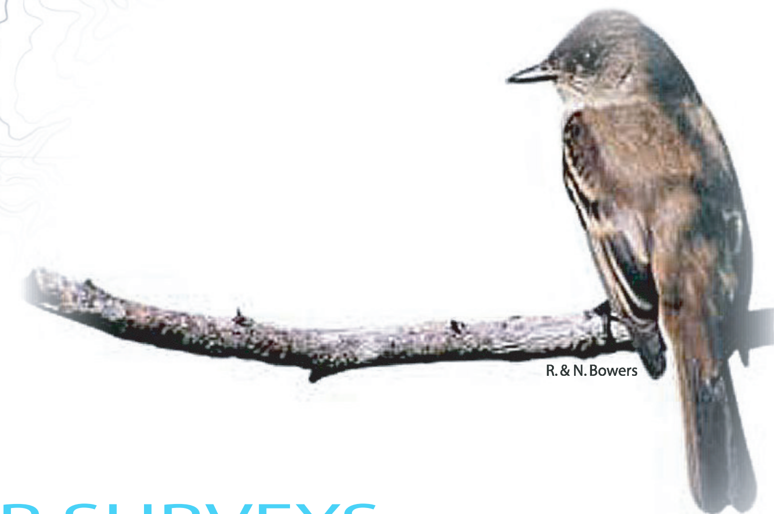
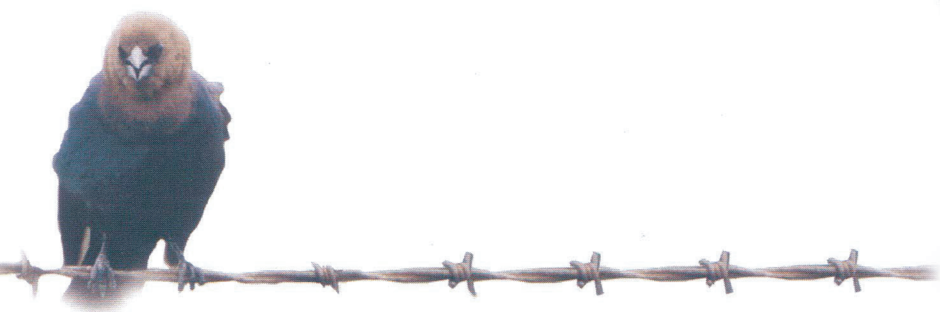

R. & N. Bowers

SOUTHWESTERN WILLOW FLYCATCHER SURVEYS, DEMOGRAPHY, AND ECOLOGY ALONG THE LOWER COLORADO RIVER AND TRIBUTARIES, 2005

Contract No. 03-CS-30-0093



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Lower Colorado Region
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February 2006


Bureau of Reclamation

SOUTHWESTERN WILLOW FLYCATCHER SURVEYS, DEMOGRAPHY, AND ECOLOGY ALONG THE LOWER COLORADO RIVER AND TRIBUTARIES, 2005

Contract # 03-CS-30-0093

Annual Report

Submitted to

U.S. BUREAU OF RECLAMATION
Lower Colorado Region
500 Fir Street
Boulder City, Nevada 89005

Submitted by

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February 27, 2006

RECOMMENDED CITATION:

Koronkiewicz, T.J., M.A. McLeod, B.T. Brown, and S.W. Carothers. 2006. Southwestern Willow Flycatcher surveys, demography, and ecology along the lower Colorado River and tributaries, 2005. Annual report submitted to U.S. Bureau of Reclamation, Boulder City, NV by SWCA Environmental Consultants, Flagstaff, AZ. 176 pp.

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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 of riparian habitat 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 (USFWS) regarding U.S. Bureau of Reclamation (Reclamation) routine operations and maintenance along the lower Colorado River. Biological Assessments and the resulting Biological Opinions on operations and maintenance were prepared as steps to developing a Multi-Species Conservation Program (MSCP) for long-term endangered species compliance and management in the historical floodplain of the lower Colorado River. The MSCP calls for continued surveys and monitoring of willow flycatchers along the lower Colorado River. The MSCP was signed in April 2005, and implementation of the program began in October 2005.

Reclamation and USFWS completed a separate consultation on the potential effects to threatened and endangered species from implementation of surplus guidelines through 2016 and an annual change in the point of diversion for up to 400,000 acre-feet of California apportionment water for 75 years. The point of diversion, previously located below Parker Dam, will change to a point above Parker Dam, and there will be no return flow to the Colorado River below Parker Dam. These changes in water regulation could cause a drop in floodplain groundwater levels of 1.55 feet (0.47 m) or less and have the potential to modify riparian habitats below Parker Dam. A Biological Opinion for Interim Surplus Criteria, Secretarial Implementation Agreements, and Conservation Measures was issued in January 2001 and required monitoring of 150.5 ha of existing, occupied southwestern willow flycatcher habitat between Parker and Imperial Dams. In 2004, Reclamation biologists initiated studies of the microclimate within potentially affected areas. In 2005, these studies were continued and expanded by SWCA Environmental Consultants (SWCA) to address how the hydrological changes might affect riparian habitats along the Parker to Imperial reach.

From 1997 to 2004, breeding populations of Southwestern Willow Flycatchers were documented along the Virgin and lower Colorado Rivers and tributaries at eight study areas from Mesquite, Nevada, south to the Bill Williams River in Arizona. Willow flycatchers also have been detected during the breeding season at several sites along the Colorado River south of the Bill Williams River to the Mexico border, with over 200 detections recorded in 2003 and over 600 in 2004. Behavioral observations and timing of detections strongly suggest this section of the river corridor is a major flyway for migrant willow flycatchers in spring. The degree to which Southwestern Willow Flycatchers use this riparian corridor is unknown and requires further study.

SWCA was contracted by 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 2005. We completed presence/absence surveys and site descriptions at 98 pre-selected sites in 15 study areas from the Pahranagat National Wildlife Refuge (NWR), Nevada, south to Yuma, Arizona. We also conducted intensive life history studies at 4 of the 15 areas: Pahranagat NWR, Mesquite, and Mormon Mesa, Nevada, and Topock Marsh, Arizona. At these life history study areas, we monitored willow flycatcher nests to document depredation 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 recorded broadcasts of willow flycatcher song and calls to elicit responses from willow flycatchers at 98 sites, ranging in size from 1 to 68 ha, along the Virgin and lower Colorado Rivers and tributaries between 15 May and 25 July 2005, following a 10-survey protocol. We detected willow flycatchers on at least one occasion at 61 of these sites. Resident, breeding flycatchers were detected at 15 sites within the following six study areas: Pahranagat NWR, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams. South of Bill Williams, over 300 willow flycatchers were recorded between 14 May and 18 June; other than a single detection at one site on 6 July, no flycatcher detections were recorded at any sites south of Bill Williams after 20 June. Monitoring results suggest these flycatchers were not resident, breeding individuals and were most likely migrants.

We used targeted mist-net and passive netting techniques to capture and uniquely color-band adult and fledgling willow flycatchers at the four life history study areas and at all survey sites where resident willow flycatchers were detected. Nestlings were banded between 8 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, 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 combinations on their legs.

At the four life history study areas and at Littlefield, Muddy River, Grand Canyon, and Bill Williams (all monitoring sites), we color-banded 31 new adult flycatchers and recaptured 25 individuals banded in previous years, including 11 flycatchers banded as juveniles in previous years. An additional 44 previously banded flycatchers were resighted, of which 30 could be identified to individual and 8 were banded as juveniles in 2003 or 2004 but could not be recaptured to determine origin and identity. We banded 56 nestlings from 25 nests. In addition, we recaptured one fledgling that had been banded as a nestling, and captured seven previously unbanded fledglings. We banded flycatchers opportunistically at Key Pittman Wildlife Management Area, capturing and color-banding one new adult and four nestlings from one nest.

For the third consecutive year, we conducted color-banding studies from 10–30 June along the lower Colorado River downstream of Parker Dam to better determine flycatcher residency, breeding status, and movement patterns in this area. We recorded 28 willow flycatcher detections at nine sites along the Colorado River from Hoge Ranch south to Hunter's Hole, and along the Gila River near Yuma. All these detections were recorded from 10 to 20 June. From 10 to 17 June at three sites, field personnel captured and color-banded nine new adults, of which four were second-year birds. None of the color-banded individuals were detected post-capture, and other than a single detection at one site on 6 July, no flycatcher detections were recorded at any sites south of Bill Williams after 20 June, suggesting these individuals were northbound migrants.

On 17 May, a Southwestern Willow Flycatcher banded as a nestling in 2003 or 2004 was resighted at River Mile 33, and was not detected during subsequent visits through the end of July. Because we were unable to recapture this individual, its identity could not be determined. It is likely this individual was a northbound migrant.

At the four life history study areas and at Littlefield, Muddy River, Grand Canyon, and Bill Williams we recorded a total of 73 territories. Of these, 49 (67%) consisted of paired flycatchers and 24 (33%) consisted of unpaired individuals. Five breeding males were polygynous; four were paired with two females and one was paired with three females.

Of the 108 adult willow flycatchers identified to individual in 2004, 42 (39%) returned in 2005; 5 (12%) were detected at a different study area from where they were detected in 2004. We detected two within-year, between-study-area movements in 2005; one male moved from Littlefield to Mesquite, and another male moved from Mesquite to Mormon Mesa.

Of 82 juveniles banded in 2004 that were known to have fledged, 4 (5%) were recaptured and identified in 2005. Of these, one was detected at a different study area from where originally banded, and three were detected at the same study area. Six nestlings at Key Pittman WMA were banded in 2004, of which one was recaptured at Pahranagat in 2005. Three individuals originally banded as nestlings in 2003 and one banded in 2002 were also recaptured, all of which returned to the same study where originally banded. We also recaptured two individuals originally banded as nestlings in 2003 at Roosevelt Lake, Arizona. The median dispersal distance for all returning juvenile flycatchers exhibiting between-year movements in 2005 was 193 km.

We documented a total of 88 willow flycatcher nesting attempts at the four life history study areas, Muddy River, and Bill Williams, 81 of which contained eggs and were used in calculating nest success and productivity. Twenty-nine (36%) nests were successful and fledged young; 48 (59%) failed; and four were of undetermined fate. Mayfield survival probability at the four life history study areas, Muddy River, and Bill Williams ranged from 0.21 to 1.00 and was 0.37 for all sites combined. Depredation was the major cause of nest failure, accounting for 64% of all failed nests and 73% of nests that failed after flycatcher eggs were laid.

Twenty-six of 81 nests (32%) with flycatcher eggs were brood parasitized by Brown-headed Cowbirds. Brood parasitism at all sites ranged from 0 to 75% and was highest at Muddy River Delta. We observed the third consecutive year of no brood parasitism at Pahranagat. Nests that contained flycatcher eggs and were brood parasitized were less likely to fledge flycatcher young than nests that were not parasitized.

For the third consecutive year, we used a modification of the Australian crow trap to capture and remove Brown-headed Cowbirds at each of the four life history study areas. We replaced one of two traps at Pahranagat, one of three at Mesquite, and three of six at Topock with a different design to test the relative efficacy of the two styles of trap. At Topock, the locations of the new and old traps were exchanged half way through the season to control for location effects when evaluating trapping success of the different designs.

We captured and removed 56, 61, 5, and 244 Brown-headed Cowbirds at Pahranagat, Mesquite, Mormon Mesa, and Topock, respectively. Overall, the new traps had a significantly higher daily capture rate per trap-day than the old traps, and the ratio of the new to old trap capture rates varied depending on trap location. The escape rate of cowbirds was also significantly lower with the new trap design than with the old. The greater variety of non-target species captured in 2005 is likely the result of use of the new style trap, which captured more non-target individuals as well as cowbirds. The capture of non-target species is of concern but has been found to be unavoidable.

The proportion of flycatcher nests parasitized during the pretrapping (1997–2002) and trapping (2003–2005) periods shows no significant difference at any of the four study areas. Although statistical analysis did not reveal a decrease in brood parasitism at Pahranagat, no brood parasitism was recorded at Pahranagat in 2003–2005. At Mesquite and Mormon Mesa, brood parasitism continues to remain high, with 28.6 and 33.3% recorded in 2005, respectively. Brood parasitism at Topock (51.4%) was the highest recorded since monitoring was initiated in 1997.

We gathered data on vegetation and habitat characteristics at 79 nest plots, 69 non-use plots, and 43 within-territory plots within the four life history study areas and Muddy River. To obtain an overall description of entire habitat blocks at each life history study area, we gathered data at an additional 42 randomly selected plots. The life history study areas vary in vegetation age, 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 ranged from 1.3 to 10.0 m (mean = 3.4 m, SE = 0.2). Flycatchers placed 67% of all nests in tamarisk (*Tamarix* sp.), 6% in coyote willow (*Salix exigua*), 20% in Goodding willow (*Salix gooddingii*), 3% in Fremont cottonwood (*Populus fremontii*), and 4% in snags. 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 at Pahranagat, Mesquite, and Topock. 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. Breeding riparian birds in the desert Southwest are exposed to extreme environmental conditions, and dense vegetation at the nest may be needed to provide a more suitable microclimate for raising offspring.

We collected microclimate data simultaneously at nest, within-territory, and non-use sites at the four life history study areas and Muddy River between May and July 2005. The microclimate assessment indicated that Southwestern Willow Flycatchers placed their nests in habitats that were cooler, exhibited smaller temperature fluctuations, were more humid, and had higher soil moisture than non-use sites. To a lesser extent, flycatchers also placed nests within their territories at sites exhibiting smaller temperature fluctuations.

We selected 11 sites between Parker and Imperial Dams for inclusion in the habitat monitoring study addressing how changes in water transfer actions might affect riparian habitat. We also selected two control sites above Parker Dam and two below Imperial Dam. At each site we installed 3–5 temperature/humidity data loggers and one groundwater observation well (piezometer). Soil moisture measurements were collected at each data logger location during each of approximately 10 flycatcher surveys between 15 May and 25 July. Vegetation measurements were also collected at each data logger location after surveys were completed.

Preliminary analyses of groundwater data indicate a strong correlation between piezometer water levels and releases from Parker Dam. Data did not show a correlation between piezometer water level and either temperature or absolute humidity within the habitat monitoring sites. All microclimate parameters except for mean nocturnal temperature were significantly different between Topock Marsh and the habitat monitoring sites. Topock was cooler, and exhibited higher diurnal/nocturnal relative humidity, diurnal/nocturnal vapor pressure, and soil moisture than habitat monitoring sites. However, Mormon Mesa, where flycatchers are known to nest, had higher mean diurnal temperatures than the habitat monitoring areas. This suggests that high diurnal temperatures alone may not have been responsible for the absence of known flycatcher nests in 2005 at the habitat monitoring sites.

CHAPTER 1

INTRODUCTION

PROJECT HISTORY

In 1995, the U.S. Bureau of Reclamation (Reclamation), other federal, state, and tribal agencies, and environmental and recreational interests agreed to form a partnership to develop and implement a Multi-Species Conservation Program (MSCP) for long-term endangered species compliance and management in the historical floodplain of the lower Colorado River. As a step to developing the MSCP, Reclamation prepared a Biological Assessment (BA) in August 1996, evaluating the effects of dam operations and maintenance activities on threatened, endangered, and sensitive (TES) species. These species included the Southwestern Willow Flycatcher (*Empidonax traillii 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 (BO) in April 1997 outlining several terms and conditions Reclamation 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 2002, Reclamation reinitiated consultation with USFWS on the effects of continued dam operations and maintenance on TES species along the lower Colorado River. The USFWS responded with a BO in April 2002 requiring continued Southwestern Willow Flycatcher studies along the lower Colorado River through April 2005. The BO also required implementation of a study to evaluate the effectiveness of Brown-headed Cowbird trapping for conservation of the flycatcher.

Reclamation and USFWS completed a separate consultation on the potential effects to threatened and endangered species from implementation of surplus guidelines through 2016 and an annual change in the point of diversion for up to 400,000 acre-feet for 75 years. A Biological Opinion for Interim Surplus Criteria, Secretarial Implementation Agreements, and Conservation Measures was issued in January 2001 and required monitoring of 150.5 ha of existing, occupied Southwestern Willow Flycatcher habitat between Parker and Imperial Dams.

The MSCP is a 50-year program that seeks to protect 26 TES species and their habitats along the lower Colorado River while maintaining river regulation and water management required by law. The MSCP was approved in April 2005 with the signing of a Record of Decision by the Secretary of the Department of the Interior, and implementation of the program began in October 2005. Documentation for the MSCP includes a Habitat Conservation Plan (HCP), BA/BO, and an Environmental Impact Statement. The HCP specifies monitoring and research measures that call for surveys and research to better define habitat requirements for the Southwestern Willow Flycatcher and studies to determine the effects of cowbird nest parasitism on flycatcher reproduction.

Reclamation initiated willow flycatcher studies along the lower Colorado River in 1996, in anticipation of the requirements outlined in the BOs that were part of MSCP development. These studies have been conducted annually since 1996. In compliance with the consultation on Interim Surplus Criteria and Secretarial Implementation Agreements, Reclamation biologists deployed temperature/humidity data loggers in 2004 at a subset of sites currently monitored for Southwestern Willow Flycatcher along the Colorado River in California and Arizona. These studies were expanded in 2005 to include monitoring of groundwater levels, vegetation, and soil moisture in addition to temperature and humidity.

Willow flycatcher and habitat monitoring studies along the lower Colorado River are anticipated to continue through 2007 under the current contract.[1] Willow flycatcher studies of similar scope are anticipated to continue beyond 2007 under a new contract (Reclamation 2005a).

SPECIES INTRODUCTION

The Southwestern Willow Flycatcher 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).

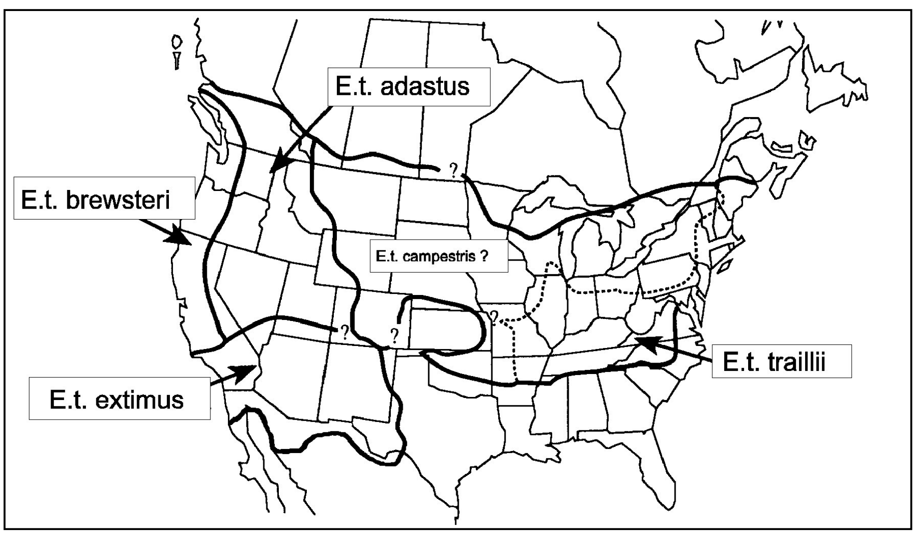

Figure 1.1. Breeding range distribution of the subspecies of the willow flycatcher (*Empidonax traillii*). Adapted from Unitt (1987), Browning (1993), and Sogge et al. (1997).

[1] From 1996 through 2002, Reclamation'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. From 2003 to 2005, these studies were continued by SWCA Environmental Consultants under contract to Reclamation. This contract has annual option years through 2007. Habitat monitoring studies between Parker and Imperial Dams were conducted by SWCA in 2005, with option years through 2007 (Contract # 03-CS-30-0093).

In the Southwest, most willow flycatcher breeding territories are found within small breeding sites containing five or fewer territories (Sogge et al. 2003). One of the last long-distance Neotropical migrants to arrive in North America in spring, Southwestern Willow Flycatchers have a short, approximately 100-day breeding season, with individuals typically arriving in May or June and departing in August (Sogge et al. 1997). All four subspecies of willow flycatchers spend the non-breeding season in portions of southern Mexico, Central America, and northwestern South America (Stiles and Skutch 1989, Ridgely and Tudor 1994, Howell and Webb 1995, Unitt 1997), with wintering ground habitat similar to the breeding grounds (Lynn et al. 2003). 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).

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 and Braden 2002, Koronkiewicz et al. 2004, McLeod et al. 2005, this document). Factors contributing to the decline of flycatchers on the breeding grounds include loss, degradation, and/or fragmentation of riparian habitat; invasion of riparian habitat 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 2004,[2] breeding populations of Southwestern Willow Flycatchers were documented at eight study areas along the Virgin and lower Colorado Rivers and tributaries: (1) Pahranagat National Wildlife Refuge (NWR), Nevada; (2) Beaver Dam Wash/Virgin River confluence at Littlefield, Arizona; (3) Mesquite and (4) Mormon Mesa on the Virgin River, Nevada; (5) Overton Wildlife Management Area along the Muddy River, Nevada; (6) Grand Canyon, Arizona; (7) Topock Marsh on the Colorado River, Havasu NWR, Arizona; and (8) Bill Williams River NWR (hereafter Bill Williams), Arizona (McKernan and Braden 2002; Koronkiewicz et al. 2004; McLeod et al. 2005; Braden and McKernan, unpubl. data). 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 no nesting activity was confirmed.

PURPOSE AND DESCRIPTION OF STUDY

The purpose of the 2005 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 three 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; (2) intensive, long-term life history studies at four

[2] Studies in 1996 did not include any sites in Nevada.

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; and (3) monitoring of microclimate, vegetation, and groundwater conditions of currently occupied[3] Southwestern Willow Flycatcher habitat between Parker and Imperial Dams. SWCA's contract specifies the following field tasks:

(1) **Presence/absence Surveys**: At approximately 136 sites[4] 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;
- (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.

(3) **Habitat Monitoring**: At 150.5 ha of currently occupied Southwestern Willow Flycatcher habitat between Parker and Imperial Dams complete the following:

- (a) at sites equating to at least 75.3 ha each on the California and Arizona sides of the Colorado River, monitor microclimate, vegetation, and groundwater conditions within and under habitat stands to determine the effects of water transfer actions at Parker Dam;
- (b) at four control sites, two above Parker Dam and two below Imperial Dam, monitor microclimate, vegetation, and groundwater conditions within and under habitat stands

[3] As per Reclamation (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 in any year.

[4] A site is defined as one contiguous area that can be surveyed by one person in one morning. The contract specifies 136 survey sites; however, this number reflects studies performed before 2003 in which several areas were counted as multiple sites. In 2005, 98 sites were surveyed as described in the results section of Chapter 2 of this report.

to distinguish any changes in microclimate, groundwater, or vegetation caused by water transfer actions from those caused by fluctuations in climate or rainfall; and

(c) conduct a detailed analysis consisting of a comparison and correlation of microclimate, vegetation, and groundwater levels within years, among sites, and with Southwestern Willow Flycatcher life history sites.

Each distinct aspect of the 2005 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 2005 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 8 – Habitat Monitoring. The methodology and results of monitoring microclimate, vegetation, and groundwater conditions at occupied sites between Parker and Imperial Dams 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, because 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.[1] 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 because spring is the only time that migrant 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 unpubl. 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 2005, we completed multiple broadcast surveys at sites in 15 study areas[2] along the lower Colorado River and its tributaries to detect both migrant and resident willow flycatchers (Figure 2.1).

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[1] 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.

[2] Study areas consist of 1–19 survey sites that are grouped geographically (see Table 2.1). Four of these study areas are also life history areas.

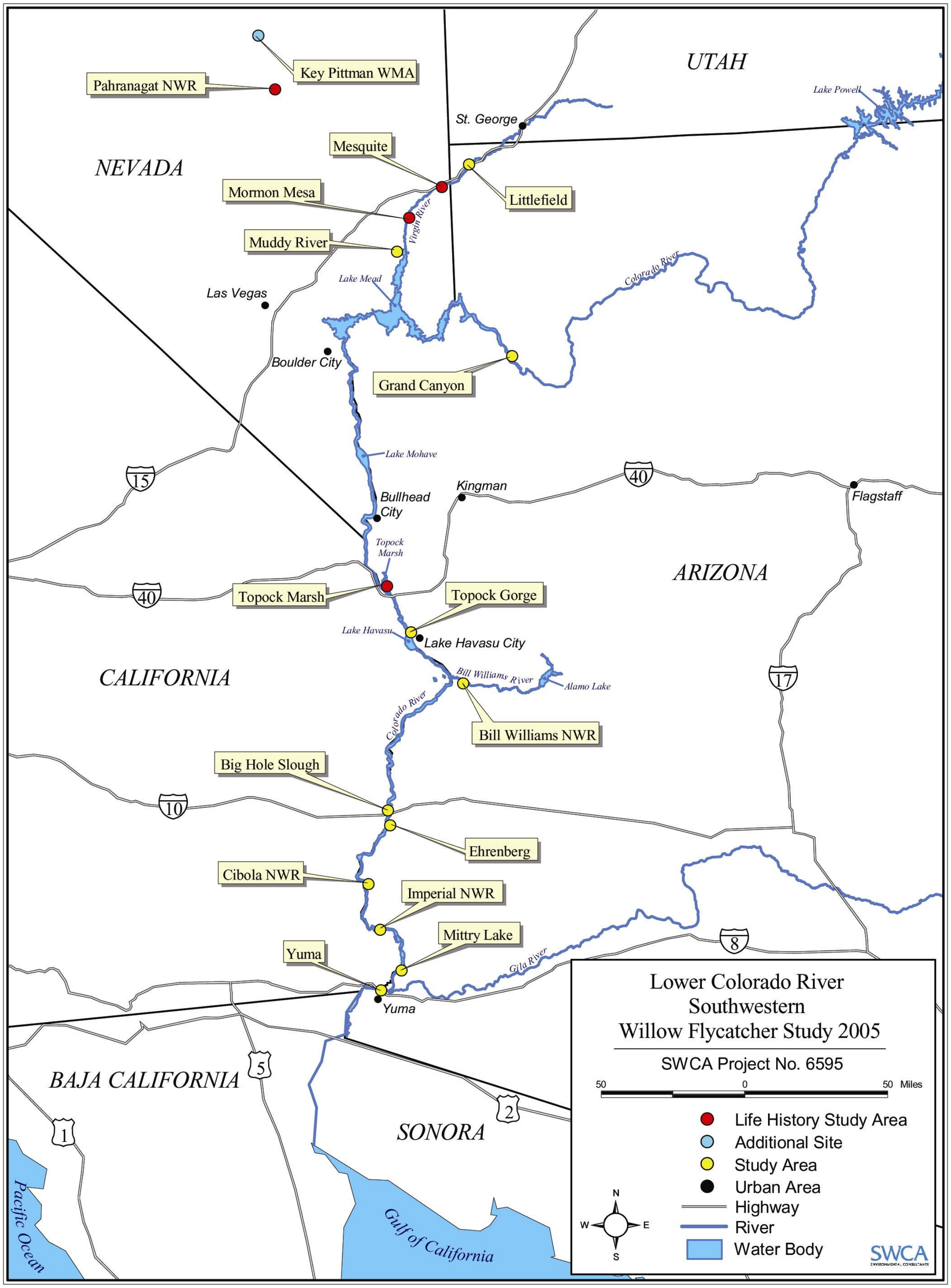

Figure 2.1. Locations of Southwestern Willow Flycatcher study areas along the lower Colorado River and tributaries, 2005. (Note, study area labels represent the approximate center of multiple sites within that region; see Table 2.1)

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; Koronkiewicz et al. 2004; McLeod et al. 2005) and reconnaissance by helicopter, by boat, and on foot prior to the start of the 2005 survey period. Reclamation biologists Theresa Olson and John Swett guided and approved site selection. For sites 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 83) 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 83 using a Garmin Rino 110 GPS unit. All UTM coordinates in this report are presented in NAD 83 to comply with Federal Geographic Data Committee standards.

BROADCAST SURVEYS

To elicit responses from nearby willow flycatchers, we broadcast conspecific vocalizations previously recorded throughout the Southwest from 1996 to 1998. All flycatcher surveys were conducted according to methods described in Sogge et al. (1997), and we followed a modification of the 10-survey protocol proposed by Braden and McKernan (1998). We completed at least two surveys between 15 and 30 May, at least two surveys between 1 and 15 June, and six 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 (*breets*). 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*, *whitts*, *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 1,295 observer-hours conducting willow flycatcher broadcast surveys at 98 sites along the Virgin and lower Colorado Rivers and tributaries.[3,4] Willow flycatcher survey results are summarized in Table 2.1 and are presented below along with site descriptions. The boundaries of survey sites and occupancy in 2005 are shown on orthophotos in Appendix B, along with historically occupied habitat.[5] Each site that was not occupied by territorial flycatchers was formally surveyed between 4 and 11 times. In cases where sites were surveyed fewer than 10 times, logistical constraints (e.g., high water, locked gates, and disabled vehicles) prevented access for a portion of the survey season. 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 (Sogge et al. 1997, USFWS 2002), flycatcher detections after 15 June at sites where breeding or residency were not confirmed 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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[3] 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 2005 differed little from previous years.

[4] We started the 2005 survey season with 98 survey sites. Surveys at one site were discontinued immediately because of poor habitat quality. Surveys at two other sites were discontinued later in the season; one because of loss of habitat to flooding and one because of the lack of landowner permission. One additional site at Mormon Mesa was surveyed opportunistically.

[5] As per Reclamation (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, 2005

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
PAHR	North	4.5	30 (10 May–1 August)
	West	0.6	1 (9 June)
	South	2.4	5 (10 May–10 August)
	Salt Cedar	3.1	ND
LIFI	North	4.7	2 (15 May)
	South	1.6	ND
MESQ	East	3.8	1 (3–24 June)
	West	13.8	12 (8 May–12 August)
	Bunker Farm	3.1	6 (1 June–24 August)
MOME	Mormon Mesa North	13.5	4 (14 May–15 July)
	Hedgerow	1.3	ND
	Mormon Mesa South	23.9	ND
	Virgin River #1	50.5	2 (16 May–14 June)
	Virgin River #2	38.2	7 (31 May–10 August)
	Delta West[4]	12.2	1 (14–30 May)
MUDD	Overton WMA	13.0	12 (8 June–11 August)
GRCA	Separation Canyon	5.3	ND
	RM 243S	1.8	ND
	Spencer Canyon	5.0	ND
	Surprise Canyon	4.9	ND
	Clay Tank Canyon	0.4	ND
	No WIFL Point	1.2	ND
	No WIFL Bay	1.1	ND
	Reference Point Creek	4.2	ND
	RM 257.5N	1.2	ND
	Burnt Springs	11.0	ND
	Quartermaster Canyon	3.3	ND
	Columbine Falls	6.3	ND
	RM 274.5N	10.4	1 (1–20 June)
TOPO	Pipes #1	5.2	1 (18 May), 1(6 July)
	Pipes #2	2.8	ND
	Pipes #3	5.7	2 (13 May–5 July)
	PC6-1	4.8	3 (19 May–5 July)
	The Wallows[5]	0.4	1 (15–29 June)
	PB 2001	2.1	ND
	Pig Hole	2.4	ND
	In Between	7.7	10 (5 May–3 August)
	800M	6.1	6 (27 May–13 August)
	Pierced Egg	6.7	8 (5 May–28 July)
	Swine Paradise	3.7	ND
	Barbed Wire	2.6	ND
	IRFB03	1.0	ND
	IRFB04	1.5	ND
	Platform	1.3	ND

Table 2.1. Willow Flycatcher Detections along the Virgin and Colorado Rivers and Tributaries, 2005, continued

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
TOPO	250M	2.3	2 (26 May–24 July)
	Hell Bird	3.7	ND
	Glory Hole	3.8	5 (12 May–16 August)
	Lost Lake	9.1	ND
TOGO	Pulpit Rock	1.8	ND
	Picture Rock	5.5	2 (24 May)
	Blankenship Bend North	26.7	ND
	Blankenship Bend South	25.9	ND
	Havasu NE	12.6	ND
BIWI	Site #1	2.8	1 (7 June)
	Site #2	3.1	ND
	Site #11	6.3	ND
	Site #4	9.9	2 (18 May–20 July)
	Site #3	7.7	4 (18 May–29 July)
	Site #5	5.3	ND
	Mineral Wash Complex	18.8	1 (23 June)
	Beaver Pond	21.7	ND
	Site #8	10.3	1 (17 May)
BIHO	Big Hole Slough	16.5	1 (23 May), 2 (3 June), 1 (7 June), 1 (18 June)
EHRE	Ehrenberg	4.7	2 (20 May), 1 (3 June), 1 (7 June)
CIBO	Cibola Site 2	16.4	7 (25 May), 1 (5 June)
	Cibola Site 1	7.7	1 (25 May), 4 (5 June)
	Hart Mine Marsh	31.6	5 (25 May), 2 (5 June)
	Three Fingers Lake	67.9	14 (24 May), 3 (6 June), 1 (17 June)
	Cibola Lake #1 (North)	8.5	1 (23 May)
	Cibola Lake #2 (East)	4.5	ND
	Cibola Lake #3 (West)	7.0	1 (23 May), 2 (8 June)
	Walker Lake	11.4	1 (6 July)
IMPE	Paradise	7.8	10 (17 May), 7 (2 June), 22 (8 June), 1 (16 June)
	Hoge Ranch	20.7	7 (18 May), 10 (25 May), 5 (1 June), 8 (7 June), 1 (15 June)
	Adobe Lake	7.6	20 (17 May), 7 (25 May), 3 (1 June), 9 (7 June), 1 (15 June), 1 (20 June)
	Rattlesnake	7.6	1 (20 May), 4 (25 May)
	Norton South	1.2	1 (4 June)
	Picacho NW	8.8	1 (13 May), 1 (19 May), 1 (26 May), 5 (4 June), 2 (17 June)
	Milemarker 65	10.0	4 (18 May), 3 (24 May), 2 (4 June)
	Clear Lake/The Alley	8.3	ND
	Imperial Nursery	1.4	1 (14 May), 2 (19 May)
	Ferguson Lake	26.0	2 (14 May), 1 (22 May), 13 (31 May), 2 (5 June)
	Ferguson Wash	6.8	1 (14 May, 1 (21 May), 6 (31 May), 2 (5 June)
	Great Blue Heron	7.1	2 (14 May), 3 (20 May), 5 (26 May), 2 (9 June), 2 (10 June), 2 (11 June), 2 (18 June)
	Powerline	2.0	1 (19 May), 1 (4 June)
	Martinez Lake	4.6	2 (26 May), 1 (3 June)

Table 2.1. Willow Flycatcher Detections along the Virgin and Colorado Rivers and Tributaries, 2005, continued

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
MITT	Mittry West	4.4	4 (19 May), 1 (22 May), 1 (6 June)
	Mittry South	13.8	4 (18 May), 1 (31 May), 1 (6 June)
	Potholes East	2.0	1 (6 June)
	Potholes West	6.6	1 (6 June), 1 (14 June)
YUMA	River Mile 33	17.6	3 (17 May), 3 (24 May), 4 (2 June)
	Gila Confluence West	3.8	4 (18 May), 4 (31 May), 3 (9 June)
	Gila Confluence North	4.6	5 (18 May) 1 (9 June), 1 (14 June)
	Gila River Site 2[6]	5.1	ND
	Fortuna Site 1[6]	2.5	ND
	Fortuna North	3.8	3 (31 May), 1 (9 June)
	Gadsden Bend	4.4	6 (17 May), 2 (21 May), 2 (3 June), 1 (8 June), 1 (12 June), 3 (13 June), 3 (14 June), 2 (16 June), 3 (17 June)
	Gadsden	17.3	7 (17 May), 7 (21 May), 1 (3 June), 2 (8 June), 2 (12 June)
	Hunter's Hole	15.9	6 (18 May), 2 (21 May), 1 (3 June), 2 (8 June), 1 (17 June)

[1] PAHR = Pahranagat National Wildlife Refuge; LIFI = Littlefield; MESQ = Mesquite; MOME = Mormon Mesa; MUDD = Muddy River Delta; 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 3 for details on territories, residency, pairing, and color-banding; see Chapter 4 for details on nesting activity.

[4] Site was monitored/surveyed until the end of May, when we were denied access by local landowner.

[5] Territory was monitored, but no formal surveys were completed.

[6] Site not surveyed prior to 15 June because of locked gates restricting access.

Table 2.2. Detections of Willow Flycatchers Recorded after 15 June 2005 at Sites Where Breeding or Residency Was Not Confirmed

Study Area[1]	Site	Date	Comments
BIWI	Mineral Wash Complex	23 June	Lone flycatcher, responded to playbacks with sporadic song (*fitz-bew*)
BIHO	Big Hole Slough	18 June	Lone flycatcher, responded to playbacks with calls (*whitts)* and primary song (*fitz-bew*)
CIBO	Three Fingers Lake	17 June	Lone flycatcher, primary song (*fitz-bew*) heard prior to playbacks; no response to playbacks
	Walker Lake	6 July	Lone flycatcher, primary song (*fitz-bew*) heard prior to playbacks; responded strongly to playbacks
IMPE	Paradise	16 June	Lone flycatcher, responded to playbacks with primary song (*fitz-bew*)
	Adobe Lake	20 June	Lone flycatcher, responded to playbacks with primary song (*fitz-bew*)
	Picacho NW	17 June	Two flycatchers, approximately 60 m apart, responded to playbacks with primary song (*fitz-bew*) and calls
	Great Blue Heron	18 June	At least two flycatchers heard singing (spontaneously), one captured passively in mist net
YUMA	Gadsden Bend	16 June	At least two flycatchers detected while mist netting, one individual responded to playbacks
		17 June	Three flycatchers captured passively in mist nets; unresponsive to playbacks prior to capture
	Hunter's Hole	17 June	One flycatcher heard singing (*fitz-bew*)

[1] BIWI = Bill Williams NWR; BIHO = Big Hole Slough; CIBO = Cibola NWR; IMPE = Imperial National Wildlife Refuge; YUMA = Yuma.

Table 2.3. Yellow-Billed Cuckoo Detections along the Virgin, Lower Colorado, and Gila Rivers, 2005*

Study Area[1]	Site	Date(s)	Behavioral Observations
YUMA	Gila Confluence North	21 July	Calls heard
		27 July	One individual observed and heard calling from 0730 to 1000 hrs.

* Unless otherwise stated, number of individual cuckoos was undetermined.
[1] YUMA = Yuma.

Table 2.4. Yuma Clapper Rail Detections along the Virgin and Lower Colorado Rivers, 2005*

Study Area[1]	Site	Date(s)	Behavioral Observations
TOPO	Pierced Egg	9 May	Calls heard
CIBO	Three Fingers Lake	17 June	Calls heard
		20 June	Calls heard from two locations approximately 250 m apart
	Cibola Lake #1 (North)	15 June	Calls heard
		19 June	Calls heard
	Cibola Lake #3 (West)	18 June	Calls heard from two locations approximately 300 m apart
IMPE	Ferguson Lake	14 June	Calls heard
		28 June	Calls heard

* Unless otherwise stated, number of individuals was undetermined.
[1] TOPO = Topock Marsh; CIBO = Cibola National Wildlife Refuge; IMPE = Imperial National Wildlife Refuge.

Table 2.5. Summary of Hydrologic Conditions at Each Survey Site along the Virgin and Lower Colorado Rivers and Tributaries, 2005*

Study Area[1]	Survey Site	% Site Inundated[2]	Depth (cm) of Surface Water[2]	% Site with Saturated Soil[2,3]	Distance (m) to Surface Water or Saturated Soil[2]
PAHR	North[4]	90/70/5	100/70/10	10/30/85	0/0/0
	West[4]	50/50/50	30/30/5	5/5/5	0/0/0
	South	10/10/5	50/50/10	15/15/5	0/0/0
	Salt Cedar[4]	90/60/40	70/50/25	5/35/25	0/0/0
LIFI	North	0/0/0	0/0/0	0/0/0	35/35/35
	South	0/0/0	0/0/0	0/0/0	0/--/40
MESQ	East	1/5/1	--/40/5	2/15/10	0/0/0
	West	20/15/15	40/30/30	5/5/5	0/0/0
	Bunker Farm	1/1/1	10/10/10	20/20/20	0/0/0
MOME	Mormon Mesa North[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Hedgerow	--/0/--	--/0/--	--/0/--	--/110/--
	Mormon Mesa South[4,5]	--/--/0	--/--/0	--/--/0	0/0/0
	Virgin River #1 North[5]	10/--/10	35/--/25	80/--/20	0/--/0
	Virgin River #1 South[4,5]	--/--/0	--/--/0	--/--/0	0/0/0
	Virgin River #2[4]	--/--/10	--/--/10	--/--/20	--/--/0
	Delta West[4,6]	95/--/--	10/--/--	5/--/--	0/--/--

Table 2.5. Summary of Hydrologic Conditions at Each Survey Site along the Virgin and Lower Colorado Rivers and Tributaries, 2005*, continued

Study Area[1]	Survey Site	% Site Inundated[2]	Depth (cm) of Surface Water[2]	% Site with Saturated Soil[2,3]	Distance (m) to Surface Water or Saturated Soil[2]
MUDD	Overton WMA	5/--/5	5/--/5[7]	20/--/20	0/0/0
GRCA	Separation Canyon	15/10/5	10/5/10	25/20/10	0/0/0
	RM 243S[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Spencer Canyon	10/10/10	25/25/25	15/15/15	0/0/0
	Surprise Canyon	15/15/10	10/10/10	20/20/15	0/0/0
	Clay Tank Canyon[4]	20/20/10	10/10/10	25/25/15	0/0/0
	No Wifl Point[4]	0/0/0	0/0/0	0/0/0	0/0/0
	No Wifl Bay[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Reference Point Creek[4]	5/5/10	10/10/10	10/10/15	0/0/0
	RM 257.5N[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Burnt Springs	20/20/15	10/10/25	50/50/20	0/0/0
	Quartermaster Canyon	20/20/10	15/25/10	40/40/15	0/0/0
	Columbine Falls	10/10/15	5/5/5	15/15/20	0/0/0
	RM 274.5N[4]	20/20/15	10/10/10	30/35/20	0/0/0
TOPO	Pipes #1	0/0/0	0/0/0	0/0/0	50/50/50[8]
	Pipes #2	0/0/0	0/0/0	0/0/0	50/50/50[8]
	Pipes #3	1/0/0	5/0/0	50/70/0	0/0/100
	The Wallows	--/5/--	--/10/--	--/70/--	--/0/--
	PC6-1	0/0/0	0/0/0	0/0/0	50/50/50
	PB 2001	5/0/0	5/0/0	5/5/5	0/0/0
	Pig Hole	0/0/0	0/0/0	0/0/0	130/130/130
	In Between	5/0/0	5/0/0	5/5/5	0/0/0
	800M	0/0/1	0/0/5	5/50/30	0/0/0
	Pierced Egg	0/0/0	0/0/0	15/15/15	0/0/0
	Swine Paradise[9]	0/0/0	0/0/0	0/0/0	0/0/0
	Barbed Wire	0/0/0	0/0/0	0/0/0	160/160/160
	IRFB03	0/0/0	0/0/0	0/0/0	150/150/150
	IRFB04	0/0/0	0/0/0	0/0/0	75/75/75[8]
	Platform[9]	0/0/0	0/0/0	0/0/0	0/0/0
	250M[9]	0/0/0	0/0/0	0/0/0	0/0/0
	Hell Bird	0/2/15	0/5/5	0/5/10	30/0/0
	Glory Hole	10/10/10	5/15/15	10/10/5	0/0/0
	Lost Lake[9]	5/5/5	10/10/10	10/15/15	0/0/0
TOGO	Pulpit Rock[4]	10/10/10	5/5/5	5/5/5	0/0/0
	Picture Rock[4]	--/--/--	--/--/--	--/--/--	0/0/0
	Blankenship Bend North[4]	15/15/15	100/100/100	10/10/10	0/0/0
	Blankenship Bend South[4]	20/20/20	30/30/30	30/30/30	0/0/0
	Havasu NE[4]	0/0/0	0/0/0	0/0/0	0/0/0

Table 2.5. Summary of Hydrologic Conditions at Each Survey Site along the Virgin and Lower Colorado Rivers and Tributaries, 2005*, continued

Study Area[1]	Survey Site	% Site Inundated[2]	Depth (cm) of Surface Water[2]	% Site with Saturated Soil[2,3]	Distance (m) to Surface Water or Saturated Soil[2]
BIWI	Site #1[4]	10/10/10	40/40/40	10/5/10	0/0/0
	Site #2[4]	5/0/0	25/0/0	5/2/0	0/0/0
	Site #11[4]	--/--/--	--/--/--	--/--/--	0/0/0
	Site #4[4]	20/10/5	50/30/30	60/60/60	0/0/0
	Site #3[4]	10/10/10	50/30/10	90/60/60	0/0/0
	Site #5	20/--/--	100/--/--	5/--/--	0/--/--
	Mineral Wash Complex[4]	10/10/10	25/25/10	10/5/5	0/0/0
	Beaver Pond[4]	20/5/5	15/15/15	20/5/5	0/0/0
	Site #8[4]	30/--/20	30/30/20	30/5/5	0/0/0
BIHO	Big Hole Slough	10/10/10	10/10/10	10/10/10	0/0/0
EHRE	Ehrenberg	0/0/5	0/0/10	0/0/10	15/15/0
CIBO	Cibola Site 2[11,12]	--/--/--	--/--/--	--/--/--	0/0/0
	Cibola Site 1[11,12]	--/--/--	--/--/--	--/--/--	0/0/0
	Hart Mine Marsh[9]	10/10/10	50/50/35	10/10/10	0/0/0
	Three Fingers Lake[4]	25/25/25	>100/>100/>100	5/5/5	0/0/0
	Cibola Lake #1 (North)[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Cibola Lake #2 (East)[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Cibola Lake #3 (West)[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Walker Lake[4]	0/0/0	0/0/0	0/0/0	0/0/0
IMPE	Paradise[4]	30/15/0	5/25/0	35/--/0	0/0/0
	Hoge Ranch[4]	15/5/25	5/10/30	30/15/45	0/0/0
	Adobe Lake[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Rattlesnake[9]	0/1/5	0/5/5	0/2/2	0/0/0
	Norton South[9]	1/15/10	5/10/30	5/--/10	0/0/0
	Picacho NW[4]	0/0/0	0/0/0	0/0/0	30/30/30
	Milemarker 65[4]	--/--/--	--/--/--	--/--/--	0/0/0
	Clear Lake/The Alley[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Imperial Nursery	2/0/0	5/0/0	5/0/0	0/10/10
	Ferguson Lake[4]	1/5/10	10/10/25	1/--/15	0/0/0
	Ferguson Wash[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Great Blue Heron[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Powerline[4]	5/5/5	--/--/--	2/2/2	0/0/0
	Martinez Lake[4]	0/0/5	0/0/--	5/0/5	0/0/0
MITT	Mittry West	0/0/0	0/0/0	0/35/15	0/0/0
	Mittry South[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Potholes East[12]	30/30/30	--/--/--	5/5/5	0/0/0
	Potholes West[12]	20/20/20	>100/>100/>100	5/5/5	0/0/0

Table 2.5. Summary of Hydrologic Conditions at Each Survey Site along the Virgin and Lower Colorado Rivers and Tributaries, 2005*, continued

Study Area[1]	Survey Site	% Site Inundated[2]	Depth (cm) of Surface Water[2]	% Site with Saturated Soil[2,3]	Distance (m) to Surface Water or Saturated Soil[2]
YUMA	River Mile 33	2/5/5	50/25/25	0/10/10	0/0/0
	Gila Confluence West[4]	5/5/5	30/30/30	5/5/5	0/0/0
	Gila Confluence North[4]	15/10/10	10/50/10	10/15/10	0/0/0
	Gila River Site 2[4]	--/0/0	--/0/0	--/0/0	--/0/0
	Fortuna Site 1	--/0/0	--/0/0	0/0/0	0/0/0
	Fortuna North[4]	5/--/0	10/--/0	45/--/0	0/--/0
	Gadsden Bend	5/5/5	50/10/30	1/1/5	0/0/0
	Gadsden[4]	8/10/5	50/50/70	3/5/10	0/0/0
	Hunter's Hole	0/0/0	0/0/0	0/0/0	25/25/25

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

1 PAHR = Pahranagat National Wildlife Refuge; LIFI = Littlefield; MESQ = Mesquite West; MOME = Mormon Mesa; MUDD = Muddy River; 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 -- = Hydrologic information not recorded.

3 Percent of site with saturated soil does not include inundated areas.

4 Site bordered by a river or lake.

5 Site not monitored until mid-June because high water levels in the Virgin River prevented access.

6 Site was monitored only until the end of May because we were denied access by local landowner.

7 Water within the channel of the Muddy River was up to 100 cm deep.

8 Distance to water was estimated in the field in previous years as 100 m. GIS was used in 2005 to obtain this more accurate measurement of the distance from the edge of the site to the nearest water.

9 Site borders marsh.

10 Distance to water was estimated in the field in previous years as 200 m. GIS was used in 2005 to obtain this more accurate measurement of the distance from the edge of the site to the nearest water.

11 Site contains cattail marshes, but hydrologic conditions within marshes unknown.

12 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: 4.5 ha Elevation: 1,026 m

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 approximately 1 m of water in mid-May and became progressively drier through the survey season. By mid-June 70% of the site had standing water, with only 10% of the site inundated by late July.

We located 17 resident, breeding willow flycatchers at Pahranagat North. We detected nine additional unpaired males and four additional flycatchers for which residency or breeding status could not be determined. 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 five times throughout the breeding season, totaling 11.3 observer-hours.. The site lies immediately adjacent to a cattle pasture, but livestock have access only to the cottonwood stringer on the northwest corner of the lake. Brown-headed Cowbirds were detected during surveys in May, and none were recorded during surveys in June and July.

PAHRANAGAT WEST

Area: 0.6 ha Elevation: 1,026 m

This native site consists of a stringer of Fremont cottonwood 20 m in height on the west edge of Upper Pahranagat Lake. A few Goodding willow 2–4 m in height are also present, and the edge of the lake is vegetated with bulrush (*Schoenoplectus californicus*). The upland edge of the site was dry, while the lake edge had standing water throughout the survey season.

We detected one willow flycatcher at the site on 9 June. Details of banding status are presented in Chapter 3. We surveyed the site six times throughout the breeding season, totaling 3.8 observer-hours. No cowbirds or sign of livestock use were detected.

PAHRANAGAT SOUTH

Area: 2.4 ha Elevation: 1,023 m

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 cottonwoods reach approximately 20 m in height, while the willows are generally less than 10 m. Greater vegetation volume of coyote willow was noted compared to previous years, with record winter precipitation likely contributing to this change. 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 four resident, breeding willow flycatchers at Pahranagat South and an additional unpaired male. 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 six times throughout the breeding season, totaling 2.8 observer-hours. One Brown-headed Cowbird was detected during one survey in May.

PAHRANAGAT SALT CEDAR

Area: 3.1 ha Elevation: 975 m

This site consists of dense clumps of tamarisk 3–4 m in height interspersed with open areas at the south end of Lower Pahranagat Lake. Canopy closure at the site is approximately 50%. The site is bordered to the north by the lake and to the south by upland desert. We investigated this site in 2003 but did not survey it that year because it was completely dry. In 2005, the site was almost completely inundated in May, and the water slowly receded throughout the breeding season, with 40% of the site inundated in July.

We did not detect any flycatchers at this site. We surveyed the site six times, totaling 10.0 observer-hours. A cowbird was detected on one visit. Although the site was not occupied by livestock during the survey season, signs of previous use by cattle were noted.

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. Both sites were scoured during the 2004–2005 winter by floods that removed some of the overstory vegetation and most of the understory vegetation.

LITTLEFIELD NORTH

Area: 4.7 ha Elevation: 543 m

This site originally extended from the I-15 bridge over the Virgin River upstream to the confluence of the Virgin River and Beaver Dam Wash and up Beaver Dam Wash approximately 250 m to a golf course. Much of the vegetation was completely removed by winter floods. The remaining vegetation consists of a mixed-native stand of mature Fremont cottonwood with a very sparse understory of willow, tamarisk, and arrowweed (*Pluchea sericea*) on the northwest corner of the confluence of Beaver Dam Wash and the Virgin River. The understory in this area was almost completely scoured by winter floods, but a few tamarisk have sprouted, and coyote willow is regenerating between the cottonwood stand and Beaver Dam Wash. Canopy height in the cottonwood stand is 10–15 m, and overall canopy closure is 25–50%. The site received significant sediment deposition, and the only surface water or saturated soils occurred in and along Beaver Dam Wash and the Virgin River, about 35 m from the cottonwood stand.

We detected two willow flycatchers during the first survey in mid-May. One individual was not detected again, and the other later moved to Mesquite West where it held a breeding territory. Details of occupancy, color-banding, and breeding are presented in Chapters 3 and 4. Areas of Littlefield North not known to be occupied by flycatchers were surveyed six times throughout the breeding season, totaling 8.5 observer-hours. One cowbird was detected during a survey in May, and there was sign of hunting in the study area (two tree stands). ATV tracks were recorded at the site.

LITTLEFIELD SOUTH

Area: 1.6 ha Elevation: 543 m

This site originally extended along the Virgin River for 550 m immediately downstream from the I-15 bridge and encompassed a backwater area. The backwater area was scoured by winter floods, and this mixed-native site now consists of a narrow strip of vegetation on the right bank of the Virgin River, extending for 320 m immediately downstream of the I-15 bridge. Vegetation in the area is primarily an overstory of cottonwood and willow 10–15 m in height with a scattered understory consisting primarily of tamarisk 3 m in height but also containing coyote willow and honey mesquite (*Prosopis glandulosa*). The site also contains small areas of cattail (*Typha* sp.) and arrowweed. Overall canopy closure is 25–50%. The only surface water was within the Virgin River channel, which was adjacent to the site in May but had receded to 30 m from the site in July.

We did not detect willow flycatchers at Littlefield South. We surveyed the site five times, totaling 2.0 observer-hours. Surveys were discontinued in mid-July because of the narrow width of the site and the lack of dense vegetation and moist soils. No cowbirds were detected, and there was no sign of livestock use.

MESQUITE, NEVADA

The Mesquite study area is in the floodplain of the Virgin River near Mesquite and Bunkerville, Nevada. In 2003 and 2004, we surveyed and monitored one site in the area, Mesquite West. In 2005, we surveyed and monitored two additional sites, Mesquite East and Bunker Farm, where personnel from an unrelated flycatcher project had located territorial flycatchers in 2004. All sites in the Mesquite study area experienced flooding, scouring, and deposition over the 2004–2005 winter.

MESQUITE EAST

Area: 3.8 ha Elevation: 468 m

This mixed-native site lies on several terraces within the floodplain of the Virgin River in Mesquite, Nevada. The lowest terrace, on the north edge of the site adjacent to the river, consists of Fremont cottonwood and Goodding willow generally less than 10 m in height. The cottonwoods in this area were yellow and dropping leaves by early July. This area was inundated by winter floods but stood at least 1 m above the river level during the survey season. The central portion of the site lies on a slightly higher terrace and is vegetated entirely by dense tamarisk 7–8 m in height with canopy closure around 80%. This terrace was also inundated during winter flooding and had deposition of sediment and debris. The terrace was dry throughout the survey season. The uppermost terrace is vegetated with Goodding willow and a few Fremont cottonwood 18–25 m in height. Understory in this area consists of dense clumps of coyote willow about 8 m in height. Canopy closure on this terrace varies from 50% in the cottonwood/Goodding willow areas to over 90% in the coyote willow clumps. This upper terrace borders an agricultural field and periodically receives irrigation runoff. A small pond is present at the end of an irrigation ditch. The western half of the upper terrace burned over the 2004–2005 winter and was not included in the survey area. The burned area also receives irrigation runoff, and wetted areas were growing thick stands of coyote willow, common reed (*Phragmites australis*), and cattail.

We located one unpaired male at Mesquite East. Details of occupancy and color-banding are presented in Chapter 3. Areas of Mesquite East not known to be occupied by flycatchers were surveyed five times throughout the flycatcher breeding season, totaling 13.5 observer-hours. Cowbirds were detected on all but one survey, and no evidence of livestock use was observed.

MESQUITE WEST

Area: 13.8 ha Elevation: 470 m

This mixed-native site lies within the floodplain of the Virgin River in Mesquite, Nevada. The site is a mosaic of cattail and bulrush marshes separated by narrow (40–50 m) strips of dense coyote willow with interspersed tamarisk. The willows are generally 4 m in height, and canopy closure varies from 50 to >90%.

The southeastern portion of the site was completely inundated during winter floods, which deposited up to 0.5 m of sediment in the vegetation, reducing overall canopy height in this area. Adjacent cattail/bulrush marshes in this area were scoured, and willow foliage density in the inundated area was less than observed in 2003 or 2004, with yellowing and dying vegetation likely caused by reduced water availability or sediment deposition on the root crowns. Winter floods also shifted the Virgin River to the north, removing approximately 0.8 ha of the site. No flycatcher nests were recorded in the scoured area in 2003 or 2004, but territorial flycatchers and flycatchers for which residency status could not be determined were present.

In 2003 and 2004, the amount of surface water present within the site was influenced by irrigation runoff from two golf courses immediately adjacent to the site. These irrigation return flows supported much of the vegetation within the site, and water levels varied on a daily basis. In 2005, portions of the site where deposition occurred had no surface water, and only the western and northern portions of the site were inundated throughout the flycatcher breeding season. The lack of surface water within the southeastern portion of the site may have been the result of the sediment deposition noted above, with this area now perched higher than the runoff from the golf courses, and may also have been influenced by changes in irrigation patterns on the golf course.

We located 10 resident, breeding willow flycatchers at Mesquite West and detected two unpaired males. Details of occupancy, color-banding, and breeding are presented in Chapters 3 and 4. Areas of Mesquite West not known to be occupied by flycatchers were surveyed nine times throughout the flycatcher breeding season, totaling 29.7 observer-hours. Cowbirds were detected on all surveys. No evidence of livestock use was observed.

BUNKER FARM

Area: 3.1 ha Elevation: 457 m

This mixed-exotic site lies within the floodplain of the Virgin River in Bunkerville, Nevada, approximately 3 km downstream of Mesquite West. The site varies in width from 50 to 100 m and lies between an agricultural field to the southeast and the Virgin River to the northwest. Vegetation within the site is highly variable. The edge of the site adjacent to the agricultural field consists primarily of dense stands of coyote willow 7–8 m in height with emergent Russian olive and Goodding willow, interspersed with stands of tamarisk. Canopy closure in this area is 70–90%. Toward the river, the vegetation grades into clumps of tamarisk 3–4 m in height with less than 70% canopy closure. Surface water was present in the site throughout the survey season in small channels near the river. Surface water was present in the willow areas only when the adjacent agricultural field was irrigated.

We located four resident, breeding willow flycatchers at Bunker Farm and detected two unpaired males. Details of occupancy, color-banding, and breeding are presented in Chapters 3 and 4. Surveys and monitoring at Bunker Farm commenced on 31 May, and we surveyed areas of Bunker Farm not known to be occupied by flycatchers three times throughout the remainder of the breeding season, totaling 2.5 observer-hours. Cowbirds were detected on all but one survey. Evidence of livestock use was observed on portions of Bunker Farm occupied by breeding flycatchers.

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 cattail marshes and tamarisk and willow forest. Much of the area is typically seasonally inundated from snowmelt in the spring and monsoon rains in mid and late summer, and the entire study area experienced severe flooding over the 2004–2005 winter. 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 most surveys. Large portions of the study area were not surveyed until mid-June because high water levels in the Virgin River prevented access.

MORMON MESA NORTH

Area: 13.5 ha Elevation: 390 m

This mixed-exotic site is north of a channel of the Virgin River that cuts from east to west across the floodplain. In 2003 and 2004, this channel was dry, and the site was bordered to the west by a seasonally inundated cattail marsh and to the east by the active channel of the Virgin River. During the winter flooding, the previously dry channel became the main channel of the Virgin River and contained water throughout the flycatcher breeding season. The cattail marsh to the west of the site was scoured during the flooding and was an open pond during the summer of

2005. The entire site was flooded during the winter, and flood debris was visible on the trees up to 2 m above the ground. From the river channel toward the cattails, vegetation at the site grades from dense arrowweed to tamarisk with arrowweed understory to a mixture of tamarisk, Goodding willow, and coyote willow. No standing water or saturated soils were present within the site. Canopy height in Mormon Mesa North is generally 4–5 m and extends to 8 m where willow is present. Canopy closure is approximately 70–90%.

We found two breeding pairs at Mormon Mesa North and detected an additional territorial flycatcher that later held a breeding territory in Virgin River #2. Details of occupancy, breeding activity, and color-banding are presented in Chapters 3 and 4. Portions of the site not known to be occupied were surveyed eight times, totaling 20.3 observer-hours.

MORMON MESA SOUTH

North half: Area: 14.8 ha Elevation: 385 m
South half: Area: 9.1 ha Elevation: 385 m

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 site. Canopy height of the willows is up to 10 m. Canopy closure varies throughout the site, averaging around 70%. This site could not be accessed until 15 June because of high water levels and swift currents in the Virgin River. Soils in the site were dry in July; soil conditions prior to this were not recorded.

We did not detect any flycatchers in Mormon Mesa South. We surveyed the site four times, totaling 35.1 observer-hours.

VIRGIN RIVER #1

North half: Area: 25.5 ha Elevation: 380 m
South half: Area: 25.0 ha Elevation: 380 m

Virgin River #1 was also divided into two areas, Virgin River #1 North and Virgin River #1 South, to facilitate streamlining of field logistics. Virgin River #1 North contains both tamarisk and willow habitats. The western half of Virgin River #1 North contains dense tamarisk 4 m in height and the eastern half is a mixture of tamarisk, Goodding willow, and coyote willow with cattails in the understory. Canopy height in the willow areas is approximately 10 m. Canopy closure throughout the site is approximately 70%. Surface water was present in braided channels throughout the survey season.

We surveyed this site in mid-May and then could not access the site again until mid-June because of high water levels in the Virgin River. We located one territorial flycatcher and one additional flycatcher for which residency status could not be determined. Details of occupancy and color-banding are presented in Chapter 3. Portions of the site not known to be occupied were surveyed nine times, totaling 36.3 observer-hours.

Virgin River #1 South is primarily tamarisk approximately 4 m in height with many dry, open areas. Canopy closure in vegetated areas is approximately 80%. The northeastern portion of Virgin River #1 South contains a few Goodding willow. The southern half of Virgin River #1 South was dry in mid-July; hydrologic conditions during other parts of the survey season were not recorded. Virgin River #1 South was surveyed five times after 15 June, totaling 18.5 observer-hours. No flycatchers were detected.

VIRGIN RIVER #2

Area: 38.2 ha Elevation: 380 m

This site is primarily a monotypic stand of tamarisk 4 m in height with 50–70% canopy closure. Patches of emergent Goodding willow up to 10 m in height are also present, primarily in the southeastern end of the site. This portion of the site had surface water throughout the survey season.

We detected three breeding pairs in the southeastern portion of Virgin River #2. Details of occupancy, nesting, and color-banding are presented in Chapters 3 and 4. Portions of Virgin River #2 not known to be occupied by flycatchers were surveyed six times, totaling 36.2 observer-hours.

DELTA WEST

Area: 12.2 ha Elevation: 370 m

This site is approximately 7 km downstream of Virgin River #2 and in some previous years was called Virgin River Delta #4. 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 and overall canopy closure is around 70%. The eastern portion of the site closest to the river channel is primarily small-diameter tamarisk 4–5 m in height with patches of cattails. The central portion of the site was almost completely inundated with approximately 10 cm of water from mid- to late May.

We located one territorial flycatcher, which was later detected in Virgin River #2. Details of occupancy and color-banding are presented in Chapter 3. We surveyed Delta West three times in May, totaling 17.0 observer-hours, before further access to the site was denied by a local landowner.

OTHER SURVEY AREAS

Hedgerow: Area: 1.3 ha Elevation: 390 m

This mixed-native site is east of Mormon Mesa North, on the east side of the Virgin River. The site consists primarily of mature Goodding willow up to 20 m in height with a sparse understory of Goodding willow and tamarisk. The stand of mature willows is surrounded by tamarisk 3–8 m in height. Canopy closure at the site is 50–70%. Soils within the site were dry at the time of surveys.

We surveyed this site opportunistically on 29 June and 12 July, for a total of 0.8 observer-hours. No flycatchers were detected.

MUDDY RIVER, NEVADA

OVERTON WILDLIFE MANAGEMENT AREA

Area: 13.0 ha Elevation: 378 m

The Overton Wildlife Management Area (WMA) is at the inflow of the Muddy River into the Overton Arm of Lake Mead. The flycatcher survey site consists of a 150-m-wide strip of riparian vegetation on both sides of the Muddy River. The site is bordered to the southwest by open fields and to the northeast by sparse riparian vegetation. The site flooded during the 2004–2005 winter, but vegetation at the site was relatively unchanged. The northern portion of the site is dominated by very dense tamarisk up to 7 m in height with canopy closure of 70–90%. The southern portion of the site consists primarily of a stand of Goodding willow 10–12 m in height with an understory of tamarisk and cattail. Flowing water was present in the Muddy River throughout the survey season, and much of the site contained muddy soils.

We began surveying and monitoring the southern portion of the site in early July, after an individual completing unrelated bird surveys reported a nesting flycatcher in the area. Approximately 0.3 ha of the southern portion of the site had been recently bulldozed as part of Overton WMA efforts to repair flood damage to their water control system.

We detected four nesting flycatchers, comprising three females and one male, in the northern portion of the site. In the southern portion of the site we detected three nesting pairs, a territorial individual, and an individual for which residency could not be determined. Details of occupancy, color-banding, and nesting are presented in Chapters 3 and 4. Portions of the site not known to be occupied by flycatchers were surveyed 11 times, totaling 38.0 observer-hours. Cowbirds were detected on 10 of the 11 surveys, and no evidence of livestock use was observed at the site.

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 five years as the result of a 27-m drop in the level of Lake Mead from 2000 to 2004.[6] 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

[6] The water level in Lake Mead Reservoir has risen approximately 7 m since mid-2004.

Lees Ferry. River left and river right are indicated by "S" (south) and "N" (north), respectively. Livestock do not use any of the survey sites within Grand Canyon.

SEPARATION CANYON (RM 239.5N)

Area: 5.3 ha Elevation: 378 m

This mixed-exotic site consists of dense patches of tamarisk 6 m in height interspersed with open areas along a streambed in a narrow side canyon of the Colorado River. Overall canopy closure is 25–50%. The streambed that runs through the site held surface water through mid-July. Seep willow (*Baccharis salicifolia*) dominates the understory near the mouth of the canyon, while young coyote willow (1–3 m in height) dominates the understory farther up the canyon. Mesquite trees (*Prosopis* sp.) are also present at this site.

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

RM 243S

Area: 1.8 ha Elevation: 366 m

This site lies immediately adjacent to the Colorado River and is vegetated by dense tamarisk 5 m in height. Canopy closure is 70–90%. A dry wash draining a narrow side canyon cuts through the downstream end of the site. No standing water or saturated soils occurred in the site during the survey season, and the site is elevated approximately 2 m above the Colorado River.

We detected no willow flycatchers or Brown-headed Cowbirds at this site. The site was surveyed nine times, totaling 9.0 observer-hours.

SPENCER CANYON (RM 246S)

Area: 5.0 ha Elevation: 366 m

This mixed-native site consists of a patch of dense tamarisk approximately 5 m in height bordering the Colorado River and stringers of cottonwood and Goodding and coyote willow along Spencer Creek, which is perennial. Fremont cottonwood and Goodding willow form an overstory of variable height, and willow and tamarisk are present in the understory. Portions of the stream are lined with cattails and seep willow, and overall canopy closure is around 70%.

We did not detect willow flycatchers or Brown-headed Cowbirds at this site. The site was surveyed nine times, totaling 16.6 observer-hours.

SURPRISE CANYON (RM 248.5N)

Area: 4.9 ha Elevation: 365 m

This mixed-exotic site consists of patches and stringers of tamarisk and coyote willow along both sides of a stream in the bottom of a narrow canyon. Much of the vegetation present in previous years was scoured during winter floods, which created cut banks 2–3 m in height. The stream contained flowing water throughout the survey season. Canopy height is approximately 4–5 m, and overall canopy closure is <25%.

We did not detect willow flycatchers or Brown-headed Cowbirds at this site. The site was surveyed nine times, totaling 7.8 observer-hours.

CLAY TANK CANYON (RM 249S)

Area: 0.4 ha Elevation: 363 m

This mixed-exotic site consists of a small patch of tamarisk and arrowweed between the Colorado River and a large pond. Small patches of seep and coyote willow are also present. A stream was flowing from the pond to the river throughout the survey season. Tamarisk at this site ranges from 3 to 5 m in height, and overall canopy closure is approximately 70%.

We did not detect willow flycatchers or Brown-headed Cowbirds at this site. The site was surveyed nine times, totaling 2.7 observer-hours.

NO WIFL POINT (RM 249.5S)

Area: 1.2 ha Elevation: 363 m

This mixed-exotic site consists of a narrow (20–40 m) band of tamarisk 3–5 m in height with seep willow bordering the site along the river. Canopy closure is approximately 70%. No standing water or saturated soils occurred in the site during the survey season, but the site borders the Colorado River.

No willow flycatchers or Brown-headed Cowbirds were detected at this site. The site was surveyed 10 times, totaling 9.2 observer-hours.

NO WIFL BAY (RM 249.5N)

Area: 1.1 ha Elevation: 363 m

This mixed-exotic site borders the Colorado River and consists of a narrow (20–40 m) band of tamarisk 4 m in height with seep willow bordering the edge of the site along the river and arrowweed scattered throughout the site. No standing water or saturated soils occurred in the site during the survey season, and the site is elevated approximately 2 m above the Colorado River. Canopy closure is approximately 70%.

No willow flycatchers or Brown-headed Cowbirds were detected at this site. The site was surveyed 10 times, totaling 8.1 observer-hours.

REFERENCE POINT CREEK (RM 252S)

Area: 4.2 ha Elevation: 360 m

This site, at the confluence of Reference Point Creek with the Colorado River, is vegetated almost entirely by a dense stand of tamarisk 5 m in height. The tributary canyon opens up approximately 500 m before reaching the Colorado River into a 200-m-wide patch of tamarisk. The site was completely dry during the surveys of 2003 and 2004, but a small stream flowed through the site throughout the survey season of 2005. Open, grassy areas occur in the center of the site. Overall canopy closure at the site is approximately 80%.

No willow flycatchers or Brown-headed Cowbirds were detected at this site. The site was surveyed 10 times, totaling 15.7 observer-hours.

RM 257.5N

Area: 1.2 ha Elevation: 360 m

This mixed-exotic site borders the Colorado River. Immediately adjacent to the river, vegetation is primarily a thin band of dead willow approximately 5 m in height. Behind the willow, the site is dominated by dense tamarisk 5 m in height. The site was dry throughout the survey season and was elevated approximately 4–5 m above the level of the river. Vegetation throughout the site, particularly in the northern half of the site, is dead or dying. Canopy closure at the site is approximately 60%.

We did not detect willow flycatchers at this site. The site was surveyed nine times, totaling 7.1 observer-hours. Brown-headed Cowbirds were detected during the first survey.

BURNT SPRINGS (RM 259.5N)

Area: 11.0 ha Elevation: 363 m

Vegetation within the first 200 m of Burnt Springs Canyon upstream from the Colorado River consists of monotypic tamarisk approximately 4 m in height. The next 150 m of the canyon is vegetated by very young tamarisk. This is followed by an approximately 700-m stretch of mature Goodding willow 15 m in height with an understory of cattails. Canopy closure is approximately 70–90%. Flowing water was present in the creek through July.

We did not detect willow flycatchers at this site. The site was surveyed 10 times, totaling 16.2 observer-hours. Brown-headed Cowbirds were detected during all but one survey.

QUARTERMASTER CANYON (RM 260S)

Area: 3.3 ha Elevation: 360 m

This mixed-exotic site lies at the confluence of the Colorado River and Quartermaster Canyon. Vegetation along the river is predominately tamarisk 4 m in height, and canopy height decreases with distance from the river. Patches of Goodding and coyote willow occupy approximately 10% of the site, and cattail marshes occupy 10% of the site. A small stream flowed through the site and soils were saturated throughout the survey season. Canopy closure is approximately 50%.

We did not detect willow flycatchers at this site. The site was surveyed 10 times, totaling 12.2 observer-hours. Brown-headed Cowbirds were detected during all surveys.

COLUMBINE FALLS (RM 274.5S)

Area: 6.3 ha Elevation: 354 m

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 5–6 m in height and tamarisk 2–3 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 11.3 observer-hours. Brown-headed Cowbirds were detected on all but three surveys.

RM 274.5N

Area: 10.4 ha Elevation: 354 m

This mixed-exotic site lies immediately adjacent to the Colorado River and contains spring-fed seeps, small creeks, and a cattail marsh. Approximately 50% of the site contained saturated soil or standing water throughout the survey season. Vegetation at the site is a mix of Goodding willow and tamarisk. Canopy height averages 7 m, but canopy height and relative proportions of the two species vary throughout the site. Overall canopy closure is approximately 50%.

We detected one unpaired male willow flycatcher at this site. Details of occupancy and color-banding are presented in Chapter 3. Portions of the site not known to be occupied by flycatchers were surveyed nine times, totaling 15.1 observer-hours. Brown-headed Cowbirds were detected on all but one survey.

OTHER SURVEY AREAS

RM 260.5N: Area: 3.5 ha Elevation: 354 m

This site borders the Colorado River and stands about 4 m above the river level. 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 <50%.

Surveys at this site were discontinued after a single survey in May because of poor habitat quality for willow flycatchers, with the site demonstrating dying vegetation, dry soils, and little canopy closure.

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. No cattle were present, but feral pigs frequented all areas surveyed.

During aerial reconnaissance in April 2005, we noted that water levels in Topock Marsh seemed lower than they had been during the breeding seasons of 2003 and 2004. Ground reconnaissance in May confirmed this observation, and many of the sites that had surface water and/or saturated soils in previous years were notably drier at the start of the 2005 flycatcher breeding season. Water levels within the marsh rose during the early part of the summer, and by mid-June, some of the sites were notably wetter than they had been in early or mid-May.

PIPES

Pipes #1: Area: 5.2 ha Elevation: 140 m
Pipes #2: Area: 2.8 ha Elevation: 140 m
Pipes #3: Area: 5.7 ha Elevation: 140 m

These three contiguous sites are vegetated primarily by monotypic tamarisk 5–7 m in height, and canopy closure generally exceeds 70%. The northern edge of Pipes #1 has larger stems and taller canopy than the rest of Pipes and has little deadfall. The central and southern portions of Pipes #1 have many dead stems and clusters of fallen trees. Pipes #2 is very dense, with most stems <3 cm in diameter, and large, impenetrable areas of deadfall are present within the site. Pipes #1 and Pipes #2 had dry soil throughout the survey season. Pipes #3, particularly the southwestern portion of the site, contained the wettest areas and had small, marshy openings. Standing water in Pipes 3 was confined to pig wallows. The site became noticeably wetter from mid-May to mid-June, when 70% of the site had damp soil. By mid-July, soils within the site were dry.

We detected two willow flycatchers at Pipes #1 (each detected for a single day), for which residency could not be confirmed. No willow flycatchers were detected in Pipes #2. Two unpaired males were detected in Pipes #3. Details of color-banding and occupancy are presented in Chapter 3. Portions of Pipes #1 and #3 not known to be occupied by flycatchers were surveyed 10 times each, totaling 26.7 observer-hours. Pipes #2 was surveyed 10 times, totaling 3.3 observer hours. Multiple Brown-headed Cowbirds were detected on almost all visits to Pipes.

THE WALLOWS

Area: 0.4 ha Elevation: 140 m

The Wallows is between Pipes 3 and PC6-1. This was not a survey site at the beginning of the season, but a new site was delineated when a territorial flycatcher was discovered outside of existing survey sites. This site is primarily tamarisk 5–6 m in height with an occasional emergent Goodding willow. Surface water was confined to pig wallows.

We detected one territorial flycatcher in The Wallows. Details of occupancy and color-banding are presented in Chapter 3. This territory was monitored throughout the season, and no surveys were completed at this site.

PC6-1

Area: 4.8 ha Elevation: 140 m

This mixed-exotic site has a scattered overstory of Goodding willow approximately 10 m in height, a continuous mid-story of tamarisk 6–7 m in height, and patches of arrowweed and cattails in the understory. A portion of the site within approximately 50 m of the refuge road contains thick stands of arrowweed. Canopy closure in the interior of the site is approximately 90%, while canopy closure on the periphery of the site near the refuge road is approximately 50%. Although portions of the understory contain cattail, no part of the site contained standing water or saturated soils throughout the survey season.

In PC6-1, we detected three willow flycatchers, of which two were members of a breeding pair and one was an unpaired male. Details of color-banding, occupancy, and nesting are presented in Chapters 3 and 4. Portions of PC6-1 not known to be occupied by willow flycatchers were surveyed four times, totaling 8.8 observer-hours. Numerous cowbirds were recorded on all but one visit.

PB 2001

Area: 2.1 ha Elevation: 140 m

This mixed-exotic site consists primarily of very dense tamarisk 4–5 m in height with patches of dense arrowweed in the understory. A few emergent Goodding willow approximately 15 m in height are present in the center of the site, with a few patches of cattails in the understory. Canopy closure ranges from 50 to 70%, with the site containing small areas of open canopy.

Less than 5% of the site had standing water and saturated soil throughout the flycatcher breeding season.

We did not detect willow flycatchers at this site. The site was surveyed 11 times, totaling 5.4 observer-hours. Brown-headed Cowbirds were detected during six of the surveys.

PIG HOLE

Area: 2.4 ha Elevation: 140 m

Pig Hole consists of monotypic tamarisk 5–6 m in height, with canopy closure ranging from 70 to 90%. Dense patches of arrowweed occur in approximately 5% of the site. No part of the site contained standing water or saturated soils during the flycatcher breeding season.

No willow flycatchers were detected in Pig Hole, with the site surveyed 10 times totaling 5.1 observer-hours.

IN BETWEEN AND 800M

In Between: Area: 7.7 ha Elevation: 140 m
800M: Area: 6.1 ha Elevation: 140 m

These two contiguous sites consist of approximately 50-m-wide linear patches of monotypic tamarisk between swampy areas that have contained varying amounts of standing water across years. 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 generally over 90%. Standing water within the sites was confined to pig wallows. Saturated soils were present within the sites near the marsh edges, and the sites were wettest in mid-June.

We located 10 breeding adults at In Between and 6 breeding adults in 800M. Details of pairing, occupancy, color-banding, and nesting are presented in Chapters 3 and 4. Portions of In Between not known to be occupied by willow flycatchers were surveyed 10 times, totaling 8.2 observer-hours; cowbirds were recorded during six surveys. Portions of 800M not known to be occupied by willow flycatchers were surveyed five times, totaling 2.4 observer-hours. Cowbirds were recorded on all but one survey.

PIERCED EGG

Area: 6.7 ha Elevation: 140 m

This mixed-exotic site borders the western edge of 800M and consists of dense tamarisk 7 m in height with a scattered overstory of Goodding willow 15 m in height. Areas with willows tend to have a more open understory and contain patches of cattails. Overall canopy closure is approximately 90%. Standing water was present only in pig wallows that were excavated approximately 50 cm below the surrounding ground surface. Saturated soils were present in the southern portion of the site. The northern portion of the site is drier than the southern portion and contains stands of dense arrowweed.

We located eight breeding adults at Pierced Egg. Details of occupancy, color-banding, and nesting are presented in Chapters 3 and 4. Portions of the site not known to be occupied by willow flycatchers were surveyed 10 times, totaling 16.2 observer-hours. Cowbirds were recorded on all surveys.

SWINE PARADISE

Area: 3.7 ha Elevation: 140 m

This mixed-exotic 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 5–7 m in height. Overall canopy closure is approximately 90%. No standing water or saturated soils were present within the site during the flycatcher breeding season.

No willow flycatchers were detected at Swine Paradise. We surveyed the site 10 times, totaling 6.5 observer-hours. Cowbirds were detected on eight visits.

BARBED WIRE

Area: 2.6 ha Elevation: 140 m

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. No standing water or saturated soils were present during the flycatcher breeding season.

No willow flycatchers were detected at Barbed Wire. We surveyed the site 10 times, totaling 7.0 observer-hours. Cowbirds were detected on eight visits.

IRFB03 AND IRFB04

IRFB03: Area: 1.0 ha Elevation: 140 m
IRFB04: Area: 1.5 ha Elevation: 140 m

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, and lower branches and the ground are covered with thick layers of tamarisk duff. Soils within these sites were completely dry throughout the survey season. These sites are separated from the Barbed Wire site by a firebreak road.

We did not detect willow flycatchers at either IRFB03 or IRFB04. We surveyed these sites 10 times each, totaling 6.6 observer-hours. Cowbirds were detected on seven visits.

PLATFORM

Area: 1.3 ha Elevation: 140 m

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. Overall canopy closure is approximately 70%. 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.

No willow flycatchers were detected at Platform. We surveyed the site 10 times, totaling 3.5 observer-hours. Cowbirds were detected on four visits.

250M

Area: 2.3 ha Elevation: 140 m

This site lies between the main refuge road and the open marsh. Vegetation composition and structure varies with distance from the marsh. Closest to the refuge road the site is dominated by mesquite trees with an understory of arrowweed. The center of the site is dominated by tamarisk approximately 7 m in height. Closest to the marsh, the site contains patches of coyote willow and one large Goodding willow. Canopy closure within the site generally exceeds 70%. Soils at the site were dry throughout the flycatcher breeding season.

We detected two willow flycatchers (one breeding pair) in 250M. Details of occupancy, color-banding, and nesting are presented in Chapters 3 and 4. Portions of the site not known to be occupied by flycatchers were surveyed three times, totaling 2.1 observer-hours. Cowbirds were detected on one survey.

HELL BIRD AND GLORY HOLE

Hell Bird: Area: 3.7 ha Elevation: 140 m
Glory Hole: Area: 3.8 ha Elevation: 140 m

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. Canopy closure ranges from 50 to 90%. The survey areas are bordered on the west by a sand dune and on other sides by dense bulrush. Swampy areas vegetated by cattail and bulrush are interspersed throughout the survey areas. Hell Bird was completely dry in mid-May but became progressively wetter throughout the flycatcher breeding season as the water level in Topock Marsh rose. Glory Hole contained small areas of standing water in May, and water depth increased through mid-June.

We recorded no willow flycatchers in Hell Bird and five breeding flycatchers in Glory Hole. Details of occupancy, color-banding, and nesting activity are presented in Chapters 3 and 4.

Portions of Hell Bird not known to be occupied by flycatchers were surveyed 11 times, totaling 13.8 observer-hours; cowbirds were detected on all but two surveys. Portions of Glory Hole not known to be occupied by flycatchers were surveyed twice, totaling 5.3 observer-hours; cowbirds were detected on all surveys.

LOST LAKE

Area: 9.1 ha Elevation: 140 m

Lost Lake is located 6 km south of Glory Hole and Hell Bird. It is a narrow (<100 m wide) strip of riparian vegetation separated from the Colorado River to the west by a low ridge of barren sand dunes and bordered to the east by marshy areas. Lost Lake (a 200 × 500–m body of open water) is located north of the site. Vegetation at the site is variable. The northern edge of the central portion of the site consists of an overstory of planted cottonwoods 10 m in height, with an understory of tamarisk 5 m in height. Many of the cottonwoods appear to be dying. 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. To the northwest of the cottonwoods, the site consists primarily of tamarisk and arrowweed. Overall canopy closure is approximately 70%. Areas to the south and west of Lost Lake burned in the past few years and contain patches of young tamarisk and small willows. The southeastern portion of the site, adjacent to the marsh, had standing water throughout the survey season.

No willow flycatchers were detected at Lost Lake. We surveyed the site 10 times, totaling 14.7 observer-hours. Cowbirds were detected on six visits.

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

PULPIT ROCK

Area: 1.8 ha Elevation: 140 m

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 Goodding 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 primarily dry throughout the survey period, but the northwestern edge of the site is partially inundated by the Colorado River.

We did not detect any willow flycatchers at this site. We surveyed the site 10 times, totaling 1.8 observer-hours. Cowbirds were detected on one visit. No livestock use at the site was recorded, but evidence of wild burros was observed.

PICTURE ROCK

Area: 5.5 ha Elevation: 138 m

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. Canopy closure within the site is 70–90%. 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.

We detected two migrant willow flycatchers at this site during one survey in May. We surveyed the site 10 times, totaling 8.6 observer-hours. Cowbirds were detected on six visits. Feral pigs and burros use the site and adjacent uplands.

BLANKENSHIP BEND

Blankenship Bend North: Area: 26.7 ha Elevation: 138 m
Blankenship Bend South: Area: 25.9 ha Elevation: 138 m

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. Because of the proximity to the Colorado River, both sites contained standing water and saturated soils throughout the survey season.

We did not detect any willow flycatchers at these sites. Blankenship Bend North was surveyed 10 times, totaling 15.7 observer-hours; cowbirds were detected on six visits. Blankenship Bend South was surveyed nine times, totaling 8.6 observer-hours; cowbirds were detected on six visits. Feral pigs, bighorn sheep, and burros use the site and adjacent uplands.

HAVASU NE

Area: 12.6 ha Elevation: 136 m

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. Canopy closure is approximately 50%. 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 did not detect any willow flycatchers at this site. We surveyed the site 10 times, totaling 18.2 observer-hours. Numerous cowbirds were detected on all visits. No livestock use at the site was recorded, but evidence of wild burros was observed.

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. Survey sites within Bill Williams are listed below from west to east, moving progressively farther upstream. All survey sites at Bill Williams that are influenced by water levels in the Bill Williams River were noticeably wetter during 2005 than in 2004. Winter floods shifted the Bill Williams River to the south, inundating historical flycatcher breeding habitat and survey sites.

BILL WILLIAMS SITE #1

Area: 2.8 ha Elevation: 140 m

This mixed-native site has an overstory of large Goodding willow and Fremont cottonwood 15 m in height 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. The site contains large quantities of downed wood, and some of the overstory trees have dropped large branches, creating gaps in the canopy. Overall canopy closure is approximately 50%. Approximately 10% of the site remained inundated throughout the flycatcher breeding season.

We detected one migrant willow flycatcher at Site #1 during one survey on 7 June. Details of occupancy of all flycatchers at Bill Williams are presented in Chapter 3. Site #1 was surveyed 10 times, totaling 6.0 observer-hours. Cowbirds were detected on seven visits, and there was no evidence of livestock at the site.

BILL WILLIAMS SITE #2

Area: 3.1 ha Elevation: 140 m

This mixed-native site has an overstory of large Goodding willow and Fremont cottonwood trees up to 15 m in height and an understory of tamarisk 5 m in height. Overall canopy closure is approximately 50%. Soils in the interior of the site were dry throughout the flycatcher breeding season. The site is bordered on the southwest by a narrow channel of open water where an arm of Lake Havasu follows the channel of the Bill Williams River. The site is accessible by kayak.

