SWCA
ENVIRONMENTAL CONSULTANTS

SOUTHWESTERN WILLOW FLYCATCHER SURVEYS, DEMOGRAPHY, AND ECOLOGY ALONG THE LOWER COLORADO RIVER AND TRIBUTARIES, 2003

Contract No. 03-CS-30-0093

Submitted to
U.S. Bureau of Reclamation
Lower Colorado Region
400 Railroad Avenue
Boulder City, NV 89005

Submitted by
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SOUTHWESTERN WILLOW FLYCATCHER SURVEYS, DEMOGRAPHY, AND ECOLOGY ALONG THE LOWER COLORADO RIVER AND TRIBUTARIES, 2003

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Annual Report

Submitted to

U.S. BUREAU OF RECLAMATION
Lower Colorado Region
400 Railroad Avenue
Boulder City, NV 89005

Submitted by

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EXECUTIVE SUMMARY

The Southwestern Willow Flycatcher (*Empidonax traillii extimus*), 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. Historical breeding records and museum collections indicate a sizable population of Southwestern Willow Flycatchers may have existed along the extreme southern stretches of the lower Colorado River region. Factors contributing to the decline of flycatchers on the breeding grounds include loss, degradation and/or fragmentation of riparian habitat; invasion by nonnative plants; and brood parasitism by Brown-headed Cowbirds (*Molothrus ater*).

Willow flycatcher studies have been conducted along the Virgin and lower Colorado Rivers and tributaries annually since 1996, in compliance with requirements set forth by the U.S. Fish and Wildlife Service regarding U.S. Bureau of Reclamation routine operations and maintenance along the lower Colorado River. From 1997 to 2001, breeding populations of Southwestern Willow Flycatchers were documented along the Virgin and lower Colorado Rivers and tributaries at seven study areas, from Mesquite, Nevada south to the Bill Williams River. Willow flycatchers have been detected during the breeding season at several sites along the Colorado River south of the Bill Williams River to the Mexico border from 1996 to 2001, but more information is needed to determine flycatcher residency, breeding status, and demography in this area.

SWCA® Environmental Consultants was contracted by the U.S. Bureau of Reclamation to continue surveys, monitoring, and demographic and ecological studies of the Southwestern Willow Flycatcher in suitable and/or historical riparian and wetland habitats throughout the Virgin and lower Colorado River regions in 2003. We completed presence/absence surveys and site descriptions at 95 pre-selected sites and conducted intensive life history studies at Pahranagat National Wildlife Refuge (NWR), Mesquite, and Mormon Mesa, Nevada, and Topock Marsh, Arizona. At these life history study areas, we monitored willow flycatcher nests to document predation and brood parasitism rates and nesting success; color-banded and resighted as many willow flycatchers as possible to determine the breeding status of territorial flycatchers and document movement and recruitment; measured characteristics of vegetation and microclimate at nest sites and at unused sites to assess factors important in nest-site selection; and implemented trapping and removal of Brown-headed Cowbirds to evaluate the effects of trapping on nest brood parasitism and flycatcher nest success.

We used tape recorded broadcasts of willow flycatcher song and calls to elicit responses from willow flycatchers at 95 sites, ranging in size from 1 to 70 ha, along the Virgin and lower Colorado Rivers and tributaries between 15 May and 25 July 2003, following a 10-survey protocol. We detected willow flycatchers on at least one occasion at 54 of these sites. Resident, breeding flycatchers were detected at 11 sites within the following five study areas: Pahranagat NWR, Mesquite, Mormon Mesa, Topock Marsh, and the Bill Williams River NWR. Although many flycatchers were recorded at 32 of the 38 sites south of Bill Williams until 18 June with a single detection recorded on 2 July, monitoring results at these sites suggest these flycatchers were not resident, breeding individuals and were most likely northbound migrants.

We used targeted mist net and passive netting techniques to capture and uniquely color-band adult and fledgling willow flycatchers. Nestlings were banded between 7 and 10 days of age. We banded each adult and fledged willow flycatcher with a single anodized (colored), numbered U.S. federal aluminum band on one leg and one colored metal (aluminum) band on the other. Nestlings were banded with a single anodized numbered federal band, uniquely identifying it as a returning nestling in the event it returns in a subsequent year. We used binoculars to determine the identity of previously color-banded flycatchers by observing, from a distance, the unique color combination on its legs. At all study areas where breeding flycatchers were located in 2003, we color-banded 26 new adult flycatchers, recaptured 20 adults banded in previous years, resighted 17 additional adults banded in previous years, and banded 63 nestlings from 23 nests.

At the four life history study areas and Bill Williams, we recorded a total of 60 territories. Of these, 40 (67%) consisted of paired flycatchers and 20 (33%) consisted of unpaired individuals. Four breeding males were polygynous, each being paired with two females. Five of the 20 unpaired territories were abandoned before mid-June and averaged nine days of activity. These individuals most likely were northbound migrants.

Of the 27 willow flycatchers that returned from previous years for which original banding locations were available, 17 (63%) returned to the same site at which they were banded and 10 (37%) returned to a different site. Of the 10 returning individuals detected at a different site from where originally banded, 8 (80%) were banded as nestlings. We also detected one within-year movement of an adult male flycatcher that originally held an unpaired territory at Mormon Mesa and was later recaptured approximately 40 km to the northwest at Mesquite West.

We initiated color-banding studies at sites along the Gila River and the Colorado River from the Gila confluence south to the Mexico border from 10 to 30 June to better determine flycatcher residency, breeding status, and movement patterns in this area. Of 59 willow flycatcher detections, we captured and color-banded four adults at three sites. All four individuals were determined to be second-year birds (born in 2002). Flycatcher behavioral observations in combination with active molt patterns exhibited on captured individuals suggest strongly that the individuals detected at these sites were northbound migrants.

We documented 57 willow flycatcher nesting attempts at the four life history study areas and Bill Williams, 50 (88%) of which contained eggs and were used in calculating nest success and productivity. Twenty-seven (54%) nests were successful and fledged young, and 23 (46%) failed. Depredation was the major cause of nest failure, accounting for 57% of all failed nests and 74% of nests that failed after flycatcher eggs were laid. Seven of the 50 nests (14%) that contained flycatcher eggs were brood parasitized by Brown-headed Cowbirds. One additional flycatcher nest was abandoned prior to egg laying after being parasitized. Mayfield survival probability at the four life history study areas and Bill Williams ranged from 0 to 100% and was 56% for all sites combined.

We used a variation of the Australian crow trap to capture and remove Brown-headed Cowbirds at each of the four life history study areas. Cowbird traps were deployed at least two weeks prior to the initiation of flycatcher nesting (mid-May) and continually operated until all nests were past the egg stage (mid-August). We captured and removed 115, 6, 3, and 113 Brown-headed

Cowbirds at Pahranagat, Mesquite, Mormon Mesa, and Topock, respectively. Variability in trapping success among sites did not appear to be directly related to the total number of traps per site or relative abundance of cowbirds at each site. Landscape characteristics of the sites and/or trap locations may have affected capture success. We detected no obvious differences in brood parasitism rates at any of the study areas during 2003 compared to previous years, although one year of trapping is probably insufficient to detect any differences in flycatcher parasitism rates or reproductive success.

We gathered data on vegetation and habitat characteristics at 49 nest plots and 48 non-use plots. We gathered data at an additional 35 plots at the life history study areas to obtain an overall description of entire habitat blocks at each study area. The life history study areas vary in vegetation age, vegetation structure, and species composition. The habitat block at Pahranagat consists of mature, native, large-diameter trees with little shrub and sapling understory. The habitat blocks at Mesquite, Mormon Mesa and Topock are composed primarily of very dense stands of both mixed-native (Mesquite and Mormon Mesa) and exotic (Topock) woody vegetation.

We found willow flycatchers nesting in a diverse array of riparian habitats. Willow flycatcher nest heights at the four life history study areas and Bill Williams ranged from 1.0 to 9.3 m (mean=2.9 m, SE=0.19). Flycatchers placed 57% of all nests at these five study areas in tamarisk (*Tamarix* sp.), 18% in coyote willow (*Salix exigua*), and 24% in Goodding willow (*Salix gooddingii*). Differences in nest-site characteristics between study areas were reflective of the differences in overall habitat characteristics of the sites.

Nest sites consistently differed from non-use sites in several variables. We found greater canopy closure at nest sites than at non-use sites, and three of the four life history study areas (Mesquite, Mormon Mesa, and Topock) had taller canopy height at nest sites than at non-use sites. At all study areas, vertical foliage density was greatest at and immediately above mean nest height.

Microclimate assessment along the Virgin and lower Colorado Rivers indicated that Southwestern Willow Flycatchers placed their nests in habitats exhibiting the lowest mean maximum diurnal temperatures (i.e., the coolest locales). To a lesser extent, flycatchers also placed nests within their territories at sites exhibiting the lowest mean diurnal temperature (i.e., locales with the most thermally moderate microclimate). Non-use sites tended to exhibit less canopy closure, were hotter and drier, and had a greater mean daily temperature range (i.e., were less thermally stable) than either nest or within-territory locales.

CHAPTER 1

INTRODUCTION

PROJECT HISTORY

In response to the 1994 designation of critical habitat along the lower Colorado River for endangered fish species, the U.S. Bureau of Reclamation (USBR) and other federal, state, and tribal agencies formed a partnership to develop and implement the Multi-Species Conservation Program (MSCP). This program seeks to protect threatened, endangered, and sensitive (TES) species and their habitats along the lower Colorado River while maintaining river regulation and water management required by law. The MSCP is currently under development and will be evaluated through an Environmental Impact Statement, as required by the National Environmental Policy Act of 1969 (42 USC §4321 et seq.).

Because all federal agencies are required to ensure their actions do not violate the Endangered Species Act (ESA) of 1973, the USBR prepared a Biological Assessment (BA) in August 1996 as part of planning for the MSCP, evaluating the effects of dam operations and maintenance activities on TES species. These species included the Southwestern Willow Flycatcher (*Empidonax trailli extimus*), which was listed by the U.S. Fish and Wildlife Service (USFWS) as endangered in 1995 (60 FR 10694-10715). In response to the BA, the USFWS issued a Biological Opinion in April 1997 outlining several terms and conditions the USBR must implement in order not to jeopardize the species. Among these terms and conditions was the requirement to survey and monitor occupied and potential habitat for Southwestern Willow Flycatchers along the lower Colorado River for a period of five years. The studies were intended to determine the number of willow flycatcher territories, status of breeding pairs, flycatcher nest success, the biotic and abiotic characteristics of occupied willow flycatcher sites, and Brown-headed Cowbird (*Molothrus ater*) brood parasitism rates. In anticipation of these requirements, the USBR initiated willow flycatcher studies along the lower Colorado River in 1996. The studies have been conducted every year since.

A separate Biological Opinion for Interim Surplus Criteria, Secretarial Implementation Agreements, and Conservation Measures was issued in January 2001. This Opinion required annual presence/absence surveys and nest monitoring for up to five years in suitable habitat surrounding Lake Mead and between Parker and Imperial Dams. In 2002, the USBR completed a second BA on the effects of continued dam operations and maintenance on TES species along the lower Colorado River. The USFWS responded with a Biological Opinion in April 2002 requiring continued Southwestern Willow Flycatcher studies along the lower Colorado River through April 2005. The Opinion also required implementation of a study to evaluate the effectiveness of Brown-headed Cowbird trapping for conservation of the flycatcher. Thus, willow flycatcher studies along the lower Colorado River are currently anticipated to continue through 2007.

From 1996 through 2002, the USBR's Southwestern Willow Flycatcher studies along the lower Colorado and Virgin Rivers were completed under the direction and management of the San Bernardino County Museum, Redlands, California. In 2003 the studies were continued by SWCA Environmental Consultants under contract to USBR (Contract # 03-CS-30-0093). This contract has annual option years through 2007.

SPECIES INTRODUCTION

The Southwestern Willow Flycatcher (*Empidonax trailli extimus*) is one of four subspecies of willow flycatcher currently recognized (Unitt 1987), although Browning (1993) posits a fifth subspecies (*E. t. campestris*) occurring in the central portions of the United States (Figure 1.1). The Southwestern Willow Flycatcher 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 (Unitt 1987). In the Southwest, most willow flycatcher breeding territories are found within small breeding sites containing five or fewer territories; only two sites are known to have 50 or more territories (Sogge et al. 2003). One of the last long-distance Neotropical migrants to arrive in North America during spring migration, willow flycatchers have a short, approximately 100-day breeding season, with individuals typically arriving in May or June and departing in late August (Sogge et al. 1997, Sedgwick 2000). 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). Willow flycatchers have been recorded on the 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 2002).

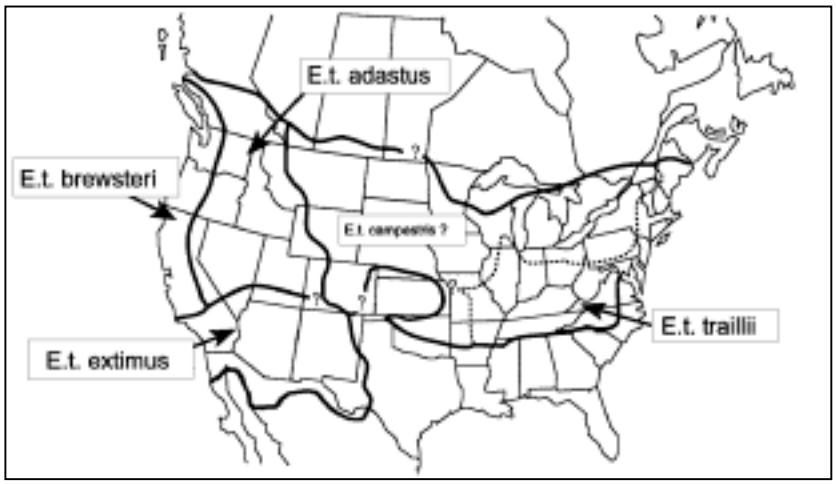

Figure 1.1. Breeding range distribution of the subspecies of the willow flycatcher (*Empidonax traillii*). Adapted from Unitt (1987), Browning (1993), and Sogge et al. (1997).

Historical breeding records and museum collections indicate that a sizable population of Southwestern Willow Flycatchers may have existed along the extreme southern stretches of the lower Colorado River 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 1997; McKernan and Braden, 1999, 2001a, 2001b, 2002; this document). Factors contributing to the decline of flycatchers on the breeding grounds include loss, degradation and/or fragmentation of riparian habitat; invasion by nonnative plants; and brood parasitism by Brown-headed Cowbirds (USFWS 1995, Marshall and Stoleson 2000). Because of low population numbers range-wide, identifying and conserving willow flycatcher breeding sites is thought to be crucial to the recovery of the species (USFWS 2002).

From 1997 to 2001,[1] breeding populations of Southwestern Willow Flycatchers were documented at seven study areas along the Virgin and lower Colorado Rivers and tributaries: (1) Pahranagat National Wildlife Refuge (NWR), Nevada; (2) Mesquite and (3) Mormon Mesa on the Virgin River, Nevada; (4) Overton Wildlife Management Area located in the lower Virgin River Valley on the Overton Arm of Lake Mead; (5) Grand Canyon, Arizona; (6) Topock Marsh on the Colorado River, Havasu NWR, Arizona; and (7) Bill Williams River NWR (hereafter Bill Williams), Arizona (McKernan and Braden 2002). Willow flycatchers were detected during the breeding season at several sites along the Colorado River south of the Bill Williams River to the Mexico border, but more information is needed to determine flycatcher residency, breeding status, and demography in this area.

PURPOSE AND DESCRIPTION OF STUDY

The purpose of the 2003 study is to continue surveys, monitoring, and demographic and ecological studies of the Southwestern Willow Flycatcher in suitable and/or historical riparian and wetland habitats throughout the lower Colorado and Virgin River region. This project encompasses two types of studies: (1) presence/absence surveys, including site descriptions, at pre-selected sites along the lower Colorado and Virgin Rivers and tributaries, including the lower Grand Canyon and Bill Williams River; and (2) intensive, long-term life history studies at four specific study areas (Pahranagat NWR, Mesquite, and Mormon Mesa, Nevada, and Topock Marsh, Arizona) to assess Southwestern Willow Flycatcher demographics and ecology, habitat selection, and the effects of Brown-headed Cowbird brood parasitism. SWCA's contract specifies the following field tasks:

(1) **Presence/absence Surveys**: At approximately 136 sites[2] along the lower Colorado River, complete the following:

   (a) conduct presence/absence surveys, following a 10-survey protocol (per Braden and McKernan 1998);
   (b) provide a general site description for each site;

[1] Studies in 1996 did not include any sites in Nevada, and data from 2002 were not available at the time of this writing.
[2] A site is defined as one contiguous area that can be surveyed by one person in one morning.

(c) conduct nest searches if territorial flycatchers are located and monitor any nests found;
(d) collect habitat and physical measurements around each nest site; and
(e) band as many adult and juvenile flycatchers as possible with unique color-bands.

(2) **Life History Studies:** At the four life history study areas, complete the following tasks in addition to all tasks listed above under Presence/absence Surveys:

(a) conduct Brown-headed Cowbird trapping and determine its effectiveness in reducing brood parasitism rates;
(b) conduct in-depth vegetation sampling of the whole habitat block;
(c) replicate all habitat measurements collected at nest sites at unused sites of similar structure; and
(d) monitor microclimatic conditions of soil moisture, temperature and humidity.

Each distinct aspect of the 2003 study is addressed in a separate chapter in 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 site description for each survey site, including life history sites.
Chapter 3 – Color-banding and Resighting. Details of banding activities in 2003 and resighting of previously banded flycatchers are presented in this chapter. Also included are the identities and locations of all Southwestern Willow Flycatchers that could be identified to individual and 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 Southwestern Willow Flycatcher nesting activity documented during this study.
Chapter 5 – Brown-headed Cowbird Trapping. This chapter summarizes the efforts and results of cowbird trapping at the four life history study areas.
Chapter 6 – Vegetation Sampling. Vegetation and habitat characteristics of all nest and non-use sites are presented and compared in this chapter. Vegetation characteristics of the whole habitat block at each life history study area are also presented.
Chapter 7 – Microclimate. The methodology and results of monitoring temperature, humidity, and soil moisture within each life history study area at nest and non-use sites are presented.

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. 1997). Willow flycatchers detected between approximately 15 June and 20 July in the breeding range of *E. t. extimus* probably belong to the southwestern subspecies (Sogge et al. 1997, USFWS 2002). However, as northbound individuals of all subspecies of the willow flycatcher migrate through areas where *E. t. extimus* are actively nesting, and southbound migrants occur where *extimus* are still breeding (USFWS 2002, Sogge et al. 1997), field confirmation of the southwestern subspecies is problematic.[3] 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 20 June (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 23 June. 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 Southwestern Willow 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 as spring is the only time that willow flycatchers sing 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 (Yong and Finch 1997), migrants are also found in a variety of unsuitable breeding habitats in both spring and fall. 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 2003, we completed multiple broadcast surveys at sites in 15 study areas along the lower Colorado River and its tributaries to detect both migrant and resident willow flycatchers (Figure 2.1).

[3] Throughout this document, the terms "flycatcher" and "willow flycatcher" refer to *E. t. extimus* when individuals are confirmed as residents. For individuals for which residency is undetermined, subspecies is unknown.

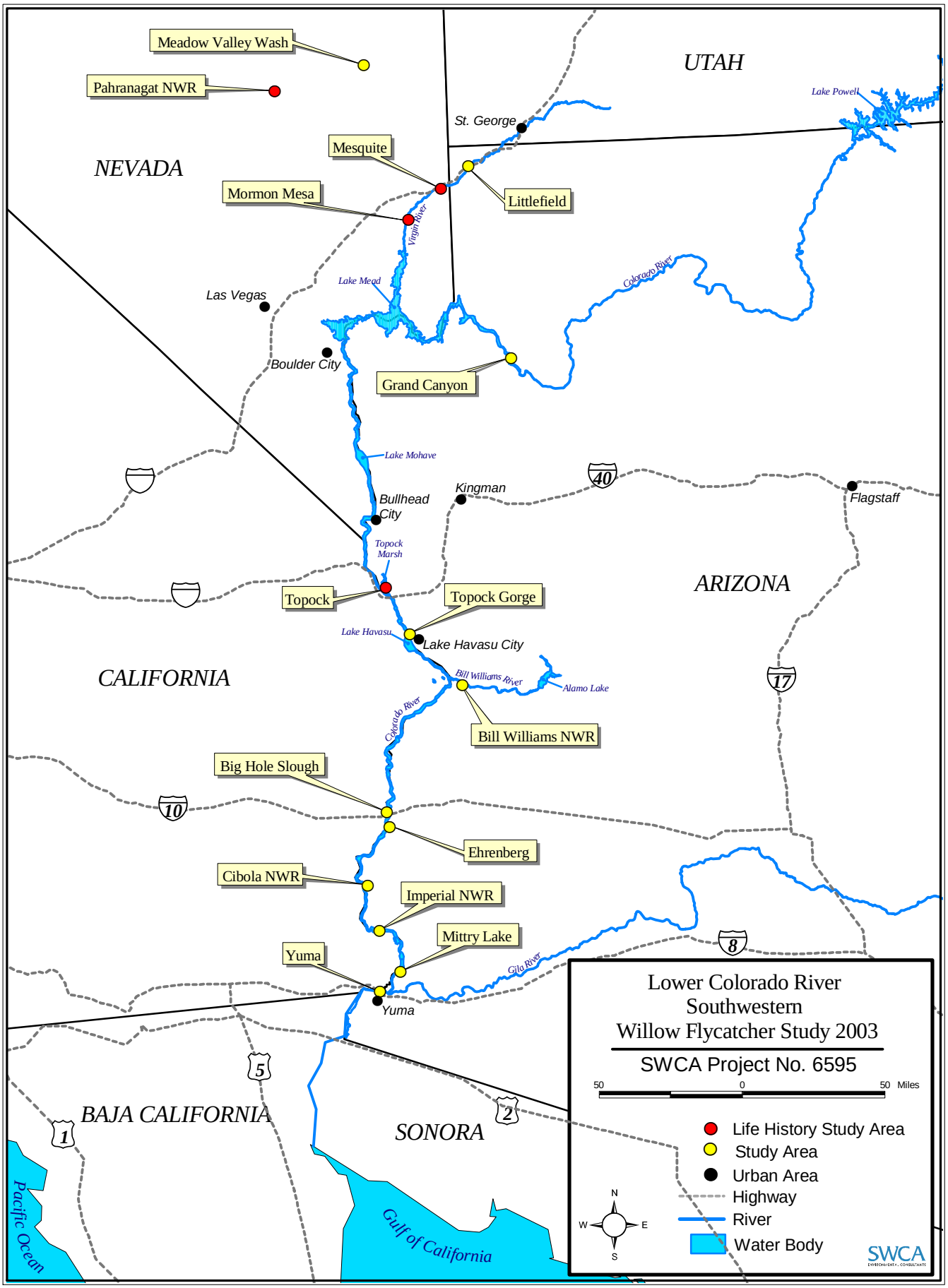

Figure 2.1. Locations of Southwestern Willow Flycatcher study areas along the lower Colorado River and tributaries, 2003. *(Note, study area labels represent the approximate center of multiple sites within that region, see Table 2.1 and Appendix B.)*

YELLOW-BILLED CUCKOO AND YUMA CLAPPER RAIL

The Yuma Clapper Rail (*Rallus longirostris yumanensis*) is listed as federally endangered by the USFWS, and the Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) is a candidate for federal listing. Both species occur along the lower Colorado River and its tributaries and are of concern to managing agencies. We did not survey specifically for these species but recorded all incidental detections.

METHODS

SITE SELECTION

Survey sites were selected based on locations surveyed during previous years of willow flycatcher studies on the lower Colorado River (McKernan 1997, McKernan and Braden 1998, 1999, 2001a, 2001b, 2002) and reconnaissance by helicopter, by boat, and on foot prior to the start of the 2003 survey period. USBR biologists Theresa Olson and John Swett guided and approved site selection. For sites that had been surveyed in previous years, we retained original site names. We provided field personnel with high-resolution aerial photographs of all selected survey sites. The photographs were overlain with a UTM grid (NAD 27) and an outline of the proposed survey area. The boundaries of all survey sites were refined to include potential flycatcher habitat actually present. New boundaries were delineated on the aerial photographs based on UTM coordinates obtained in the field. All UTM coordinates were obtained in NAD 27 using a Garmin Rino 110 GPS unit.

BROADCAST SURVEYS

We broadcast conspecific vocalizations previously recorded from 1996 to 1998 throughout the Southwest to elicit responses from nearby willow flycatchers. All flycatcher surveys were conducted according to methods described in Sogge et al. (1997), and we followed the 10-survey protocol proposed by Braden and McKernan (1998). We completed at least one survey between 15 and 30 May, at least one survey between 1 and 15 June, and eight additional surveys between 16 June and 25 July. Surveys were separated by a minimum of five days whenever logistically possible. Field personnel surveyed within the habitat wherever possible, using a portable CD player (various models were used) coupled to a Radio Shack 277-1008C mini amplified speaker. Surveyors stopped every 30–40 m and broadcast willow flycatcher primary song (*fitz-bew*) and calls (*whitts*). Field personnel watched for flycatchers and listened for vocal responses for approximately one to two minutes before proceeding to the next survey station. Wherever territorial flycatchers were detected, broadcast surveys were discontinued within a radius of 50 m of territories, and territory and nest monitoring commenced (see Chapter 4). If a willow flycatcher was observed but did not respond with song to the initial broadcast, we broadcast other conspecific vocalizations including *creets/breets*, *wee-oos*, *churr/kitters*, and a set of interaction calls given by a mated pair of flycatchers (per Lynn et al. 2003). These calls were frequently effective in eliciting a *fitz-bew* song, thereby enabling surveyors to positively identify willow flycatchers. To produce a spatial representation of all survey areas, field personnel recorded survey start and stop UTM coordinates as well as the UTM coordinates of intermediate survey points. Observers recorded start and stop times and the location(s) and behavior of all

willow flycatchers detected (see survey form, Appendix A). Field personnel also recorded the presence of Brown-headed Cowbirds and livestock, as requested by the Arizona Game and Fish Department. Cowbirds may affect flycatcher populations by decreasing flycatcher productivity (see Chapter 5), while livestock may substantially alter the vegetation in an area (USFWS 2002).

SITE DESCRIPTION

Because vegetation structure and hydrology within riparian habitats are seasonally dynamic, field personnel completed site description forms (Appendix A) for each survey site at least three times throughout the survey season: early season (mid-May to mid-June), mid-season (mid-June to mid-July), and late season (mid-July to August). Vegetation composition (native vs. exotic) at survey sites followed the definitions of Sogge et al. (1997) and the Southwestern Willow 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; and 4) mixed exotic: 50 to 90% of the vegetation at a site was exotic/introduced. Information from 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

Field personnel spent 1,571 observer-hours conducting willow flycatcher broadcast surveys at 95 sites along the Virgin and lower Colorado Rivers and tributaries.[4,5] Willow flycatcher survey results are summarized in Table 2.1 and are presented below along with site descriptions. The UTM coordinates presented below are the centroid of each survey area. The boundaries of survey sites and occupancy in 2003 are shown on orthophotos in Appendix B, along with historically occupied habitat.[6] Because willow flycatchers detected between approximately 15 June and 20 July in the breeding range of *E. t. extimus* probably belong to the southwestern subspecies (USFWS 2002, Sogge et al. 1997), flycatcher detections between these dates are summarized in Table 2.2. Yellow-billed Cuckoo and Yuma Clapper Rail detections are summarized in Tables 2.3 and 2.4. Hydrologic characteristics of each site are summarized in Table 2.5.

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[4] For sites surveyed in previous years, we counted each survey area with a distinct name as one site. In previous years, several of these areas were counted as multiple sites. For example, the report from the 2001 field season (McKernan and Braden 2002) lists 41 sites at Topock (Table 2), but only 19 sites are named on the map (Appendix 4). Total acreage surveyed for all sites in 2003 differed little from previous years.

[5] We started the 2003 survey season with 101 survey sites, ranging in size from 1 to 67 ha. Surveys at nine sites were discontinued because of poor habitat quality, inaccessibility, or loss of habitat to fire. One site was added to the survey protocol after field personnel from an unrelated project detected a willow flycatcher, and two additional sites at the Bill Williams were surveyed opportunistically.

[6] As per the USBR (1999), we defined occupied Southwestern Willow Flycatcher habitat as patches of vegetation that are similar to and contiguous with areas where willow flycatchers were detected after 15 June.

Table 2.1. Willow flycatcher detections along the Virgin and Colorado Rivers and tributaries, 2003.

Study area[1]	Survey site	Area (ha)	# of willow flycatchers detected (date(s) of detection)[2]
PAHR	Pahranagat North	4.4	18 (13 May–6 August)[3]
	Pahranagat South	2.8	3 (13 May–6 August)[3]
MVWA	Meadow Valley #6	7.1	ND
	Meadow Valley #3	3.2	ND
	Meadow Valley #4	1.2	ND
LIFI	Littlefield North	9.3	ND
	Littlefield South	5.7	ND
MESQ	Mesquite West	18.2	38 (13 May–5 August)[3]
MOME	Mormon Mesa North	15.8	7 (14 May–17 July)[3]
	Mormon Mesa South	35.6	1 (14 May)
	Virgin River #1 (North)	43.3	7 (15 May–9 July)[3]
	Virgin River Delta #4	12.2	5[4] (14 May–15 July)[3]
GRCA	Separation Canyon	8.0	ND
	RM 243S	1.8	1 (18 July)
	Spencer Canyon	5.5	ND
	Clay Tank Canyon	0.5	ND
	Reference Point Creek	4.2	ND
	RM 257.5N	7.1	ND
	Burnt Springs	11.0	ND
	Quartermaster Canyon	2.8	ND
	RM 260.5N	3.4	ND
	RM 262.5S	12.8	ND
	RM 268N	7.2	ND
	Columbine Falls	7.2	ND
	RM 274.5N	4.5	ND
TOPO	Pipes #1	5.3	ND
	Pipes #2	2.8	ND
	Pipes #3	4.9	1 (3 June)
	In Between	8.0	12 (13 May–10 August)[3]
	800M	6.2	4 (22 May–6 August)[3]
	Pierced Egg	6.8	ND
	Swine Paradise	3.3	ND
	Barbed Wire	2.6	ND

Table 2.1, continued

Study area[1]	Survey site	Area (ha)	# of willow flycatchers detected (date(s) of detection)[2]
TOPO, cont	IRFB03	1.0	ND
	IRFB04	1.5	ND
	Platform	1.3	1 (16 May)
	250M	2.3	2 (11 June)
	Hell Bird	3.7	2 (20 June–6 August) [3]
	Glory Hole	1.0	3 (25 May–22 July) [3]
	Lost Lake	8.7	ND
TOGO	Pulpit Rock	1.8	ND
	Picture Rock	5.5	ND
	Blankenship Bend North	18.9	ND
	Blankenship Bend South	43.7	ND
	Topock Gorge North	3.8	ND
	Topock Gorge South	2.6	ND
	Havasu NE	33.5	6 (18 May), 2 (19 May)
BIWI	Bill Williams Site 1	1.9	1 (10–26 June) [3]
	Bill Williams Site 2	2.6	ND
	Bill Williams Site 11	2.2	1 (17 June)
	Bill Williams Site 4	5.8	4 (14 May–27 June) [3]
	Bill Williams Site 3	3.7	5 (7 May–20 July) [3]
	Bill Williams Site 5	2.8	ND
	Mineral Wash Complex	19.6	ND
	Bill Williams Site 8	10.3	1 (6 June)
	Beaver Pond	19.0	1 (16 May)
BIHO	Big Hole Slough	16.5	1 (17 May), 4 (10 June)
EHRE	Ehrenberg	4.7	1 (17 May)
CIBO	Cibola Site 2	16.4	1 (15 May), 1 (20 May), 1 (3 June)
	Cibola Site 1	7.7	ND
	Hart Mine Marsh	31.6	4 (20 May), 1(29 May)
	Three Fingers Lake	70.1	7 (19 May), 10 (1 June)
	Cibola Lake #1 (North)	8.5	1 (16 May), 1 (21 May), 1 (2 June)
	Cibola Lake #2 (East)	4.5	1 (18 May)
	Cibola Lake #3 (West)	7.0	1 (21 May)
	Walker Lake	24.0	1 (22 May)

Table 2.1, continued

Study area[1]	Survey site	Area (ha)	# of willow flycatchers detected (date(s) of detection)[2]
IMPE	Paradise	5.2	1 (30 May)
	Hoge Ranch	21.8	2 (29 May), 1 (30 May), 1 (12 June), 1 (17 June), 1 (2 July)
	Adobe Lake	8.2	1 (30 May), 1 (12 June)
	Taylor Lake	3.1	2 (30 May)
	Picacho NW	3.2	1 (13 June)
	Picacho Camp Store	3.3	1 (30 May), 2 (10 June), 1 (11 June), 1 (16 June)
	Milemarker 65	10.0	ND
	Clear Lake/The Alley	8.3	1 (21 May), 1 (2 June)
	Imperial Nursery	1.4	ND
	Ferguson Lake	29.1	2 (5 June)
	Ferguson Wash	6.8	1 (22 May)
	Great Blue	7.1	1 (15 May), 7 (21 May), 1 (10 June)
	Powerline	2.0	ND
	Martinez Lake	4.6	ND
MITT	Mittry West	4.4	2 (17 May), 3 (6 June), 1 (8 June), 4 (9 June), 1 (18 June)
	Mittry South	15.5	2 (23 May), 1 (27 May)
	Potholes East	2.0	1 (2 June)
	Potholes West	6.6	1 (2 June)
YUMA	I-8 Site #1	17.9	ND
	River Mile 33	20.6	6 (20 May), 3 (22 May), 1 (4 June), 2 (7 June), 4 (13 June), 1 (17 June)
	Gila Confluence West	5.6	1 (19 May), 1 (13 June), 1 (17 June)
	Gila Confluence North	4.6	1 (19 May), 1 (13 June)
	Gila River Site #1	5.7	1 (17 May), 3 (20 May), 1 (3 June), 3 (13 June)
	Gila River Site #2	8.0	1 (20 May), 3 (4 June), 14 (11 June)
	Fortuna North	4.8	3 (20 May), 4 (3 June), 4 (11 June), 4 (12 June)
	Gadsden Bend	4.4	9 (18 May), 8 (5 June), 4 (12 June), 4 (13 June), 2 (17 June)
	Gadsden	24.3	25 (19 May), 2 (1 June), 3 (16 June)
	Hunter's Hole	13.0	14 (18 May), 1 (1 June), 8 (12 June), 2 (14 June), 1 (15 June), 2 (16 June)

[1]PAHR=Pahranagat National Wildlife Refuge; MVWA=Meadow Valley Wash; LIFI=Littlefield; MESQ=Mesquite West; MOME=Mormon Mesa; GRCA=Grand Canyon; TOPO=Topock Marsh; TOGO=Topock Gorge; BIWI=Bill Williams National Wildlife Refuge; BIHO=Big Hole Slough; EHRE=Ehrenberg; CIBO=Cibola National Wildlife Refuge; IMPE=Imperial National Wildlife Refuge; MITT=Mittry Lake; YUMA=Yuma.
[2]ND = no willow flycatchers were detected.
[3]See Chapter 2 for details on territories, residency, and pairing; see Chapter 3 for details on nesting activity.
[4]One female moved to this site from Virgin River #1.

Table 2.2. Detections of willow flycatchers recorded at sites after 15 June 2003. Sites in which breeding was confirmed are not included. (See Chapters 3 and 4 for details.)

Study area[1]	Site	Date	Comments
IMPE	Picacho Camp Store	16 June	Lone flycatcher not very responsive or territorial.
YUMA	Gadsden	16 June	3 willow flycatchers detected. 1 sang spontaneously, 2 others responded to broadcasts. None could be relocated when surveyor entered area where birds had been singing.
YUMA	Hunter's Hole	16 June	2 willow flycatchers detected; unsuccessful capture attempt made on one.
BIWI	Bill Williams Site 11	17 June	Lone bird responded to broadcasts. This was the only detection of a willow flycatcher at this site.
YUMA	River Mile 33	17 June	Lone bird responded to broadcasts.
YUMA	Gila Confluence West	17 June	Lone bird responded to broadcasts.
YUMA	Gadsden Bend	17 June	2 willow flycatchers responded; neither could be relocated 45 minutes later.
MITT	Mittry West	18 June	Lone bird mildly responsive to broadcasts
IMPE	Hoge Ranch	2 July	This bird vocalized with only a single wheeo when it was startled by the arrival of the observer. It did not vocalize in response to broadcasts.
GRCA	RM 243 S	18 July	Hualapai Division of Natural Resources biologist reported that a willow flycatcher was detected "nearby" on 2 July. Flycatchers were not detected on any other dates despite multiple surveys.

[1]GRCA=Grand Canyon; BIWI=Bill Williams National Wildlife Refuge; IMPE=Imperial National Wildlife Refuge; MITT=Mittry Lake; YUMA=Yuma.

Table 2.3. Yellow-billed Cuckoo detections along the Virgin, lower Colorado, and Gila Rivers, 2003. Unless otherwise stated, number of individual cuckoos was undetermined.

Study area[1]	Site	Date(s) detected	Behavioral observations
PAHR	Pahranagat North	1, 5 Aug	primary song heard from same location, different days
MOME	Mormon Mesa North	20 June	observed foraging in canopy, silent
TOPO	Glory Hole	28 June	primary song and calls heard from canopy
BIWI	Bill Williams Site 1	13, 14 July	observed mid-canopy, silent, same location, different days
IMPE	Picacho NW	9 July	calls heard
YUMA	Gila Confluence West	24 July	calls heard
YUMA	Hunter's Hole	11 July	calls heard
		23 July	calls heard, possibly two individuals

[1]PAHR=Pahranagat National Wildlife Refuge; MOME=Mormon Mesa; TOPO=Topock Marsh; BIWI=Bill Williams River National Wildlife Refuge; IMPE=Imperial National Wildlife Refuge; YUMA=Yuma.

Table 2.4. Yuma Clapper Rail detections along the Virgin and lower Colorado Rivers, 2003. Unless otherwise stated, number of individuals was undetermined.

Study area	Site	Date(s) detected	Behavioral observations
MESQ	Mesquite West	17 May	calls heard
		20 May	calls heard
MOME	Mormon Mesa North	14 May	calls heard, two individuals
MOME	Mormon Mesa South	18 May	calls, possibly two individuals
MOME	Virgin River #1 (North)	17 May	calls heard, four individuals
		14 May	calls heard
MOME	Virgin River Delta #4	17 May	calls heard
TOPO	250M	12, 14 June	calls heard
MITT	Mittry West	16 May	calls heard

[1]MESQ=Mesquite; MOME=Mormon Mesa; TOPO=Topock Marsh; MITT=Mittry Lake.

Table 2.5. Summary of hydrologic conditions at each survey site along the Virgin and lower Colorado Rivers and tributaries, 2003. Values are given for each site as recorded in mid-May, mid-June, and mid-July.

