-	-	-	40829.59	1410.86	0
Site	None	Y+R	-42.88(10.36)	-15.62(1.83)	0.04(0.01)	1.00E-4 (4.00E-6)	0(0)	-	-	-	44291.94	4873.21	0
Site	CS	Y+R	-42.88(10.36)	-15.62(1.83)	0.04(0.01)	1.0E-4(4.0E-6)	0(0)	-	-	-	44293.94	4875.21	0
Site	None	Y+R+I	-26.14(10.83)	-27.07(2.69)	0.06(0.01)	8.0E-6(1.3E-5)	0(0)	-0.02(6.5E-3)	6.20E-5(8.00E-6)	0(0)	44303.4	4884.67	0
Site	CS	Y+R+I	-26.14(10.83)	-27.07(2.69)	0.06(0.01)	8.0E-6(1.3E-5)	0(0)	-1.74E-2 (6.50E-3)	6.2E-5(8.0E-6)	0(0)	44305.4	4886.67	0
Site	None	R	-65.70(9.80)	-	0.04(0.01)	1.00E-4 (4.00E-6)	0	-	-	-	44365.13	4946.40	0
Site-year	None	R	-55.70(9.63)	-	0.05(0.01)	6.0E-5(3.0E-6)	0(0)	-	-	-	44365.13	4946.40	0
Site	CS	R	-65.70(9.80)	-	0.04(0.01)	1.0E-4(4.0E-6)	0(0)	-	-	-	44367.13	4948.40	0
Site	None	Y+R	-32.65(10.59)	-16.54(1.89)	0.08(0.01)	5.00E-5 (3.00E-6)	-	-	-	-	44510.4	5091.67	0
Site	CS	Y+R	-32.65(10.59)	-16.54(1.89)	0.08(0.01)	5.0E-5(3.0E-6)	-	-	-	-	44512.4	5093.67	0
Site	None	Y+R+I	-22.07(10.95)	-23.96(2.54)	0.06(0.01)	4.0E-6(1.0E-5)	-	0.01(4.36E-3)	3.3E-5(6.0E-6)	-	44520.26	5101.53	0
Site	CS	Y+R+I	-22.07(10.95)	-23.96(2.54)	0.06(0.01)	4.0E-6(1.0E-5)	-	1.18E-2(4.37E-3)	3.3E-5(6.0E-6)	-	44522.26	5103.53	0

Table 11-4.—Models used to predict difference in mean nocturnal vapor pressure (Pascals) between HOBO and iButton data loggers over 2 years at 33 beetle monitoring points at Topock Marsh and Bill Williams, 2014 and 2015*

Random effect	Correlation structure[1]	Fixed effects[2]	Intercept	Y	R	R^2	R^3	I	I^2	I^3	AIC$_c$[3]	ΔAIC$_C$	AIC[4] weight
Site	CS	R	-56.67(10.02)	-	0.08(0.01)	5.0E-5(3.0E-6)	-	-	-	-	44589.63	5170.90	0
Site	None	Y+R	-136.58(12.10)	-20.03(1.92)	0.06(0.01)	-	-	-	-	-	44713.14	5294.41	0
Site	CS	Y+R	-127.09(17.82)	-21.00(10.60)	0.06(0.01)	-	-	-	-	-	44715.14	5296.41	0
Site	None	Y+R+I	-132.26(15.13)	-23.23(7.04)	0.06(0.01)	-	-	1.79E-3(3.78E-3)	-	-	44724.24	5305.51	0
Site	CS	Y+R+I	-132.26(15.13)	-23.23(7.04)	0.06(0.01)	-	-	1.79E-3(3.78E-3)	-	-	44726.24	5307.51	0
Site	None	R	-162.56(12.13)	-	0.06(0.01)	-	-	-	-	-	44821.25	5402.52	0
Site	CS	R	-162.56(12.13)	-	0.06(0.01)	-	-	-	-	-	44823.25	5404.52	0

* Coefficients are followed by standard error in parentheses.

[1] ARMA (1,1) = first-order autoregressive moving average, AR1 = first-order autoregressive, and CS = compound-symmetric.
[2] Y = year, R = reference method measurement (i.e., HOBO measurement), and I = year * reference method measurement interaction.
[3] AIC$_c$ = Akaike's information criterion for small sample size.
[4] AIC = Akaike's information criterion.

Table 11-5.—Linear mixed models used to predict effects of light level and maximum daily temperature (degrees Celsius) as measured by HOBO data loggers on bias in daily maximum temperature at 47 beetle monitoring points at Muddy River, Topock Marsh, and Bill Williams, 2015*

Fixed effects[1]	Intercept	T	L	T*L	AIC*c*[2]	ΔAIC*c*	AIC[3] weight
T	-0.98(0.84)	2.79E-2(1.84E-2)	–	–	3439.4	0.00	0.99
L	-0.18(0.37)	–	1.02E-5(5.4E-6)	–	3454.4	15.01	0.001
T+L	-1.22(0.85)	2.51E-2(1.84E-2)	9.6E-6(5.4E-6)	–	3460.7	21.35	0
T*L	-1.97(1.26)	0.04(0.03)	2.72E-5(2.27E-5)	-4.0E-7(5.0E-7)	3489.3	49.96	0

* Coefficients are followed by standard error in parentheses. Models used first-order autoregressive correlation structure and had site as a random effect.

[1] T = maximum daily temperature, and L = light level.
[2] AIC_c = Akaike's information criterion for small sample size.
[3] AIC = Akaike's information criterion.

ATTACHMENT 12

Contributing Personnel

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