No willow flycatchers were detected at Site #2. We surveyed the site 10 times, totaling 6.1 observer-hours. Cowbirds were detected on five visits, and there was no evidence of livestock at the site.

BILL WILLIAMS SITE #11

Area: 6.3 ha Elevation: 140 m

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 ranging from 3 to 5 m in height is the dominant species in the understory. The amount of standing water within the site was undetermined because we were unable to traverse the site on foot because of thick vegetation. However, large areas of standing water are present because an arm of Lake Havasu follows the channel of the Bill Williams River through the site. The site is accessible by kayak.

No willow flycatchers were detected at Site #11. We surveyed the site 10 times, totaling 3.8 observer-hours. Cowbirds were detected on two visits, and there was no evidence of livestock at the site.

BILL WILLIAMS SITE #4 AND SITE #3

Site #4: Area: 9.9 ha Elevation: 140 m
Site #3: Area: 7.7 ha Elevation: 140 m

These two sites are contiguous and together are known as Mosquito Flats. Vegetation is mixed-native, with an overstory of Goodding willow and Fremont cottonwood 15–20 m in height and patches of monotypic tamarisk up to 8 m in height. Canopy closure is approximately 50%. Stands of cattails occupy approximately 10% of the site. Many large willows and cottonwoods have fallen in the last two years, leaving large gaps in the canopy. Ground cover in portions of the site consists of thick, dead, fallen woody vegetation, and large amounts of flood debris are lodged in the understory. Mosquito Flats contained large areas of standing water and saturated soil throughout the flycatcher breeding season.

We detected two willow flycatchers (a breeding pair) in Site #4 and four willow flycatchers (a breeding pair and two unpaired males) in Site #3. Details of color-banding, occupancy, and nesting are presented in Chapters 3 and 4. Portions of the sites not known to be occupied by flycatchers were surveyed 10 times, totaling 28.9 observer-hours. Cowbirds were detected on seven visits, and evidence of feral pigs was noted at these sites.

BILL WILLIAMS SITE #5

Area: 5.3 ha Elevation: 143 m

Site #5 is located on the eastern edge of the Bill Williams River floodplain and is bordered to the east by upland desert. The survey area was expanded in 2005 to include the trail used to access Site #5 from the west side of the floodplain. The portion of the site on the east side of the floodplain consists of mixed-native vegetation, with a canopy of Goodding willow and Fremont cottonwood 10 m in height and an understory of tamarisk 3 m in height. Canopy closure in this area is approximately 25%, and the Bill Williams River flowed through this portion of the site during May. Hydrologic conditions in this area were not recorded later in the summer.

Vegetation along the trail consists of tamarisk 6–8 m in height with emergent Fremont cottonwood and Goodding willow. Canopy closure in this area is 70–90%, and soils were generally dry and sandy.

No willow flycatchers were detected at Site #5. We surveyed the site 10 times, totaling 5.9 observer-hours. Cowbirds were detected on two visits, and there was evidence of feral pigs at the site.

MINERAL WASH COMPLEX

Area: 18.8 ha Elevation: 162 m

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 15–20 m in height and an understory of tamarisk 3 m in height. Overall canopy closure is <50%. A channel of the Bill Williams River was flowing along the edge of the site throughout the flycatcher breeding season. Approximately 5% of the site contained saturated soils until July.

We detected one migrant willow flycatcher during one survey in June. The site was surveyed 10 times, totaling 8.8 observer-hours. Cowbirds were detected on five visits, and a feral pig was seen on one visit.

BEAVER POND

Area: 21.7 ha Elevation: 165 m

This mixed-native site consists of Fremont cottonwood and Goodding willow with an understory of tamarisk along the Bill Williams River. The cottonwoods are up to 20 m in height and are emergent above the willows. Areas not immediately adjacent to the river channel were dry and are vegetated by tamarisk and honey mesquite 5–7 m in height. Overall canopy closure at the site is <50%. A channel of the Bill Williams River was flowing along the edge of the site, and an old channel in the center of the site contained pools of water throughout the flycatcher breeding season. Approximately 5% of the site contained saturated soils until July.

No willow flycatchers were detected at Beaver Pond. We surveyed the site 10 times, totaling 10.0 observer-hours. Cowbirds were detected on seven visits, and there was no evidence of livestock at the site.

BILL WILLIAMS SITE #8

Area: 10.3 ha Elevation: 168 m

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 and willow trees 15 m in height line a flowing river channel, with an understory of tamarisk also present throughout the site. This site had flowing water in the river channel throughout the flycatcher breeding season. Overall canopy closure is <50%.

We detected one migrant willow flycatcher during one survey in May. The site was surveyed 10 times, totaling 10.4 observer-hours. Cowbirds were detected on seven visits, and there was no evidence of livestock at the site.

BIG HOLE SLOUGH, CALIFORNIA

BIG HOLE SLOUGH

Area: 16.5 ha Elevation: 82 m

This mixed-native site consists of a cattail marsh edged with narrow bands of coyote willow 5 m in height and an understory of seep willow. Away from the marsh, the site contains tamarisk and honey and screwbean mesquite (*Prosopis pubescens*) 8 m in height with an understory of arrowweed. A few tall Goodding willow and Fremont cottonwood are present at the site. Overall canopy closure is approximately 50%. The cattail marsh (approximately 30% of the site) had shallow, standing water throughout the survey season.

We detected one willow flycatcher on 23 May, two on 3 June, one on 7 June, and one on 18 June. No willow flycatchers were detected during the remaining six surveys. The site was surveyed 10 times, totaling 27.4 observer-hours. Large flocks of cowbirds were detected on all visits. Although no livestock use was noted, evidence of human traffic was recorded at the site.

EHRENBERG, ARIZONA

EHRENBERG

Area: 4.7 ha Elevation: 78 m

This mixed-native site consists of a canopy of Fremont cottonwood and Goodding willow 15 m in height with an understory of coyote willow. The periphery of the site is vegetated with a mix of tamarisk and mesquite. Approximately 5% of the site is a cattail marsh that contained no standing water or saturated soils until July, when the marsh became inundated with approximately 5 cm of water. The site is separated from the Colorado River by a levee. Canopy closure at the site is approximately 50%.

We detected two willow flycatchers at Ehrenberg on 20 May, one on 3 June, and one on 7 June. No willow flycatchers were detected during the remaining seven surveys. The site was surveyed 10 times, totaling 9.3 observer-hours. Cowbirds were detected on eight visits, and burros use the periphery of the site.

CIBOLA NATIONAL WILDLIFE REFUGE, ARIZONA AND CALIFORNIA

CIBOLA SITE #2 AND CIBOLA SITE #1

Cibola Site #2: Area: 16.4 ha Elevation: 65 m
Cibola Site #1: Area: 7.7 ha Elevation: 65 m

These adjacent, mixed-exotic sites consist of a 200-m-wide strip of vegetation bordering the channelized Colorado River. The sites are vegetated primarily by tamarisk, which is dry and scrubby on the eastern edge of the sites and becomes denser toward the cattail marshes on the western edge of the sites adjacent to the canal. Emergent Fremont cottonwood and Goodding willow occur primarily along the eastern edge of these marshy areas. The cottonwoods and tamarisk reach heights of 20 and 6 m, respectively, and overall canopy closure is 50–70%. The hydrologic conditions at these sites were undetermined because dense vegetation inhibited the ability of observers to access the marshes, but standing water was likely present within the cattail marshes.

We detected eight willow flycatchers at these sites on 25 May and five on 5 June. No willow flycatchers were detected during the remaining eight surveys. We surveyed the sites 10 times each, totaling 32.9 observer-hours. Cowbirds were recorded on all visits, and burro trails were noted on the periphery of the site.

HART MINE MARSH

Area: 31.6 ha Elevation: 65 m

This mixed-exotic site parallels the channelized 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 5 m, and canopy closure is approximately 70%. The marsh held up to 50 cm of standing water until mid-June, and the water level fell slightly throughout July. Tamarisk areas contained dry soils throughout the survey season.

We detected five willow flycatchers on 25 May and two on 5 June. No willow flycatchers were detected during the remaining eight surveys. The site was surveyed 10 times, totaling 15.1 observer-hours. Cowbirds were detected on all visits, and burro trails were noted on the east side of the site.

THREE FINGERS LAKE

Area: 67.9 ha Elevation: 65 m

This mixed-exotic site consists of a large island separated from the surrounding area by a dredged backwater channel. The shores of the island are vegetated by cattails, bulrush, tamarisk 6 m in height, and a few large Goodding willow. Canopy closure along the shore is approximately 50%. The interior of the island is vegetated primarily by arrowweed and had dry soils throughout the survey period. Saturated soils were only present along the shore of the island.

We detected 14 willow flycatchers on 24 May, 3 on 6 June, and 1 on 17 June. No willow flycatchers were detected during the remaining seven surveys. The site was surveyed 10 times, totaling 36.0 observer-hours. Cowbirds were detected on all visits, and burros use the adjacent uplands.

CIBOLA LAKE NORTH, EAST, AND WEST

Cibola Lake North:	Area: 8.5 ha	Elevation: 64 m
Cibola Lake East:	Area: 4.5 ha	Elevation: 64 m
Cibola Lake West:	Area: 7.0 ha	Elevation: 64 m

These mixed-exotic sites border Cibola Lake. The perimeter of each site adjacent to the lake is vegetated by cattail and bulrush. Areas immediately inland from the cattail marshes are vegetated by dense tamarisk 4–6 m in height with scattered Goodding willow. The interiors of the sites have patchy vegetation with a mix of tamarisk, arrowweed, and open sandy areas. Canopy closure along the marsh edges is 50–70%, while the interiors of sites have canopy closure <25%. Except for along the shores, soils within the interior of all sites were dry throughout the survey period.

We detected one willow flycatcher at Cibola Lake North on 23 May. At Cibola Lake East, no flycatchers were detected. At Cibola Lake West, we detected one willow flycatcher on 23 May and two flycatchers on 8 June. No willow flycatchers were detected during the remaining eight surveys. The sites were surveyed 10 times each, totaling 56.0 observer-hours. Cowbirds were detected on most visits, and tracks of burros and feral pigs were noted at Cibola Lake East.

WALKER LAKE

Area: 11.4 ha   Elevation: 64 m

This mixed-exotic site is located between Walker Lake and the Colorado River. In 2003 and 2004, we surveyed the area adjacent to the river. In 2005 we shifted our survey efforts to the area adjacent to Walker Lake. A mix of cattail and tamarisk up to 7 m in height border the eastern edge of Walker Lake. A band of emergent Fremont cottonwood and Goodding willow approximately 15 m in height are present farther east, away from the lake edge. Walker Lake had standing water approximately 30 cm deep in mid-May but had dried to deep mud by July. Soils in the interior of the site were dry throughout the survey season.

We detected one willow flycatcher at Walker Lake on 6 July. No willow flycatchers were detected during the remaining nine surveys. The site was visited 10 times, totaling 21.2 observer-hours. Cowbirds were detected on all but one visit, and no evidence of livestock was recorded.

IMPERIAL NATIONAL WILDLIFE REFUGE, ARIZONA AND CALIFORNIA

PARADISE

Area: 7.8 ha Elevation: 62 m

This site is mixed-native habitat, with stringers of Fremont cottonwood and Goodding willow, 15–20 m in height, bordering a small cattail marsh. Tamarisk (5 m in height) and arrowweed (3 m in height) make up the understory. Standing water and saturated soil were present in the cattail marsh until mid-June. The cottonwoods and willows are separated from the Colorado River by a narrow strip (50 m wide) of dense tamarisk. A cattail marsh borders the site to the south. Overall canopy closure is approximately 25%.

We detected 10 willow flycatchers on 17 May, 7 on 2 June, 22 on 8 June, and 1 on 16 June. No willow flycatchers were detected during the remaining six surveys. The site was surveyed 10 times, totaling 23.3 observer-hours. Cowbirds were detected on every visit except one, and no sign of livestock use was observed on the site.

HOGE RANCH

Area: 20.7 ha Elevation: 61 m

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). Pockets of cattails, bulrush, and common reed occupy less than 20% of the site. The marshes in the interior of the site contained standing water and saturated soil throughout the survey season. The site also borders the Colorado River. Canopy closure is approximately 70%.

We detected 7 willow flycatchers at Hoge Ranch on 18 May, 10 on 25 May, 5 on 1 June, 8 on 7 June, and 1 on 15 June. No flycatchers were detected during the last five surveys. The site was surveyed 10 times, totaling 27.0 observer-hours. Cowbirds were detected on eight visits, and there were signs of wild burros using portions of the site.

ADOBE LAKE

Area: 7.6 ha Elevation: 60 m

This site consists primarily 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) on the site, but no contiguous stands of willows. The site is adjacent to the Colorado River, but soils within the site were dry throughout the survey season. Canopy closure within the site is 70–90%.

We detected 20 willow flycatchers on 17 May, 7 on 25 May, 3 on 1 June, 9 on 7 June, 1 on 15 June, and 1 on 20 June. No willow flycatchers were detected during the last four surveys. The site was surveyed 10 times, totaling 5.5 observer-hours. Cowbirds were detected on six visits, and there was no sign of livestock use at the site.

RATTLESNAKE

Area: 7.6 ha Elevation: 60 m

This mixed-native site is a patchwork of emergent Goodding willow, strips of dense coyote willow 6–8 m in height, and tamarisk. Tamarisk is widespread in patches throughout the site but is not the dominant vegetation. Canopy closure is 70–90%. Large cattail marshes separate this site from the Colorado River. Portions of the site adjacent to the cattail marsh had standing water and saturated soil in June and July.

We detected one willow flycatcher on 20 May and four on 25 May. No willow flycatchers were detected during the remaining eight surveys. The site was surveyed 10 times, totaling 22.4 observer-hours. Cowbirds were detected on eight visits, and there were signs of wild burros using portions of the site.

NORTON SOUTH

Area: 1.2 ha Elevation: 60 m

This mixed-native site consists of a planted stand of Goodding willow and Fremont cottonwood approximately 20 × 100 m in size. Canopy height is 15–20 m and overall canopy closure is around 50%. The understory is varied and contains tamarisk, arrowweed, seep willow, cattail, mesquite, and coyote willow. The site is bordered to the north by a cattail marsh on the margin of Taylor Lake and to the south by desert upland. Standing water and saturated soils were present in the cattail marsh on the north edge of the site throughout the survey season.

We detected one willow flycatcher at Norton South on 4 June. This site was surveyed 10 times, totaling 10.7 observer-hours. Cowbirds were detected on two visits. There was no sign of livestock use of the site, but there were signs of wild burros using portions of the site.

PICACHO NW

Area: 8.8 ha Elevation: 59 m

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 no standing water or saturated soil was present within the site. The eastern portion of the site is fenced to exclude burros, and this portion of the site has a denser understory than unfenced portions. Outside of the managed area, the habitat is dominated by tamarisk and common reed.

We detected one willow flycatcher on 13 May, one on 19 May, one on 26 May, five on 4 June, and two on 17 June. No willow flycatchers were detected during the last five surveys. The site was surveyed 10 times, totaling 21.3 observer-hours. Cowbirds were detected on all but one visit, and there was evidence of heavy use of the site by wild burros.

MILEMARKER 65

Area: 10.0 ha Elevation: 58 m

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 primarily of dense tamarisk 6 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. Because of the impenetrable vegetation at this site, we surveyed the site from the river. Thus, hydrologic conditions of the interior of the site were undetermined.

We detected four willow flycatchers on 18 May, three on 24 May, and two on 4 June. The site was surveyed 10 times, totaling 7.9 observer-hours. Cowbirds were recorded on all visits, and no livestock use was noted.

CLEAR LAKE/THE ALLEY

Area: 8.3 ha Elevation: 59 m

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 during the survey period.

No willow flycatchers were detected at Clear Lake. The site was surveyed 10 times, totaling 6.1 observer-hours. Cowbirds were detected on five visits, and there were signs of wild burros using portions of the site.

IMPERIAL NURSERY

Area: 1.4 ha Elevation: 58 m

This site is a cottonwood planting managed by the Imperial NWR. The cottonwoods are approximately 10 m in height, and a 10-m-diameter clump of willows 4 m in height grows 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. Refuge personnel periodically inundate the cottonwood plantation with up to 15 cm of water.

We detected one willow flycatcher on 14 May and one on 19 May. The site was surveyed nine times, totaling 4.1 observer-hours. Cowbirds were detected on seven visits, and there was no evidence of livestock using the site.

FERGUSON LAKE

Area: 26.0 ha Elevation: 57 m

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 bordering Ferguson Lake. On the eastern edge of the site adjacent to the Colorado River the area is vegetated by scattered tamarisk, arrowweed, and mesquite. Portions of the site up to 50 m from the lakeshore had saturated soils and standing water throughout the survey season, and water depth increased as the season progressed.

We detected 2 willow flycatchers at Ferguson Lake on 14 May, 1 on 22 May, 13 on 31 May, and 2 on 5 June. No flycatchers were detected on the last six visits. The site was surveyed 10 times, totaling 32.5 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was recorded.

FERGUSON WASH

Area: 6.8 ha Elevation: 58 m

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 around 90%. The site is bordered on the lakeside by cattails and bulrush and on the upland side by desertscrub. A backwater channel penetrates to the interior of the site. Soils in the interior of the site were dry throughout the survey season.

We detected one willow flycatcher at Ferguson Wash on 14 May, one on 21 May, six on 31 May, and two on 5 June. No willow flycatchers were detected during the last six surveys. The site was visited 10 times, totaling 18.6 observer-hours. Cowbirds were recorded on nine visits, and burro trails were abundant on the periphery of the site.

GREAT BLUE HERON

Area: 7.1 ha Elevation: 58 m

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, though soils near Martinez Lake were damp throughout the survey season.

We detected two willow flycatchers on 14 May, three on 20 May, five on 26 May, two on 9 June, two on 10 June, two on 11 June, and two on 18 June. The site was surveyed 10 times, with 42.4 observer-hours spent at the site. Flycatcher banding activities occurred at this site on 10, 11, 18, and 19 June. Cowbirds were recorded on all visits, and burros use the uplands on the periphery of the site.

POWERLINE

Area: 2.0 ha Elevation: 58 m

This site is located south of the Great Blue Heron site 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 cattail marsh. Overstory height is approximately 12 m, and canopy closure is <50%. Tamarisk, arrowweed, and seep willow are present in the understory. The only standing water and saturated soil noted within the site occurred within the cattail marsh.

We detected one willow flycatcher at this site on 19 May and one on 4 June. The site was surveyed 10 times, with 6.9 observer-hours spent at the site. Cowbirds were recorded on seven visits, and burros use the uplands on the periphery of the site.

MARTINEZ LAKE

Area: 4.6 ha Elevation: 58 m

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 15 m in height are present in the southern portion. Arrowweed and tamarisk dominate the understory, and overall canopy closure is <25%. Cattails and common reed border the site along the lakeshore. The only standing water and saturated soil were recorded along the lake.

We detected two willow flycatchers at Martinez Lake on 26 May and one on 3 June. The site was visited 10 times, totaling 10.2 observer-hours. Cowbirds were detected on six visits, and burros use the adjacent uplands.

MITTRY LAKE, ARIZONA AND CALIFORNIA

MITTRY WEST

Area: 4.4 ha Elevation: 48 m

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 the only saturated soil was in the cattails. No surface water was present in the site during the survey season.

We detected four willow flycatchers on 19 May, one on 22 May, and one on 6 June. No flycatchers were detected during the remaining seven surveys. The site was visited 10 times, totaling 19.4 observer-hours. Cowbirds were detected on five visits, and burros use the uplands adjacent to the site.

MITTRY SOUTH

Area: 13.8 ha Elevation: 46 m

This monotypic tamarisk site lies immediately adjacent to Mittry Lake. Vegetation at the site is very dense, with abundant 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 during the survey period and is bordered by an area that has been recently bulldozed.

We detected four willow flycatchers at Mittry South on 18 May, one on 31 May, and one on 6 June. No willow flycatchers were detected during the remaining seven surveys. The site was visited 10 times, totaling 11.0 observer-hours. Cowbirds were detected during all but one visit, and no evidence of livestock use was recorded.

POTHOLES EAST

Area: 2.0 ha Elevation: 54 m

This mixed-exotic site is 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. Standing water and saturated soil, present throughout the survey season, were confined to the center and edges of the cattails, respectively.

We detected one willow flycatcher on 6 June. No willow flycatchers were detected during the remaining nine surveys. The site was surveyed 10 times, totaling 4.7 observer-hours. Cowbirds were detected on seven visits, and evidence of burros was abundant in the upland areas surrounding the site.

POTHOLES WEST

Area: 6.6 ha Elevation: 53 m

This mixed-exotic site is adjacent to the All American Canal. A pond with cattail and bulrush occupies the center of the site and is surrounded by tamarisk and athel. Canopy closure is 50–70%, and canopy height is 5–10 m. Standing water and saturated soil, present throughout the survey season, were confined to the center and edges of the cattails, respectively. A patch of mesquite trees grows on the north side of the site. Soils away from the pond were very dry during the survey period.

We detected one willow flycatcher on 6 June and one on 14 June. No willow flycatchers were detected during the remaining eight surveys. The site was surveyed 10 times, totaling 7.6 observer-hours. Cowbirds were detected on eight visits, and burros use the uplands surrounding the site.

YUMA, ARIZONA

RIVER MILE 33

Area: 17.6 ha Elevation: 38 m

This mixed-native site lies approximately 100 m south of the Colorado River approximately 2 km downstream of the confluence with the Gila River. The main portion 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. Canopy cover is variable from 25 to 70%. In previous years, this portion of the site contained standing water in May and early June, but no surface water was recorded in this area in 2005. Small areas of standing water and saturated soil were present throughout the survey season along a stream channel to the southeast of the main willow and cottonwood stand. Cottonwoods and willows also occur in narrow stringers along irrigation ditches on the periphery of the site. The area north of the stringer on the western end of the site burned prior to the 2005 survey season, but the stringer of trees was not affected.

At River Mile 33, we detected three willow flycatchers on 17 May, three on 24 May, and four on 2 June. The individual detected and resighted on 17 May was originally banded as a nestling at an unidentified life history study area in 2003 or 2004 (see Chapter 3). No flycatchers were detected during the last seven surveys. The site was surveyed 10 times, totaling 28.2 observer-hours. Cowbirds were recorded on all visits, and there was no evidence of livestock use at the site. Large numbers of homeless people inhabit the dry, tamarisk area immediately to the south of the site.

GILA CONFLUENCE WEST

Area: 3.8 ha Elevation: 37 m

This mixed-native site borders the Colorado and Gila Rivers. Sparse Goodding willows and Fremont cottonwoods surround a cattail marsh in the center of the site. Standing water and saturated soil, present throughout the survey season, were confined to the center and edges of the cattails, respectively. Canopy height is approximately 10 m, and canopy closure is 25–50%. Arrowweed and tamarisk form a patchy understory, with sandy, open areas throughout the site.

We detected four willow flycatchers on 18 May, four on 31 May, and three on 9 June. No willow flycatchers were detected during the remaining six surveys. The site was surveyed nine times, totaling 9.9 observer-hours. Cowbirds were detected on all but two visits, and no evidence of livestock use was noted. The area receives human recreational activity and off-road vehicle use.

GILA CONFLUENCE NORTH

Area: 4.6 ha Elevation: 40 m

This mixed-native site borders the north side of the Colorado River at the confluence of the Gila and Colorado Rivers. The site is approximately 650 m long and less than 100 m wide. Overstory vegetation at the site is a combination of Goodding willow, coyote willow, and Fremont cottonwood. Dense stands of these trees surround a cattail marsh, which contained standing water throughout the survey season, near the center of the site. Canopy height is variable from 4 to 13 m, and canopy closure is approximately 50%. Arrowweed, tamarisk, and seep willow are common in the understory.

We detected five willow flycatchers at Gila Confluence North on 18 May, one on 9 June, and one on 14 June. No willow flycatchers were detected during the remaining seven surveys. The site was surveyed 10 times, totaling 17.2 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was noted.

GILA RIVER SITE #2

Area: 5.1 ha Elevation: 45 m

This mixed-native site consists of an overstory (up to 15 m in height) of Fremont cottonwood and Goodding willow, with 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. There was no standing water or saturated soils within the site during June and July, but the western edge of the site borders a large pond.

No willow flycatchers were detected at Gila River Site #2. The site was surveyed six times, totaling 8.9 observer-hours. The site was not surveyed prior to 15 June because of locked gates restricting access. Cowbirds were detected on two visits. No evidence of livestock use was observed within the site.

FORTUNA SITE #1

Area: 2.5 ha Elevation: 45 m

This mixed-native site consists of a narrow patch of Fremont cottonwood and Goodding willow about 10 m in height with 50–70% canopy closure. Tamarisk and arrowweed form a patchy understory on the periphery of the site. Within the densest cottonwood/willow areas, there is little understory but many downed branches. No standing water or saturated soils were observed within the site during June and July. The site is bordered to the north by agricultural fields and to the south by a cattail marsh and the Gila River.

We did not detect any willow flycatchers at this site. We surveyed the site six times, totaling 3.9 observer-hours. The site was not surveyed prior to 15 June because of locked gates restricting access. Cowbirds were detected on three visits, and no evidence of livestock use was noted at the site.

FORTUNA NORTH

Area: 3.8 ha Elevation: 46 m

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. Canopy closure is approximately 80%. Standing water and saturated soils were recorded in May, but the site had dried out by July. The western edge of the site borders the Gila River.

Three willow flycatchers were detected on 31 May, and one on 9 June. No willow flycatchers were detected during the remaining eight surveys. The site was surveyed 10 times, totaling 11.8 observer-hours. Cowbirds were detected on nine visits, and no sign of livestock use was recorded.

GADSDEN BEND

Area: 4.4 ha Elevation: 28 m

This mixed-native site is adjacent to a beaver pond along 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 and west by a large stand of mesquite. Small areas of standing water and saturated soil were recorded within the site throughout the survey season.

We detected six willow flycatchers on 17 May, two on 21 May, two on 3 June, one on 8 June, one on 12 June, three on 13 June, three on 14 June, two on 16 June, and three on 17 June. The site was surveyed eight times, with 8.0 observer-hours spent at the site. Flycatcher banding activities occurred at this site on 12–14, 16–17, and 21 June. Cowbirds were recorded on seven surveys and on four banding days. Burros use the uplands on the periphery of the site, and the site receives heavy foot traffic by illegal immigrants.

GADSDEN

Area: 17.3 ha Elevation: 25 m

This mixed-native site consists of stringers of Goodding willow and scattered Fremont cottonwood lining backwater channels of the Colorado River. Canopy height is variable, ranging from approximately 8 to 12 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. Standing water and saturated soil were recorded within the site throughout the survey season. Approximately 50% of the site comprises open, sandy areas, sparsely vegetated by arrowweed, between the backwater channels.

We detected seven willow flycatchers at Gadsden on 17 May, seven on 21 May, one on 3 June, two on 8 June, and two on 12 June. No flycatchers were detected during the last five surveys. The site was surveyed 10 times, totaling 12.5 observer-hours, and cowbirds were recorded on eight visits. No livestock use was recorded, but the site receives heavy foot traffic by illegal immigrants.

HUNTER'S HOLE

Area: 15.9 ha Elevation: 26 m

This mixed-native site consists of two patches of Goodding willow separated by a dry pond surrounded by cattail and common reed. In the southern patch, stringers of willow 10 m in height surround a dry oxbow. Areas away from the dry 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 dry channels and ponds. Canopy closure along the stringers is approximately 50%. Between the stringers, vegetation is a mix of tamarisk and arrowweed. Agricultural fields border the site to the east. Although this site contained water during most surveys in 2003 and 2004, no standing water or saturated soil was recorded within the site throughout the survey season in 2005, and the nearest water was the irrigation canal approximately 25 m from the edge of the site.

At Hunter's Hole, we detected six willow flycatchers on 18 May, two on 21 May, one on 3 June, two on 8 June, and one on 17 June. No flycatchers were detected during the remaining five surveys. The site was surveyed 10 times, totaling 16.1 observer-hours, and cowbirds were recorded on all but one visit. No livestock use was recorded at the site, but the site receives heavy foot traffic by illegal immigrants.

DISCUSSION

In 2005, we found resident and breeding Southwestern Willow Flycatchers at the four life history study areas (Pahranagat NWR, Mesquite, Mormon Mesa, and Topock Marsh) as well as at Muddy River Delta and Bill Williams NWR. A resident, unpaired male flycatcher was also detected at Grand Canyon, but no breeding activity was recorded at this site (details of occupancy and breeding are presented in Chapters 3 and 4).

Habitat occupancy and breeding at some sites differed from that of previous years (McKernan and Braden 2002, Koronkiewicz et al. 2004, McLeod et al. 2005). Flycatcher breeding at Littlefield, Arizona, was recorded for the first time in 2004, but flycatchers abandoned the site in 2005, probably because winter floods caused extensive loss of vegetation. Willow flycatcher breeding has been documented at the Bill Williams from 1999 to 2003, with residency but no breeding recorded in 2004, and residency and breeding recorded again in 2005. The fluctuating availability of surface water at Bill Williams is likely one factor influencing willow flycatcher habitat occupancy and breeding at the site in any given year, with flycatchers breeding in years when sites contained standing water.

Willow flycatchers have been detected within lower Grand Canyon since surveys began in 1997, with breeding flycatchers detected in 1999–2001 but not in 2002 or 2003. A single breeding pair was detected in 2004, and an unpaired male occupied this same area in 2005. Flycatchers in Grand Canyon are likely responding to changes in habitat structure, which are largely influenced by the availability of water. The level of Lake Mead, which influences water levels in lower Grand Canyon, dropped steadily from January 2000 to July 2004, losing nearly 90 feet in elevation (Reclamation 2005b). Although the water level in Lake Mead increased approximately 20 feet over the 2004–2005 winter, the water level has been slowly decreasing again since March 2005, and areas along the banks of the Colorado River in lower Grand Canyon that were inundated in 1998 and 1999 are still several meters above water level. Much of the vegetation in these areas is dead or dying. The site occupied by a breeding pair in 2004 and an unpaired male in 2005 is spring-fed, and appears to be unaffected by water levels in Lake Mead. This site contains well-developed riparian vegetation, and vegetation and the availability of surface water appeared unchanged between 2004 and 2005. New stands of vegetation in the Colorado River Delta in Lake Mead have also been developing in areas exposed by receding water, and some of these revegetated areas are now inundated because of rising water levels in Lake Mead. Young stringers of willow are particularly evident in the historically occupied delta area, and reconnaissance should be conducted in these areas in future years to determine the potential suitability of the habitat for breeding flycatchers.

The amount of standing water throughout the entire Topock study area was markedly reduced in 2005 compared to 2003 and 2004. Although we observed a reduction in the number of adults detected at PC6-1 from 9 to 3, a reduction at Glory Hole from 10 to 5, and total flycatcher abandonment at Hell Bird, it is undetermined whether the reduced amount of standing water at these sites contributed to the lower number of adults recorded in 2005 compared to 2004. Given that the Topock study area has experienced annual fluctuation in the total numbers of adults detected from 2003 to 2005, with 25, 67, and 41 individuals, respectively, a combination of biotic and abiotic factors may be driving the demographics of this local population.

Although many flycatchers were recorded at surveyed sites south of Bill Williams until 15 June, and 11 detections were recorded post 15 June, 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., 10 flycatcher detections at Paradise on 17 May, 0 on 20 May, 7 on 2 June, 22 on 8 June, 1 on 16 June, and 0 on 21 June) and the overall lack of territorial, aggressive behaviors exhibited toward conspecific broadcasts, willow flycatchers detected at sites south of Bill Williams in 2005 were most likely migrants. These results are consistent with those recorded in 2003 and 2004 (Koronkiewicz et al. 2004, McLeod et al. 2005). 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 northbound, migrant flycatchers along the southern stretches of lower Colorado River until late June and July

[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).

is not surprising. Furthermore, with over 200 willow flycatcher detections recorded in 2003 (Koronkiewicz et al. 2004), over 600 detections recorded in 2004 (McLeod et al. 2005), and over 300 detections in 2005, this section of the lower Colorado River corridor is undoubtedly a major flyway for migrant willow flycatchers in spring. Results at survey sites south of Bill Williams in 2005 are consistent with those of previous years from 1997 to 2004 (McKernan and Braden 2002, Koronkiewicz et al. 2004, McLeod et al. 2005), with no confirmed nesting recorded since 1938 (Unitt 1987).

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 conduct color-banding studies at sites south of Bill Williams in 2005 (see Chapter 3), no resightings 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.

MANAGEMENT RECOMMENDATIONS

The 10-survey protocol should be evaluated for its effectiveness in 1) identifying areas containing resident flycatchers and 2) determining the dynamics of northbound migration up the lower Colorado River drainage. While 10 survey visits are probably excessive if the goal is to locate resident and breeding individuals, this protocol may be useful in recording the timing of migration and identifying areas used by migrating flycatchers. Increased observation time in areas used during migration may lead to the resighting of banded Southwestern Willow Flycatchers, though these observations would likely be rare. Multiple visits may also increase the detection of non-breeding individuals that may be investigating sites for possible territory establishment.

Current, high-resolution aerial photographs are essential for guiding survey efforts in extensive riparian corridors. Ground reconnaissance of large areas in riparian habitat is often prohibitively difficult and time consuming. Areas containing dense vegetation can often be distinguished from surrounding habitat on high-resolution aerial photographs, and these areas can be prioritized for ground reconnaissance and survey. This type of prioritization was instrumental in the discovery in 2005 of breeding flycatchers in Virgin River #2 at Mormon Mesa.

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 of adults and young, site fidelity, seasonal and between-year movements, and population structure. Thus, as an integral part of life history studies, we captured and uniquely color-banded as many willow flycatchers as possible, allowing field personnel to resight individuals throughout the breeding season, as well as in subsequent years. Resighting consisted of using binoculars to determine the identity of a color-banded flycatcher by observing, from a distance, the unique color combination on its legs. This allowed field personnel to detect and monitor individuals without recapturing each bird. This was our third consecutive year of color-banding studies and builds upon color-banding initiated at these sites in 1998 (McKernan and Braden 1999).

METHODS

COLOR-BANDING

From early May through mid-August, we captured, uniquely color-banded, and subsequently monitored adult, nestling, and fledged willow flycatchers at the four life history study areas. Color-banding and monitoring were also conducted at all survey areas where resident willow flycatchers were detected. These additional monitoring sites were the Overton Wildlife Management Area on the Muddy River Delta, River Mile 274 along the Colorado River in Grand Canyon, and the Bill Williams National Wildlife Refuge. Color-banding effort was also expanded to include opportunistic banding at Key Pittman Wildlife Management Area in Nevada. The Mesquite life history study area was expanded in 2005 to include the sites of Bunker Farm and Mesquite East, where flycatcher residency or breeding was documented in 2004 (SWCA 2004).

For the third consecutive year, we conducted color-banding studies from 10–30 June along the extreme southern stretches of the lower Colorado River downstream of Parker Dam. In 2005, banding attempts were conducted along the Colorado River at Imperial NWR (Hoge Ranch), along Martinez Lake (Great Blue Heron), and at sites near the Mexico border (Gadsden Bend, Gadsden, and Hunter's Hole). These additional studies were conducted in conjunction with subsequent surveys and resighting at these sites through late July to better determine flycatcher residency, breeding status, and movement patterns in this area. Because of extremely dense vegetation in these areas, banding effort at all sites was primarily dependent upon the ability of field personnel to erect nets within the habitat.

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. We banded each adult and fledged willow flycatcher with a single anodized (colored), numbered U.S. federal aluminum band on one leg and a colored metal band on the other. We coordinated all color combinations 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 unpubl. 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, was recorded along with the federal band number.

Nestlings were banded at 8 to 10 days of age when they were large enough to retain the leg bands, yet young enough that they would not prematurely fledge from the nest (Whitfield 1990, Paxton et al. 1997). Nestlings were banded only when the location of the nest was such that nest access and removal/replacement of the nestlings would not endanger the nest, nest plant, or nestlings. Nestlings were banded with a single anodized, numbered federal band, uniquely identifying each bird as a returning nestling in the event it returns in a subsequent year.

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 and/or egg(s) in the oviduct for females. Because physical breeding characteristics are not always present on captured individuals, flycatchers observed engaging in lengthy, primary song from high perches (male advertising song) prior to capture were sexed as male. Captured flycatchers lacking breeding characteristics and not observed engaging in male advertising song as noted above were sexed as unknown. Flycatchers with retained primary, secondary, and/or primary covert feathers (multiple aged remiges) were aged as second year adults, and those without (uniformly aged remiges) were aged as after second year (per Kenwood and Paxton 2001 and Koronkiewicz et al. 2002). Individuals in juvenile plumage (unworn flight feathers and body plumage with broad, buff colored wing bars and fleshy gape) were aged as hatch year.

RESIGHTING

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 for which detections spanned one week or longer were considered resident at a site, regardless of the portion of the breeding season in which the bird was observed or whether a possible mate was observed. Resighted flycatchers observed engaging in lengthy, primary song from high perches (male advertising song) were sexed as male. Resighted flycatchers observed carrying nest material or constructing or incubating a nest were sexed as female. Resighted flycatchers not observed engaging in one of these diagnostic activities were sexed as unknown. All inactive territories were visited at least three times (each visit four days apart) before territory visits stopped. All territories were assigned a unique alphanumeric code and were plotted onto high-resolution aerial photographs, thus producing a spatial representation of the flycatcher population at each study location. 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).

Unbanded flycatchers could not be identified to individual, but an unbanded flycatcher detected in a given location on multiple, consecutive visits was assumed to be the same individual. If an unbanded flycatcher was detected at a given location on multiple visits but one or more intervening visits failed to detect a flycatcher, the detections were considered to be different individuals in the absence of behavioral observations indicating the flycatcher was actively defending a territory or was a member of a breeding pair.

RESULTS

ALL MONITORING SITES

Color-Banding and Resighting – Field personnel color-banded 31 new adult flycatchers and recaptured 14 individuals banded in previous years, not including individuals banded as juveniles in a previous year and not detected since. An additional 44 adults banded in previous years were resighted, of which 30 (68%) could be identified to individual, 8 were banded as juveniles in 2003 or 2004 but could not be recaptured to determine origin and identity, 1 had a federal band on one leg and was missing the other leg below the intertarsal joint, and 5 did not have their band combinations confirmed. We banded 56 nestlings from 25 nests and captured 9 fledglings (4 from 3 nests that were too high to band, 3 for which nest origin could not be determined, 1 that was too old to band as a nestling when discovered, and 1 that was a previously banded 2005 nestling). Of the 56 nestlings banded, none were known to have died before fledging. We detected 19 individuals originally banded as juveniles in a previous year and not detected again until 2005, with 11 (58%) identified to individual via recapture. Two of the 11 returning nestlings of known identity were originally banded as nestlings at Roosevelt Lake, Arizona. Overall, 75% of the adult flycatchers detected at the monitoring sites were color-banded by the end of the breeding season (Table 3.1). For seven adult flycatchers detected, we were unable to determine if these individuals were color-banded (that is, banding status was undetermined).

Table 3.1. Summary of Willow Flycatchers Detected at Monitored Sites during the 2005 Breeding Season*

Study Area	Site	Adults									Nestlings Banded (# Nests)	Fledglings Captured	% of All Adults Banded
				Recaptured		Resighted							
		Total Adults Detected	New Captured	Not including returning Nestlings	Returning Nestlings	Color combination confirmed, individual identified	Color combination confirmed, individual not identified	Unbanded	Band Status Undetermined	Banded (color combinations unconfirmed)			
Pahranagat	North	30	12	6	5	6	1[1]	0	0	0	14 (5)	8[2]	**100**
	South	5	2	1	1	1	0	0	0	0	7 (2)	0	100
	West	1	0	0	0	0	0	1	0	0	0	0	0
	MAPS	1	0	0	1	0	0	0	0	0	0	0	100
	Study Area Total	**37**	**14**	**7**	**7**	**7**	**1**	**1**	**0**	**0**	**21 (7)**	**8**	**97**
Littlefield	North	2	0	0	0	1[3]	0	0	1	0	0	0	50
Mesquite	East	1	1	0	0	0	0	0	0	0	0	0	100
	West	12	1	1	0	7[3]	1[4]	0	0	2	8 (5)	0	100
	Bunker Farm	6	2	2	0	2[5]	0	0	0	0	5 (2)	0	100
	Study Area Total	**19**	**4**	**3**	**0**	**9**	**1**	**0**	**0**	**2**	**13 (7)**	**0**	**100**
Mormon Mesa	North	4	0	0	0	1	1[1]	2	0	0	2 (1)	0	50
	Virgin River #1 North	2	0	0	0	0	0	0	1	1	0	0	50
	Virgin River #2	7	1	2[5]	1	1	1[1]	1	0	0	0	0	86
	Delta West	1	0	0	0	1	0	0	0	0	0	0	100
	Study Area Total	**14**	**1**	**2**	**1**	**3**	**2**	**3**	**1**	**1**	**2 (1)**	**0**	**71**
Muddy River	Overton WMA	12	4	0	1[6]	1	3[1]	3	0	0	4 (2)	1	75
Grand Canyon	RM 274.5	1	1	0	0	0	0	0	0	0	0	0	100
Topock	Pipes 1	2	0	0	0	0	0	0	2	0	0	0	50
	Pipes 3	2	0	0	1	0	0	1	0	0	0	0	100
	PC6-1	3	1	0	0	0	0	2	0	0	0	0	33
	The Wallows	1	0	0	0	0	0	1	0	0	0	0	0
	In Between	10	0	1	0	3	0	5	0	1	6 (3)	0	50
	800M	6	0	0	0	5	0	1	0	0	4 (2)	0	83
	Pierced Egg	8	1	0	1[6]	0	2[1]	3	0	1	2 (1)	0	63

Table 3.1. Summary of Willow Flycatchers Detected at Monitored Sites during the 2005 Breeding Season*, continued

Study Area	Site	Adults									Nestlings Banded (# Nests)	Fledglings Captured	% of All Adults Banded
		Total Adults Detected	New Captured	Recaptured		Resighted							
				Not including returning Nestlings	Returning Nestlings	Color combination confirmed, individual identified	Color combination confirmed, individual not identified	Unbanded	Band Status Undetermined	Banded (color combinations unconfirmed)			
Topock	250M	2	0	0	0	2	0	0	0	0	0	0	100
	Glory Hole	5	0	1	0	1	0	3	0	0	1 (1)	0	40
	BHCO Trap 6[7]	2	0	0	0	0	0	0	2	0	0	0	0
	Study Area Total	**41**	**2**	**2**	**2**	**11**	**2**	**16**	**4**	**2**	**13 (7)**	**0**	**53**
Bill Williams	Site 1	1	0	0	0	0	0	1	0	0	0	0	0
	Site 4	2	1	0	0	0	0	1	0	0	3 (1)	0	50
	Site 3	4	4	0	0	0	0	0	0	0	0	0	100
	Mineral Wash	1	0	0	0	0	0	0	1	0	0	0	0
	Site 8	1	0	0	0	0	0	1	0	0	0	0	0
	Study Area Total	**9**	**5**	**0**	**0**	**0**	**0**	**3**	**1**	**0**	**3 (1)**	**0**	**56**
TOTAL		**133**	**31**	**14**	**11**	**30[8]**	**9**	**26**	**7**	**5**	**56 (25)**	**8**	**75**

* Individuals are identified as new captures (previously unbanded), recaptures of previously banded birds, resightings of previously banded birds for which band combinations were confirmed, birds known to be unbanded, birds for which band status could not be determined, and resighting of previously banded birds for which band combinations were undetermined. Included are total numbers of adults detected and percent of all adults banded. For breeding and/or residency status of adults see Tables 3.2–3.15.

[1] Returning nestling(s).

[2] One fledgling was previously banded as a nestling (not included in total number of nestlings banded); seven fledglings previously unbanded.

[3] One individual moved from Littlefield North to Mesquite West.

[4] Bird had federal band only; left leg was missing below the intertarsal joint.

[5] One individual moved from Mesquite Bunker Farm to Mormon Mesa Virgin River #2.

[6] Nestling originally banded at Roosevelt Lake, AZ, by USGS.

[7] Not a formal survey site, flycatchers detected en route.

[8] The two individuals that moved between sites are tallied only once in the total.

Thus, the percentage of color-banded adult flycatchers at sites is a conservative estimate. For details on all banded flycatchers detected at the study areas from 2003 to 2005, see Appendix C.

SITE-BY-SITE COLOR-BANDING AND RESIGHTING

MONITORING SITES

Pahranagat – We detected 31 resident, adult willow flycatchers from 21 territories at Pahranagat. In addition to resident adults, we detected six individuals for which residency and/or breeding status could not be confirmed, of which at least one individual was a suspected migrant (Tables 3.2 and 3.3). Of the 21 territories recorded at Pahranagat, 11 consisted of breeding individuals and 10 consisted of unpaired males. Of the breeding individuals, one male was polygynous with two females.

Table 3.2. Paired, Nestling, and Fledgling Willow Flycatchers Banded and Resighted at Pahranagat NWR, NV, 2005

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Old Color Combination[1,2,3]	Age[3]	Sex[5]	Territory	Observation status[6]
South	26-Jun-05	2370-39958	PU:ZW(M)	N/A	AHY	F	31	N
South	17-May-03	3500-68971	XX:DD(M)	N/A	A3Y	M	31	R 28 May
South	26-Jun-05	2360-59707	EE:UB	N/A	L	U	31	N
South	26-Jun-05	2360-59708	EE:UB	N/A	L	U	31	N
South	26-Jun-05	2360-59709	EE:UB	N/A	L	U	31	N
South	26-Jun-05	2360-59710	EE:UB	N/A	L	U	31	N
North	8-Jul-05	2370-39964	BY(M):PU	N/A	AHY	F	50	N
North	1-Jun-05	2370-39951	PU:OZ(M)	N/A	AHY	M	50	N
North	22-Jul-05	2320-31574	EE:UB	N/A	L	U	50	N
North	22-Jul-05	2360-59718	EE:UB	N/A	L	U	50	N
South	17-Jul-04	2320-31637	BD(M):EE	UB:EE	SY	F	53	R 21 Jul
South	2-Jun-05	2370-39953	OB(M):PU	N/A	AHY	M	53	N
South	21-Jul-05	2370-40016	UB:PU	N/A	L	U	53	N
South	21-Jul-05	2320-31683	EE:UB	N/A	L	U	53	N
South	21-Jul-05	2320-31682	UB:EE	N/A	L	U	53	N
North	7-Jul-05	2370-39962	PU:RG(M)	N/A	SY	F	54	N
North	27-Jun-03	2320-31467	EE:BD(M)	EE:UB	3Y	M	54	R 7 Jun
North	29-Jul-05	2360-59740	UB:EE	N/A	L	U	54	N
North	19-Jun-04	2320-31656	WD(M):EE	N/A	A3Y	F	60	RS
North	15-May-04	2320-31590	GR(M):EE	N/A	A3Y	M	60	R 1 Jun
North	20-Jun-04	2320-31657	WO(M):EE	N/A	A3Y	F	61	R 20 Jul
North	4-Jun-02	2370-40015	PU:WG(M)	Zs:BB(P)[7]	A5Y	M	61, 91	R 20 Jul
North	16-Jul-05	2320-31684	YO(M):EE	UB:EE	HY	U	61	N, R 1 Aug
North	16-Jul-05	2320-31685	EE:UB	N/A	L	U	61	N
North	16-Jul-05	2320-31686	UB:EE	N/A	L	U	61	N

Table 3.2. Paired, Nestling, and Fledgling Willow Flycatchers Banded and Resighted at Pahranagat NWR, NV, 2005, continued

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Old Color Combination[1,2,3]	Age[3]	Sex[5]	Territory	Observation status[6]
North	16-Jul-05	2320-31687	EE:UB	N/A	L	U	61	N
North	17-Jun-04	2320-31661	EE:DW(M)	N/A	3Y	F	62	RS
North	23-Jul-02	2370-39952	BB(M):PU	BR(P):Zs[8]	A5Y	M	62	R 2 Jun
North	30-Jun-05	2320-31697	EE:UB	N/A	L	U	62	N
North	30-Jun-05	2320-31698	UB:EE	N/A	L	U	62	N
North	30-Jun-05	2320-31699	UB:EE	N/A	L	U	62	N
North	30-Jun-05	2320-31700	UB:EE	N/A	L	U	62	N
North	18-Jun-04	2320-31663	RR(M):UB[9]	EE:GK(M)	A3Y	F	66	R 28 Jul
North	30-Jun-05	2370-39961	PU:ZR(M)	N/A	AHY	M	66	N
North	28-Jul-05	2370-39914	PU:GG(M)	N/A	HY	U	66	N
North	3-Jul-05	2370-40014	PU:VY(M)	N/A	AHY	F	68	N
North	6-Aug-01	2320-31592	GO(M):EE	N/A	5Y	M	68	RS
North	3-Jul-05	2320-31692	EE:UB	N/A	L	U	68	N
North	3-Jul-05	2320-31693	UB:EE	N/A	L	U	68	N
North	3-Jul-05	2320-31694	EE:UB	N/A	L	U	68	N
North	3-Jul-05	2320-31695	EE:UB	N/A	L	U	68	N
North	INA	INA	UB:EE	N/A	AHY	F	80	RS
North	5-Jul-02	2370-39963	PU:BG(M)	BD(P):Zs[10]	4Y	M	80	R 7 Jul
North	30-Jul-05	2370-39980	WO(M):PU	N/A	HY	U	80	N
North	30-Jul-05	2370-39981	PU:GW(M)	N/A	HY	U	80	N
North	6-Aug-04	3500-68972	GG(M):XX	N/A	SY	F	91	R 17 Jul
North	31-Jul-05	2370-40019	KW(M):PU	N/A	HY	U	91	N
North	29-Jul-05	2370-39979	WD(M):PU	N/A	HY	U	H1[11]	N
North	29-Jul-05	2370-39977	WW(M):PU	N/A	HY	U	H2[11]	N
North	2-Aug-05	2370-40020	OD(M):PU	N/A	HY	U	H3[11]	N

[1] N/A = not applicable; INA = information not available.
[2] **Color-band codes**: EE = electric yellow federal band, XX = standard silver federal band, PU = pumpkin federal band, Zs = gold federal band, (M) = metal pin striped band, (P) = full plastic band, UB = unbanded, W = white, R = red, G = green, Z = gold, D = dark/navy blue, B = light blue, K = black, O = orange, Y = yellow, V = violet. 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] Old combination included only if rebanded in 2005.
[4] **Age in 2005**: L = nestling, HY = hatch year, SY = 2 years, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = 4 years, A4Y = 4 years or older, etc.
[5] **Sex codes**: F = female, M = male, U = sex unknown.
[6] **Observation status codes**: N = new capture, R = recapture followed by date recaptured, RS = resight.
[7] Original federal band number: 2140-66561. Band was replaced because of fading and chipping of the color.
[8] Original federal band number: 2140-66568. Band was replaced because of fading and chipping of the color.
[9] Federal band removed because of leg injury.
[10] Original federal band number: 2140-66566. Band was replaced because of fading and chipping of the color.
[11] Captured as fledgling; nest origin within Pahranagat North undetermined.

Table 3.3. Unpaired, Resident Willow Flycatchers and Individuals for which Residency and/or Breeding Status Could Not Be Confirmed, Pahranagat NWR, 2005

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Old Color Combination[1, 2, 3]	Age[3]	Sex[5]	Territory	Observation status[6]
North	25-Jun-03	2320-31458	EE:ZB(M)	EE:UB	3Y	M	T30	R 22 May, unpaired, detected 14 May–8 Jul
North	27-Jun-03	2320-31468	EE:RO(M)	EE:UB	3Y	M	T51	R 1 Jun, unpaired, detected 20 May–24 Jul
South	18-May-04	2320-31595	GV(M):EE	N/A	A3Y	M	T52	RS, unpaired, detected 20 May–29 Jun
North	14-May-04	2320-31589	EE:YD(M)	N/A	A3Y	M	T55	RS, unpaired, detected 11 May–31 Jul
North	22-Jun-05	2370-40013	PU:WD(M)	N/A	SY	M	T57	N; R 31 Jul, unpaired, detected 21 Jun–31 Jul
North	1-Jun-05	2370-39911	RW(M):PU	N/A	AHY	M	T63	N, unpaired, detected 13 May–27 Jul
North	14-Jul-01	2320-31597	EE:BW(M)	EE:UB	A6Y	M	T64	R 30 May, unpaired, detected 13 May–30 Jul
North	18-May-04	2320-31593	EE:WV(M)	N/A	A3Y	M	T65	RS, unpaired, detected 14 May–9 Jul
North	15-May-04	2320-31591	GY(M):EE	N/A	A3Y	M	T67	RS, unpaired, detected 17 May–25 Jul
North	28-Jun-05	2370-39959	VB(M):PU	N/A	SY	M	T90	N, unpaired, detected 16 Jun–28 Jun
West	N/A	N/A	UB:UB	N/A	AHY	U	F56	RS, detected 9 Jun
North	17-May-05	2370-39971	WZ(M):PU	N/A	AHY	U	F93	N, suspected migrant, not detected post-capture
North	28-Jul-05	2370-39915	PU:RZ(M)	N/A	AHY	M	F94	N, not detected post-capture[8]
North	29-Jul-05	2370-39978	WR(M):PU	N/A	AHY	F	F95	N, not detected post-capture[9]
North	2-Aug-05	2370-40021	KY(M):PU	N/A	SY	M	F96	N, not detected post-capture[8]
MAPS	23-Jun-04	2320-31484	UB:EE	N/A	SY	U	F97	R 16 Jun, not detected post-capture[10]

[1] N/A = not applicable.
[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, W = white, R = red, G = green, Z = gold, D = dark/navy blue, B = light blue, K = black, O = orange, Y = yellow, V = violet. 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] Old combination included only if rebanded in 2005.
[4] **Age in 2005**: SY = 2 years, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = four years, A4Y = 4 years or older, etc.
[5] **Sex codes**: F = female, M = male, U = sex unknown.
[6] **Location code**: T = territorial individual detected for at least 7 days, F = individual detected for less than 7 days.
[7] **Observation status codes**: N = new capture, R = recapture followed by date recaptured, RS = resight.
[8] No unbanded territorial males were known pre-capture.
[9] No unbanded females were known pre-capture; therefore, breeding status for this individual at this site is unknown.
[10] Captured in passive net at MAPS station.

Field personnel captured and color-banded 14 new adults and recaptured 14 adult flycatchers banded in previous years, including 7 individuals originally banded as nestlings (1 from 2002, 3 from 2003, and 3 from 2004). Of the returning nestlings, four (two females and two males) were part of breeding pairs, two were unpaired males, and one was not detected post capture (see Table 3.20 for juvenile dispersal data). One resighted, breeding female was a returning nestling, but we were unable to recapture her to determine the study area and year she was originally banded. We banded 21 nestlings from 7 nests and 4 fledglings from 3 nests that were too high to band. Three additional fledglings were banded for which the nest origin could not be determined. We captured one fledgling previously banded as a nestling.[1] Of all the adults detected, only one, for which residency and/or breeding status could not be confirmed, remained unbanded.

Littlefield – At Littlefield, we detected two unpaired individuals for a single day in mid-May. One later moved to Mesquite West where it occupied a breeding territory, and the other was not detected again (Table 3.4). No breeding was documented at Littlefield in 2005. Of the two individuals detected, one was banded and the band status for the other was undetermined.

Table 3.4. Willow Flycatchers Resighted at Littlefield, AZ, in 2005

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Location[5]	Observation Status[6]
North	3-Jun-04	2320-31490	EE:OO(M)	A3Y	M	F41	RS, detected 15 May; occupied territory 60 at Mesquite West 25 May–16 Jul
North	INA	INA	undetermined	AHY	U	F42	Detected 15 May

[1] **INA = information not available**

[2] **Color-band codes**: EE = electric yellow federal band, (M) = metal pin striped band, O = orange, undetermined = presence of color-bands could not be determined. 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 2005**: AHY = 2 years or older, A3Y = 3 years or older.

[4] **Sex codes**: M = male, U = unknown.

[5] **Location Code**: F = individual detected for less than 7 days.

[6] **Observation status codes**: RS = resight.

Mesquite – We detected 19 resident, adult willow flycatchers from 12 territories at Mesquite. Of the 12 territories recorded at Mesquite, 7 consisted of breeding individuals and 5 consisted of unpaired individuals (Tables 3.5 and 3.6). No returning nestlings were detected, and no polygyny was recorded at Mesquite in 2005.

Field personnel captured and color-banded four new adults and recaptured three adult flycatchers banded in previous years. We resighted 12 other returning banded individuals; of these, band combinations could not be confirmed on 2 individuals, and a third individual was missing a foot and could not be uniquely identified. We banded 13 nestlings from seven nests. All the adults that were resident at Mesquite in 2005 were banded.

Mormon Mesa – We detected 13 resident, adult willow flycatchers from seven territories at Mormon Mesa. In addition to resident adults, we detected one individual for which residency could not be confirmed (Tables 3.7 and 3.8). Of the seven territories recorded at Mormon Mesa, five consisted of breeding individuals and two consisted of unpaired individuals. No polygyny was recorded at Mormon Mesa in 2005.

[1] Individuals banded as nestlings and later captured as 2005 fledglings and provided with a second colored metal band are not included in the total of nestlings banded.

Table 3.5. Paired and Nestling Willow Flycatchers Banded and Resighted at Mesquite, NV, in 2005

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Territory	Observation status[5]
West	1-Aug-03	2320-31445	EE:WK(M)	A4Y	F	2	R 12 Jul
West	4-Aug-00	2320-31614	VY(M):EE	6Y	M	2	RS
West	21-Jul-05	2360-59716	UB:EE	L	U	2	N
West	6-Jul-04	2320-31573	WY(M):EE	A3Y	F	21	RS
West	INA	INA	no foot:EE[6]	AHY	M	21	RS
West	19-Jul-05	2360-59714	UB:EE	L	U	21	N
West	19-Jul-05	2360-59715	UB:EE	L	U	21	N
West	31-Jul-03	2320-31444	RW(M):EE	A4Y	F	30	RS
West	3-Jun-05	2370-40012	OY(M):PU	AHY	M	30	N
West	15-Jul-05	2320-31688	EE:UB	L	U	30	N
West	15-Jul-05	2320-31689	EE:UB	L	U	30	N
West	INA	INA	banded:XX	AHY	F	51	RS
West	7-Jul-00	2320-92365	RG(M):XX	6Y	M	51	RS
West	2-Jul-05	2320-31696	UB:EE	L	U	51	N
West	14-Jun-04	2320-31655	VW(M):EE	3Y	F	60	RS
West	3-Jun-04	2320-31490	EE:OO(M)	A3Y	M	60	RS
West	13-Jul-05	2320-31690	UB:EE	L	U	60	N
West	13-Jul-05	2320-31691	EE:UB	L	U	60	N
Bunker Farm	21-Jun-05	2370-39957	PU:YB(M)	AHY	F	70	N
Bunker Farm	22-May-04	2320-31652	WG(M):EE	A3Y	M	70	RS
Bunker Farm	21-Jun-05	2360-59701	UB:EE	L	U	70	N
Bunker Farm	21-Jun-05	2360-59702	UB:EE	L	U	70	N
Bunker Farm	21-Jun-05	2360-59703	UB:EE	L	U	70	N
Bunker Farm	9-Aug-05	2360-59741	UB:EE	L	U	70	N
Bunker Farm	9-Aug-05	2360-59742	EE:UB	L	U	70	N
Bunker Farm	23-Jul-03	2320-31486	YV(M):EE	3Y	F	72	R 8 Jun
Bunker Farm	8-Jun-05	2370-39954	BO(M):PU	AHY	M	72	N

[1] INA = information not available.

[2] **Color-band codes**: EE = electric yellow federal band, XX = standard silver federal band, PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, K = black, R = red, O = orange, G = green, V = violet, Y = yellow, W = white, B = light blue, banded = bands were present but colors could not be confirmed. 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 2005**: L = nestling, SY = 2 years, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = 4 years, A4Y = 4 years or older, etc.

[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] Bird was missing the left leg below the intertarsal joint.

Table 3.6. Unpaired, Resident Willow Flycatchers Banded and Resighted at Mesquite, NV, 2005

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Location[5]	Observation status[6]
East	8-Jun-05	2370-39912	VK(M):PU	SY	M	T10	N, unpaired, detected 3–24 Jun
West	INA	INA	banded:XX	AHY	M	T33	RS, unpaired, detected 10–31 Jul
West	26-Jul-01	2390-92475	XX:WY(M)	5Y	M	T50	RS, unpaired, detected 12 May–31 Jul
Bunker Farm	4-Jul-01	2390-92434	UB:XX[7]	6Y	M	T71	R 10 Jun, unpaired, detected 1–21 Jun
Bunker Farm	12-Jun-03	2320-31428	EE:GZ(M)	3Y	M	T73	RS, unpaired, detected 1 Jun–6 Jul[8]

[1] INA = information not available.

[2] **Color-band codes**: EE = electric yellow federal band, XX = standard silver federal band, PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, G = green, V = violet, K = black, Y = yellow, W = white, Z = gold, banded = bands were present but colors could not be confirmed. 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 2005**: SY = 2 years, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = 4 years, A4Y = 4 years or older, etc.

[4] **Sex codes**: M = male, U = sex unknown.

[5] **Location Codes**: T = territorial individual detected for at least 7 days.

[6] **Observation status codes**: N = new capture, R = recapture followed by date recaptured, RS = resight.

[7] No bands were placed on the left leg because of a pre-existing leg injury.

[8] This individual detected at Mormon Mesa 11–23 Jul.

Table 3.7. Paired, Nestling, and Fledgling Willow Flycatchers Banded and Resighted at Mormon Mesa, NV, 2005

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Old Color Combination[1,2]	Age[3]	Sex[4]	Territory	Observation status[5]
Virgin River #2	8-Jul-04	2320-31618	EE:GB(M)	EE:UB	SY	F	10	R 26 Jul
Virgin River #2	26-Jul-05	2370-40017	PU:WR(M)	N/A	SY	M	10	N
North	INA	INA	UB:EE	N/A	AHY	F	34	RS
North	N/A	N/A	UB:UB	N/A	AHY	M	34	RS
Virgin River #2	INA	INA	UB:EE	N/A	AHY	F	35	RS
Virgin River #2	27-Jun-01	2390-92421	XX:WR(M)	N/A	5Y	M	35[6]	R 11 Jul
North	N/A	N/A	UB:UB	N/A	AHY	F	40	RS
North	1-Jul-98	1710-20638	YR(M):XX	N/A	A9Y	M	40	RS
North	25-Jun-05	2360-59704	UB:EE	N/A	L	U	40	N
North	25-Jun-05	2360-59705	UB:EE	N/A	L	U	40	N
Virgin River #2	N/A	N/A	UB:UB	N/A	AHY	F	50	RS
Virgin River #2	15-Jul-04	2320-31517	EE:OR(M)	N/A	3Y	M	50[7]	RS
Virgin River #2	12-Jun-03	2320-31428	EE:GZ(M)	N/A	3Y	M	50[8]	R 11 Jul

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

[2] **Color-band codes**: EE = electric yellow federal band, XX = standard silver federal band, PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, W = white, Y = yellow, B = light blue, O = orange, R = red, G = green, Z = gold. 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 2005**: L = nestling, SY = 2 years, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = 4 years, A4Y = 4 years or older, etc.

[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] This male was observed in Mormon Mesa North from 27 May–6 Jun.

[7] This male occupied territory 50 from 31 May to 29 Jun. Between 29 Jun and 11 Jul he was displaced by EE:GZ(M) and was detected ~60 m away 24–30 Jul.

[8] This male was observed in Mesquite Bunker Farm from 1 Jun to 6 Jul, then in this territory from 11 to 23 Jul.

Table 3.8. Unpaired, Resident Willow Flycatchers and Individuals for which Residency and/or Breeding Status Could Not Be Confirmed, Mormon Mesa, NV, 2005

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Location[5]	Observation Status[6]
Delta West	27-May-04	2320-31653	WV(M):EE	3Y	M	T30	RS, unpaired, detected 14–30 May[7]
Virgin River #1 North	INA	INA	banded	AHY	M	T71	RS, unpaired, detected 16 May and 14 Jun[8]
Virgin River #1 North	INA	INA	undetermined	AHY	U	F70	Detected 16 May[8]

[1] INA = information not available.

[2] **Color-band codes**: EE = electric yellow federal band, (M) = metal pin striped band, W = white, V = violet, banded = bird has color-bands but combination undetermined, undetermined = presence of bands could not be determined. Color combinations are read as the bird's left leg and right leg, top to bottom; two letters designate every band; color-band designations for right and left legs are separated with a colon.

[3] **Age in 2004**: AHY = 2 years or older, 3Y = 3 years.

[4] **Sex codes**: M = male, U = sex unknown.

[5] **Location code**: T = territorial individual detected for at least 7 days, F = individual detected for less than 7 days.

[6] **Observation status codes**: RS = resight.

[7] Monitoring of Delta West ceased after 30 May because access to the site was denied by a local landowner. This individual was detected 30 July in Virgin River #2.

[8] Site not monitored 17 May–8 Jun because high flows in the Virgin River made the site inaccessible.

Field personnel captured and color-banded one new adult and recaptured three adult flycatchers banded in previous years, including one female banded as a nestling in 2004. The returning nestling was part of a breeding pair in 2005 (see Table 3.20 for juvenile dispersal data). We resighted five other returning banded individuals, including two females that were known returning nestlings; however, study area and year banded could not be determined because we were unable to recapture these individuals. We banded two nestlings from one nest. Of the resident adults, three remained unbanded. For two individuals for which residency and/or breeding status could not be determined, banding status could not be confirmed for one, and the band combination could not be confirmed for the other. Of all the adults detected at Mormon Mesa in 2005, 71% were banded.

Muddy River – We detected 11 resident, adult willow flycatchers from seven territories at the Muddy River and detected an additional adult flycatcher for which residency and breeding status could not be determined. Of the seven territories recorded, six consisted of breeding individuals and one consisted of an unpaired individual (Tables 3.9 and 3.10). One male was polygynous with three females.

Field personnel captured and color-banded four new adults and recaptured one individual banded as a nestling at Roosevelt Lake, Arizona in 2003 (see Table 3.20 for juvenile dispersal data). We resighted four other returning banded individuals, of which three were returning nestlings; however, study area and year banded for returning nestlings could not be determined because we were unable to recapture these individuals. We banded four nestlings from two nests and captured one fledgling from one nest. Three breeding adults remained unbanded.

Grand Canyon – At River Mile 274.5 we detected a single, unpaired individual that was captured and color-banded (Table 3.11). No breeding was recorded at Grand Canyon in 2005.

Table 3.9. Paired, Nestling, and Fledgling Willow Flycatchers Banded and Resighted at the Muddy River Delta, NV, 2005

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Old Color Combination[1,2,3]	Age[4]	Sex[5]	Territory	Observation status[6]
Overton WMA	INA	INA	UB:EE	N/A	AHY	F	2	RS
Overton WMA	26-Jun-03	2370-39955[7]	BV(M):PU	Vs:UB	3Y	M	2, 4, 60	R 9 Jun
Overton WMA	9-Jun-05	2370-39956	PU:ZZ(M)	N/A	SY	F	4	N
Overton WMA	INA	INA	EE:UB	N/A	AHY	F	6	RS
Overton WMA	9-Jul-05	2370-39975	WY(M):PU	N/A	AHY	M	6	N
Overton WMA	3-Aug-05	2370-39966	YB(M):PU	N/A	HY	U	6	N
Overton WMA	INA	INA	UB:EE	N/A	AHY	F	36	RS
Overton WMA	N/A	N/A	UB:UB	N/A	AHY	M	36	RS
Overton WMA	3-Aug-05	2360-59787	UB:EE	N/A	L	U	36	N
Overton WMA	24-Jul-02	2320-31613	DR(M):EE	N/A	A5Y	F	51	RS
Overton WMA	N/A	N/A	UB:UB	N/A	AHY	M	51	RS
Overton WMA	6-Aug-05	2360-59785	EE:UB	N/A	L	U	51	N
Overton WMA	6-Aug-05	2360-59786	EE:UB	N/A	L	U	51	N
Overton WMA	6-Aug-05	2360-59788	UB:EE	N/A	L	U	51	N
Overton WMA	N/A	N/A	UB:UB	N/A	AHY	F	60	RS

[1] N/A = not applicable, INA = information not available.
[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, Vs = violet federal band, (M) = metal pin striped band, UB = unbanded, W = white, Y = yellow, B = light blue, D = dark blue, Z = gold, G = green, R = red, V = violet, 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] Old combination included only if rebanded in 2005.
[4] **Age in 2005**: L = nestling, HY = hatch year, SY = 2 years, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = 4 years, A4Y = 4 years or older, etc.
[5] **Sex codes**: F = female, M = male, U = sex unknown.
[6] **Observation status codes**: N = new capture, R = recapture followed by date recaptured, RS = resight.
[7] Original federal band number: 1490-89889.

Table 3.10. Unpaired, Resident Willow Flycatchers and Individuals for which Residency and/or Breeding Status Could Not Be Confirmed, Muddy River Delta, NV, in 2005

Site	Date Banded	Federal Band #	Color Combination[1]	Age[2]	Sex[3]	Location[4]	Observation Status[5]
Overton WMA	9-Jul-05	2370-39976	PU:KV(M)	SY	M	T5	N, unpaired, detected 3–29 Jul
Overton WMA	3-Aug-05	2370-39965	PU:GB(M)	AHY	U	F7	N, not detected post-capture[6]

[1] **Color-band codes**: PU = pumpkin federal band, (M) = metal pin striped band, B = light blue, G = green, V = violet, K = black. 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 2005**: SY = 2 years, AHY = 2 years or older.
[3] **Sex codes**: M = male, U = sex unknown.
[4] **Location codes**: T = territorial individual detected for at least 7 days, F = individual detected for less than 7 days.
[5] **Observation status codes**: N = new capture.
[6] This could have been the male from territory 36, who was not resighted after 3 Aug.

Table 3.11. Summary of Unpaired Willow Flycatchers Banded at Grand Canyon, AZ, 2005

Site	Date Banded	Federal Band #	Color Combination[1]	Age[2]	Sex[3]	Location[4]	Observation status[5]
RM 274.5	17-Jun-05	2370-39913	PU:DW(M)	AHY	M	T1	N, unpaired, detected 1–20 Jun

[1] **Color-band codes**: PU = pumpkin federal band, D = dark/navy blue, W = white, (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 2005**: AHY = 2 years or older.

[3] **Sex codes**: M = male.

[4] **Location codes**: T = territorial individual detected for at least 7 days.

[5] **Observation status codes**: N = new capture.

Topock – We detected 36 resident, adult willow flycatchers from 21 territories at Topock. In addition to resident adults, we detected five individuals for which residency and/or breeding status could not be confirmed (Tables 3.12 and 3.13). Of these five, three were detected for only one day in May and were suspected to be migrants. Of the 21 territories recorded at Topock, 18 consisted of paired individuals and 3 consisted of unpaired individuals. Of the breeding individuals, three males were each polygynous with two females.

Table 3.12. Paired, Nestling, and Fledgling Willow Flycatchers Banded and Resighted at Topock, Havasu NWR, AZ, 2005

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Old Color Combination[1,2,3]	Age[4]	Sex[5]	Territory	Observation status[6]
Glory Hole	N/A	N/A	UB:UB	N/A	AHY	F	4	RS
Glory Hole	1-Jul-04	2320-31567	YD(M):EE	N/A	3Y	M	4	RS
Glory Hole	6-Aug-05	2360-59732	UB:EE	N/A	L	U	4	N
In Between	N/A	N/A	UB:UB	N/A	AHY	F	5	RS
In Between	17-May-04	2320-31414	RG(M):EE	N/A	A3Y	M	5	RS
800M	23-Jun-04	2320-31565	EE:KD(M)	N/A	A3Y	F	6	RS
800M	N/A	N/A	UB:UB	N/A	AHY	M	6, 33	RS
Glory Hole	N/A	N/A	UB:UB	N/A	AHY	F	15	RS
Glory Hole	25-Jul-04	2320-31560	EE:GY(M)	N/A	3Y	M	15, 21	R 9 Jun
Pierced Egg	N/A	N/A	UB:UB	N/A	AHY	F	16	RS
Pierced Egg	23-Jun-05	2370-40056	PU:OK(M)	N/A	AHY	M	16, 38[7]	N
Pierced Egg	INA	INA	UB:EE	N/A	AHY	F	17	RS
Pierced Egg	N/A	N/A	UB:UB	N/A	AHY	M	17	RS
Glory Hole	N/A	N/A	UB:UB	N/A	AHY	F	21	RS
Pierced Egg	INA	INA	banded	N/A	AHY	F	32	RS
Pierced Egg	27-Jun-03	1710-20312	BG(M):Vs	UB:Vs	3Y	M	32	R 12 May
800M	2-Jun-03	2320-31526	OD(M):EE	N/A	A4Y	F	33	RS
800M	2-Jul-05	2360-59720	UB:EE	N/A	L	U	33	N
800M	2-Jul-05	2360-59722	EE:UB	N/A	L	U	33	N
800M	6-Aug-05	2360-59733	UB:EE	N/A	L	U	33	N

Table 3.12. Paired, Nestling, and Fledgling Willow Flycatchers Banded and Resighted at Topock, Havasu NWR, AZ, 2005, continued

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Old Color Combination[1,2,3]	Age[4]	Sex[5]	Territory	Observation status[6]
800M	6-Aug-05	2360-59734	EE:UB	N/A	L	U	33	N
PC6-1	20-Jun-05	2370-40055	GZ(M):PU	N/A	AHY	F	34	N
PC6-1	N/A	N/A	UB:UB	N/A	AHY	M	34	RS
Pierced Egg	INA	INA	EE:UB	N/A	AHY	F	38	RS
Pierced Egg	N/A	N/A	UB:UB	N/A	AHY	M	38	RS
Pierced Egg	19-Jul-05	2320-31680	EE:UB	N/A	L	U	38	N
Pierced Egg	19-Jul-05	2320-31681	UB:EE	N/A	L	U	38	N
In Between	1-Jun-03	2320-31577	GW(M):EE	N/A	A4Y	F	40	RS
In Between	N/A	N/A	UB:UB	N/A	AHY	M	40	RS
In Between	14-Jun-05	2360-59719	UB:EE	N/A	L	U	40	N
In Between	18-Jul-05	2360-59729	EE:UB	N/A	L	U	40	N
In Between	18-Jul-05	2360-59730	UB:EE	N/A	L	U	40	N
In Between	18-Jul-05	2360-59731	EE:UB	N/A	L	U	40	N
In Between	N/A	N/A	UB:UB	N/A	AHY	F	43	RS
In Between	25-Jul-04	2320-31559	OK(M):EE	N/A	3Y	M	43, 50	R 14 Jun
In Between	16-Jul-05	2320-31675	UB:EE	N/A	L	U	43	N
In Between	16-Jul-05	2320-31676	EE:UB	N/A	L	U	43	N
800M	3-Jul-03	2320-31584	EE:YK(M)	N/A	4Y	F	50	RS
800M	6-Aug-04	2320-31521	EE:DY(M)	N/A	3Y	F	55	RS
800M	22-Jun-04	2320-31541	EE:KW(M)	N/A	3Y	M	55	RS
In Between	8-Jul-02	2110-78841	B(HP)/Y(HP):BEs	N/A	4Y	F	57	RS
In Between	N/A	N/A	UB:UB	N/A	AHY	M	57	RS
250M	8-Jul-04	2320-31515	EE:WY(M)	N/A	SY	F	58	RS
250M	17-Jun-04	2320-31418	EE:RR(M)	N/A	SY	M	58	RS
In Between	N/A	N/A	UB:UB	N/A	AHY	F	76	RS
In Between	INA	INA	Bs:banded	N/A	A4Y	M	76	RS

[1] N/A = not applicable; INA = information not available.

[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, BEs = berry federal band, Bs = blue federal band, Vs = violet federal band, (M) = metal pin striped band, (HP) = half plastic bands/bands cut to half the height, UB = unbanded, W = white, Y = yellow, B = light blue, Z = gold, D = dark blue, G = green, O = orange, R = red, V = violet, K = black, banded = bird has color-bands but combination undetermined. 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] Old combination included only if rebanded in 2005.

[4] **Age in 2005**: L = nestling, SY = 2 years, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = 4 years, A4Y = 4 years or older, etc

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

[6] **Observation status codes**: N = new capture, R = recapture followed by date recaptured, RS = resight.

[7] Male nested successively, rather than simultaneously, with two females.

Table 3.13. Unpaired, Resident Willow Flycatchers and Individuals for which Residency and/or Breeding Status Could Not Be Confirmed, Topock, Havasu NWR, AZ, 2005

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Old Color Combination	Age[3]	Sex[4]	Location[5]	Observation Status[6]
The Wallows	N/A	N/A	UB:UB	N/A	AHY	M	T8	RS, unpaired, detected 16–29 Jun
Pipes 3	7-Jul-04	2320-31424	DB(M):EE	UB:EE	SY	M	T20	R 20 Jun, unpaired, detected 15 May–20 Jun
PC6-1	N/A	N/A	UB:UB	N/A	AHY	M	T35	RS, unpaired, detected 19 May–13 Jun
Pipes 1	INA	INA	undetermined	N/A	AHY	M	F11	Detected 18 May, suspected migrant
BHCO Trap 6[7]	INA	INA	undetermined	N/A	AHY	M	F52	Detected 30 May, suspected migrant
BHCO Trap 6[7]	INA	INA	undetermined	N/A	AHY	U	F52	Detected 30 May, suspected migrant
Pipes 3	N/A	N/A	UB:UB	N/A	AHY	M	F75	RS, detected 13–15 May
Pipes 1	N/A	N/A	undetermined	N/A	AHY	U	F83	Detected 6 July

[1] N/A = not applicable; INA = information not available.

[2] **Color-band codes**: D = dark/navy blue, EE = electric yellow federal band, G = green, K = black, (M) = metal pin striped band, O = orange, R = red, UB = unbanded, Y = yellow, undetermined = presence of bands could not be determined. Color combinations are read as the bird's left leg and right leg, top to bottom; two letters designate every band; color-band designations for right and left legs are separated with a colon.

[3] **Age in 2004**: SY = 2 years, AHY = 2 years or older.

[4] **Sex codes**: M = male, U = sex unknown.

[5] **Location codes**: T = territorial individual detected for at least 7 days, F = individual detected for less than 7 days.

[6] **Observation status codes**: R = recapture followed by date recaptured, RS = resight.

[7] Not a formal survey site, flycatchers detected en route.

Field personnel captured and color-banded two new adults and recaptured four adults banded in previous years. Of the recaptured adults, two were returning nestlings, one of which was banded at Roosevelt Lake, Arizona (see Table 3.20 for juvenile dispersal data). We resighted the color combinations of 13 other returning banded adults, of which 2 females were returning nestlings. We were unable to recapture the returning nestlings, and study area and year banded could not be determined. We banded 13 nestlings from seven nests. The color-band combinations of two breeding individuals could not be confirmed. For individuals for which residency and/or breeding status could not be confirmed, four were of unknown band status and one was unbanded. Of the resident individuals, 15 remained unbanded.

Bill Williams – We detected six resident willow flycatchers from four territories at Bill Williams. In addition to resident adults, we detected three individuals for one day that were most likely migrants (Tables 3.14 and 3.15). Of the four territories recorded at Bill Williams, two consisted of paired individuals and two consisted of unpaired individuals. No polygyny was recorded at Bill Williams in 2005.

Field personnel captured and color-banded five new adults. One breeding adult and two suspected migrants were unbanded. Banding status was undetermined for one suspected migrant. We banded three nestlings from one nest. No returning nestlings were detected at Bill Williams in 2005.

Table 3.14. Paired and Nestling Willow Flycatchers Banded and Resighted at Bill Williams NWR, AZ, 2005

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Territory	Observation status[5]
Site 3	24-May-05	2370-39932	BK(M):PU	AHY	F	41	N
Site 3	24-May-05	2370-40052	KV(M):PU	AHY	M	41	N
Site 4	N/A	N/A	UB:UB	AHY	F	59	RS
Site 4	6-Aug-05	2370-40032	GR(M):PU	AHY	M	59	N
Site 4	8-Jul-05	2360-59725	EE:UB	L	U	59	N
Site 4	8-Jul-05	2360-59727	EE:UB	L	U	59	N
Site 4	8-Jul-05	2360-59728	EE:UB	L	U	59	N

[1] N/A = not applicable.
[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, B = light blue, G = green, R = red, K = black, V = violet. 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 2005**: L = nestling, AHY = 2 years or older.
[4] **Sex codes**: F = female, M = male, U = sex unknown.
[5] **Observation status codes**: N = new capture.

Table 3.15. Unpaired, Resident Willow Flycatchers and Individuals for which Residency and/or Breeding Status Could Not Be Confirmed, Bill Williams NWR, AZ, 2005

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Location[5]	Observation status[6]
Site 3	8-Jun-05	2370-40054	PU:OY(M)	SY	M	T7	N, unpaired, detected 31 May–8 Jun
Site 3	24-May-05	2370-40053	KR(M):PU	AHY	U	T42	N, unpaired, detected 18 May–12 Jul
Site 8	N/A	N/A	UB:UB	AHY	M	F40	RS, detected 17 May, suspected migrant
Site 1	N/A	N/A	UB:UB	AHY	M	F80	RS, detected 7 Jun, suspected migrant
Mineral Wash	INA	INA	undetermined	AHY	U	F82	Detected 23 Jun, suspected migrant

[1] N/A = not applicable, INA = information not available.
[2] **Color-band codes**: PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, O = orange, R = red, Y = yellow, K = black, undetermined = presence of bands could not be determined. Color combinations are read as the bird's left leg and right leg, top to bottom; two letters designate every band; color-band designations for right and left legs are separated with a colon.
[3] **Age in 2005**: SY = 2 years, AHY = 2 years or older.
[4] **Sex codes**: M = male, U = sex unknown.
[5] **Location codes**: T = territorial individual detected for at least 7 days, F = individual detected for less than 7 days.
[6] **Observation status codes**: N = new capture.

NON-MONITORING SITE

Key Pittman Wildlife Management Area – Field personnel captured and color-banded one new adult male, and banded four nestlings from one nest (Table 3.16).

Table 3.16. Willow Flycatchers Color-Banded at Key Pittman Wildlife Management Area, NV, in 2005

Site	Date Banded	Federal Band #	Color Combination[1]	Age[2]	Sex[3]	Territory	Observation status[4]
Key Pittman	6-Jul-05	2360-59706	UB:EE	L	U	9A	N
Key Pittman	6-Jul-05	2360-59711	UB:EE	L	U	9A	N
Key Pittman	6-Jul-05	2360-59712	EE:UB	L	U	9A	N
Key Pittman	6-Jul-05	2360-59713	EE:UB	L	U	9A	N
Key Pittman	29-Jun-05	2370-39960	BW(M):PU	AHY	M	B1	N

[1] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, B = light blue, W = white. 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 2005**: L = nestling, AHY = 2 years or older.
[3] **Sex codes**: M = male, U = sex unknown.
[4] **Observation status codes**: N = new capture.

COLOR-BANDING AND RESIGHTING DOWNSTREAM OF PARKER DAM

From 10 to 30 June 2005, we recorded 28 willow flycatcher detections at nine sites along the Colorado River from Hoge Ranch (Imperial NWR) south to Hunter's Hole, and along the Gila River near Yuma (see Chapter 2 for details). All these detections were recorded from 10 to 20 June. From 10 to 17 June at three sites, field personnel captured and color-banded nine new adults, of which four were second-year birds (Table 3.17). Unsuccessful netting attempts were made at Gadsden and Hunter's Hole on 12 June. None of the color-banded individuals were detected post-capture, and other than a single detection at Walker Lake on 6 July (see Chapter 2, Table 2.2 and p. 42), no flycatcher detections were recorded at any sites south of Bill Williams after 20 June, suggesting these individuals were northbound migrants.

Table 3.17. Willow Flycatchers Color-Banded along the Lower Colorado River South of the Bill Williams NWR to the Mexico Border, 2005

Site	Date Banded	Federal Band #	Color Combination[1]	Age[2]	Sex[3]	Observation status[4]
Great Blue Heron	10-Jun-05	2370-39972	VV(M):PU	AHY	U	N
Gadsden Bend	13-Jun-05	2370-39973	VV(M):PU	SY	U	N
Gadsden Bend	13-Jun-05	2370-40033	VV(M):PU	SY	U	N
Gadsden Bend	14-Jun-05	2370-40034	VV(M):PU	AHY	U	N
Gadsden Bend	14-Jun-05	2370-40035	VV(M):PU	SY	U	N
Hoge Ranch	15-Jun-05	2370-39974	VV(M):PU	SY	U	N
Gadsden Bend	17-Jun-05	2370-39933	VV(M):PU	AHY	U	N
Gadsden Bend	17-Jun-05	2370-39934	VV(M):PU	AHY	U	N
Gadsden Bend	17-Jun-05	2370-39935	VV(M):PU	AHY	U	N

[1] **Color-band codes**: PU = pumpkin federal band, (M) = metal pin striped band, V = violet. 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 2005**: SY = 2 years, AHY = 2 years or older.
[3] **Sex codes**: U = sex unknown.
[4] **Observation status codes**: N = new capture.

On 17 May, a Southwestern Willow Flycatcher banded as a nestling in 2003 or 2004 was resighted at River Mile 33. This individual responded to playback with primary song (*fitz-bews*), and was not detected during subsequent visits through the end of July. Because we were unable to recapture this individual, its identity could not be determined. It is likely this individual was a northbound migrant.

ADULT BETWEEN-YEAR RETURN AND DISPERSAL

In 2004 we identified 108 adult, resident willow flycatchers at the life history study areas, Littlefield, Muddy River, Grand Canyon, and Bill Williams, of which 42 (39%) were detected in 2005 (Table 3.18). Of the returning adults, 5 (12%) were detected at a different study area than where they were detected in 2004 (Table 3.19). The median dispersal distance for all returning adult flycatchers exhibiting between-year movements in 2005 was 24 km (min = 21 km, max = 67 km).

Table 3.18. Adult Willow Flycatcher Annual Return from 2004 to 2005

Study Area	# Identified in 2004	# of 2004 Birds Detected in 2005	% Return	% Return to Same Site
Pahranagat	27	12	44	100
Littlefield	3	2	67	0
Mesquite	32	10	31	100
Mormon Mesa	14	4	29	50
Muddy River	1	0	0	---
Grand Canyon	2	1	50	0
Topock	27	13	48	100
Bill Williams	2	0	0	---
Total	**108**	**42**	**39**	**88**

Table 3.19. Summary of Adult Willow Flycatcher Between-Year Movements for All Individuals Identified in 2004 and Recaptured or Resighted at a Different Study Area in 2005

Study Area/ Site Detected 2004[1]	Study Area/Site Detected 2005[1]	Distance Moved (km)	Federal Band #	Color Combination[2]	Sex[3]
LIFI/North	MESQ/West	21	2320-31490	EE:OO(M)	M
LIFI/North	MESQ/Bunker Farm	32	2320-31486	YV(M):EE	F
MOME/Virgin River #1	MESQ/Bunker Farm[4]	24	2320-31428	EE:GZ(M)	M
MOME/Virgin River #1	MESQ/Bunker Farm	24	2320-31652	WG(M):EE	M
GRCA/RM 274.5	MOME/Virgin River #2	67	2320-31517	EE:OR(M)	M

[1] MESQ = Mesquite, MOME = Mormon Mesa, LIFI = Littlefield, GRCA = Grand Canyon.

