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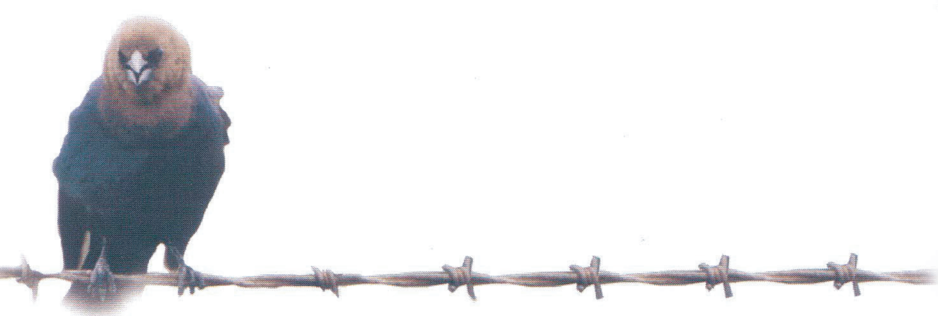
SOUTHWESTERN WILLOW FLYCATCHER SURVEYS, DEMOGRAPHY, AND ECOLOGY ALONG THE LOWER COLORADO RIVER AND TRIBUTARIES, 2006

Contract No. 03-CS-30-0093



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U.S. Bureau of Reclamation
Lower Colorado Region
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SOUTHWESTERN WILLOW FLYCATCHER SURVEYS, DEMOGRAPHY, AND ECOLOGY ALONG THE LOWER COLORADO RIVER AND TRIBUTARIES, 2006

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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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 2005–2006, 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 2005, 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, over 600 in 2004, and over 300 detections in 2005. 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 2006. We completed presence/absence surveys and site descriptions at 101 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; and measured characteristics of vegetation and microclimate at nest sites and at unused sites to assess factors important in nest-site selection. We implemented trapping and removal of Brown-headed Cowbirds at three of the four life history study areas to evaluate the effects of trapping on nest brood parasitism and flycatcher nest success. Additionally, we conducted nest monitoring, color-banding, and resighting, and measured characteristics of vegetation at the Muddy River Delta, Nevada, and at Grand Canyon and Bill Williams, Arizona; microclimate studies were also conducted at the Muddy River Delta.

We used recorded broadcasts of willow flycatcher song and calls to elicit responses from willow flycatchers at 101 sites, ranging in size from 1 to 68 ha, along the Virgin and lower Colorado Rivers and tributaries between 15 May and 25 July 2006, following a 10-survey protocol. We detected willow flycatchers on at least one occasion at 73 of these sites. Resident, breeding flycatchers were detected at 13 sites within the following seven study areas: Pahranagat NWR, Mesquite, Mormon Mesa, Muddy River, Grand Canyon, Topock Marsh, and Bill Williams. South of Bill Williams, over 450 willow flycatchers were recorded between 13 May and 21 June; other than a single detection at one site on 28 July, no flycatcher detections were recorded at any sites south of Bill Williams after 21 June. Monitoring results suggest these flycatchers were not resident, breeding individuals and were most likely spring and/or fall 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 Muddy River, Grand Canyon, and Bill Williams (all monitoring sites), we color-banded 28 new adult flycatchers and recaptured 25 individuals banded in previous years, including 12 flycatchers banded as juveniles in previous years. An additional 56 previously banded flycatchers were resighted, of which 42 could be identified to individual; 10 were banded as juveniles in 2003–2005 but could not be recaptured to determine origin and identity, 1 had a federal band on one leg and an injury on the other leg, and 3 did not have their band combinations confirmed. We banded 55 nestlings from 29 nests.

In addition, we captured three previously unbanded fledglings. We banded flycatchers opportunistically at Key Pittman Wildlife Management Area, capturing and color-banding two new adults and recapturing three returning nestlings; three nestlings from one nest were banded.

For the fourth 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 44 willow flycatcher detections at 11 sites along the Colorado River from Picacho NW south to Hunter's Hole, and along the Gila River near Yuma. All these detections were recorded from 10 to 21 June. From 10 to 18 June, field personnel captured and color-banded 22 new adults at Gadsden, of which all but 2 were second-year birds. Reconnaissance efforts from 7 to 9 June resulted in the capture and color-banding of seven second-year willow flycatchers at Hunter's Hole and Gadsden. None of the color-banded individuals were detected post-capture, and other than a single detection at one site on 28 July, no flycatcher detections were recorded at any sites south of Bill Williams after 21 June, suggesting these individuals were northbound migrants.

At the four life history study areas and at Muddy River, Grand Canyon, and Bill Williams we recorded a total of 85 territories. Of these, 66 (77%) consisted of paired flycatchers and 19 (22%) consisted of unpaired individuals. Twelve breeding males were polygynous; 10 were paired with two females, one was paired with three females, and one was paired with four females.

Of the 80 adult willow flycatchers identified to individual in 2005, 48 (60%) returned in 2006; two (4%) were detected at a different study area from where they were detected in 2005. We detected three within-year, between study area movements in 2006. Two of these were from the Grand Canyon RM 285.3N to Mesquite West and the third was from Mesquite West to Mormon Mesa Virgin River #1.

Of 65 juveniles banded in 2005 that were known to have fledged, 10 (15%) were recaptured and identified in 2006. Of these, three were detected at a different study area from where originally banded, and seven were detected at the same study area. Seven individuals originally banded as nestlings in 2004 and one banded in 2003 were also recaptured, of which six returned to a different study area than where originally banded. The median dispersal distance for all returning juvenile flycatchers exhibiting between-year movements in 2006 was 38 km.

We documented a total of 82 willow flycatcher nesting attempts at the four life history study areas, Muddy River, Grand Canyon and Bill Williams, 77 of which contained eggs and were used in calculating nest success and productivity. Thirty-three (43%) nests were successful and fledged young; 41 (53%) failed; and three (4%) were of undetermined fate. Mayfield survival probability at the four life history study areas, Muddy River, Grand Canyon and Bill Williams ranged from 0.002 to 0.628 and was 0.457 for all sites combined. Depredation was the major cause of nest failure, accounting for 48% of all failed nests and 54% of nests that failed after flycatcher eggs were laid.

Eleven of 71 nests (15%) with flycatcher eggs and known contents were brood parasitized by Brown-headed Cowbirds. Brood parasitism at all study areas ranged from 0 to 31% and was highest at Topock Marsh. We observed the fourth consecutive year of no brood parasitism at

Pahranagat. Nests that contained flycatcher eggs and were brood parasitized were not less likely to fledge flycatcher young than nests that were not parasitized.

For the fourth consecutive year, we used a modification of the Australian crow trap to capture and remove Brown-headed Cowbirds at three of the four life history study areas. Because traps could not be deployed close enough to the flycatcher breeding habitat at Mormon Mesa, trapping there was discontinued. We experimented with slots of two different widths to determine if slight variations in slot size had any effect on capture rates of cowbirds or non-target species.

We captured and removed 70, 125, and 323 Brown-headed Cowbirds at Pahranagat, Mesquite, and Topock, respectively. We found that cowbird traps with wider slots captured significantly more cowbirds per trap-day than those with narrower slots. The escape rate of captured cowbirds did not differ significantly between the wide and narrow slots. Data also showed a trend toward traps with wider slots capturing more non-target individuals, and these tended to be larger species.

A comparison of the proportion of flycatcher nests parasitized during the pretrapping (1997–2002) and trapping (2003–2006) periods showed a statistical difference only at Pahranagat, where we documented the fourth consecutive year of no brood parasitism. At Mesquite and Topock, brood parasitism continues to remain high, with 23.8 and 31.2% recorded in 2006, respectively.

At the four life history study areas, Muddy River, Grand Canyon, and Bill Williams, we gathered data on vegetation and habitat characteristics at 72 nest plots, 66 non-use plots, and 46 within-territory plots. To obtain an overall description of entire habitat blocks at each life history study area, we gathered data at an additional 52 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 1.0 to 15.0 m (mean = 3.0 m, SE = 0.2). Flycatchers placed 61% of all nests in tamarisk (*Tamarix* sp.), 10% in coyote willow (*Salix exigua*), 24% in Goodding willow (*Salix gooddingii*), 1% in Fremont cottonwood (*Populus fremontii*), 1% in mesquite (*Prosopis pubscens*), and 3% 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. Nest sites had significantly greater canopy heights than non-use sites at Mesquite, Mormon Mesa, and Muddy River. Canopy closure at nest sites were higher than at non-use sites at four study areas (Mesquite, Mormon Mesa, Muddy River, Topock), though differences were not statistically significant. At all study areas, vertical foliage density was greatest at and immediately above mean nest height, and there was a strong trend for nest sites to be closer to water or saturated soil than non-use sites for the entire season. 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 August 2006. Similar to findings from 2003, 2004, and 2005, nests in 2006, on average, were located in areas that exhibited greater soil moisture and higher relative humidity. In contrast to the findings of previous study years, however, temperature variables in 2006, on average, were not significantly different between nest and non-nest sites after adjusting for other explanatory variables. Nevertheless, temperature was significantly different between nest and non-nest sites at some study areas in 2006. Other sources of covariance and other alternative explanations will be evaluated in the forthcoming five-year final summary report for the purpose of determining the relationship(s) between yearly findings and meaningful, longer-term microclimatic patterns.

In 2005, 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). All logger and piezometer locations selected in 2005 were retained in 2006, and loggers have been collecting data since installation. 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.

Daily, weekly, and seasonal cycles in groundwater levels were apparent. Water levels drop during afternoon hours when evapotranspiration is high and on the weekends when water releases from Parker Dam decline. The seasonal cycle in groundwater levels mirrors the seasonal fluctuation in river flow.

Analyses of groundwater data indicate a strong correlation between piezometer water levels and releases from Parker Dam. Data did not show strong correlations between piezometer water level and either soil moisture or absolute humidity within the habitat monitoring sites. Most microclimatic variables at the combined habitat monitoring sites differed significantly from those at Topock Marsh. Topock was cooler, and exhibited higher diurnal/nocturnal relative humidity and diurnal/nocturnal vapor pressure than habitat monitoring sites. In 2006, the habitat monitoring sites had a higher diurnal temperature than that at any of the flycatcher breeding sites where we collected microclimate data.

Comparisons of microclimate characteristics between 2005 and 2006 at the habitat monitoring sites indicated generally hotter and drier conditions in 2006. However, these differences could be caused by interannual variation in regional climatic conditions. Additional analyses will examine differences at the test sites compared to the control sites to determine if any of the interannual differences in microclimate conditions could be related to changes in river operations.

We noted between-year differences at the habitat monitoring sites for distance to water, tree counts, and vertical foliage densities within the first two meters of the ground. There was no evidence that these differences occurred exclusively at control sites or at test sites; rather, the differences occurred across all sites. Ground cover did not differ between years at test locations but increased at control plots. This may represent an actual increase in the amount of woody ground cover or may be a spurious result of observer variation. Additional years of vegetation measurements will help clarify these trends.

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.

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).

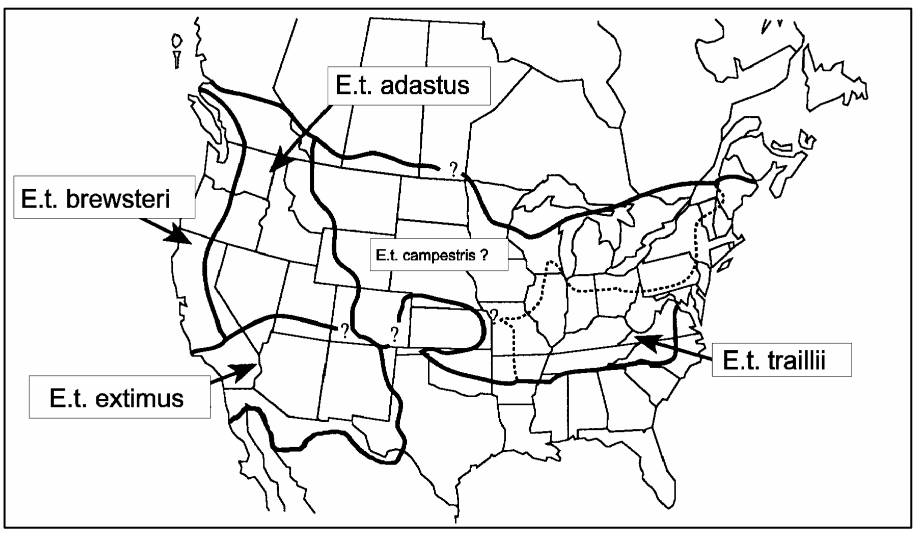

Figure 1.1. Breeding range distribution of the subspecies of the willow flycatcher (*Empidonax traillii*). Adapted from Unitt (1987), Browning (1993), and Sogge et al. (1997).

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 et al. 2006b).

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, Koronkiewicz et al. 2006a, 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 2005,[1] 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 (Bill Williams), Arizona (McKernan and Braden 2002, Koronkiewicz et al. 2004, McLeod et al. 2005, Koronkiewicz et al. 2006a, Braden and McKernan unpubl. data). Willow flycatchers, including one banded migrant Southwestern Willow Flycatcher (Koronkiewicz et al. 2006a), 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 2006 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 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

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

microclimate, vegetation, and groundwater conditions of currently occupied[2] 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[3] 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 to distinguish any changes in microclimate, groundwater, or vegetation caused by water transfer actions from those caused by fluctuations in climate or rainfall; and

[2] 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, 1996–2006.

[3] 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 2006, 101 sites were surveyed as described in the results section of Chapter 2 of this report.

(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 2006 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 2006 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 9 – Management Recommendations. All management recommendations are consolidated into one Chapter for ease of reference.

CHAPTER 2

PRESENCE/ABSENCE SURVEYS AND SITE DESCRIPTIONS

INTRODUCTION

Broadcasts of recorded conspecific vocalizations are useful in eliciting responses from nearby willow flycatchers, and multiple broadcast surveys conducted throughout the breeding season are the standard technique for determining the presence or absence of *E. t. extimus* (Sogge et al. 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 2006, 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 study areas, where intensive demographic and ecology studies are conducted.

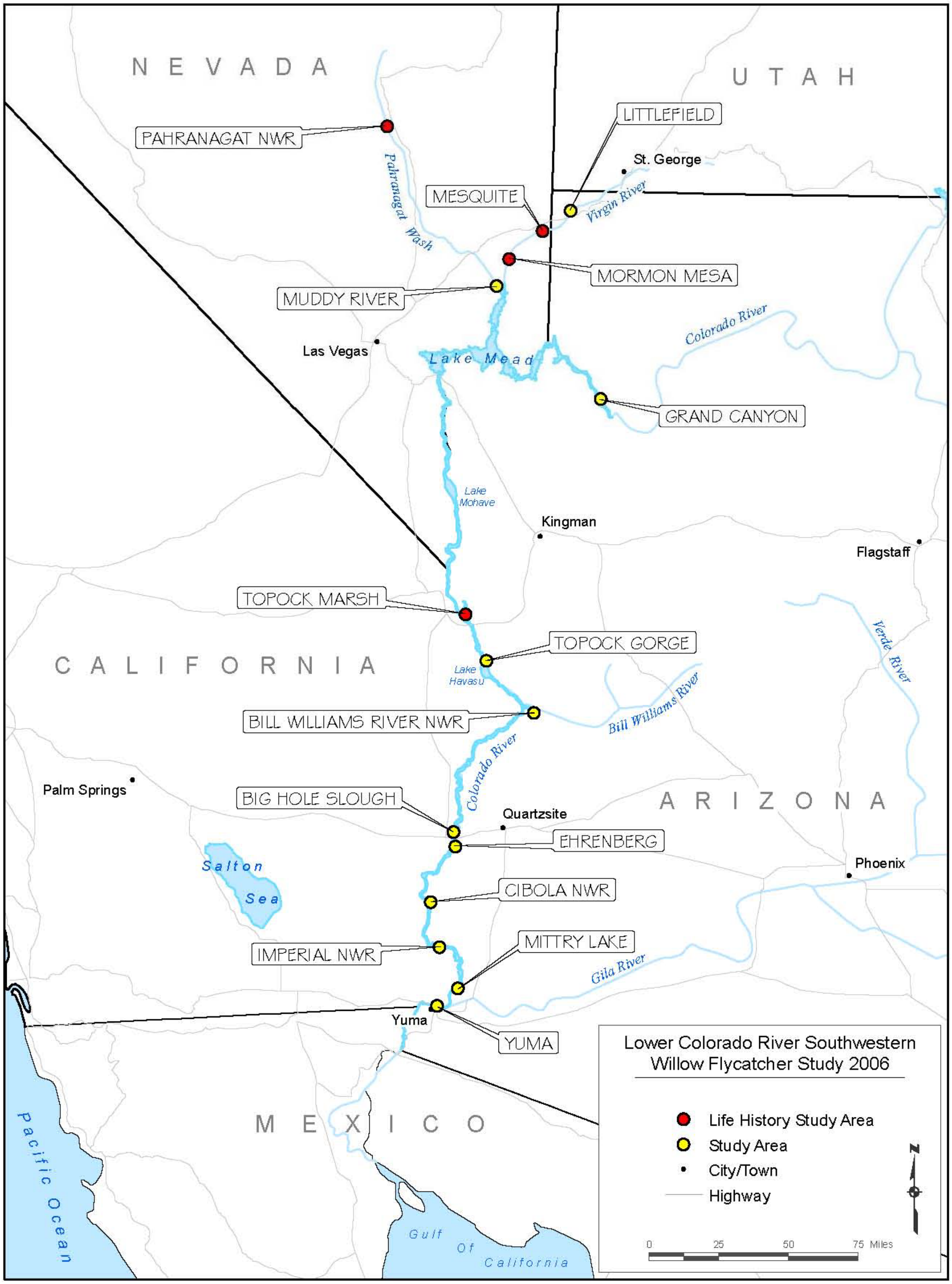

Figure 2.1. Locations of Southwestern Willow Flycatcher study areas along the lower Colorado River and tributaries, 2006. (Note, study area labels represent the approximate center of multiple sites within that region; see Table 2.1)

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; Koronkiewicz et al. 2006a) and reconnaissance by helicopter, by boat, and on foot prior to the start of the 2006 survey period. Reclamation biologist Theresa Olson 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.

ADDITIONAL SITE SELECTION

During the survey season, we conducted on-the-ground habitat reconnaissance to locate additional potentially suitable willow flycatcher habitat in lower Grand Canyon in the delta area where the Colorado River enters Lake Mead and along the Bill Williams River. Field personnel were provided high-resolution aerial photographs overlain with a UTM grid to aide with navigation and the identification of potentially suitable flycatcher habitat. We focused habitat reconnaissance in areas that contained or were adjacent to standing water or saturated soils, and that had vegetation characteristics similar to that of flycatcher breeding sites (i.e., dense vegetation within 2–4 m of the ground and high canopy closure). We consulted with Dr. Kathleen Blair, Refuge Ecologist, for her assistance in identifying potentially suitable habitat at Bill Williams, and Greg Clune, Reclamation, provided locations of willow flycatchers detected during unrelated bird surveys on the Lake Mead Delta. Broadcast surveys were conducted opportunistically during ground reconnaissance, and subsequent surveys were conducted at sites where potentially suitable habitat was present and logistical considerations permitted repeated access. If territorial individuals were located, broadcast surveys were discontinued and territory/nest monitoring was initiated. Field personnel formulated qualitative site descriptions of potentially suitable flycatcher habitat in the field.

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 1,148 observer-hours conducting willow flycatcher broadcast surveys at 101 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 2006 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 12 times. In cases where sites were surveyed fewer than 10 times, either the sites were added partway through the survey season or logistical constraints 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.

Table 2.1. Willow Flycatcher Detections at Survey Sites along the Virgin and Colorado Rivers and Tributaries, 2006*

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
PAHR	North	4.5	28 (9 May–12 August)
	West	0.6	ND
	MAPS	2.7	1 (25 May–23 June)
	South	2.5	7 (13 May–17 July)
	Salt Cedar	3.1	ND
LIFI	North	4.7	ND
MESQ	East	3.8	2 (13 July)
	West	13.1	25 (6 May–23 August)
	Bunker Farm	3.1	1 (6–13 May)
MOME	Mormon Mesa North	12.4	ND
	Hedgerow	1.3	ND
	Mormon Mesa South	23.6	1 (13–17 June)
	Virgin River #1	50.2	4 (23 May–4 July)
	Virgin River #2	50.8	16 (11 May–3 August)

[3] For sites surveyed prior to 2003, 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 2006 differed little from previous years.

[4] We started the 2006 survey season with 94 survey sites. Two survey sites in lower Grand Canyon (Separation Canyon and RM 251N) were discontinued after two surveys to allow field time for the addition of nine survey sites in the Lake Mead Delta area. Surveys at three sites were discontinued later in the survey season: one site (River Mile 33) was discontinued because of safety concerns, and two sites (Pipes #2 and Gadsden Bend) were discontinued because of poor habitat quality. Five additional sites at Mesquite were 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 at Survey Sites along the Virgin and Colorado Rivers and Tributaries, 2006,* continued

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
MUDD	Overton WMA	14.9	11 (7 May–30 July)
GRCA	Burnt Springs	11.0	ND
	RM 274.5N	18.3	3 (14 June–15 July)
	Pearce Ferry	0.8	1 (15–20 June)
	RM 285.3N	8.7	5 (1–21 June)
	Kowlp Corner	5.4	1 (15–30 June)
	RM 286N	3.4	ND
	Driftwood Island	3.7	ND
	Twin Coves	1.8	2 (15–22 June)
	Bradley Bay	7.6	ND
	Chuckwalla Cove	3.4	3 (21–29 June)
	Center Point	3.1	ND
TOPO	Pipes #1	5.2	ND
	Pipes #2[4]	2.8	ND
	Pipes #3	5.7	3 (21–29 June)
	The Wallows	0.4	2 (6 June–2 July)
	Pig Hole	2.4	1 (15–23 May)
	PC6-1	4.8	ND
	In Between	7.7	8 (5 May–23 July)
	800M	6.1	2 (7 May–9 July)
	Pierced Egg	6.7	6 (27 May–10 August)
	Swine Paradise	3.7	2 (3 June)
	Barbed Wire	2.6	ND
	IRFB03	1.0	ND
	IRFB04	1.5	ND
	Platform	1.3	ND
	250M	2.3	1(15 May–9 June)
	Hell Bird	3.7	ND
	Glory Hole	4.3	9 (15 May–9 August)
	Beal Lake	42.8	1 (24 May)
	Lost Lake	9.1	1 (24 May)
TOGO	Pulpit Rock	1.8	1 (23 May)
	Picture Rock	5.5	1 (23 May), 1 (8 June)
	Blankenship Bend North	26.7	ND
	Blankenship Bend South	25.9	ND
	Havasu NE	12.6	ND
BIWI	Site #1	2.8	1 (22 May)
	Site #2	3.1	ND
	Site #11	6.3	1 (22 May)

Table 2.1. Willow Flycatcher Detections at Survey Sites along the Virgin and Colorado Rivers and Tributaries, 2006,* continued

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
BIWI	Site #4	9.9	1 (18 May), 1 (4 June)
	Site #3	8.3	5 (5 May–8 August)
	Site #5	5.3	ND
	Mineral Wash Complex	18.8	ND
	Beaver Pond	21.7	ND
	Site #8	10.3	ND
BIHO	Big Hole Slough	16.5	2 (21 May)
EHRE	Ehrenberg	4.7	1 (4 June), 1 (19 June)
CIBO	Cibola Nature Trail	13.7	4 (19 May), 1 (24 May)
	Cibola Site 2	16.4	1 (19 May)
	Cibola Site 1	7.7	1 (24 May), 1 (14 June)
	Hart Mine Marsh	31.6	2 (22 May), 1 (31 May), 1 (2 June)
	Three Fingers Lake	67.9	25 (23 May), 3 (31 May), 2 (3 June), 7 (6 June)
	Cibola Lake #1 (North)	8.5	1 (22 May), 2 (5 June)
	Cibola Lake #2 (East)	4.5	2 (19 May), 1 (2 June)
	Cibola Lake #3 (West)	7.0	1 (18 May), 2 (1 June)
	Walker Lake	11.4	1 (20 May), 3 (23 May), 1 (3 June), 1 (20 June)
IMPE	Draper Lake	4.6	8 (23 May), 6 (7 June)
	Paradise	7.8	1 (18 May), 9 (23 May), 5 (1 June), 4 (7 June), 1 (21 June)
	Hoge Ranch	20.7	7 (22 May), 6 (31 May), 9 (6 June)
	Adobe Lake	7.6	1 (16 May), 1 (6 June), 1 (15 June)
	Rattlesnake	7.6	2 (22 May), 3 (31 May)
	Norton South	1.2	1 (16 May), 1 (5 June)
	Picacho NW	8.8	7 (22 May), 3 (5 June)
	Milemarker 65	10.0	1 (17 May), 2 (30 May)
	Clear Lake/The Alley	8.3	1 (30 May), 1 (21 June)
	Nursery NW	7.0	2 (24 May), 4 (4 June)
	Imperial Nursery	1.4	2 (24 May), 4 (4 June)
	Ferguson Lake	26.0	3 (15 May), 4 (20 May), 5 (2 June), 1 (13 June)
	Ferguson Wash	6.8	5 (28 May)
	Great Blue Heron	7.1	9 (15 May), 5 (20 May), 18 (29 May), 11 (3 June), 1 (17 June)
	Powerline	2.0	2 (15 May), 2 (20 May), 1 (29 May)
	Martinez Lake	4.6	2 (15 May), 8 (20 May), 3 (29 May)
MITT	Mittry West	4.4	5 (21 May), 4 (28 May)
	Mittry South	13.8	ND
	Potholes East	2.0	1 (24 May), 5 (27 May)
	Potholes West	6.6	1 (24 May), 3 (27 May)

Table 2.1. Willow Flycatcher Detections at Survey Sites along the Virgin and Colorado Rivers and Tributaries, 2006,* continued

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
YUMA	River Mile 33[5]	17.6	1 (13 May), 5 (21 May), 7 (30 May), 1 (14 June)
	Gila Confluence West	3.8	1 (25 May), 1 (2 June), 1 (16 June)
	Gila Confluence North	4.6	4 (18 May), 3 (30 May), 2 (12 June), 1 (17 June), 1 (19 June), 1 (28 July)
	Gila River Site #1	5.7	2 (25 May), 1 (4 June), 1 (14 June)
	Gila River Site #2	5.1	9 (27 May)
	Fortuna Site #1	2.5	10 (27 May)
	Fortuna North	3.8	3 (4 June), 1 (21 June)
	Morelos Dam	7.7	ND
	Gadsden Bend [6]	4.4	4 (15 May), 24 (19 May), 2 (26 May), 3 (30 May), 1 (15 June)
	Gadsden	17.3	9 (15 May), 19 (19 May), 7 (26 May), 2 (30 May), 11 (8 June), 2 (15 June), 8 (17 June), 6 (18 June)
	Hunter's Hole	15.9	10 (13 May), 11 (19 May), 1 (26 May), 26 (30 May), 5 (7 June), 5 (8 June), 1 (15 June)

* Because opportunistic broadcast surveys were conducted at selected sites in 2006, sites where broadcast surveys were conducted less than four times during the flycatcher breeding season are not included.

[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 River 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] Surveys discontinued 1 June.

[5] Surveys discontinued 17 June.

[6] Surveys discontinued 15 June.

Table 2.2. Detections of Willow Flycatchers Recorded after 15 June 2006 at Sites Where Breeding or Residency Was Not Confirmed

Study Area[1]	Site	Date	Comments
EHRE	Ehrenberg	19 June	Lone flycatcher, responded to playbacks with calls (*whitts)* and primary song (*fitz-bew*)
CIBO	Walker Lake	20 June	Lone flycatcher, responded to playbacks with primary song (*fitz-bew*)
IMPE	Paradise	21 June	Lone flycatcher, responded to playbacks with primary song (*fitz-bew*)
	Great Blue Heron	17 June	Lone flycatcher detected spontaneously singing (*fitz-bew*) and calling (*breets*)
YUMA	Gila Confluence West	16 June	Lone flycatcher, responded to playbacks with primary song (*fitz-bew*)
	Gila Confluence North	28 July	Individual heard spontaneously singing (*fitz-bew*)
	Fortuna North	21 June	Lone flycatcher, responded to playbacks with calls (*whitts)* and primary song (*fitz-bew*)
	Gadsden	17 June	Five flycatchers captured passively in mists nets, and three flycatchers detected spontaneously vocalizing
		18 June	Three flycatchers captured passively in mists nets, and three flycatchers detected spontaneously singing (*fitz-bew*)

[1] EHRE = Ehrenberg; 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, 2006*

Study Area[1]	Site	Date(s)	Behavioral Observations
GRCA	RM 286N	13 June	One individual heard calling (*kuk-kuk-kuk* and *kowlp*) for approximately 10 min
	Chuckwalla Cove	3 July	Observed singing from top of willow; singing throughout morning in the area
		17 July	Individual observed and heard calling
BIWI	Site #2	20 June	Individual observed skulking through vegetation
	Site #3	2 July	Calls heard at a distance
	Mineral Wash	13 July	Calls heard in large cottonwood
	Planet Ranch	13 July	Calls heard
EHRE	Ehrenberg	19 June	Individual observed flying over Colorado River; one vocalization heard
CIBO	Cibola Nature Trail	3 July	Calls heard[2]
	Cibola Site #2	4 July	Calls heard
	Hart Mine Marsh	4 July	Calls heard at a distance
YUMA	Gila Confluence North	28 June	At least two individuals heard counter-singing
	Gadsden	17 June	Individual heard calling for approximately 10 min.[2]
		20 June	Heard calling in the distance
		1 July	At least two individuals heard counter-singing, one of which was observed
		19 July	Calls heard

* Unless otherwise stated, number of individual cuckoos was undetermined.
[1] GRCA = Grand Canyon; BIWI = Bill Williams River National Wildlife Refuge; EHRE = Ehrenberg; CIBO = Cibola National Wildlife Refuge; YUMA = Yuma.
[2] Cuckoo broadcast surveys conducted by field personnel unrelated to this project may have occurred simultaneously with this detection.

Table 2.4. Yuma Clapper Rail Detections along the Virgin and Lower Colorado Rivers, 2006*

Study Area[1]	Site	Date(s)	Behavioral Observations
CIBO	Cibola Site #2	24 May	One individual heard calling
	Cibola Site #1	24 May	Calls heard
	Hart Mine Marsh	18 May	Two individuals heard counter-calling
		22 May	At least two individuals heard counter-calling
		4 July	One individual heard calling
	Three Fingers Lake	23 May	Three individuals heard calling
	Cibola Lake #1 (North)	18 May	One individual heard calling
	Cibola Lake #3 (West)	18 May	Two individuals heard counter-calling
	Walker Lake	20 May	Two individuals heard counter-calling
IMPE	Draper Lake	7 June	Calls heard
		21 June	At least one individual heard calling
		2 July	One individual heard calling
	Paradise	7 June	Two individuals heard counter-calling
	Imperial Nursery	28 May	One individual heard calling
MITT	Mittry West	28 June	One individual heard calling
	Mittry South	16 July	Calls heard

* Unless otherwise stated, number of individuals was undetermined.
[1] CIBO = Cibola National Wildlife Refuge; IMPE = Imperial National Wildlife Refuge; MITT = Mittry Lake.

Table 2.5. Summary of Hydrologic Conditions at Each Survey Site along the Virgin and Lower Colorado Rivers and Tributaries, 2006*

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]	80/45/20	70/15/5	10/35/75	0/0/0
	MAPS[4]	30/10/5	10/10/10	20/15/5	0/0/0
	West[4]	50/15/15	30/30/5	5/5/5	0/0/0
	South	10/10/10	10/10/10	10/10/10	0/0/0
	Salt Cedar[4]	5/0/0	25/0/0	5/0/0	0/0/0
LIFI	North	0/0/0	0/0/0	0/0/0	35/35/35
MESQ	East	80/0/1	100/0/100	10/0/0	0/10/0
	West	30/30/50	25/25/25	25/10/10	0/0/0
	Bunker Farm	2/0/0	5/0/0	0/0/0	0/80/80
MOME	Mormon Mesa North[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Hedgerow	0/0/0	0/0/0	0/0/0	100/100/100
	Mormon Mesa South[4]	1/0/0	3/0/0	10/0/0	0/0/0
	Virgin River #1	3/1/0	25/70/0	8/10/2	0/0/0
	Virgin River #2[4]	3/1/--	10/5/--	20/20/--	0/0/--
MUDD	Overton WMA	5/5/5	100/100/100[5]	10/10/10	0/0/0
GRCA	Burnt Springs[4]	5/5/5	25/25/25	10/10/10	0/0/0
	RM 274.5N[4]	15/15/15	70/70/70	10/10/10	0/0/0
	Pearce Ferry[4]	--/0/0	--/0/0	--/0/0	--/0/0
	RM 285.3N[4]	--/0/0	--/0/0	--/10/10	--/0/0
	Kowlp Corner[4]	--/0/0	--/0/0	--/0/0	--/0/0
	RM 286N[4]	--/0/0	--/0/0	--/0/0	--/0/0
	Driftwood Island[4]	--/0/0	--/0/0	--/0/0	--/0/0
	Twin Coves[4]	--/0/0	--/0/0	--/0/0	--/0/0
	Bradley Bay[4]	--/0/0	--/0/0	--/0/0	--/0/0
	Chuckwalla Cove[4]	--/0/0	--/0/0	--/0/0	--/0/0
	Center Point[4]	--/0/0	--/0/0	--/0/0	--/0/0
TOPO	Pipes #1	0/0/1[6]	0/0/5	1/0/5	0/50/0
	Pipes #2	0/--/--	0/--/--	0/--/--	50/--/--
	Pipes #3	5/5/0	10/10/0	0/5/10	0/0/0
	The Wallows	0/2[6]/10	0/5/10	0/2/20	90/0/0
	Pig Hole	0/0/0	0/0/0	3/0/0	0/130/130
	PC6-1	30/10/5	5/10/10	40/10/10	0/0/0
	In Between	0/0/0	0/0/0	0/0/5	50/50/0
	800M	30/10/0	5/5/0	30/10/0	0/0/50
	Pierced Egg	20/0/2	5/0/5	30/5/10	0/0/0
	Swine Paradise[7]	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

Table 2.5. Summary of Hydrologic Conditions at Each Survey Site along the Virgin and Lower Colorado Rivers and Tributaries, 2006,* 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]
TOPO	Platform[7]	0/0/0	0/0/0	0/0/0	0/0/0
	250M[7]	0/5/0	0/10/0	0/5/0	0/0/0
	Hell Bird	40/60/50	25/25/25	5/5/5	0/0/0
	Glory Hole	30/30/20	30/30/30	5/5/5	0/0/0
	Beal Lake[10]	40/0/5	25/0/25	0/1/2	0/0/0
	Lost Lake[7]	--/--/5	--/5/5	0/3/20	0/0/0
TOGO	Pulpit Rock[4]	10/0/0	100/0/0	5/0/0	0/0/0
	Picture Rock[8]	--/--/--	--/--/--	--/--/--	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
BIWI	Site #1[4]	5/0/1	25/0/10	0/0/0	0/0/0
	Site #2[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Site #11[4]	0/0/0	0/0/0	--/0/--	0/0/0
	Site #4[4]	10/10/1	30/30/5	5/10/10	0/0/0
	Site #3[4]	15/10/1	10/10/5	10/10/5	0/0/0
	Site #5	10/1/--	70/50/--	0/0/--	0/0/--
	Mineral Wash Complex[4]	10/10/10	25/10/10	10/5/5	0/0/0
	Beaver Pond[4]	5/5/5	25/10/10	5/5/5	0/0/0
	Site #8[4]	15/15/15	25/25/25	5/5/5	0/0/0
BIHO	Big Hole Slough	10/10/10	10/10/10	5/5/5	0/0/0
EHRE	Ehrenberg[9]	0/3/5	0/3/10	0/3/0	15/0/0
CIBO	Cibola Nature Trail[10]	0/5/0	0/3/0	0/5/0	--/0/--
	Cibola Site #2[8,9]	--/--/--	--/--/--	--/--/--	0/0/0
	Cibola Site #1[8,9]	--/--/--	--/--/--	--/--/--	0/0/0
	Hart Mine Marsh[7]	40/30/5	70/50/10	10/10/5	0/0/0
	Three Fingers Lake[4]	25/25/25	>100/>100/>100	5/5/5	0/0/0
	Cibola Lake #1 (North)[4]	10/5/0	5/5/0	5/1/--	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]	5/0/0	20/0/0	5/0/5	0/0/0
	Walker Lake[4]	15/5/0	10/--/0	20/5/--	0/0/0
IMPE	Draper Lake[7]	5/5/5	10/10/10	10/10/10	0/0/0
	Paradise[4]	30/0/0	5/0/0	10/50/0	0/0/0
	Hoge Ranch[4]	25/5/30	25/50/15	10/5/10	0/0/0
	Adobe Lake[4]	--/--/--	--/--/--	--/--/--	0/0/0
	Rattlesnake[7]	5/--/0	3/--/0	5/--/0	0/0/0
	Norton South[7]	30/15/10	30/25/10	0/1/20	0/0/0
	Picacho NW[4]	0/0/0	0/0/0	0/0/0	30/30/30

Table 2.5. Summary of Hydrologic Conditions at Each Survey Site along the Virgin and Lower Colorado Rivers and Tributaries, 2006,* 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]
IMPE	Milemarker 65[4]	--/--/--	--/--/--	--/--/--	0/0/0
	Clear Lake/The Alley[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Nursery NW[7]	90/5/20	25/10/5	5/0/15	0/0/0
	Imperial Nursery[10]	80/0/0	3/0/0	10/0/0	0/10/10
	Ferguson Lake[4]	5/1/15	5/3/10	10/5/5	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	0/0/5	0/0/0
	Powerline[4]	1/0/10	0/0/5	0/--/0	0/0/0
	Martinez Lake[4]	0/0/0	0/0/0	0/0/0	0/0/0
MITT	Mittry West	5/0/0	5/0/0	10/0/0	0/180/180
	Mittry South[4]	0/0/0	0/0/0	0/--/0	0/0/0
	Potholes East[9]	10/10/10	--/--/--	5/5/5	0/0/0
	Potholes West[9]	20/15/20	>100/>100/>100	5/5/5	0/0/0
YUMA	River Mile 33	0/0/--	0/0/--	0/0/--	100/100/--
	Gila Confluence West[4]	5/5/0	30/30/0	1/1/0	0/0/0
	Gila Confluence North[4]	0/15/0	0/10/0	5/0/--	0/0/0
	Gila River Site #1[4]	10/10/10	40/40/40	0/0/1	0/0/0
	Gila River Site #2[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Fortuna Site #1[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Fortuna North[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Morelos Dam[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Gadsden Bend[4]	0/0/--	0/0/--	0/0/--	0/0/--
	Gadsden[4]	5/5/5	50/50/50	5/5/5	0/0/0
	Hunter's Hole	1/10/1	10/10/5	1/10/1	0/0/0

* 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 River 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, lake, or pond.
5 Channel of the Muddy River.
6 Water was present in pig wallows.
7 Site borders marsh.
8 Site contains marshes, but hydrologic conditions within marshes unknown.
9 Site borders canal.
10 Site is irrigated as part of restoration efforts; amount of standing water highly variable throughout survey season.

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 majority of the site is inundated annually, with up to 1 m of water present in mid-May and becoming progressively drier through the survey season. In mid-May this year, 75% of the site had standing water, with less than 10% of the site inundated by late July. Water levels in early spring in Upper Pahranagat Lake were higher in 2006 than in previous years of this study (M. Maxwell, pers. comm.).

We located 23 resident, breeding willow flycatchers at Pahranagat North. We detected three additional unpaired males and two additional flycatchers that were likely migrants. 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 seven times throughout the breeding season, totaling 7.3 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. No Brown-headed Cowbirds were detected during surveys.

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 did not detect any flycatchers at this site. We surveyed the site six times throughout the breeding season, totaling 1.3 observer-hours. No cowbirds or sign of livestock use were detected.

Pahranagat MAPS

Area: 2.7 ha Elevation: 1,026 m

Pahranagat MAPS is a mixed native stringer consisting predominantly of Fremont cottonwood on the west edge of Upper Pahranagat Lake. Canopy height is 15–20 m, and canopy closure is approximately 50%. Tamarisk (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*) form a very sparse understory, and cattail (*Typha* sp.) and bulrush line the east edge of the tree line. Portions of the site held standing water and saturated soils throughout the survey season.

We detected one unpaired male at the site. Details of banding status and residency are presented in Chapter 3. We surveyed the site five times throughout the breeding season, totaling 3.9 observer-hours. No cowbirds or sign of livestock use were detected.

PAHRANAGAT SOUTH

Area: 2.5 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. In 2005, we noted that dense coyote willow was increasing on the west side of the patch; this area of willow had very sparse canopy in 2006. The site is bordered to the west by an open marsh and to the east by upland scrub. Tamarisk and Russian olive form a sparse understory. Overall canopy closure at this site is approximately 50%.

We detected six 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 seven times throughout the breeding season, totaling 1.6 observer-hours. No cowbirds or sign of livestock use were detected.

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 and 2004 but did not survey it those years because it was completely dry. The site was surveyed in 2005, with the site containing standing water until July. Only 5% of the site was inundated in May 2006, and the site completely dried out by mid-June. We surveyed the site in 2006 at the request of the refuge manager in preparation for tamarisk removal at the site.

We did not detect any flycatchers at this site. We surveyed the site six times, totaling 3.9 observer-hours. Cowbirds were detected on two visits, and signs of cattle were noted.

LITTLEFIELD, ARIZONA

From 2003 to 2005, 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 (Littlefield North) and the other just downstream of the I-15 overpass (Littlefield South). No detections were recorded in 2003, and flycatcher breeding was documented at North in 2004. During the winter of 2004–2005, both sites were completely scoured by floods that removed most of the understory vegetation. Two males were detected at North on a single occasion in 2005; one of these males was subsequently detected breeding in Mesquite West. Surveys at Littlefield South were discontinued in 2005 because of the lack of vegetation. In 2006, we completed periodic habitat evaluation and surveys at Littlefield North.

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 flycatcher habitat was completely removed by floods during the winter of 2004–2005. 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%. During the survey season, no part of the site contained standing water or saturated soils, although the Virgin River lies less than 50m away.

We did not detect any flycatchers at this site. We surveyed the site four times, totaling 4.8 observer-hours. No cowbirds or sign of livestock use were detected.

MESQUITE, NEVADA

The Mesquite study area is in the floodplain of the Virgin River near Mesquite and Bunkerville, Nevada. All sites in the Mesquite study area experienced flooding, scouring, and deposition over the 2004–2005 winter. In 2003 and 2004, we surveyed and monitored one site in the area, Mesquite West. In 2005 and 2006, we surveyed and/or monitored two additional sites, Mesquite East and Bunker Farm, where personnel from an unrelated flycatcher project had located territorial flycatchers in 2004. In 2006, we conducted habitat reconnaissance and opportunistic surveys at five additional sites in the Virgin River floodplain between Mesquite and Bunkerville.

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. Vegetation on 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 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%. The uppermost terrace is vegetated with Goodding willow and a few Fremont cottonwood 18–25 m in height and an understory 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 site borders an agricultural field and periodically receives varying amounts of irrigation runoff during flycatcher breeding. A small drainage 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. During the 2006 survey season, the portions of the burned area that receive irrigation runoff were growing thick stands of coyote willow, common reed (*Phragmites australis*), and cattail.

Field personnel from an unrelated project located a pair of flycatchers on 13 July 2006 at Mesquite East. Details of occupancy and banding status were undetermined. Mesquite East was surveyed six times throughout the flycatcher breeding season, totaling 7.0 observer-hours. Cowbirds were detected on all surveys, and some evidence of livestock use was observed.

MESQUITE WEST

Area: 13.1 ha Elevation: 470 m

This mixed-native site lies within the floodplain of the Virgin River in Mesquite, Nevada. This large 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%. Standing water and muddy soils were present under the vegetation throughout the flycatcher breeding season.

The southeastern portion of the site was completely inundated during floods in the winter of 2004-2005, which deposited up to 0.5 m of sediment in the vegetation, reducing overall canopy height and foliage density in this area. Adjacent cattail/bulrush marshes were also scoured, but they have regenerated. The amount of surface water present within the site is influenced by irrigation runoff from two golf courses immediately adjacent to the site. These irrigation return flows support much of the vegetation within the site, and water levels vary on a daily basis. In 2005 and 2006, 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 24 resident, breeding willow flycatchers at Mesquite West and detected one male that later moved to Mormon Mesa. 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 six times throughout the flycatcher breeding season, totaling 15.3 observer-hours. Cowbirds were detected on all but two 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. Puddles of standing water were present in the site only in May, and the site was completely dry and dusty by mid July. The agricultural field adjacent to the site was fallow during the flycatcher breeding season of 2006, and, in contrast to previous years, the site did not receive agricultural runoff.

We located one unpaired male at Bunker Farm. Details of occupancy and color-banding are presented in Chapters 3. Areas of Bunker Farm not known to be occupied by willow flycatchers were surveyed eight times throughout the breeding season, totaling 8.2 observer-hours. Cowbirds were detected on all surveys and evidence of livestock use was observed.

OTHER SURVEY AREAS

Hafen Lane: Area: 5.6 ha Elevation: 475 m

This mixed-exotic site lies within the floodplain of the Virgin River in Mesquite, Nevada. Vegetation on the site consists primarily of tamarisk averaging 5 m in height. Canopy closure is approximately 70–90%. Several emergent Goodding willow and tamarisk are scattered throughout the site, and coyote willow is present on the eastern portion of the site. On the north end of the site there is a small marsh vegetated with cattail and bulrush. During the survey season, standing water was present in channels that connect to the Virgin River, which forms the southern boundary of the site. Saturated soils were confined to the edges of the channels and the river.

We did not detect any flycatchers at this site. Surveys were discontinued after two visits, totaling 8.4 observer-hours. Cowbirds were detected on both surveys, and no evidence of livestock use was observed.

Electric Avenue North: Area: 2.1 ha Elevation: 460 m

This mixed-native site lies adjacent to an agricultural field within the floodplain of the Virgin River in Bunkerville, Nevada. Vegetation on the site consists of an overstory of Fremont cottonwood averaging 10 m in height with a coyote willow understory. Canopy closure is approximately 70–90%. An isolated patch of tamarisk is located on the west side of the site, and arrowweed and scattered mesquite (*Prosopis* sp.) trees are present on the edges of the site. During the survey season, standing water was present in a canal that runs through the northern portion of the site. Soils throughout the site were dry.

We did not detect any flycatchers at this site. We surveyed the site three times, totaling 2.2 observer-hours. Cowbirds were detected on all surveys, and evidence of livestock use was observed.

Electric Avenue South: Area: 4.0 ha Elevation: 460 m

This mixed-exotic site lies adjacent to an agricultural field within the floodplain of the Virgin River in Bunkerville, Nevada. Vegetation on the site consists of a stringer of Fremont cottonwood and Goodding willow averaging 12 m in height with a predominantly tamarisk understory. Some coyote willow is scattered throughout the site, and arrowweed and mesquite trees mix with the tamarisk in some areas. Canopy closure is approximately 70–90%. A tall stand of Fremont cottonwood with on open understory is located on the north end of the site. No standing water or saturated soils were present during the survey season, although a dry channel indicated the Virgin River previously flowed through the site.

We did not detect any flycatchers at this site. We surveyed the site three times, totaling 2.4 observer-hours. Cowbirds were detected on all surveys, and evidence of livestock use was observed.

Bunker Marsh North: Area: 13.6 ha Elevation: 453 m

This exotic site lies within the floodplain of the Virgin River in Bunkerville, Nevada. The dominant vegetation at the site is tamarisk, which averages 7–9 m in height. Scattered mesquite trees are present on the edges of the site. Canopy closure is approximately 70–90%. The site lies adjacent to an agricultural field, and a large pond vegetated with cattail and bulrush is located on the southeastern edge of the site. During the survey, standing water was present in the marsh, and soils were dry under the vegetation.

We did not detect any flycatchers at this site. Surveys were discontinued after one visit, totaling 2.8 observer-hours. Cowbirds were detected during the survey, and evidence of livestock use was observed.

Bunker Marsh South: Area: 3.8 ha Elevation: 450 m

This exotic site lies within the floodplain of the Virgin River in Bunkerville, Nevada. The site consists of a marsh vegetated with cattail and bulrush, with widely spaced tamarisk trees averaging 5 m in height. Canopy closure is <25%. The site lies adjacent to an agricultural field. A large area west and north of the site has been recently bulldozed. During the survey, standing water and saturated soils were present in the marsh.

We did not detect any flycatchers at this site. Surveys were discontinued after one visit, totaling 1.0 observer-hour. Cowbirds were detected during the survey, and no evidence of livestock use was observed.

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 where the Virgin River enters Lake Mead is dead or dying as the result of fluctuating reservoir levels. All the areas surveyed at Mormon Mesa are at least 10 km upstream of Lake Mead. All of the areas we surveyed are used extensively by cattle, and cowbirds were detected on most surveys.

MORMON MESA NORTH

Area: 12.4 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. In 2005, the previously dry channel became the main channel of the Virgin River; it contained water throughout the flycatcher breeding season in 2006. The cattail marsh to the west of the site was scoured during flooding in 2004–2005, and was an open pond during the summer of 2006. Flood debris is still 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. Some of the patches of coyote willow have little canopy and appear to be dying. 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%. No standing water or saturated soils were present within the site during the survey season.

We did not detect any flycatchers at this site. We surveyed the site seven times, totaling 15.7 observer-hours.

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 throughout the survey season.

We did not detect any flycatchers at Hedgerow. We surveyed the site seven times, totaling 3.1 observer-hours.

MORMON MESA SOUTH

North half: Area: 14.5 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%. The only standing water and saturated soil under the vegetation was present in May, and consisted of a few puddles.

We detected one willow flycatcher in Mormon Mesa South. Details of banding and occupancy are presented in Chapter 3. We surveyed the site eight times totaling 23.0 observer-hours.

VIRGIN RIVER #1

North half: Area: 25.4 ha Elevation: 380 m
South half: Area: 24.8 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%. The only standing water present during the survey season was limited to stagnant pools on cattle trails early in the season.

We did not detect any flycatchers at Virgin River #1 North. We surveyed the site six times, totaling 18.4 observer-hours.

Virgin River #1 South is primarily dense tamarisk approximately 4 m in height with many dry, open areas. Canopy closure in vegetated areas is approximately 80%. The northeastern and southern portions of Virgin River #1 South contain a few emergent Goodding willow. Standing water was present in an old river channel through June, and saturated soils were present in old river braids and on cow trails throughout the survey season.

At Virgin River #1 South we detected one pair, an unpaired male, and a male that was detected for a single day in May and had been previously detected in 2006 at Mesquite West. Areas of the site not known to be occupied by willow flycatchers were surveyed five times throughout the breeding season, totaling 6.8 observer-hours.

VIRGIN RIVER #2

Area: 50.8 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. The site contained some surface water through June, with saturated soils present throughout the survey season.

At Virgin River #2 we located 11 resident, breeding willow flycatchers, six unpaired males, and one male for which residency and/or breeding status 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 six times, totaling 13.9 observer-hours.

MUDDY RIVER, NEVADA

OVERTON WILDLIFE MANAGEMENT AREA

Area: 14.9 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 agricultural fields and to the northeast by sparser areas of riparian vegetation. The site flooded heavily 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. Approximately 0.3 ha of the southern portion of the site was bulldozed in 2005 as part of Overton WMA efforts to repair flood damage to their water control system. Flowing water was present in the Muddy River throughout the survey season, and much of the site contained muddy soils.

We located 10 resident, breeding willow flycatchers and one unpaired male at Overton. 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 six times, totaling 19.0 observer-hours. Cowbirds were detected on all but one survey, and no evidence of livestock use was observed at the site.

GRAND CANYON, ARIZONA

The Colorado River in lower 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 seven years as the result of a 27.5-m drop in the level of Lake Mead from 2000 to 2006.[6] Much of the riparian vegetation in lower Grand Canyon from approximately RM 259.5 to RM 274 that was inundated and potentially suitable for flycatchers in the late 1990s is now terraced well above the current river level, and the existing vegetation in most of these areas is dead or dying. Over the past two to three years, suitable flycatcher habitat has developed in Lake Mead National Recreation Area on sediments previously inundated by Lake Mead. Therefore, in June 2006 we conducted habitat reconnaissance in the extensive areas of recently developed willow along the Colorado River in Lake Mead National Recreation Area. We identified and subsequently surveyed nine new sites within the recreation area in 2006. Surveys that had been conducted by SWCA on river left between Separation Canyon (RM 239.5) and RM 274.5 in 2003–2005 were conducted in 2006 by Hualapai Department of Natural

[6] The water level in Lake Mead Reservoir rose approximately 7 m from mid-2004 to early 2005 because of record precipitation during the winter of 2004–2005. Since mid-2005, the water level has continued to drop.

Resources. The remaining survey sites on river right upstream of Burnt Springs (RM 259.5N) were discontinued by 1 June to allow time for surveys and monitoring in new areas on the Lake Mead Delta.

Site names below indicate historical names (if applicable) and the river mile, as measured downstream from Lees Ferry. River left and river right are indicated by "S" (south) and "N" (north), respectively.

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 extremely dense 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%. Muddy soil and slow flowing water were present in the creek through July.

We did not detect willow flycatchers at this site. The site was surveyed nine times, totaling 10.9 observer-hours. Brown-headed Cowbirds were detected during all but three surveys.

RM 274.5N

Area: 18.3 ha Elevation: 354 m

This mixed-native site lies immediately adjacent to the Colorado River and contains several perennial springs, which feed small creeks, flooded willow and tamarisk forest, beaver ponds, and cattail marshes. Perennial creeks lined with coyote and Goodding willow connect the wetlands to the Colorado River. Deep pools of clear, standing water were present at springs, and large areas of the site contained muddy soils and standing water throughout the survey season. Vegetation at the site is a mosaic of well developed, mature Goodding willow forest, willow forest with tamarisk understory, and cattail marsh. Canopy height averages 7 m, but canopy height and relative proportions of the two species vary throughout the site. Overall canopy closure is highly variable throughout the site, but averages approximately 70%. The survey area was expanded greatly in 2006 to include large adjacent areas of recently developed mature willow.

We detected one breeding pair and one unpaired male at this site. 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 12 times, totaling 33.5 observer-hours. Brown-headed Cowbirds were detected on all but three surveys.

PEARCE FERRY

Area: 0.85 ha Elevation: 343 m

This mixed-native site lies immediately adjacent to the Colorado River and consists primarily of a 30-m-wide strip of Goodding willow averaging 7 m in height. On the upland edge of the site, the vegetation consists of dense stands of tamarisk 3 m in height. Patches of young arrowweed are scattered throughout the site. Canopy closure is 50–70%. Soils throughout the site were dry and sandy during the survey season.

We detected one unpaired male at the 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 five times, totaling 1.4 observer-hours. No Brown-headed Cowbirds were detected during surveys.

RM 285.3N

Area: 8.7 ha Elevation: 343 m

This mixed-native site lies between the Colorado River and Grand Wash Bay, which was isolated from the Colorado River when the water level dropped in Lake Mead. Vegetation consists primarily of even-aged stands of Goodding willow, approximately 8 m in height, along the Colorado River on the south edge of the site and on the north side of the site adjacent to Grand Wash Bay. A large, open sandy area lies in the middle of the site. Patches of dense coyote willow, tamarisk, and cattail are also present near Grand Wash Bay. Canopy closure at the site is 50–70%. The willows near Grand Wash Bay occur along dry swales that apparently held water as the lake level receded. No standing water was present under the vegetation during the survey season, and saturated soils were present only in areas immediately adjacent to Grand Wash Bay.

We detected two breeding pairs and one additional male at RM 285.3N. 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 eight times, totaling 12.2 observer-hours. Brown-headed Cowbirds were detected on all but three surveys, and there was sign of burros.

KOWLP CORNER

Area: 5.4 ha Elevation: 342 m

This mixed-native site lies immediately adjacent to the Colorado River. Vegetation consists of even-aged stringers of Goodding willow averaging 7 m in height, with a few small tamarisk scattered throughout the site in the understory. Canopy closure is 50–70%. Soils throughout the site were dry and sandy during the survey season.

We detected one unpaired male at the 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 six times, totaling 5.4 observer-hours. Brown-headed Cowbirds were detected on all but two surveys, and there was sign of burros.

RM 286N

Area: 3.4 ha Elevation: 342 m

This mixed-native site lies between the Colorado River and a high desert bluff and consists of three distinct strips of vegetation. An approximately 10-m-wide strip of vegetation next to the river consists of very young Goodding and coyote willow <2 m in height. Small, scattered patches of arrowweed and cattail are also present next to the river. Behind this is an approximately 10-m-wide band of more mature Goodding willow, approximately 10 m tall, with some coyote willow in the understory. Canopy closure is 50–70%. Along the foot of the bluff, vegetation consists of a band of tamarisk averaging 4 m in height. On the downstream end of the site lies a dry cove vegetated with short, scattered tamarisk and a few dead and dying Goodding willows. During the survey season, no standing water was present under the vegetation, and saturated soils were present only along the river.

We detected a single flycatcher at this site, but this bird appeared to be the same individual that was documented as holding a territory across the river at Kowlp Corner. The site was surveyed five times, totaling 2.1 observer-hours. Brown-headed Cowbirds were detected during two surveys.

DRIFTWOOD ISLAND

Area: 3.7 ha Elevation: 342 m

This mixed-native site lies immediately adjacent to the Colorado River and consists of a narrow band (< 25 m wide) of even-aged Goodding and coyote willow 6m in height. Small, scattered patches of cattail are present next to the river. Canopy closure is 50–70%. During the survey season, no standing water was present under the vegetation, and saturated soils were present only along the river.

We did not detect willow flycatchers at Driftwood Island. The site was surveyed six times, totaling 3.8 observer-hours. Brown-headed Cowbirds were detected during one survey, and there was sign of cattle.

TWIN COVES

Area: 1.8 ha Elevation: 342 m

This mixed-native site lies along the Colorado River and consists primarily of a narrow band (<35 m wide) of Goodding willow 8 m in height with scattered 2-m-tall tamarisk in the understory. Canopy closure is 50–70% and patchy. Dry swales are present along the willow, and they run parallel with the river. Along the riverbank, the vegetation consists of young Goodding willow up to 2 m in height. On the upland edge of the site, tamarisk 2–3 m in height is scattered along open sandy areas. During the survey season, no standing water was present under the vegetation, and saturated soils were present only along the river.