Study area[1]	Survey site	% site inundated	Depth (cm) of surface water	% site with saturated soil[2]	Distance (m) to surface water or saturated soil
PAHR	Pahranagat North	100/80/50	50/50/20	0/20/35	0/0/0
	Pahranagat South	20/20/20	20/20/20	30/10/0	0/0/0
MVWA	Meadow Valley #6	40/40/55	30/30/50	10/10/10	0/0/0
	Meadow Valley #3	20/20/30	50/30/30	5/0/10	0/0/0
	Meadow Valley #4	25/25/20	30/30/40	15/0/5	0/0/0
LIFI	Littlefield North	40/30/30	40/20/25	40/20/15	0/0/0
	Littlefield South	10/5/5	10/10/10	20/15/15	0/0/0
MESQ	Mesquite West	60/20/5	30/10/2	30/15/5	0/0/0
MOME	Mormon Mesa North	10/0/0	40/0/0	25/0/0	0/>1000/>1000
	Mormon Mesa South	25/0/0	50/0/0	30/0/0	0/>1000/>1000
	Virgin River #1 (North)	10/0/0	30/0/0	0/0/0	0/>1000/>1000
	Virgin River Delta #4	90/0/0	30/0/0	10/0/0	0/>1000/>1000
GRCA	Separation Canyon	5/1/1	4/4/4	1/1/1	0/0/0
	RM 243S[3]	0/1/1	0/50/100	0/0/0	0/0/0
	Spencer Canyon	30/30/30	100/100/100	5/5/5	0/0/0
	Clay Tank Canyon	3/5/5	50/100/100	3/0/0	0/0/0
	Reference Point Creek[3]	0/0/0	0/0/0	0/0/0	0/0/0
	RM 257.5N[3]	0/0/0	0/0/0	0/0/0	0/0/0
	Burnt Springs[4]	--/--/--	--/--/--	--/--/--	--/--/--
	Quartermaster Canyon	1/1/1	5/5/5	15/15/5	0/0/0
	RM 260.5N[3]	0/0/0	0/0/0	0/0/0	0/0/0
	RM 262.5S[3]	0/0/0	0/0/0	0/0/0	0/0/0
	RM 268N[3,5]	--/--/0	--/--/0	--/--/5	--/--/0
	Columbine Falls	3/3/5	15/10/10	4/5/3	0/0/0
	RM 274.5N[3]	5/1/10	50/30/50	15/5/50	0/0/0

Table 2.5, continued.

Study area[1]	Survey site	% site inundated	Depth (cm) of surface water	% site with saturated soil[2]	Distance (m) to surface water or saturated soil
TOPO	Pipes #1	10/0/0	35/0/0	10/0/0	0/100/100
	Pipes #2	35/5/0	100/10/0	5/10/0	0/0/100
	Pipes #3	60/10/0	15/10/0	10/25/0	0/0/100
	In Between	60/--/0	20/--/0	40/--/0	0/--/100
	800M	0/--/0	0/--/0	15/--/0	0/--/100
	Pierced Egg	30/0/0	6/0/0	70/90/0	0/0/100
	Swine Paradise[6]	0/0/0	0/0/0	0/0/0	0/0/0
	Barbed Wire	0/0/0	0/0/0	70/0/0	0/200/200
	IRFB03	0/0/0	0/0/0	0/0/0	150/150/150
	IRFB04	0/0/0	0/0/0	0/0/0	100/100/100
	Platform[6]	5/3/0	15/5/0	10/3/0	0/0/0
	250M[6]	30/5/0	--/5/0	--/5/0	0/0/0
	Hell Bird	90/75/--	100/--/--	5/--/--	0/0/--
	Glory Hole	20/5/--	45/45/--	5/--/--	0/0/--
	Lost Lake[6]	0//0/0	0/0/0	0/0/0	0/0/0
TOGO	Pulpit Rock[3]	0//0/0	0/0/0	0/0/0	0/0/0
	Picture Rock[3]	5/5/0	10/10/0	5/5/0	0/0/0
	Blankenship Bend North[3]	5/5/0	30/30/0	5/5/0	0/0/0
	Blankenship Bend South[3]	5/5/0	30/30/0	5/5/0	0/0/0
	Topock Gorge North[3]	10/0/0	10/0/0	10/5/0	0/0/0
	Topock Gorge South[3]	10/0/0	10/0/0	10/5/0	0/0/0
	Havasu NE[3]	5/0/--	20/0/--	5/0/--	0/0/--
BIWI	Bill Williams Site 1	80/10/40	50/50/20	20/10/10	0/0/0
	Bill Williams Site 2	--/20/10	--/10/20	--/50/30	0/0/0
	Bill Williams Site 11	0/--/--	0/--/--	0/--/--	0/30/30
	Bill Williams Site 4	25/0/0	100/0/0	15/1/10	0/--/--
	Bill Williams Site 3	20/0/0	80/0/0	50/1/10	0/--/--
	Bill Williams Site 5	50/30/0	>100/80/0	50/30/1	0/0/0
	Mineral Wash Complex	5/25/1	80/80/80	5/25/1	0/0/0
	Bill Williams Site 8	--/1/1	--/80/80	--/1/1	--/0/0
	Beaver Pond	50/--/--	50/--/--	0/--/--	0/--/--
BIHO	Big Hole Slough	5/0/5	8/0/5	5/5/5	0/0/0
EHRE	Ehrenberg	0/0/0	0/0/0	5/5/10	0/0/0
CIBO	Cibola Site 2[7]	5/5/3	5/5/--	10/10/0	0/0/0
	Cibola Site 1[7]	10/10/5	5/5/--	10/10/3	0/0/0
	Hart Mine Marsh[7]	50/40/5	100/100/20	5/3/3	0/0/0
	Three Fingers Lake[3]	30/30/--	150/150/--	0/0/--	0/0/0
	Cibola Lake #1 (North)[3]	0/0/0	0/0/0	0/0/0	0/0/0
	Cibola Lake #2 (East)[3]	0/0/0	0/0/0	0/0/0	0/0/0
	Cibola Lake #3 (West)[3]	0/0/0	0/0/0	0/0/0	0/0/0
	Walker Lake[3,6]	0/0/0	0/0/0	0/0/0	0/0/0
IMPE	Paradise	5/5/1	100/75/40	0/0/0	0/0/0
	Hoge Ranch[3]	--/0/0	--/0/0	--/3/0	0/0/0
	Adobe Lake[3]	0/0/0	0/0/0	0/0/0	0/0/0
	Taylor Lake[3]	0/0/0	0/0/0	0/0/0	0/0/0
	Picacho NW[3]	0/0/0	0/0/0	0/0/0	75/75/75
	Picacho Camp Store[3]	10/0/3	20/0/10	--/0/3	0/0/0
	Milemarker 65[3]	5/0/--	40/0/--	--/0/--	0/0/0
	Clear Lake/The Alley[3]	5/5/0	10/--/0	10/5/--	0/0/0

Table 2.5, continued.

Study area[1]	Survey site	% site inundated	Depth (cm) of surface water	% site with saturated soil[2]	Distance (m) to surface water or saturated soil
IMPE	Imperial Nursery	5/30/0	25/25/0	5/--/0	0/0/40
	Ferguson Lake[3]	5/0/0	5/0/0	--/0/0	0/0/0
	Ferguson Wash[3]	1/3/5	--/--/--	0/1/2	0/0/0
	Great Blue[3]	0/0/0	0/0/0	0/0/0	0/0/0
	Powerline[3]	0/0/0	0/0/0	0/0/0	0/0/0
	Martinez Lake[3]	0/0/0	0/0/0	0/0/0	0/0/0
MITT	Mittry West	5/5/3	--/15/15	--/3/3	0/0/0
	Mittry South[3]	8/0/0	20/0/0	15/3/0	0/0/0
	Potholes East[7]	30/30/30	--/--/--	0/0/0	0/0/0
	Potholes West[7]	20/20/20	>100/>100/>100	0/0/0	0/0/0
YUMA	I-8 Site #1[3]	--/--/--	--/--/--	--/--/--	0/0/0
	River Mile 33	10/10/0	50/30/0	15/5/0	0/0/--
	Gila Confluence West[3]	0/0/0	0/0/0	0/0/0	0/0/0
	Gila Confluence North[3]	0/0/0	0/0/0	5/5/5	0/0/0
	Gila River Site #1[7]	0/0/0	0/0/0	0/0/0	0/200/0
	Gila River Site #2	0/0/0	0/0/0	0/0/0	300/300/300
	Fortuna North[3]	0/0/0	0/0/0	0/0/0	0/0/0
	Gadsden Bend	1/0/5	10/0/20	0/5/0	0/0/0
	Gadsden[3]	20/20/20	40/40/40	0/0/0	0/0/0
	Hunter's Hole	20/25/10	75/50/50	5/--/2	0/0/0

[1]PAHR=Pahranagat National Wildlife Refuge; MVWA=Meadow Valley Wash; LIFI=Littlefield; MESQ=Mesquite West; MOME=Mormon Mesa; GRCA=Grand Canyon; TOPO=Topock Marsh; TOGO=Topock Gorge; BIWI=Bill Williams National Wildlife Refuge; BIHO=Big Hole Slough; EHRE=Ehrenberg; CIBO=Cibola National Wildlife Refuge; IMPE=Imperial National Wildlife Refuge; MITT=Mittry Lake; YUMA=Yuma.
[2]Percent of site with saturated soil does not include inundated areas.
[3]Site borders river or lake
[4]--=Hydrologic information not recorded
[5]Site not surveyed until July
[6]Site borders marsh
[7]Site borders canal

PAHRANAGAT NATIONAL WILDLIFE REFUGE, NEVADA

Pahranagat National Wildlife Refuge consists of a series of lakes and marshes in Pahranagat Valley approximately 150 km north of Las Vegas, Nevada. Patches of primarily native vegetation exist at the inflow and outflow of Upper Pahranagat Lake.

PAHRANAGAT NORTH

Area: 4.4 ha Elevation: 1,026 m UTM 666067E 4130786N

Pahranagat North is a stand of large-diameter Goodding willow (*Salix gooddingii*) at the inflow of Upper Pahranagat Lake. Fremont cottonwood (*Populus fremontii*) lines the northern, upland edge of the site and extends in narrow stringers around the edge of the lake. Canopy height within the patch is 15–18 m, and canopy closure is >90%. The entire site was inundated with up to 1.0 m of water in mid-May and became progressively drier through the flycatcher breeding season. By mid-July only half the site had standing water.

We located 18 resident, breeding willow flycatchers at Pahranagat North. Details of occupancy, pairing, color-banding, and breeding are presented in Chapters 3 and 4. Areas of Pahranagat North not known to be occupied by willow flycatchers were surveyed throughout the breeding season. The site lies immediately adjacent to cattle pasture, but livestock have access only to the cottonwood stringer on the northwest corner of the lake. Brown-headed Cowbirds (*Molothrus ater*) were detected during the entire season.

PAHRANAGAT SOUTH

Area: 2.8 ha Elevation: 1,023 m UTM 666774E 4127841N

Pahranagat South consists of a relatively small stringer of Goodding willow, coyote willow (*Salix exigua*), and Fremont cottonwood lining a human-made channel that carries the outflow from Upper Pahranagat Lake. The site is bordered to the west by an open marsh and to the east by upland scrub. Tamarisk (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*) form a sparse understory. Overall canopy closure at this site is approximately 50%.

We detected two resident, breeding willow flycatchers at Pahranagat South and an additional flycatcher on 6 August. Details of occupancy, color-banding, and breeding are presented in Chapters 3 and 4. Areas of Pahranagat South not known to be occupied by willow flycatchers were surveyed throughout the breeding season. Brown-headed Cowbirds were detected during the entire season.

PAHRANAGAT SALT CEDAR

We evaluated a patch of tamarisk at the outflow of Lower Pahranagat Lake for potential as willow flycatcher habitat. The site was completely dry in mid-May and is vegetated by patchy, tamarisk and sagebrush 3 m in height. Other than surveys in mid-May, no further surveys were completed at the site.

MEADOW VALLEY WASH, NEVADA

Meadow Valley Wash has its headwaters in the Wilson Creek Range near the Nevada/Utah border, flows south through a narrow valley past Elgin and Carp, and joins the Muddy River near Glendale, Nevada. We surveyed three sites in Rainbow Canyon between Elgin and Caliente, where Meadow Valley Wash is perennial. All sites consist of native vegetation, with narrow stringers of mature cottonwood and willow on either side of the stream and little to no understory. Canopy height varies from 10 to 15 m, and canopy closure along the creek ranges from 50 to 80%. All sites are used intermittently by livestock (cattle).

MEADOW VALLEY #6

Area: 7.1 ha Elevation: 1,182 m UTM: 714637E 4148655N

This site extends for 2 km along Meadow Valley Wash approximately 12 km north of Elgin. We did not detect any willow flycatchers at this site. We spent 11.9 observer-hours at the site over 10 surveys and detected Brown-headed Cowbirds on two visits.

MEADOW VALLEY #3

Area: 3.2 ha Elevation: 1,128 m UTM: 716984E 4139681N

This site extends for 800 m along Meadow Valley Wash approximately 3 km north of Elgin. We did not detect willow flycatchers or cowbirds on any of 10 surveys, totaling 2.8 observer-hours.

MEADOW VALLEY #4

Area: 1.2 ha Elevation: 1,048 m UTM: 717399E 4137919N

This site extends for 500 m along Meadow Valley Wash approximately 1.5 km north of Elgin. We did not detect willow flycatchers or cowbirds on any of 10 surveys, totaling 4.4 observer-hours.

LITTLEFIELD, ARIZONA

We surveyed two adjacent sites at Littlefield, one at the confluence of the Virgin River with Beaver Dam Wash just upstream of the I-15 overpass and the other just downstream of the I-15 overpass.

LITTLEFIELD NORTH

Area: 9.3 ha Elevation: 543 m UTM: 774404E 4087601N

This mixed-native site is a stand of mature Fremont cottonwood with an understory of willow and tamarisk. The site extends from the I-15 bridge over the Virgin River upstream to the confluence of the Virgin River and Beaver Dam Wash. The site extends 250 m up Beaver Dam Wash to a golf course. Canopy closure at the site is 25–50%. The site had standing water and saturated soil throughout the survey period.

We did not detect willow flycatchers at Littlefield North. We surveyed the site 10 times, totaling 25.0 observer-hours. Cowbirds were recorded on four visits, and there was no sign of livestock use.

LITTLEFIELD SOUTH

Area: 5.7 ha Elevation: 543 m UTM: 774466E 4087174N

This mixed-native site extends along the east bank of the Virgin River for 550 m immediately downstream from the I-15 bridge and encompasses a backwater area. Vegetation in the area is primarily willow mixed with tamarisk 3 m in height. The site also contains areas of cattail (*Typha* sp.), arrowweed (*Pluchea sericea*), and seep willow (*Baccharis salicifolia*).

We did not detect willow flycatchers at Littlefield South. We surveyed the site 10 times, totaling 21.9 observer-hours. Cowbirds were recorded on six visits, and there was no sign of livestock use.

MESQUITE, NEVADA

MESQUITE WEST

Area: 18.2 ha Elevation: 470 m UTM: 758057E 4075307N

This mixed-native site lies within the floodplain of the Virgin River in Mesquite, Nevada. Vegetation at the site is supported by runoff from two golf courses immediately adjacent to the site. The site is a mosaic of cattail and bulrush (*Schoenoplectus californicus*) marshes separated by narrow (40–50 m) strips of dense coyote willow with a scattered understory of tamarisk. The willows are generally 5 m in height, and canopy closure is >90%. Water levels within the site varied daily according to irrigation activities at the golf course, but water levels and areas of inundation generally decreased throughout the season. Runoff from heavy monsoon activity inundated areas immediately adjacent to the Virgin River in August.

We located 30 resident, breeding willow flycatchers at Mesquite West and detected an additional 8 individuals for which occupancy could not be determined. Details of occupancy, pairing, color-banding, and breeding are presented in Chapters 3 and 4.

MORMON MESA, NEVADA

For approximately 15 km upstream from its outflow to Lake Mead, the Virgin River flows through a 1-km-wide floodplain with a mosaic of habitats including tamarisk and willow forest, cattail marsh, and mixed-native and nonnative forest. Much of the area is seasonally inundated from snowmelt in the spring and monsoon rains in mid and late summer. Vegetation in much of the floodplain near the Lake Mead Delta is dead or dying as the result of fluctuating reservoir levels. Except for one small site, all the areas surveyed at Mormon Mesa are at least 10 km upstream of Lake Mead. All the areas we surveyed are used extensively by cattle, and cowbirds were detected on almost every survey.

MORMON MESA NORTH

Area: 15.8 ha Elevation: 390 m UTM: 729756E 4057879N

This mixed-exotic site is north of a dry channel of the Virgin River that cuts from east to west across the floodplain. The site is bordered to the west by a seasonally inundated cattail marsh. From the dry river channel toward the cattails, the site grades from dense arrowweed to tamarisk with arrowweed understory to a mixture of tamarisk, Goodding willow, and coyote willow. The areas with a mix of tamarisk and willow forest were inundated to a depth of 0.4 m during site reconnaissance in March. When surveys commenced in May, these areas had damp soil but standing water was present only in the cattail marsh to the west. By mid-June the cattail marsh was also dry. Canopy height in Mormon Mesa North is generally 4–5 m and extends to 8 m where willow is present.

We found three breeding pairs at Mormon Mesa North and detected one additional territorial flycatcher. Details of occupancy and breeding activity are presented in Chapters 3 and 4.

Portions of the site not known to be occupied were surveyed throughout the breeding season, totaling 30.2 observer-hours.

MORMON MESA SOUTH

North half: Area: 24.0 ha	Elevation: 385 m	UTM: 739601E 4057203N
South half: Area: 11.6 ha	Elevation: 385 m	UTM: 739464E 4056623N

Mormon Mesa South was split into two contiguous areas to facilitate tracking of survey activity. Mormon Mesa South consists of a mosaic of tamarisk 4 m in height and patches of willow and cattail. A long stringer of willow runs north to south through the east-central portion of the northern half and the eastern edge of the southern half of the site. Approximately 20% of the site contained up to 0.5 m of standing water in mid-May, but the site was completely dry by mid-June.

We detected one willow flycatcher at the western edge of Mormon Mesa South on 14 May. No other flycatchers were detected through 14 subsequent surveys totaling 36.8 observer-hours.

VIRGIN RIVER #1

North half: Area: 43.3 ha	Elevation: 380 m	UTM: 739300E 4056036N
South half: Area: 49.2 ha	Elevation: 380 m	UTM: 739340E 4055293N

Virgin River #1 was also divided into two contiguous areas to facilitate streamlining of field logistics. Surveys of the southern half were discontinued because this area is primarily tamarisk 3 m in height with many dry, open areas and represents poor willow flycatcher habitat. The northern half of Virgin River #1 contains both tamarisk and willow habitats. The western half of the site contains dense, tamarisk 4 m in height and the eastern half is a mixture of tamarisk, Goodding willow, and coyote willow. Canopy height in the willow areas is approximately 13 m. The willow areas had standing water up to 0.5 m deep in mid-May but were completely dry by mid-June. These areas were inundated again in August following monsoon storms.

We located three breeding pairs of willow flycatchers in the eastern half of Virgin River #1. An additional territorial individual was present at the site from 12 to 28 June. Details of occupancy and breeding activity are presented in Chapters 3 and 4. Portions of the site not known to be occupied were surveyed every few days throughout the entire breeding season, totaling 33.6 observer-hours.

VIRGIN RIVER #2

Area: 67.2 ha	Elevation: 380 m	UTM: 739013E 4054694N

Site reconnaissance was completed at this site during the third and fourth weeks of May, revealing poor willow flycatcher habitat. The site is a monotypic stand of tamarisk 4 m in height with 50–70% canopy closure. There was no standing water or saturated soils within the site during reconnaissance in May, and much of the vegetation was dead. Surveys were discontinued in 2003.

VIRGIN RIVER DELTA #4

Area: 12.2 ha Elevation: 370 m UTM: 738248E 4047366N

This site is approximately 7 km downstream of Virgin River #2 and is also known as Delta West. The site lies along the western edge of the floodplain, between the river channel and upland desert. The upland edge of the site is vegetated by tamarisk and arrowweed while the interior of the site contains a mix of Goodding and coyote willow forest with an understory of tamarisk. Canopy height of the willows is up to 15 m. This site was inundated with up to 0.5 m of water in mid-May. By mid-June a few patches of saturated soil remained, and by mid-July the site was completely dry. This site contained a large, active Great Blue Heron (*Ardea herodias*) and Black-crowned Night Heron (*Nycticorax nycticorax*) rookery.

We located two breeding pairs of willow flycatchers in Virgin River Delta #4 and detected an additional territorial flycatcher from 14 to 20 May. Details of occupancy and nesting are presented in Chapters 3 and 4. Field personnel spent 29.2 observer-hours surveying unoccupied portions of the site throughout the breeding season.

GRAND CANYON, ARIZONA

The Colorado River in Grand Canyon downstream of Separation Canyon is strongly influenced by water levels in Lake Mead. Potential willow flycatcher habitat in this area has changed dramatically in the last three years as the result of a 27-m drop in the level of Lake Mead since 2000. Areas that were inundated in the late 1990s are now well above the current water level, and the existing riparian vegetation in many of these areas is dead or dying. Survey efforts focused on side canyons that receive water from tributaries and on the few areas along the main channel of the Colorado River that still contain live, dense, riparian vegetation. Site names below indicate side canyons (if applicable) and the river mile, as measured downstream from Lees Ferry. River left and river right are indicated by "S" (south) and "N" (north), respectively.

SEPARATION CANYON (RM 239.5N)

Area: 8.0 ha Elevation: 378 m UTM: 810281E 3970155N

This mixed-exotic site consists of dense patches of tamarisk 5 m in height interspersed with open areas along a streambed in a narrow side canyon of the Colorado River. Overall canopy closure is <50%. The streambed was dry throughout the survey season except for a small trickle at the upstream end of the tamarisk habitat. Willow and mesquite trees are also present in the canyon, though the willow trees appeared to be dying.

We did not detect willow flycatchers or Brown-headed Cowbirds at this site. The site was surveyed 10 times, totaling 12.1 observer-hours.

RM 243S

Area: 1.8 ha Elevation: 366 m UTM: 805789E 3971656N

This site lies immediately adjacent to the Colorado River and is vegetated by dense tamarisk 5 m in height. Canopy closure is >90%. A small pool adjacent to the river was filled periodically throughout the survey season during high river flows.

We did not detect any willow flycatchers at this site during the first eight surveys from 28 May to 5 July. We detected one willow flycatcher at the site on 18 July. The flycatcher responded to broadcasts but did not vocalize spontaneously and could not be relocated on two subsequent visits. According to biologists from the Hualapai Department of Natural Resources, a willow flycatcher was detected at this site on 2 July but it could not be relocated on 3, 5 and 8 July. We surveyed this site 11 times, totaling 9.6 observer-hours. We did not detect cowbirds on any visits.

SPENCER CANYON (RM 246S)

Area: 5.5 ha Elevation: 366 m UTM: 802670E 3969264N

This side canyon consists of mixed-native vegetation and a perennial stream. Fremont cottonwood and willow form an overstory of variable height, and willow and tamarisk are present in the understory. Cattails line portions of the stream, and overall canopy closure is 70–90%.

We did not detect willow flycatchers or Brown-headed Cowbirds at this site. The site was surveyed 10 times, totaling 14.7 observer-hours.

CLAY TANK CANYON (RM 249S)

Area: 0.5 ha Elevation: 363 m UTM: 801003E 3973516N

This mixed-exotic site consists of a small patch of tamarisk and arrowweed between the Colorado River and a large pond. A stream was flowing from the pond to the river throughout the survey season. Most of the tamarisk at this site is approximately 2 m in height, though the northern edge of the site has slightly taller vegetation.

We did not detect willow flycatchers or Brown-headed Cowbirds at this site. The site was surveyed 10 times, totaling 4.2 observer-hours.

REFERENCE POINT CREEK (RM 252S)

Area: 4.2 ha Elevation: 360 m UTM: 796581E 3976052N

This site, at the confluence of Reference Point Creek with the Colorado River, is vegetated almost entirely by tamarisk 3 m in height, and a dry, backwater pond in part of the site is

growing in with young tamarisk. Soils at this site were dry throughout the survey season, and the nearest water is the Colorado River. Overall canopy closure at the site is approximately 80%.

We did not detect willow flycatchers or Brown-headed Cowbirds at this site. The site was surveyed 10 times, totaling 9.6 observer-hours.

RM 257.5N

Area: 7.1 ha Elevation: 360 m UTM: 794172E 3982334N

This mixed-exotic site borders the Colorado River. Immediately adjacent to the river, vegetation is primarily a thin band of willow 5 m in height. Behind the willow, the site is dominated by tamarisk. The site was dry throughout the survey season, and vegetation in some portions of the site is dying. Canopy closure at the site is approximately 90%.

We did not detect willow flycatchers at this site. The site was surveyed 10 times, totaling 6.6 observer-hours. Brown-headed Cowbirds were detected on one visit.

BURNT SPRINGS (RM 259.5N)

Area: 11.0 ha Elevation: 363 m UTM: 793447E 3985647N

Vegetation within this side canyon varies from a monotypic patch of tamarisk 3 m in height near the Colorado River to a stand of mature, Goodding willow 15 m in height with an understory of cattails. Canopy closure is approximately 90%. No standing water was noted at the site, but the presence of live cattails suggests recent inundation or subsurface water.

We did not detect willow flycatchers at this site. The site was surveyed 10 times, totaling 12.9 observer-hours. Brown-headed Cowbirds were detected on six visits.

QUARTERMASTER CANYON (RM 260S)

Area: 2.8 ha Elevation: 360 m UTM: 792285E 3984916N

This mixed-exotic site lies at the confluence of the Colorado River and Quartermaster Canyon. Vegetation is predominately tamarisk 4 m in height with patches of dead cattails and scattered willow. Throughout the survey season approximately 5% of the site contained saturated soil near a small spring. Canopy closure is approximately 90%.

We did not detect willow flycatchers at this site. The site was surveyed 10 times, totaling 9.0 observer-hours. Brown-headed Cowbirds were detected on two visits.

RM 260.5N

Area: 3.4 ha Elevation: 354 m UTM: 791588E 3985548N

This site borders the Colorado River and stands about 3 m above the river level. Mixed-exotic vegetation at the site is dominated by tamarisk ranging in height from 1 to 4 m. The interior of the site is open and dry, with many dead and dying trees, and dead willows line the riverbank. Canopy closure at the site is approximately 70%.

We did not detect willow flycatchers at this site. The site was surveyed 10 times, totaling 4.7 observer-hours. Brown-headed Cowbirds were detected on two visits.

RM 262.5S

Area: 12.8 ha Elevation: 354 m UTM: 790004E 3989361N

This mixed-native site lies immediately adjacent to the Colorado River. Vegetation consists of a mix of Goodding willow and tamarisk, varying in density with proximity to the river. In a 10-m-wide strip adjacent to the river, canopy closure is >90%, while interior portions of the site contain dead and dying vegetation with 20% canopy closure. Soils at the site were dry throughout the survey period.

We did not detect willow flycatchers at this site. The site was surveyed 10 times, totaling 15.3 observer-hours. Brown-headed Cowbirds were detected on three visits.

RM 268N

Area: 7.2 ha Elevation: 354 m UTM: 784536E 3993889N

This mixed-exotic site lies immediately adjacent to the Colorado River and consists of a mix of Goodding willow 6 m in height and tamarisk 3 m in height. The interior of the site contains a low-lying area that appeared to have been wet in previous years. Canopy closure at the site is approximately 50%. Soils within the site were dry throughout the survey season.

No willow flycatchers were detected at this site. The site was surveyed four times between 6 and 19 July, totaling 4.3 observer-hours. Surveys from 31 May to 23 June took place at Wheeo (across the river from RM 268N). PTCNT1 (upstream of RM 268N) was surveyed on 2 July. Habitat at these sites is very poor, consisting of sparse canopy and many dead and dying trees. No willow flycatchers were detected at these sites. Further survey efforts were therefore spent at RM 268N, which, of the three sites, has habitat most suitable for willow flycatchers. Cowbirds were detected at PTCNT1 and on three of the four surveys at RM 268N.

COLUMBINE FALLS (RM 274.5S)

Area: 7.2 ha Elevation: 354 m UTM: 777192E 3998751N

This mixed-native site is located at the confluence of Cave Canyon and the Colorado River, and the site receives water from springs above Columbine Falls. Approximately 10% of the site had shallow, standing water or saturated soil throughout the survey season. Vegetation at the site is a mix of willow 5 m in height and tamarisk 2 m in height, and canopy closure is approximately 50%.

We did not detect willow flycatchers at this site. The site was surveyed 10 times, totaling 10.8 observer-hours. Brown-headed Cowbirds were detected on four visits.

RM 274.5N

Area: 4.5 ha Elevation: 354 m UTM: 777130E 3999412N

This mixed-exotic site lies immediately adjacent to the Colorado River and contains seeps and small creeks. Approximately half the site contained saturated soil or standing water up to 1 m deep throughout the survey season. Vegetation at the site is a mix of Goodding willow and tamarisk. Canopy height averages about 5 m, but canopy height and relative proportions of the two species vary throughout the site. Overall canopy closure is approximately 90%.

We did not detect willow flycatchers at this site. The site was surveyed 10 times, totaling 14.9 observer-hours. Brown-headed Cowbirds were detected on eight visits.

OTHER SURVEY AREAS

Lake Mead Delta Elevation: 354 m UTM: 771200E 4002650N

This site was surveyed once 3 June. Surveys were discontinued because vegetation in the area is sparse and less than 2 m in height. Most of the vegetation present in previous years has since fallen off because of steep cut banks (Orthophoto not available).

TOPOCK MARSH, ARIZONA

Topock Marsh lies within Havasu NWR 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 floodplain between the Colorado River on the western edge of the floodplain and the open water of Topock Marsh on the eastern edge of the floodplain. The vegetation is primarily monotypic tamarisk with isolated patches of tall Goodding willow, and seasonally wet, low-lying areas are interspersed throughout the riparian area. Brown-headed Cowbirds were detected during the entire season. Feral pigs frequent all areas surveyed.

PIPES

Pipes #1: Area: 5.3 ha	Elevation: 140 m	UTM: 726971E 3856717N
Pipes #2: Area: 2.8 ha	Elevation: 140 m	UTM: 727041E 3856527N
Pipes #3: Area: 4.9 ha	Elevation: 140 m	UTM: 727080E 3856337N

These three contiguous sites are vegetated by monotypic tamarisk 5–7 m in height. Pipes #2 is very dense, with most stems <3 cm in diameter, and large, impenetrable areas of deadfall are present within the site. The northern edge of Pipes 1 has larger stems, taller canopy, and little deadfall. Pipes 3 and the southern edge of Pipes 2 contain the wettest areas, with Pipes 3 having small, marshy openings. All three sites had areas of standing water in mid-May, and the deepest pools were over 0.5 m deep. By mid-June about 5% of the area had water approximately 0.1 m deep, and by mid-July there was no standing water although soils in some areas were still damp.

We detected one willow flycatcher at Pipes 3 on 3 June. This bird sang briefly in response to broadcasts, but additional broadcasts in the area failed to elicit further responses. No willow flycatchers were detected during the last eight surveys at the site. Pipes was surveyed 11 times, totaling 56.2 observer-hours. Cowbirds were recorded on all but one visit.

IN BETWEEN AND 800M

In Between:	Area: 8.0 ha	Elevation: 140 m	UTM: 727116E 3854983N
800M:	Area: 6.2 ha	Elevation: 140 m	UTM: 726987E 3854826N

These two contiguous sites consist of 50-m-wide linear patches of monotypic tamarisk between swampy areas. The tamarisk patches have stems spaced at approximately 0.5 to 1.0 m intervals. Canopy height is approximately 7 m, with the lowest 3 m of the stand generally lacking foliage, resulting in a relatively open understory. Canopy closure in the tamarisk stands is over 90%. In mid-May, these sites had saturated soils and some standing water, with knee-deep water in the adjacent swamps. The sites became progressively drier through the breeding season, and by early July the swamps were completely dry.

We located eight nesting pairs at In Between and 800M. Details of occupancy, color-banding, and nesting are presented in Chapters 3 and 4. Brown-headed Cowbirds were detected during the entire season.

PIERCED EGG

Area: 6.8 ha	Elevation: 140 m	UTM: 726733E 3854797N

This site borders the western edge of 800M and is a monotypic stand of tamarisk. Canopy height in this area is approximately 2 m shorter than canopy in 800M and In Between, and portions of the understory are thick with deadfall and standing dead wood. Canopy closure is approximately 90%. Parts of the site contained knee-deep standing water in mid-May, but by late June only saturated soils remained.

We did not detect willow flycatchers at this site. The site was surveyed 12 times, totaling 28.3 observer-hours. Brown-headed Cowbirds were detected on 11 visits.

SWINE PARADISE

Area: 3.3 ha Elevation: 140 m UTM: 726331E 3854278N

This site borders the open water of Topock Marsh. Near the marsh, vegetation at the site is dominated by Goodding willow 10 m in height, with some coyote willow and very little tamarisk. The remainder of the site, on both sides of the main refuge road, is vegetated by tamarisk 7 m in height. Overall canopy closure is approximately 90%.

We did not detect any willow flycatchers at this site. We surveyed the site 10 times, totaling 5.6 observer-hours. Cowbirds were detected on nine visits.

BARBED WIRE

Area: 2.6 ha Elevation: 140 m UTM: 726232E 3854356N

This site is contiguous with Swine Paradise. There is one large, emergent Goodding willow at the site; otherwise, the site is vegetated by tamarisk of varying height and density. The northeastern portion of the site contains taller stems, less dead wood in the understory, and fewer large canopy openings than the southwestern portion of the site. Soils in the northeastern part of the site were saturated in mid-May, damp in early June, and dry by mid-June.

We did not detect any willow flycatchers at this site. We surveyed the site 12 times, totaling 19.1 observer-hours. Cowbirds were detected on all visits.

IRFB03 AND IRFB04

IRFB03: Area: 1.0 ha Elevation: 140 m UTM: 726021E 3854153N
IRFB04: Area: 1.5 ha Elevation: 140 m UTM: 726025E 3854039N

These two contiguous sites are vegetated by a monotypic stand of tamarisk 7 m in height, which forms a dense canopy and relatively open understory. There is little deadfall, although many standing stems are dead. These sites had no standing water, but damp soils were present in mid-May. These sites are separated from the Barbed Wire site by a firebreak road.

A silent, unidentified *Empidonax* flycatcher was detected at the site on 1 June. We surveyed these sites seven times, totaling 5.9 observer-hours. Cowbirds were detected on all visits.

PLATFORM

Area: 1.3 ha Elevation: 140 m UTM: 725913E 3853785N

This site forms a narrow strip of vegetation between the main refuge road and the open marsh. Vegetation at the site consists of tamarisk 6 m in height with a few isolated, emergent Goodding willow. Bulrush and cattail line the eastern edge of the site adjacent to the marsh. Soils in the interior of the site were dry throughout the survey season.

We detected one willow flycatcher at Platform on 16 May, but no willow flycatchers were detected on 10 subsequent surveys, totaling 6.8 hours. Cowbirds were detected on 10 visits.

250M

Area: 2.3 ha Elevation: 140 m UTM: 725920E 3853319N

This site lies between the main refuge road and the open marsh. Vegetation composition and structure are highly variable, and the site is dominated by patches of tamarisk and coyote willow of varying height and density, with Gooding willow scattered throughout. Closest to the marsh, the site was inundated through late May. Closest to the refuge road the site is very dry and is dominated by mesquite trees (*Prosopis* spp.) with an understory of arrowweed.

We detected two, interacting willow flycatchers on the northeastern edge of the site on 11 June. As mating and agonistic flycatcher interactions (other than copulation or aggressive displacement) are similar, this observation is difficult to interpret. However, five visits to monitor this area over the next 11 days failed to detect any flycatcher activity. The site was surveyed 11 times, totaling 16.2 observer-hours. Cowbirds were detected on all but one visit.

HELL BIRD AND GLORY HOLE

Hell Bird:	Area: 3.7 ha	Elevation: 140 m	UTM: 725955E 3853061N
Glory Hole:	Area: 1.0 ha	Elevation: 140 m	UTM: 725757E 3852887N

These contiguous sites are located on an island separated from the main riparian area by a narrow, deep channel. Vegetation composition and structure is highly variable, with the survey areas vegetated primarily by a mosaic of tamarisk 6 m in height and Goodding willow 12 m in height. Approximately two-thirds of the island is surrounded by dense bulrush.

We recorded one nesting pair and one unpaired, territorial willow flycatcher in Glory Hole and one unpaired territorial flycatcher in Hell Bird. An additional flycatcher was detected a single time in Hell Bird. Details of occupancy and nesting activity are presented in Chapters 3 and 4.

LOST LAKE

Area: 8.7 ha Elevation: 140 m UTM: 727685E 3846951N

Lost Lake is located 6 km south of Glory Hole and Hell Bird. It is separated from the Colorado River to the west by a low ridge of barren sand dunes, and the site lies adjacent to marshy areas to the east. Lost Lake (a 200 x 500 m body of open water) is located north of the site. Vegetation at the site is variable. The northwestern portion of the site consists an overstory of planted cottonwoods 10 m in height, with an understory of tamarisk 5 m in height. Southeast of the cottonwoods, the site is a monotypic stand of tamarisk, 5–8 m in height. The southeastern end of the site is dominated by dense stands of coyote willow, 5–7 m in height, with an understory of arrowweed. Areas to the south and west of Lost Lake burned in the past few years and contain patches of young tamarisk and small willows.

We did not detect willow flycatchers at Lost Lake. We surveyed the site 13 times, totaling 36.8 observer-hours. Cowbirds were detected on all visits.

OTHER SURVEY AREAS

PC6-1: Area: 3.9 ha Elevation: 140 m UTM: 727367E 3855631N
PB2001: Area 3.9 ha Elevation: 140 m UTM: 727401E 3855427N

Two additional areas, PC6-1 and PB2001, were surveyed once in May. Surveys at these sites were discontinued because of poor habitat quality for willow flycatchers. Both sites demonstrated little canopy closure.

TOPOCK GORGE, ARIZONA AND CALIFORNIA

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 there is little vegetation along the river. We surveyed backwater areas that support marsh and riparian vegetation.

PULPIT ROCK

Area: 1.8 ha Elevation: 156 m UTM: 734146E 3838380N

The Pulpit Rock site is a small backwater area where an unnamed wash enters the Colorado River from the Mohave Mountains. The site is vegetated primarily by tamarisk and young willow 8 m in height. The northwestern edge of the site borders the river and is vegetated by cattails. The upland edges of the site are vegetated by arrowweed and mesquite. Overall canopy closure at the site is approximately 70%. Soils within the site were dry throughout the survey period.

We did not detect any willow flycatchers at this site. We surveyed the site 10 times, totaling 5.0 observer-hours. Cowbirds were detected on four visits. Feral pigs, bighorn sheep, and burros use the site and adjacent uplands.