[2] **Color-band codes**: EE = electric yellow federal band, (M) = metal pin striped band, G = green, O = orange, R = red, Z = gold, Y = yellow, V = violet, W = white. Color combinations are read as the bird's left leg and right leg, top to bottom; two letters designate every band; color-band designations for right and left legs are separated with a colon.

[3] **Sex codes**: F = female, M = male.

[4] This individual detected later in 2005 at MOME/Virgin River #2.

JUVENILE BETWEEN-YEAR RETURN AND DISPERSAL

In 2004, we banded 83 nestlings and 8 fledglings at the life history study areas, Littlefield, and Grand Canyon; 9 of these nestlings were known to have died before fledging. Of the 82 remaining 2004 juveniles, 4 (5%) were recaptured and identified in 2005. Of the four returning 2004 juveniles, one was detected at a different study area from where originally banded, and three were detected at the same study area. Six nestlings at Key Pittman WMA were banded in 2004, of which one was recaptured at Pahranagat in 2005. Three individuals originally banded as nestlings in 2003 and one banded in 2002 were also recaptured, all of which returned to the same study area where originally banded (Table 3.20). We also recaptured two individuals originally banded as nestlings in 2003 at Roosevelt Lake, Arizona (Table 3.20). The median dispersal distance for all returning juvenile flycatchers exhibiting between-year movements in 2005 was 193 km (min = 30 km, max = 440 km).

Eight additional returning nestlings from 2003 or 2004 were resighted in 2005 (one at Pahranagat, two at Mormon Mesa, three at Muddy River, two at Topock), but the identity of these individuals was undetermined because we were unable to recapture them.

Table 3.20. Summary of Juvenile Flycatchers Banded as Hatch Year Birds in 2002, 2003, or 2004 and Recaptured or Resighted for the First Time in 2005*

Study Area/ Site Banded	Year Hatched	Study Area/Site Detected 2005[1]	Distance Moved (km)	Federal Band #	Color Combination[2]	Sex[3]
KEPI	2004	PAHR/South	30	2320-31637	BD(M):EE	F
PAHR	2002	PAHR/North	--	2370-39963[4]	PU:BG(M)	M
PAHR/North	2003	PAHR/North	--	2320-31467	EE:BD(M)	M
PAHR/North	2003	PAHR/North	--	2320-31458	EE:ZB(M)	M
PAHR/North	2003	PAHR/North	--	2320-31468	EE:RO(M)	M
PAHR/North	2004	PAHR/MAPS	--	2320-31484	UB:EE	U
PAHR/South	2004	PAHR/North	--	3500-68972	GG(M):XX	F
MESQ/West	2004	MOME/Virgin River #2	40	2320-31618	EE:GB(M)	F
ROOS/Salt River	2003	MUDD/Overton WMA	440	2370-39955[5]	BV(M):PU	M
ROOS/Salt River	2003	TOPO/Pierced Egg	346	1710-20312	BG(M):Vs	M
TOPO/Hell Bird	2004	TOPO/Pipes 3	--	2320-31424	DB(M):EE	M

* Dispersal distances are given for flycatchers that moved between study areas.

[1] KEPI = Key Pittman Wildlife Management Area, PAHR = Pahranagat, MESQ = Mesquite, MOME = Mormon Mesa, ROOS = Roosevelt Lake, AZ, TOPO = Topock Marsh

[2] **Color-band codes**: EE = electric yellow federal band, XX = standard silver federal band, Vs = violet federal band, PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, B = light blue, D = dark/navy blue, G = green, O = orange, R = red, V = violet, Z = gold. Color combinations are read as the bird's left leg and right leg, top to bottom; two letters designate every band; color-band designations for right and left legs are separated with a colon.

[3] **Sex codes**: F = female, M = male, U = sex unknown.

[4] Original federal band number: 2140-66566.

[5] Original federal band number: 1490-89889.

WITHIN-YEAR, BETWEEN-STUDY AREA MOVEMENTS

We detected two within-year, between study area movements in 2005. A male flycatcher who successfully bred at Littlefield in 2004 (EE:OO(M), 2320-31490) returned to the study area in 2005 where it was detected for a single day in mid-May. This individual later moved to Mesquite West where it successfully bred. Another male (EE:GZ(M), 2320-31428) that was unpaired at Mesquite from 1 June to 6 July later moved to Mormon Mesa where it displaced a paired, breeding male.

DISCUSSION

Color-Banding Effort – Overall, 75% of the adult flycatchers detected at the monitoring sites during 2005 were color-banded by the end of the breeding season. This compares to 55% in 2003 and 57% in 2004. We have maintained high overall percentages of banded birds annually over the three years, which has enabled us to detect movements and generate dispersal data. The demographic information collected via observing known individuals in multiple years provides the framework for future analyses of population structure, survivorship, and fecundity. Also, a large number of color-banded flycatchers are vital for detecting flycatcher movements as a response to stochastic events (e.g., fire, drought, flood) at flycatcher breeding sites.

Differences between study areas in the percentage of color-banded individuals are directly related to vegetation density and overall structure, which affect our ability to erect mist-nets in the habitat. For example, in 2003–2005 an average of 80% of the flycatcher population at Pahranagat was color-banded versus 50% at Topock. Pahranangat has a relatively open understory, and personnel are able to deploy a large number of large mist-nets over the entire site, whereas the dense vegetation at Topock only allows for one or two small nets to be deployed in relatively few areas. Because sites with dense vegetation have relatively few open areas, these areas may be used multiple times during any given season and in multiple years, resulting in some resident flycatchers who return each year becoming "net smart" and avoiding the nets during target or passive netting.

Breeding vs. Unpaired Territories – Given the high incidence of unpaired, resident individuals at all the monitoring sites across years, it is apparent that unpaired and floater individuals make up a substantial part of the Virgin/lower Colorado River population. At the monitoring sites, we recorded a total of 73 willow flycatcher territories in 2005. Of these, 49 (67%) consisted of paired flycatchers and 24 (33%) consisted of unpaired individuals. Over three years, the annual proportion of paired and unpaired territories at the monitoring sites has been relatively constant with an average 71 and 29%, respectively. As discussed at length in McLeod et al. (2005), this is not surprising given that the spacing of any territorial bird species in a fragmented landscape excludes some individuals from the breeding population(s). As prime and sub-optimal habitats are filled, the remaining non-breeding individuals must wait for vacancies as unpaired individuals or floaters (Brown 1964, Gill 1995). These non-breeding individuals use adjacent or nearby "sub-optimal" and/or non-breeding habitats unoccupied by breeding individuals. The highly heterogeneous environment found along the Colorado River and its tributaries likely facilitates such habitat use. It has been shown via radiotelemetry that in addition to the well-developed vegetation in which they nest, willow flycatchers also use surrounding non-riparian and sparsely vegetated young riparian habitat adjacent to active breeding sites (Paxton et al. 2003, Cardinal and Paxton 2005). Given the highly dynamic nature of riparian habitats (Periman and Kelly 2000), the vagile nature of willow flycatchers, and the propensity of flycatchers to use successional habitats, it is not surprising that not all individuals breed in any given year. It may be that fragmented, "sub-optimal" riparian habitats adjacent to breeding sites may be crucial to the species as these areas may provide habitat for individuals that serve as population reservoirs and replace other individuals that move or die. Further, a large number of juvenile flycatchers go undetected for up to three years after being banded, and habitat use by these individuals remains largely unknown. Undetected, returning juveniles are likely a portion of the unpaired and floater individuals using these "sub-optimal" habitats.

Adult and Juvenile Between-Year Return and Dispersal – Thirty-nine percent of the adult, resident willow flycatchers identified in 2004 were detected again in 2005. Eighty-eight percent of the returning individuals were detected at the same study area in both years. For 2003–2005, 93% of all adults detected in consecutive years returned to the same site. Adult willow flycatcher return and dispersal data at the monitoring sites for 2003–2005 are consistent with range-wide data (Kenwood and Paxton 2001, Koronkiewicz et al. 2002, Newell et al. 2005) and results from previous years at the study areas (McKernan and Braden 2002, Koronkiewicz et al. 2004, McLeod et al. 2005), with adult flycatchers likely to exhibit high site fidelity to breeding areas.

Of the 11 individuals that were banded as juveniles in 2002, 2003, and 2004 and detected for the first time in 2005, 64% returned to the same study area where originally banded. Since 1997, 78 returning juvenile flycatchers have been recaptured or resighted in subsequent years, of which 30 (38%) dispersed away from the natal area (McKernan and Braden unpublished data; Koronkiewicz et al. 2004; McLeod et al. 2005; this document).

Demographic data collected thus far show high site fidelity exhibited by adult flycatchers and lower natal site fidelity exhibited by juveniles, with juveniles dispersing among study areas annually. Juvenile dispersal within the Virgin/lower Colorado River population(s) is largely limited to this region, and while reciprocal juvenile movements among geographically isolated flycatcher populations of the greater Southwest do occur, they are rare. Only two instances of willow flycatcher immigration from sites outside the Virgin/lower Colorado River region have been recorded since 1997 (McKernan and Braden 2002, this document). Both of these movements were recorded in 2005, with two males originally banded as nestlings in 2003 at Roosevelt Lake recaptured in 2005 at Muddy River and Topock. The individual recaptured at Muddy River was polygynous with three females at the site, and the individual at Topock was paired. Both of these individuals were undetected in 2004. Although movements of this magnitude are infrequent, other instances of dispersal distances greater than 140 km have been reported for Southwestern Willow Flycatcher (Kenwood and Paxton 2001).

These demographic traits fit well with the tenets of contemporary metapopulation theory (Hanski and Simberloff 1997), suggesting the Virgin/lower Colorado River population may be a panmictic sub-population of a greater metapopulation. Occasional juvenile dispersal between sub-populations is likely an important population variable in terms of both gene flow and possibly the establishment of new flycatcher populations. These juvenile movements 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). Physical connectivity of riparian habitats within the greater landscape is crucial in enabling these long-distance movements. Without adequate stop-over habitats and foraging areas, flycatchers attempting long-distance movements are more likely to be exposed to adverse environmental conditions. The degree to which these rare, long-distance juvenile movements affect the population dynamics of Southwestern Willow Flycatcher sub-populations warrants further investigation.

Adult and Juvenile Survivorship – Annual survivorship is defined as the number of individuals that survive from one year to the next, and accurate estimates depend on year-to-year detection of uniquely marked birds. In 2004 we identified 108 adult and 82 juvenile willow flycatchers at the monitoring sites, of which 42 (39%) and 4 (5%), respectively, were detected in 2005. Thus, minimum estimated adult and juvenile survival from 2004 to 2005 was 39 and 5%, respectively. These simple annual percent survivorship calculations assume that all living flycatchers are detected in a given year, and individuals not detected are assumed to have died, unless detected elsewhere. As discussed above, some adults and juveniles go undetected for up to three years after being banded, and simple annual percent survivorship thus underestimates survival. To provide more robust estimates of annual survival, software programs (e.g., White and Burnham 1999) 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 other monitoring sites, we anticipate the application of modeling software in determining detection probabilities and annual, between-year, maximum-likelihood survivorship estimates for adult and juvenile willow flycatcher.

Habitat Change at Littlefield and Mesquite – Abandonment of the Littlefield site by willow flycatchers and the 50% decline[2] in the number of flycatcher territories at Mesquite West in 2005 is likely the result of recent flood events and habitat change along the Virgin River. During January 2005, above-normal precipitation produced flows estimated at 8,000 cubic feet per second (cfs) on Beaver Dam Wash and in excess of 30,000 cfs on the Virgin River. These floods removed much of the vegetation at Littlefield and deposited sediment at Mesquite, which reduced canopy cover in portions of the site via reduced moisture availability (see Chapter 2 for details). Given the highly dynamic nature of riparian habitats, with some patches becoming too dry, too mature, or too sparse for breeding flycatchers, while other patches develop and become suitable for flycatcher breeding, willow flycatchers would be expected to respond to changes in habitat quality. Willow flycatcher demographic data and the habitat requirements of the species correlate well with the recent synthesis of metapopulation theory and landscape ecology (Wiens 1997), with local flycatcher population dynamics strongly influenced by variation in patch quality over space and time (environmental stochasticity) and the connectivity of patches within the greater landscape.

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[2] In 2003 and 2004, 19 and 16 territories, respectively, were recorded at Mesquite West; eight territories were recorded at Mesquite West in 2005.

Logistical Constraints at Mormon Mesa – Monitoring at Mormon Mesa was limited in 2005 by high water levels in the Virgin River, which precluded access to some sites between mid-May and mid-June, and by a local landowner, who denied us permission to access Delta West, the most downstream of the historical breeding sites at Mormon Mesa. Reduced access to these sites may have affected our ability to determine flycatcher occupancy at sites over the season and flycatcher movement patterns.

Increase in the Number of Flycatcher Territories at Muddy River – The threefold increase in the total number of adult willow flycatchers detected at the Muddy River in 2005 compared to 2004 was attributable to monitoring an additional area in 2005. In the area that was monitored in both years, we detected one unpaired male and three individuals of unknown residency in 2004 and one male paired with three different females in 2005.

Surface Water and Flycatcher Breeding at Bill Williams – Flycatcher habitat occupancy and breeding patterns at Bill Williams seem to be correlated with the presence/absence of standing water, with flycatchers breeding only in years when sites contained standing water.[3] Since we began monitoring at Bill Williams in 2003, all flycatcher breeding has been documented at two contiguous sites, Sites 3 and 4, collectively known as Mosquito Flats. In 2003, Mosquito Flats contained up to 100 cm of standing water in May, with saturated soils present until July. Three pairs produced two successful nests at the site in 2003. In 2004, Mosquito Flats contained no standing water, with the nearest standing water >100 m away, and no flycatcher breeding was documented at the site. Because of above-normal winter precipitation and a shift in the location of the Bill Williams River during the winter of 2004–2005, Mosquito Flats contained standing water throughout the 2005 flycatcher breeding season (see Chapter 2 for details), and two pairs of flycatchers produced one successful nest each. Although other biotic and/or abiotic factors may be contributing to this pattern, the fluctuating availability of standing water at Mosquito Flats is likely one factor influencing willow flycatcher habitat occupancy and breeding in any given year. No obvious change in the woody vegetation at Mosquito Flats has been observed from 2003 to 2005, with only the presence or absence of standing water changing over this period. Although the willow flycatcher's affinity with standing water is noted consistently in the literature, the biological explanation as to why willow flycatchers breeding sites are associated with standing water remains largely undetermined.

COLOR-BANDING AND RESIGHTING DOWNSTREAM OF PARKER DAM

In 2005, we continued the color-banding studies initiated in 2003 on the extreme southern stretches of the Colorado River. We captured and color-banded nine individuals, none of which were detected post-capture. As in 2003 and 2004, flycatcher behavioral observations in this area strongly suggest that the individuals detected at these sites were northbound migrants (see Chapter 2). It is apparent that the lower Colorado and Gila River riparian corridors are important flyways and stopover habitat for willow flycatchers. The degree to which Southwestern Willow Flycatchers use these riparian corridors is unknown and requires further study.

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[3] Willow flycatchers were recorded as breeding at Bill Williams from 2000 to 2002. Although data on the availability of standing water at Mosquito Flats is limited for this period, it is suspected that saturated soils and/or surface water were present at the site.

Of the nine flycatchers captured in 2005, four were second-year birds (hatched in 2004), based on the presence of retained flight feathers (per Kenwood and Paxton 2001 and Koronkiewicz et al. 2002). Of the 17 individuals captured in 2003–2005 during these banding attempts, 12 (71%) were second-year birds. Given the relatively high frequency of second year birds, there may be differential age patterns in willow flycatcher northbound migration along the lower Colorado River. Differential age patterning of southbound migrant willow flycatchers in the Caribbean lowlands of Costa Rica has been documented extensively, with adults migrating before juveniles (C.J. Ralph unpublished data). Determining whether northbound willow flycatchers along the lower Colorado River also exhibit differential age patterns would require sampling over a larger portion of the annual migratory period.

During the 10–30 June sampling period of 2005, we captured nine flycatchers, more than twice the number of flycatchers captured during the same period in 2003 or 2004 (four in each year). This increase may have been influenced by a change in mist-netting strategy. In 2003 and 2004, we actively surveyed for flycatchers and then, after one or more individuals had been detected in an area, erected either passive or target mist-nets. In 2005, we primarily identified areas where the vegetation structure allowed us to erect multiple mist-nets, and we set up as many nets as possible regardless of whether a flycatcher had been detected at the site that day. This strategy resulted in many more net-hours and a corresponding increase in the number of flycatchers captured.

Color-Banded Juvenile Flycatcher Resighted at River Mile 33 – On 17 May, a migrant Southwestern Willow Flycatcher banded as a nestling in 2003 or 2004 was resighted at River Mile 33 near the confluence of the Colorado and Gila Rivers. This is the first confirmed record of a Southwestern Willow Flycatcher occurring south of the Bill Williams River in over 65 years.[4] This sighting further emphasizes the importance of this river corridor as flyway and stopover habitat for migrants, including Southwestern Willow Flycatchers.

MANAGEMENT RECOMMENDATIONS

A substantial component of the Southwestern Willow Flycatcher population along the Virgin and lower Colorado rivers comprises unpaired resident and non-territorial floater individuals. These individuals likely serve as population reservoirs and replace other individuals that move or die. Habitat use by unpaired residents and non-territorial floaters remains largely unknown; however, it seems likely these individuals use non-riparian and sparsely vegetated young riparian habitat adjacent to active breeding sites. Studies incorporating telemetry and/or netting in areas adjacent to breeding sites may provide habitat use data for unpaired resident and non-territorial floater willow flycatchers. These data may help guide restoration efforts and promote recovery of the species by providing quantitative information regarding how the spatial patterning of habitats within the greater landscape best facilitates flycatcher immigration and establishment of new populations. For example, restoration sites located within contiguous riparian areas may attract floater and/or dispersing flycatchers more easily than isolated sites.

[4] A willow flycatcher possessing leg bands was sighted at Pratt Restoration Area near Mittry Lake on 13 June 2003 (J. Kahl pers. comm.). Although color of the leg bands could not be confirmed, Southwestern Willow Flycatchers are more likely to be banded than other subspecies of willow flycatcher.

The high degree to which willow flycatchers are associated with standing water is noted consistently in the literature. However, the biological explanation for the species' affinity with standing water remains largely unknown and may include prey base, vegetation structure, and microclimate. Manipulative experiments at restoration sites that attempt to duplicate conditions at breeding sites may provide managers information regarding the amount of standing water needed at sites, the period of time standing water needs to be present at sites, and the types of water impoundment structures and materials (e.g., organic vs. inorganic) that are best suited for riparian ecosystem replication.

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 2005, 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 Chapter 3, Color-banding and Resighting) 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 2005 were compared with those at the study areas from 1996 to 2004 (McKernan 1997; McKernan and Braden 1998, 1999, 2001a, 2001b, 2002; Koronkiewicz et al. 2004; McLeod et al. 2005; Braden and McKernan, unpubl. data). 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 the 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 abandoned prior to egg laying (abandoned); (2) the nest was deserted with flycatcher eggs or young remaining (deserted); (3) the nest was found empty or destroyed more than two days prior to the estimated fledge date (depredated); (4) the nest was destroyed due to weather (weather); or (5) the entire clutch was incubated for an excess of 20 days (infertile/addled). For nests containing flycatcher eggs, parasitism was considered the cause of nest failure if (1) cowbird young outlived any flycatcher eggs or young, or (2) the nest was parasitized during egg laying and the disappearance of flycatcher eggs coincided with the appearance of cowbird eggs.

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 or dates of depredation events were unknown, we estimated the transition date as halfway between observations. To calculate Mayfield survival probabilities (MSP), we used the average length of each nest stage (2.27, 12.88, and 13.57 days for laying, incubation, and nestling stages, respectively) as observed in this study in 2003–2005 for nests where transition dates were known. Nest productivity was calculated as the 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 88 willow flycatcher nesting attempts at the four life history study areas, Muddy River Delta, and Bill Williams; 81 of these nests were known to contain flycatcher eggs and were used in calculating nest success and productivity. Twenty-nine (36%) nests were successful and fledged young, and 48 (59%) failed. The fates of four nests (5%) were undetermined (Table 4.1). In all four cases, the nests were suspected to have fledged, but no fledglings could be visually confirmed. Nest success ranged from 17% at Mormon Mesa to 100% at Bill Williams. For a comparison of nest success at all monitoring sites from 1998 to 2005, see Table 4.2.

Forty-eight nesting females, all of which produced at least one egg each, were followed through all of their nesting attempts. One additional female was detected for which no nesting attempt could be confirmed. Of the 48 nesting females, 18 had one nesting attempt, 23 had two nesting attempts, 4 had three nesting attempts, and 3 had four nesting attempts. Of the 30 females who had multiple nesting attempts, 3 renested after successfully fledging young, 26 renested after unsuccessful nests, and 1 renested after a nesting attempt of undetermined fate.

Table 4.1. Summary of Willow Flycatcher Nest Monitoring Results at the Four Life History Study Areas, Muddy River Delta, NV, and Bill Williams, AZ, 2005*

Study Area[1]	Site	# Pairs	# Nests	# Nests with 1+ WE[2]	# Successful Nests	# Failed Nests	# Nests with Unknown Fate[3]	# Parasitized Nests[4]
PAHR	North	9	18	17	9 (53)	8 (47)	0	0
	South	2	3	2	2 (100)	0	0	0
	Total	**11**	**21**	**19**	**11 (58)**	**8 (42)**	**0**	**0**
MESQ	West	5	7	7	3 (43)	2 (29)	2 (29)	2 (29)
	Bunker Farm	2	6	5	2 (40)	3 (60)	0	1 (20)
	Total	**7**	**13**	**12**	**5 (42)**	**5 (42)**	**2 (17)**	**3 (25)**
MOME	Mormon Mesa North	2	3	3	0	2 (67)	1 (33)	1 (33)
	Virgin River #2	3	3	3	1 (33)	2 (67)	0	0
	Total	**5**	**6**	**6**	**1 (17)**	**4 (67)**	**1 (17)**	**1 (17)**
MUDD	Overton WMA	6	8	8	2 (25)	5 (63)	1	6 (75)
	Total	**6**	**8**	**8**	**2 (25)**	**5 (63)**	**1 (12)**	**6 (75)**
TOPO	PC6-1	1	2	1	0	1 (100)	0	0
	In Between	5	8	7	4 (57)	3 (43)	0	5 (71)
	800M	4	11	10	2 (20)	8 (80)	0	4 (40)
	Pierced Egg	4	5	5	1 (20)	4 (80)	0	1 (20)
	250M	1	2	2	0	2 (100)	0	0
	Glory Hole	3	10	9	1 (11)	8 (89)	0	6 (67)
	Total	**18**	**38**	**34**	**8 (24)**	**26 (76)**	**0**	**16 (47)**
BIWI	Site 3	1	1	1	1 (100)	0	0	0
	Site 4	1	1	1	1 (100)	0	0	0
	Total	**2**	**2**	**2**	**2 (100)**	**0**	**0**	**0**
Overall Total		**49**	**88**	**81**	**29 (36)**	**48 (59)**	**4 (5)**	**26 (32)**

* Only nests with at least one flycatcher egg were used in percentage calculations. Percentages are given in parentheses.
[1] PAHR = Pahranagat National Wildlife Refuge, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River Delta, TOPO = Topock Marsh, BIWI = Bill Williams NWR.
[2] WE = willow flycatcher egg.
[3] No fledglings were visually located but nests are suspected to have fledged.
[4] Parasitized nests include all nests that contained at least one flycatcher egg and one cowbird egg, regardless of nest fate. Nests that contained at least one cowbird egg but no flycatcher eggs are addressed under Brood Parasitism later in this chapter. Percentages include only nests for which contents could be determined.

NEST FAILURE

Depredation was the major cause of nest failure, accounting for 64% (35 of 55) of all failed nests (Table 4.3) and 73% (35 of 48) of nests that failed after flycatcher eggs were laid. Seven nesting attempts (13% of all failed nests) were abandoned prior to willow flycatcher eggs being laid and five nests (9%) were deserted. Five nests (9%) failed because of Brown-headed Cowbird parasitism (see below for more details on parasitism). Two nests failed because of infertile or addled eggs, and one nest failed because the nest tree was knocked over by a falling willow branch.

Table 4.2. Willow Flycatcher Percent Nest Success Recorded at Breeding Sites along the Virgin and Lower Colorado Rivers and Tributaries from 1996 to 2005*

Year	Pahranagat	Littlefield	Mesquite[1]	Mormon Mesa[2]	Muddy River Delta	Grand Canyon	Topock	Bill Williams
1996	Nm[3]	Nm[3]	Nm[3]	Nm[3]	Nm[3]	57 (7)	100 (1)	Nm[3]
1997	Nm[3]	Nd[4]	40 (5)	38 (16)	Bc[9]	29 (14)	78 (9)	Nd[4]
1998	37 (19)	Nd[4]	0 (7)	58 (13)	Nm[3]	Nd[4]	43 (21)	Nd[4]
1999	56 (16)	Ns[5]	Nm[3]	50 (12)	Nm[3]	Nc[6]	35 (20)	Nd[4]
2000	52 (21)	Nd[4]	56 (9)	31 (16)	100 (1)	Nc[6]	28 (18)	100[7] (1)
2001	33 (27)	Nd[4]	47 (19)	35 (20)	33 (3)	Nc[8]	25 (20)	60[7] (5)
2002	29 (21)	Nd[4]	53 (19)	0 (10)	Nd[4]	Nd[4]	25 (12)	50[7] (11)
2003	91 (11)	Nd[4]	44 (18)	0 (10)	Nd[4]	Nd[4]	78 (9)	100 (2)
2004	76 (17)	50 (2)	24 (17)	50 (6)	Nd[4]	Bc[9]	45 (38)	Nd[4]
2005	58 (19)	Nd[4]	42 (12)	17 (6)	25 (8)	Nd[4]	24 (34)	100 (2)

* Data from 1997 to 2002 are from McKernan 1997, McKernan and Braden (2002), and Braden and McKernan (unpubl. data) unless noted otherwise; data from 2003 are from Koronkiewicz et al. (2004); data from 2004 are from McLeod et al. (2005), and data from 2005 can be found in this document. Total number of nests is indicated in parentheses.

1 Study area includes the Mesquite East, Mesquite West, and Bunker Farm sites.
2 Study area includes the Virgin River Delta at Lake Mead.
3 Study area not monitored.
4 Study area surveyed, no breeding documented.
5 Study area not surveyed.
6 Breeding suspected, nest success not calculated.
7 Nest success calculated by Paradzick et al. (2001), and Smith et al. (2002, 2003).
8 Breeding confirmed, nest success not calculated.
9 Breeding confirmed, undetermined if nestlings from a single nest fledged.

Table 4.3. Summary of Causes of Willow Flycatcher Nest Failure at the Four Life History Study Areas, Muddy River Delta, NV, and Bill Williams, AZ, 2005*

Study Area[1]	Total # Nests	All Failed Nests	Abandoned	Deserted	Depredated	Parasitized	Addled	Other
PAHR	21	10	2 (20)	0	8 (80)	0	0	0
MESQ	13	6	1 (17)	0	4 (66)	1 (17)	0	0
MOME	6	4	0	0	1 (25)	1 (25)	2 (50)	0
MUDD	8	5	0	1[2] (20)	2 (40)	2 (40)	0	0
TOPO	38	30	4[3] (13)	4[4] (13)	20 (67)	1 (3)	0	1[5] (3)
BIWI	2	0	0	0	0	0	0	0
Total	**88**	**55**	**7 (13)**	**5 (9)**	**35 (64)**	**5 (9)**	**2 (4)**	**1 (2)**

* All nesting attempts (those with and without flycatcher eggs) are included. Percentage of failed nests is shown in parentheses for each cause of failure.

1 PAHR = Pahranagat National Wildlife Refuge, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River Delta, TOPO = Topock Marsh, BIWI = Bill Williams NWR.
2 Nest deserted after being parasitized.
3 Three of the four nests were abandoned after being parasitized.
4 Two nests were deserted after partial depredation, and one after 16 days of incubation.
5 Nest tree fell over.

BROOD PARASITISM

Twenty-six of 81 nests (32%) with flycatcher eggs were brood parasitized by Brown-headed Cowbirds. An additional three nests at Topock were parasitized prior to flycatcher eggs being laid and were subsequently abandoned (see Table 4.1; Table 4.4). For nests containing flycatcher eggs, parasitism caused nest failure at five nests. Two of these fledged cowbird young, and three instances of parasitism coincided with the disappearance of any flycatcher eggs and abandonment of the nest. Three parasitized nests fledged flycatchers but no cowbirds, and two nests fledged both a flycatcher and a cowbird. One nest was suspected to have fledged a flycatcher, but fledging status could not be confirmed. Of the remaining 15 parasitized nests that failed, 13 nests were depredated with both flycatcher and cowbird eggs or young in the nest, 1 nesting attempt was deserted with flycatcher and cowbird eggs in the nest, and 1 nest failed when the nest tree was knocked over by a falling branch. Brood parasitism at all sites ranged from 0 to 75% and was highest at Muddy River Delta (see Table 4.1). Nests that contained flycatcher eggs and were brood parasitized were less likely to fledge flycatcher young than nests that were not parasitized (Chi-square = 4.04, $P = 0.04$).

Table 4.4. Fates of Willow Flycatcher Nests Parasitized by Brown-Headed Cowbirds, 2005*

Study Area[1]	Nest ID Code	Outcome[2]
MESQ	21A	Two of three WE disappeared; final WE disappeared when CE appeared; nest abandoned
	51A	Parasitized after 9 days of incubation; two WE disappeared when CE appeared; 14-day-old flycatcher nestling seen perched on nest rim, but fledging not confirmed
	70C	CE disappeared during incubation; fledged one flycatcher
MOME	40B	Parasitized after 5 days of incubation; both WE disappeared when CE appeared; nest abandoned
MUDD	2A	Three of four WE disappeared when nest was parasitized after 5 days of incubation. Remaining WE hatched, then nestling disappeared. Nest abandoned with one CE
	2B	Deserted during egg laying with two WE and one CE
	4A	Parasitized during egg laying; single WE disappeared and two CE appeared; nest abandoned
	4B	Fledged a cowbird
	6A	Fledged one flycatcher; CE did not hatch
	60A	Depredated with two flycatcher nestlings and one cowbird nestling
TOPO	4A	Parasitized during egg laying; one WE disappeared and two CE appeared; depredated with two CE and one WE
	4B	Nest tree knocked over by falling branch during incubation with three WE and one CE
	4D	Fledged one cowbird and one flycatcher
	5A	Parasitized during egg laying; one WE disappeared when CE appeared; nest depredated with three WE and one CE
	6A	Nest parasitized prior to WE being laid; nest then depredated with one CE
	6B	Parasitized during incubation; one WE disappeared when CE appeared; nest depredated during incubation with two WE and one CE.
	6D	Depredated with one WE and one CE

Table 4.4. Fates of Willow Flycatcher Nests Parasitized by Brown-Headed Cowbirds, 2005*, continued

Study Area[1]	Nest ID Code	Outcome[2]
TOPO	15A	Fledged a cowbird
	15B	Depredated with one WE and one CE
	21A	Partially depredated with one WE and one CE; nest abandoned with one CE
	34B	Abandoned with one CE before flycatcher eggs were laid
	38A	Depredated with two WE and one CE
	43A	Abandoned with one CE before flycatcher eggs were laid
	43B	Fledged two flycatchers, CE did not hatch
	50A	Depredated with two flycatcher nestlings and one cowbird nestling
	50B	Nest partially depredated with three WE and one CE; nest deserted with one remaining WE
	57A	Depredated with three WE and one CE
	57B	Fledged one flycatcher and one cowbird
	76A	Depredated with one flycatcher nestling and one cowbird nestling

* All nesting attempts are included.
[1] MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River Delta, TOPO = Topock Marsh.
[2] WE = willow flycatcher egg, CE = cowbird egg.

MAYFIELD NEST SUCCESS AND NEST PRODUCTIVITY

Mayfield survival probability (MSP) at the four life history study areas, Muddy River Delta, and Bill Williams ranged from 0.21 to 1.00 and was 0.37 for all sites combined (Table 4.5). At all sites, 57 nestlings were confirmed to have fledged from 77 nests of known outcome (mean number of nestlings/nest = 0.77, SE = 0.14). Fecundity across study areas ranged from 0.25 to 3.00 young per female and averaged 1.34 (SE = 0.22) (Table 4.6).

DISCUSSION

In 2005, willow flycatcher nesting was documented at the four life history study areas, Muddy River Delta, and Bill Williams. Unlike in 2004, no nesting was detected at Littlefield or Grand Canyon, Arizona, though an unpaired male flycatcher was present in Grand Canyon 1–20 June. In addition, fewer breeding pairs (5) were detected at Mesquite West in 2005 than in 2004 (12 pairs) or 2003 (13 pairs) (Koronkiewicz et al. 2004, McLeod et al. 2005). Although we detected no breeding flycatchers at Bill Williams in 2004, flycatchers nested at this study area in 2005, as they had in 2000–2003. Given that southwestern riparian ecosystems experience dynamic change and are not ecologically static (Periman and Kelly 2000), willow flycatcher occupancy and nesting are likely to be affected by changes in habitat suitability, with breeding flycatchers detected in one year and not in another. See Chapter 3 for a discussion of how habitat characteristics at Littlefield, Grand Canyon, Mesquite, and Bill Williams may have affected the presence and numbers of breeding flycatchers at these sites.

Table 4.5. Daily Survival Rates and Mayfield Survival Probabilities (MSP) for Willow Flycatcher Nest Stages at the Four Life History Study Areas, Muddy River Delta, NV, and Bill Williams, AZ, in 2005*

Study Area	Nest Stage[1]	Nest Losses/ Observation Days	Daily Survival Rate	Mayfield Survival Probability
Pahranagat	1	0/40	1.000	1.000
	2	6/193.5	0.969	0.667
	3	2/152.5	0.987	0.836
	MSP all stages = 0.557			
Mesquite	1	2/17	0.882	0.753
	2	2/112.5	0.982	0.794
	3	1/68.5	0.985	0.819
	MSP all stages = 0.490			
Mormon Mesa	1	0/9	1.000	1.000
	2	6/68.5	0.956	0.562
	3	1/14	0.929	0.366
	MSP all stages = 0.205			
Muddy River	1	2/10.5	0.810	0.619
	2	0/47	1.000	1.000
	3	2/34.5	0.942	0.445
	MSP all stages = 0.275			
Topock	1	4/37.5	0.893	0.774
	2	17/253	0.933	0.408
	3	4/128	0.969	0.650
	MSP all stages = 0.205			
Bill Williams	1	0/2.5	1.000	1.000
	2	0/28.5	1.000	1.000
	3	0/26	1.000	1.000
	MSP all stages = 1.00			
TOTAL	1	8/116.5	0.931	0.851
	2	28/703	0.960	0.593
	3	10/423.5	0.976	0.723
	MSP all stages = 0.365			

* Mayfield survival probability was calculated using 2.27-day egg laying, 12.88-day incubation, and 13.57-day nestling stages.

[1] 1 = egg laying, 2 = incubation, 3 = nestling.

Table 4.6. Willow Flycatcher Nest Productivity (Young Fledged per Nest) and Fecundity (Young Fledged per Female) at the Four Life History Study Areas, Muddy River Delta, NV, and Bill Williams, AZ, 2005*

Study Area	# Young Fledged (# Nests)	Productivity Mean (SE)	Fecundity Mean (SE)
Pahranagat	33 (19)	1.74 (0.39)	3.00 (0.30)
Mesquite	5 (10)	0.50 (0.17)	1.00 (0.32)
Mormon Mesa	1 (5)	0.20 (0.20)	0.25 (0.25)
Muddy River	2 (7)	0.29 (0.18)	0.40 (0.24)
Topock	13 (34)	0.38 (0.13)	0.72 (0.29)
Bill Williams	5 (2)	2.5 (0.5)	2.5 (0.5)
Total	**57 (77)**	**0.77 (0.14)**	**1.31 (0.21)**

* Calculations include nests that contained flycatcher eggs and had a known outcome.

NEST SUCCESS

Although nest success at Pahranagat was lower in 2005 than in 2003 or 2004, Pahranagat continued to exhibit the highest nest success of the four life history study areas (see Table 4.2 for nest success at study areas in 1997–2004). Nest success at Bill Williams was 100%, as it was in 2003, though sample size in both years was small. Nest success at the remaining study areas continued to exhibit the yearly fluctuations seen since nest monitoring began in 1996. Overall nest success across all study areas was the lowest recorded since 2003, but success rates did not differ significantly across years (Chi-square = 2.84, $P = 0.24$). Nest success results again illustrate that the demographic patterns of passerine populations often vary year to year, and sometimes to a very large degree (Wiens 1989a). The different patterns of nest success observed at the study areas over many years further demonstrate the need for long-term data.

NEST FAILURE

As in both 2003 and 2004, depredation was the major cause of willow flycatcher nest failure, accounting for 64% of all failed nests in 2005 (see Table 4.3). Depredation accounted for 80, 66, 25, 40, and 67% of all failed nests at Pahranagat, Mesquite, Mormon Mesa, Muddy River, and Topock, respectively. These results are consistent with those reported at the life history study areas from 1998 to 2004 (McKernan and Braden 2002; Koronkiewicz et al. 2004; McLeod et al. 2005, Braden and McKernan, unpubl. data) and at monitored sites across Arizona from 2000 to 2004 (Paradzick et al. 2001; Smith et al. 2002, 2003, 2004; Munzer et al. 2005), which indicate depredation as accounting for the majority of all willow flycatcher nest failures. Factors influencing the increases and decreases in nest depredation at the life history study areas are inherently complex and at this time remain undetermined. 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 landscape characteristics and fluctuations in predator densities, abundance, and richness (Wiens 1989b, Robinson 1992, Howlett and Stutchbury 1996).

BROOD PARASITISM

Brood parasitism by Brown-headed Cowbirds across all study areas ranged from 0 to 75% and averaged 32% (see Table 4.1). These results are consistent with those reported at the study areas from 1998 to 2004 (McKernan and Braden 2002; Koronkiewicz et al. 2004; McLeod et al. 2005; Braden and McKernan, unpubl. data; see Table 5.3 in Chapter 5). These parasitism rates are higher than those reported at monitored sites across Arizona, which averaged 4, 5, 11, 2, and 6% in 2000, 2001, 2002, 2003, and 2004, respectively (Paradzick et al. 2001; Smith et al. 2002, 2003, 2004; Munzer et al. 2005). We observed the third consecutive year of no brood parasitism at Pahranagat. Cowbird trapping and removal studies were initiated at all the life history studies in 2003, and we discuss trends in brood parasitism rates in detail in Chapter 5.

The effect of parasitism on nest fate was variable, but parasitism reduced the likelihood that a nest containing flycatcher eggs would fledge flycatcher young. We observed eight nests in which the disappearance of flycatcher eggs coincided with the parasitism event. In these cases, cowbirds were suspected of ejecting the eggs. Female Brown-headed Cowbirds are known to physically attack willow flycatcher nestlings (Woodward and Stoleson 2002), remove single eggs, and occasionally destroy entire broods after laying is complete or after hatching (Lowther 1993 as cited in Woodward and Stoleson 2002). Therefore, it is also possible that some depredation events on eggs and nestlings are attributable to cowbirds. We also observed three nests that were parasitized prior to flycatcher eggs being laid and were subsequently abandoned. Thus, cowbird brood parasitism negatively affects overall flycatcher productivity by multiple mechanisms including interspecific nestling competition, depredation, and causing female flycatchers to expend energy renesting following parasitism events. Moreover, given that adult flycatchers exhibit high site fidelity to breeding areas (McKernan and Braden 2002, Koronkiewicz et al. 2004, this document) and renest most often after failed nests (Sedgwick 2000), females returning to sites with high brood parasitism are likely to reduce lifetime fecundity because they are expending energy on multiple failed nesting attempts over many years. Cowbird impacts to flycatcher populations may therefore be more severe than parasitism rates alone suggest. Because it is still unclear how brood parasitism rates affect flycatcher population sizes (Rothstein et al. 2003), baseline nesting studies in conjunction with cowbird control experiments 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

As presented in McLeod et al. (2005), calculating Mayfield survival probabilities (MSP) using slightly different average nest stage lengths results in MSP estimates that differ less than two percent. Thus, MSP comparisons between study areas or across years can be used to evaluate trends in nest success. Overall MSP (0.365) was similar to the overall MSP (0.383) reported at the life history study areas for 1997–2002 for the egg laying, incubation, and nestling stages (Braden and McKernan, unpubl. data). Overall MSP in 2005 was lower than in 2003 (0.556) or 2004 (0.436).

MSP alone, however, is an incomplete measure of the production of young. Successful nests produce from one to four young, and variations in nest productivity are not reflected in MSP. In addition, although every failed nest attempt lowers percent nest success and MSP, success of a subsequent nesting attempt may result in the same number of young produced as if the initial nesting attempt had been successful. Thus, nest productivity (young produced per nesting attempt) and fecundity (young produced per female), in conjunction with nest success, provide additional information on the success of a given breeding season. Although overall MSP was lower in 2005 than in 2003 or 2004, fecundity in 2005 (1.31) did not differ significantly from that recorded in 2003 (1.40) or 2004 (1.27) ($F_{2,144} = 0.90$, $P = 0.91$).

MANAGEMENT RECOMMENDATIONS

Depredation has been the major cause of Southwestern Willow Flycatcher nest failure at the Virgin/lower Colorado River sites since nest monitoring studies were initiated in 1996. Depredation of eggs and young are ultimately linked to landscape characteristics and fluctuations in predator densities, abundance, and richness, with these fluctuations ultimately driving flycatcher nest success. Factors influencing flycatcher nest depredation are inherently complex and at this time remain undetermined, as direct observations of nest predation events are rare to nonexistent during nest monitoring. The identification of nest predator assemblages across sites that are structurally and compositionally heterogeneous (i.e., exhibit variation in landscape characteristics), such as those found within the Virgin/lower Colorado River region, may help guide restoration efforts by providing managers information as to how best to construct restoration sites and pattern these habitats within the greater landscape to minimize depredation. Depredation information obtained for any one species of riparian, open-cup nesting passerine would likely be applicable to others. Studies specifically designed to address open-cup nest predation at the Virgin/lower Colorado River sites are therefore warranted.

CHAPTER 5

BROWN-HEADED COWBIRD TRAPPING

INTRODUCTION

In 2003, we initiated intensive Brown-headed Cowbird trapping at all the life history study areas and continued the same effort in 2004 and 2005. From 1997 to 2002, willow flycatcher nest success and brood parasitism rates were documented at the life history study areas (McKernan and Braden 2002), with no cowbird trapping conducted in the proximity of the breeding sites except for one year of trapping at Topock Marsh in 1998 (White et al. 1998). In this study we compare willow flycatcher life history data under the influence of cowbird trapping (2003–2007) with data gathered at the life history study areas from 1997 to 2002 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, following methods outlined in Griffith Wildlife Biology (1994). 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 at the study area were at least past the egg laying and incubation stages (beginning of August).

TRAP DESIGN

In 2003 and 2004, we used a modification of the Australian crow trap (as per Ahlers and Tisdale-Hein 2001; Figure 5.1) at all sites to capture Brown-headed Cowbirds. These portable, wood-framed traps were 1.2 m high, 1.2 m wide, and 2.4 m long, with a flat top. This trap design was chosen because of its portability, because traps at some locations need to be transported via all-terrain vehicle and/or hand-carried through dense vegetation. In 2005, we replaced one of two traps at Pahranagat, one of three at Mesquite, and three of six at Topock with a different design to test the relative efficacy of the two styles of trap. At Topock, the locations of the new and old traps were exchanged half way through the season to control for location effects when evaluating trapping success of the different designs.

The new, portable wood-framed traps used in 2005 were 1.8 m high, 1.8 m wide, and 2.4 m long, and had funnel-shaped top (Figure 5.2). These traps were chosen because they better replicate widely used crow trap designs (Bub 1991). All panels on both trap designs consisted of 5 × 5–cm wood supports covered with 1.27-cm wire mesh and included a bottom panel. Each trap had a door located on one end. A piece of plywood, with two 3.2-cm slots down the middle, was attached to the top of each trap for cowbird entry.[1] Signs were posted on each trap

[1] Trap design per Ahlers and Tisdale-Hein (2001) included a bottomless panel (no wire mesh) and an entrance slot 3.5 cm wide.

Figure 5.1. Original flat-topped design of Brown-headed Cowbird trap used at life history study areas, 2003–2005.

Figure 5.2. New Brown-headed Cowbird trap design introduced at life history study areas, 2005.

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, at least two male and three female live-decoy cowbirds were maintained in each trap whenever possible. 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. Six or more horizontal perches were provided in the trap corners, and shadecloth was attached to sections of the outside of each trap to provide adequate shade.

TRAP LOCATION

We operated two traps at Pahranagat, three at Mesquite, four at Mormon Mesa, and six at Topock. The number of traps set in each life history study area was determined by landscape characteristics and area of the site. Each trap had 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 previously known areas of occupied willow flycatcher habitat were under the influence of trapping, within the limitations imposed by vegetation, hydrology, and landownership. Reclamation biologists approved trap numbers and locations.

Over-winter flooding and high river levels at Mormon Mesa required us to relocate the two traps that were near the Mormon Mesa North flycatcher breeding area in 2004. One trap was relocated to a xeroriparian wash on the west side of Mormon Mesa North, and the second was relocated within the riparian vegetation in the Virgin River #1 flycatcher breeding area. Traps at Pahranagat, Mesquite, and Topock remained in essentially the same locations used in 2004 (Figures 5.3–5.6).

TRAP MAINTENANCE

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 a daily data sheet (Appendix A). Upon entering a trap, field personnel carefully flushed out any non-target birds, recording the number of each species, and, when possible, sex and age. Each day we recorded the number, sex, and age of newly trapped cowbirds, and we clipped the wings of all cowbirds at the edge of the secondary and primary feathers, thus lowering the probability of injury in the trap and the likelihood that any escaped bird would be able to survive. We also recorded any cowbirds that were missing, dead, or removed from the trap as well as any pertinent notes. The disposition (transferred to another trap or euthanized) of all removed cowbirds was noted. Excess numbers of cowbirds were removed periodically, placed in a small holding cage, and euthanized using carbon monoxide. Cowbirds carcasses were discarded off-site at Pahranagat and Mesquite. Carcasses were disposed of on-site at Mormon Mesa and Topock, at least 400 and 1,000 m, respectively, from any flycatcher nests.

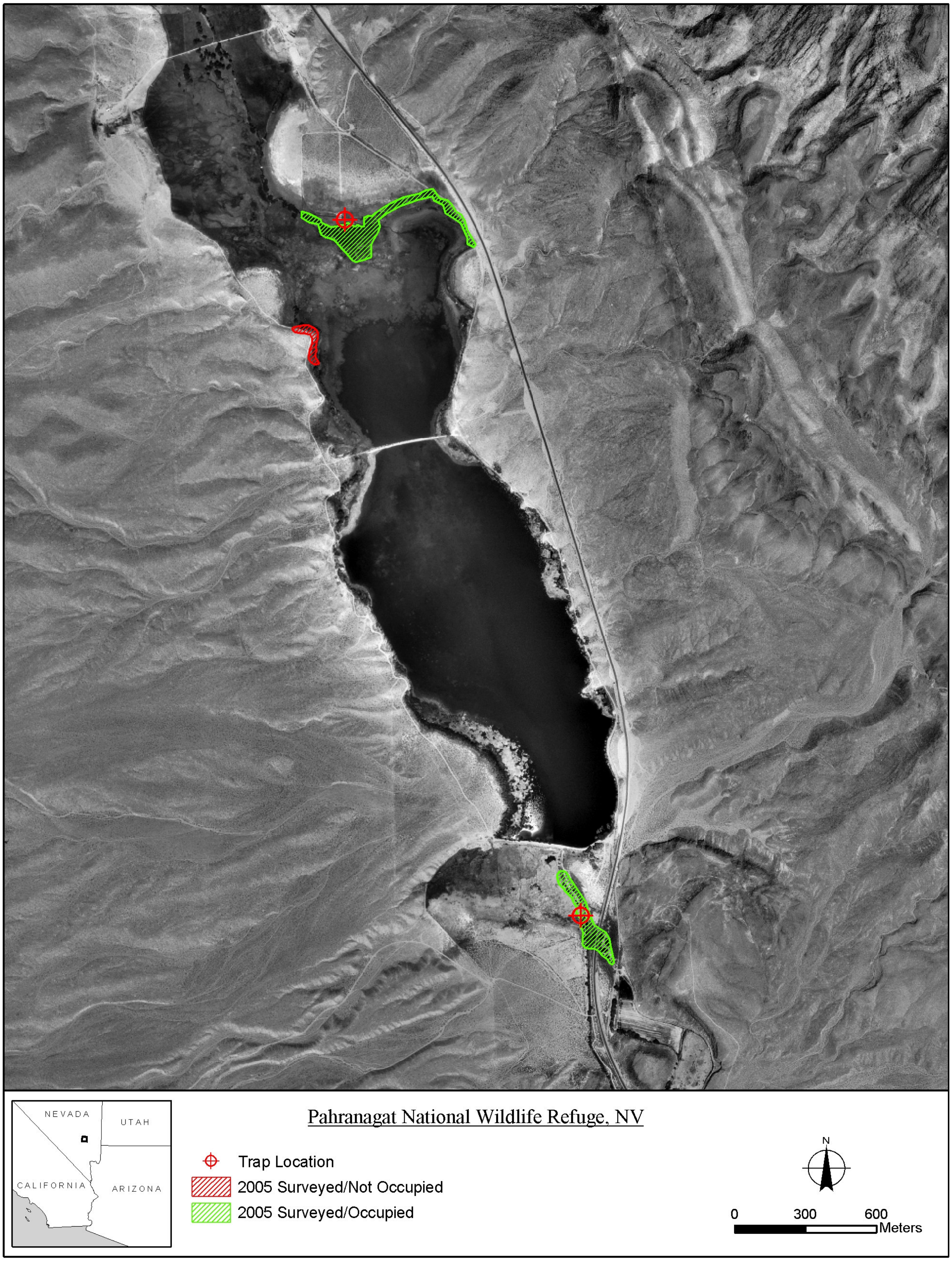

Figure 5.3. Cowbird trap locations at Pahranagat NWR, NV, 2005.

Figure 5.4. Cowbird trap locations at Mesquite, NV, 2005.

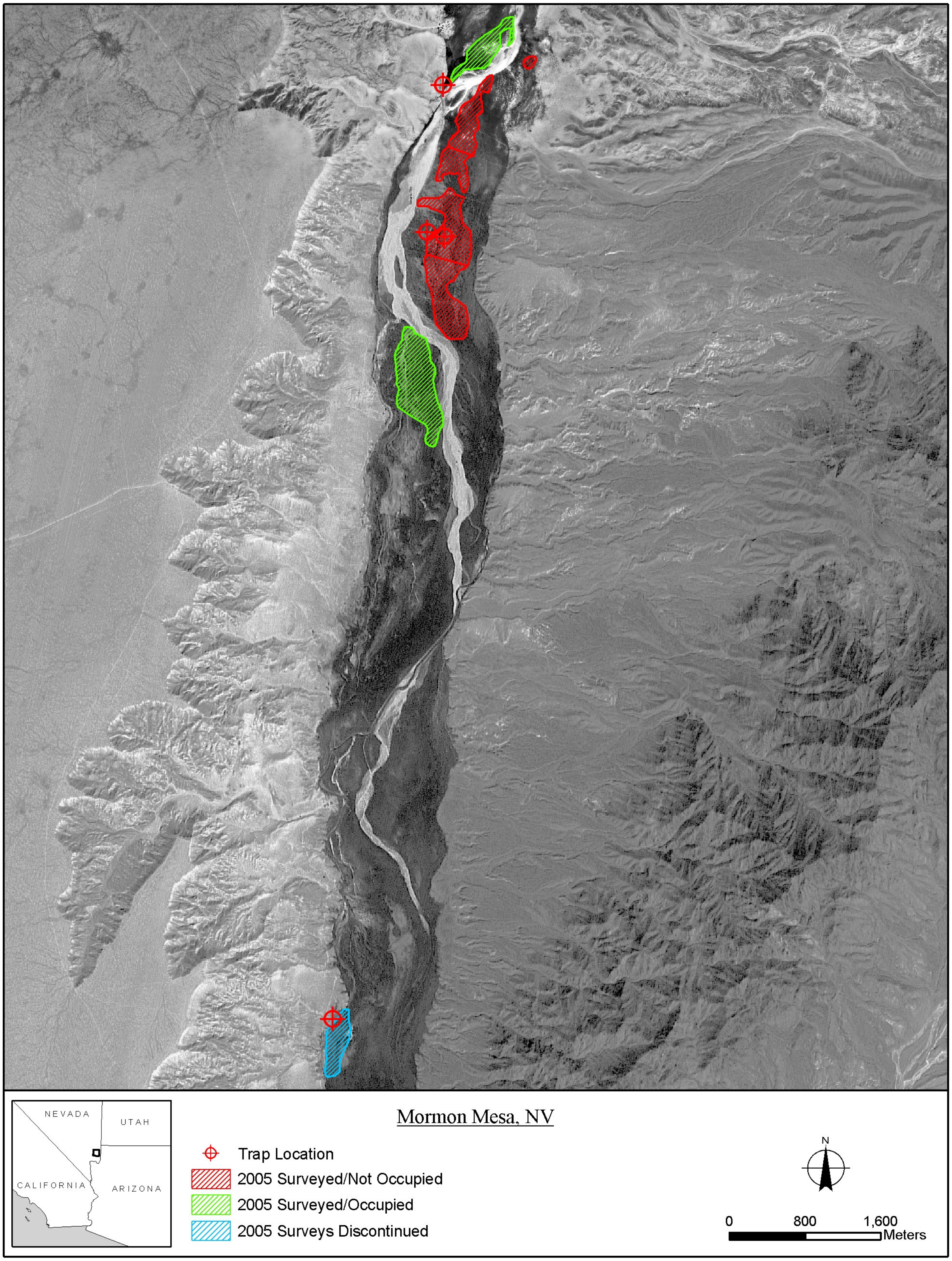

Figure 5.5. Cowbird trap locations at Mormon Mesa, NV, 2005.

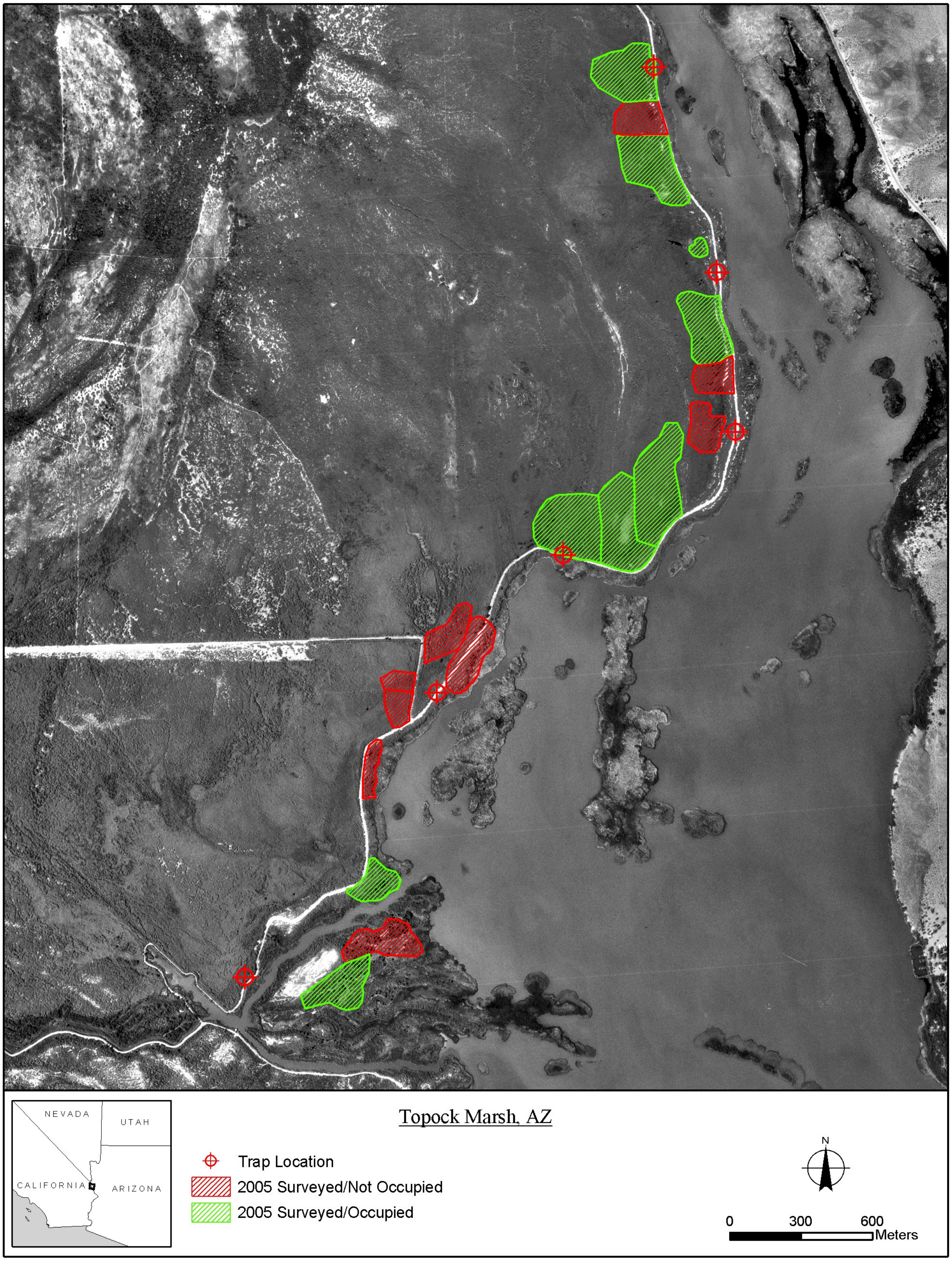

Figure 5.6. Cowbird trap locations at Topock Marsh, AZ, 2005.

DATA ANALYSIS

We used JMP IN® Version 4 (SAS Institute Inc.) and SAS® Version 9.1 (SAS Institute 2003) 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.

Analysis of trap design – We used a one-way ANOVA to compare capture rates (number of cowbirds captured per trap-day) and escape rates (number of cowbirds reported to have escaped per trap-day) of new versus old traps at Topock. A multi-way ANOVA was used to test for differences in capture rate after adjusting for location and for date (categorized into two-week intervals).

Analysis of brood parasitism rates: pre-trapping vs. trapping periods – Percent brood parasitism at each of the life history study areas during the pretrapping period (1997–2002) and trapping period (2003–2005) were compared using one-way ANOVA.[2] Data from 1998 at Topock were excluded from the analysis.

RESULTS

TRAP OPERATION

We operated cowbird traps at Pahranagat, Mesquite, Mormon Mesa, and Topock (see Figures 5.3–5.6) from 14 May to 31 July, 15 May to 31 July, 18 May to 17 July, and 6 May to 2 August, respectively, for a total of 138, 224, 82, and 507 trap-days at each study area. High water levels in the Virgin River prevented us from operating two cowbird traps at Mormon Mesa until mid-June, and another trap was inaccessible after the end of May because we were denied access to the site by a local landowner. High water levels and dense vegetation prevented us from placing the trap at Mormon Mesa North closer than approximately 575 m from nesting flycatchers. We did not have any cowbird traps within 2.0 km of the flycatcher nests in Virgin River #2 because this breeding site was not discovered until the 2005 breeding season, and the dense vegetation within the site and high water levels adjacent to the site precluded placing a trap in proximity to the nesting flycatchers. Thus, none of the flycatcher nests we monitored at Mormon Mesa in 2005 were within 400 m (the effective trapping radius) of a cowbird trap. We also did not have a trap in the vicinity of Bunker Farm at the Mesquite study area because we did not anticipate monitoring the site in 2005. Monitoring at Bunker Farm did not commence until flycatcher nests were located at the end of May, after cowbird trap operation had already started. The closest cowbird traps were at Mesquite East and Mesquite West, approximately 3.4 km from Bunker Farm. Because Mormon Mesa and Bunker Farm were not under the influence of cowbird trapping in 2005, parasitism data from these sites are not included in the analysis below.

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[2] Data were compared between pre- and post-trapping periods in McLeod et al. (2005) using a chi-square analysis. Because ANOVA places equal weight on each year, rather than equal weight on each nest, we decided ANOVA was a more appropriate way to analyze data across years.

BROWN-HEADED COWBIRD TRAPPING

We captured and removed 56, 61, 5, and 244 Brown-headed Cowbirds at Pahranagat, Mesquite, Mormon Mesa, and Topock, respectively (Table 5.1).

Table 5.1. Summary of Brown-headed Cowbirds Trapped and Removed at Pahranagat NWR, Mesquite, and Mormon Mesa, NV, and Topock Marsh, AZ, 2005

Study Area	Trap #	# Males	# Females	# Juveniles	Total # Brown-headed Cowbirds
Pahranagat	1	24	11	0	35
	2	8	13	0	21
	Total	**32**	**24**	**0**	**56**
Mesquite	1	31	15	0	46
	2	0	4	3	7
	3	3	5	0	8
	Total	**34**	**24**	**3**	**61**
Mormon Mesa	1	-1	0	0	-1
	2	2	3	3	8
	3	2	0	1	3
	4	-2	-3	0	-5
	Total	**1**	**0**	**4**	**5**
Topock	1	30	14	2	46
	2	15	7	9	31
	3	19	14	4	37
	4	12	10	2	24
	5	40	13	3	56
	6	18	19	13	50
	Total	**134**	**77**	**33**	**244**

TRAP DESIGN

Overall, new traps had a daily capture rate of 0.86 cowbirds per trap-day while old traps captured 0.30 cowbirds per trap-day ($F_{1,\ 505}$ = 38.9, $P < 0.001$). The ratio of the new to old trap capture rates varied depending on trap location (Table 5.2) and date (Table 5.3). After adjusting for difference by trap location and date, the new style of trap still captured significantly more cowbirds ($P < 0.001$) than the flat-topped traps. The escape rate of cowbirds was lower ($F_{1,\ 505}$ = 4.9, $P = 0.03$) with the new trap design (0.08 cowbirds per trap-day) than with the old (0.19 cowbirds per trap-day).

Table 5.2. Mean Number and Standard Error of Brown-headed Cowbirds Captured per Trap-day at Each Trap Location by New and Old Trap Styles, Topock, 2005

Location	Funnel (new)	Flat (old)	New/Old Ratio
1	1.18 (0.20)	0.05 (0.04)	23.6
2	0.51 (0.15)	0.15 (0.13)	3.4
3	0.69 (0.20)	0.28 (0.10)	2.5
4	0.28 (0.09)	0.37 (0.10)	0.8
5	1.23 (0.19)	0.35 (0.14)	3.5
6	1.13 (0.20)	0.53 (0.13)	2.1

Table 5.3. Mean Number and Standard Error of Brown-headed Cowbirds Captured per Two-week Period in New and Old Trap Styles, Topock, 2005

Date	Funnel (new)	Flat (old)	New/old ratio
5/01–14	0.69 (0.16)	0.12 (0.05)	5.8
5/15–31	0.58 (0.12)	0.25 (0.09)	2.3
6/01–14	0.81 (0.15)	0.24 (0.08)	3.4
6/15–31	0.60 (0.14)	0.26 (0.09)	2.3
7/01–14	2.5 (0.39)	0.93 (0.32)	2.7
7/15–8/2	0.90 (0.18)	0.39 (0.13)	2.3

BROOD PARASITISM RATES

The proportion of flycatcher nests parasitized during the pretrapping (1997–2002) and trapping (2003–2005) periods shows no significant difference at Pahranagat (P = 0.079), Mesquite (P = 0.973), Mormon Mesa (P = 0.239), and Topock (P = 0.148) (Table 5.4). Although statistical analysis did not reveal a decrease in brood parasitism at Pahranagat, no brood parasitism was recorded at Pahranagat in 2003–2005. At Mesquite and Mormon Mesa, brood parasitism continues to remain high, with 28.6 and 33.3% recorded in 2005, respectively. Brood parasitism at Topock (51.4%) was the highest recorded since monitoring was initiated in 1997.

Table 5.4. Brown-Headed Cowbird Brood Parasitism Rates at the Four Life History Study Areas, 1997–2005*

	Year	Pahranagat	Mesquite[1]	Mormon Mesa[2]	Topock
Pre-trapping periods	1997	nm[3]	60.0% (5)	18.8% (16)	11.1% (9)
	1998	0.0% (19)	57.1% (7)	15.4% (13)	28.6% (21) [4]
	1999	12.5% (16)	nd[5]	0.0% (12)	30.0% (20)
	2000	14.3% (21)	22.2% (9)	25.0% (16)	16.7% (18)
	2001	14.8% (27)	15.8% (19)	20.0% (20)	25.0% (20)
	2002	33.3% (21)	31.6% (19)	0.0% (10)	16.7% (12)
Trapping periods	2003	0.0% (12)	21.0% (19)[6]	16.7% (12)[7]	18.2% (11)
	2004	0.0% (17)	45.0%(20)	28.6% (7)	31.7% (43)
	2005	0.0% (21)	28.6% (7)	16.7% (6)[8]	51.4% (37)
% parasitism pretrapping periods (SE)		14.9% (5.3)	37.3% (9.0)	13.2% (4.4)	21.4% (3.1)
% parasitism trapping periods (SE)		0.0% (0.0)	36.8% (8.2)	28.6%	33.8% (9.6)

* Total number of nests is indicated in parentheses for each year. In Koronkiewicz et al. (2004) and McLeod et al. (2005) total number of nests included only nests that contained at least one flycatcher egg. These numbers have been revised here to include all parasitised nests. Data for pre-trapping periods (1997–2002) are from McKernan and Braden (2002) and Braden and McKernan (unpubl. data); data for trapping periods (2003–2005) are from Koronkiewicz et al. (2004), McLeod et al. (2005), and this document. Total number of nests for 2003–2005 includes nests for which contents could be determined.

1 Study area includes Mesquite East in 1997–1999 and Mesquite West in 2000–2005. Bunker Farm is not included in 2005.

2 Study area included Virgin River Delta sites in 1997–2004.

3 Study area not monitored.

4 A total of 232 cowbirds were trapped and removed from the local population in 1998 at Topock (White et al. 1998).

5 Study area monitored, no breeding documented.

6 Brood parasitism rate at Mesquite in 2003 was not used in calculating mean percent parasitism during trapping periods because the low number of cowbirds removed from the site (4 males, 2 juveniles) would likely have little effect on parasitism rate.

7 Brood parasitism rate at Mormon Mesa in 2003 was not used in calculating mean percent parasitism during trapping periods because the low number of cowbirds removed from the site (3 males) would likely have little effect on parasitism rate.

8 Brood parasitism rate at Mormon Mesa in 2005 was not used in calculating mean percent parasitism during trapping periods because logistical constraints precluded deployment and operation of traps within 400 m of nesting flycatchers.

NON-TARGET SPECIES

Fourteen non-target species were captured and identified at all life history study areas during cowbird trapping (Table 5.5). Non-target species captures included Abert's Towhee (*Pipilo aberti*), Bewick's Wren (*Thryomanes bewickii*), Blue Grosbeak (*Guiraca caerulea*), Black-tailed Gnatcatcher (*Polioptila melanura*), Bullock's Oriole (*Icterus galbula*), Great-tailed Grackle (*Quiscalus mexicanus*), House Finch (*Carpodacus mexicanus*), Indigo Bunting (*Passerina cyanea*), Loggerhead Shrike (*Lanius ludovicianus*), Lucy's Warbler (*Vermovira luciae*), Marsh Wren (*Cistothorus palustris*), Red-winged Blackbird (*Agelaius phoeniceus*), Song Sparrow (*Melospiza melodia*), and White-winged Dove (*Zenaida asiatica*). Abert's Towhee, House Finch, and Red-winged Blackbird accounted for the vast majority of captures. Because the same individual(s) may be captured and released on multiple days, the total number of individuals of each species captured cannot be determined when there are multiple capture instances. Mortalities consisted of two Abert's Towhees, one House Finch, one Bewick's Wren, and one Loggerhead Shrike. Injuries to three Abert's Towhees and one Blue Grosbeak were also noted (see Table 5.5).

Table 5.5. Summary of Non-target Species Captured during Brown-headed Cowbird Trapping at the Life History Study Areas, 2005*

Species	Pahranagat				Mesquite				Mormon Mesa				Topock			
	Instance	Occurrence	Injured	Died	Instance	Occurrence	Injured	Died	Instance	Occurrence	Injured	Died	Instance	Occurrence	Injured	Died
Abert's Towhee	-	-	-	-	46	96	1[a]	1	-	-	-	-	42	59	2[b]	1
Bewick's Wren	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Blue Grosbeak	-	-	-	-	1	2	-	-	-	-	-	-	1	1	1[c]	-
Black-tailed Gnatcatcher	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
Bullock's Oriole	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-
Great-tailed Grackle	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
House Finch	-	-	-	-	31	139	-	1	-	-	-	-	8	16	-	-
Indigo Bunting	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
Loggerhead Shrike	-	-	-	-	1	1	-	-	1	1	-	1	3	3	-	-
Lucy's Warbler	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
Marsh Wren	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Red-winged Blackbird	-	-	-	-	1	1	-	-	-	-	-	-	27	99	-	-
Song Sparrow	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
White-winged Dove	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
Unknown grosbeak	-	-	-	-	1	1	-	-	-	-	-	-	1	1	-	-
Unknown sparrow	-	-	-	-	8	21	-	-	1	1	-	-	-	-	-	-
Unknown species	1	1	-	-	1	1	-	-	-	-	-	-	1	1	-	-

* Data are presented both as the number of capture instances (number of days on which a given species was present in any trap in the study area) and capture occurrences (number of individuals of a species captured each day summed over all days).

[a] Right eye swollen and possibly blinded.

[b] Heat stressed; no tail, bloodied bill.

[c] Broken lower mandible.

TRAP DESIGN

We examined the non-target capture data from Topock to determine whether the two styles of trap had different capture rates for non-target species. The new style of cowbird trap tested in 2005 captured significantly more non-target species than did the old traps (Table 5.6).

Table 5.6. Non-target Species Captured during Brown-headed Cowbird Trapping in Old and New Trap Styles, Topock, 2005

Species	New Trap				Old Trap			
	Instance	Occurrence	Injured	Died	Instance	Occurrence	Injured	Died
Abert's Towhee	40	57	2[a]	1	2	2	-	-
Blue Grosbeak	1	1	1[b]	-	-	-	-	-
Bullock's Oriole	2	2	-	-	-	-	-	-
Black-tailed Gnatcatcher	-	-	-	-	1	1	-	-
Great-tailed Grackle	1	1	-	-	-	-	-	-
House Finch	7	15	-	-	1	1	-	-
Indigo Bunting	1	1	-	-	-	-	-	-
Loggerhead Shrike	3	3	-	-	-	-	-	-
Lucy's Warbler	1	1	-	-	-	-	-	-
Red-winged Blackbird	27	99	-	-	-	-	-	-
White-winged Dove	1	1	-	-	-	-	-	-
Unknown grosbeak	-	-	-	-	1	1	-	-
Unknown species	1	1	-	-	-	-	-	-

[a] Heat stressed; no tail, bloodied bill.
[b] Broken lower mandible.

DISCUSSION

Brown-headed 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 frequency of cowbird brood parasitism of willow flycatcher across its range is known to be highly variable, ranging from less than 5% at some sites to over 60% at others (Sedgwick 2000). Cowbird brood parasitism of *E. t. extimus* is of particular concern because brood parasitism usually results in reduced reproductive output (Sedgwick and Knopf 1988, Harris 1991, Whitfield and Sogge 1999, Rothstein et al. 2003, this document).

A comparison of the proportion of flycatcher nests parasitized during the pretrapping (1997–2002) and trapping (2003–2005) periods shows no statistical difference at any of the study areas. However, Pahranagat exhibits a trend towards lower brood parasitism during trapping, with no brood parasitism recorded at the site since trapping began in 2003. It is likely cowbird trapping at Pahranagat has lowered flycatcher brood parasitism, with the landscape characteristics of the site facilitating the efficacy of trapping. The trapping area at Pahranagat consists of small, relatively isolated patches of mature riparian forest, and cowbird immigration to the site probably occurs at a relatively low rate. The trapping areas at Mesquite, Mormon Mesa, and Topock are part of larger, contiguous riparian corridors, and cowbirds that are removed by trapping are quickly replaced by other individuals (L. White, pers. comm.).

Although we implemented cowbird trapping at all life history sites starting in 2003, relatively few cowbirds have been removed at Mesquite and Mormon Mesa. In 2003, 2004, and 2005, we removed 0, 9, and 24 female cowbirds, respectively, at Mesquite; and 0, 15, and 0 female cowbirds, respectively, at Mormon Mesa. The low number of captures at both sites has likely been influenced both by trap design (see below for details) and by logistical constraints (e.g., land use, dense vegetation, water) that limit possible trap locations at both sites. Given that we consistently detect cowbirds within flycatcher breeding habitat at both Mesquite and Mormon Mesa (see Chapter 2), removal of so few individuals is likely to have little effect on brood parasitism rates. Since 2003, 402 cowbirds, including 138 females, have been removed from Topock. Although the rate of brood parasitism in 2005 was the highest recorded at Topock since monitoring began, passerine point count data at the site from 2005 show a significant decline in cowbird abundance compared to previous years (L. White, pers. comm.). Three years of trapping may be an insufficient amount of time to influence flycatcher parasitism rates or reproductive success at sites (Rothstein et al. 2003), and trapping results and brood parasitism rates recorded over the next two years will provide additional data with which to evaluate the effects of trapping.

In 2003 and 2004, we used a modification of the Australian crow trap (per Ahlers and Tisdale-Hein 2001) at all sites to capture Brown-headed Cowbirds. During this time it became apparent that cowbirds were escaping from these flat-topped traps, and the low number of cowbirds captured was not reflective of the large number of cowbirds detected at trapping sites during surveys and monitoring. In 2005, in an effort to determine the relative efficacy of the flat-topped design, we deployed traps that more closely replicated the original Australian crow trap design, which has a funnel-shaped top. We found that the trap with the funnel-shaped top reduced the escape rate of cowbirds. Perches can be positioned above the entrance slot in traps with a funnel-shaped top, which prevents perched birds from seeing the only exit. We also found the funnel-shaped traps captured a significantly larger number of cowbirds and non-target species compared to the flat-topped traps. The funnel shape of the top likely directs approaching birds towards the entrance slot more effectively than the flat-topped trap. In 2006, traps at all study areas will be of the funnel-shape design wherever logistically possible.

Fourteen non-target species were captured at Pahranagat, Mesquite, Mormon Mesa, and Topock during cowbird trapping in 2005. This compared to eight non-target species captured in each year in 2003 and 2004. The greater variety of non-target species captured in 2005 is likely the result of use of the funnel-topped traps, which captured more non-target individuals as well as cowbirds. The capture of non-target species is of concern but has been found to be unavoidable. 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 as specified in the above methods.

CHAPTER 6

VEGETATION AND HABITAT CHARACTERISTICS

INTRODUCTION

During the 2005 field season, 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 measured vegetation and habitat characteristics in Southwestern Willow Flycatcher nest, within-territory, and non-use plots at the four life history study areas and at Muddy River Delta. We also measured vegetation and habitat characteristics at flycatcher nest sites at Bill Williams. Field methods at each sampling plot were identical in 2005 to those used in 2003 and 2004. 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. Vegetation and microclimate data (see Chapter 7) obtained in 2003 to 2005 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. These results will be presented in a five-year report summarizing findings from 2003 to 2007.

METHODS

At each of the four life history study areas, 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 (0.04 ha) circle. 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 (0.28 ha) 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 late in the summer when the nest, territory, and adjacent flycatcher territories were inactive.

We measured habitat characteristics at 30 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 Pahranagat and Mesquite, these areas were contiguous with habitat that was occupied in 2005, while at Mormon Mesa and Topock, portions of the habitat block were separated from occupied habitat by roads, open water, dry washes, marshes, or dead vegetation. All life history study areas in 2005 consisted of several sites, and 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 ArcGIS 9.0 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, or 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. For plots where distance to water or saturated soil was recorded as >30 m in the field, distance to the nearest known water was estimated using ArcMap and high-resolution aerial photographs.

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 diameter at breast height (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 2005 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, dbh of substrate species, 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 within-territory plots located at a randomly selected distance 5–10 m from the nest in a randomly selected compass direction. We sampled approximately 10 within-territory locations at each study area to investigate any differences between nest and non-nest locations within the nest stand. If more than 10 within-territory locations had been designated in a study area for microclimate sampling (see Chapter 7), the 10 sites used for vegetation sampling were randomly selected from all the within-territory locations in the study area.

We also measured habitat characteristics at non-use plots located 50–200 m from any willow flycatcher nest or territory center. We sampled one non-use plot for each willow flycatcher nest in which at least one flycatcher egg was laid at Pahranagat, Mesquite, Mormon Mesa, and Muddy River Delta. At Topock, after a minimum sample size of 15 was obtained, we assigned corresponding non-use sites to a subsample of nest sites. Each non-use plot was surveyed multiple times throughout the season to confirm the absence of flycatchers. Non-use plot locations were randomly selected by superimposing a 25 × 25–m grid over an ArcGIS 9.0 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 and 2004), 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 and distance to broadleaf tree 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 × 2 contingency tables. If differences were indicated across sites, we used 2 × 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. within-territory vs. non-use sites – Canopy closure, canopy height, percent woody ground cover, distance to water, total stem counts, and vertical foliage density within each meter interval were compared between nest, within-territory, and non-use sites at each study area using one-way ANOVA and Tukey's multiple comparison test. Distance to canopy gap and broadleaf tree were analyzed as described above. 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, the Muddy River Delta, and Bill Williams, we gathered data on vegetation and habitat characteristics at 79 nest plots, 69 non-use plots, and 43 within-territory plots. We gathered data at an additional 42 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, distance to water or saturated soil, and number of shrub/sapling and tree stems (Table 6.1). Distance to broadleaf tree and canopy gap had greater than 5% of the measurements recorded as >30 m and were analyzed as categorical variables. All variables but percent woody ground cover and percent canopy closure differed significantly between sites. All sites except Pahranagat had the densest foliage within 4 m of the ground (Figures 6.1–6.4).

Table 6.1. Summary of Vegetation and Habitat Characteristics of Entire Habitat Blocks at the Four Life History Study Areas, 2005*

Parameter	Pahranagat (n = 30)	Mesquite (n = 30)	Mormon Mesa (n = 30)	Topock (n = 30)
Average canopy height (m)	19.4 (1.4) 2.9–34.2 A	4.2 (0.2) 1.5–6.3 B	4.0 (0.2) 2.3–7.0 B	5.7 (0.2) 4.0–8.0 B
% total canopy closure	77.8 (3.4) 21.0–98.0 A	77.4 (4.0) 12.0–98.0 A	81.2 (3.8) 0.0–99.0 A	86.9 (3.6) 19.0–100.0 A
% woody ground cover	18.7 (4.0) 0.0–72.0 A	21.3 (4.0) 0.0–96.0 A	9.9 (2.0) 0.0–48.0 A	21.7 (4.6) 0.0–100.0 A
Distance (m) to nearest standing water or saturated soil	39.4 (5.7) 0.0–150.0 A	54.7 (8.1) 0.3–150.0 A,B	85.6 (12.8) 0.0–230.0 B	132.9 (17.8) 0.0–385.0 C
% of plot centers within 30 m of nearest canopy gap	100.0 A	96.7 A	60.0 B	73.3 B
% of plot centers within 30 m of a broadleaf tree	100.0 A	90.0 A	56.7 B	33.3 B
# shrub/sapling stems within 5-m radius of plot center	5.6 (2.1) 0–61 A	65.6 (7.2) 21–176 B	88.3 (5.2) 34–149 B	166.5 (21.0) 7–465 C
# tree stems within 11.3-m radius of plot center	9.9 (1.5) 1–28 A	6.2 (1.9) 0–40 A	4.9 (1.2) 0–21 A	20.9 (3.2) 0–67 B

* 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.

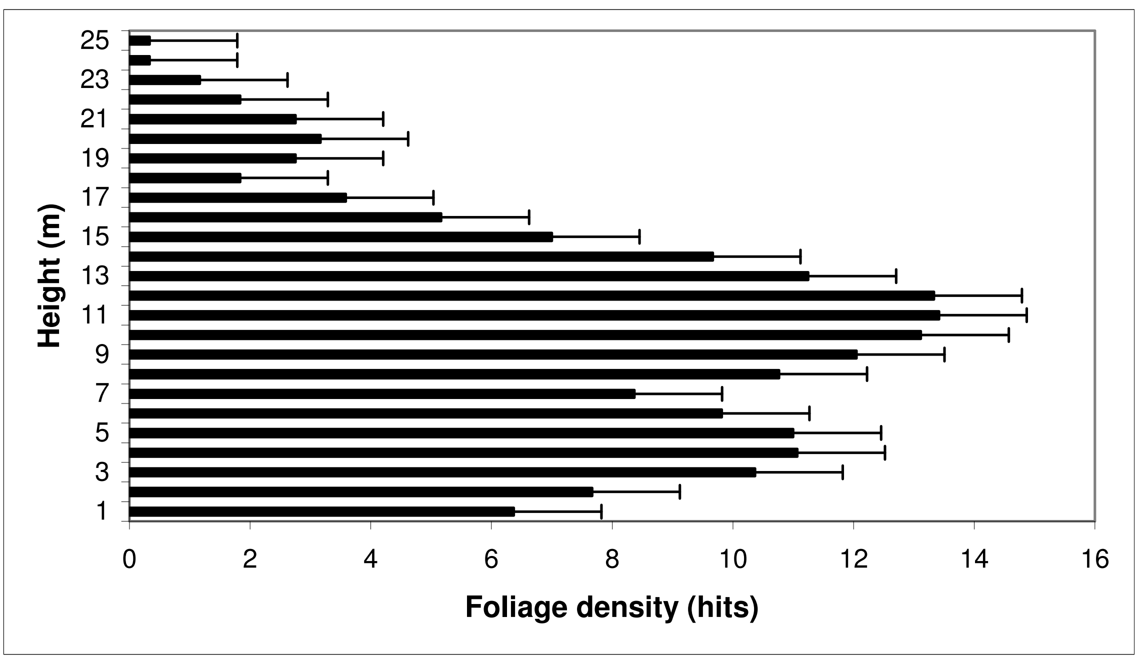

Figure 6.1. Vertical foliage density at habitat block points, Pahranagat NWR, NV, 2005. Values shown are mean and standard error of hits per meter interval. Standard error is pooled across all intervals.

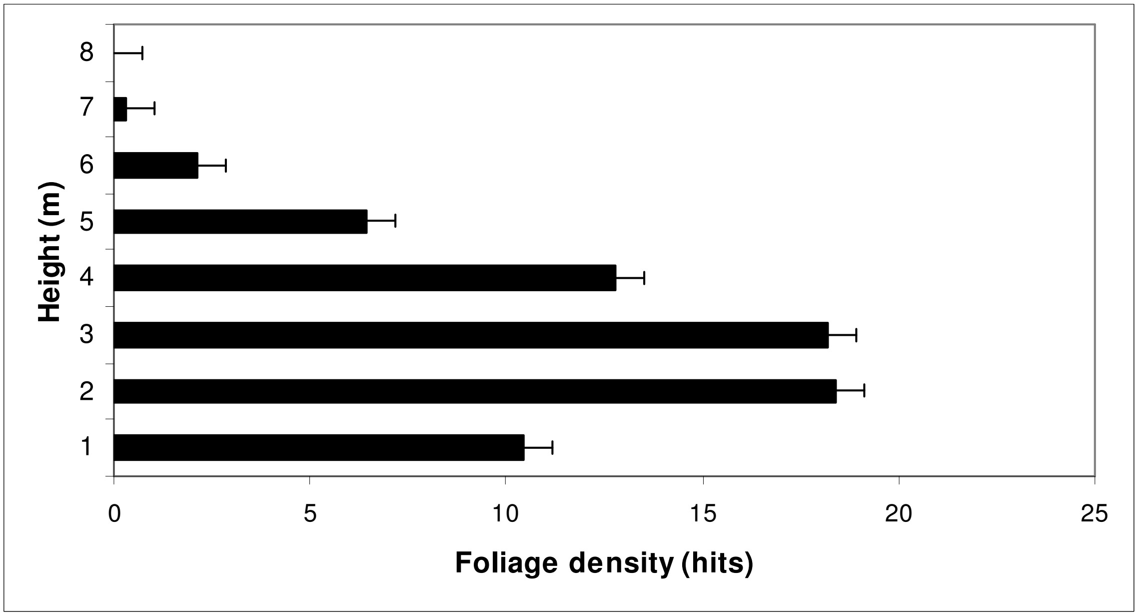

Figure 6.2. Vertical foliage density habitat block points, Mesquite, NV, 2005. Values shown are mean and standard error of hits per meter interval. Standard error is pooled across all intervals.

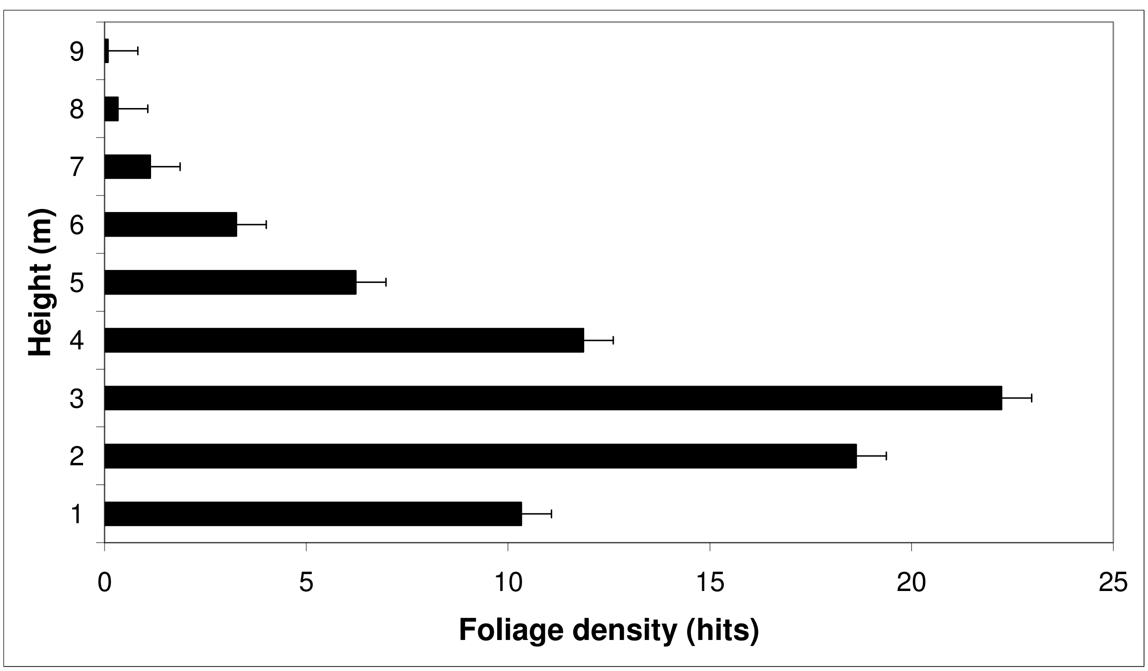

Figure 6.3. Vertical foliage density at habitat block points, Mormon Mesa, NV, 2005. Values shown are mean and standard error of hits per meter interval. Standard error is pooled across intervals.