We detected one pair of willow flycatchers at this site. 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 six times, totaling 3.1 observer-hours. Brown-headed Cowbirds were detected during three surveys.

BRADLEY BAY

Area: 7.6 ha Elevation: 341 m

This relatively large, mixed-exotic site is located in a dry, backwater bay adjacent to the Colorado River. Close to the river the vegetation consists primarily of even-aged bands of Goodding willow, 8 m in height, along dry swales that parallel the river. These swales held standing water as the water level in Lake Mead receded. Farther up the dry bay away from the river, the willow forest grades into a dense mixture of willow and tamarisk, which averages 6 m in height. Along the upland edges of the site, the vegetation consists of dense stands of tamarisk 3 m in height. Small, scattered patches of arrowweed and cattail are present next to the river. Canopy closure throughout the site is 50–70%. During the survey season, no standing water was present under the vegetation, and saturated soils were present only along the river.

We did not detect willow flycatchers at Bradley Bay. The site was surveyed seven times, totaling 9.4 observer-hours. Brown-headed Cowbirds were detected during three surveys.

CHUCKWALLA COVE

Area: 3.4 ha Elevation: 341 m

This mixed-native site is located in a dry cove between high bluffs and the Colorado River. The site consists of stringers of Goodding willow, 10–15 m in height, separated by dry, sandy areas vegetated by scattered tamarisk and dead cattail. Coyote willow is mixed with Goodding willow throughout the site. Canopy closure throughout the site is 25–90% and highly variable. During the survey season, no standing water was present under the vegetation, and saturated soils were present only along the river.

We detected one pair of willow flycatchers and one additional male 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 seven times, totaling 6.3 observer-hours. Brown-headed Cowbirds were detected on all but two surveys, and there was sign of cattle.

CENTER POINT

Area: 3.1 ha Elevation: 341 m

This mixed-native site lies immediately adjacent to the Colorado River and consists of a narrow band (<25 m wide) of Goodding willow approximately 8 m in height. Coyote willow and tamarisk are scattered throughout the site, and small, scattered patches of cattail are present next to the river. Canopy closure is 25–50%. During the survey season, no standing water was present under the vegetation, and saturated soils were present only along the river.

We did not detect willow flycatchers at Center Point. The site was surveyed four times, totaling 1.2 observer-hours. No Brown-headed Cowbirds were detected during surveys.

OTHER SITES

Separation Canyon (RM 239.5N): Area: 5.3 ha Elevation: 378 m

This mixed-exotic site features 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%. 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 are also present at this site. The streambed that runs through the site held surface water through at least 1 June.

The site was surveyed two times, totaling 2.0 observer-hours. Surveys were discontinued after 1 June. We did not detect willow flycatchers or Brown-headed Cowbirds at this site.

RM 251N: Area: 1.7 ha Elevation: 375 m

This mixed-exotic site consists of a 50-m-wide strip of tamarisk, averaging 3 m in height, along the Colorado River. Some Goodding willow is scattered throughout the site. Canopy closure is approximately 50%. The site is terraced approximately 2 m above the Colorado River, and soils throughout the site were completely dry during the survey season.

The site was surveyed two times, totaling 0.8 observer-hours. Surveys were discontinued after 1 June. We did not detect willow flycatchers or Brown-headed Cowbirds at this site.

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.

The amount of standing water throughout the entire Topock study area was markedly reduced in 2005 compared to 2003 and 2004. Compared to 2005 the amount of standing water in 2006 increased at breeding sites, and was similar to that of 2003 and 2004.

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; large, impenetrable areas of deadfall are present within the site. Soils within Pipes #2 were dry in 2006, and surveys were discontinued after 1 June due to the lack of suitable flycatcher habitat. Pipes #1 had mostly dry soils throughout the survey season. Standing water within Pipes #3 was confined to pig wallows, and the site did not become wetter mid-season as it did in 2005.

One pair and one additional male were detected in Pipes #3. Details of color-banding and occupancy are presented in Chapter 3. Portions of Pipes #3 not known to be occupied by flycatchers were surveyed 10 times, totaling 13.5 observer-hours. Pipes #1 was surveyed nine times, totaling 13.1 hours; Pipes #2 was surveyed five times, totaling 3.9 observer hours. Brown-headed Cowbirds were detected on almost all surveys at Pipes #1 and #3; no cowbirds were detected at Pipes #2.

THE WALLOWS

Area: 0.4 ha Elevation: 140 m

The Wallows is between Pipes #3 and PC6-1. This site is primarily vegetated by tamarisk 5–6 m in height with an occasional emergent Goodding willow. Overall canopy closure is 50–70%. The west edge of the site borders an open cattail marsh. Surface water was present in June and July in pig wallows and the marsh.

One pair was detected at The Wallows. 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 five times, totaling 1.9 observer-hours. Brown-headed Cowbirds were detected during two surveys.

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%. In contrast to 2005, standing water and saturated soils were present in pig wallows and on trails throughout the survey season.

No willow flycatchers were detected at the site. The site was surveyed nine times, totaling 12.4 observer-hours. Brown-headed Cowbirds were detected during all but one survey.

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 during the flycatcher breeding season, with saturated soils present only near a few pig wallows.

We detected one unpaired male at the 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 eight times, totaling 7.5 observer-hours. Brown-headed Cowbirds were detected during five surveys.

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 in and along small areas of marsh and in pig wallows, mostly early in the season in 800M. Saturated soils were present only near the marsh edges.

We located six breeding adults, two unpaired males, and one individual that was likely a migrant at In Between. One pair was located 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 eight times, totaling 9.1 observer-hours; cowbirds were recorded during all but two surveys. Portions of 800M not known to be occupied by willow flycatchers were surveyed four times, totaling 2.7 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%. Some standing water and saturated soils were present early in the season, along a marsh in the southern portion of the site.

We located five breeding adults and one additional male 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 five times, totaling 7.9 observer-hours. Cowbirds were recorded on all but one survey.

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.

Two willow flycatchers, likely migrants, were detected at Swine Paradise. We surveyed the site 10 times, totaling 6.9 observer-hours. Cowbirds were detected on five 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 7.8 observer-hours. Cowbirds were detected on four 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 separated from the Barbed Wire site by a firebreak road. They 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.

We did not detect willow flycatchers at either IRFB03 or IRFB04. We surveyed these sites 10 times each, totaling 10.3 observer-hours. Cowbirds were detected on all but six 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 five 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 within the site were dry throughout the flycatcher breeding season.

We detected one willow flycatcher in 250M. Details of occupancy and color-banding are presented in Chapter 3. Portions of the site not known to be occupied by flycatchers were surveyed eight times, totaling 5.7 observer-hours. Cowbirds were detected on three surveys.

HELL BIRD AND GLORY HOLE

Hell Bird: Area: 3.7 ha Elevation: 140 m
Glory Hole: Area: 4.3 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. Large swampy areas vegetated by cattail and bulrush are interspersed throughout the survey areas. In contrast to 2005, Hell Bird and Glory Hole contained standing water throughout the flycatcher breeding season.

We recorded no willow flycatchers in Hell Bird. Eight breeding flycatchers and one additional male were recorded 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 nine times, totaling 11.7 observer-hours; cowbirds were detected on all but three surveys. Portions of Glory Hole not known to be occupied by flycatchers were surveyed twice, totaling 2.5 observer-hours; cowbirds were detected on one survey.

BEAL LAKE

Area: 42.8 ha Elevation: 140 m

This mixed-native restoration site consists of a mosaic of relatively young Fremont cottonwood, Goodding willow, coyote willow, and arrowweed, with some tamarisk and mesquite scattered throughout the site. Canopy height is highly variable and averages approximately 4 m; canopy closure is sparse, averaging <25%. The amount of standing water and saturated soil at the site is highly variable because it is flood irrigated.

We detected one willow flycatcher, likely a migrant, at Beal Lake. Details of occupancy and color-banding are presented in Chapter 3. Portions of Beal Lake not known to be occupied by flycatchers were surveyed 10 times, totaling 10.2 observer-hours; cowbirds were detected on two 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. 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. Areas adjacent to the marsh edges held some standing water throughout the survey season.

We detected one willow flycatcher, likely a migrant, at Lost Lake. Details of occupancy and color-banding are presented in Chapter 3. Portions of Lost Lake not known to be occupied by flycatchers were surveyed nine times, totaling 15.3 observer-hours; cowbirds were detected on all but two surveys.

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 was partially inundated by the Colorado River.

We detected one willow flycatcher on 23 May and one on 30 May; both detections were likely migrants. We surveyed the site nine times, totaling 2.2 observer-hours. Cowbirds were not detected during surveys. 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 one willow flycatcher on 23 May and one on 8 June; both detections were likely migrants. We surveyed the site nine times, totaling 9.6 observer-hours. Cowbirds were detected on all but one visit. 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 that 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 eight times, totaling 10.2 observer-hours; cowbirds were detected on all but two surveys. Blankenship Bend South was surveyed nine times, totaling 7.3 observer-hours; cowbirds were detected on four 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%. Many Goodding willows at the site are mature and stand 5 m above the 10-m-tall tamarisk and mesquite. Soils in the interior of the site were dry throughout the survey season.

We did not detect any willow flycatchers at this site. We surveyed the site nine times, totaling 13.1 observer-hours. Numerous cowbirds were detected on all but one visit. 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 River 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.

In an effort to locate all potentially suitable willow flycatcher habitat within the Bill Williams River NWR, we reduced the number of surveys at the most upstream sites, which are difficult to access, and instead explored additional areas. Results of this reconnaissance effort are presented below after the survey results.

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%. One small pothole of standing water was present throughout the flycatcher breeding season, and no saturated soil was present.

We detected one willow flycatcher, likely a migrant, at Site #1 on 22 May. Details of occupancy and color-banding of all flycatchers at Bill Williams are presented in Chapter 3. Site #1 was surveyed nine times, totaling 8.5 observer-hours. Cowbirds were detected on all but two 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 eight times, totaling 5.4 observer-hours. Cowbirds were detected on four 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. Large areas of standing water are present because an arm of Lake Havasu follows the channel of the Bill Williams River through the site. However, no saturated soils were present under the vegetation during the survey season. The site is accessible by kayak.

We detected one willow flycatcher, likely a migrant, at Site #11 on 22 and 23 May. We surveyed the site seven times, totaling 4.5 observer-hours. Cowbirds were detected on all but one visit, 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: 8.3 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 three 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 areas of standing water and saturated soil throughout the flycatcher breeding season.

We detected two willow flycatchers, each on a single occasion, in Site #4 and five willow flycatchers (one likely a migrant and four breeding adults) 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 24.5 observer-hours. Cowbirds were detected on five visits to Site #4 and six visits to Site #3.

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%. 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 during the survey season.

No willow flycatchers were detected at Site #5. We surveyed the site five times, totaling 3.9 observer-hours. Cowbirds were detected on four visits, and there was no evidence of livestock 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.

No willow flycatchers were detected at Mineral Wash. The site was surveyed five times, totaling 6.4 observer-hours. Cowbirds were detected on all visits, and feral pig sign 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 are vegetated by tamarisk and honey mesquite 5–7 m in height and were dry during the surveys. 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 small 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 five times, totaling 6.4 observer-hours. Cowbirds were detected on all visits, and there was evidence of feral pigs at the site on one visit.

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. Overall canopy closure is <50%. This site had flowing water in the river channel throughout the flycatcher breeding season.

No willow flycatchers were detected at Site #8. The site was surveyed five times, totaling 8.9 observer-hours. Cowbirds were detected on three visits, and there was no evidence of livestock at the site.

GROUND RECONNAISSANCE RESULTS

Field personnel spent a total of 54 person-hours conducting habitat reconnaissance and opportunistic broadcast surveys, which covered almost the entire Bill Williams River corridor. We identified four areas, Last Gasp, River End, Flooded Refuge Road, and Black Rail (see below for details), that should be visited and evaluated in subsequent years. Other than in these four areas, vegetation structure and/or hydrological conditions in the remaining areas we evaluated are not characteristic of willow flycatcher breeding habitat at this time. No willow flycatchers were located during habitat reconnaissance.

Because the vegetation along the Bill Williams River consists of large, contiguous stretches of riparian habitat, it is not practicable to formulate descriptions of discrete sites assessed during our reconnaissance. Therefore, below we qualitatively describe vegetation and hydrology for contiguous stretches of habitat by section as related to our current study sites (see Figures 2.2 and 2.3 and Appendix B). The following descriptions are organized from downstream to upstream along the Bill Williams River.

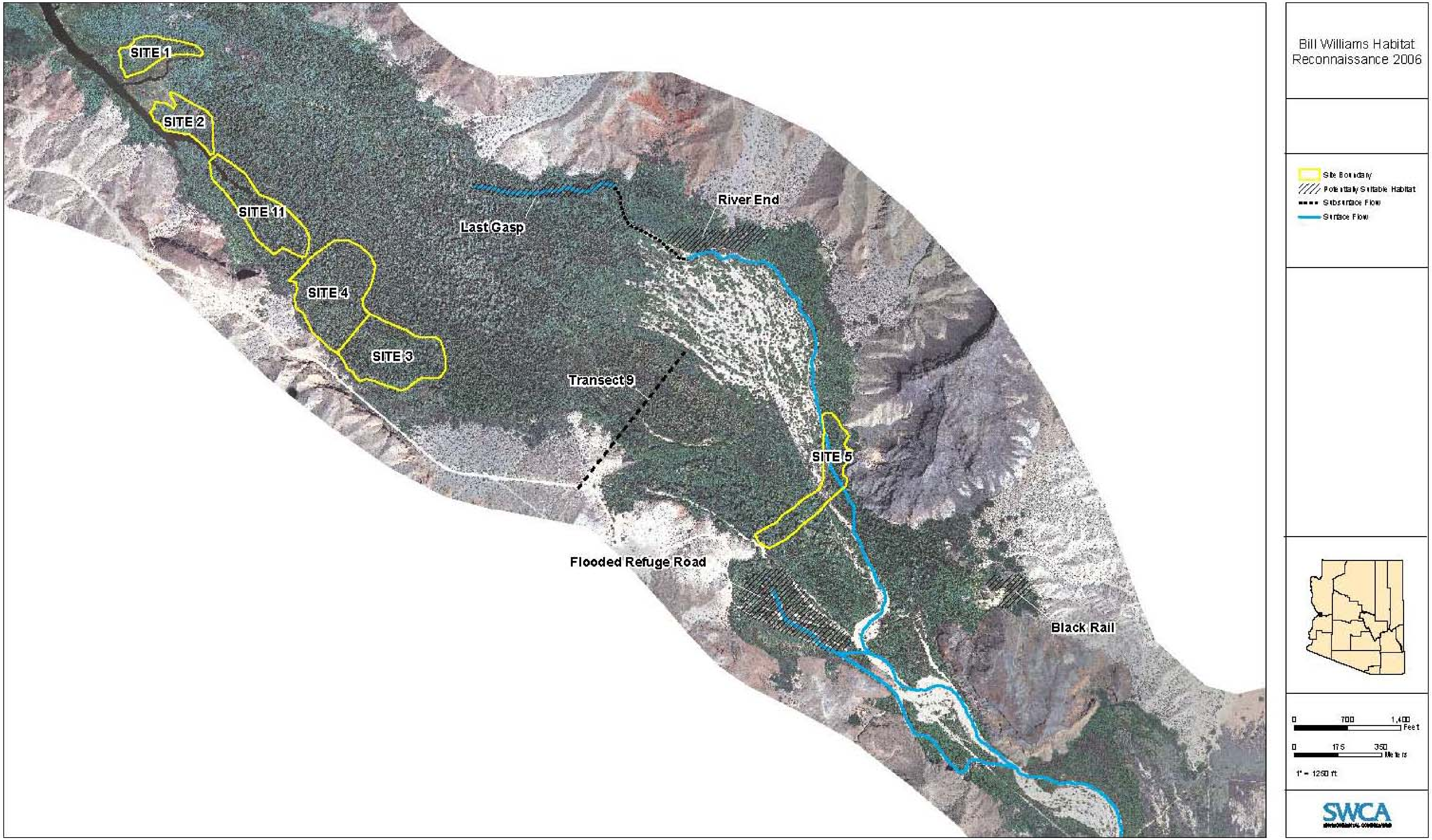

Figure 2.2. Bill Williams River NWR habitat reconnaissance 2006.

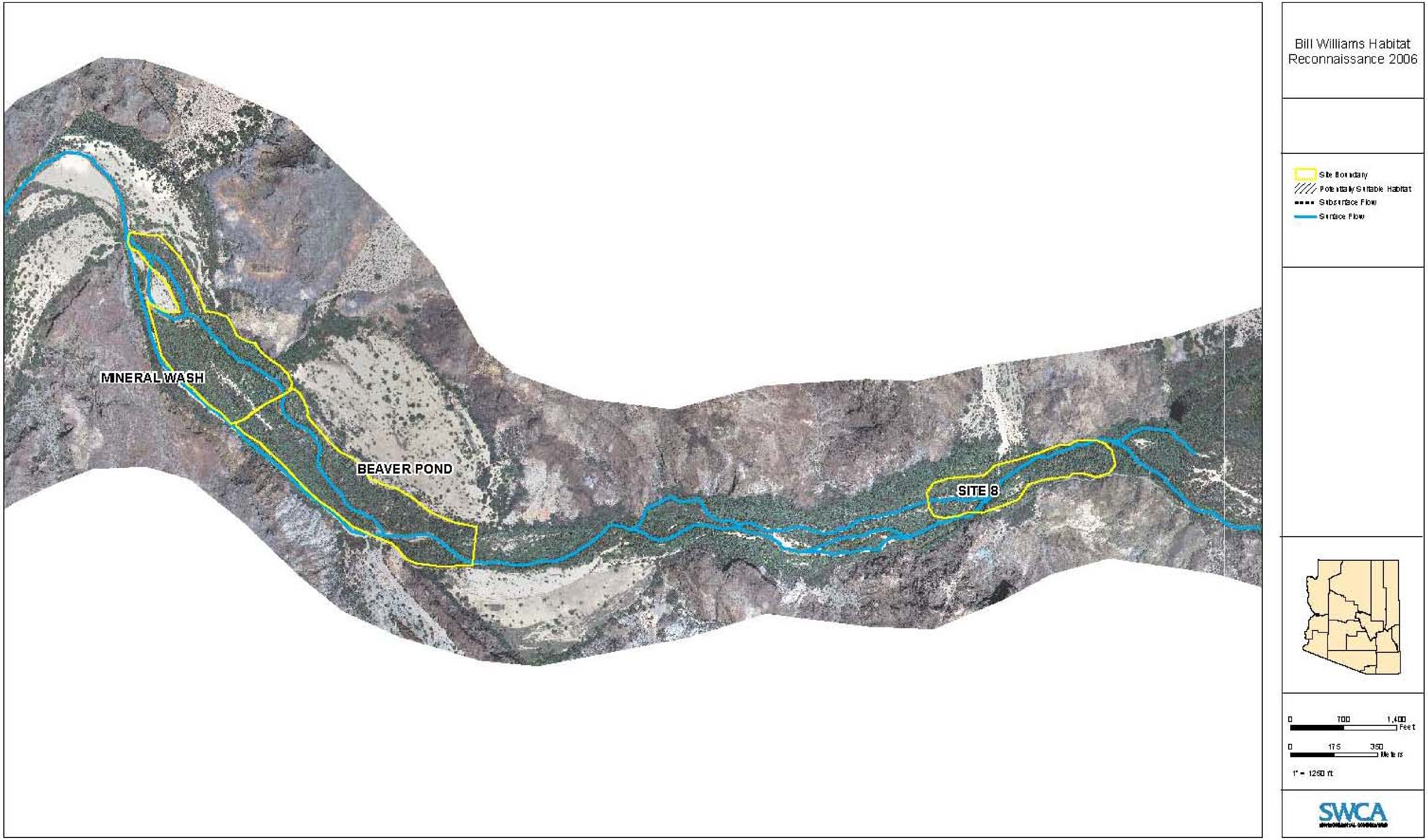

Figure 2.3. Bill Williams River NWR habitat reconnaissance 2006, continued.

"North of Site #2 to Site #1"

Starting our habitat reconnaissance at Site #2, we followed an approximately 150 m route north to the southern edge of Site #1. Tall willow forest with a dense tamarisk understory is present in this area. Lower strata vegetation from ground level up to approximately 2 m is choked with deadfall creating an almost impenetrable understory that is used little by most passerines (K. Blair, pers. comm.), including the willow flycatcher. Although slow moving and standing water is present in a channel nearby, soils under the vegetation are completely dry. Based on aerial photography, similar habitat extends for at least 400 meters east of this route. The impenetrable understory and dry soils encountered during the reconnaissance are not characteristic of willow flycatcher habitat.

"Upstream From Mosquito Flats"

The historical flycatcher breeding sites Site #3 and Site #4 are contiguous, and together are known as Mosquito Flats. Starting our habitat reconnaissance at this breeding area, we followed the edge of standing water and saturated soils upstream/east for approximately 100 m, at which point the water went subsurface and soils became completely dry. We followed this east bearing for another approximately 350 m. Vegetation in this section consisted of live and dead tamarisk with tangles of cottonwood and willow deadfall. Vegetation became more and more dense as we progressed upstream. When the vegetation became impenetrable, we headed due south for approximately 300 m until we reached the riparian/desert upland interface. Based on aerial photography, similar habitat extends for approximately 450 meters east of this route to "*Transect #9*" (see below).

Excluding the 100 m immediately adjacent to Site #3, vegetation encountered during the reconnaissance is not suitable flycatcher habitat. The understory was nearly or completely impenetrable, with much deadfall tangled in with dead and live tamarisk. Hydrological conditions encountered during the reconnaissance are not characteristic of occupied flycatcher habitat, with only dry soils present under the vegetation.

"Last Gasp"

This area is depicted as a wetland on the USGS Monkey's Head 7.5-min topographic map. We attempted to reach this area by following the river downstream from Site #5 (see Downstream from Site #5 to River End, below) but encountered impenetrable vegetation just upstream of the "wetland" area. We then accessed the area by crossing the river at Site #5 and following the desert uplands on the north edge of the riparian zone. The area depicted as a wetland consists of tall cottonwood/willow forest with a dense tamarisk understory and abundant deadfall. Surface water was present in multiple channels ranging from small, ponded areas over 100 cm deep to narrow, flowing streams. We attempted to follow the water to its terminus in both the upstream and downstream directions but encountered very dense vegetation. Soils away from the channels were dry. Because of the presence of surface water within the vegetation, this area should be evaluated in future years.

"Transect #9"

The habitat reconnaissance route followed a transect cut through the vegetation that is used by the U.S. Geological Survey for sedimentation studies (K. Blair, pers. comm.). The transect runs southwest to northeast for approximately 460 m, and it is located approximately halfway between Mosquito Flats and Site #5.

Vegetation encountered during the reconnaissance is not suitable flycatcher habitat. Although scattered emergent willow and cottonwood with a dense tamarisk understory are present within the southern half of the transect, most of the area consists primarily of impenetrable tamarisk. Hydrological conditions encountered during the reconnaissance are not characteristic of habitat occupied by breeding flycatchers, with only sandy soils present under the vegetation. Based on aerial photography, similar habitat extends for approximately 685 meters southeast of this route to Site #5.

"Downstream From Site #5 to River End"

Starting habitat reconnaissance at Site #5, we followed vegetation along the Bill Williams River downstream/northwest for approximately 1.3 km. The river along this route was channelized, with banks averaging 1–2 m in height. Standing water was limited to the channel, and dry soils were present under the riverside vegetation. Toward the end of the route, the river becomes wider and less channelized and terminates in a small body of standing water, where the Bill Williams River goes subsurface. Downstream of this area soils were completely dry and we followed dry, sandy, braided channels downstream for another approximately 300 m. Here the dry channels terminated near the east end of Last Gasp in a stand of cottonwood/willow forest with dense tamarisk understory.

The vegetation along the river consists of a mosaic of dense tamarisk, emergent willow and cottonwood trees, and mesquite. Small islands of cattail marsh are scattered about this stretch of river and are confined to the channel. Understory vegetation along the north bank of the river and where the river became subsurface is almost impenetrable. Vegetation along the south bank of the river has a more open understory. Hydrological conditions along the channelized section of the Bill Williams River are not characteristic of occupied flycatcher habitat because standing water is confined to the channel. Although dry swales adjacent to the river indicate overbank flooding occurs during extreme high flows, no standing water or saturated soils were present under the vegetation. The area where surface water of the Bill Williams River goes subsurface is less channelized and contains tall, dense vegetation with some standing water. Because of standing water this "River End" area should be evaluated in future years.

"Flooded Refuge Road"

This area is located approximately 300 m southeast of Site #5 and straddles the refuge road, which is currently flooded. The habitat reconnaissance routes followed the flooded refuge road and small meandering channels that penetrated the vegetation. The patch consists primarily of flooded tamarisk forest. A few emergent willows and cottonwoods are scattered throughout the area. Because standing water is present under the vegetation this area should be evaluated in future years.

"Black Rail"

This area is located approximately 840 m east/southeast of Site #5, is difficult to access, and lies adjacent to the desert uplands approximately 350 m from the Bill Williams River. At this time access to the site is possible only via 4x4 ATV over the desert uplands to the north. This small site consists of a mosaic of coyote willow, cattail marsh, and tamarisk. A small stand of cottonwoods with a tamarisk understory lies adjacent to marsh, which is likely spring-fed, and mesquite trees are present in drier areas. Hydrological conditions are characteristic of occupied flycatcher habitat, with standing water present under the vegetation and in the marsh. Although this site is small in area, it has characteristics typical of flycatcher habitat and should be evaluated in future years.

"Upstream From Site #5 to Mineral Wash"

Starting habitat reconnaissance at Site #5, we followed vegetation along the Bill Williams River upstream/southeast for approximately 3,800 m to the Mineral Wash site. In an effort to get a better view of the habitat and better access to the vegetation along the river, routes also followed dry washes west of the river near Site #5, and the desert uplands east and west of the river. The vegetation along the river consists of a mosaic of dense tamarisk, willow and cottonwood forest, and scattered mesquite. Although some patches of Goodding willow forest with tamarisk understory closest to the river have structure typical of suitable flycatcher habitat, soils under the vegetation are dry. Because surface water and saturated soils are confined to the river this area is not typical of flycatcher habitat.

"Beaver Pond to Site #8"

Starting habitat reconnaissance at the Beaver Pond site, we followed the Bill Williams River upstream/east for approximately 1,800 m to Site #8. The vegetation in this area consists primarily of grassy areas and scattered cottonwood and willow trees with no understory vegetation. Because surface water is confined to the river, and because soils are dry under the vegetation and there is no understory vegetation, this area is not suitable flycatcher habitat.

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 two flycatchers at the site on 21 May. No willow flycatchers were detected during the remaining nine surveys. The site was surveyed 10 times, totaling 29.8 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. Canopy closure at the site is approximately 50%. Approximately 5% of the site is a cattail marsh that contained standing water and saturated soils in June and July. The site is separated from the Colorado River by a levee.

We detected one willow flycatcher on 4 June and one on 19 June. No willow flycatchers were detected during the remaining eight surveys. The site was surveyed 10 times, totaling 8.9 observer-hours. Cowbirds were detected on all but one survey, and burros use the periphery of the site.

CIBOLA NATIONAL WILDLIFE REFUGE, ARIZONA AND CALIFORNIA

CIBOLA NATURE TRAIL

Area: 13.7 ha Elevation: 70 m

This mixed-native restoration site consists of a mosaic of Fremont cottonwood, Goodding willow, coyote willow, and mesquite. The site is completely surrounded by plowed agricultural fields. Canopy height varies from 15–20 m in the cottonwood areas to 5–7 m in the willows and 4–5 m in the mesquite. Canopy closure ranges from 25 to 50%. Only a small amount of standing water and saturated soil was recorded in June. The amount of standing water and saturated soil is highly variable because the site is flood irrigated.

We detected four willow flycatchers on 19 May and one on 24 May. No willow flycatchers were detected during the remaining eight surveys. The site was surveyed 10 times, totaling 14.0 observer-hours. Cowbirds were detected on all surveys.

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 one willow flycatcher on 19 May, one on 24 May, and one on 14 June. No willow flycatchers were detected during the remaining seven surveys. We surveyed the sites 10 times each, totaling 26.0 observer-hours. Cowbirds were recorded on all visits, and burro trails were noted on the periphery of the sites.

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 two willow flycatchers on 22 May, one on 31 May, and one on 2 June. No willow flycatchers were detected during the remaining seven surveys. The site was surveyed 10 times, totaling 14.9 observer-hours. Cowbirds were detected on all visits.

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 25 willow flycatchers on 23 May, 3 on 31 May, 2 on 3 June, and 7 on 6 June. No willow flycatchers were detected during the remaining six surveys. The site was surveyed 10 times, totaling 32.4 observer-hours. Large numbers of cowbirds were detected on all visits.

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 22 May and two on 5 June. At Cibola Lake East, we detected two willow flycatchers on 19 May, and one on 2 June. At Cibola Lake West, we detected one willow flycatcher on 18 May and two flycatchers on 1 June. No willow flycatchers were detected during the remaining six surveys. The sites were surveyed 10 times each, totaling 43.7 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 and 2006 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 is present farther east, away from the lake edge. Walker Lake had standing water in May, but had dried to deep mud by July. Areas of the site adjacent to Walker Lake had standing water and saturated soils through June, while soils in the interior of the site were dry throughout the survey season.

We detected one willow flycatcher on 20 May, three on 23 May, one on 3 June, and one on 20 June. No willow flycatchers were detected during the remaining six surveys. The site was visited 10 times, totaling 25.9 observer-hours. Numerous cowbirds were detected on all surveys, and evidence of burros was recorded.

IMPERIAL NATIONAL WILDLIFE REFUGE, ARIZONA AND CALIFORNIA

DRAPER LAKE

Area: 4.6 ha Elevation: 63 m

The main landscape feature of the site is Draper Lake, which lies approximately 200 m west of the Colorado River. This site burned prior to the 2003 survey season and has not been surveyed since then. Between the lake and the river is mixed-exotic vegetation consisting mostly of tamarisk averaging 4 m in height. Goodding and coyote willow averaging 5 m in height are scattered throughout the site, and a large patch of coyote willow extends approximately 100 m west of Draper Lake. Cattail marsh lies in areas closest to the lake and along the edge of the river. Standing water and saturated soils were present throughout the survey season in the cattail marsh.

We detected eight willow flycatchers on 23 May and six on 7 June. No willow flycatchers were detected during the remaining eight surveys. The site was surveyed 10 times, totaling 17.2 observer-hours. Large numbers of cowbirds were detected on all but one survey, and no sign of livestock use was observed on the site.

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. 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%. Standing water was present at the site in May, and saturated soil persisted in the marsh until June.

We detected one willow flycatcher on 18 May, nine on 23 May, five on 1 June, four on 7 June, and one on 21 June. No willow flycatchers were detected during the remaining five surveys. The site was surveyed 10 times, totaling 28.5 observer-hours. Cowbirds were detected on every visit, and no sign of livestock use was observed on the site.

HOGE RANCH

Area: 20.7 ha Elevation: 61 m

This large, wetland 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. Canopy closure is approximately 70%. The marshes in the interior of the site contained fluctuating amounts of standing water and saturated soil throughout the survey season. The site also borders the Colorado River.

We detected seven willow flycatchers at Hoge Ranch on 22 May, six on 31 May, and nine on 6 June. No flycatchers were detected during the remaining seven surveys. The site was surveyed 10 times, totaling 20.3 observer-hours. Cowbirds were detected on all but one survey, and there were signs of feral 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. Canopy closure within the site is 70–90%. The site is adjacent to the Colorado River, but hydrological conditions in the interior of the site were undetermined.

We detected one willow flycatcher on 16 May, one on 6 June, and one on 15 June. No willow flycatchers were detected during the remaining seven surveys. The site was surveyed 10 times, totaling 4.7 observer-hours. Cowbirds were detected on four visits, and there was sign of burro 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. Water levels within the site fluctuated, and portions of the site held standing water intermittently throughout the season.

We detected two willow flycatchers on 22 May and three on 31 May. No willow flycatchers were detected during the remaining eight surveys. The site was surveyed 10 times, totaling 17.1 observer-hours. Cowbirds were detected on all but three surveys, and there were signs of feral burros and pigs 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 on 16 May and one on 5 June. No willow flycatchers were detected during the remaining eight surveys. This site was surveyed 10 times, totaling 12.2 observer-hours. Cowbirds were detected on six visits, and feral burros use 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 during the survey season. 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 seven willow flycatchers on 22 May and three on 5 June. No willow flycatchers were detected during the remaining eight surveys. The site was surveyed 10 times, totaling 18.1 observer-hours. An additional 4.0 observer-hours were spent at the site during banding efforts on 14 June. Cowbirds were detected on all visits, and there was evidence of heavy use of the site by feral 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 impenetrable 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 it from the river. Thus, hydrologic conditions of the interior of the site were undetermined.

We detected one willow flycatcher on 17 May and one on 30 May. No willow flycatchers were detected on the remaining eight surveys. The site was surveyed 10 times, totaling 6.3 observer-hours. Cowbirds were recorded on all but two visits.

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.

We detected one willow flycatcher on 30 May and one on 21 June. No willow flycatchers were detected on the remaining eight surveys. The site was surveyed 10 times, totaling 8.6 observer-hours. Cowbirds were detected on all but one visit.

NURSERY NW

Area: 7.0 ha Elevation: 58 m

This mixed exotic site lies between the Colorado River and a cattail marsh. The dominant vegetation is tamarisk 5–7 m in height with an understory of common reed. The site also contains marshy areas vegetated by common reed, cattail, and bulrush. Overall canopy closure is around 25%.

We detected two willow flycatchers on 24 May and four on 4 June. No willow flycatchers were detected on the remaining eight surveys. The site was surveyed 10 times, totaling 10.8 observer-hours. Cowbirds were detected on all visits, and there was no evidence of livestock using 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 four on 20 May. No willow flycatchers were detected on the remaining eight surveys. The site was surveyed 10 times, totaling 7.7 observer-hours. Cowbirds were detected on six 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 fluctuating levels of standing water throughout the survey season.

We detected three willow flycatchers on 15 May, four on 20 May, five on 2 June, and one on 13 June. No flycatchers were detected on the last six visits. The site was surveyed 10 times, totaling 29.9 observer-hours. Large numbers of cowbirds were detected on all visits.

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 five willow flycatchers on 28 May. No willow flycatchers were detected during the remaining nine surveys. The site was visited 10 times, totaling 18.2 observer-hours. Cowbirds were recorded on all 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 9 willow flycatchers on 15 May, 5 on 20 May, 18 on 29 May, 11 on 3 June, and 1 on 17 June. No flycatchers were detected on the remaining five surveys. The site was surveyed 10 times, with 30.2 observer-hours spent at the site. Large numbers of 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. The marsh was primarily dry until late June, when the water level increased markedly. The water level then declined during July.

We detected two willow flycatchers at this site on 15 May, two on 20 May, and one on 29 May. No willow flycatchers were detected during the remaining seven surveys. The site was surveyed 10 times, with 8.6 observer-hours spent at the site. Cowbirds were recorded on all 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. No standing water or saturated soils were recorded in the interior of the site.

We detected two willow flycatchers at Martinez Lake on 15 May, eight on 20 May, and three on 29 May. No flycatchers were detected on the remaining seven surveys. The site was visited 10 times, totaling 8.9 observer-hours. Cowbirds were detected on all 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. Surface water was present in the site only during May.

We detected five willow flycatchers on 21 May and four on 28 May. No flycatchers were detected during the remaining eight surveys. The site was visited 10 times, totaling 17.8 observer-hours. Cowbirds were detected on all but one visit.

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 marsh held standing water through mid-July. The land north of the western half of the site has been recently bulldozed and converted to fields, which were inundated in June. An approximately 50- x 50-m patch of vegetation in the center of the site has been removed for a pump and canal, which water the nearby fields.

No willow flycatchers were detected at Mittry South. The site was visited 11 times, totaling 16.7 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 24 May and five on 27 May. No willow flycatchers were detected during the remaining eight surveys. The site was surveyed 10 times, totaling 5.0 observer-hours. Cowbirds were detected on all visits, and evidence of burros was abundant in the upland areas surrounding the site.

POTHOLES WEST

Area: 6.6 ha   Elevation: 53 m

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 24 May and three on 27 May. No willow flycatchers were detected during the remaining eight surveys. The site was surveyed 10 times, totaling 7.9 observer-hours. Cowbirds were detected on all 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 anywhere at the site in 2006. 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. The northern portion of the east end of the site, including part of the Goodding willow stand, burned during the first half of June 2006.

At River Mile 33, we detected one willow flycatcher on 13 May, five on 21 May, seven on 30 May, and one on 14 June. Cowbirds were recorded on all visits, and there was no evidence of livestock use at the site. Because of safety concerns of our field personnel, surveys were discontinued on 17 June. Large numbers of homeless people inhabit the area immediately 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 intermittently 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 one willow flycatcher on 25 May, one on 2 June, and one on 16 June. No willow flycatchers were detected during the remaining five surveys. The site was surveyed 10 times, totaling 10.1 observer-hours. Cowbirds were detected on all 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 in the middle of 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 four willow flycatchers at Gila Confluence North on 18 May, three on 30 May, two on 12 June, one on 17 June, and one on 19 June. No willow flycatchers were detected during the remaining five surveys. One willow flycatcher was detected during vegetation measurements on 28 July. The site was surveyed 10 times, totaling 16.7 observer-hours. An additional 4.5 observer-hours were spent at the site during banding efforts on 19 June. Cowbirds were detected on all visits, and no evidence of livestock use was noted.

GILA RIVER SITE #1

Area: 5.7 ha Elevation: 45 m

This site was surveyed in 2003 but not in 2004 and 2005 because a fire removed most of the vegetation early in the 2004 survey season. The site has regenerated with mixed-native vegetation and was surveyed in 2006. The western third of the site consists of a narrow stringer of Fremont cottonwood and Goodding willow which averages 15 m in height; canopy closure is <25%. The central part of the site has regenerated with Goodding willow up to 5 m in height, but canopy closure is <15%. The site is bordered to the north by agricultural fields and to the south by the Gila River. A channel bordered with tamarisk and cattail marsh, which held standing water until July, passes through the central part of site. The eastern portion of the site has regenerated with dense arrowweed and some Goodding willow and Fremont cottonwood up to 3 m in height. The eastern area may become more suitable for flycatchers in subsequent years.

Two willow flycatchers were detected on 25 May, one on 4 June, and one on 14 June. No willow flycatchers were detected during the remaining seven surveys. We surveyed the site 10 times, totaling 10.1 observer-hours. Cowbirds were detected on all visits, and human disturbance was recorded at the site.

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 cottonwood and Goodding willow extends to the west along the edge of the agricultural fields. There was no standing water or saturated soils within the site during the survey period, but the western edge of the site borders a large pond.

Nine willow flycatchers were detected at this site on 27 May. No willow flycatchers were detected during the remaining nine surveys. We surveyed the site 10 times, totaling 11.1 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was noted at 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 at the site. The site is bordered to the north by agricultural fields and to the south by a cattail marsh and the Gila River.

Ten willow flycatchers were detected at this site on 27 May. No willow flycatchers were detected during the remaining nine surveys. We surveyed the site 10 times, totaling 6.1 observer-hours. Cowbirds were detected on all 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%. The site did not contain any standing water or saturated soils during the survey period. The western edge of the site borders the Gila River.

Three willow flycatchers were detected on 4 June, and one on 21 June. No willow flycatchers were detected during the remaining eight surveys. The site was surveyed 10 times, totaling 16.6 observer-hours. Cowbirds were detected on all visits, and no sign of livestock use was recorded.

MORELOS DAM

Area: 7.7 ha Elevation: 34 m

This mixed-native site lies next to the Colorado River. The site burned prior to the 2003 survey season and has not been surveyed since then. The site consists primarily of widely spaced Goodding willow averaging 8 m in height with scattered Fremont cottonwood and an understory of common reed. The northern end of the site contains a patch of dense tamarisk. Canopy closure is 25–50%. Much burned, downed, dead wood is scattered throughout the site along with tall burned snags. A small body of water formed by Morelos Dam lies adjacent to the northwest side of the site.

No willow flycatchers were detected at Morelos Dam. The site was visited nine times, totaling 14.1 observer-hours. Cowbirds were detected during all visits, and no evidence 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 site is bordered to the north and east by agricultural fields and to the south and west by a large stand of mesquite. A fire prior to the 2006 survey season removed most of the understory vegetation. Sparse stands of Fremont cottonwood and Goodding willow 20 m in height remain, of which only 50% are alive. Most of the ground has been bulldozed.

We detected 4 willow flycatchers on 15 May, 24 on 19 May, 2 on 26 May, 3 on 30 May, and 1 on 15 June. The site was surveyed five times, with surveys discontinued on 15 June. Cowbirds were detected during all visits. No livestock use was recorded, but 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 9 willow flycatchers on 15 May, 19 on 19 May, 7 on 26 May, 2 on 30 May, 11 on 8 June, and 2 on 15 June. No flycatchers were detected during the remaining four surveys. The site was surveyed 10 times, totaling 18.9 observer-hours. An additional 44.5 hours were spent at the site conducting banding studies from 9 to 20 June. During banding efforts we detected 3, 6, 4, 2, 3, 8, and 6 willow flycatchers on 9, 10, 11, 12, 16, 17, and 18 June, respectively. Large numbers of cowbirds were recorded on all 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 channels and small ponds that contained standing water and saturated soils throughout the survey season. 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. An irrigation canal that contained water during the surveys lies approximately 25 m from the edge of the site.

We detected 10 willow flycatchers on 13 May, 11 on 19 May, 1 on 26 May, 26 on 30 May, and 1 on 15 June. No flycatchers were detected during the remaining four surveys. The site was surveyed nine times, totaling 28.8 observer-hours. An additional 8.6 hours were spent at the site conducting banding studies from 7 to 8 June. We detected five willow flycatchers on 7 June and five on 8 June. Large numbers of cowbirds were recorded on all visits. No livestock use was recorded, but the site receives heavy foot traffic by illegal immigrants.

DISCUSSION

In 2006, we found resident[7] and breeding Southwestern Willow Flycatchers at the four life history study areas (Pahranagat NWR, Mesquite, Mormon Mesa, and Topock Marsh) as well as at the Muddy River Delta, lower Grand Canyon and the Lake Mead Delta, and Bill Williams River NWR (details of residency and breeding are presented in Chapters 3 and 4).

Habitat occupancy by resident or breeding flycatchers at some sites differed from that of previous years (McKernan and Braden 2002, Koronkiewicz et al. 2004, McLeod et al. 2005, Koronkiewicz et al. 2006a). Flycatcher breeding at Littlefield, Arizona, was recorded for the first time in 2004, but flycatchers abandoned the site in 2005 because winter floods caused extensive loss of vegetation. No flycatchers were recorded at the site in 2006. Willow flycatcher breeding was documented at Bill Williams from 1999 to 2003, with residency but no breeding recorded in 2004, and residency and breeding recorded again in 2005 and 2006. The fluctuating availability of surface water at Bill Williams is likely one factor influencing willow flycatcher residency and breeding at the site in any given year, with flycatchers breeding in years when sites contained standing water. The influence of the availability of surface water on flycatcher breeding was also observed along the Virgin River at the Bunker Farm site, which periodically

[7] An individual present for a week or longer was considered resident.

receives runoff from an adjacent agricultural field. In 2005, the site contained standing water and saturated soils throughout the flycatcher breeding season, and two flycatcher pairs produced six nests. In 2006, the Bunker Farm site did not receive any agricultural runoff, and only an unpaired male occupied the site for one week in May.

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 when the declining water levels in Lake Mead left most vegetated areas on high, dry river banks. Breeding and residency was recorded again in 2004 and 2005, respectively, at a spring-fed site (RM 274.5N) in lower Grand Canyon. In 2006, breeding was recorded at RM 274.5N and in the Lake Mead Delta, where suitable flycatcher habitat has developed over the last two to three years on sediments previously inundated by Lake Mead.

Although no standing water or saturated soil was present during the breeding season within the vegetation at occupied flycatcher sites in the Lake Mead Delta, the presence of swales indicates water was present at one time. It is likely that at the time vegetation began to develop at these sites, surface water was present periodically as the result of slight fluctuations in reservoir levels. However, by the time the vegetation reached the height and density to be occupied by flycatchers, water levels had receded such that soils underneath the vegetation were dry. It is unknown whether the occupied sites in the Lake Mead Delta can retain the current vegetation structure if lake levels continue to drop. The lack of surface water or saturated soils at these sites may have contributed to site abandonment immediately after the first nests were depredated and to brief pairing of individuals with no nesting attempts located.

The amount of standing water throughout the entire Topock study area was markedly reduced in 2005 compared to 2003 and 2004. Compared to 2005 the amount of standing water increased in 2006 at PC6-1, 800M, Pierced Egg, Hell Bird, and Glory Hole, and was similar to that of 2003 and 2004. It is undetermined whether annual fluctuations in the amount of standing water at Topock contribute to the annual fluctuation in the total numbers of adults detected from 2003 to 2006, with 25, 67, 41 and 37 individuals, respectively. A combination of biotic and abiotic factors may be driving the demographics of this local population.

In an effort to locate all potentially suitable willow flycatcher habitat within the Bill Williams River NWR, we conducted extensive habitat reconnaissance and opportunistic surveys, which covered large portions of the river corridor, throughout the survey season. Although the Bill Williams River NWR contains the largest expanse of native cottonwood-willow forest on the lower Colorado River, vegetation structure and hydrological conditions along most of the river corridor are not characteristic of willow flycatcher breeding habitat at this time. Currently, willow flycatchers are known to breed on the refuge at one small site (Mosquito Flats). The hydrological characteristics of the site may not be strongly influenced by the Bill Williams River. A perched water table influenced by Lake Havasu lies beneath Mosquito Flats (K. Blair, pers. comm.), and it is likely that the hydrological conditions (standing water and saturated soils) observed at the site are influenced more by this water table than by the Bill Williams River. As far as we know, these hydrological conditions do not exist anywhere else on the refuge. Habitat reconnaissance still needs to be conducted near the refuge boundary with Planet Ranch.

Because of Alamo Dam, the Bill Williams River does not typically flood to the degree required for scouring, which would remove deadfall from the understory. If scouring were to occur on Bill Williams, it is likely much impenetrable understory vegetation would be removed and young vegetation would develop, which would provide habitat for successional habitat specialists such as the willow flycatcher. Additionally, scouring floods would also likely de-channelize much of the Bill Williams River, altering the drainage such that overbank flooding would occur more often. Overbank flooding over time would create the hydrological conditions necessary for the generation of multi-aged stands of riparian vegetation characteristic of "natural" riparian ecosystems and willow flycatcher breeding habitat.

Although many flycatchers were recorded at sites surveyed south of Bill Williams until 15 June, and nine detections were recorded post 15 June, including one detection on 28 July, monitoring results at these sites suggest these flycatchers were not resident or breeding individuals. Results at survey sites south of Bill Williams in 2006 are consistent with those of previous years from 1997 to 2005 (McKernan and Braden 2002, Koronkiewicz et al. 2004, McLeod et al. 2005, Koronkiewicz et al. 2006a), with no confirmed nesting recorded since 1938 (Unitt 1987). Based upon the variation in total numbers of flycatchers detected at a particular site over the survey period (e.g., 9 flycatcher detections at Great Blue Heron on 15 May, 5 on 20 May, 18 on 29 May, 11 on 3 June, 1 on 17 June, and 0 on four subsequent surveys), and the overall lack of territorial, aggressive behaviors exhibited toward conspecific broadcasts, willow flycatchers detected at sites south of Bill Williams in 2006 were most likely migrants. These results are consistent with those recorded in 2003–2005 (Koronkiewicz et al. 2004, McLeod et al. 2005, Koronkiewicz et al. 2006a). Given that willow flycatchers are one of the last long-distance migrant passerines to arrive in the Southwest in spring,[8] and fall migrant *E. t. brewsteri* can arrive in southern California as early as 18 July (Unitt 1987), the occurrence of northbound migrant willow flycatchers along the lower Colorado River until late June and southbound migrants in late July is not surprising. Regarding the early fall migration of willow flycatchers in the West, Unitt (1987) notes "[18 July] may seem inordinately early for fall migration of a land bird, but is in fact no earlier than the beginning of fall migration of such familiar species as Western Tanager (*Piranga ludoviciana*) and Black-headed Grosbeak (*Pheuticus melanocephalus*)." Furthermore, with over 200 willow flycatcher detections recorded in 2003 (Koronkiewicz et al. 2004), over 600 detections recorded in 2004 (McLeod et al. 2005), over 300 detections in 2005 (Koronkiewicz et al. 2006a), and over 450 detections in 2006, this section of the lower Colorado River corridor is undoubtedly a major flyway for migrant willow flycatchers in spring. The degree to which willow flycatchers use the corridor during fall migration is undetermined.

A willow flycatcher was detected singing (*fitz-bew*) spontaneously on 28 July at Gila Confluence North. It is unlikely the bird was resident at the site because no willow flycatchers were recorded during four surveys prior to the detection. However, willow flycatchers rarely sing during fall migration (Unitt 1987, Finch et al. 2000), and the status and subspecies of this individual remain undetermined.

[8] 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 et al. 2006b).

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. We conducted color-banding studies at sites south of Bill Williams in 2006, as in 2003–2005 (see Chapter 3). We captured and color-banded willow flycatchers at one site on several consecutive days but did not recapture or resight any banded flycatchers, suggesting that, at least in these cases, flycatchers did not remain at the site for multiple days. Color-banding studies at sites south of Bill Williams will be continued in 2007 to better determine residency, breeding status, and movement patterns in this area.

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 fourth 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, several sites along the Colorado River in Grand Canyon and on the Lake Mead Delta, and the Bill Williams River National Wildlife Refuge. The color-banding effort also included opportunistic banding, in cooperation with Nevada Division of Wildlife, at Key Pittman Wildlife Management Area in Nevada, approximately 30 km north of Pahranagat NWR.

For the fourth 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 2006, we began reconnaissance and preliminary banding attempts on 7 June to identify areas where capture success was likely and thus increase the efficiency of our banding effort. Banding attempts focused along the Colorado River near the Mexico border (Gadsden and Hunter's Hole) and were also made at Imperial NWR (Picacho NW) and at the confluence of the Gila and Colorado Rivers (Gila Confluence North). These banding 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 with 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.

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, 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 28 new adult flycatchers and recaptured 13 individuals banded in previous years, not including individuals banded as juveniles in a previous year and not identified since. An additional 56 adults banded in previous years were resighted, of which 42 (75%) could be identified to individual, 10 were banded as juveniles in a previous year but could not be recaptured to determine origin and identity, 1 had a federal band on one leg and an injury on the other leg, and 3 did not have their band combinations confirmed. We banded 55 nestlings from 29 nests and captured 3 fledglings from two nests that were too high to band. Of the 55 nestlings banded, 2 were known to have died before fledging. We detected 22 individuals originally banded as juveniles in a previous year, with 12 (55%) identified to individual via recapture. Overall, 70% of the adult flycatchers detected at the monitoring sites were color-banded by the end of the breeding season (Table 3.1). For 14 adult flycatchers detected, we were unable to determine if these individuals were color-banded (that is, banding status was undetermined). 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 2006, see Appendix C.

SITE-BY-SITE COLOR-BANDING AND RESIGHTING

MONITORING SITES

Pahranagat – We detected 34 resident, adult willow flycatchers from 20 territories at Pahranagat. In addition to resident adults, we detected two individuals for which residency and/or breeding status could not be confirmed; both of these were suspected migrants (Tables 3.2

and 3.3). Of the 20 territories recorded at Pahranagat, 15 consisted of breeding individuals and 5 consisted of unpaired males. Of the breeding individuals, one male was polygynous with two females.

Field personnel captured and color-banded 4 new adults and recaptured 13 adult flycatchers banded in previous years, including 5 individuals originally banded as nestlings (1 from 2004, 4 from 2005). Of the returning nestlings, four females were part of breeding pairs and one male was unpaired (see Table 3.20 for juvenile dispersal data). We resighted and confirmed band combinations for an additional 16 adults and could not confirm band status for 1 adult. We banded 18 nestlings from 7 nests and 3 fledglings from 2 nests that were too high to band. Of the banded nestlings, two were known to have died before fledging. Of all the adults detected, only two, for which residency and/or breeding status could not be confirmed, remained unbanded.

Mesquite – We detected 27 resident, adult willow flycatchers from 16 territories at Mesquite. In addition to resident adults, we detected one individual that was subsequently resighted at Mormon Mesa. Of the 16 territories recorded at Mesquite, 13 consisted of breeding individuals, 2 consisted of paired individuals for whom no nest was found, and 1 consisted of an unpaired individual (Tables 3.4 and 3.5). Of the breeding individuals, four males were each polygynous with two females.

Field personnel captured and color-banded three new adults and recaptured four banded adult flycatchers, including two individuals originally banded as nestlings in 2005 and one individual banded as an adult in Grand Canyon in 2006. We resighted 13 other returning banded individuals; of these, band combinations could not be confirmed on 1 individual with plastic bands, and a second individual had only a federal band because the opposite leg was injured. We banded 24 nestlings from 11 nests. Of the resident adults at Mesquite in 2006, four remained unbanded and band status could not be determined for four.

Mormon Mesa – We detected 20 resident, adult willow flycatchers from 14 territories at Mormon Mesa. In addition to resident adults, we detected three individuals for which residency could not be confirmed (Tables 3.6 and 3.7). Of the 14 territories recorded at Mormon Mesa, 7 consisted of breeding individuals and 7 consisted of unpaired individuals. Of the breeding individuals, one male was polygynous with two females.

Field personnel captured and color-banded five new adults and recaptured three adult flycatchers banded in previous years. We resighted 10 other returning banded individuals; color combinations could not be determined for one, and one banded female was a known returning nestling; however, study area and year banded could not be determined because we were unable to recapture this individual. We banded seven nestlings from three nests. Of the resident adults, three remained unbanded, and two individuals for which residency and/or breeding status could not be determined remained unbanded.

Table 3.1. Summary of Willow Flycatchers Detected at Monitored Sites during the 2006 Breeding Season*

Study Area	Site	Adults									Nestlings Banded (# Nests)	Fledglings Captured	% of All Adults Banded
				Recaptured		Resighted							
						Color combination confirmed							
		Total Adults Detected	New Captured	Not including returning Nestlings	Returning Nestlings	Individual identified	Individual not identified	Unbanded	Band Status Undetermined	Banded (color combinations unconfirmed)			
Pahranagat	North	28	4	8	3	11	0	2	0	0	18(7)	3[1]	**93**
	MAPS	1	0	0	0	1	0	0	0	0	0	0	100
	South	7	0	0	2	4	0	0	1	0	0	0	86
	Study Area Total	**36**	**4**	**8**	**5**	**16**	**0**	**2**	**1**	**0**	**18(7)**	**3**	**92**
Mesquite	East	2	0	0	0	0	0	0	2	0	0	0	0
	West	25	3	2[2]	2	11[3,4]	1[5]	4	1	1	24(11)	0	80
	Bunker Farm	1	0	0	0	0	0	0	1	0	0	0	0
	Study Area Total	**28**	**3**	**2**	**2**	**11**	**1**	**4**	**4**	**1**	**24(11)**	**0**	**71**
Mormon Mesa	Mormon Mesa South	1	0	0	0	0	0	1	0	0	0	0	0
	Virgin River #1 South	4	1	0	0	1[3]	0	2	0	0	0	0	50
	Virgin River #2	18	4	3	0	7	1[6]	2	0	1	7(3)	0	89
	Study Area Total	**23**	**5**	**3**	**0**	**8**	**1**	**5**	**0**	**1**	**7(3)**	**0**	**78**
Muddy River	Overton WMA	11	2	0	4	3	1[6]	1	0	0	8(4)	0	91
Grand Canyon	RM 274.5N	3	2	0	0	0	0	1	0	0	0	0	67
	Pearce Ferry	1	1	0	0	0	0	0	0	0	0	0	100
	RM 285.3N	5	3[4]	0	1[2]	0	0	0	1	0	0	0	80
	Kowlp Corner	1	0	0	0	0	0	1	0	0	0	0	0
	Twin Coves	2	1	0	0	0	0	0	1	0	0	0	50
	Chuckwalla Cove	3	3	0	0	0	0	0	0	0	0	0	100
	Study Area Total	**15**	**10**	**0**	**1**	**0**	**0**	**2**	**2**	**0**	**0**	**0**	**73**
Topock	Pipes #3	3	1	0	0	0	0	0	2	0	0	0	33
	The Wallows	2	1	0	0	0	0	1	0	0	0	0	50
	Pig Hole	1	0	0	0	0	0	1	0	0	0	0	0
	In Between	9	0	0	0	2	2[6]	5	0	0	0	0	44
	800M	2	0	0	0	0	1[6]	1	0	0	0	0	50
	Pierced Egg	6	1	0	0	1	2[6]	2	0	0	4(2)	0	67
	Swine Paradise	2	0	0	0	0	0	1	1	0	0	0	0
	250M	1	0	0	0	0	0	1	0	0	0	0	0
	Glory Hole	9	0	1	0	1	3[6]	4	0	0	2(2)	0	56
	Beal Lake	1	0	0	0	0	0	0	1	0	0	0	0
	Lost Lake	1	0	0	0	0	0	0	1	0	0	0	0
	Study Area Total	**37**	**3**	**1**	**0**	**4**	**8**	**16**	**5**	**0**	**6(4)**	**0**	**43**
Bill Williams	Site 1	1	0	0	0	0	0	0	1	0	0	0	0
	Site 11	1	0	0	0	0	0	1	0	0	0	0	0
	Site 4	2	0	0	0	0	0	1	0	1	0	0	50
	Site 3	5	1	0	0	2	0	1	1	0	0	0	60
	Study Area Total	**9**	**1**	**0**	**0**	**2**	**0**	**3**	**2**	**1**	**0**	**0**	**44**
Total		**156[7]**	**28**	**13[7]**	**12**	**42[7]**	**11**	**33**	**14**	**3**	**55(29)**	**3**	**70**

* 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] All three fledglings previously unbanded
[2] One individual recaptured in Grand Canyon, then moved to Mesquite
[3] One individual moved from Mesquite to Mormon Mesa
[4] One individual banded in Grand Canyon, then moved to Mesquite.
[5] Bird had silver federal band only and had a visible injury on the unbanded left leg; a male with silver federal band number 2390-92434 and a visible injury on the unbanded left leg was captured at Mesquite in 2005, and this is likely the same individual.
[6] Returning nestling(s)
[7] The individuals that moved between sites are tallied only once in the total.