PICTURE ROCK

Area: 5.5 ha Elevation: 138 m UTM: 734632E 3833574N

Picture Rock is a backwater area where an unnamed wash enters the Colorado River from the west. The vegetation is mixed-exotic and is dominated by tamarisk 8 m in height with thick deadfall throughout the site. A few isolated, emergent Goodding willow are present. Bulrush and cattail are present on the edge of the site along the river, and the upland edges of the site contain arrowweed, mesquite, foothills paloverde (*Parkinsonia microphylla*), and brittlebush (*Encelia farinosa*), especially along the wash. The interior of the site was dry throughout the survey season but dead cattails within the site suggest it may have been wetter in previous years.

We did not detect any willow flycatchers at this site. We surveyed the site 10 times, totaling 14.9 observer-hours. Cowbirds were detected on five visits. Feral pigs and burros use the site and adjacent uplands.

BLANKENSHIP BEND

Blankenship Bend North: Area: 18.9 ha Elevation: 138 m UTM: 736419E 3832449N
Blankenship Bend South: Area: 43.7 ha Elevation: 133 m UTM: 736639E 3831235N

Blankenship Bend is a 2-km-long strip of riparian and marsh vegetation which lies along the east bank of the Colorado River adjacent to the Blankenship Valley. The eastern, upland edge of the site is vegetated by a 100-m-wide strip of mature tamarisk and mesquite. The northern half of the site contains a stand of large Goodding willows adjacent to a cattail marsh. Between the river and the strip of tamarisk, the southern half of the site consists of a mosaic of cattail, bulrush, and scattered islands of small willows and tamarisk. Canopy closure and height are highly variable throughout this mixed-exotic site.

We did not detect any willow flycatchers at this site. We surveyed the site 11 times, totaling 32.9 observer-hours. Cowbirds were detected on five visits. Feral pigs, bighorn sheep and burros use the site and adjacent uplands.

TOPOCK GORGE

Topock Gorge North: Area: 3.8 ha Elevation: 136 m UTM: 736634E 3828736N
Topock Gorge South: Area: 2.6 ha Elevation: 140 m UTM: 736952E 3828437N

These two mixed-exotic sites are located in adjacent backwater coves separated by a narrow, rocky ridge. An unnamed wash enters the Colorado River at each site. The vegetation at both sites grades from cattails and bulrush along the river to a strip of young closely spaced willow. Close to the center of each site, a mix of tamarisk and willow 6 m in height merge with tamarisk

and mesquite (both honey and screwbean), which border the upland edge of the sites. Within the sites, canopy closure is >90% with a few emergent Goodding willow, approximately 15 m in height. In mid-May, there was standing water to a depth of approximately 0.1 m in the portions of the site with young willow, but by the end of May the interiors of the sites were dry.

We did not detect any willow flycatchers at the sites. We surveyed the sites 10 times each, totaling 12.9 observer-hours. Cowbirds were detected on half the visits. Burros use the sites and adjacent uplands.

HAVASU NE

Area: 33.5 ha Elevation: m UTM: 741287E 3823576N

This mixed-native site consists of a 1.3-km-long and <100-m-wide strip of riparian vegetation along the northeastern shore of Lake Havasu. Vegetation at the site grades from cattails along the lakeshore to Goodding willow and tamarisk in the center of the site and a mix of tamarisk and mesquite on the upland edge. Soils within the site were dry throughout the survey season. Many Goodding willows at the site are mature, and stand 5 m above the 10-m-tall tamarisk and mesquite.

We detected six willow flycatchers at Havasu NE on 18 May and two on 19 May. No breeding behavior was observed, and no flycatchers were detected on 10 subsequent surveys totaling 46.5 hours. Cowbirds were detected on all but one visit. Feral pigs were observed at the site on two occasions.

BILL WILLIAMS RIVER NATIONAL WILDLIFE REFUGE, ARIZONA

The Bill Williams NWR contains the last expanse of native cottonwood-willow forest on the lower Colorado River. The refuge encompasses over 2,500 ha along the Bill Williams River upstream from its mouth at Lake Havasu and contains a mixture of native forest, stands of monotypic tamarisk, beaver ponds, and cattail marsh. No evidence of livestock use was reported. Survey sites within Bill Williams are listed below from west to east, moving progressively farther upstream.

BILL WILLIAMS SITE #1

Area: 1.9 ha Elevation: 140 m UTM: 768991E 3798298N

This mixed-native site has a tall overstory of large Goodding willow and Fremont cottonwood and an understory of tamarisk and arrowweed. The site is surrounded by water and is accessible by kayak, with approximately 40% of the site vegetated by cattail. Approximately 80% of the site was inundated with up to 0.6 m of water in mid-May, and the site got progressively drier through the summer, with approximately 40% of the site inundated to a depth up to 0.3 m in mid-July. The site contains large quantities of downed wood.

We detected one willow flycatcher at Site #1 on 20 May and 10, 17, and 26 June. The flycatcher detected on 20 May did not vocalize but approached the broadcast recording. On subsequent visits when a willow flycatcher was detected, the bird was heard vocalizing from many, widely spaced perches over a 100-m-long area. Details of occupancy and breeding status of all flycatchers at Bill Williams are presented in Chapters 3 and 4.

BILL WILLIAMS SITE #2

Area: 2.6 ha Elevation: 140 m UTM: 769122E 3798042N

This mixed-native site has an overstory of large Goodding willow and Fremont cottonwood trees up to 20 m in height and an understory of tamarisk. The site is surrounded by water and is accessible by kayak. Cattails are present along the edges of the site.

We did not detect willow flycatchers at this site. The site was surveyed 10 times, totaling 17.6 observer-hours. Cowbirds were recorded on nine visits.

BILL WILLIAMS SITE #11

Area: 2.2 ha Elevation: 140 m UTM: 769432E 3797863N

This mixed-native site has an overstory of Goodding willow and Fremont cottonwood trees up to 20 m in height, with canopy closure approximately 50%. Tamarisk is the dominant species in the understory, and there is thick deadfall up to 2 m in height. Soils within the site were dry throughout the survey period. Standing water was present throughout the breeding season in channels approximately 30 m from the site.

We detected one willow flycatcher at the site on 17 June. No flycatchers were detected during the last seven surveys. The site was surveyed nine times, totaling 9.0 observer-hours. Cowbirds were recorded on seven visits.

BILL WILLIAMS SITE #4 AND SITE #3

Site 4: Area: 5.8 ha Elevation: 140 m UTM: 769740E 3797299N
Site 3: Area: 3.7 ha Elevation: 140 m UTM: 769897E 3797138

These two sites are contiguous and together are known as Mosquito Flats. Vegetation is mixed-native, with a overstory of Goodding willow 15 m in height and patches of monotypic tamarisk 8 m in height. Canopy closure is approximately 50%, and cattails occupy approximately 20% of the site. Ground cover in portions of the site consists of thick, dead, woody vegetation. The southern portion of Site #3 near the river had standing water up to a depth of 1.2 m in mid-May, but the interior of the sites was dry throughout the breeding season.

We located resident, breeding willow flycatchers at both sites, and details of occupancy and nesting activity are presented in Chapters 3 and 4.

BILL WILLIAMS SITE #5

Area: 2.8 ha Elevation: 143 m UTM: 771723E 3796741N

Site #5 is located on the eastern edge of the Bill Williams River floodplain and is bordered to the east by upland desert. This site consists of mixed-native vegetation, with a canopy of Goodding willow and Fremont cottonwood and an understory of tamarisk 3 m in height. Overall canopy closure is approximately 25%. The site was very wet in mid-May, with deep pools of standing water in approximately 50% of the site and saturated soils in the remainder. The site became progressively drier through the survey season and was completely dry by mid-July.

We did not detect any willow flycatchers at the site. The site was surveyed 11 times, totaling 10.8 observer-hours. Cowbirds were recorded on seven visits.

MINERAL WASH COMPLEX

Area: 19.6 ha Elevation: 162 m UTM: 774662E 3795179N

A channel of the Bill Williams River runs through this mixed-native site, approximately 3 km upstream of Site #5. The site is similar in structure and composition to the other survey sites at Bill Williams, with an overstory of Fremont cottonwood and Goodding willow and an understory of tamarisk 3 m in height. The river was flowing through the site in mid-May, but by mid-July only isolated puddles remained in the upstream portion of the site.

We did not detect any willow flycatchers at the site. The site was surveyed 10 times, totaling 22.0 observer-hours. Cowbirds were recorded on seven visits.

BILL WILLIAMS SITE #8

Area: 10.3 ha Elevation: 168 m UTM: 777994E 3794489N

This narrow, linear site borders the river channel approximately 3 km upstream from the Mineral Wash Complex, at the confluence of Mohave Wash and the Bill Williams River. This section of the river is confined between high cliffs on both banks. Cottonwood-willow stands line the river channel and the edges of beaver ponds, with tamarisk also present throughout the site. This site had flowing water in the river channel throughout the survey season.

We detected one willow flycatcher at Site #8 on 6 June. The bird vocalized three times over a 2-hour period, and only in response to broadcasts. No willow flycatchers were detected on eight subsequent surveys of the site. The site was surveyed 10 times, totaling 24.1 observer-hours. Cowbirds were detected on six visits.

ADDITIONAL SURVEY SITES

Beaver Pond: Area: 19.0 ha	Elevation: 165 m	UTM: 775335E 3794427N
Cougar Point: Area: 7.2 ha	Elevation: 158 m	UTM: 773902E 3795225N

Two additional sites, Beaver Pond and Cougar Point, were surveyed opportunistically throughout the season. Beaver Pond is between the Mineral Wash Complex and Bill Williams Site #8, and Cougar Point is located immediately downstream of the Mineral Wash Complex. These sites are comparable in structure and composition to other survey sites at Bill Williams. The downstream end of the Cougar Point area is very dry and vegetated by dense stands of mesquite.

One willow flycatcher was detected at Beaver Pond on 16 May, but no flycatchers were detected on five subsequent visits. No willow flycatchers were detected at Cougar Point.

BIG HOLE SLOUGH, CALIFORNIA

BIG HOLE SLOUGH

Area: 16.5 ha	Elevation: 82 m	UTM: 728876E 3723848N

This mixed-exotic site consists of a cattail marsh edged with narrow bands of young willow 5 m in height. Away from the marsh, the site contains tamarisk and mesquite 8 m in height with an understory of arrowweed. Approximately 5% of the site had shallow, standing water or saturated soils throughout the survey season.

We detected one willow flycatcher on 17 May and four willow flycatchers on 10 June. No willow flycatchers were detected during the last eight surveys. The site was surveyed 11 times, totaling 23.7 observer-hours. Cowbirds were detected on 10 visits, and livestock (cattle) was noted on 1 visit.

EHRENBERG, ARIZONA

EHRENBERG

Area: 4.7 ha	Elevation: 78 m	UTM: 730018E 3715571N

This site consists of a canopy of Fremont cottonwood and Goodding willow 15 m in height with many young willows in the understory. The periphery of the site is vegetated with a mix of tamarisk and mesquite. Approximately 5% of the site is vegetated with bulrush and had saturated soils throughout the survey season. Canopy closure at the site is approximately 70%.

We detected one willow flycatcher at Ehrenberg on 17 May. No willow flycatchers were detected during the last eight surveys. The site was surveyed nine times, totaling 9.5 observer-hours. Cowbirds were detected on the first three visits to the site, and burros use the periphery of the site.

CIBOLA NATIONAL WILDLIFE REFUGE, ARIZONA AND CALIFORNIA

CIBOLA SITE 2

Area: 16.4 ha Elevation: 65 m UTM: 716938E 3683913N

This mixed-native site consists of a 200-m-wide strip of vegetation bordering a canal east of the Colorado River. The northern quarter of the site consists primarily of tamarisk, while the remainder of the site is vegetated with an overstory of Fremont cottonwood and Goodding willow, with an understory of arrowweed. The cottonwoods reach 20 m in height, and canopy height of the tamarisk is approximately 6 m. Overall canopy closure is 70–90%. Small marshes are scattered throughout the southern portion of the site, and approximately 5% of the site had 5 cm of standing water throughout the survey season.

We detected one willow flycatcher at Cibola Site 2 on 15 and 20 May and 3 June. No willow flycatchers were detected during the last eight surveys. We surveyed the site 11 times, totaling 26.8 observer-hours. Cowbirds were recorded on eight visits, and burro trails were noted on the periphery of the site.

CIBOLA SITE 1

Area: 7.7 ha Elevation: 65 m UTM: 717291E 3683368N

This mixed-native site, immediately south of Cibola Site 2, borders a linear marsh along its western edge, which lies adjacent to a canal. Goodding willow and Fremont cottonwood are the dominant vegetation along the eastern edge of the marsh, and vegetation grades into tamarisk and arrowweed on the dry, eastern edge of the site. The cottonwoods and tamarisk reach heights of 20 and 6 m, respectively. Overall canopy closure is 70–90%. Approximately 10% of the site held 0.1 m of standing water throughout the survey season.

No willow flycatchers were detected at the site. The site was surveyed 11 times, totaling 23.2 observer-hours. Cowbirds were detected on nine visits, and burro trails were noted on the periphery of the site.

HART MINE MARSH

Area: 31.6 ha Elevation: 65 m UTM: 717562E 3682317N

This mixed-exotic site parallels a canal just east of the Colorado River, immediately south of Cibola Site 1. The site consists of a mix of tamarisk and linear stretches of marsh, which make up approximately half the site. Canopy height of the tamarisk is approximately 4 m, and canopy closure is approximately 70%. The marsh held up to 1 m of standing water in mid-May, began to dry up by early June, and by mid-July the marsh in the northeast section of the site was mostly dry. Tamarisk areas contained dry soils throughout the survey season.

We detected four willow flycatchers on 20 May and one on 29 May. No willow flycatchers were detected during the last nine surveys. The site was surveyed 11 times, totaling 27.4 observer-hours. Cowbirds were detected on seven visits, and burro trails were noted on the east side of the site.

THREE FINGERS LAKE

Area: 70.1 ha Elevation: 65 m UTM: 715150E 3681593N

This mixed-exotic site consists of a large island with shores vegetated by cattails, bulrush, tamarisk 6 m in height, and a few large Goodding willow. Canopy closure along the shore is 50–70%. The interior of the island is vegetated primarily by arrowweed and had dry soils throughout the survey period.

We detected 7 willow flycatchers on 19 May and 10 on 1 June. No willow flycatchers were detected during the last eight surveys. The site was surveyed 10 times, totaling 23.8 observer-hours. Cowbirds were detected on six visits, and no livestock use was noted.

CIBOLA LAKE NORTH

Area: 8.5 ha Elevation: 64 m UTM: 716541E 3679811N

This mixed-exotic site consists primarily of tamarisk 4 m in height with scattered Goodding willow and is bordered to the east by a marsh. Canopy closure is 50–70%, and soils within the site were dry throughout the survey period.

We detected one willow flycatcher at Cibola Lake North on 16 and 21 May and 2 June. No willow flycatchers were detected during the last eight surveys. The site was surveyed 11 times, totaling 9.8 observer-hours. Cowbirds were detected on six visits, and no livestock use was noted.

CIBOLA LAKE EAST

Area: 4.5 ha Elevation: 64 m UTM: 717255E 3679475N

This mixed-exotic site is vegetated primarily by tamarisk 5 m in height, with a few Goodding willow and Fremont cottonwood scattered throughout the site. Canopy closure is 70–90%. There was no standing water or saturated soils during the survey season, but the western edge of the site borders a marsh.

We detected one willow flycatcher on 18 May. No willow flycatchers were detected during the last 10 surveys. The site was surveyed 11 times, totaling 12.6 observer-hours. Cowbirds were detected on seven visits, and no livestock use was noted.

CIBOLA LAKE WEST

Area: 7.0 ha Elevation: 64 m UTM: 716761E 3679159N

This mixed-exotic site consists primarily of dense, tamarisk 4 m in height with a few Fremont cottonwood and Goodding willow. Canopy closure is 70–90%. The site is surrounded completely by a marsh, and the edges of the site are vegetated with bulrush. Soils in the interior of the site were dry throughout the survey season.

We detected one willow flycatcher on 21 May. No willow flycatchers were detected during the last nine surveys. The site was surveyed 10 times, totaling 9.3 observer-hours. Cowbirds were detected on five visits, and no livestock use was noted.

WALKER LAKE

Area: 24.0 ha Elevation: 64 m UTM: 716162E 3676068N

This mixed-exotic site is located between Walker Lake and the Colorado River. Most of the site consists of monotypic tamarisk approximately 5 m in height with 50–70% canopy closure. Patches of arrowweed, short tamarisk, and individual Goodding willow and Fremont cottonwood trees are interspersed throughout the site. A narrow band of common reed (*Phragmites* sp.) borders the site along the river. Soils in the interior of the site were dry, and water levels in the marsh on the western side of the site dropped approximately 50 cm between 22 May and 19 June.

We detected one willow flycatcher at Walker Lake on 22 May. No willow flycatchers were detected during the last eight surveys. The site was visited nine times, totaling 13.4 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock was recorded.

IMPERIAL NATIONAL WILDLIFE REFUGE, ARIZONA AND CALIFORNIA

PARADISE

Area: 5.2 ha Elevation: 62 m UTM: 714184E 3665895N

This site is mixed-native habitat, with stringers of Fremont cottonwood and Goodding willow, 15–20 m in height, bordering a small cattail/bulrush marsh. Tamarisk (5 m in height) and arrowweed (3 m in height) make up the understory. Standing water was present throughout the survey season in one small pond comprising less than 5% of the survey area. The site is separated from the Colorado River by a narrow strip (50 m wide) of dense tamarisk. A dry cattail marsh borders the site to the south. Overall canopy closure is approximately 25%.

We detected one willow flycatcher on 30 May. No willow flycatchers were detected during the last nine surveys. The site was surveyed 10 times, totaling 13.2 observer-hours. Cowbirds were detected on every visit, and there was no sign of livestock use of the site.

HOGE RANCH

Area: 21.8 ha Elevation: 61 m UTM: 717220E 3660097N

This large site is mixed-exotic habitat, dominated by tamarisk (4-6 m in height), with some young (8 m in height) Goodding willows and, at the southern end of the site near the old ranch, a few emergent Fremont cottonwoods (15 to 18 m in height). There are pockets of cattails, bulrush, and common reed, which occupy less than 10% of the site. The site borders the Colorado River, and standing water 0.3 m deep was also present in interior portions of the site. Canopy closure is approximately 70%.

We detected two willow flycatchers at Hoge Ranch on 29 May and one on 30 May, 12 and 17 June, and 2 July. The flycatcher detected on 2 July was very skittish and vocalized only with a single *wheeo*. The flycatcher came in twice to broadcasts of interaction calls but was otherwise unresponsive. We surveyed the area where the flycatcher was detected on five subsequent visits but recorded no further detections. The site was surveyed 12 times, totaling 12.3 observer-hours. Cowbirds were detected on two visits, and there were signs of wild burros using portions of the site.

ADOBE LAKE

Area: 8.2 ha Elevation: 60 m UTM: 717395E 3658838N

This site consists primarily of exotic vegetation, consisting of dense tamarisk (5 to 7 m in height) with many dead branches in the understory. There are scattered Goodding willows (10 m in height) in the site, but there are no contiguous stands of willows. The site is adjacent to the Colorado River, but soils within the site were dry. Canopy closure within the site is 70–90%.

We detected one willow flycatcher on 30 May and 12 June. No willow flycatchers were detected during the last eight surveys. The site was surveyed 11 times, totaling 9.8 observer-hours. Cowbirds were detected on two visits, and there was no sign of livestock use of the site.

TAYLOR LAKE

Area: 3.0 ha Elevation: 60 m UTM: 721647E 3657207N

Taylor Lake is a mixed-native site, consisting of an overstory of Goodding willow (15 m in height) and an understory (3–4 m in height) of varying densities of tamarisk, seep willow, and arrowweed. Dead willow branches compose much of the ground cover, and canopy closure is approximately 50%. The site borders the Colorado River, and the interior of the site is separated from the river by hummocks of live and dead common reed. Soils in the interior of the site were dry throughout the survey period.

We detected two willow flycatchers at Taylor Lake on 30 May. No willow flycatchers were detected during the last nine surveys. The site was surveyed 10 times, totaling 15.0 observer-

hours. Cowbirds were detected on six visits, and there was evidence of occasional use of the site by wild burros.

PICACHO NW

Area: 3.2 ha Elevation: 59 m UTM: 722574E 3656387N

This site is mixed-native habitat that was intensively managed in the 1990s to remove tamarisk and plant cottonwoods. It is currently a gallery forest of Fremont cottonwood and Goodding willow, 15–20 m in height, with canopy closure approximately 50%. The understory is 2–4 m in height and contains honey mesquite, arrowweed, seep willow, and tamarisk. The site borders the Colorado River, but there was no standing water in the gallery forest during the survey period. Outside of the managed area, the habitat is dominated by tamarisk and common reed. To the west of the site there is a flooded area with tamarisk snags.

We detected one willow flycatcher at Picacho NW on 13 June. No willow flycatchers were detected during the last eight surveys. The site was surveyed 10 times, totaling 7.2 observer-hours. Cowbirds were detected on half the visits, and there was evidence of heavy use of the site by wild burros.

PICACHO CAMP STORE

Area: 3.3 ha Elevation: 58 m UTM: 724472E 3656376N

Picacho Camp Store is a mixed-native site, dominated by Goodding willow 20 m in height with an understory of common reed and tamarisk 3 m in height. Canopy closure is 50–70%. The site is bordered to the north by the Colorado River and to the south and west by a patchwork of cattail marshes bordered by Goodding willow and tamarisk 4 m in height. Standing water was present in approximately 5% of the site throughout the survey season.

We detected one willow flycatcher on 30 May, 11 June, and 16 June and detected two willow flycatchers on 10 June. No willow flycatchers were detected during the last seven surveys. The site was visited 12 times, totaling 21.6 observer-hours. Cowbirds were recorded on six visits, and there was evidence of occasional use of the site by wild burros.

MILEMARKER 65

Area: 10.0 ha Elevation: 58 m UTM: 726278E 3657468N

Milemarker 65 is a narrow strip of mixed-exotic vegetation between the Colorado River and a backwater marsh, which is dominated by bulrush. Vegetation at the site consists entirely of dense tamarisk 5 m in height. Dense common reed, approximately 3 m in height, also occurs throughout the site and together with the tamarisk creates almost complete canopy closure. Soils within the site were dry.

We did not detect willow flycatchers at this site. The site was surveyed 10 times, totaling 11.4 observer-hours. Cowbirds were recorded on six visits.

CLEAR LAKE/THE ALLEY

Area: 8.3 ha Elevation: 59 m UTM: 731531E 3657701N

Vegetation at this site is primarily exotic, consisting of monotypic tamarisk 8–10 m in height. Emergent Goodding willow, up to 13 m in height, are scattered throughout the site. The tamarisk is mature, with large amounts of deadfall ground cover, and canopy closure is approximately 90%. The site is surrounded on the east, north, and west by upland desert and is bordered on the south by cattail marshes and common reed. A narrow, backwater channel runs northward from the Colorado River into the center of the site, but soils outside of the channel were dry.

We detected one willow flycatcher on 21 May and 2 June. No willow flycatchers were detected during the last ten surveys. The site was surveyed 12 times, totaling 25.3 observer-hours. Cowbirds were detected on half the visits, and wild burros use the site and the surrounding uplands.

IMPERIAL NURSERY

Area: 1.4 ha Elevation: 58 m UTM: 734341E 3653620N

This site is a cottonwood planting managed by the Imperial NWR. The cottonwoods are approximately 10 m in height, and there is a 10-m-diameter clump of willows 4 m in height in one portion of the understory. Except for this clump of willows, the understory is completely open, and canopy closure is approximately 90%. The site is bordered to the north by a patchwork of cattails, common reed, and tamarisk. The cottonwood plantation was inundated with up to 25 cm of water on 14 June but was completely dry on 26 June and 13 July.

We did not detect willow flycatchers at this site. The site was surveyed 13 times, totaling 7.5 observer-hours. Cowbirds were detected on nine visits, and there was no evidence of livestock using the site.

FERGUSON LAKE

Area: 29.1 ha Elevation: 57 m UTM: 733660E 3651506N

The Ferguson Lake site is on a strip of land between Ferguson Lake and the Colorado River. Vegetation is mixed-native, with stringers of Goodding willow and Fremont cottonwood, up to 15 m in height, forming a sparse overstory with <50% canopy closure along the western edge of the site along Ferguson Lake. On the eastern edge of the site adjacent to the Colorado River, soils were dry and the area is vegetated by scattered tamarisk, arrowweed, and mesquite.

This site was not scheduled for surveys because much of the site had recently burned. Personnel from an unrelated field crew heard a willow flycatcher singing along the Ferguson Lake shore on 20 May, and formal surveys of the site commenced on 5 June. Two willow flycatchers were detected on the first survey, but flycatchers were not detected on nine subsequent visits, totaling 22.9 observer-hours for all surveys. Cowbirds were detected on all visits, and evidence of burros using the site was documented on one visit.

FERGUSON WASH

Area: 6.8 ha Elevation: 58 m UTM: 734059E 3650162N

This mixed-exotic site, at the outflow of Ferguson Wash into Ferguson Lake, is dominated by dense, mature tamarisk, approximately 7 m in height, with dense deadfall in the understory. A few scattered, emergent Goodding willows are present near the lake, and canopy closure is >90%. The site is bordered on the lakeside by cattails and bulrush and on the upland side by desert scrub. A backwater channel penetrates to the interior of the site.

One willow flycatcher was detected at this site on 22 May. No willow flycatchers were detected during the last ten surveys. The site was visited 11 times, totaling 20.5 observer-hours. Cowbirds were recorded on five visits, and burro trails are abundant on the periphery of the site.

GREAT BLUE

Area: 7.1 ha Elevation: 58 m UTM: 736946E 3652143N

This site, on the eastern shore of Martinez Lake, consists of mixed-exotic vegetation. Near the shore of Martinez Lake, Goodding willows form an overstory 15 m in height, with an understory of tamarisk, common reed, and giant reed (*Arundo* sp.). Canopy closure in this area is 80%. Farther from the lake, the site is vegetated by scattered arrowweed and tamarisk 6 m in height, with canopy closure <50%. No standing water or saturated soils were noted within the site.

One willow flycatcher was detected on 15 May; seven were detected on 21 May, and one was detected on 10 June. No willow flycatchers were detected during the last nine surveys. The site was surveyed 13 times, totaling 32 observer-hours. Cowbirds were detected on all but one visit, and burros use the uplands on the periphery of the site.

POWERLINE

Area: 2.0 ha Elevation: 58 m UTM: 737443E 3651901N

This site is located south of Great Blue Heron along the eastern shore of Martinez Lake. Vegetation is mixed-native, and consists of a strip of Goodding willow and Fremont cottonwood along the border of a dry cattail marsh. Overstory height is approximately 12 m, and canopy closure is <50%. Tamarisk, arrowweed, and seep willow are present in the understory. No standing water or saturated soils were noted within the site.

We did not detect willow flycatchers at this site. The site was surveyed 12 times, totaling 7.3 observer-hours. Cowbirds were recorded on nine visits, and burros use the uplands on the periphery of the site.

MARTINEZ LAKE

Area: 4.6 ha Elevation: 58 m UTM: 737445E 3651592N

This mixed-native site is adjacent to and south of the Powerline site on the eastern shore of Martinez Lake. Goodding willows <10 m in height are scattered throughout the northern portion of the site, and clustered Goodding willows and Fremont cottonwoods up to 15m in height are present in the southern portion of the site. Arrowweed and tamarisk dominate the understory, and overall canopy closure is <25%. Cattails and common reed border the site along the lakeshore. No standing water or saturated soils were recorded within the site.

We did not detect willow flycatchers at this site. The site was visited 12 times, totaling 17.8 observer-hours. Cowbirds were detected on every visit, and burros use the adjacent uplands.

MITTRY LAKE, ARIZONA AND CALIFORNIA

MITTRY WEST

Area: 4.4 ha Elevation: 48 m UTM: 735055E 3638408N

The center of this mixed-native site is dominated by Goodding willow 12 m in height with a dense understory of arrowweed and tamarisk. Canopy closure is approximately 80%. Honey and screwbean mesquite are scattered throughout the site but are more common near the periphery. Portions of the site appear to have burned within the last several years. There are patches of cattail within the site, and <15 cm of standing water was reported in approximately 5% of the site throughout the survey season.

We detected two willow flycatchers on 17 May, three on 6 June, one on 8 June, four on 9 June, and one on 18 June. No flycatchers were detected during the last eight surveys. The site was visited 15 times, totaling 37.2 observer-hours. Cowbirds were detected on 11 visits, and burros use the uplands adjacent to the site.

MITTRY SOUTH

Area: 15.5 ha Elevation: 46 m UTM: 736068E 3634182N

This monotypic tamarisk site borders Mittry Lake. Vegetation at the site is very dense, with many dead branches and deadfall in the understory. Canopy closure within the tamarisk is >90%, and canopy height is approximately 7 m. The site is bordered to the south by Mittry Lake, and the marshy edge of the site is vegetated by cattail, bulrush, and common reed. The northern edge of the site was dry and is bordered by an area that has been recently bulldozed.

Two willow flycatchers were detected at Mittry South on 23 May, and one flycatcher was detected on 27 May. No willow flycatchers were detected during the last 11 surveys. The site was visited 13 times, totaling 18.8 observer-hours. Cowbirds were detected on 10 visits, and no evidence of livestock use was recorded.

POTHOLES EAST

Area: 2.0 ha Elevation: 54 m UTM: 731905E 3634205N

This mixed-exotic site is located adjacent to the All American Canal. A cattail pond in the center of the site is surrounded by athel (*Tamarix aphylla*) and tamarisk 8 m in height and a few emergent Fremont cottonwoods up to 15 m in height. Overall canopy closure is <25%. Fan palms (*Washingtonia* sp.) are also present at the site, and honey mesquite trees grow on the upland edges of the site.

One willow flycatcher was detected on 2 June. No willow flycatchers were detected during the last ten surveys. The site was surveyed 12 times, totaling 5.8 observer-hours. Cowbirds were detected on all visits, and evidence of burros was abundant in the upland areas surrounding the site.

POTHOLES WEST

Area: 6.6 ha Elevation: 53 m UTM: 730489E 3635396N

This mixed-exotic site is located adjacent to the All American Canal. A pond with cattails and bulrush occupies the center of the site and is surrounded by tamarisk and athel. Canopy closure is 50–70%, and canopy height ranges from 5 to 10 m. Soils away from the pond were very dry, and there is a patch of mesquite trees on the north side of the site.

One willow flycatcher was detected on 2 June. No willow flycatchers were detected during the last 10 surveys. The site was surveyed 12 times, totaling 9.1 observer-hours. Cowbirds were detected on 10 visits, and burros use the uplands surrounding the site.

YUMA, ARIZONA

I-8 SITE 1

Area: 17.9 ha Elevation: UTM: 723956E 3623696N

This mixed-native site was vegetated by Goodding willow and dense tamarisk. Soils were dry, except on the western edge of the site adjacent to a backwater channel. The site borders the Colorado River.

This site was surveyed twice before it burned between 11 and 28 June. No willow flycatchers were detected.

RIVER MILE 33

Area: 20.6 ha Elevation: 38 m UTM: 726401E 3622886N

This mixed-native site borders the Gila River. The center of the site consists of a stand of Goodding willow and Fremont cottonwood with a multilayered canopy up to 15 m in height. Tamarisk is present in the understory, and common reed occurs in dense clumps. This portion of the site was inundated with approximately o.5 m of water in early June but was completely dry by 28 June. Cottonwoods and willows also occur in narrow stringers along irrigation ditches on the periphery of the site. These ditches contained water up to 1 m deep in early June and were dry by 28 June. Portions of the site that were dry throughout the survey period are vegetated by tamarisk, arrowweed, and young, dying willows.

At River Mile 33, we detected six willow flycatchers on 20 May, three on 22 May, one on 4 June, two on 7 June, four on 13 June, and one on 17 June. No flycatchers were detected during the last six surveys. The site was surveyed 13 times, totaling 39.7 observer-hours. Cowbirds were detected on all but one visit, and there was no evidence of livestock use at the site.

GILA CONFLUENCE WEST

Area: 5.6 ha Elevation: 37 m UTM: 729176E 3622701N

This mixed-native site borders the Colorado and Gila Rivers. Goodding willows and Fremont cottonwoods surround a dry cattail marsh in the center of the site. Canopy height is approximately 10 m, and canopy closure is 25–50%. Arrowweed and tamarisk form a patchy understory. Soils within the site were dry.

One willow flycatcher was detected on 19 May and 13 and 17 June. The flycatcher detected on 19 June was detected during a survey of the adjacent Gila Confluence North site. No willow flycatchers were detected during the last seven surveys. The site was surveyed 11 times, totaling 10.5 observer-hours. Cowbirds were detected on all but one visit, and there was no evidence of livestock use of the site.

GILA CONFLUENCE NORTH

Area: 4.6 ha Elevation: 40 m UTM: 729535E 3622938N

This mixed-native site borders the north side of the Colorado River at the confluence of the Gila and Colorado Rivers. Goodding willow, approximately 8 m in height and closely spaced, is the dominant vegetation at the site, although many appear to be dying, and canopy closure is approximately 50%. Fremont cottonwoods up to 13 m in height are also scattered throughout the site, and arrowweed, tamarisk, and seep willow are common in the understory. Areas of cattails within the site were dry throughout the survey season, and the only saturated soils were adjacent to the Colorado River.

One willow flycatcher was detected at Gila Confluence North on 19 May and 13 June. No willow flycatchers were detected during the last seven surveys. The site was surveyed 10 times, totaling13.4 observer-hours. Cowbirds were detected on all but one visit, and there was no evidence of livestock use at the site.

GILA RIVER SITE 1

Area: 5.7 ha Elevation: 44 m UTM: 733864E 3623420N

The center of this mixed-native site consists of a grove of Fremont cottonwood up to 20 m in height. Stringers of cottonwood, Goodding willow, and tamarisk extend to the east and west, with pockets of arrowweed present throughout the site. Canopy closure is <50%. The site is bordered to the north by agricultural fields and to the south by the Gila River. Water was observed in a canal in the center of the site on 3 June and 10 July but not on 13 June.

One willow flycatcher was detected at the site on 17 May and 3 June, and three willow flycatchers were detected on 20 May and 13 June. No willow flycatchers were detected during the last eight surveys. The site was surveyed 12 times, totaling 12.1 observer-hours. Cowbirds were detected on all but one visit, and there was no evidence of livestock use at the site.

GILA RIVER SITE 2

Area: 8.0 ha Elevation: 45 m UTM: 736565E 3623600N

This mixed-native site consists of an overstory of Fremont cottonwood (up to 15 m in height) and an understory of arrowweed. Tamarisk is present along the northern edge of the site, and canopy closure is <50%. The site is bordered to the north by agricultural fields and to the south by an open, sandy area vegetated by arrowweed. A stringer of cottonwoods and Goodding willows extends to the west along the edge of the agricultural fields toward Gila River Site 1. There was no standing water or saturated soils within the site, but the western edge of the site borders a large pond.

One willow flycatcher was detected on 20 May and 11 June, and three flycatchers were detected on 4 June. No willow flycatchers were detected during the last eight surveys. An additional 13 willow flycatchers were detected on a single day on 11 June in a stringer of cottonwoods and willows between Gila River Site 2 and Gila River Site 1. Gila River Site 2 was surveyed 11 times, totaling 17.0 observer-hours. Cowbirds were detected on all visits, and there was no evidence of livestock use at the site.

FORTUNA NORTH

Area: 4.8 ha Elevation: 46 m UTM: 739857E 3625337N

This site is vegetated primarily by mature tamarisk approximately 8 m in height. Goodding willow and honey mesquite are scattered throughout the site but make up less than 10% of the vegetation, and canopy closure is approximately 80%. There was no standing water or saturated soils within the site, but the western edge of the site borders the Gila River.

Three willow flycatchers were detected on 20 May, and four flycatchers were detected on 3, 11, and 12 June. No willow flycatchers were detected during the last eight surveys. The site was surveyed 12 times, totaling 18.1 observer-hours. Cowbirds were recorded on seven visits, and burro sign was recorded on one visit.

GADSDEN BEND

Area: 4.4 ha Elevation: 28 m UTM: 707333E 3605485N

This mixed-native site is adjacent to a beaver pond along old backwater channels of the Colorado River. The canopy reaches 20 m in height and is composed of Fremont cottonwood and Goodding willow. Many of these trees appear to be dying, and canopy closure is <50%. The site contains a sparse understory of scattered tamarisk and patches of arrowweed and common reed. The site is bordered to the north and east by agricultural fields and to the south by a large stand of mesquite.

At Gadsden Bend, we detected nine willow flycatchers on 18 May, eight on 5 June, four on 12 June, four on 13 June, and two on 17 June. No flycatchers were detected during the last six surveys. The site was surveyed 12 times, totaling 18.8 observer-hours. Cowbirds were detected on 10 visits. No livestock use was recorded at the site, but site receives heavy foot traffic by illegal immigrants.

GADSDEN

Area: 24.3 ha Elevation: 25 m UTM: 707210E 3603847N

This mixed-native site consists of stringers of Goodding willow and scattered Fremont cottonwood along backwater channels of the Colorado River. Canopy height is approximately 8 m, and canopy closure is <25%. The site is bordered to the east by agricultural fields. The backwater channels, portions of which are vegetated by cattail and bulrush, have open, sandy shores.

Twenty-five willow flycatchers were detected on 19 May, two were detected on 1 June, and three were detected on 16 June. No flycatchers were detected during the last seven surveys. The site was surveyed 11 times, totaling 17.9 observer-hours, and cowbirds were recorded on 10 visits. No livestock use was recorded at the site, but site receives heavy foot traffic by illegal immigrants.

HUNTER'S HOLE

Area: 13.0 ha Elevation: 26 m UTM: 706558E 3600016N

This mixed-native site consists of two patches of Goodding willow separated by a pond surrounded by cattail and common reed. In the southern patch, stringers of willow 10 m in height surround an oxbow that was full of water in May but completely dry by 29 June. Areas away from the oxbow are vegetated by arrowweed and tamarisk with sparse canopy.

The northern patch is a mixture of willow and scattered Fremont cottonwood in stringers along channels and ponds. Between the stringers, vegetation is a mix of tamarisk and arrowweed. Water was present in ponds and a small stream in the northern patch throughout the survey season. Agricultural fields border the site to the east.

At Hunte Hole, we detected 14 willow flycatchers on 18 May, one on 1 June, eight on 12 June, two on 14 June, one on 15 June, and two on 16 June. No flycatchers were detected during the last six surveys. The site was surveyed 12 times, totaling 34.8 observer-hours, and cowbirds were recorded on 11 visits. No livestock use was recorded at the site, but site receives heavy foot traffic by illegal immigrants.