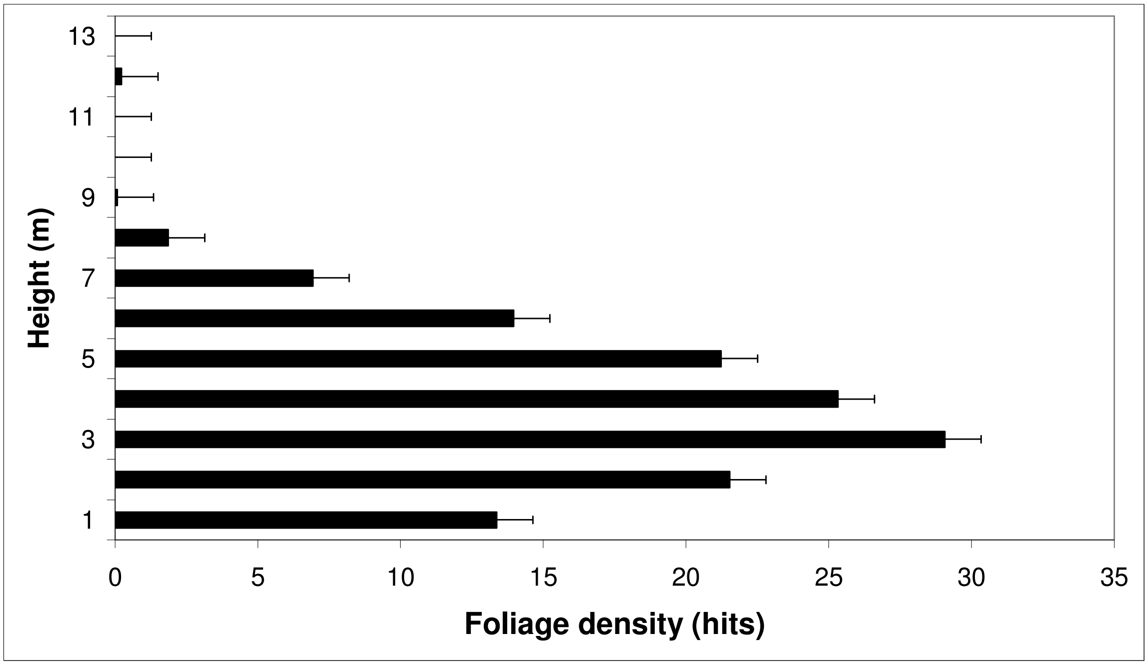

Figure 6.4. Vertical foliage density at habitat block points, Topock Marsh, AZ, 2005. Values shown are mean and standard error of hits per meter interval. Standard error is pooled across intervals.

VEGETATION MEASUREMENTS AT THE NEST

Willow flycatcher nest height at the four life history study areas, Muddy River Delta, and Bill Williams ranged from 1.3 to 10.0 m, with a mean nest height of 3.4 m (SE = 0.2). Nest substrate included four woody species of trees, three native and one exotic, as well as dead trees. Flycatchers placed 67% of all nests at the study areas in tamarisk, 6% in coyote willow, 20% in Goodding willow, 3% in Fremont cottonwood, and 4% in snags. Nest substrate height at all sites ranged from 1.9 to 27.8 m, with a mean nest substrate height of 5.9 m (SE = 0.4). Nest substrate dbh was highly variable, ranging from 0.9 to 86.4 cm, with a mean nest substrate dbh of 12.7 cm (SE = 2.1). Nest height at Mesquite was lower than at Pahranagat and Topock, while nest substrate height and dbh were greater at Pahranagat than at the other study areas (Table 6.2). Nest height, substrate height, and substrate dbh at the life history study areas did not differ significantly from 2003 to 2005.

VEGETATION MEASUREMENTS AT NEST, WITHIN-TERRITORY, AND NON-USE PLOTS

Canopy height, canopy closure, number of shrub/sapling stems, and number of tree stems differed among nest, within-territory, and non-use plots in at least one study area (Table 6.3). Average canopy height was taller at nest and within-territory sites than at non-use sites at Mesquite, Mormon Mesa, and Topock. Canopy closure was significantly higher at nest and within-territory sites than at non-use sites at Pahranagat, Mesquite, and Topock.

Table 6.2. Summary of Nest Measurements at the Four Life History Study Areas, Muddy River Delta, and Bill Williams, 2005*

Parameter	Pahranagat (n = 19)	Mesquite (n = 12)	Mormon Mesa (n = 6)	Topock (n = 33)	Muddy River (n = 7)	Bill Williams (n = 2)
Nest height (m)	3.8 (0.6) 1.3–10.0 A	2.1 (0.1) 1.7–2.8 B	2.6 (0.2) 1.8–3.1 A,B	3.9 (0.2) 1.3–6.5 A	2.2 (0.2) 1.7–2.8 A,B	4.4 (0.1) 4.3–4.5
Nest substrate[1]	84% SAGO 11% POFR 5% TASP	50% TASP 33% SAEX 17% SNAG[1]	83% TASP 17% SNAG[2]	100% TASP	86% TASP 14% SAEX	100% TASP
Nest substrate height (m)	10.3 (1.6) 2.9–27.8 A	3.6 (0.3) 2.6–5.5 B	4.1 (0.4) 2.5–5.0 B	5.4 (0.3) 2.3–9.0 B	3.8 (0.3) 1.9–4.4 B	6.4 (0.1) 6.3–6.5
Nest substrate dbh (cm)	37.3 (5.3) 2.5–86.4 A	2.4 (0.3) 0.9–4.3 B	4.3 (0.9) 1.6–7.9 B	5.6 (0.5) 2.0–13.0 B	2.0 (0.4) 0.9–3.4 B	8.7 (4.3) 4.4–13.0

* Numerical data presented are means, (standard error), and range. Significant differences (Tukey's test, $\alpha = 0.05$) 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.

TASP = *Tamarix* sp. (tamarisk), SAEX = *Salix exigua* (coyote willow), SAGO = *Salix gooddingii* (Goodding willow), POFR = *Populus fremontii* (Fremont cottonwood), SNAG = standing dead tree.

[1] One snag was SAEX, other not identified to species.

[2] Snag was tamarisk.

Shrub/sapling stem count was significantly greater at nest sites than at non-use sites at Mesquite and Mormon Mesa. Shrub/sapling stem count was significantly lower at both nest and within-territory sites vs. non-use sites at Topock, while tree stem count was higher at nest and within-territory plots than at non-use plots. At Muddy River, shrub/sapling stem count was lower at within-territory sites than at either nest or non-use sites. There was no difference in stem counts among plot types at Pahranagat.

Percent woody ground cover and distance to water or saturated soil did not differ significantly between nest, within-territory, and non-use plots at any of the study areas. The percent of plot centers within 30 m of a canopy gap or broadleaf tree appeared to differ at some study areas, but sample sizes were too small to allow statistical analyses.

Vertical foliage density did not differ between nest and within-territory plots in any meter interval at any study area (ANOVA and Tukey's multiple comparison test, $\alpha = 0.05$); within-territory plots were therefore excluded from further analyses.

Vertical foliage density was greatest in the upper strata of the canopy at nest sites vs. non-use sites at Mesquite, Mormon Mesa, and Topock (Figures 6.5–6.9). At Pahranagat, significantly greater vertical foliage density occurred within the 3-m interval at nest sites vs. non-use sites. Vertical foliage density was greater at non-use vs. nest sites in the 20-m interval at Pahranagat and the 2-m interval at Mormon Mesa.

Table 6.3. Comparison of Habitat Characteristics between Willow Flycatcher Nest (NS), Within-Territory (WT) and Non-Use (NU) Sites at the Four Life History Study Areas and Muddy River Delta, 2005[1]

Parameter	Pahranagat			Mesquite			Mormon Mesa			Topock			Muddy River		
	NS (n=19)	WT (n=9)	NU (n=19)	NS (n=12)	WT (n=11)	NU (n=12)	NS (n=6)	WT (n=6)	NU (n=6)	NS (n=33)	WT (n=10)	NU (n=25)	NS (n=7)	WT (n=7)	NU (n=7)
Canopy height (m)	16.9 (1.4)	15.9 (1.2)	21.3 (1.8)	5.4 (0.2) A	5.0 (0.2) A	4.0 (0.2) B***	5.7 (0.3) A	5.7 (0.2) A	3.6 (0.4) B***	6.6 (0.3) A	6.4 (0.7) A	5.0 (0.2) B***	6.7 (0.4)	6.1 (0.1)	5.7 (0.5)
% canopy closure	90.3 (1.8) A	90.6 (2.2) A	70.9 (4.6) B***	94.4 (0.9) A	93.7 (1.6) A	73.5 (5.2) B****	88.5 (2.8)	91.2 (2.5)	81.7 (9.1)	95.9 (0.7) A	97.5 (0.7) A	88.2 (2.9) B**	96.4 (0.5) A	93.0 (1.4) B*	96.4 (0.4) A
% woody ground cover	25.5 (6.2)	21.8 (8.5)	12.5 (3.7)	16.3 (5.4)	16.0 (3.9)	21.5 (7.2)	6.8 (2.6)	7.2 (1.1)	16.2 (7.2)	16.9 (3.1)	13.4 (3.9)	23.3 (5.2)	10.6 (2.6)	11.9 (2.5)	15.0 (4.1)
Distance (m) to nearest water or saturated soil	47.1 (7.2)	55.6 (13.0)	33.7 (5.7)	81.4 (14.5)	89.4 (13.1)	58.9 (12.2)	69.2 (30.6)	69.9 (31.0)	96.7 (23.2)	124.4 (14.0)	142.5 (19.8)	156.3 (23.8)	23.8 (10.0)	23.8 (10.0)	41.1 (9.7)
% of plot centers <30 m from nearest canopy gap	100.0	100.0	100.0	91.7	100.0	91.7	33.3	33.3	50.0	78.8	80.0	64.0	100.0	100.0	28.5[2]
% of plot centers <30 m from a broadleaf tree	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0[3]	39.4	20.0	36.0	100.0	85.7	14.3[3]
# shrub/sapling stems within 5 m of plot center	6.9 (3.2)	4.8 (2.8)	3.9 (1.2)	98.9 (11.6) A	86.2 (10.7) A,B	52.9 (9.1) B*	127.8 (6.5) A	100.7 (5.8) A,B	86.7 (14.6) B*	97.8 (9.1) A	103.5 (46.2) A	191.3 (22.9) B***	70.4 (7.8) A	30.3 (3.3) B***	59.0 (7.0) A
# tree stems within 11.3 m of plot center	8.7 (1.3)	13.4 (3.2)	8.4 (2.0)	6.2 (2.1)	5.1 (1.8)	3.2 (1.9)	10.8 (4.4)	9.3 (3.6)	5.0 (3.5)	38.2 (4.1) A	34.8 (4.9) A	12.4 (2.6) B****	15.0 (2.8)	12.1 (3.5)	14.6 (3.7)

[1] Data are presented as means (SE). Significant differences (α = 0.05) between nest, within-territory, and non-use plots in a given study area are indicated by alpha codes; plots with different letters differed from one another while plots with the same letter did not. Level of significance is indicated by asterisks as follows: * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; **** $P < 0.0001$.

[2] Although there appears to be a trend toward non-use plots being farther from a canopy gap at this study area, small sample sizes preclude statistical analyses.

[3] Although there appears to be a trend toward non-use plots being farther from a broadleaf tree at this study area, small sample sizes preclude statistical analyses.

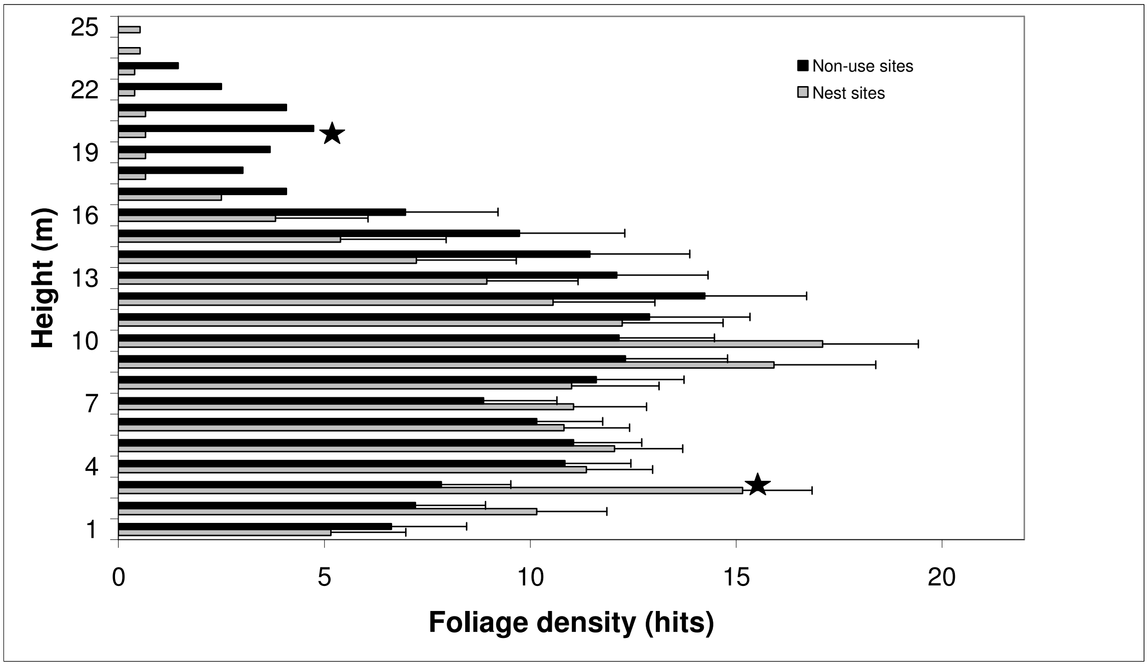

Figure 6.5. Vertical foliage density and standard error at willow flycatcher nest sites versus non-use sites at Pahranagat NWR, NV, 2005. Differences (Student's t-test, α=0.05) between nest and non-use sites within a given meter interval are indicated by asterisks.

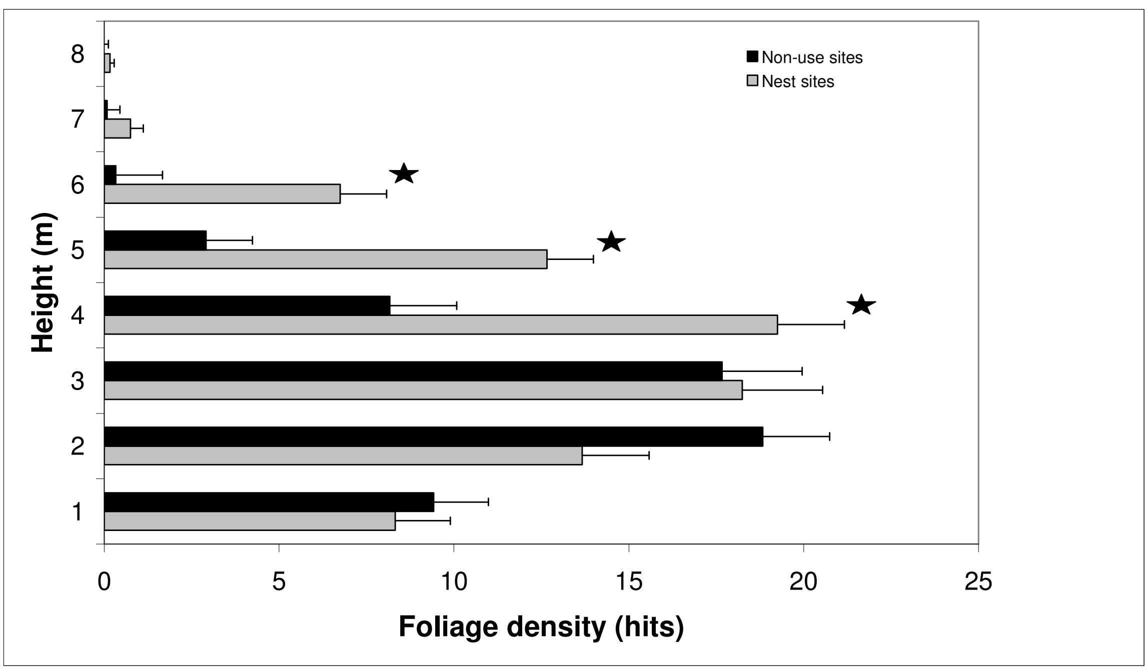

Figure 6.6. Foliage density and standard error at willow flycatcher nest sites vs. non-use sites at Mesquite, NV, 2005. Differences (Student's t-test, α=0.05) between nest and non-use sites within a given meter interval are indicated by asterisks.

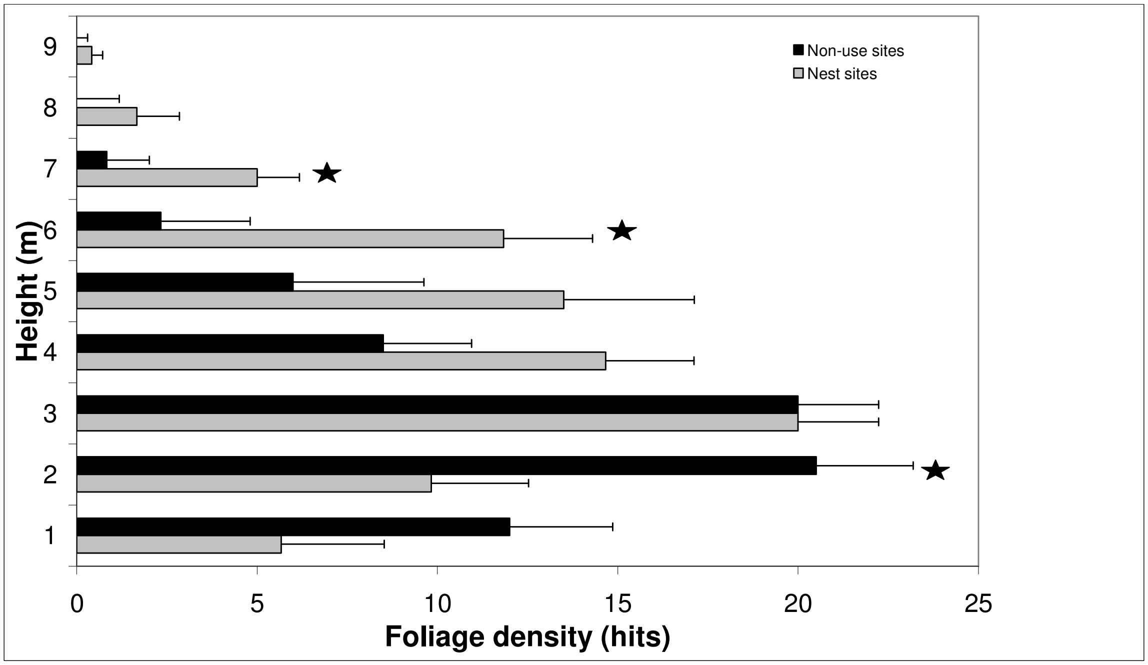

Figure 6.7. Foliage density and standard error at willow flycatcher nest sites vs. non-use sites at Mormon Mesa, NV, 2005. Differences (Student's t-test, α=0.05) between nest and non-use sites within a given meter interval are indicated by asterisks.

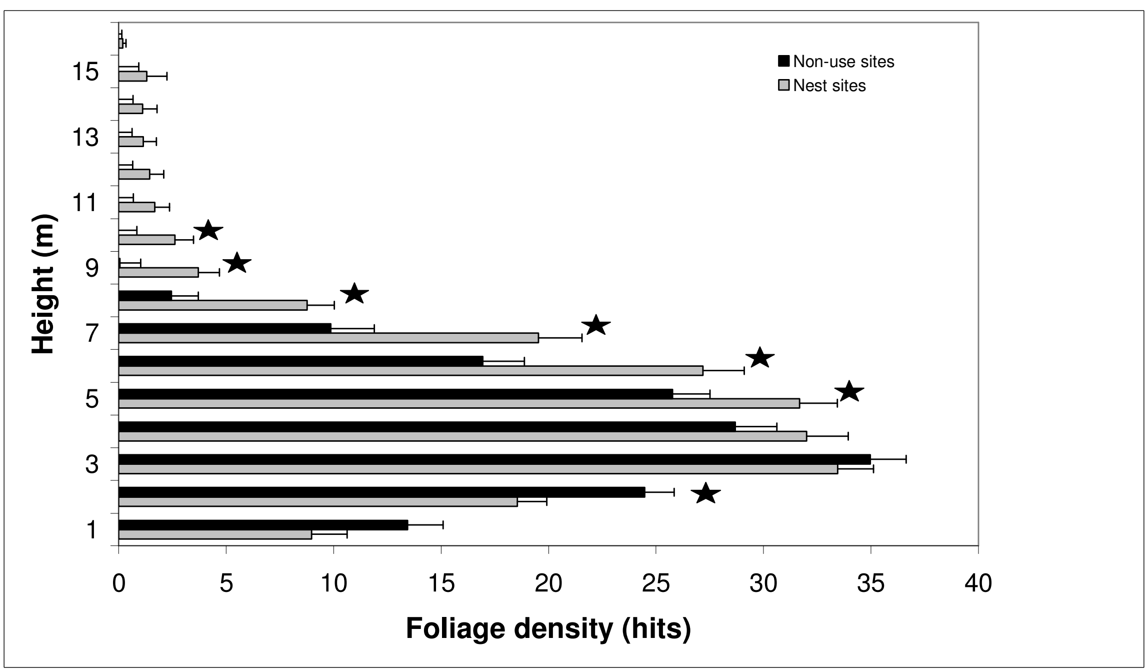

Figure 6.8. Foliage density and standard error at willow flycatcher nest sites versus non-use sites at Topock Marsh, AZ, 2005. Differences (Student's t-test, α=0.05) between nest and non-use sites within a given meter interval are indicated by asterisks.

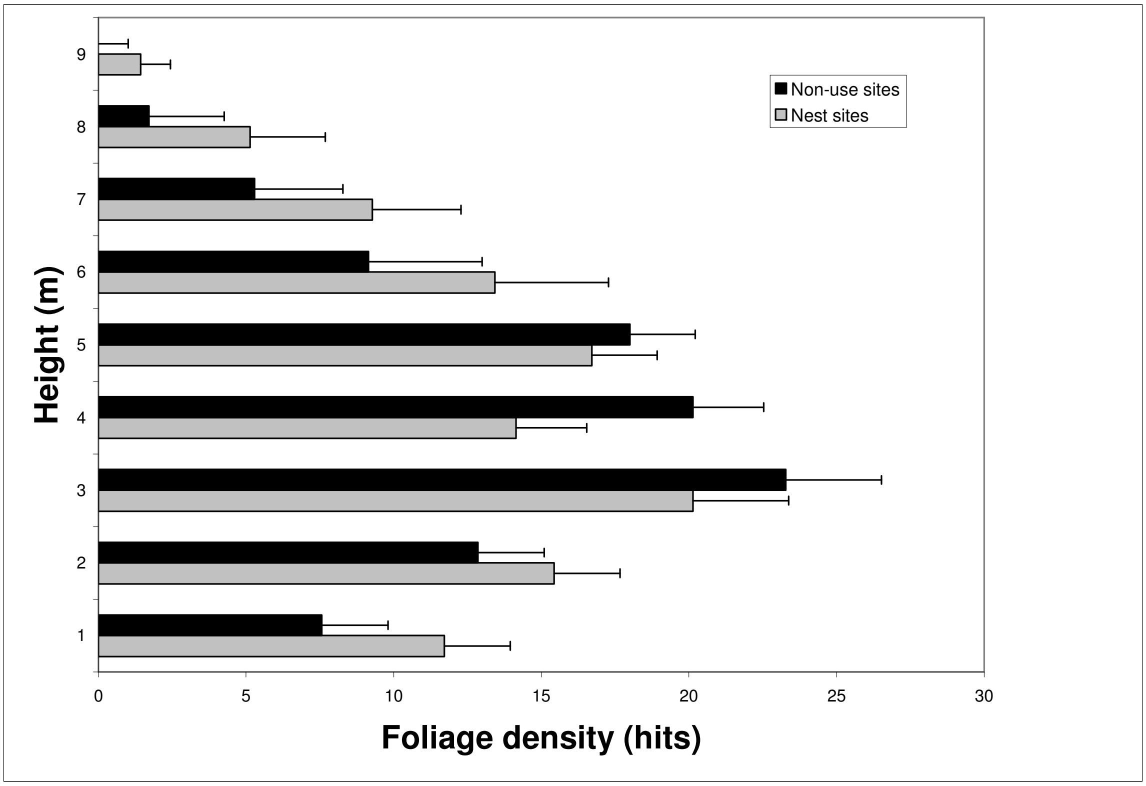

Figure 6.9. Foliage density and standard error at willow flycatcher nest sites versus non-use sites at Muddy River Delta, NV, 2005. Vertical foliage density did not differ between nest and non-use sites in any meter interval.

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 relatively 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. The very dense vegetation at Mesquite, Mormon Mesa, and Topock is reflected in higher shrub counts at these sites than at Pahranagat. The Topock habitat block also has a significantly greater number of tree stems than the other study areas.

At all study areas, habitat blocks have relatively high canopy closure with vertical foliage profiles showing no distinct understory, overstory, or structural layers. These results are consistent with those of McKernan and Braden (2001a) and indicate that high vegetation volume (amount of 3-dimensional space occupied by the vegetation) may be more important than a particular habitat structure for breeding flycatchers. At Mesquite, Mormon Mesa, and Topock, the greatest vertical foliage density occurs at 2–3 m above the ground. At Pahranagat, vertical foliage density within a given meter interval is generally less than at the other study areas but is relatively evenly distributed from 3–14 m above the ground. Although any given meter interval at Pahranagat is less dense than at other sites, combined they equate to high canopy closure.

As in 2003 and 2004, differences in nest characteristics between study areas reflected general differences in habitat structure, with nest substrates at Pahranagat being significantly taller and having larger dbh than substrates at the other life history study areas and the Muddy River. Nest height, substrate height, and substrate dbh did not differ significantly between years in 2003–2005 at any of the life history study areas. As in previous years, nearly all nests at Pahranagat were placed in native species while all nests at Topock and at least 50% of nests at Mesquite and Mormon Mesa were placed in tamarisk. Although nest substrates may not be chosen in proportion to their availability in the habitat, it is clear that willow flycatchers nest in both predominantly native and predominantly exotic habitats. Analyses of nest productivity as related to native vs. non-native vegetation will be conducted in subsequent years to determine the relative importance of species composition at flycatcher breeding sites along the lower Colorado River.

Comparisons between nest and non-use sites in 2005 demonstrated patterns similar to those that emerged in 2003 and 2004. We found higher canopy closure at nest sites than at non-use sites at three (Pahranagat, Mesquite, and Topock) of the four life history study areas. Nest sites had significantly greater canopy heights than non-use sites at Mesquite, Mormon Mesa, and Topock. These results are consistent with those of Allison et al. (2003) who reported a trend for Southwestern Willow Flycatcher nest sites to have a higher percentage canopy closure and taller canopy than non-use sites. At Pahranagat, canopy height at non-use sites tended to be taller than at nest sites 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 found a significantly greater number of shrub/sapling stems at nest sites than at non-use sites at two (Mesquite and Mormon Mesa) of the four life history study areas. Sedgwick and Knopf (1992) also reported higher shrub density at nest sites vs. unused sites for a flycatcher population in north-central Colorado. In both 2004 and 2005, nest sites at Topock demonstrated higher tree stem counts and lower shrub/sapling stem counts than non-use sites. This may be an indication that flycatchers are nesting in areas of more mature tamarisk within the Topock study area. Future analyses will examine stem counts by size category to refine the analyses of differences between nest, within-territory, and non-use sites.

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. In both 2003 and 2004, vertical foliage density at nest sites was generally greatest at and/or immediately above mean nest height. This same pattern was exhibited in 2005. 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 Rivers.

Distance to nearest surface water or saturated soil did not differ significantly between nest and non-use plots at any of the study areas in 2005, and the mean distance from nest sites to standing water or saturated soil varied among study areas by as much as 100 m. In 2003, a greater proportion of nests sites than non-use sites were within 30 m of standing water at Mesquite, and this was true at both Mesquite and Topock in 2004. The lack of a difference in 2005 may be the result of hydrologic changes at both Topock and Mesquite, with Topock being drier in 2005 than in previous years and Mesquite being altered by over-winter flooding (see Chapter 2).

The affinity of breeding flycatchers with standing water and saturated soil is noted consistently in the literature, and presence of water may be a factor in providing a more suitable microclimate for raising offspring (Sogge and Marshall 2000). Our ability to detect differences in distance to water between nest and non-use sites is strongly influenced by our sampling methodology. Surface water or saturated soil were present at many nest sites at the time flycatchers arrived in May and at the time of nest initiation, but vegetation measurements were conducted at the end of the breeding season so as to minimize disturbance to flycatchers. Distance to surface water and saturated soil were also estimated at the time microclimate equipment was deployed after nests were vacated (see Chapter 7). Because of extreme seasonal changes in hydrology at the study areas, with many nest sites dry by July or August, distance to water as measured after nests are vacated or after the breeding season may not reflect hydrologic conditions during nest-site selection. In addition, distance to water was measured inconsistently in the field, in that distances >30 m were sometimes recorded as precise measurements and sometimes as >30 m. We attempted to obtain precise measurements for all distances via ArcGIS and high-resolution aerial photographs, but this allowed us to measure distances only to obvious bodies of water and did not take saturated soils into account. Converting all measurements recorded as >30 into 31 to allow analysis of the variable as continuous would also produce questionable results, since some distances >30 m were measured precisely.

We propose a change in methodology to allow a measure of distance to water at the time of nest initiation. In 2006, we propose to measure distance to surface water or saturated soil as soon as flycatcher eggs are observed in a nest. At the same time, non-use plots will be designated, and distance to water from the non-use plot will also be measured at this time, rather than after the nest is vacated. Field personnel will be instructed to obtain precise measurements of distance to water whenever possible, rather than defaulting to a measurement of >30 m. We will also explore the applicability of analyzing distance to water as a categorical, rather than continuous, variable.

From 2003 to 2005, percent woody ground cover did not differ significantly between nest and non-use plots at any of the study areas. These results suggest that percent woody ground cover may not be a useful variable in distinguishing between nest and non-use sites. The vegetation sampling variables used in our study were identified by the Arizona Game and Fish Department, and percent woody ground cover was included as a way to quantify ground cover available to potential nest predators. Whether this vegetation characteristic should be measured in subsequent years to distinguish between nest and non-use plots will be evaluated.

Distance to nearest broadleaf did not differ significantly between nest and non-use plots at any of the study areas from 2003 to 2005. Allison et al. (2003) reported that distance to nearest native plant was useful in distinguishing nesting and non-nesting plots at two large sites composed of even-aged vegetation. Because of the variation in species composition among our study areas, distance to nearest broadleaf may not be a variable useful in distinguishing between flycatcher nest and non-use plots along the Virgin and lower Colorado Rivers.

As in previous years, the percent of plot centers within 30 m of a canopy gap was largely inconclusive. Allison et al. (2003) reported that, compared to the center of non-use plots, Southwestern Willow Flycatchers placed nests closer to canopy gaps, while Sedgwick and Knopf (1992) reported that a willow flycatcher population in northern Colorado placed nests farther from canopy gaps. Because of the variation in vegetation structure among the study areas, presence of canopy gaps may not be a good predictor of flycatcher breeding habitat along the Virgin and lower Colorado Rivers.

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, 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' in a complex formula that integrates all the above factors (Gloutney and Clark 1997).

The purpose of this microclimate investigation was to document temperature, relative humidity, vapor pressure, 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, vapor pressure, and soil moisture were used as indices to microclimate, although it was recognized that substantial interaction likely occurred among those four variables.

METHODS

OVERVIEW

We located active flycatcher nests at four life history study areas (Pahranagat, Mesquite, Mormon Mesa, and Topock) and at Muddy River Delta between May and August 2005. Microclimate variables 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 2 m of a nest (i.e., the nest site [NS]).
2. Within the territory associated with that nest (but 5–10 m from the nest; i.e., within-territory site [WT]).
3. Within unoccupied riparian habitat 50–200 m from the nearest known nest or territory (i.e., non-use site [NU]).

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 a flycatcher 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.

Microclimate 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 randomly selected locations within known flycatcher breeding areas and at representative locations in adjacent desertscrub habitat. The riparian SV sensor arrays (SVR) were designed to monitor T/RH fluctuations throughout the nesting season within the riparian zone to document ambient environmental conditions throughout the study period. Specific locations for SVR sensors were selected by superimposing a 25 × 25–m grid on flycatcher breeding areas known from previous years, numbering the grid blocks, selecting blocks by using a random number generator, and using the centroid of each selected block. The SVR 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 below. The desertscrub SV sensor arrays (SVD) 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 m 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.

(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.

C. The sensor array was placed at a randomly selected height within the range of flycatcher nest heights documented at that study area in 2003 and 2004 (Koronkiewicz et al. 2004, McLeod et al. 2005). The distribution of random numbers followed the distribution of nest heights.[1] 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 and Muddy River, we identified NU habitat after the first territories and nests were located. We used ArcGIS 9.0 software to generate two circles 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. Specific locations for non-use sensors were selected by superimposing a 25 × 25–m grid on the NU habitat, numbering the grid blocks, selecting blocks by using a random number generator, and using the centroid of each selected block. 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.

[1] We did not have nest height distribution data for Muddy River, so we used the nest height distribution from Mormon Mesa, which is the nearest study area to Muddy River.

To obtain adequate sample size but still use resources efficiently, we established at least 15 NS, WT, and NU sites at each study area. If more than 15 nests were found and logistical considerations made it difficult to establish an NU site for every NS, an NU site was established for a subset of nest sites after the minimum sample size of 15 was established.

At each location where we deployed a HOBO sensor array, we also visually estimated canopy closure as <25%, 25–75%, or >75%, and habitat type was identified as native (cottonwood/willow), exotic (tamarisk), or mixed native and exotic (see data forms in Appendix A).

Soil Moisture (SM) Measurements

Hand-held probes were used to document SM at NS, WT, and NU sites at the time the T/RH sensor arrays were placed, and at the time the T/RH sensor arrays were removed 14 days later. In addition, SM readings were taken at SVR locations at least twice a week throughout the season. No SM readings were taken at SVD locations because SM was assumed to be at or near zero. Each time soil moisture readings were taken at a site, we also recorded the nearest distance to inundated or saturated soil. Distances <30 m were estimated in the field, and distances >30 m were measured either with a GPS unit or from high-resolution aerial photographs. If distance to the nearest saturated or inundated soil was >30 m and the location of the nearest saturated or inundated soil was unknown, distance was recorded as >30 m.

A ThetaProbe ML2x coupled to an HH2 Moisture Meter Readout (Macaulay Land Use Research Institute, Aberdeen, UK, and Delta-T Devices, Cambridge, UK, respectively) were used to gather soil moisture data. The SM readings (nine per site) were recorded directly beneath the HOBO logger (plot center) and at 1.0 and 2.0 m from plot center in each cardinal direction for each SVR, NS, WT, and NU site. SM was recorded both as voltage (mV) and as volumetric water content (%).[2] Soil type on the HH2 was set to mineral soil. For any SM measurement point that was underwater, we recorded the depth of standing water and assigned a value of 994 mV, which is equivalent to 50% volumetric water content, or fully saturated soil.

Soil samples were collected at each SM site (SVR, 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

[2] The soil moisture logger measures the dielectric constant of moist soil via a direct current voltage, which is converted to volumetric soil moisture with conversion tables. For very high (above ~1000 mV) or low (below ~90 mV) voltage readings, the HH2 reports volumetric soil moisture as “above” or “below” the table, respectively. To eliminate these qualitative readings, we recorded both mV and volumetric soil moisture in 2005, rather than just volumetric soil moisture, which we had recorded in 2004.

analysis, with the exception of the SV dataset, which was summarized separately for descriptive purposes and was not included in any of the analyses. We calculated the following variables for each sensor array by overall study period:

- Mean soil moisture from plot center to 2.0 m from plot center
- Mean diurnal temperature
- Mean number of 15-minute intervals above 41°C each day[3]
- Mean nocturnal temperature
- Mean daily temperature range (diurnal maximum minus nocturnal minimum)
- Mean diurnal relative humidity
- Mean diurnal vapor pressure[4]
- Mean nocturnal relative humidity
- Mean nocturnal vapor pressure

Analyses of mean soil moisture were done using mV readings, and mean values are converted back to percent volume for presentation of results to facilitate comparison with data from 2004.

We did not analyze distance to water in 2005 because of inherent problems in our method of data collection for this variable. For a complete discussion of methodology issues and proposed solutions, see Chapter 6.

The overall study period constituted the entire season for SV sensor arrays and the 14 days of monitoring for sites (NS, WT, and NU) associated with nests. We determined diurnal and nocturnal periods by using the actual daily sunrise and sunset times reported for the region by the National Weather Service (2005).

In the 2003 and 2004 reports, we used statistical tests to determine whether placing the sensor arrays *after* the nest had been vacated was appropriate, by testing the mean weekly diurnal temperature and mean soil moisture 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. Both years revealed few differences between consecutive weeks for T/RH and SM measurements, so we did not perform these tests again in 2005, as we are confident in the validity of measuring nest microclimate after nests were vacated.

Chi-square (χ^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.

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[3] In 2003 and 2004, we analyzed mean maximum diurnal temperature. However, the length of time for which an organism experiences high temperatures may be more indicative of stresses than the maximum temperature reached. Estimated thermal tolerance of avian embryos for short exposures in most species is 16 to 41°C (Webb 1987).

[4] In prior years, we evaluated humidity by examining relative humidity. In 2005, we decided to add an analysis of vapor pressure. Vapor pressure, unlike relative humidity, is not influenced by ambient temperature, and may be a more biologically meaningful measure of water content of the air (e.g., the relative vapor pressure inside and outside an egg determines whether the egg loses moisture). We calculated vapor pressure from the absolute humidity and temperature recorded by the HOBOs.

Using the results of the MANOVA analyses in 2003 and 2004, we formulated models to find the most parsimonious set of variables associated with a nest site versus a non-nest site. In 2005, we used logistic regression to determine which set of variables is significantly associated with NS versus WT and NS versus NU location types. The full models included those variables that differed significantly by location type in the 2003 and 2004 analyses: soil moisture, diurnal temperature and relative humidity, and daily temperature range. Mean maximum temperature was also significant, but we included instead the more meaningful measure from this year's analysis, number of 15-minute intervals above 41°C. Nocturnal temperature and humidity were not associated and so not included in the models. All models adjusted for differences in canopy cover, habitat, and life history site. In a supplementary analysis, we plan to analyze whether smaller sample sizes for NU compared to NS and WT at Topock influenced the results.

Analyses were conducted using SAS® Version 9.1 (SAS Institute 2003) and Stata® Version 8.0 (StataCorp 2004).

RESULTS

SEASONAL VARIATION

Twenty-four SV T/RH sensor arrays were placed at the four life history study areas in early May and remained in place until August (Pahranagat, Mormon Mesa) or late September (Mesquite, Topock). One T/RH sensor in riparian habitat at Topock Marsh failed to function. One SVD sensor at Mesquite could not be relocated at the end of the season and we suspect it was stolen. One SVD and two SVR sensors initially set up in Mormon Mesa were unrecoverable because a local landowner barred our reentry. The SVR sensors were replaced mid-season by sensors in other locations. 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, 2005*

Descriptive Statistics	Pahranagat	Mesquite	Mormon Mesa	Topock
n	4	4	4	3
Mean soil moisture (mV)	953.8 (22.2)	460.1 (153.0)	526.4 (149.2)	488.8 (174.0)
Mean soil moisture (%)	46.2	17.9	20.7	19.1
Mean diurnal temperature (°C)	24.6 (0.1)	29.7 (0.1)	34.8 (0.2)	31.1 (0.2)
Mean no. of 15-min. intervals above 41°C each day	0.0 (0.0)	5.3 (0.4)	20.0 (0.6)	7.2 (0.6)
Mean nocturnal temperature (°C)	20.4 (0.2)	22.3 (0.2)	22.8 (0.2)	23.5 (0.2)
Mean daily temperature range (°C)	16.1 (0.2)	24.0 (0.3)	29.9 (0.4)	23.9 (0.4)
Mean diurnal relative humidity (%)	39.8 (0.7)	49.4 (0.7)	35.3 (0.8)	51.5 (0.8)
Mean diurnal vapor pressure (Pa)	1169.8 (24.5)	1781.8 (25.4)	1499.0 (33.5)	2093.1 (38.8)
Mean nocturnal relative humidity (%)	45.2 (0.8)	61.2 (0.7)	59.9 (0.9)	59.9 (0.8)
Mean nocturnal vapor pressure (Pa)	1077.4 (22.6)	1564.6 (20.4)	1616.0 (26.2)	1735.1 (35.3)

*All values are means (standard error in parentheses).

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, 2005*

Descriptive Statistics	Pahranagat	Mesquite	Mormon Mesa	Topock
n (Temp./Humidity)	2	1	1	2
Mean diurnal temperature (°C)	32.7 (0.3)	32.6 (0.3)	40.3 (0.5)	39.1 (0.3)
Mean no. of 15-min. intervals above 41°C each day	12.2 (1.0)	8.0 (1.1)	32.1 (1.0)	26.0 (1.0)
Mean nocturnal temperature (°C)	22.6 (0.3)	26.4 (0.3)	25.9 (0.4)	29.2 (0.3)
Mean daily temperature range (°C)	25.7 (0.4)	20.4 (0.4)	33.4 (0.6)	29.8 (0.6)
Mean diurnal relative humidity (%)	21.4 (0.8)	28.2 (1.1)	20.6 (1.1)	23.3 (0.8)
Mean diurnal vapor pressure (Pa)	825.0 (31.8)	1187.7 (50.8)	1174.5 (52.6)	1242.5 (45.9)
Mean nocturnal relative humidity (%)	36.1 (1.3)	35.7 (1.5)	36.0 (1.3)	33.2 (1.2)
Mean nocturnal vapor pressure (Pa)	932.6 (36.3)	1150.6 (51.4)	1185.8 (51.4)	1258.2 (49.0)

*All values are means (standard error in parentheses). No SM data were gathered in desertscrub habitat.

LOCATION TYPES: DESCRIPTIVE STATISTICS AND SINGLE EFFECTS ANALYSIS

Data on temperature and humidity were successfully collected for 72 NS, 70 WT, and 67 NU sites (Tables 7.3–7.7). Sample sizes between location types differed because of sensor failure.

The single effects analyses (Tables 7.3–7.7) indicate that the NS, WT, and NU sites were significantly different at two (Pahranagat and Topock) of the five study locations for the three diurnal temperature values: mean diurnal temperature, mean daily number of 15-minute intervals $> 41^{o}$ C, and mean daily temperature range. Mean daily temperature range was also significantly different among NS, WT, and NU sites at Mesquite. Pairwise differences demonstrated that NU sites on average were significantly hotter during the day than either NS or WT sites for the indicated parameters at the specified locations. Figures 7.1 through 7.4 show box plots comparing mean diurnal temperature and other selected response variables for NS, WT, and NU sites by study location.

Mean nocturnal temperature differed significantly among NS, WT, and NU sites only at Pahranagat (NU warmer than either NS or WT).

Mean diurnal relative humidity differed significantly among NS, WT, and NU sites at only two study locations: Pahranagat and Topock. The NS and WT sites were more humid than NU sites in both instances. Mean diurnal vapor pressure did not differ significantly among NS, WT, and NU sites at any of the five study locations.

Mean nocturnal relative humidity and mean nocturnal vapor pressure did not differ significantly among NS, WT, and NU sites at any of the five study locations.

Table 7.3. Descriptive Statistics (Chi-square) and Single Effects (ANOVA) for Southwestern Willow Flycatcher Microclimate Data by Location Type at **Pahranagat NWR**, June–August, 2005*

Response Variable	Nest Site	Within Territory	Non-Use	*P*	Significant Pairwise Differences
n (Temp./Humidity Sensor Arrays)	18	16	18	N/A	N/A
Habitat					
Native (cottonwood or willow)	18 (100.0)	16 (100.0)	18 (100.0)	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 Cover					
Less than 25%	4 (22.2)	4 (25.0)	7 (38.9)	0.617	N/A
25–75%	11 (61.1)	11 (68.8)	10 (55.6)		
More than 75%	3 (16.7)	1 (6.3)	1 (5.6)		
Soil Moisture					
Mean soil moisture (mV)	903.7 (25.7)	896.1 (31.2)	592.1 (58.1)	<0.001	NU<NS, WT
Mean soil moisture (%)	41.4	40.8	23.7	--	--
Temperature					
Mean diurnal temperature (°C)	26.4 (0.4)	26.6 (0.5)	29.6 (0.4)	<0.001	NU>NS, WT
Mean no. of 15-min. intervals above 41°C each day	0.1 (0.1)	0.8 (0.6)	2.5 (0.8)	0.014	NU>NS
Mean nocturnal temperature (°C)	22.0 (0.4)	22.2 (0.5)	23.9 (0.5)	0.008	NU>NS, WT
Mean daily temperature range (°C)	17.0 (0.7)	17.5 (1.0)	20.5 (0.9)	0.012	NS<NU
Humidity					
Mean diurnal relative humidity (%)	45.3 (3.6)	46.5 (3.8)	32.7 (3.1)	0.013	NU<NS, WT
Mean diurnal vapor pressure (Pa)	1456.8 (111.7)	1509.0 (119.6)	1189.1 (106.5)	0.106	N/A
Mean nocturnal relative humidity (%)	50.5 (4.0)	51.9 (4.4)	41.5 (3.9)	0.158	N/A
Mean nocturnal vapor pressure (Pa)	1314.0 (110.9)	1359.5 (121.8)	1170.4 (110.6)	0.478	N/A

* Habitat and canopy cover variables are presented as n followed by % of column totals (in parentheses), while soil moisture and temperature/humidity values are means (standard error in parentheses).
N/A = data not available or not applicable.

Table 7.4. Descriptive Statistics (Chi-square) and Single Effects (ANOVA) for Southwestern Willow Flycatcher Microclimate Data by Location Type at **Mesquite**, June–August, 2005*

Response Variable	Nest Site	Within Territory	Non-Use	*P*	Significant Pairwise Differences
n (Temp./Humidity Sensor Arrays)	12	10	12	N/A	N/A
Habitat					
Native (cottonwood or willow)	5 (41.7)	4 (40.0)	3 (25.0)	0.376	N/A
Exotic (tamarisk)	0 (0.0)	0 (0.0)	2 (16.7)		
Mixed (native and exotic)	7 (58.3)	6 (60.0)	7 (58.3)		
Canopy Cover					
Less than 25%	0 (0.0)	0 (0.0)	3 (25.0)	0.191	N/A
25–75%	9 (75.0)	8 (80.0)	7 (58.3)		
More than 75%	3 (25.0)	2 (20.0)	2 (16.7)		
Soil Moisture					
Mean soil moisture (mV)	562.4 (82.0)	559.1 (81.9)	557.0 (79.7)	0.984	N/A
Mean soil moisture (%)	22.3	22.2	22.1	--	--
Temperature					
Mean diurnal temperature (°C)	30.6 (0.5)	32.1 (0.9)	33.4 (1.1)	0.069	N/A
Mean no. of 15-min. intervals above 41°C each day	5.0 (1.6)	10.4 (3.1)	12.9 (3.2)	0.112	N/A
Mean nocturnal temperature (°C)	24.5 (0.5)	24.5 (0.6)	23.7 (0.5)	0.563	N/A
Mean daily temperature range (°C)	20.4 (1.3)	22.1 (1.8)	25.9 (1.4)	0.032	NS>NU
Humidity					
Mean diurnal relative humidity (%)	54.0 (3.7)	50.6 (4.2)	50.0 (4.4)	0.758	N/A
Mean diurnal vapor pressure (Pa)	2135.8 (166.0)	2146.6 (184.5)	2207.5 (182.2)	0.952	N/A
Mean nocturnal relative humidity (%)	61.7 (4.0)	61.5 (4.6)	66.2 (3.7)	0.640	N/A
Mean nocturnal vapor pressure (Pa)	1816.7 (131.8)	1798.2 (141.5)	1863.0 (127.9)	0.940	N/A

* Habitat and canopy cover variables are presented as n followed by % of column totals (in parentheses), while soil moisture and temperature/humidity values are means (standard error in parentheses).
N/A = data not available or not applicable.

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, 2005*

Response Variable	Nest Site	Within Territory	Non-Use	*P*	Significant Pairwise Differences
n (Temp./Humidity Sensor Arrays)	4	6	6	N/A	N/A
Habitat					
Native (cottonwood or willow)	0 (0.0)	0 (0.0)	0 (0.0)		
Exotic (tamarisk)	3 (75.0)	3 (50.0)	6 (100.0)	0.135	N/A
Mixed (native and exotic)	1 (25.0)	3 (50.0)	0 (0.0)		
Canopy Cover					
Less than 25%	0 (0.0)	0 (0.0)	2 (33.3)		
25–75%	4 (100.0)	6 (100.0)	1 (16.7)	0.017	NS-NU, WT-NU
More than 75%	0 (0.0)	0 (0.0)	3 (50.0)		
Soil Moisture					
Mean soil moisture (mV)	589.3 (147.6)	585.2 (146.8)	500.9 (145.7)	0.571	N/A
Mean soil moisture (%)	23.5	23.4	19.6	--	--
Temperature					
Mean diurnal temperature (°C)	32.3 (1.1)	33.9 (1.1)	34.7 (1.2)	0.443	N/A
Mean no. of 15-min. intervals above 41°C each day	9.8 (4.3)	14.3 (3.4)	17.0 (3.9)	0.470	N/A
Mean nocturnal temperature (°C)	26.2 (0.5)	26.2 (0.3)	25.4 (0.4)	0.250	N/A
Mean daily temperature range (°C)	18.9 (1.9)	22.2 (1.5)	25.8 (2.1)	0.700	N/A
Humidity					
Mean diurnal relative humidity (%)	55.2 (6.8)	49.6 (4.2)	51.9 (6.2)	0.803	N/A
Mean diurnal vapor pressure (Pa)	2339.7 (173.3)	2267.6 (95.7)	2385.4 (249.0)	0.897	N/A
Mean nocturnal relative humidity (%)	67.4 (6.9)	62.1 (5.1)	69.5 (6.2)	0.609	N/A
Mean nocturnal vapor pressure (Pa)	2216.6 (175.8)	2052.4 (140.1)	2169.3 (154.5)	0.754	N/A

* Habitat and canopy cover variables are presented as n followed by % of column totals (in parentheses), while soil moisture and temperature/humidity values are means (standard error in parentheses).
N/A = data not available or not applicable

Table 7.6. Descriptive Statistics (Chi-square) and Single Effects (ANOVA) for Southwestern Willow Flycatcher Microclimate Data by Location type **Topock**, June–August, 2005*

Response Variable	Nest Site	Within Territory	Non-Use	*P*	Significant Pairwise Differences
n (Temp./Humidity Sensor Arrays)	31	31	24	N/A	N/A
Habitat					
Native (cottonwood or willow)	0 (0.0)	0 (0.0)	1 (4.2)		
Exotic (tamarisk)	29 (93.5)	29 (93.5)	19 (79.2)	0.386	N/A
Mixed (native and exotic)	2 (6.5)	2 (6.5)	3 (12.5)		
Canopy Cover					
Less than 25%	2 (6.5)	3 (9.7)	12 (52.2)		
25–75%	17 (54.8)	15 (48.4)	9 (39.1)	<0.001	NS-NU, WT-NU
More than 75%	12 (38.7)	13 (41.9)	2 (8.7)		
Soil Moisture					
Mean soil moisture (mV)	762.4 (37.1)	799.3 (36.3)	629.3 (57.3)	0.035	NU<WT
Mean soil moisture (%)	32.6	34.7	25.5	--	--
Temperature					
Mean diurnal temperature (°C)	30.3 (0.4)	30.9 (0.4)	33.3 (0.8)	<0.001	NU>NS, WT
Mean no. of 15-min. intervals above 41°C each day	2.4 (0.8)	3.8 (0.9)	14.8 (2.2)	<0.001	NU>NS, WT
Mean nocturnal temperature (°C)	24.2 (0.5)	24.2 (0.5)	23.6 (0.6)	0.668	N/A
Mean daily temperature range (°C)	18.3 (0.8)	20.0 (0.8)	25.7 (1.1)	<0.001	NU>NS, WT
Humidity					
Mean diurnal relative humidity (%)	58.0 (2.1)	56.2 (1.6)	46.3 (2.0)	<0.001	NU<NS, WT
Mean diurnal vapor pressure (Pa)	2357.5 (108.2)	2349.5 (94.0)	2036.9 (106.4)	0.064	N/A
Mean nocturnal relative humidity (%)	68.5 (1.8)	68.3 (1.7)	65.6 (2.3)	0.513	N/A
Mean nocturnal vapor pressure (Pa)	2081.7 (87.6)	2075.4 (82.6)	1906.2 (98.3)	0.327	N/A

* Habitat and canopy cover variables are presented as n followed by % of column totals (in parentheses), while soil moisture and temperature/humidity values are means (standard error in parentheses).
N/A = data not available or not applicable.

Table 7.7. Descriptive Statistics (Chi-square) and Single Effects (ANOVA) for Southwestern Willow Flycatcher Microclimate Data by Location type at **Muddy River**, June–August, 2005*

Response Variable	Nest Site	Within Territory	Non-Use	*P*	Significant Pairwise Differences
n (Temp./Humidity Sensor Arrays)	7	7	7	N/A	N/A
Habitat					
Native (cottonwood or willow)	0 (0.0)	0 (0.0)	0 (0.0)		
Exotic (tamarisk)	1 (14.3)	3 (42.9)	7 (100.0)	0.005	NU-NS, WT
Mixed (native and exotic)	6 (85.7)	4 (57.1)	0 (0.0)		
Canopy Cover					
Less than 25%	1 (14.3)	1 (14.3)	1 (14.3)		
25–75%	4 (57.1)	6 (85.7)	3 (42.9)	0.423	N/A
More than 75%	2 (28.6)	0 (0.0)	3 (42.9)		
Soil Moisture					
Mean soil moisture (mV)	710.3 (53.3)	766.0 (70.5)	452.6 (49.0	0.003	NU<NS, WT
Mean soil moisture (%)	29.6	32.8	17.6	--	--
Temperature					
Mean diurnal temperature (°C)	28.8 (0.7)	30.4 (0.8)	31.8 (1.1)	0.084	N/A
Mean no. of 15-min. intervals above 41°C each day	0.5 (0.4)	4.0 (2.1)	9.7 (4.4)	0.094	N/A
Mean nocturnal temperature (°C)	24.4 (0.6)	24.2 (0.6)	25.2 (0.6)	0.499	N/A
Mean daily temperature range (°C)	14.8 (1.3)	21.6 (1.9)	19.6 (2.4)	0.059	N/A
Humidity					
Mean diurnal relative humidity (%)	60.8 (6.2)	54.7 (3.0)	47.1 (4.7)	0.160	N/A
Mean diurnal vapor pressure (Pa)	2256.6 (205.3)	2187.7 (144.9)	1885.0 (170.2)	0.304	N/A
Mean nocturnal relative humidity (%)	66.2 (6.9)	63.1 (4.6)	56.1 (3.8)	0.395	N/A
Mean nocturnal vapor pressure (Pa)	1974.9 (200.7)	1858.7 (140.9)	1749.6 (151.2)	0.639	N/A

* Habitat and canopy cover variables are presented as n followed by % of column totals (in parentheses), while soil moisture and temperature/humidity values are means (standard error in parentheses).
N/A = data not available or not applicable.

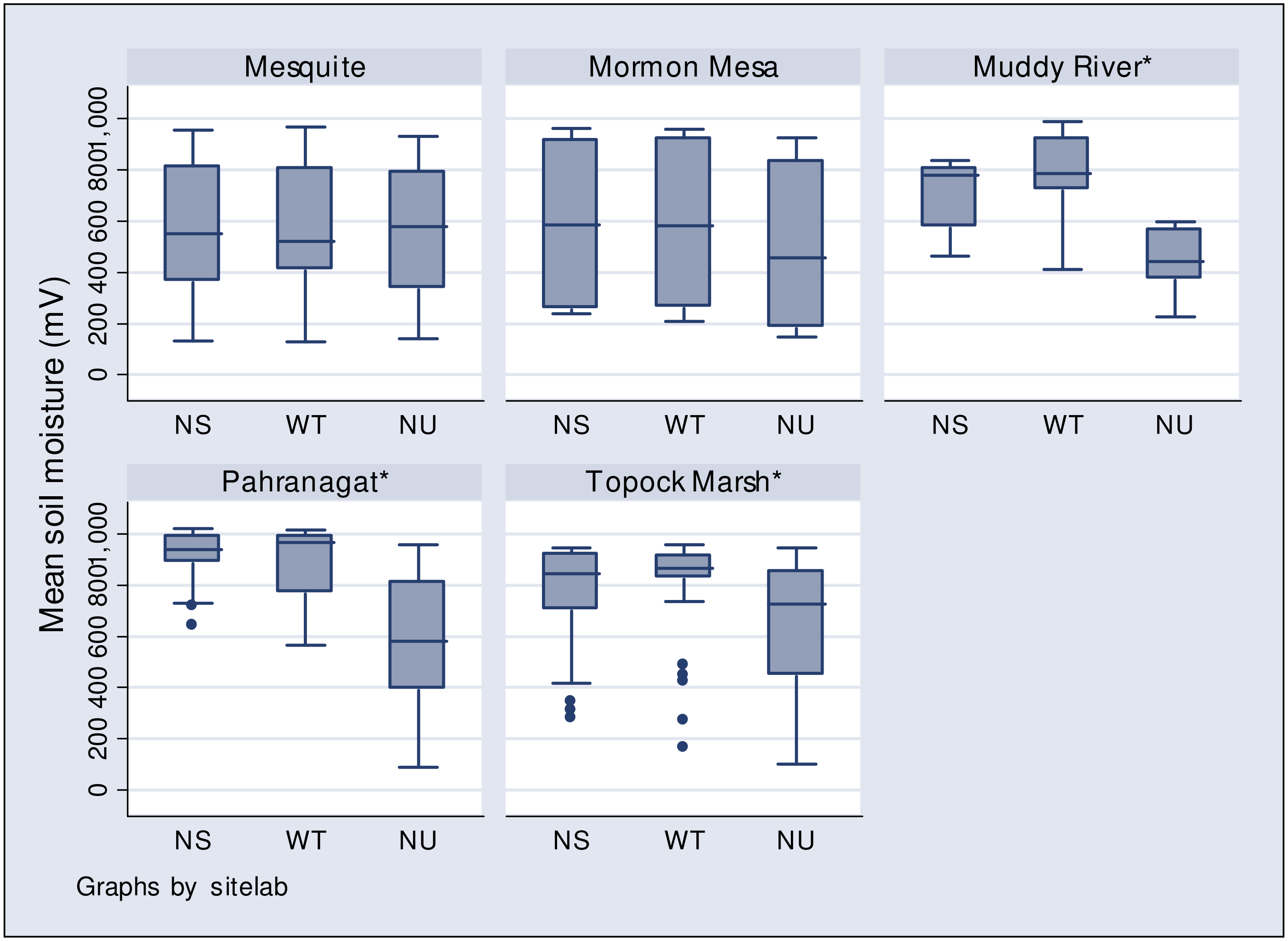

Figure 7.1. Box plots for the mean **soil moisture** by study area and location type for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado River regions, June–August, 2005. (Lines = minimum and maximum values; Box = 25^{th} to 75^{th} quartiles; Dots = outliers; and Center line = Median; * = $P < 0.05$.)

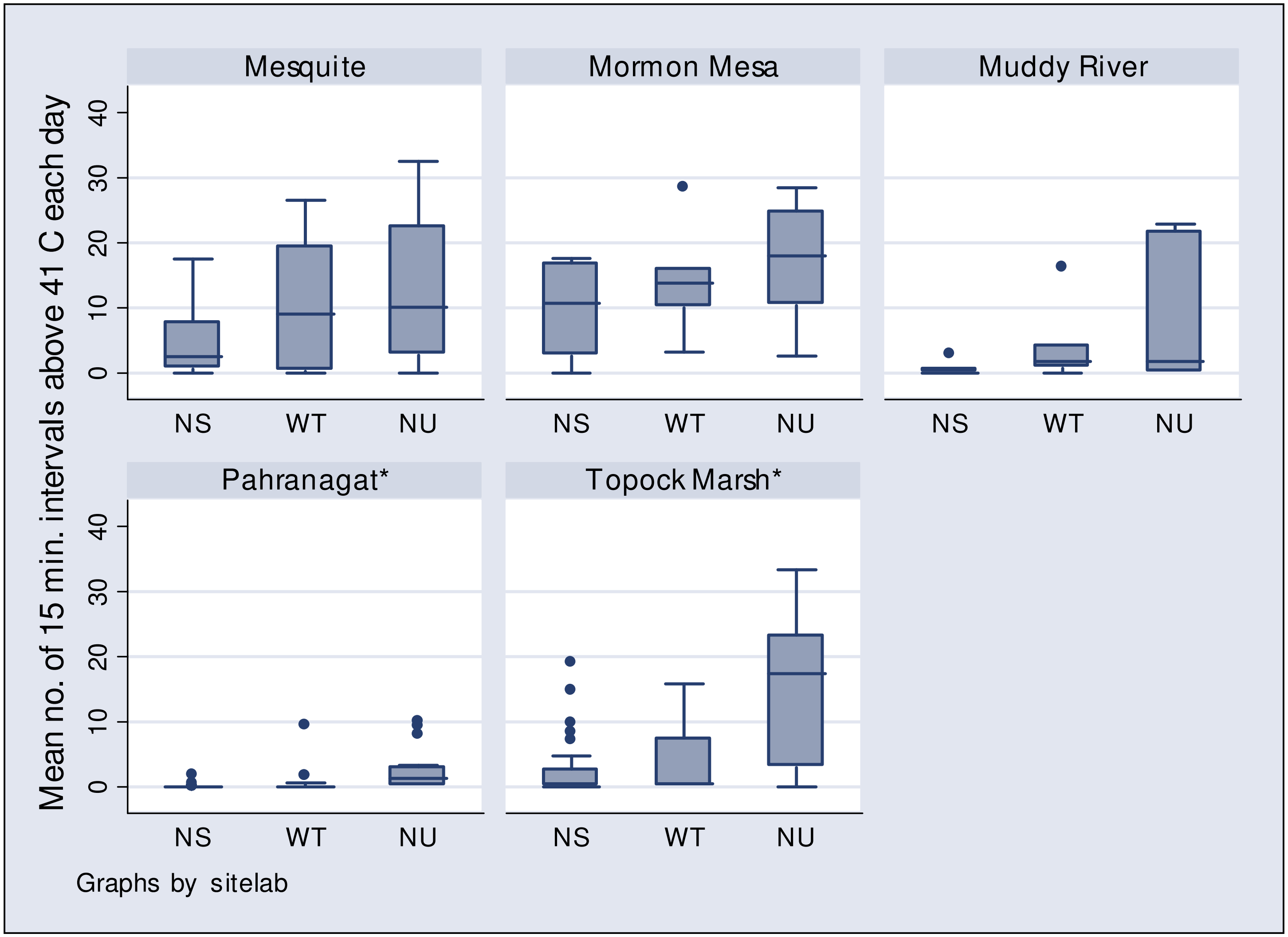

Figure 7.2. Box plots of the mean **number of 15-minute intervals above 41°C** each day by study area and location type for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado River regions, June–August, 2005. (Lines = minimum and maximum values; Box = 25^{th} to 75^{th} quartiles; Dots = outliers; and Center line = Median; * = $P < 0.05$.)

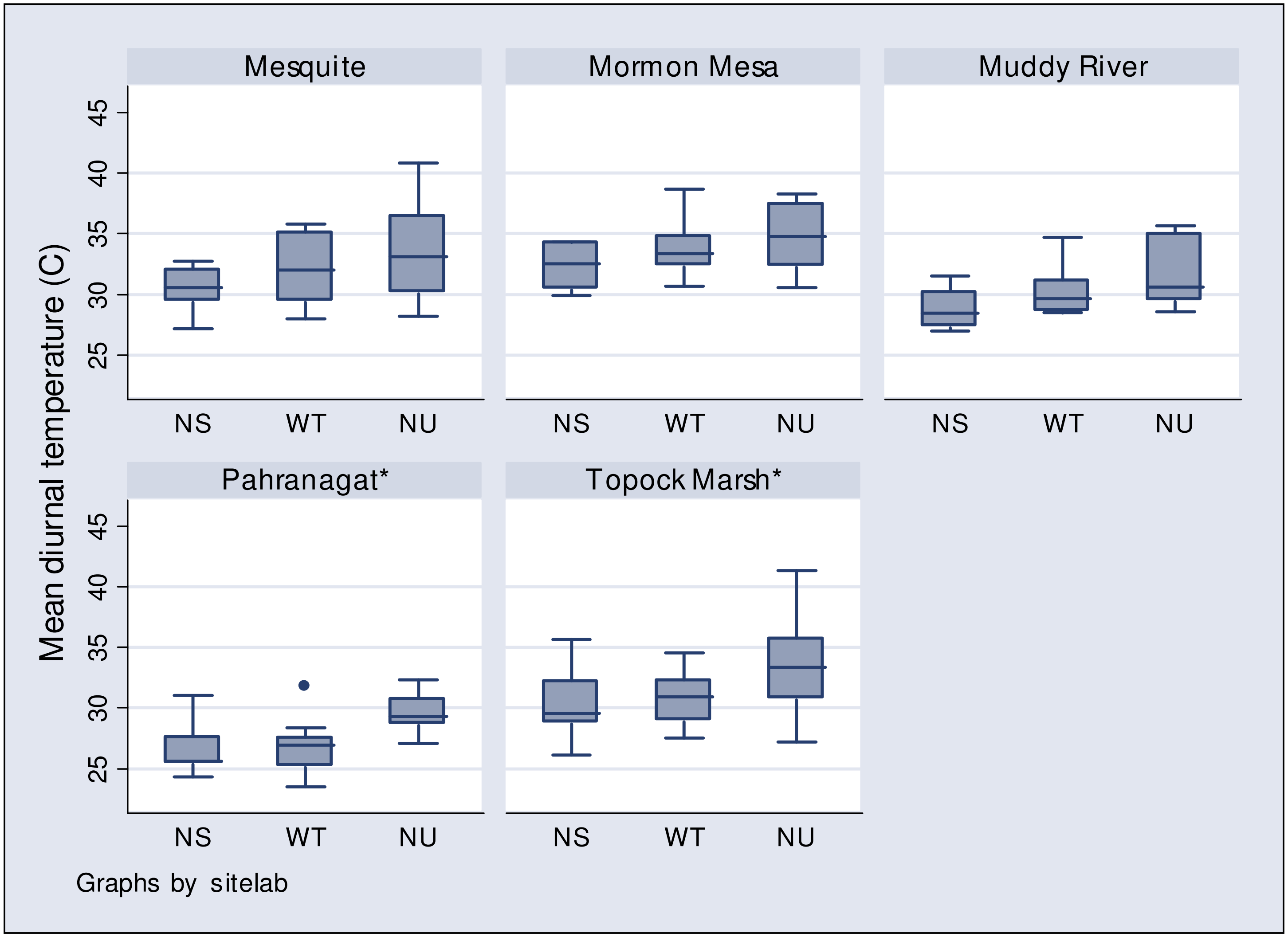

Figure 7.3. Box plots of the mean **diurnal temperature** by study area and location type for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado River regions, June–August, 2005. (Lines = minimum and maximum values; Box = 25^{th} to 75^{th} quartiles; Dots = outliers; and Center line = Median; * = $P < 0.05$.)

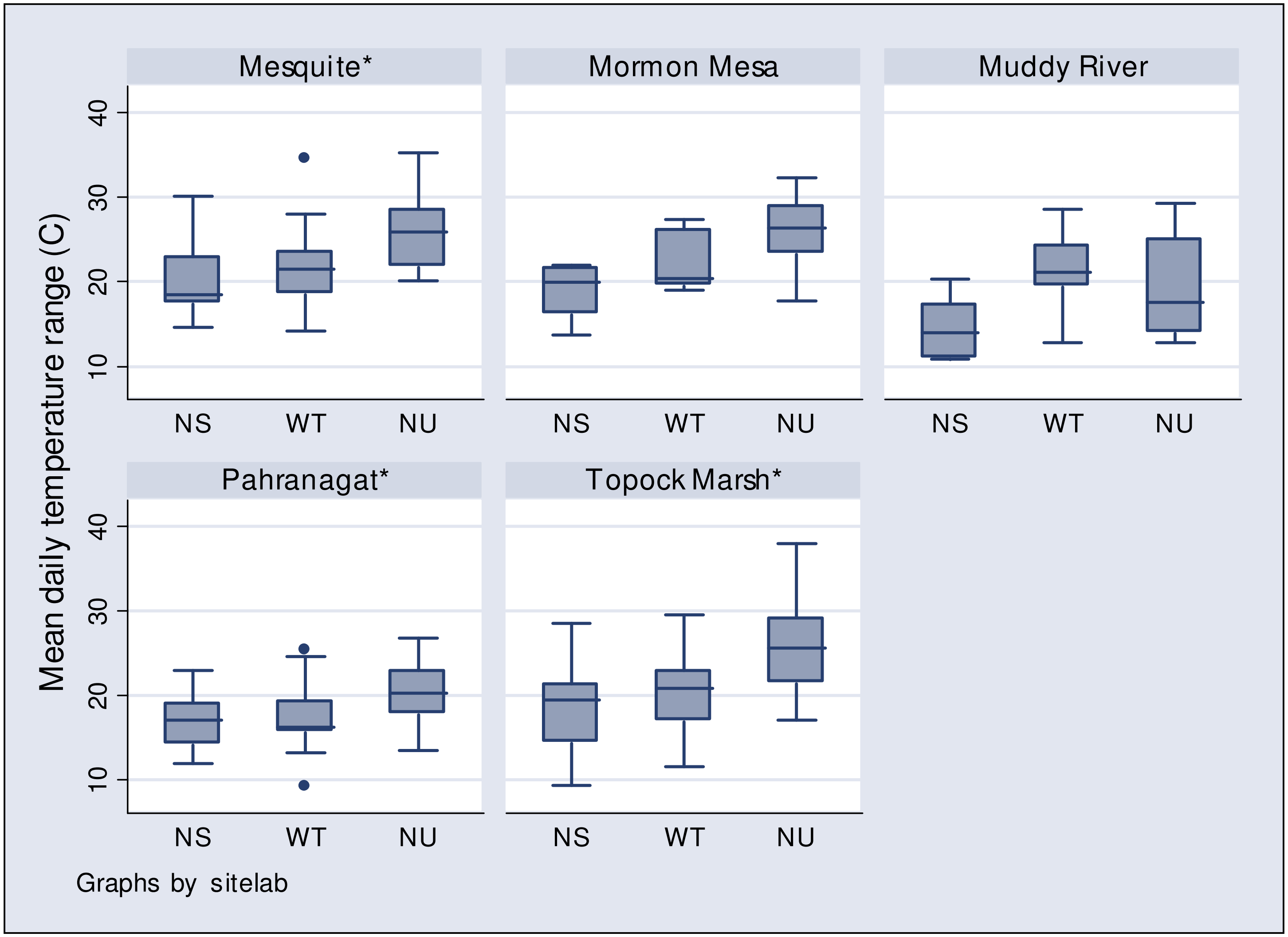

Figure 7.4. Box plots of the mean **daily temperature range** by study area and location type for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado River regions, June–August, 2005. (Lines = minimum and maximum values; Box = 25th to 75th quartiles; Dots = outliers; and Center line = Median; * = $P < 0.05$.)

Mean soil moisture differed significantly among NS, WT, and NU sites at Muddy River, Pahranagat, and Topock (NU exhibited lower soil moisture than NS and WT sites).

No significant difference existed in the proportions of native, exotic, and mixed habitats among NS, WT, and NU sites at four of the five study locations. Muddy River was the only location to exhibit a significant difference in habitat (NU sites exhibited more exotic habitat). Canopy cover differed significantly among NS, WT, and NU sites only at Mormon Mesa and Topock (NS and WT sites had more canopy cover in the 25–75 % category than did NU sites).

INDIVIDUAL EFFECT OF PREDICTOR VALUES

The single effects analyses (Tables 7.8 through 7.11) illustrate the individual effect that each predictor had on response variables across location types for all five study areas combined. The NU sites were significantly different (hotter, lower humidity, less vapor pressure) from both NS and WT sites for all diurnal variables (see Table 7.8). No significant difference existed between NS, WT, and NU sites for any nocturnal variables. Soil moisture was significantly less at NU compared to NS and WT sites (NS and WT sites were similar).

All response variables differed significantly among all five study areas, as would be expected given their different elevations, latitudes, and other environmental attributes (see Table 7.9).

All temperature and humidity response variables differed significantly among habitat types (see Table 7.10) except mean temperature range. Native habitats exhibited cooler diurnal and nocturnal temperatures, and higher humidity and vapor pressure as compared to exotic or mixed habitats, although native and mixed habitats were similar for some response variables. However, the majority of sites with native habitat occur at Pahranagat, which has the highest latitude and elevation of the study areas and exhibited the lowest diurnal and nocturnal temperatures. Thus, habitat type and study area are likely confounded.

Sites with the greatest canopy closure level (>75%) were significantly cooler, more humid, and had greater vapor pressure during the daytime (see Table 7.11). They also had greater humidity and vapor pressure at night than sites with low to intermediate canopy closure.

LOGISTIC REGRESSION MODELS

We used a logistic regression model to determine whether variables that were significant in the single effects analyses were also significant predictors of nest and non-nest sites, even after adjusting for the other explanatory variables (Table 7.12). When soil moisture, diurnal temperature, diurnal relative humidity, daily temperature range, and number of 15-minute intervals above 41°C were modeled, the only significant difference between NS and WT was mean daily temperature range. On average, NS sites had 0.14°C less fluctuation in temperature then WT sites. The NS and NU sites differed in both mean daily temperature range and mean diurnal temperature. On average, NS sites had 0.48°C less fluctuation in temperature and were 0.02°C cooler then NU sites. These differences in temperature are not due to any factors for which we adjusted in the model, namely differences in canopy cover, habitat, life history area,

Table 7.8. Single Effects ANOVA Response Variables by **Location Type** for Southwestern Willow Flycatcher Microclimate Data along the Virgin and Lower Colorado River Regions, June–August, 2005*

Response Variable	Location Type			*P*	Significant Pairwise Differences
	Nest Site	Within Territory	Non-Use		
Soil Moisture					
Mean soil moisture (mV)	747.5 (27.5)	765.6 (27.9)	577.4 (32.4)	<0.001	NU<NS, WT
Mean soil moisture (%)	31.8	32.8	23.0	--	--
Temperature					
Mean diurnal temperature (°C)	29.3 (0.3)	30.3 (0.4)	32.3 (0.4)	<0.001	NU>NS, WT
Mean no. of 15-min. intervals above 41°C each day	2.5 (0.6)	5.0 (0.8)	10.8 (1.3)	<0.001	NU>NS, WT
Mean nocturnal temperature (°C)	23.9 (0.3)	24.0 (0.3)	24.0 (0.3)	0.904	N/A
Mean daily temperature range (°C)	18.0 (0.5)	20.1 (0.6)	23.7 (0.7)	<0.001	NU>NS, WT; WT>NS
Humidity					
Mean diurnal relative humidity (%)	54.3 (1.7)	52.5 (1.4)	43.9 (1.7)	<0.001	NU<NS, WT
Mean diurnal vapor pressure (Pa)	2084.6 (77.1)	2105.2 (69.9)	1855.0 (81.2)	0.040	None
Mean nocturnal relative humidity (%)	62.6 (1.8)	62.5 (1.7)	58.6 (2.1)	0.221	N/A
Mean nocturnal vapor pressure (Pa)	1842.7 (66.7)	1848.5 (62.4)	1708.0 (68.3)	0.242	N/A

* All values are means (standard error in parentheses); N/A = data not available or not applicable.

Table 7.9. Single Effects ANOVA Response Variables by **Study Area** for Southwestern Willow Flycatcher Microclimate Data along the Virgin and Lower Colorado River Regions, June–August, 2005*

Response Variable	Study Area					*P*	Significant Pairwise Differences
	Pahranagat (PA)	Mesquite (MW)	Mormon Mesa (MM)	Topock (TM)	Muddy River (MD)		
Soil Moisture							
Mean soil moisture (mV)	797.3 (30.2)	559.5 (45.5)	558.5 (80.2)	738.0 (25.5)	642.9 (44.2)	<0.001	MW<PA, TM
Mean soil moisture (%)	34.6	22.2	22.2	31.2	26.1	--	--
Temperature							
Mean diurnal temperature (°C)	27.6 (0.3)	32.0 (0.5)	33.8 (0.7)	31.3 (0.3)	30.3 (0.6)	<0.001	MD<MM; TM>PA, MD; TM<MM; PA<MW, MD
Mean no. of 15-min. intervals above 41°C each day	1.2 (0.3)	9.4 (1.6)	14.2 (2.2)	6.4 (0.9)	4.7 (1.8)	<0.001	MM>TM, MD, PA; PA<MW, TM
Mean nocturnal temperature (°C)	22.7 (0.3)	24.2 (0.3)	25.9 (0.2)	24.1 (0.3)	24.6 (0.3)	<0.001	PA<TM, MD, MM, MW; TM<MM
Mean daily temperature range (°C)	18.4 (0.5)	22.8 (0.9)	22.7 (1.2)	21.0 (0.6)	18.7 (1.2)	<0.001	MW>MD, PA; PA<MM, TM
Humidity							
Mean diurnal relative humidity (%)	41.3 (2.2)	51.6 (2.3)	51.9 (3.1)	54.1 (1.2)	54.2 (2.9)	<0.001	PA<TM, MD, MM, MW
Mean diurnal vapor pressure (Pa)	1380.2 (66.6)	2164.3 (99.5)	2329.8 (102.8)	2265.1 (60.9)	2109.8 (102.5)	<0.001	PA<MW, MD, MM, TM
Mean nocturnal relative humidity (%)	47.8 (2.4)	63.2 (2.3)	66.2 (3.1)	67.6 (1.1)	61.8 (3.0)	<0.001	PA<TM, MD, MM, MW
Mean nocturnal vapor pressure (Pa)	1278.3 (65.6)	1827.6 (74.8)	2137.3 (85.4)	2030.5 (51.4)	1861.1 (93.4)	<0.001	PA-TM, MD, MM, MW

* All values are means (standard error in parentheses); N/A = data not available or not applicable.

Table 7.10. Single Effects ANOVA Response Variables by **Habitat Type** for Southwestern Willow Flycatcher Microclimate Data along the Virgin and Lower Colorado River Regions, June–August, 2005*

Response Variable	Habitat Type			*P*	Significant Pairwise Differences
	Native (Cottonwood or Willow)	Exotic (Tamarisk)	Mixed (Native and Exotic)		
Soil Moisture					
Mean soil moisture (mV)	738.2 (32.7)	722.6 (24.6)	601.2 (36.7)	0.041	None
Mean soil moisture (%)	31.2	30.3	24.1	--	--
Temperature					
Mean diurnal temperature (°C)	28.7 (0.4)	31.4 (0.3)	31.6 (0.5)	<0.001	N<M, E
Mean no. of 15-min. intervals above 41°C each day	3.6 (0.9)	6.9 (0.9)	7.5 (1.5)	0.042	None
Mean nocturnal temperature (°C)	23.0 (0.3)	24.3 (0.3)	24.5 (0.3)	0.003	E<N, M
Mean daily temperature range (°C)	19.6 (0.6)	21.0 (0.6)	20.7 (0.8)	0.394	N/A
Humidity					
Mean diurnal relative humidity (%)	41.8 (1.9)	54.5 (1.1)	53.9 (2.0)	<0.001	N<E, M
Mean diurnal vapor pressure (Pa)	1484.8 (68.5)	2273.8 (53.6)	2241.8 (74.2)	<0.001	N<E, M
Mean nocturnal relative humidity (%)	49.0 (2.1)	67.3 (1.0)	65.8 (2.0)	<0.001	N<E
Mean nocturnal vapor pressure (Pa)	1336.1 (59.8)	2037.1 (45.0)	1962.4 (62.6)	<0.001	N<E, M

* All values are means (standard error in parentheses); N/A = data not available or not applicable. N = native; E = exotic; M = mixed.

Table 7.11. Single Effects ANOVA Response Variables by **Canopy Closure** for Southwestern Willow Flycatcher Microclimate Data along the Virgin and Lower Colorado River Regions, June–August, 2005*

Response Variable	Canopy Closure Categories			*P*	Significant Pairwise Differences
	< 25%	25–75%	> 75%		
Soil Moisture					
Mean soil moisture (mV)	622.1 (46.6)	714.3 (22.7)	725.2 (35.0)	0.079	N/A
Mean soil moisture (%)	25.1	29.8	30.5	--	--
Temperature					
Mean diurnal temperature (°C)	31.4 (0.7)	30.4 (0.3)	30.5 (0.4)	0.217	N/A
Mean no. of 15-min. intervals above 41°C each day	9.9 (1.7)	5.2 (0.7)	4.8 (1.2)	0.004	LT25>GT75, 25–75
Mean nocturnal temperature (°C)	23.2 (0.4)	24.1 (0.2)	24.4 (0.3)	0.082	N/A
Mean daily temperature range (°C)	23.9 (0.9)	20.0 (0.4)	18.9 (0.8)	<0.001	LT25>GT75, 25–75
Humidity					
Mean diurnal relative humidity (%)	44.0 (2.4)	49.9 (1.2)	57.0 (1.8)	<0.001	GT75>LT25, 25–75; LT25<25–75
Mean diurnal vapor pressure (Pa)	1824.5 (120.4)	1979.3 (56.0)	2289.3 (75.4)	0.002	GT75>LT25, 25–75
Mean nocturnal relative humidity (%)	57.7 (3.1)	60.2 (1.3)	67.2 (1.6)	0.007	GT75>LT25, 25–75
Mean nocturnal vapor pressure (Pa)	1633.2 (104.5)	1772.3 (48.3)	2026.6 (62.7)	0.002	GT75>LT25, 25–75

* All values are means (standard error in parentheses); N/A = data not available or not applicable. LT = less than; GT = greater than.

Table 7.12. Logistic Regression Models for Location Type, Adjusting for Study Area, Habitat, and Canopy Closure for Southwestern Willow Flycatcher Microclimate Data along the Virgin and Lower Colorado River regions, June–August, 2005

Explanatory Variables	Coefficient*	Adjusted odds ratio**	95% CI	*P*
NS vs. WT				
Mean soil moisture (mV)	-0.00	1.0	0.998, 1.001	0.560
Mean diurnal temperature (°C)	-0.09	0.9	0.679, 1.218	0.525
Mean diurnal relative humidity (%)	-0.03	1.0	0.936, 1.016	0.227
Mean daily temperature range (°C)	-0.14	0.9	0.759, 0.996	0.043
Mean no. of 15-min. intervals above 41°C each day	-0.02	1.0	0.848, 1.123	0.734
NS vs. NU				
Mean soil moisture (mV)	0.00	1.0	1.000, 1.004	0.083
Mean diurnal temperature (°C)	-0.43	0.7	0.456, 0.936	0.021
Mean diurnal relative humidity (%)	-0.02	1.0	0.928, 1.033	0.437
Mean daily temperature range (°C)	-0.27	0.8	0.628, 0.931	0.008
Mean no. of 15-min. intervals above 41°C each day	0.03	1.0	0.884, 1.204	0.690

* The coefficient of the model tells us the expected unit change for a nest versus a non-nest site for a given variable, when all other variables are equal.

** The ratio of the odds of being a nest versus a non-nest site given a one unit change in the given variable. If there were no difference between nest and non-nest sties, we would expect an odds ratio of 1.0. All values are adjusted for canopy cover, habitat, and life history area, as well as the other variables in the model.

soil moisture, or relative humidity. These differences are quite small, which may be the result of using continuous measures of temperature, humidity, and soil moisture. We plan to look at the same models with categorical variables in a supplementary analysis, to determine if meaningful differences are still present within categories of temperature, humidity, and soil moisture.

DISCUSSION

The 2005 analysis corroborated our findings from 2003 and 2004: on average, nests were located in areas that exhibited fewer temperature extremes, greater soil moisture, higher relative humidity, and cooler diurnal temperature. Nocturnal temperature and relative humidity were not as highly associated with nest locations. Diurnal temperature and daily temperature range remained significant predictors of nest sites (NS versus NU) above and beyond the effects of humidity, soil moisture, canopy cover, habitat, or life history area. Our findings from 2003 indicated that only mean maximum diurnal temperature remained significantly different between NS and WT sites when these individual effects were adjusted for differences in canopy cover, habitat, and life history area. In 2004, mean maximum diurnal temperature, mean diurnal temperature, and mean daily temperature range remained significantly different between NS and WT sites after adjustment.

In 2003 and 2004, we determined heights of sensor arrays at WT and NU sites by assigning random heights distributed evenly across the range of known nest heights for the particular study area. Because nest heights are not evenly distributed across this range, this method resulted in WT and NU sensors being, on average, higher than NS sensors. We were concerned that this discrepancy in average height might influence temperature and humidity readings. To remedy this problem, in 2005 we assigned sensor heights at WT and NU locations to follow the distribution of nest heights observed at the study area in 2003 and 2004 (Table 7.13). In 2005, heights of sensors at WT and NU sites were no longer consistently higher than those at NS sites. This change in methodology does not appear to have affected the difference in mean daily temperature between NS and WT sites; this difference was not significant at any study area in either 2004 or 2005. For NS and NU sites, this change in height distributions may have attenuated the magnitude of the differences in mean daily temperature, but the direction of these differences remained consistent between 2004 and 2005.