Table 3.2. Paired, Nestling, and Fledgling Willow Flycatchers Banded and Resighted at Pahranagat NWR, NV, 2006

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Old Color Combination[1,2,3]	Age[4]	Sex[5]	Territory	Observation status[6]
North	19-Jun-04	2320-31656	WD(M):EE	N/A	A4Y	F	11	RS
North	15-May-04	2320-31590	GR(M):EE	N/A	A4Y	M	11, 54	R 11 Jul
North	1-Jul-06	2370-40047	PU:DD(M)	N/A	AHY	F	12	N
North	15-May-04	2320-31591	GY(M):EE	N/A	A4Y	M	12	R 30 Jun
North	3-Jul-06	2360-59792	UB:EE	N/A	L	U	12	N
North	3-Jul-06	2360-59794	UB:EE	N/A	L	U	12	N
North	3-Jul-06	2360-59795	EE:UB	N/A	L	U	12	N
North	18-Jun-04	N/A	RR(M):no foot	N/A	A4Y	F	14	R 30 Jun, 11 Jul
North	14-Jul-01	2320-31597	EE:BW(M)	N/A	A7Y	M	14	R 30 Jun
North	11-Jul-06	2370-39946	GW(M):PU	N/A	HY	U	14	N
North	21-Jul-06	2370-39947	PU:OW(M)	N/A	HY	U	14	N
North	5-Jul-06	2370-40062	YK(M):PU	N/A	SY	F	16	N
North	1-Jun-05	2370-39951	PU:OZ(M)	N/A	A3Y	M	16	R 22 Jul
North	13-Jul-06	2370-40064	PU:UB	N/A	L	U	16	N
South	INA	INA	undetermined	INA	AHY	F	25	
South	18-May-04	2320-31595	GV(M):EE	N/A	A4Y	M	25	RS
North	6-Aug-04	3500-68972	GG(M):XX	N/A	3Y	F	42	RS
North	17-May-03	3500-68971	XX:DD(M)	N/A	A5Y	M	42	R 30 Jul
North	3-Jul-06	2360-59791	UB:EE	N/A	L	U	42	N
North	3-Jul-06	2360-59793	EE:UB	N/A	L	U	42	N
North	3-Jul-05	2370-40014	PU:VY(M)	N/A	A3Y	F	43	RS
North	6-Aug-01	2320-31592	GO(M):EE	N/A	6Y	M	43	RS
North	27-Jun-06	2320-31678	UB:EE	N/A	L	U	43	N
North	27-Jun-06	2360-59745	EE:UB	N/A	L	U	43	N
North	27-Jun-06	2320-31674	UB:EE	N/A	L	U	43	N
North	20-Jun-04	2320-31657	WO(M):EE	N/A	A4Y	F	50	RS
North	4-Jun-02	2370-40015	PU:WG(M)	N/A	A6Y	M	50	RS
North	26-Jun-05	2360-59708	EE:KK(M)	EE:UB	SY	F	51	R 30 Jun
North	14-May-04	2320-31589	EE:YD(M)	N/A	A4Y	M	51	RS
North	27-Jul-06	2370-40071	PU:WB(M)	N/A	HY	U	51	N
North	26-Jun-05	2360-59707	EE:YB(M)	EE:UB	SY	F	53	R 20 Jun
North	27-Jul-05	2370-39915	PU:RZ(M)	N/A	A3Y	M	53	R 20 Jun
North	9-Jul-06	2360-59758	UB:EE	N/A	L	U	53	N
North	9-Jul-06	2360-59756	EE:UB	N/A	L	U	53	N
North	9-Jul-06	2370-39945	UB:PU	N/A	L	U	53	N
North	4-Jul-6	2370-40061	YR(M):PU	N/A	SY	F	54	N
South	3-Jul-05	2320-31695	EE:ZZ(M)	EE:UB	SY	F	60	R 29Jun
South	2-Jun-05	2370-39953	OB(M):PU	N/A	A3Y	M	60	RS
South	1-Aug-04	2360-59724	ZB(M):EE	UB:EE	3Y	F	61	R 29 Jun
South	2-Aug-05	2370-40021	KY(M):PU	N/A	3Y	M	61	RS

Table 3.2. Paired, Nestling, and Fledgling Willow Flycatchers Banded and Resighted at Pahranagat NWR, NV, 2006, 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]
North	17-Jun-04	2320-31661	EE:DW(M)	N/A	4Y	F	62	R 1 Jul
North	23-Jul-02	2370-39952	BB(M):PU	N/A	A6Y	M	62	RS
North	27-Jun-06	2360-59735	EE:UB	N/A	L	U	62	N
North	27-Jun-06	2360-59759	UB:EE	N/A	L	U	62	N
North	27-Jun-06	2360-59736	UB:EE	N/A	L	U	62	N
North	8-Jul-05	2370-39964	BY(M):PU	N/A	A3Y	F	63	RS
North	18-May-04	2320-31593	EE:WV(M)	N/A	A4Y	M	63	RS
North	5-Jul-06	2360-59796	UB:EE	N/A	L	U	63	N
North	5-Jul-06	2360-59797	EE:UB	N/A	L	U	63	N
North	5-Jul-06	2360-59798	EE:UB	N/A	L	U	63	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, (M) = metal pin striped band, UB = unbanded, W = white, R = red, G = green, Z = gold, D = dark 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 2006.
[4] **Age in 2006**: 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.

Table 3.3. Unpaired, Resident Willow Flycatchers and Individuals for which Residency and/or Breeding Status Could Not Be Confirmed, Pahranagat NWR, 2006

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Old Color Combination[1,2,3]	Age[3]	Sex[5]	Location	Observation status[6]
North	27-Jun-03	2320-31467	EE:BD(M)	N/A	4Y	M	T13	RS, unpaired, detected 10–22 May
MAPS	22-Jun-05	2370-40013	PU:WD(M)	N/A	3Y	M	T17	RS, unpaired, detected 25 May–23 Jun
North	21-Jun-06	2370-40060	YG(M):PU	N/A	AHY	M	T44	N, unpaired, detected 20 May–16 Jul
South	27-Jun-03	2320-31468	EE:RO(M)	N/A	4Y	M	T45	RS, unpaired, detected 21 May–1 Jul
North	16-Jul-05	2320-31686	OB(M):EE	UB:EE	SY	M	T52	R 3 Jun, unpaired, detected 28 May–19 Jun
North	N/A	N/A	UB:UB	N/A	AHY	U	F97	RS, detected 12 Aug, probable migrant
North	N/A	N/A	UB:UB	N/A	AHY	U	F98	RS, detected 12 Aug, probable migrant

[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, D = dark/navy blue, B = light blue, O = orange, Y = yellow. 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 2006.
[4] **Age in 2006**: 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**: 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. Number indicates unique location.
[7] **Observation status codes**: N = new capture, R = recapture followed by date recaptured, RS = resight.

Table 3.4. Paired and Nestling Willow Flycatchers Banded and Resighted at Mesquite, NV, 2006

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Old Color Combination[1, 2, 3]	Age[4]	Sex[5]	Territory	Observation status[6]
West	1-Aug-03	2320-31445	EE:WK(M)	N/A	A5Y	F	10	RS
West	26-Jul-01	2390-92475	XX:WY(M)	N/A	6Y	M	10, 32	RS
West	28-Jun-06	2360-59790	EE:UB	N/A	L	U	10	N
West	28-Jun-06	2320-31575	UB:EE	N/A	L	U	10	N
West	4-Aug-06	2370-40105	UB:PU	N/A	L	U	10	N
West	4-Aug-06	2370-40104	PU:UB	N/A	L	U	10	N
West	4-Aug-06	2370-40103	PU:UB	N/A	L	U	10	N
West	INA	INA	Y(HP):banded	N/A	AHY	F	11	RS
West	3-Jun-04	2320-31490	EE:OO(M)	N/A	A4Y	M	11, 40	RS
West	21-Jun-05	2360-59701	ZW(M):EE	UB:EE	SY	F	12	R 15 Jul
West	INA	INA	undetermined	N/A	AHY	M	12	
West	20-Jul-06	2370-40066	YO(M):PU	N/A	SY	F	14	N
West	2-Jun-06	2370-40036	PU:GR(M)	N/A	AHY	M	14	R 20 Jul; breeding in GRCA 2–21 Jun
West	N/A	N/A	UB:UB	N/A	AHY	F	20	RS
West	INA	INA	UB:XX[7]	N/A	6Y	M	20, 35	RS
West	31-Jul-03	2320-31444	RW(M):EE	N/A	A5Y	F	30	RS
West	3-Jun-05	2370-40012	OY(M):PU	N/A	A3Y	M	30	RS
West	13-Aug-06	2370-40083	UB:PU	N/A	L	U	30	N
West	13-Aug-06	2370-40084	UB:PU	N/A	L	U	30	N
West	21-Jun-05	2370-39957	PU:YB(M)	N/A	A3Y	F	31	RS
West	22-May-04	2320-31652	WG(M):EE	N/A	A4Y	M	31	RS
West	4-Jul-06	2360-59739	EE:UB	N/A	L	U	31	N
West	4-Jul-06	2370-39941	UB:PU	N/A	L	U	31	N
West	11-Aug-06	2370-40106	UB:PU	N/A	L	U	31	N
West	11-Aug-06	2370-40107	PU:UB	N/A	L	U	31	N
West	11-Aug-06	2370-40108	UB:PU	N/A	L	U	31	N
West	6-Jul-04	2320-31573	WY(M):EE	N/A	A4Y	F	32	RS
West	20-Jul-06	2370-40067	PU:UB	N/A	L	U	32	N
West	20 Jul-06	2370-40065	UB:PU	N/A	L	U	32	N
West	20-Jul-06	2370-40068	PU:UB	N/A	L	U	32	N
West	23-Jun-04	2320-31498	KW(M):EE	UB:EE	3Y	F	35	RS, R 3 Jun in GRCA where breeding 2–21 Jun
West	27-Jul-06	2370-39949	UB:PU	N/A	L	U	35	N
West	27-Jul-06	2370-39950	PU:UB	N/A	L	U	35	N
West	14-Jun-04	2320-31655	VW(M):EE	N/A	4Y	F	40	RS
West	28-Jun-06	2360-59789	UB:EE	N/A	L	U	40	N

Table 3.4. Paired and Nestling Willow Flycatchers Banded and Resighted at Mesquite, NV, 2006, 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]
West	N/A	N/A	UB:UB	N/A	AHY	F	41	RS
West	8-Jun-05	2370-39954	BO(M):PU	N/A	A3Y	M	41, 62	R 17 Jul
West	N/A	N/A	UB:UB	N/A	AHY	F	50	RS
West	15-Jul-05	2320-31688	EE:BG(M)	EE:UB	SY	M	50	R 13 Jun, 19 Jul
West	19-Jul-06	2370-40063	PU:UB	N/A	L	U	50	N
West	22-Jun-06	2370-39939	KD(M):PU	N/A	AHY	F	62	N
West	7-Jul-06	2360-59752	EE:UB	N/A	L	U	62	N
West	7-Jul-06	2360-59754	UB:EE	N/A	L	U	62	N
West	7-Jul-06	2360-59753	EE:UB	N/A	L	U	62	N
West	7-Jul-06	2360-59755	UB:EE	N/A	L	U	62	N
West	N/A	N/A	UB:UB	N/A	AHY	F	64	RS
West	18-May-06	2370-39937	KK(M):PU	N/A	SY	M	64	N; R 27 Jul
West	27-Jul-06	2370-40080	UB:PU	N/A	L	U	64	N
East	INA	INA	undetermined	N/A	AHY	F	100	Detected 13 July[8]
East	INA	INA	undetermined	N/A	AHY	M	100	Detected 13 July[8]

[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, (HP) = half plastic bands/ bands cut to half the height, UB = unbanded, K = black, R = red, O = orange, G = green, V = violet, Y = yellow, W = white, D = dark blue, B = light blue, banded = bands were present but colors could not be confirmed, 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] Old combination included only if rebanded in 2006.
[4] **Age in 2006**: 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] Band number likely 2390-92434 but cannot be confirmed because bird was not captured in 2006. Bird had a visible injury on left leg.
[8] Details of occupancy and breeding undetermined.

Table 3.5. Unpaired, Resident Willow Flycatchers and Individuals for which Residency and/or Breeding Status Could Not Be Confirmed, Mesquite, NV, 2006

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Location[5]	Observation status[6]
Bunker Farm	INA	INA	undetermined	AHY	M	T1	Detected 6–13 May
West	22-Jul-02	2140-66709	Bs:GW(M)	A6Y	M	F9	RS, detected 10–13 May, then displaced by another male; detected 23 May at Mormon Mesa

[1] INA = information not available.
[2] **Color-band codes**: Bs = blue federal band, (M) = metal pin striped band, G = green, W = white, 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 2006**: AHY = 2 years or older, A6Y = 6 years or older.
[4] **Sex codes**: M = male.
[5] **Location Codes**: T = territorial individual detected for at least 7 days, F = individual detected for less than 7 days. Number indicates unique location.
[6] **Observation status codes**: RS = resight.

Table 3.6. Paired and Nestling Willow Flycatchers Banded and Resighted at Mormon Mesa, NV, 2006

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Territory	Observation status[5]
Virgin River #2	16-Jul-04	2320-31632	RZ(M):EE	4Y	F	15	R 25 Jul
Virgin River #2	15-Jul-04	2320-31517	EE:OR(M)	4Y	M	15	R 25 Jul
Virgin River #2	25-Jul-04	2370-40069	UB:PU	L	U	15	N
Virgin River #2	25-Jul-04	2370-40070	PU:UB	L	U	15	N
Virgin River #2	INA	INA	UB:EE	AHY	F	22	RS
Virgin River #2	27-May-04	2320-31653	WV(M):EE	4Y	M	22	R 7 Jun
Virgin River #2	8-Jul-04	2320-31618	EE:GB(M)	3Y	F	24	RS
Virgin River #2	26-Jul-05	2370-40017	PU:WR(M)	3Y	M	24[6]	RS
Virgin River #2	6-Jul-06	2360-59799	EE:UB	L	U	24	N
Virgin River #2	6-Jul-06	2360-59751	UB:EE	L	U	24	N
Virgin River #2	6-Jul-06	2360-59750	EE:UB	L	U	24	N
Virgin River #1 South	N/A	N/A	UB:UB	AHY	F	40	RS
Virgin River #1 South	N/A	N/A	UB:UB	AHY	M	40	RS
Virgin River #2	30-Jun-04	2320-31485	EE:WO(M)	A4Y	F	47	RS
Virgin River #2	7-Jun-04	2320-31553	EE:GW(M)	4Y	M	47	RS
Virgin River #2	23-Jul-06	2370-39948	PU:OR(M)	SY	F	62	N
Virgin River #2	23-Jul-03	2320-31486	YV(M):EE	4Y	F	70	RS
Virgin River #2	9-Jul-05	2370-39975	WY(M):PU	A3Y	M	70	RS
Virgin River #2	26-Jun-06	2360-59769	UB:EE	L	U	70	N
Virgin River #2	26-Jun-06	2320-31671	EE:UB	L	U	70	N

[1] N/A = not applicable, INA = information not available.
[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, W = white, Y = yellow, B = light blue, V = violet, 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 2006**: 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 likely also paired with the 62 female.

Table 3.7. Unpaired, Resident Willow Flycatchers and Individuals for which Residency and/or Breeding Status Could Not Be Confirmed, Mormon Mesa, NV, 2006

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Location[5]	Observation Status[6]
Virgin River #2	23-Jun-06	2370-39940	GY(M):PU	AHY	M	T4	N, pair status undetermined, detected 20 Jun–17 Jul
Virgin River #2	N/A	N/A	UB:UB	AHY	M	T10	RS, unpaired, detected 7–21 Jun
Virgin River #2	7-Jun-06	2370-39967	KO(M):PU	AHY	M	T46	N, unpaired, detected 24 May–6 Jul
Virgin River #2	INA	INA	EE:banded	AHY	M	T50	RS, unpaired, detected 5–17 Jun
Virgin River #2	27-Jun-01	2390-92421	XX:WR(M)	6Y	M	T61	RS, unpaired, detected 16 May–23 Jun
Virgin River #2	7-Jun-06	2370-40058	PU:BK(M)	AHY	M	T63	N, unpaired, detected 16 May–25 Jun
Virgin River #1 South	8-Jun-06	2370-39938	KG(M):PU	SY	M	T65	N, unpaired, detected 1–8 Jun
Mormon Mesa South	N/A	N/A	UB:UB	AHY	M	F27	RS, detected 13–17 Jun
Virgin River #2	N/A	N/A	UB:UB	AHY	M	F60	RS, detected 23–27 Jun
Virgin River #1 South	22-Jul-02	2140-66709	Bs:GW(M)	A6Y	M	F66	RS, detected 23 May, detected 10–13 May at Mesquite West

[1] N/A = not applicable, INA = information not available.
[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, Bs = blue federal band, XX = standard silver federal band, (M) = metal pin striped band, UB = unbanded, W = white, Y = yellow, O = orange, B = light blue, G = green, 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] **Age in 2006**: SY = 2 years, AHY = 2 years or older, 6Y = 6 years, A6Y = 6 years or older.
[4] **Sex codes**: M = male.
[5] **Location code**: T = territorial individual detected for at least 7 days, F = individual detected for less than 7 days. Number indicates unique location.
[6] **Observation status codes**: N = new capture, RS = resight.

Muddy River – We detected 11 resident, adult willow flycatchers from 8 territories at Muddy River. Of the eight territories recorded, seven consisted of breeding individuals and one consisted of an unpaired male that later displaced a male in one of the breeding territories (Tables 3.8 and 3.9). One male was polygynous with four females, and another male was polygynous with two females.

Field personnel captured and color-banded two new adults and recaptured four adults that were returning nestlings (two each from 2004 and 2005; see Table 3.20 for juvenile dispersal data). We resighted four other returning banded individuals, of which one was a returning nestling; however, study area and year banded could not be determined because we were unable to recapture this individual. We banded eight nestlings from four nests. One breeding adult remained unbanded.

Table 3.8. Paired and Nestling Willow Flycatchers Banded and Resighted at Muddy River Delta, NV, 2006

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	16-Jul-04	2320-31631	BB(M):EE	UB:EE	3Y	F	3	R 29 Jun
Overton WMA	26-Jun-03	2370-39955	BV(M):PU	N/A	4Y	M	3, 25	RS
Overton WMA	5-Jul-06	2370-39942	PU:UB	N/A	L	U	3	N
Overton WMA	5-Jul-06	2370-39943	PU:UB	N/A	L	U	3	N
Overton WMA	5-Jul-06	2370-39944	UB:PU	N/A	L	U	3	N
Overton WMA	6-Aug-05	2360-59788	BO(M):EE	UB:EE	SY	F	18	R 1 Jul
Overton WMA	21-Jun-05	2360-59702	WB(M):EE	UB:EE	SY	M	18	R 6 Jun
Overton WMA	8-Jul-04	2320-31616	EE:BY(M)	EE:UB	3Y	F	21	R 10 Jun
Overton WMA	11-May-06	2370-40057	YD(M):PU	N/A	AHY	M	21, 41, 51, 52	N
Overton WMA	4-Jul-06	2360-59737	EE:UB	N/A	L	U	21	N
Overton WMA	14-Jun-06	2370-40059	PU:BY(M)	N/A	AHY	F	25	N
Overton WMA	INA	INA	UB:EE	N/A	AHY	F	41	RS
Overton WMA	29-Jun-06	2360-59747	EE:UB	N/A	L	U	41	N
Overton WMA	29-Jun-06	2360-59749	UB:EE	N/A	L	U	41	N
Overton WMA	29-Jun-06	2360-59748	EE:UB	N/A	L	U	41	N
Overton WMA	9-Jun-05	2370-39956	PU:ZZ(M)	N/A	3Y	F	51	RS
Overton WMA	4-Jul-06	2360-59738	UB:EE	N/A	L	U	51	N
Overton WMA	N/A	N/A	UB:UB	N/A	AHY	F	52	RS

[1] N/A = not applicable, INA = information not available.
[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, W = white, Y = yellow, B = light blue, D = dark blue, V = violet, Z = gold, O= orange. 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 2006.
[4] **Age in 2006**: 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.

Table 3.9. Unpaired, Resident Willow Flycatchers, Muddy River Delta, NV, 2006

Site	Date Banded	Federal Band #	Color Combination[1]	Age[2]	Sex[3]	Location[4]	Observation Status[5]
Overton WMA	21-Jun-04	2320-31615	EE:OY(M)	3Y	M	T2	RS, unpaired 15 May–29 June, then displaced male at 18

[1] **Color-band codes**: EE = electric yellow federal band, (M) = metal pin striped band, O = orange, Y = yellow. 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 2006**: 3Y = 3 years.
[3] **Sex codes**: M = male.
[4] **Location codes**: T = territorial individual detected for at least 7 days. Number indicates unique location.
[5] **Observation status codes**: RS = resight.

Grand Canyon – We detected 11 resident, adult willow flycatchers from 6 territories at various sites in lower Grand Canyon and on the Lake Mead delta. In addition to resident adults, we detected four adult willow flycatchers for which residency and/or breeding status could not be confirmed (Tables 3.10 and 3.11). Of the six territories, three consisted of breeding pairs, two consisted of pairs for which no nest could be located, and one consisted of an unpaired male.

Field personnel captured and color-banded 10 new adults and recaptured one returning nestling from 2004 (see Table 3.20 for juvenile dispersal data). Two resident adults remained unbanded, and band status could not be determined for one resident adult and one adult for whom residency and/or breeding status could not be determined.

Table 3.10. Paired Willow Flycatchers Banded and Resighted at Grand Canyon, AZ, 2006

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Old Color Combination[1,2,3]	Age[4]	Sex[5]	Territory	Observation status[6]
RM 285.3N	2-Jun-06	2370-40037	PU:DR(M)	N/A	AHY	F	1	N
RM 285.3N	2-Jun-06	2370-40036	PU:GR(M)	N/A	AHY	M	1	N; detected at Mesquite West 19–26 Jul
RM 285.3N	23-Jun-04	2320-31498	KW(M):EE	UB:EE	3Y	F	2	R 3 Jun, breeding at Mesquite West 5 Jul–3 Aug
RM 285.3N	3-Jun-06	2370-40038	PU:DO(M)	N/A	AHY	M	2	N
Twin Coves	INA	INA	undetermined	INA	AHY	F	10	
Twin Coves	19-Jun-06	2370-39986	GO(M):PU	N/A	AHY	M	10	N
Chuckwalla Cove	22-Jun-06	2370-39990	WB(M):PU	N/A	SY	F	85	N
Chuckwalla Cove	21-Jun-06	2370-39988	DW(M):PU	N/A	SY	M	85	N
RM 274.5N	N/A	N/A	UB:UB	N/A	AHY	F	95	RS
RM 274.5N	4-Jul-06	2370-39929	PU:YG(M)	N/A	AHY	M	95	N

1 N/A = not applicable, INA = information not available.
2 **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, W = white, Y = yellow, O = orange, B = light blue, D = dark blue, G = green, R = red, 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 Old combination included only if rebanded in 2006.
4 **Age in 2006**: SY = 2 years, AHY = 2 years or older, 3Y = 3 years.
5 **Sex codes**: F = female, M = male.
6 **Observation status codes**: N = new capture, R = recapture followed by date recaptured, RS = resight.

Table 3.11. Unpaired, Resident Willow Flycatchers and Individuals for which Residency and/or Breeding Status Could Not Be Confirmed, Grand Canyon, AZ, 2006

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Location[5]	Observation status[6]
Kowlp Corner	N/A	N/A	UB:UB	AHY	M	T9	RS, unpaired, detected 15–30 Jun
RM 274.5	14-Jun-06	2370-40046	PU:DK(M)	SY	M	F3	N, detected 14 Jun
Chuckwalla Cove	21-Jun-06	2370-39989	PU:OZ(M)	SY	M	F7	N, detected 21 Jun
Pearce Ferry	20-Jun-06	2370-39987	GW(M):PU	SY	M	F11	N, detected 15–20 Jun
RM 285.3N	INA	INA	undetermined	AHY	M	F93	Detected 2 Jun

1 N/A = not applicable.
2 **Color-band codes**: PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, D = dark blue, W = white, K = black, O = orange, Z = gold, G = green, 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 2006**: SY = 2 years, AHY = 2 years or older.
4 **Sex codes**: M = male.
5 **Location codes**: F = individual detected for less than 7 days. Number indicates unique location.
6 **Observation status codes**: N = new capture, RS = resight.

Topock – We detected 29 resident, adult willow flycatchers from 18 territories at Topock. In addition to resident adults, we detected eight individuals for which residency and/or breeding status could not be confirmed (Tables 3.12 and 3.13). Of these eight individuals, six were detected for only one day in late May or early June and were suspected to be migrants. Of the 18 territories recorded at Topock, 14 consisted of paired individuals and 4 consisted of unpaired individuals. Of the breeding individuals, three males were each polygynous with two females.

Field personnel captured and color-banded three new adults and recaptured one adult banded in a previous year. We resighted the color combinations of 12 other returning banded adults, of which 8 were returning nestlings. We were unable to recapture the returning nestlings, and study area and year banded could not be determined. We banded six nestlings from four nests. The band status of one breeding individual could not be determined, and 12 resident individuals remained unbanded. Four of the eight individuals for which residency and/or breeding status could not be confirmed were of unknown band status and four were unbanded.

Table 3.12. Paired, Nestling, and Fledgling Willow Flycatchers Banded and Resighted at Topock, Havasu NWR, AZ, 2006

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Territory	Observation status[5]
The Wallows	6-Jun-06	2370-39992	GK(M):PU	SY	M	2	N
The Wallows	N/A	N/A	UB:UB	AHY	F	2	RS
Pierced Egg	INA	INA	UB:EE	AHY	F	21	RS
Pierced Egg	INA	INA	EE:UB	AHY	M	21, 58	RS
Pierced Egg	2-Aug-06	2360-59744	UB:EE	L	U	21	N
Pierced Egg	2-Aug-06	2320-31673	EE:UB	L	U	21	N
Pierced Egg	3-Jul-03	2320-31584	EE:YK(M)	5Y	F	22	RS
Pierced Egg	1-Jun-06	2370-39916	PU:YD(M)	AHY	M	22	N
Pierced Egg	23-Jul-06	2320-31650	EE:UB	L	U	22	N
Pierced Egg	23-Jul-06	2320-31677	UB:EE	L	U	22	N
Pipes #3	INA	INA	undetermined	AHY	F	25	
Pipes #3	27-Jun-06	2370-40003	PU:RR(M)	SY	M	25	N
Glory Hole	N/A	N/A	UB:UB	AHY	F	26	RS
Glory Hole	25-Jul-04	2320-31560	EE:GY(M)	4Y	M	26, 33	RS
Glory Hole	27-Jul-06	2320-31566	UB:EE	L	U	26	N
In Between	N/A	N/A	UB:UB	AHY	F	31	RS
In Between	25-Jul-04	2320-31559	OK(M):EE	4Y	M	31	RS
Glory Hole	N/A	N/A	UB:UB	AHY	F	32	RS
Glory Hole	22-Jul-04	2320-31562	KY(M):EE	3Y	M	32, 34	R 18 Jul
Glory Hole	INA	INA	UB:EE	AHY	F	33	RS
Glory Hole	INA	INA	UB:EE	AHY	F	34	RS
Glory Hole	INA	INA	UB:EE	AHY	U[6]	36	RS
Glory Hole	N/A	N/A	UB:UB	AHY	U[6]	36	RS

Table 3.12. Paired, Nestling, and Fledgling Willow Flycatchers Banded and Resighted at Topock, Havasu NWR, AZ, 2006, continued

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Territory	Observation status[5]
Glory Hole	31-Jul-06	2360-59768	EE:UB	L	U	36	N
800M	INA	INA	UB:EE	AHY	F	53	RS
800M	N/A	N/A	UB:UB	AHY	M	53	RS
In Between	8-Jul-04	2320-31515	EE:WY(M)	4Y	F	54	RS
In Between	N/A	N/A	UB:UB	AHY	M	54	RS
Pierced Egg	N/A	N/A	UB:UB	AHY	F	58	RS
In Between	N/A	N/A	UB:UB	AHY	F	59	RS
In Between	INA	INA	UB:EE	AHY	M	59	RS

[1] N/A = not applicable; INA = information not available.
[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, W = white, Y = yellow, D = dark blue, G = green, O = orange, R = red, 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 2006**: 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] Unknown which bird is female and which male

Table 3.13. Unpaired, Resident Willow Flycatchers and Individuals for which Residency and/or Breeding Status Could Not Be Confirmed, Topock, Havasu NWR, AZ, 2006

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Location[5]	Observation Status[6]
Pig Hole	N/A	N/A	UB:UB	AHY	M	T42	RS, unpaired, detected 15–23 May
In Between	INA	INA	UB:EE	AHY	M	T71	RS, unpaired, detected 5 May–11 Jul
In Between	N/A	N/A	UB:UB	AHY	M	T72	RS, unpaired, detected 6–20 May
250M	N/A	N/A	UB:UB	AHY	U	T90	RS, detected 16 May–9 Jun
Pipes #3	INA	INA	undetermined	AHY	M	F24	Detected 21 Jun
In Between	N/A	N/A	UB:UB	AHY	U	F43	RS, detected 23 May
Swine Paradise	N/A	N/A	UB:UB	AHY	U	F56	RS, detected 3 June
Swine Paradise	INA	INA	undetermined	AHY	U	F57	Detected 3 June
Pierced Egg	N/A	N/A	UB:UB	AHY	M	F67	RS, detected 17–20 Jun
Lost Lake	INA	INA	undetermined	AHY	U	F91	Detected 24 May
Beal Lake	INA	INA	undetermined	AHY	M	F92	Detected 24 May
Glory Hole	N/A	N/A	UB:UB	AHY	M	F100	RS, detected 21–25 Jun

[1] N/A = not applicable; INA = information not available.
[2] **Color-band codes**: EE = electric yellow federal band, UB = unbanded, 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 2006**: 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. Number indicates unique location.
[6] **Observation status codes**: RS = resight.

Bill Williams – We detected four resident willow flycatchers from three territories at Bill Williams. In addition to resident adults, we detected five individuals for which residency and/or breeding status could not be determined. Four of these individuals were suspected to be migrants (Tables 3.14 and 3.15). The three territories recorded at Bill Williams consisted of one male paired with three females.

Field personnel captured and color-banded one new adult and resighted the color combinations on two adults. One breeding adult and two suspected migrants were unbanded. Band status was undetermined for two suspected migrants, and band combination could not be determined for one adult for which residency and/or breeding status could not be confirmed. We did not band any nestlings or detect any returning nestlings at Bill Williams in 2006.

Table 3.14. Paired Willow Flycatchers Banded and Resighted at Bill Williams River NWR, AZ, 2006

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	A3Y	F	23	RS
Site 3	24-May-05	2370-40052	KV(M):PU	A3Y	M	23, 35, 74	RS
Site 3	2-Jul-06	2370-40004	PU:RW(M)	AHY	F	35	N
Site 3	N/A	N/A	UB:UB	AHY	F	74	RS

[1] N/A = not applicable.
[2] **Color-band codes**: PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, B = light blue, R = red, K = black, 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] **Age in 2006**: AHY = 2 years or older, A3Y = 3 years or older.
[4] **Sex codes**: F = female, M = male
[5] **Observation status codes**: N = new capture, RS = resight.

Table 3.15. Unpaired, Resident Willow Flycatchers and Individuals for which Residency and/or Breeding Status Could Not Be Confirmed, Bill Williams River NWR, AZ, 2006

Site	Date Banded[1]	Federal Band #[1]	Color Combination[2]	Age[3]	Sex[4]	Location[5]	Observation status[6]
Site 4	INA	INA	banded	AHY	M	F1	Detected 4 Jun
Site 3	INA	INA	undetermined	AHY	U	F11	Detected 20 May, suspected migrant
Site 1	INA	INA	undetermined	AHY	U	F12	Detected 22 May, suspected migrant
Site 11	N/A	N/A	UB:UB	AHY	M	F13	RS, detected 22–23 May, suspected migrant
Site 4	N/A	N/A	UB:UB	AHY	M	F34	RS, detected 18 May, suspected migrant

[1] N/A = not applicable, INA = information not available.
[2] **Color-band codes**: UB = unbanded, banded = bands were present but colors could not be confirmed, 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 2006**: 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. Number indicates unique location.
[6] **Observation status codes**: RS = resight.

NON-MONITORING SITE

Key Pittman Wildlife Management Area – Field personnel captured and color-banded two new adults and recaptured three returning nestlings (one each from 2003, 2004, and 2005; see Table 3.20 for juvenile dispersal data). We resighted the color combinations of two adults, one of whom was a returning nestling. We banded three nestlings from one nest (Table 3.16).

Table 3.16. Willow Flycatchers Color-Banded and Resighted, Key Pittman Wildlife Management Area, NV, 2006

Site	Date Banded	Federal Band #	Color Combination[1]	Old Color Combination[1,2,3]	Age[2]	Sex[3]	Observation status[4]
Key Pittman	25-Jun-04	2320-31604	KR(M):EE	UB:EE	3Y	M	R 1 Aug
Key Pittman	26-Jun-03	2320-31463	EE:WB(M)	EE:UB	4Y	F	R 1 Aug
Key Pittman	1-Aug-06	2370-40101	PU:UB	N/A	L	U	N
Key Pittman	1-Aug-06	2370-40100	UB:PU	N/A	L	U	N
Key Pittman	1-Aug-06	2370-40102	PU:UB	N/A	L	U	N
Key Pittman	6-Aug-06	2370-40082	PU:OK(M)	N/A	SY	F	N
Key Pittman	3-Jul-05	2320-31692	EE:ZW(M)	EE:UB	SY	M	R 5 Aug
Key Pittman	5-Aug-06	2370-40081	PU:OO(M)	N/A	SY	M	N
Key Pittman	30-Jul-05	2370-39980	WO(M):PU	N/A	SY	M	RS
Key Pittman	INA	INA	EE:UB	N/A	AHY	U	RS

[1] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, B = light blue, O = orange, R = red, W = white, Z = gold, 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 2006:** 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.
[3] **Sex codes**: F = female, M = male, U = sex unknown.
[4] **Observation status codes**: N = new capture, R = recapture followed by date recaptured, RS = resight.

COLOR-BANDING AND RESIGHTING DOWNSTREAM OF PARKER DAM

From 10 to 30 June 2006, we recorded 44 willow flycatcher detections at 11 sites along the Colorado River from Picacho NW (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 21 June. From 10 to 18 June, field personnel captured and color-banded 22 new adults at Gadsden, of which all but 2 were second-year birds (Table 3.17). Reconnaissance efforts from 7 to 9 June resulted in the capture and color-banding of 7 willow flycatchers at Hunter's Hole and Gadsden. Unsuccessful netting attempts were made at Yuma West Wetlands on 13 June, Picacho NW on 14 June, Gadsden on 15 and 20 June, and Gila Confluence North on 19 June. None of the color-banded individuals were detected post-capture, and, with the exception of a single flycatcher detected at Gila Confluence North on 28 July (see Chapter 2 for details), no flycatcher detections were recorded at any sites south of Bill Williams between 22 June and 29 July, suggesting these individuals were northbound migrants.

Table 3.17. Willow Flycatchers Color-Banded along the Lower Colorado River South of the Bill Williams River NWR to the Mexico Border, 2006

Site	Date Banded	Federal Band #	Color Combination[1]	Age[2]	Sex[3]	Observation status[4]
Gadsden	10-Jun-06	2370-39917	DD(M):PU	SY	U	N
Gadsden	10-Jun-06	2370-39918	DD(M):PU	SY	U	N
Gadsden	10-Jun-06	2370-39919	DD(M):PU	SY	U	N
Gadsden	10-Jun-06	2370-39920	DD(M):PU	SY	U	N
Gadsden	10-Jun-06	2370-39921	DD(M):PU	SY	U	N
Gadsden	10-Jun-06	2370-39922	DD(M):PU	SY	U	N
Gadsden	11-Jun-06	2370-39923	DD(M):PU	SY	U	N
Gadsden	11-Jun-06	2370-39924	DD(M):PU	SY	U	N
Gadsden	11-Jun-06	2370-39925	DD(M):PU	SY	U	N
Gadsden	11-Jun-06	2370-39926	DD(M):PU	SY	U	N
Gadsden	12-Jun-06	2370-39927	DD(M):PU	AHY	U	N
Gadsden	12-Jun-06	2370-39928	DD(M):PU	SY	U	N
Gadsden	16-Jun-06	2370-39982	UB:PU	SY	U	N
Gadsden	16-Jun-06	2370-39983	PU:UB	SY	U	N
Gadsden	17-Jun-06	2370-39984	UB:PU	SY	U	N
Gadsden	16-Jun-06	2370-39985	PU:UB	SY	U	N
Gadsden	17-Jun-06	2370-39993	UB:PU	SY	U	N
Gadsden	17-Jun-06	2370-39994	PU:UB	SY	U	N
Gadsden	17-Jun-06	2370-39995	UB:PU	SY	U	N
Gadsden	18-Jun-06	2370-39996	DD(M):PU	SY	U	N
Gadsden	18-Jun-06	2370-39997	DD(M):PU	SY	U	N
Gadsden	18-Jun-06	2370-39998	DD(M):PU	AHY	U	N
Hunter's Hole	7-Jun-06	2370-40039	DD(M):PU	SY	U	N
Hunter's Hole	7-Jun-06	2370-40040	DD(M):PU	SY	U	N
Hunter's Hole	8-Jun-06	2370-40041	DD(M):PU	SY	U	N
Hunter's Hole	8-Jun-06	2370-40042	DD(M):PU	SY	U	N
Hunter's Hole	9-Jun-06	2370-40043	DD(M):PU	SY	U	N
Gadsden	9-Jun-06	2370-40044	DD(M):PU	SY	U	N
Gadsden	9-Jun-06	2370-40045	DD(M):PU	SY	U	N

[1] **Color-band codes**: PU = pumpkin federal band, (M) = metal pin striped band, UB = unbanded, D = dark blue. Color combinations are read as the bird's left leg and right leg, top to bottom; two letters designate every band; color-band designations for right and left legs are separated with a colon.
[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.

ADULT BETWEEN-YEAR RETURN AND DISPERSAL

In 2005 we identified 80 adult, resident willow flycatchers at the life history study areas, Muddy River, Grand Canyon, and Bill Williams, of which 48 (60%) were detected in 2006 (Table 3.18). Of the returning adults, two (4%) were detected at a different study area than where they were detected in 2005 (Table 3.19). An additional adult that was detected in 2004 and 2006 but not in 2005 exhibited between-year movement. The median dispersal distance for all returning adult flycatchers exhibiting between-year movements in 2006 was 26 km (min = 12 km, max = 29 km).

Table 3.18. Resident Adult Willow Flycatcher Annual Return from 2005 to 2006

Study Area	# Identified in 2005	# of 2005 Birds Detected in 2006	% Return	% Return to Same Site
Pahranagat	30	22	73	100
Mesquite	15	12	80	92
Mormon Mesa	7	5	71	100
Muddy River	5	3	60	67
Grand Canyon	1	0	--	--
Topock	17	4	24	100
Bill Williams	5	2	40	100
Total	**80**	**48**	**60**	**97**

Table 3.19. Summary of Adult Willow Flycatcher Between-Year Movements for All Individuals Identified in 2005 or 2004 and Recaptured or Resighted at a Different Study Area in 2006

Study Area/ Site Detected 2005[1]	Study Area/Site Detected 2006[1]	Distance Moved (km)	Federal Band #	Color Combination[2]	Sex[3]
MESQ/ West	MOME/Virgin River #2	29	2320-31486	YV(M):EE	F
MUDD/Overton WMA	MOME/Virgin River #2	12	2370-39975	WY(M):PU	M
MESQ/Bunker Farm	MOME/Virgin River #2	26	2320-31632	RZ(M):EE	F

[1] MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River.
[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, (M) = metal pin striped band, 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.

JUVENILE BETWEEN-YEAR RETURN AND DISPERSAL

In 2005, we banded 57 nestlings and 8 fledglings at the life history study areas, Muddy River, and Bill Williams. Of these 65 juveniles, 10 (15%) were recaptured or resighted and identified in 2006. Of the 10 returning 2005 juveniles, 3 were detected at a different study area from where originally banded, and 7 were detected at the same study area. Seven individuals originally banded as nestlings in 2004 and one banded in 2003 were also recaptured for the first time, of which six returned to a different study area than where originally banded (Table 3.20).

The median dispersal distance for all returning juvenile flycatchers exhibiting between-year movements in 2006 was 38 km (min = 30 km, max = 56 km).

Table 3.20. Summary of Juvenile Flycatchers Banded as Hatch Year Birds in 2003, 2004, or 2005 and Recaptured or Resighted for the First Time in 2006*

Study Area/Site Banded	Year Hatched	Study Area/Site Detected 2006[1]	Distance Moved (km)	Federal Band #	Color Combination[2]	Sex[3]
MESQ/West	2005	MESQ/West	--	2320-31688	EE:BG(M)	M
MESQ/Bunker Farm	2005	MESQ/West	--	2360-59701	ZW(M):EE	F
MESQ/Bunker Farm	2005	MUDD/Overton WMA	38	2360-59702	WB(M):EE	M
MUDD/Overton WMA	2005	MUDD/Overton WMA	--	2360-59788	BO(M):EE	F
PAHR/North	2005	PAHR/North	--	2320-31686	OB(M):EE	M
PAHR/North	2005	KEPI	30	2320-31692	EE:ZW(M)	M
PAHR/North	2005	PAHR/South	--	2320-31695	EE:ZZ(M)	F
PAHR/South	2005	PAHR/North	--	2360-59707	EE:YB(M)	F
PAHR/South	2005	PAHR/North	--	2360-59708	EE:KK(M)	F
PAHR/North	2005	KEPI	30	2370-39980	WO(M):PU	U
MESQ/West	2004	MUDD/Overton WMA	41	2320-31615	EE:OY(M)	F
MESQ/West	2004	MUDD/Overton WMA	41	2320-31616	EE:BY(M)	F
MESQ/Bunker Farm	2004	MUDD/Overton WMA	38	2320-31631	BB(M):EE	F
MOME/North	2004	GRCA/RM 285.3N	56	2320-31498	KW(M):EE	F
PAHR/North	2004	KEPI	30	2320-31604	KR(M):EE	M
PAHR/North	2004	PAHR/South	--	2360-59724	ZB(M):EE	F
TOPO/Pipes 3	2004	TOPO/Glory Hole	--	2320-31562	KY(M):EE	M
PAHR/North	2003	KEPI	30	2320-31463	EE:WB(M)	F

* 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, MUDD = Muddy River, TOPO = Topock Marsh
[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, (M) = metal pin striped band, B = light blue, G = green, O = orange, R = red, Z = gold, W = white, Y = yellow, 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.
[3] **Sex codes**: F = female, M = male, U = sex unknown.

Ten additional returning nestlings from 2003–2005 were resighted in 2006 (one at Mormon Mesa, one at Muddy River, eight at Topock), but the identity of these individuals was undetermined because we were unable to recapture them.

Within-Year, Between-Study Area Movements

We detected three within-year, between study area movements in 2006. Two of these were from Grand Canyon RM 285.3N to Mesquite West and the third was from Mesquite West to Mormon Mesa Virgin River #1. A male flycatcher whose nest failed at Grand Canyon later moved to Mesquite West where it paired, but no nest was located. The other Grand Canyon individual was a female whose nest failed, and who later moved to Mesquite where it successfully bred. The third individual was a male who was detected briefly at both Mesquite and Mormon Mesa.

DISCUSSION

Color-Banding Effort – Overall, 70% of the adult flycatchers detected at the monitoring sites during 2006 were color-banded by the end of the breeding season. This compares to 55% in 2003, 57% in 2004, and 75% in 2005. We have maintained high overall percentages of banded birds annually over the four 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 analyses of population structure, survivorship, and fecundity, which will be presented in the five-year summary report. 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 2003–2006 an average of 83% of the flycatcher population at Pahranagat was color-banded versus 48% at Topock. Pahranangat has a relatively open understory, and personnel are able to deploy a large number of long 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 for netting 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(s). At the monitoring sites, we recorded a total of 85 willow flycatcher territories in 2006. Of these, 66 (77%) consisted of paired flycatchers and 19 (22%) consisted of unpaired individuals. Over four years, the annual proportion of paired and unpaired territories at the monitoring sites has been relatively constant, with an average 72 and 28%, 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). According to the tenets of avian territorial social systems, 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 – Sixty percent of the adult, resident willow flycatchers identified in 2005 were detected again in 2006. Ninety-seven percent of the returning individuals were detected at the same study area in both years. For 2003–2006, 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 2003–2006 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), with adult flycatchers likely to exhibit high site fidelity to breeding areas.

Of the eighteen individuals that were banded as juveniles in 2003–2005 and detected for the first time in 2006, 50% returned to the same study area where originally banded. Since 1997, 94 returning juvenile flycatchers have been recaptured or resighted in subsequent years, of which 37 (39%) dispersed away from the natal area (McKernan and Braden unpubl. data, Koronkiewicz et al. 2004, McLeod et al. 2005, Koronkiewicz et al. 2006a, 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, Koronkiewicz et al. 2006a), with two males originally banded as nestlings in 2003 at Roosevelt Lake recaptured in 2005 at Muddy River and Topock. 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 genetic isolation among Southwestern Willow Flycatcher populations (Busch et al. 2000). 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 2005 we identified 80 adult and 65 juvenile willow flycatchers at the monitoring sites, of which 48 (60%) and 10 (15%), respectively, were detected in 2006. Thus, minimum estimated adult and juvenile survival from 2005 to 2006 was 60 and 15%, 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 Lake Mead – The five-fold increase in the number of breeding adults detected in lower Grand Canyon from 2004 (2 breeding adults) to 2006 (10 breeding or paired adults) is likely the result of the recent development of extensive areas of willow along the Colorado River near Lake Mead. Over the past two to three years, suitable flycatcher habitat has developed in Lake Mead National Recreation Area on sediments previously inundated by Lake Mead (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.

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.[1] 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

[1] 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.

documented at the site. Because of above-normal winter precipitation during the winter of 2004–2005, Mosquito Flats contained standing water throughout the 2005 and 2006 flycatcher breeding seasons (see Chapter 2 for details), with flycatcher breeding recorded in each year. 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 2006, 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 2006, we continued the color-banding studies initiated in 2003 on the extreme southern stretches of the Colorado River. In 2006, we captured and color-banded 29 individuals downstream of Parker Dam, none of which were detected post-capture. As in 2003–2005, 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.

Of the 46 flycatchers captured from 7 to 18 June in 2003–2006, 39 (85%) were second-year birds (hatched the year before), based on the presence of retained flight feathers (per Kenwood and Paxton 2001 and Koronkiewicz et al. 2002). Given the relatively high frequency of second-year birds during these banding attempts across years, 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 periods in 2005 and 2006, we captured 9 and 22 flycatchers, respectively. In 2003 and 2004, only four individuals were captured in each year. The increase in captures in 2005–2006 has been influenced by a change in mist-netting strategy. In 2003–2004, 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 2005–2006, 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.

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 2006, 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 2006 were compared with those at the study areas from 1996 to 2005 (McKernan 1997; McKernan and Braden 1998, 1999, 2001a, 2001b, 2002; Koronkiewicz et al. 2004; McLeod et al. 2005; Koronkiewicz et al. 2006a; 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 (2.24, 12.82, and 13.70 days for laying, incubation, and nestling stages, respectively) as observed in this study in 2003–2006 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 82 willow flycatcher nesting attempts at the four life history study areas, Muddy River Delta, Grand Canyon, and Bill Williams; 77 of these nests were known to contain flycatcher eggs and were used in calculating nest success and productivity. Thirty-three (43%) nests were successful and fledged young, and 41 (53%) failed. The fates of three nests (4%) were undetermined (Table 4.1). In all three cases, the nests were suspected to have fledged, but no fledglings could be visually confirmed. Nest success ranged from 20% at Bill Williams to 60% at Pahranagat. For a comparison of nest success at all monitoring sites from 1998 to 2006, see Table 4.2.

Fifty-nine nesting females, of which 56 produced at least one egg, were followed through all of their nesting attempts. Six additional females were detected for which no nesting attempt could be confirmed. Of the 59 nesting females, 40 had one nesting attempt, 16 had two nesting attempts, 2 had three nesting attempts, and 1 had four nesting attempts. Of the 19 females who had multiple nesting attempts, 4 renested after successfully fledging young and 15 renested after unsuccessful nests.

Table 4.1. Summary of Willow Flycatcher Nest Monitoring Results at the Four Life History Study Areas, Muddy River Delta, NV, and Grand Canyon and Bill Williams, AZ, 2006*

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	12	15	13	9 (69)	4 (31)	0	0
	South	3	3	2	0	2 (100)	0	0
	Total	**15**	**18**	**15**	**9 (60)**	**6 (40)**	**0**	**0**
MESQ	East	1	0	--	--	--	--	--
	West	14	21	20	11 (55)	9 (45)	0	5 (25)
	Total	**15**	**21**	**20**	**11 (55)**	**9 (45)**	**0**	**5 (25)**
MOME	Virgin River #1 South	1	1	0	--	--	--	--
	Virgin River #2	6	8	8	4 (50)	4 (50)	0	0
	Total	**7**	**9**	**8**	**4 (50)**	**4 (50)**	**0**	**0**
MUDD	Overton WMA	7	9	9	4 (44)	5 (56)	0	1 (11)
	Total	**7**	**9**	**9**	**4 (44)**	**5 (56)**	**0**	**1 (11)**
GRCA	RM 274.5	1	1	**1**	0	1 (100)	0	0
	RM 285.3	2	2	**2**	0	2 (100)	0	0
	Twin Coves	1	0	**--**	--	--	--	--
	Chuckwalla Cove	1	0	**--**	--	--	--	--
	Total	**5**	**3**	**3**	**0**	**3 (100)**	**0**	**0**
TOPO	Pipes #3	1	0	--	--	--	--	--
	The Wallows	1	1	1	0	1 (100)	0	1 (100)
	In Between	3	4	4	0	4 (100)	0	1 (33)
	800M	1	0	--	--	--	--	--
	Pierced Egg	3	6	6	2 (33)	3 (50)	1 (17)	1 (17)
	Glory Hole	5	6	6	2 (33)	2 (33)	2 (33)	2 (33)
	Total	**14**	**17**	**17**	**4 (23)**	**10 (59)**	**3 (18)**	**5 (31)**
BIWI	Site 3	3	5	5	1 (20)	4 (80)	0	0
	Total	**3**	**5**	**5**	**1 (20)**	**4 (80)**	**0**	**0**
Overall Total		**65**[5]	**82**	**77**	**33 (43)**	**41 (53)**	**3 (4)**	**11 (15)**

* 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, GRCA = Grand Canyon, TOPO = Topock Marsh, BIWI = Bill Williams River 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. Percentages include only nests for which contents could be determined.
[5] One female nested in both GRCA and MESQ and is counted only once in the total.

NEST FAILURE

Depredation was the major cause of nest failure, accounting for 48% (22 of 46) of all failed nests (Table 4.3) and 54% (22 of 41) of nests that failed after flycatcher eggs were laid. Five nesting attempts (11% of all failed nests) were abandoned prior to willow flycatcher eggs being laid and 13 nests (28%) were deserted. Two nests (4%) failed because of Brown-headed Cowbird parasitism (see below for more details on parasitism). Four nests (9%) failed because of infertile or addled eggs.

Table 4.2. Willow Flycatcher Percent Nest Success Recorded at Breeding Sites along the Virgin and Lower Colorado Rivers and Tributaries from 1996 to 2006*

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)	Nm[3]	Nm[3]	50 (12)	Nm[3]	Nc[5]	35 (20)	Nd[4]
2000	52 (21)	Nd[4]	56 (9)	31 (16)	100 (1)	Nc[5]	28 (18)	100[6] (1)
2001	33 (27)	Nd[4]	47 (19)	35 (20)	33 (3)	Nc[7]	25 (20)	60[6] (5)
2002	29 (21)	Nd[4]	53 (19)	0 (10)	Nd[4]	Nd[4]	25 (12)	50[6] (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[8]	45 (38)	Nd[4]
2005	58 (19)	Nd[4]	42 (12)	17 (6)	38[9] (8)	Nd[4]	24 (34)	100 (2)
2006	60 (15)	Nd[4]	55 (20)	50 (8)	44 (9)	0 (3)	23 (17)[10]	20 (5)

* Data from 1997 to 2002 are from McKernan 1997, McKernan and Braden (2002), and Braden and McKernan (unpubl. data) unless noted otherwise; 2003 data are from Koronkiewicz et al. (2004); 2004 data are from McLeod et al. (2005), 2005 data are from Koronkiewicz et al. 2006a, and data from 2006 can be found in this document. Total number of nests is indicated in parentheses. For 2003–2006, this is the number of nests with at least one flycatcher egg.
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 Breeding suspected, nest success not calculated.
6 Nest success calculated by Paradzick et al. (2001), and Smith et al. (2002, 2003).
7 Breeding confirmed, nest success not calculated.
8 Breeding confirmed, undetermined if nestlings from a single nest fledged.
9 Nest success was reported in 2005 as 25%, with the fate of one additional nest unknown; a fledgling from this nest was recaptured in 2006.
10 An additional 3 nests (18%) were suspected to have fledged but fledglings were not visually confirmed.

Table 4.3. Summary of Causes of Willow Flycatcher Nest Failure at the Four Life History Study Areas, Muddy River Delta, NV, and Grand Canyon and Bill Williams, AZ, 2006*

Study Area[1]	Total # Nests	All Failed Nests	Abandoned	Deserted	Depredated	Parasitized	Addled
PAHR	18	9	3 (33)	3 (33)[2]	2 (22)	0	1 (11)
MESQ	21	10	1 (10)	2 (20)[3]	5 (50)	2 (20)	0
MOME	9	5	1 (20)	1 (20)[4]	1 (20)	0	2 (40)
MUDD	9	5	0	2 (40)[5]	3 (60)	0	0
GRCA	3	3	0	1 (33)[6]	2 (67)	0	0
TOPO	17	10	0	3 (30)[7]	6 (60)	0	1 (10)
BIWI	5	4	0	1 (25)	3 (75)	0	0
Total	**82**	**46**	**5 (11)**	**13 (28)**	**22 (48)**	**2 (4)**	**4 (9)**

* 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, GRCA = Grand Canyon, TOPO = Topock Marsh, BIWI = Bill Williams River NWR.
2 One nest deserted after 14 days of incubation, one with 11-day-old chicks, one early in incubation.
3 One nest deserted after being parasitized, one after partial depredation.
4 Nest deserted after 19 days of incubation.
5 Nests deserted after 17 and 18 days of incubation.
6 Nest deserted with one egg, possibly after partial depredation.
7 One nest deserted after 19 days of incubation, one deserted during laying, one deserted at beginning of incubation.
8 Nest deserted after at least 15 days of incubation.

Brood Parasitism

Eleven of 71 nests (15%) with flycatcher eggs and known contents were brood parasitized by Brown-headed Cowbirds (Table 4.4). We did not find any nests that were parasitized prior to flycatcher eggs being laid. Parasitism caused nest failure at two nests. In both cases, parasitism coincided with the disappearance of any flycatcher eggs; one nest was subsequently abandoned and the other fledged a cowbird. One parasitized nest fledged flycatchers but no cowbirds, and one nest fledged both a flycatcher and a cowbird. Two nests were suspected to have fledged flycatchers, but fledging status could not be confirmed. Of the remaining five parasitized nests that failed, four nests were depredated with both flycatcher and cowbird eggs or young in the nest, and one nesting attempt was deserted with flycatcher and cowbird eggs in the nest. Brood parasitism at all sites ranged from 0 to 31% and was highest at Topock Marsh (see Table 4.1). In 2006, nests that contained flycatcher eggs and were brood parasitized were not less likely to fledge flycatcher young than nests that were not parasitized (Chi-square = 1.20, $P = 0.27$).

Table 4.4. Fates of Willow Flycatcher Nests Parasitized by Brown-Headed Cowbirds, 2006*

Study Area[1]	Nest ID Code	Outcome[2]
MESQ	12A	Parasitized during egg laying. Disappearance of WE coincided with appearance of 2nd CE. Fledged one cowbird.
	20A	Parasitized during egg laying. Appearance of 2nd CE coincided with disappearance of WE. Nest abandoned with 2 CE
	30B	Parasitized during incubation; deserted with 1 WE and 1 CE
	31A	Fledged 2 flycatchers; CE did not hatch
	41A	Partially depredated with 2 WE and 2 CE; abandoned with 2 CE remaining
MUDD	25A	Nest depredated with 1 CE buried in nest lining and 2 WE
TOPO	2A	Partially depredated with 2 WE and 1 CE; abandoned with 1 CE remaining
	26A	CE did not hatch; nest suspected but not confirmed to have fledged one flycatcher
	31A	Nest depredated during incubation
	32A-2	CE did not hatch; nest suspected but not confirmed to have fledged two flycatchers
	58B	Fledged one flycatcher and one cowbird

* All nesting attempts are included.
[1] MESQ = Mesquite, 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 0.002 to 0.628 and was 0.457 for all sites combined (Table 4.5). At all sites, 68 nestlings were confirmed to have fledged from 74 nests of known outcome (mean number of nestlings/nest = 0.92, SE = 0.14). Fecundity across study areas ranged from 0.0 to 1.64 young per female and averaged 1.11 (SE = 0.18) (Table 4.6).