DISCUSSION

In 2003, we found resident, breeding Southwestern Willow Flycatchers at Pahranagat NWR, Mesquite West, Mormon Mesa, Topock Marsh, and Bill Williams River NWR (details presented in Chapters 3 and 4). Although many flycatchers were recorded at 32 of the 38 sites south of Bill Williams until 18 June, with a single detection recorded on 2 July, monitoring results at these sites suggest these flycatchers were not resident, breeding individuals. Based upon the variation in total numbers of flycatchers detected at a particular site over the survey period (e.g., 14 flycatcher detections at Gila River #2 on 11 June, no detections on 20 June), the overall lack of territorial, aggressive behaviors exhibited toward conspecific broadcasts, and the molt patterns exhibited on captured individuals (see Chapter 3 for details), willow flycatchers detected at sites south of Bill Williams in 2003 were most likely northbound migrants. Given that willow flycatchers are one of the last long-distance Neotropical migrant passerines to arrive in the Southwest in spring,[7] the occurrence of migrant flycatchers along the southern stretches of lower Colorado River until the end of June is not surprising. Results at survey sites south of Bill Williams in 2003 are consistent with those of previous years from 1997 to 2001 (McKernan and Braden 2002), with no confirmed nesting recorded since 1938 (Unitt 1987). Residency and breeding status of the flycatcher detected on 18 July at RM 243 in Grand Canyon is undetermined; however, based upon survey results (no detections at the site on eight visits prior to the detection and no detections on subsequent visits after the detection) this individual was most likely not resident at the site for the entire 2003 breeding season.

Although conservative estimates of the total number of flycatchers detected at a site on a particular survey day are presented above, estimating the total number of flycatchers detected at a site throughout the season is problematic. Unless the birds are uniquely color-banded there is no way of determining if the same individuals were observed at a site multiple times or if different individuals were present on subsequent surveys. Although we did initiate color-banding studies at sites south of Bill Williams in 2003 (see Chapter 3), no detections were recorded on subsequent visits to sites where flycatchers were captured and color-banded. Color-banding studies at sites south of Bill Williams will be conducted in subsequent years to better determine residency, breeding status, and movement patterns in this area.

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[7] Migrants have been documented as late as 23 June in southern Arizona (Phillips et al. 1964) and resident, wintering individuals have been recorded as far south as Costa Rica until the end of May (Koronkiewicz 2002).

CHAPTER 3

COLOR-BANDING AND RESIGHTING

INTRODUCTION

Long-term monitoring of willow flycatchers of known identity, sex, and age is the only effective way to determine demographic life history parameters such as annual survivorship and mortality of adults and young, between-year site fidelity, and seasonal and between-year movements, within and between sites. Thus, as an integral part of the life history studies, we captured and uniquely color-banded as many willow flycatchers as possible, allowing field personnel to resight individuals throughout the 2003 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.

METHODS

COLOR-BANDING

From approximately mid-May through the end of August 2003, we captured and uniquely color-banded adult, nestling, and fledged willow flycatchers, with banding efforts concentrated at the life history study areas and Bill Williams. In addition to these sites, we initiated color-banding studies from 10–30 June along the extreme southern stretches of the lower Colorado River from its confluence with the Gila River south to the Mexico border. In conjunction with subsequent resighting and monitoring through the end of July, these additional studies were conducted to better determine flycatcher residency, breeding status, and movement patterns in this area. Banding efforts at all sites were primarily dependent upon the presence of territorial individuals, as determined by survey, monitoring, and banding field personnel.

Adult and fledgling flycatchers were captured using mist-nets, which provide the most effective technique for live-capture of adult songbirds (Ralph et al. 1993). We used a targeted capture technique (per Sogge et al. 2001), whereby a variety of conspecific vocalizations are broadcast from a CD player and remote speakers to lure territorial flycatchers into the nets. In addition, we used "passive netting," whereby several mist-nets are erected and periodically checked, with no broadcast of conspecific vocalizations.

Nestlings to be banded were gently removed from the nest at 7 to 10 days of age. At that age, they are large enough to retain the leg bands, yet young enough that they will 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/replacement of the nestlings would not endanger the nest, nest plant, or nestlings. We banded each adult and fledged willow flycatcher with a single anodized (colored), numbered U.S. federal aluminum band on one leg and one

colored metal band on the other. Nestlings were banded with a single anodized numbered federal band, uniquely identifying it as a returning nestling in the event it returns in a subsequent year. We coordinated all color combinations used at study locations with the Federal Bird Banding Laboratory and all other Southwestern Willow Flycatcher banding projects to minimize replication of color combinations. For each color-banded bird recaptured, we visually inspected the legs and noted any evidence of irritation or injury that may be related to the presence of leg bands. Color change and fading have been documented in Hughes's celluloid-plastic leg bands, making resighting difficult under field conditions (Lindsey et al. 1995, USGS unpublished data). For birds recaptured with faded and indistinguishable plastic bands, we replaced the bands with metal color-bands. All plastic bands removed were collected and the color-band combination, if recognizable, recorded along with the federal band number.

For each captured adult and fledged willow flycatcher, we recorded morphological measurements including culmen, tail, wing, mass, fat level, and molt onto standardized data forms (Appendix A). Sex was determined based on the presence of a cloacal protuberance in males or brood patch for females. 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 second year (per Kenwood and Paxton 2001 and Koronkiewicz et al. 2002).

RESIGHTING

We determined the identity of a color-banded flycatcher by observing with binoculars, from a distance, the unique color combination on its legs. 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 then redirected 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 onto standardized data forms (Appendix A). For resighted flycatchers, we recorded color-band combinations, territory number, site, standardized confidence levels of the resight, and behavioral observations. Willow flycatchers exhibiting territorial behaviors for one week or greater, regardless of whether a possible mate was observed, were considered territorial at a site. All territories were assigned a unique alphanumeric code and were plotted onto high-resolution aerial photographs, thus producing a spatial representation of flycatcher population structure at each study location. 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. 1997).

RESULTS

LIFE HISTORY STUDY AREAS AND BILL WILLIAMS

Color-Banding and Resighting – Field personnel color-banded 26 new adult flycatchers, recaptured 20 adults banded in previous years, and resighted 17 additional adults banded in previous years. Of the resighted adults, nine could be identified to individual. Seventeen of the previously banded individuals were originally banded as nestlings or hatch-year birds, with 11 recaptured to determine identity. Field personnel banded 63 nestlings from 23 nests and recaptured and color-banded 3 fledglings. Overall, 55% of the adult flycatchers detected at the study areas were banded by the end of the 2003 breeding season (Table 3.1). For 17 adult flycatchers detected, we were unable to determine if these individuals were color-banded (that is, we could not confirm banding status). Thus, the percentage of color-banded adult flycatchers at sites is a conservative estimate.

SITE-BY-SITE COLOR-BANDING AND RESIGHTING

Pahranagat – We detected 20 resident, adult willow flycatchers (color-banded and unbanded) from 14 territories at Pahranagat. Field personnel captured and color-banded six new adults, recaptured four adult flycatchers, resighted two other returning banded individuals, and banded 22 nestlings (Tables 3.2 and 3.3). Six resident flycatchers remained unbanded, and banding status could not be confirmed for two resident individuals. Of the 14 territories recorded at Pahranagat, 8 consisted of breeding individuals and 6 consisted of unpaired individuals. Of the breeding individuals, two males were polygynous. In addition to resident individuals, we detected one individual for one day in a previously unoccupied area; banding status of this bird could not be confirmed (Table 3.3).

Mesquite – We detected 30 resident, adult willow flycatchers (color-banded and unbanded) from 19 territories at Mesquite. Of the resident birds, field personnel captured and color-banded 3 new adults, recaptured 10 adults, resighted 5 other returning banded individuals, banded 18 nestlings, and recaptured and color-banded 3 fledglings (Table 3.4). Six resident adults remained unbanded, three wore bands but band combinations could not be determined, and the banding status of three individuals could not be confirmed. Of the 19 territories recorded at Mesquite, 13 consisted of breeding individuals (Table 3.4) and 6 consisted of unpaired individuals (Table 3.5). Of the breeding individuals, two males were polygynous. In addition to known resident individuals, we color-banded two new adults and recaptured four adults that were not detected again after capture, and detected an additional two individuals that were observed at the site for less than six days (Table 3.5).

Mormon Mesa – We detected 17 resident, adult willow flycatchers (color-banded and unbanded) from 10 territories at Mormon Mesa. Field personnel captured and color-banded two new adults, recaptured one adult flycatcher, resighted three other returning banded individuals, and banded one nestling (Table 3.6). Seven resident adults remained unbanded, and banding status could not be confirmed for three individuals. Of the 10 territories recorded at Mormon Mesa, 8 consisted of breeding individuals and 2 consisted of unpaired individuals, one of which was later captured at Mesquite during the 2003 season. After a failed nesting attempt, one breeding female moved

to a location 8.8 km south of the initial nest and nested a second time. In addition to resident adults, we detected two individuals that were observed at the site for less than three days (Table 3.7).

Topock – We detected 20 resident willow flycatchers (color-banded and unbanded) from 11 territories at Topock. Field personnel captured and color-banded seven new adults, recaptured one adult flycatcher, resighted four other returning banded individuals, and banded 16 nestlings (Table 3.8). Six resident adults remained unbanded, and two wore bands but color-band combinations could not be determined. Of the 11 territories recorded at Topock, 9 consisted of breeding individuals and 2 consisted of unpaired individuals (Table 3.9). In addition to resident adults, we detected five individuals that were observed at the site for one day (Table 3.9).

Bill Williams – We detected 10 resident willow flycatchers (color-banded and unbanded) from seven territories at Bill Williams. Field personnel captured and color-banded six new adults and banded six nestlings (Tables 3.10 and 3.11). No flycatchers banded in previous years were detected. Three resident adults remained unbanded, and banding status of one individual could not be determined. Of the seven territories recorded at Bill Williams, two consisted of breeding individuals, one consisted of a pair that did not nest, and four consisted of unpaired individuals. In addition to resident adults, we detected three individuals that were observed at the site for one day (Table 3.11).

GILA RIVER AND COLORADO/GILA RIVER CONFLUENCE SOUTH TO MEXICO

From 10 to 17 June 2003, we recorded 59 willow flycatcher detections at the nine sites along the Gila River and the lower Colorado River from its confluence with the Gila River south to the Mexico border. Field personnel captured and color-banded four new adults at three sites (Table 3.12). All four individuals were second-year birds with one individual exhibiting heavy body molt and another exhibiting active growth of the primary coverts. These color-banded individuals were never detected post-capture, and no flycatcher detections were recorded at any of the nine sites after 17 June, suggesting these individuals were northbound migrants.

ADULT AND NESTLING BETWEEN-YEAR RETURN AND DISPERSAL

Through resighting and banding, we detected 37 previously color-banded willow flycatchers that returned to the life history study areas and Bill Williams from previous years. Of these, original banding locations were available for 27 (color combinations could not be confirmed for 8 birds, including one for which a leg injury obstructed the color-band; no previous banding location information was available for two). Of these 27 returning individuals, 17 (63%) returned to the same site at which they were banded and 10 (37%) returned to a different site. Of the 10 returning individuals detected at a different site from where originally banded, 9 moved to Mesquite West. Eight of the nine were originally banded as nestlings. Overall, 60% of the between-year movements detected in 2003 were from Mormon Mesa to Mesquite (Table 3.13). The median dispersal distance for all flycatchers exhibiting between-year movements in 2003 was 43.0 km (min=40.0 km, max=234.0 km).

Table 3.1. Summary of willow flycatchers detected during the 2003 breeding season at the four life history study areas and Bill Williams. Individuals are identified as new captures (previously unbanded), recaptures of previously banded birds, resightings of previously banded birds, birds known to be unbanded, and birds for which band status could not be determined. Included are total numbers of adults detected and percent of all adults banded.

Study area	Site	# new adults captured	# adults recaptured	# adults resighted	# unbanded adults	# adults with unknown band status	Total # adults detected	# nestlings banded (#nests)	# fledglings captured	% of all adults banded
Pahranagat	North	5	4	1	6	2	18	18 (6)	0	56%
	South	1	0	1	0	1	3	4 (1)	0	67%
Mesquite	West	5	14[A]	8	7	4	38	18 (7)	3	71%
Mormon Mesa	North	0	1	1	3	2	7	0	0	33%
	South	0	0	0	1	0	1	**		0%
	Virgin River #1	1[B]	0	2[A]	4	0	7	0	0	43%
	Virgin River Delta #4	1	0	1[B]	2	1	5	1 (1)	0	40%
Topock	Pipes	0	0	0	0	1	1	** 0	0	0%
	In Between	6	0	2	4	0	12	9 (3)	0	67%
	800M	1	1	0	2	0	4	6 (2)	0	50%
	Platform	0	0	0	1	0	1	**	0	0%
	250M	0	0	0	0	2	2	**	0	0%
	Glory Hole	0	0	3	0	0	3	1 (1)	0	100%
	Hell Bird	0	0	0	1	1	2	**	0	0%
Bill Williams	Site 1	0	0	0	1	0	1	**	0	0%
	Site 11	0	0	0	1	0	1	**	0	0%
	Site 3	4	0	0	0	1	5	6 (2)	0	80%
	Site 4	2	0	0	2	0	4	**		50%
	Beaver Pond	0	0	0	0	1	1	**	0	0%
	Site 8	0	0	0	0	1	1	**	0	0%
TOTALS		**26**	**20**	**19**	**35**	**17**	**115[C]**	**63** 0	**3**	**55%**

**No nesting occurred within site.
[A]One bird resighted at Mormon Mesa, Virgin River #1 and then recaptured at Mesquite.
[B]This female moved from Virgin River #1 to Virgin River Delta #4
[C]Total number does not include two individuals detected in multiple sites.

Table 3.2. Breeding and nestling willow flycatchers banded and resighted at Pahranagat, NV in 2003.

Site	Date banded[1]	Federal band #[1]	Color combination[2]	Old color combination[1,2]	Age[3]	Sex[4]	Territory	Observation status[5]
North	1997	1590-97338	BEs:XX	N/A	A8Y	M	13	R 27 May
North	4-JUL-02	2140-66564	RR(P):Zs	N/A	SY	F	11	RS
North	18-JUL-00	2140-66621	Rs:KG(M)	Rs:DD(P)	A5Y	F	13	R 18 June
North	14-JUL-01	2190-76604	KK(M):XX	UB:XX	A3Y	M	15	R 27 May
North	1-JUL-03	2320-31430	EE:UB	N/A	L	U	12	N
North	1-JUL-03	2320-31432	EE:UB	N/A	L	U	12	N
North	3-JUL-03	2320-31435	EE:UB	N/A	L	U	6	N
North	3-JUL-03	2320-31436	UB:EE	N/A	L	U	6	N
North	3-JUL-03	2320-31437	UB:EE	N/A	L	U	6	N
South	17-MAY-03	2320-31451	EE:KK(M)	N/A	AHY	M	16	N
North	28-MAY-03	2320-31453	EE:WW(M)	N/A	AHY	M	5, 19	N
North	1-JUN-03	2320-31454	EE:KR(M)	N/A	AHY	M	11,12	N
North	25-JUN-03	2320-31456	EE:UB	N/A	L	U	13	N
North	25-JUN-03	2320-31457	EE:UB	N/A	L	U	13	N
South	25-JUN-03	2320-31458	EE:UB	N/A	L	U	16	N
South	25-JUN-03	2320-31459	EE:UB	N/A	L	U	16	N
South	25-JUN-03	2320-31460	EE:UB	N/A	L	U	16	N
South	25-JUN-03	2320-31461	EE:UB	N/A	L	U	16	N
North	26-JUN-03	2320-31462	EE:UB	N/A	L	U	5	N
North	26-JUN-03	2320-31463	EE:UB	N/A	L	U	5	N
North	26-JUN-03	2320-31464	EE:UB	N/A	L	U	5	N
North	26-JUN-03	2320-31465	EE:UB	N/A	L	U	5	N
North	26-JUN-03	2320-31466	EE:KW	N/A	AHY	F	12	N
North	27-JUN-03	2320-31467	EE:UB	N/A	L	U	15	N
North	27-JUN-03	2320-31468	EE:UB	N/A	L	U	15	N
North	27-JUN-03	2320-31469	EE:UB	N/A	L	U	15	N
North	27-JUN-03	2320-31470	EE:UB	N/A	L	U	15	N
North	1-JUL-03	2320-31475	EE:UB	N/A	L	U	12	N
North	30-JUL-03	2320-31481	UB:EE	N/A	L	U	13	N
North	30-JUL-03	2320-31482	UB:EE	N/A	L	U	13	N
South	INA	INA	Rs:UB	N/A	AHY	F	16	RS
North	N/A	N/A	unbanded	N/A	AHY	F	15	RS
North	N/A	N/A	unbanded	N/A	AHY	F	19	RS
North	N/A	N/A	unbanded	N/A	AHY	F	5	RS
North	N/A	N/A	unbanded	N/A	AHY	F	6	RS
North	N/A	N/A	unbanded	N/A	AHY	M	6	RS

[1]N/A=not applicable; INA=information not available.
[2]**Color-band codes**: EE=electric yellow federal band, XX=silver federal band, BEs=berry federal band, Bs=blue federal band, Zs=gold federal band, Rs=red federal band, R=red, D=dark/navy blue, B=light blue, K=black, V=violet, Z=gold, Y=yellow, G=green, W=white, O=orange, UB = unbanded, (M)=metal pin striped band, (P)=full plastic band, (HP)=half plastic bands/bands cut to half the height of a full plastic band.
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]**Age in 2003**: L=nestling, SY=2 years, AHY=2 years or older, 3Y=3 years, A3Y=3 years or older, +A5Y=5 years or older, A8Y=8 years or older.
[4]**Sex codes**: F=female, M=male, U=sex unknown.
[5]**Observation status codes**: N=new capture, R=recapture - followed by date recaptured, RS=resight.

Table 3.3. Summary of unpaired, resident willow flycatchers and individuals for which residency and/or breeding status could not be confirmed, Pahranagat, 2003.

Site	Date banded[1]	Federal band #[1]	Color combination[2]	Age[3]	Sex[4]	Observation status[5]
North	INA	INA	undetermined[6]	AHY	U	Unpaired; detected 28 May–4 June
North	20-MAY-03	2320-31452	EE:KO(M)	AHY	M	N; unpaired; detected 17 May–9 July
North	3-JUN-03	2320-31455	EE:KV(M)	SY	M	N; unpaired; detected 3–30 June
North	N/A	N/A	unbanded	AHY	U	RS; unpaired; detected 4–26 June
North	23-JUL-02	2140-66568	BR(P):Zs	A3Y	M	R 7 July; unpaired; detected 4 June–23 July
North	INA	INA	undetermined[6]	AHY	U	Unpaired; detected 29 July–6 August
South	INA	INA	undetermined[6]	AHY	U	Detected 6 August

[1]N/A=not applicable; INA=information not available.
Color-band codes: EE=electric yellow federal band, Zs=gold federal band, R=red, B=light blue, K=black, V=violet, O=orange, (M)=metal pin striped band, (P)=full plastic band.
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]**Age in 2003**: SY=2 years, AHY=2 years or older, A3Y=3 years or older.
[4]**Sex codes**: M=male, U=sex unknown.
[5]**Observation status codes**: N=new capture, R=recapture - followed by date recaptured, RS=resight.
[6]Presence of bands could not be determined.

Table 3.4. Breeding and nestling willow flycatchers banded and resighted at Mesquite, NV in 2003.

Site	Date banded[1]	Federal band #[1]	Color combination[2]	Old color combination[1,2]	Age[3]	Sex[4]	Territory	Observation status[5]
West	1-JUL-98	2090-42022	GG(P):XX	N/A	6Y	F	12	RS
West	31-JUL-02	2110-78842	OB(HP):BEs	N/A	A3Y	M	9	R 29 May
West	24-JUL-02	2140-66517	OY(HP):Zs	N/A	A3Y	F	9	RS
West	17-JUL-98	2140-66606	KY(M):Rs	VP(P):Rs	6Y	M	6	R 31 July
West	2-AUG-01	2140-66693	Rs:OK(M)	Rs:GW(HP)	3Y	M	5	R 26 June
West	3-AUG-01	2140-66696	Rs:RO(HP)	N/A	3Y	F	8	RS
West	22-JUL-02	2140-66709	Bs:GW(M)	Bs:VO(HP)	A3Y	M	4	R 16 June
West	4-AUG-00	2140-66775	VG(M):Bs	VW(HP):Bs	4Y	M	8, 21	R 4 June
West	12-JUN-03	2320-31428	UB:EE	N/A	L	U	6	N
West	12-JUN-03	2320-31429	UB:EE	N/A	L	U	6	N
West	26-JUL-03	2320-31431	EE:UB	N/A	L	U	6	N
West	26-JUL-03	2320-31433	EE:UB	N/A	L	U	6	N
West	26-JUL-03	2320-31434	EE:UB	N/A	L	U	6	N
West	5-JUL-03	2320-31438	RK(M):EE	N/A	L	U	2	N; R 7July, 1 Aug
West	5-JUL-03	2320-31439	RO(M):EE	N/A	L	U	2	N; R 30 July
West	5-JUL-03	2320-31440	OY(M):EE	N/A	L	U	2	N; R 2 Aug

Table 3.4, continued.

Site	Date banded[1]	Federal band #[1]	Color combination[2]	Old color combination[1,2]	Age[3]	Sex[4]	Territory	Observation status[5]
West	29-JUL-03	2320-31443	EE:UB	N/A	L	U	1	N
West	1-AUG-03	2320-31445	EE:WK(M)	N/A	AHY	F	1	N
West	29-JUN-03	2320-31471	EE:UB	N/A	L	U	12	N
West	29-JUN-03	2320-31472	EE:UB	N/A	L	U	12	N
West	29-JUN-03	2320-31473	EE:UB	N/A	L	U	12	N
West	29-JUN-03	2320-31474	EE:UB	N/A	L	U	12	N
West	17-JUN-03	2320-31476	DD(M):EE	N/A	SY	F	14	N
West	25-JUN-03	2320-31477	EE:UB	N/A	L	U	1	N
West	25-JUL-02	2320-31478	DW(M):EE	OG(HP):Zs	A3Y	M	1, 22	R 25 June, 10 July
West	26-JUN-03	2320-31479	GG(M):EE	N/A	SY	F	5	N
West	27-JUN-03	2320-31480	UB:EE	N/A	L	U	6	N
West	23-JUL-03	2320-31486	UB:EE	N/A	L	U	22	N
West	23-JUL-03	2320-31487	EE:UB	N/A	L	U	22	N
West	23-JUL-03	2320-31488	EE:UB	N/A	L	U	22	N
West	17-MAY-00	2390-92350	XX:YR(P)	N/A	A5Y	M	12, 22	RS
West	7-JUL-00	2390-92365	RG(M):XX	BR(P):XX	4Y	M	7	R 28,29 July
West	27-JUN-01	2390-92421	XX:WR(M)	XX:OD(HP)	3Y	M	14	R 17 June
West	29-JUN-01	2390-92427	XX:OW(HP)	N/A	3Y	F	19	RS
West	INA	INA	undetermined[6]	INA	AHY	F	7	N/A
West	N/A	N/A	unbanded	N/A	AHY	F	6	RS
West	N/A	N/A	unbanded	N/A	AHY	F	4	RS
West	N/A	N/A	unbanded	N/A	AHY	M	2	RS
West	INA	INA	banded[7]	INA	AHY	F	2	RS
West	N/A	N/A	unbanded	N/A	AHY	F	22	RS
West	N/A	N/A	unbanded	N/A	AHY	F	21	RS
West	INA	INA	undetermined[6]	INA	AHY	M	19	N/A

[1]N/A=not applicable; INA=information not available.
[2]**Color-band codes**: EE=electric yellow federal band, XX=silver federal band, BEs=berry federal band, Bs=blue federal band, Zs=gold federal band, Rs=red federal band, R=red, D=dark/navy blue, B=light blue, K=black, V=violet, Y=yellow, G=green, W=white, O=orange, UB = unbanded, (M)=metal pin striped band, (P)=full plastic band, (HP)=half plastic bands/bands cut to half the height of a full plastic band.
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]**Age in 2003**: L=nestling, SY=2 years, AHY=2 years or older, 3Y=3 years, A3Y=3 years or older, 4Y=4 years, A5Y=5 years or older, 6Y=6 years.
[4]**Sex codes**: F=female, M=male, U=sex unknown.
[5]**Observation status codes**: N=new capture, R=recapture - followed by date recaptured, RS=resight, N/A=not applicable.
[6]Presence of bands could not be determined.
[7]Bird has color-bands; combination undetermined.

Table 3.5. Summary of unpaired, resident willow flycatchers and individuals for which residency and/or breeding status could not be confirmed, Mesquite, NV, 2003.

Site	Date banded[1]	Federal band #[1]	Color combination[2]	Old color combination[1,2]	Age[3]	Sex[4]	Observation status[5]
West	6-JUL-02	2110-78861	BEs:VK(M)[6]	BEs:VV(P)	SY	M	R 28 July and 1 Aug;
West	5-AUG-03	2320-31413	EE:RY(M)	N/A	SY	U	N; not detected post-capture
West	19-JUL-02	2320-31442	EE:WD(M)	Zs:RB(P)	SY	M	R 28 July; not detected post-capture
West	31-JUL-03	2320-31444	RW(M):EE[7]	N/A	AHY	F	N; not detected post-capture
West	29-MAY-01	2390-92410	XX:DD(P)	N/A	A4Y	M	R 10 June; captured in Territory 4, not detected post-capture
West	31-JUL-02	2390-92420	XX:ZK(M)	XX:RV(HP)	A3Y	M	Unpaired; R 29 May; detected 17 May–23 July
West	4-JUL-01	2390-92433	XX:ZR(M)	XX:YO(HP)	3Y	M	Unpaired; R 18 June; detected 25 May–9 July
West	26-JUL-01	2390-92475	XX:WY(M)	XX:VG(P)	3Y	U	R 31 July; not detected post capture
West	INA	INA	banded[8]	N/A	AHY	U	RS; unpaired; detected 17 May–27 June
West	N/A	N/A	unbanded	N/A	AHY	U	RS; unpaired; detected 13 May–29 July
West	INA	INA	undetermined[9]	N/A	AHY	U	Unpaired; detected 29 May–11 June
West	INA	INA	banded[8]	N/A	AHY	U	RS; unpaired; detected 6–17 June
West	INA	INA	undetermined[9]	N/A	AHY	U	Detected 22 May
West	INA	N/A	unbanded	N/A	AHY	U	RS; detected 29 May–3 June

[1]N/A=not applicable; INA=information not available.
[2]**Color-band codes**: EE=electric yellow federal band, XX=silver federal band, BEs=berry federal band, Zs=gold federal band, R=red, D=dark/navy blue, B=light blue, K=black, V=violet, Z=gold, Y=yellow, G=green, W=white, O=orange, (M)=metal pin striped band, (P)=full plastic band, (HP)=half plastic bands/bands cut to half the height of a full plastic band.
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]**Age in 2003**: SY=2 years, AHY=2 years or older, 3Y=3 years, A3Y=3 years or older, A4Y=4 years or older.
[4]**Sex codes**: F=female, M=male, U=sex unknown.
[5]**Observation status codes**: N=new capture, R=recapture - followed by date recaptured, RS=resight.
[6]Held territory at Mormon Mesa from 12 – 28 June 2003 prior to capture at Mesquite.
[7]This was a female with a brood patch; could be one of unbanded resident females from Mesquite.
[8]Bird has color-bands; combination undetermined.
[9]Presence of bands could not be determined.

Table 3.6. Breeding and nestling willow flycatchers banded and resighted at Mormon Mesa, NV in 2003.

Site	Date banded[1]	Federal band #[1]	Color combination[2]	Old color combination[1,2]	Age[3]	Sex[4]	Territory	Observation status[5]
North	1-JUL-98	1710-20638	YR(M):XX	WK(M):XX	A7Y	M	1	R 7 June
Virgin River #1 North	8-JUN-03	2320-31426	EE:VV(M)	N/A	AHY	F	21, 26	N
Virgin River Delta #4	22-JUN-03	2320-31427	VG(M):EE	N/A	AHY	M	24	N; R 24 June
Virgin River Delta #4	9-JUL-03	2320-31441	UB:EE	N/A	L	U	24	N
North	INA	INA	UB:XX	N/A	AHY	F	6	RS
Virgin River #1 North	INA	INA	KY(HP):XX	N/A	AHY	F	23	RS
Virgin River Delta #4	INA	INA	undetermined[6]	N/A	AHY	M	26	N/A
North	INA	INA	undetermined[6]	N/A	AHY	F	25	N/A
North	INA	INA	undetermined[6]	N/A	AHY	M	6	N/A
North	N/A	N/A	unbanded	N/A	AHY	M	25	RS
Virgin River #1 North	N/A	N/A	unbanded	N/A	AHY	F	32	RS
Virgin River #1 North	N/A	N/A	unbanded	N/A	AHY	M	32	RS
Virgin River Delta #4	N/A	N/A	unbanded	N/A	AHY	F	24	RS
Virgin River #1 North	N/A	N/A	unbanded	N/A	AHY	M	23	RS
Virgin River #1 North	N/A	N/A	unbanded	N/A	AHY	M	21	RS
North	N/A	N/A	unbanded	N/A	AHY	F	1	RS

[1]N/A=not applicable; INA=information not available.
[2]**Color-band codes**: EE=electric yellow federal band, XX=silver federal band, R=red, K=black, V=violet, Y=yellow, G=green, W=white, UB = unbanded, (M)=metal pin striped band, (HP)=half plastic bands/bands cut to half the height of a full plastic band.
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]**Age in 2003**: L=nestling, AHY=2 years or older, A7Y=7 years or older.
[4]**Sex codes**: F=female, M=male, U=sex unknown.
[5]**Observation status codes**: N=new capture, R=recapture - followed by date recaptured, RS=resight, N/A=not applicable.
[6]Presence of bands could not be determined.

Table 3.7. Summary of unpaired, resident willow flycatchers and individuals for which residency and/or breeding status could not be confirmed, Mormon Mesa, NV, 2003.

Site	Date banded[1]	Federal band #[1]	Color combination[2]	Old color combination[1,2]	Age[3]	Sex[4]	Observation status[5]
Virgin River #1 North	6-JUL-02	2110-78861	BEs:VK(M)	BEs:VV(P)	SY	M	Unpaired; RS; detected 12–28 June, later captured twice at Mesquite 28 July and 1 Aug
Virgin River Delta #4	N/A	N/A	unbanded	N/A	AHY	U	Unpaired; RS; detected 14–20 May
North	N/A	N/A	unbanded	N/A	AHY	U	RS; detected 11–13 June
South	N/A	N/A	unbanded	N/A	AHY	U	RS; detected 14 May

[1]N/A=not applicable.
[2]**Color-band codes**: BEs=berry federal band, K=black, V=violet, (M)=metal pin striped band, (P)=full plastic band. 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]**Age in 2003**: SY=2 years, AHY=2 years or older.
[4]**Sex codes**: M=male, U=sex unknown.
[5]**Observation status codes**: RS=resight.

Table 3.8. Breeding and nestling willow flycatchers banded and resighted at Topock, Havasu NWR, AZ in 2003.

Site	Date banded[1]	Federal band #[1]	Color combination[2]	Old color combination[1,2]	Age[3]	Sex[4]	Territory	Observation status[5]
In Between	8-JUL-02	2110-78841	BY(HP):BEs	N/A	SY	F	20	RS
800M	7-JUL-02	2110-78855	RK(M):BEs	DO(HP):BEs	SY	M	2	R 31 May
In Between	28-MAY-03	2320-31502	ZR(M):EE	N/A	AHY	F	21	N
800M	2-JUN-03	2320-31526	OD(M):EE	N/A	AHY	F	11	N
In Between	21-JUN-03	2320-31527	KZ(M):EE	N/A	AHY	F	42	N
In Between	24-JUN-03	2320-31528	EE:YV(M)	N/A	AHY	M	42	N
800M	26-JUN-03	2320-31529	UB:EE	N/A	L	U	11	N
800M	26-JUN-03	2320-31530	UB:EE	N/A	L	U	11	N
800M	26-JUN-03	2320-31531	UB:EE	N/A	L	U	11	N
In Between	27-JUN-03	2320-31532	UB:EE	N/A	L	U	20	N
In Between	27-JUN-03	2320-31533	UB:EE	N/A	L	U	20	N
In Between	27-JUN-03	2320-31534	UB:EE	N/A	L	U	20	N
800M	2-JUL-03	2320-31535	UB:EE	N/A	L	U	2	N
800M	2-JUL-03	2320-31536	UB:EE	N/A	L	U	2	N
800M	2-JUL-03	2320-31537	UB:EE	N/A	L	U	2	N
In Between	19-MAY-03	2320-31576	KK(M):EE	N/A	AHY	M	22	N
In Between	1-JUN-03	2320-31577	GW(M):EE	N/A	AHY	F	41	N
In Between	3-JUL-03	2320-31581	UB:EE	N/A	L	U	22	N
In Between	3-JUL-03	2320-31582	UB:EE	N/A	L	U	22	N

Table 3.8. Breeding and nestling willow flycatchers banded and resighted at Topock, Havasu NWR, AZ in 2003, continued.

Site	Date banded[1]	Federal band #[1]	Color combination[2]	Old color combination[1,2]	Age[3]	Sex[4]	Territory	Observation status[5]
In Between	3-JUL-03	2320-31583	UB:EE	N/A	L	U	22	N
In Between	3-JUL-03	2320-31584	EE:YK(M)	N/A	SY	F	22	N
In Between	3-JUL-03	2320-31585	UB:EE	N/A	L	U	41	N
In Between	3-JUL-03	2320-31586	UB:EE	N/A	L	U	41	N
In Between	3-JUL-03	2320-31587	UB:EE	N/A	L	U	41	N
Glory Hole	17-JUL-03	2320-31588	UB:EE	N/A	L	U	3	N
In Between	INA	INA	Bs: [6]	N/A	AHY	M	21	RS
Glory Hole	INA	INA	banded[7]	N/A	AHY	F	3	RS
Glory Hole	INA	INA	banded[7]	N/A	AHY	M	3	RS
In Between	N/A	N/A	unbanded	N/A	AHY	M	44	RS
In Between	N/A	N/A	unbanded	N/A	AHY	F	44	RS
800M	N/A	N/A	unbanded	N/A	AHY	M	11	RS
In Between	N/A	N/A	unbanded	N/A	AHY	M	20	RS
800M	N/A	N/A	unbanded	N/A	AHY	F	2	RS
In Between	N/A	N/A	unbanded	N/A	AHY	M	41	RS

[1]N/A=not applicable; INA=information not available
[2]**Color-band codes**: EE=electric yellow federal band, BEs=berry federal band, Bs=blue federal band, R=red, D=dark/navy blue, B=light blue, K=black, V=violet, Z=gold, Y=yellow, G=green, W=white, O=orange, UB= unbanded, (M)=metal pin striped band, (HP)=half plastic bands/bands cut to half the height of a full plastic band. 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]**Age in 2003**: L=nestling, SY=2 years, AHY=2 years or older.
[4]**Sex codes**: F=female, M=male, U=sex unknown.
[5]**Observation status codes**: N=new capture, R=recapture - followed by date recaptured, RS=resight.
[6]Color combination could not be determined due to a leg injury masking the band
[7]Bird has color-bands; combination undetermined

Table 3.9. Summary of unpaired, resident willow flycatchers and individuals for which residency and/or breeding status could not be confirmed, Topock, Havasu NWR, 2003.

Site	Date banded[1]	Federal band #[1]	Color combination[2]	Age[3]	Sex[4]	Observation status[5]
Glory Hole	6-JUL-02	2110-78863	RV(HP):BEs	SY	M	Unpaired; RS; detected 17 June–29 July
Hell Bird	N/A	N/A	unbanded	AHY	U	Unpaired; RS; detected 22 June–6 Aug
Platform	N/A	N/A	unbanded	AHY	U	RS; detected 16 May
250M	INA	INA	undetermined[6]	AHY	U	Detected 11 June
250M	INA	INA	undetermined[6]	AHY	U	Detected 11 June
Hell Bird	INA	INA	undetermined[6]	AHY	U	Detected 20 June
Pipes 3	INA	INA	undetermined[6]	AHY	U	Detected 3 June

[1]N/A=not applicable; INA=information not available.
[2]**Color-band codes**: BEs=berry federal band, R=red, V=violet, (HP)=half plastic bands/bands cut to half the height of a full plastic band.
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]**Age in 2003**: SY=2 years, AHY=2 years or older.
[4]**Sex codes**: M=male, U=sex unknown.
[5]**Observation status codes**: RS=resight.
[6]Presence of bands could not be determined.

Table 3.10. Paired and nestling willow flycatchers banded and resighted at Bill Williams River NWR, AZ in 2003.

Site	Date banded[1]	Federal band #[1]	Color combination[2]	Age[3]	Sex[4]	Territory	Observation status[5]
Site 4	29-MAY-03	2320-31401	OO(M):EE	AHY	M	5	N
Site 3	27-JUN-03	2320-31404	RD(M):EE	AHY	F	1	N
Site 3	28-JUN-03	2320-31405	EE:RW(M)	SY	F	2	N
Site 3	29-JUN-03	2320-31406	UB:EE	L	U	2	N
Site 3	29-JUN-03	2320-31407	UB:EE	L	U	2	N
Site 3	29-JUN-03	2320-31408	UB:EE	L	U	2	N
Site 3	2-JUL-03	2320-31409	UB:EE	L	U	1	N
Site 3	2-JUL-03	2320-31410	UB:EE	L	U	1	N
Site 3	2-JUL-03	2320-31411	UB:EE	L	U	1	N
Site 3	7-MAY-03	2320-31501	EE:DD(M)	AHY	M	1	N, R 27 June
Site 4	N/A	N/A	unbanded	AHY	F	5	RS
Site 3	INA	INA	undetermined[6]	AHY	M	2	N/A

[1]N/A=not applicable; INA=information not available.
[2]**Color-band codes**: EE=electric yellow federal band, R=red, D=dark/navy blue, O=orange, UB=unbanded, (M)=metal pin striped band.
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]**Age in 2003**: L=nestling, SY=2 years, AHY=2 years or older.
[4]**Sex codes**: F=female, M=male, U=sex unknown.
[5]**Observation status codes**: N=new capture, R=recapture - followed by date recaptured, RS=resight, N/A=not applicable.
[6]Presence of bands could not be determined.

Table 3.11. Summary of unpaired, resident willow flycatchers and individuals for which residency and/or breeding status could not be confirmed, Bill Williams NWR, 2003.