Table 7.13. Distribution of HOBO Sensor Heights at Nest (NS), Within-Territory (WT) and Non-Use (NU) Sites at the Life History Study Areas, 2004 and 2005

Study Area Location Type	2004			2005		
	Mean sensor height	Difference in mean daily temperature of nest site	Significant differences with nest site	Mean sensor height	Difference in mean daily temperature of nest site	Significant differences with nest site
All sites	3.2		NU>NS	3.1		NU>NS
NS	2.8	--		3	--	
WT	3.7	1.2		3.1	1	
NU	3.2	2.6		3.1	3	
Pahranagat	4.9		NU>NS	3.4		NU>NS
NS	4	--		3.3	--	
WT	6.3	1.5		2.9	0.2	
NU	4.6	2.5		4.1	3.2	
Mesquite	2.1		NU>NS	2.1		--
NS	1.5	--		1.8	--	
WT	2.4	1.7		2.6	1.5	
NU	2.4	4.4		1.9	2.8	
Mormon Mesa	2.2		NU>NS	2.3		--
NS	1.6	--		2	--	
WT	2.9	1.3		2.8	1.6	
NU	2.2	3.5		2.2	2.4	
Topock	3.1		NU>NS	3.6		NU>NS
NS	2.9	--		3.8	--	
WT	3.1	0.6		3.6	0.6	
NU	3.3	1.7		3.4	2.4	

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 at two study areas was consistent with Allison et al. (2003). Our vegetation analyses (see previous chapter), which used a quantitative, continuous measure rather than a categorical measure of canopy closure, parallel this, in that canopy closure was greater at NS than at NU sites at three study areas.

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 that microclimate variables are unlikely to limit habitat suitability for the species (McKernan and Braden 2001b:78).

The 2005 findings support our earlier assertion (Koronkiewicz et al. 2004) that the differences among our mean diurnal temperature measures at the three location types, although small (only 3.0^{o}C in 2005), appear to be biologically meaningful since they paralleled significant vegetative differences identified in the previous chapter and reported by Allison et al. (2003). Our finding of a 3.0^{o}C difference in mean diurnal temperature difference between NS and NU sites can be put in perspective with the following comparisons. Patten et al. (2005) reported that Lesser Prairie-Chickens (*Tympanuchus pallidicinctus*) used microhabitats exhibiting significantly cooler mean diurnal temperatures (1.9^{o}C) and greater relative humidity (3.6%) than random sites in New Mexico and Oklahoma, and that survivorship was higher for prairie-chickens using the cooler and more humid microhabitats. Ganey (2004) found that Mexican Spotted Owl (*Strix occidentalis*) nest areas were significantly cooler (1.8^{o}C) than randomly selected areas, resulting in significantly lower estimated evaporative water loss. His finding suggested that water balance in nesting owls might be more important than previously realized and that microclimate could help regulate water balance. Finally, Ledneva et al. (2004) documented that a rise of 2.0^{o}C in average annual local temperatures in Massachusetts (assumed to be the result of global warming) was significantly correlated to the earlier spring arrival of 5 of 16 bird species, a finding corroborated by the findings of other investigators that even small changes in mean temperature can result in profound changes to bird behavior (e.g., Bradley et al. 1999, Butler 2003, Cotton 2003).

Therefore, it continues to appear that microclimate may limit nesting habitat suitability, territory location, and nest placement in willow flycatchers. 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 continue to show whether the patterns observed to date are consistent across years and will help clarify whether suitable nesting habitat for willow flycatchers is limited by microclimate.

CHAPTER 8

HABITAT MONITORING: PARKER TO IMPERIAL DAMS

INTRODUCTION

Southwestern Willow Flycatcher nests and breeding territories are typically located near rivers, streams, and open water (Sogge and Marshall 2000) or over wet soil (Flett and Sanders 1987, Harris et al. 1987, Harris 1991). Nest substrate plants are often rooted in or overhang standing water. Although the association between breeding flycatchers and open water or wet soil is widely recognized by managers and scientists alike, the exact nature of the association is poorly quantified. Water may be a direct environmental cue for flycatcher nesting behavior or it may be the ultimate cause of proximate factors such as vegetation composition and structure, prey base, and microclimate.

Anthropogenic or natural modifications to surface water resources (i.e., fluvial hydrology and geomorphology) can modify existing and potential flycatcher breeding habitat and therefore have the potential to modify flycatcher abundance, distribution, and nesting success (Graf et al. 2002, this document Chapters 2 and 3). For example, nine flycatcher territories at San Marcial on the middle Rio Grande in New Mexico exhibited a near absence of nesting attempts in 1996 when a combination of drought, upstream dam operations, and upstream withdrawals for irrigation removed all surface water (Johnson et al. 1999). This was in contrast to previous (1994, 1995) and subsequent (1997) years when active nests were documented at the site, with the river flowing in those years. A nearby control site that contained water exhibited multiple nesting attempts during all four years, leading Johnson et al. (1999) to suggest that the presence of water was a minimal requirement for nesting. The high degree to which willow flycatchers are associated with standing water can also be seen by correlating flycatcher habitat occupancy and breeding patterns with the presence/absence of standing water at Bill Williams, with flycatchers breeding only in years when sites contained standing water (this document Chapter 3).

Flow characteristics of the lower Colorado River have been modified by numerous dams and irrigation withdrawals (Rosenberg et al. 1991). The river reach between Parker Dam and Imperial Dam is regulated by releases from Parker Dam, which has been in operation since 1939. Existing riparian habitat in the Parker to Imperial reach has likely adjusted to historical water release patterns from Parker Dam and appears to be in a stable or declining condition (Lower Colorado River Multi-Species Conservation Program 2004). Implementation of the Secretarial Implementation Agreements/California 4.4 Plan (hereafter SIAs) by Reclamation would change the point of diversion for up to 400,000 acre-feet of California apportionment water for up to 75 years (USFWS 2001). The point of diversion, presently located below Parker Dam, would change to a point above Parker Dam and would be no return flow to the Colorado River below Parker Dam.

River flow changes related to the change in point of diversion have the potential to further modify riparian habitats below Parker Dam, habitats that are presently potentially suitable for willow flycatcher (USFWS 2001:47). Reclamation (2000) estimated that implementation of the SIAs will cause a drop in floodplain groundwater levels of 1.55 feet (0.47 m) or less. As a result, 372 acres (151 ha) of occupied[1] Southwestern Willow Flycatcher habitat could lose their moist soils. This loss would likely influence plant species composition (loss of cottonwood and willow) over an undetermined length of time. In addition, Reclamation estimated that 5,404 acres (2,187 hectares) of potential flycatcher habitat could be influenced by the drop in groundwater level. These changes may affect the distribution, abundance, occupancy, and prey base of Southwestern Willow Flycatchers in the Parker to Imperial reach.

In 2004, Reclamation completed a pilot year of habitat monitoring by deploying temperature/humidity data loggers at several sites in the Parker to Imperial reach. Reclamation then initiated a more comprehensive, three-year study (2005–2007) for the purpose of addressing how the above hydrological changes might affect riparian habitats along the Parker to Imperial reach. The objective of the first study year was to monitor 372 acres (151 ha) of currently occupied Southwestern Willow Flycatcher habitat between Parker and Imperial dams to determine how microclimate, vegetation, and groundwater conditions might be affected by the SIA water transfer actions. An additional objective was to compare microclimate characteristics of sites in the Parker to Imperial reach with those at flycatcher breeding areas. This chapter reports the results of the first year of this study.

METHODS

With the guidance of Reclamation biologists, we selected a subset of sites that are currently surveyed for the presence of willow flycatchers (see Chapter 2 for a list of all surveyed sites) for inclusion in the habitat monitoring study. We chose sites distributed along the Parker to Imperial reach that are reasonably accessible, and where we believed groundwater levels were influenced primarily by river levels and not by outside sources such as irrigation return flows. Chosen sites equated to at least 75.3 ha (186 acres) on the California side of the lower Colorado River and at least 75.3 ha (186 acres) on the Arizona side. We also chose four control sites, two above Parker Dam and two below Imperial Dam, to distinguish any changes in microclimate, groundwater, or vegetation caused by water transfer actions from those caused by fluctuations in climate or rainfall. We completed a preliminary reconnaissance of each selected site on the ground and by helicopter in April 2005 to focus our study area to the portion of each site most likely to be affected by changes in river flows, i.e., those portions of the sites that had shallow, standing water or saturated soils. We attempted to eliminate or minimize portions of the sites that had dry soils and contained upland vegetation such as mesquite.

TEMPERATURE/HUMIDITY (T/RH) LOGGERS

We deployed HOBO H8 Pro (Onset Computer Corporation, Pocasset, MA) temperature/ humidity data loggers at several locations within the portion of each site selected for habitat monitoring. The number of loggers deployed corresponded with the size of each habitat monitoring area: three loggers were deployed at sites <4.0 ha, four at sites 4.0–12.1 ha, and five

[1] As per the USFWS, occupied Southwestern Willow Flycatcher habitat is defined as patches of vegetation that are similar to and contiguous with areas where willow flycatchers were detected after 15 June.

at sites >12.1 ha. All loggers collected data every 15 minutes and were placed in inverted plastic containers and camouflaged as described in Chapter 7.

Locations for each HOBO logger were selected by superimposing a 25 × 25–m grid on an ArcGIS 9.0 software shapefile of the habitat monitoring area boundary, numbering the grid blocks, selecting blocks by using a random number generator, and using the centroid of each selected block. These points were located in the field by navigating to the given UTM coordinates using a Rino 110 GPS unit. The exact location of the logger was determined by selecting the closest woody tree or shrub at least 3 m in height and using the random number procedures described in Chapter 7 for non-use sites to determine the height and distance and direction from the bole at which to place the logger. Heights were distributed according to the distribution of observed nest heights at the four life history study areas in 2003 and 2004. If the chosen point was inaccessible (e.g., impenetrable vegetation or deep water) or was in clearly unsuitable habitat for flycatchers (e.g., open marsh), the next UTM coordinate was used.

After the precise location for the logger was chosen, field personnel inserted a piece of rebar into the ground at the chosen location. A piece of ½-inch conduit was placed over the rebar and cut or spliced so that it extended 30–50 cm above the chosen location for the logger. Field personnel then bent the top of the conduit at a 90-degree angle at the height at which the logger was to be hung, and the logger was wired to the horizontal portion of the conduit so that when the conduit was reset on the rebar, the logger was hanging in the desired location. We hung the HOBO loggers in this manner to facilitate periodic download and maintenance of the loggers and subsequent reinstallation in exactly the same location. At each location where we deployed a HOBO logger, we also visually estimated canopy closure as <25%, 25–75%, or >75%, and habitat type was identified as native (cottonwood/willow), exotic (tamarisk), or mixed native and exotic.

SOIL MOISTURE (SM) MEASUREMENTS

Soil moisture beneath each HOBO logger was measured and recorded using a hand-held ThetaProbe ML2x coupled to an HH2 Moisture Meter Readout (Macaulay Land Use Research Institute, Aberdeen, UK, and Delta-T Devices, Cambridge, UK, respectively). Soil moisture measurements were collected at set-up, during each of approximately 10 presence/absence surveys between 15 May and 25 July, and when HOBO data were downloaded. Soil moisture measurements were recorded directly beneath the HOBO logger and at estimated 1.0-m intervals at 1.0 and 2.0 m in each cardinal direction for a total of nine measurements per location. Soil moisture readings were recorded in mV and percent volume, as described in Chapter 7. Each time soil moisture readings were taken at a site, we also recorded the nearest distance to inundated or saturated soil. Distances <30 m were estimated in the field, and distances >30 m were measured either with a GPS unit or from high-resolution aerial photographs. If distance to the nearest saturated or inundated soil was >30 m and the location of the nearest saturated or inundated soil was unknown, distance was recorded as >30 m.

VEGETATION MEASUREMENTS

We completed vegetation measurements, following the methods described in Chapter 6, at each HOBO location after flycatcher surveys were completed in late July. All HOBO loggers were also downloaded at this time.

GROUNDWATER MEASUREMENTS

Small-diameter shallow wells, or piezometers, were installed near each of the sites selected for habitat monitoring to monitor groundwater levels.

PIEZOMETER INSTALLATION

The piezometers were constructed with pre-formed ¾-inch-diameter PVC well points. These well points are approximately 1 foot in length, have a pre-installed permeable well screen, and are sturdy enough to be driven into the ground. The well points were glued to standard ¾-inch-diameter Schedule 40 PVC pipe, which was then cut long enough to extend several feet above land surface. The piezometer was protected at the surface against vandalism and damage by a 2-inch diameter PVC surface casing that extended several feet below ground and was secured in place with a small amount of concrete. A locking, watertight PVC cap was glued to the top 2-inch-diameter surface casing.

Although the piezometers can be driven into the ground, in most cases this was not the most efficient method of installation. We installed most of the piezometers by first digging a 2-inch-diameter borehole using either a manual hand auger or a powered auger. The powered auger was used initially, but it soon became apparent that a manual hand auger worked just as well, and was less cumbersome. The boreholes were advanced as deeply as possible. Groundwater was usually encountered within several feet of the ground surface. Most of the soils encountered were sandy once below the water table, and the boreholes often became unstable and would not stay open. Once the borehole had been advanced as deeply as possible, the piezometer was placed in the hole and then driven as deeply as possible using a hammer drill or hand maul.

Given the relatively large amount of equipment needed to install the piezometers, locations were largely limited to areas of available access. In most cases, the piezometers were installed within 20 feet of surface water. We attempted to install all data loggers within the designated habitat monitoring area. In some cases this was not possible, either because sufficient access was not available for the equipment or because depth-to-water at the accessible locations would have been too great. At these locations, we installed the piezometers as close as possible to the habitat polygons given the access and depth-to-water restrictions. Based on conditions observed in the field, the water levels in piezometers near the designated habitat polygons are likely hydrologically similar to those beneath the habitat.

DATA COLLECTION

A pressure transducer/data logger (mini-Troll Standard-P, 5psi, manufactured by In-Situ Corporation) was installed in each of the piezometers. These devices measure and record pressure from the water column present in the well, and these pressure measurements are then easily converted into water levels (in distance below top of casing). Vented cables with data-transfer ports were also used for each data logger. With these cables there is no need to correct measurements for atmospheric pressure changes, and the data can be downloaded at the wellhead without disturbing the pressure transducer in the well.

After we placed the pressure transducers at their desired depth, we measured water levels in the piezometers using an electric water level sounder (Solinst-brand). These known water levels were then used to program the pressure transducer with a baseline measurement from which all other water levels were calculated. The pressure transducers recorded water levels in the piezometers every hour.

Because the pressure transducer is almost the same diameter as the inside of the piezometer, inserting the pressure transducers tends to change the water levels in the piezometer temporarily but drastically. This disturbance cannot be corrected until the water levels in the piezometer come back into equilibrium with water levels in the aquifer. Because some of the data loggers are in tight, clayey soils, in many cases we declined to wait until this equilibrium occurred, which could take hours or days. Instead, we planned to reprogram the piezometers upon the next field visit. This was done with the understanding that 1) the resulting data (discussed in the next section) would still be valid in terms of precision and ability to monitor water level fluctuations, but simply had an offset from the actual water level, and 2) the first several days of data might show the recovery from the disturbance and would not accurately reflect aquifer water level trends. In this document, this phenomenon will be referred to as "install offset error."

We obtained additional hydrologic data from the U.S. Geological Survey (USGS) regarding streamflow and stage height in the Colorado River at several gages: Colorado River below Parker Dam (09427520), Colorado River below Palo Verde Dam (09429010), Colorado River below Imperial Dam (09429500), and Colorado River below Laguna Dam (09429600). Lake water levels were also obtained from the USGS for Lake Havasu. In addition, daily water releases were obtained from the Bureau of Reclamation for Parker and Imperial Dams.[2] Our goal was to define the relationship between the water levels in the piezometers and operation of the reservoirs on the Colorado River.

STATISTICAL ANALYSES

MICROCLIMATE

The following values were calculated for each habitat monitoring site by year (some values were not available in 2004):

- Mean soil moisture from plot center to 2.0 m from plot center
- Mean distance to saturated/inundated soil
- Mean diurnal temperature
- Mean number of 15-minute intervals above 41°C each day

[2] Because hydrologic data are generally collected and presented in English units, hydrologic data within this chapter are in English, rather than metric, units.

- Mean nocturnal temperature
- Mean daily temperature range (diurnal maximum minus nocturnal minimum)
- Mean diurnal relative humidity
- Mean diurnal vapor pressure
- Mean nocturnal relative humidity
- Mean nocturnal vapor pressure

The diurnal and nocturnal periods were determined from the daily sunrise and sunset times reported for the region by the National Weather Service (2005).

These values were then calculated for all 2005 sites combined, and compared to the same values for within-territory (WT; see Chapter 7) locations at the Topock Marsh life history breeding area in 2005. We chose within-territory locations (rather than nest or non-use locations) because these represent locations within flycatcher breeding areas that were chosen using the same random number techniques that were used for locations at habitat monitoring sites. Chi-square (χ^2) tests were used to test for significant differences in the proportion of habitat types and canopy cover. One-way ANOVA tests were used to test the difference in means for the T/RH and SM values. Analyses were conducted using SAS® Version 9.1 (SAS Institute 2003).

We also summarized average monthly temperature and absolute humidity to look for latitudinal trends in microclimate conditions along the lower Colorado River.

VEGETATION

Descriptive statistics were produced using JMP IN® Version 4 (SAS Institute Inc.) software.

GROUNDWATER LEVELS

We examined the following correlations between piezometer levels and reservoir operations: 1) correlation of the Havasu NE piezometer with Lake Havasu water levels; and 2) correlation of seven of the lower Colorado River piezometers (Paradise, Hoge Ranch, Rattlesnake, Clear Lake, Ferguson Wash, Ferguson Lake, and Great Blue Heron) with releases from Parker Dam, which largely regulates streamflow in the lower Colorado River between Parker and Imperial Dams. Groundwater fluctuations under potential flycatcher habitat are expected to be tied most closely to the water level, or stage, rather than to the flow of the Colorado River. Stage and streamflow are related, though not necessarily in a linear manner. The relationship between streamflow measurements versus stage height at the USGS gaging station below Parker Dam is known as the "rating curve" for the gaging station. We calculated various types of best-fit regression analyses for the Parker Dam rating curve. We conducted linear regression analysis of piezometer water levels and Parker Dam reservoir releases for the seven lower Colorado piezometers located between Parker and Imperial Dams. To account for the travel time of river water from Parker Dam, several regression analyses were conducted with time lags varying from zero to four days.

In addition to correlating piezometer levels with reservoir operations, we used linear regression to examine potential relationships between average daily piezometer level and average daily soil moisture, as well as average daily absolute humidity.

All statistical analyses were conducted using the built-in trend analysis functions of Microsoft Excel. Daily averages for water levels, humidity, and temperature were calculated using Microsoft Access. Locational and daily averages for soil moisture were also calculated using Microsoft Access.

RESULTS

HOBO LOGGER INSTALLATION

We selected 11 sites between Parker and Imperial Dams, 2 sites upstream of Parker Dam, and 2 sites downstream of Imperial Dam for inclusion in this study (Table 8.1). We installed a total of 60 HOBO temperature/humidity loggers at these sites. Installation of HOBOs began in mid-April and was completed in mid-June 2005. All HOBO loggers were downloaded in late July or early August, concurrent with vegetation measurements.

Table 8.1. Deployment and Data Download Schedule of HOBO Temperature/Humidity Loggers at Sites Selected for Habitat Monitoring, Lower Colorado River, 2005

Location	Site Name	# HOBO Loggers	Date(s) HOBOs Installed	Date HOBOs Downloaded
Above Parker	Blankenship Bend	4	18, 19, 22 May	29 July
	Havasu NE	4	19 May	27 July
Between Parker and Imperial	Ehrenberg	4	20, 23 May	28 July
	Three Fingers Lake	5	12, 23 May	29 and 31 July
	Cibola Lake	5	10–11 May	30 July
	Walker Lake	3	2, 6 June	29 July
	Paradise	4	17, 20 May	27 July
	Hoge Ranch	4	18 May; 1, 7 June	28 July
	Rattlesnake	4	11, 20, 25 May; 15 June	1 August
	Clear Lake	3	22 April, 10 May	28 July
	Ferguson Lake	5	8–9 May	29 July
	Ferguson Wash	4	21–22 April	31 July
	Great Blue Heron	4	19 April	26 July
Below Imperial	Mittry West	4	21 April	30 July
	Gila Confluence North	3	20 April	27 July

PIEZOMETER INSTALLATION

Piezometers were installed at 11 of the sites on 9–11 and 30–31 May 2005. Piezometer installation was attempted at an additional site (Blankenship Bend), but a suitable access point was not located. Piezometers were not installed at the three remaining sites (Ehrenberg, Mittry

West, and Gila Confluence North) in May because archaeological clearance was required at the sites. Piezometers at these four sites were installed on 28–29 August 2005, after archaeological clearance was obtained.

The total depth of the piezometers (i.e., the depth of the well point below ground surface) ranged from 5 to 11.7 feet, with an average depth of about 7.5 feet. From a hydrologic standpoint, the total depth of the piezometer is not important. As long as the well point is below the water table, the water level in the piezometer will reflect that of the aquifer. Construction details of each piezometer are summarized in Table 8.2.

At the majority of sites, piezometers were installed within the area designated for habitat monitoring. In some cases (Rattlesnake, Cibola Lake, Walker Lake, Mittry West, Gila Confluence, and Great Blue Heron) this was not possible, either because sufficient access was not available for the equipment or because depth-to-water at the accessible locations would have been too great. At these locations, we installed the piezometers as close as possible to the habitat polygons given the access and depth-to-water restrictions. With the exception of Rattlesnake, where the piezometer is just over 1,000 feet from the designated habitat, all piezometers are within 500 feet of the habitat (Table 8.2). Data were downloaded on August 28–29 and September 29–30 2005.

MICROCLIMATE

2005 MICROCLIMATE DESCRIPTIVE STATISTICS

Habitat, canopy cover, soil moisture, temperature, relative humidity, and vapor pressure parameters from the 15 study sites monitored in 2005 exhibited substantial variation among sites (Table 8.3). Half (n = 30) of all HOBO locations were dominated by exotic vegetation (tamarisk). Three study sites (Three Fingers Lake, Clear Lake, Ferguson Wash) consisted entirely of locations dominated by exotic vegetation, while only one study site (Gila Confluence North) consisted entirely of locations dominated by native vegetation. Approximately half (n = 28) of all locations exhibited 25–75% canopy cover.

Soil moisture varied by a factor of five among study sites, from a low of 175.9 mV at Ferguson Wash to a high of 941.7 mV at Mittry West. Mean distance to saturated/inundated soil varied by a factor of 47, with a low of 4.1 m at Blankenship Bend to a high of 195.3 m at Great Blue Heron.

Mean diurnal temperatures at most study areas ranged from 30 to 35^{o}C, with a low of 29.8^{o}C at Rattlesnake and a high of 37.9^{o}C at Cibola Lake. Mean nocturnal temperatures at most study sites ranged from 23 to 26^{o}C, with a low of 20.6^{o}C at Gila Confluence North and a high of 26.5^{o}C at Walter Lake. Mean number of 15-minute intervals above 41^{o}C each day varied from 4.8 at Rattlesnake to 26.6 at Cibola Lake, with most study sites occurring in the 6–18 range. Mean daily temperature range varied from 19.3^{o}C (Havasu NE) to 33.1^{o}C (Three Fingers Lake).

Mean diurnal relative humidity ranged from 28.3% (Cibola Lake) to 54.3% (Rattlesnake), while mean nocturnal relative humidity ranged from 38.1% (Havasu NE) to 65.6% (Rattlesnake).

Mean diurnal vapor pressure was lowest at Cibola Lake (1389.2 Pa) and highest at Rattlesnake (2071.8 Pa). Mean nocturnal vapor pressure was lowest at Havasu NE (1334.0 Pa) and highest at Rattlesnake (1863.7 Pa).

2004 MICROCLIMATE DESCRIPTIVE STATISTICS

Data gathered on microclimatic variables by Reclamation in 2004 were taken at slightly different sites than were the 2005 data (Table 8.4). Nevertheless, qualitative comparison of 2004 versus 2005 data from study sites where data were collected during both years revealed that most variables were approximately similar between years. Differences could be due to the selection of different sites between years, different date ranges of loggers collecting data, or interannual climatic differences.

COMPARISON OF PARKER/IMPERIAL TO TOPOCK: MICROCLIMATE

All microclimate parameters except for canopy cover and mean nocturnal temperature were significantly different between Topock Marsh and the habitat monitoring sites (Table 8.5). Topock was cooler and exhibited higher diurnal/nocturnal relative humidity, diurnal/nocturnal vapor pressure, and soil moisture than habitat monitoring sites. In contrast, habitat monitoring sites had a significantly greater proportion of sites dominated by native vegetation, and the mean distance to saturated/inundated soil was less than half that recorded at Topock.

GEOGRAPHIC VARIATION OF TEMPERATURE AND HUMIDITY MEASUREMENTS

Summaries of monthly averages for temperature and absolute humidity in May–July 2005 for all habitat monitoring sites are shown in Table 8.6. Because HOBO loggers were installed through mid-June, only the month of July has a full data set. Linear regression of temperature and humidity values for the month of July against the UTM northing revealed little or no trend with latitude (R^2 = 0.07 and 0.30, respectively).

VEGETATION MEASUREMENTS

We completed vegetation plots at all HOBO logger sites after flycatcher surveys were completed in late July. Vegetation characteristics varied widely both between and within the selected habitat monitoring sites (Table 8.7). Average canopy height ranged from 4.6 m (Cibola Lake) to 9.3 m (Ehrenberg), and average canopy closure ranged from 62.5% (Ehrenberg) to 96.8% (Rattlesnake). Measures of other habitat characteristics were similarly variable. Vertical foliage profiles for each site are shown in Figure 8.1. Sites typically exhibited the densest foliage within 4 m of the ground.

Table 8.2. Summary of Piezometer Construction at Habitat Monitoring Sites, Lower Colorado River, 2005

Site	Depth (ft)	Stickup Height (ft)	Date installed	Date(s) downloaded	Average depth to water (ft)	Approximate install offset error (ft)[1]	Dates affected by install offset error	Distance (ft) from habitat	Distance (ft) to nearest HOBO
Blankenship Bend	7.2	3.4	28 Aug	29 Sep	6.61	-0.04	None	Within	4,400
Havasu NE	6.1	2.2	09 May	28 Aug, 29 Sep	4.71	+0.27	9 May–28 Aug	Within	250
Ehrenburg	7.4	2.6	29 Aug	30 Sep	4.86	+0.09	None	Within	110
Three Fingers Lake	7.7	4.1	31 May	29 Sep	7.52	+0.33	31 May–29 Sep	540	1,400
Cibola Lake	7.2	3.4	30 May	29 Sep	7.92	+1.01	31 May–28 Sep	Within	550
Walker Lake	7.4	2.9	30 May	29 Sep	4.13	+0.79	30 May–Present[2]	230	1,080
Paradise	11.7	0.6	11 May	30 Aug	5.17	+0.15	None	Within	320
Hoge Ranch	8.7	2.8	11 May	30 Aug	5.35	+1.19	11 May–30 Aug	Within	190
Rattlesnake	7.0	2.8	10 May	30 Aug	6.53	+1.47	10 May–30 Aug	1,080	1,400
Clear Lake	8.7	2.4	10 May	30 Aug	4.58	+1.37	10 May–30 Aug	Within	190
Ferguson Lake	7.6	2.7	10 May	30 Aug	4.03	+0.02	None	Within	1,580
Ferguson Wash	-	2.2	10 May	30 Aug	5.49	+2.36	10 May–30 Aug	Within	260
Great Blue Heron	7.3	1.7	31 May	30 Aug	3.66	-0.26	31 May–30 Aug	60	870
Mittry West	5.0	3.0	29 Aug	30 Sep	6.26	+0.01	29 Aug–30 Sep	270	600
Gila Confluence North	7.9	2.7	29 Aug	30 Sep	7.04	+0.03	None	50	1,200

[1] Install Offset Error = Pressure Transducer depth-to-water – Manual depth-to-water.
[2] Due to field conditions, pressure transducer could not be re-set during field visit.

Table 8.3. Microclimatic Data Summaries Collected From Habitat Monitoring Sites, Lower Colorado River, May–July 2005*

Descriptive Statistics	Blankenship Bend	Havasu NE	Ehrenberg	Three Fingers Lake	Cibola Lake	Walker Lake	Paradise	Hoge Ranch	Rattlesnake	Clear Lake	Ferguson Lake	Ferguson Wash	Great Blue Heron	Mittry West	Gila Confluence North
n	4	3	4	5	5	3	4	4	4	3	5	4	4	4	3
Date range of loggers	5/18–7/29	5/19–7/27	5/20–7/28	5/12–7/31	5/10–7/30	6/2–7/29	5/17–7/27	5/18—7/28	5/11—8/1	4/22–7/28	5/8–7/29	4/21–7/31	4/19–7/26	4/21–7/30	4/20–7/27
Habitat															
Native (cottonwood or willow)	1 (25.0)	0 (0.0)	3 (75.0)	0 (0.0)	1 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (50.0)	0 (0.0)	3 (100.0)
Exotic (tamarisk)	1 (25.0)	3 (75.0)	0 (0.0)	5 (100.0)	4 (80.0)	2 (66.7)	1 (25.0)	1 (25.0)	1 (25.0)	3 (100.0)	2 (40.0)	4 (100.0)	1 (25.0)	2 (50.0)	0 (0.0)
Mixed (native and exotic)	2 (50.0)	1 (25.0)	1 (25.0)	0 (0.0)	0 (0.0)	1 (33.3)	3 (75.0)	3 (75.0)	3 (75.0)	0 (0.0)	3 (60.0)	0 (0.0)	1 (25.0)	2 (50.0)	0 (0.0)
Canopy cover															
Less than 25%	2 (50.0)	1 (25.0)	1 (25.0)	2 (40.0)	1 (20.0)	0 (0.0)	1 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (75.0)	1 (33.3)	1 (33.3)
25–75%	2 (50.0)	0 (0.0)	1 (25.0)	2 (40.0)	3 (60.0)	2 (66.7)	1 (33.3)	4 (100.0)	1 (25.0)	2 (66.7)	3 (60.0)	2 (50.0)	1 (25.0)	2 (66.7)	2 (66.7)
More than 75%	0 (0.0)	3 (75.0)	2 (50.0)	1 (20.0)	1 (20.0)	1 (33.3)	1 (33.3)	0 (0.0)	3 (75.0)	1 (33.3)	2 (40.0)	2 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)
Soil Moisture															
Mean soil moisture (mV)	356.4 (85.1)	221.9 (24.8)	616.8 (37.3)	557.9 (27.1)	308.1 (31.2)	894.2 (17.2)	692.8 (61.7)	869.4 (15.8)	698.1 (35.2)	408.2 (72.7)	701.5 (45.7)	175.9 (4.3)	892.0 (10.8)	941.7 (4.6)	695.5 (19.7)
Mean distance (m) to saturated/ inundated soil	4.1 (1.6)	31.0 (0.0)	50.9 (1.8)	67.8 (8.7)	53.6 (7.2)	41.6 (2.2)	28.2 (6.4)	30.7 (5.5)	63.5 (17.1)	26.0 (3.2)	19.5 (3.7)	141.7 (13.3)	195.3 (110.2)	31.0 (0.0)	11.7 (2.5)
Temperature/Humidity															
Mean diurnal temperature (°C)	35.1 (0.2)	32.8 (0.2)	35.8 (0.2)	36.5 (0.2)	37.9 (0.2)	34.4 (0.2)	31.7 (0.3)	33.2 (0.2)	29.8 (0.2)	30.5 (0.2)	32.0 (0.2)	30.3 (0.2)	30.1 (0.2)	31.7 (0.2)	31.5 (0.2)
Mean no. of 15-min. intervals above 41°C each day	19.4 (0.9)	7.7 (0.6)	18.8 (0.8)	24.8 (0.5)	26.6 (0.6)	16.5 (0.9)	10.8 (0.8)	12.2 (0.6)	4.8 (0.6)	5.6 (0.5)	9.2 (0.5)	6.4 (0.4)	7.2 (0.5)	10.1 (0.5)	12.7 (0.5)
Mean nocturnal temperature (°C)	24.7 (0.2)	26.6 (0.2)	25.8 (0.2)	24.3 (0.2)	25.4 (0.2)	26.5 (0.3)	24.3 (0.2)	26.0 (0.2)	23.4 (0.2)	24.8 (0.3)	26.6 (0.2)	24.8 (0.2)	23.1 (0.2)	23.5 (0.2)	20.6 (0.2)
Mean daily temperature range (°C)	26.0 (0.4)	19.3 (0.4)	25.7 (0.3)	33.1 (0.4)	30.0 (0.3)	26.3 (0.7)	23.3 (0.6)	23.9 (0.5)	20.3 (0.4)	20.0 (0.4)	20.6 (0.3)	21.1 (0.5)	23.0 (0.5)	24.9 (0.5)	29.4 (0.6)
Mean diurnal relative humidity (%)	32.1 (0.6)	32.7 (0.6)	31.1 (0.7)	31.8 (0.5)	28.3 (0.4)	36.2 (0.9)	46.1 (1.1)	39.8 (0.7)	54.3 (1.0)	41.0 (0.8)	42.0 (0.5)	46.4 (0.8)	47.1 (0.8)	42.4 (0.8)	46.0 (0.7)
Mean diurnal vapor pressure (Pa)	1487.6 (31.6)	1511.7 (31.9)	1517.9 (34.6)	1423.9 (27.2)	1389.2 (24.3)	1618.1 (47.3)	1820.4 (39.4)	1738.5 (37.8)	2071.8 (42.5)	1658.9 (39.3)	1742.8 (27.7)	1768.3 (31.5)	1747.2 (33.1)	1671.7 (32.6)	1734.4 (31.8)
Mean nocturnal relative humidity (%)	48.0 (0.8)	38.1 (0.6)	46.8 (0.8)	48.7 (0.6)	49.0 (0.6)	47.0 (1.1)	54.7 (1.0)	48.5 (0.8)	65.6 (1.0)	44.7 (0.7)	47.3 (0.5)	47.0 (0.6)	55.6 (0.7)	52.6 (0.5)	65.1 (0.5)
Mean nocturnal vapor pressure (Pa)	1435.5 (28.2)	1334.0 (30.7)	1516.4 (31.0)	1406.1 (24.8)	1505.0 (21.9)	1542.3 (39.6)	1589.8 (31.2)	1571.8 (33.4)	1863.7 (36.2)	1400.0 (33.3)	1597.2 (24.3)	1423.4 (24.8)	1528.9 (25.7)	1492.5 (25.1)	1553.9 (25.8)

* Habitat and canopy cover variables are presented as N followed by % of column totals (in parentheses), while soil moisture and temperature/humidity values are means (standard error in parentheses).

Table 8.4. Microclimatic Data Summaries Collected by the Bureau of Reclamation From Habitat Monitoring Sites, Lower Colorado River, May–August 2004*

Descriptive Statistics	Big Hole Slough	Ehrenberg	Cibola Lake	Walker Lake	Hoge Ranch	Adobe Lake	Picacho NW	Clear Lake	Ferguson Lake	Ferguson Wash	Great Blue Heron	Pratt	Mittry South	Hunter's Hole
n	2	2	2	1	2	2	2	2	2	2	2	2	2	2
Date range of loggers	5/7–8/6	5/10–8/6	6/15–10/26	5/27–8/13	5/26–8/13	5/26–8/13	5/26–10/21	5/25-8/13	5/10-8/13	5/7-8/13	5/10-8/13	5/10-8/13	5/25-12/10	5/25-8/13
Temperature/Humidity														
Mean diurnal temperature (°C)	31.5 (0.2)	33.2 (0.2)	35.7 (0.1)	33.8 (0.3)	31.5 (0.3)	34.0 (0.2)	33.9 (0.2)	31.1 (0.2)	31.8 (0.2)	30.1 (0.2)	29.0 (0.2)	33.2 (0.2)	32.2 (0.1)	33.7 (0.2)
Mean no. of 15-min. intervals above 41°C each day	9.2 (0.5)	13.0 (0.8)	13.8 (0.6)	16.2 (1.2)	9.7 (0.8)	13.3 (0.9)	10.3 (0.6)	7.0 (0.4)	5.9 (0.5)	3.1 (0.4)	1.5 (0.3)	8.0 (0.6)	4.1 (0.5)	11.8 (0.7)
Mean nocturnal temperature (°C)	22.3 (0.3)	24.3 (0.3)	24.7 (0.2)	25.5 (0.4)	24.3 (0.3)	27.4 (0.3)	26.8 (0.3)	24.9 (0.2)	25.2 (0.3)	27.7 (0.3)	22.9 (0.3)	23.5 (0.2)	25.1 (0.4)	24.5 (0.3)
Mean daily temperature range (°C)	25.9 (0.5)	24.5 (0.4)	29.3 (0.4)	23.5 (0.6)	23.7 (0.5)	20.8 (0.3)	22.9 (0.4)	25.7 (0.5)	23.5 (0.4)	18.3 (0.4)	21.4 (0.4)	26.7 (0.4)	21.5 (0.4)	23.7 (0.4)
Mean diurnal relative humidity (%)	43.2 (0.8)	33.0 (0.6)	39.1 (0.4)	34.3 (0.6)	43.9 (0.7)	32.8 (0.5)	28.8 (0.5)	44.4 (0.8)	38.5 (0.5)	39.3 (0.6)	50.8 (0.8)	45.4 (0.4)	37.8 (0.4)	40.9 (0.5)
Mean nocturnal relative humidity (%)	60.3 (1.2)	49.0 (1.2)	56.5 (0.7)	45.3 (0.8)	54.5 (0.7)	37.9 (0.6)	38.6 (0.6)	51.0 (0.7)	47.3 (0.7)	35.9 (0.6)	59.7 (0.8)	64.2 (0.6)	45.0 (1.1)	62.2 (0.5)

*All values are means (standard error in parentheses).

Table 8.5. Comparison of Microclimatic Variables at Habitat Monitoring Sites to Within-Territory Locations at the Topock Marsh Life History Study Area, 2005*

Response Variable	Habitat Monitoring Sites	Topock Marsh WT	P^1
N (Temp./Humidity Sensor Arrays)	59	31	N/A
Habitat			
Native (cottonwood or willow)	10 (17.0)	0 (0.0)	
Exotic (tamarisk)	29 (49.2)	29 (93.5)	<0.001
Mixed (native and exotic)	18 (30.5)	2 (6.5)	
Canopy Cover			
Less than 25%	13 (22.8)	3 (9.7)	
25–75%	28 (49.1)	15 (48.4)	0.238
More than 75%	16 (28.1)	13 (41.9)	
Soil Moisture			
Mean soil moisture (mV)	586.4 (14.2)	795.4 (37.9)	0.006
Mean distance to saturated/ inundated soil	45.8 (3.4)	125.3 (14.5)	<0.001
Temperature/Humidity			
Mean diurnal temperature (°C)	32.9 (0.1)	30.9 (0.4)	<0.001
Mean no. of 15 min. intervals above 41°C each day	13.1 (0.2)	3.8 (0.9)	<0.001
Mean nocturnal temperature (°C)	24.6 (0.1)	24.2 (0.5)	0.002
Mean daily temperature range (°C)	24.7 (0.1)	20.0 (0.8)	0.003
Mean diurnal relative humidity (%)	40.0 (0.2)	56.2 (1.6)	<0.001
Mean diurnal vapor pressure (Pa)	1657.1 (9.0)	2349.5 (94.0)	<0.001
Mean nocturnal relative humidity (%)	50.8 (0.2)	68.3 (1.7)	<0.001
Mean nocturnal vapor pressure (Pa)	1515.9 (7.5)	2075.4 (82.6)	<0.001

* Habitat and canopy cover variables are presented as N followed by % of column totals (in parentheses), while soil moisture and temperature/humidity values are means (standard error in parentheses). N/A = data not available or not applicable.

[1] For the significance testing, the analysis was restricted to the dates when monitoring occurred at both habitat monitoring sites and Topock WT: 6/10/05 – 8/1/05.

Table 8.6. Average Monthly Temperature and Absolute Humidity from May–June at habitat monitoring sites, Lower Colorado River, 2005

Site	UTM Northing	Temperature (ºC)			Absolute humidity (g/m³)		
		May	June	July	May	June	July
Blankenship Bend	3831571	28.59	29.25	32.48	7.552	8.679	12.542
Havasu NE	3824239	28.31	29.16	32.91	7.587	9.436	12.472
Ehrenberg	3715859	26.04	31.03	35.22	6.997	8.263	11.881
Three Fingers Lake	3682253	27.32	29.96	34.45	7.652	8.486	12.294
Cibola Lake	3680194	29.60	31.73	36.06	8.480	8.973	12.418
Walker Lake	3675951	26.92	28.29	31.48	6.996	9.836	14.234
Paradise	3666336	26.47	29.37	32.38	7.840	9.317	13.573
Hoge Ranch	3660346	28.19	28.35	31.63	6.989	9.935	14.056
Rattlesnake	3659614	24.98	23.93	27.27	8.566	13.061	18.649
Clear Lake	3657985	24.58	27.84	30.79	8.609	10.535	15.291
Great Blue Heron	3652424	24.94	27.42	30.13	9.486	11.185	16.285
Ferguson Lake	3651948	25.80	28.73	32.00	9.766	10.846	15.696
Ferguson Wash	3650544	25.82	29.26	33.02	8.951	9.545	14.118
Mitttry West	3638678	25.74	28.70	32.55	9.111	10.097	14.943

Table 8.7. Summary of Vegetation Characteristics at Habitat Monitoring Sites, Lower Colorado River, 2005*

Parameter	Blankenship Bend (n=4)	Havasu NE (n=4)	Ehrenberg (n=4)	Three Fingers Lake (n=5)	Cibola Lake (n=5)	Walker Lake (n=3)	Paradise (n=4)	Hoge Ranch	Rattlesnake (n=4)	Clear Lake (n=3)	Ferguson Lake (n=5)	Ferguson Wash (n=4)	Great Blue Heron (n=4)	Mittry West (n=4)	Gila Confluence North (n=3)
Average canopy height (m)	5.9 (1.1)	4.7 (0.6)	9.3 (3.9)	3.4 (0.2)	4.6 (0.7)	7.3 (3.3)	8.6 (2.6)	5.5 (0.4)	8.4 (1.5)	7.5 (0.9)	5.7 (0.4)	5.5 (0.1)	9.0 (2.5)	8.7 (1.5)	7.3 (0.2)
	4.0–8.0	3.3–6.0	2.0–16.3	3.0–4.0	3.0–7.0	3.5–14.0	3.5–15.4	4.5–6.0	6.0–11.3	6.0–9.0	5.0–7.0	5.2–5.8	5.0–16.2	6.4–12.9	7.0–7.5
% total canopy closure	86.5 (6.9)	71.3 (10.5)	62.5 (10.4)	72.8 (13.6)	83.4 (10.4)	94.7 (1.2)	82.5 (7.0)	89.3 (2.6)	96.8 (1.1)	95.3 (2.2)	83.4 (9.7)	94.0 (1.6)	86.3 (4.9)	90.0 (3.7)	73.7 (5.5)
	66.0–95.0	49.0–92.0	43.0–92.0	33.0–96.0	42.0–97.0	93–97	65.0–99.0	84.0–95.0	94.0–99.0	91.0–98.0	45.0–96.0	91.0–98.0	73.0–94.0	81.0–96.0	64.0–83.0
% woody ground cover	47.5 (22.5)	22.5 (4.7)	26.5 (10.5)	11.8 (3.6)	27.0 (8.3)	29.3 (24.3)	63.5 (22.9)	32.3 (9.0)	59.3 (9.3)	42.0 (12.5)	17.0 (4.0)	36.3 (5.6)	16.0 (4.8)	15.3 (4.0)	8.3 (2.8)
	9.0–100.0	13.0–31.0	6.0–56.0	3.0–24.0	1.0–49.0	4.0–78.0	5.0–100.0	12.0–52.0	44.0–76.0	22.0–65.0	8.0–28.0	24.0–52.0	10.0–30.0	8.0–24.0)	5.0–14.0
Distance (m) to nearest standing water or saturated soil	11.8 (8.3)	73.8 (8.8)	49.3 (6.9)	128.4 (32.2)	75.8 (24.7)	42.3 (11.3)	43.8 (13.6)	36.3 (17.1)	73.8 (15.3)	44.0 (20.0)	20.1 (4.1)	85.0 (19.5)	85.0 (20.5)	126.8 (27.1)	14.3 (10.3)
	0.0–35.0	55.0–95.0	35.0–62.0	27.0–210.0	24.0–170.0	30.0–65.0	15.0–80.0	5.0–75.0	30.0–95.0	4.0–65.0	4.3–26.0	50.0–130.0	45.0–140.0	60.0–180.0	3.0–35.0
% of plot centers within 30 m of nearest canopy gap	100	100	100	100	100	100	75	100	75	100	20	100	100	100	100
% of plot centers within 30 m of a broadleaf tree	75	100	100	0	40	100	50	50	100	33.3	60	100	75	100	100
# shrub/sapling stems within 5-m radius of plot center	25.3 (5.8)	10.0 (3.5)	36.3 (14.6)	72.2 (10.9)	30.2 (5.8)	20.3 (3.8)	37.5 (21.4)	79.0 (36.6)	65.8 (22.1)	42.3 (25.3)	74.0 (17.6)	49.8 (5.2)	49.0 (10.1)	64.3 (8.2)	60.3 (16.3)
	11–39	4–20	10–73	33–96	17–45	16–28	5–100	24–185	20–126	17–93	41–134	39–63	21–69	48–86	28–80
# tree stems within 11.3-m radius of plot center	4.3 (1.9)	24.8 (7.0)	5.8 (1.1)	0.0 (0.0)	2.2 (1.0)	5.0 (4.5)	5.8 (2.5)	2.3 (0.6)	7.8 (3.1)	22.0 (9.2)	2.4 (0.9)	15.8 (2.2)	22.0 (7.2)	9.3 (5.1)	4.0 (1.7)
	1–8	13–45	4–9		0–5	0–14	0–12	1–4	2–15	4–34	1–5	10–20	2–33	1–24	1–7

* Data presented for continuous variables are means, (standard error), and range.

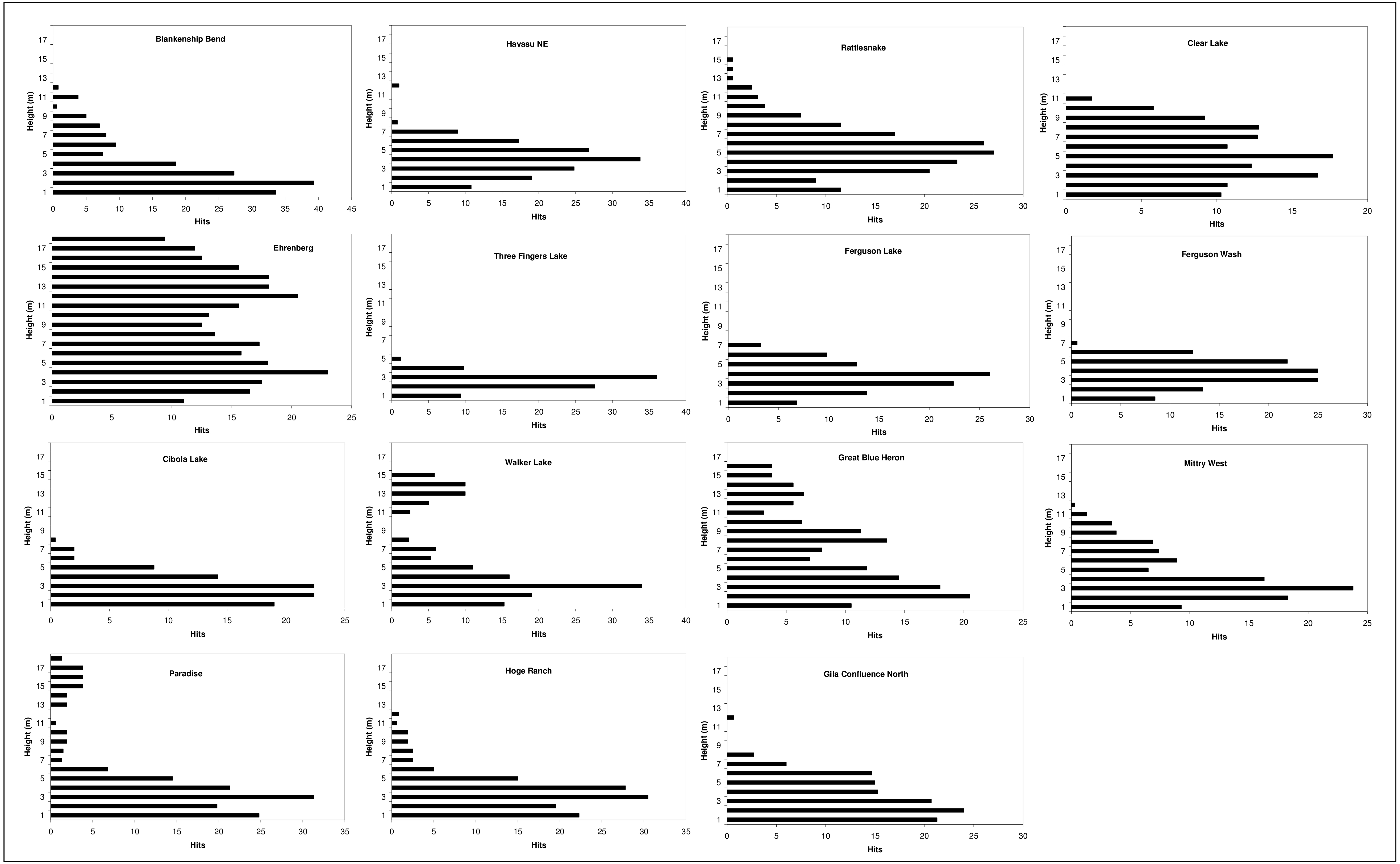

Figure 8.1. Vertical foliage profiles for each habitat monitoring site, lower Colorado River, 2005.

GROUNDWATER MONITORING

OVERVIEW OF PIEZOMETER WATER LEVELS

All the piezometer hydrographs exhibit some common characteristics. Two general trends appear in each of the hydrographs. First, water levels follow a weekly cycle, with the lowest water levels occurring roughly during the weekend, and the highest water levels occurring roughly in the middle of the week. Most of the piezometers also exhibit a second, daily cycle of water level change. In this cycle, water levels peak in the early morning and are at their lowest levels in late afternoon. Hydrographs for all piezometers are presented in Appendix D.

CORRELATION OF PIEZOMETER WATER LEVELS WITH RESERVOIR RELEASES

Lake Havasu Water Levels – The relationship between water levels in the Havasu NE piezometer and water levels in Lake Havasu is clear and direct (Figure 8.2). Because of the install offset error, linear regression analysis for data collected from 9 May through 29 August was analyzed separately from data collected after 29 August. Both data sets show a strong correlation (R^2 = 0.89–0.92) between water levels in Lake Havasu as measured by the USGS and water levels below the habitat as measured in the Havasu NE piezometer.

Colorado River Water Levels – The rating curve for the USGS gaging station below Parker Dam is shown in Figure 8.3. The results of best-fit regression analyses for the Parker Dam rating curve are shown in Table 8.8. Although multiple-order polynomial regressions offer the highest correlation, the linear regression makes a good fit (R^2 = 0.95). Because a linear relationship exists (at least at the Parker Dam gage), we correlated releases from Parker Dam directly with piezometer water levels (Table 8.9) without any additional manipulation of the data. The "best fit" time lag varied from two days for the upstream piezometers (Paradise, Hoge Ranch, Rattlesnake) to three days for the downstream piezometers (Clear Lake, Ferguson Lake, Ferguson Wash, and Great Blue Heron). The R^2 statistic varied from 0.67 to 0.87.

CORRELATION OF PIEZOMETER WATER LEVELS WITH SOIL MOISTURE MEASUREMENTS

Linear regressions between the average soil moisture measurements at 11 of the habitat monitoring sites and the average daily water level in the piezometer for that site show very little to no correlation between these two variables (R^2 = 0.0–0.45; Table 8.10, Appendix E).

CORRELATION OF PIEZOMETER WATER LEVELS WITH HUMIDITY MEASUREMENTS

Linear regression between average daily piezometer water levels and average daily absolute humidity at 11 of the habitat monitoring sites revealed little to no correlation between these two variables (R^2 = 0–0.35; Table 8.11, Appendix F).

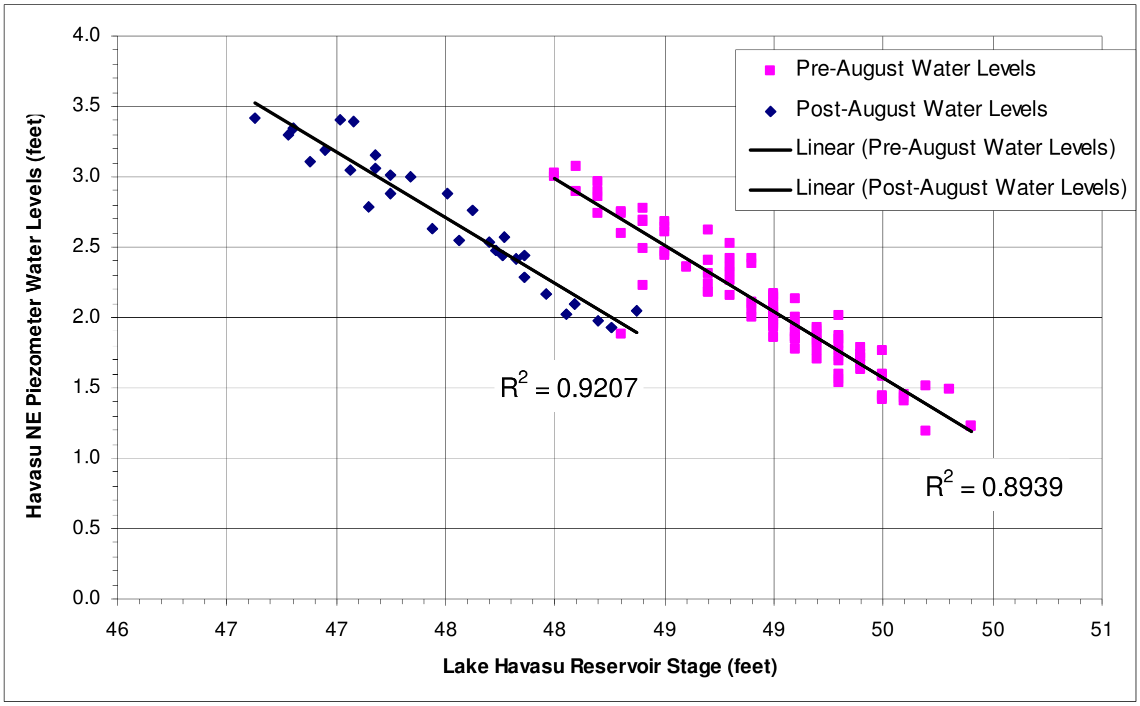

Figure 8.2. Correlation of Havasu NE piezometer and Lake Havasu water levels, 2005.

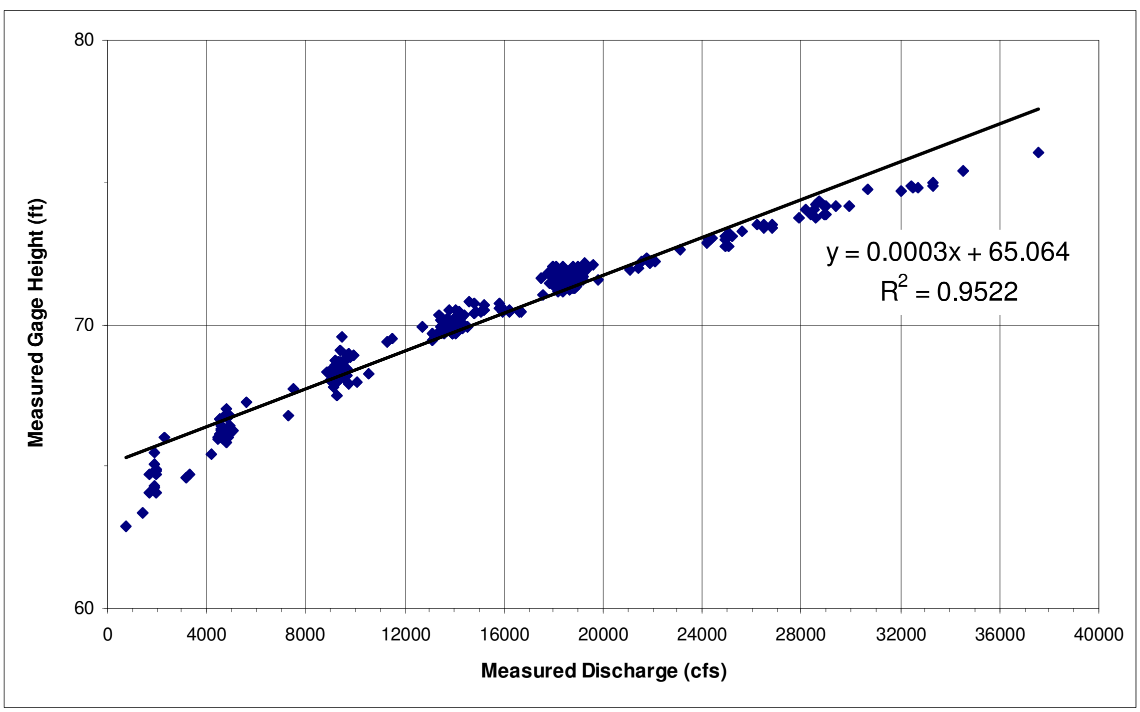

Figure 8.3. Rating curve for Colorado River below Parker Dam.

Table 8.8. Results of Best-fit Regression Analyses for the Parker Dam Rating Curve

Type of Regression	R^2
LINEAR	0.95
LOG	0.93
POLYNOMIAL	
2nd order	0.98
3rd order	0.99
4th order	0.99
5th order	0.99
EXPONENTIAL	0.94
POWER	0.94

Table 8.9. Correlation (R^2 Statistic) of Parker Dam Daily Releases (cfs) with Average Daily Water Levels (feet bgs) of Piezometers at Habitat Monitoring Sites, 2005*

Site	Time Lag				
	None	1 day	2 days	3 days	4 days
Paradise	0.08	0.43	0.83	0.47	0.15
Hoge Ranch	0.09	0.45	0.87	0.46	0.14
Rattlesnake	0.02	0.22	0.74	0.63	0.23
Clear Lake	0.05	0.16	0.55	0.73	0.48
Ferguson Lake	0.01	0.14	0.61	0.75	0.34
Ferguson Wash[1]	0.06	0.01	0.40	0.74	0.31
Great Blue Heron	0.01	0.06	0.33	0.67	0.55

* Shaded cells indicate best correlation
[1] August data only

Table 8.10. Results of Linear Regression Between Average Daily Piezometer Water Levels and Soil Moisture at Habitat Monitoring Sites, Lower Colorado River, 2005

Site	Number of data points	Range of soil moisture values (mV)	Median soil moisture value (mV)	R^2
Havasu NE	10	69–621	161	0.01
Cibola Lake	11	95–994	258	0.08
Three Fingers Lake	10	287–883	508	0.07
Walker Lake	8	762–1022	941	0.06
Paradise	8	349–974	873	0.02
Hoge Ranch	10	667–954	894	0.01
Rattlesnake	10	380–994	794	0.42
Clear Lake	10	113–969	165	0.0
Ferguson Lake	12	636–994	891	0.45
Ferguson Wash	11	130–283	169	0.01
Great Blue Heron	7	729–967	914	0.23

Table 8.11. Results of Linear Regression Between Average Daily Piezometer Water Levels and Absolute Humidity at Habitat Monitoring Sites, Lower Colorado River, 2005

Site	Number of data points	Range of absolute humidity values (g/m³)	Median absolute humidity value (g/m³)	R^2
Havasu NE	81	4.8–20.4	9.2	0.17
Cibola Lake	84	5.3–19.6	9.3	0.10
Three Fingers Lake	104	3.1–19.4	8.3	0.0
Walker Lake	102	3.3–20.3	8.7	0.28
Paradise	100	4.0–22.5	8.8	0.11
Hoge Ranch	101	3.9–21.7	8.9	0.09
Rattlesnake	105	3.9–24.2	11.9	0.09
Clear Lake	101	4.1–24.1	10.3	0.03
Ferguson Lake	85	5.6–23.6	11.3	0.07
Ferguson Wash	104	4.5–24.8	9.6	0.12
Great Blue Heron	99	5.3–23.9	10.9	0.35

DISCUSSION

MICROCLIMATE

Most microclimatic variables at the combined habitat monitoring sites differed significantly from those at Topock Marsh. As noted previously in Chapter 7, all four life history study areas were significantly different with respect to most microclimate variables due their different elevations, latitudes, and other environmental attributes. The habitat monitoring sites were lower in elevation and at lower latitudes than Topock and therefore were more likely to be warmer, an expectation confirmed by all three diurnal temperature parameters compared in Table 8.5. However, the habitat monitoring sites were not the warmest of the study areas we monitored. Mormon Mesa, where flycatchers are known to nest, had higher mean diurnal temperatures than the habitat monitoring areas. This suggests that high diurnal temperatures alone may not have been responsible for the absence of known flycatcher nests in 2005 at the habitat monitoring sites.

VEGETATION

Vegetation measurements at these sites are intended to detect any changes in vegetation characteristics that may occur over time as a result of water transfer actions. In subsequent years, vegetation measurements will be repeated at the same locations, and pairwise comparisons will be made at each location between years.

GROUNDWATER LEVELS

PIEZOMETER WATER LEVELS

The weekly water level cycle appears to be driven by fluctuations in the river water level. The total water level change experienced in the piezometers during the weekly cycle is usually greater than 1 foot. The daily small-scale water level fluctuations (no more than 0.5 feet, and often much less) are caused by evapotranspiration of plants. During the day, the riparian vegetation removes water from aquifer storage, which is then replenished as evapotranspiration lessens near the end of the day. The total volume of water transpired can actually be estimated from these small-scale fluctuations; however, we have not conducted such an analysis at this time, although this estimate may be made later in the project.

Several anomalous hydrograph features deserve discussion:

Ferguson Wash – The Ferguson Wash piezometer was installed 10 May 2005. Although the pressure transducer and data logger appear to have been functioning, the water level response in the piezometer was muted and sluggish, and did not match the other piezometers very well. This condition lasted until an exceptionally large water level rise on 2 August 2005. After this event, the piezometer appeared to be reacting more as expected, although the daily water level fluctuations observed at many other piezometers were still missing from the hydrograph. We hypothesize that the well screen on this piezometer may be partially clogged, due to very fine-grained or clayey soils at the site. The large water level rise on 2 August may have helped clean the screen, but problems may still exist. If the muted water level response persists, this piezometer may be a candidate for re-installation in 2006.

Three Fingers and Walker Lakes – The Three Fingers and Walker Lake piezometers are both installed away from the river near backwater lakes. Both pressure transducers appear to be functioning properly, as shown by their measurement of daily evapotranspiration fluctuations. However, on 10 August 2005, both piezometers exhibit a phenomenally large rise in water levels. In fact, if the water levels are correct, water at the Three Fingers piezometer peaked over a foot above ground surface.

The fact that both piezometers recorded this large water level increase suggests that it was a real occurrence and not an artifact of the equipment. Discussions with Reclamation personnel have not indicated any operations in Three Fingers Lake or Walker Lake that would cause such a rise in water levels. The most likely scenario is that the water level rise could have been caused by runoff from an exceptionally powerful summer thunderstorm. Whatever occurred, it seems to have done the Three Fingers piezometer no lasting harm. The Walker Lake piezometer, however, did not appear to recover quickly from the inundation, but indicated rather that the water is slowly draining away. However, this could indeed be a true representation of how the aquifer at the site responds, since daily water fluctuations are still observable, which suggests the piezometer is still in communication with the aquifer and the equipment is still functioning properly. The Walker Lake piezometer needs to be restarted to negate the install offset error (this normally would have been done during the data download trip on September 29, but site conditions prevented it). We do not recommend reinstalling the piezometer at this time.

Mittry West – The Mittry West piezometer was installed 29 August 2005. Water levels exhibited a slow decline until about 3 September, as the piezometer came into equilibrium with the surrounding aquifer after the install offset error. After 3 September, water levels were remarkably flat, and while the daily evapotranspiration fluctuations are noticeable, they are much smaller than observed in other piezometers.

Although this piezometer is only 50 feet from the habitat monitoring area, there is very little dense vegetation in the vicinity. To obtain shallow groundwater levels, the piezometer was installed in a low-lying reed-covered area. Most of the reeds in the immediate vicinity had been burnt by wildfire in the recent past. It could be that 1) there is simply very little evapotranspiration occurring at this piezometer site, 2) that the site is far enough removed from the river that excessive water level fluctuations do not occur, or 3) that regulated river water levels downstream of Imperial Dam are relatively steady. Given these uncertainties, other possible piezometer locations within the habitat polygon will be reconnoitered. If conditions allow (access for equipment, shallow water levels), the piezometer will be reinstalled at a different location within the Mittry West habitat polygon.

CORRELATION OF PIEZOMETER WATER LEVELS WITH RESERVOIR RELEASES

Correlating the water levels in the piezometers and operation of the reservoirs on the Colorado River is complicated by the fact that 1) there is a lag time while releases move downriver, 2) release data are available only on a daily basis, and 3) basic hydrologic theory indicates that the relationship between streamflow (i.e., reservoir releases) and river stage is not necessarily linear. Although a polynomial regression yielded the best fit between flow releases from Parker Dam and gage height, a linear regression showed that flow releases still explained 95% of the variability in gage height, and we proceeded with correlating flow releases with piezometer readings without further manipulation of the flow release data.

Regression analyses indicated that, as would be expected, piezometer readings were best correlated with flow release data that had been time-lagged to allow for the progression of releases downstream. The most upstream site included in the analyses (Paradise) showed a two-day lag, while the most downstream site (Great Blue Heron) showed a three-day lag.

The piezometer data set for 2005 is not complete for two reasons. First, some of the piezometers were installed at the end of the season (in August). Secondly, during the period from installation in May to downloading in August, water levels had not yet been corrected for install offset errors. Because we had incomplete data sets, we did not include data from piezometers near Blythe (Ehrenberg, Cibola Lake, Three Fingers Lake, Walker Lake), below Imperial Dam (Gila Confluence and Mittry West), and above Lake Havasu (Blankenship Bend). Future analyses will incorporate data from these piezometers.

CORRELATION OF PIEZOMETER WATER LEVELS WITH SOIL MOISTURE MEASUREMENTS

We did not find a linear relationship between piezometer water levels and soil moisture measurements at the subset of habitat monitoring sites for which we had complete data sets. Future analyses incorporating data from all sites will help determine if a relationship exists between these two variables. Soil moisture varied widely between sites, and fell into two distinct groups. Soil moisture measurements collected from Havasu NE, Cibola Lake, Clear Lake, and Ferguson Wash all have median results less than 300 mV, while measurements collected from Walker Lake, Paradise, Hoge Ranch, Rattlesnake, Ferguson Lake, and Great Blue Heron all have median soil results greater than 700 mV. We do not know how this variation may affect correlation between piezometer water levels and soil moisture measurements. Future analysis will likely include soil textural analysis to determine if fine-grained soils respond differently than coarse-grained soils.

CORRELATION OF PIEZOMETER WATER LEVELS WITH HUMIDITY MEASUREMENTS

We did not find a correlation between piezometer water levels and absolute humidity at the habitat monitoring sites. Qualitative analysis of humidity trends at the data loggers and at regional weather stations suggest that much of the humidity change is the result of large-scale seasonal fluctuations in humidity. With a longer period of record to work with, future analysis may focus on teasing out smaller-scale humidity fluctuations that are superimposed on the seasonal increase in humidity during the summer.

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ACKNOWLEDGEMENTS

This project was made possible by the support of many persons, agencies, private landowners, and our dedicated staff and crew. Work was conducted under the auspices of Federal Fish and Wildlife Threatened and Endangered Species Permit TE-028605 and Master Banding Permit #23258. Funding was provided by the U.S. Bureau of Reclamation (USBR, Contract No. 03-CS-30-0093). Theresa Olson and John Swett from USBR Boulder City provided background information and guidance, and Mark Santee piloted the helicopter for site tours.

Many thanks to the following national wildlife refuges and personnel for all their assistance and for providing housing: Eddy Pausch at Pahranagat NWR; John Earl, Aimee Haskew, and Jack Allen at Havasu NWR; Dr. Kathleen Blair and Dick Gilbert at Bill Williams River NWR; Tom Alexander and Bill Seese at Cibola NWR; and Ken Edwards and Guy Walker at Imperial NWR. Also, we would like to thank Cris Tomlinson and Keith Brose with Nevada Division of Wildlife for their support at Key Pittman and Overton Wildlife Management Areas.

Thanks to the following agencies and personnel for assistance with obtaining permits: Greg Beatty, Daniel Marquez, Jeri Krueger, and Sarah Quamme with the U.S. Fish and Wildlife Service; Florence Soehnlein and Mary Gustafson with the federal bird Banding Laboratory; Melissa Swain with the Arizona Game and Fish Department; Gloria Shaw with Lake Mead National Recreation Area; Emma Benenati, Bette Anne Domilici, and Kristin Heins with Grand Canyon National Park; John Gustafson with the California Department of Fish and Game; Cris Tomlinson and Maureen Hullinger with the Nevada Division of Wildlife; Kerry Christensen with the Hualapai Department of Natural Resources; Michael Herder with the Bureau of Land Management, St. George; and Gary White with the Cocopah Tribe. The following private landowners granted access to their properties: Phillip, Betty, and Angela Reber and Robert Bunker.

A very special thanks to the Arizona Game and Fish Department and to Eben Paxton, Patti Newell, Suzanne Cardinal, Scott Durst, Caroline Causey, and Mark Sogge with the U.S. Geological Survey, Southwest Biological Science Center for support and assistance in all phases of the project. Thanks also to Susan Sferra with USBR, Phoenix. We would also like to thank David at Anocote Corp. for producing color-anodized federal bands, and Suzanne Rhodes for making colorbands. Thanks to Bill Burris for constructing cowbird traps and Johnny and Kathy at Monte Vista Marine for assisting with boating logistics.

This project would not be a success without our dedicated staff and field personnel. Many, many thanks to Lisa Dickerson, Jessica Maggio, and Beth Moser, who went beyond their administrative duties and coordinated housing, permitting, payroll, vehicles, computers, and telecommunications and handled all manner of crises with cheerful aplomb. A very special thanks to Glenn Dunno for his GIS talents. Thanks also to Terri Patrick for administrative and accounting support. Cooper Carothers and Yael Bernstein served as river guides. And sincere thanks to the 2005 field personnel for hard work, dedication, and sweat.

APPENDIX A

Field Data Forms

SWFL SURVEY AND DETECTION FORM

Study Area ____________ **Survey Site** __________________________________ **Date** __________________

Observer(s) ____ **UTM Zone** _______________

Start Time ______________ UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __	**Stop** Time ______________ UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __

Intermediate Waypoints

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __

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UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __

SWFL Detections

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
____

Survey Summary

Total survey hours _______ # SWFLS found ________ Est. # Pairs _________ Est. # Territories ________

Playbacks used? Y or N Cowbirds Detected? Y or N If Y, approx # ___________________________

Sign of Livestock? Y or N If yes, explain ____

Additional Comments ____
____
____
____
____
____

SWFL SURVEY AND DETECTION FORM – Additional Waypoints

Study Area ____________ **Survey Site** __________________________________ **Date** __________________

Observer(s) ____ **UTM Zone** _______________

Intermediate Waypoints

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __	UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __
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UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __	UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __

Comments ____

SWFL SURVEY AND DETECTION FORM – Additional Detections

Study Area ___________ **Survey Site** ______________________________ **Date** ________________

Observer(s) ____ **UTM Zone** _____________

SWFL Detections

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____

SWFL General Site Description

(Complete at least 3 times during season: early (15–25 May), mid-season (10–25 June), and late season (10–25 July)

Study Area: __________ **Survey Site:** ________________________________ **Date:** _________________

Observer(s):_____________________ **early**_____ **mid**______ **late** ______ **other**_____

Vegetation at site: >90% native 50-90% native 50-90% exotic >90% exotic

Canopy closure: <25% 25-50% 50-70% 70-90% >90%

Dominant overstory species: TASP SAGO SAEX POFR Other _____________

Overstory height (m): ____

Dominant understory species: TASP SAGO SAEX PLSE Other _____________

Understory height (m): _________

Other vegetation types present (e.g., cattail)? Yes No

If yes, type of vegetation: _____________________________ **percentage of site:**___________
type of vegetation: _____________________________ **percentage of site:**___________
type of vegetation: _____________________________ **percentage of site:**___________

% of site inundated: _________________

Depth of surface water: toes (<5cm) ankles (5-15 cm) calves (15-40 cm) knees (40-60 cm) thighs (60-80 cm) waist (100 cm) too deep to wade (>100 cm)

% of site with saturated soils: ____________________

If not inundated, distance to standing water or saturated soil (m):______________________

Give a narrative description of the site, including adjacent habitats:

____
____
____
____
____
____
____
____
____

Additional comments:____
____
____
____
____
____
____

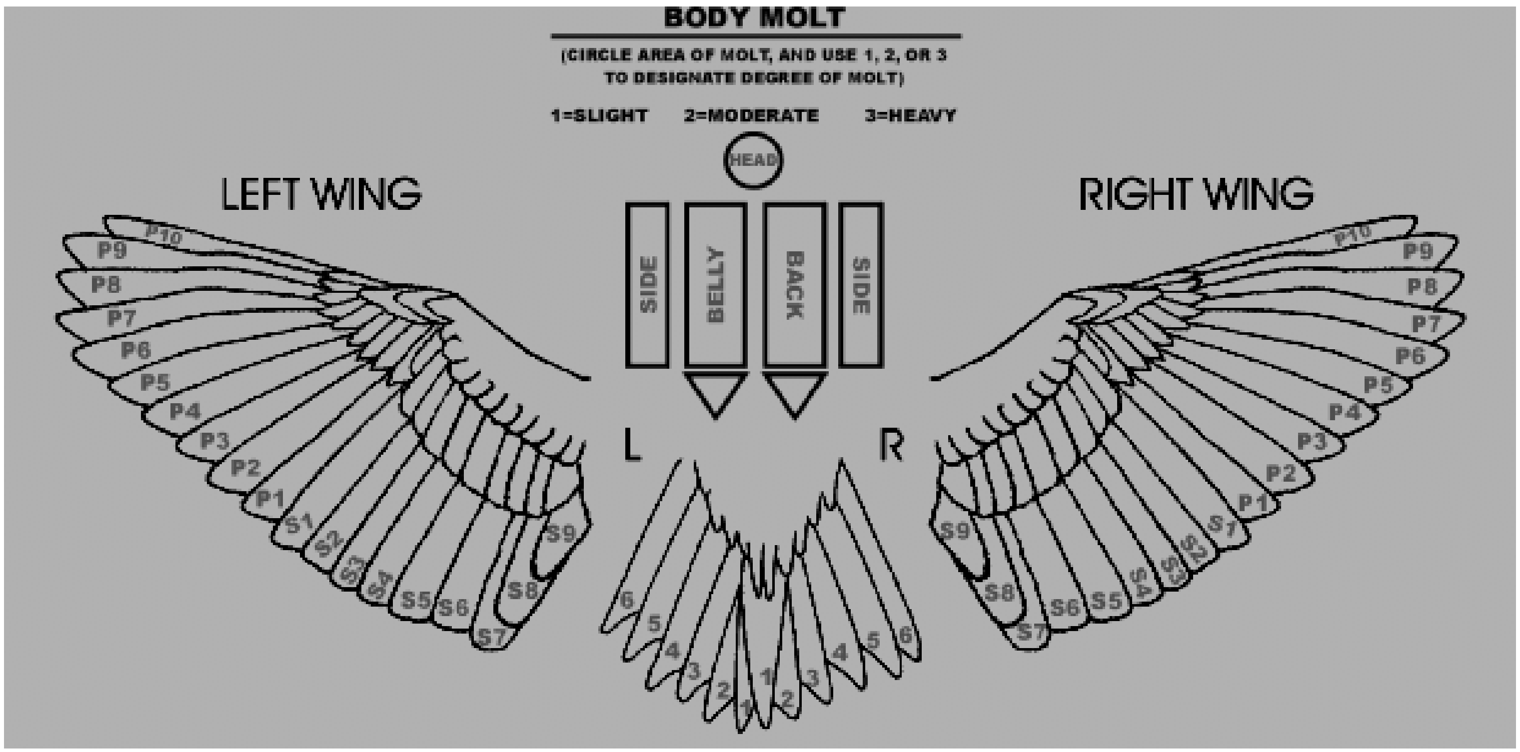
STUDY AREA: _______ **SITE**: _____________ **BANDER**: ______ **DATE**: ________ **TIME**: _______ **TERR/NEST #**: ________ **NBN:** ___ of ___ nestlings banded.
NOTES:____

FEDERAL BAND #	COLOR COMBO L	COLOR COMBO R	STATUS	SEX	CP	BP	AGE AHY, SY, L, or HY	FECAL SAMPLE? (Y or N)	GENETIC SAMPLE? (Y or N)	FEATHER SAMPLE? (Y or N)	WING CHORD (mm)	TAIL (mm)	CULMEN LENGTH (mm)	CULMEN WIDTH (mm)	FAT	MASS (g)

Retained Feathers Present: Yes or No (circle) – if Yes use diagram below
Active Molt: Yes or No (circle) – if Yes use diagram below

Colorimeter sample: Yes or No (circle)
Tail older (more worn) than PPs and SSs? Yes or No (Circle)

STATUS: NCP (new cap passive), NCT (new cap target), RCP (recap passive), RCT (recap target). NBN (nestling banded)
SEX: U=unknown, F=female, M=male
CP: 0=non-breeding, S=partial breeding, M=full breeding
BP: 0= none, 1=smooth, 2=vascularized and filled with fluid, 3 =wrinkled, 4=molting
FAT: 0 = no fat; 1 = trace of fat in furculum, deeply concave, scattered patches, less than 5 percent filled; 2 = thin layer of fat in furculum, less than a third filled, trace of thin layer of fat in abdomen; 3 = furculum is ½ filled or more. Small patches, not covering some areas, on abdomen; or 4 = furculum more than 2/3 filled, level with clavicles, slightly mounded on abdomen



DETAIL ALL MOLTS AND RETAINED FEATHERS ONTO DIAGRAM AND DETAIL IN NOTES

Colorimetry Data Sheet

SITE: ______________________________ **DATE:** ______________________________

BANDER: ______________________________ **FED BAND NUMBER:** ____________________

CROWN MEASUREMENTS

PAGE: ____________

	L*	a*	b*
1			
2			
3			
4			
5			
6			
7			
8			
MAX			
MIN			
AVG			
SD			

BACK MEASUREMENTS

PAGE: __________

	L*	a*	b*
1			
2			
3			
4			
5			
6			
7			
8			
MAX			
MIN			
AVG			
SD			

NOTES:

Date:________________ Page ____ of _____

				COLOR COMBO								
OBS	STUDY AREA	TERR	NEST	LEFT LEG (Top/ Bottom)	RIGHT LEG (Top/ Bottom)	CONF LEVL	ASSOC WITH A NEST?	CAPTURE?	# WIFLS PRESENT	SEX	NBN (__of __)	OBSERVATIONS AND COMMENTS: discuss observations & activities.
												Service Band Number =
												Service Band Number =
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												Service Band Number =

Entered by: _________________ Date entered:___________________

Willow Flycatcher Territory/Nest Record Form (2005)

Study Area:________________Survey Site:________________________________Territory/Nest no.:__________

Territory/Nest Location:
NAD:________ Zone:________

Territory UTMs:

Easting:________________________

Northing:________________________

GPS Accuracy: __________m

Nest UTMs:

Easting:________________________

Northing:________________________

GPS Accuracy: __________m

Nest Height:_________________m (approximate)

Nest Substrate:________________(e.g., TASP=tamarisk, SAGO=Goodding willow, POFR=cottonwood, SAEX = coyote willow, etc.)

Distance to standing water or saturated soil when nest found: ________________(m)

Depth of surface water at nest (please circle how wet you got when nest was found):

dry saturated soil toes (<5cm) ankles (5-15 cm)

calves (15-40 cm) knees (40-60 cm) thighs (60-80 cm)

waist (100 cm) too deep to wade (>100 cm)

PLEASE DO NOT FILL OUT ANYTHING BELOW

Bird 1: Color band combination:______________________________ **Band Number:**______________________________Female

Bird 2: Color band combination:______________________________ **Band Number:**______________________________Male

Willow Flycatcher

Trans dates	BD	(T/F)
		Found
		First egg
		Clutch completion
		Hatching
		Fledged or Failed

Willow Flycatcher

No.	Presumed	Confirmed
		Eggs
		Nestlings
		Fledglings

Cowbird

Trans dates	BD	(T/F)
		First egg
		Hatching
		Fledged

Cowbird

No.	Complete? (T/F)	
		Eggs
		Nestlings
		Fledglings

Outcome (Record code & describe)**:______:**____

____

____

____

Outcome codes:
UN= unknown; **FY=** fledged young, with at least one young seen leaving or in the vicinity of nest; **FP=** fledged young, as determined by parents behaving as if dependent fledgling(s) nearby; **FU=** suspected fledging of at least one young; **FC=** fledged at least one host young with cowbird parasitism; **FD=** Nest partially depredated with confirmed fledging of at least one young; **PO=** predation observed; **PE=** probable predation, nest empty and intact; **PD=** probable predation, damage to nest structure; **AB=** nest abandoned prior to egg(s) being laid; **DE=** deserted with egg(s) or young; **PA=** parasitized, host attempted to raise cowbird young. No host young were fledged from the nest**; WE=** failure due to weather; **AD=** failure, entire clutch addled/infertile; **OT=** failure due to other, or unknown, causes.

Mayfield Success

(WIFL) Period	# Exposure days	Success
Egg Laying		
Incubation		
Nestling		

Mayfield success codes: **S=** successful; **D=** depredated; **U=** status unknown/nest occupied- fate unknown; **M=** mortality other than predation; **A=** abandoned with host egg(s) or young; **Z=** abandoned, no (zero) eggs laid.

Willow Flycatcher Territory/Nest Record Form (continued)

Study Area:_______________Survey Site:____________________________Territory/Nest no.:_______

Date	Time		Obs	Mon Type	Stage	Adult pres.	# WF Egg	# CB Egg	# WF Nstl	# CB Nstl	#WF Fldg	Age Yng	Comments
	In	Out											

Brown-headed Cowbird Traps

Observer(s): ____________________ Start Time: __________ End Time: __________ Date: __________

Study Area: ____________________

Trap #

COWBIRDS	M	F	J	M	F	J	M	F	J	M	F	J	M	F	J	M	F	J
Decoys previously in trap[1]																		
Newly trapped																		
Added[2]																		
Died in trap																		
Escaped																		
Transferred[3]																		
Euthanized																		
Total left in trap[4]																		
NON-TARGET SPECIES[5]																		

Comments____

LCR Southwestern Willow Flycatcher Project - Vegetation Datasheet

Study area:	Survey site:	Plot type:	ID#:
Date:	Obs:	UTM: E N	GPS Accuracy: m

Nest site only	Substr.:	**All plot centers**	Dist water: m	**Woody Ground Cover**		**Total Canopy**
Substr. DBH: cm	Substr. Ht.: m	Dist canopy gap: m	Dist. Broadleaf: m	N:	E:	N:
Nest Ht.: m or %- % X m		Top Can.: m or %- % X m		S:	W:	S:

Species		TASP	SAGO	SAEX	POFR	SNAG	OTSP1:______	OTSP2:______	OTSP3:______
Shrub/Sapling Count In 5m Plot < or = 8 cm dbh	<1								
	1-2.5								
	2.6-5.5								
	5.6-8								

Species		TASP	SAGO	SAEX	POFR	SNAG	OTSP1:______	OTSP2:______	OTSP3:______
Tree Count In 5m Plot > 8 cm dbh	8.1-10.5								
	10.5-15								
	Measured Trees >15 cm dbh								

Species	TASP	SAGO	SAEX	POFR	SNAG	OTSP1:______	OTSP2:______	OTSP3:______
Tree Count in 5m to 11.3m Plot >8 cm dbh								

NOTES

* If, at ankle height or above, shrub/sapling/tree splits into multiple branches, count it as one stem and measure the biggest stem. If splits below ankle height, count all stems

**** If shrub/sapling/tree is not at least breast height, do not count**

Vertical Foliage Sampling (i.e., "Hits on the pole") : Microplot Vegetation

CENTER PLOT							
	Hits/Species						
Height (m)	**Tasp**	**Sago**	**Saex**	**Pofr**	**Snag**	**Otsp 1***	**Otsp 2****
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							

Record number of decimeters with hits on pole (within 10 cm radius) per 1-m interval up to 8 m; above 8 m, estimate 0, < 5, or > 5 or hits per meter interval.

*** Other species 1 (write out full name) ____________________________________**
**** Other species 2 (write out full name) ____________________________________**

Vertical Foliage Sampling (i.e., “Hits on the pole”) Data Form : Microplot Vegetation

Study area: **Survey site:** **Plot type:** **ID#:**

Date: **Obs.:**

Vertical Foliage Volume

NORTH	Hits/Species							EAST	Hits/Species						
Height (m)	**Tasp**	**Sago**	**Saex**	**Pofr**	**Snag**	**Otsp 1***	**Otsp 2****	**Height (m)**	**Tasp**	**Sago**	**Saex**	**Pofr**	**Snag**	**Otsp 1****	**Otsp 2****
1								1							
2								2							
3								3							
4								4							
5								5							
6								6							
7								7							
8								8							
9								9							
10								10							
11								11							
12								12							
13								13							
14								14							
15								15							
16								16							
17								17							
18								18							
19								19							
20								20							
21								21							
22								22							
23								23							
24								24							
25								25							

SIDE 1

*** Other species 1 (write out full name) ___________________________________**

**** Other species 2 (write out full name) ___________________________________**

SIDE 2

SOUTH	Tasp	Sago	Saex	Pofr	Snag	Otsp 1*	Otsp 2**	WEST	Tasp	Sago	Saex	Pofr	Snag	Otsp 1*	Otsp 2**
1								1							
2								2							
3								3							
4								4							
5								5							
6								6							
7								7							
8								8							
9								9							
10								10							
11								11							
12								12							
13								13							
14								14							
15								15							
16								16							
17								17							
18								18							
19								19							
20								20							
21								21							
22								22							
23								23							
24								24							
25								25							

Record hits on pole (within 10 cm radius) per 0.1 m intervals up to 8 m; above 8 m, estimate 0, < 5, or > 5 hits per interval.