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 Grand Canyon and Bill Williams, AZ, in 2006*

Study Area	Nest Stage[1]	Nest Losses/ Observation Days	Daily Survival Rate	Mayfield Survival Probability
Pahranagat	1	0/28.5	1.000	1.000
	2	5/177	0.972	0.693
	3	1/141	0.993	0.907
	MSP all stages = 0.628			
Mesquite	1	1/32	0.969	0.931
	2	8/183	0.956	0.564
	3	0/153.5	1.000	1.000
	MSP all stages = 0.525			
Mormon Mesa	1	0/8	1.000	1.00
	2	3/104	0.971	0.687
	3	1/48	0.979	0.749
	MSP all stages = 0.515			
Muddy River	1	1/13	0.923	0.836
	2	3/108	0.972	0.697
	3	1/57.5	0.983	0.786
	MSP all stages = 0.458			
Grand Canyon	1	0/5	1.000	1.000
	2	2/34	0.941	0.460
	3	1/3	0.667	0.004
	MSP all stages = 0.002			
Topock	1	1/27	0.963	0.919
	2	8/120	0.933	0.413
	3	1/48.5	0.979	0.752
	MSP all stages = 0.285			
Bill Williams	1	1/3.5	0.714	0.417
	2	2/40	0.950	0.518
	3	1/21	0.952	0.513
	MSP all stages = 0.125			
TOTAL	1	4/117	0.966	0.925
	2	31/766	0.960	0.589
	3	6/472.5	0.987	0.839
	MSP all stages = 0.457			

* Mayfield survival probability was calculated using 2.24-day egg laying, 12.82-day incubation, and 13.70-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 Grand Canyon and Bill Williams, AZ, 2006*

Study Area	# Young Fledged (# Nests)	Productivity Mean (SE)	Fecundity Mean (SE)
Pahranagat	24 (15)	1.60 (0.38)	1.60 (0.38)
Mesquite	23 (20)	1.15 (0.28)	1.64 (0.46)
Mormon Mesa	8 (8)	1.00 (0.42)	1.14 (0.46)
Muddy River	7 (9)	0.78 (0.36)	1.00 (0.44)
Grand Canyon	0 (3)	0.00 (0.00)	0.00 (0.00)
Topock	4 (14)	0.29 (0.16)	0.36 (0.20)
Bill Williams	2 (5)	0.40 (0.40)	0.67 (0.67)
Total	**68 (74)**	**0.92 (0.14)**	**1.11 (0.18)**

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

DISCUSSION

In 2006, willow flycatcher nesting was documented at the four life history study areas, Muddy River Delta, lower Grand Canyon, and Bill Williams. Unlike in 2005, flycatcher breeding was recorded in Grand Canyon, with breeding occurring in the recently developed willow along the Colorado River in Lake Mead National Recreation Area (see Chapter 2 for site description details). In addition, an almost three-fold increase in the number of breeding pairs was recorded at Mesquite West in 2006 (14) compared to 2005 (5). Three individuals that bred at Bunker Farm in 2005 moved to Mesquite West in 2006, accounting for some of this increase. The lack of standing water at Bunker Farm in 2006 (see Chapter 2 for details) likely facilitated this immigration. 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 at a given site in one year and not in another.

NEST SUCCESS

As in 2003–2005, Pahranagat exhibited the highest nest success of the four life history study areas (see Table 4.2 for nest success at study areas in 1996–2006). Nest success at Bill Williams was 20%, the lowest recorded since monitoring began in 1997, though sample size across years is small. Nest success at the remaining study areas continued to exhibit the yearly fluctuations seen since nest monitoring began in 1996. 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 variable patterns of nest success observed at the study areas over many years further demonstrate the need for long-term data.

NEST FAILURE

As in 2003–2005, depredation was the major cause of willow flycatcher nest failure, accounting for 48% of all failed nests in 2006 (see Table 4.3). Depredation accounted for 22, 50, 20, 60, 67, 60, and 75% of all failed nests at Pahranagat, Mesquite, Mormon Mesa, Muddy River, Grand Canyon, Topock, and Bill Williams, respectively. These results are consistent with those reported at the life history study areas from 1998 to 2005 (McKernan and Braden 2002, Koronkiewicz et al. 2004, McLeod et al. 2005, Koronkiewicz et al. 2006a, Braden and McKernan unpubl. data) and at monitored sites across Arizona from 2000 to 2005 (Paradzick et al. 2001; Smith et al. 2002, 2003, 2004; Munzer et al. 2005; English et al. 2006), 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 31% and averaged 15% (see Table 4.1). These results are consistent with those reported at the study areas from 1998 to 2005 (McKernan and Braden 2002; Koronkiewicz et al. 2004; McLeod et al. 2005; Koronkiewicz et al. 2006a; 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, 6 and 7% in 2000, 2001, 2002, 2003, 2004, and 2005, respectively (Paradzick et al. 2001; Smith et al. 2002, 2003, 2004; Munzer et al. 2005; English et al 2006). We observed the fourth 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.

We observed two 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 one nest that was parasitized during incubation and subsequently deserted. 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. In addition, willow flycatchers that fledge late in the season have been shown to have a lower survival rate than those that fledge early in the season (USGS, unpubl. data), suggesting additional hidden effects of parasitism and subsequent renesting on flycatcher demography. Cowbird impacts to flycatcher populations may therefore be more severe than parasitism rates alone suggest.

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 (0.457) was higher than 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 2006 was lower than in 2003 (0.556), and higher than in 2004 (0.436) and 2005 (0.365).

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. Fecundity in 2006 (1.11) did not differ significantly from that recorded in previous years ($F_{3,204} = 0.55$, $P = 0.65$).

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. In 2006, we discontinued trapping at Mormon Mesa because logistical constraints prevented placement of traps within 400 m of breeding areas. 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 (2003–2006) 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 Pahranagat, Mesquite, and Topock Marsh, 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 (late July or early August).

TRAP DESIGN

In 2005, we experimented with two different trap designs: a flat-topped trap, which we had used in 2003 and 2004, and a trap with a funnel-shaped top. The traps with funnel-shaped tops captured significantly more cowbirds than the flat-topped traps (Koronkiewicz et al. 2006a), so in 2006 all traps were of the funnel-topped design. The traps used in 2006 were 1.8 m high, 1.8 m wide, and 2.4 m long, and had a funnel-shaped top (Figure 5.1). All panels 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 slots down the middle, was attached to the top of each trap for cowbird entry.

The width of the entrance slot in cowbird traps varies from project to project, ranging from 3.1 cm (2.2 inches) to 4.4 cm (1.7 inches) (Reclamation 2004). The Texas Parks and Wildlife Department (n.d.) emphasizes the importance of using a 3.2-cm (1.25-inch) slot, while Griffith Wildlife Biology (2001) recommends a 3.5-cm (1.38-inch) slot. In 2006 we experimented with slots of two different widths to determine if slight variations in slot size had any effect on capture rates of cowbirds or non-target species. Three of the six traps at Topock had 3.8-cm-wide slots and three had 3.2-cm-wide slots. The slot size on each trap was exchanged half way through the season to control for location effects when evaluating trapping success of the different slot sizes.

Figure 5.1. Brown-headed Cowbird trap design used at life history study areas, 2006.

Signs were posted on each trap door to inform the public of the nature and relevance of the trapping program. The signs were clearly marked and laminated to maintain legibility over the season. Padlocks were used on the doors of traps in public locations 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, and six at Topock. Traps at Pahranagat and Topock remained in essentially the same locations used in 2005. One trap that had been at Mesquite East in 2005 was moved to Mesquite West in 2006 (Figures 5.2–5.4). 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.

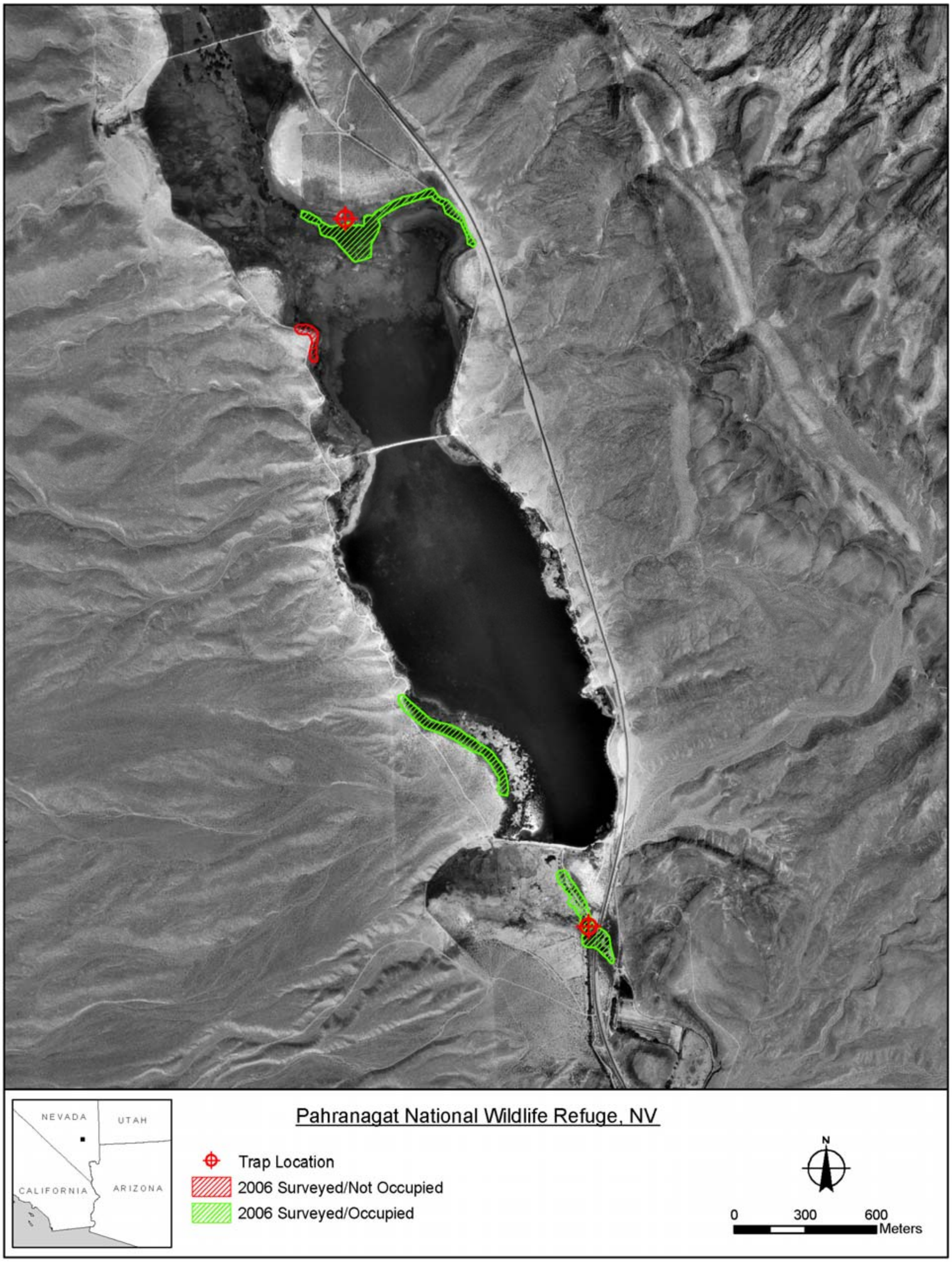

Figure 5.2. Cowbird trap locations at Pahranagat NWR, NV, 2006.

Figure 5.3. Cowbird trap locations at Mesquite, NV, 2006.

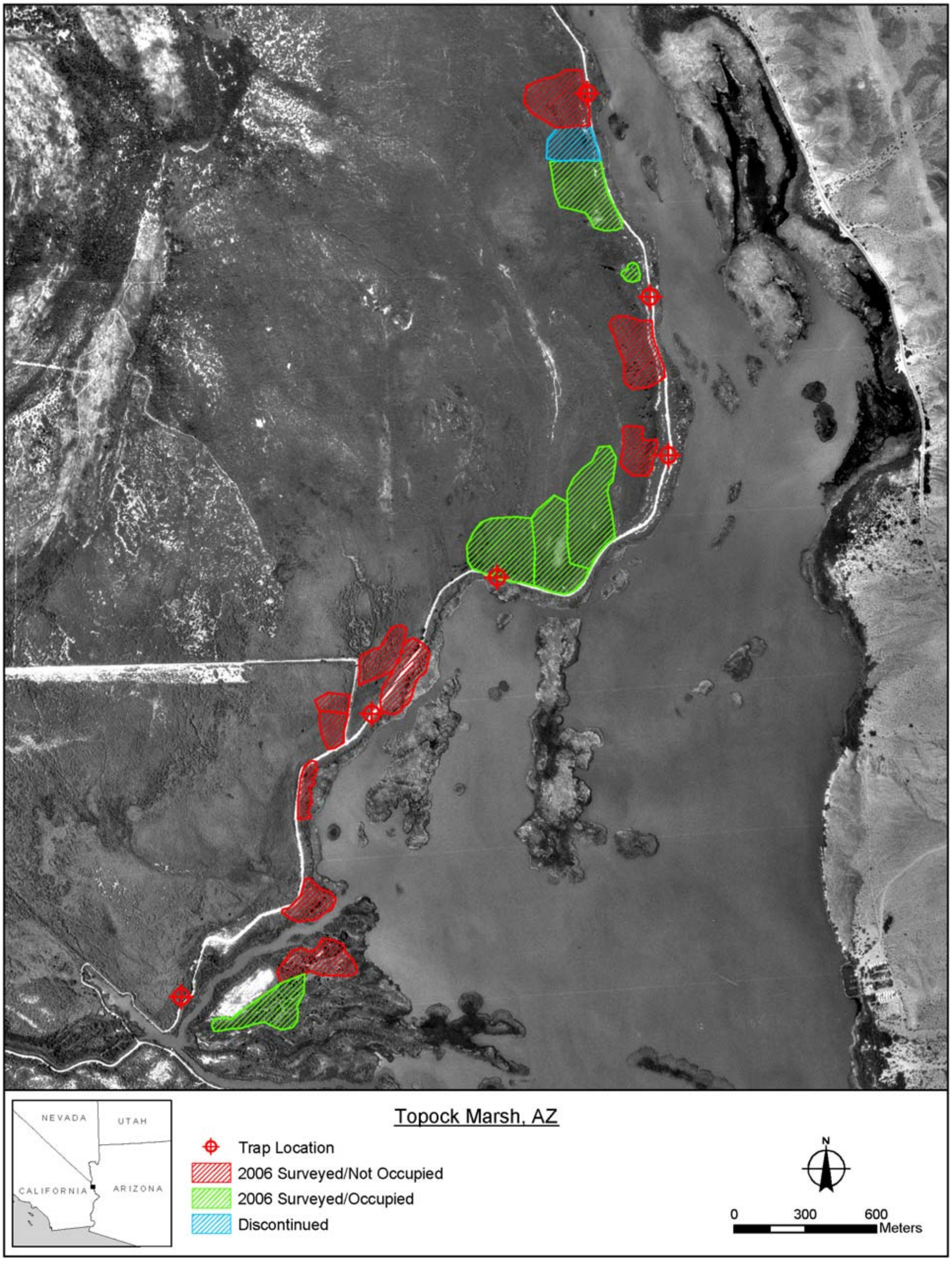

Figure 5.4. Cowbird trap locations at Topock Marsh, AZ, 2006.

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 frozen and donated to feed captive raptors.

Data Analysis

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.

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 the two slot widths at Topock.

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 (2003–2006) were compared using one-way ANOVA. Data from 1998 at Topock were excluded from the analysis.

Results

Trap Operation

We operated cowbird traps at Pahranagat, Mesquite, and Topock (see Figures 5.2–5.4) from 14 May to 31 July, 21 May to 4 August, and 11 May to 28 July, respectively, for a total of 154, 221, and 455 trap-days at each study area.

Brown-headed Cowbird Trapping

We captured and removed 70, 125, and 323 Brown-headed Cowbirds at Pahranagat, Mesquite, and Topock, respectively (Table 5.1).

Table 5.1. Summary of Brown-headed Cowbirds Trapped and Removed at Pahranagat NWR, Mesquite, NV, and Topock Marsh, AZ, 2006

Study Area	Trap #	# Males	# Females	# Juveniles	Total # Brown-headed Cowbirds
Pahranagat	1	23	10	0	33
	2	22	15	0	37
	Total	**45**	**25**	**0**	**70**
Mesquite	1	20	15	3	38
	2	42	28	4	74
	3	11	1	1	13
	Total	**73**	**44**	**8**	**125**
Topock	1	26	18	8	52
	2	32	8	8	48
	3	35	23	0	58
	4	28	12	2	42
	5	25	11	2	38
	6	49	36	0	85
	Total	**195**	**108**	**20**	**323**

TRAP DESIGN

Overall, traps with the wider slots had a daily capture rate of 0.88 cowbirds per trap-day, while the narrow slots captured 0.63 cowbirds per trap-day ($F_{1, 453} = 4.27$, $P = 0.039$). The escape rate of cowbirds did not differ significantly ($F_{1, 451} = 1.43$, $P = 0.23$) between the wide slots (0.03 cowbirds per trap-day) and the narrow slots (0.01 cowbirds per trap-day).

BROOD PARASITISM RATES

The proportion of flycatcher nests parasitized during the pretrapping (1997–2002) and trapping (2003–2006) periods shows no significant difference at Mesquite ($P = 0.719$), Mormon Mesa ($P = 0.239$), and Topock ($P = 0.115$) (Table 5.2). Parasitism rates at Pahranagat were significantly lower during the trapping than pre-trapping period ($P = 0.042$), with the fourth consecutive year of no brood parasitism recorded in 2006. No brood parasitism was recorded at Mormon Mesa in 2006, despite there being no cowbird trapping. At Mesquite and Topock, brood parasitism rates remained substantial, with 23.8 and 31.2%, respectively, recorded in 2006.

Table 5.2. Brown-Headed Cowbird Brood Parasitism Rates at the Four Life History Study Areas, 1997–2006*

	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)
	2006	0.0% (14)	23.8% (21)	0.0% (8)[9]	31.2% (20)
% 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)	32.5% (6.4)	28.6%	33.1% (6.8)

* 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 parasitized nests. Data for pre-trapping periods (1997–2002) are from McKernan and Braden (2002) and Braden and McKernan (unpubl. data); data for trapping periods (2003–2006) are from Koronkiewicz et al. (2004), McLeod et al. (2005), Koronkiewicz et al. (2006a), and this document. Total number of nests for 2003–2006 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.

9 Brood parasitism rate at Mormon Mesa in 2006 was not used in calculating mean percent parasitism during trapping periods because no trapping occurred at Mormon Mesa in 2006.

NON-TARGET SPECIES

Sixteen non-target species were captured and identified at all life history study areas during cowbird trapping (Table 5.3). Non-target species captures included Abert's Towhee (*Pipilo aberti*), Bewick's Wren (*Thryomanes bewickii*), Black-headed Grosbeak (*Pheucticus melanocephalus*), Gambel's Quail (*Callipepla gambelii*), Gila Woodpecker (*Melanerpes uropygialis*), Great-tailed Grackle (*Quiscalus mexicanus*), House Finch (*Carpodacus mexicanus*), Loggerhead Shrike (*Lanius ludovicianus*), Lucy's Warbler (*Vermovira luciae*), Red-winged Blackbird (*Agelaius phoeniceus*), Western Kingbird (*Tyrannus verticalis*), White-crowned Sparrow (*Zonotrichia leucophrys*), White-winged Dove (*Zenaida asiatica*), and Yellow-breasted Chat (*Icteria virens*). Abert's Towhee and House Finch 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 one Abert's Towhee, two House Finches, one Lucy's Warbler, and one Yellow-breasted Chat. Injuries to one Abert's Towhee were also noted (see Table 5.3).

Table 5.3. Summary of Non-target Species Captured during Brown-headed Cowbird Trapping at the Life History Study Areas, 2006*

Species	Pahranagat				Mesquite				Topock			
	Instance	Occurrence	Injured	Died	Instance	Occurrence	Injured	Died	Instance	Occurrence	Injured	Died
Abert's Towhee	-	-	-	-	112	161	1[a]	1	48	52	-	-
Bewick's Wren	1	1	-	-	-	-	-	-	-	-	-	-
Black-headed Grosbeak	4	7	-	-	-	-	-	-	1	1	-	-
Gambel's Quail	-	-	-	-	1	1	-	-	-	-	-	-
Gila Woodpecker	-	-	-	-	-	-	-	-	1	1	-	-
Great-tailed Grackle	-	-	-	-	-	-	-	-	3	3	-	-
Hooded Oriole	-	-	-	-	-	-	-	-	1	1	-	-
House Finch	1	1	-	-	29	123	-	-	14	19	-	2
House Wren	-	-	-	-	-	-	-	-	1	1	-	-
Loggerhead Shrike	-	-	-	-	1	1	-	-	-	-	-	-
Lucy's Warbler	1	1	-	1	-	-	-	-	-	-	-	-
Red-winged Blackbird	-	-	-	-	2	2	-	-	-	-	-	-
Western Kingbird	-	-	-	-	-	-	-	-	1	1	-	-
White-crowned Sparrow	-	-	-	-	-	-	-	-	4	6	-	-
White-winged Dove	-	-	-	-	-	-	-	-	2	2	-	-
Yellow-breasted chat	-	-	-	-	1	1	-	1	-	-	-	-
Unknown wren	1	1	-	-	1	1	-	-	-	-	-	-
Unknown species	-	-	-	-	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] Scrape on forehead.

TRAP DESIGN

We examined the non-target capture data from Topock to determine whether the two slot widths had different capture rates for non-target species (Table 5.4). The traps with wide slots had a tendency to have more occurrences of non-target captures than traps with narrow slots ($F_{1,457}$ = 3.49, P = 0.063).

Table 5.4. Non-target Species Captured during Brown-headed Cowbird Trapping in Traps with Wide and Narrow Slots, Topock, 2006

Species	Narrow slot				Wide slot			
	Instance	Occurrence	Injured	Died	Instance	Occurrence	Injured	Died
Abert's Towhee	20	20	-	-	28	32	-	-
Black-headed Grosbeak	1	1	-	-	-	-	-	-
Gila Woodpecker	-	-	-	-	1	1	-	-
Great-tailed Grackle	-	-	-	-	3	3	-	-
Hooded Oriole	-	-	-	-	1	1	-	-
House Finch	6	7	-	1	8	12	-	1
House Wren	-	-	-	-	1	1	-	-
Western Kingbird	-	-	-	-	1	1	-	-
White-crowned sparrow	4	6	-	-	-	-	-	-
White-winged Dove	-	-	-	-	2	2	-	-

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, Koronkiewicz et al. 2006a).

Because traps could not be deployed close enough to the flycatcher breeding habitat at the Mormon Mesa study area, trapping was not conducted there in 2006. The effectiveness of other cowbird control measures (e.g., shooting) in lowering parasitism rates should be evaluated for sites where parasitism is a concern and trapping is impractical.

A comparison of the proportion of flycatcher nests parasitized during the pretrapping (1997–2002) and trapping (2003–2006) periods showed a statistical difference only at Pahranagat, where we documented the fourth consecutive year of no brood parasitism. 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 and Topock are part of larger, contiguous riparian corridors, and cowbirds that are removed by trapping are likely quickly replaced by other individuals (L. White, pers. comm.).

In 2006 we found that cowbird traps with wider slots captured significantly more cowbirds per trap-day than those with narrower slots. The escape rate of captured cowbirds did not differ significantly between the wide and narrow slots. To maximize the capture rates of cowbirds, traps should have slots 3.8 cm rather than 3.2 cm wide. We have not evaluated the efficacy of slots wider than 3.8 cm.

Sixteen non-target species were captured at Pahranagat, Mesquite, and Topock during cowbird trapping in 2006. This compared to eight non-target species captured in each year in 2003 and 2004, and 14 in 2005. The greater variety of non-target species captured in 2005 and 2006 is likely the result of use of the funnel-topped traps, which captured more non-target individuals as well as cowbirds. Data also showed a trend toward traps with wider slots capturing more non-target individuals. Non-target individuals captured in traps with wider slots also tended to be of larger species (e.g., Gila Woodpecker, Great-tailed Grackle, White-winged Dove). 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 2006 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 and Grand Canyon. Field methods at each sampling plot were identical in 2006 to those used in 2003–2005. 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 2006 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 2006, 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 2006 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 9.1 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. Distances >30 m were either measured in the field using GPS or were estimated, when possible, using ArcMap and high-resolution aerial photographs. For distances that were >30 m that could not be estimated using ArcMap (e.g., distance to canopy gap), distance was recorded as >30 m.

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 2006 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. Distance to standing water or saturated soil was also measured at the time the nest was found.

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. In 2006, non-use plot locations were established and distance to water was measured when the corresponding nest was determined to contain eggs. We sampled one non-use plot for each willow flycatcher nest in which at least one flycatcher egg was laid at the four life history sites and Muddy River. 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 9.1 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 2003–2005), per Allison et al. (2003).

DATA ANALYSES

We used SPSS® Version 15.0 (SPSS 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 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, Muddy River, Grand Canyon, and Bill Williams, we gathered data on vegetation and habitat characteristics at 72 nest plots, 66 non-use plots, and 46 within-territory plots. We gathered data at an additional 52 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 between sites in canopy height, distance to water or saturated soil, distance to nearest broadleaf, and number of shrub/sapling and tree stems (Table 6.1). All sites 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, 2006*

Parameter	Pahranagat (n = 30)	Mesquite (n = 30)	Mormon Mesa (n = 30)	Topock (n = 29)
Average canopy height (m)	19.3 (1.4) 1.5–36.2 A	4.5 (0.4) 2.0–12.5 B	4.4 (0.4) 2.5–13.0 B	5.7 (0.3) 2.5–9.0 B
% total canopy closure	85.1 (3.3) 21.0–100.0 A	89.0 (1.6) 55.0–100.0 A	79.7 (3.4) 12.0–97.0 A	83.2 (3.2) 24.0–99.0 A
% woody ground cover	29.2 (5.0) 0.0–100.0 A	21.8 (4.0) 3.0–99.0 A	23.8 (3.2) 1.0–72.0 A	15.3 (3.5) 2.0–100.0 A
Distance (m) to nearest standing water or saturated soil	43.0 (7.2) 0.0–120.0 A	47.9 (9.2) 0.0–160.0 A	198.1 (29.7) 5.0–550.0 C	128.2 (17.1) 5.0–325.0 B
Distance (m) to nearest canopy gap	6.2 (0.7) 0.0–17.0 A	8.7 (1.9) 0.0–50.0 A	9.7 (2.1) 0.0–50.0 A	4.8 (0.9) 0.0–19.0 A
Distance (m) to nearest broadleaf tree	2.1 (0.9) 0.0–25 A	5.4 (2.0) 0.0–36.0 A	53.4 (11.8) 0.0-225.0 A	167.3 (47.1) 0.0–900.0 B
# shrub/sapling stems within 5-m radius of plot center	3.5 (2.1) 0–61 A	137.3 (12.9) 18–333 C	95.1 (7.3) 19–198 B	83.8 (11.2) 8–222 B
# tree stems within 11.3-m radius of plot center	11.2 (1.9) 0–43 A	5.0 (1.2) 0–24 A	6.8 (1.5) 0–28 A	21.7 (3.0) 0–62 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.

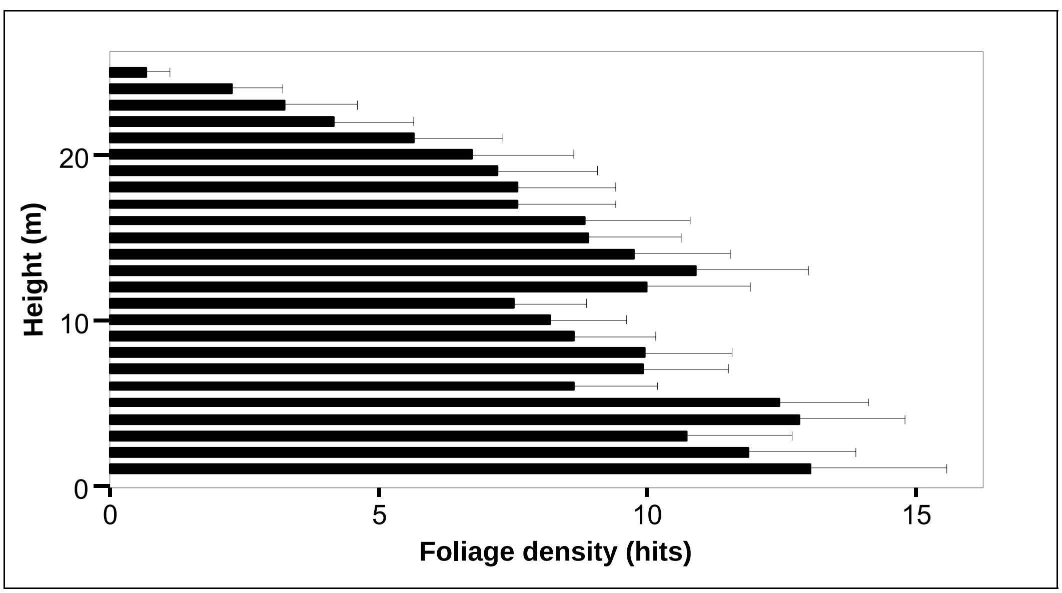

Figure 6.1. Vertical foliage density at habitat block points, Pahranagat NWR, NV, 2006. Values shown are mean and standard error of hits per meter interval.

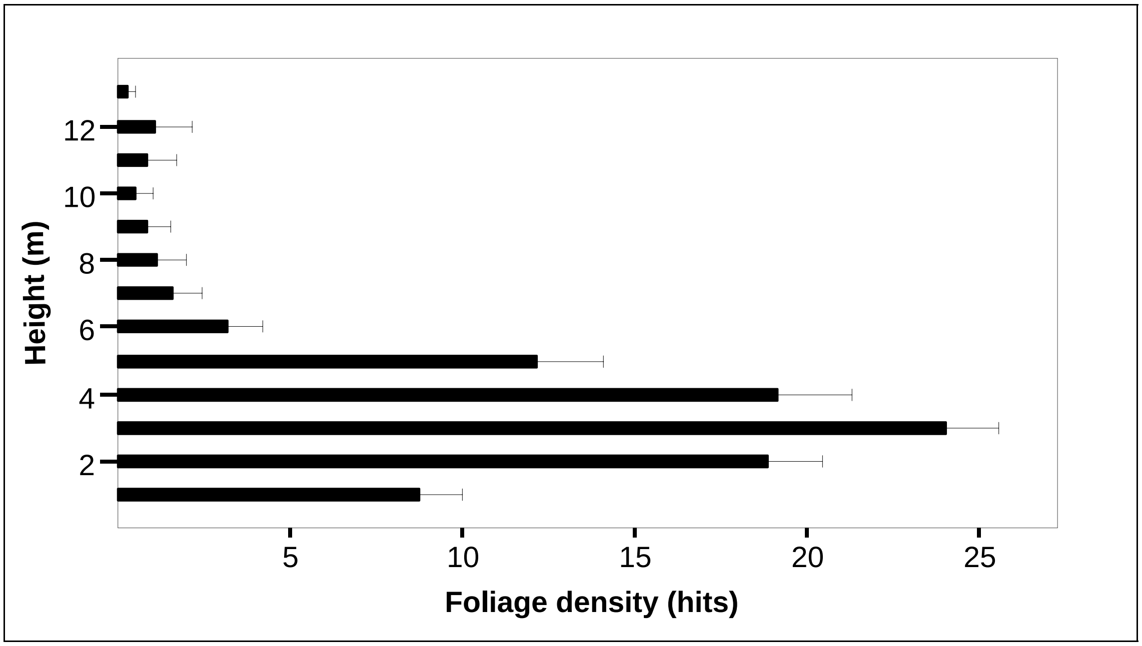

Figure 6.2. Vertical foliage density habitat block points, Mesquite, NV, 2006. Values shown are mean and standard error of hits per meter interval.

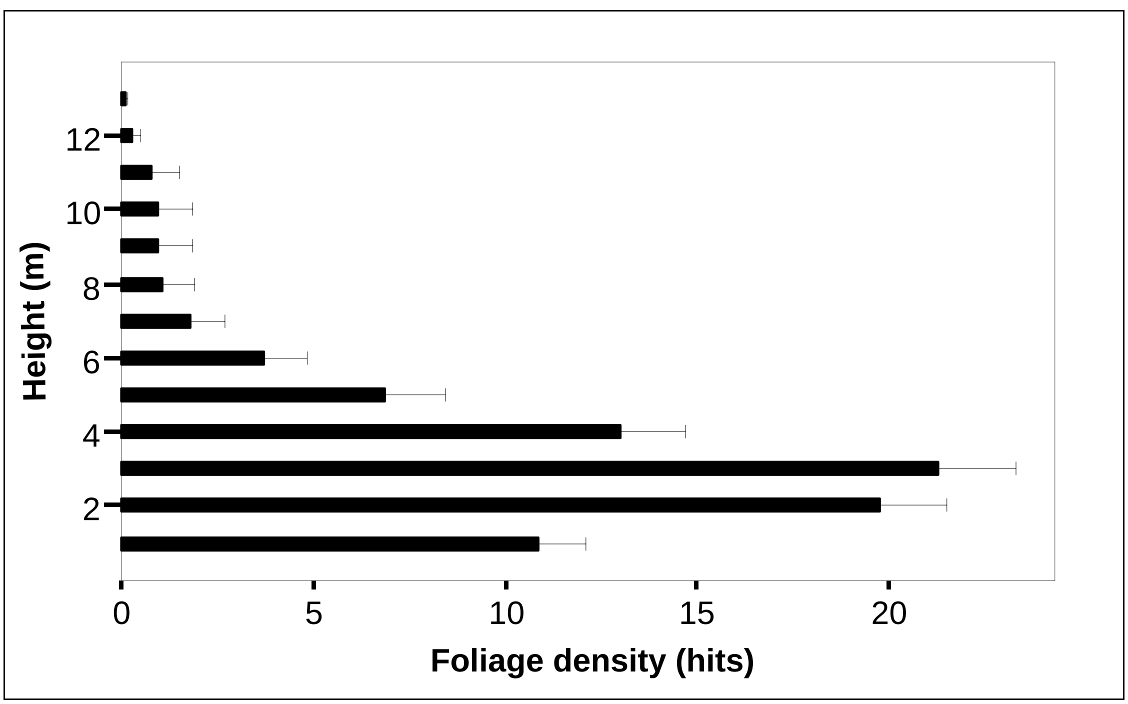

Figure 6.3. Vertical foliage density at habitat block points, Mormon Mesa, NV, 2006. Values shown are mean and standard error of hits per meter interval.

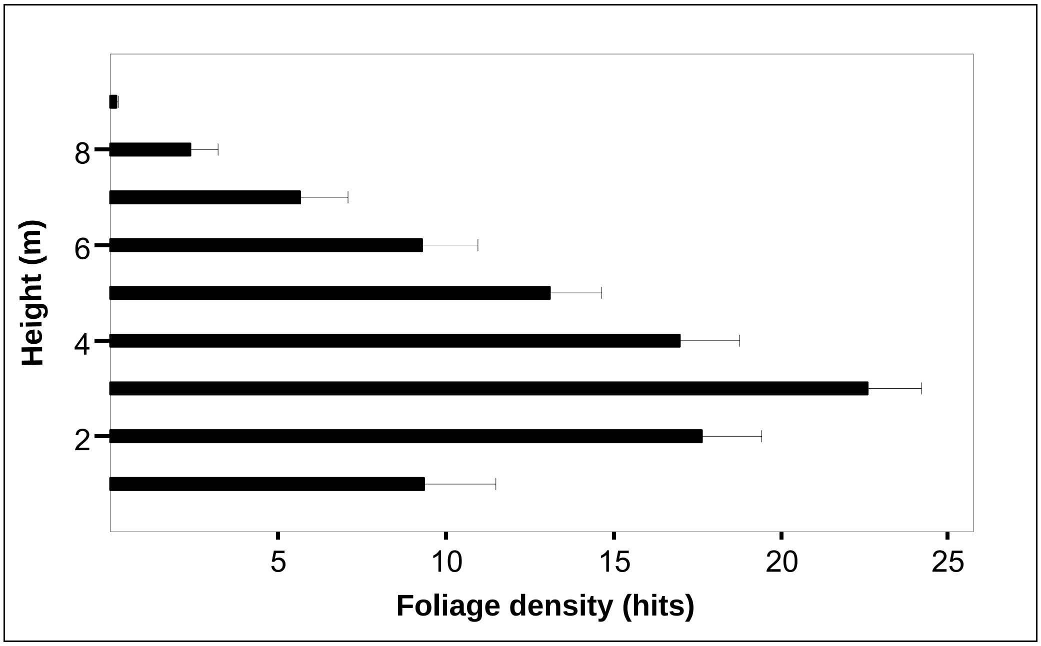

Figure 6.4. Vertical foliage density at habitat block points, Topock Marsh, AZ, 2006. Values shown are mean and standard error of hits per meter interval.

VEGETATION MEASUREMENTS AT THE NEST

Willow flycatcher nest height at the four life history study areas, Muddy River Delta, Grand Canyon, and Bill Williams ranged from 1.0 to 15.0 m, with a mean nest height of 3.0 m (SE = 0.2). Nest substrate included five woody species of trees, four native and one exotic, as well as dead trees. Flycatchers placed 61% of all nests at the study areas in tamarisk, 10% in coyote willow, 24% in Goodding willow, 1% in Fremont cottonwood, 1% in mesquite, and 3% in snags. Nest substrate height at all sites ranged from 2.2 to 24.0 m, with a mean nest substrate height of 6.3 m (SE = 0.6). Nest substrate dbh was highly variable, ranging from 1.2 to 79.0 cm, with a mean nest substrate dbh of 11.8 cm (SE = 2.1). Nest height at Pahranagat was higher than at Mesquite, Mormon Mesa, or Muddy River, and 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 2006.

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

Canopy height, percent ground cover, distance to water, distance to water during nesting, distance to canopy gap, distance to broadleaf, and number of shrub/sapling 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 and Mormon Mesa, while canopy height was greater at nest than non-use sites at Muddy River.

Table 6.2. Summary of Nest Measurements at the Four Life History Study Areas, Muddy River Delta, Grand Canyon, and Bill Williams, 2006*

Parameter	Pahranagat (n = 15)	Mesquite (n = 19)	Mormon Mesa (n = 7)	Topock (n = 16)	Muddy River (n = 9)	Grand Canyon (n=3)	Bill Williams (n = 3)[1]
Nest height (m)	4.3 (0.8) 1.4–15.0 A	2.2 (0.1) 1.0–3.3 B	2.1 (0.1) 1.6–2.5 B	3.5 (0.2) 2.2–6.0 A,B	2.3 (0.1) 1.4–2.9 B	2.3 (0.2) 2.0–2.6	4.7 (0.3) 4.4–5.0[2]
Nest substrate[3]	86% SAGO 7% POFR 7% TASP	69% TASP 26% SAEX 5% SNAG[4]	100% TASP	94% TASP 6% MESQ	56% TASP 22% SAEX 11% SAGO 11% SNAG[4]	100% SAGO	100% TASP
Nest substrate height (m)	14.0 (1.5) 4.0–24.0 A	3.4 (0.2) 2.2–5.0 B	4.6 (0.6) 2.8–7.5 B	4.7 (0.3) 2.6–7.0 B	3.9 (0.5) 2.5–7.5 B	5.2 (2.4) 2.8–10.0	6.3 (0.9) 4.5–7.5
Nest substrate dbh (cm)	39.0 (5.8) 7.0–79.0 A	2.8 (0.2) 1.2–5.3 B	4.7 (0.7) 2.3–7.8 B	6.6 (0.8) 2.0–13.5 B	4.0 (1.5) 1.2–16.0 B	5.3 (3.8) 1.5–13.0	7.1 (0.1) 7.0–7.3

* Numerical data presented are means, (standard error), and range. Significant differences (Tukey's test, α = 0.05) between sites for a given continuous variable are indicated by alpha codes; sites with different letters differed from one another, while sites with the same letter did not. Bill Williams and Grand Canyon were excluded from between-site comparisons because of low sample size.
[1] Vegetation measurements were obtained for three of the five nests at Bill Williams. One nest site could not be accurately relocated and one had been dramatically altered by a fallen tree.
[2] Height measurements obtained for two of the three nests.
[3] TASP = *Tamarix* sp. (tamarisk), SAEX = *Salix exigua* (coyote willow), SAGO = *Salix gooddingii* (Goodding willow), POFR = *Populus fremontii* (Fremont cottonwood), MESQ = *Prosopis pubscens* (screwbean mesquite), SNAG = standing dead tree.
[4] Snag was SAEX.

Shrub/sapling stem count was significantly lower at both nest and within-territory sites vs. non-use sites at Topock. There was no significant difference in stem counts among plot types at the other study areas.

Percent woody ground cover was greater at non-use than within-territory sites at Mesquite, but woody ground cover at nest sites did not differ from either within-territory or non-use sites. Distance to water or saturated soil as measured both during vegetation sampling and during nesting was greater at non-use than nest sites at both Mesquite and Muddy River. Mormon Mesa and Topock also demonstrated this same trend, but not statistically so. At Pahranagat, distance to water was greater at non-use than at nest sites during nesting, but less at non-use than at nest sites during vegetation sampling. Nest sites were farther from canopy gaps than were non-use sites at both Mesquite and Topock, while nests were closer than non-use sites to broadleaf trees at Muddy River.

Vertical foliage density differed between nest and within-territory plots only in the 5-m interval at Pahranagat (NS = 20.8, WT = 9.4 hits) and in the 1-m interval at Muddy River (NS = 4.6, WT = 11.9 hits) (ANOVA and Tukey's multiple comparison test, α = 0.05). Within-territory plots were 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, Topock, and Muddy River (Figures 6.5–6.9). At Pahranagat, significantly greater vertical foliage density occurred within the 4- to 6-m intervals at nest sites vs. non-use sites.

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, 2006*

Parameter	Pahranagat			Mesquite			Mormon Mesa			Topock			Muddy River		
	NS (n=15)	WT (n=10)	NU (n=15)	NS (n=19)	WT (n=10)	NU (n=19)	NS (n=7)	WT (n=7)	NU (n=7)	NS (n=16)	WT (n=10)	NU (n=16)	NS (n=9)	WT (n=9)	NU (n=9)
Canopy height (m)	19.9 (2.1)	22.1 (2.9)	22.3 (1.4)	5.0 (0.2) A	5.2 (0.3) A	3.5 (0.2) B****	6.4 (0.4) A	6.4 (0.2) A	4.3 (0.4) B***	6.8 (0.4)	5.8 (0.5)	6.1 (0.4)	6.4 (0.5) A	6.3 (0.4) A,B	4.4 (0.7) B*
% canopy closure	87.0 (3.9)	93.0 (3.1)	92.3 (2.3)	89.8 (1.1)	89.6 (2.2)	79.4 (4.9)	87.6 (2.8)	87.9 (2.7)	79.7 (6.4)	90.1 (3.2)	94.2 (1.0)	84.9 (2.8)	94.6 (1.2)	94.3 (1.4)	85.4 (4.9)
% woody ground cover	40.1 (6.1)	38.0 (9.2)	29.1 (7.3)	25.1 (3.6) A,B	16.5 (5.6) A	42.6 (6.2) B**	22.0 (2.8)	20.4 (4.7)	36.0 (5.0)	24.6 (6.7)	25.0 (10.6)	20.6 (5.4)	21.6 (5.1)	25.1 (6.2)	31.3 (10.5)
Distance (m) to nearest water or saturated soil	66.5 (9.5) A	78.6 (12.3) A	27.4 (7.1) B**	7.6 (2.8) A	5.7 (2.9) A	62.7 (12.9) B****	64.7 (17.3)	62.6 (16.3)	111.0 (24.2)	70.8 (20.9)	104.6 (29.9)	153.9 (22.6)	21.6 (6.6) A	21.4 (6.9) A	54.3 (8.8) B**
Distance (m) to nearest water or saturated soil during nesting	6.3 (4.0) A	--	22.5 (6.1) B*	8.1 (2.3) A	--	59.6 (10.6) B****	39.4 (14.5)	--	54.6 (25.1)	74.8 (25.2)	--	124.9 (26.7)	19.0 (6.7) A	--	49.9 (10.4) B*
Distance (m) to nearest canopy gap	7.4 (1.4)	7.9 (1.7)	7.3 (0.6)	17.5 (3.4) A	15.0 (3.4) A	3.3 (0.9) B***	8.9 (1.2)	14.1 (2.9)	10.3 (6.7)	6.9 (1.1) A	3.6 (0.7) B**	2.8 (0.6) B	11.9 (2.8)	11.7 (3.5)	4.9 (1.8)
Distance (m) to nearest broadleaf tree	2.5 (1.7)	2.5 (2.0)	0.3 (0.2)	0.2 (0.1)	0.1 (0.1)	1.8 (0.7)	28.0 (21.2)	28.3 (22.0)	59.7 (21.4)	69.4 (28.5)	110.1 (40.9)	132.3 (19.8)	1.6 (0.8) A	1.9 (0.8) A	54.7 (11.5) B****
# shrub/sapling stems within 5 m of plot center	1.3 (1.0)	2.2 (2.0)	0.3 (0.3)	172.9 (13.0)	158.1 (15.9)	123.9 (21.6)	76.4 (6.1)	75.4 (9.7)	105.3 (14.5)	62.5 (8.5) A	52.5 (10.3) A	107.4 (12.8) B**	124.4 (18.4)	122.9 (15.6)	150.6 (23.1)
# tree stems within 11.3 m of plot center	10.0 (2.3)	11.9 (2.7)	11.9 (3.2)	2.2 (0.7)	5.3 (2.6)	1.9 (0.7)	20.1 (3.8)	13.6 (3.1)	10.0 (3.2)	19.2 (2.1)	13.1 (2.8)	18.3 (3.3)	22.1 (3.4)	23.7 (4.3)	15.8 (5.7)

* 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: * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; **** $P < 0.0001$.

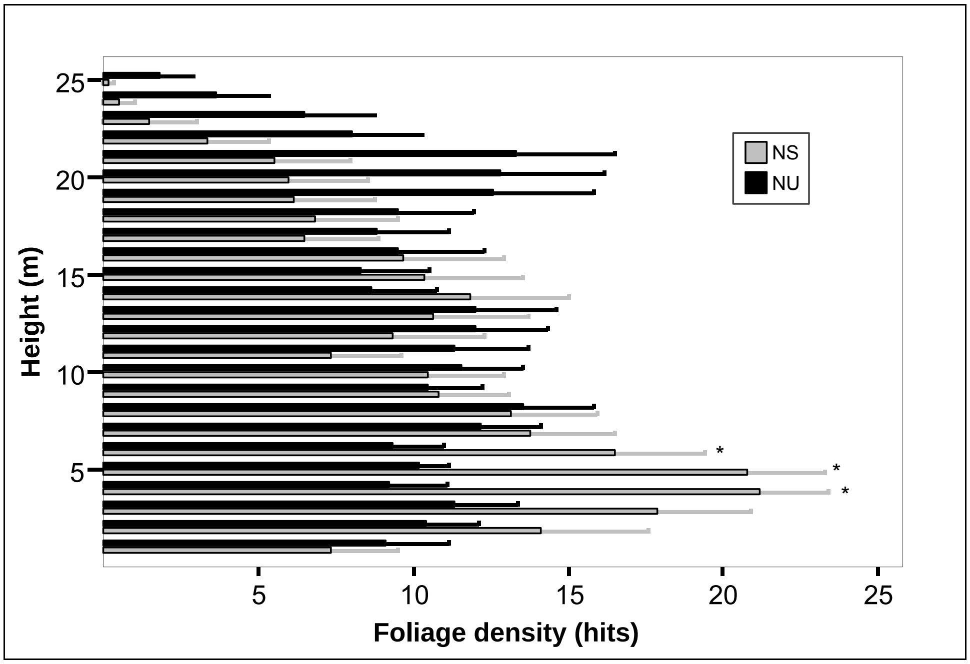

Figure 6.5. Vertical foliage density and standard error at willow flycatcher nest sites versus non-use sites at Pahranagat NWR, NV, 2006. Differences (Student's t-test, α=0.05) between nest (NS) and non-use (NU) sites within a given meter interval are indicated by asterisks.

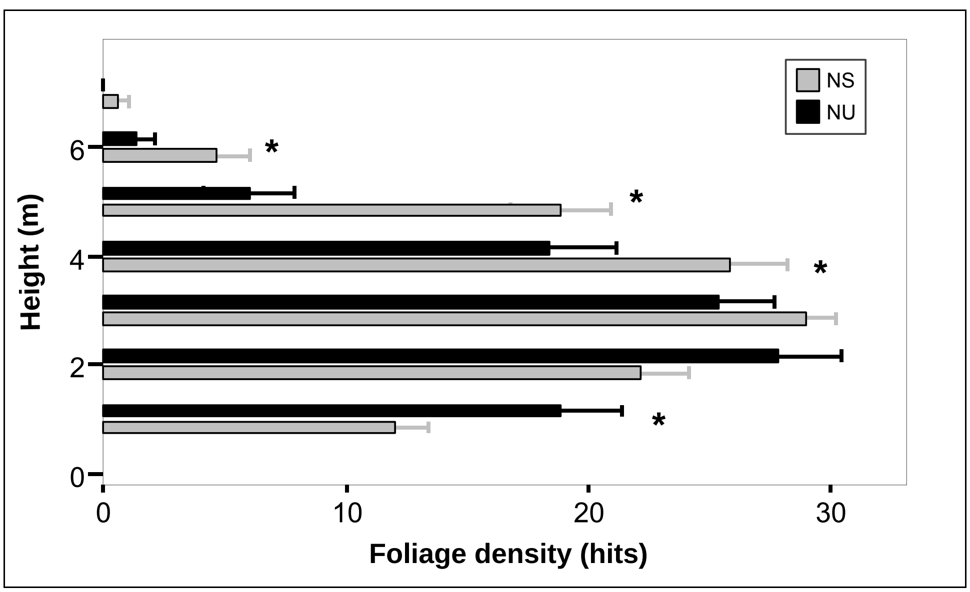

Figure 6.6. Vertical foliage density and standard error at willow flycatcher nest (NS) vs. non-use (NU) sites at Mesquite, NV, 2006. Differences (Student's t-test, α=0.05) between nest and non-use sites within a given meter interval are indicated by asterisks.

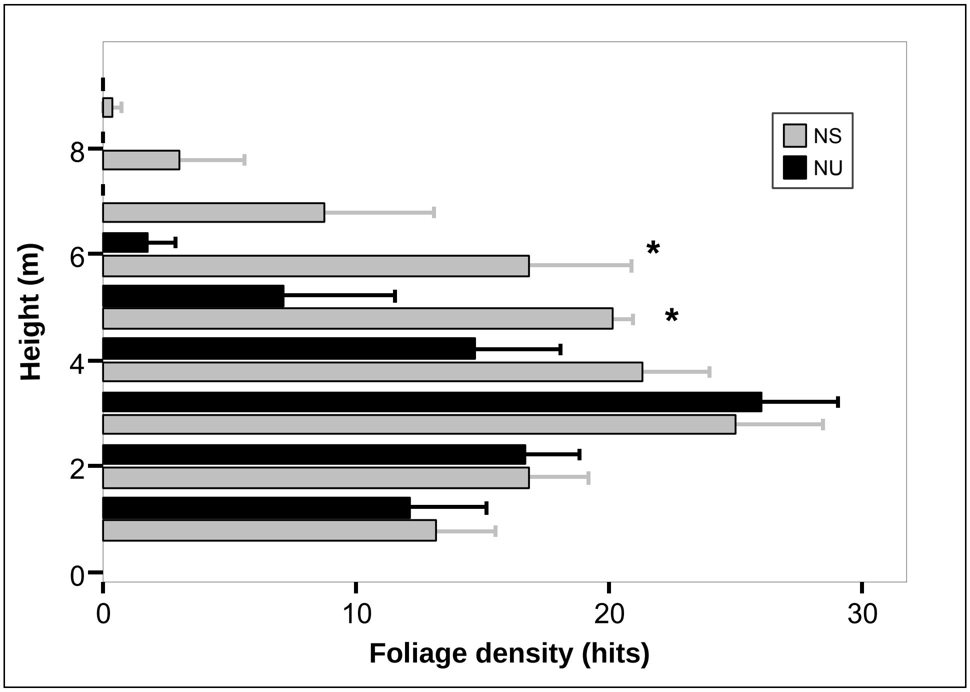

Figure 6.7. Vertical foliage density and standard error at willow flycatcher nest (NS) vs. non-use (NU) sites at Mormon Mesa, NV, 2006. Differences (Student's t-test, α=0.05) between nest and non-use sites within a given meter interval are indicated by asterisks.

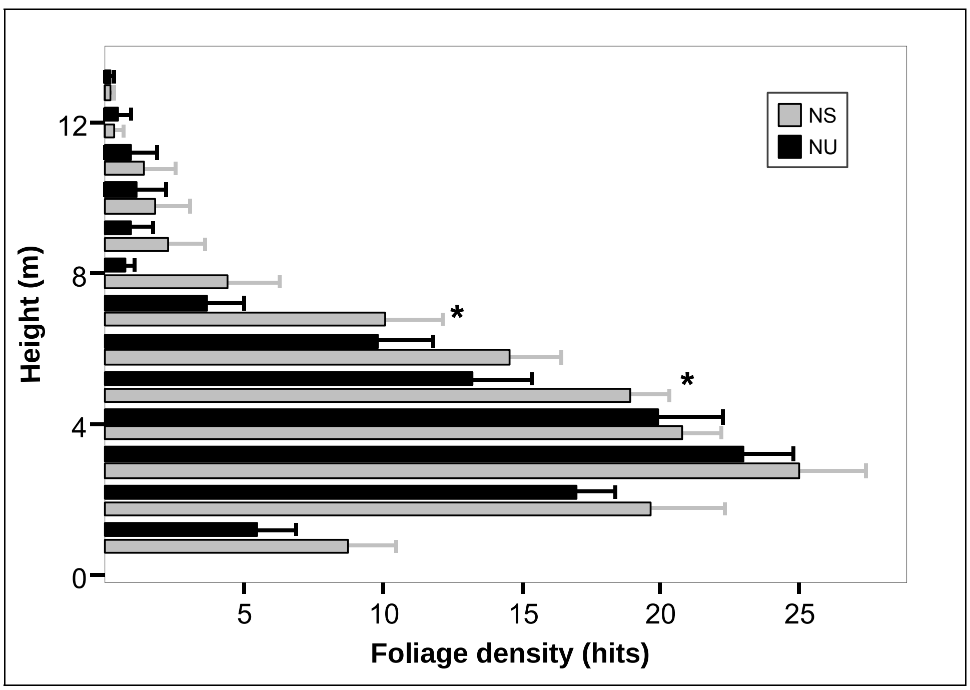

Figure 6.8. Vertical foliage density and standard error at willow flycatcher nest (NS) vs. non-use (NU) sites at Topock Marsh, AZ, 2006. Differences (Student's t-test, α=0.05) between nest and non-use sites within a given meter interval are indicated by asterisks.

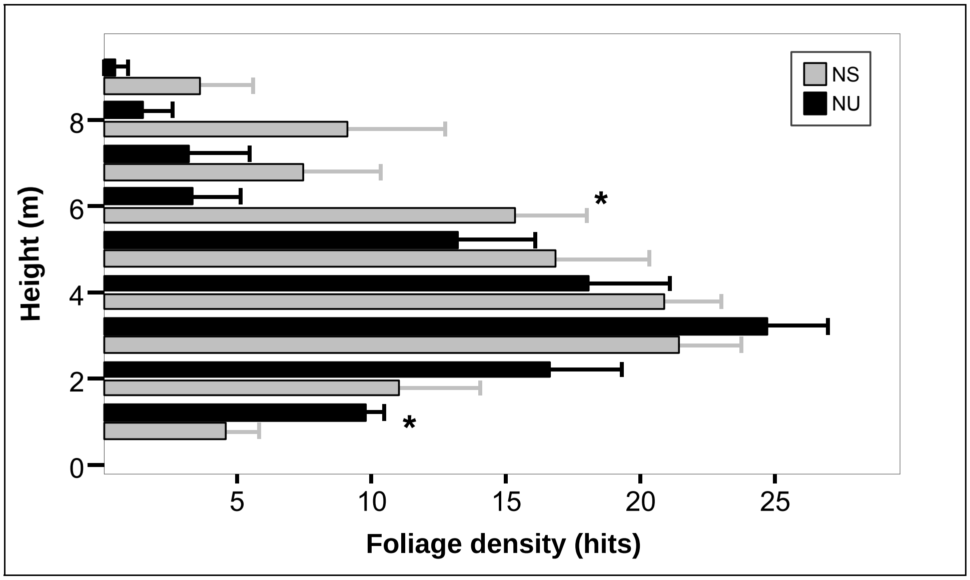

Figure 6.9. Vertical foliage density and standard error at willow flycatcher nest (NS) vs. non-use (NU) sites at Muddy River, NV, 2006. Differences (Student's t-test, α=0.05) between nest and non-use sites within a given meter interval are indicated by asterisks.

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 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 3–16 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 2003–2005, 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 Muddy River. Nest height, substrate height, and substrate dbh did not differ significantly between years in 2003–2006 at any of the life history study areas. As in previous years, nearly all nests at Pahranagat were placed in native species, while at least 50% of nests at Mesquite and Mormon Mesa were placed in tamarisk. In 2003–2005 all nests at Topock were in tamarisk, while in 2006 one nest was in screwbean mesquite and the remaining nests were 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 2006 demonstrated patterns similar to those that emerged in 2003–2005. Nest sites had significantly greater canopy heights than non-use sites at Mesquite, Mormon Mesa, and Muddy River. Canopy closure values at nest sites were higher than at non-use sites at three (Mesquite, Mormon Mesa, and Topock) of the four life history study areas and Muddy River, but these differences were not statistically significant in 2006. 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. Paradzick (2005) also found occupied willow flycatcher sites in Arizona to have higher canopy cover than unoccupied sites. Although there was a trend for canopy height at non-use sites to be taller than at nest sites at Pahranagat, this was because many non-use sites were in tall stringers of cottonwoods on the periphery of the main habitat block, while nest sites were within a shorter stand of Goodding willow.

In 2004–2006, nest sites at Topock demonstrated 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 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 2003–2005, vertical foliage density at nest sites was generally greatest at and/or immediately above mean nest height. This same pattern was exhibited in 2006. Allison et al. (2003) found the greatest foliage density to be at nest height at three large willow flycatcher breeding sites in Arizona. Paradzick (2005) also found occupied willow flycatcher sites to have denser foliage in the upper (7–9 m) strata of the canopy than unoccupied sites. Greater canopy closure, taller canopy height, and dense foliage at or immediately above 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.