Site	Date banded[1]	Federal band #[1]	Color combination[2]	Age[3]	Sex[4]	Observation status[5]
Site 4	10-JUN-03	2320-31402	EE:VG(M)	AHY	M	Unpaired; N; detected 3–10 June, not detected post capture
Site 3	7-JUL-03	2320-31412	OW(M):EE	SY	M	Unpaired; N; detected 29 June–20 July, not detected post capture
Site 4	N/A	N/A	unbanded	AHY	U	Unpaired; RS; detected 14 May–27 June
Site 1	N/A	N/A	unbanded	AHY	U	Unpaired; RS; detected 10–26 June
Site 8	INA	INA	undetermined[6]	AHY	U	Detected 6 June
Beaver Pond	INA	INA	undetermined[6]	AHY	U	Detected 16 May
Site 11	N/A	N/A	unbanded	AHY	U	RS; detected 17 June

[1]N/A=not applicable; INA=information not available.
[2]**Color-band codes**: EE=electric yellow federal band, V=violet, G=green, W=white, O=orange, (M)=metal pin striped band.
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]**Age in 2003**: SY=2 years, AHY=2 years or older.
[4]**Sex codes**: M=male, U=sex unknown.
[5]**Observation status codes**: N=new capture, RS=resight.
[6]Presence of bands could not be determined.

Table 3.12. Willow flycatchers color-banded along the Gila River and the lower Colorado River from its confluence with the Gila River south to the Mexico border, 2003.

Site	Date banded	Federal band #	Color combination[1]	Age[2]	Sex[3]	Observation status[4]
Gila River Site 2[5]	12-JUN-03	2320-31403	EE:VK(M)	SY	M	N
Hunters Hole	15-JUN-03	2320-31578	KG(M):EE	SY	U	N
River Mile 33	18-JUN-03	2320-31579	KD(M):EE	SY	U	N
River Mile 33	18-JUN-03	2320-31580	GZ(M):EE	SY	U	N

[1]**Color-band codes**: EE=electric yellow federal band, D=dark/navy blue, K=black, V=violet, Z=gold, G=green, (M)=metal pin striped band.
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.
[2]**Age in 2003**: SY=2 years.
[3]**Sex codes**: M=male, U=sex unknown.
[4]**Observation status codes**: N=new capture.
[5]Bird was captured and color-banded between Gila River Site 2 and Gila River Site 1.

Table 3.13. Summary of willow flycatcher between-year movements during the 2003 breeding season at the four life history study areas and Bill Williams.

Study area/site/year originally banded[1]	Age banded[2]	Study area/site detected 2003[1]	Distance moved (km)	Color combination[3]	Federal band #	Sex
TOPO/In Between/2002	L	MESQ/West MOME/Virgin River #1	234 208	BEs:VK(M)	2110-78861	M
MOME/1998	L	MESQ/West	40	KY(M):Rs	2140-66606	M
MOME/Virgin River Delta #4/2001	L	MESQ/West	43	Rs:OK(M)	2140-66693	M
TOPO/800M/2000	L	MESQ/West	234	VG(M):Bs	2140-66775	M
NDOW/2000	L	MESQ/West	45	RG(M):XX	2390-92365	M
MOME/Virgin River Delta #4/2001	L	MESQ/West	43	XX:WY(M)	2390-92475	U
GRCA/RM 267/1998	AHY	MOME/North	76	YR(M):XX	1710-20638	M
MOME/South/2000	AHY	MESQ/West	40	XX:YR(P)	2390-92350	M
MOME/1998	L	MESQ/West	40	GG(P):XX	2090-42022	F
MOME/North/2001	L	MESQ/West	40	XX:OW(HP)	2390-92427	F

[1] MESQ=Mesquite, MOME=Mormon Mesa, GRCA=Grand Canyon, TOPO=Topock, NDOW=Nevada Division of Wildlife Overton Wildlife Management Area located in the lower Virgin River Valley on the Overton Arm of Lake Mead.
[2]**Age codes:** L = nestling, AHY = after hatch year.
[3]**Color-band codes**: BEs=berry federal band, XX=silver federal band, Rs=red federal band, R=red, D=dark/navy blue, K=black, V=violet, Z=gold, G=green, W=white, Y=yellow, O=orange, (M)=metal pin striped band, (P)=full plastic band, (HP)=half plastic bands/bands cut to half the height of a full plastic band.
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, F=female, U=sex unknown.

2003 WITHIN-YEAR, BETWEEN-SITE MOVEMENTS

A male flycatcher banded as a nestling at Topock/In Between in 2002 (BEs:VK(M), 2110-78861) held a territory as a lone male at Mormon Mesa/Virgin River #1 from 12–28 June 2003. This same individual was later recaptured twice at Mesquite West on 28 July and 1 August, where it was never detected prior- or post-capture.

DISCUSSION

LIFE HISTORY STUDY AREAS AND BILL WILLIAMS

Overall, 26 new adults, 3 fledglings and 63 nestling Southwestern Willow Flycatchers were captured and color-banded in 2003. Thirty-seven individuals banded in previous years returned. This resulted in 55% of all adult flycatchers detected at the life history study areas, including Bill Williams, being color-banded by the end of the 2003 season. Maintaining high overall percentages of banded birds annually is important because it increases the ability to detect site fidelity and movement, provides a more accurate calculation of survivorship, and provides the

necessary information needed for future fecundity studies. Also, a large number of color-banded flycatchers will be vital in detecting and tracking movements in the event of a stochastic occurrence (e.g., fire, drought, flood), natural or otherwise, at any of the flycatcher life history study areas. As target and passive capture techniques are continually being refined, we anticipate the numbers of color-banded willow flycatchers at sites to increase in subsequent years.

Breeding vs. Unpaired Territories – At the four life history study areas and Bill Williams, we recorded a total of 60 willow flycatcher territories in 2003. Of these, 40 (67%) consisted of paired flycatchers and 20 (33%) consisted of unpaired individuals. Five of the 20 unpaired territories were abandoned before mid-June and averaged nine days of activity. These individuals were most likely northbound migrants. The other 15 unpaired territories were active from 9 to 78 days (mean=36.4, SE=5.1). Detection of unpaired willow flycatchers at intensively monitored sites during the breeding season is not uncommon, and unpaired individuals have been recorded at other breeding sites (Kenwood and Paxton 2001, Smith et al. 2002, Koronkiewicz et al. 2002, Furtek and Tomlinson 2003, Whitfield 2003, Whitfield and Cohen in prep.). Additionally, other research has shown that an unequivocal determination of breeding status for all willow flycatchers in a population often cannot be made. Willow flycatchers may be detected only once during the breeding season (Kenwood and Paxton 2001, this document), some individuals are non-territorial floaters (individuals that are seen once or irregularly, are typically quiet, and do not display territorial behavior toward other flycatchers or respond aggressively to conspecific broadcasts; Kenwood and Paxton 2001, Koronkiewicz et al. 2002), and willow flycatcher males frequently engage in extra pair copulations (Paxton et al. 1997, Pearson 2002) and are commonly polygynous (Whitfield et al. 1998, Davidson and Allison 2003, this document). The documentation of unpaired flycatchers and individuals for which breeding status cannot be determined is important for demographic analyses and management and conservation of the species.

Adult and Juvenile Survivorship – Survivorship is defined as the number of individuals that survive from one year to the next, and accurate estimations depend on year-to-year detection of uniquely marked birds. In 2003, we detected a total of 27 flycatchers that returned from previous years for which age at the time of color-banding could be determined. Of these individuals, 16 (59%) had been banded as juveniles and 11 (41%) had been banded as adults and were known to have survived from previous years. Of the 38 juvenile flycatchers banded in 2002, 6 were detected in 2003. Thus, minimum estimated juvenile survival from 2002 to 2003 was 16%. Given that the numbers and identities of banded adult flycatchers detected annually from previous years is unknown to us, minimum adult annual survivorship cannot be calculated at the study areas from 2002 to 2003. Simple annual percent survivorship is problematic in that it assumes that all living flycatchers are detected in a given year, and individuals not detected are assumed to have died, unless detected elsewhere. Previous research has shown detection affects estimates of willow flycatcher annual percent survivorship in that some adults and juveniles go undetected up to three years after being banded, thus underestimating survival (Koronkiewicz et al. 2002, McKernan and Braden 2002). To provide more robust estimates of annual survival, software programs (e.g., Brownie et al. 1985, White 1996) incorporating both survival and detection probabilities have been developed in recent years. In subsequent years of this study, as more flycatcher demographic data are acquired at the life history study areas and Bill Williams,

we anticipate using this software in determining annual adult and juvenile willow flycatcher survivorship.

Adult and Nestling Between-Year Return and Dispersal – Of the 27 willow flycatchers that returned from previous years for which original banding locations were available, 17 (63%) returned to the same site at which they were banded and 10 (37%) returned to a different site. Of the 10 returning individuals detected at a different site from where originally banded, 8 (80%) were banded as nestlings. Willow flycatcher dispersal data in 2003 were consistent with results reported in previous years at the life history study areas (McKernan and Braden 2002) and range-wide data (Luff et al. 2000, Kenwood and Paxton 2001, Koronkiewicz et al. 2002), with adult flycatchers likely to exhibit strong site fidelity to breeding areas, and juveniles likely to disperse away from natal areas. Given the small population sizes and geographic isolation of willow flycatcher breeding populations in the Southwest, juvenile dispersal is an important population variable in terms of both gene flow and the establishment of new flycatcher populations. Furthermore, the observed differential age patterns in willow flycatcher dispersal may contribute to an understanding of the observed patterns of high genetic diversity within, and low reproductive isolation among Southwestern Willow Flycatcher populations (Busch et al. 2000 as cited in Koronkiewicz et al. 2002).

2003 Within-Year, Between-Site Movements – We resighted a male flycatcher that held an unpaired territory at Mormon Mesa/Virgin River #1 from 12–28 June 2003. This same individual was later recaptured at Mesquite West on 28 July and 1 August, where it was never detected prior- or post-capture. Straight-line distance between the sites is only approximately 40 km, no great distance for a Neotropical migrant passerine. However, this movement and detection at two sites within a very short period of time illustrates why for some individual flycatchers, breeding status and/or residency at a particular site cannot be determined.

GILA RIVER AND COLORADO/GILA RIVER CONFLUENCE SOUTH TO MEXICO

In 2003, we initiated color-banding studies at sites along the Gila River and the Colorado/Gila River confluence south to the Mexico border to better determine flycatcher residency, breeding status, and movement patterns in this area. Of 59 willow flycatcher detections, we captured and color-banded four adults at three sites. Flycatcher behavioral observations in combination with active molt patterns exhibited on captured individuals suggest strongly that the individuals detected at these sites were northbound migrants. Of the 59 detections at nine sites, all were recorded within an eight-day period with no subsequent detections post 17 June. Although flycatchers detected did sing and call in response to conspecific broadcasts used for target capture, the agonistic behaviors exhibited toward broadcasts were weak (i.e., no direct movements toward speaker locations) in comparison to flycatchers at breeding sites. One of the flycatchers captured exhibited moderate to heavy, active body molt that included the head, mantle, flanks, and belly, and another captured individual was actively growing in primary coverts. As it is known that willow flycatchers molt on the wintering grounds (Pyle 1997, 1998; T. Koronkiewicz unpublished data) and active molt at breeding sites is rare in Southwestern Willow Flycatcher populations (P. Unitt pers. com., T. Koronkiewicz unpublished data), these data strongly suggest that these individuals were still migrating. Also, all four captured flycatchers were second year birds (born in 2002) based on the presence of retained

flight feathers (per Kenwood and Paxton 2001 and Koronkiewicz et al. 2002). Whether there are differential age patterns in willow flycatcher northbound migration along the lower Colorado River is in need of further study. Likewise, it is quite apparent that the lower Colorado and Gila River riparian corridors are important flyways and stopover habitat for northbound willow flycatchers. The degree to which Southwestern Willow Flycatchers use these riparian corridors is unknown and requires further study.

CHANGE IN COLOR-BAND METHODOLOGY

Field personnel experienced difficulty resighting and correctly identifying the color combinations of willow flycatchers previously banded with celluloid-plastic color-bands and epoxy-enamel colored federal bands. As has been shown by Lindsey et al. (1995), celluloid-plastic leg bands undergo fading and discoloration to such a degree that within two years primary colors cannot be recognized under field conditions. Upon recapturing flycatchers previously banded with epoxy-enamel colored federal bands, we found that chipping of the enamel, which revealed the original silver band color underneath, caused the difficulties in correct color identification. Chipping of the epoxy enamel was recorded on federal bands less than one year old. Correct field identification over multiple years of the unique set of color-bands on a bird's legs is important in a long-term study such as this because it eliminates the need to recapture an individual flycatcher multiple times to determine identity. To remedy the color-band problems noted above, in 2003 we used metal pinstriped color-bands and color anodized federal bands, which have shown to be safe for willow flycatchers and colorfast for over six years (Koronkiewicz et al. in prep.). These metal color-bands were used on all newly captured flycatchers and on recaptured flycatchers in 2003 that wore faded and indistinguishable color-bands.

CHAPTER 4

NEST MONITORING

INTRODUCTION

Documentation of nest success and productivity is critical to understanding local population status and demographic patterns of the Southwestern Willow Flycatcher. In 2003, at all sites where willow flycatcher breeding activity was suspected, we conducted intensive nest searches and nest monitoring. Specific objectives of nest monitoring included identifying breeding individuals (see color-banding, Chapter 3) for subsequent fecundity studies, 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 2003 were compared with those at the study areas in previous years (McKernan and Braden 1998–2001). Although aspects of willow flycatcher breeding ecology can vary widely across its broad geographical and elevational ranges throughout the Southwest (Whitfield et al. 2003), we compared monitoring results with range-wide data to identify specific variables that may contribute to the characterization of flycatcher breeding ecology throughout the lower Colorado and Virgin River riparian systems.

METHODS

Upon locating territorial willow flycatchers, regardless of whether a possible mate was observed, we conducted intensive nest searches following the methods of Rourke et al. (1999). Nest monitoring followed the methods described by Rourke et al. (1999) and a modification of 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 two to four days after nest building was complete and incubation was confirmed. During incubation and after hatching, nest contents were observed directly 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 any chance of abandonment during these periods. To reduce the risk of depredation (Martin et al. 1997), brood parasitism by the Brown-headed Cowbird, and premature fledging of young (Rourke et al. 1999), we observed nests from a distance with 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, we conducted a systematic search of the area to locate possible fledglings.

We considered a willow flycatcher nest 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 and thus is a conservative estimate. We considered a nest to have failed if (1) the nest was found empty or destroyed more than two days prior to the estimated fledge date (depredated); (2) the nest fledged no willow flycatcher young, but

contained Brown-headed Cowbird eggs or young (parasitized); (3) the nest was deserted with eggs remaining (deserted); (4) the nest was abandoned prior to egg laying (abandoned); (5) the nest was destroyed due to weather (weather); or (6) the entire clutch was incubated for an excess of 20 days (infertile/addled).

During each nest check, we recorded 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 onto standardized data forms (Appendix A) that included the nest or territory number and UTM coordinates. We calculated flycatcher nest success using both simple nesting success (number of successful nests/total number of nests) and the Mayfield method (Mayfield 1961, 1975), which calculates daily nest survival to account for nests that failed before they were found. We assumed 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 were unknown, we estimated the transition date as halfway between observations. To calculate Mayfield survival probabilities (MSP), we used 2.6, 12, and 12.5 days as the length of the egg laying, incubation, and nestling stages, respectively (per Rourke et al. 1999). We also calculated the average number of days in each nest stage using nests where transition dates were known. These averages are presented below, but we did not use these numbers in calculating MSP because of low sample size and possible year-to-year variability. Average length of each nest stage at the Virgin and lower Colorado River study areas may be used to calculate MSP in future years when additional data on stage lengths are available from subsequent years of study. Nest productivity was calculated as number of young fledged per nesting attempt. Only willow flycatcher nests that contained at least one flycatcher egg were used in calculating nest success and productivity. Fecundity was calculated as number of young produced per female over the breeding season.

RESULTS

NEST MONITORING

We documented 57 willow flycatcher nesting attempts at the four life history study areas and Bill Williams, 50 of which contained eggs and were used in calculating nest success and productivity. Twenty-seven (54%) nests were successful and fledged young, and 23 (46%) failed (Table 4.1). Thirty-nine females were followed through all of their nesting attempts. Of the 37 females who produced at least one egg, 26 had one nesting attempt, 10 had two nesting attempts, and 1 had three nesting attempts. Of the 11 females who had multiple nesting attempts, 4 renested after successfully fledging young, and 7 renested after unsuccessful nests.

NEST FAILURE

Depredation was the major cause of nest failure, accounting for 57% of all failed nests (Table 4.2) and 74% of nests that failed after flycatcher eggs were laid. Six nesting attempts (20%) were abandoned prior to willow flycatcher eggs being laid and four (13%) were deserted after 13 or 14 days incubation. Cause of failure could not be determined at three nests (10%). No nests failed because of weather.

Table 4.1. Summary of willow flycatcher nest monitoring results at the four life history study areas and Bill Williams, 2003. Only nests with at least one flycatcher egg were used in calculations.

Study area	Site	# Pairs	# Nests	# Successful nests (%)	# Failed nests (%)	# Parasitized nests (%)
Pahranagat	Pahranagat North	7	10	9 (90%)	1 (10%)	0
	Pahranagat South	1	1	1 (100%)	0	0
	Total	***8***	***11***	***10 (91%)***	***1 (10%)***	***0***
Mesquite	Mesquite West	13	18	8 (44%)	10 (56%)	4 (22%)
	Total	***13***	***18***	***8 (44%)***	***10 (56%)***	***4 (22%)***
Mormon Mesa	Mormon Mesa North	3	4	0	4 (100%)	1 (50%)
	Virgin River #1 North	3	4	0	4 (100%)	0
	Virgin River Delta #4	2	2	0	2 (100%)	0
	Total	***8***	***10***	***0***	***10 (100%)***	***1 (10%)***
Topock	In Between	6	6	4 (67%)	2 (33%)	1 (17%)
	800M	2	2	2 (100%)	0	0
	Glory Hole	1	1	1 (100%)	0	1 (100%)
	Total	***9***	***9***	***7 (78%)***	***2 (22%)***	***2 (22%)***
Bill Williams	Site 3	3	2	2 (100%)	0	0
	Total	***3***	***2***	***2 (100%)***	***0***	***0***
Overall total		**41**	**50**	**27 (54%)**	**23 (46%)**	**7 (14%)**

Table 4.2. Summary of willow flycatcher nest failure at the four life history study areas and Bill Williams, 2003. All nesting attempts are included.

Study area	Total # of nests	Depredated	Deserted	Abandoned	Infertile/ addled eggs	Unknown
Pahranagat	12	1	0	1	0	0
Mesquite	19	7	3[a]	0	0	1[b]
Mormon Mesa	13	9	0	3[c]	0	1[d]
Topock	11	0	1[a]	2	0	1[e]
Bill Williams	2	0	0	0	0	0
Totals all sites	**57**	**17**	**4**	**6**	**0**	**3**

[a]All nests deserted after 13 or 14 days incubation.
[b]Nest abandoned during building or depredated during egg-laying.
[c]One nest was abandoned with one cowbird egg in the nest.
[d]Nest probably depredated during incubation, but nest was too high to mirror pole to confirm fate.
[e]Nest unattended when found with one flycatcher egg and one cowbird egg.

BROOD PARASITISM

Seven of 50 nests (14%) with flycatcher eggs were brood parasitized by Brown-headed Cowbirds (Table 4.1). Parasitism may have resulted in nest desertion at one nest at Topock that was first discovered unattended with one flycatcher egg and one cowbird egg. One additional flycatcher nest at Mormon Mesa was abandoned prior to egg laying after being parasitized. Only one nestling mortality at Topock could potentially be attributed to brood parasitism (Table 4.3). Brood parasitism at all sites ranged from 0 to 22% and was highest at Mesquite and Topock.

Table 4.3. Summary of fates of willow flycatcher nests parasitized by Brown-headed Cowbirds, 2003.

Study area	# of parasitized nests	Outcome
Mesquite	4	2–depredated; 1–deserted after 13 days incubation (1 flycatcher egg, 1 cowbird egg); 1– cowbird nestling disappeared at four days of age, fledged flycatcher nestling (two flycatcher eggs addled/infertile)
Mormon Mesa	2	1–depredated; 1–abandoned with one cowbird egg before flycatcher eggs were laid
Topock	2	1–nest unattended when found with one cowbird egg and one flycatcher egg; 1–fledged cowbird and flycatcher nestling, another flycatcher nestling disappeared before fledge date

MAYFIELD NEST SUCCESS AND NEST PRODUCTIVITY

MSP at the four life history study areas and Bill Williams ranged from 0 to 100% and was 56% for all sites combined (Table 4.4). At all sites, 65 nestlings were confirmed to have fledged from 50 nests (mean number of nestlings/nest=1.30, SE=0.19; Table 4.5). This total does not include at least two additional fledglings that were detected at Topock, where a re-nest of a color-banded female was suspected but never found. Fecundity ranged from 0.0 to 3.50 young per female and averaged 1.63 across all study sites (Table 4.5).

Table 4.4. Daily survival rates and Mayfield survival probabilities (MSP) for willow flycatcher nest stages at the four life history study areas and Bill Williams in 2003. Mayfield survival probability was calculated using 2.6-day egg laying, 12-day incubation, and 12.5-day nestling stages.

Study area	Nest stage[1]	Nest losses/ observation days	Daily survival rate	Mayfield survival probability
Pahranagat	1	0/22	1.000	1.000
	2	1/112	0.991	0.898
	3	0/139	1.000	1.000
	MSP all stages = 0.898			
Mesquite	1	2/32	0.938	0.846
	2	5/201	0.975	0.739
	3	3/120	0.975	0.728
	MSP all stages = 0.454			
Mormon Mesa	1	0/16	1.000	1.000
	2	7/81	0.913	0.336
	3	3/24	0.875	0.188
	MSP all stages = 0.063			
Topock	1	0/13	1.000	1.000
	2	1/99	0.990	0.885
	3	0/96	1.000	1.000
	MSP all stages = 0.885			
Bill Williams	1	0/2	1.000	1.000
	2	0/12	1.000	1.000
	3	0/22	1.000	1.000
	MSP all stages = 1.000			
Totals all sites	1	2/87	0.957	0.941
	2	14/504	0.972	0.713
	3	6/401	0.985	0.828
	MSP all stages = 0.556			

[1]Nest Stages: 1=egg laying, 2=incubation, 3=nestling

Table 4.5. Willow flycatcher nest productivity and fecundity at the four life history study areas and Bill Williams, 2003.

Site	# Young fledged (total # nests)	Mean # of young fledged/nest	Fecundity (young fledged per female)
Pahranagat	28 (11)	2.55 (SE=0.34)	3.50 (SE=0.33)
Mesquite	16 (18)	1.68 (SE=0.84)	1.23 (SE=0.48)
Mormon Mesa	0 (10)	0.00	0.00
Topock	16 (9)	1.78 (SE=0.40)	1.78 (SE=0.40)
Bill Williams	5 (2)	2.50 (SE=0.50)	1.67 (SE=0.88)
Totals all sites	**65* (50)**	**1.30 (SE=0.19)**	**1.63 (SE=0.26)**

*=total does not include at least two additional fledglings detected where a re-nest was suspected but never found.

DISCUSSION

NEST SUCCESS

Nest success at Pahranagat (91%) was the highest recorded at the site since monitoring began there in 1998, with 37, 56, 52, and 33% nest success recorded at the site in 1998 to 2001, respectively (McKernan and Braden 2002). Nest success at Mesquite West (44%) differed little from results recorded at the site in previous years, with 56 and 47% nest success recorded in 2000 and 2001, respectively. Topock showed an increase in nest success (78%), rebounding from a continuous downward trend recorded in 1997 to 2001 (78, 43, 35, 28, and 25%, respectively). Nest success at Bill Williams in 2003 was high (100%), consistent with results reported from 2000 (100%; Paradzick et al. 2001), 2001 (60%; Smith et al. 2002), and 2002 (50%; Smith et al. 2003). Nest success at Mormon Mesa (0%) was the lowest recorded since monitoring began at that study area in 1997, with a downward trend recorded in 1997 to 2001 (100, 55, 50, 31, and 35%, respectively).

Of 10 flycatchers exhibiting between-year, between-site movements (see Chapter 3), 7 moved approximately 40 km from Mormon Mesa to Mesquite West. A continual downward trend in nest success combined with the relatively high degree of flycatcher emigration and little immigration is highly suggestive that the Mormon Mesa study area may be a population sink. However, differences in nest success among study areas and the annual fluctuations of nest success at sites are difficult to interpret as it has been shown that demographic patterns of passerine populations often vary year to year, and sometimes to a very large degree (Wiens 1989a). Factors driving the continual downward trend in flycatcher nest success at Mormon Mesa are unidentified at this time. The different patterns of nest success observed at the study areas reinforce the variability of the demographic traits of the willow flycatcher and further demonstrate the need for long-term data.

Depredation was the major cause of willow flycatcher nest failure in 2003, accounting for 57% of all failed nests at the four life history study areas and Bill Williams. These results are consistent with those reported at the life history study areas from 1997 to 2001 (McKernan and Braden 2002) and with all monitored sites in Arizona from 2000 to 2002 (Paradzick et al. 2001, Smith et al. 2002, 2003), with depredation accounting for the majority of all willow flycatcher

nest failures. Nest depredation at Pahranagat in 2003 (9%) was the lowest since monitoring began there in 1998, with 63, 31, 19, and 44% nest depredation recorded at the site in 1998 to 2001, respectively. Nest depredation at Mesquite West has increased since monitoring began there in 2000, with 22, 32, and 39% nest depredation recorded at the site in 2000, 2001, and 2003, respectively. In 2003, Topock exhibited the lowest rate of nest depredation (0%) since monitoring began there in 1997, with 11, 33, 55, 44, and 35% nest depredation recorded at the site in 1997 to 2001 (McKernan and Braden 2002). Bill Williams exhibited 0% nest depredation for the fourth consecutive year since year 2000 (Paradzick et al. 2001, Smith et al. 2002, 2003). Over half (53%) of all depredated nests at the four life history study areas in 2003 were documented at Mormon Mesa, with nest depredation accounting for 90% of all nest failures at the site. Nest depredation at Mormon Mesa in 2003 was the highest since monitoring began there in 1997, with 0, 36, 31, 31, and 30% recorded at the site in 1997 to 2001, respectively (McKernan and Braden 2002). Factors influencing the sharp increase in nest depredation at the Mormon Mesa site and decreases in nest depredation at Pahranagat and Topock in 2003 are inherently complex and at this time remain undetermined. However, the large variation in nest depredation rates we observed among study areas in 2003 (0 to 90%) and the annual fluctuations in nest depredation recorded at the sites since 1998 (McKernan and Braden 2002) are not unusual for open cup nesting species. For open cup nesting passerines, it has been shown that nest depredation rates can vary year to year, and sometimes substantially, with depredation of eggs and young ultimately linked to fluctuations in predator densities, abundance, and richness (Howlett and Stutchbury 1996, Robinson 1992, Wiens 1989b). As direct observations of nest predation events are rare during nest monitoring, studies specifically designed to address willow flycatcher nest predator management strategies are therefore warranted.

BROOD PARASITISM

Brood parasitism by Brown-headed Cowbirds at the four life history study areas and Bill Williams ranged from 0 to 22% in 2003. One nest abandonment, one desertion, and one nestling mortality were potentially associated with parasitism. These results are consistent with those reported from 1998 to 2001, with brood parasitism averaging 10, 19, 23, 22 and 20% for Pahranagat, Mesquite, Mormon Mesa, Topock and the Bill Williams, respectively (Paradzick et al. 2001, McKernan and Braden 2002, Smith et al. 2002). Because the incidence of brood parasitism reported for the willow flycatcher is highly variable, ranging from less than 10% at some sites to over 60% at others (Sedgwick 2000), 2003 results are difficult to interpret. However, our results indicate a minimal effect of brood parasitism on reproductive output of flycatchers at the life history study areas in 2003. Because it is still unclear how brood parasitism rates affect flycatcher population sizes (Rothstein et al. 2003), baseline nesting studies need to be continued to determine whether brood parasitism presents a serious problem for populations at the life history study areas.

MAYFIELD NEST SUCCESS AND NEST PRODUCTIVITY

Comparing MSP with those from previous years is somewhat problematic because of differences in methods. Average lengths of the egg laying, incubation, and nestling stages used to calculate MSP at the study areas in previous years were 2, 14, and 13 days, respectively (McKernan and Braden 2002), and were calculated assuming that incubation commenced with the penultimate egg. We used the average lengths of the nest stages (2.6, 12, and 12.5 days, respectively)

reported in Rourke et al. (1999), which were calculated assuming incubation commenced with the final egg, as recommended by Martin et al. (1997). These differences in methods may result in differences in overall MSP of few percentage points. Therefore, MSP should be used to evaluate broad trends and not fine-scale differences between years.

MSP at the four life history study areas and Bill Williams (56%) differed little from results reported in previous years, with an average MSP of 44.3% reported from 1997 to 2001 across the four life history sites (McKernan and Braden 2002). MSP in 2003 was also within the range of MSP values reported for all monitored sites in Arizona, with an MSP of 55.0, 64.6 and 28.4% reported for 2000–2002, respectively (Paradzick et al. 2001, Smith et al. 2002 and 2003). Except for Mormon Mesa in 2003, we observed an increase in MSP at each of the study areas compared to previous years, with Pahranagat and Topock exhibiting the greatest increases. MSP at Pahranagat averaged 48.1% from 1997 to 2001 and was 89.8% in 2003, while Topock went from an average MSP of 33.3% in 1997–2001 to 88.5% in 2003. However, these increases in MSP must be interpreted cautiously because annual MSP are unavailable for each of the life history study areas prior to 2003, and we are therefore unable to assess annual variation in MSP.

MSP in 2003 for the egg laying (94.1%), incubation (71.3%), and nestling stages (82.8%) also differed little from results reported in previous years, with an MSP of 75.0, 72.0, and 82% for the egg laying, incubation, and nestling stages, respectively, reported at the four life history study areas from 1997 to 2001 (data not available for Bill Williams).

Nest productivity at all sites ranged from 0 to 2.55 young per nest. Nest productivity for all sites combined was 1.30 young per nest. These results are consistent with those at monitored sites in Arizona, with nest productivity reported at 0.50, 1.66, and 1.02 young per nest from 2000 to 2002, respectively (Paradzick et al. 2001, Smith et al. 2002, 2003). Fecundity at all sites ranged from 0.0 to 3.50 and averaged 1.63. From 1996 to 2001, fecundity at the life history study areas and the Grand Canyon averaged 1.27 (SE=0.52) (McKernan and Braden 2002). As stated above, the demographic traits of the willow flycatcher are highly variable and difficult to interpret based on limited data.

CHAPTER 5

BROWN-HEADED COWBIRD TRAPPING

INTRODUCTION

During 2003, we initiated intensive Brown-headed Cowbird trapping at all the life history study areas. From 1997 to 2001, willow flycatcher nest success and brood parasitism rates have been documented at the life history study areas (McKernan and Braden 2002), with no cowbird trapping conducted in the proximity of the breeding sites. We will compare willow flycatcher life history data under the influence of cowbird trapping with the data gathered at the life history study areas from 1997 to 2001 to determine if cowbird trapping and removal affects brood parasitism rates and willow flycatcher nest success and productivity.

METHODS

We conducted Brown-headed Cowbird trapping at each of the four life history study areas, with the number of traps set in each area determined by landscape characteristics and acreage of the site. Each trap has an effective trapping radius of 0.4 km (John Griffith, GWB, pers. comm., March 2002), and we deployed as many traps as needed at each site such that all the areas of occupied willow flycatcher habitat were under the influence of trapping. USBR biologists approved trap numbers and locations, and trapping methods followed those outlined in Griffith Wildlife Biology (1994a). To minimize the number of parasitism days (the number of days a host population is exposed to each female cowbird), cowbird traps were deployed at least two weeks prior to the initiation of flycatcher nesting (mid-May) and continually operated until all nests were at least past the egg stage (mid-August).

We used a variation of the Australian crow trap (Figure 5.1) to capture Brown-headed Cowbirds. These portable, wood-framed traps were 4 feet high, 4 feet wide, and 8 feet long, with a door located on one end. The panels consisted of 2-inch by 2-inch wood supports covered with 0.5-inch wire mesh. A piece of plywood, with two 1.25-inch slots down the middle, was attached to the top of each trap for cowbird entry. Signs were posted on each trap door to inform the public of the nature and relevance of the trapping program. The signs were clearly marked and laminated to maintain legibility over the season. Padlocks were used on the doors to discourage vandalism. Each trap was situated in an accessible location and was visible from above with some natural tree cover. To attract cowbirds, a ratio of two male and three female live-decoy cowbirds were maintained in each trap each day. Each trap was leveled, and the wire mesh floor covered with a thin layer of soil to encourage natural foraging and social behavior among the decoy birds.

Figure 5.1. Brown-headed Cowbird trap used at life history study areas, 2003.

Six or more horizontal perches were provided in the trap corners, and shadecloth was attached to the outside of each trap to provide adequate shade. An abundant supply of wild birdseed (not containing sunflower seeds, which attract non-target species) and a 1-gallon guzzler of water were kept in each trap and replenished daily.

Each trap was checked every 24 hours, and findings were recorded on an individual daily data sheet (Appendix A). Each day we recorded the number of cowbirds captured and removed, including sex and age, the number of non-target birds captured and released, and any pertinent notes. Upon entering a trap, field personnel carefully flushed out any non-target birds noting species, sex, and, when possible, age. We clipped the wings of all cowbirds at the edge of the secondary feathers, removing the primary feathers and thus lowering the probability of injury in the trap and the likelihood that any escaped bird would be able to survive. Newly trapped cowbirds were removed, placed in a small holding cage, and then euthanized off-site using carbon monoxide. We deposited all cowbirds with the U.S. Geological Survey Southwest Biological Science Center at Northern Arizona University for serological studies, in particular to examine for the occurrence of the West Nile Virus.

RESULTS

BROWN-HEADED COWBIRDS

From 20 May to 11 August 2003, we deployed and continuously operated two cowbird traps at Pahranagat, two at Mesquite, four at Mormon Mesa, and six at Topock (see Figures 5.1–5.4 for trap locations). We captured and removed 115, 6, 3, and 113 Brown-headed Cowbirds, respectively, at each study area (Table 5.1).

NON-TARGET SPECIES

Eight non-target species (excluding unidentified sparrow species) were captured at Pahranagat, Mormon Mesa, and Topock during cowbird trapping; no non-target species were captured at Mesquite (Table 5.2). Non-target species captures included Loggerhead Shrike (*Lanius ludovicianus*), Northern Mockingbird (*Mimus polyglottos*), Lucy's Warbler (*Vermivora luciae*), Blue Grosbeak (*Guiraca caerulea*), Abert's Towhee (*Pipilo aberti*), Red-winged Blackbird (*Agelaius phoeniceus*), House Sparrow (*Passer domesticus*), and House Finch (*Carpodacus mexicanus*). Because the same individual(s) may be captured and released on consecutive days, the total number of individuals of each species captured cannot be accurately determined. Mortalities included four individuals of four species (Northern Mockingbird, Lucy's Warbler, Blue Grosbeak, Abert's Towhee), with cause of death undetermined.

Table 5.1. Summary of Brown-headed Cowbirds trapped and removed at Pahranagat NWR, Mesquite, and Mormon Mesa, NV and Topock Marsh, AZ, 2003.

Study area	Trap #	# Males	# Females	# Juveniles	Total # Brown-headed Cowbirds
Pahranagat	1	25	27	0	52
	2	28	33	2	63
	Total	**53**	**60**	**2**	**115**
Mesquite	1	0	0	0	0
	2	4	0	2	6
	Total	**4**	**0**	**2**	**6**
Mormon Mesa	1	0	0	0	0
	2	3	0	0	3
	3	0	0	0	0
	4	0	0	0	0
	Total	**3**	**0**	**0**	**3**
Topock	1	6	8	3	17
	2	5	6	4	15
	3	7	8	8	23
	4	13	14	3	30
	5	2	3	1	6
	6	14	6	2	22
	Total	**47**	**45**	**21**	**113**

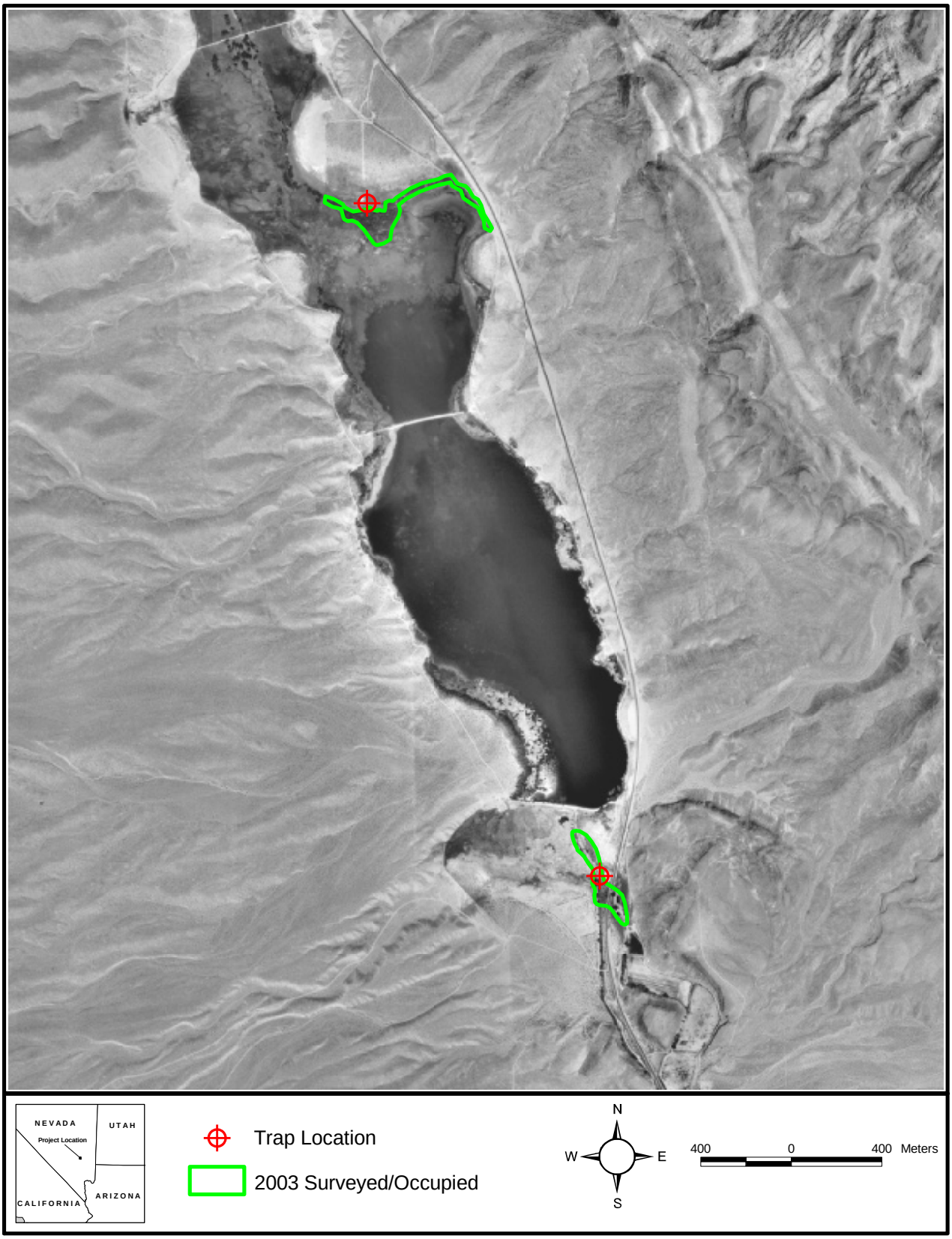

Figure 5.2. Cowbird trap locations at Pahranagat NWR, NV, 2003.