*** Other species 1 (write out full name) ____**
**** Other species 2 (write out full name) ____**

If an NS site, is there a corresponding NU? Y or N

SWFL Microclimate at Life History Study Areas

Study Area ________ **Survey Site** ______________________ **LOCATION ID** _________–________–______
(Study area) – (Location) – (Number)

UTM coordinates: Easting (x) 0__ __ __ __ __ __ **Northing (y)** __ __ __ __ __ __ __ **Accuracy** ________ m

Dominant habitat within 10 m: Cottonwood/Willow Tamarisk Mixed Native/Exotic Other (specify:)

Estimated canopy cover at the logger: Less than 25% 25%-75% More than 75%

Temperature/Relative Humidity (T/RH)

Set-up: Date (MM/DD/YY):_____________ Time (military):___________ Crew member(s)__________________

Logger 6-digit serial number (e.g., #630863):_____________ Was red LED checked at set-up? Y or N

If nest site, when was nest vacated (known or estimated; MM/DD/YY)? ________________

Logger location: Tree Shrub Est. overall height of tree or shrub? _______ m Est. height of logger _______ m

Take-down: Date (MM/DD/YY):_____________ Time (military):_________ Crew member(s):_________________

Logger 6-digit serial number (e.g., #630863):_____________

Did any events occur that might have interfered with accuracy of data gathered by this logger (e.g., array blown out of tree, etc.)? No Yes If yes, explain:

Soil Moisture (SM)

Set-up: Date (MM/DD/YY):______________ Time (military):____________ Crew member(s)___________________

6-digit sensor serial number: _______________ logger number: ________________

Soil sample taken (at set-up only)? Yes No If no, explain:

SM readings: Plot center ______% ______mV

N: 1.0 m ______% ______mV	2.0 m ______% ______mV	**S:** 1.0 m ______% ______mV	2.0 m ______% ______mV
E: 1.0 m ______% ______mV	2.0 m ______% ______mV	**W:** 1.0 m _____% ______mV	2.0 m ______% ______mV

Distance to saturated/inundated soil: ___________ m

Take-down: Date (MM/DD/YY):______________ Time (military):_________ Crew member(s):_________________

6-digit sensor serial number: _______________ logger number: ________________

SM readings: Plot center ______% ______mV

N: 1.0 m ______% ______mV	2.0 m ______% ______mV	**S:** 1.0 m ______% ______mV	2.0 m ______% ______mV
E: 1.0 m ______% ______mV	2.0 m ______% ______mV	**W:** 1.0 m _____% ______mV	2.0 m ______% ______mV

Distance to saturated/inundated soil: ___________ m

Location identifier format: Study area code (MW, MM, PA, TM) – Location code (NS, WT, SU, SVR, SVD) – Nest number (for NS, WT, SU locations) or Seasonal Variation number; e.g., TM-SU-9A or MM-SVD-2

SWFL Microclimate at Life History Study Areas

Seasonal Variation Supplement

Study Area ________ **Survey Site** ____________________ **LOCATION ID** _________–_________–_______
(Study area) – (Location) – (Number)

Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Microclimate at Sites South of Topock – T/RH

Study Area ________ **Survey Site** ______________________ **LOCATION ID** _________–________–______
(Study area) – (Survey site) – (Number)

UTM coordinates: Easting (x) 0__ __ __ __ __ __ **Northing (y)** __ __ __ __ __ __ __ **Accuracy** ________ m

Dominant habitat within 10 m: Cottonwood/Willow Tamarisk Mixed Native/Exotic Other (specify:)

Estimated canopy cover at the logger: Less than 25% 25%-75% More than 75%

Temperature/Relative Humidity (T/RH)

Set-up: Date (MM/DD/YY):______________ Time (military):___________ Crew member(s)__________________

Logger 6-digit serial number (e.g., #630863):______________ Was red LED checked at set-up? Y or N

Logger location: Tree Shrub Est. overall height of tree or shrub? _______ m Est. height of logger _______ m

Download: Date (MM/DD/YY):______________ Time (military):_________ Crew member(s):__________________

Logger 6-digit serial number (e.g., #630863):______________ Did you check red LED? Y or N

Did any events occur that might have interfered with accuracy of data gathered by this logger (e.g., blown out of tree, etc.)?
No Yes If yes, explain:

Download: Date (MM/DD/YY):______________ Time (military):_________ Crew member(s):__________________

Logger 6-digit serial number (e.g., #630863):______________ Did you check red LED? Y or N

Did any events occur that might have interfered with accuracy of data gathered by this logger (e.g., blown out of tree, etc.)?
No Yes If yes, explain:

Download: Date (MM/DD/YY):______________ Time (military):_________ Crew member(s):__________________

Logger 6-digit serial number (e.g., #630863):______________ Did you check red LED? Y or N

Did any events occur that might have interfered with accuracy of data gathered by this logger (e.g., blown out of tree, etc.)?
No Yes If yes, explain:

Download: Date (MM/DD/YY):______________ Time (military):_________ Crew member(s):__________________

Logger 6-digit serial number (e.g., #630863):______________ Did you check red LED? Y or N

Did any events occur that might have interfered with accuracy of data gathered by this logger (e.g., blown out of tree, etc.)?
No Yes If yes, explain:

Location ID codes: Study area codes – Topock Gorge = TG, Ehrenberg = EH, Cibola = CI, Imperial = IM, Mittry = MI, Yuma = YU.
Survey site codes – Blankenship = BK, Havasu NE = HV, Three Fingers Lake = TF, Cibola Lake = CL, Walker Lake = WL, Paradise = PV, Hoge Ranch = HR, Rattlesnake = RS, Clear Lake = LK, Ferguson Lake = FL, Ferguson Wash = FW, Great Blue Heron = GB, Martinez Lake = ML, Mittry West = MW, Gila Confluence North = GC

Microclimate at Sites South of Topock – T/RH, continued

Study Area ________ **Survey Site** ______________________ **LOCATION ID** _________–________–______
(Study area) – (Survey site) – (Number)

Download: Date (MM/DD/YY):______________ Time (military):_________ Crew member(s):__________________

Logger 6-digit serial number (e.g., #630863):______________ Did you check red LED? Y or N

Did any events occur that might have interfered with accuracy of data gathered by this logger (e.g., blown out of tree, etc.)?
No Yes If yes, explain:

Download: Date (MM/DD/YY):______________ Time (military):_________ Crew member(s):__________________

Logger 6-digit serial number (e.g., #630863):______________ Did you check red LED? Y or N

Did any events occur that might have interfered with accuracy of data gathered by this logger (e.g., blown out of tree, etc.)?
No Yes If yes, explain:

Download: Date (MM/DD/YY):______________ Time (military):_________ Crew member(s):__________________

Logger 6-digit serial number (e.g., #630863):______________ Did you check red LED? Y or N

Did any events occur that might have interfered with accuracy of data gathered by this logger (e.g., blown out of tree, etc.)?
No Yes If yes, explain:

Download: Date (MM/DD/YY):______________ Time (military):_________ Crew member(s):__________________

Logger 6-digit serial number (e.g., #630863):______________ Did you check red LED? Y or N

Did any events occur that might have interfered with accuracy of data gathered by this logger (e.g., blown out of tree, etc.)?
No Yes If yes, explain:

Takedown: Date (MM/DD/YY):______________ Time (military):_________ Crew member(s):__________________

Logger 6-digit serial number (e.g., #630863):______________ Did you check red LED? Y or N

Did any events occur that might have interfered with accuracy of data gathered by this logger (e.g., blown out of tree, etc.)?
No Yes If yes, explain:

Microclimate at Sites South of Topock – Soil Moisture 2005

Study Area ________ **Survey Site** ______________________ **LOCATION ID** _________–________–______
(Study area) – (Survey site) – (Number)

Soil Moisture (SM)

Set-up: Date (MM/DD/YY):_____________ Time (military):___________ Crew member(s)_________________
6-digit sensor serial number: ______________ logger number: _______________
Soil sample taken (at set-up only)? Yes No If no, explain:

SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):_____________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: ______________ logger number: _______________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):_____________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: ______________ logger number: _______________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):_____________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: ______________ logger number: _______________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):_____________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: ______________ logger number: _______________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):_____________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: ______________ logger number: _______________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Microclimate at Sites South of Topock – Soil Moisture 2005

Supplement

Study Area _______ **Survey Site** ____________________ **LOCATION ID** ________–________–______
(Study area) – (Survey site) – (Number)

Additional SM readings

Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

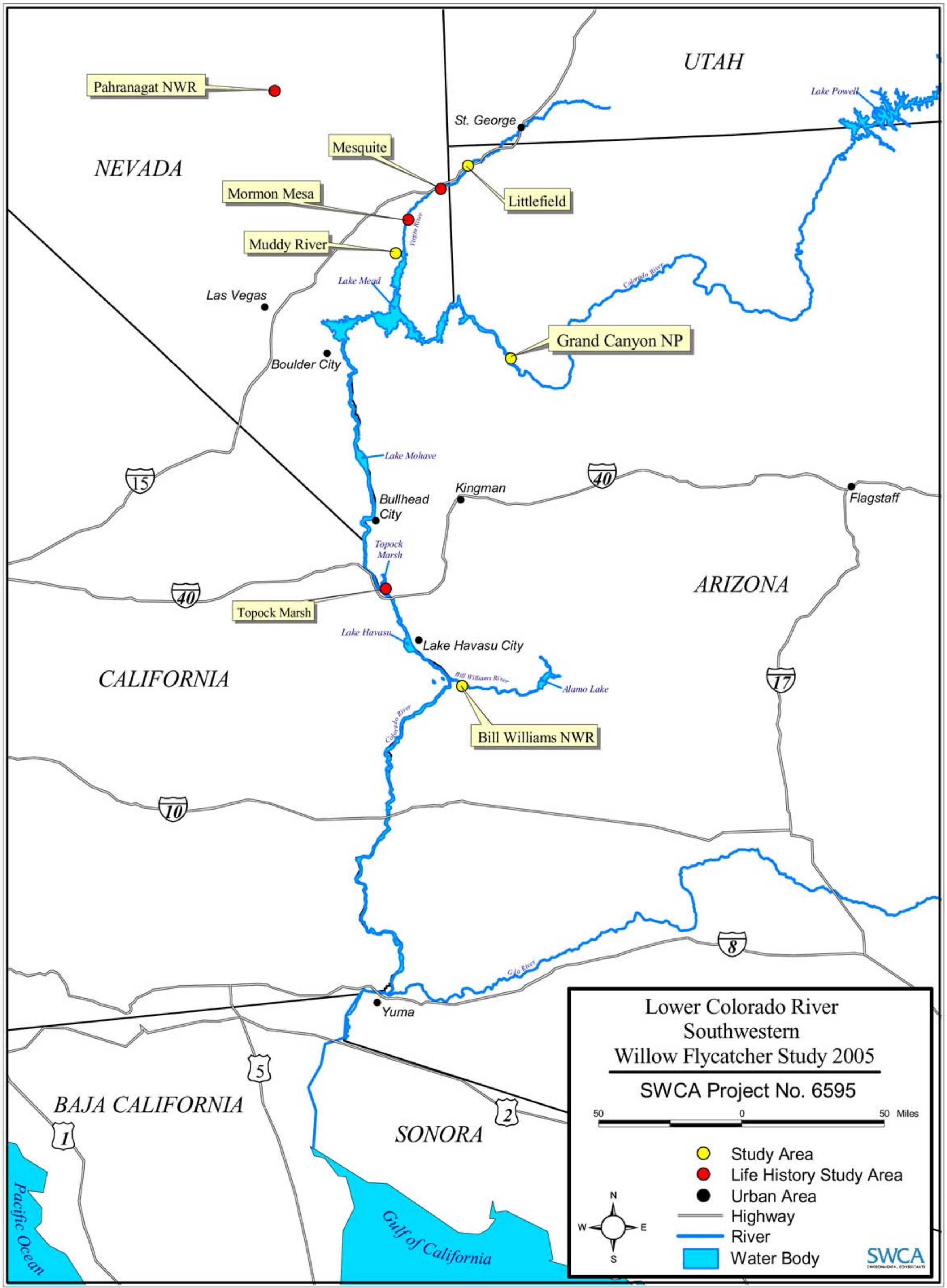
Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

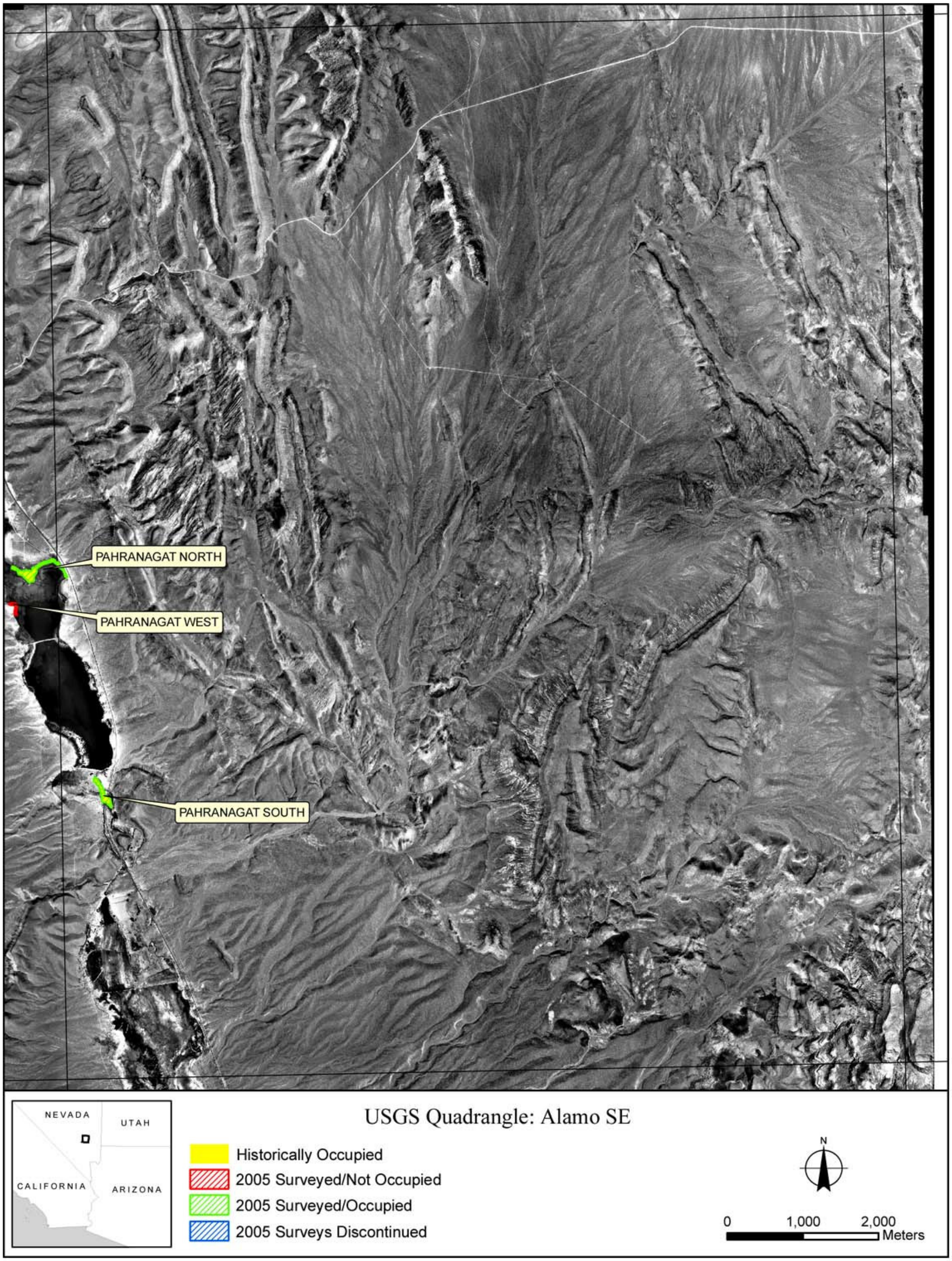
Date (MM/DD/YY):______________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: _______________ logger number: ________________
SM readings: Plot center _______% _______mV
N: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **S:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
E: 1.0 m ______% ______mV | 2.0 m ______% ______mV | **W:** 1.0 m _____% ______mV | 2.0 m ______% ______mV
Distance to saturated/inundated soil: ___________ m

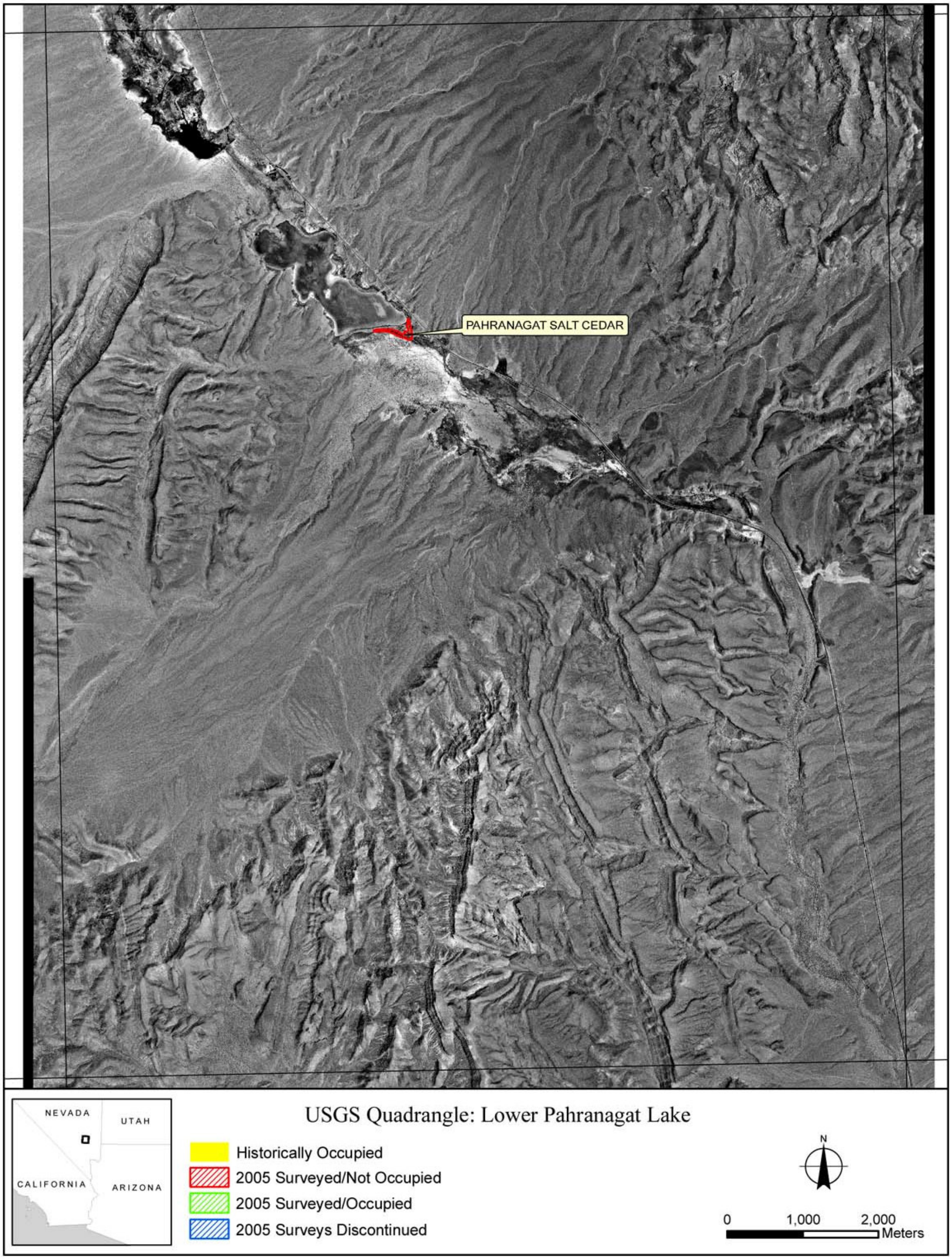
APPENDIX B

Orthophotos Showing Study Sites

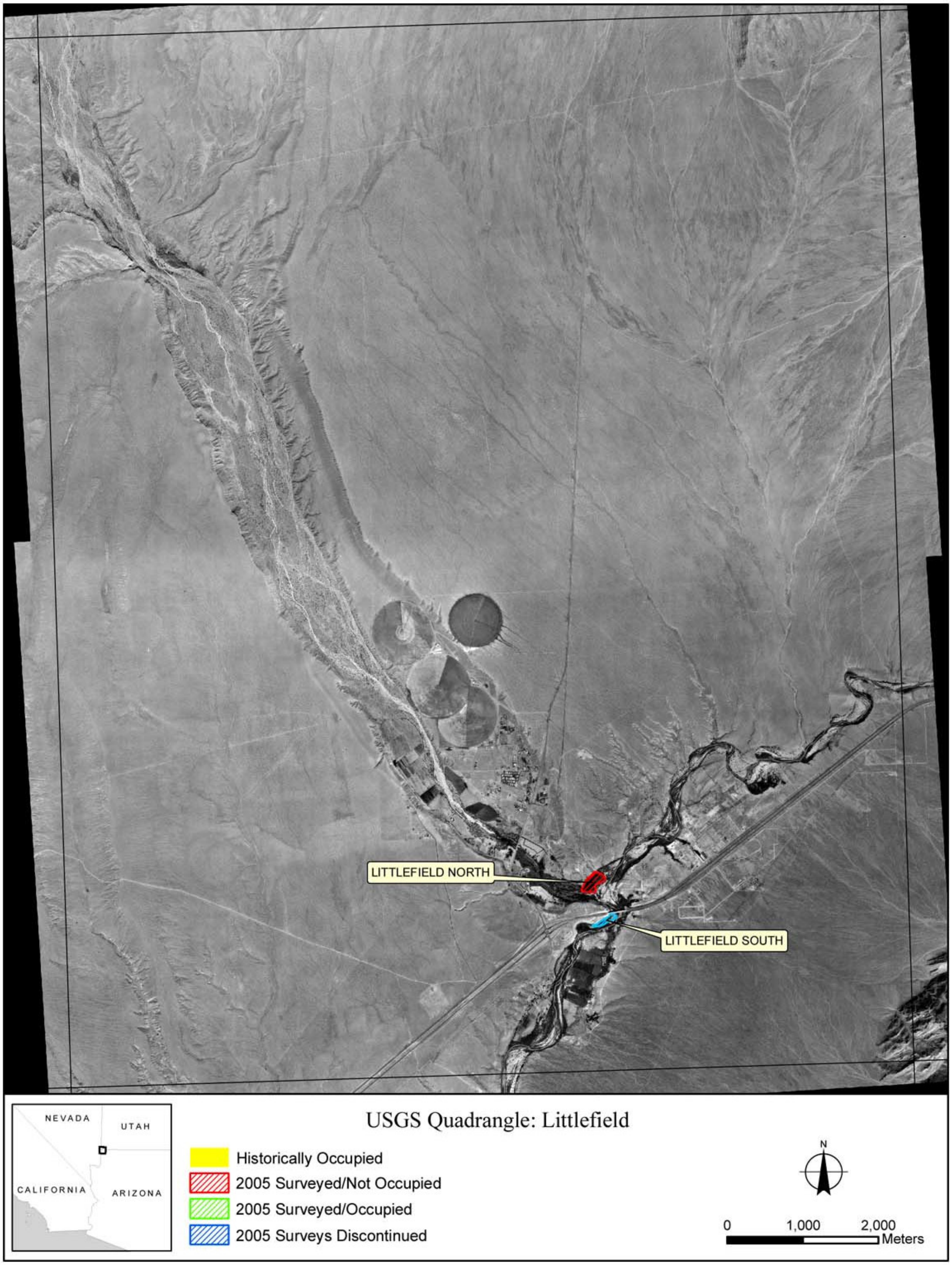


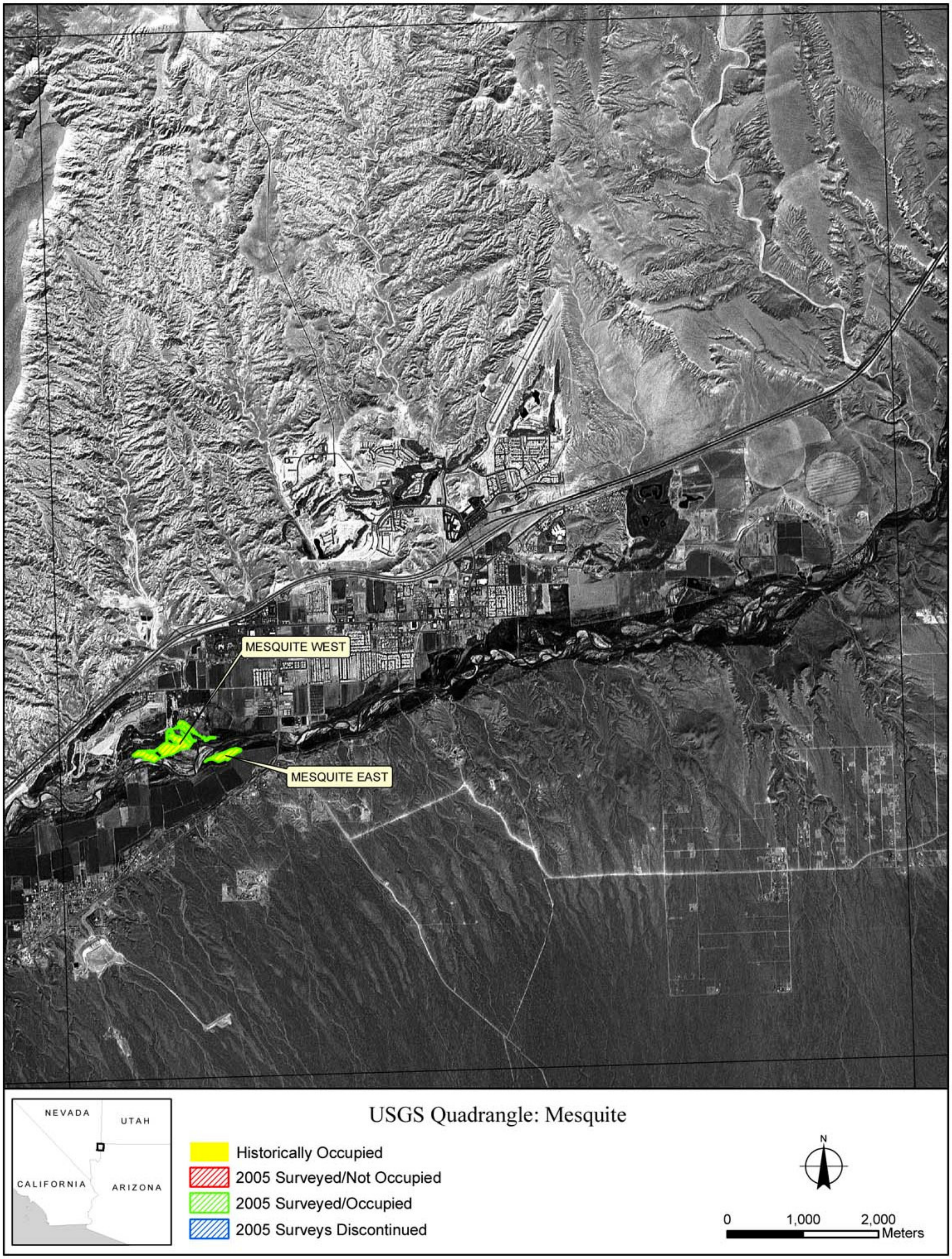
J:\6595 lcr swfl\GIS\PROJECTS\ai swfl oad.aor


PAHRANAGAT NORTH
PAHRANAGAT WEST
PAHRANAGAT SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Alamo SE
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

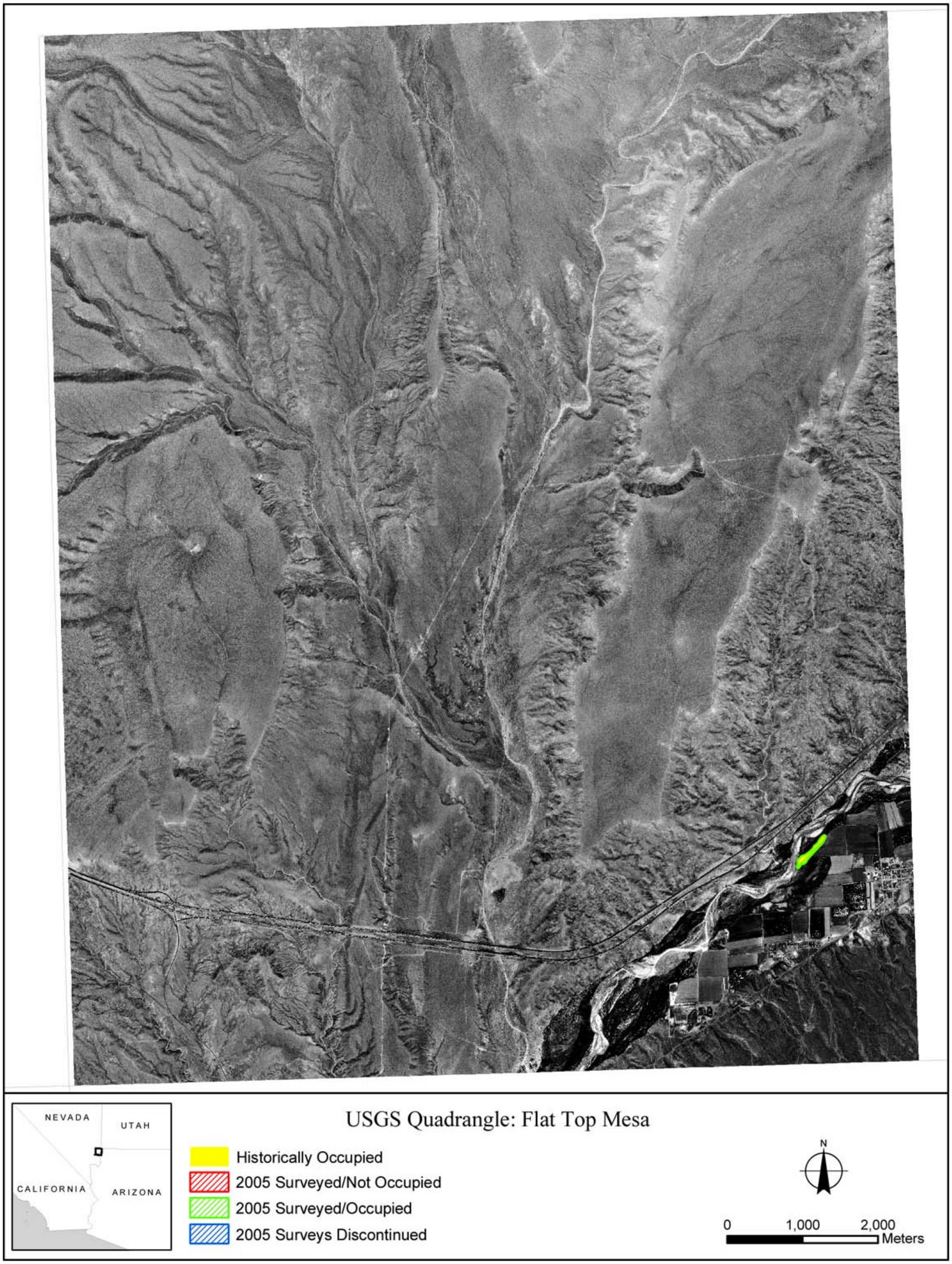


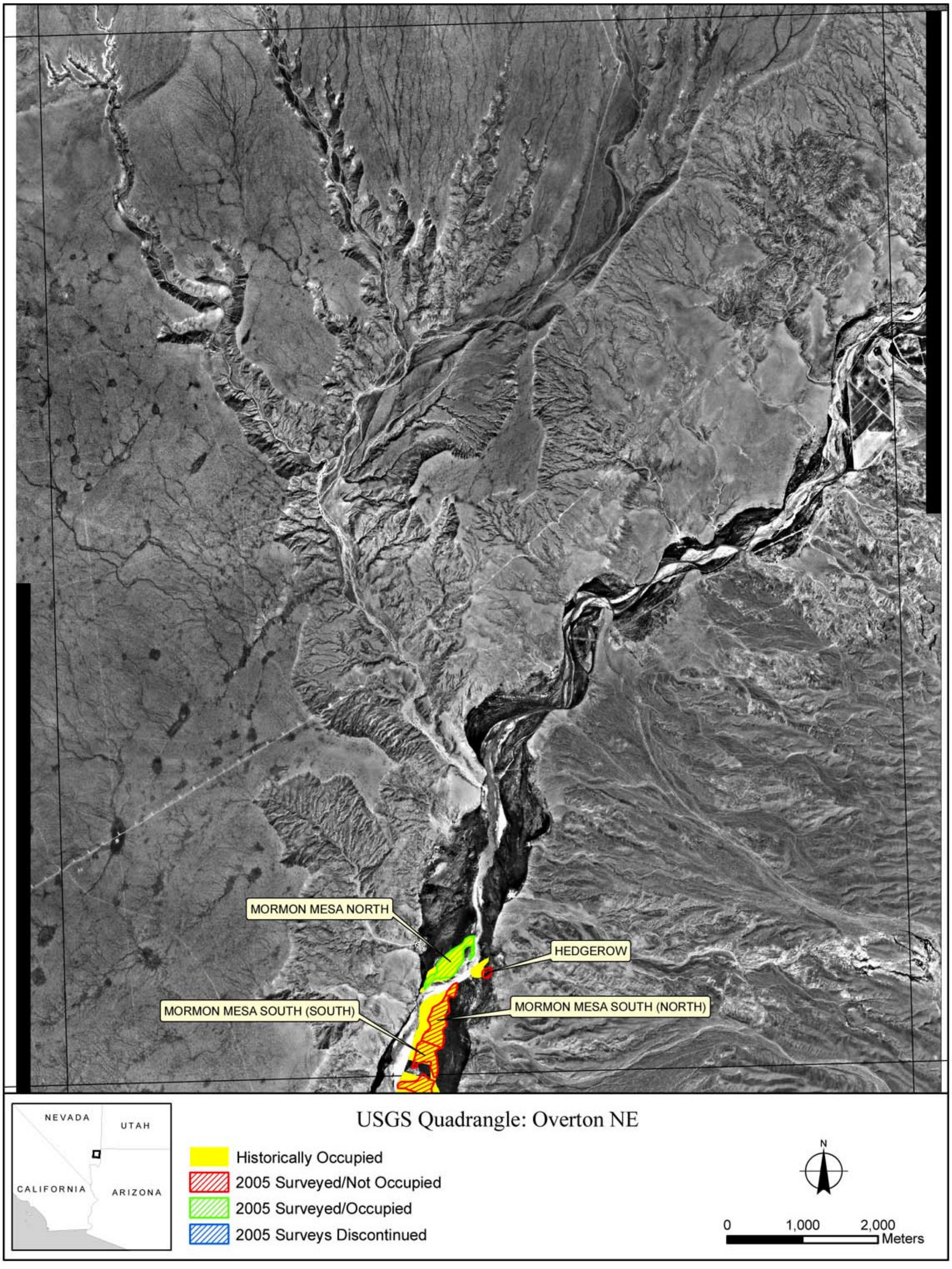
USGS Quadrangle: Lower Pahranagat Lake

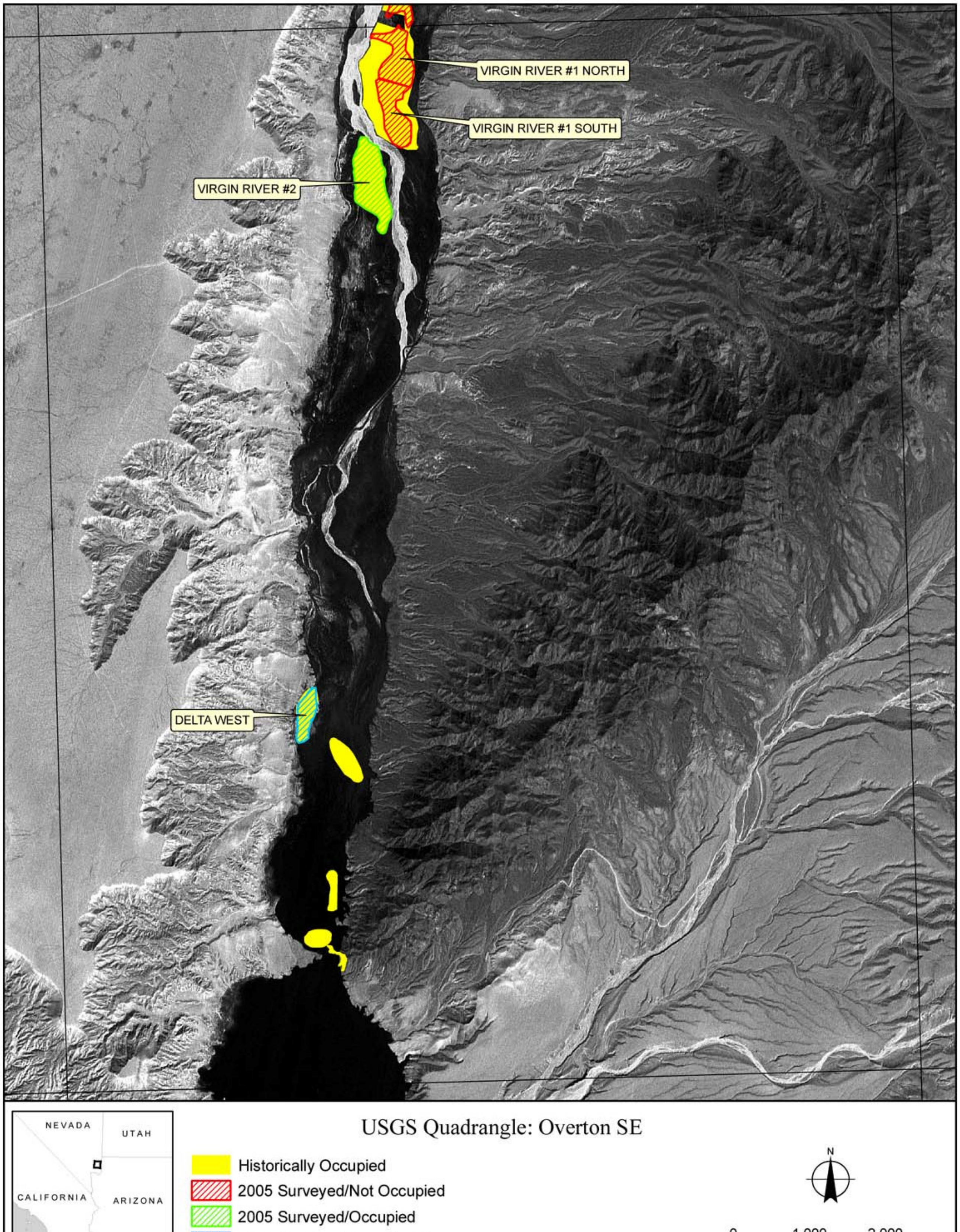

LITTLEFIELD NORTH
LITTLEFIELD SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Littlefield
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters



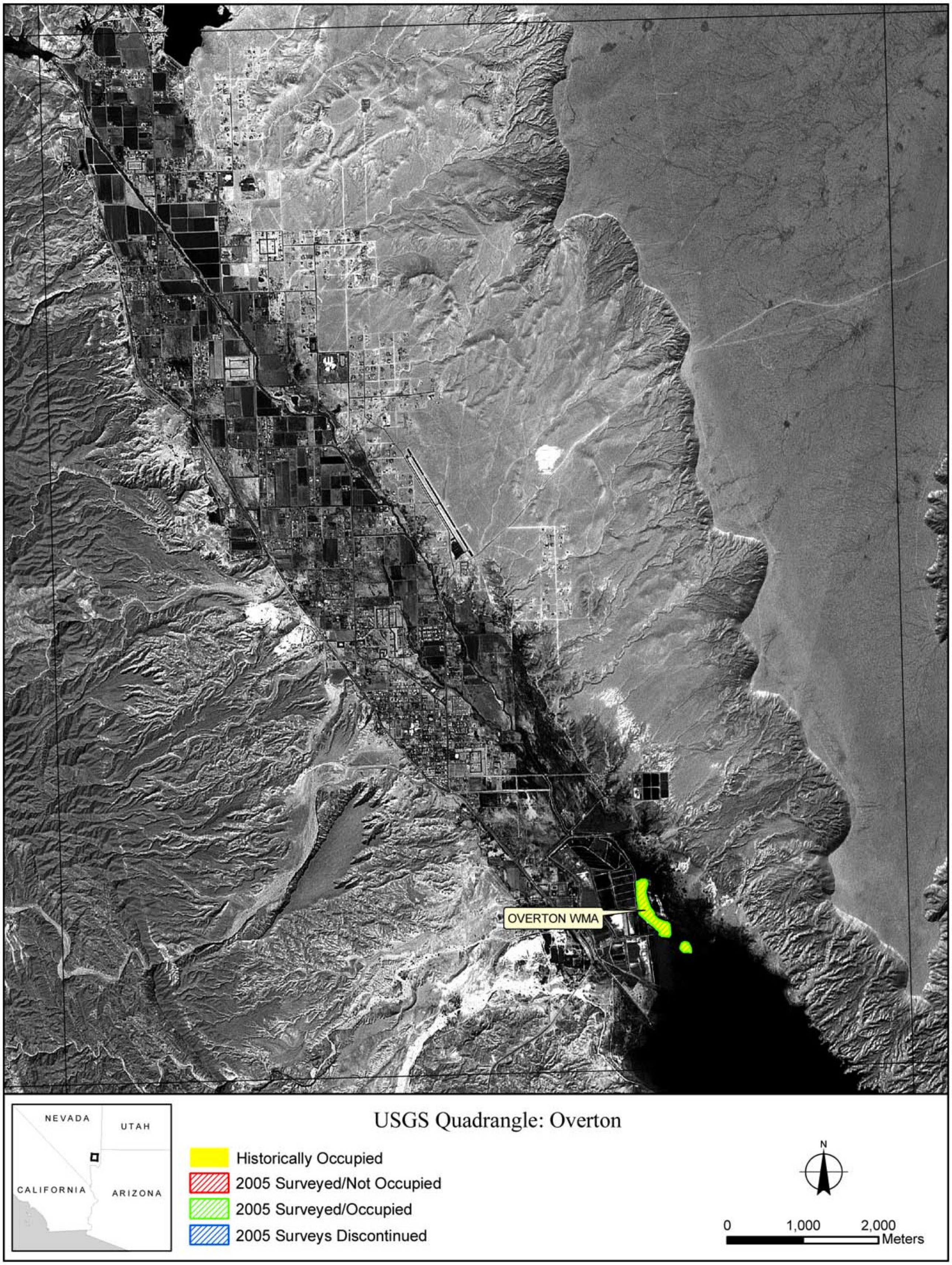
MESQUITE WEST
MESQUITE EAST
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Mesquite
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters


NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Flat Top Mesa
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

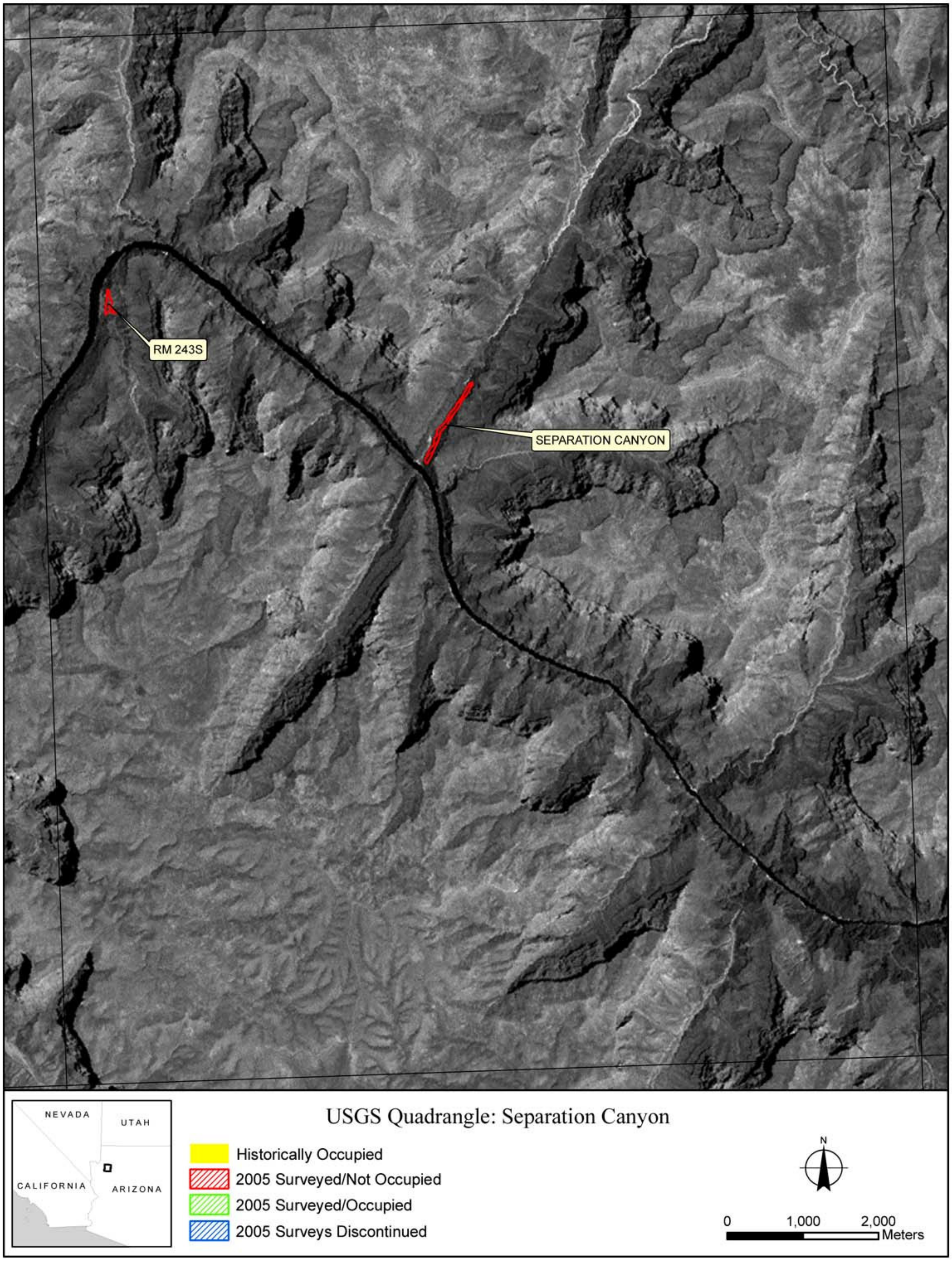

MORMON MESA NORTH
HEDGEROW
MORMON MESA SOUTH (SOUTH)
MORMON MESA SOUTH (NORTH)
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton NE
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

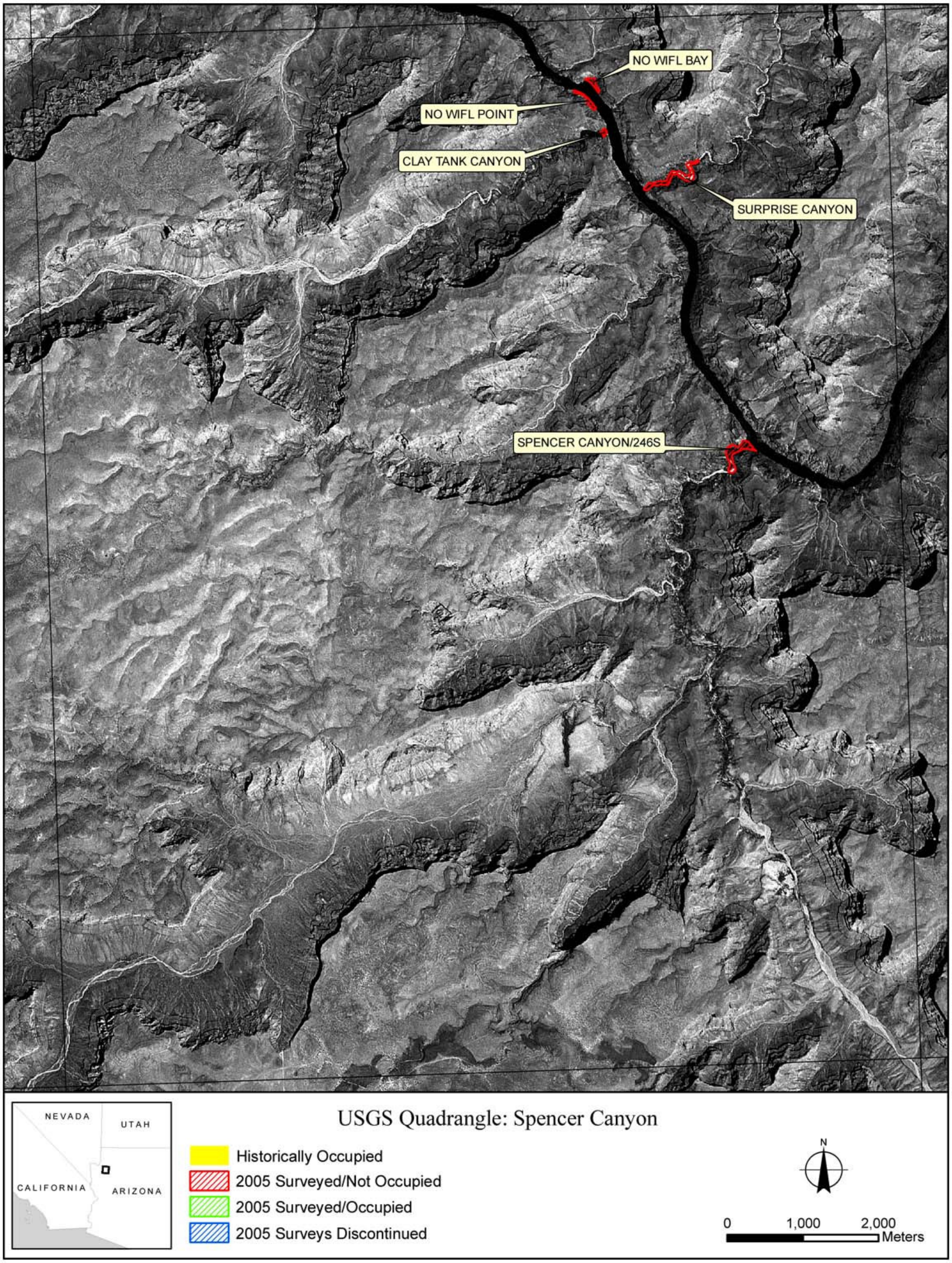


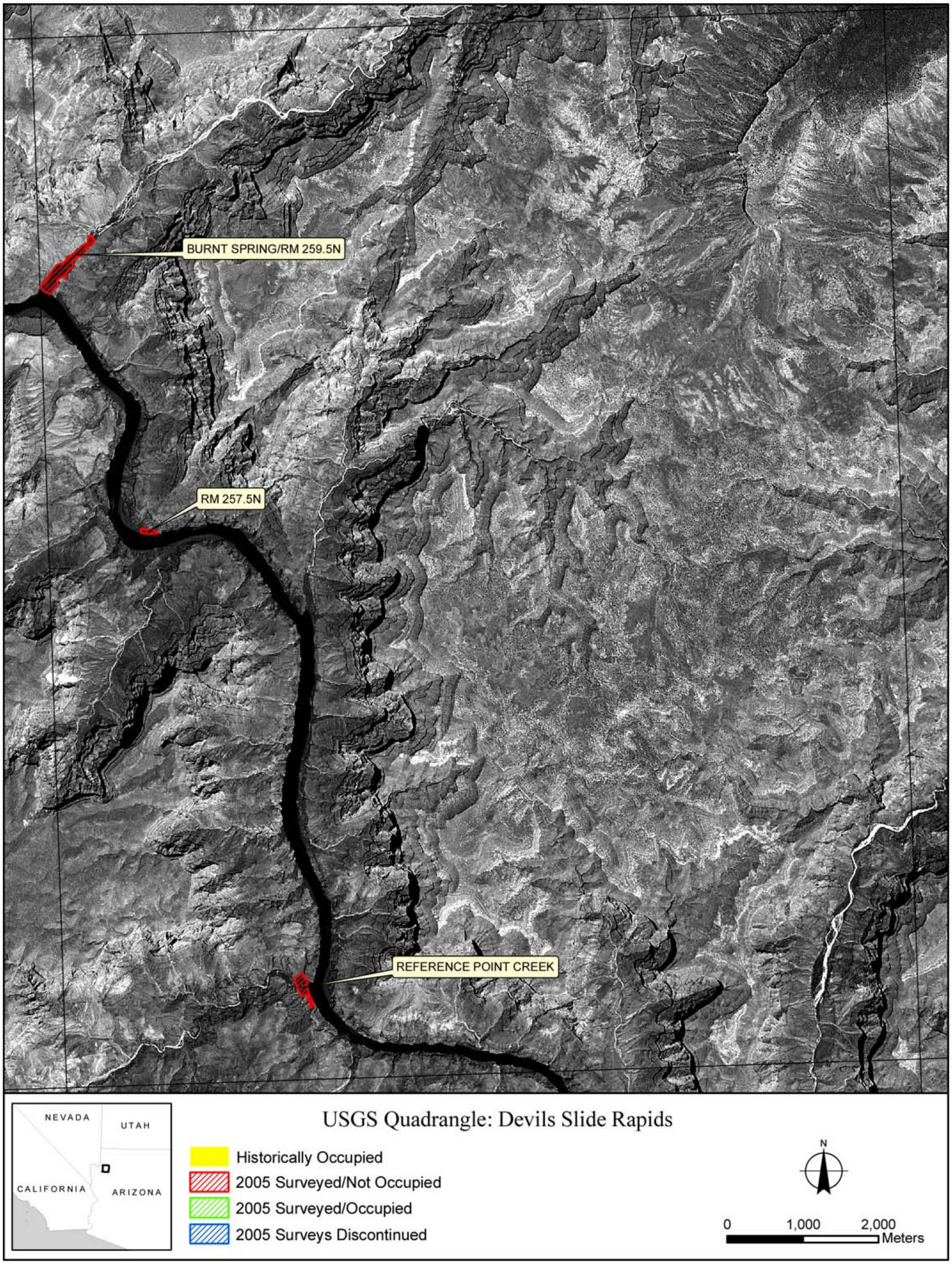
USGS Quadrangle: Overton SE

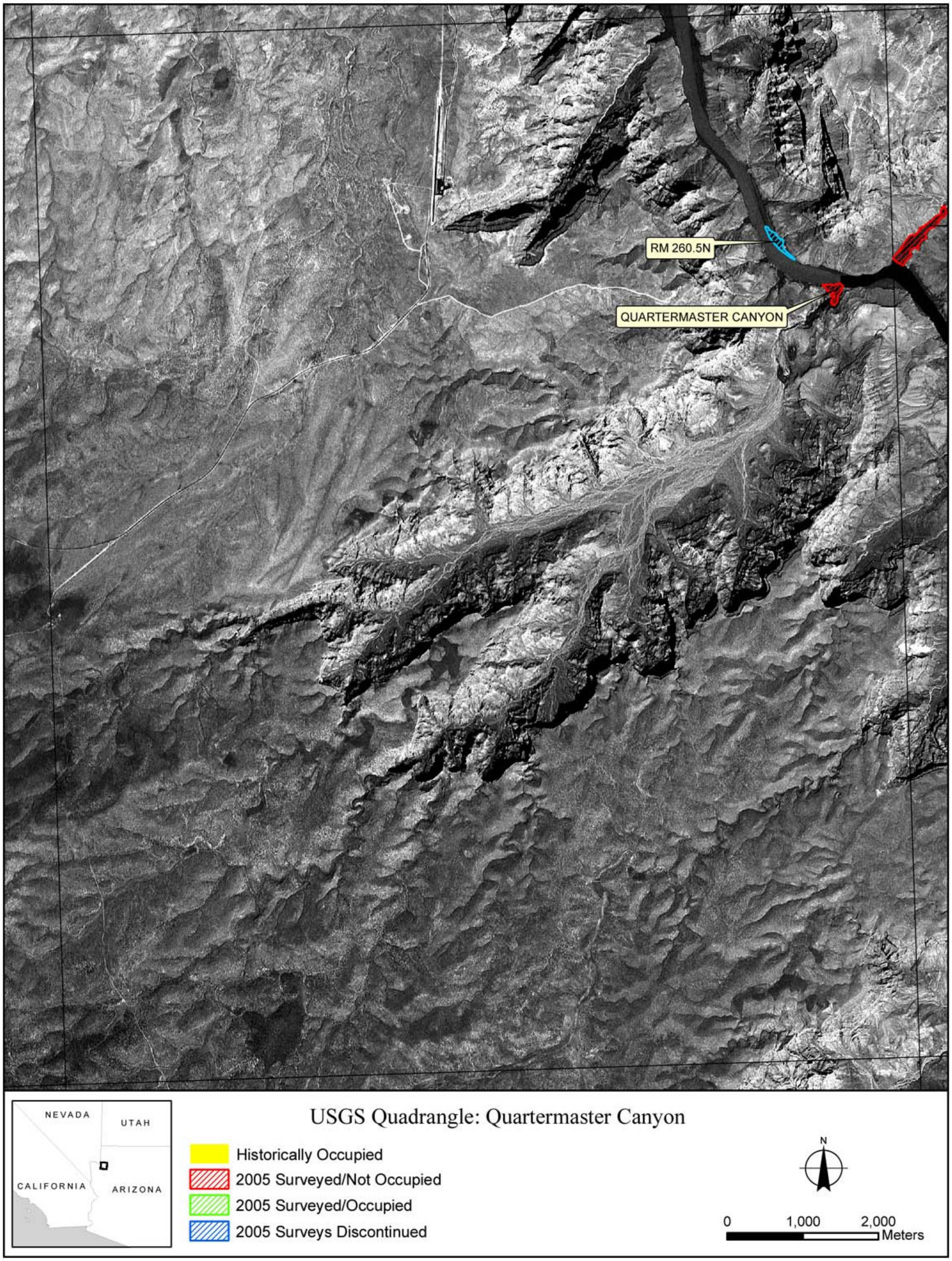


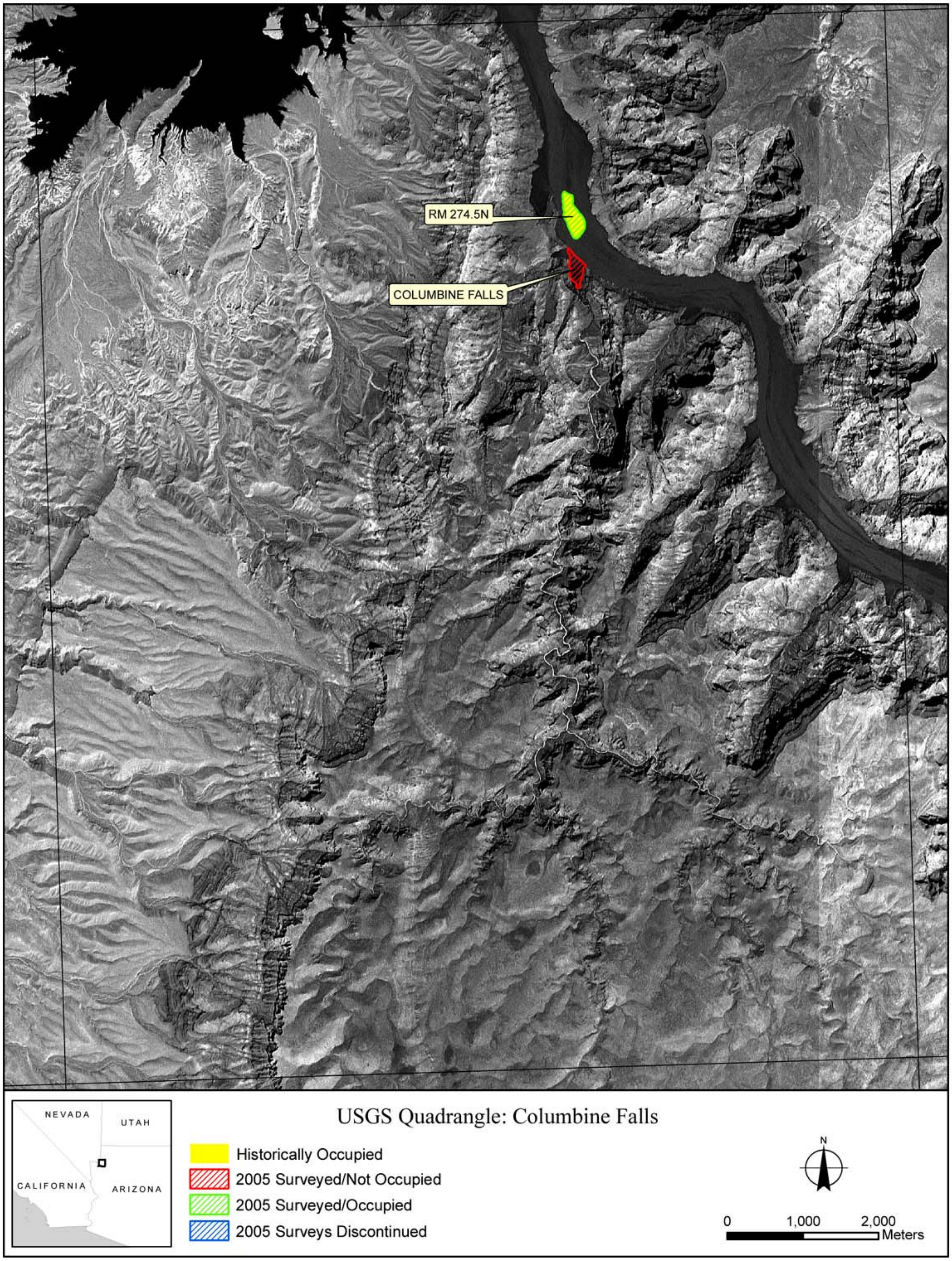
USGS Quadrangle: Overton

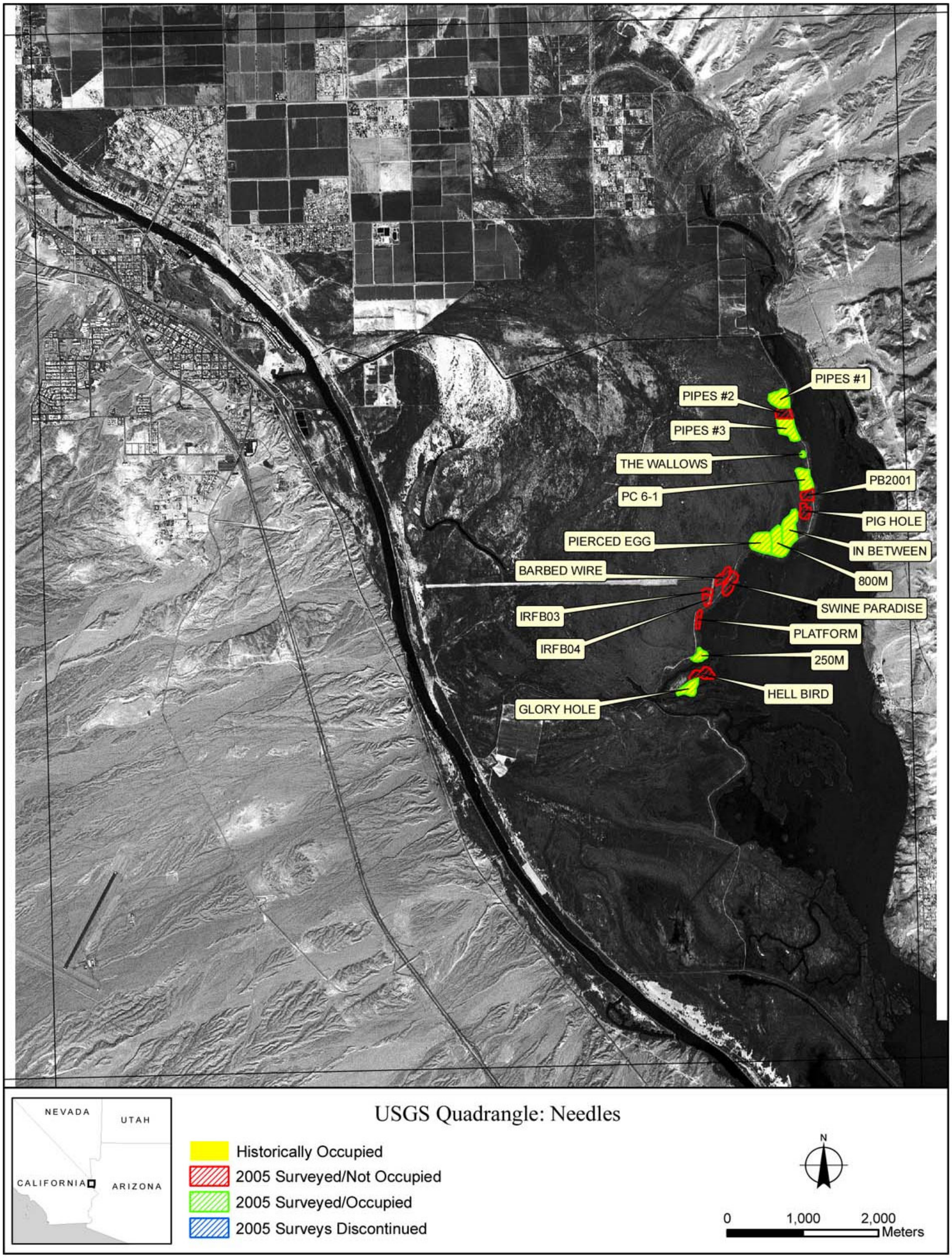

RM 243S
SEPARATION CANYON
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Separation Canyon
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

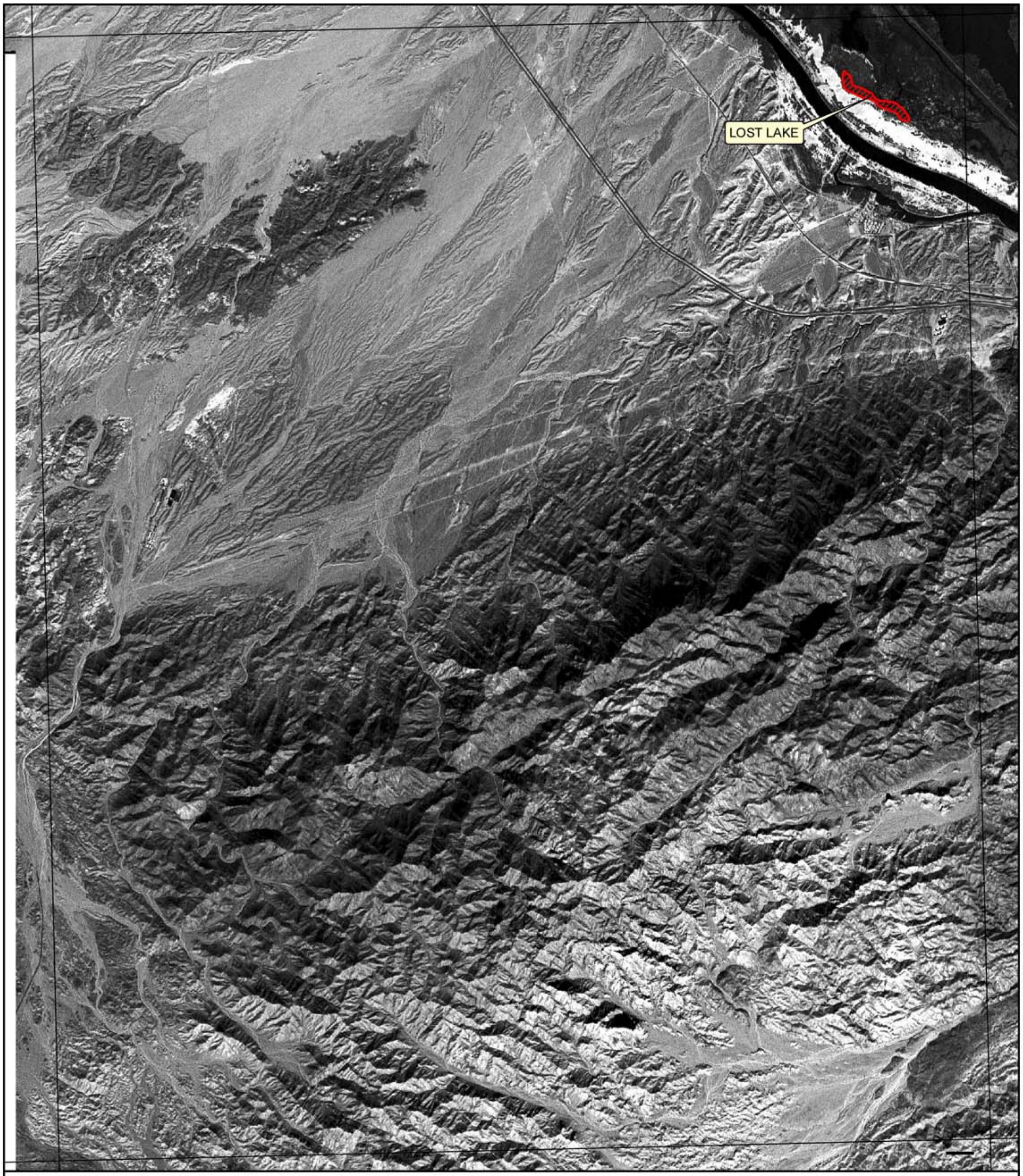

NO WIFL BAY
NO WIFL POINT
CLAY TANK CANYON
SURPRISE CANYON
SPENCER CANYON/246S
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Spencer Canyon
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters


BURNT SPRING/RM 259.5N
RM 257.5N
REFERENCE POINT CREEK
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Devils Slide Rapids
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters


RM 260.5N
QUARTERMASTER CANYON
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Quartermaster Canyon
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters


RM 274.5N
COLUMBINE FALLS
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Columbine Falls
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters


PIPES #1
PIPES #2
PIPES #3
THE WALLOWS
PB2001
PC 6-1
PIG HOLE
PIERCED EGG
IN BETWEEN
BARBED WIRE
800M
SWINE PARADISE
IRFB03
PLATFORM
IRFB04
250M
HELL BIRD
GLORY HOLE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Needles
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

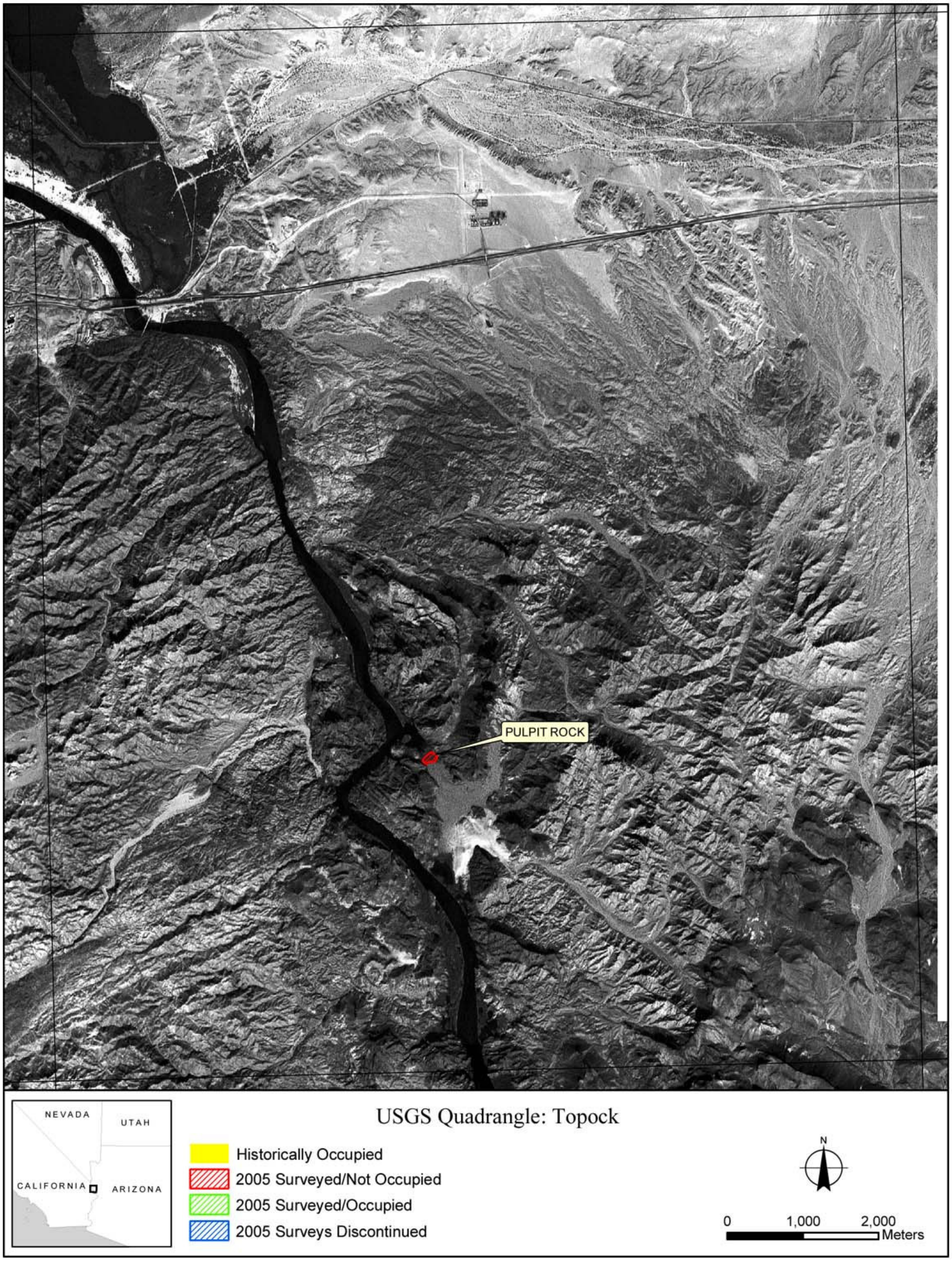


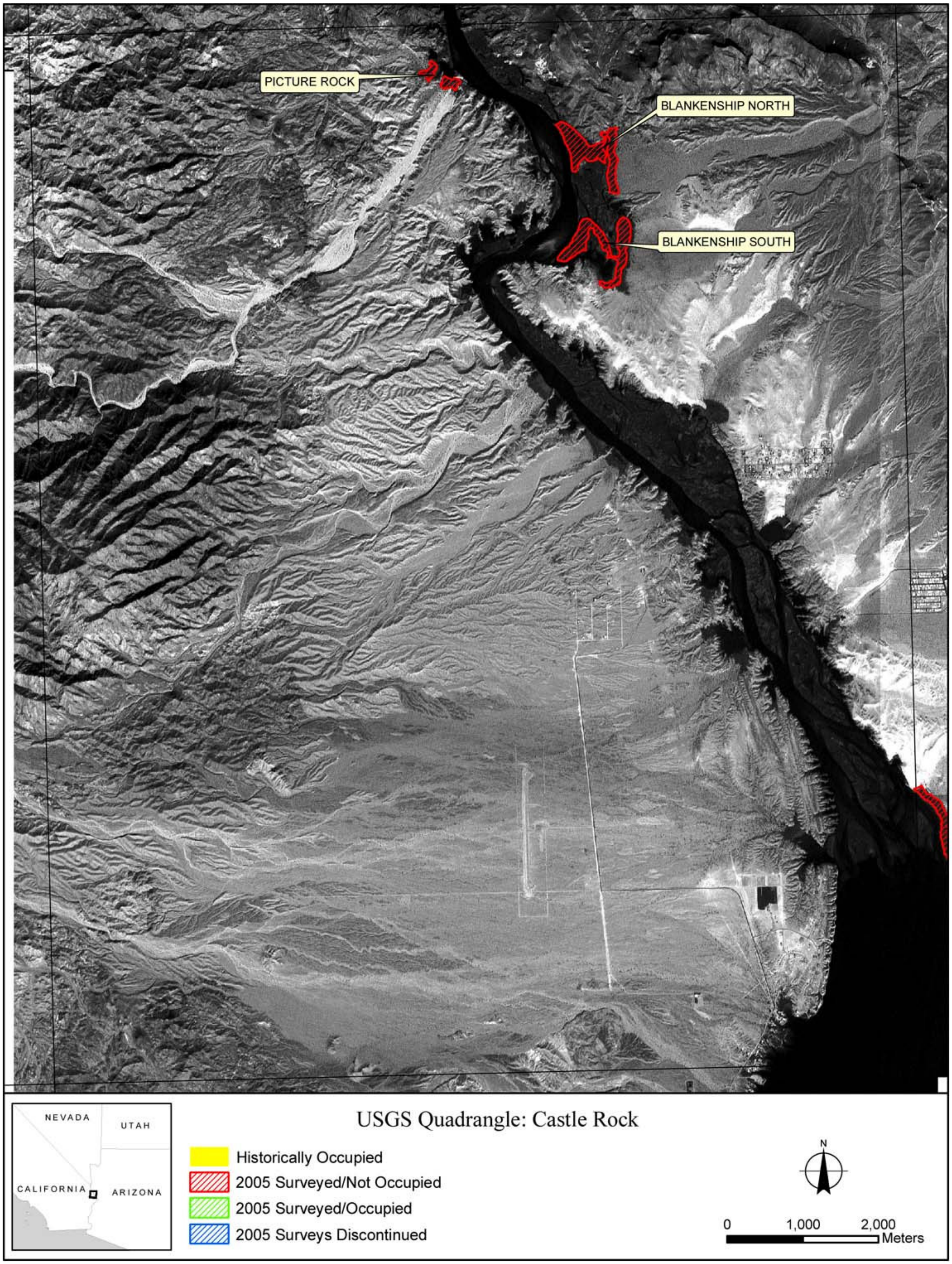
USGS Quadrangle: Whale Mountain

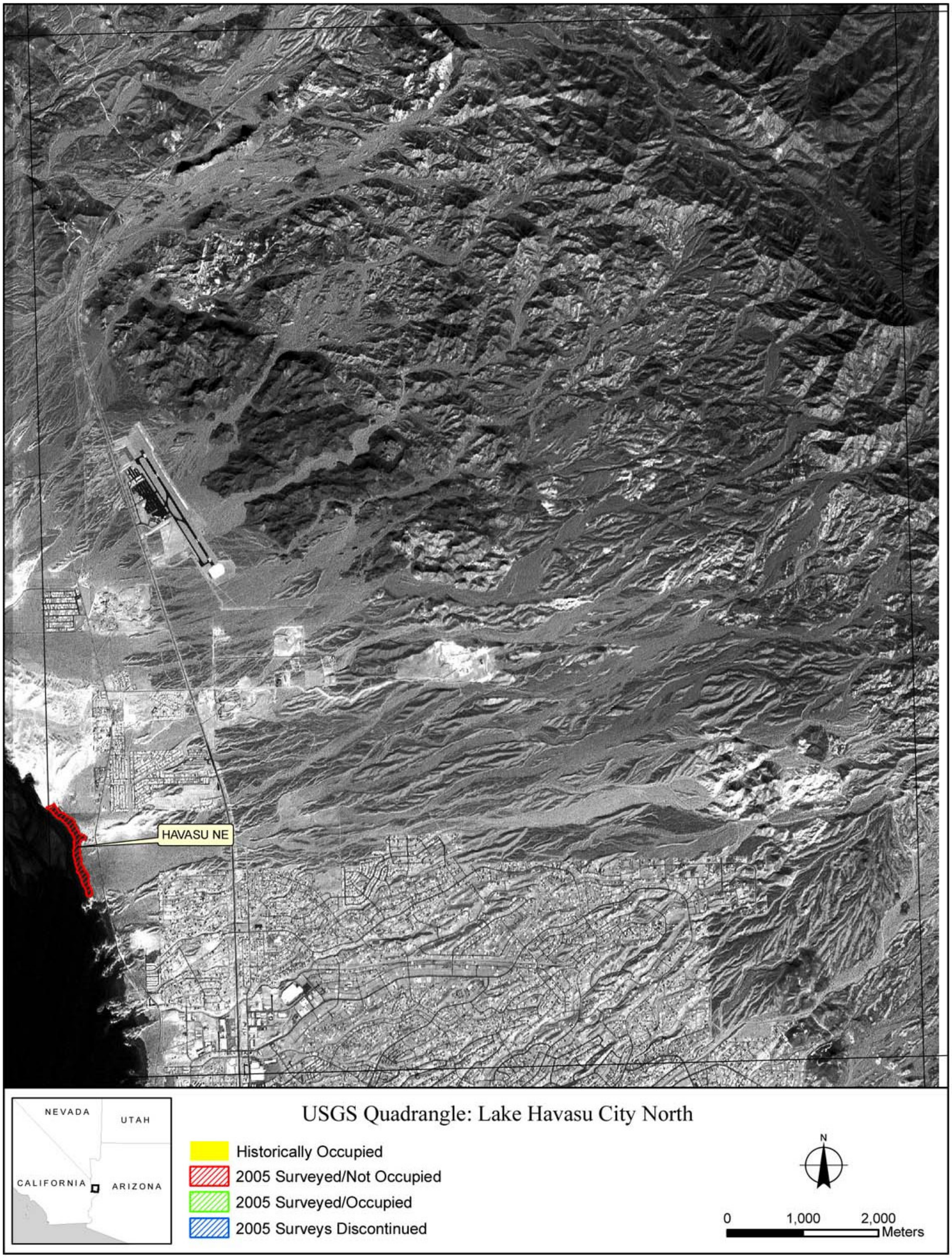
- Historically Occupied
- 2005 Surveyed/Not Occupied
- 2005 Surveyed/Occupied
- 2005 Surveys Discontinued

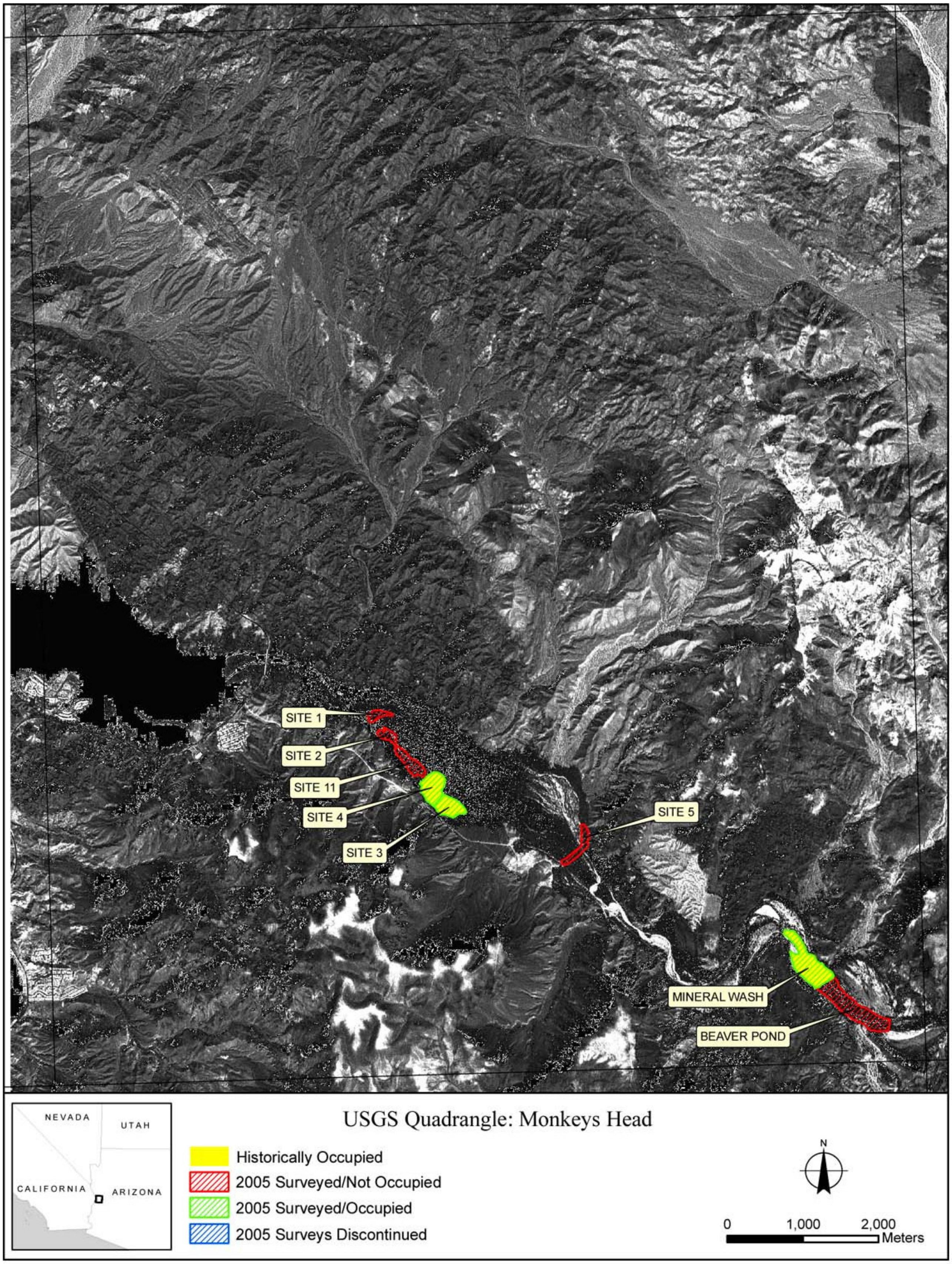
N

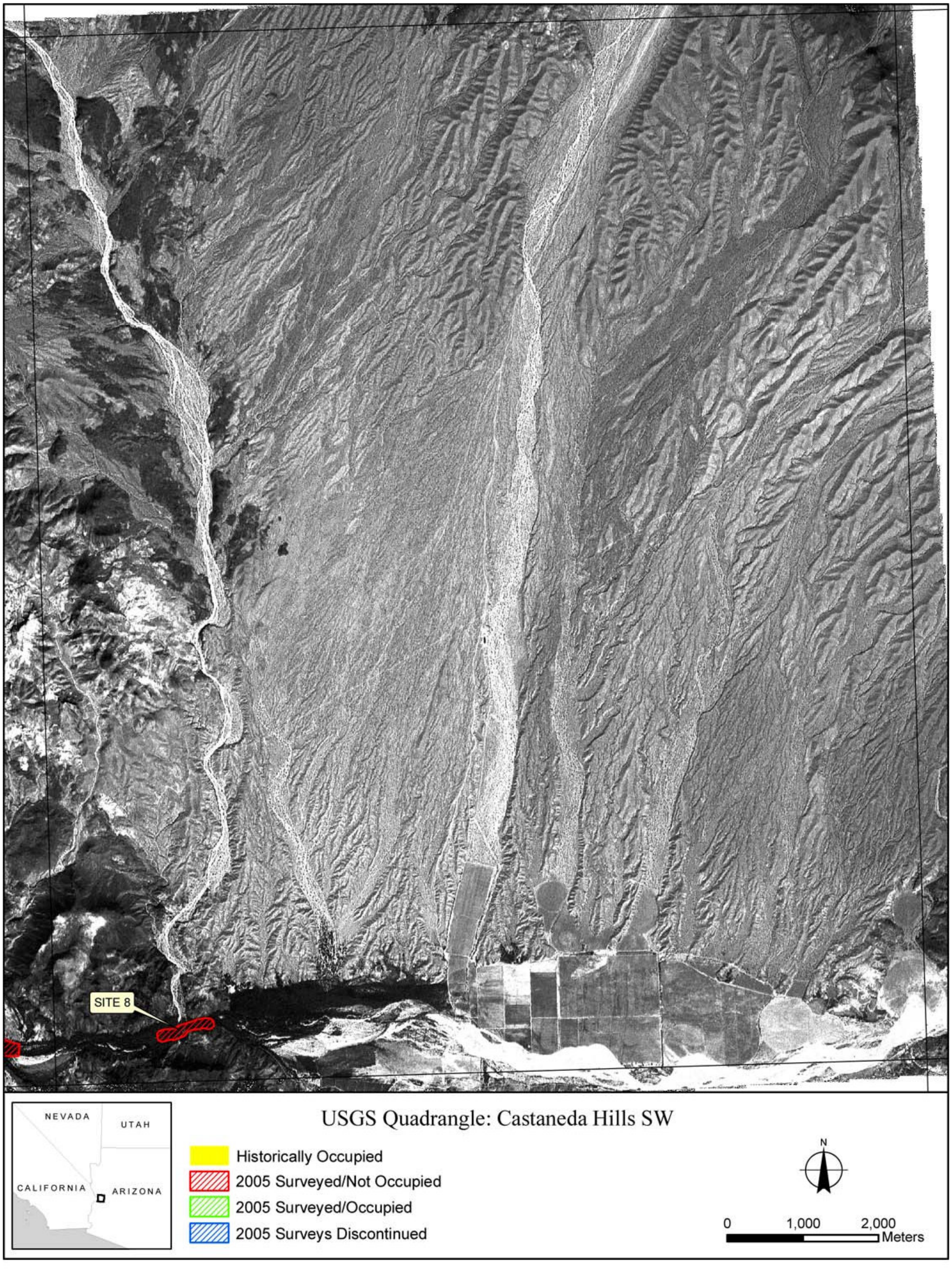
0 1,000 2,000 Meters


PULPIT ROCK
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Topock
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