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 sustaining particular vegetation features at breeding sites (Paradzick 2005) and providing a more suitable microclimate for raising offspring (Sogge and Marshall 2000). From 2003 to 2005, our inability to detect differences in distance to water between nest and non-use sites at some study areas may have been influenced by our sampling methodology, with distance to water measured at the end of the flycatcher breeding season. Because of extreme seasonal changes in hydrology at study areas, with many nest sites dry by July or August, distance to water as measured at the end of the breeding season may not reflect hydrologic conditions during nest-site selection. Therefore, in 2006 we measured distance to surface water or saturated soil at nest and non-use sites as soon as flycatcher eggs were observed in a nest and at the end of the breeding season. At all study areas except Pahranagat, there was a strong trend for nest sites to be closer to water or saturated soil than non-use sites for the entire season. At Pahranagat, distance to water was greater at non-use than at nest sites during nesting, but less at non-use than at nest sites at the end of the season. This is because the standing water under flycatcher nests at the beginning of the breeding season recedes as the season progresses, while non-use sites are along the perimeter of the lake and along inflow and outflow canals that experience less of a temporal change in water levels. Results at Pahranagat illustrate the importance of measuring hydrologic conditions in a way that accounts for temporal changes.

Woody ground cover differed between within-territory and non-use sites at Mesquite in 2006 but did not differ between nest and non-use sites in any of the study areas from 2003 to 2006. 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, and differed only at one site (Muddy River) in 2006. 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.

Nests were farther from canopy gaps than were non-use plots at Mesquite in 2003, 2004, and 2006. Results at the other study areas have been inconclusive across years. 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 2006. 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 14 full days (midnight to midnight; with some exceptions in the case of equipment failure, etc.), 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, 2004, and 2005 (Koronkiewicz et al. 2004, McLeod et al. 2005, Koronkiewicz et al. 2006a). The distribution of random numbers followed the distribution of nest heights. 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 9.1 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.

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 were estimated visually in the field or were measured either with a GPS unit or from high-resolution aerial photographs. In 2006, non-use plot locations were established when the corresponding nest was determined to contain eggs, and distance to water was measured at both NU and NS sites at this time to obtain a measure of distance to water during nesting.

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 (%).[1] 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. All mV values greater than 994 were also reassigned as 994 mV, because this reading represents fully saturated soil and because the mV to percent relationship becomes excessively nonlinear for mV readings above this point.

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 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
- Distance to water as measured during nesting for NS and NU locations

[1] 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 and 2006, rather than just volumetric soil moisture, which we had recorded in 2004.

- Mean diurnal temperature
- Mean number of 15-minute intervals above 41°C each day[2]
- Mean nocturnal temperature
- Mean daily temperature range (diurnal maximum minus nocturnal minimum)
- Mean diurnal relative humidity
- Mean diurnal vapor pressure[3]
- Mean nocturnal relative humidity
- Mean nocturnal vapor pressure

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 (2006).

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 or 2006, 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.

Logistic regression was used to test the association of NS versus WT and NU with predictor variables, adjusting for the effects of the other variables. All predictor variables were included in the models unless they were ≥90% correlated with another variable. For example, diurnal temperature was correlated with the number of 15-minute intervals above 41°C each day ($R=0.9$), so only diurnal temperature was included. All models are adjusted for differences in canopy cover, habitat, and study area. We also used a conditional logistic regression model to examine differences between NS and WT and between NS and NU locations while taking into account the matching between an NS and its paired WT or NU site.

Analyses were conducted using SAS® Version 9.1 (SAS Institute 2003) and Stata® Version 9.2 (StataCorp 2006).

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[2] 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).

[3] In prior years, we evaluated humidity by examining relative humidity. In 2005 and 2006, 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.

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. One T/RH sensor in riparian habitat in Mormon Mesa failed to function, and one T/RH sensor in desertscrub habitat at Topock Marsh was washed away in a flood. 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, 2006*

Descriptive Statistics	Pahranagat	Mesquite	Mormon Mesa	Topock
n	4	4	3	4
Mean soil moisture (mV)	940.9 (137.4)	293.3 (34.6)	940.9 (22.4)	717.6 (154.2)
Mean diurnal temperature (°C)	24.9 (0.2)	31.1 (0.1)	35.3 (0.2)	29.8 (0.1)
Mean no. of 15-min. intervals above 41°C each day	0.3 (0.1)	9.2 (0.4)	20.9 (0.6)	0.2 (0.1)
Mean nocturnal temperature (°C)	21.4 (0.2)	22.8 (0.2)	22.9 (0.3)	24.4 (0.1)
Mean daily temperature range (°C)	16.5 (0.3)	26.1 (0.3)	31.3 (0.4)	16.9 (0.2)
Mean diurnal relative humidity (%)	44.5 (0.7)	49.2 (0.6)	34.5 (0.5)	56.3 (0.6)
Mean diurnal vapor pressure (Pa)	1,349.1 (26.8)	1,903.0 (30.3)	1,570.3 (24.4)	2,250.9 (34.0)
Mean nocturnal relative humidity (%)	48.1 (0.7)	63.0 (0.9)	55.0 (0.7)	62.4 (0.6)
Mean nocturnal vapor pressure (Pa)	1,222.9 (23.0)	1,667.5 (24.5)	1,508.3 (24.5)	1,918.2 (28.4)

*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, 2006*

Descriptive Statistics	Pahranagat	Mesquite	Mormon Mesa	Topock
n (Temp./Humidity)	2	2	2	1
Mean diurnal temperature (°C)	30.8 (0.3)	39.4 (0.2)	38.0 (0.3)	43.7 (0.4)
Mean no. of 15-min. intervals above 41°C each day	14.8 (0.9)	30.4 (0.7)	27.3 (0.4)	38.1 (0.8)
Mean nocturnal temperature (°C)	21.3 (0.3)	29.7 (0.3)	26.5 (0.3)	26.7 (0.4)
Mean daily temperature range (°C)	28.7 (0.4)	29.4 (0.4)	27.3 (0.4)	37.3 (0.7)
Mean diurnal relative humidity (%)	27.9 (0.8)	16.7 (0.6)	21.5 (0.5)	21.6 (0.7)
Mean diurnal vapor pressure (Pa)	1,012.3 (31.2)	925.5 (32.0)	1,216.2 (31.5)	1,413.0 (48.3)
Mean nocturnal relative humidity (%)	39.7 (1.0)	23.6 (0.7)	37.6 (0.7)	45.2 (1.2)
Mean nocturnal vapor pressure (Pa)	975.0 (30.2)	927.7 (30.3)	1,304.4 (33.2)	1,590.9 (59.4)

*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 64 NS, 64 WT, and 65 NU sites (Tables 7.3–7.7). Sample sizes between location types differed due to sensor failure; data from 13 of these sites were collected for slightly less than the full 14-day, midnight-to-midnight, sample period of the study design.

The single effects analyses (Tables 7.3–7.7) indicate that the NS, WT, and NU sites were significantly different at two (Mesquite and Muddy River) of the five study areas for habitat; NU sites at both locations exhibited more exotic habitat and less native and mixed habitat than NS or WT sites. Canopy closure was different at one (Mesquite) of the five study areas; NS sites there exhibited more than 75% canopy closure. Soil moisture was different at two (Pahranagat and Mesquite) of the five study areas; NU sites at both study areas were drier than NS and WT sites.

The NS, WT, and NU sites were significantly different at four (Mesquite, Muddy River, Pahranagat and Topock) of the five study areas for mean diurnal temperature; NU sites at all four study areas were hotter. The mean number of 15-minute intervals > 41^{o} C were different at three (Mesquite, Paranagat, and Topock) study areas; NU sites at all three study areas were hotter. Mean nocturnal temperature differed only at the Mesquite study area; NU sites there were hotter than NS sites. Mean daily temperature range was also significantly different among NS, WT, and NU sites at three study areas (Mesquite, Pahranagat, and Topock); NU sites exhibited a greater daily temperature range than NS and WT sites.

Mean diurnal relative humidity differed significantly among NS, WT, and NU sites at three study areas (Mesquite, Pahranagat and Topock); the NS and WT sites were more humid than NU sites at all three study areas. Mean nocturnal relative humidity differed at only two study areas (Mesquite and Topock); as before, NS and WT sites were more humid. Mean diurnal and mean nocturnal vapor pressure differed significantly among NS, WT, and NU sites at only two of the five study areas (Mesquite and Topock); both NS and WT sites or just WT sites exhibited higher diurnal and nocturnal vapor pressures than NU sites. 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 area.

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, 2006*

Response Variable	Nest Site	Within Territory	Non-Use	*P*	Significant Pairwise Differences
n (Temp./Humidity Sensor Arrays)	15	14	15	N/A	N/A
Habitat					
Native (cottonwood or willow)	13 (92.9)	12 (92.3)	15 (100.0)	0.557	N/A
Exotic (tamarisk)	1 (7.1)	1 (7.7)	0 (0.0)		
Mixed (native and exotic)	0 (0.0)	0 (0.0)	0 (0.0)		
Canopy Cover					
Less than 25%	0 (0.0)	1 (7.7)	0 (0.0)	0.666	N/A
25–75%	4 (28.6)	4 (30.8)	5 (33.3)		
More than 75%	10 (71.4)	8 (61.5)	10 (66.7)		
Soil Moisture					
Mean soil moisture (mV)	865.6 (40.7)	879.9 (32.3)	620.8 (46.7)	<0.001	NU<NS & WT
Mean distance (m) to saturated/inundated soil	6.3 (4.0)	N/A	22.5 (6.1)	0.039	NU>NS
Temperature					
Mean diurnal temperature (°C)	27.3 (0.4)	27.3 (0.5)	29.7 (0.4)	<0.001	NU>NS & WT
Mean no. of 15-min. intervals above 41°C each day	0.2 (0.2)	0.4 (0.3)	1.8 (0.6)	0.025	NU>NS
Mean nocturnal temperature (°C)	23.8 (0.4)	23.9 (0.4)	24.8 (0.4)	0.123	N/A
Mean daily temperature range (°C)	15.3 (0.7)	15.2 (0.8)	18.6 (0.9)	0.006	NU>NS & WT
Humidity					
Mean diurnal relative humidity (%)	46.6 (1.8)	45.1 (2.2)	35.4 (2.6)	0.001	NU<NS & WT
Mean diurnal vapor pressure (Pa)	1,618.1 (68.0)	1,549.7 (71.2)	1,362.7 (86.9)	0.057	N/A
Mean nocturnal relative humidity (%)	48.3 (2.1)	46.9 (2.0)	42.6 (2.5)	0.179	N/A
Mean nocturnal vapor pressure (Pa)	1,398.3 (63.5)	1,369.3 (64.0)	1,295.8 (68.6)	0.517	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, 2006*

Response Variable	Nest Site	Within Territory	Non-Use	*P*	Significant Pairwise Differences
n (Temp./Humidity Sensor Arrays)	19	19	19	N/A	N/A
Habitat					
Native (cottonwood or willow)	5 (29.4)	7 (38.9)	4 (22.2)	0.005	NU-NS & WT
Exotic (tamarisk)	0 (0.0)	0 (0.0)	6 (33.3)		
Mixed (native and exotic)	12 (70.6)	11 (61.1)	6 (33.3)		
Canopy Cover					
Less than 25%	0 (0.0)	0 (0.0)	3 (16.7)	0.005	WT-NS
25–75%	4 (23.5)	11 (61.1)	11 (61.1)		
More than 75%	13 (76.5)	7 (38.9)	4 (22.2)		
Soil Moisture					
Mean soil moisture (mV)	889.2 (12.5)	870.2 (25.6)	425.2 (65.8)	<0.001	NU<NS & WT
Mean distance (m) to saturated/inundated soil	8.3 (2.4)	N/A	60.8 (11.1)	<0.001	NU>NS
Temperature					
Mean diurnal temperature (°C)	29.2 (0.3)	30.3 (0.5)	33.8 (0.9)	<0.001	NU>NS & WT
Mean no. of 15-min. intervals above 41°C each day	0.6 (0.4)	2.7 (1.4)	14.9 (2.7)	<0.001	NU>NS & WT
Mean nocturnal temperature (°C)	23.8 (0.3)	24.1 (0.4)	25.2 (0.5)	0.034	NU>NS
Mean daily temperature range (°C)	17.2 (0.9)	18.9 (1.0)	24.1 (1.4)	<0.001	NU>NS & WT
Humidity					
Mean diurnal relative humidity (%)	65.3 (2.5)	63.5 (2.6)	46.3 (2.3)	<0.001	NU<NS & WT
Mean diurnal vapor pressure (Pa)	2,525.9 (112.1)	2,574.5 (104.6)	2,078.2 (86.7)	0.002	NU<NS & WT
Mean nocturnal relative humidity (%)	73.1 (1.7)	72.8 (1.9)	61.9 (1.8)	<0.001	NU<NS & WT
Mean nocturnal vapor pressure (Pa)	2108.3 (64.8)	2132.4 (93.8)	1877.3 (46.8)	0.026	NU<WT

* 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, 2006*

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)	0.326	N/A
Exotic (tamarisk)	3 (42.9)	4 (57.1)	5 (83.3)		
Mixed (native and exotic)	4 (57.1)	3 (42.9)	1 (16.7)		
Canopy Cover					
Less than 25%	0 (0.0)	0 (0.0)	0 (0.0)	0.376	N/A
25–75%	6 (85.7)	7 (100.0)	6 (100.0)		
More than 75%	1 (14.3)	0 (0.0)	0 (0.0)		
Soil Moisture					
Mean soil moisture (mV)	744.2 (28.2)	706.1 (52.4)	753.5 (76.1)	0.887	N/A
Mean distance (m) to saturated/inundated soil	39.4 (14.5)	N/A	54.6 (25.1)	0.815	N/A
Temperature					
Mean diurnal temperature (°C)	32.7 (0.7)	33.8 (0.6)	33.8 (0.9)	0.462	N/A
Mean no. of 15-min. intervals above 41°C each day	5.4 (2.7)	12.3 (2.6)	11.1 (3.3)	0.209	N/A
Mean nocturnal temperature (°C)	26.7 (0.5)	26.3 (0.4)	25.8 (0.8)	0.540	N/A
Mean daily temperature range (°C)	18.8 (1.8)	22.7 (2.0)	23.7 (2.0)	0.201	N/A
Humidity					
Mean diurnal relative humidity (%)	44.6 (1.2)	40.5 (1.9)	43.9 (1.1)	0.132	N/A
Mean diurnal vapor pressure (Pa)	1,955.7 (57.7)	1,763.7 (121.7)	1,946.3 (36.6)	0.212	N/A
Mean nocturnal relative humidity (%)	58.0 (1.2)	55.1 (2.9)	63.1 (2.0)	0.062	N/A
Mean nocturnal vapor pressure (Pa)	1,971.3 (74.6)	1,797.6 (120.5)	2,003.3 (52.0)	0.194	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, 2006*

Response Variable	Nest Site	Within Territory	Non-Use	*P*	Significant Pairwise Differences
n (Temp./Humidity Sensor Arrays)	14	15	15	N/A	N/A
Habitat					
Native (cottonwood or willow)	0 (0.0)	0 (0.0)	0 (0.0)		
Exotic (tamarisk)	14 (100.0)	14 (93.3)	15 (100.0)	0.372	N/A
Mixed (native and exotic)	0 (0.0)	1 (6.7)	0 (0.0)		
Canopy Cover					
Less than 25%	0 (0.0)	0 (0.0)	1 (6.7)		
25–75%	8 (57.1)	9 (60.0)	11 (73.3)	0.460	N/A
More than 75%	6 (42.9)	6 (40.0)	3 (20.0)		
Soil Moisture					
Mean soil moisture (mV)	759.8 (57.9)	760.1 (54.8)	688.6 (64.2)	0.705	N/A
Mean distance (m) to saturated/inundated soil	85.0 (27.8)	N/A	138.5 (28.6)	0.200	N/A
Temperature					
Mean diurnal temperature (°C)	32.4 (0.5)	32.2 (0.5)	34.3 (0.6)	0.014	NU>NS & WT
Mean no. of 15-min. intervals above 41°C each day	4.8 (1.8)	5.5 (1.7)	12.2 (2.5)	0.026	NU>NS
Mean nocturnal temperature (°C)	26.3 (0.3)	26.2 (0.3)	26.5 (0.2)	0.705	N/A
Mean daily temperature range (°C)	18.3 (0.9)	18.6 (0.8)	22.4 (1.2)	0.007	NU>NS & WT
Humidity					
Mean diurnal relative humidity (%)	57.8 (1.9)	59.0 (2.4)	47.9 (1.9)	<0.001	NU<NS & WT
Mean diurnal vapor pressure (Pa)	2,606.8 (77.5)	2,612.5 (84.0)	2,276.3 (63.0)	0.003	NU<NS & WT
Mean nocturnal relative humidity (%)	69.9 (2.1)	70.7 (2.1)	63.5 (1.6)	0.022	NU<WT
Mean nocturnal vapor pressure (Pa)	2,338.4 (52.0)	2,347.9 (59.4)	2,163.6 (45.8)	0.028	NU<WT

* 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, 2006*

Response Variable	Nest Site	Within Territory	Non-Use	*P*	Significant Pairwise Differences
n (Temp./Humidity Sensor Arrays)	9	9	9	N/A	N/A
Habitat					
Native (cottonwood or willow)	3 (37.5)	2 (22.2)	0 (0.0)		
Exotic (tamarisk)	1 (12.5)	1 (11.1)	8 (88.9)	0.003	NU-NS & WT
Mixed (native and exotic)	4 (50.0)	6 (66.7)	1 (11.1)		
Canopy Cover					
Less than 25%	0 (0.0)	0 (0.0)	1 (11.1)		
25–75%	1 (12.5)	3 (33.3)	6 (66.7)	0.074	N/A
More than 75%	7 (87.5)	6 (66.7)	2 (22.2)		
Soil Moisture					
Mean soil moisture (mV)	547.1 (64.9)	574.6 (68.7)	517.4 (66.8)	0.815	N/A
Mean distance (m) to saturated/inundated soil	19.0 (6.7)	N/A	49.9 (10.4)	0.014	NU>NS
Temperature					
Mean diurnal temperature (°C)	31.4 (0.9)	32.3 (0.8)	34.5 (0.7)	0.042	NU>NS
Mean no. of 15-min. intervals above 41°C each day	5.3 (2.1)	7.7 (2.7)	14.5 (3.6)	0.094	N/A
Mean nocturnal temperature (°C)	26.3 (0.8)	26.5 (0.7)	26.7 (0.8)	0.958	N/A
Mean daily temperature range (°C)	17.2 (1.3)	19.4 (1.7)	22.5 (2.7)	0.208	N/A
Humidity					
Mean diurnal relative humidity (%)	50.6 (2.8)	49.8 (2.0)	43.9 (2.8)	0.142	N/A
Mean diurnal vapor pressure (Pa)	2,141.1 (137.3)	2,192.1 (115.6)	2,070.4 (147.3)	0.808	N/A
Mean nocturnal relative humidity (%)	58.8 (2.4)	58.8 (1.9)	56.5 (2.0)	0.665	N/A
Mean nocturnal vapor pressure (Pa)	1,992.6 (143.3)	2,002.2 (122.1)	1,922.7 (123.9)	0.891	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.

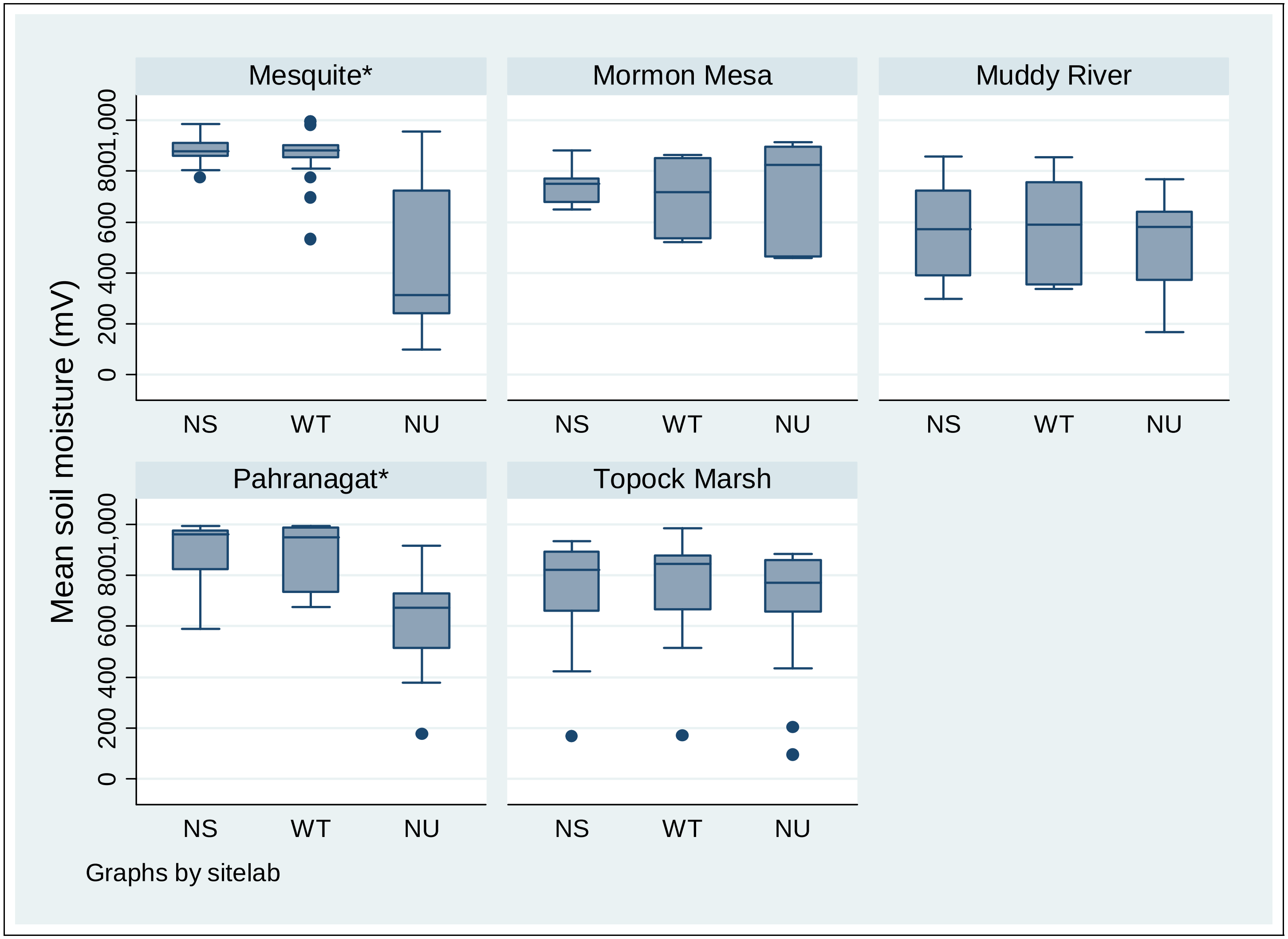

Figure 7.1. Box plots for the mean soil moisture by study area and location type for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado River regions, June–August, 2006. (Lines = minimum and maximum values; Box = 25th to 75th quartiles; Dots = outliers; and Center line = Median; * = $P < 0.05$.)

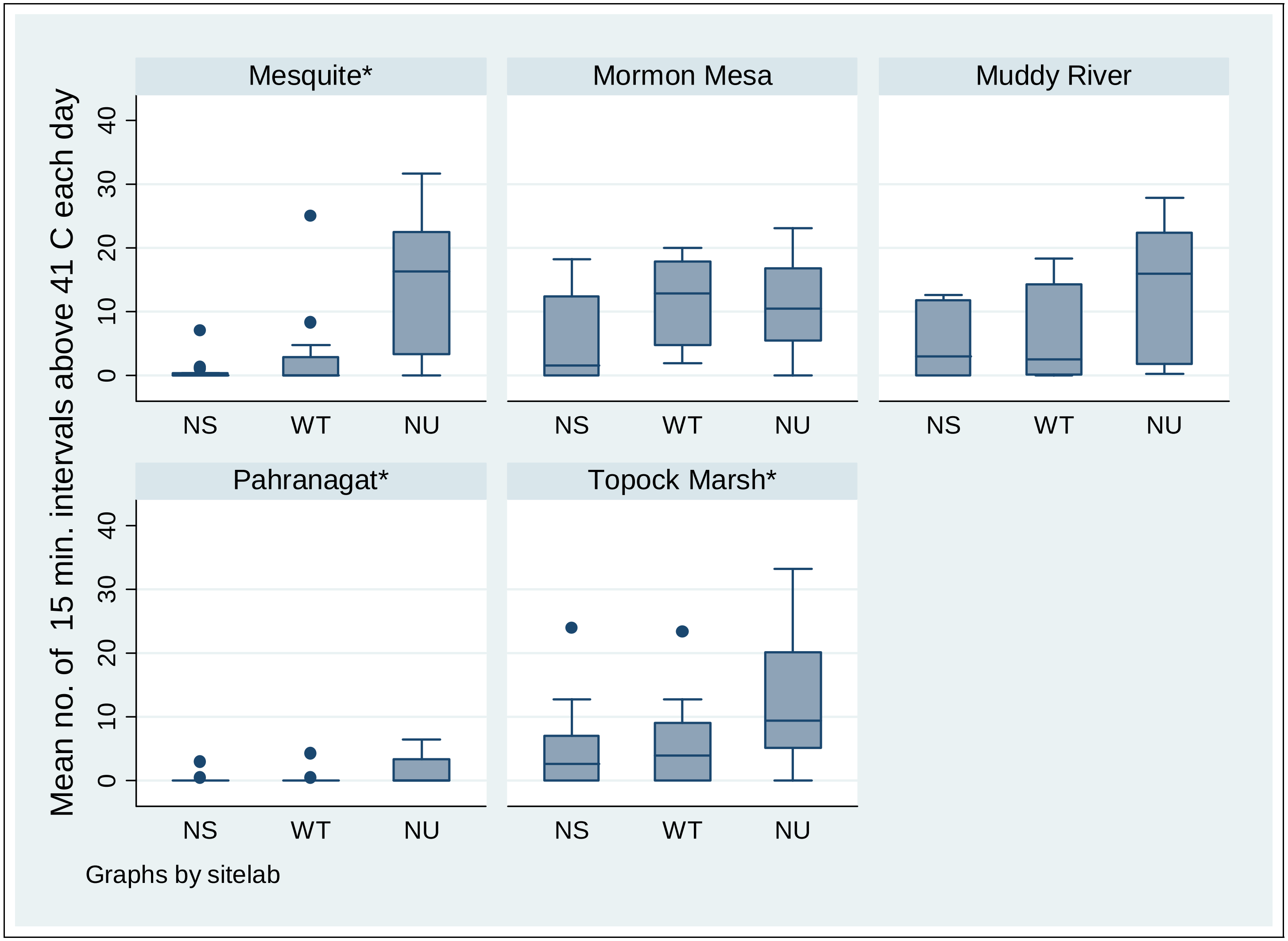

Figure 7.2. Box plots of the mean number of 15-minute intervals above 41°C each day by study area and location type for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado River regions, June–August, 2006. (Lines = minimum and maximum values; Box = 25th to 75th quartiles; Dots = outliers; and Center line = Median; * = $P < 0.05$.)

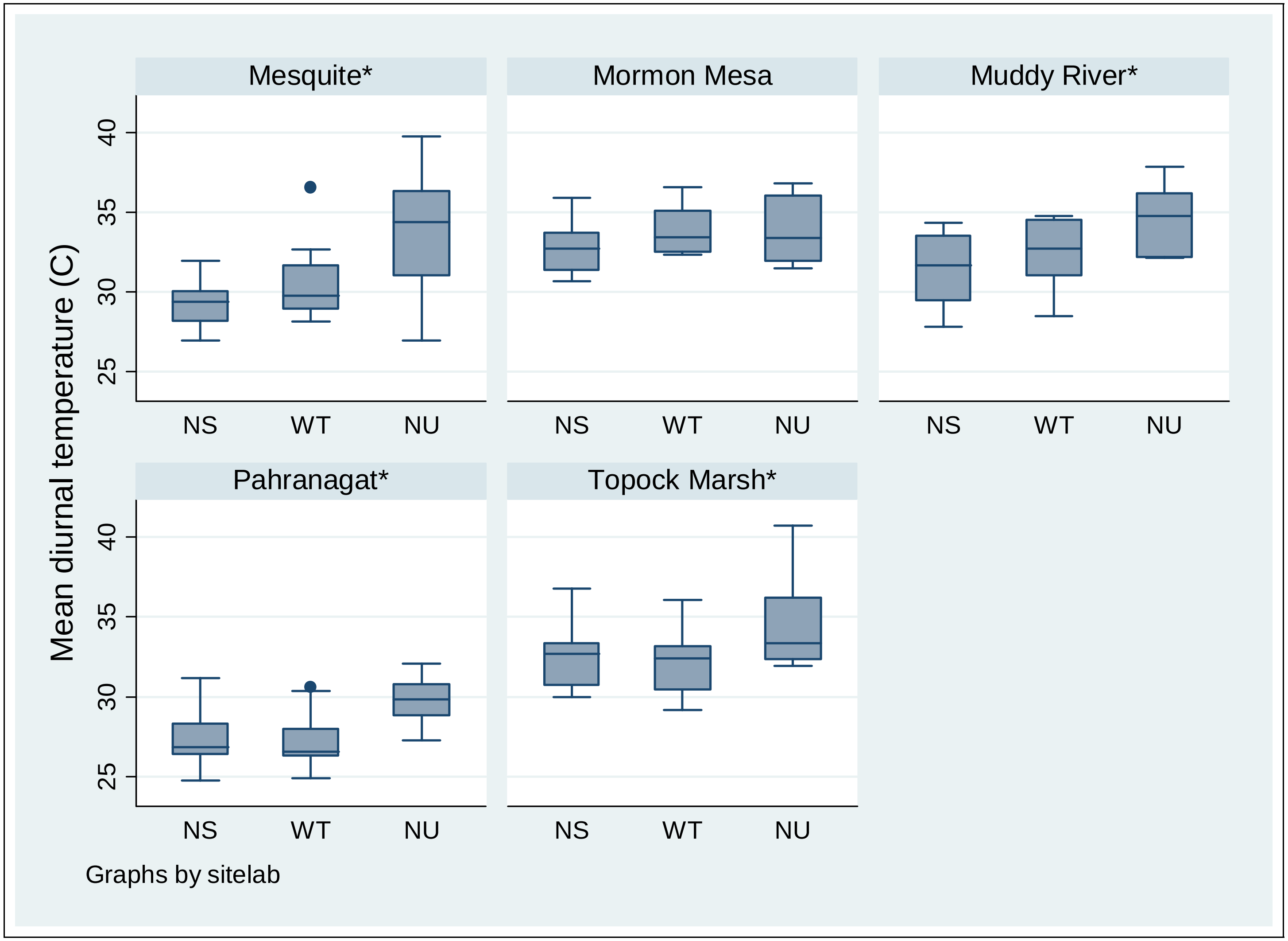

Figure 7.3. Box plots of the mean diurnal temperature by study area and location type for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado River regions, June–August, 2006. (Lines = minimum and maximum values; Box = 25th to 75th quartiles; Dots = outliers; and Center line = Median; * = $P < 0.05$.)

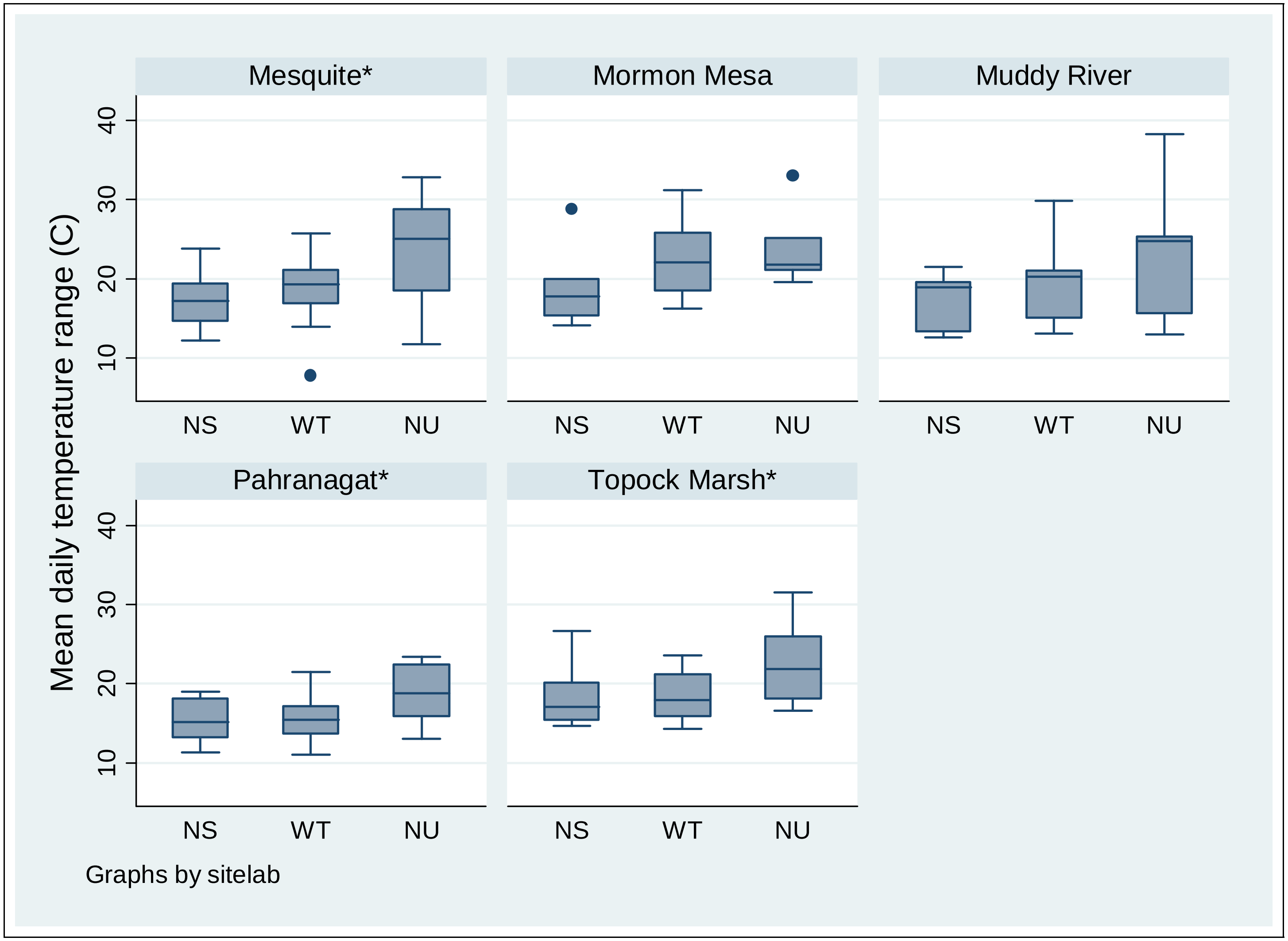

Figure 7.4. Box plots of the mean daily temperature range by study area and location type for Southwestern Willow Flycatcher microclimate data along the Virgin and lower Colorado River regions, June–August, 2006. (Lines = minimum and maximum values; Box = 25^{th} to 75^{th} quartiles; Dots = outliers; and Center line = Median; * = $P < 0.05$.)

INDIVIDUAL EFFECT OF PREDICTOR VALUES

The individual effect that each predictor had on response variables across location types for all five study areas combined in 2006 are presented in Table 7.8. The NU sites were significantly different (hotter, lower humidity, less vapor pressure) from both NS and WT sites for all diurnal variables and for nocturnal relative humidity. No significant difference existed between NS, WT, and NU sites for mean nocturnal vapor pressure. 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 in 2006, as would be expected given their different elevations, latitudes, and other environmental attributes (Table 7.9).

All temperature and humidity response variables differed significantly among habitat types (Table 7.10). 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.

Sites with the greatest canopy closure level (>75%) were significantly cooler and more humid during the daytime as compared to sites with less canopy closure (Table 7.11).

MULTIPLE EFFECTS 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). All variables were included in the logistic regression model unless they were ≥90% correlated with another variable in the model. Diurnal temperature was correlated with the number of 15-minute intervals above 41°C each day (R=0.9), so only diurnal temperature was included. Diurnal relative humidity was correlated with diurnal vapor pressure (R=0.9), and nocturnal relative humidity was correlated with nocturnal vapor pressure (R=0.9), so only the relative humidity measures were included.

When variables for temperature, relative humidity, and soil moisture were modeled, there was no significant difference between NS and WT sites. The NS and NU sites differed in that mean diurnal relative humidity, mean nocturnal relative humidity, and mean soil moisture were all greater at NS sites. These differences were not due to the factors for which we adjusted in the model, such as differences in canopy cover, habitat, and study area.

No variables were significant predictor of NS vs. WT locations in the conditional logistic regression model, while mean diurnal relative humidity was the only significant predictor of NS vs. NU locations.

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, 2006*

Response Variable	Location Type			*P*	Significant Pairwise Differences
	Nest Site	Within Territory	Non-Use		
n (Temp./Humidity Sensor Arrays)	64	64	65	N/A	N/A
Soil Moisture					
Mean soil moisture (mV)	797.4 (23.2)	788.4 (23.3)	579.2 (32.0)	<0.001	NU<NS & WT
Mean distance (m) to saturated/inundated soil	29.8 (7.5)	N/A	69.4 (9.7)	0.003	NU>NS
Temperature					
Mean diurnal temperature (°C)	30.2 (0.3)	30.8 (0.4)	33.1 (0.4)	<0.001	NU>NS & WT
Mean no. of 15-min. intervals above 41°C each day	2.7 (0.7)	4.7 (0.9)	10.7 (1.3)	<0.001	NU>NS & WT
Mean nocturnal temperature (°C)	25.1 (0.3)	25.1 (0.2)	25.7 (0.2)	0.132	N/A
Mean daily temperature range (°C)	17.2 (0.5)	18.5 (0.6)	22.1 (0.7)	<0.001	NU>NS & WT
Humidity					
Mean diurnal relative humidity (%)	54.8 (1.4)	54.0 (1.5)	43.5 (1.2)	<0.001	NU<NS & WT
Mean diurnal vapor pressure (Pa)	2,215.1 (66.9)	2,221.8 (71.0)	1,941.4 (58.8)	0.003	NU<NS & WT
Mean nocturnal relative humidity (%)	54.8 (1.4)	62.8 (1.6)	57.1 (0.7)	0.008	NU>NS, NU<WT
Mean nocturnal vapor pressure (Pa)	1,964.9 (54.2)	1,967.8 (59.3)	1,825.5 (49.4)	0.107	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, 2006*

Response Variable	Study Area					*P*	Significant Pairwise Differences
	Pahranagat (PA)	Mesquite (MW)	Mormon Mesa (MM)	Topock (TM)	Muddy River (MD)		
n (Temp./Humidity Sensor Arrays)	42	53	20	44	26	N/A	N/A
Soil Moisture							
Mean soil moisture (mV)	788.8 (29.0)	728.2 (370)	734.6 (30.9)	735.7 (33.8)	546.4 (37.3)	0.002	MD<PA & MW & TM
Mean distance (m) to saturated/inundated soil	13.5 (3.8)	34.6 (7.2)	45.8 (12.9)	111.8 (20.2)	34.4 (7.1)	<0.001	TM>PA & MW & MM & MD
Temperature							
Mean diurnal temperature (°C)	28.2 (0.3)	31.1 (0.4)	33.4 (0.4)	33.0 (0.3)	32.8 (0.5)	<0.001	PA<MW & MM & TM & MD, MW<MM & TM
Mean no. of 15-min. intervals above 41°C each day	0.8 (0.3)	6.2 (1.3)	9.5 (1.7)	7.6 (1.3)	9.3 (1.8)	<0.001	PA<MW & MM & TM & MD
Mean nocturnal temperature (°C)	24.2 (0.2)	24.4 (0.2)	26.3 (0.3)	26.3 (0.2)	26.5 (0.4)	<0.001	PA<MM & TM & MD MW<MM & TM & MD
Mean daily temperature range (°C)	16.5 (0.5)	20.1 (0.8)	21.6 (1.2)	19.8 (0.6)	19.8 (1.2)	<0.001	PA<MW & MM & TM & MD
Humidity							
Mean diurnal relative humidity (%)	42.2 (1.5)	58.3 (1.8)	43.0 (0.9)	54.8 (1.4)	48.0 (1.5)	<0.001	PA<MW & TM MW>MM & MD MM<TM
Mean diurnal vapor pressure (Pa)	1,505.7 (46.5)	2,390.4 (65.3)	1,885.7 (50.3)	2,496.1 (48.8)	2,134.3 (74.9)	<0.001	PA<MW & MM & TM & MD, MW<TM & MD MM<MW & TM & MD
Mean nocturnal relative humidity (%)	45.8 (1.3)	69.2 (1.2)	58.5 (1.4)	68.0 (1.2)	58.0 (1.2)	<0.001	PA<MW & MM & TM & MD, MW>MM & TM MM<MW TM\>MD
Mean nocturnal vapor pressure (Pa)	1,352.7 (37.7)	2,038.1 (43.5)	1,920.1 (49.7)	2,282.0 (32.4)	1,971.7 (71.9)	<0.001	PA<MW & TM & MD TM>MW & 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, 2006*

Response Variable	Habitat Type			*P*	Significant Pairwise Differences
	Native (Cottonwood or Willow)	Exotic (Tamarisk)	Mixed (Native and Exotic)		
Soil Moisture					
Mean soil moisture (mV)	754.7 (27.5)	676.4 (29.0)	745.6 (29.0)	0.002	None
Mean distance (m) to saturated/inundated soil	18.5 (5.0)	82.8 (12.1)	28.0 (7.1)	<0.001	E>N & M
Temperature					
Mean diurnal temperature (°C)	29.4 (0.4)	33.3 (0.3)	30.9 (0.4)	<0.001	E>N & M
Mean no. of 15-min. intervals above 41°C each day	2.9 (0.8)	9.2 (1.1)	4.8 (1.0)	<0.001	E>N & M
Mean nocturnal temperature (°C)	24.5 (0.2)	26.3 (0.2)	24.8 (0.3)	<0.001	E>N & M
Mean daily temperature range (°C)	17.5 (0.6)	20.7 (0.6)	19.3 (0.6)	<0.001	E>N
Humidity					
Mean diurnal relative humidity (%)	46.8 (1.7)	50.6 (1.1)	56.0 (1.7)	<0.001	N<M
Mean diurnal vapor pressure (Pa)	1,790.7 (70.1)	2,301.4 (47.9)	2,277.1 (69.2)	<0.001	N<E & M
Mean nocturnal relative humidity (%)	52.9 (1.8)	64.3 (1.0)	65.6 (1.4)	<0.001	N<E & M
Mean nocturnal vapor pressure (Pa)	1,597.9 (59.1)	2,144.3 (34.4)	1,979.9 (45.5)	<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, 2006*

Response Variable	Canopy Closure Categories			*P*	Significant Pairwise Differences
	< 25%	**25–75%**	**> 75%**		
Soil Moisture					
Mean soil moisture (mV)	440.6 (133.8)	715.2 (20.9)	737.3 (26.9)	0.012	LT25<2575 & GT75
Mean distance (m) to saturated/inundated soil	43.0 (22.7)	58.6 (8.7)	38.1 (9.5)	0.296	N/A
Temperature					
Mean diurnal temperature (°C)	35.8 (1.9)	32.2 (0.3)	30.2 (0.3)	<0.001	LT25>2575 & GT75 2575>GT75
Mean no. of 15-min. intervals above 41°C each day	20.8 (4.9)	7.8 (0.9)	3.1 (0.6)	<0.001	LT25>2575 & GT75 2575>GT75
Mean nocturnal temperature (°C)	24.8 (1.2)	25.4 (0.2)	25.2 (0.2)	0.523	N/A
Mean daily temperature range (°C)	29.2 (2.7)	20.6 (0.5)	17.1 (0.4)	<0.001	LT25>2575 & GT75 2575>GT75
Humidity					
Mean diurnal relative humidity (%)	37.4 (3.3)	49.9 (1.0)	52.6 (1.5)	0.007	LT25<2575 & GT75
Mean diurnal vapor pressure (Pa)	1,737.1 (157.8)	2,148.5 (44.4)	2,123.9 (68.5)	0.183	N/A
Mean nocturnal relative humidity (%)	56.0 (3.8)	62.1 (1.1)	59.9 (1.5)	0.294	N/A
Mean nocturnal vapor pressure (Pa)	1,677.6 (151.7)	1,960.1 (35.0)	1,887.7 (56.3)	0.202	N/A

* 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, 2006

Explanatory Variables	Coefficient*	Adjusted odds ratio**	95% CI	*P*
NS vs. WT				
Mean diurnal temperature (°C)	-0.01	1.0	0.425, 2.311	0.983
Mean nocturnal temperature (°C)	-0.13	0.9	0.388, 1.996	0.761
Mean daily temperature range (°C)	-0.12	0.9	0.658, 1.187	0.411
Mean diurnal relative humidity (%)	-0.05	1.0	0.846, 1.076	0.442
Mean nocturnal relative humidity (%)	-0.04	1.0	0.927, 1.172	0.488
Mean soil moisture (mV)	-0.00	1.0	0.997, 1.002	0.640
NS vs. NU				
Mean diurnal temperature (°C)	0.20	1.2	0.409, 3.673	0.717
Mean nocturnal temperature (°C)	-0.35	0.7	0.247, 2.002	0.511
Mean daily temperature range (°C)	0.01	1.0	0.707, 1.432	0.974
Mean diurnal relative humidity (%)	0.41	1.5	1.153, 1.968	0.003
Mean nocturnal relative humidity (%)	-0.22	0.8	0.654, 0.987	0.037
Mean soil moisture (mV)	0.01	1.0	1.002, 1.009	0.001

* 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.

Table 7.13. Conditional 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, 2006

Explanatory Variables	Coefficient*	Adjusted odds ratio**	95% CI	*P*
NS vs. WT				
Mean diurnal temperature (°C)	-0.48	0.6	0.147, 2.592	0.509
Mean nocturnal temperature (°C)	0.58	0.8	0.361, 8.873	0.477
Mean daily temperature range (°C)	-0.17	0.8	0.532, 1.314	0.437
Mean diurnal relative humidity (%)	-0.19	0.8	0.670, 1.018	0.074
Mean nocturnal relative humidity (%)	-0.17	1.2	0.969, 1.450	0.098
Mean soil moisture (mV)	-0.00	1.0	0.987, 1.005	0.367
NS vs. NU				
Mean diurnal temperature (°C)	0.61	1.0	0.198, 17.171	0.591
Mean nocturnal temperature (°C)	-1.78	0.2	0.014, 2.022	0.160
Mean daily temperature range (°C)	0.15	1.2	0.455, 2.984	0.749
Mean diurnal relative humidity (%)	0.66	1.9	1.003, 3.749	0.049
Mean nocturnal relative humidity (%)	-0.64	0.5	0.239, 1.168	0.115
Mean soil moisture (mV)	0.01	3.3	1.000, 1.014	0.068
Mean distance (m) to saturated/inundated soil	-0.00	1.0	0.981, 1.013	0.698

* 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.

DISCUSSION

Similar to findings from 2003, 2004, and 2005, nests in 2006, on average, were located in areas that exhibited greater soil moisture and higher relative humidity. In contrast to the findings of previous study years, however, temperature variables in 2006, on average, were not significantly different between nest and non-nest sites after adjusting for other explanatory variables.[4] Nevertheless, temperature was significantly different between nest and non-nest sites at some study areas in 2006. This latter finding tended to reinforce our 2003–2005 interim findings that NS sites are significantly cooler, and that cooler temperatures are a significant predictor of nest sites.

[4] 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 were significantly different between NS and WT sites after adjustment. In 2005, diurnal temperature and daily temperature range were significant predictors of nest sites (NS versus NU).

We were unable to account for the lack of temperature significance in the overall 2006 model results. It is possible that some other source of covariance may have influenced the analysis.

Conversely, it is also possible that annual results vary as a function of the statistical model employed. These and other alternative explanations will be evaluated in detail in the forthcoming five-year final summary report for the purpose of determining the relationship(s) between yearly findings and meaningful, longer-term microclimatic patterns.

Soil moisture and both diurnal and nocturnal humidity were significant predictors of 2006 nest sites (NS versus NU) above and beyond the effects of canopy cover, habitat, or study area. The differences were relatively small, which may be the result of using continuous measures. We plan to evaluate the same models with categorical measures in the five-year final summary report, to determine if meaningful differences are still present within categories of temperature, humidity, and soil moisture.

Any single year's findings probably do not accurately portray overall microclimatic preferences influencing flycatcher nest site location. Fitness consequences of microclimatic preferences, assuming they exist, also may not be operative for each year of an individual's reproductive lifetime due to natural climatic variation and other factors. We are not aware of any empirical data supporting this hypothesis, but such a scenario is plausible when considering other factors (such as habitat use, prey base, etc.) that occasionally have anomalous years.

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 and Bunker Farm at Mesquite, with flycatchers breeding only in years when sites contained standing water (this document Chapters 2 and 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 at Imperial Dam, would change to a point above Parker Dam and there would be no return flow to the Colorado River below Parker Dam, resulting in lower water levels in the river between Parker and Imperial. The change in point of diversion was scheduled to begin in 2002.

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 considered 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 could influence plant species composition (loss of cottonwood and willow) and structure (loss of vegetation volume) 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 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 this study.

METHODS

In 2005, we selected a subset of sites that are currently surveyed for the presence of willow flycatchers for inclusion in the habitat monitoring study. We chose 11 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 monitored the same 15 sites in 2006 that were monitored in 2005.

TEMPERATURE/HUMIDITY (T/RH) LOGGERS

In 2005, we deployed HOBO H8 Pro (Onset Computer Corporation, Pocasset, MA) temperature/ humidity data loggers at several locations within each site selected for habitat monitoring. All loggers collected data at 15-minute intervals and were placed in inverted plastic containers and camouflaged as described in Chapter 7. All 60 logger locations selected in 2005 were retained in 2006. Categorical data on percent canopy closure and habitat type were collected in

[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.

2005 when data loggers were deployed but were not collected again as part of microclimate measurements in 2006. More detailed quantification of canopy closure and vegetation composition was completed as part of vegetation measurements in both 2005 and 2006 (see below).

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 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 were estimated visually in the field or measured either with a GPS unit or from high-resolution aerial photographs.

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. Vegetation measurements were completed at the same locations and following the same methods as in 2005.

GROUNDWATER MEASUREMENTS

A small-diameter shallow well, or piezometer, was installed in May–August 2005 near each of the fifteen sites selected for habitat monitoring to monitor groundwater levels. These fifteen piezometers are described in Koronkiewicz et al. (2006a) and were initially downloaded in August–September 2005. Piezometers have been collecting water level data every hour since installation. One additional piezometer was installed at Topock Marsh in 2006. This piezometer was installed within a consistently occupied breeding site to obtain groundwater levels and patterns with which we can compare results obtained at the habitat monitoring sites.

PIEZOMETER INSTALLATION

The Topock Marsh piezometer is similar to the 15 previously installed piezometers. It is constructed of standard ¾-inch-diameter Schedule 40 PVC pipe with a pre-formed ¾-inch-diameter PVC well point glued to the end. The well point is approximately 1 foot in length, has a pre-installed permeable well screen, and is sturdy enough to be driven into the ground. The piezometer is protected at the surface against vandalism and damage by a 2-inch-diameter PVC surface casing that extends several feet below ground and is secured in place with a small amount of concrete. A locking, watertight PVC cap was glued to the top 2-inch-diameter surface casing.

We installed the Topock Marsh piezometer by first hand digging a 2-inch-diameter borehole several feet deep until groundwater was encountered. 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 hand maul.

DATA COLLECTION

A pressure transducer/data logger (mini-Troll Standard-P, 5psi, manufactured by In-Situ Corporation) collected data at each piezometer. These devices measure and record pressure of 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.

During the initial installation of the pressure transducers, as well as at each data download thereafter, water levels were measured 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 reprogrammed each piezometer at the following field visit.

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.

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

Statistical Analyses

Microclimate

The following values were calculated for all 15 habitat monitoring sites:

- 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
- 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 (2006).

These values were then calculated for all sites combined and compared to the same values for within-territory (WT; see Chapter 7) locations at the Topock Marsh life history breeding area. These analyses were restricted to 21 June–28 August 2006, the dates during which microclimate data were collected at both WT and habitat monitoring locations. 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.

We assigned all plots as a control site (above Parker Dam or below Imperial Dam) or as a test site (between Parker and Imperial), then analyzed between-year differences in T/RH and SM values within these two groups using paired t-tests. We then analyzed the between-year differences among the test sites compared to the control sites using one-way repeated measures ANOVA. 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

We analyzed between-year differences in vegetation characteristics within the test and control groups using paired t-tests. We then analyzed the between-year differences among the test sites compared to the control sites using one-way repeated measures ANOVA. These analyses and all descriptive statistics were produced using SPSS® Version 15.0 (SPSS Inc.) software.

GROUNDWATER LEVELS

We examined the following correlations between piezometer levels and reservoir operations: 1) correlation of the Havasu NE and Blankenship Bend piezometers (control sites) with Lake Havasu water levels; and 2) correlation of the 11 test site piezometers between Parker and Imperial Dams (Ehrenberg, Cibola Lake, Three Fingers Lake, Walker Lake, Paradise, Hoge Ranch, Rattlesnake, Clear Lake, Ferguson Wash, Ferguson Lake, and Great Blue Heron) with releases (in cubic feet per second, or cfs) 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. The relationship between streamflow and stage is not necessarily linear; however, initial analyses from 2005 indicate it is close enough to a linear relationship to allow a very close match between Parker releases and piezometer water levels. 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. We examined monthly river flow data from below Parker Dam from 2000 to 2005 to determine whether there has been a decrease in water levels since the scheduled implementation of the change in point of diversion from Imperial Dam to above Parker Dam.

Reclamation (2000) estimated the expected change in river stage between Parker and Imperial Dams that would result from a 400,000 acre-foot reduction in releases from Parker Dam. SWCA developed regression equations correlating average daily gage height at the USGS gage below Parker Dam to average daily piezometer water levels. Using the estimated decreases in river stage and these regression equations, we estimated the corresponding decrease in water levels that would be expected at each habitat polygon.

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, temperature, and locational and daily averages for soil moisture were also calculated using Microsoft Access and Microsoft Excel.

RESULTS

HOBO LOGGER MAINTENANCE

HOBO loggers were downloaded in December 2005, May or June 2006, and July or August 2006 (Table 8.1). Two loggers at Walker Lake, two at Rattlesnake, and two at Blankenship Bend were not downloaded in December 2005 because of access difficulties or computer problems. These loggers were downloaded in May 2006 but had ceased logging in March because memory was full. One logger at Ehrenberg was missing on the December check and was replaced with new unit.

Table 8.1. Data Download Schedule of HOBO Temperature/Humidity Loggers at Sites Selected for Habitat Monitoring, Lower Colorado River, December 2005–August 2006

Location	Site Name	# HOBO Loggers	Dates HOBOs Downloaded
Above Parker	Blankenship Bend	4	16 Dec, 17 or 18 May, 14 Aug
	Havasu NE	4	16 Dec, 29 May, 19 Jul
Between Parker and Imperial	Ehrenberg	4	12 Dec, 1 Jun, 23 Jul
	Three Fingers Lake	5	12–13 Dec, 31 May, 29 or 30 Jul
	Cibola Lake	5	12 Dec, 1 Jun, 28 Jul
	Walker Lake	3	13 Dec, 31 May, 27 Jul
	Paradise	4	15 Dec, 23 May or 1 Jun, 29 Jul
	Hoge Ranch	4	15 Dec, 22 or 31 May, 29 Jul
	Rattlesnake	4	15 Dec, 16 or 22 May, 26 Jul
	Clear Lake	3	14 Dec, 30 May, 29 Jul
	Ferguson Lake	5	14 Dec, 15 or 20 May, 22 Jul
	Ferguson Wash	4	14 Dec, 17 May or 2 Jun, 25 Jul
	Great Blue Heron	4	15 Dec, 20 May, 21 Jul
Below Imperial	Mittry West	4	14 Dec, 13 or 21 May, 20 Jul
	Gila Confluence North	3	13 Dec, 30 May, 28 Jul

PIEZOMETER INSTALLATION AND MAINTENANCE

One piezometer was installed at Topock Marsh on 13 August in the site designated In Between, which has contained breeding flycatchers every year from 2003 to 2006. Data from all 15 original piezometers were downloaded in December 2005 and June and September 2006. All 15 data loggers have been in equilibrium since fall 2005; no corrections were required this field season. In three instances, the pressure transducers temporarily failed to collect water levels, resulting in data gaps ranging from 1 to 2.5 months at Cibola Lake, Great Blue Heron, and Paradise. Table 8.2 lists details on data download and data gaps associated with each of the piezometers.

Table 8.2. Summary of Piezometer Construction and Data Collection at Habitat Monitoring Sites, Lower Colorado River, 2005–2006*

Site	Depth (ft)	Stickup height (ft)	Date installed	Dates downloaded	Median depth (ft bgs) to water		Distance (ft) from habitat	Data gaps
					Aug 2005	Aug 2006		
Topock Marsh	INA	2.5	13-Aug-06	N/A	N/A	N/A	Within	N/A
Blankenship Bend	7.2	3.4	28-Aug-05	16-Dec-05 14-Aug-06	2.86	2.58	Within	none
Havasu NE	6.1	2.2	09-May-05	16-Dec-05 14-Aug-06	1.77	2.00	Within	none
Ehrenburg	7.4	2.6	29-Aug-05	12-Dec-05 8-Jun-06 20-Sep-06	2.01	1.98	Within	none
Three Fingers Lake	7.7	4.1	31-May-05	13 Dec-05 8-Jun-06 20-Sep-06	3.03	3.38	540	none

Table 8.2. Summary of Piezometer Construction and Data Collection at Habitat Monitoring Sites, Lower Colorado River, 2005–2006*, continued

Site	Depth (ft)	Stickup height (ft)	Date installed	Dates downloaded	Median depth (ft bgs) to water		Distance (ft) from habitat	Data gaps
Cibola Lake	7.2	3.4	30-May-05	12 Dec-05 8-Jun-06 20-Sep-06	3.12	3.68	Within	29-Sep-05 to 12-Dec-05
Walker Lake	7.4	2.9	30-May-05	13-Dec-05 8-Jun-06 20-Sep-06	1.41	5.05	230	none
Paradise	11.7	0.6	11-May-05	15-Dec-05 12-Jun-06 15-Sep-06	5.5	5.32	Within	7-May-06 to 12-Jun-06
Hoge Ranch	8.7	2.8	11-May-05	15-Dec-05 12-Jun-06 09-Sep-06	3.11	3.30	Within	none
Rattlesnake	7.0	2.8	10-May-05	15-Dec-05 12-Jun-06 5-Sep-06	2.41	1.76	1,080	none
Clear Lake	8.7	2.4	10-May-05	14-Dec-05 11-Jun-06 14-Sep-06	2.71	2.41	Within	none
Ferguson Lake	7.6	2.7	10-May-05	14-Dec-05 11-Jun-06 14-Sep-06	2.27	1.86	Within	none
Ferguson Wash	INA	2.2	10-May-05	14-Dec-05 11-Jun-06 14-Sep-06	1.93	1.66	Within	none
Great Blue Heron	7.3	1.7	31-May-05	15-Dec-05 11-Jun-06 14-Sep-06	2.28	1.69	60	30-Aug-05 to 15-Dec-05
Mittry West	5.0	3.0	29-Aug-05	14-Dec-05 11-Jun-06 14-Sep-06	2.77	1.85	270	none
Gila Confluence North	7.9	2.7	29-Aug-05	12-Dec-05 11-Jun-06 14-Sep-06	4.32	4.98	50	none

* INA = information not available, N/A = not applicable, bgs = below ground surface.