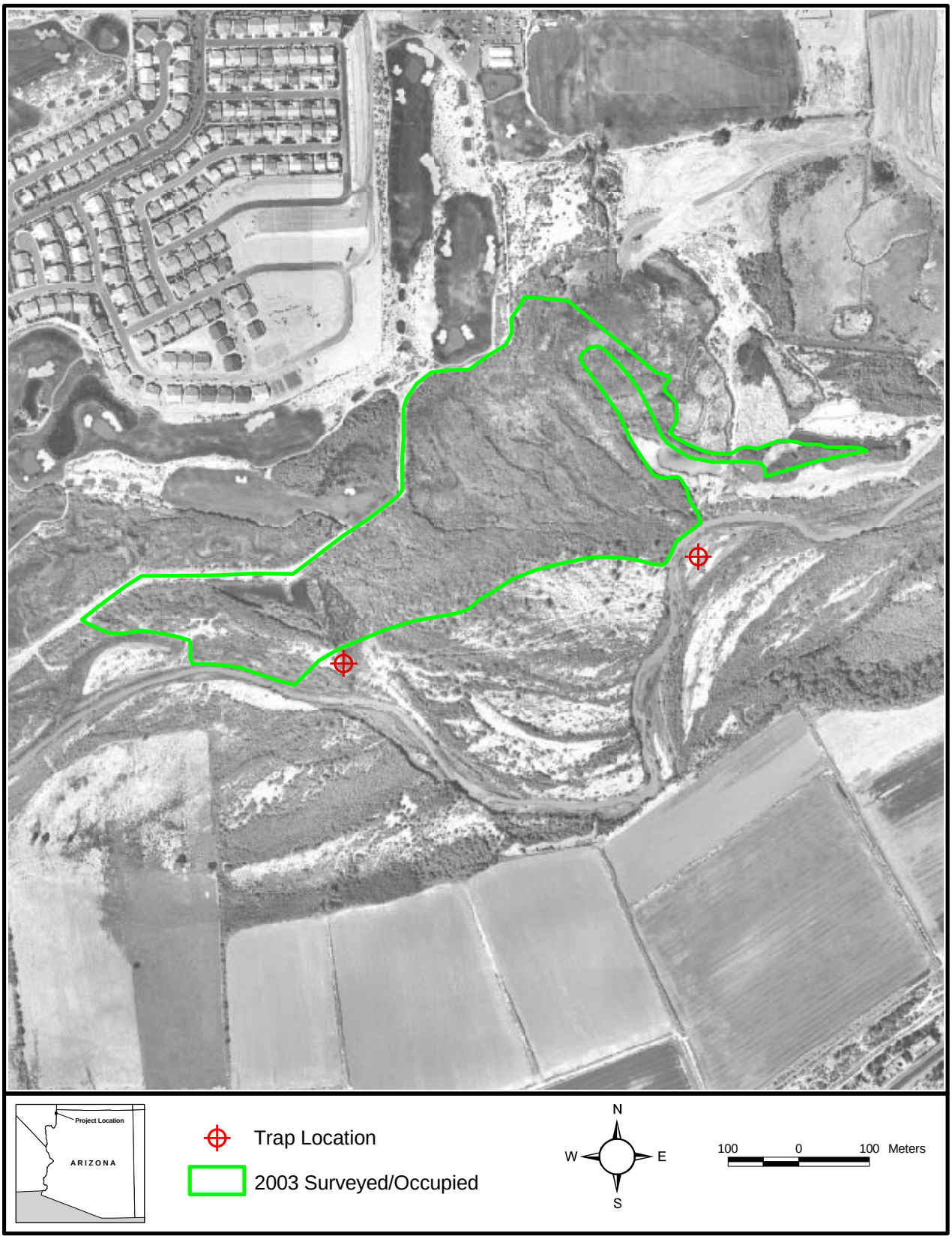

Figure 5.3. Cowbird trap locations at Mesquite, NV, 2003.

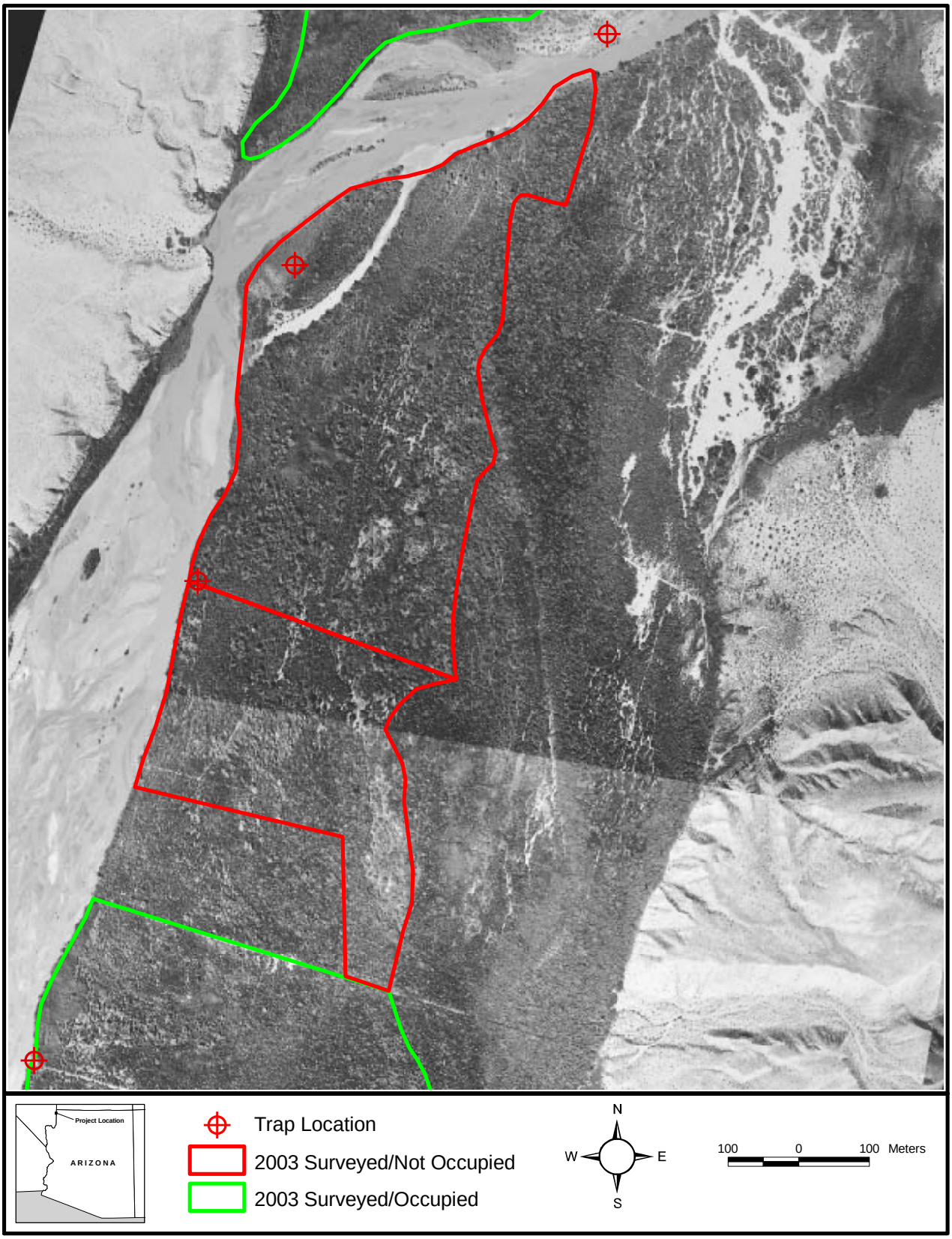

Figure 5.4. Cowbird trap locations at Mormon Mesa, NV, 2003.

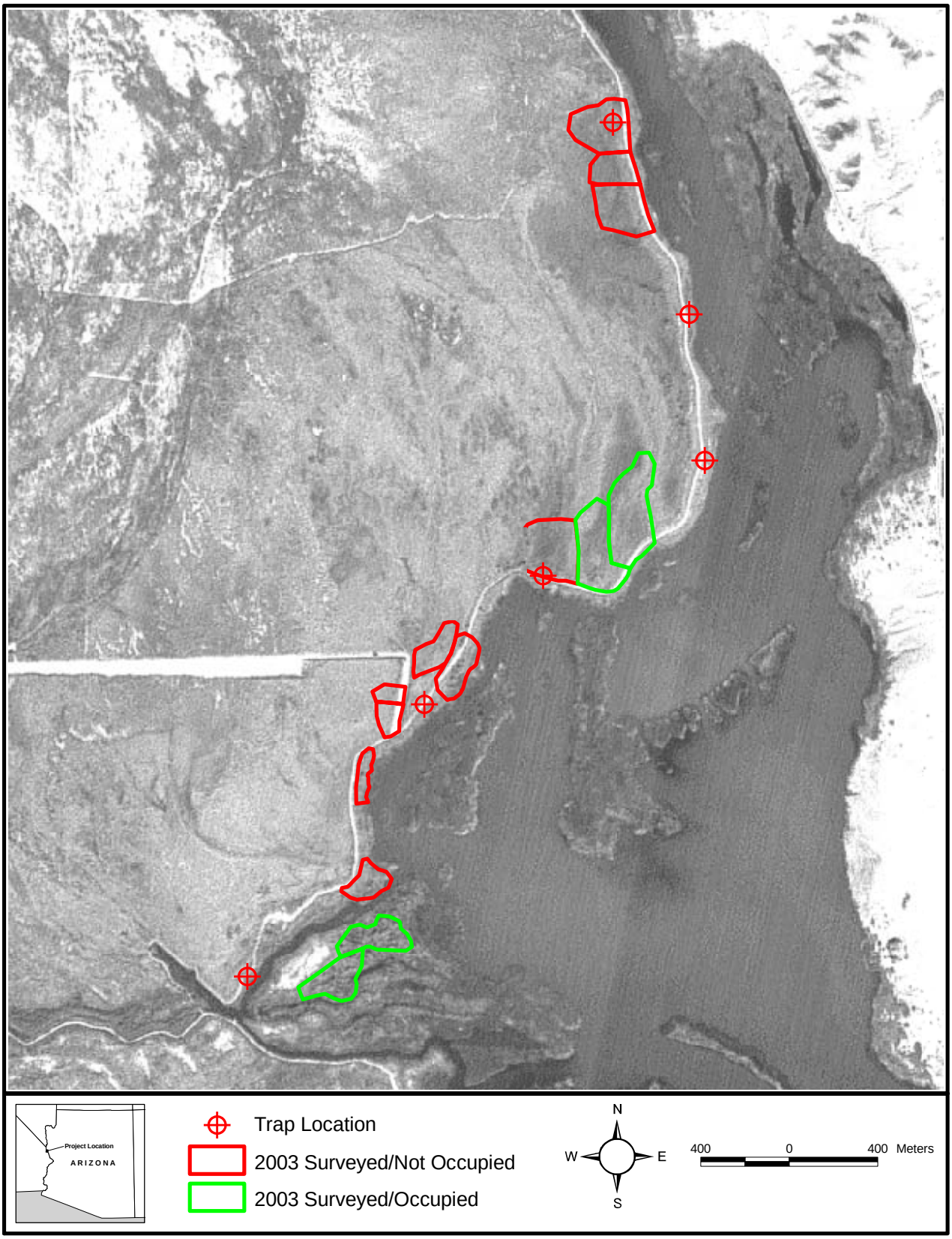

Figure 5.5. Cowbird trap locations at Topock Marsh, AZ, 2003.

Table 5.2. Summary of non-target species captured during Brown-headed Cowbird trapping at the life history study areas, 2003.

Study area	(Number captured) Species (sex - F, M, or?)	Capture date(s)[1]
Pahranagat	(1) Northern Mockingbird (?)	8**, 17 July
	(1) Blue Grosbeak (F)	31 May
	(1) House Sparrow (?)	22 June
	(1) sparrow species (?)	18 July
	(2) sparrow species (?)	11, 13, 17 July
	(3) sparrow species (?)	15 July
Mormon Mesa	(1) Northern Mockingbird (?)	12 July
Topock	(1) Loggerhead Shrike (?)	27 June
	(1) Lucy's Warbler (?)	17 July ** 2 Aug
	(1) Blue Grosbeak (F)	22, 28, 30 May 2, 5, 7–14, 16–28 June 1**, 14 July
	(1) Blue Grosbeak (?)	22 July
	(2) Blue Grosbeak (?)	18 July, 1–2 Aug
	(3) Blue Grosbeak (?)	29 July
	(1) Abert's Towhee (?)	23 June 19, 22, 29 July
	(1) Abert's Towhee (?)	11 Aug **
	(2) Abert's Towhee (?)	17 June
	(1) Red-winged Blackbird (M)	16 June
	(1) House Sparrow (?)	27 June
	(1) House Finch (F)	21–24, 26 June
	(2) House Finch (F)	25 June 23 July
	(1) sparrow species (?)	5 June

** = mortality
[1]Dates given indicate a separate capture on each date. Unless preceded by a mortality, it is not known whether a bird captured on a specific date is the same or a different individual than captured on previous dates.

DISCUSSION

The frequency of Brown-headed Cowbird brood parasitism of willow flycatchers is known to be highly variable, ranging from less than 10% at some sites to over 60% at others (Sedgwick 2000). Cowbird brood parasitism of the flycatcher is of particular concern because parasitism usually results in reduced reproductive output (Sedgwick and Knopf 1988, Harris 1991, Whitfield and Sogge 1999, Rothstein et al. 2003). However, Brown-headed Cowbirds are native passerines, and willow flycatchers can raise offspring to fledging from a brood parasitized nest. Thus, cowbird management issues are complicated, particularly because it is still unclear how brood parasitism rates affect willow flycatcher population sizes (Rothstein et al. 2003).

The total number of Brown-headed Cowbirds captured at each of the four life history study areas was highly variable, ranging from 3 to 115, with large numbers of captures recorded at Pahranagat (115) and Topock (113) and few captures recorded at Mesquite (6) and Mormon Mesa (3). Reasons for this variability are undetermined; however, the total number of cowbird captures at each site appeared not to be directly related to the total number of traps per site. For example, Pahranagat had two traps and the greatest number of cowbirds captured, while Mormon Mesa had four traps and few cowbirds captured. Given that large numbers of cowbirds were detected at Mesquite and Mormon Mesa while the traps were deployed is highly suggestive that landscape characteristics of the sites and/or trap locations may have been factors in the low number of captures. Although it was apparent early in the 2003 season that the traps at Mesquite and Mormon Mesa were capturing few cowbirds, traps were not moved (per instruction from USBR biologists). In 2004, traps will be relocated at Mormon Mesa if possible; at Mesquite, cowbird trap locations are limited due to the proximity of two golf courses, a large housing development, and private land.

Brood parasitism rates by Brown-headed Cowbirds from 1998 to 2001 (pre-trapping periods) at the four life history study areas averaged 10, 19, 23, and 22% for Pahranagat, Mesquite, Mormon Mesa, and Topock, respectively (McKernan and Braden 2002). In 2003 (trapping period 1), brood parasitism at the study areas were 0, 22, 10, and 22%, Pahranagat, Mesquite, Mormon Mesa, and Topock, respectively (details in Chapter 4, this document). These values are within the range of parasitism rates recorded at each site from 1998 to 2001. Although we detected no obvious differences in brood parasitism rates at any of the study areas during 2003 compared to previous years, one year of trapping is probably insufficient to influence flycatcher parasitism rates or reproductive success (Rothstein et al. 2003).

Eight non-target species were captured at Pahranagat, Mormon Mesa and Topock during cowbird trapping in 2003; mortalities included four individuals of four species (Northern Mockingbird, Lucy's Warbler, Blue Grosbeak, Abert's Towhee). Capturing non-target species is of concern but is unavoidable. For example, Griffith Wildlife Biology (1994b) reported over 8,400 captures of non-target species during a single season of cowbird trapping at Camp Pendelton, California. Species other than cowbirds have higher mortality rates in traps and may incur reduced breeding success because of time spent away from the nest (Rothstein et al. 2003). This emphasizes the need to check traps every 24 hours.

Vandalism of cowbird traps was encountered only at Pahranagat, with one of the two traps damaged and the decoy birds released on two occasions. In 2004, the trap will be moved to a more secluded area approximately 30 m from its original location.

CHAPTER 6

VEGETATION AND HABITAT CHARACTERISTICS

INTRODUCTION

During the 2003 study, we measured vegetation and habitat characteristics at plots located throughout the four life history study areas to obtain an overall description of the whole habitat block. We also measured vegetation and habitat characteristics in Southwestern Willow Flycatcher nesting and non-use plots at the four life history study areas and Bill Williams. Our specific objectives for vegetation sampling are to understand how habitat characteristics at sites used by nesting willow flycatchers differ from those at unused sites, and to identify specific variables that may contribute to the characterization of breeding habitat throughout the Virgin and lower Colorado River riparian systems. Data from nesting and non-use plots in 2003 will be pooled with data acquired in subsequent years to contribute to an understanding of general habitat features that characterize Southwestern Willow Flycatcher breeding habitat.

METHODS

At each of the four life history study areas and Bill Williams, we described and measured vegetation and habitat features following a modification of the methods of James and Shugart (1970). These methods were developed over several seasons by the Arizona Game and Fish Department (see data form, Appendix A). All vegetation characteristics were measured within an 11.3-m-radius circle (0.04 ha). A plot this size centered on a nest is likely to be sufficient to describe variability within a flycatcher territory without measuring areas outside the territory (Sedgwick and Knopf 1992). We also chose a distance of 30 m from plot centers to record presence or absence of certain habitat features. An area of this size (2,827 m^2) should represent an unbiased characterization of willow flycatcher habitat selection given that it encompasses approximately 25–50% of the home range of a breeding willow flycatcher (Paxton et al. 2003, Sedgwick 2000). To avoid disrupting flycatcher breeding activities, we measured vegetation in late August when the nest, territory, and adjacent flycatcher territories were inactive for at least two weeks.

We measured habitat characteristics at approximately thirty 11.3-m-radius plots throughout each of the four life history study areas to obtain a description of the overall characteristics and the variability of habitat characteristics within the habitat block. We considered the habitat block to include all riparian areas that were potential nesting habitat or use areas (e.g., foraging, roosting, feeding young) for willow flycatchers. At Mesquite and Pahranagat, these areas were contiguous with nesting habitat that was occupied in 2003, while at Topock and Mormon Mesa, portions of the habitat block were separated from occupied habitat by roads, open water, dry washes, marshes, or dead vegetation. At the life history study areas that are separated into several noncontiguous sites, the number of plots measured in each site was proportional to the area of the site in relation to the total area of all sites in the study area to obtain a representative

sampling of the habitat. Nest and non-use plots (see below) were included in the habitat block measurements as long as they did not overlap with an adjacent plot and did not result in disproportionate representation of a site.

Plot center locations for habitat block points were selected by superimposing a 25 × 25 m grid on an ArcView® GIS 3.3 software shapefile of the study area boundary, numbering the grid blocks, selecting blocks by using a random number generator, and using the centroid of each selected block. Plot centers were located in the field by navigating to the given coordinates using a Rino 110 GPS unit.

At each plot, we laid out four 11.3-m–long ropes from plot center, one in each of the four cardinal directions. Each rope was marked at 1 m and 5 m from the center of the plot. At 1 m from the center of the plot in each cardinal direction, we measured vertical foliage density using a 7.5-m-tall survey rod. Working our way up the rod, we recorded the presence of vegetation, by species, within a 10-cm radius of the rod in 0.1-m intervals (presence of the species within the 0.1-m interval equaled one "hit" on the rod), and tallied all hits in 1-m intervals. Presence of dead vegetation (snags) was recorded in the same manner, but not identified to species. If canopy vegetation continued above 7.5 m, we estimated the number of hits as greater than or less than five hits per 1-m interval until the canopy vegetation stopped (modified from Rotenberry 1985). We measured total canopy and sub-canopy closure using a Model-A spherical densiometer at 1 m north and south of the center of each plot and averaged these measurements to obtain a single canopy closure value for each plot. We measured average canopy height within each 11.3-m plot by selecting a representative tree and using a survey rod or a clinometer and measuring tape to measure the height of the selected tree. We measured the distance, if less than 30 m, from plot center to the nearest native broadleaf tree (e.g., cottonwood, willow, and mesquite); canopy gap (at least 1 m square); and standing water or saturated soil. If any of the distances were >30 m, they were recorded as such.

We estimated percent woody ground cover, alive and dead, using a Daubenmire-type frame with the lower edge of the frame centered at 1 m north, south, east, and west of plot center. These percentages were averaged to obtain a single measure of percent woody ground cover for each plot. We tallied the number of live shrub and sapling stems for each species, by quadrant, within 5 m of the center of the plot and summed all species over all quadrants to obtain the total stem count for each plot. Shrub and sapling stems were tallied if they were at least 1.4 m tall and >2.5 cm in diameter at 10 cm above the ground. If a stem branched above 10 cm but below 1.4 m above the ground, only the largest stem was tallied. Stems were tallied by the following dbh categories: <1 cm, 1–2.5 cm, 2.6–5.5 cm, and 5.6–8 cm. Dead stems were also tallied in these categories, but not identified to species. We tallied live trees (defined as dbh >8 cm) by species, in each quadrant of the 5-m-radius circle, in 8.1–10.5 cm and 10.5–15 cm dbh categories. Any trees greater than 15 cm dbh were measured and the exact dbh was recorded. Snags were also recorded in these categories, but not identified to species. Within each quadrant between 5 and 11.3 m of plot center, we tallied live trees >8 cm dbh by species but did not separate trees into size categories. Snags >8 cm dbh were also tallied, and tallies for each species and quadrant were summed to obtain a total tree count for the plot. Additional information recorded at each plot included the date when the measurements were taken, observer initials, and UTM coordinates for each plot center.

We recorded these habitat and vegetation characteristics at each willow flycatcher nest located during the 2003 breeding season, including renests by the same female, in which at least one flycatcher egg had been laid. In addition to the variables described above, we recorded nest height and substrate species, diameter of substrate species at breast height (dbh), and height of the nesting substrate. If the distance to standing water or saturated soil was different during nesting than at the time of vegetation measurement, distance during nesting was estimated and recorded.

All habitat characteristics, excluding those specific to the nest, were also measured at non-use plots located between 50 and 200 m from any willow flycatcher nest or territory center. Each non-use plot was surveyed multiple times throughout the season to confirm the absence of flycatchers. One non-use plot was selected for each willow flycatcher nest in which at least one flycatcher egg was laid. Non-use plot locations were randomly selected by superimposing a 25 x 25-m grid over an ArcView® GIS 3.3 software shapefile of the study area boundaries, including nest and territory locations, and clipping the grid to include areas between 50 and 200 m of known nests or territories, and within the study area boundaries. Each grid square was numbered, and grid squares were chosen using a random number generator. The centroid of each selected grid was the target location for the non-use plots. Non-use plots were located in the field by navigating to the given coordinates using a Rino 110 GPS unit and selecting the nearest woody plant at least 3 m tall. The plot was centered at a distance and direction from the bole of the tree determined by random number tables. Because randomly chosen non-use plots in clearly unsuitable habitat (e.g., desertscrub or open cattail or bulrush marsh) would have exaggerated differences between nesting and non-use plots, we only used non-use plots that contained at least one live, woody stem a minimum of 3 m in height (approximate average nest height in 2003), per Allison et al. (2003).

DATA ANALYSES

We used JMP IN® Version 4 (SAS Institute Inc.) software for statistical analyses. A statistical significance level of $P \leq 0.05$ was chosen to reject null hypotheses. Data presented are means ± standard error (SE) unless otherwise stated.

Analyses of habitat blocks – Canopy closure, canopy height, percent woody ground cover, and total stem counts at habitat block plots were compared across study areas using one-way analysis of variance (ANOVA). If differences across study areas were indicated by the ANOVA, we used Tukey's multiple comparison test to determine which study areas differed.

Measures of distance to canopy gap, distance to broadleaf tree, and distance to water or saturated soil often contained both continuous and categorical (>30 m) data. If less than 5% of the measurements for a given variable were categorical, we converted all >30 m measurements to 31 m and analyzed distance using ANOVA. If greater than 5% of the measurements were categorical, we categorized all data as ≤30 m or >30 m and analyzed the data across sites using 4 x 2 contingency tables. If differences were indicated across sites, we used 2 x 2 contingency tables to determine which sites differed.

Vertical foliage density data in each habitat block were summarized graphically, but we did not make between-site comparisons. Vertical foliage density measurements above 7.5 m that were recorded as < or > 5 hits per meter were converted to 2.5 and 7.5 hits, respectively, to allow analyses of these data as continuous rather than categorical.

Analyses of nest characteristics – Characteristics specific to the nest (nest height, nest substrate species, nest substrate height, and nest substrate dbh) were compared between study areas using ANOVA and Tukey's multiple comparison test. Study areas where sample size was <5 were excluded from comparisons.

Analyses of nest vs. non-use sites – Canopy closure, canopy height, percent woody ground cover, total stem counts, and vertical foliage density within each meter interval were compared between nest and non-use sites at each life history study area using Student's *t*-tests. Distance to water, canopy gap, and broadleaf tree were analyzed as described above. Although sample sizes at each study area in 2003 were small, we did not pool data across study areas because of significant differences in many variables between study areas.

RESULTS

At the four life history study areas and Bill Williams in 2003, we gathered data on vegetation and habitat characteristics at 49 nest plots and 48 non-use plots. We gathered data at an additional 35 habitat block plots at the life history study areas.

VEGETATION MEASUREMENTS OF ENTIRE HABITAT BLOCKS

Quantitative measurements of vegetation and habitat characteristics across habitat blocks at the four life history study areas varied within and between sites in canopy height and closure, percent woody ground cover, and number of shrub/sapling and tree stems (Table 6.1). Distance to canopy gap had 5% of the measurements recorded as >30 m. These values were converted to 31 m, and data were analyzed as continuous. Distance to broadleaf tree and water or saturated soil had greater than 5% of the measurements recorded as >30 m and were analyzed as categorical variables. All variables differed significantly between sites. Regardless of overall canopy height, all sites had the densest foliage within 4 m of the ground (Figures 6.1–6.4).

VEGETATION MEASUREMENTS AT THE NEST

Willow flycatcher nest height at the four life history study areas and Bill Williams ranged from 1.0 to 9.3 m, with a mean nest height of 2.9 m (SE=0.19). Nest substrate included three woody species of trees, two native and one exotic. Flycatchers placed 57% of all nests at the study areas in tamarisk, 18% in coyote willow, and 24% in Goodding willow. Nest substrate height at all sites ranged from 1.7 to 18.0 m, with a mean nest substrate height of 5.5 m (SE=0.47). Nest substrate dbh was highly variable, ranging from 1.0 to 133.0 cm, with a mean nest substrate dbh of 11.5 cm (SE=3.24). Nest height at Mesquite was lower than at the other three study areas, while nest substrate height and dbh were greater at Pahranagat than at the other study areas (Table 6.2).

Table 6.1. Summary of vegetation and habitat characteristics of entire habitat blocks at the four life history study areas in 2003. Data presented for continuous variables are means, (standard error), and range. Significant differences (Tukey's test, α=0.05) between sites for a given continuous variable are indicated by alpha codes; sites with different letters differed from one another while sites with the same letter did not. Categorical variables were analyzed using Pearson chi-square.

Parameter	Pahranagat (n=25)	Mesquite (n=29)	Mormon Mesa (n=30)	Topock (n=30)
Average canopy height (m)	15.3 (1.6) 3.0–34.5 A	4.0 (0.2) 1.0–6.0 B	4.7 (0.6) 1.8–13.4 B	6.0 (0.3) 11.0–2.5 B
% total canopy closure	90.8 (2.57) 55.2–100.0 A	76.7 (5.5) 4.2–100.0 A,B	70.7 (4.7) 18.2–99.5 B	91.2 (2.8) 50.0–100.0 A
% woody ground cover	13.8 (3.4) 0.0–52.5 A	2.8 (0.7) 0.0–17.3 B	2.2 (0.7) 0.0–19.3 B	15.1 (3.3) 0.3–73.8 A
% of plot centers within 30 m of standing water or saturated soil	24.0 A,B	65.5 C	10.0 A	36.7 B
Distance (m) to nearest canopy gap	5.9 (0.8) 0.0–13.0 A,B	4.7 (1.2) 0.0–31.0 B	3.4 (0.6) 0.0–13.0 B	9.8 (2.0) 0.0–31.0 A
% of plot centers within 30 m of a broadleaf tree	100.0 A	100.0 A	73.3 B	26.7 C
# shrubs/sapling stems within 5-m radius of plot center	10.6 (5.9) 0.0–107.0 A	180.5 (19.8) 21.0–519.0 C	102.3 (12.8) 20.0–270.0 B	113.9 (15.3) 4.0–305.0 B
# tree stems within 11.3-m radius of plot center	11.2 (2.3) 0.0–52.0 A	2.4 (1.0) 0.0–24.0 B	11.1 (2.6) 0.0–51.0 A	13.6 (2.7) 0.0–64.0 A

Table 6.2. Summary of nest measurements at the four life history study areas and Bill Williams in 2003. Numerical data presented are means, (standard error), and range. Significant differences (Tukey's test, α=0.05) between sites for a given continuous variable are indicated by alpha codes; sites with different letters differed from one another while sites with the same letter did not. Bill Williams was excluded from between-site comparisons because of low sample size.

Parameter	Pahranagat (n=11)	Mesquite (n=18)	Mormon Mesa (n=10)	Topock (n=8)	Bill Williams (n=2)
Nest height (m)	3.5 (0.3) 2.0–4.9 A	2.0 (0.1) 1.0–3.4 B	3.4 (0.7) 1.8–9.3 A	3.7 (0.2) 3.0–4.5 A	3.0 (1.3) 1.7–4.3
Nest substrate[1]	9% SAEX 91% SAGO	67% TASP 33% SAEX	60% TASP 20% SAEX 20% SAGO	100% TASP	100% TASP
Nest substrate height (m)	9.0 (1.3) 5.0–18.0 A	3.4 (0.3) 1.7–6.0 B	5.6 (0.9) 5.0–18.0 B	5.5 (0.5) 3.6–7.5 B	4.6 (1.5) 3.1–6.0
Nest substrate dbh (cm)	37.0 (11.7) 2.9–133.0 A	2.5 (0.4) 1.0–6.9 B	5.3 (1.5) 2.3–17.4 B	5.2 (1.0) 2.5–10.9 B	9.2 (4.5) 4.7–13.6

[1]TASP = *Tamarix* sp. (tamarisk), SAEX = *Salix exigua* (coyote willow), SAGO = *Salix gooddingii* (Goodding willow)

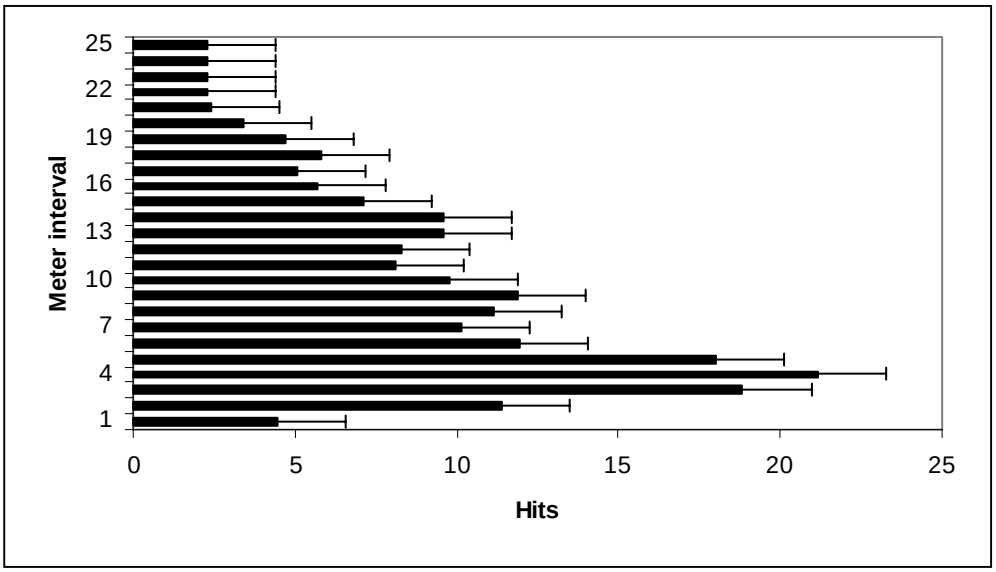

Figure 6.1. Vertical foliage density at habitat block points, Pahranagat NWR, NV, 2003. Values shown are mean and standard error of hits per meter interval. Standard error is pooled across all intervals.

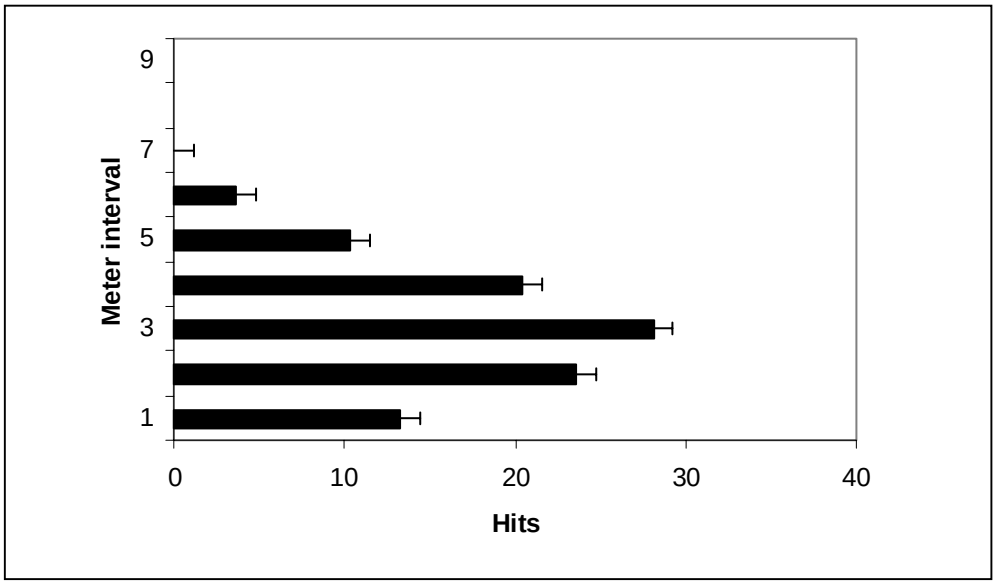

Figure 6.2. Vertical foliage density at habitat block points, Mesquite, NV, 2003. Values shown are mean and standard error of hits per meter interval. Standard error is pooled across all intervals.

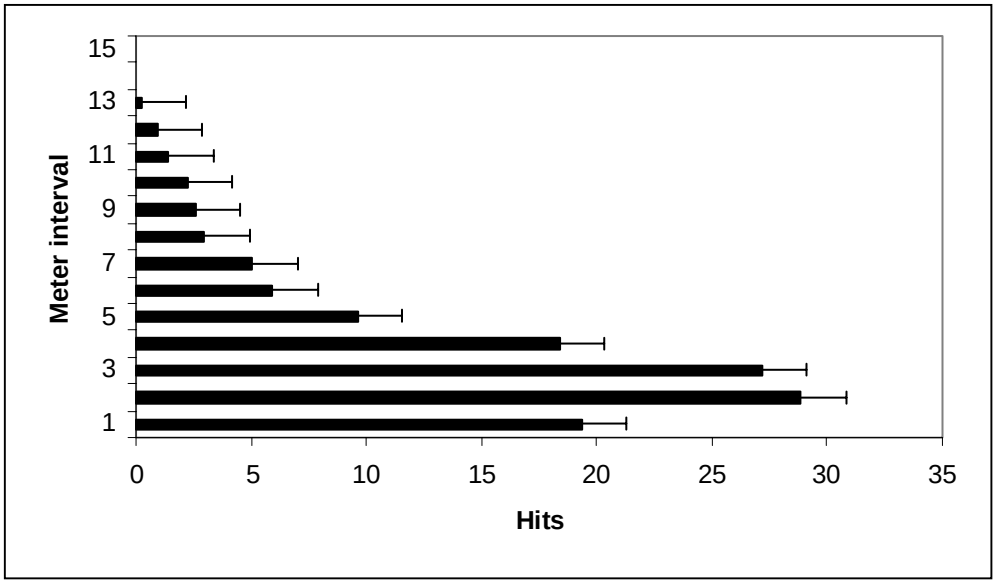

Figure 6.3. Vertical foliage density at habitat block points, Mormon Mesa, NV, 2003. Values shown are mean and standard error of hits per meter interval. Standard error is pooled across all intervals.

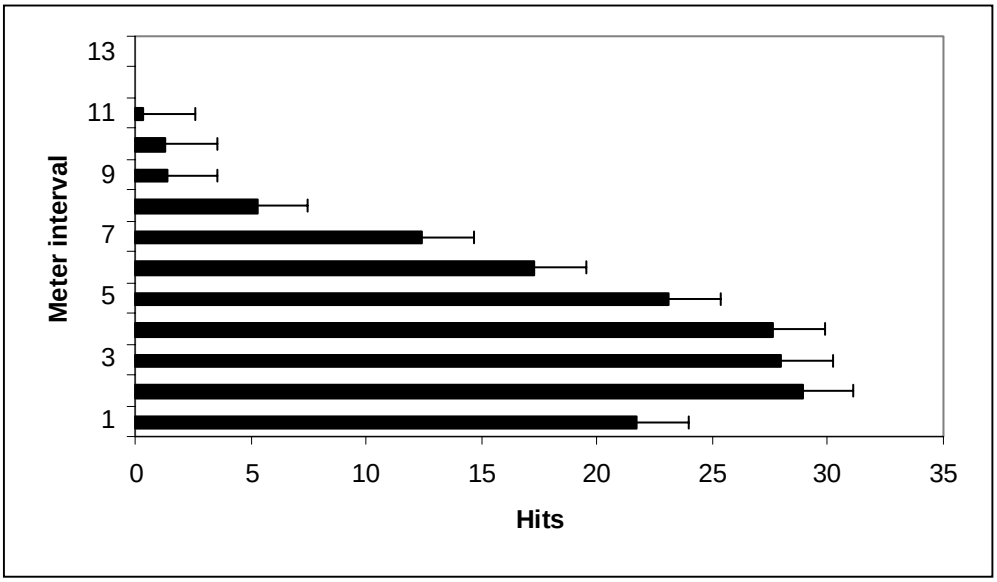

Figure 6.4. Vertical foliage density at habitat block points, Topock, AZ, 2003. Values shown are mean and standard error of hits per meter interval. Standard error is pooled across all intervals.