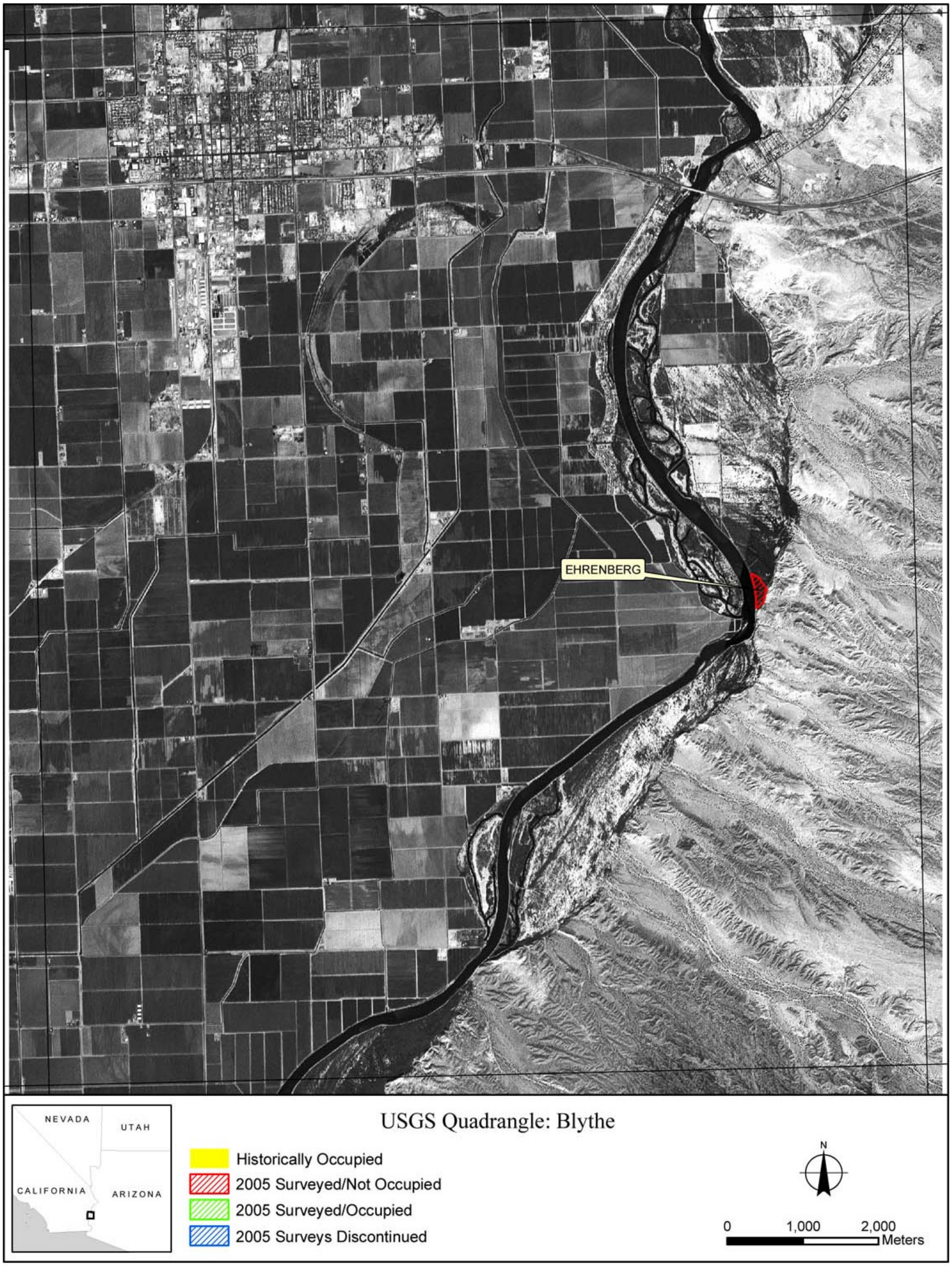

PICTURE ROCK
BLANKENSHIP NORTH
BLANKENSHIP SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castle Rock
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

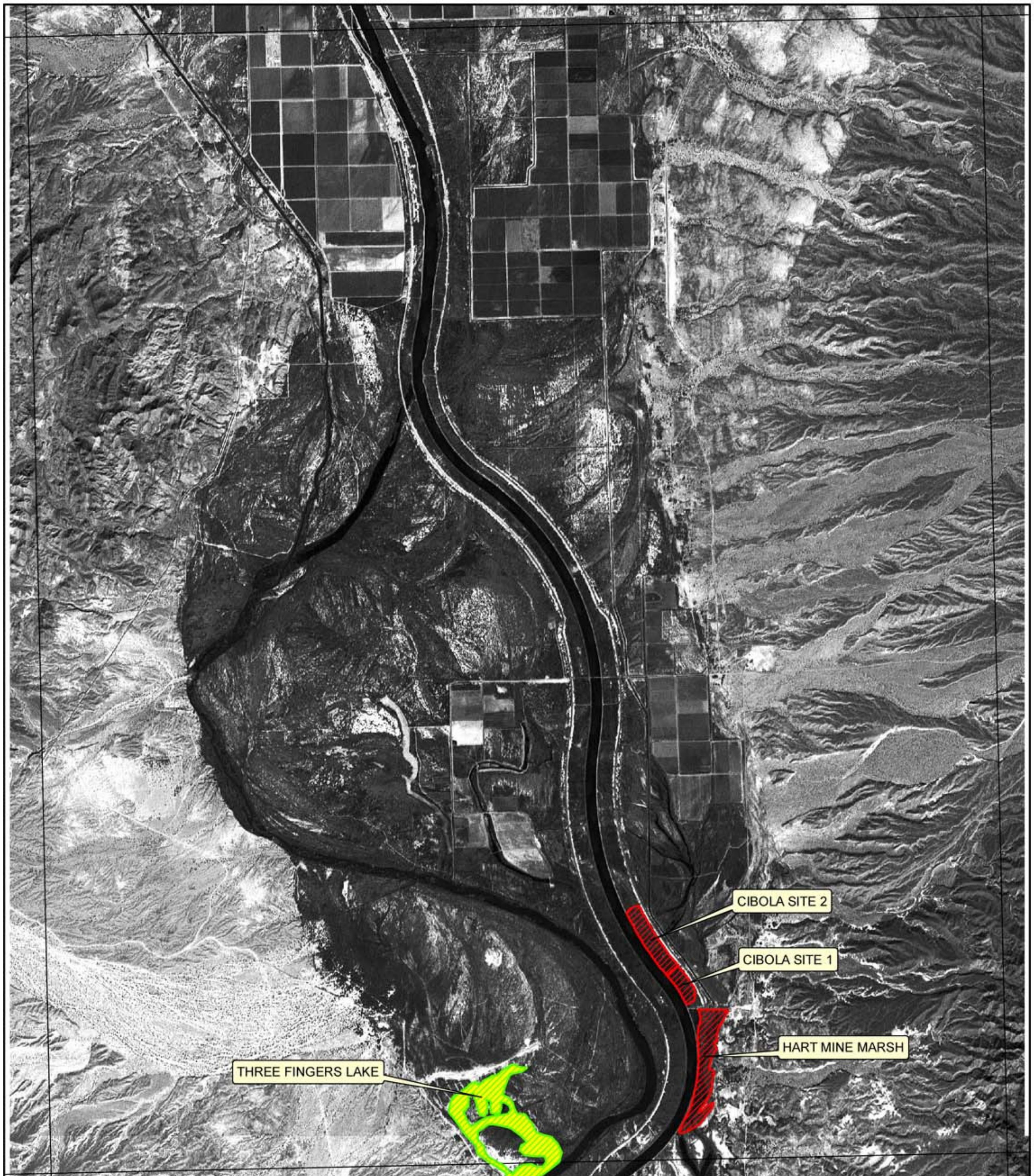

HAVASU NE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Lake Havasu City North
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters


SITE 1
SITE 2
SITE 11
SITE 4
SITE 3
SITE 5
MINERAL WASH
BEAVER POND
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Monkeys Head
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters


SITE 8
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castaneda Hills SW
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters


BIG HOLE SLOUGH
USGS Quadrangle: Blythe NE
NEVADA
UTAH
CALIFORNIA
ARIZONA
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

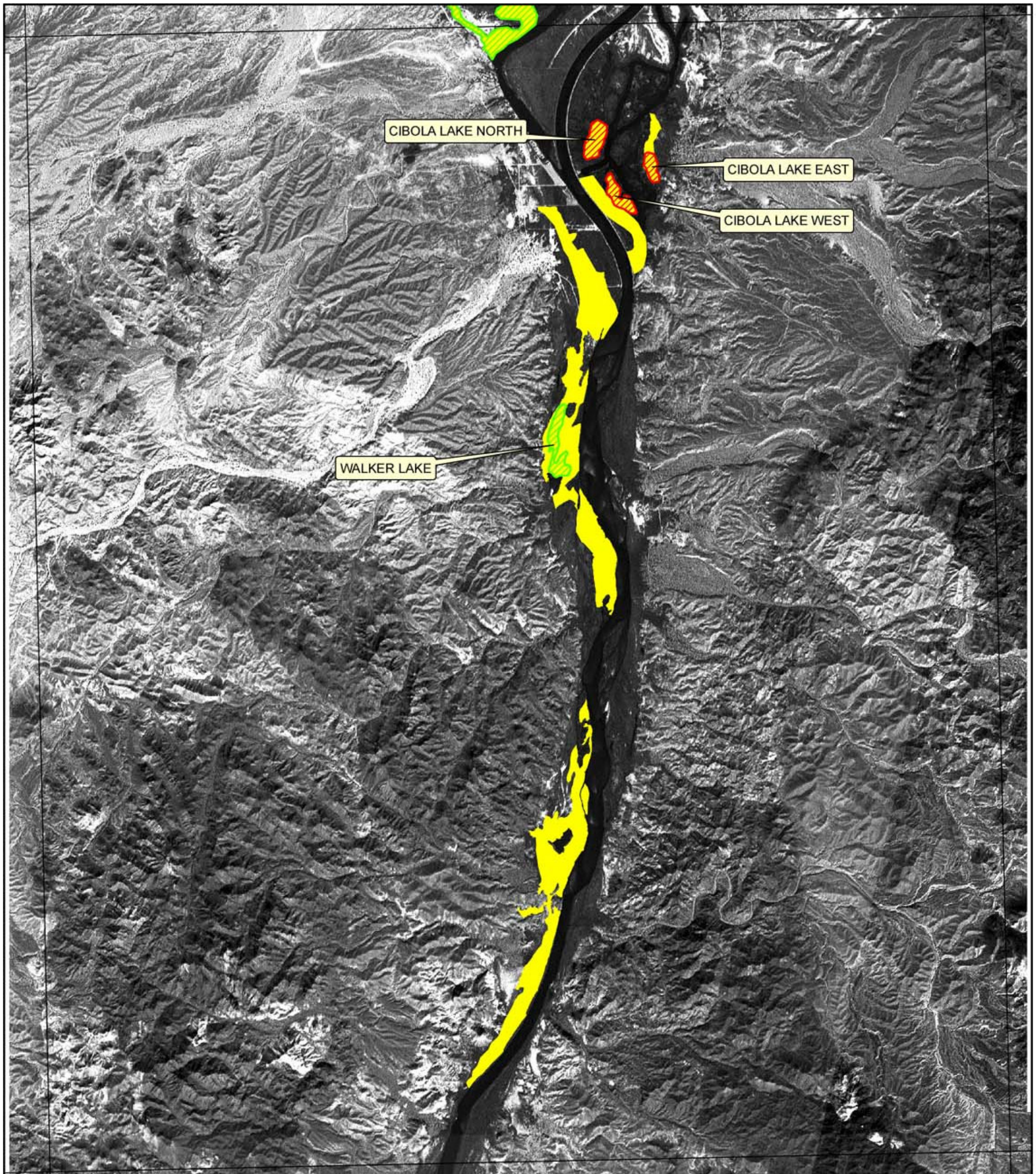

EHRENBERG
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Blythe
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters



USGS Quadrangle: Cibola

Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued

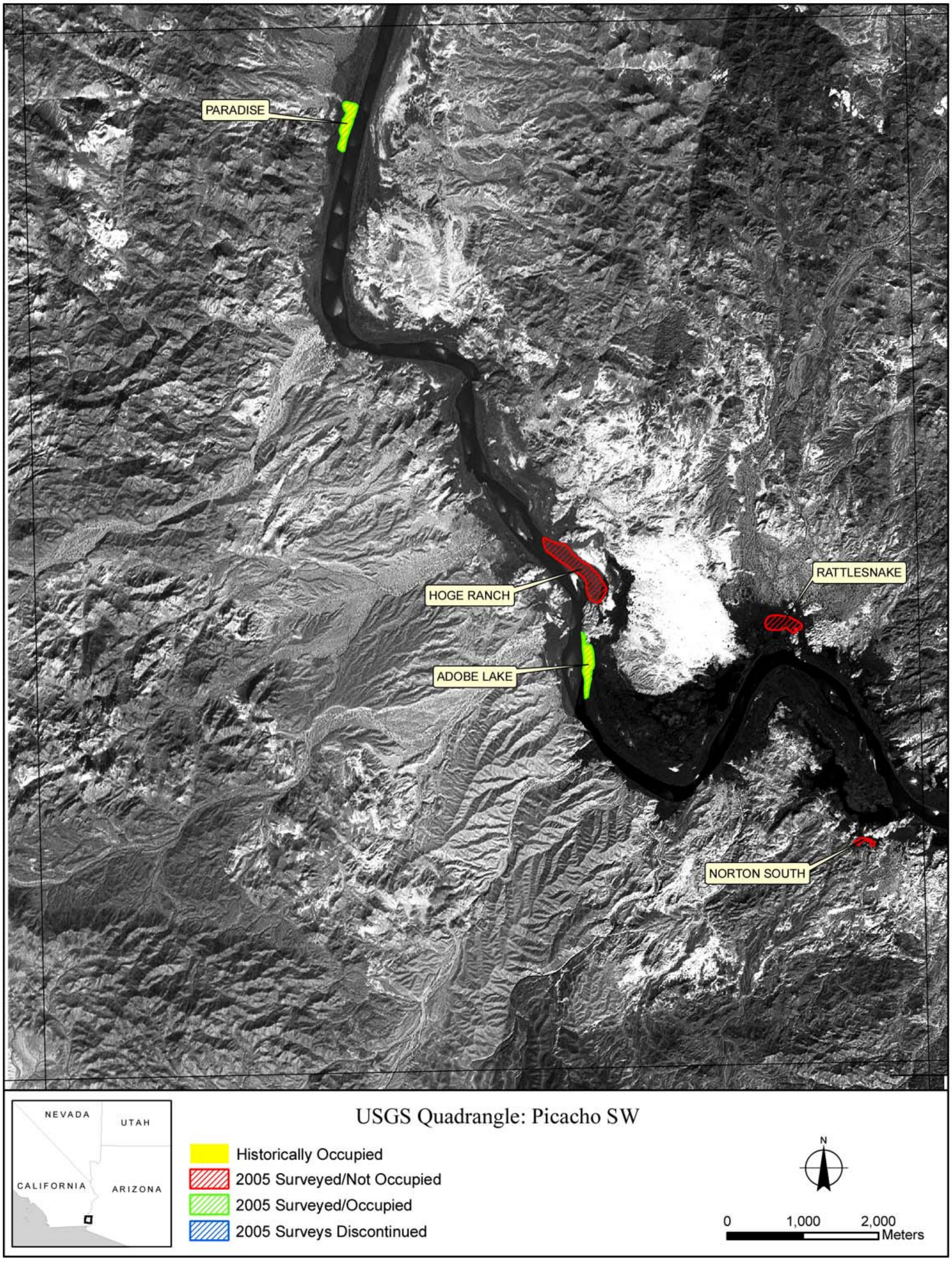
N
0 1,000 2,000 Meters

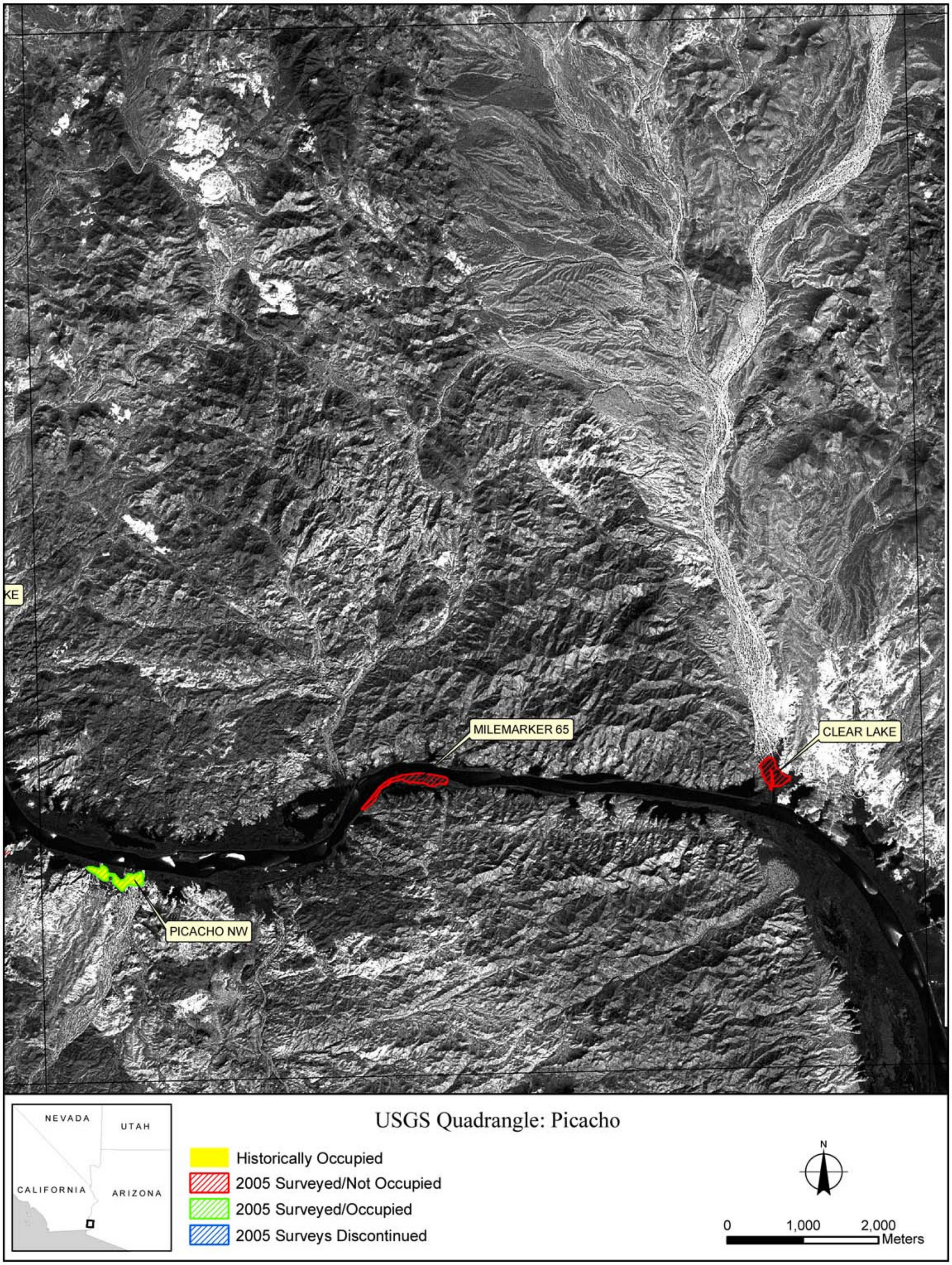


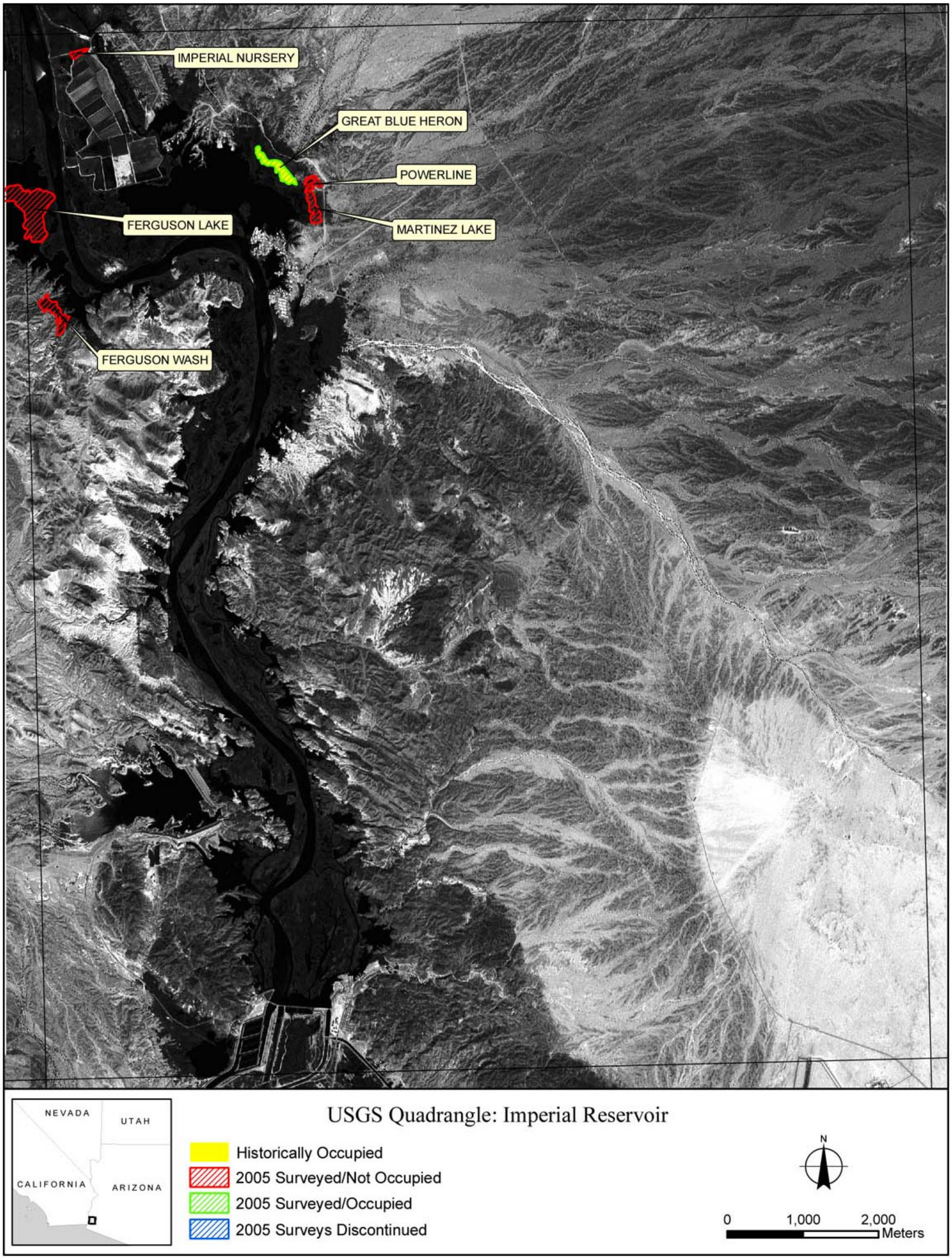
USGS Quadrangle: Picacho NW

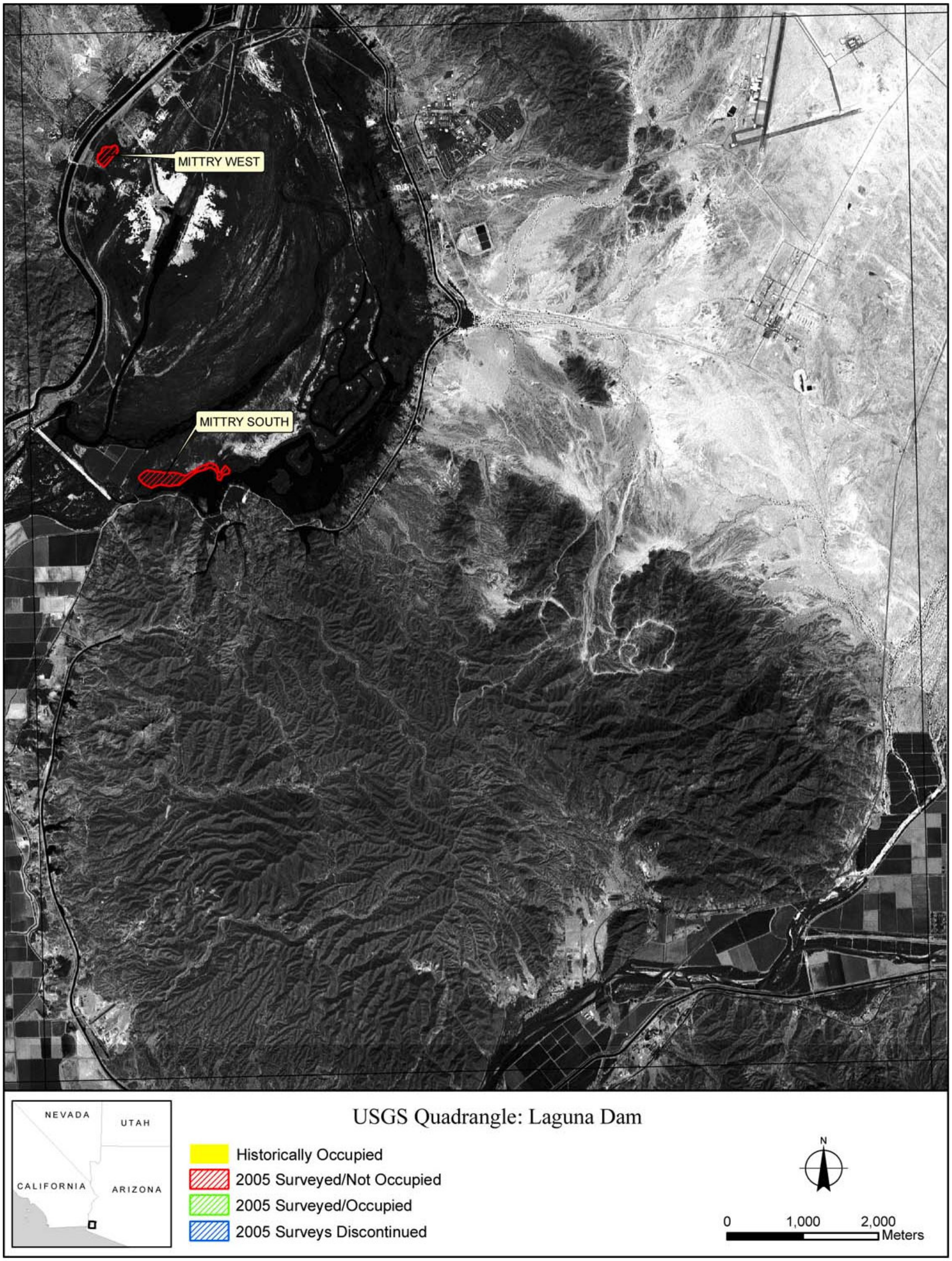
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued

0 1,000 2,000 Meters


PARADISE
HOGE RANCH
RATTLESNAKE
ADOBE LAKE
NORTON SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho SW
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

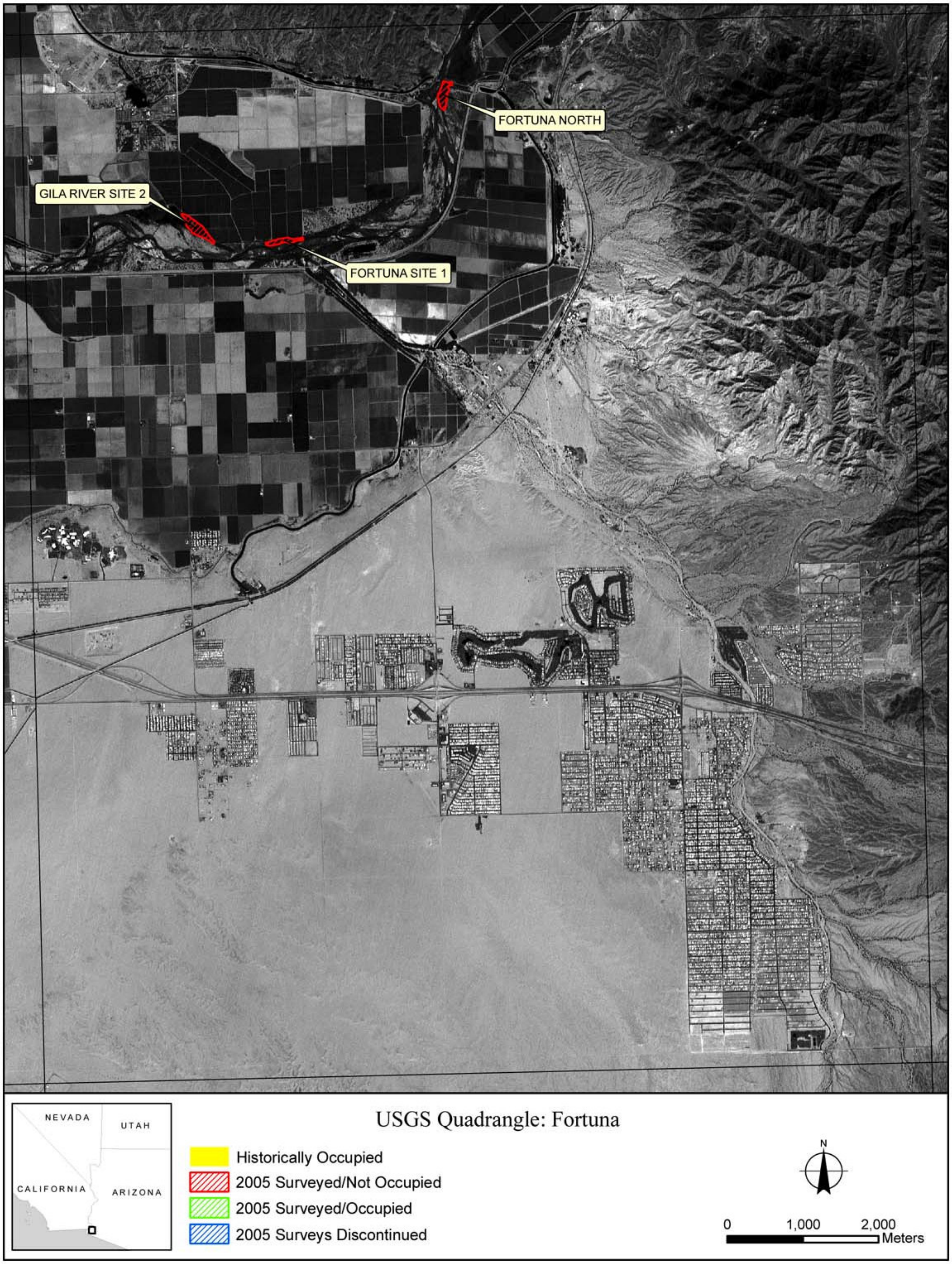

MILEMARKER 65
CLEAR LAKE
PICACHO NW
KE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters


IMPERIAL NURSERY
GREAT BLUE HERON
POWERLINE
FERGUSON LAKE
MARTINEZ LAKE
FERGUSON WASH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Imperial Reservoir
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

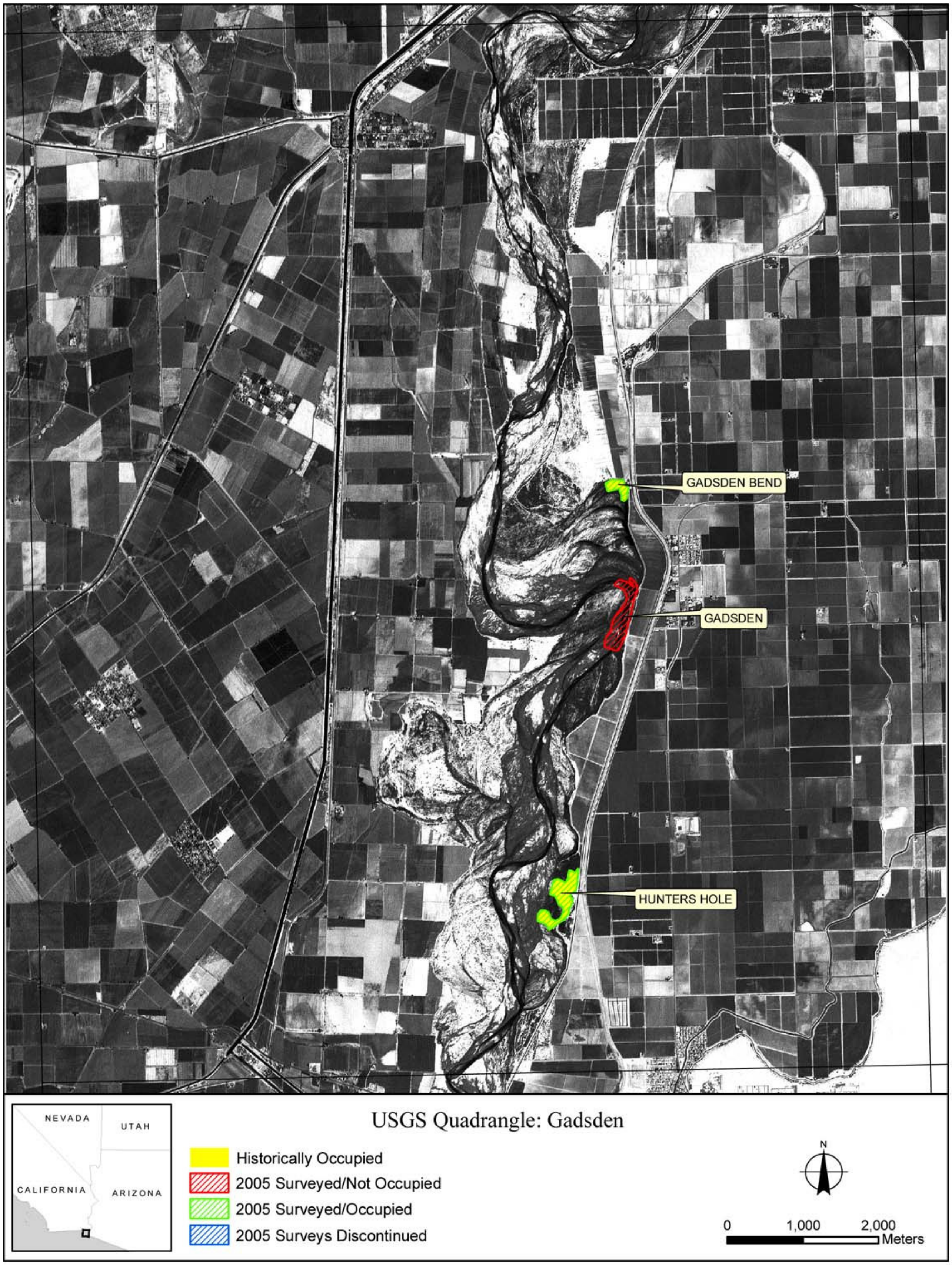

MITTRY WEST
MITTRY SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Laguna Dam
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

USGS Quadrangle: Bard

Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued


FORTUNA NORTH
GILA RIVER SITE 2
FORTUNA SITE 1
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Fortuna
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

GILA CONFLUENCE NORTH
RM 33
GILA CONFLUENCE WEST
GIL
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Yuma East
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters


GADSDEN BEND
GADSDEN
HUNTERS HOLE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Gadsden
Historically Occupied
2005 Surveyed/Not Occupied
2005 Surveyed/Occupied
2005 Surveys Discontinued
N
0
1,000
2,000
Meters

APPENDIX C

All Willow Flycatchers Color-banded and/or Resighted
2003–2005

Appendix C. Willow flycatchers banded and resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2005. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. The table is sorted by federal band number, and includes color combination, study area and site originally banded, age when banded, sex, date originally banded, and the year(s) detected (including the year banded). A numerical footnote in the "Years Detected" column indicates the individual moved that year to a different study area than it occupied the prior year, with the footnote number indicating the new location (see legend at end of table).

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
1590-97338	OG(M):XX	PAHR	NORTH	AHY	M	16-Jun-97	1997, 2001	X	X	
1710-20312	BG(M):Vs	ROOS	SHANGRI-LA	L	M	27-Jun-03				X[3]
1710-20638	YR(M):XX	GRCA	RM 267.0	AHY	M	1-Jul-98	1998	X[1]	X	X
2090-42022	GG(P):XX	MOME	UNKNOWN	L	F	1-Jul-98	1998	X[2]		
2110-78841	B(HP)/Y(HP):BEs	TOPO	800M	HY	F	8-Jul-02	2002	X	X	X
2110-78842	OB(P):BEs	MESQ	WEST	AHY	M	31-Jul-02	2002	X	X	
2110-78855	RK(M):BEs	TOPO	800M	HY	M	7-Jul-02	2002	X		
2110-78861	BEs:VK(M)	TOPO	INBETWEEN	L	M	6-Jul-02	2002	X[4]	X[2]	
2110-78863	R(HP)/V(HP):BEs	TOPO	INBETWEEN	L	M	6-Jul-02	2002	X	X	
2140-66564	RR(P):Zs	PAHR	UNKNOWN	L	F	4-Jul-02	2002	X[5]		
2140-66606	KY(M):Rs	MOME	UNKNOWN	L	M	17-Jul-98	1998, 2000, 2001	X[2]		
2140-66693	Rs:OK(M)	MOME	DELTA WEST	L	M	2-Aug-01	2001, 2002[G]	X[2]		
2140-66696	Rs:R(HP)/O(HP)	MESQ	WEST	L	F	3-Aug-01	2001	X		
2140-66709	Bs:GW(M)	MESQ	WEST	AHY	M	22-Jul-02	2002	X	X	
2140-66728	Bs:DD(P)	TOPO	800M	L	M	8-Jul-01	2001		X	
2140-66743	OG(M):Bs	TOPO	800M	L	M	7-Jul-99	1999		X	
2320-31401	OO(M):EE	BIWI	SITE 4	AHY	M	29-May-03		X		
2320-31402	EE:VG(M)	BIWI	SITE 4	AHY	M	10-Jun-03		X		

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2320-31403	EE:VK(M)	YUMA	GILA 1.5[H]	SY	M	12-Jun-03		X		
2320-31404	RD(M):EE	BIWI	SITE 3	AHY	F	27-Jun-03		X		
2320-31405	EE:RW(M)	BIWI	SITE 3	SY	F	28-Jun-03		X		
2320-31406	UB:EE	BIWI	SITE 3	L	U	29-Jun-03		X		
2320-31407	ZO(M):EE	BIWI	SITE 3	L	F	29-Jun-03		X	X[3]	
2320-31408	UB:EE	BIWI	SITE 3	L	U	29-Jun-03		X		
2320-31409	UB:EE	BIWI	SITE 3	L	U	2-Jul-03		X		
2320-31410	UB:EE	BIWI	SITE 3	L	U	2-Jul-03		X		
2320-31411	UB:EE	BIWI	SITE 3	L	U	2-Jul-03		X		
2320-31412	OW(M):EE	BIWI	SITE 3	SY	M	7-Jul-03		X	X	
2320-31413	EE:RY(M)	MESQ	WEST	SY	U	5-Aug-03		X		
2320-31414	RG(M):EE	TOPO	INBETWEEN	AHY	M	17-May-04			X	X
2320-31415	OZ(M):EE	TOPO	PIERCED EGG	AHY	F	6-Jun-04			X	
2320-31416	UB:EE	TOPO	800M	L	U	16-Jun-04			X	
2320-31417	UB:EE	TOPO	800M	L	U	16-Jun-04			X	
2320-31418	EE:RR(M)	TOPO	250M	SY	M	17-Jun-04			X	X
2320-31419	UB:EE	TOPO	PIERCED EGG	L	U	4-Jul-04			X	
2320-31420	UB:EE	TOPO	PIERCED EGG	L	U	4-Jul-04			X	
2320-31421	UB:EE	TOPO	PIERCED EGG	L	U	5-Jul-04			X	
2320-31422	UB:EE	TOPO	PIERCED EGG	L	U	5-Jul-04			X	
2320-31423	EE:RK(M)	TOPO	HELLBIRD	AHY	U	6-Jul-04			X	
2320-31424	DB(M):EE	TOPO	HELLBIRD	L	U	7-Jul-04			X	X
2320-31425	EE:UB	TOPO	HELLBIRD	L	U	7-Jul-04			X	

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2320-31426	EE:VV(M)	MOME	VIRGIN RIVER #1NORTH	AHY	F	8-Jun-03		X		
2320-31427	VG(M):EE	MOME	DELTA WEST	AHY	M	22-Jun-03		X		
2320-31428	EE:GZ(M)	MESQ	WEST	L	U	12-Jun-03		X	X[1]	X[8]
2320-31429	UB:EE	MESQ	WEST	L	U	12-Jun-03		X		
2320-31430	EE:UB	PAHR	NORTH	L	U	1-Jul-03		X		
2320-31431	EE:UB	MESQ	WEST	L	U	26-Jul-03		X		
2320-31432	EE:UB	PAHR	NORTH	L	U	1-Jul-03		X		
2320-31433	EE:UB	MESQ	WEST	L	U	26-Jul-03		X		
2320-31434	EE:UB	MESQ	WEST	L	U	26-Jul-03		X		
2320-31435	EE:UB	PAHR	NORTH	L	U	3-Jul-03		X		
2320-31436	UB:EE	PAHR	NORTH	L	U	3-Jul-03		X		
2320-31437	UB:EE	PAHR	NORTH	L	U	3-Jul-03		X		
2320-31438	RK(M):EE	MESQ	WEST	L	M	5-Jul-03		X	X	
2320-31439	RO(M):EE	MESQ	WEST	L	U	5-Jul-03		X		
2320-31440	OY(M):EE	MESQ	WEST	L	U	5-Jul-03		X	X[1]	
2320-31441[J]	UB:EE	MOME	Delta West	L	U	9-Jul-03		X		
2320-31442	EE:WD(M)	MESQ	WEST	L	M	19-Jul-02	2002	X		
2320-31443	EE:UB	MESQ	WEST	L	U	29-Jul-03		X		
2320-31444	RW(M):EE	MESQ	WEST	AHY	F	31-Jul-03		X	X	X
2320-31445	EE:WK(M)	MESQ	WEST	AHY	F	1-Aug-03		X	X	X
2320-31446	UB:EE	PAHR	NORTH	L	U	29-Jun-04			X	
2320-31447[J]	UB:EE	PAHR	NORTH	L	U	25-Jul-04			X	
2320-31448	UB:EE	PAHR	NORTH	L	U	29-Jun-04			X	

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2320-31449[J]	UB:EE	PAHR	NORTH	L	U	25-Jul-04			X	
2320-31450[J]	UB:EE	PAHR	NORTH	L	U	25-Jul-04			X	
2320-31452	EE:KO(M)	PAHR	NORTH	AHY	M	20-May-03		X		
2320-31453	EE:WW(M)	PAHR	NORTH	AHY	M	28-May-03		X	X	
2320-31454	EE:DO(M)	PAHR	NORTH	AHY	M	1-Jun-03		X	X	
2320-31455	EE:KV(M)	PAHR	NORTH	SY	M	3-Jun-03		X		
2320-31456	EE:UB	PAHR	NORTH	L	U	25-Jun-03		X		
2320-31457	EE:KG(M)	PAHR	NORTH	L	M	25-Jun-03		X	X[6]	
2320-31458	EE:ZB(M)	PAHR	SOUTH	L	M	25-Jun-03		X		X
2320-31459	EE:DK(M)	PAHR	SOUTH	L	M	25-Jun-03		X	X	
2320-31460	EE:UB	PAHR	SOUTH	L	U	25-Jun-03		X		
2320-31461	EE:UB	PAHR	SOUTH	L	U	25-Jun-03		X		
2320-31462	EE:UB	PAHR	NORTH	L	U	26-Jun-03		X		
2320-31463	EE:UB	PAHR	NORTH	L	U	26-Jun-03		X		
2320-31464	EE:UB	PAHR	NORTH	L	U	26-Jun-03		X		
2320-31465	EE:UB	PAHR	NORTH	L	U	26-Jun-03		X		
2320-31466	EE:KW(M)	PAHR	NORTH	AHY	F	26-Jun-03		X		
2320-31467	EE:BD(M)	PAHR	NORTH	L	M	27-Jun-03		X		X
2320-31468	EE:RO(M)	PAHR	NORTH	L	M	27-Jun-03		X		X
2320-31469	EE:UB	PAHR	NORTH	L	U	27-Jun-03		X		
2320-31470	EE:UB	PAHR	NORTH	L	U	27-Jun-03		X		
2320-31471	EE:OW(M)	MESQ	WEST	L	F	29-Jun-03		X	X	
2320-31472	EE:UB	MESQ	WEST	L	U	29-Jun-03		X		

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2320-31473	EE:OKO(M)	MESQ	WEST	L	M	29-Jun-03		X	X	
2320-31474[J]	EE:UB	MESQ	WEST	L	U	29-Jun-03		X		
2320-31475	EE:WR(M)	PAHR	NORTH	L	M	1-Jul-03		X	X[7]	
2320-31476	DD(M):EE	MESQ	WEST	SY	F	17-Jun-03		X		
2320-31477[J]	EE:UB	MESQ	WEST	L	U	25-Jun-03		X		
2320-31478	DW(M):EE	MESQ	WEST	AHY	M	25-Jul-02	2002	X		
2320-31479	GG(M):EE	MESQ	WEST	SY	F	26-Jun-03		X	X	
2320-31480	WR(M):EE	MESQ	WEST	L	F	27-Jun-03		X	X	
2320-31481	UB:EE	PAHR	NORTH	L	U	30-Jul-03		X		
2320-31482	UB:EE	PAHR	NORTH	L	U	30-Jul-03		X		
2320-31483	RR(M):EE	MESQ	WEST	L	U	21-Jun-04			X	
2320-31484	UB:EE	PAHR	NORTH	L	U	23-Jun-04			X	X
2320-31485	EE:WO(M)	MOME	VIRGIN RIVER #1NORTH	AHY	F	30-Jun-04			X	
2320-31486	YV(M):EE	MESQ	WEST	L	F	23-Jul-03		X	X[7]	X[2]
2320-31487	EE:UB	MESQ	WEST	L	U	23-Jul-03		X		
2320-31488	EE:UB	MESQ	WEST	L	U	23-Jul-03		X		
2320-31489	EE:OK(M)	MOME	VIRGIN RIVER #1NORTH	AHY	U	27-May-04			X	
2320-31490	EE:OO(M)	LIFI	NORTH	AHY	M	3-Jun-04			X	X[2]
2320-31491	GK(M):EE	BLM/MESQ	ELECTRIC AVE	AHY	M	4-Jun-04			X	
2320-31492	EE:RG(M)	MESQ	WEST	L	F	19-Jul-02	2002		X	
2320-31493	DO(M):EE	MUDD	Overton WMA	AHY	M	9-Jun-04			X	
2320-31494	EE:OG(M)	BLM/MESQ	RIVERSIDE WEST	AHY	U	19-Jun-04			X	
2320-31495	DY(M):EE	TOPO	LOST LAKE	AHY	M	16-Jun-04			X	

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2320-31496	UB:EE	MOME	NORTH	L	U	23-Jun-04			X	
2320-31497	UB:EE	MOME	NORTH	L	U	23-Jun-04			X	
2320-31498	UB:EE	MOME	NORTH	L	U	23-Jun-04			X	
2320-31499	KO(M):EE	MESQ	WEST	SY	M	25-Jun-04			X	
2320-31500[J]	EE:UB	MESQ	WEST	L	U	25-Jun-04			X	
2320-31501	EE:DD(M)	BIWI	SITE 3	AHY	M	7-May-03		X		
2320-31502	ZR(M):EE	TOPO	INBETWEEN	AHY	F	28-May-03		X	X	
2320-31503	EE:GG(M)	IMPE	GREAT BLUE HERON	SY	U	10-Jun-04			X	
2320-31504	EE:GG(M)	IMPE	GREAT BLUE HERON	SY	U	11-Jun-04			X	
2320-31505	EE:DR(M)	TOPO	GLORY HOLE	SY	M	1-Jul-04			X	
2320-31506	UB:EE	TOPO	GLORY HOLE	L	U	22-Jul-04			X	
2320-31507	UB:EE	TOPO	GLORY HOLE	L	U	22-Jul-04			X	
2320-31508	UB:EE	TOPO	PIG HOLE	L	U	17-Jul-04			X	
2320-31510	UB:EE	TOPO	PC6-1	L	U	16-Jul-04			X	
2320-31511	UB:EE	TOPO	PC6-1	L	U	16-Jul-04			X	
2320-31512	UB:EE	TOPO	250M	L	U	16-Jul-04			X	
2320-31513	UB:EE	TOPO	GLORY HOLE	L	U	16-Jul-04			X	
2320-31514	UB:EE	TOPO	GLORY HOLE	L	U	16-Jul-04			X	
2320-31515	EE:WY(M)	TOPO	PC6-1	SY	F	8-Jul-04			X	X
2320-31516	EE:RD(M)	GRCA	RM 274.5	SY	F	15-Jul-04			X	
2320-31517	EE:OR(M)	GRCA	RM 274.5	SY	M	15-Jul-04			X	X[1]
2320-31518	UB:EE	TOPO	800M	L	U	30-Jul-04			X	
2320-31519	UB:EE	TOPO	800M	L	U	30-Jul-04			X	

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2320-31520	UB:EE	TOPO	800M	L	U	30-Jul-04			X	
2320-31521	EE:DY(M)	TOPO	INBETWEEN	SY	F	6-Aug-04			X	X
2320-31526	OD(M):EE	TOPO	800M	AHY	F	2-Jun-03		X	X	X
2320-31527	KZ(M):EE	TOPO	INBETWEEN	AHY	F	21-Jun-03		X		
2320-31528	EE:YV(M)	TOPO	INBETWEEN	AHY	M	24-Jun-03		X		
2320-31529	UB:EE	TOPO	800M	L	U	26-Jun-03		X		
2320-31530	UB:EE	TOPO	800M	L	U	26-Jun-03		X		
2320-31531	UB:EE	TOPO	800M	L	U	26-Jun-03		X		
2320-31532	UB:EE	TOPO	INBETWEEN	L	U	27-Jun-03		X		
2320-31533	UB:EE	TOPO	INBETWEEN	L	U	27-Jun-03		X		
2320-31534	UB:EE	TOPO	INBETWEEN	L	U	27-Jun-03		X		
2320-31535	UB:EE	TOPO	800M	L	U	2-Jul-03		X		
2320-31536	UB:EE	TOPO	800M	L	U	2-Jul-03		X		
2320-31537	UB:EE	TOPO	800M	L	U	2-Jul-03		X		
2320-31538	EE:YR(M)	TOPO	INBETWEEN	AHY	M	3-Jun-04			X	
2320-31539	EE:YY(M)	BIWI	SITE 3	SY	M	10-Jun-04			X	
2320-31540	EE:KR(M)	TOPO	PIPES 3	SY	F	22-Jun-04			X	
2320-31541	EE:KW(M)	TOPO	PIPES 3	SY	M	22-Jun-04			X	X
2320-31542	UB:EE	TOPO	INBETWEEN	L	U	2-Aug-04			X	
2320-31543	UB:EE	TOPO	INBETWEEN	L	U	2-Aug-04			X	
2320-31544	EE:UB	TOPO	INBETWEEN	L	U	2-Aug-04			X	
2320-31551	EE:GO(M)	MESQ	WEST	AHY	M	5-Jun-04			X	
2320-31552	EE:GR(M)	MOME	VIRGIN RIVER #1NORTH	AHY	M	7-Jun-04			X	

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2320-31553	EE:GW(M)	MOME	VIRGIN RIVER #1NORTH	SY	U	7-Jun-04			X	
2320-31554	UB:EE	TOPO	INBETWEEN	L	U	22-Jun-04			X	
2320-31555	EE:UB	TOPO	INBETWEEN	L	U	22-Jun-04			X	
2320-31556	UB:EE	TOPO	INBETWEEN	L	U	22-Jun-04			X	
2320-31557[J]	EE:UB	TOPO	INBETWEEN	L	U	30-Jul-04			X	
2320-31558	UB:EE	TOPO	INBETWEEN	L	U	30-Jul-04			X	
2320-31559	OK(M):EE	TOPO	HELLBIRD	SY	U	25-Jul-04			X	X
2320-31560	EE:GY(M)	TOPO	HELLBIRD	SY	M	25-Jul-04			X	X
2320-31561	EE:UB	TOPO	PIPES 3	L	U	22-Jul-04			X	
2320-31562	KY(M):EE	TOPO	PIPES 3	L	U	22-Jul-04			X	
2320-31563	EE:UB	TOPO	PIPES 3	L	U	22-Jul-04			X	
2320-31564	EE:UB	TOPO	INBETWEEN	L	U	25-Jun-04			X	
2320-31565	EE:KD(M)	TOPO	800M	AHY	F	23-Jun-04			X	X
2320-31567	YD(M):EE	TOPO	GLORY HOLE	SY	M	1-Jul-04			X	X
2320-31568	YG(M):EE	PAHR	NORTH	AHY	F	2-Jul-04			X	
2320-31569	UB:EE	PAHR	NORTH	L	U	2-Jul-04			X	
2320-31570	EE:UB	PAHR	NORTH	L	U	2-Jul-04			X	
2320-31571	UB:EE	PAHR	NORTH	L	U	2-Jul-04			X	
2320-31572	YK(M):EE	MOME	VIRGIN RIVER #1NORTH	SY	M	4-Jul-04			X	
2320-31573	WY(M):EE	MESQ	WEST	AHY	F	6-Jul-04			X	X
2320-31574	EE:UB	PAHR	NORTH	L	U	22-Jul-05				X
2320-31576	KK(M):EE	TOPO	INBETWEEN	AHY	M	19-May-03		X	X	
2320-31577	GW(M):EE	TOPO	INBETWEEN	AHY	F	1-Jun-03		X	X	X

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2320-31578	KG(M):EE	GADS	HUNTER'S HOLE	SY	U	15-Jun-03		X		
2320-31579	KD(M):EE	GADS	RIVER MILE 33	SY	U	18-Jun-03		X		
2320-31580	GZ(M):EE	GADS	RIVER MILE 33	SY	U	18-Jun-03		X		
2320-31581	UB:EE	TOPO	INBETWEEN	L	U	3-Jul-03		X		
2320-31582	UB:EE	TOPO	INBETWEEN	L	U	3-Jul-03		X		
2320-31583	UB:EE	TOPO	INBETWEEN	L	U	3-Jul-03		X		
2320-31584	EE:YK(M)	TOPO	INBETWEEN	SY	F	3-Jul-03		X	X	X
2320-31585	UB:EE	TOPO	INBETWEEN	L	U	3-Jul-03		X		
2320-31586	UB:EE	TOPO	INBETWEEN	L	U	3-Jul-03		X		
2320-31587	UB:EE	TOPO	INBETWEEN	L	U	3-Jul-03		X		
2320-31588	UB:EE	TOPO	GLORY HOLE	L	U	17-Jul-03		X		
2320-31589	EE:YD(M)	PAHR	NORTH	AHY	M	14-May-04			X	X
2320-31590	GR(M):EE	PAHR	NORTH	AHY	M	15-May-04			X	X
2320-31591	GY(M):EE	PAHR	NORTH	AHY	M	15-May-04			X	X
2320-31592	GO(M):EE	MESQ	WEST	L	U	6-Aug-01	2001		X[5]	X
2320-31593	EE:WV(M)	PAHR	NORTH	AHY	M	18-May-04			X	X
2320-31594	EE:YO(M)	PAHR	NORTH	AHY	M	18-May-04			X	
2320-31595	GV(M):EE	PAHR	NORTH	AHY	M	18-May-04			X	X
2320-31596	EE:YG(M)	PAHR	NORTH	SY	M	19-May-04			X	
2320-31597[I]	EE:BW(M)	9 E OF ALAMO	UNKNOWN	AHY	M	14-Jul-01	2001	X[5]	X	X
2320-31598	DK(M):EE	TOPO	PIG HOLE	AHY	M	28-May-04			X	
2320-31599	EE:GG(M)	IMPE	GREAT BLUE HERON	SY	U	10-Jun-04			X	
2320-31600	EE:GG(M)	IMPE	GREAT BLUE HERON	SY	U	10-Jun-04			X	

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2320-31601	UB:EE	PAHR	NORTH	L	U	25-Jun-04			X	
2320-31602	UB:EE	PAHR	NORTH	L	U	25-Jun-04			X	
2320-31603	UB:EE	PAHR	NORTH	L	U	25-Jun-04			X	
2320-31604	UB:EE	PAHR	NORTH	L	U	25-Jun-04			X	
2320-31605	UB:EE	PAHR	NORTH	L	U	25-Jun-04			X	
2320-31606	UB:EE	PAHR	NORTH	L	U	25-Jun-04			X	
2320-31607	UB:EE	PAHR	NORTH	L	U	26-Jun-04			X	
2320-31608	EE:UB	PAHR	NORTH	L	U	26-Jun-04			X	
2320-31609	UB:EE	PAHR	NORTH	L	U	26-Jun-04			X	
2320-31610	EE:UB	PAHR	NORTH	L	U	26-Jun-04			X	
2320-31611[J]	EE:UB	MESQ	WEST	L	U	25-Jun-04			X	
2320-31612[J]	EE:UB	MESQ	WEST	L	U	25-Jun-04			X	
2320-31613[K]	DR(M):EE	MESQ	WEST	AHY	F	24-Jul-02	2002	X	X	X[9]
2320-31614[L]	VY(M):EE	TOPO	800M	L	M	4-Aug-00	2000	X[2]	X	X
2320-31615	EE:OY(M)	MESQ	WEST	L	U	21-Jun-04			X	
2320-31616	EE:UB	MESQ	WEST	L	U	8-Jul-04			X	
2320-31617	UB:EE	MESQ	WEST	L	U	8-Jul-04			X	
2320-31618	EE:GB(M)	MESQ	WEST	L	F	8-Jul-04			X	X[1]
2320-31619[J]	UB:EE	MOME	VIRGIN RIVER #1NORTH	L	U	10-Jul-04			X	
2320-31620[J]	UB:EE	MOME	VIRGIN RIVER #1NORTH	L	U	10-Jul-04			X	
2320-31621	VV(M):EE	MOME	VIRGIN RIVER #1NORTH	AHY	F	30-Jun-04			X	
2320-31622	VK(M):EE	MESQ	WEST	AHY	M	3-Jul-04			X	
2320-31623	UB:EE	MOME	DELTA WEST	L	U	4-Jul-04			X	

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2320-31624	UB:EE	MOME	DELTA WEST	L	U	4-Jul-04			X	
2320-31625	EE:WG(M)	MOME	DELTA WEST	AHY	F	4-Jul-04			X	
2320-31627	WW(M):EE	MESQ	WEST	SY	M	5-Jul-04			X	
2320-31628	EE:KZ(M)	MOME	VIRGIN RIVER #1NORTH	SY	U	6-Jul-04			X	
2320-31629	UB:EE	MOME	VIRGIN RIVER #1NORTH	L	U	6-Jul-04			X	
2320-31630	UB:EE	BLM/MESQ	BUNKER FARM	L	U	16-Jul-04			X	
2320-31631	UB:EE	BLM/MESQ	BUNKER FARM	L	U	16-Jul-04			X	
2320-31632	RZ(M):EE	BLM/MESQ	BUNKER FARM	SY	F	16-Jul-04			X	
2320-31633	UB:EE	MESQ	WEST	L	U	16-Jul-04			X	
2320-31634	UB:EE	MESQ	WEST	L	U	16-Jul-04			X	
2320-31635	EE:YDY(M)	KEPI	KEPI	AHY	M	17-Jul-04			X	
2320-31636	UB:EE	KEPI	KEPI	L	U	17-Jul-04			X	
2320-31637	BD(M):EE	KEPI	KEPI	L	F	17-Jul-04			X	X[5]
2320-31638	UB:EE	KEPI	KEPI	L	U	17-Jul-04			X	
2320-31651	EE:OD(M)	MOME	DELTA WEST	AHY	M	21-May-04			X	
2320-31652	WG(M):EE	MOME	VIRGIN RIVER #1NORTH	AHY	M	22-May-04			X	X[2]
2320-31653	WV(M):EE	MOME	DELTA WEST	SY	M	27-May-04			X	X
2320-31654	EE:KY(M)	BLM/MESQ	ELECTRIC AVE	AHY	M	4-Jun-04			X	
2320-31655	VW(M):EE	MESQ	WEST	SY	F	14-Jun-04			X	X
2320-31656	WD(M):EE	PAHR	NORTH	AHY	F	19-Jun-04			X	X
2320-31657	WO(M):EE	PAHR	NORTH	AHY	F	20-Jun-04			X	X
2320-31658	WK(M):EE	PAHR	NORTH	AHY	F	20-Jun-04			X	
2320-31660	UB:EE	MESQ	WEST	L	U	21-Jun-04			X	

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2320-31661	EE:DW(M)	PAHR	NORTH	SY	F	17-Jun-04			X	X
2320-31662	YY(M):EE	PAHR	NORTH	SY	F	17-Jun-04			X	
2320-31664	YW(M):EE	PAHR	NORTH	AHY	F	18-Jun-04			X	
2320-31665	UB:EE	PAHR	NORTH	L	U	22-Jun-04			X	
2320-31666	UB:EE	PAHR	NORTH	L	U	22-Jun-04			X	
2320-31667	UB:EE	PAHR	PAHR	L	U	22-Jun-04			X	
2320-31668	ZG(M):EE	PAHR	NORTH	AHY	F	22-Jun-04			X	
2320-31669	ZK(M):EE	PAHR	SOUTH	AHY	F	6-Aug-04			X	
2320-31675	UB:EE	TOPO	INBETWEEN	L	U	16-Jul-05				X
2320-31676	EE:UB	TOPO	INBETWEEN	L	U	16-Jul-05				X
2320-31680	EE:UB	TOPO	PIERCED EGG	L	U	19-Jul-05				X
2320-31681	UB:EE	TOPO	PIERCED EGG	L	U	19-Jul-05				X
2320-31682	UB:EE	PAHR	SOUTH	L	U	21-Jul-05				X
2320-31683	EE:UB	PAHR	SOUTH	L	U	21-Jul-05				X
2320-31684	YO(M):EE	PAHR	NORTH	L	U	16-Jul-05				X
2320-31685	EE:UB	PAHR	NORTH	L	U	16-Jul-05				X
2320-31686	UB:EE	PAHR	NORTH	L	U	16-Jul-05				X
2320-31687	EE:UB	PAHR	NORTH	L	U	16-Jul-05				X
2320-31688	EE:UB	MESQ	WEST	L	U	15-Jul-05				X
2320-31689	EE:UB	MESQ	WEST	L	U	15-Jul-05				X
2320-31690	UB:EE	MESQ	WEST	L	U	13-Jul-05				X
2320-31691	EE:UB	MESQ	WEST	L	U	13-Jul-05				X
2320-31692	EE:UB	PAHR	NORTH	L	U	3-Jul-05				X

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2320-31693	UB:EE	PAHR	NORTH	L	U	3-Jul-05				X
2320-31694	EE:UB	PAHR	NORTH	L	U	3-Jul-05				X
2320-31695	EE:UB	PAHR	NORTH	L	U	3-Jul-05				X
2320-31696	UB:EE	MESQ	WEST	L	U	2-Jul-05				X
2320-31697	EE:UB	PAHR	NORTH	L	U	30-Jun-05				X
2320-31698	UB:EE	PAHR	NORTH	L	U	30-Jun-05				X
2320-31699	UB:EE	PAHR	NORTH	L	U	30-Jun-05				X
2320-31700	UB:EE	PAHR	NORTH	L	U	30-Jun-05				X
2360-59701	UB:EE	MESQ	BUNKER FARM	L	U	21-Jun-05				X
2360-59702	UB:EE	MESQ	BUNKER FARM	L	U	21-Jun-05				X
2360-59703	UB:EE	MESQ	BUNKER FARM	L	U	21-Jun-05				X
2360-59704	UB:EE	MOME	NORTH	L	U	25-Jun-05				X
2360-59705	UB:EE	MOME	NORTH	L	U	25-Jun-05				X
2360-59706	UB:EE	KEPI		L	U	6-Jul-05				X
2360-59707	EE:UB	PAHR	SOUTH	L	U	26-Jun-05				X
2360-59708	EE:UB	PAHR	SOUTH	L	U	26-Jun-05				X
2360-59709	EE:UB	PAHR	SOUTH	L	U	26-Jun-05				X
2360-59710	EE:UB	PAHR	SOUTH	L	U	26-Jun-05				X
2360-59711	UB:EE	KEPI		L	U	6-Jul-05				X
2360-59712	EE:UB	KEPI		L	U	6-Jul-05				X
2360-59713	EE:UB	KEPI		L	U	6-Jul-05				X
2360-59714	UB:EE	MESQ	WEST	L	U	19-Jul-05				X
2360-59715	UB:EE	MESQ	WEST	L	U	19-Jul-05				X

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2360-59716	UB:EE	MESQ	WEST	L	U	21-Jul-05				X
2360-59717	RY(M):EE	MESQ	WEST	AHY	M	18-Jul-04			X	
2360-59718	EE:UB	PAHR	NORTH	L	U	22-Jul-05				X
2360-59719	UB:EE	TOPO	INBETWEEN	L	U	14-Jun-05				X
2360-59720	UB:EE	TOPO	800M	L	U	2-Jul-05				X
2360-59721	UB:EE	PAHR	NORTH	L	U	1-Aug-04			X	
2360-59722	EE:UB	TOPO	800M	L	U	2-Jul-05				X
2360-59723	UB:EE	PAHR	NORTH	L	U	1-Aug-04			X	
2360-59724	UB:EE	PAHR	NORTH	L	U	1-Aug-04			X	
2360-59725	EE:UB	BIWI	SITE 4	L	U	8-Jul-05				X
2360-59727	EE:UB	BIWI	SITE 4	L	U	8-Jul-05				X
2360-59728	EE:UB	BIWI	SITE 4	L	U	8-Jul-05				X
2360-59729	EE:UB	TOPO	INBETWEEN	L	U	18-Jul-05				X
2360-59730	UB:EE	TOPO	INBETWEEN	L	U	18-Jul-05				X
2360-59731	EE:UB	TOPO	INBETWEEN	L	U	18-Jul-05				X
2360-59732	UB:EE	TOPO	GLORY HOLE	L	U	6-Aug-05				X
2360-59733	UB:EE	TOPO	800M	L	U	6-Aug-05				X
2360-59734	EE:UB	TOPO	800M	L	U	6-Aug-05				X
2360-59740	UB:EE	PAHR	NORTH	L	U	29-Jul-05				X
2360-59741	UB:EE	MESQ	BUNKER FARM	L	U	9-Aug-05				X
2360-59742	EE:UB	MESQ	BUNKER FARM	L	U	9-Aug-05				X
2360-59746	UB:EE	GRCA	RIVER MILE 274.5	L	U	17-Jul-04			X	
2360-59757	UB:EE	KEPI	KEPI	L	U	17-Jul-04			X	

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2360-59760	UB:EE	LIFI	NORTH	L	U	29-Jul-04			X	
2360-59761	UB:EE	LIFI	NORTH	L	U	29-Jul-04			X	
2360-59762	EE:UB	MESQ	WEST	L	U	7-Aug-04			X	
2360-59763	EE:UB	MESQ	WEST	L	U	7-Aug-04			X	
2360-59766	EE:UB	MESQ	WEST	L	U	7-Aug-04			X	
2360-59767	UB:EE	KEPI	KEPI	L	U	11-Aug-04			X	
2360-59770	EE:UB	KEPI	KEPI	L	U	11-Aug-04			X	
2360-59771	UB:EE	GRCA	RIVER MILE 274.5	L	U	17-Jul-04			X	
2360-59772	YR(M):EE	KEPI	KEPI	AHY	F	12-Aug-04			X	
2360-59787	UB:EE	MUDD	Overton WMA	L	U	3-Aug-05				X
2360-59800	UB:EE	GRCA	RIVER MILE 274.5	L	U	17-Jul-04			X	
2370-39901	OO(M):XX	PAHR	NORTH	AHY	U	12-Aug-04			X	
2370-39902	XX:KY(M)	PAHR	NORTH	HY	U	12-Aug-04			X	
2370-39903	DD(M):XX	PAHR	UNKNOWN	AHY	F	10-Aug-00	2000		X[5]	
2370-39904	YV(M):XX	PAHR	NORTH	HY	U	12-Aug-04			X	
2370-39911	RW(M):PU	PAHR	NORTH	AHY	M	1-Jun-05				X
2370-39912	VK(M):PU	MESQ	EAST	SY	M	8-Jun-05				X
2370-39913	PU:DW(M)	GRCA	RM274.5	AHY	M	17-Jun-05				X
2370-39914	PU:GG(M)	PAHR	NORTH	HY	U	28-Jul-05				X
2370-39915	PU:RZ(M)	PAHR	NORTH	AHY	M	25-Jul-05				X
2370-39932	BK(M):PU	BIWI	SITE 3	AHY	F	24-May-05				X
2370-39933	VV(M):PU	YUMA	GADSDEN BEND	AHY	U	17-Jun-05				X
2370-39934	VV(M):PU	YUMA	GADSDEN BEND	AHY	U	17-Jun-05				X

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2370-39935	VV(M):PU	YUMA	GADSDEN BEND	AHY	U	17-Jun-05				X
2370-39951	PU:OZ(M)	PAHR	NORTH	AHY	M	1-Jun-05				X
2370-39952	BB(M):PU	PAHR	UNKNOWN	AHY	M	23-Jul-02	2002	X[5]		X[5]
2370-39953	OB(M):PU	PAHR	SOUTH	AHY	M	2-Jun-05				X
2370-39954	BO(M):PU	MESQ	BUNKER FARM	AHY	M	8-Jun-05				X
2370-39955	BV(M):PU	ROOS	Northshore 1-East	L	M	26-Jun-03				X[9]
2370-39956	PU:ZZ(M)	MUDD	Overton WMA	SY	F	9-Jun-05				X
2370-39957	PU:YB(M)	MESQ	BUNKER FARM	AHY	F	21-Jun-05				X
2370-39958	PU:ZW(M)	PAHR	SOUTH	AHY	F	26-Jun-05				
2370-39959	VB(M):PU	PAHR	NORTH	SY	M	28-Jun-05				X
2370-39960	BW(M):PU	KEPI		AHY	M	29-Jun-05				X
2370-39961	PU:ZR(M)	PAHR	NORTH	AHY	M	30-Jun-05				X
2370-39962	PU:RG(M)	PAHR	NORTH	SY	F	7-Jul-05				X
2370-39963	PU:BG(M)	PAHR		L	M	5-Jul-02				X
2370-39964	BY(M):PU	PAHR	NORTH	AHY	F	8-Jul-05				X
2370-39965	PU:GB(M)	MUDD	Overton WMA	AHY	U	3-Aug-05				X
2370-39966	YB(M):PU	MUDD	Overton WMA	HY	U	3-Aug-05				X
2370-39971	WZ(M):PU	PAHR	NORTH	AHY	U	17-May-05				X
2370-39972	VV(M):PU	IMPE	GREAT BLUE HERON	AHY	U	10-Jun-05				X
2370-39973	VV(M):PU	YUMA	GADSDEN BEND	SY	U	13-Jun-05				X
2370-39974	VV(M):PU	IMPE	HOGE RANCH	SY	U	15-Jun-05				X
2370-39975	WY(M):PU	MUDD	Overton WMA	AHY	M	9-Jul-05				X
2370-39976	PU:KV(M)	MUDD	Overton WMA	SY	M	9-Jul-05				X

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2370-39977	WW(M):PU	PAHR	NORTH	HY	U	29-Jul-05				X
2370-39978	WR(M):PU	PAHR	NORTH	AHY	F	29-Jul-05				X
2370-39979	WD(M):PU	PAHR	NORTH	HY	U	29-Jul-05				X
2370-39980	WO(M):PU	PAHR	NORTH	HY	U	30-Jul-05				X
2370-39981	PU:GW(M)	PAHR	NORTH	HY	U	29-Jul-05				X
2370-40012	OY(M):PU	MESQ	WEST	AHY	M	3-Jun-05				X
2370-40013	PU:WD(M)	PAHR	NORTH	SY	M	22-Jun-05				X
2370-40014	PU:VY(M)	PAHR	NORTH	AHY	F	3-Jul-05				X
2370-40015	PU:WG(M)	PAHR		AHY	M	4-Jun-02				X
2370-40016	UB:PU	PAHR	SOUTH	L	U	21-Jul-05				X
2370-40017	PU:WR(M)	MOME	VR#2	SY	M	26-Jul-05				X
2370-40019	KW(M):PU	PAHR	NORTH	HY	U	31-Jul-05				X
2370-40020	OD(M):PU	PAHR	NORTH	HY	U	2-Aug-05				X
2370-40021	KY(M):PU	PAHR	NORTH	SY	M	2-Aug-05				X
2370-40032	GR(M):PU	BIWI	SITE 4	AHY	M	8-Jun-05				X
2370-40033	VV(M):PU	YUMA	GADSDEN BEND	SY	U	13-Jun-05				X
2370-40034	VV(M):PU	YUMA	GADSDEN BEND	AHY	U	14-Jun-05				X
2370-40035	VV(M):PU	YUMA	GADSDEN BEND	SY	U	14-Jun-05				X
2370-40052	KV(M):PU	BIWI	SITE 3	AHY	M	24-May-05				X
2370-40053	KR(M):PU	BIWI	SITE 3	AHY	U	24-May-05				X
2370-40054	PU:OY(M)	BIWI	SITE 3	SY	M	8-Jun-05				X
2370-40055	GZ(M):PU	TOPO	PC6-1	AHY	F	20-Jun-05				X
2370-40056	PU:OK(M)	TOPO	PIERCED EGG	AHY	M	23-Jun-05				X

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
2390-92348	YY(P):XX	TOPO	1000m	L	F	25-Jul-98	1998		X[3]	
2390-92350	XX:DY(M)	MOME	UNKNOWN	AHY	M	17-May-00	2000	X[2]	X	
2390-92365	RG(M):XX	MUDD	OWMA	L	M	7-Jul-00	2000	X[2]	X	X
2390-92410	XX:DD(P)	MESQ	WEST	AHY	M	29-May-01	2001	X[2]		
2390-92420	XX:ZK(M)	MESQ	WEST	L	M	27-Jun-01	2001, 2002	X[2]		
2390-92421	XX:WR(M)	MESQ	WEST	L	M	27-Jun-01	2001	X	X	X[1]
2390-92427	XX:OW(HP)	MOME	UNKNOWN	L	F	29-Jun-01	2001	X[2]		
2390-92433	XX:ZR(M)	MESQ	WEST	L	M	4-Jul-01	2001	X[2]	X	
2390-92434	UB:XX	MESQ	WEST	L	M	4-Jul-01	2001		X	X
2390-92451	KW(M):XX	MOME	UNKNOWN	L	F	2-Jul-99	1999, 2002[G]		X[2]	
2390-92470	KR(M):XX	MESQ	WEST	L	F	24-Jul-01	2001		X	
2390-92475	XX:WY(M)	MOME	DELTA WEST	L	M	26-Jul-01	2001, 2002[G]	X[2]	X	X
3500-68963	XX:UB	TOPO	HELLBIRD	L	U	7-Jul-04			X	
3500-68968	DW(M):XX	PAHR	SOUTH	HY	U	6-Aug-04			X	
3500-68969	XX:GG(M)	PAHR	SOUTH	HY	U	6-Aug-04			X	
3500-68971[M]	XX:DD(M)	PAHR	SOUTH	AHY	M	17-May-03		X	X	X
3500-68972	GG(M):XX	PAHR	SOUTH	HY	U	6-Aug-04			X	X
INA	Rs:UB	Detected PAHR South 2003	UNKNOWN	AHY	F	INA		X		
INA	UB:XX	Detected MOME North 2003	UNKNOWN	INA	F	INA		X		
INA	KY(HP):XX	Detected MOME VR #1 North 2003	UNKNOWN	INA	F	INA		X		
INA	Bs:undetermined[N]	Detected TOPO Inbetween 2003	UNKNOWN	INA	M	INA		X		
INA	?? banded:EE [N]	Detected MESQ West 2004	UNKNOWN	INA	F	INA			X	
none[F]	WR(M):UB	PAHR	UNKNOWN	AHY	F	18-Jul-00	2000	X[5]	X	

Current Federal Band Number	Current Color Combination[A]	Study Area Originally Banded[B]	Site Originally Banded	Age When Banded[C]	Sex[D]	Date Originally Banded	Years Detected			
							Pre-2003[E]	2003	2004	2005
	RR(M):UB	PAHR	NORTH	AHY	F	18-Jun-04			X	X
	Bs:banded	Detected TOPO Inbetween 2005.			M					X
	no foot:EE	detected Mesq West 2005			M					X
	banded:XX	detected Mesq West 2005			M					X
	banded:XX	detected Mesq West 2005			F					X

A **Current Color Combo**: EE = electric yellow federal band; PU = pumpkin federal band; Vs = violet federal band; XX = standard silver federal band; BEs = berry federal band; Zs = gold federal band; Rs = red federal band; Bs = blue federal band; G = green; D = blue; B = light blue; Z = gold; R = red; K = black; Y = yellow; W = white; V = violet; O = orange; P = hot pink. Color combinations are read as the bird's left leg and right leg, top to bottom; two or three letters designate every band; color band designations for right and left legs are separated with a colon; bands stacked one over the over are separated with a slash (/). (M) following a color code designates the band as a metal pin-striped band; (P) following a color code designates the band as a full plastic band; (HP) following a color code designates the band as a half-plastic band, cut to half the height of a full plastic band.

B **Study Area Originally Banded**: PAHR = Pahranagat National Wildlife Refuge, NV; LIFI = Virgin River/Beaver Dam Wash confluence, Littlefield, AZ; MESQ = Mesquite, NV; MOME = Mormon Mesa, NV; MUDD = Muddy River Delta at Lake Mead, Overton Wildlife Management Area, NV; GRCA = Grand Canyon National Park, AZ; TOPO = Topock Marsh, Havasu National Wildlife Refuge, AZ; BIWI = Bill Williams River National Wildlife Refuge, AZ; YUMA = Yuma, AZ; GADS = Gadsden Bend area along CO River, AZ; 9 E OF ALAMO = bird captured and banded 9 miles east of Alamo, NV (per Federal Bird Banding Laboratory); KEPI = Key Pittman Wildlife Management Area, NV; ROOS = Roosevelt Lake Reservoir, AZ.

C **Age When Banded**: AHY = 2 years or older, SY = 2 years old, HY = hatch year, born that year, L = nestling, born that year.

D **Sex**: F = female, M = male, U = unknown.

E Location for each year detected pre-2003 is the "Study Area Originally Banded" unless otherwise noted.

F Original federal band (2140-66621) removed due to a leg injury; no federal band on right leg.

G Detected at Mesquite West in 2002.

H Site is located between Gila River Site 2 and Gila River Site 1.

I Original federal band (2190-76604) replaced.

J Individual known to have died before fledging.

K Original federal band (2140-66517) replaced.

L Original federal band (2140-66775) replaced.

M Original federal band (2320-31451) replaced.

N Color combination could not be determined due to a leg injury masking the band.

INA = information not available.

1 Mormon Mesa

2 Mesquite

3 Topock

4 Exhibited within season movement in 2003, Mormon Mesa then to Mesquite

5 Pahranagat

6 Key Pittman Wildlife Management Area

7 Littlefield

8 Exhibited within season movement in 2005, Mesquite then to Mormon Mesa

9 Muddy River Overton WMA

APPENDIX D

Hydrographs for Piezometers at Habitat Monitoring Sites

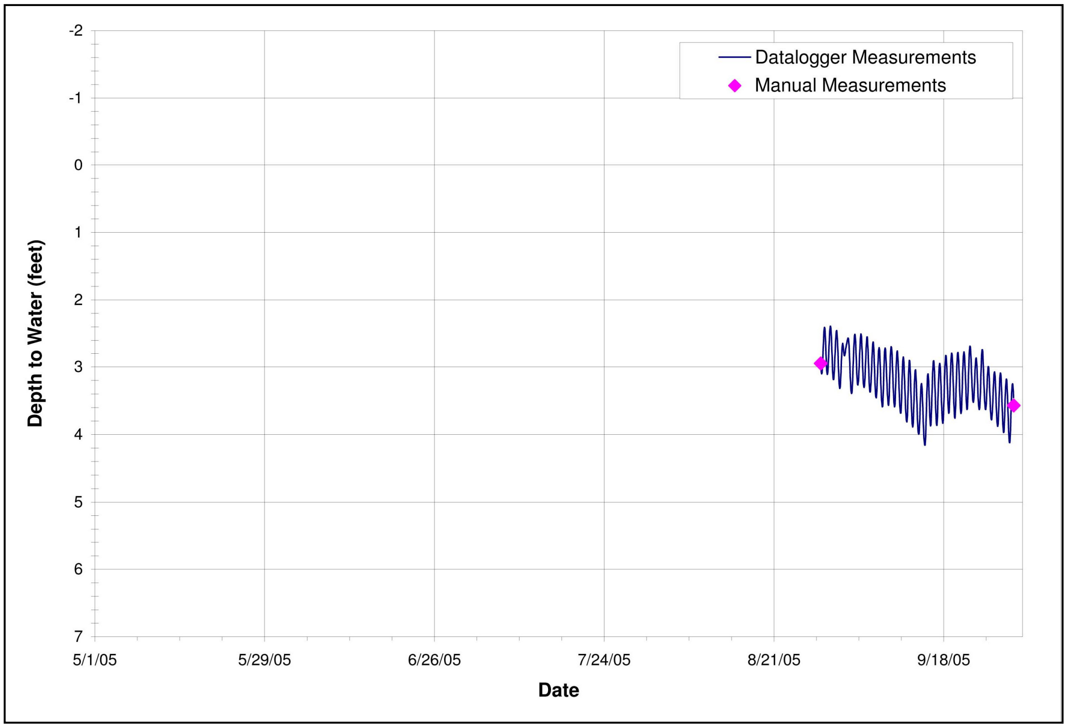


Figure D1. Hydrograph for piezometer at Blankenship Bend.

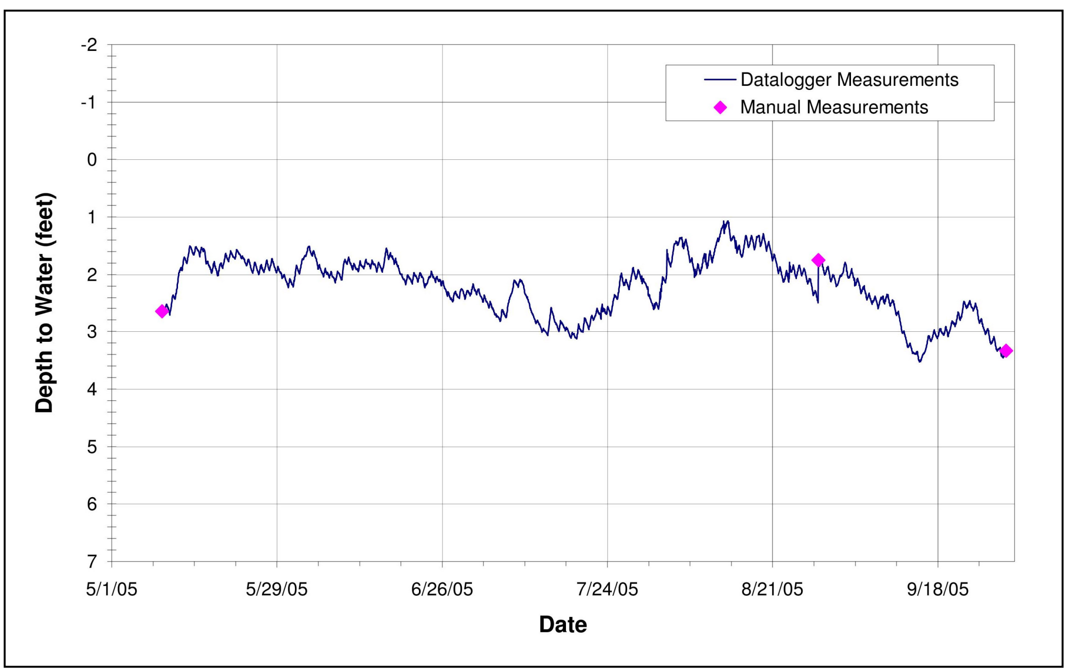


Figure D2. Hydrograph for piezometer at Havasu NE.