MICROCLIMATE

2006 MICROCLIMATE DESCRIPTIVE STATISTICS

Habitat, canopy cover, soil moisture, temperature, relative humidity, and vapor pressure parameters from the 15 study sites monitored in 2006 exhibited substantial variation among sites (Tables 8.3a and 8.3b). 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.

Table 8.3a. 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
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)

Habitat and canopy cover variables are presented as N followed by % of column totals (in parentheses).

Table 8.3b. Microclimatic Data Summaries Collected From Habitat Monitoring Sites, Lower Colorado River, May–July **2006***

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
Soil Moisture															
Mean soil moisture (mV)	599.0 (15.8)	198.5 (32.6)	621.3 (49.0)	410.7 (30.6)	282.0 (26.9)	954.0 (10.8)	697.6 (43.6)	867.8 (11.9)	787.3 (27.6)	397.6 (74.2)	945.4 (7.7)	156.9 (6.3)	915.7 (6.3)	897.9 (9.3)	302.6 (20.2)
Temperature/Humidity															
Mean diurnal temperature (°C)	35.7 (0.2)	34.3 (0.2)	36.1 (0.2)	37.3 (0.2)	37.9 (0.2)	33.2 (0.3)	34.2 (0.2)	32.7 (0.2)	29.4 (0.2)	31.1 (0.2)	32.7 (0.2)	35.0 (0.3)	30.6 (0.2)	32.6 (0.2)	34.5 (0.2)
Mean no. of 15-min. intervals above 41°C each day	20.7 (0.7)	13.0 (0.7)	19.3 (0.6)	25.2 (0.7)	27.0 (0.6)	14.6 (0.5)	14.3 (0.7)	11.8 (0.4)	2.6 (0.2)	5.2 (0.4)	10.6 (0.5)	18.4 (0.7)	5.5 (0.4)	12.6 (0.7)	18.6 (0.5)
Mean nocturnal temperature (°C)	25.5 (0.2)	25.8 (0.2)	25.4 (0.3)	25.0 (0.3)	26.3 (0.2)	23.3 (0.4)	25.7 (0.2)	24.6 (0.2)	22.1 (0.2)	25.1 (0.2)	26.1 (0.2)	27.0 (0.2)	23.0 (0.2)	23.6 (0.2)	22.6 (0.3)
Mean daily temperature range (°C)	26.9 (0.4)	24.1 (0.4)	27.0 (0.3)	31.2 (0.4)	28.6 (0.3)	30.2 (0.7)	26.0 (0.6)	26.5 (0.4)	21.4 (0.4)	20.4 (0.4)	22.4 (0.4)	27.4 (0.5)	23.1 (0.4)	26.5 (0.5)	32.3 (0.4)
Mean diurnal relative humidity (%)	29.9 (0.5)	31.5 (0.5)	25.7 (0.4)	30.0 (0.6)	26.2 (0.4)	47.0 (0.9)	37.0 (0.6)	41.3 (0.5)	59.5 (0.6)	46.1 (0.8)	40.9 (0.5)	37.6 (0.5)	45.9 (0.7)	39.9 (0.6)	38.4 (0.5)
Mean diurnal vapor pressure (Pa)	1,310.7 (28.7)	1,560.5 (31.8)	1,280.5 (26.4)	1,356.8 (31.4)	1,315.9 (28.2)	2,040.5 (66.2)	1,681.3 (34.1)	1,765.4 (38.0)	2,320.5 (41.4)	1,974.9 (47.8)	1,709.9 (31.0)	1,697.0 (35.2)	1,835.8 (40.2)	1,661.8 (37.8)	1,718.1 (40.2)
Mean nocturnal relative humidity (%)	44.0 (0.8)	40.2 (0.7)	43.2 (0.6)	46.0 (0.6)	44.0 (0.5)	60.2 (0.9)	48.3 (0.5)	52.0 (0.6)	72.0 (0.6)	50.1 (0.8)	50.0 (0.5)	40.2 (0.7)	57.4 (0.6)	50.0 (0.5)	55.7 (0.5)
Mean nocturnal vapor pressure (Pa)	1,376.7 (28.2)	1,343.4 (27.6)	1,356.7 (25.2)	1,398.0 (26.0)	1,471.9 (26.2)	1,718.1 (54.0)	1,566.5 (28.7)	1,601.4 (33.3)	1,949.7 (32.3)	1,629.1 (39.0)	1,643.8 (24.9)	1,383.4 (29.7)	1,643.9 (30.3)	1,459.9 (30.5)	1,554.7 (34.9)

, Soil moisture and temperature/humidity values are means (standard error in parentheses).

Soil moisture varied by a factor of six among the 2006 study sites, from a low of 156.9 mV at Ferguson Wash to a high of 954.0 mV at Walker Lake (see Table 8.3b). Mean distance to saturated/inundated soil varied by a factor of 25, with a low of 10.7 m at Walker Lake to a high of 273.8 m at Mittry West.

Mean diurnal temperatures at most study areas in 2006 ranged from 30 to 35°C, with a low of 29.4°C at Rattlesnake and a high of 37.3°C at Three Fingers Lake (see Table 8.3b). Mean nocturnal temperatures at most study sites ranged from 23 to 26°C, with a low of 22.1°C at Rattlesnake and a high of 27.0°C at Ferguson Wash. Mean number of 15-minute intervals above 41°C each day varied from 2.6 at Rattlesnake to 27.0 at Cibola Lake, with most study sites occurring in the 6–18 range. Mean daily temperature range varied from 20.4°C (Clear Lake) to 32.3°C (Gila Confluence North).

Mean diurnal relative humidity (see Table 8.3b) ranged from 25.7% (Ehrenberg) to 59.5% (Rattlesnake), while mean nocturnal relative humidity ranged from 40.2% (Havasu NE and Ferguson Wash) to 72.0% (Rattlesnake). Mean diurnal vapor pressure was lowest at Ehrenberg (1280.5 Pa) and highest at Rattlesnake (2320.5 Pa). Mean nocturnal vapor pressure was lowest at Havasu NE (1343.4 Pa) and highest at Rattlesnake (1949.7 Pa).

Between-year Comparisons of Microclimate Characteristics

Most microclimatic variables at habitat monitoring sites differed significantly between 2005 and 2006 for all 15 sites combined (Table 8.4). Mean soil moisture was greater in 2006. Two of the four temperature variables, mean number of 15 minute intervals above 41°C each day and mean nocturnal temperature, were greater in 2006; mean diurnal temperature and mean daily temperature range were similar between years. Both measures of diurnal humidity and vapor pressure were significantly less in 2006; mean nocturnal relative humidity was less in 2006, while mean nocturnal vapor pressure was greater in 2006.

Comparison of Parker/Imperial to Topock: Microclimate

All microclimate parameters except for canopy cover and soil moisture were significantly different between Topock Marsh and the habitat monitoring sites (Table 8.5). Topock was cooler and exhibited higher diurnal/nocturnal relative humidity and diurnal/nocturnal vapor pressure than habitat monitoring sites. Habitat monitoring sites had a significantly greater proportion of sites dominated by native vegetation.

Geographic Variation of Temperature and Humidity Measurements

Summaries of monthly averages for temperature and absolute humidity in August 2005–July 2006 for all habitat monitoring sites are shown in Tables 8.6a and 8.6b. No consistent latitudinal trends emerged in either temperature or absolute humidity. When data were grouped by region (Topock Gorge, Cibola, Imperial, Martinez Lake, below Imperial Dam) and season (fall, winter, spring, summer), linear regression of temperature and absolute humidity against UTM northing had R^2 values ranging from 0.00 to 0.61, showing no strong latitudinal trends in any season.

Table 8.4. Change in Microclimatic Variables at Habitat Monitoring Sites from 2005 to 2006*

Parameter	Test				Control				P-value for difference in means between years among test sites compared to control sites[1]
	2005	2006	Difference in means between years[1]	P-value for the difference between years	2005	2006	Difference in means between years[1]	P-value for the difference between years	
N (Temp./Humidity Sensor Arrays)	42		N/A	N/A	13		N/A	N/A	N/A
Soil Moisture									
Mean soil moisture (mV)	633.5	614.5	-19.0	0.227	717.9	598.2	-119.7	0.040	0.004
Temperature/Humidity									
Mean diurnal temperature (°C)	34.4	34.9	0.5	0.318	34.4	35.6	1.2	0.285	0.558
Mean no. of 15 min. intervals above 41°C each day	16.5	31.7	15.2	<0.001	16.0	36.7	20.7	0.002	0.368
Mean nocturnal temperature (°C)	26.2	30.5	4.3	<0.001	25.4	30.3	4.9	<0.001	0.455
Mean daily temperature range (°C)	24.8	24.9	0.1	0.909	24.8	28.1	3.3	0.055	0.153
Mean diurnal relative humidity (%)	41.0	45.0	4.0	0.013	37.3	40.7	3.4	0.257	0.850
Mean diurnal vapor pressure (Pa)	1837.6	2128.5	290.9	<0.001	1714.6	1946.2	231.6	0.089	0.601
Mean nocturnal relative humidity (%)	51.9	48.2	-3.7	0.016	51.7	46.4	-5.3	0.080	0.610
Mean nocturnal vapor pressure (Pa)	1704.7	1884.0	179.3	<0.001	1636.5	1797.1	160.6	0.015	0.770

[1] The analysis was restricted to 6/10/05–8/1/05 and 6/10/06–8/1/06.

Table 8.5. Comparison of Microclimatic Variables at Habitat Monitoring Sites to Within-Territory Locations at the Topock Marsh Life History Study Area, 2006*

Response Variable	Habitat Monitoring Sites	Topock Marsh WT	*P*[1]
N (Temp./Humidity Sensor Arrays)	58	15	N/A
Habitat			
Native (cottonwood or willow)	10 (17.0)	0 (0.0)	
Exotic (tamarisk)	29 (49.2)	14 (93.3)	0.025
Mixed (native and exotic)	18 (30.5)	1 (6.7)	
Canopy Cover			
Less than 25%	13 (22.8)	0 (0.0)	
25–75%	28 (49.1)	9 (60.0)	0.116
More than 75%	16 (28.1)	6 (40.0)	
Soil Moisture			
Mean soil moisture (mV)	607.6 (10.7)	760.1 (54.8)	0.106
Temperature/Humidity			
Mean diurnal temperature (°C)	36.4 (0.1)	32.2 (0.5)	<0.001
Mean no. of 15 min. intervals above 41°C each day	18.1 (0.3)	5.5 (1.7)	<0.001
Mean nocturnal temperature (°C)	28.6 (0.1)	26.2 (0.3)	<0.001
Mean daily temperature range (°C)	22.4 (0.2)	18.6 (0.8)	0.034
Mean diurnal relative humidity (%)	43.4 (0.3)	59.0 (2.4)	<0.001
Mean diurnal vapor pressure (Pa)	2219.3 (13.2)	2612.5 (84.0)	0.008
Mean nocturnal relative humidity (%)	54.3 (0.3)	70.7 (2.1)	<0.001
Mean nocturnal vapor pressure (Pa)	2039.8 (9.5)	2347.9 (59.4)	<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. Habitat and canopy cover variables were recorded at the habitat monitoring sites only in 2005.

[1] For the significance testing, the analysis was restricted to the dates when monitoring occurred at both habitat monitoring sites and Topock WT: 6/21/06–8/28/06.

Both temperature and absolute humidity varied more among sites during summer months than winter months.

VEGETATION MEASUREMENTS

Vegetation characteristics varied widely both between and within the selected habitat monitoring sites (Table 8.7). Average canopy height ranged from 3.5 m (Three Fingers Lake) to 16.6 m (Ehrenberg), and average canopy closure ranged from 65.0% (Three Fingers Lake) to 89.8% (Ferguson Wash). 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 8.6a. Average Monthly Temperature (°C) from August 2005 to July 2006 at Habitat Monitoring Sites, Lower Colorado River

Site	UTM Northing	August	September	October	November	December	January	February	March	April	May	June	July
Blankenship Bend	3831571	31.90	27.47	21.87	15.07	10.22	11.53	14.67	15.47	22.32	27.37	31.10	33.80
Havasu NE	3824239	29.79	26.38	21.04	14.33	9.78	11.48	14.34	16.27	22.61	28.08	31.57	34.41
Ehrenberg	3715859	33.54	28.40	22.52	15.73	10.43	11.46	14.11	16.16	22.15	28.59	32.42	35.43
Three Fingers Lake	3682253	32.89	26.52	20.06	12.82	8.53	9.73	12.89	16.09	21.46	27.73	32.88	35.90
Cibola Lake	3680194	34.33	28.74	22.32	15.14	10.40	11.32	14.09	16.82	22.81	28.90	34.27	36.90
Walker Lake	3675951	30.47	26.74	21.56	14.49	9.86	10.96	13.53	15.41	21.25	26.27	29.61	32.36
Paradise	3666336	31.31	26.53	20.59	14.41	10.42	11.19	14.02	16.03	21.19	26.96	31.55	34.02
Hoge Ranch	3660346	30.41	26.33	21.10	15.52	11.13	12.21	14.86	16.32	21.15	26.51	30.06	32.83
Rattlesnake	3659614	27.59	22.77	18.24	13.03	9.58	10.69	13.21	14.89	19.17	23.27	26.36	29.44
Clear Lake	3657985	30.24	26.15	21.19	15.28	11.22	12.38	15.42	17.01	21.76	25.80	29.16	31.39
Great Blue Heron	3652424	30.09	25.04	20.03	14.24	10.20	10.80	13.24	15.72	20.62	25.11	28.11	30.53
Ferguson Lake	3651948	31.53	27.66	21.80	15.95	11.16	12.32	14.80	16.72	21.99	27.00	30.92	33.36
Ferguson Wash	3650544	31.50	27.23	21.34	15.17	10.68	11.95	14.88	17.17	22.53	28.06	32.76	35.20
Mittry West	3638678	31.11	26.73	21.40	15.73	11.00	11.43	14.30	16.17	21.50	26.19	30.36	32.34
Gila Confluence North	3623131	30.77	25.53	20.95	14.58	10.20	11.23	13.34	15.73	20.54	25.42	30.60	33.66

Table 8.6b. Average Monthly Absolute Humidity (gm/m^{3}) from August 2005 to July 2006 at Habitat Monitoring Sites, Lower Colorado River

Site	UTM Northing	August	September	October	November	December	January	February	March	April	May	June	July
Blankenship Bend	3831571	17.27	9.49	9.01	6.07	3.86	3.56	3.08	4.27	4.81	6.31	8.65	12.80
Havasu NE	3824239	18.40	10.49	9.76	6.83	4.40	4.00	3.52	5.14	5.93	7.58	10.49	14.82
Ehrenberg	3715859	15.79	9.79	8.56	5.58	3.98	3.59	3.34	4.81	5.52	6.39	9.37	13.18
Three Fingers Lake	3682253	16.55	11.00	8.94	5.56	3.55	3.38	3.11	4.54	5.41	6.90	8.68	13.30
Cibola Lake	3680194	15.99	10.75	9.10	5.83	3.85	3.51	3.24	4.57	5.22	6.40	9.10	13.91
Walker Lake	3675951	20.54	15.33	11.73	7.67	4.86	4.14	3.84	5.29	7.03	9.64	13.66	18.22
Paradise	3666336	18.40	11.54	9.69	6.42	4.30	3.71	3.38	4.96	5.92	7.72	10.98	16.49
Hoge Ranch	3660346	18.60	11.82	9.96	6.54	4.52	4.00	3.83	5.30	6.53	8.32	12.08	17.26
Rattlesnake	3659614	21.20	14.15	10.92	6.77	4.00	3.49	3.15	4.93	7.22	10.53	15.33	20.64
Clear Lake	3657985	18.70	11.74	9.40	5.90	3.85	3.22	2.82	4.57	5.82	8.04	12.84	18.88
Great Blue Heron	3652424	18.67	12.90	10.08	6.39	3.90	3.34	3.10	4.90	6.15	8.37	13.21	18.17
Ferguson Lake	3651948	19.05	12.76	10.76	7.47	5.25	4.58	4.55	5.74	7.06	8.76	12.18	16.43
Ferguson Wash	3650544	18.21	11.29	9.27	5.87	3.71	3.16	2.87	4.45	5.51	7.45	10.96	15.96
Mittry West	3638678	17.55	11.58	9.38	5.95	3.83	3.27	3.10	4.65	5.68	7.95	11.90	16.81
Gila Confluence North	3623131	18.77	12.50	10.05	6.39	4.19	3.69	3.81	5.31	6.12	7.61	11.39	16.75

Table 8.7. Summary of Vegetation Characteristics at Habitat Monitoring Sites, Lower Colorado River, 2006*

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)	4.5 (0.8)	5.9 (0.8)	16.6 (1.5)	3.5 (0.2)	4.8 (0.6)	6.3 (2.4)	9.8 (3.5)	4.4 (0.6)	8.8 (2.1)	6.0 (0.6)	5.8 (0.5)	5.3 (0.3)	7.3 (1.5)	8.8 (1.2)	8.7 (0.9)
	3.5–6.0	4.5–7.5	14.4–21.0	3.0–4.0	3.5–7.0	3.5–11.0	3.0–19.0	3.0–5.5	6.0–15.0	5.0–7.0	4.5–7.0	4.5–6.0	4.0–11.0	7.0–12.2	7.0–10.0
% total canopy closure	84.5 (3.0)	66.3 (8.4)	75.5 (4.4)	65.0 (11.5)	71.2 (10.6)	85.7 (3.9)	83.5 (5.1)	66.8 (10.1)	86.8 (4.3)	70.3 (7.1)	81.6 (10.5)	89.8 (6.3)	84.8 (5.0)	77.3 (5.8)	80.7 (6.5)
	77.0–91.0	42.0–80.0	66.0–86.0	38.0–92.0	32.0–90.0	78.0–91.0	70.0–94.0	55.0–97.0	79.0–98.0	57.0–81.0	41.0–97.0	71.0–98.0	70.0–91.0	67.0–90.0	71.0–93.0
% woody ground cover	61.8 (20.1)	56.3 (18.5)	10.3 (3.3)	18.3 (6.2)	41.0 (11.2)	37.3 (18.2)	58.5 (24.5)	31.3 (11.6)	32.5 (6.6)	14.3 (3.5)	13.4 (7.2)	22.8 (8.3)	25.3 (21.6)	31.3 (8.3)	35.0 (14.4)
	10.0–97.0	15.0–90.0	1.0–15.0	5.0–35.0	20.0–80.0	7.0–70.0	4.0–100.0	10.0–60.0	15.0–45.0	8.0–20.0	1.0–40.0	1.0–40.0	3.0–90.0	15.0–50.0	10.0–60.0
Distance (m) to nearest standing water or saturated soil	13.3 (7.1)	63.8 (8.3)	50.0 (7.4)	107.5 (25.0)	67.0 (29.1)	10.7 (9.7)	58.8 (10.1)	23.5 (11.0)	88.5 (47.8)	24.0 (11.4)	16.4 (7.2)	92.3 (23.5)	210.0 (6.1)	273.8 (25.6)	46.3 (13.9)
	0.0–30.0	45.0–85.0	35.0–65.0	40.0–150.0	15.0–180.0	1.0–30.0	35.0–80.0	8.0–56.0	1.0–218.0	2.0–40.0	0.0–37.0	50.0–140.0	200.0–225.0	215.0–330.0	22.0–70.0
Distance (m) to nearest canopy gap	1.5 (1.2)	2.0 (0.4)	3.5 (0.5)	1.5 (0.5)	0.6 (0.2)	1.2 (0.4)	8.0 (5.7)	8.5 (3.4)	10.5 (6.8)	3.7 (0.9)	7.8 (3.2)	7.8 (2.8)	5.0 (1)	3.1 (0.4)	3.0 (0.0)
	0.0–5.0	1.0–3.0	3.0–5.0	1.0–3.0	0.0–1.0	0.5–2.0	0.0–25.0	2.0–17.0	3.0–31.0	2.0–5.0	2.0–20.0	2.0–15.0	4.0–8.0	2.0–4.0	3.0–3.0
Distance (m) to nearest broadleaf tree	5.3 (3.5)	7.3 (1.4)	0.3 (0.3)	290.0 (33.2)	108.4 (67)	15.3 (4.7)	19.3 (8.3)	25.8 (24.8)	4.6 (2.6)	41.5 (18.5)	16.2 (5.1)	5.0 (3.7)	12.8 (10.5)	2.5 (0.9)	0.3 (0.2)
	0.0–15.0	3.0–9.0	0.0–1.0	200.0–360.0	2.0–370.0	6.0–20.0	5.0–40.0	0.0–100.0	0.0–10.0	4.5–4.5	5.0–35.0	0.0–16.0	0.0–44.0	1.0–5.0	0.0–0.5
# shrub/sapling stems within 5-m radius of plot center	42.3 (9.0)	5.3 (1.4)	36.8 (18.2)	91.8 (10.1)	56.2 (13.1)	62.7 (16.8)	48.8 (25.6)	56.3 (13.5)	98.3 (61.9)	35.3 (5.5)	53.8 (13.5)	13.3 (4.8)	49.3 (14.1)	78.5 (17.9)	104.7 (18.2)
	31.0–60.0	1.0–7.0	8.0–88.0	67.0–113.0	13.0–95.0	32.0–90.0	6.0–120.0	24.0–87.0	2.0–262.0	26.0–45.0	18.0–91.0	3.0–26.0	15.0–84.0	29.0–112.0	72.0–135.0
# tree stems within 11.3-m radius of plot center	11.0 (4.7)	21.8 (8.4)	5.5 (1.7)	0.0 (0.0)	4.2 (1.6)	3.0 (2.1)	14.0 (7.0)	7.8 (4.7)	17.5 (3.8)	24.3 (3.7)	9.2 (4.0)	21.0 (1.5)	32.5 (8.0)	24.3 (10.4)	26.7 (4.4)
	2.0–18.0	5.0–45.0	3.0–10.0	0.0–0.0	1.0–10.0	0.0–7.0	0.0–27.0	0.0–21.0	8.0–24.0	17.0–29.0	2.0–24.0	18.0–25.0	14.0–53.0	9.0–54.0	18.0–32.0

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

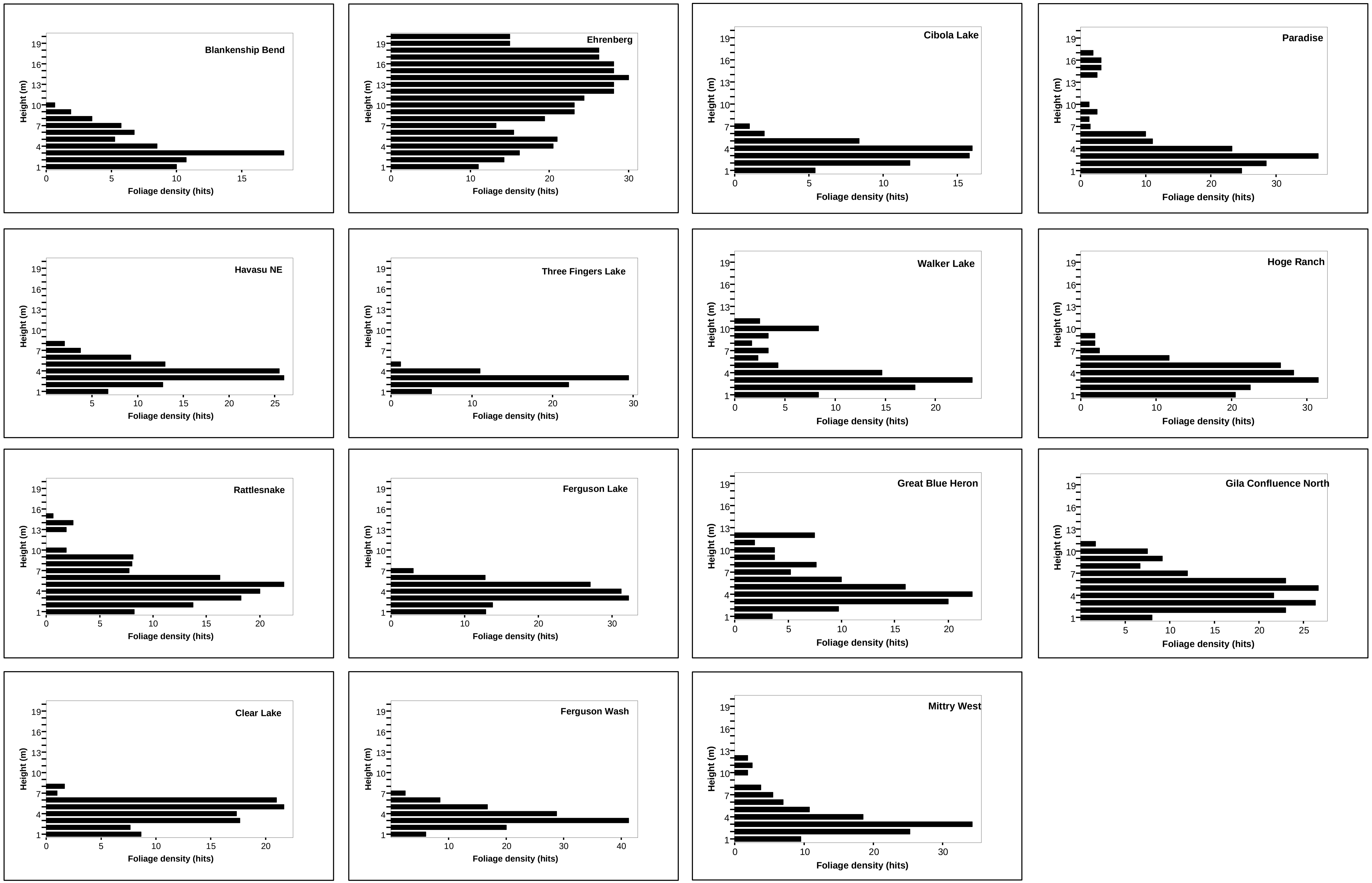

Figure 8.1. Vertical foliage profiles for each habitat monitoring site, lower Colorado River, 2006.

Between-year Comparisons of Vegetation Characteristics

Average values of canopy cover, canopy closure, woody ground cover, distance to water, distance to canopy gap, distance to broadleaf tree, total shrub stem count, and total tree stem count for both test and control sites are shown in Table 8.8. Repeated measures ANOVA comparing canopy cover, canopy closure, woody ground cover, distance to water, distance to canopy gap, distance to broadleaf tree, total shrub stem count, and total tree stem count between years showed an overall between-year difference in canopy closure ($F_{1,58}$ = 5.3, P= 0.025), woody ground cover ($F_{1,57}$ = 8.5, P= 0.005), distance to water ($F_{1,58}$ = 10.0, P= 0.003), and tree counts ($F_{1,58}$ = 26.5, P < 0.001) for all plots combined. There were no significant interactions between canopy closure or tree counts and location (test vs. control sites), meaning the change in these variables from 2005 to 2006 among test sites was not significantly different than the change at control sites from 2005 to 2006. There was a significant interaction between year and location for woody ground cover ($F_{1,57}$ = 17.5, P < 0.001) and distance to water ($F_{1,58}$ = 4.6, P= 0.036; both average ground cover and distance to water increased at control sites between 2005 and 2006, while it did not change at test plots.

Repeated measures ANOVAs for vertical foliage in each meter interval showed significant between-year differences for the first ($F_{1,58}$ = 10.7, P = 0.002) and second ($F_{1,58}$ = 4.8, P = 0.03) meter intervals above the ground. In both cases, foliage density was less in 2006, and there was no significant interaction between vertical foliage density and location (test vs. control sites).

Table 8.8. Annual Means of Vegetation Characteristics at Plots between Parker and Imperial Dams (Test Sites) and Plots above Parker or below Imperial (Control Sites), 2005 and 2006

Parameter	Test				Control				P-value for difference in means between years among test sites compared to control sites
	2005	2006	Difference in means between years	P-value for the difference between years	2005	2006	Difference in means between years	P-value for the difference between years	
Average canopy height (m)	6.6	7.0	0.4	0.550	6.5	7.0	0.5	0.103	0.902
% total canopy closure	84.7	78.3	-6.5	0.006	80.8	76.9	-3.9	0.331	0.564
% woody ground cover	31.1	27.1	-4.0	0.197	24.4	46.7	22.3	0.002	<0.001
Distance (m) to nearest standing water or saturated soil	63.8	72.1	8.2	0.269	59.5	102.8	43.3	0.030	0.036
Distance (m) to nearest canopy gap	8.1	5.0	-3.0	0.023	2.7	2.4	-0.3	0.593	0.223
Distance (m) to nearest broadleaf tree	53.0	55.0	2.0	0.245	5.2	4.1	-1.2	0.380	0.303
# shrub/sapling stems within 5-m radius of plot center	51.9	55.7	3.8	0.584	38.6	55.4	16.9	0.047	0.323
# tree stems within 11.3-m radius of plot center	7.6	12.0	4.5	<0.001	11.7	21.2	9.5	0.014	0.069

GROUNDWATER MONITORING

OVERVIEW OF PIEZOMETER WATER LEVELS

At least one full year of data has been collected at 15 of the 16 piezometers (excluding Topock Marsh). Data collected after fall 2005 are relatively complete; however, Great Blue Heron and Cibola each experienced a recording error between August and December of 2005, and Paradise had no data between May and July of 2006.

The piezometer hydrographs generally exhibit some common characteristics. Initially, two general trends, a weekly trend and a daily cycle, appeared with the data available from the fall 2005 downloads. Water levels were lowest during the afternoon hours and on weekends, while high water was observed in early morning hours and in the middle of the week. These patterns were visible in the 2006 data as well.

A third general trend, a seasonal pattern, has appeared in the hydrographs with the more extended period of record. In the majority of the hydrographs, the lowest water levels occurred in the winter and highest water levels occurred in the spring (Table 8.9). Seasonal water level change ranged from approximately 2 feet at Blankenship Bend to over 7 feet at Three Fingers Lake, with an average seasonal water level change of 4.4 feet. Hydrographs for all piezometers are included in Appendix D.

Table 8.9. High and Low Water Depths Recorded at Piezometers at Habitat Monitoring Sites, August 2005–September 2006

Location	Shallowest water level (ft bgs)	Month occurred	Deepest water level (ft bgs)	Month occurred
Blankenship Bend	1.43	June	4.32	December
Havasu NE	0.80	August	3.56	February
Ehrenburg	0.38	April	5.11	December
Three Fingers Lake	0.00	August	5.63	January
Cibola Lake	1.49	April	5.10	December
Walker Lake	0.00	August	5.72	September
Paradise	3.77	August	7.625	December
Hoge Ranch	0.27	August	5.78	December
Rattlesnake	0.02	August	4.65	January
Clear Lake	1.18	April	4.54	January
Ferguson Lake	0.50	March	3.92	January
Ferguson Wash	0.35	April	3.91	December
Great Blue Heron	0.53	April	2.80	January
Mittry West	0.00	April	2.88	January
Gila Confluence North	0.00	October	5.24	June

CORRELATION OF PIEZOMETER WATER LEVELS WITH RESERVOIR RELEASES

Lake Havasu Water Levels – There is a strong correlation (R^2 = 0.79) between water levels in Lake Havasu as measured by the USGS and water levels below the habitat as measured in the Havasu NE piezometer (Figure 8.2). The piezometer at Blankenship Bend appears to be too far upstream to be strongly correlated with lake levels, showing a correlation through the same period with an R^2 value of only 0.09.

Colorado River Water Levels – Data were collected between August 2005 and September 2006 in hourly intervals and averaged by the day. The "best fit" time lag varied from two days for the upstream piezometers (Paradise, Hoge Ranch, Ehrenberg, Cibola Lake, Three Fingers Lake) to three days for the downstream piezometers (Rattlesnake, Clear Lake, Ferguson Lake, Ferguson Wash, and Great Blue Heron). The best fit R^2 statistics vary from 0.71 to 0.95 (Table 8.10). Walker Lake was the only site that had no correlation (R^2 = 0.06–0.07), with releases and subsequent lag times having virtually no effect on water levels.

Planned Declines in Parker Releases – An examination of monthly river flows below Parker Dam from 2000 to 2006 (Table 8.11) revealed there has been a noticeable decline in reservoir releases. While there is significant variation, in general each month's average flow decreased from 2001 (the year prior to the scheduled change in point of diversion) to present, ranging from 5.9% in May to 28.6% in September.

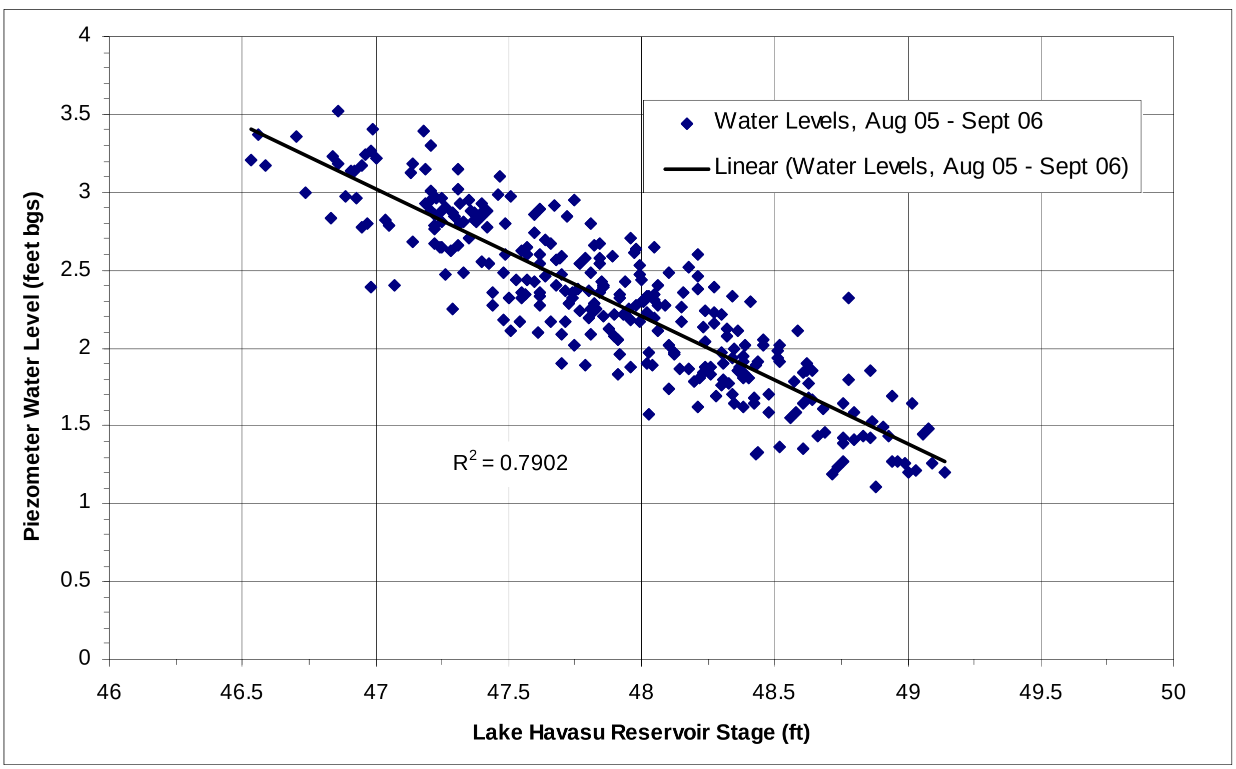

Figure 8.2. Correlation of Havasu NE piezometer and Lake Havasu water levels, August 2005–September 2006.

Table 8.10. Correlation (R^2 Statistic) of Parker Dam Daily Releases (cfs) with Average Daily Water Levels (feet bgs) of Piezometers at Habitat Monitoring Sites, August 2005–September 2006*

Site	Time Lag				
	None	1 day	2 days	3 days	4 days
Ehrenberg	0.74	0.90	0.91	0.80	0.70
Cibola Lake	0.52	0.62	0.71	0.65	0.57
Three Fingers Lake	0.62	0.83	0.94	0.80	0.67
Walker Lake	0.07	0.07	0.06	0.06	0.06
Paradise	0.64	0.79	0.95	0.71	0.40
Hoge Ranch	0.55	0.71	0.89	0.75	0.59
Rattlesnake	0.61	0.72	0.89	0.93	0.81
Clear Lake	0.65	0.73	0.86	0.90	0.84
Ferguson Lake	0.57	0.68	0.85	0.93	0.80
Ferguson Wash	0.54	0.67	0.85	0.93	0.79
Great Blue Heron	0.54	0.60	0.72	0.83	0.79

* Shaded cells indicate best correlation.

Table 8.11. Average Monthly Flows (cfs) Below Parker Dam, 2000–2006

	2000	2001	2002	2003	2004	2005	2006	Difference (present-2001)	% Change (2001-present)
January	6,820	5,599	6,478	6,327	5,536	4,166	5,842	-636	-11.4%
February	9,123	8,505	8,978	6,881	7,129	4,888	7,798	-1,180	-13.9%
March	11,594	10,524	11,334	12,360	11,523	9,699	9,752	-1,582	-15.0%
April	14,613	14,090	13,610	13,803	12,824	11,356	11,985	-1,625	-11.5%
May	14,174	14,068	12,826	11,990	12,252	11,428	11,998	-828	-5.9%
June	13,803	14,733	13,713	12,778	12,741	12,444	12,383	-1,330	-9.0%
July	14,210	14,974	14,439	13,100	12,331	13,842	11,688	-2,751	-18.4%
August	11,441	12,047	12,118	10,803	11,420	10,316	10,141	-1,977	-16.4%
September	11,233	10,837	10,429	11,159	9,566	9,048	7,334	-3,095	-28.6%
October	9,362	8,852	8,765	9,761	7,405	6,967	--	-1,797	-20.3%
November	7,437	7,357	7,049	6,153	5,163	6,335	--	-713	-9.7%
December	6,706	5,970	5,615	5,737	4,129	4,841	--	-774	-13.0%

We used regression equations to calculate expected decreases in water levels at each piezometer based on projected decreases in river stage for April, August, and December as the result of an annual reduction in Parker Dam releases of 400,000 acre-feet (Reclamation 2000). Not unexpectedly, the correlation between river stage and groundwater levels is approximately a 1:1 ratio, with regression slopes ranging from 0.86 (i.e., a 1-foot change in river stage would result in an 0.86-foot change in groundwater level) to 1.4 (Table 8.12).

Table 8.12. Estimated Decrease (ft) in Piezometer Water Levels at Habitat Monitoring Sites as the Result of Decreases in River Stage*

Site	April	August	December
Ehrenberg	0.71	0.16	0.07
Cibola Lake	0.62	0.14	0.06
Three Fingers Lake	0.85	0.19	0.08
Paradise	0.90	0.20	0.09
Hoge Ranch	0.74	0.17	0.07
Rattlesnake	0.70	0.16	0.07
Clear Lake	0.90	0.20	0.09
Ferguson Lake	0.95	0.21	0.09
Ferguson Wash	1.00	0.22	0.10
Great Blue Heron	0.68	0.15	0.07

* Reclamation (2000) predicted a decrease in river stage of 0.71, 0.16, and 0.07 feet for April, August, and December, respectively, based on hourly maximum flows at river mile 171.3.

CORRELATION OF PIEZOMETER WATER LEVELS WITH SOIL MOISTURE MEASUREMENTS

Linear regressions between the average soil moisture measurements at all 15 of the habitat monitoring sites and the average daily water level in the piezometer for that site show little to no correlation between these two variables (R^2 = 0.0–0.76; Table 8.13, Appendix E). Analysis included both 2005 and 2006 data and four additional sites where piezometers were installed late in the 2005 season.

Table 8.13. Results of Linear Regression Between Average Daily Piezometer Water Levels and Soil Moisture at Habitat Monitoring Sites, Lower Colorado River, 2005–2006

Site	Number of data points	Range of soil moisture values (mV)	Median soil moisture value (mV)	R^2
Blankenship Bend	9	393–1070	994	0.13
Havasu NE	16	12–907	151	0.00
Ehrenburg	10	92–1018	694	0.76
Cibola Lake	22	11–994	199	0.21
Three Fingers Lake	22	59–958	443	0.05
Walker Lake	19	599–1504	968	0.38
Paradise	17	45–1020	827	0.02
Hoge Ranch	20	452–1313	892	0.00
Rattlesnake	22	99–994	824	0.33
Clear Lake	18	54–1017	172	0.39
Ferguson Lake	22	437–1020	929	0.64
Ferguson Wash	23	34–607	160	0.08
Great Blue Heron	16	336–987	933	0.30
Mittry West	12	431–1006	938	0.07
Gila Confluence North	11	96–937	507	0.00

CORRELATION OF PIEZOMETER WATER LEVELS WITH HUMIDITY MEASUREMENTS

We prepared linear regression analyses for all 15 locations with piezometers water level measurements that overlapped the same time period as the humidity measurements. Average daily humidity measurements and average daily piezometer water levels were used for the analysis. The results are similar to those obtained for the soil moisture measurements, with very little correlation (R^2 = 0 to 0.27; Table 8.14, Appendix F).

Table 8.14. Results of Linear Regression between Average Daily Piezometer Water Levels and Absolute Humidity at Habitat Monitoring Sites, Lower Colorado River, August 2005–July 2006

Site	Number of data points	Range of absolute humidity values (g/m^3)	Median absolute humidity value (g/m^3)	R^2
Blankenship Bend	349	0–66.6	5.83	0.27
Havasu NE	323	1.0–47.1	6.45	0.00
Ehrenberg	327	0.7–42.8	5.88	0.11
Cibola Lake	332	0.1–49.8	5.95	0.14
Three Fingers Lake	334	0.8–38.7	6.12	0.10
Walker Lake	331	0.7–38.7	8.16	0.01
Paradise	332	1.1–37.5	6.83	0.16
Hoge Ranch	333	1.2–46	7.20	0.09
Rattlesnake	330	1.1–37.5	7.85	0.23
Clear Lake	333	1.1–49.7	6.53	0.20
Ferguson Lake	326	0.2–37.2	7.72	0.13
Ferguson Wash	329	0.7–69.8	6.19	0.15
Great Blue Heron	325	0.7–39.3	6.77	0.16
Gila Confluence North	332	0.1–48.3	6.83	0.00
Mittry West	326	0.1–53.4	6.31	0.04

DISCUSSION

MICROCLIMATE

COMPARISON OF PARKER/IMPERIAL TO TOPOCK

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 to 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.

The habitat monitoring sites exhibited a collective greater mean diurnal temperature than any of the five study areas where we measured microclimate variables (compare Table 8.5 to WT mean diurnal temperatures in Tables 7.3 through 7.7). This 2006 finding is in contrast to the 2005 finding that Mormon Mesa, where flycatchers are known to nest, had higher mean diurnal temperatures than the habitat monitoring areas (Koronkiewicz et al. 2006a). The 2005 finding suggested that higher diurnal temperatures alone may not have been responsible for the absence of known flycatcher nests in 2005 at the habitat monitoring sites, while the 2006 finding suggested that higher mean diurnal temperatures may have contributed to the absence of known flycatcher nests. The final year of microclimate monitoring may provide data to help explain this apparent contradiction. However, it is likely that (1) other factors beyond microclimate and (2) other microclimatic factors beyond mean diurnal high temperature influence nest-site selection in a complicated interaction.

BETWEEN-YEAR COMPARISONS OF MICROCLIMATE CHARACTERISTICS

Paired t-test comparisons of microclimate characteristics between 2005 and 2006 at the habitat monitoring sites indicated generally hotter and drier conditions in 2006. The interannual changes were generally similar between test and control sites, suggesting that changes in conditions may have been regional, rather than being influenced by changes in river operations.

VEGETATION

Between-year differences were noted for canopy closure, woody ground cover, distance to water, and tree counts. There was no evidence that differences in canopy closure or tree counts occurred exclusively at control sites or at test sites; rather, the differences occurred across all sites, with an overall increase in tree counts and decrease in canopy closure.

Increases in tree counts (up to 30 stems in a given plot) were recorded at numerous plots. These differences do not seem to be explainable by stems growing larger and thus being counted as shrubs in one year and trees in a subsequent year; increases in tree counts were not associated either with increases or decreases in shrub counts. Future analyses of stem counts by size class may help clarify the causes for between-year differences in total stem counts. Decreases in canopy closure could be caused by changes in overall weather conditions between the two years. Between-year differences in both canopy closure and tree counts may also be the result of systematic observer variation.

Differences in distance to water between 2005 and 2006 seemed to be driven largely by Mittry West and Great Blue Heron. A wetland area near Mittry West that was recorded as containing water in 2005 was not noted to be wet in 2006. Distance to water at Great Blue Heron was determined from aerial photos in both years; the photos were not updated between years, and any differences in values recorded were thus clearly the result of differing interpretations of the aerial photo and were not related to actual differences on the ground.

Ground cover did not differ between years at test locations but increased at control plots. This may represent an actual increase in the amount of woody ground cover or may be a spurious result of observer variation. Additional years of vegetation measurements will help clarify these trends.

Vertical foliage values in the first two meter intervals were greater in 2006 than in 2005. These differences could be caused by an increase in young or herbaceous growth. Future analyses of vertical foliage densities by species may help clarify the causes of these between-year differences.

GROUNDWATER LEVELS

PIEZOMETER WATER LEVELS

The general daily and weekly cycles that were attributed to evapotranspiration and river operations, respectively, in the 2005 data are still visible in the 2006 data. Water levels drop during afternoon hours and on the weekends, while higher water levels occur in early morning hours and in the middle of the week. The daily small-scale water level fluctuations 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 seasonal cycle in groundwater levels mirrors the seasonal fluctuation in river flow. This is driven primarily by the operational decrease in releases from Parker Dam. Evapotranspiration would be expected to decrease during the winter months, which should result in higher river and groundwater levels during the winter; however, this trend is not observed. Any seasonal effect of evapotranspiration appears to be overwhelmed by operations at Parker Dam.

Several anomalous hydrograph features deserve discussion:

Walker Lake – The Walker Lake piezometer recovered slowly from two apparent inundations in the late summer of 2005 and went through a period of declining water levels until the 5 December 2005 download, at which time the piezometer was restarted. The daily water level cycle can be seen throughout the inundation and recovery period, but the weekly cycle is not apparent until after the restart in December. From the point of restart, this piezometer began to show the same general seasonal trend as seen in the other piezometers, with a seasonal low occurring in winter 2006 and seasonal high occurring in spring 2006. Water levels, however, have continued to drop from the seasonal high spring levels to levels more like those first recorded before the summer 2005 inundation, suggesting this lower water level is closer to the seasonal low than that recorded in the winter 2006. We suspect Walker Lake represents a backwater area that gets periodically inundated, but otherwise does not respond strongly to fluctuations in the Colorado River.

Mittry West – While the hydrograph for the Mittry West piezometer was almost flat from installation through December 2005, the data now show a seasonal trend. A peak in water level occurred on 29 April 2006, from which point water levels declined into the summer months. Weekly fluctuations and daily fluctuations are not as apparent on the rising leg of the 2006 seasonal curve, but reappear on the declining leg of the curve. This may be attributed to the onset of evapotranspiration with the regrowth of vegetation in the immediate area surrounding the piezometer. Because of the inexplicable flat data from the first data downloads, we considered reinstalling the Mittry West piezometer at a different location within the habitat polygon. It now appears that this piezometer is functioning properly and can remain in its current location.

Havasu NE and Gila Confluence North – Daily and weekly changes in water level are apparent in both the Havasu NE and Gila Confluence hydrographs; however, neither shows signs of the seasonal trend common in the other hydrographs. This lack of a seasonal trend at the Havasu NE piezometer can be attributed to the highly regulated water level at Lake Havasu. The lack of a seasonal trend at the Gila Confluence is most likely due to other outside influences such as flow in the Gila River resulting from regional storms and irrigation diversion/return flow.

CORRELATION OF PIEZOMETER WATER LEVELS WITH RESERVOIR RELEASES

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 (Ehrenberg) showed a two-day lag, while the most downstream site (Great Blue Heron) showed a three-day lag. Based on Reclamation's estimate of river stage change due to a 400,000 acre-foot reduction in releases from Parker Dam, we estimate that the lowering of the water table below habitat polygons will range from up to 1 foot in April to less than 0.1 feet in December.

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. A better correlation in the 2006 analysis over the 2005 analysis was found at five sites: Cibola Lake, Walker Lake, Clear Lake, Ferguson Lake, and Ferguson Wash with R^2 of 0.21, 0.38, 0.39, 0.64, and 0.08, respectively. Ferguson Lake ($R^2 = 0.64$) and Ehrenburg ($R^2 = 0.76$) were the only sites with $R^2 > 0.5$. Soil moisture varied widely between sites, and two distinct groups that were seen with the 2005 data still exist. Soil moisture measurements collected from Havasu NE, Cibola Lake, Clear Lake, and Ferguson Wash all have median results less than 200 mV, while measurements collected from Walker Lake, Paradise, Hoge Ranch, Rattlesnake, Ferguson Lake, Blankenship Bend, Mittry West, and Great Blue Heron all have median soil moisture greater than 800 mV. Three Fingers Lake, Ehrenberg, and Gila Confluence North do not fall within either of these groups. We do not know how this variation may be influenced by depth to groundwater or how it may affect correlation between piezometer water levels and soil moisture measurements. Future analysis may 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 throughout the year. With an entire year's worth of data, many correlation values changed significantly from 2005 values (only May to August). For example, Havasu NE changed from R^2 of 0.17 in 2005 to ~0. It appears that over the longer term, any acute fluctuations that could resemble a discernable trend are leveled out by seasonal variation. 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. In addition, daily fluctuations are determined almost entirely by time of day. Future analysis may focus on teasing out smaller-scale humidity fluctuations that are superimposed on the seasonal increase in humidity during the summer.

CHAPTER 9

MANAGEMENT RECOMMENDATIONS

PRESENCE/ABSENCE SURVEYS

Most survey sites along the lower Colorado River change little from one year to the next, with the exception of sites that have been altered by fire or hydrological events (e.g., floods or changes in reservoir levels). Surveys over the last 10 years have not revealed any resident flycatchers at currently surveyed sites south of Parker Dam, and we feel annual surveys are not necessary at these static, unoccupied sites. Adult flycatchers exhibit a high degree of site fidelity, and if flycatchers are present at a site in one year, they are likely to be present the following year, unless vegetation or hydrology of the site had been altered. Thus, biannual surveys are likely to detect any colonization of sites. Any marked changes in sites, such as growth of new vegetation, would be noted during annual reconnaissance (see Site Selection below), and survey schedules could be altered accordingly to include sites where conditions have changed. Therefore, we recommend biannual surveys for sites that exhibit little inter-annual change and have no history of flycatcher residency. We recommend continuing annual surveys and monitoring for sites with a history of flycatcher residency (see section on Color-Banding and Resighting, below).

We cannot provide a formal evaluation of the effectiveness and efficiency of the current 10-survey protocol in detecting resident flycatchers because when we detect territorial flycatchers, we switch to territory monitoring rather than continuing surveys. However, based on our observations of flycatcher behavior, we believe the current 5-survey protocol endorsed by USFWS is highly effective in detecting willow flycatchers and determining residency. This protocol calls for one survey 15–31 May, one survey 1–21 June, and three surveys between 22 June and 17 July. In the last four years of surveys, the latest we have detected flycatchers that proved to be resident was 22 June. Thus, the vast majority of resident birds would likely be detected during the first two surveys, and the final three surveys would be used to confirm residency status. This 5-survey protocol would be especially effective when coupled with territory monitoring. Territory monitoring would be initiated anytime flycatchers were detected exhibiting territorial or breeding behaviors. This would ensure several visits post the initial detection to confirm residency, pairing, and breeding status.

SITE SELECTION

The selection of survey sites, as well as the number and timing of surveys, should be reevaluated depending on the goal of the surveys (i.e., to detect resident flycatchers or to document use by migrants). Some sites that are currently surveyed (e.g., Three Fingers Lake) are used heavily by migrants but do not contain the vegetation characteristics and/or hydrologic conditions that are found at breeding sites.

Current, high-resolution aerial photographs are essential for guiding survey efforts in extensive riparian corridors, and current aerial photography should be maintained for all potential survey areas. 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 habitat reconnaissance and surveys. This type of prioritization was instrumental in the discovery in 2005 of breeding flycatchers in Virgin River #2 at Mormon Mesa. Annual helicopter overflights are also essential for identifying recent changes in vegetation and surface water conditions. Previously unknown breeding areas on the Lake Mead delta (RM 285.3), Muddy River delta (south end of Overton WMA), and in Mormon Mesa (south of the previously existing Virgin River #2 area) were identified via helicopter reconnaissance.

COLOR-BANDING AND RESIGHTING

Known, marked individuals are essential for determining many demographic parameters. Accurate estimates of the number of breeding flycatchers would be difficult without marked individuals. Flycatchers may shift territory locations within a site, or even move between sites, during a breeding season, and such individuals would be counted multiple times if they were not individually identifiable. Similarly, turnover of individuals at a given territory location occur during a given breeding season, and in these cases multiple individuals would be recorded as a single bird. Observing marked individuals who are feeding fledglings is also useful in determining the success or failure of nests.

Many non-breeding or floater individuals would go undetected if large portions of the population were not individually marked. Non-breeding birds often do not exhibit observable, territorial behaviors (e.g., song and calls from exposed perches) and thus would go undetected, even with broadcast surveys, if they were not incidentally resighted or captured during passive or target netting. These non-territorial and non-breeding individuals should be included in any population estimates of the willow flycatcher because these individuals consistently make up a substantial part of the relatively small, local populations that occur on the lower Virgin, Muddy, and Colorado Rivers. These individuals likely serve as population reservoirs and replace other individuals that move or die.

A marked population is also essential to quantifying dispersal patterns, identifying source populations, and estimating, through mark-recapture modeling, population parameters such as annual survival. Differential survival between sites or changes in survival over time can be identified only through long-term monitoring of marked individuals. Therefore, continued demographic studies including color-banding and resighting are warranted.

Habitat use by unpaired residents and non-territorial floaters (including returning juveniles) remains largely unknown, and future studies (e.g., using radio telemetry) should document habitat use 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.

MIGRATION AND HABITAT USE STUDIES

Although much funding and effort is currently being focused on creating and restoring riparian habitat along the lower Colorado River for *E. t. extimus*, the degree to which the subspecies uses the river corridor as a migratory flyway and/or prospects in existing habitat is unknown and should be investigated. Determining if, how, and where *extimus* prospects in existing habitat along the lower Colorado River may provide insight as to where restoration sites should be located to best facilitate colonization.

SITE MAINTENANCE AND ENHANCEMENT

Demographic data collected thus far indicate that willow flycatcher dispersal among local populations is largely limited to within river drainages (i.e., Pahranagat Valley, Virgin River, Colorado River). Therefore, the willow flycatcher population at Topock Marsh would likely be the main source population for MSCP riparian restoration sites being created along the lower Colorado River.[1] Efforts must be initiated to ensure Topock Marsh continues to remain suitable for breeding willow flycatchers. In particular, the site must receive an adequate amount of standing water under the vegetation annually. Fluctuations in the amount of standing water under the vegetation at Topock have been recorded, with a markedly reduced amount in 2005 compared to 2003 and 2004. It is noted consistently in the literature that breeding willow flycatchers are associated with surface water; therefore, an increase in the amount of surface water within the habitat at Topock Marsh is likely to result in a greater number of breeding flycatchers at this site. Furthermore, because of the ever-present danger of fire at Topock Marsh, buffer zones and/or firebreaks are needed around flycatcher breeding areas. Because much of the habitat that surrounds the flycatcher breeding areas at Topock Marsh is unsuitable for willow flycatchers, firebreaks could be established to protect breeding areas.

Enhancement of existing riparian habitat has been identified as part of the MSCP. Several current surveys sites may be suited for enhancement efforts because of their existing vegetation, proximity to mainstem rivers and other existing riparian habitat, and presence of standing water or proximity to groundwater. These sites include Ehrenberg, Hoge Ranch, Paradise, Gila Confluence North, River Mile 33, and Gila River sites.

Manipulative experiments at restoration sites that attempt to duplicate hydrological conditions at breeding sites may provide managers information regarding the amount and duration of standing water needed to create and maintain the structural characteristics of vegetation found at occupied flycatcher habitat. Experiments should include different types of water impoundment structures and materials to identify those that are best suited for riparian ecosystem replication.

The selection, design, and management of riparian restoration sites for land birds as part of the MSCP should include recommendations from experts in the fields of avian ecology, population biology, and landscape ecology. Although the life history traits and habitat requirements of

[1] Although a flycatcher population exists within lower Grand Canyon/Lake Mead National Recreation Area, demographic data suggests this population is more strongly connected with populations that occur within the Virgin and Muddy River drainages.

riparian land birds along the lower Colorado River are inherently complex and are difficult to quantify, a vast knowledge of species' habitat requirements does exist as result of many years of bird research throughout the Southwest. Recommendations from species experts would ensure restoration sites contain the habitat characteristics that best facilitate colonization by bird species of concern.

NEST MONITORING

Depredation has consistently been the leading cause of Southwestern Willow Flycatcher nest failure at the Virgin/lower Colorado River sites since nest monitoring studies were initiated in 1996. However, direct observations of nest depredation events are rare to nonexistent during nest monitoring, and the identity of nest predators and factors influencing nest depredation along the Virgin and lower Colorado Rivers remain undetermined. Future studies should identify nest predator assemblages as a necessary first step in addressing factors that influence depredation rates. Results of these studies would guide restoration planning and design and would be applicable to other species addressed in the MSCP.