VEGETATION MEASUREMENTS AT NEST PLOTS VS. NON-USE PLOTS

Canopy height and closure, distance to water and broadleaf, and shrub and tree stem counts differed between nest and non-use sites in at least one of the life history study areas (Table 6.3). Average canopy height was taller at nest sites than non-use sites at Mesquite, Mormon Mesa, and Topock. Canopy closure was significantly higher at nest sites than at non-use sites at Pahranagat and Mesquite and tended to be higher (P=0.06) at nest sites vs. non-use sites at Mormon Mesa.

Table 6.3. Comparison of habitat characteristics between willow flycatcher nests and non-use sites at the four life history study area, lower Colorado River, 2003. Data are presented as mean (SE). Data from Bill Williams were not included because of small sample size (n=2). Significant differences (α=0.05) between nest and non-use plots in a given study area are indicated by asterisks.

Parameter	Pahranagat		Mesquite		Topock		Mormon Mesa	
	Nest n=11	Non-use n=11	Nest n=18	Non-use n=17	Nest n=8	Non-use n=8	Nest n=10	Non-use n=10
Average canopy height (m)	15.0 (2.2)	16.2 (2.8)	4.7 (0.2)	3.3**** (0.2)	7.1 (0.2)	5.5* (0.6)	9.4 (1.1)	3.7**** (0.3)
% canopy closure	98.3 (0.4)	86.8** (3.7)	96.5 (3.8)	57.5**** (7.1)	99.3 (0.2)	96.2 (2.3)	92.5 (2.1)	83.4 (4.1)
% woody ground cover	19.0 (5.9)	7.1 (2.8)	3.1 (1.0)	2.3 (0.6)	17.9 (5.7)	21.2 (8.3)	2.8 (0.7)	3.9 (2.0)
% of plot centers within 30 m of standing water or saturated soil	18.2	18.2	94.4	29.4****	37.5	12.5	0.0	0.0
Distance (m) to nearest canopy gap	5.2 (1.1)	7.5 (1.4)	7.4 (1.6)	1.2*** (0.5)	14.9 (4.4)	7.8 (2.5)	4.9 (0.9)	3.4 (1.1)
% of plot centers within 30 m of a broadleaf tree	100.0	100.0	100.0	100.0	12.5	25.0	100.0	70.0
# shrub/sapling stems within 5 m of plot center	9.7 (9.7)	13.7 (9.5)	210.9 (15.8)	126.6* (29.9)	194.4 (22.1)	132.1 (23.5)	169.0 (35.0)	170.2 (18.1)
# tree stems within 11.3 m of plot center	14.2 (4.1)	8.6 (2.7)	2.3 (1.0)	2.9 (1.5)	31.8 (6.7)	14.4 (4.7)	25.0 (5.0)	3.2*** (1.8)

*P < 0.05
**P < 0.01
***P < 0.001
****P < 0.0001

Percent of woody ground cover and distance to broadleaf tree did not differ between nest and non-use sites at any study area. At Mesquite, distance to canopy gap was shorter at non-use plots than at nest sites, while more non-use plots than nest sites were more than 30 m from standing water or saturated soil. Shrub/sapling stem count was higher at Mesquite and tended to be higher (P=0.08) at Topock at nest vs. non-use sites. Tree stem count was higher at Mormon Mesa and tended to be higher at Topock (P=0.06) at nest vs. non-use sites.

Foliage density at Pahranagat (Figure 6.5) did not differ between nest and non-use plots in any meter interval, though there was a trend for vegetation below 13 m in height to be denser at nest sites and vegetation above 13 m height to be denser at non-use sites. At Mesquite, Mormon Mesa, and Topock, foliage was denser toward the top of the canopy at nest sites vs. non-use sites (Figures 6.6–6.8).

DISCUSSION

Overall, the vegetation and habitat characteristics of entire habitat blocks at the four life history study areas show willow flycatchers breed in widely different types of riparian habitat throughout the Virgin and lower Colorado River regions. Although occupied flycatcher habitat at each of the four life history study areas consists of relatively homogeneous, contiguous stands of riparian vegetation, the sites differ from each other both structurally and compositionally. Pahranagat differs markedly in structure and vegetation species composition from Mesquite, Mormon Mesa and Topock. The habitat block at Pahranagat consists of mature, native, large-diameter trees up to 20 m in height with little shrub and sapling understory, while the habitat blocks at Mesquite, Mormon Mesa, and Topock are composed primarily of very dense stands of both mixed-native (Mesquite and Mormon Mesa) and exotic (Topock) woody vegetation 4–8 m in height. Total canopy closure also differed among study areas, with Pahranagat and Topock exhibiting significantly greater canopy closure than Mesquite and Mormon Mesa. Of the four study areas, Mesquite has the most recently established vegetation and was first surveyed in 2000 after runoff of surface water from adjacent areas promoted riparian vegetation growth between the breeding seasons of 1999 and 2000 (McKernan and Braden 2001b). The relatively young age of the vegetation at Mesquite in 2003 was reflected in its having the shortest canopy, highest shrub count, and lowest tree count of the four study areas. The one pattern exhibited for entire habitat blocks at all occupied study areas regardless of plant species composition, height, and canopy closure is that vertical foliage density was always greatest 2–4 m above the ground.

Differences in nest-site characteristics between study areas are reflective of the differences in overall habitat characteristics of the sites, in particular, vegetation age, structure, and species composition. Mesquite had a significantly lower average nest height than Pahranagat, Mormon Mesa, and Topock, as well as the lowest average canopy height. Pahranagat had the tallest average nest substrate height as well as the largest average nest substrate dbh. The overall taller height and larger dbh of nest substrate vegetation at the Pahranagat study area compared to the other study areas reflect differences in the age and structure of the vegetation, with Pahranagat comprising very mature, widely spaced, large trees. Clearly, these differences show that Southwestern Willow Flycatchers breed in a diverse array of riparian habitats across their range.

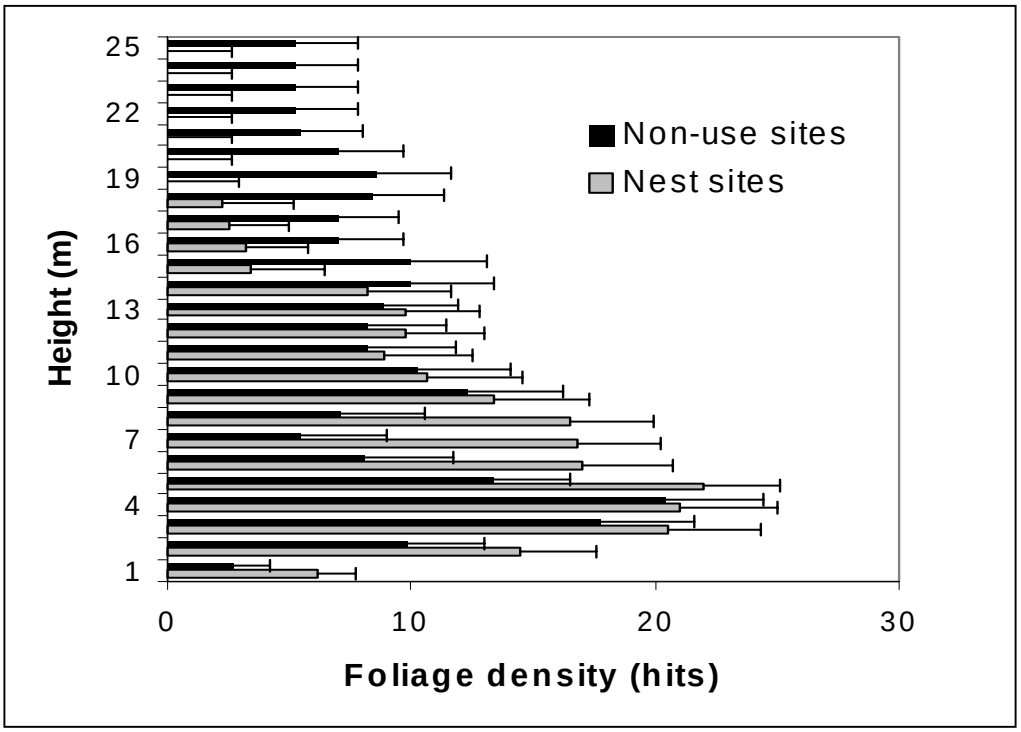

Figure 6.5. Vertical foliage density and standard error at willow flycatcher nest sites versus non-use sites at Pahranagat NWR, 2003.

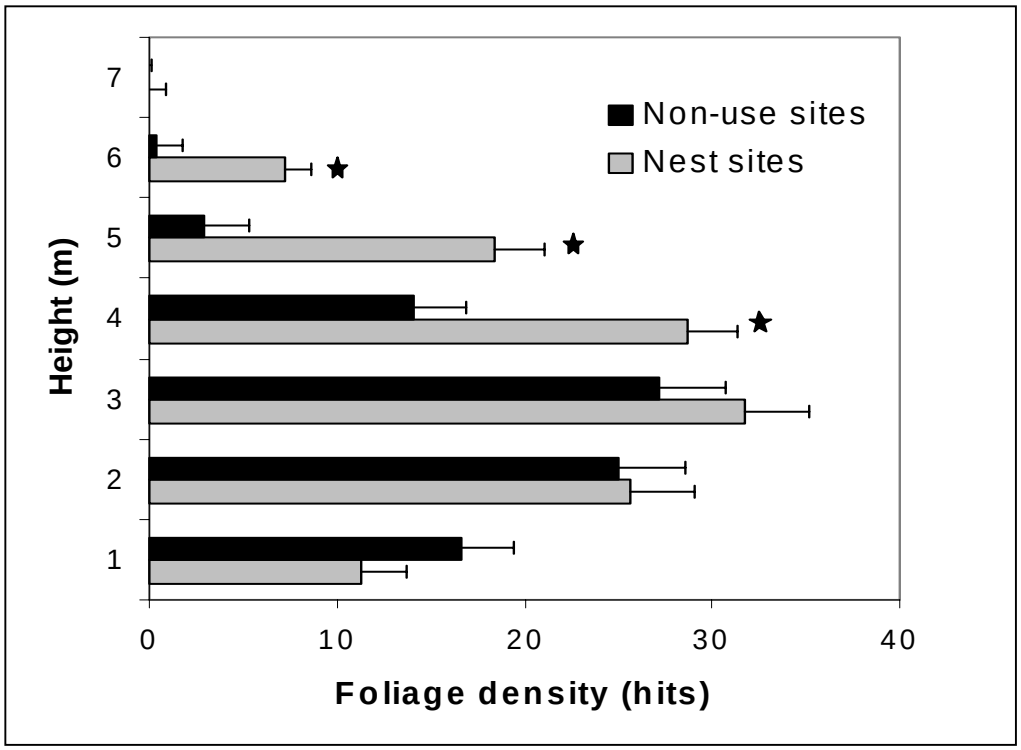

Figure 6.6. Foliage density and standard error at willow flycatcher nest sites vs. non-use sites at Mesquite, NV, 2003. Differences (Student's *t*-test, α=0.05) between nest and non-use sites within a given meter interval are indicated by asterisks.

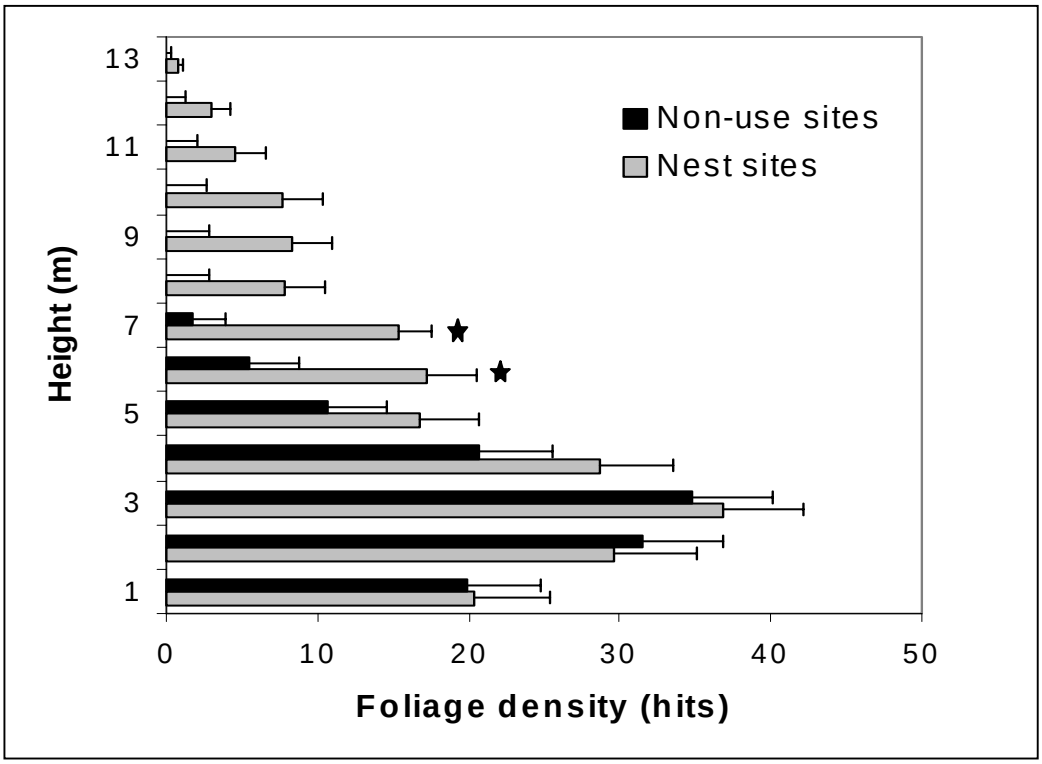

Figure 6.7. Foliage density and standard error at willow flycatcher nest sites vs. non-use sites at Mormon Mesa, NV, 2003. Differences (Student's *t*-test, α=0.05) between nest and non-use sites within a given meter interval are indicated by asterisks.

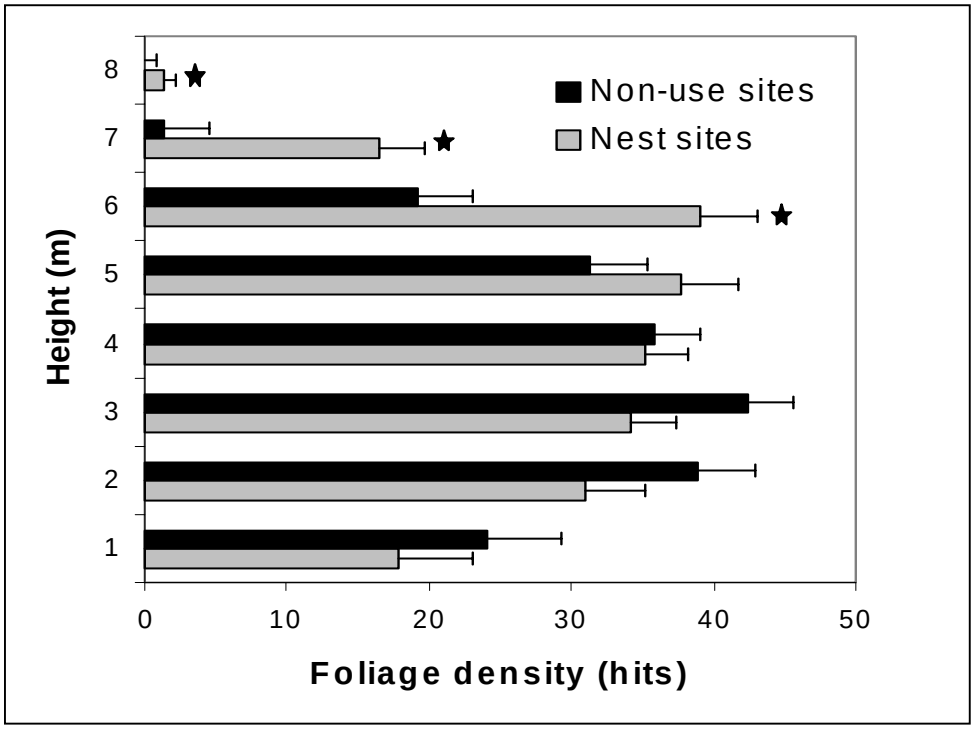

Figure 6.8. Foliage density and standard error at willow flycatcher nest sites versus non-use sites at Topock, AZ, 2003. Differences (Student's *t*-test, α=0.05) between nest and non-use sites within a given meter interval are indicated by asterisks.

Certain vegetation patterns at nest sites compared to non-use sites did emerge at the life history study areas. We found higher canopy closure at nest sites than at non-use sites, and three of the four life history study areas (Mesquite, Mormon Mesa, and Topock) had taller canopy height at nest sites than at non-use sites. Allison et al. (2003) also reported a trend for Southwestern Willow Flycatcher nest sites to have a higher percentage canopy closure and taller canopy than non-use sites, and Sedgwick and Knopf (1992) reported higher shrub density at nest sites vs. unused sites for a flycatcher population in north central Colorado. Although there was a trend for canopy height at non-use sites to be taller than at nest sites at Pahranagat, this was because many non-use sites were in very tall stringers of cottonwoods on the periphery of the main habitat block, while nest sites were within a shorter stand of Goodding willow.

We concur with Allison et al. (2003) and Sogge and Marshall (2000) in that breeding riparian birds in the desert Southwest are exposed to extreme environmental conditions and that dense vegetation at the nest may be needed to provide a more suitable microclimate for raising offspring. At all study areas, vertical foliage density was greatest at and immediately above mean nest height recorded in 2003. Allison et al. (2003) found the greatest foliage density to be at nest height at three large willow flycatcher breeding sites in Arizona. Greater canopy closure, taller canopy height, and dense foliage at nest height may facilitate a more favorable nesting microclimate and may be useful parameters in predicting preferred willow flycatcher riparian breeding habitat within the larger expanses of riparian vegetation along the Virgin and lower Colorado River regions. Given that standing water or saturated soil was present at all nest sites at the time of nest initiation, presence of water may also be a factor in providing a more suitable microclimate for raising offspring (Sogge and Marshall 2000).

Measures of distance to water were inconclusive, differing between nest and non-use sites only at Mesquite. At all study areas, standing water or saturated soil was present at all nest sites when nests were initiated. Because of extreme seasonal changes in hydrology at all study areas, with most nest sites dry by August, distance to water as measured after the breeding season may not reflect hydrologic conditions during nest-site selection. Measuring presence of water early in the breeding season may be a better indicator of preferred breeding flycatcher habitat.

Measures of distance to canopy gap were inconclusive. Previous authors have reported that, compared to the center of non-use plots, Southwestern Willow Flycatchers place nests closer to canopy gaps (Allison et al. 2003), while a willow flycatcher population in northern Colorado placed nests farther from canopy gaps (Sedgwick and Knopf 1992). Because of the variation in vegetation structure and species composition among the four life history study areas, presence of canopy gaps may not be a good predictor of flycatcher breeding habitat along the Virgin and lower Colorado Rivers.

Many of the structural vegetation patterns that emerged at flycatcher breeding sites in 2003 are consistent with those of other recent research and warrant further study. Vegetation characteristics in nesting areas are unlikely to change significantly between years, and in subsequent years we will pool data across years to further examine nest and non-use differences.

CHAPTER 7

NEST MICROCLIMATE

INTRODUCTION

Innate selection of beneficial nest-site microclimate by birds can moderate extreme environmental conditions and has the potential to improve reproductive success and increase fitness (Webb and King 1983, Walsberg 1985). Although nest microclimate may influence avian reproductive success, other factors such as habitat and food availability also are important (Cody 1985, Gloutney and Clark 1997). Potential covariance with other evolutionary forces such as predation further complicates any investigation of microclimatic nest-site selection (Martin 1995).

Most studies of microclimatic nest-site selection have concentrated on non-passerines. Waterfowl (Gloutney and Clark 1997), hummingbirds (Calder 1973), and woodpeckers (Connor 1975, Inouye 1976, Inouye et al. 1981) in particular have been evaluated with respect to various aspects of microclimatic regulation. Selected species from each of these groups have demonstrated a preference for specific physical attributes within their nesting habitat as strategies to maximize heat gain, minimize heat loss, or manipulate wind exposure depending on the situation. Several species of woodpeckers excavate cavities whose entrance holes are oriented toward or away from the sun, again depending on the situation and the need to regulate nest microclimate.

Microclimatic selection by passerines has received less attention than that of non-passerines, with most investigations of passerines directed at either ground-nesters or those building covered nests. Horned Lark (*Eremophila alpestris*) is probably the most thoroughly studied ground-nesting passerine, and numerous studies indicate that it selects nest locations based on compass orientation as a way to manipulate wind exposure, solar insolation, and resulting nest microclimate (Cannings and Threlfall 1981, With and Webb 1993, Hartman and Oring 2003). Cactus Wren (*Campylorhynchus brunneicapillus*) and Verdin (*Auriparus flaviceps*) orient the entrances to their covered nests either away from or toward prevailing winds in different parts of the nesting season to moderate nest microclimate (Austin 1974, 1976).

Microclimatic nest-site selection has been investigated in only a few open-cup, shrub- or tree-nesting passerines. The Warbling Vireo (*Vireo gilvus*) is very sensitive to fluctuations in nest microclimate (Walsberg 1981), and the San Miguel Island Song Sparrow (*Melospiza melodia micronyx*) may benefit from microhabitats that maintain higher nest relative humidity (Kern et al. 1990).

Gloutney and Clark (1997) pointed out that nonrandom distribution of nests strongly supports the microhabitat (i.e., microclimate) selection hypothesis. For example, nest-site selection for thermal advantages has been offered as an explanation as to why nonrandom nest-site placement occurs in many species (Kern and van Riper 1984, Bekoff et al. 1987, van Riper et al. 1993).

Nests placed in dense vegetation have been suggested to be less susceptible to predation (Cody 1985), and may also benefit from protection from wind, nocturnal heat loss, and diurnal heat gain (Walsberg 1981, 1985). Because the microhabitat of an individual can influence energy expenditure (Warkentin and West 1990), calories conserved through beneficial nest-site selection can aid reproductive efforts and improve fitness (Gloutney and Clark 1997).

Air temperature alone cannot portray the microclimate of an incubating bird (Gloutney and Clark 1997). Solar insolation, vapor pressure (i.e., relative humidity), and wind speed interact in a complex manner with temperature to define microclimate (McArthur 1990), so that many physiological investigators instead calculate 'operative temperature,' the complex formula that integrates all of the above factors (Gloutney and Clark 1997).

The purpose of this microclimate investigation was to document temperature, relative humidity, and soil moisture at nests of Southwestern Willow Flycatchers, an open-cup nesting passerine. We tested the null hypothesis that no difference existed between (1) a flycatcher nest site, (2) a randomly located adjacent site within that flycatcher territory, and (3) unoccupied riparian habitat outside of that territory. Air temperature, relative humidity, and soil moisture were used as indices to microclimate, although it was recognized that substantial interaction likely occurred between those three variables.

METHODS

OVERVIEW

We located active flycatcher nests at four life history study areas (Pahranagat, Mesquite, Mormon Mesa, and Topock) between May and July 2003. Temperature, relative humidity, and soil moisture were measured at three locations relative to each nest for the purpose of examining microclimate at three levels of potentially increasing differences in flycatcher nesting habitat use, as follows:

1. Within 1 m of a nest (i.e., the nest site).
2. Within the territory associated with that nest (but 5–10 m from the nest; i.e., within-territory site).
3. Within unoccupied riparian habitat 50–200 m from the nearest known nest or territory (i.e., non-use site).

We began collecting microclimate data simultaneously at nest, within-territory, and non-use sites within 48–72 hours of the time an active nest was vacated. A nest was defined as vacated if it met one of the following criteria: (1) it had been abandoned for any reason (including brood parasitism) at any stage of the nesting cycle after the first flycatcher egg was laid, (2) it had fledged young and was no longer active, or (3) it had been depredated after the first egg was laid. This technique minimized disturbance due to equipment placement or increased human activity near the nest as recommended by Hartman and Oring (2003), while still allowing for quantitative post-use comparisons of microclimate.

Temperature, relative humidity, and soil moisture data were collected over a period of at least 14 full days (midnight to midnight), after which time we transferred the equipment and effort used to collect microclimate data to the nest, within-territory, and non-use sites for another recently-vacated nest (i.e., including a second brood or second nesting attempt). The 14-day study period for each nest became the focus of all final analyses. Renests, or second nests of a known pair, were treated as independent data points because nests were the unit of analysis of this study and not individuals or pairs. All equipment used to collect microclimate data was removed after 14 full days from the time the last active nest had been vacated.

TEMPERATURE AND RELATIVE HUMIDITY (T/RH) MEASUREMENTS

Measurements of T/RH were recorded automatically every 15 minutes using a HOBO H8 Pro (Onset Computer Corporation, Pocasset, MA) that combines a thermometer (degrees Celsius), relative humidity monitor, and digital data logger (hereafter referred to as a sensor array). We camouflaged all HOBO sensor arrays by placing them in an inverted small, plastic bowl coated with spray adhesive and local vegetation. The opening at the bottom was covered with shadecloth, allowing free air circulation around the sensor array. The HOBO sensor arrays were placed in four different location types in a manner consistent with an overall randomization design, as follows:

(1) Seasonal-variation (SV) sensor arrays: When field personnel arrived at the four life history study areas in early May, they placed SV sensor arrays at representative locations within the riparian and adjacent desertscrub habitat. The riparian SV sensor arrays were designed to monitor T/RH fluctuations throughout the nesting season within the riparian zone to document ambient environmental conditions throughout the study period. Riparian SV sensor arrays were placed in the nearest tree or woody shrub at their representative sites using a prearranged random number selection sequence (see 3C–3E below). The desertscrub SV sensor arrays at each study area were placed in desert habitat outside of the riparian zone to document local extremes in T/RH.

(2) Nest-site (NS) sensor arrays: Once a known nest was vacated, an NS sensor array was placed less than 1 meter from the nest, preferably hanging directly below it. Sensor arrays were camouflaged so as not to disturb birds that may have returned to the nest to recycle nesting material. Canopy closure was visually estimated as < 25%, 25–75%, or >75% at all nest, within-territory, and non-use sites, and habitat type was identified as native (cottonwood/willow), exotic (tamarisk), or mixed native and exotic (see data forms in Appendix A).

(3) Within-territory (WT) sensor arrays: A WT sensor array was placed at a location within the territory of the pair that attended the corresponding nest. The WT sensor array sites were determined by means of the following instructions and the use of random number sequences:

A. The compass direction to walk from the nest, given in degrees from North, was determined from a random number sequence.
B. The distance (between 5 and 10 m) to walk in the designated direction was determined from a random number sequence. Once that distance was traveled, the closest woody tree or shrub was selected for sensor array placement. If several trees were tied for closest,

one of the field crew tossed a rock over his or her shoulder and the woody tree or shrub closest to its resting place was the one in which the sensor array was placed.

C. The sensor array was placed within the documented range of flycatcher nest heights (Sogge et al. 1997), and maximum height depended upon local tree or shrub maximum height at each of the four life history study areas. Sensor arrays were placed at a height between 1.5 and 5.0 m, as determined from a random number sequence, at Mesquite, Mormon Mesa, and Topock, and between 1.5 and 10.0 m (or as high as reasonably possible) at Pahranagat. If the random number at Pahranagat was greater than approximately 7 m, the sensor array was placed as close to the random height as reasonably possible. If the tree or shrub chosen for a sensor array location was of insufficient height to accept the height from the random number sequence, then field personnel placed the sensor array at the first height in the sequence that was less than the height of the tree or shrub.
D. The distance (0–3 m) at which the sensor array was placed from the bole of the tree or center of the shrub was determined from a random number sequence. If the tree or shrub was of insufficient radius to accept the distance from the random number sequence, then field personnel placed the sensor array at the first number in the sequence that was less than the radius of the tree or shrub.
E. The compass direction, given in degrees from north, at which the sensor array was placed from the bole of the tree or center of the shrub was determined from a random number sequence. If there was no branch in this compass direction that would support the sensor array at the height and distance specified in (C) and (D), field personnel proceeded clockwise around the tree or shrub until a suitable branch was located.

If, as presented in C and D, a number from a subsequent random number sequence (sequence meaning a row in the random number table) was used because the number in the initial sequence was too high, then both sequences were considered used and no longer available for future use. If these directions took field personnel outside of the riparian zone or to a site without trees or shrubs, they returned to the nest site and used the next sequence of random numbers.

(4) Non-use habitat (NU) sensor arrays: At all life history study areas, we identified NU habitat after the first territories and nests were located. Two computer-generated circles were centered on each nest site or territory center, one 50 m in radius and one 200 m in radius. The area between the two circles that was within the study area boundaries and was at least 50 m from all other nests or territory centers was classified as NU and divided into equal numbered grids on digitized, geo-referenced, and numbered aerial photographs. The grids to be used for NU purposes were selected using computer-generated random numbers, and the centroid of each selected grid became the random point near which the sensor arrays were placed. The NU site was located in the field using the UTM coordinates and a Rino 110 GPS unit. The exact location of the sensor array was determined by selecting the closest woody tree or shrub and using the procedures in 3C–3E above. If the NU site was inaccessible (e.g., impenetrable vegetation or deep water) or was in clearly unsuitable habitat (e.g., open marsh), the next UTM coordinate for a random NU site was used.

SOIL MOISTURE (SM) MEASUREMENTS

We took SM measurements using two methods: (1) SV SM sensor arrays were placed at representative locations throughout the four study areas at the same sites as the SV T/RH arrays in riparian habitat to document daily range and rate of change, and (2) hand-held probes were used to document SM at NS, WT, and NU sites during the 14-day period after nests were vacated. No SV SM sensor arrays were placed in desertscrub habitat.

(1) In mid-May, field personnel placed SV sensor arrays at representative sites within the riparian zone at each of the four life history study areas. If the locations for any of the SV SM sensor arrays were inundated or exhibited 100% saturated soils, field personnel placed the sensor array 5 m beyond the edge of the inundated or saturated area in a compass direction determined by a random number sequence. The decision rule for 100% saturated soil was as follows: a 1-cm-deep trench created with a stick filled with water or unstable mud in less than one minute.

SM data was collected at 1-hour intervals using a Smart Soil Moisture Sensor SM monitor connected to a 4-channel HOBO Micro Station data logger (both by Onset Computer Corp., Pocasset, MA). All SM sensor arrays were buried horizontally with the flat side perpendicular to the ground surface and the top edge of the sensor 1 cm beneath the soil surface.

(2) We used hand-held probes (20-cm Ech2o probes connected to Ech2o check readouts, by Decagon Devices Inc., Pullman, WA) to gather SM data during the 14-day period after nests were vacated at NS, WT, and NU sites. SM data were collected directly underneath the T/RH sensor arrays on 3–7 days during the 14-day sample period. Measurements were taken between 0700 and 1000 hours to eliminate the potential bias of time-of-day changes in the soil capillary fringe. A trench slightly narrower than the probe was excavated with a putty knife to ensure good soil-to-probe contact. Probes were inserted horizontally into the trench with the top of the sensor 1 cm beneath the soil surface. SM was assumed to be 100% at sites that were flooded, inundated, or met the 100% saturated decision rule, and no SM measurements were collected at these sites.

If a willow flycatcher pair initiated a second nest within 10 m of its initial nest at which T/RH and SM were being documented, field personnel used hand-held probes to gather SM data at the same time that the second nest was being checked for contents/status (approximately every three days) to minimize disturbance. Therefore, it was likely that the number of SM measurements would be seven at vacated nests where no second nest was located nearby, while the number of SM measurements was likely to be closer to three at vacated nests where a second nest was located nearby. Although a minimum of three to seven SM measurements were essential for statistical purposes, SM measurements were taken on as many days as possible during the 14-day sample period.

Soil samples were collected at each SM site (SV, NS, WT, NU) when sensor arrays were initially set up. Samples were approximately the size of a medium apple, collected from the surface down to and including a depth of 5 cm, and placed in a heavy zip-lock plastic bag labeled with the site designation. Because soil texture strongly influences capillary action and therefore overall SM (Sumner 2000), analysis of soil composition may be conducted in future years as time and funding allow.

STATISTICAL ANALYSES

We downloaded data from the T/RH and SM sensor arrays at SV, NS, WT, and NU sites into databases at the end of the field season. We merged all data to create one dataset for further analysis, with the exception of the SV dataset, which was summarized separately for descriptive purposes and was not included in any of the analyses. Data from SM sensor arrays occasionally exhibited negative values, an anomaly that may have been the result of poor calibration with saline and/or sandy soil. All negative SM data were omitted from all summaries and analyses. We calculated the following variables for each sensor array, by day and by overall study period:

- Mean soil moisture
- Mean diurnal temperature
- Mean maximum diurnal temperature
- Mean diurnal relative humidity
- Mean nocturnal temperature
- Mean minimum nocturnal temperature
- Mean nocturnal relative humidity
- Mean daily temperature range (mean diurnal maximum minus nocturnal minimum)

The overall study period constituted the entire season for SV sensor arrays and the 14 days of monitoring for sites associated with nests (NS, WT, and NU). We determined diurnal and nocturnal periods by using the actual daily sunrise and sunset times reported for the region by the National Weather Service (2003).

We used Tukey's multiple comparison test with a one-way Analysis-of-Variance (ANOVA) to determine whether placing the sensor arrays *after* the nest had been vacated was appropriate, by testing the mean weekly diurnal temperatures of the SV sensor arrays at each study area. Any consecutive weeks at a study area that were significantly different would be an indication that placing the sensor arrays after nests had been vacated was inappropriate.

We used probability plots and other distribution tests to test the response variables for normality. Chi-square (X^2) and one-way ANOVA tests were used to test the single effects of the three location types (NS, WT, NU) and other predictor variables for all response variables. If significant differences were found ($P<0.05$), we used Tukey's multiple comparison test to determine pairwise differences.

We used multiple factor ANOVA (multiple ANOVA) analyses with and without interaction terms to determine significant differences in means between location types for all temperature, humidity, and soil moisture variables. Multiple ANOVA tests for a difference in means, while controlling for the variance by study area, habitat, and canopy closure. The full initial analysis was:

> Response variable = Location Type + Study Area + Habitat + Canopy + (Location Type * Study Area) + (Location Type * Habitat) + (Location Type * Canopy) + (Study Area * Habitat) + (Study Area * Canopy) + (Habitat * Canopy) + (Location Type * Study Area * Habitat) + (Location Type * Study Area * Canopy) + (Location Type * Habitat *

Canopy) + (Study Area * Habitat * Canopy) + (Location Type * Study Area * Habitat * Canopy).

The R^2 value for the multiple ANOVA analyses identified the extent of the variation in the response variable that was explained by the predictor variables in each analysis. Tukey's multiple comparison test was used to determine pairwise differences for significant variables. The *P* values presented in the multiple ANOVA analyses were for type III sum of squares. All analyses were conducted using SAS® Version 8 (SAS Institute 1999).

RESULTS

SEASONAL VARIATION

Twenty SV T/RH sensor arrays and 16 SV SM sensor arrays were placed at the four life history study areas from 14 to 22 May and remained in place until late August. Because of mechanical malfunction, some SV sensor arrays did not initiate data collection or stopped collecting data during mid-season. This was true of all five SV T/RH sensor arrays at Topock. All but one of the SV SM sensor arrays functioned throughout the season. The results from all SV sensor arrays indicated desertscrub sites were substantially hotter and drier than riparian sites (Tables 7.1 and 7.2).

Table 7.1. Seasonal variation in riparian habitat by study area for Southwestern Willow Flycatcher microclimate data from along the Virgin and lower Colorado Rivers, May–August 2003. All values are ± 1 standard deviation (in parenthesis); N/A=data not available.

Descriptive statistics	Pahranagat	Mesquite	Mormon Mesa	Topock
N (Temp./Humidity)	1	3	3	0
N (Soil Moisture)	3	4	4	4
Mean soil moisture (%)	24.9 (±13.0)	20.6 (±14.2)	25.1 (±9.8)	25.3 (±6.5)
Mean diurnal temperature (°C)	26.4 (±2.3)	30.7 (±2.5)	32.3 (±4.1)	N/A
Mean maximum diurnal temperature (°C)	35.4 (±3.8)	39.7 (±4.2)	43.3 (±5.2)	N/A
Mean diurnal relative humidity (%)	39.0 (±15.6)	42.4 (±12.1)	39.3 (±13.3)	N/A
Mean nocturnal temperature (°C)	21.9 (±2.6)	24.2 (±3.0)	21.5 (±4.2)	N/A
Mean minimum nocturnal temperature (°C)	17.0 (±3.3)	19.0 (±3.6)	16.6 (±4.6)	N/A
Mean nocturnal relative humidity (%)	40.3 (±15.9)	52.8 (±14.9)	58.5 (±14.3)	N/A
Mean daily temperature range (°C)	18.4 (±5.1)	20.7 (±5.7)	26.7 (±5.1)	N/A

Table 7.2. Seasonal variation in desertscrub habitat by study area for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado Rivers, May–August 2003. All values are ± 1 standard deviation (in parenthesis); N/A=data not available.

Descriptive statistics	Pahranagat	Mesquite	Mormon Mesa	Topock
N (Temp./Humidity)	2	2	1	0
Mean diurnal temperature (°C)	32.5 (±3.7)	37.1 (±3.1)	36.7 (±3.4)	N/A
Mean maximum diurnal temperature (°C)	41.0 (±4.6)	45.1 (±4.4)	45.0 (±4.6)	N/A
Mean diurnal relative humidity (%)	20.4 (±12.2)	17.3 (±9.9)	18.0 (±9.4)	N/A
Mean nocturnal temperature (°C)	25.0 (±3.2)	30.1 (±2.5)	29.8 (±3.1)	N/A
Mean minimum nocturnal temperature (°C)	19.0 (±3.6)	23.9 (±3.1)	24.3 (±3.5)	N/A
Mean nocturnal relative humidity (%)	26.7 (±16.3)	22.1 (±12.9)	23.2 (±11.1)	N/A
Mean daily temperature range (°C)	21.9 (±4.4)	21.2 (±4.9)	20.8 (±4.8)	N/A

DATA COLLECTION AFTER NESTS WERE VACATED

Only two sets of consecutive weeks were found to be significantly different in mean diurnal temperature: the first and second week in August at Mormon Mesa ($P<0.05$) and the third and fourth week in May at Mesquite ($P<0.05$). These two anomalous sets of weeks were not during the peak of the nesting season (June-July), which exhibited fairly consistent mean diurnal temperatures from week to week.

LOCATION TYPES: DESCRIPTIVE STATISTICS AND SINGLE EFFECTS ANALYSIS

We placed sensor arrays at all nests within each of the four life history study areas. Data on T/RH were successfully collected for 48 NS, 46 WT, and 38 NU sites (Tables 7.3 through 7.6). The location type data were normally distributed for all response variables, so that no transformations or elimination of outliers were needed.

All study areas except Pahranagat showed a significant difference in percent canopy closure between pairwise location types (NS, WT, NU; Tables 7.3 through 7.6). The NU sites were primarily responsible for this difference, since they had a significantly greater proportion of sites with less than 25% canopy as compared to NS sites at Mesquite or WT sites at Mesquite, Mormon Mesa, and Topock.