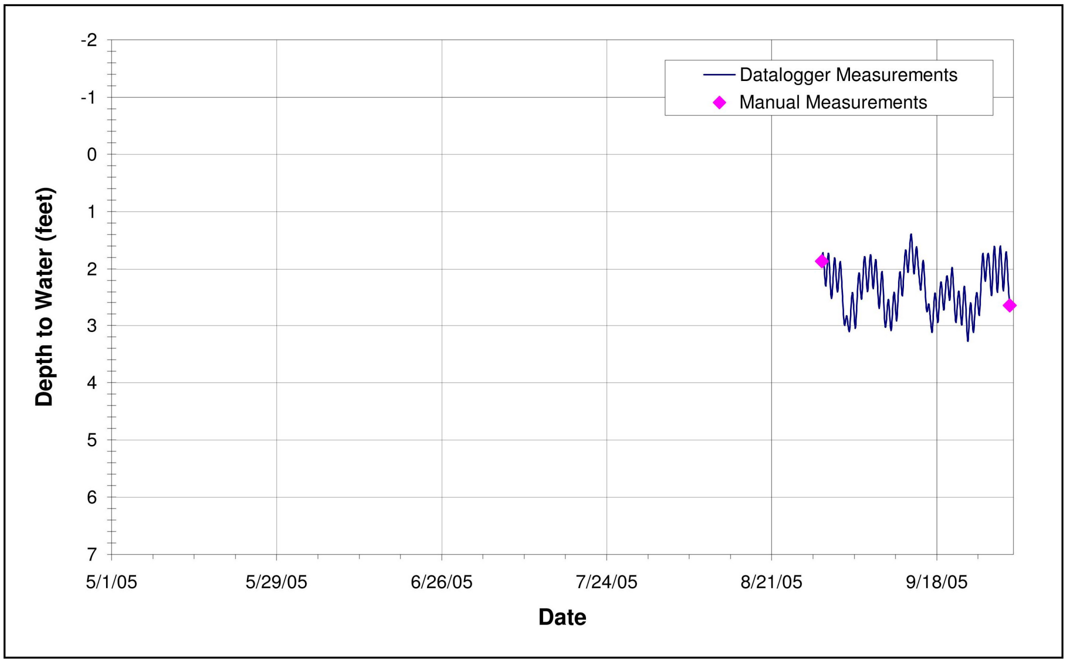


Figure D3. Hydrograph for piezometer at Ehrenberg.

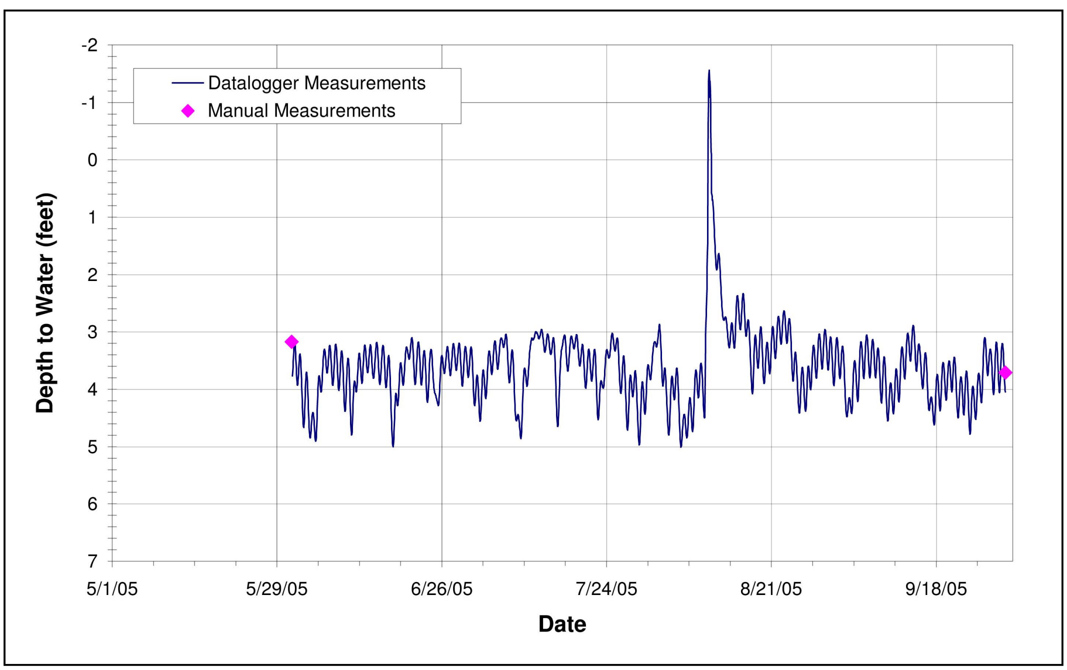


Figure D4. Hydrograph for piezometer at Three Fingers Lake.

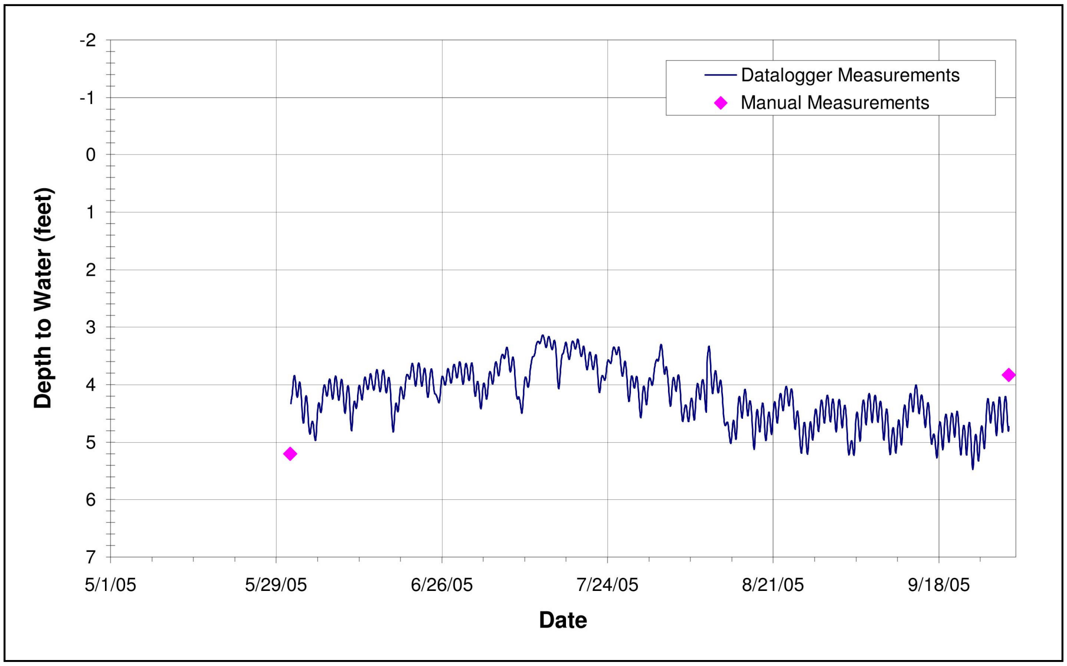


Figure D5. Hydrograph for piezometer at Cibola Lake.

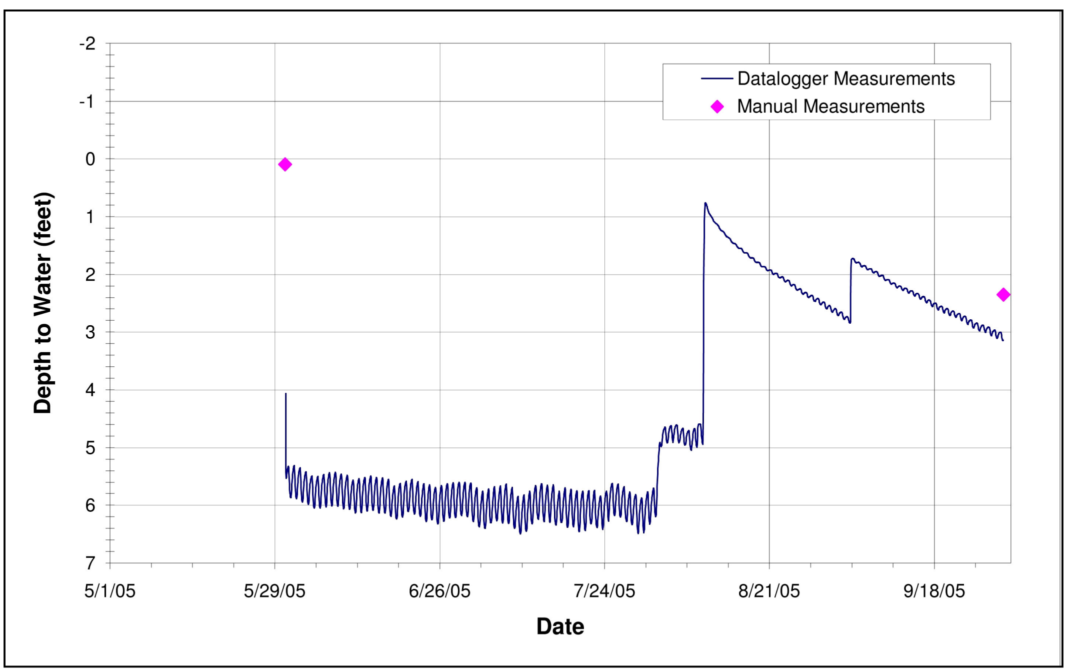


Figure D6. Hydrograph for piezometer at Walker Lake.

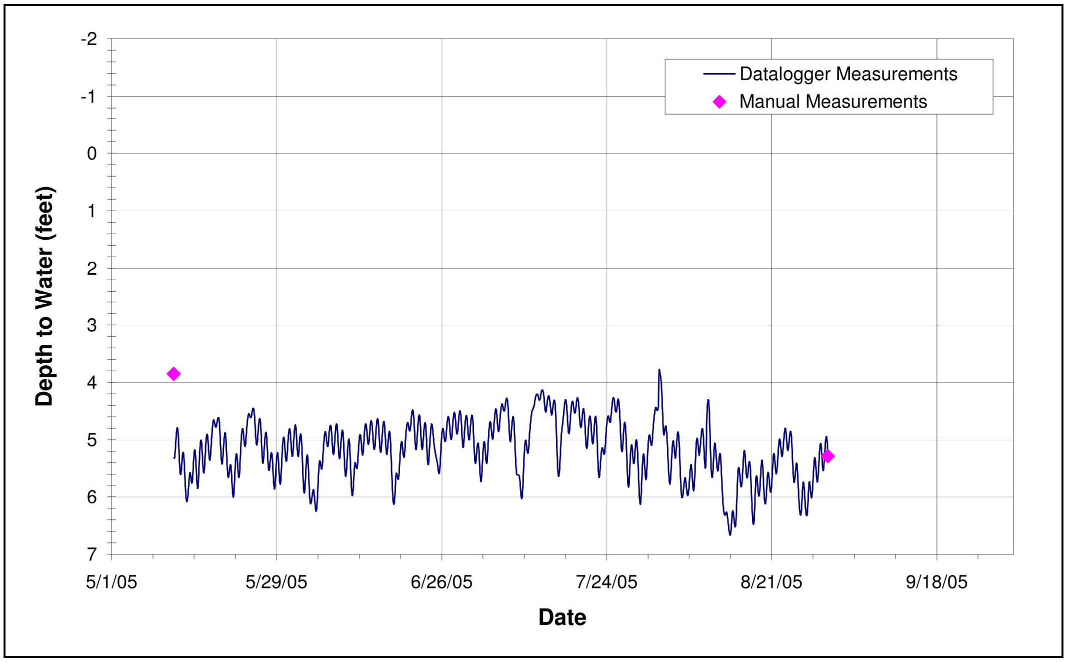


Figure D7. Hydrograph for piezometer at Paradise.

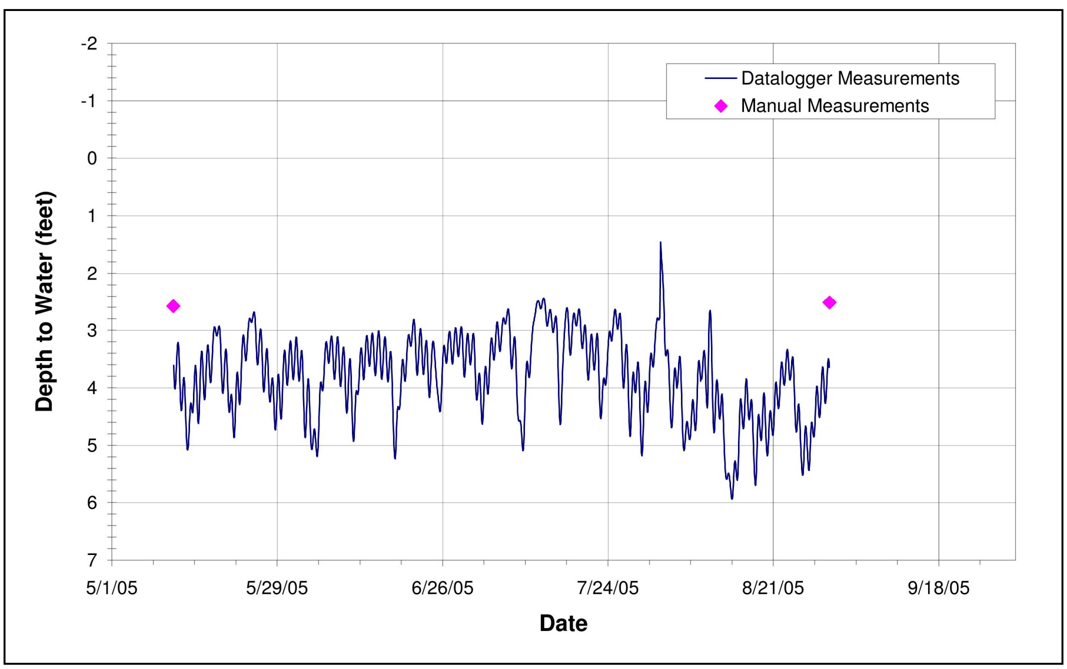


Figure D8. Hydrograph for piezometer at Hoge Ranch.

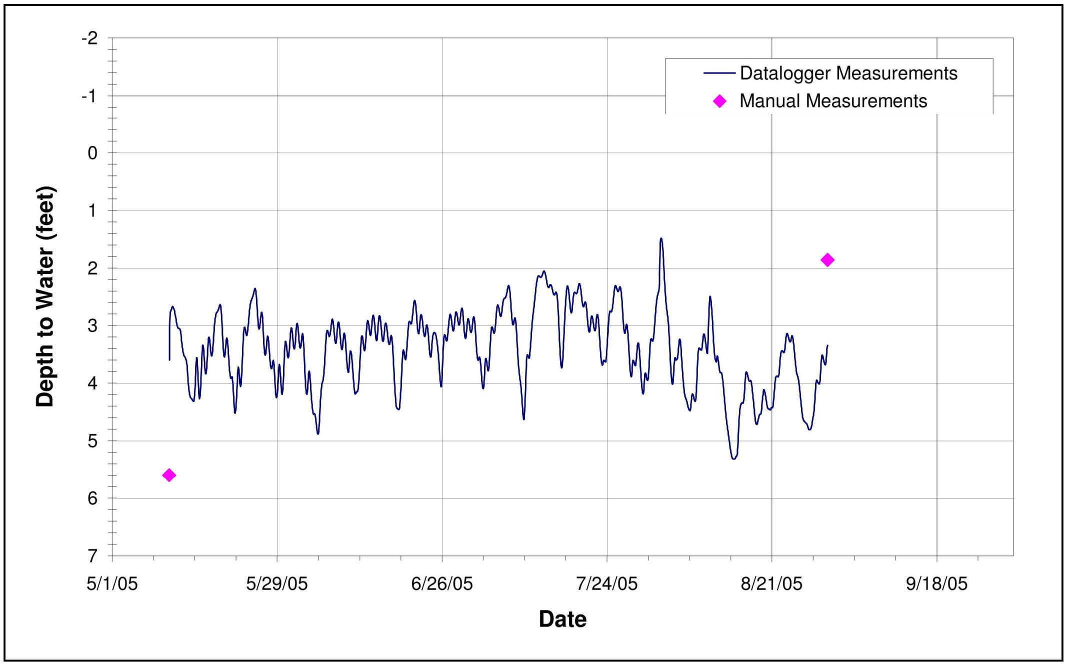


Figure D9. Hydrograph for piezometer at Rattlesnake.

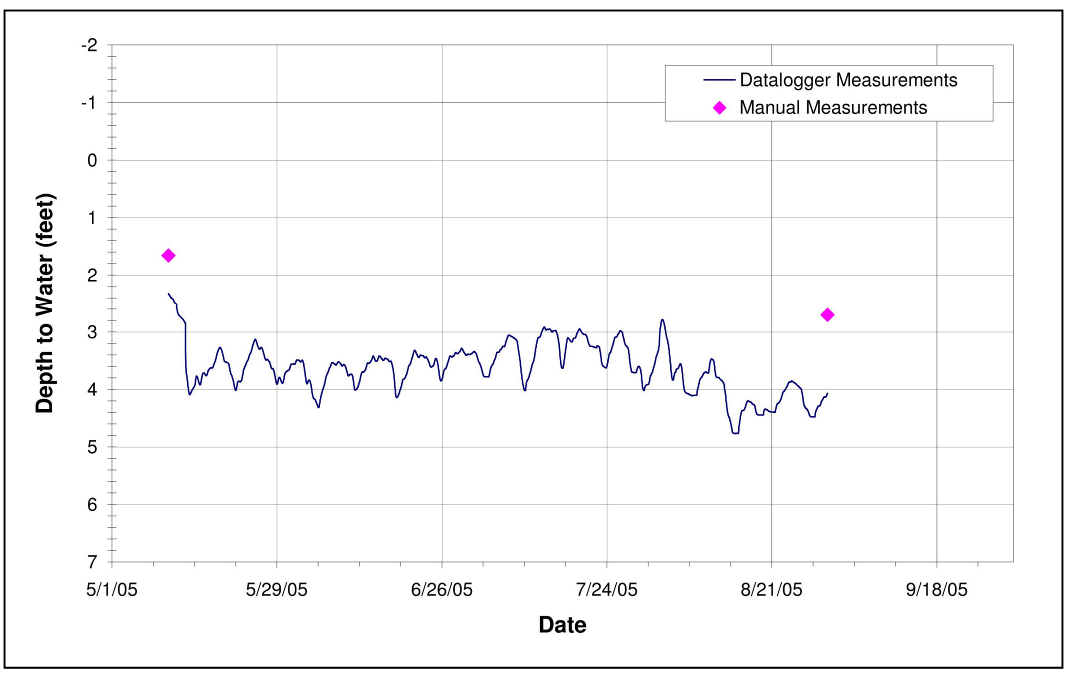


Figure D10. Hydrograph for piezometer at Clear Lake.

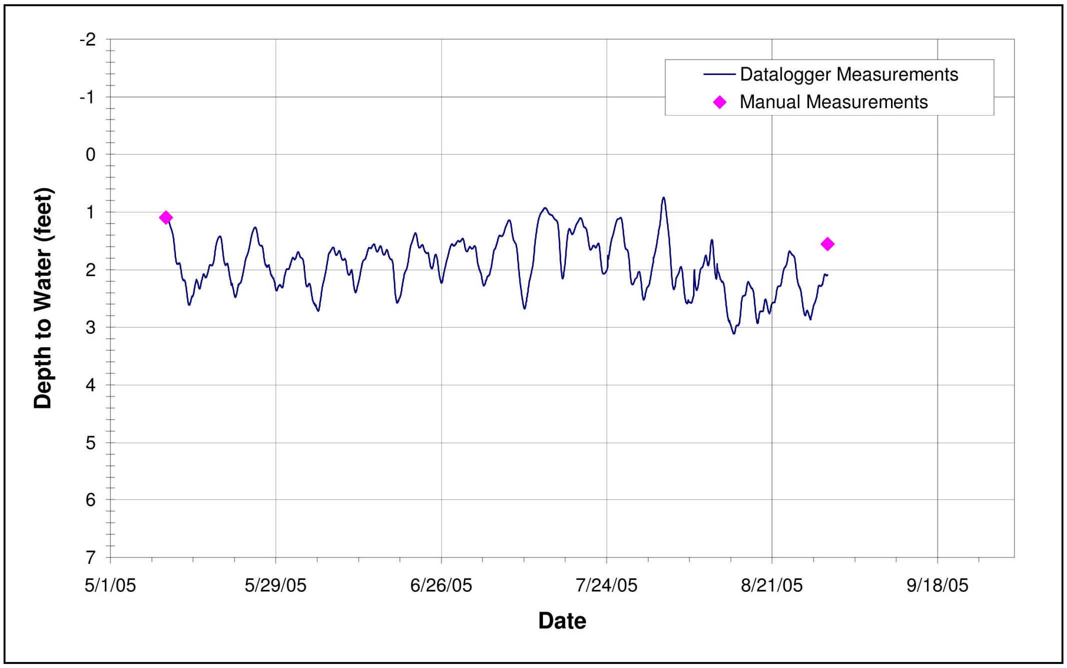


Figure D11. Hydrograph for piezometer at Ferguson Lake.

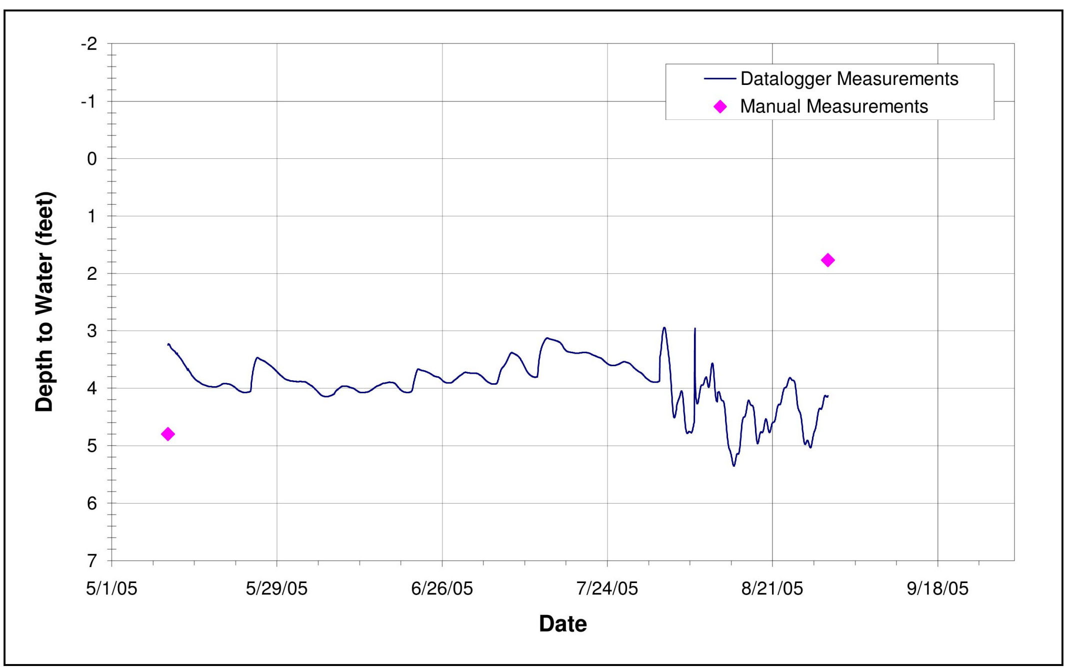


Figure D12. Hydrograph for piezometer at Ferguson Wash.

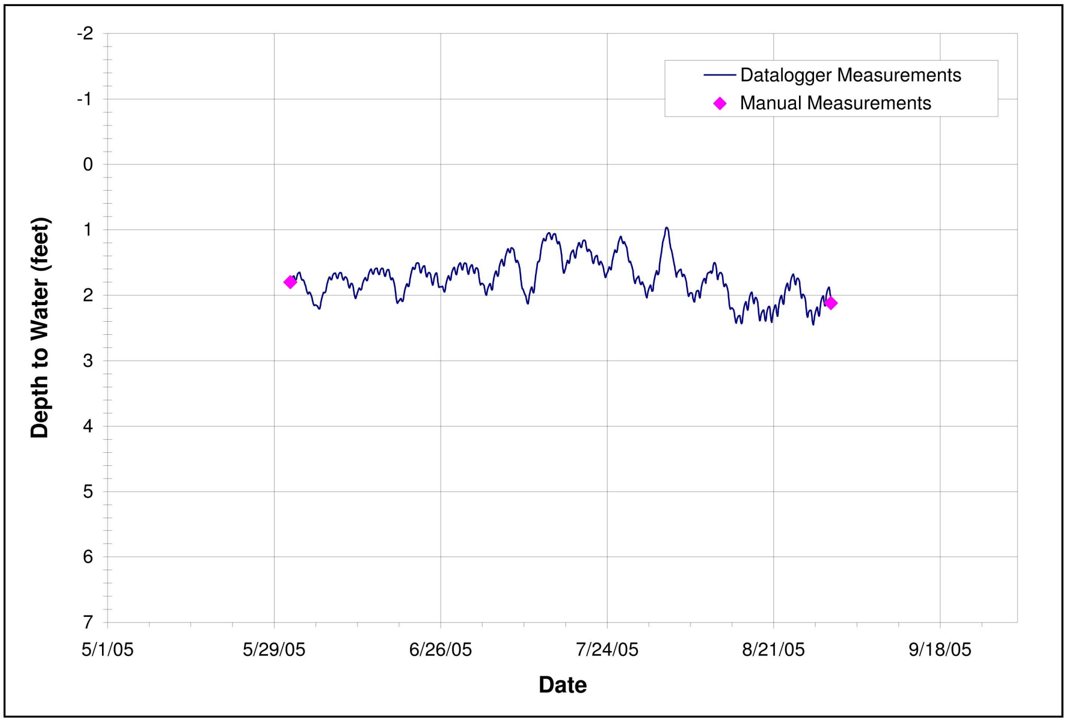


Figure D13. Hydrograph for piezometer at Great Blue Heron.

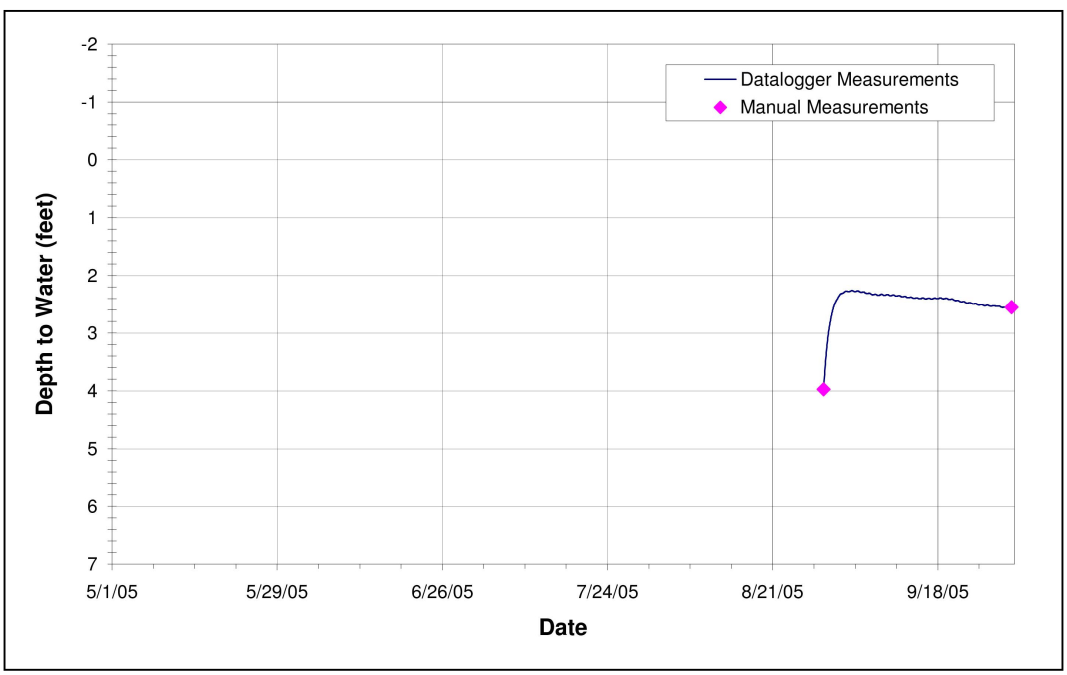


Figure D14. Hydrograph for piezometer at Mittry West.

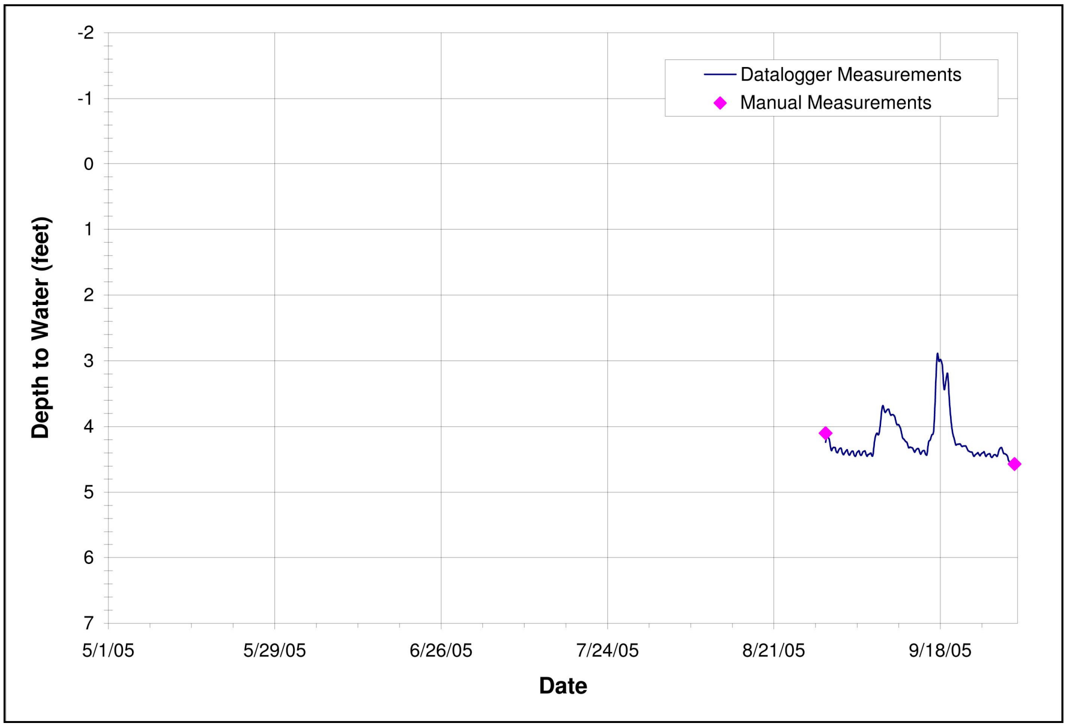


Figure D15. Hydrograph for piezometer at Gila Confluence.

APPENDIX E

Linear Regression Plots for Average Soil Moisture vs. Average Water Level

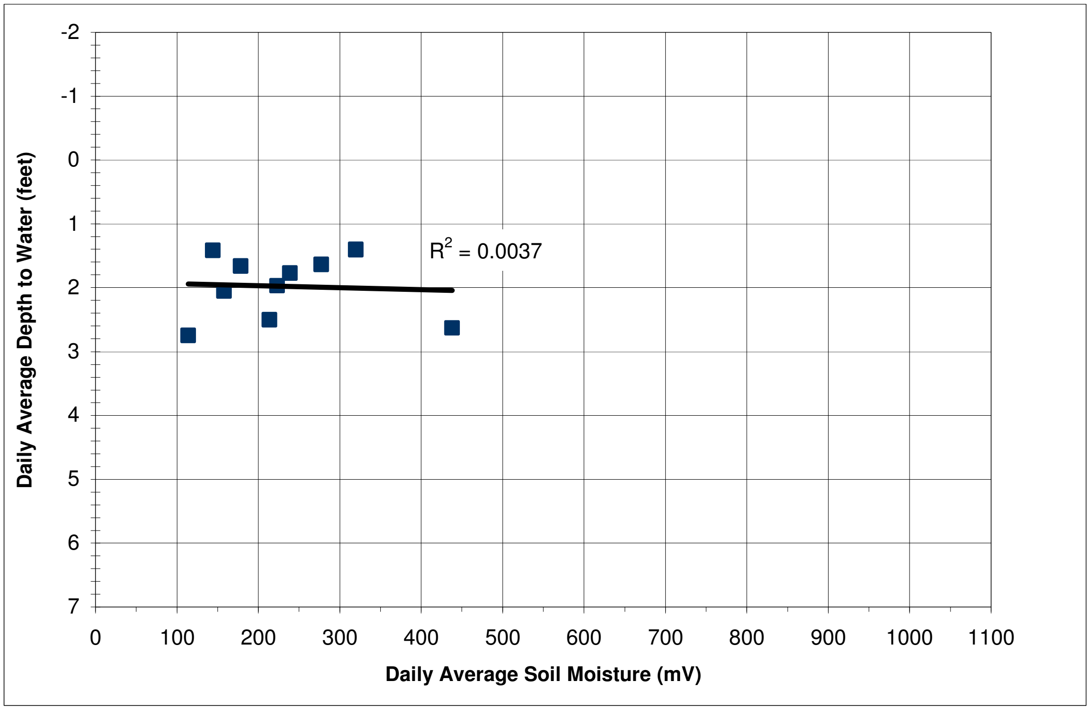


Figure E1. Average soil moisture vs. average water level for Havasu NE.

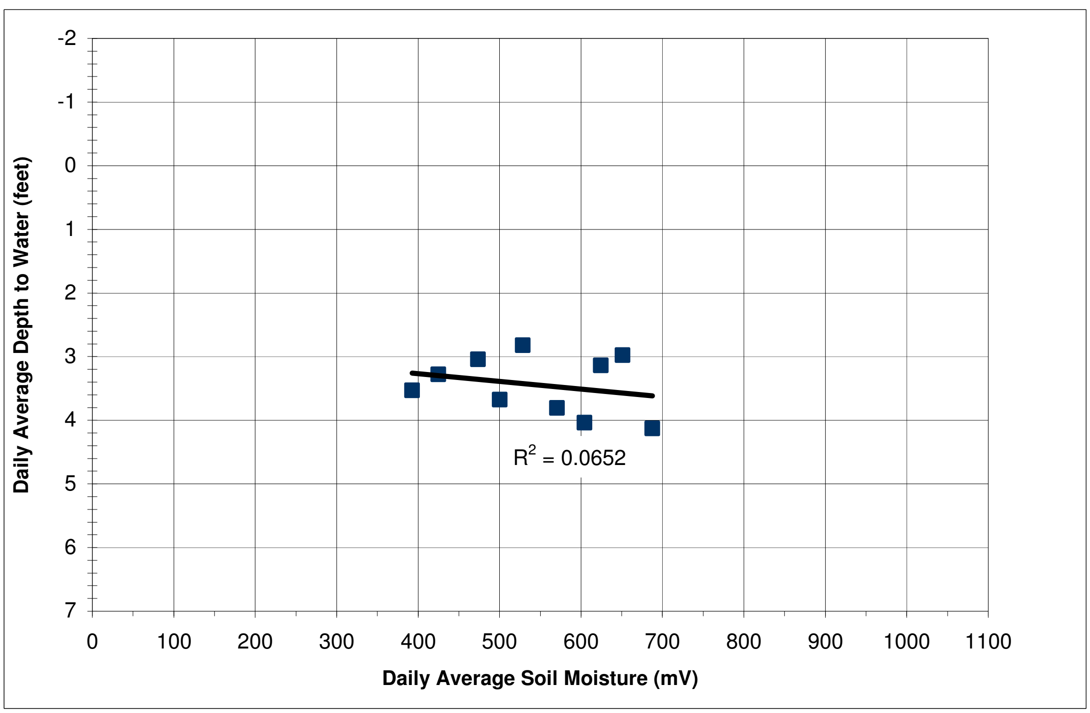


Figure E2. Average soil moisture vs. average water level for Three Fingers.

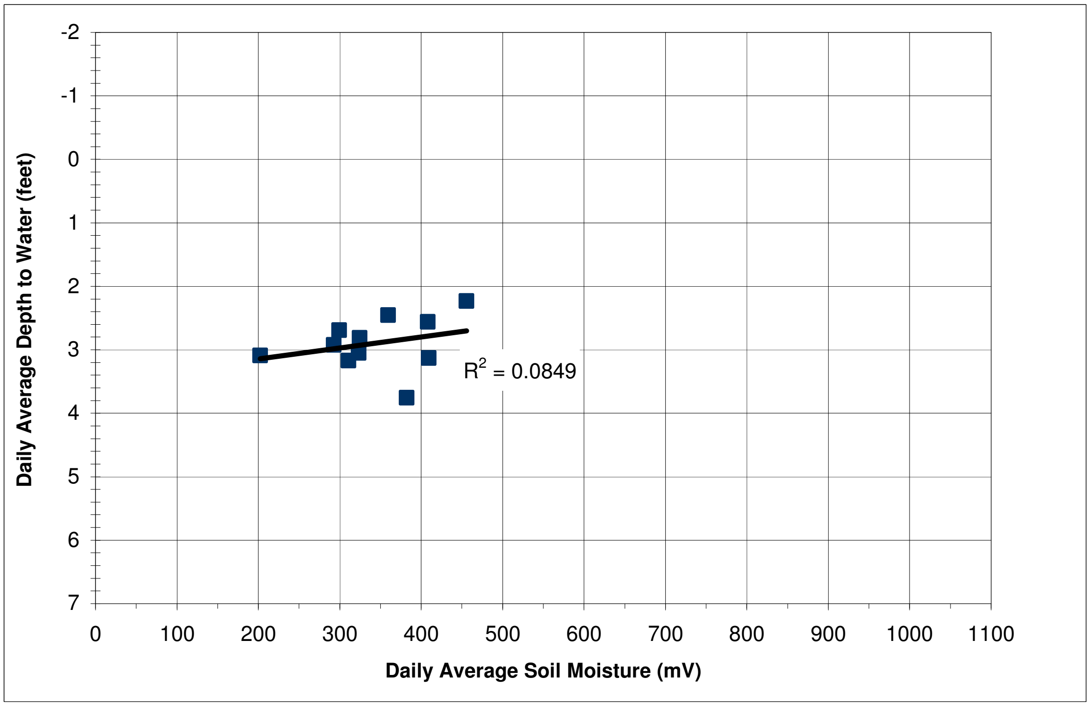


Figure E3. Average soil moisture vs. average water level for Cibola Lake.

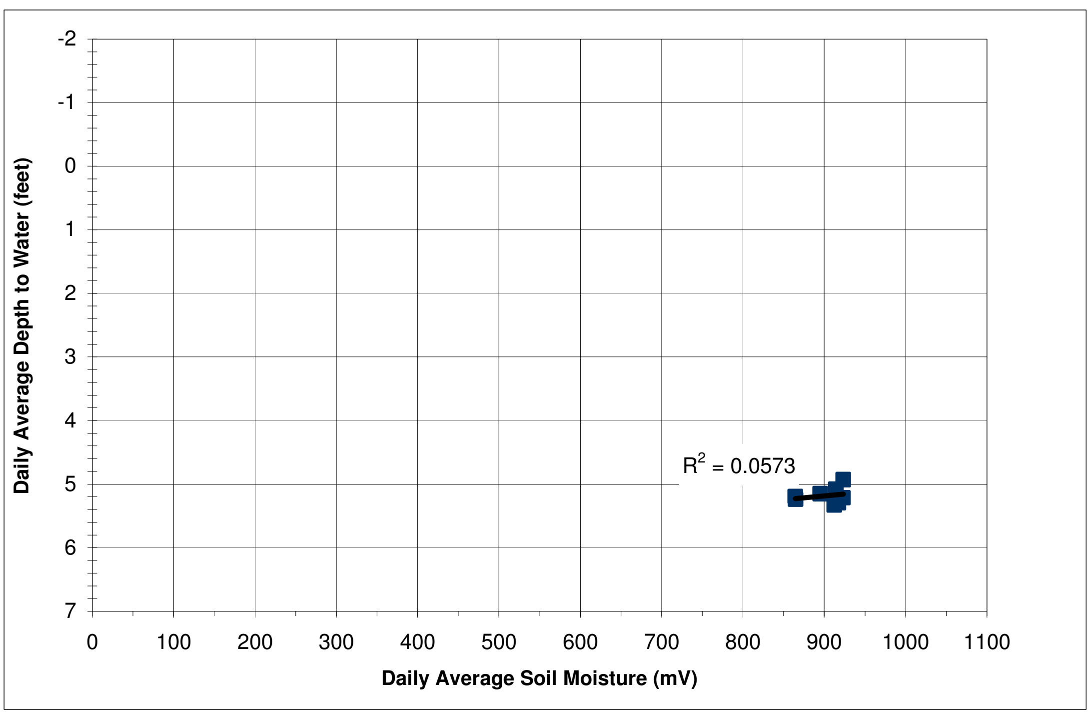


Figure E4. Average soil moisture vs. average water level for Walker.

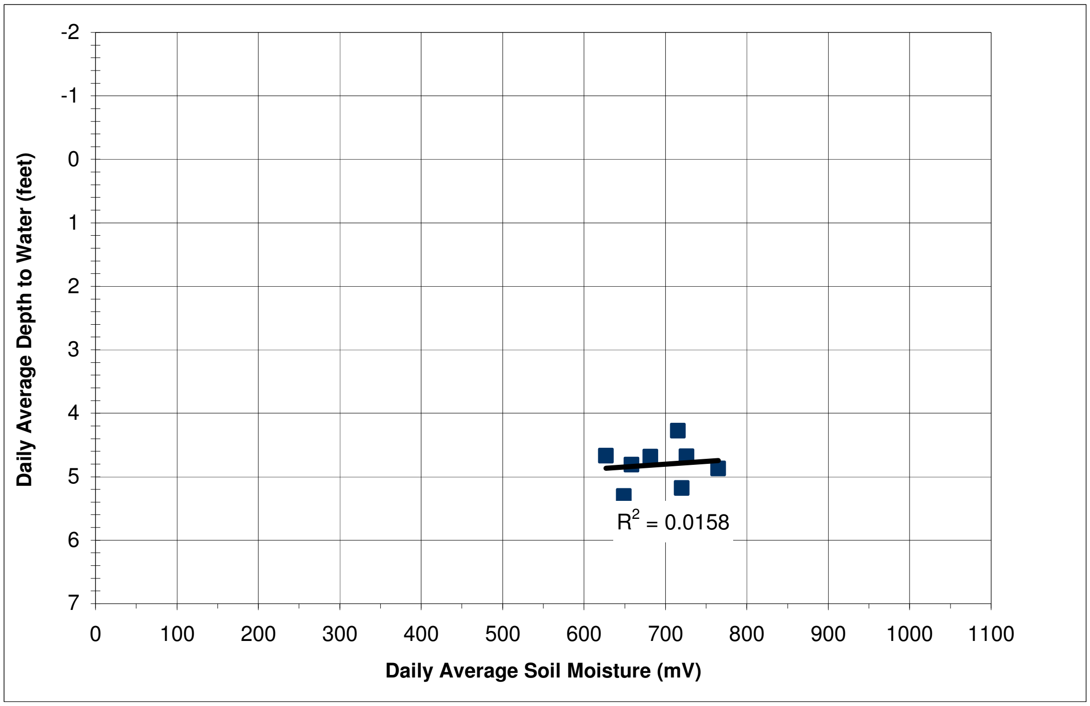


Figure E5. Average soil moisture vs. average water level for Paradise.

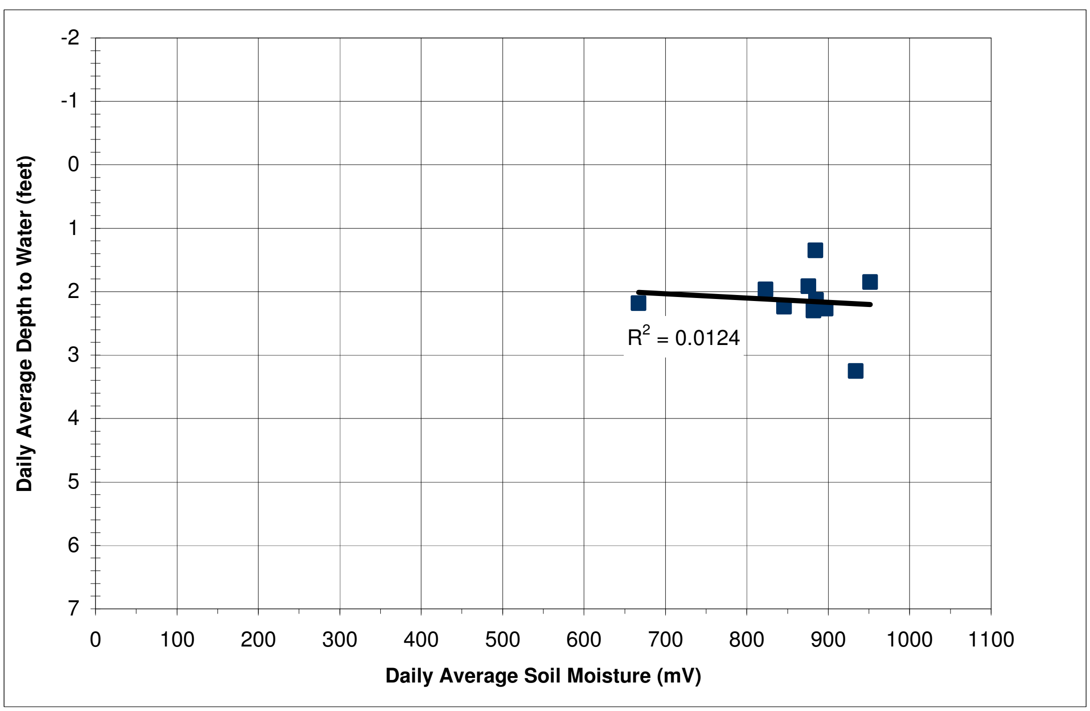


Figure E6. Average soil moisture vs. average water level for Hoge Ranch.

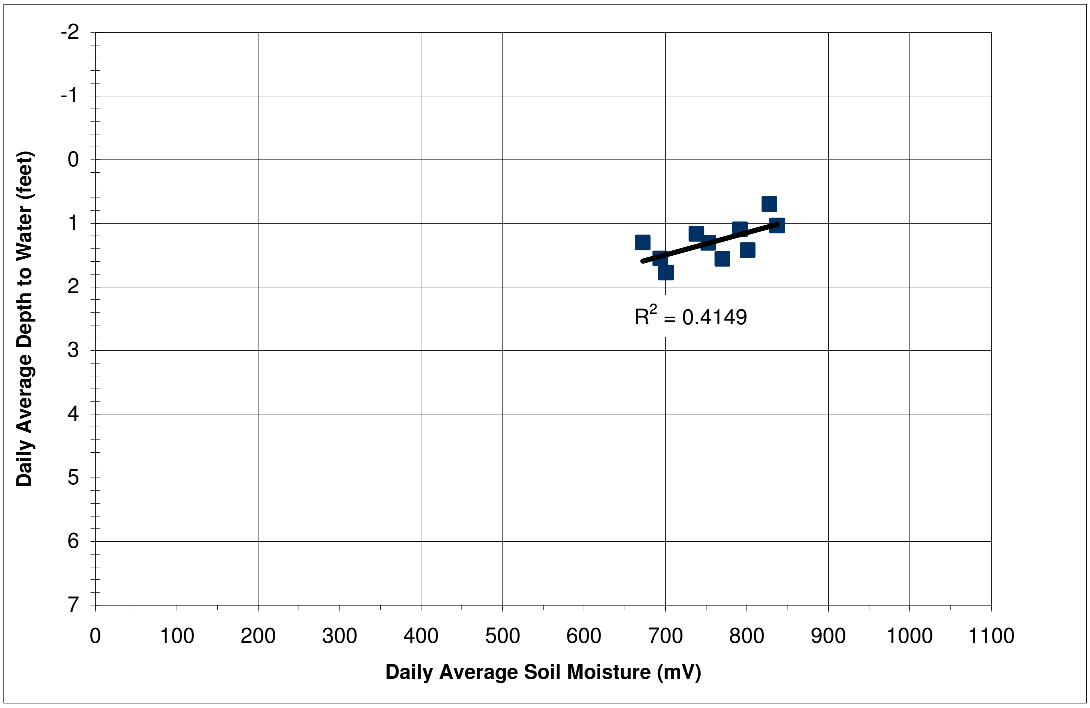


Figure E7. Average soil moisture vs. average water level for Rattlesnake.

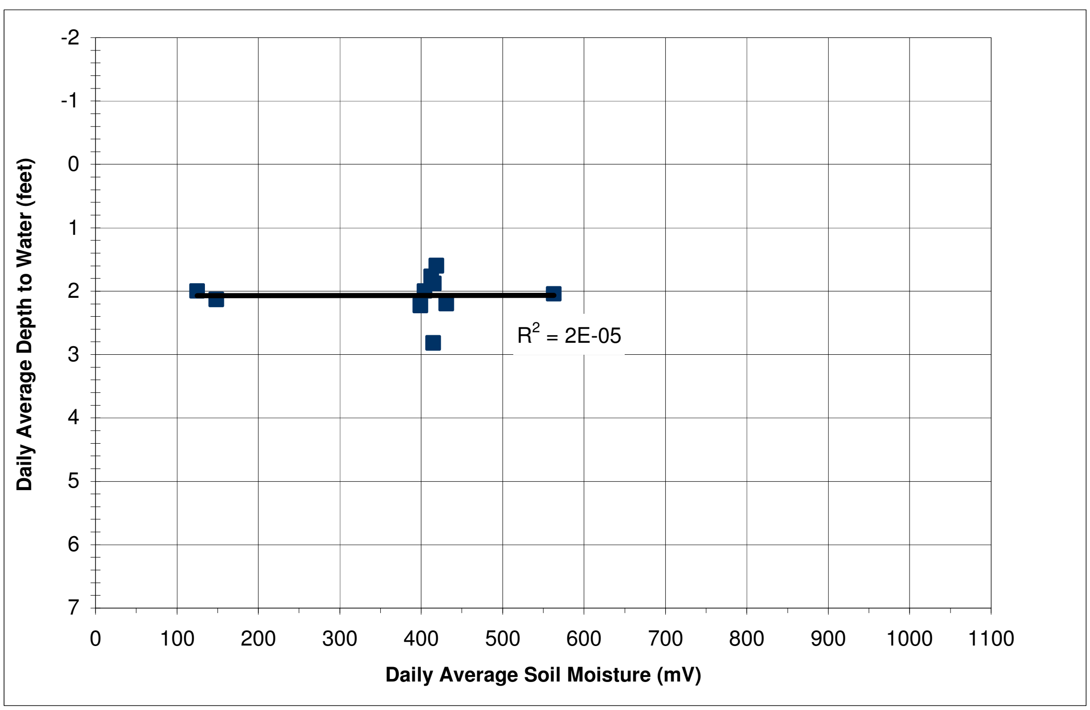


Figure E8. Average soil moisture vs. average water level for Clear Lake.

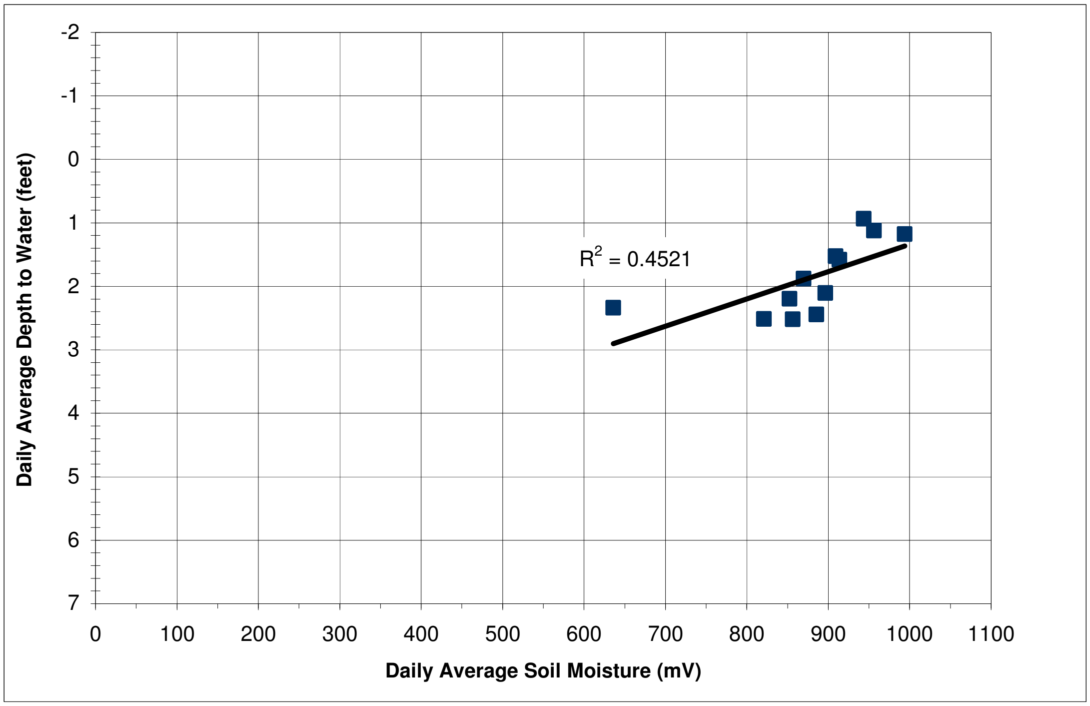


Figure E9. Average soil moisture vs. average water level for Ferguson Lake.

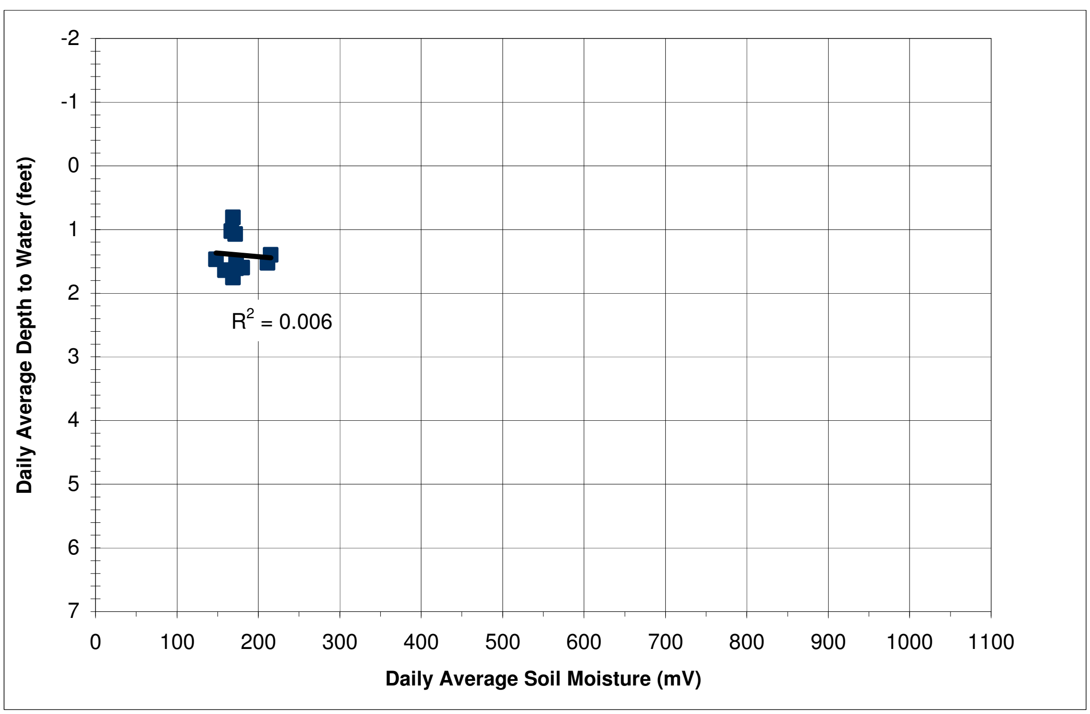


Figure E10. Average soil moisture vs. average water level for Ferguson Wash.

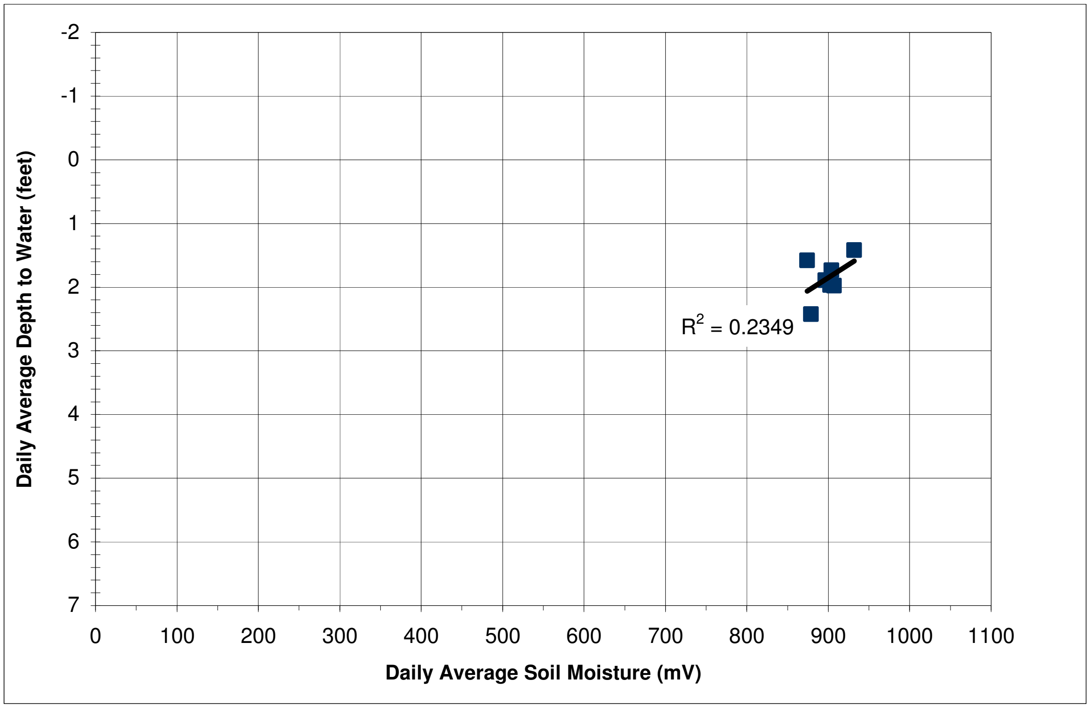


Figure E11. Average soil moisture vs. average water level for Great Blue Heron.

APPENDIX F

Linear Regression for Average Absolute Humidity vs. Average Water Level

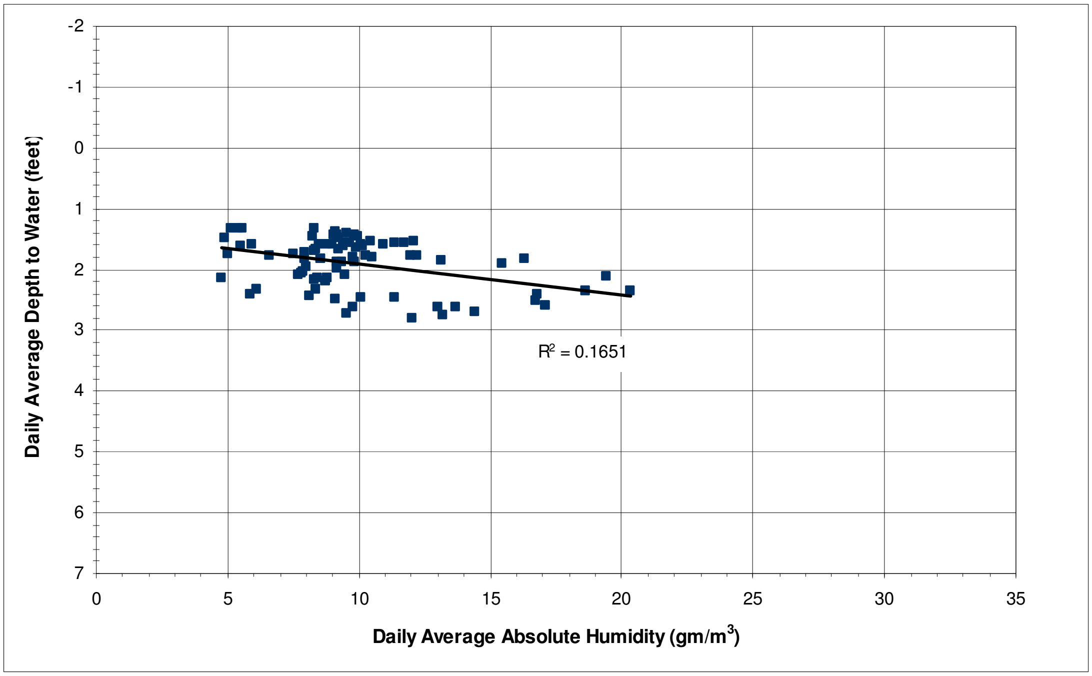


Figure F1. Linear regression of average absolute humidity vs. average piezometer water level, Havasu NE, 2005.

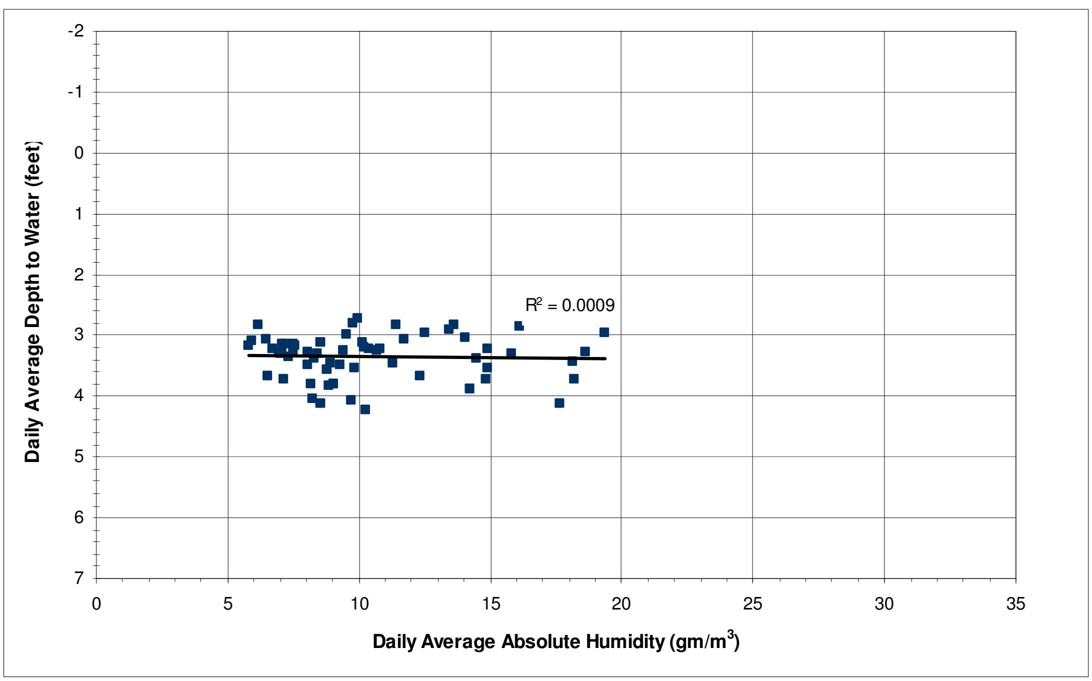


Figure F2. Linear regression of average absolute humidity vs. average piezometer water level, Three Fingers Lake, 2005.

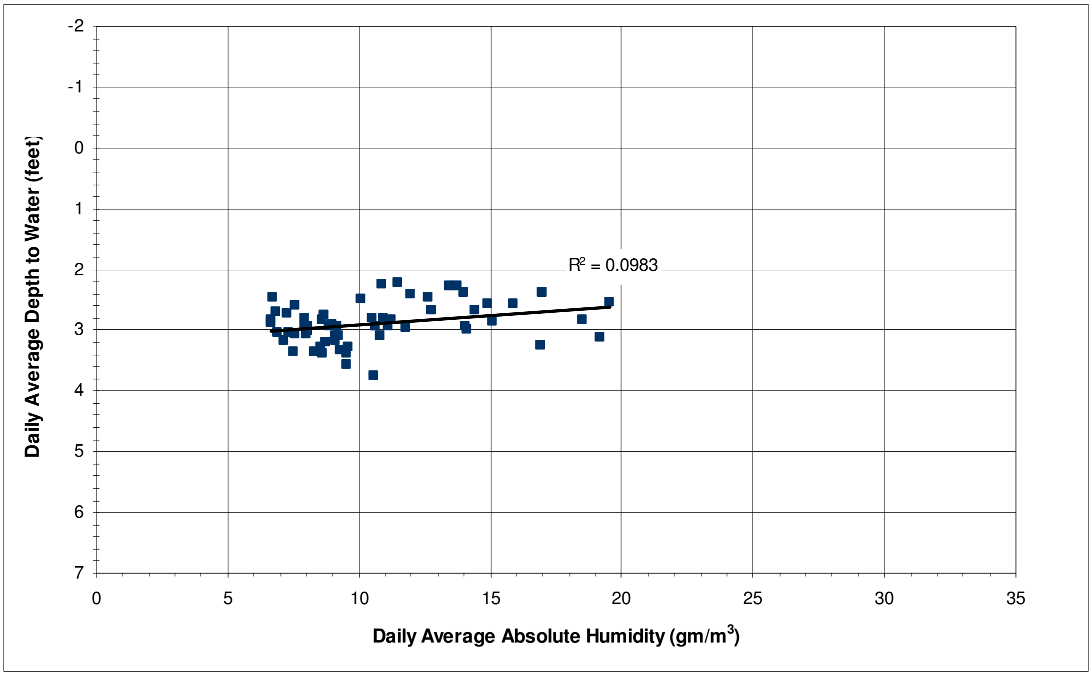


Figure F3. Linear regression of average absolute humidity vs. average piezometer water level, Cibola Lake, 2005.

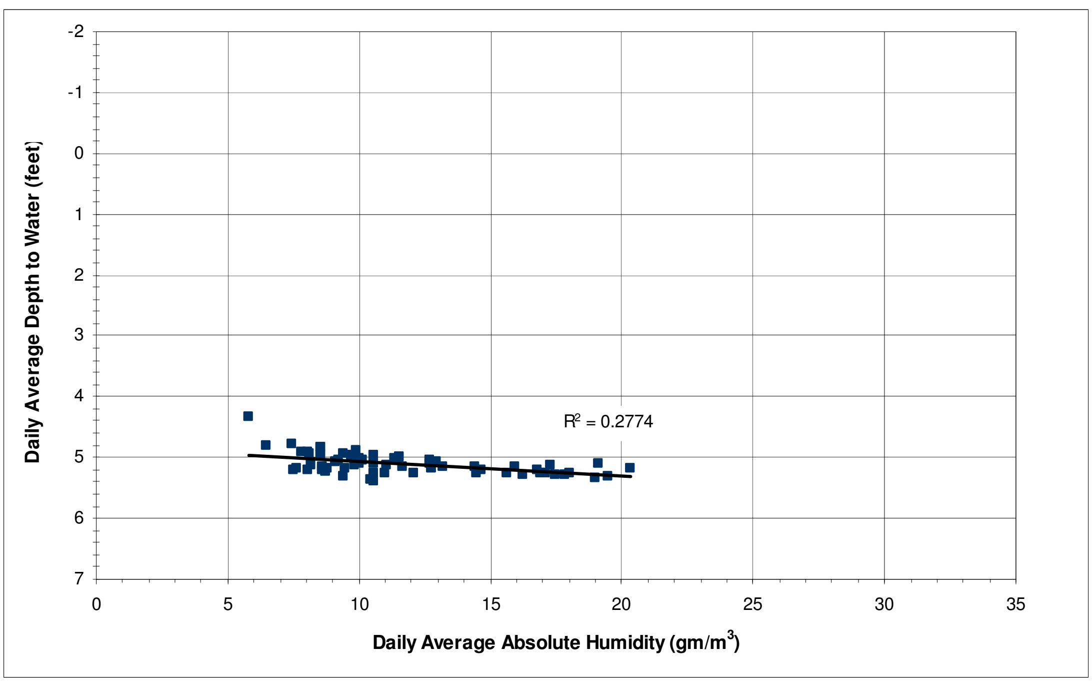


Figure F4. Linear regression of average absolute humidity vs. average piezometer water level, Walker Lake, 2005.

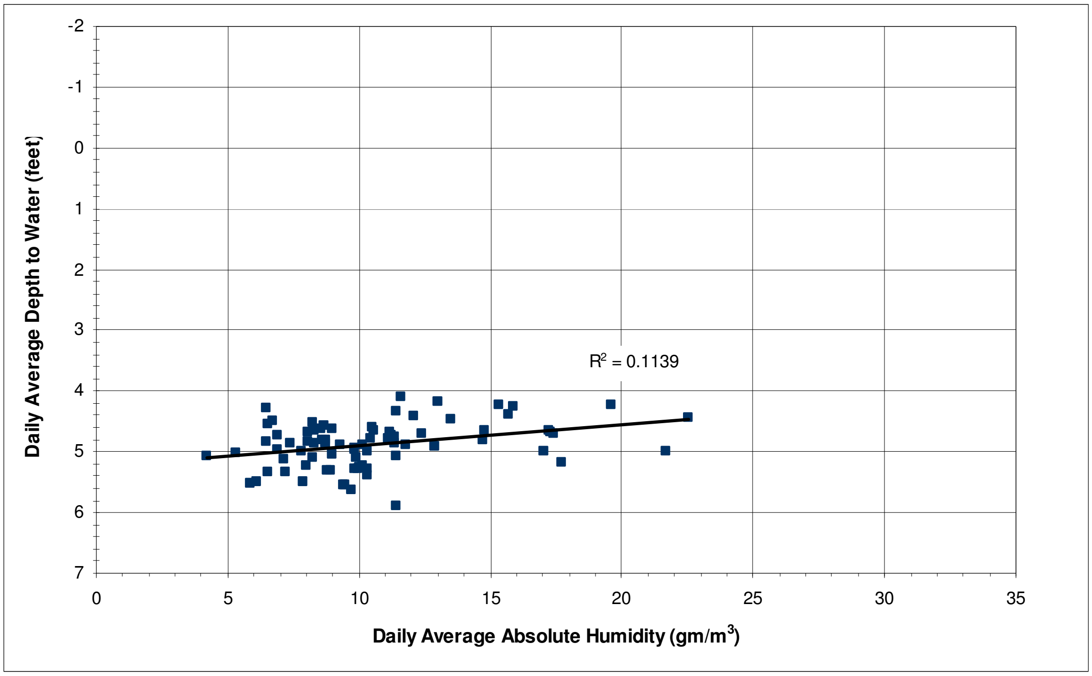


Figure F5. Linear regression of average absolute humidity vs. average piezometer water level, Paradise, 2005.

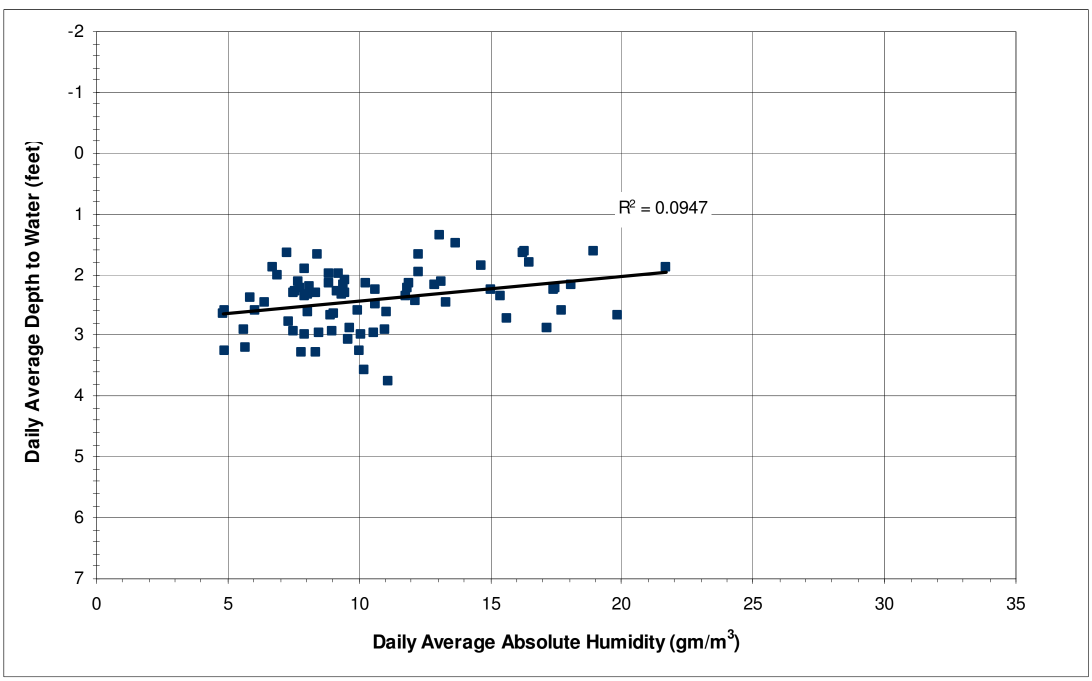


Figure F6. Linear regression of average absolute humidity vs. average piezometer water level, Hoge Ranch, 2005.

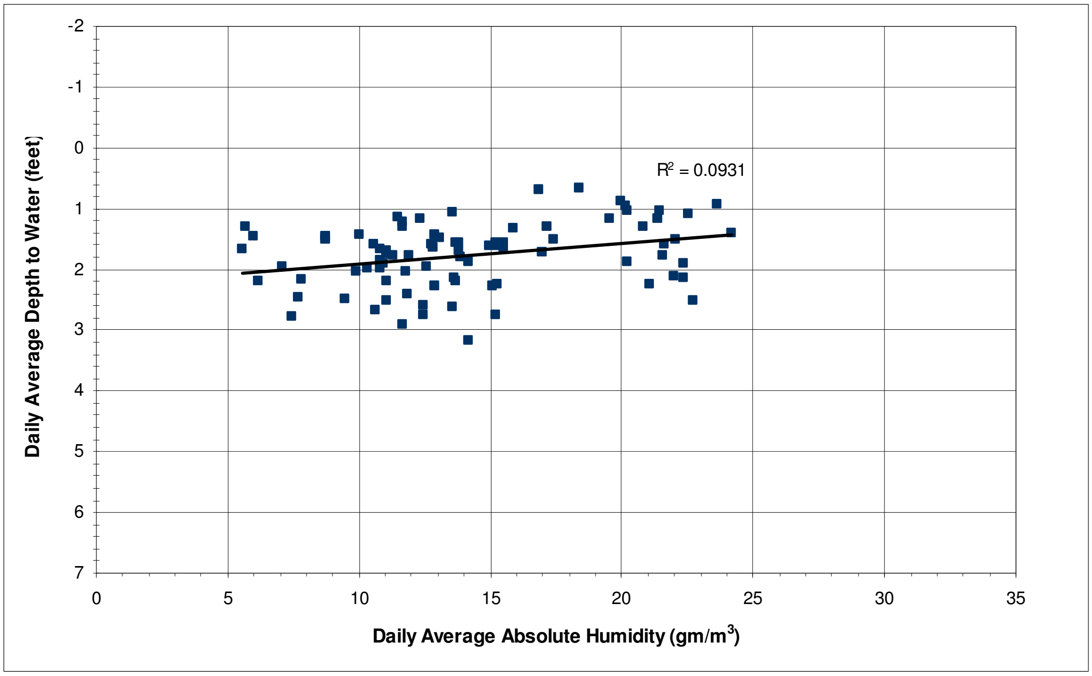


Figure F7. Linear regression of average absolute humidity vs. average piezometer water level, Rattlesnake, 2005.

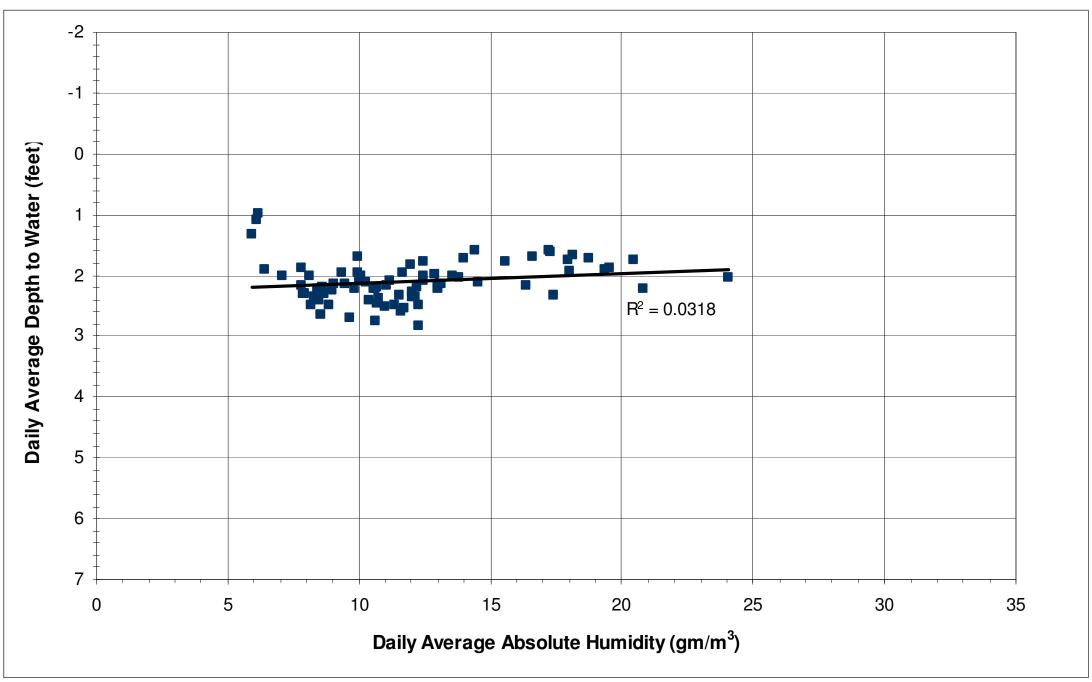


Figure F8. Linear regression of average absolute humidity vs. average piezometer water level, Clear Lake, 2005.

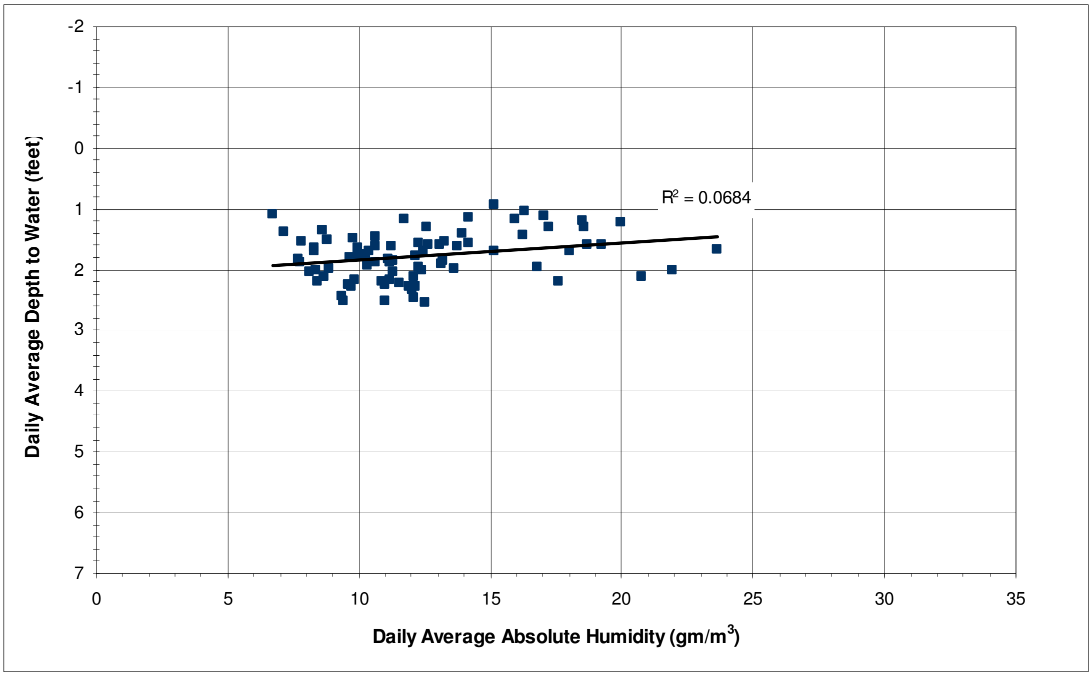


Figure F9. Linear regression of average absolute humidity vs. average piezometer water level, Ferguson Lake, 2005.

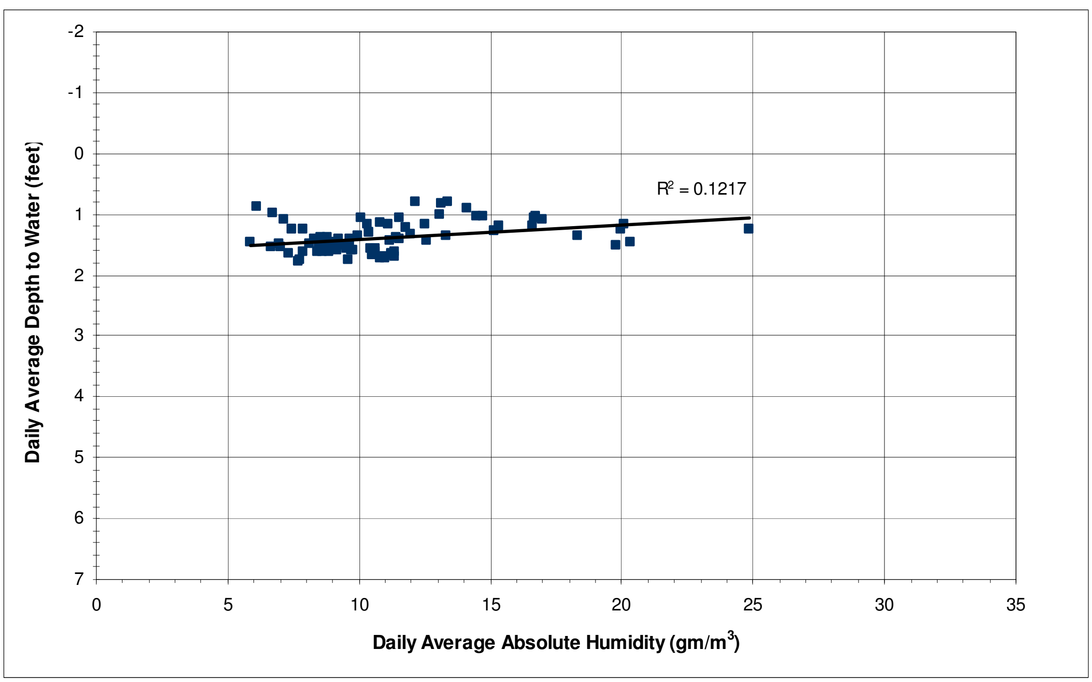


Figure F10. Linear regression of average absolute humidity vs. average piezometer water level, Ferguson Wash, 2005.

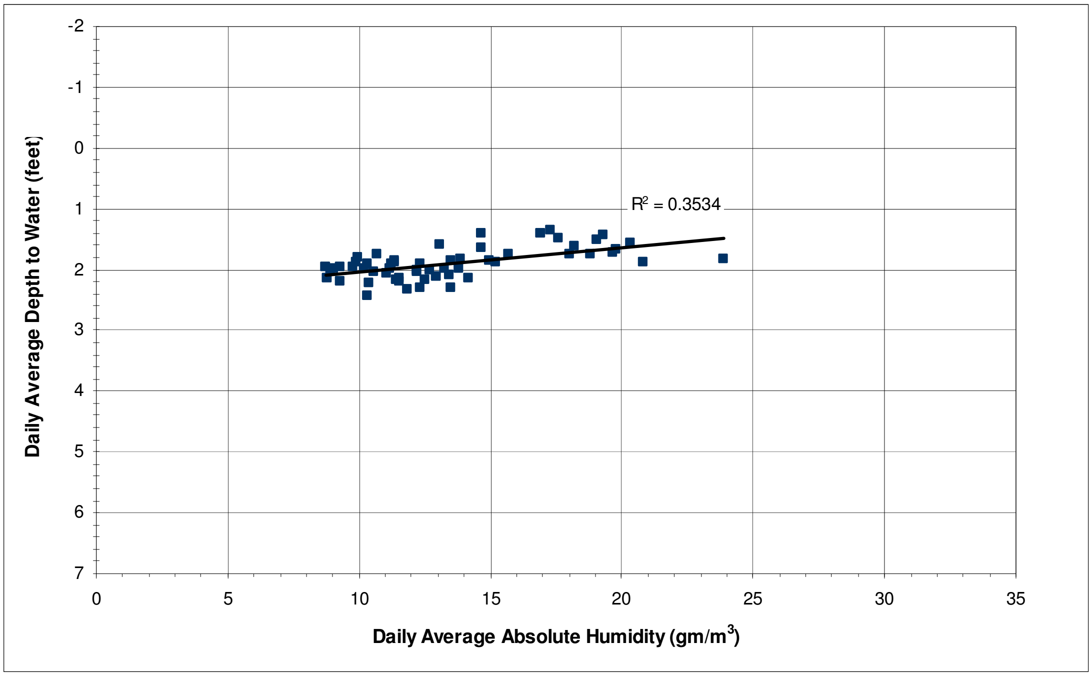


Figure F11. Linear regression of average absolute humidity vs. average piezometer water level, Great Blue Heron, 2005.

APPENDIX G

Contributing Personnel

Contributor	**Role**
Steven W. Carothers, Ph.D.	Principal-in-Charge
Mary Anne McLeod, M.S.	Project Manager/Scientist/Field Supervisor
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Wendy Langeberg, M.S.	Statistician
Glenn A. Dunno, M.A.	GIS Specialist
Lisa R. Dickerson	Project Administrator/Database Design
Jessica Maggio	Administrative Assistant/Data Entry
Beth Moser	Administrative Assistant/Data Entry
Melody Ward	Data Entry
Dorothy A. House, M.A.	Technical Editor
Katie Stumpf	Field Coordinator/Data Entry
Allyson Beckman, M.S.	Field Coordinator
Clifford B. Cordy, Ph.D.	Field Coordinator
Leah Gibbons, M.S.	Bander/Nest Monitor
Sarah Nichols	Bander/Nest Monitor
Josh Shramo	Bander/Nest Monitor
Andrew Spencer	Bander/Nest Monitor
Zachary Rowe	Bander/Nest Monitor
Wendy Austin	Surveyor/Nest Monitor
Javan Bauder	Surveyor/Nest Monitor
Robert (Todd) Eggert	Surveyor/Nest Monitor
Jessica Eyster	Surveyor/Nest Monitor
Timothy Hauck	Surveyor/Nest Monitor
Erica Henry	Surveyor/Nest Monitor
Blaik Pulley	Surveyor/Nest Monitor
Robert Bates	Surveyor
Matthew Dresser	Surveyor
Katie Eaton	Surveyor
Jennifer Gerding	Surveyor
David Hadersbeck	Surveyor
Morgan Strachan	Surveyor

APPENDIX H

Errata from McLeod et al. 2005

The following text and table replaces the corresponding section in Chapter 3, page 75.

ADULT BETWEEN-YEAR RETURN AND DISPERSAL

In 2003 we identified 55 adult, resident willow flycatchers at the life history study areas and Bill Williams, of which 28 (51%) were detected in 2004 (Table 3.19). All returning adults returned to the same study area as detected in 2003. In addition, we detected one individual banded as an adult in 2000 and not detected in 2003. This individual was detected at the same study area where originally banded.

Table 3.19. Adult Willow Flycatcher Annual Return from 2003 to 2004

Study Area	# Identified in 2003	# of 2003 Birds Detected in 2004	% Return	% Return to Same Site
Pahranagat	11	6	55	100
Mesquite	25	13	52	100
Mormon Mesa	3	1	33	100
Topock	10	7	70	100
Bill Williams	6	1	17	100
Total	**55**	**28**	**51**	**100**