This study currently uses Mayfield estimates to adjust estimates of simple nest success to account for nests that fail before they are found. Mayfield estimates require determining transition dates between nesting stages (e.g., start of incubation or nestling period), which requires frequent visits to the nest. New methods of calculating nest success do not require determining transition dates. Results obtained via new methods should be compared to those obtained using Mayfield methods. Use of these new methods could reduce the number of nest visits required, thus minimizing any impacts to nesting flycatchers.

BROWN-HEADED COWBIRD TRAPPING

Our data thus far suggest Brown-headed Cowbird trapping may be more effective in reducing willow flycatcher brood parasitism at small, isolated sites than within large, contiguous stretches of riparian habitat such as those found on the Virgin and lower Colorado Rivers. Cowbird trapping at some sites is impractical because of remoteness of the sites and difficulty in placing traps close to flycatcher breeding areas. The effectiveness of other cowbird control measures in lowering parasitism rates should be evaluated for sites where parasitism is a concern and trapping is impractical.

In areas where cowbird trapping is implemented, traps should be of the funnel-top design and have entrance slots 3.8 cm wide. Our studies have shown that traps with funnel-shaped tops are more effective in capturing and retaining cowbirds than the more portable, flat-topped design. Traps with entrance slots 3.7 cm wide were also more effective in trapping cowbirds than traps with narrower 3.2-cm-wide slots, and escape rates between the two slot dimensions did not differ significantly.

VEGETATION

Vegetation studies conducted thus far indicate that Southwestern Willow Flycatchers place their nests in habitats that are taller and have denser canopies than non-use sites. Results have been consistent between years, and at the conclusion of the current contract, five years of data will exist. Additional years of comparing vegetation at nest, within-territory, and non-use sites using current methodologies are unlikely to yield new results.

Quantification of the number and spacing of stems at occupied flycatcher sites is critical to being able to replicate these conditions at restoration areas. Current vegetation measurements have documented stem counts but have not addressed the spacing, or clumpiness, of stems. Future studies should incorporate measurements of stem spacing.

Although vegetation measurements are standardized as much as possible through the use of equipment such as densiometers and Daubenmire squares, observer variation still exists. Future studies should investigate the use of alternative methods to obtain more consistent measures of canopy and ground cover.

MICROCLIMATE

Microclimate studies conducted thus far indicate that Southwestern Willow Flycatchers place their nests in habitats that are cooler, exhibit smaller temperature fluctuations, are more humid, and have higher soil moisture than non-use sites. Results have been consistent between years, and at the conclusion of the current contract five years of data will exist. Additional years of comparing nest, within-territory, and non-use sites using current methodologies are unlikely to yield new results.

However, it remains undetermined whether changes in microclimate contribute to the abandonment of nest sites. Future studies should investigate whether changes in microclimate conditions are correlated with nest abandonment. Results from these studies may provide additional information on the habitat requirements of breeding willow flycatchers, which in turn may be applied to MSCP site restoration efforts.

In addition, soil characteristics may have a substantial influence on hydrologic and/or vegetation conditions at a site by influencing the amount of water the soil can hold and water retention time after an inundation event. Future studies should analyze soil characteristics in conjunction with microclimate and vegetation data to identify soil characteristics that may affect flycatcher occupancy. Results from these studies may provide additional information on the habitat characteristics found at willow flycatchers breeding sites, which in turn may be applied to MSCP site restoration efforts.

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APPENDIX A

Field Data Forms

Data entered by _____ on _______
Proofed by ________ on ______

SWFL SURVEY AND DETECTION FORM

Study Area ___________ **Survey Site** ________________________________ **Date** _________________

Observer(s) ____________________________________ **UTM NAD and Zone** _________________________

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

Intermediate Waypoints

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __
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SWFL Detections

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
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UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
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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 ____
____
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Data entered by _____ on _______ Page___ of ____
Proofed by ________ on ______

SWFL SURVEY AND DETECTION FORM – Additional Waypoints

Study Area __________ **Survey Site _____________________________** **Date ________________**

Observer(s) _________________________________ UTM NAD and Zone _______________________

Intermediate Waypoints

UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __
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Comments ____
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Data entered by _____ on _______ Page___ of ____
Proofed by ________ on ______

SWFL SURVEY AND DETECTION FORM – Additional Detections

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

Observer(s) __________________________________ **UTM NAD and 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 ____
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UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
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UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
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UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
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UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
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UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
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UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
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UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
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UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
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Comments ____
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UTM E 0 __ __ __ __ __ __ N __ __ __ __ __ __ __ Banded? Y N U Pair? Y N Nest Found? Y N
Comments ____
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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 (10–25 May), mid-season (10–25 June), and late season (10–25 July)

Study Area: __________ **Survey Site:** ________________________________ **Date:** _________________

Observer(s): _____________________ **early**_____ **mid**______ **late** ______ **other**_____

Vegetation at site: >90% native 50-90% native 50-90% exotic >90% exotic

Canopy closure: <25% 25-50% 50-70% 70-90% >90%

Overstory height (m): _______ **Dominant overstory species:** TASP SAGO SAEX POFR Other ___________

Understory height (m): _______ **Dominant understory species**: TASP SAGO SAEX PLSE

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: _________________

Describe type of surface water (e.g., open marsh, surface water within woody vegetation, stream, etc):
____

Average 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 (do not include inundated areas in percentage!): _____________________

% of site with damp soils (do not include inundated or saturated areas): ____________________

If not inundated or saturated, distance (m) to standing water or saturated soil:______________________

How was distance determined? Visually estimated in field Measured in field using GPS
Measured from aerial photograph Other _____________________________________

Describe type of nearest surface water: ____

Does this description cover the entire site? Y N **If not, which portion is described?**___________________________
____

Give a narrative description of the site, including adjacent habitats:
____
____
____
____
____
____
____
____

Additional comments:____
____
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____
____
____

STUDY AREA: __________ **SITE**: _________________ **BANDER**: __________ **DATE**: __________ **TIME**: __________ **TERR/NEST #**: ______________

UTM: NAD______ **Zone**________ __________________E __________________**N** **NBN:** ____ of ____ nestlings banded.

NOTES:____

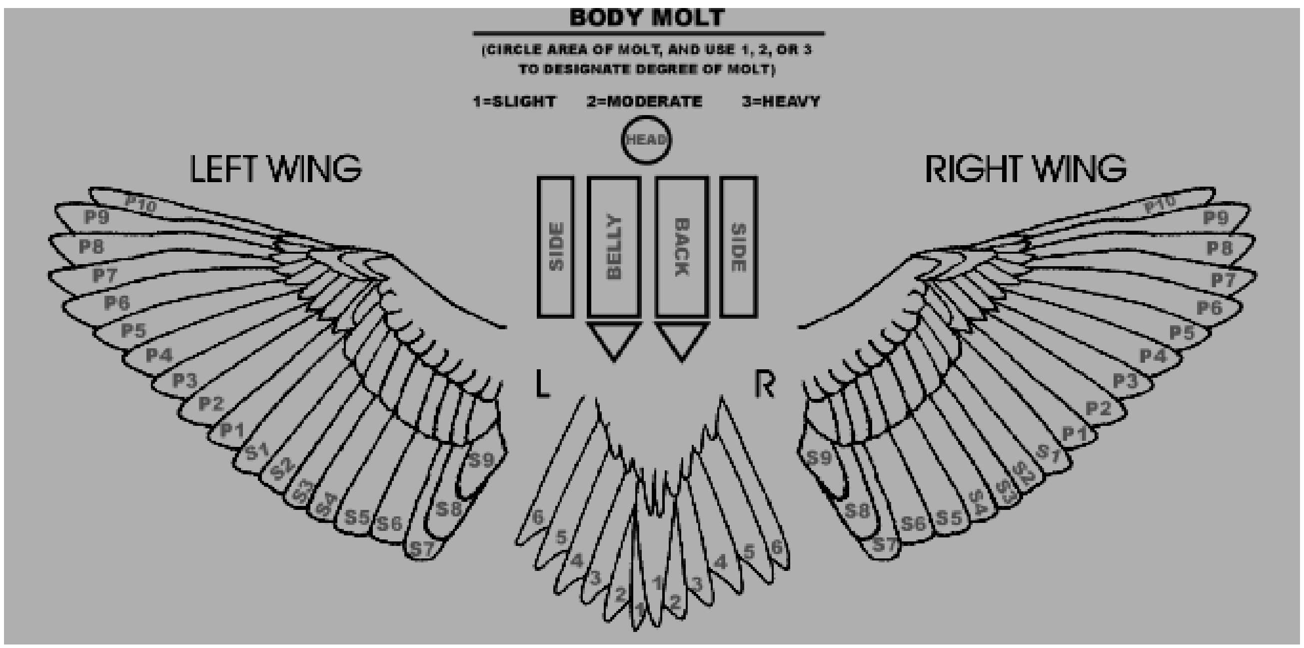
FEDERAL BAND #	COLOR COMBO		STATUS	SEX	CP	BP	AGE	FECAL SAMPLE? (Y or N)	GENETIC SAMPLE? (Y or N)	WING CHORD (mm)	TAIL (mm)	CULMEN LENGTH (mm)	CULMEN WIDTH (mm)	FAT
	L	R												

Retained Feathers Present: Yes or No (circle) – if Yes use diagram below **Colorimeter sample:** Yes or No (circle)

Active Molt: Yes or No (circle) – if Yes use diagram below

****** If a genetic sample or metric was not taken, explain why in notes ******

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
AGE: AHY = after hatch year; SY = second year; L = nestling banded in nest; HY = hatch year/young of the year
FAT: 0 = no fat; 1 = trace of fat in furculum, deeply concave, scattered patches, less than 5 percent filled; 2 = thin layer of fat in furculum, less than a third filled, trace of thin layer of fat in abdomen; 3 = furculum is ½ filled or more; small patches, not covering some areas, on abdomen; 4 = furculum more than 2/3 filled, level with clavicles, slightly mounded on abdomen



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 =
												Service Band Number =
												Service Band Number =
												Service Band Number =
												Service Band Number =
												Service Band Number =
												Service Band Number =
												Service Band Number =
												Service Band Number =
												Service Band Number =
												Service Band Number =

Entered by: _________________ Date entered:___________________

Willow Flycatcher Territory/Nest Record Form

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)

How was distance determined?____

Distance from NU point to standing water or saturated soil when nest found: _________(m)

How was distance determined?____

Depth of surface water at nest (please circle how wet you got when nest was found):

dry damp muddy 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.	# WE	# CE	# WN	# CN	#WF	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																		
Missing																		
Escaped during trap check																		
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 Method: ______________	**Woody Ground Cover**		**Total Canopy**
Substr. DBH: ____________ cm	Substr. Ht.: ________________m	Dist can gap: ___________m	Dist Brdlf:_________m Sp.: ___________	N:	E:	N:
Nest Ht.: _______ m or % - % × m	Nst Can Ht.: _______ m or % - % × m	Top Can.: ___________ m or % - % × m		S:	W:	S:

Species		**TASP**	**SAGO**	**SAEX**	**POFR**	**SNAG**	**OTSP1***: ___________	**OTSP2****: ___________	**OTSP3*****: ___________
Shrub/ Sapling Count in 5 m 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.

* **Other species 1 (write out full name)** __________________________________ (***Use the same type for every section.***)
** **Other species 2 (write out full name)** __________________________________ (***Use the same type for every section.***)
*** **Other species 3 (write out full name)** __________________________________ (***Use the same type for every section.***)

Vertical Foliage Sampling (i.e., "Hits on the pole")

CENTER PLOT								
Height (m)	Hits/Species							
	TASP	SAGO	SAEX	POFR	SNAG	OTSP1*: ____	OTSP2*: ____	OTSP3*: ____
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.

***Use same OTSP (1,2,3) as listed on main record.**

Vertical Foliage Sampling (i.e., “Hits on the pole”)

Study Area:	Survey Site:	Plot type:	ID#	Date:

NORTH									EAST										
Height (m)	Hits/Species								Height (m)	Hits/Species									
	TASP	SAGO	SAEX	POFR	SNAG	OTSP1*:	OTSP2*:	OTSP3*:		TASP	SAGO	SAEX	POFR	SNAG	OTSP1*:	OTSP2*:	OTSP3*:		
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 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.

***Use same OTSP (1,2,3) as listed on main record.**

Vertical Foliage Sampling (i.e., “Hits on the pole”)

SOUTH									WEST								
Height (m)	Hits/Species								Height (m)	Hits/Species							
	TASP	SAGO	SAEX	POFR	SNAG	OTSP1*:	OTSP2*:	OTSP3*:		TASP	SAGO	SAEX	POFR	SNAG	OTSP1*:	OTSP2*:	OTSP3*:
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 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.
***Use same OTSP (1,2,3) as listed on main record.**

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., 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:

Distance to saturated/inundated soil: ________ m **How distance was measured**: _________________________________

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

Comments:

Take-down: Date (MM/DD/YY):_______________ Time (military):_________ Crew member(s):__________________

6-digit sensor serial number: ________________ logger number: _________________

Distance to saturated/inundated soil: ________ m **How distance was measured**: _________________________________

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

Comments:

Location identifier format: Study area code (MD, MQ, MM, PA, TM) – Location code (NS, WT, NU, SVR, SVD) – Nest number (for NS, WT, NU locations) or Seasonal Variation number; e.g., TM-NU-9A or MM-SVD-2

SWFL Microclimate

Soil Moisture 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: _________________
Distance to saturated/inundated soil: _______ m **How distance was measured**: __________________________________
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

Comments:

Date **(MM/DD/YY):**________________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: ________________ logger number: _________________
Distance to saturated/inundated soil: _______ m **How distance was measured**: __________________________________
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

Comments:

Date **(MM/DD/YY):**________________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: ________________ logger number: _________________
Distance to saturated/inundated soil: _______ m **How distance was measured**: __________________________________
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

Comments:

Date **(MM/DD/YY):**________________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: ________________ logger number: _________________
Distance to saturated/inundated soil: _______ m **How distance was measured**: __________________________________
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

Comments:

Date **(MM/DD/YY):**________________ Time (military):___________ Crew member(s):_________________
6-digit sensor serial number: ________________ logger number: _________________
Distance to saturated/inundated soil: _______ m **How distance was measured**: __________________________________
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

Comments:

Microclimate at Sites South of Topock – T/RH Downloads

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:

Comments:

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:

Comments:

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:

Comments:

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:

Comments:

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

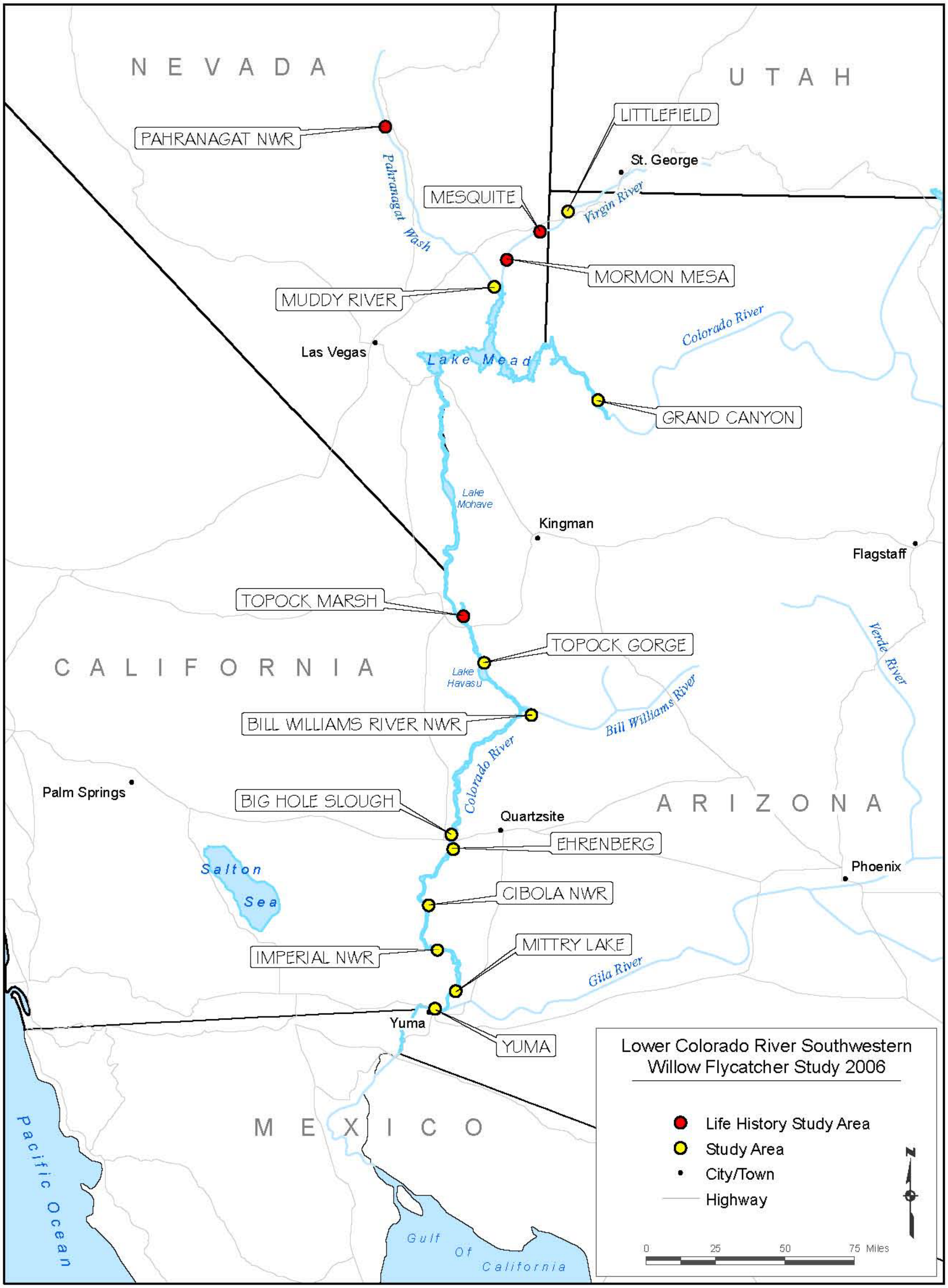
Did any events occur that might have interfered with accuracy of data gathered by this logger (e.g., blown out of tree, etc.)? No Yes If yes, explain:

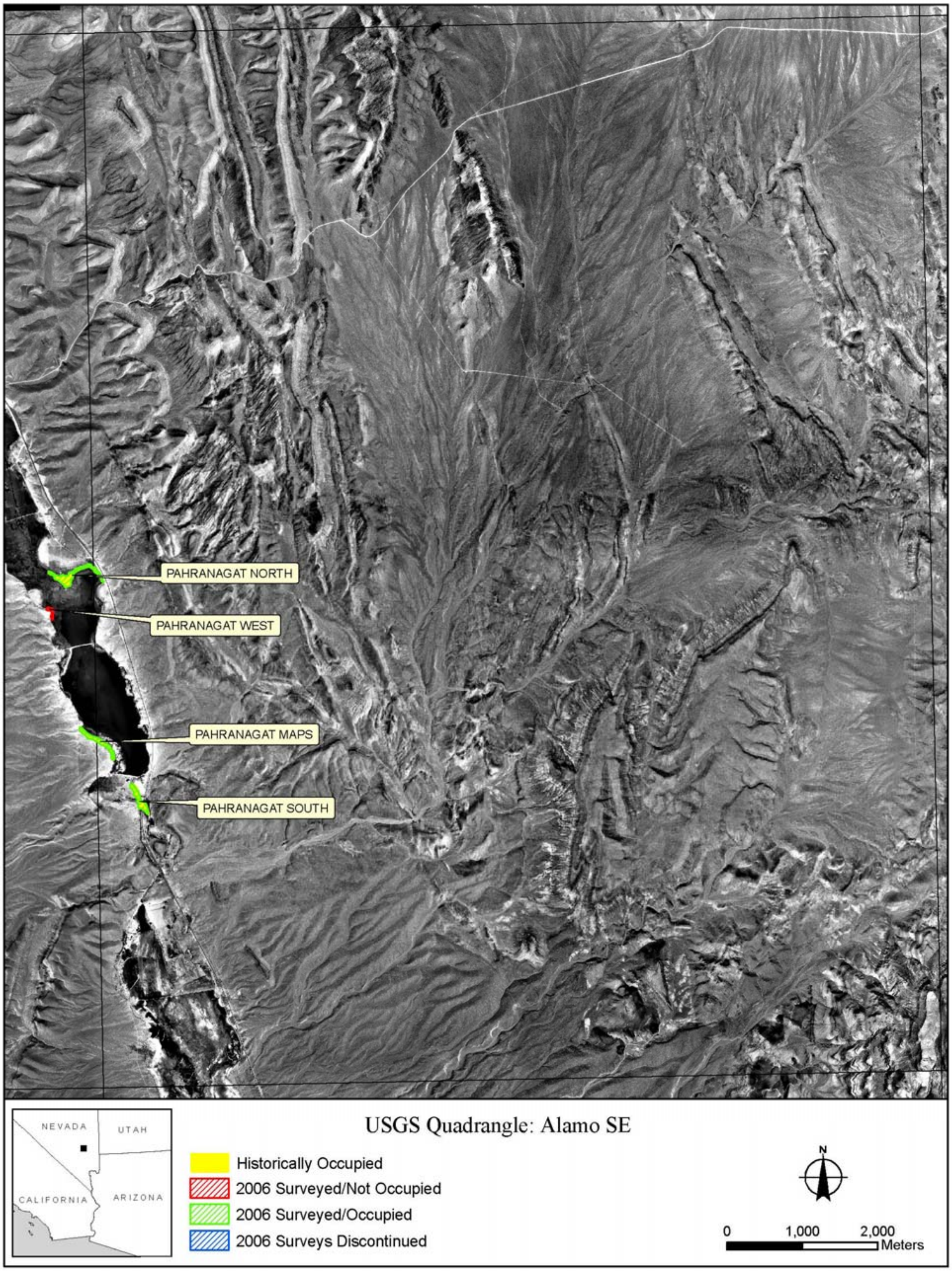
Comments:

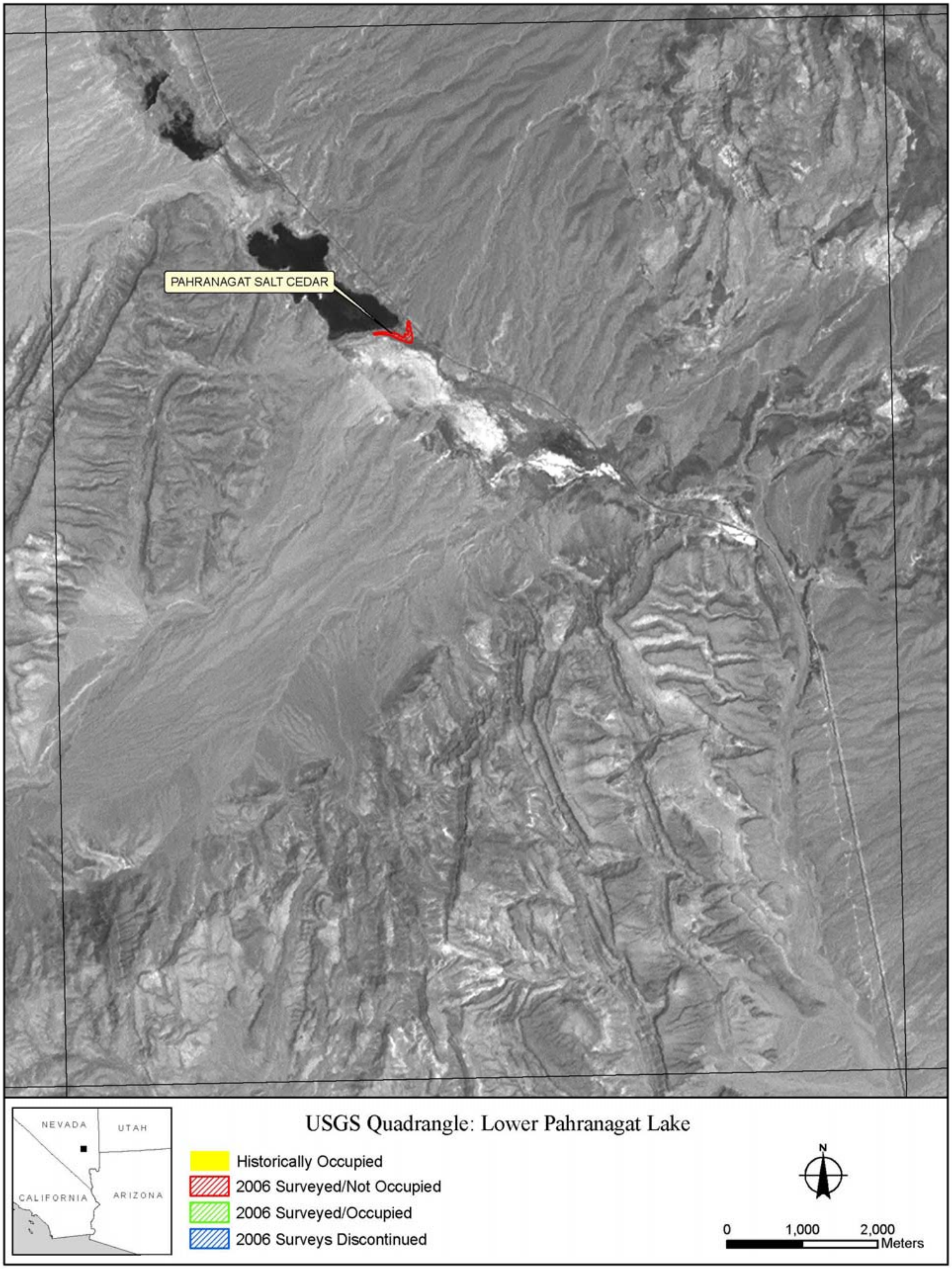
Location ID codes: Study area codes – Topock Gorge = TG, Ehrenberg = EH, Cibola = CI, Imperial = IM, Mittry = MI, Yuma = YU. Survey site codes – Blankenship = BK, Havasu NE = HV, Three Fingers Lake = TF, Cibola Lake = CL, Walker Lake = WL, Paradise = PV, Hoge Ranch = HR, Rattlesnake = RS, Clear Lake = LK, Ferguson Lake = FL, Ferguson Wash = FW, Great Blue Heron = GB, Martinez Lake = ML, Mittry West = MW, Gila Confluence North = GC

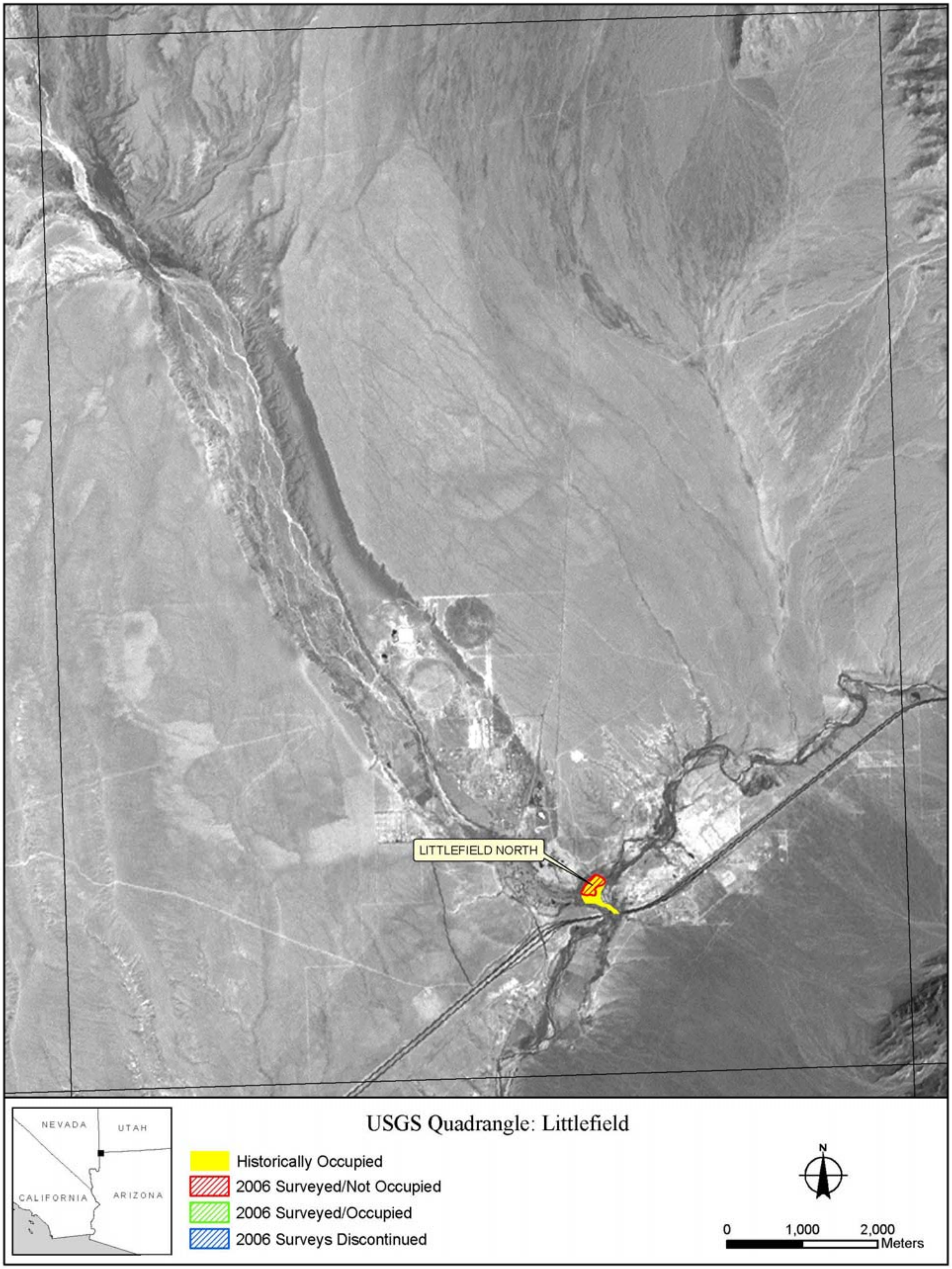
APPENDIX B

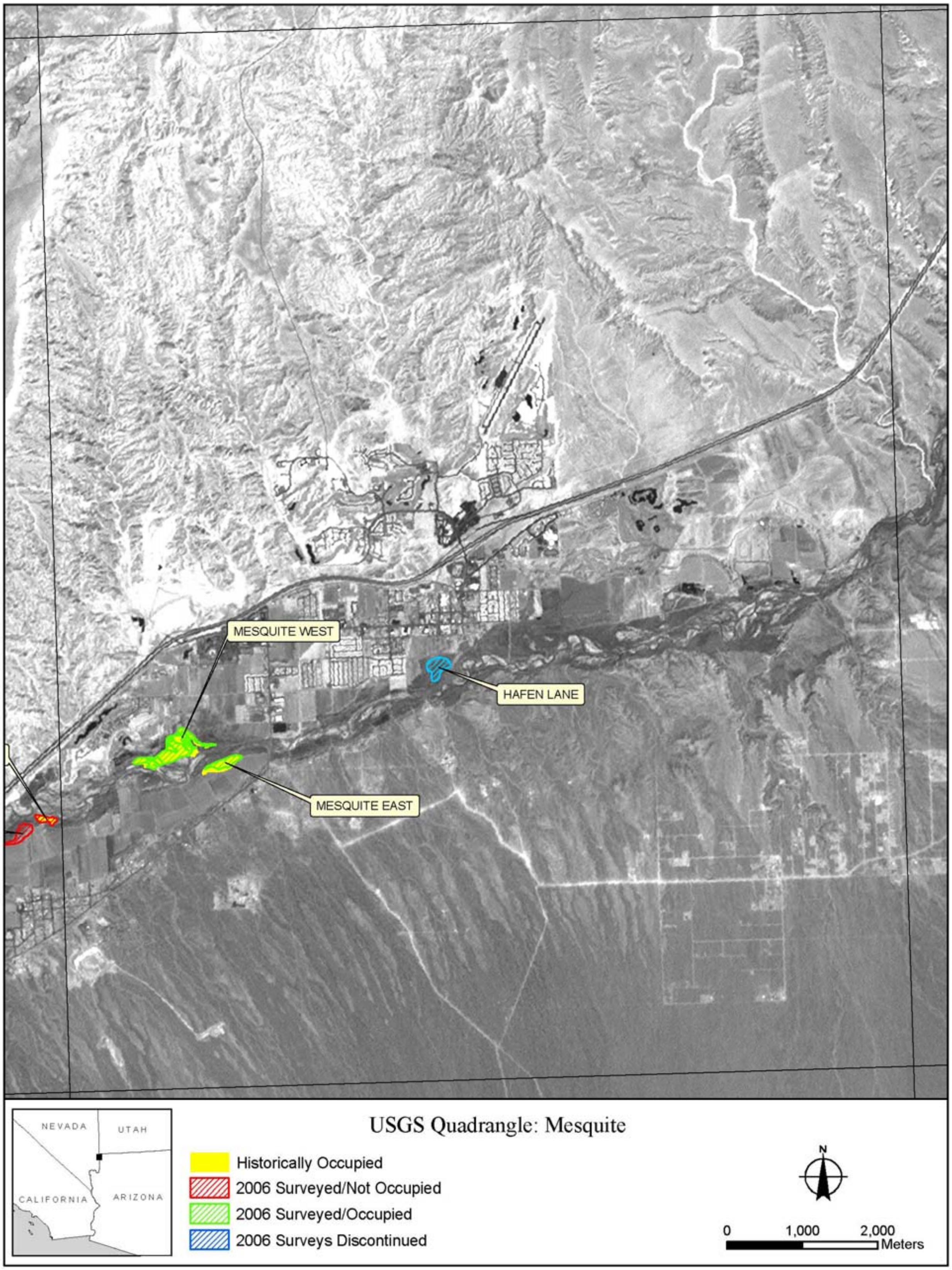
Orthophotos Showing Study Sites

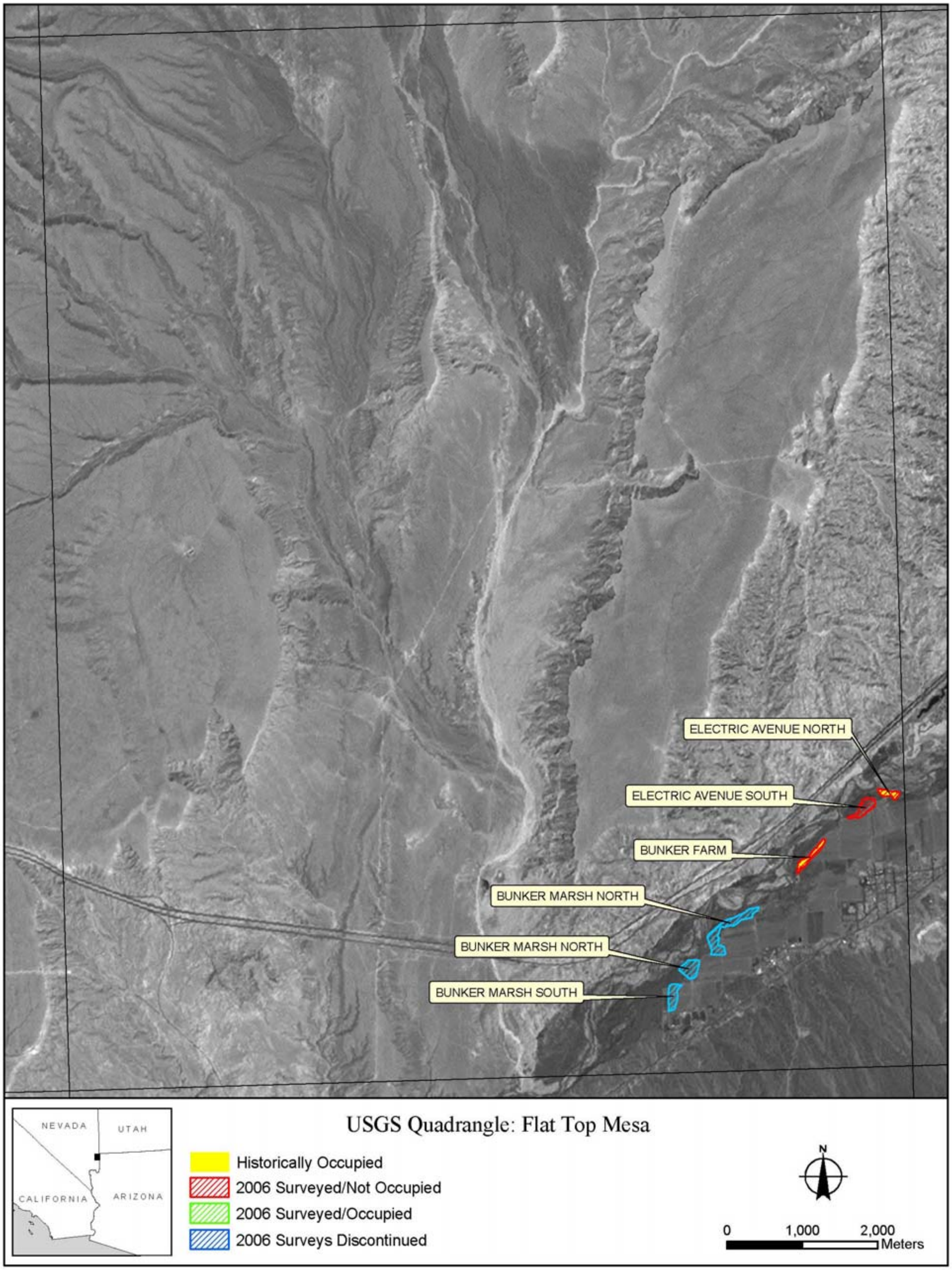

NEVADA
UTAH
PAHRANAGAT NWR
LITTLEFIELD
St. George
Pahranagat Wash
MESQUITE
Virgin River
MORMON MESA
MUDDY RIVER
Colorado River
Las Vegas
Lake Mead
GRAND CANYON
Lake Mohave
Kingman
Flagstaff
TOPOCK MARSH
TOPOCK GORGE
Verde River
CALIFORNIA
Lake Havasu
BILL WILLIAMS RIVER NWR
Bill Williams River
Colorado River
Palm Springs
BIG HOLE SLOUGH
Quartzsite
ARIZONA
EHRENBERG
Phoenix
Salton Sea
CIBOLA NWR
IMPERIAL NWR
MITTRY LAKE
Gila River
Yuma
YUMA
Lower Colorado River Southwestern Willow Flycatcher Study 2006
MEXICO
Life History Study Area
Study Area
City/Town
Highway
Pacific Ocean
Gulf Of California
0 25 50 75 Miles

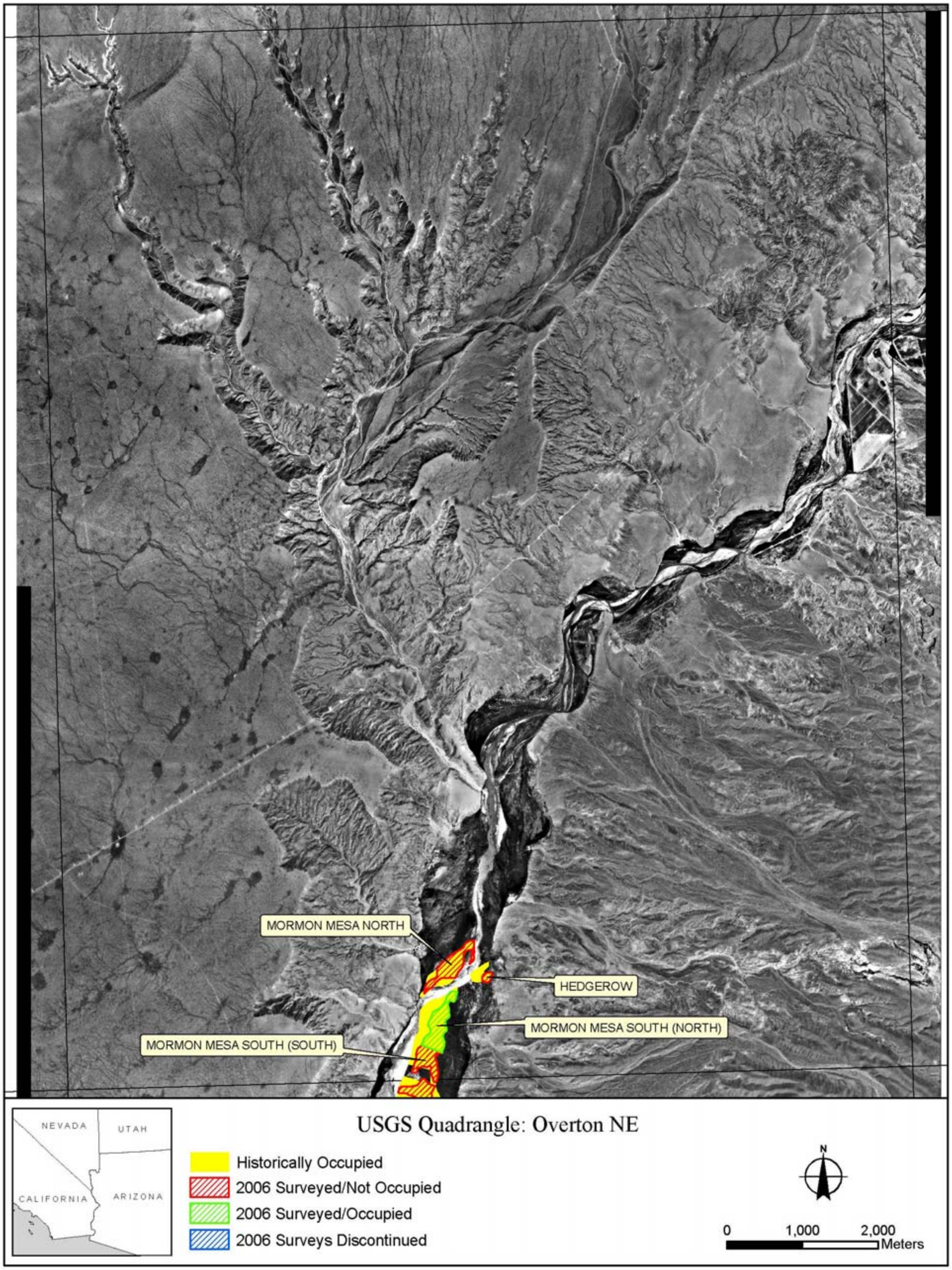

PAHRANAGAT NORTH
PAHRANAGAT WEST
PAHRANAGAT MAPS
PAHRANAGAT SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Alamo SE
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

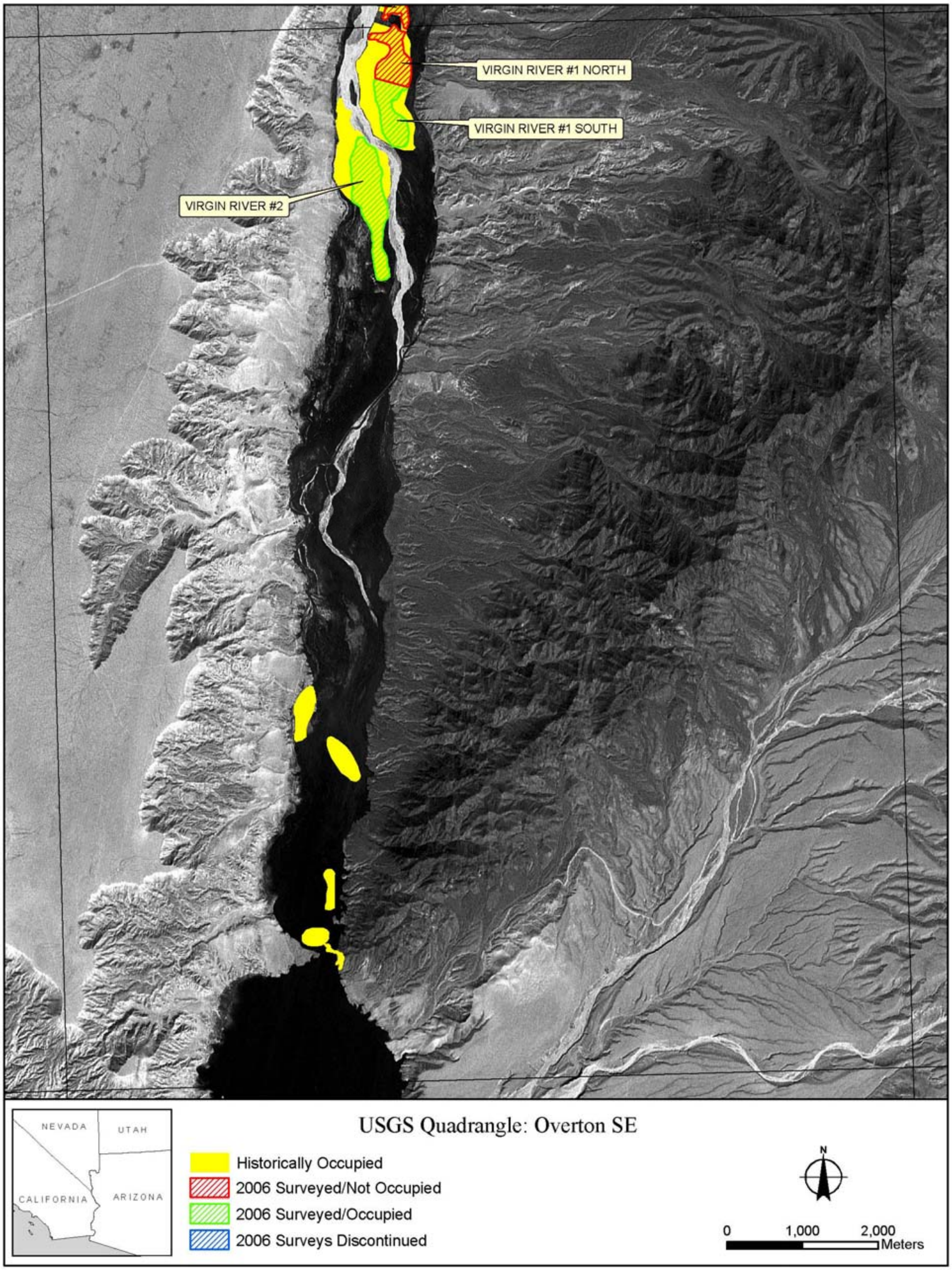

PAHRANAGAT SALT CEDAR
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Lower Pahranagat Lake
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

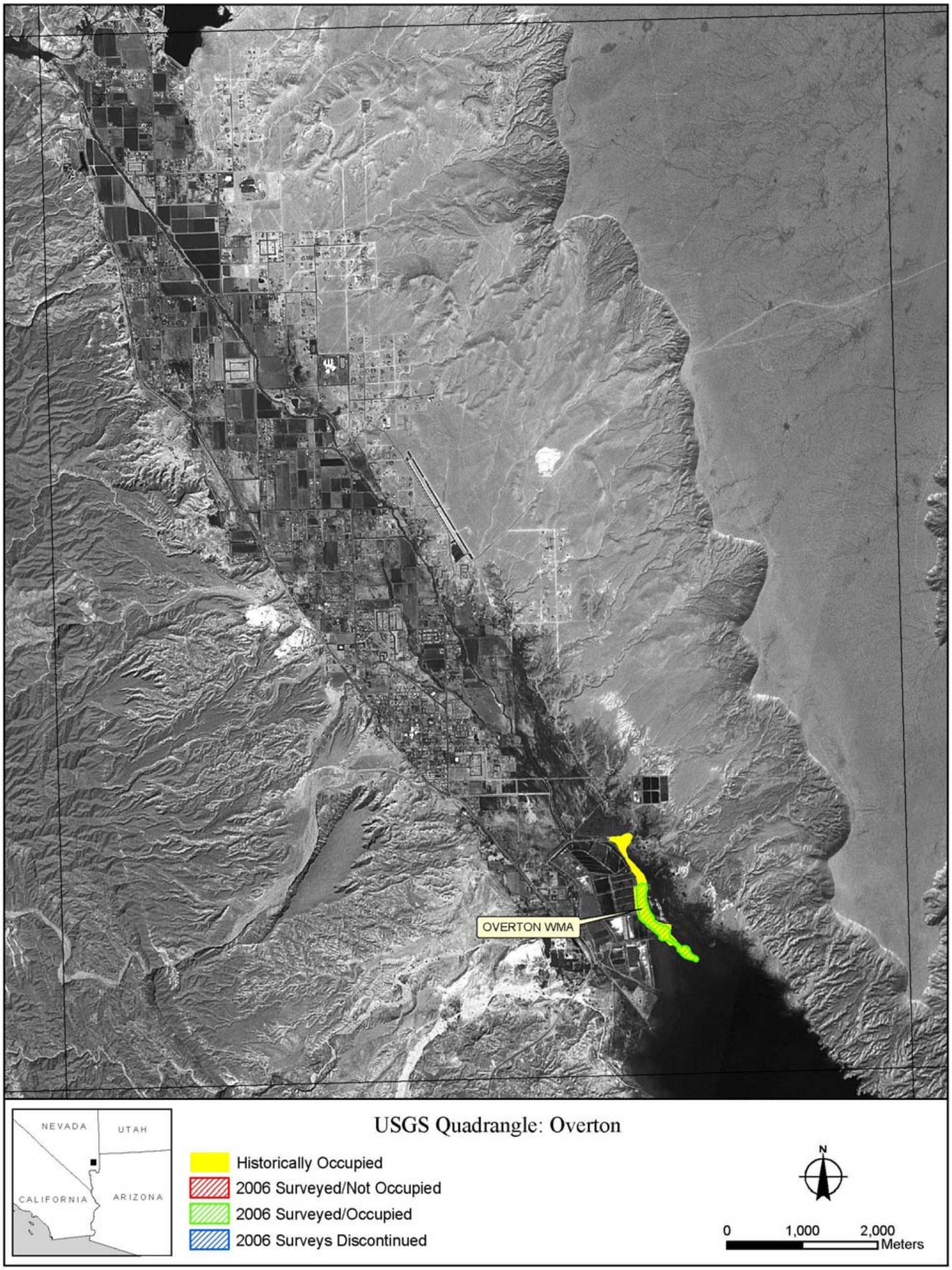

LITTLEFIELD NORTH
USGS Quadrangle: Littlefield
NEVADA
UTAH
CALIFORNIA
ARIZONA
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

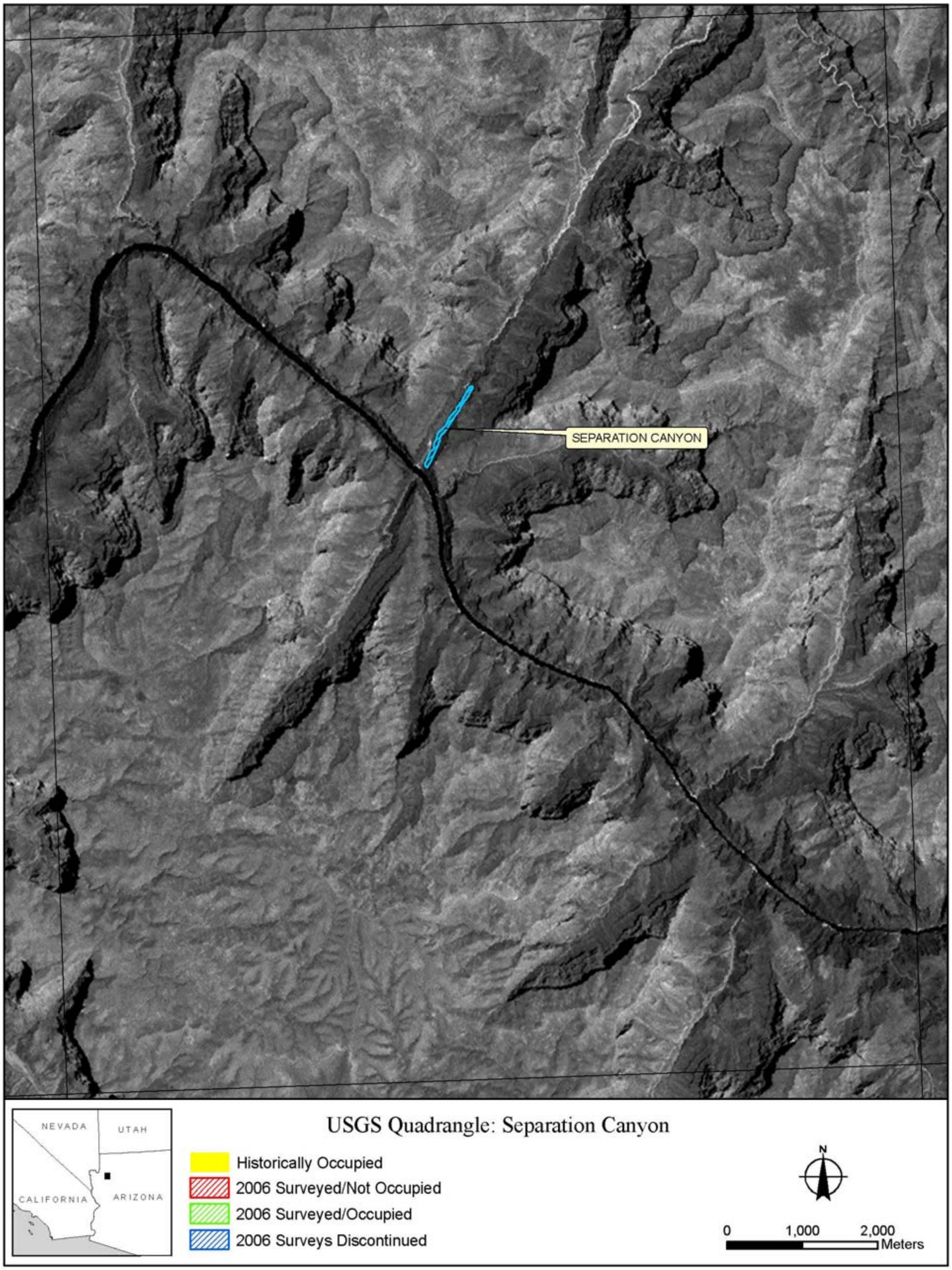

MESQUITE WEST
HAFEN LANE
MESQUITE EAST
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Mesquite
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

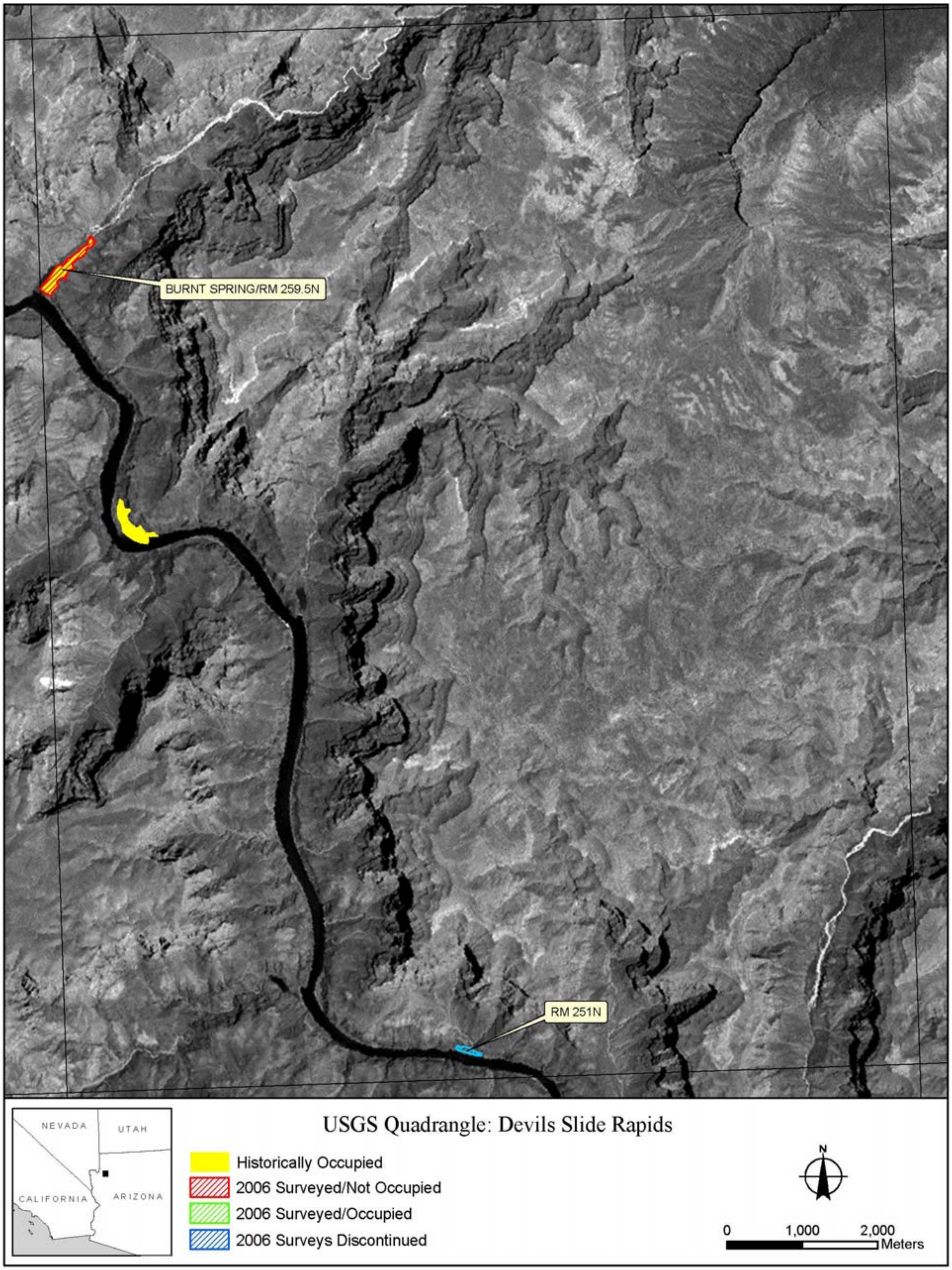

ELECTRIC AVENUE NORTH
ELECTRIC AVENUE SOUTH
BUNKER FARM
BUNKER MARSH NORTH
BUNKER MARSH NORTH
BUNKER MARSH SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Flat Top Mesa
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