Single effects analyses (Tables 7.3 through 7.6) indicate that during daytime, NS sites were cooler and more humid than NU sites at Mesquite and Pahranagat, although they were similar at Mormon Mesa and Topock (Figures 7.1 and 7.2). The NU sites were hotter and drier than either NS or WT sites at Mesquite and Pahranagat, but were similar to NS and WT sites at Mormon Mesa and Topock.

Mean nocturnal temperatures and humidity were generally similar between location types, although the average minimum nocturnal temperatures were lower for NU sites. In general, NU sites had the greatest mean daily temperature range, and NS sites had the lowest mean daily temperature range.

SM was similar among location types; however, the descriptive statistics (Tables 7.3 through 7.6) showed wide variance in percent SM readings. Despite the SM difference among location types at Pahranagat ($P = 0.048$), we decided to exclude SM from all subsequent analyses.

Table 7.3. Descriptive statistics (Chi-square) and single effects (ANOVA) for Southwestern Willow Flycatcher microclimate data by location type at Pahranagat, June–August 2003. Values for soil moisture and subsequently listed response variables are ± 1 standard deviation (in parenthesis); N/A=data not available.

Response variables	Nest Site	Within Territory	Non-use	X^2 or F-value	*P*	Significant pairwise differences
N (Temp./Humidity Sensor Arrays)	11	9	8	--	--	--
N (Soil Moisture Probes)	11	10	9	--	--	--
Habitat						
Native (cottonwood or willow)	11 (100.0)*	9 (100.0)	8 (100.0)	N/A	N/A	N/A
Exotic (tamarisk)	0 (0.0)	0 (0.0)	0 (0.0)			
Mixed (native and exotic)	0 (0.0)	0 (0.0)	0 (0.0)			
Canopy closure						
Less than 25%	0 (0.0)	1 (11.1)	0 (0.0)	4.5	0.345	--
25%-75%	1 (9.1)	2 (22.2)	3 (37.5)			
More than 75%	10 (90.9)	6 (66.7)	5 (62.5)			
Mean soil moisture (%)	24.9 (±8.5)	25.3 (±9.8)	15.4 (±9.9)	3.4	0.048	--
Mean diurnal temperature (°C)	27.7 (±1.5)	28.8 (±1.5)	30.6 (±2.4)	6.0	0.007	NU>NS
Mean maximum diurnal temperature (°C)	38.6 (±3.3)	40.9 (±3.6)	42.4 (±5.8)	2.0	0.163	--
Mean diurnal relative humidity (%)	43.4 (±7.6)	41.0 (±7.7)	31.1 (±7.5)	6.4	0.006	NS>WT>NU
Mean nocturnal temperature (°C)	24.3 (±1.2)	24.6 (±1.2)	25.7 (±2.5)	1.7	0.210	--
Mean minimum nocturnal temperature (°C)	15.0 (±2.3)	14.4 (±2.2)	16.2 (±3.3)	1.1	0.361	--
Mean nocturnal relative humidity (%)	43.8 (±7.8)	42.9 (±8.7)	37.2 (±9.7)	1.5	0.249	--
Mean daily temperature range (°C)	16.1 (±3.0)	18.8 (±4.2)	18.3 (±3.4)	1.7	0.206	--

*N followed by % of column totals

Table 7.4. Descriptive statistics (Chi-square) and single effects (ANOVA) for Southwestern Willow Flycatcher microclimate data by location type at Mesquite, June–August 2003. Values for soil moisture and subsequently listed response variables are ± 1 standard deviation (in parenthesis).

Response variables	Nest Site	Within Territory	Non-use	X^2 or F-value	*P*	Significant pairwise differences
N (Temp./Humidity Sensor Arrays)	18	17	17	--	--	--
N (Soil Moisture Probes)	14	13	17	--	--	--
Habitat						
Native (cottonwood or willow)	9 (50.0)*	11 (64.7)	8 (47.1)			
Exotic (tamarisk)	2 (11.1)	0 (0.0)	2 (11.8)	X^2=2.6	0.628	--
Mixed (native and exotic)	7 (38.9)	6 (35.3)	7 (41.2)			
Canopy closure						
Less than 25%	0 (0.0)	1 (5.9)	9 (52.9)			
25%-75%	13 (72.2)	13 (76.5)	7 (41.2)	X^2=19.5	<0.001	NS>NU, WT>NU
More than 75%	5 (27.8)	3 (17.7)	1 (5.9)			
Mean soil moisture (%)	16.8 (±10.4)	18.5 (±9.7)	11.1 (±12.3)	F=2.0	0.155	--
Mean diurnal temperature (°C)	30.8 (±2.3)	32.2 (±2.7)	36.1 (±3.8)	F=15.1	<0.001	NU>NS, NU>WT
Mean maximum diurnal temperature (°C)	41.8 (±4.3)	45.8 (±5.7)	51.9 (±6.9)	F=13.9	<0.001	NU>NS, NU>WT
Mean diurnal relative humidity (%)	51.2 (±12.6)	46.3 (±10.2)	35.6 (±7.1)	F=10.4	<0.001	NS>NU, WT>NU
Mean nocturnal temperature (°C)	24.2 (±1.9)	24.1 (±2.0)	24.0 (±2.3)	F=0.0	0.957	--
Mean minimum nocturnal temperature (°C)	16.6 (±2.3)	15.9 (±2.4)	14.7 (±2.5)	F=2.6	0.081	--
Mean nocturnal relative humidity (%)	62.8 (±10.4)	61.0 (±9.4)	59.0 (±8.5)	F=0.7	0.484	--
Mean daily temperature range (°C)	19.3 (±4.6)	22.4 (±5.2)	29.0 (±5.6)	F=16.3	<0.001	NU>NS, NU>WT

*N followed by % of column totals

Table 7.5. Descriptive statistics (Chi-square) and single effects (ANOVA) for Southwestern Willow Flycatcher microclimate data by location type at Mormon Mesa, June–August 2003. Values for soil moisture and subsequently listed response variables are ± 1 standard deviation (in parenthesis).

Response variables	Nest Site	Within Territory	Non-use	X^2 or F-value	*P*	Significant pairwise differences
N (Temp./Humidity Sensor Arrays)	12	11	6	--	--	--
N (Soil Moisture Probes)	6	7	8	--	--	--
Habitat						
Native (cottonwood or willow)	4 (33.3)*	4 (36.4)	0 (0.0)			
Exotic (tamarisk)	1 (8.3)	1 (9.0)	3 (50.0)	6.9	0.143	--
Mixed (native and exotic)	7 (58.3)	6 (54.5)	3 (50.0)			
Canopy closure						
Less than 25%	0 (0.0)	0 (0.0)	1 (16.7)			
25%-75%	10 (83.3)	11 (100.0)	3 (50.0)	8.3	0.083	WT>NU
More than 75%	2 (16.7)	0 (0.0)	2 (33.3)			
Mean soil moisture (%)	5.4 (±6.2)	9.2 (±7.7)	7.0 (±10.4)	0.3	0.715	--
Mean diurnal temperature (°C)	33.1 (±3.4)	33.6 (±3.0)	33.4 (±3.1)	0.1	0.933	--
Mean maximum diurnal temperature (°C)	46.6 (±4.7)	47.7 (±5.3)	47.8 (±4.3)	0.2	0.8261	--
Mean diurnal relative humidity (%)	39.1 (±9.6)	37.4 (±7.6)	37.7 (±8.7)	0.1	0.8878	--
Mean nocturnal temperature (°C)	23.9 (±3.2)	23.5 (±3.2)	21.2 (±3.2)	1.5	0.251	--
Mean minimum nocturnal temperature (°C)	16.6 (±2.6)	15.9 (±2.6)	13.5 (±2.2)	3.0	0.070	--
Mean nocturnal relative humidity (%)	56.5 (±6.0)	56.8 (±7.3)	62.5 (±10.1)	1.5	0.245	--
Mean daily temperature range (°C)	23.7 (±5.1)	24.7 (±3.8)	27.4 (±2.9)	1.5	0.241	--

*N followed by % of column totals

Table 7.6. Descriptive statistics (Chi-square) and single effects (ANOVA) for Southwestern Willow Flycatcher microclimate data by location type at Topock, June–August 2003. Values for soil moisture and subsequently listed response variables are ± 1 standard deviation (in parenthesis); N/A=data not available.

Response variables	Nest Site	Within Territory	Non-use	X^2 or F-value	*P*	Significant pairwise differences
N (Temp./Humidity Sensor Arrays)	7	9	7	--	--	--
N (Soil Moisture Probes)	8	8	8	--	--	--
Habitat						
Native (cottonwood or willow)	0 (0.0)*	0 (0.0)	0 (0.0)			
Exotic (tamarisk)	7 (100.0)	9 (100.0)	7 (100.0)	N/A	N/A	N/A
Mixed (native and exotic)	0 (0.0)	0 (0.0)	0 (0.0)			
Canopy closure						
Less than 25%	0 (0.0)	0 (0.0)	2 (28.6)			
25%-75%	5 (71.4)	4 (44.4)	5 (71.4)	9.2	0.056	WT>NU
More than 75%	2 (28.6)	5 (55.6)	0 (0.0)			
Mean soil moisture (%)	28.7 (±4.7)	21.4 (±8.9)	27.1 (±5.8)	2.6	0.098	--
Mean diurnal temperature (°C)	33.0 (±2.1)	32.2 (±2.5)	34.2 (±4.6)	0.8	0.476	--
Mean maximum diurnal temperature (°C)	43.9 (±4.8)	42.6 (±4.8)	48.0 (±9.8)	1.4	0.283	--
Mean diurnal relative humidity (%)	53.2 (±5.7)	56.5 (±9.1)	55.7 (±12.5)	0.3	0.783	--
Mean nocturnal temperature (°C)	27.0 (±1.2)	26.7 (±1.4)	25.7 (±1.4)	2.0	0.161	--
Mean minimum nocturnal temperature (°C)	19.3 (±1.3)	19.2 (±1.2)	17.9 (±2.0)	1.9	0.171	--
Mean nocturnal relative humidity (%)	65.1 (±3.4)	66.5 (±4.7)	68.7 (±5.2)	1.2	0.325	--
Mean daily temperature range (°C)	17.4 (±3.9)	16.3 (±4.5)	21.7 (±8.3)	1.9	0.182	--

*N followed by % of column totals

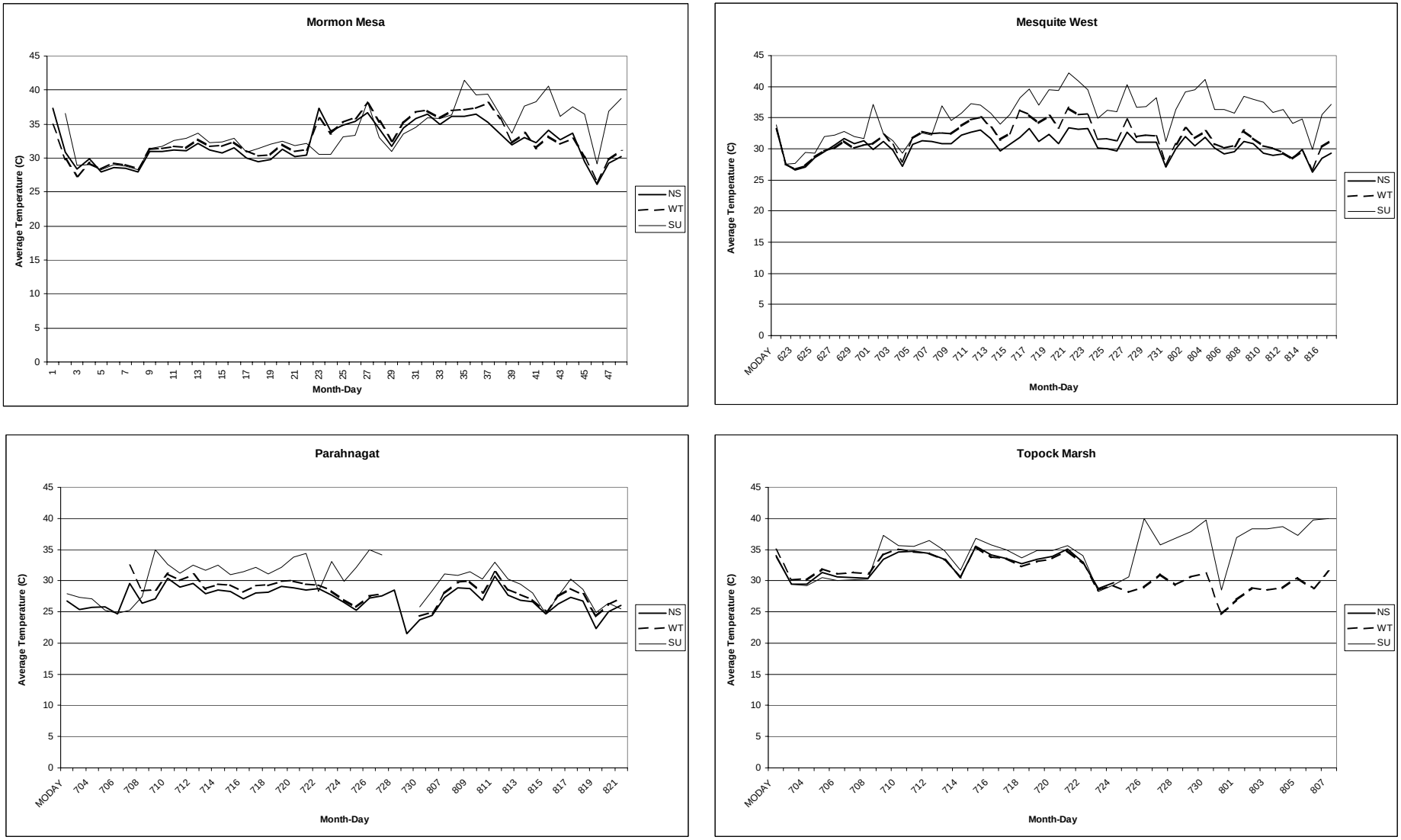

Figure 7.1. Mean diurnal temperature by study area and location type for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado Rivers, June–August 2003.

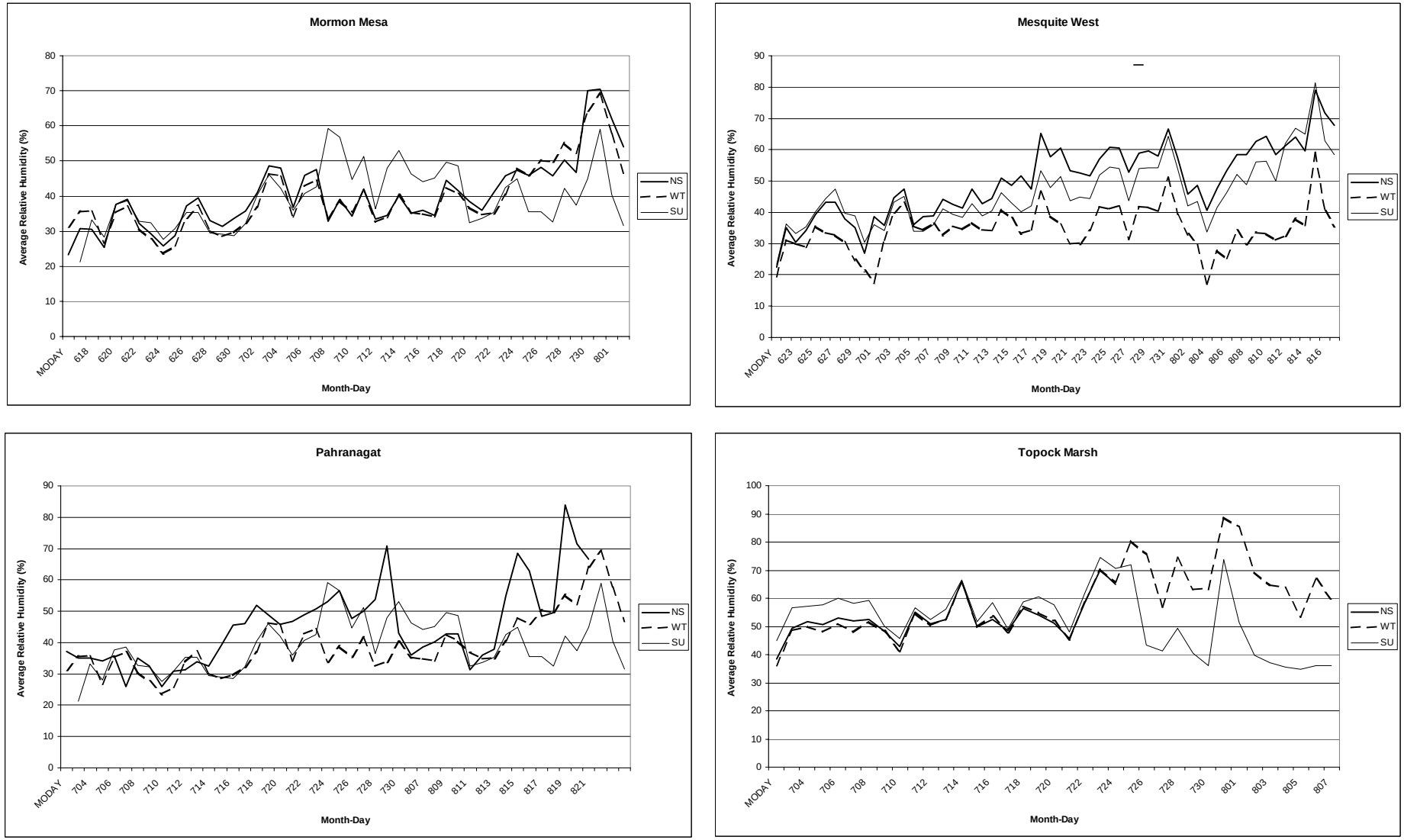

Figure 7.2. Mean diurnal relative humidity by study area and location type for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado Rivers, June–August 2003.

INDIVIDUAL EFFECT OF PREDICTOR VALUES

Single effects analyses (Tables 7.7 through 7.10) illustrate the individual effect that each predictor had on response variables. Location type (Table 7.7) was significantly related to mean diurnal temperature, mean maximum diurnal temperature, mean diurnal relative humidity, and mean daily temperature range.

Study areas differed significantly for all response variables (Table 7.8). Topock exhibited the highest overall (i.e., diurnal and nocturnal) humidity and highest nocturnal temperatures of all study areas. Diurnal temperatures at Topock were statistically similar to the two other hottest study areas (Mormon Mesa and Mesquite). However, Topock was similar to Pahranagat in that those two study areas exhibited the lowest mean daily temperature range. Pahranagat exhibited the lowest nocturnal humidity, lowest diurnal temperature, and lowest mean minimum nocturnal temperature. Pahranagat and Mormon Mesa exhibited the lowest diurnal humidity.

Habitat types were also significantly different for all response variables (Table 7.9). Native habitats, which were almost synonymous with Pahranagat, exhibited the lowest diurnal and nocturnal temperatures and the lowest mean daily temperature range as compared to exotic or mixed habitats. Exotic habitat, typified by the tamarisk monoculture at Topock, had the highest overall humidity, the highest nocturnal temperatures, and was tied with mixed habitat for the highest diurnal temperatures. Mixed habitats had the highest mean daily temperature range.

Categories of canopy closure differed significantly for mean diurnal temperature, mean maximum diurnal temperature, mean nocturnal relative humidity, and mean daily temperature range (Table 7.10).

Table 7.7. Single effects ANOVA testing location type by response variable for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado Rivers, June–August 2003. Location type values are ± 1 standard deviation (in parenthesis).

Response variables	Location type			F-value	*P*	Significant pairwise differences
	Nest Site	Within Territory	Non-use			
Mean diurnal temperature (°C)	31.0 (±3.4)	31.9 (±2.9)	34.2 (±4.1)	9.8	<0.001	NU>WT>NS
Mean maximum diurnal temperature (°C)	42.6 (±5.0)	44.7 (±5.5)	48.6 (±7.6)	10.4	<0.001	NU>WT>NS
Mean diurnal relative humidity (%)	46.7 (±11.3)	45.1 (±10.9)	38.7 (±11.8)	5.8	0.004	NS>WT>NU
Mean nocturnal temperature (°C)	24.6 (±2.3)	24.6 (±2.3)	24.2 (±2.8)	0.3	0.768	--
Mean minimum nocturnal temperature (°C)	16.6 (±2.6)	16.2 (±2.7)	15.4 (±2.9)	2.1	0.130	--
Mean nocturnal relative humidity (%)	57.2 (±11.2)	57.5 (±11.1)	56.8 (±13.6)	0.1	0.956	--
Mean daily temperature range (°C)	19.4 (±5.0)	21.0 (±5.4)	25.2 (±6.9)	11.1	<0.001	NU>WT>NS

Table 7.8. Single effects ANOVA testing study area by response variable for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado Rivers, June–August 2003. Study area values are ± 1 standard deviation (in parenthesis).

Response variables	Study area				F-value	*P*	Significant pairwise differences
	Pahranagat (PA)	Mesquite (MW)	Mormon Mesa (MM)	Topock (TM)			
Mean diurnal temperature (°C)	28.9 (±2.1)	33.0 (±3.7)	33.3 (±3.1)	33.1 (±3.2)	13.0	<0.001	MM>PA, MW>PA, TM>PA
Mean maximum diurnal temperature (°C)	40.4 (±4.4)	46.4 (±7.0)	47.3 (±4.7)	44.6 (±6.8)	7.7	<0.001	MM>PA, MW>PA
Mean diurnal relative humidity (%)	39.1 (±9.0)	44.5 (±12.0)	38.2 (±8.4)	55.3 (±9.1)	14.6	<0.001	TM>MW, TM>PA, TM>MM, MW>MM
Mean nocturnal temperature (°C)	24.8 (±1.7)	24.1 (±2.0)	23.2 (±3.3)	26.5 (±1.4)	10.2	<0.001	TM>MW, TM>PA, TM>MM, PA>MM
Mean minimum noc-turnal temperature (°C)	15.2 (±2.6)	15.7 (±2.5)	15.7 (±2.7)	18.8 (±1.6)	11.8	<0.001	TM>MW, TM>PA, TM>MM
Mean nocturnal relative humidity (%)	41.6 (±8.8)	61.0 (±9.5)	57.9 (±7.6)	66.7 (±4.5)	47.2	<0.001	TM>MW, TM>PA, TM>MM, MW>PA, MM>PA
Mean daily tempera-ture range (°C)	17.6 (±3.6)	23.5 (±6.5)	24.8 (±4.4)	18.3 (±6.0)	13.3	<0.001	MM>TM, MM>PA, MW>PA, MW>TM

Table 7.9. Single effects ANOVA testing habitat type by response variable for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado Rivers, June-August 2003. Habitat type values are ± 1 standard deviation (in parenthesis).

Response variables	Habitat type			F-value	*P*	Significant pairwise differences
	Native (cottonwood or willow)	Exotic (tamarisk)	Mixed (native and exotic)			
Mean diurnal temperature (°C)	30.6 (±3.1)	33.5 (±3.3)	34.0 (±3.3)	16.1	<0.001	Mix>Nat, Tam>Nat
Mean maximum diurnal temperature (°C)	42.9 (±5.8)	45.9 (±6.7)	48.1 (±6.2)	8.8	<0.001	Mix>Nat
Mean diurnal relative humidity (%)	43.3 (±11.3)	51.9 (±11.1)	37.8 (±8.9)	15.0	<0.001	Tam>Nat> Mix
Mean nocturnal temperature (°C)	24.0 (±2.4)	25.7 (±2.0)	24.2 (±2.6)	6.3	0.002	Tam>Mix, Tam>Nat
Mean minimum nocturnal temperature (°C)	15.5 (±2.7)	17.8 (±2.6)	15.9 (±2.3)	8.9	<0.001	Tam>Mix, Tam>Nat
Mean nocturnal relative humidity (%)	53.1 (±13.4)	66.1 (±6.5)	56.6 (±7.7)	15.8	<0.001	Tam>Mix, Tam>Nat
Mean daily temperature range (°C)	20.3 (±5.7)	20.7 (±7.0)	24.8 (±5.2)	7.2	0.001	Mix>Tam, Mix>Nat

Table 7.10. Single effects ANOVA testing canopy closure by response variable for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado Rivers, June–August 2003. Canopy closure values are ± 1 standard deviation (in parenthesis).

Response variables	Canopy closure categories			F-value	*P*	Significant pairwise differences
	< 25%	25-75%	> 75%			
Mean diurnal temperature (°C)	36.5 (±4.4)	32.7 (±3.1)	29.8 (±2.4)	27.7	<0.001	(<25)>(25–75)>(>75)
Mean maximum diurnal temperature (°C)	52.8 (±7.6)	45.8 (±5.9)	41.0 (±3.8)	24.9	<0.001	(<25)>(25–75)>(>75)
Mean diurnal relative humidity (%)	37.9 (±8.4)	44.1 (±12.0)	45.4 (±11.8)	2.3	0.109	--
Mean nocturnal temperature (°C)	24.6 (±2.0)	24.3 (±2.6)	24.7 (±2.2)	0.5	0.638	--
Mean minimum nocturnal temperature (°C)	15.1 (±2.7)	16.3 (±2.7)	16.2 (±2.8)	1.2	0.293	--
Mean nocturnal relative humidity (%)	61.1 (±7.1)	59.2 (±10.3)	52.2 (±14.2)	6.0	0.003	(<25)>(>75), (25–75)>(>75)
Mean daily temperature range (°C)	28.5 (±5.9)	22.5 (±5.6)	17.6 (±4.4)	24.5	<0.001	(<25)>(25–75)>(>75)

MULTIPLE ANOVA MODEL

Location type remained a significant predictor for mean diurnal temperature, mean maximum diurnal temperature, mean diurnal relative humidity, and mean daily temperature range even after adjusting for study area, habitat, and canopy closure (Table 7.11). When significant interaction terms were added to the analysis, location type remained significant for mean diurnal temperature and mean maximum diurnal temperature, but not for mean diurnal relative humidity or mean daily temperature range (Table 7.12).

Because location type as a significant predictor of the above response variables was most likely due to the disproportionately large sample size from Mesquite, the multiple ANOVA analysis was rerun without including any data from that study area. The new analysis remained significant for all response variables, but location type was not a significant predictor (Table 7.13).

The next analysis removed NU sites to make a discrete comparison between only NS and WT sites at all study areas because all the significant differences for the single effects of location type came from NU sites. This multiple ANOVA showed that NS sites remained significant predictors of mean maximum diurnal temperature and mean daily temperature range. However, only mean maximum diurnal temperature remained significant (Table 7.14) when significant interaction terms were added. Across all study areas, mean maximum diurnal temperature at NS sites was 4.0°C cooler than at NU sites and 2.1°C cooler than at WT sites (Table 7.7), although temperature differences by location type differed by study area (Tables 7.3 through 7.6).

Table 7.11. Single effects (without interaction terms) multiple ANOVA for location type testing of predictor variables by response variable for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado Rivers, June–August 2003. Canopy closure categories=percentages.

Response variables	F-value for overall model	*P* for overall model	R^2 (%)	F-value for location type	*P* for location type (Type III SS)	Other significant predictors	Significant pairwise differences
Mean diurnal temperature (°C)	12.2	<0.001	47.3	5.1	0.008	Habitat, Canopy closure	NU>NS, Mix>Nat, (<25)>(25–75)>(>75)
Mean maximum diurnal temperature (°C)	9.0	<0.001	40.0	5.1	0.008	Canopy closure	NU>NS, (<25)>(25–75)>(>75)
Mean diurnal relative humidity (%)	10.2	<0.001	43.0	6.7	0.002	Study area, Habitat	NS>NU, WT>NU, MW>MM, TM>MM, MW>PA, TM>PA, Nat>Mix
Mean nocturnal temperature (°C)	4.1	<0.001	23.3	1.1	0.354	Study area	PA>MM, TM>MM
Mean minimum nocturnal temperature (°C)	4.9	<0.001	26.3	1.7	0.188	Study area	TM>MM, TM>MW, TM>PA
Mean nocturnal relative humidity (%)	17.9	<0.001	57.0	0.7	0.484	Study area, Habitat	MM>PA, MW>PA, TM>PA, Mix>Nat, Tam>Mix
Mean daily temperature range (°C)	12.2	<0.001	47.4	7.5	<0.001	Study area, Canopy closure	NU>NS, NU>WT, MM>PA, MM>TM, MW>TM, (<25)>(25–75), (<25)>(>75)

Table 7.12. Single effects (with significant interaction terms) multiple ANOVA for location type testing of predictor variables by response variable for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado Rivers, June–August 2003. Canopy closure categories=percentages.

Response variables	F-value for overall model	*P* for overall model	R^2 (%)	F-value for location type	*P* for location type (Type III SS)	Other significant predictors in reduced model	Significant pairwise differences
Mean diurnal temperature (°C)	10.6	<0.001	51.6	3.7	0.028	Study area, Canopy closure, Habitat * Study area	MM>PA, MW>PA
Mean maximum diurnal temperature (°C)	9.0	<0.001	40.0	5.1	0.008	Canopy closure	NU>NS, (<25)>(25–75), (<25)>(>75)
Mean diurnal relative humidity (%)	8.9	<0.001	47.2	2.7	0.070	Study area, Habitat, Habitat * Canopy closure	MW>MM, TM>MM, MW>PA, TM>PA, Nat>Mix, Tam>Mix
Mean nocturnal temperature (°C)	4.1	<0.001	23.3	1.1	0.354	Study area	TM>MM, PA>MM
Mean minimum nocturnal temperature (°C)	4.9	<0.001	26.3	1.7	0.188	Study area	TM>MM, TM>MW, TM>PA
Mean nocturnal relative humidity (%)	8.0	<0.001	71.1	1.6	0.210	Study area, Habitat, Type * Study area * Canopy closure	--
Mean daily temperature range (°C)	5.9	<0.001	59.2	0.0	0.972	Canopy closure, Study area * Canopy closure	--

Table 7.13. Single effects (with significant interaction terms) multiple ANOVA for location type testing of predictor variables by response variable for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado Rivers, June–August 2003. Canopy closure categories=percentages. The Mesquite study area was not included in this analysis.

Response variables	F-value for overall model	*P* for overall model	R^2 (%)	F-value for location type	*P* for location type (Type III SS)	Other significant predictors in reduced model	Significant pairwise differences
Mean diurnal temperature (°C)	10.7	<0.001	60.8	0.5	0.624	Habitat, Canopy closure, Habitat * Study area	MM>PA
Mean maximum diurnal temperature (°C)	7.9	<0.001	47.1	0.2	0.847	Study area, Canopy closure	MM>TM, (<25)>(25–75),(>25)>(>75)
Mean diurnal relative humidity (%)	12.1	<0.001	66.3	0.9	0.408	Study area, Habitat, Canopy closure, Habitat * Canopy closure	TM>MW>PA>MM, Nat>Mix, Tam>Mix, (>75)>(25–75)
Mean nocturnal temperature (°C)	4.1	<0.001	23.3	1.1	0.354	Study area	TM>MM, PA>MM
Mean minimum nocturnal temperature (°C)	4.9	<0.001	35.6	0.4	0.689	Study area	TM>MM, TM>PA
Mean nocturnal relative humidity (%)	12.9	<0.001	83.3	2.7	0.078	Study area, Habitat, Habitat * Canopy closure	--
Mean daily temperature range (°C)	6.5	<0.001	68.8	1.0	0.391	Habitat, Canopy closure, Study area * Canopy closure	--

Table 7.14. Single effects (with significant interaction terms) multiple ANOVA for location type testing of predictor variables by response variable for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado Rivers, June–August 2003. Canopy closure categories=percentages. This analysis did not include NU location type, but did include all study areas.

Response variables	F-value for overall model	*P* for overall model	R^2 (%)	F-value for location type	*P* for location type (Type III SS)	Other significant predictors in full analysis	Significant predictors in reduced analysis
Mean diurnal temperature (°C)	11.5	<0.001	57.3	3.7	0.060	Habitat, Study area * Habitat	--
Mean maximum diurnal temperature (°C)	6.8	<0.001	39.1	5.9	0.017	Study area, Habitat	MM>TM, Mix>Nat, Tam>Nat
Mean diurnal relative humidity (%)	7.3	<0.001	46.7	2.4	0.127	Study area, Habitat, Habitat * Canopy closure	MW>MM, TM>MM, MW>PA, TM>PA, Nat>Mix
Mean nocturnal temperature (°C)	3.6	0.001	25.1	0.0	0.951	--	--
Mean minimum nocturnal temperature (°C)	5.5	<0.001	34.1	0.9	0.335	Study area	TM>MM, TM>MW, TM>PA
Mean nocturnal relative humidity (%)	8.0	<0.001	68.8	1.4	0.236	Study area, Habitat, Habitat * Canopy closure	--
Mean daily temperature range (°C)	4.7	<0.001	52.9	0.1	0.771	Habitat, Canopy closure	--

DISCUSSION

SEASONAL VARIATION

The finding that desertscrub habitat was substantially hotter and drier than riparian habitat was consistent with what would be expected, although it was useful to document the difference for comparative purposes.

DATA COLLECTION AFTER NESTS WERE VACATED

Results from the SV sensor arrays validated our method of initiating data collection immediately after nests were vacated to minimize human disturbance. Only two sets of consecutive weeks outside of the peak of flycatcher nesting season were found to be significantly different in mean

diurnal temperature. However, future studies should revisit this approach to data collection for additional validation.

LOCATION TYPES: DESCRIPTIVE STATISTICS AND SINGLE EFFECTS ANALYSIS

Three of the four study areas showed a significant difference in percent canopy closure between location types, with the NU sites primarily responsible for the difference. This was because NU sites had a significantly greater proportion of sites with less than 25% canopy closure as compared to NS sites. This suggests habitat with greater canopy closure was much less available in the 50–200 m ring (potential NU sites) around nests. This finding is consistent with the vegetation analyses presented in the previous chapter and concurs with results reported by other investigators (Sogge and Marshall 2000, Allison et al. 2003) showing that flycatchers may prefer habitat with dense vegetation that provides a more favorable microclimate.

Diurnal conditions at NS sites were generally cooler and more humid than NU sites, while NU sites tended to be hotter and drier and exhibited lower minimum nocturnal temperatures than NS and WT sites. This difference between NU sites versus NS and WT sites was because many NU sites had canopy closure <25% but no NS or WT sites did. Greater canopy closure tends to moderate microclimate by shading the habitat from short-wave solar radiation during midday, conserving long-wave radiation that would otherwise dissipate into the atmosphere at night, and helping to conserve humidity.

Consultation with the engineers at Onset Computers indicated that incomplete contact between the SM probe and the dense, riparian clay soils may have caused the wide variance in mean SM values, which caused us to drop SM from the multiple ANOVA analyses. In subsequent years other methods will be evaluated to better quantify percent SM in order to include SM as a variable in the final microclimate analyses.

INDIVIDUAL EFFECT OF PREDICTOR VALUES

The four life history study areas differed significantly for all response variables. The differences between Topock (hotter and most humid) and Pahranagat (coolest and least humid) were likely due to their contrasting geographic settings. The Topock study area lies farthest south, is lowest in elevation, and is surrounded by an extensive complex of inundated wetlands. Pahranagat is located farthest north, is highest in elevation, and is surrounded by comparatively small wetlands and a relatively deep lake. Extreme differences in habitat type between the two areas may also affect local microclimate. Topock comprises of very dense, monotypic tamarisk of relatively low stature, while Pahranagat consists of native riparian forest exhibiting the highest mean canopy height of all the study areas (see previous chapter).

Percent canopy closure differed significantly for mean diurnal temperature, maximum diurnal temperature, nocturnal relative humidity, and daily temperature range. Sites with greater than 75% canopy closure were responsible for most of the difference because they exhibited the lowest diurnal temperatures, the highest nocturnal relative humidity, and the lowest mean daily temperature range. As discussed above, greater canopy closure moderates overall temperature fluctuations.

MULTIPLE ANOVA

In summary, our findings indicate that Southwestern Willow Flycatchers prefer habitats exhibiting the lowest mean maximum diurnal temperatures for nest placement (i.e., the coolest locales). To a lesser extent, flycatchers also selected microclimates within their territories exhibiting the lowest mean diurnal temperature for nest placement (i.e., locales with the most thermally moderate microclimate). NU sites tended to exhibit less canopy closure, were hotter and drier during daytime, and had a greater mean daily temperature range (i.e., were less thermally stable) than either nest (NS) or territory (WT) locales. These characteristics may have been partially responsible for the absence of nesting flycatchers in adjacent NU habitat because pairs attempting to nest there may have to expend more energy on thermoregulation for themselves and for their nest contents, an expenditure that would theoretically reduce fitness.

COMPARISON WITH OTHER FINDINGS

Allison et al. (2003) reported that habitat within Southwestern Willow Flycatcher nesting territories exhibited greater canopy closure than non-nesting plots in Arizona, a relationship they suggested might provide a more favorable (i.e., more moderate) microclimate at nests. Our finding that NS and WT sites had greater canopy closure than NU sites was consistent with Allison et al. (2003). Our vegetation findings (see previous chapter) parallel this, in that canopy closure was greater at NS than NU sites.

At the four life history study areas, McKernan and Braden (2001a, 2001b) reported that mean daily temperature range (they used the term "variation in temperature") was significantly greater at NU sites than either NS or WT sites, but that NS and WT sites were similar. However, their difference between NU and NS sites was small, which was apparently the reason they discounted the difference as biologically insignificant and reported the following: "Selection of nest sites or territories by the…flycatcher was not found to be affected by specific requirements in temperature, relative humidity, or stability in these microclimate variables. Therefore, the microclimate variables are unlikely to limit habitat suitability for the species" (McKernan and Braden 2001b:78). They also reported that "…microclimate variables between native and non-native habitat types, under the same hydrological conditions, do not limit habitat suitability for the …flycatcher" (McKernan and Braden 1999:58, McKernan and Braden 2001b:81).

Our single effects analysis indicated a significantly greater mean daily temperature range at NU compared to NS sites (similar to that of McKernan and Braden 2001b), although we also detected greater mean daily temperature range at WT than at NS sites. However, after adjusting for study area, habitat, and canopy closure, and after significant interaction terms were included in our final multiple ANOVA analysis, mean maximum diurnal temperature was the only response variable that significantly predicted location type.

In addition, we suggest the differences among our mean maximum diurnal temperatures at the three location types, although small, appear to be biologically meaningful since they paralleled significant vegetative differences identified in the previous chapter and reported by Allison et al. (2003). Therefore, we propose that microclimate (in a complex interaction with habitat type, vegetative structure, and perhaps other factors) appears likely to limit nesting habitat suitability.

This key difference between our findings and those of McKernan and Braden (2001b) should be interpreted with caution as we were unable to replicate their field methods, and we used a different approach to statistical analysis. Additional microclimate data collected in subsequent years will show whether the patterns observed in 2003 are consistent across years and will help clarify whether suitable nesting habitat for willow flycatchers is limited by microclimate.

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