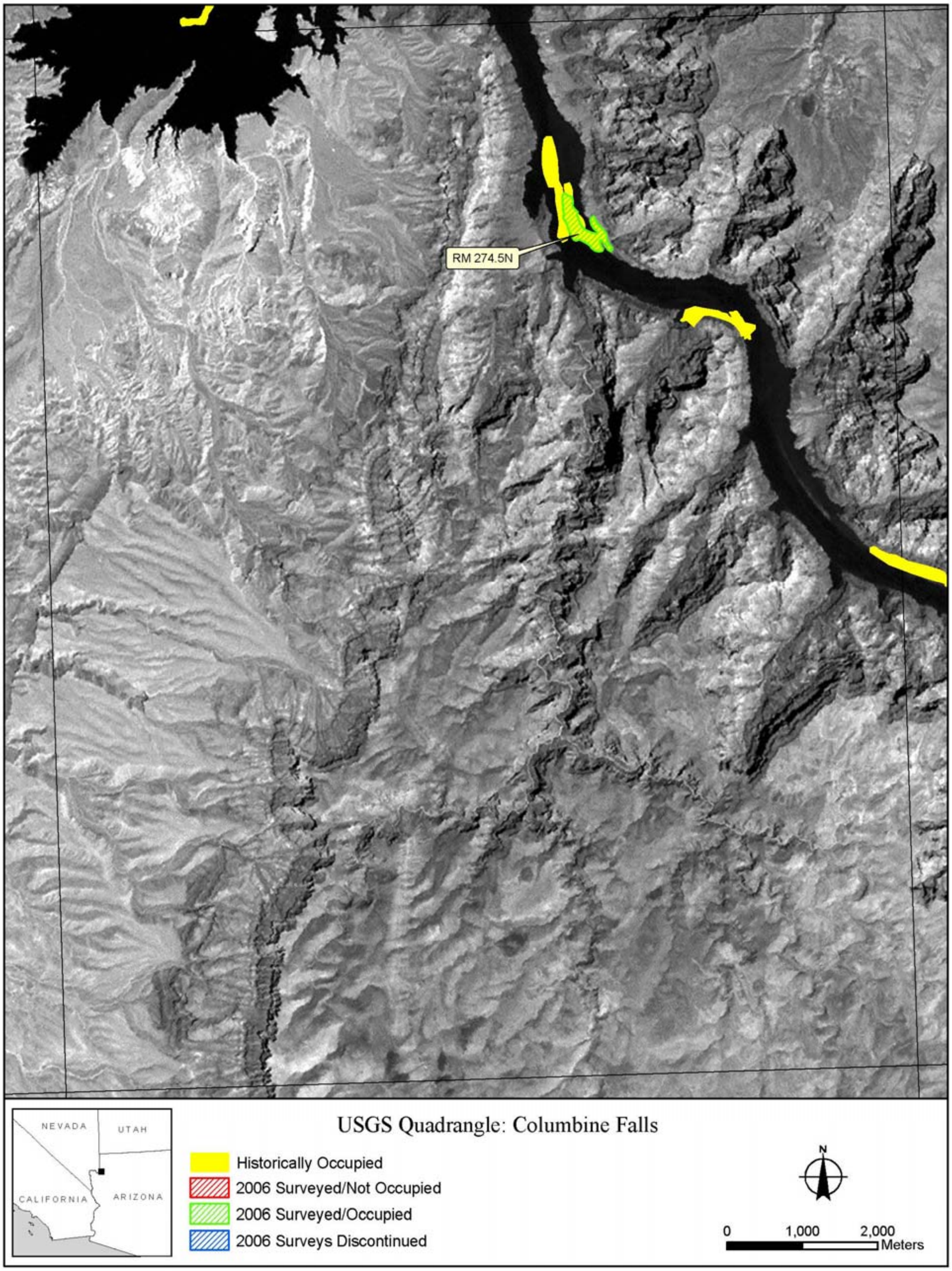

MORMON MESA NORTH
HEDGEROW
MORMON MESA SOUTH (NORTH)
MORMON MESA SOUTH (SOUTH)
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton NE
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

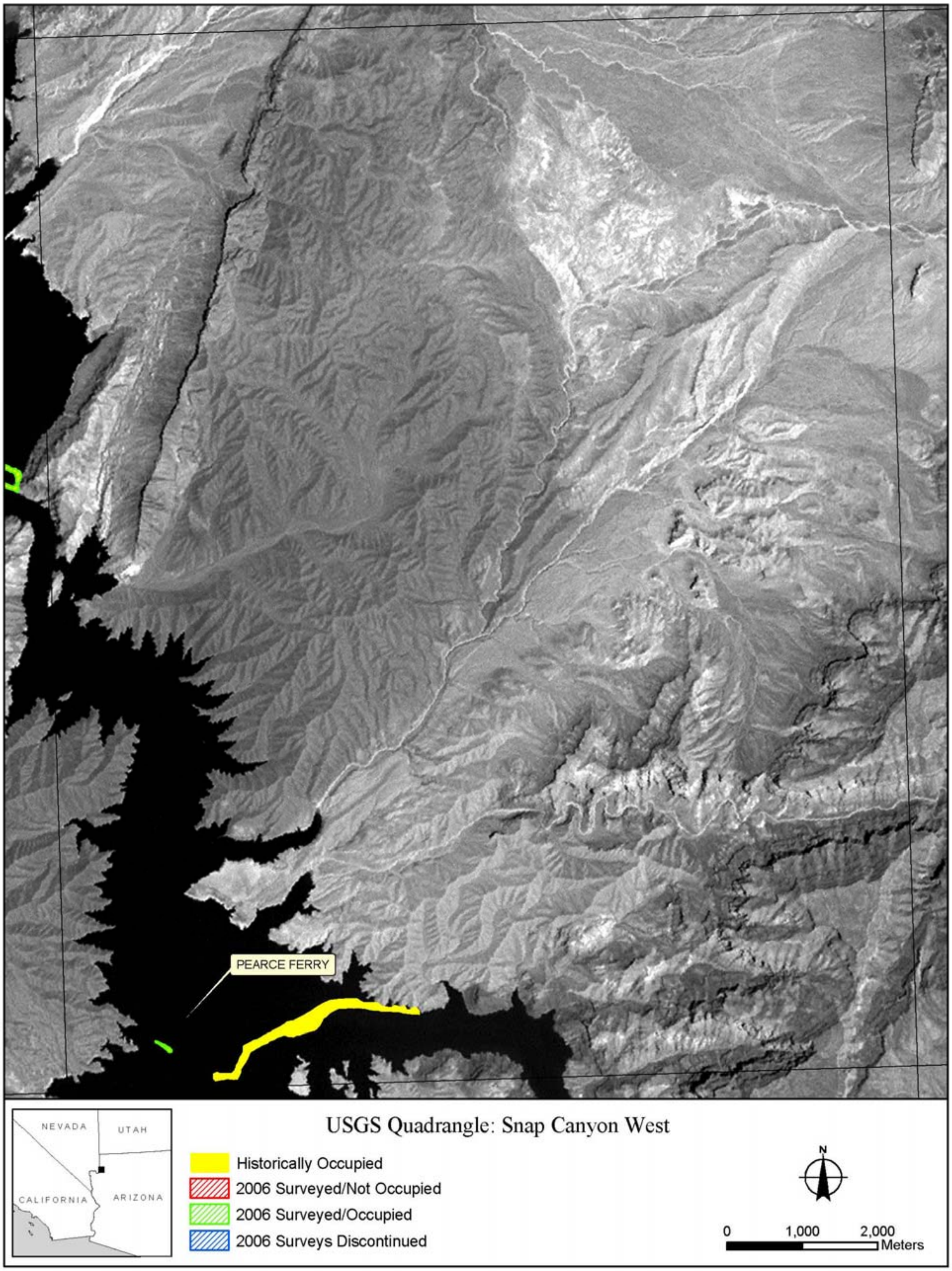

VIRGIN RIVER #1 NORTH
VIRGIN RIVER #1 SOUTH
VIRGIN RIVER #2
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton SE
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

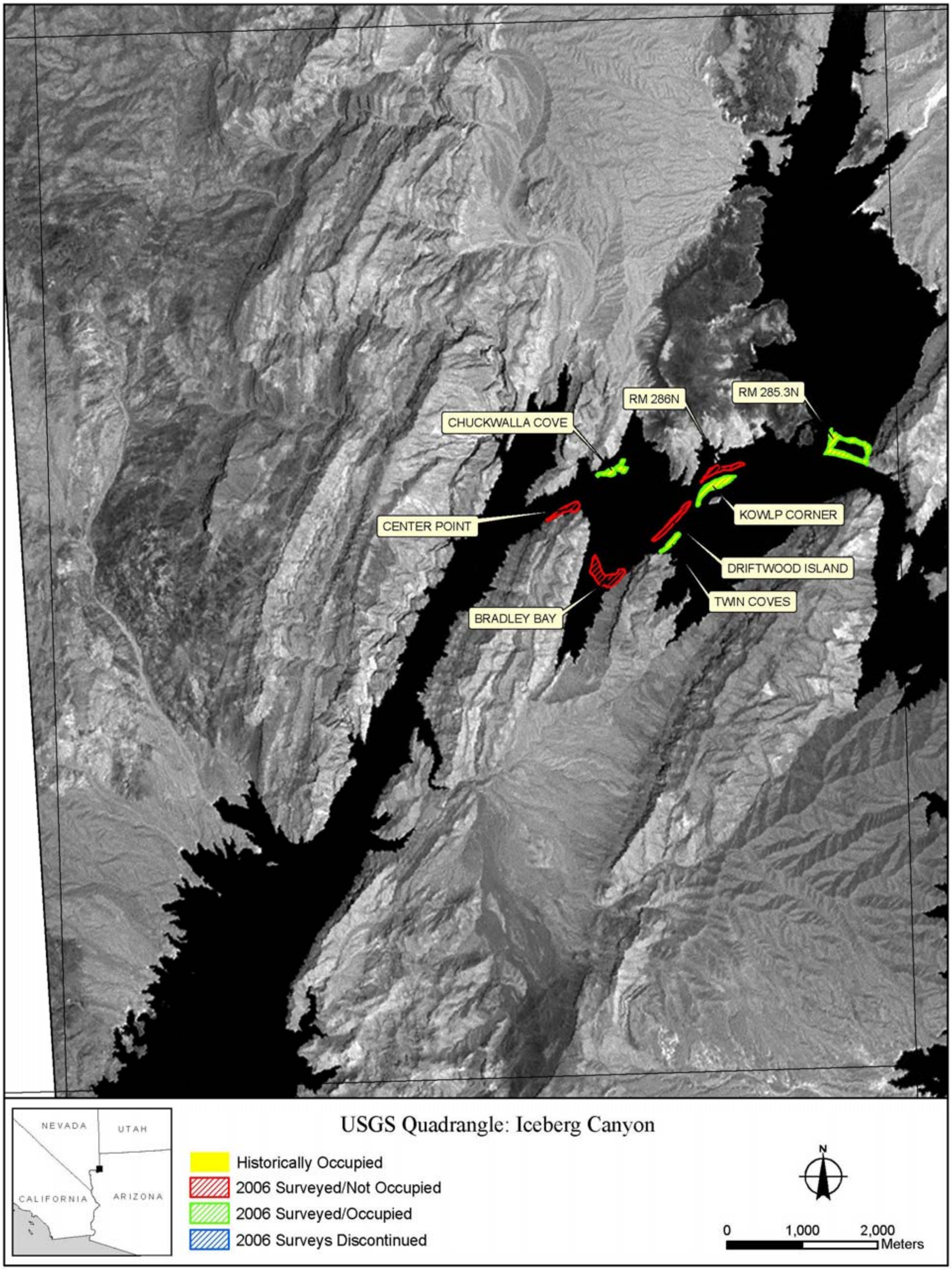

OVERTON WMA
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

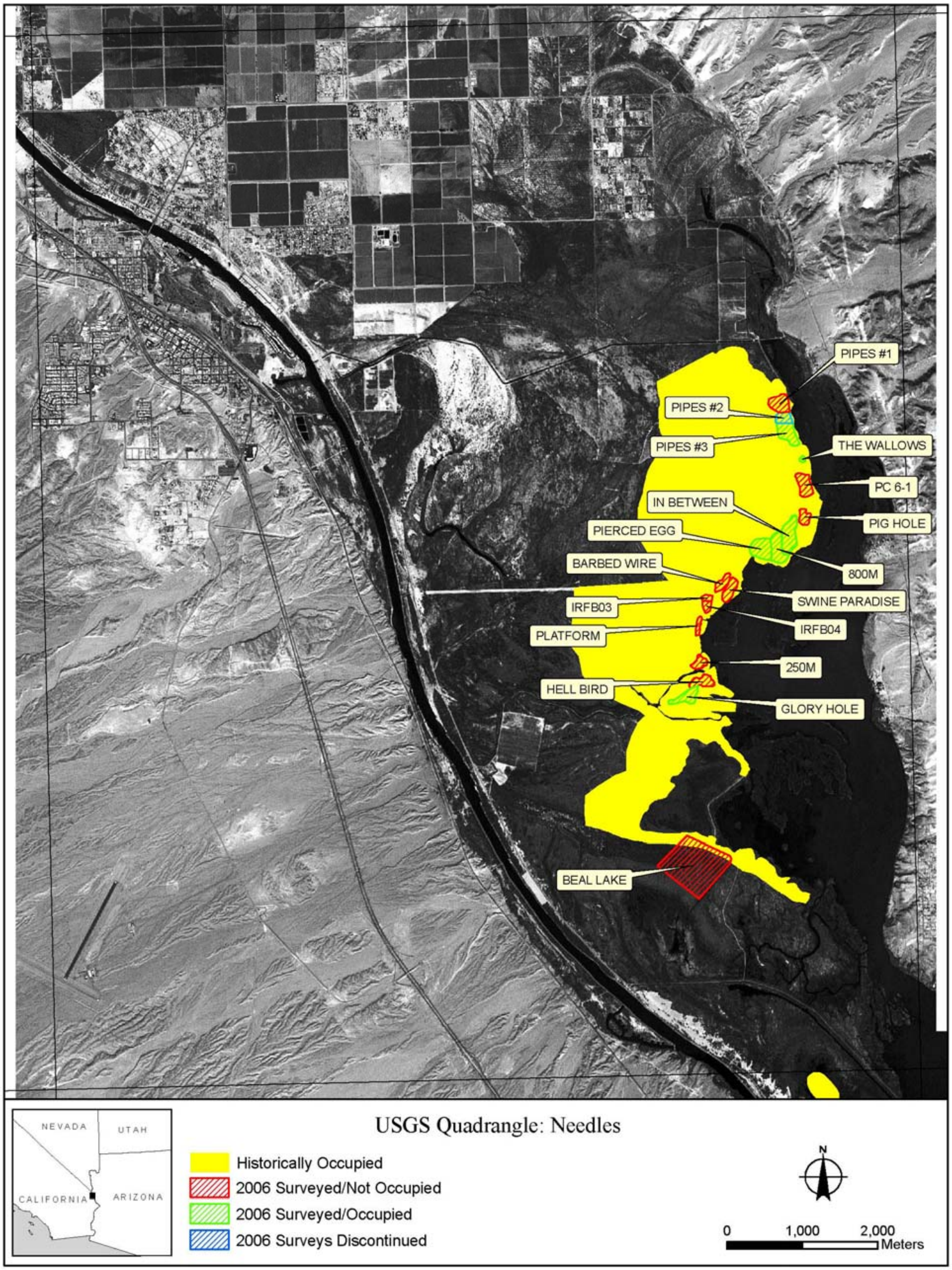

SEPARATION CANYON
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Separation Canyon
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

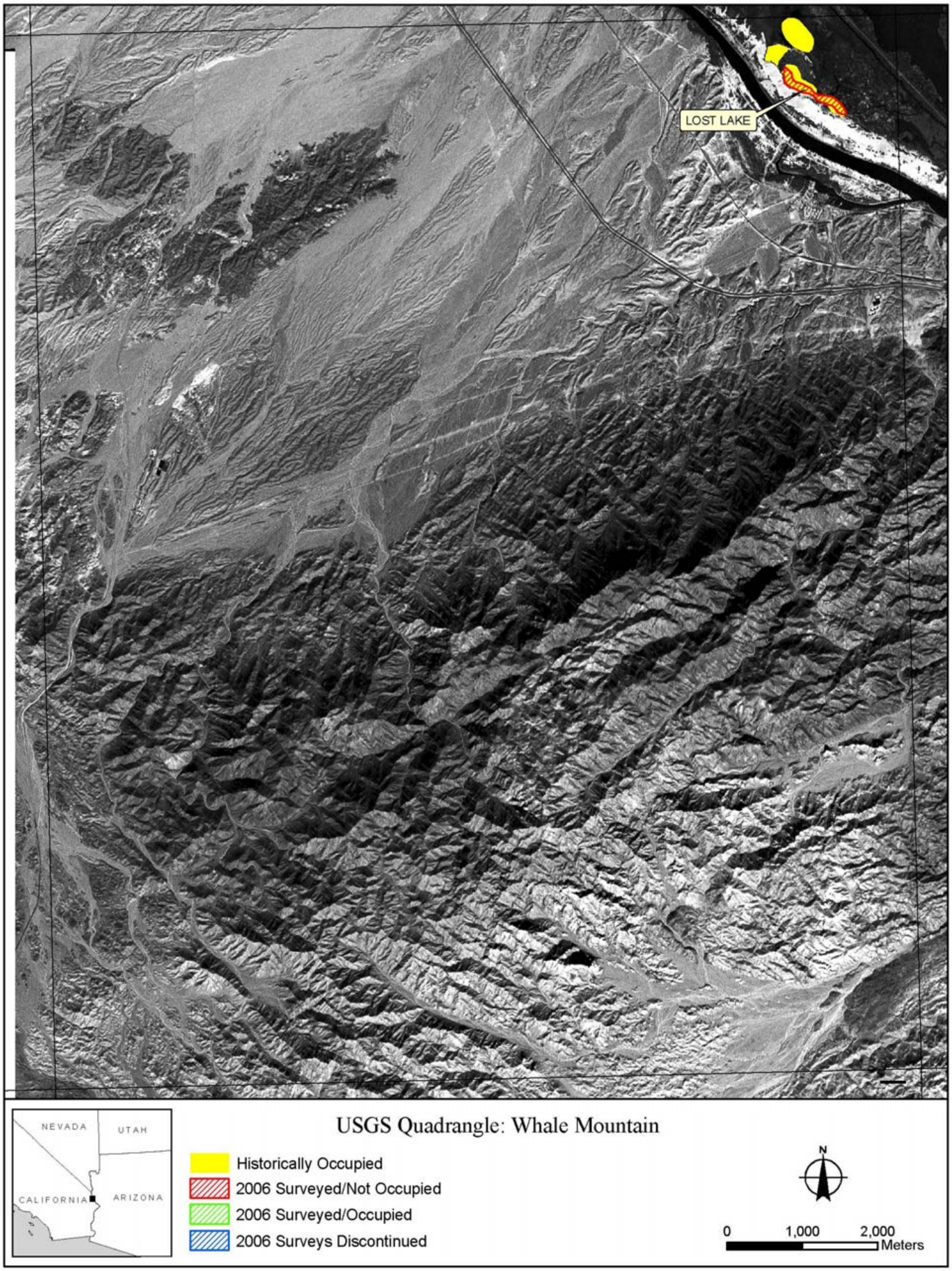

BURNT SPRING/RM 259.5N
RM 251N
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Devils Slide Rapids
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

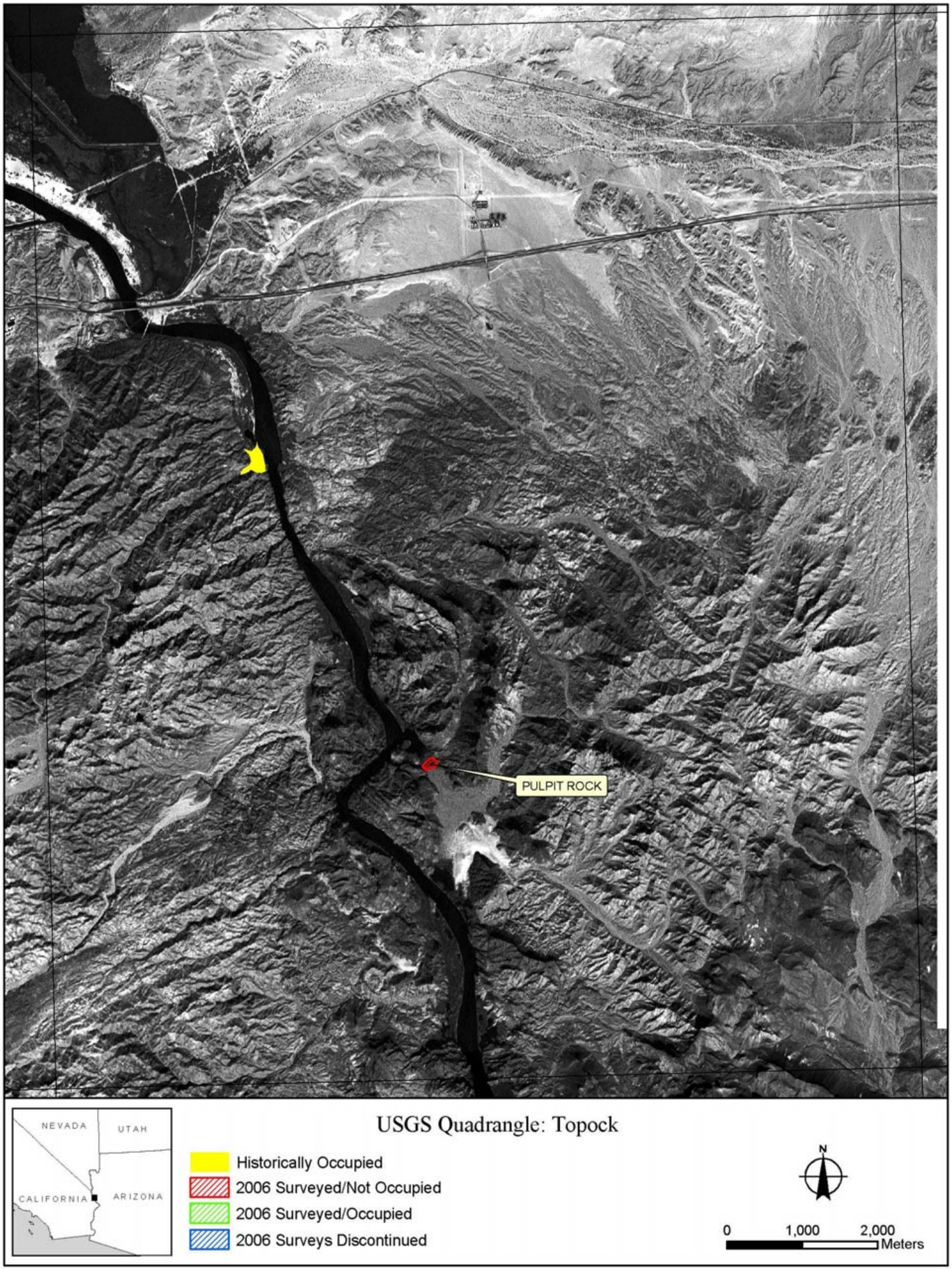

RM 274.5N
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Columbine Falls
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters


PEARCE FERRY
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Snap Canyon West
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

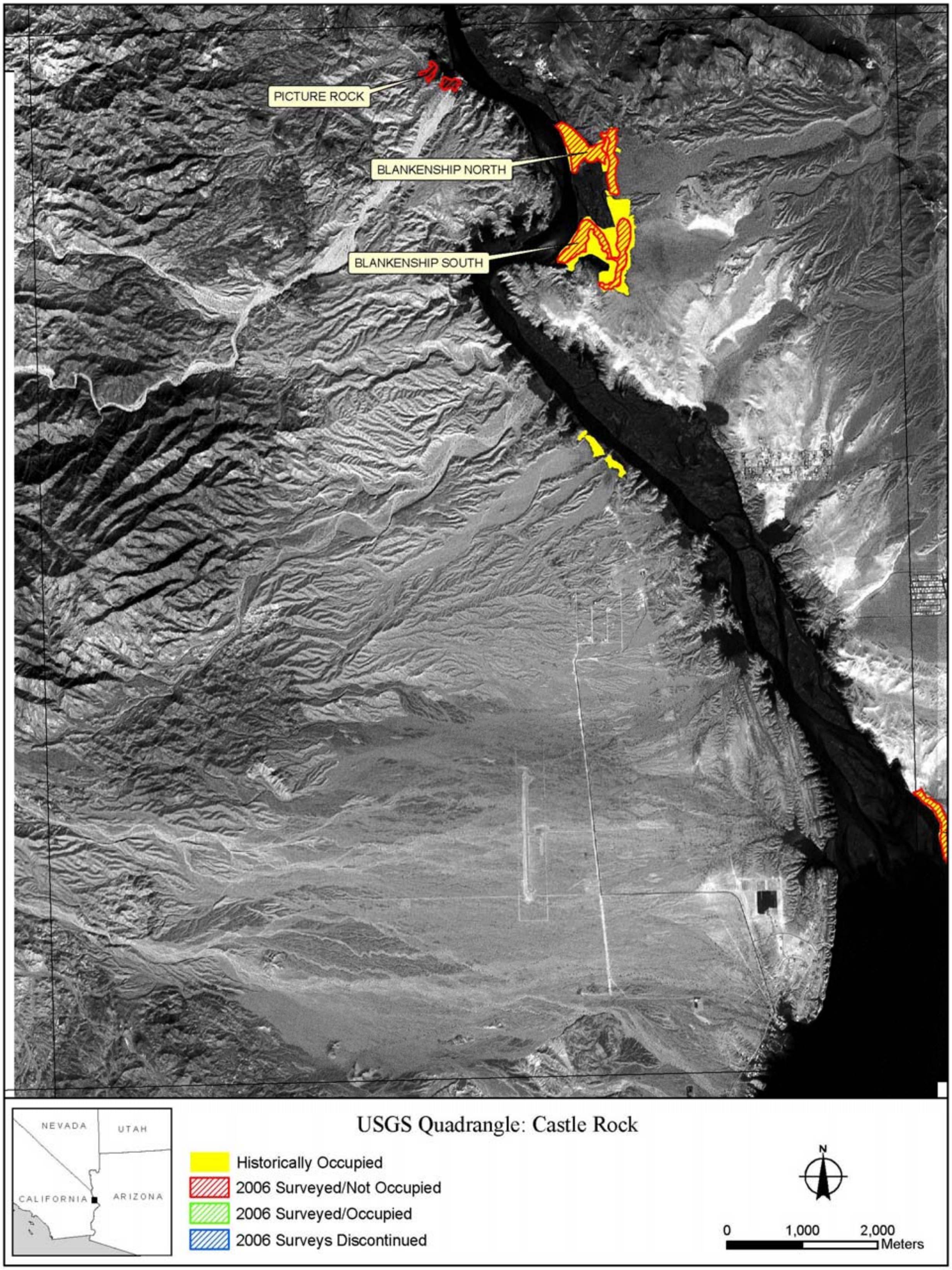

RM 285.3N
RM 286N
CHUCKWALLA COVE
KOWLP CORNER
CENTER POINT
DRIFTWOOD ISLAND
TWIN COVES
BRADLEY BAY
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Iceberg Canyon
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

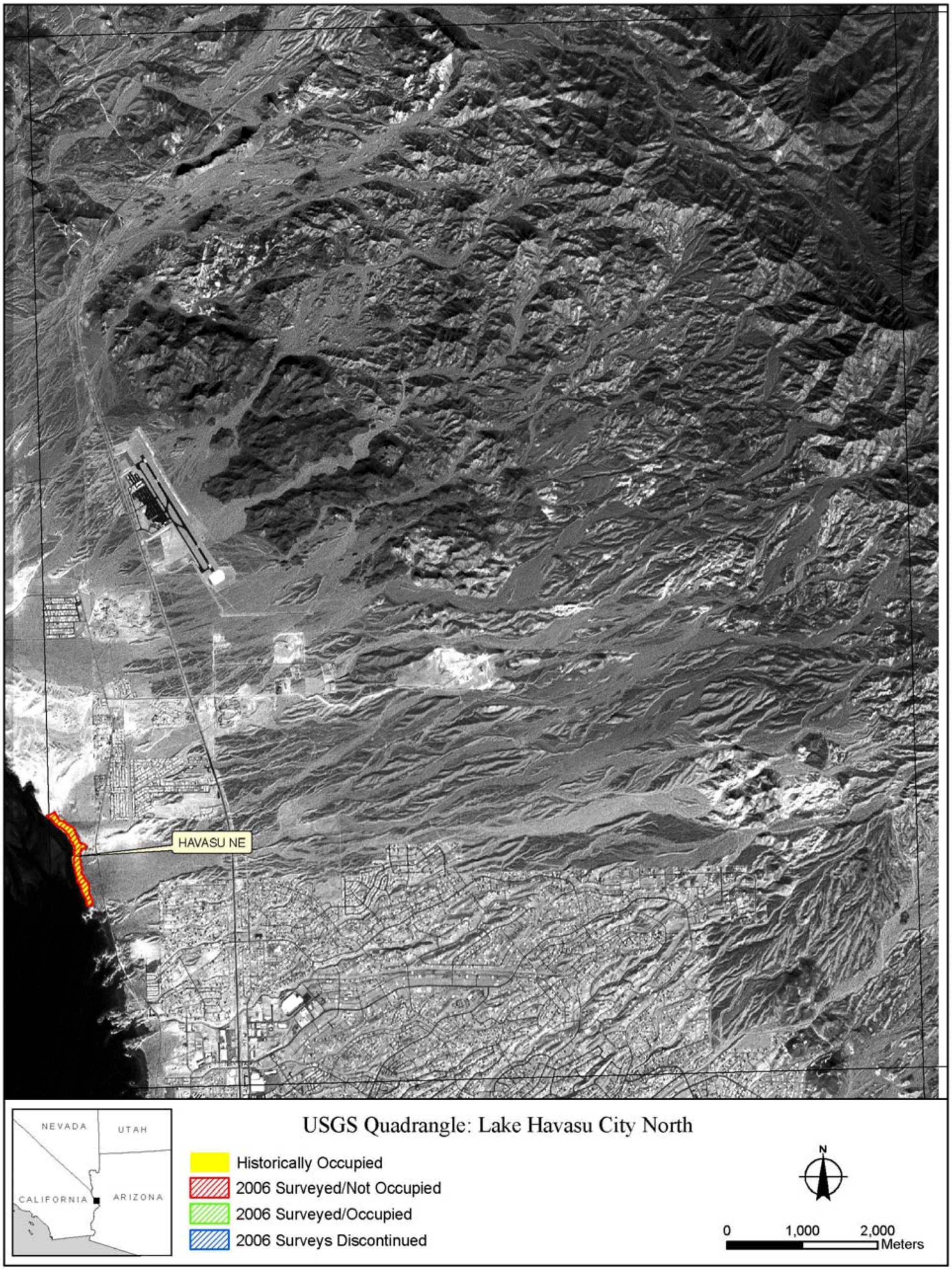

PIPES #1
PIPES #2
PIPES #3
THE WALLOWS
PC 6-1
IN BETWEEN
PIG HOLE
PIERCED EGG
800M
BARBED WIRE
SWINE PARADISE
IRFB03
IRFB04
PLATFORM
250M
HELL BIRD
GLORY HOLE
BEAL LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Needles
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters


LOST LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Whale Mountain
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

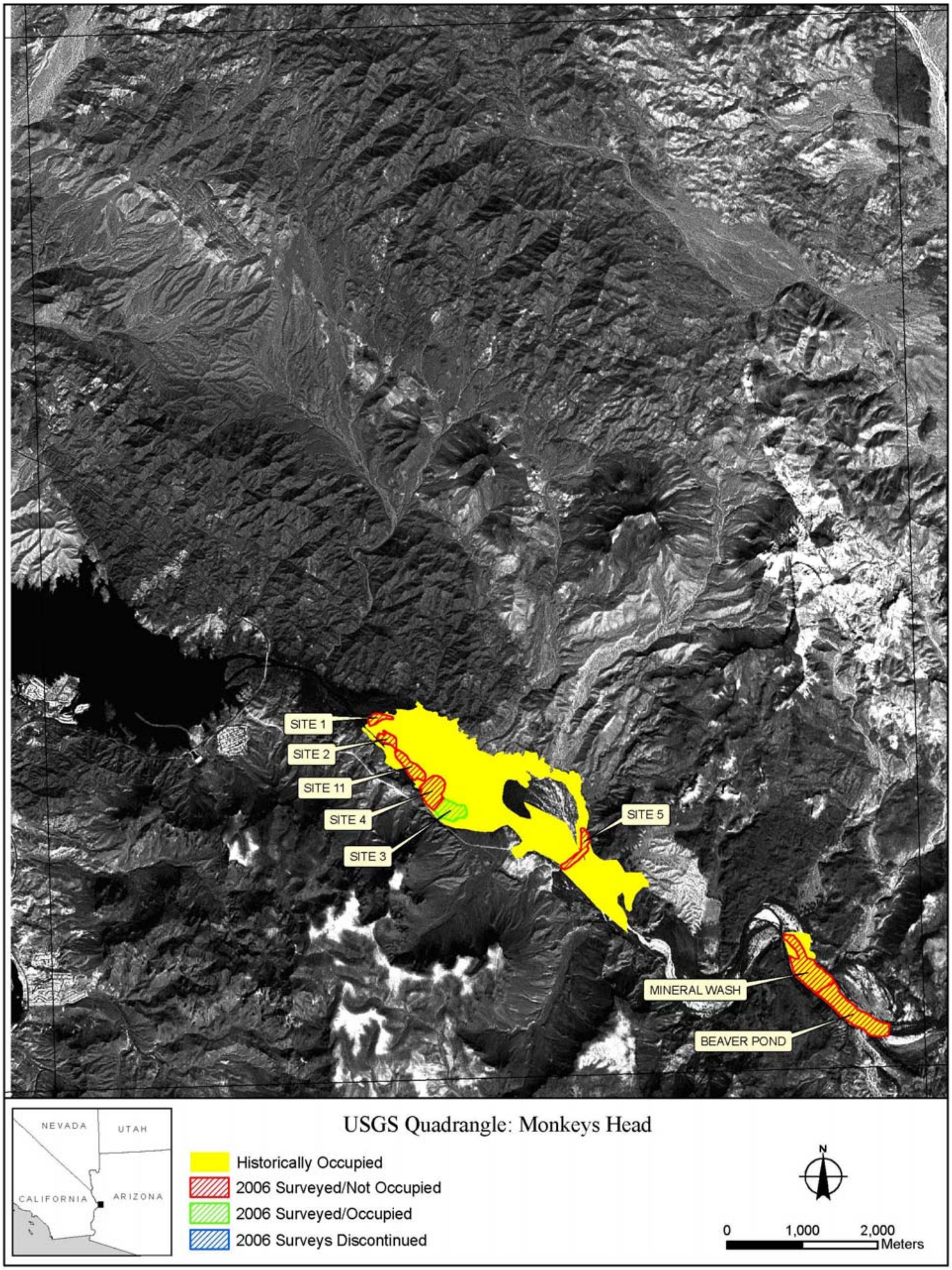


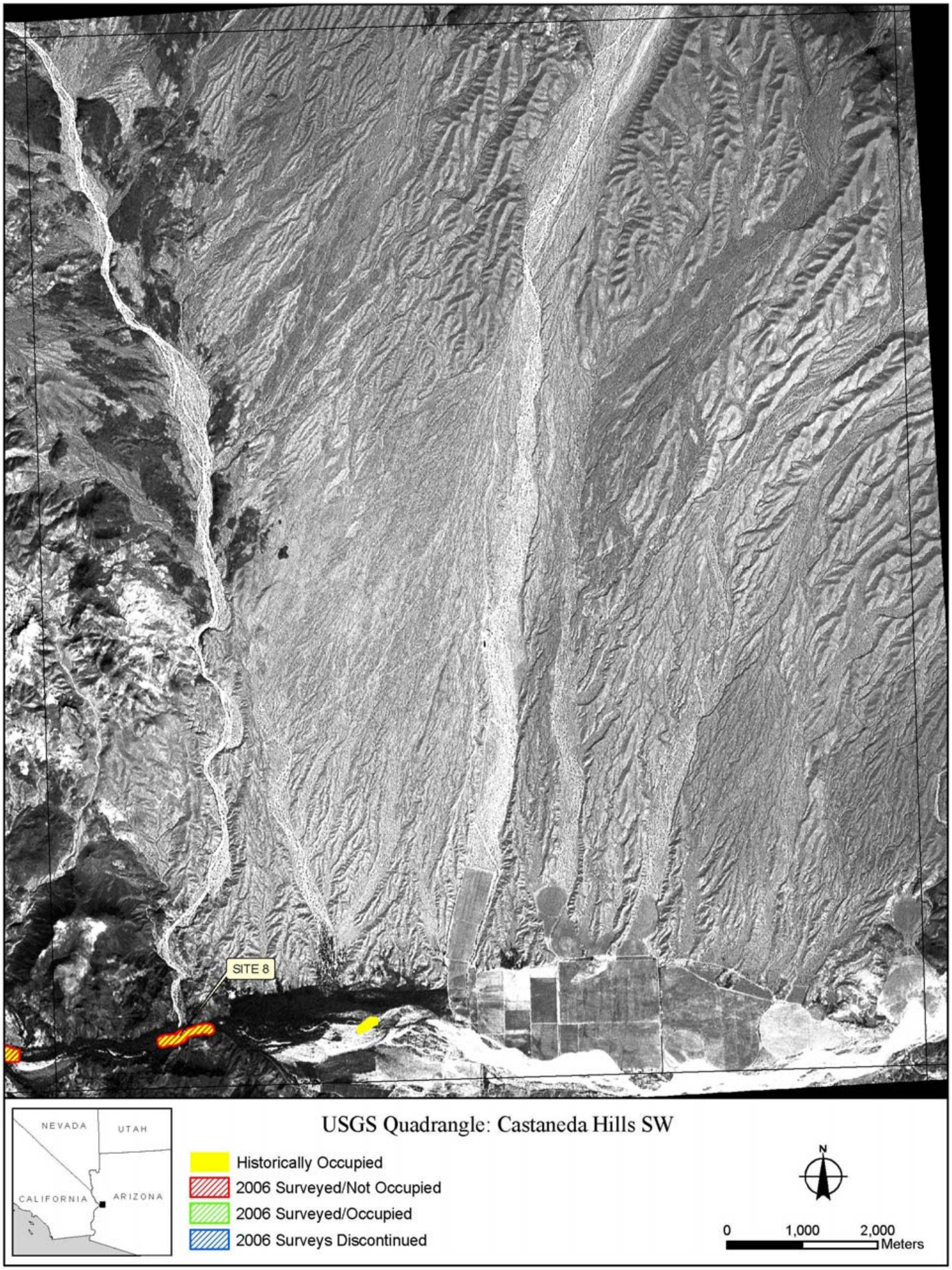
PULPIT ROCK
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Topock
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters


PICTURE ROCK
BLANKENSHIP NORTH
BLANKENSHIP SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castle Rock
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters



HAVASU NE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Lake Havasu City North
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

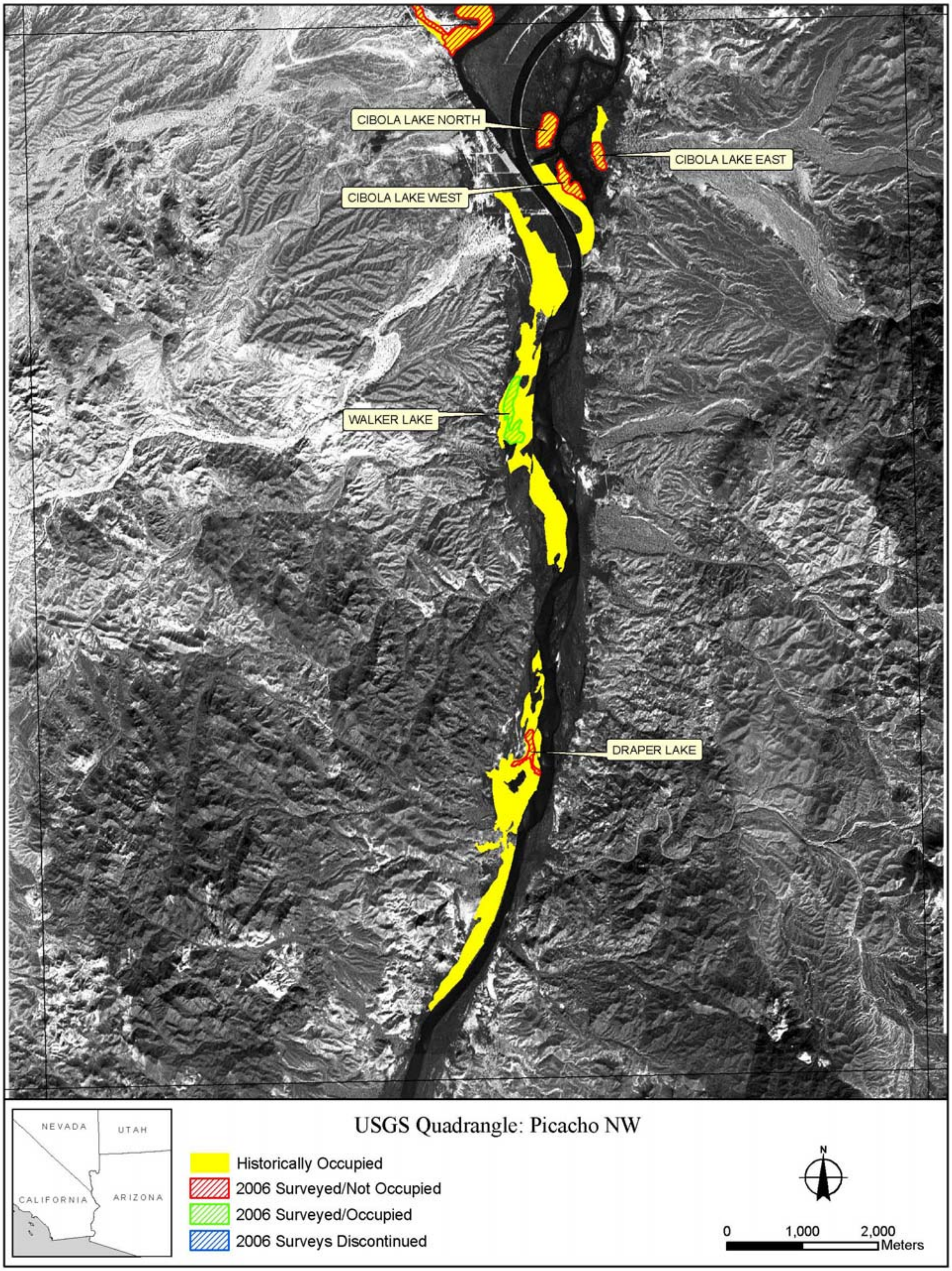

SITE 1
SITE 2
SITE 11
SITE 4
SITE 3
SITE 5
MINERAL WASH
BEAVER POND
USGS Quadrangle: Monkeys Head
NEVADA
UTAH
CALIFORNIA
ARIZONA
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

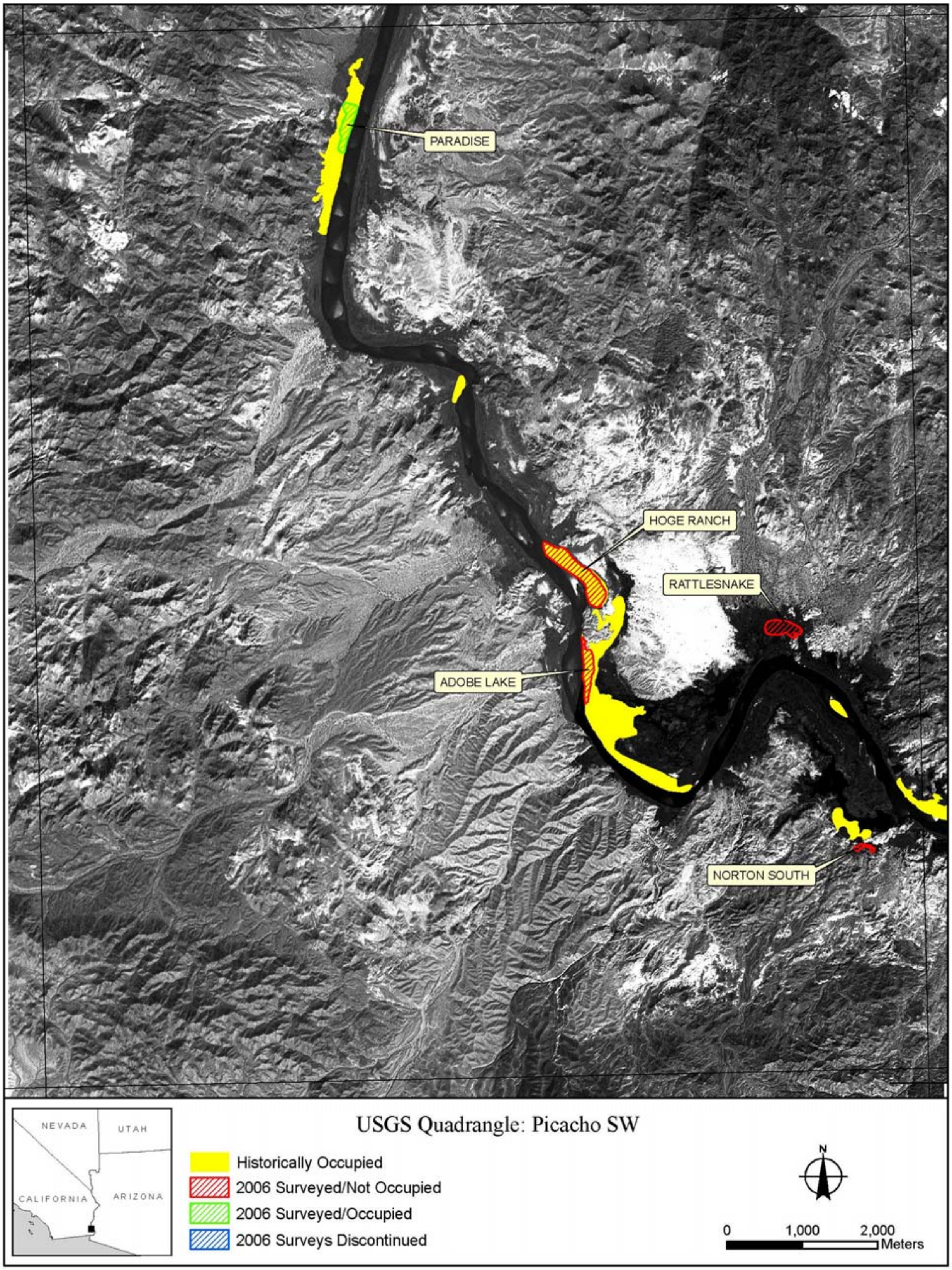

SITE 8
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castaneda Hills SW
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

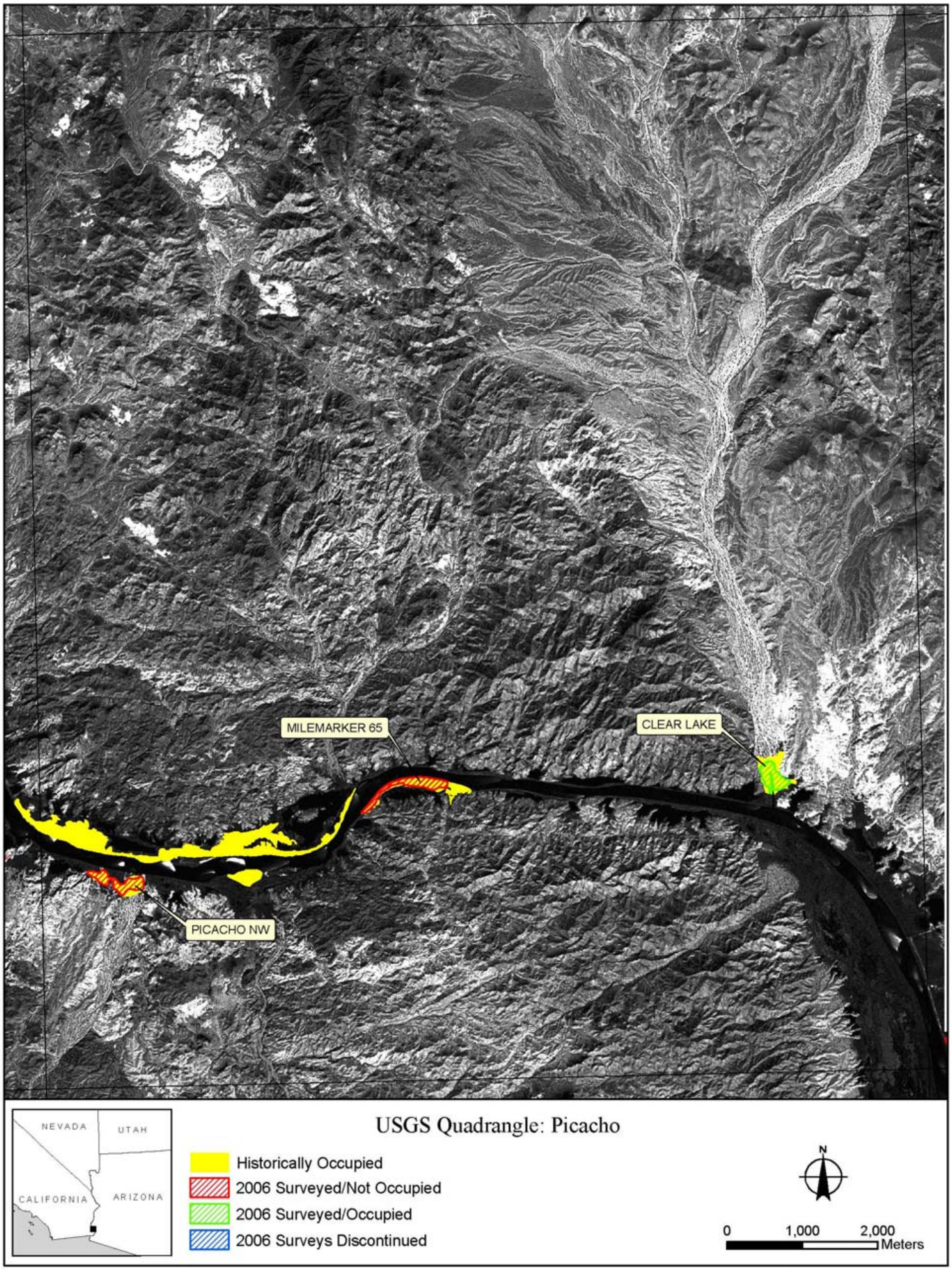

BIG HOLE SLOUGH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Blythe NE
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

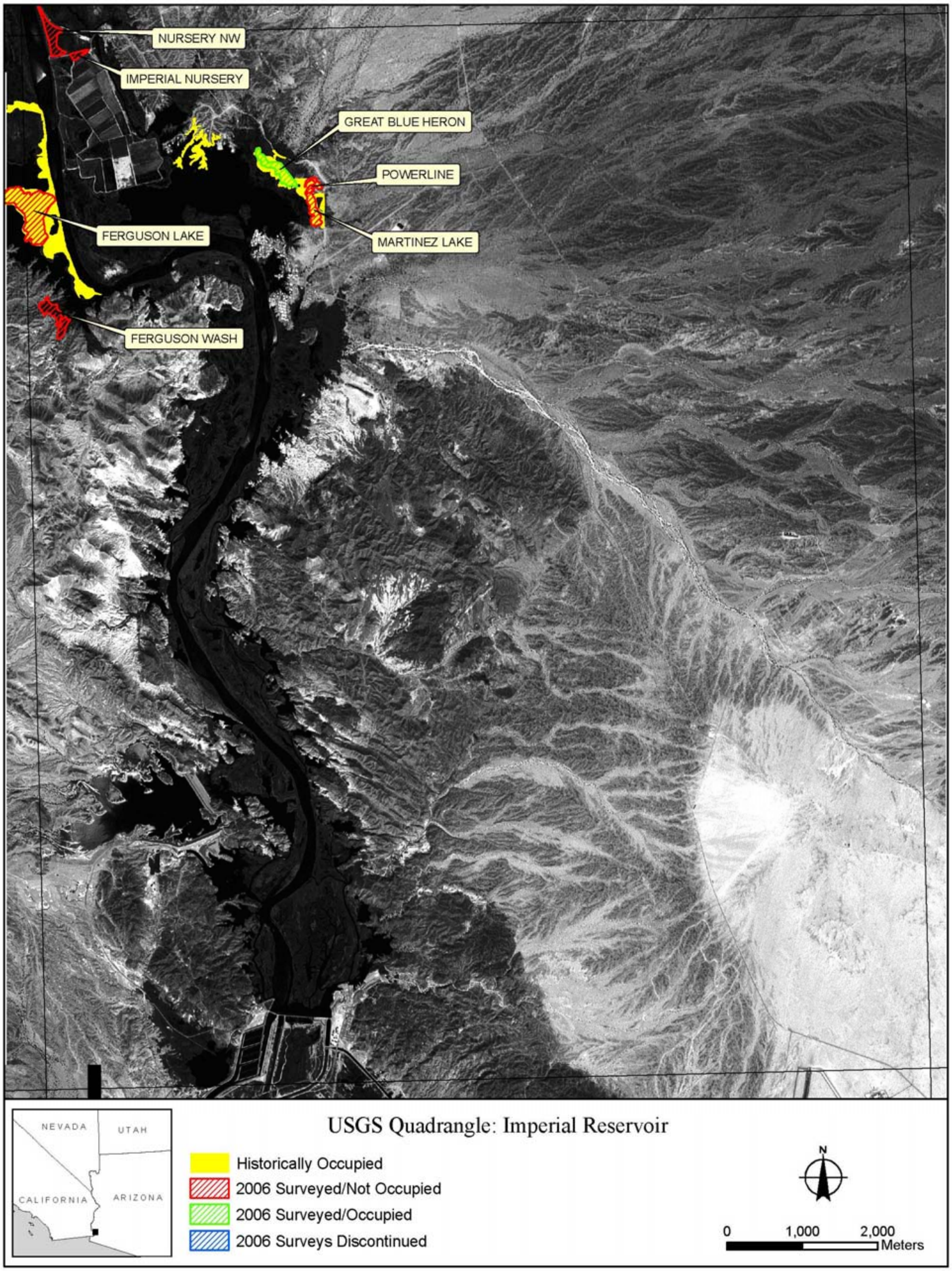

EHRENBERG
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Blythe
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

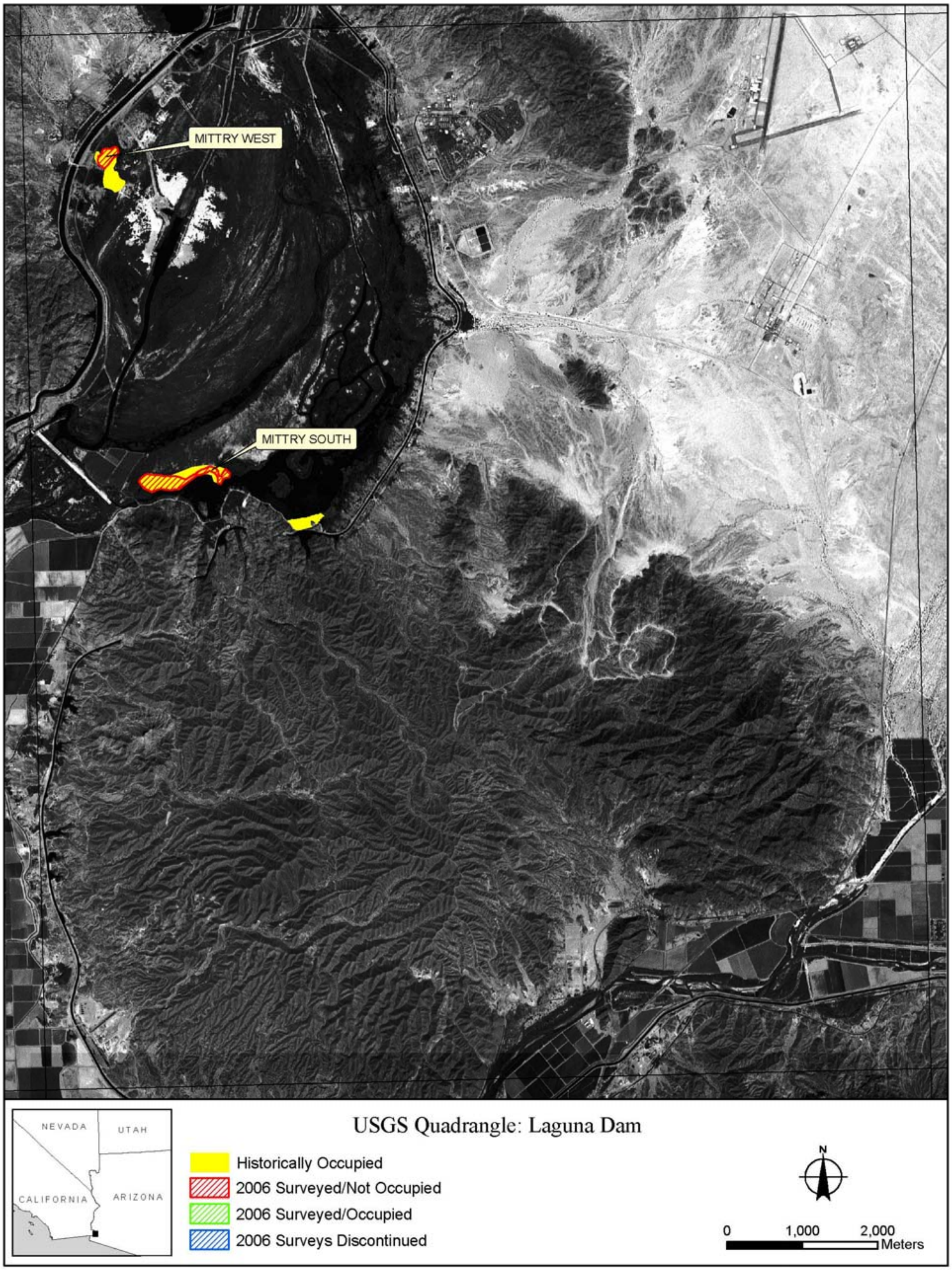

CIBOLA NATURE TRAIL
CIBOLA SITE 2
CIBOLA SITE 1
HART MINE MARSH
THREE FINGERS LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Cibola
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

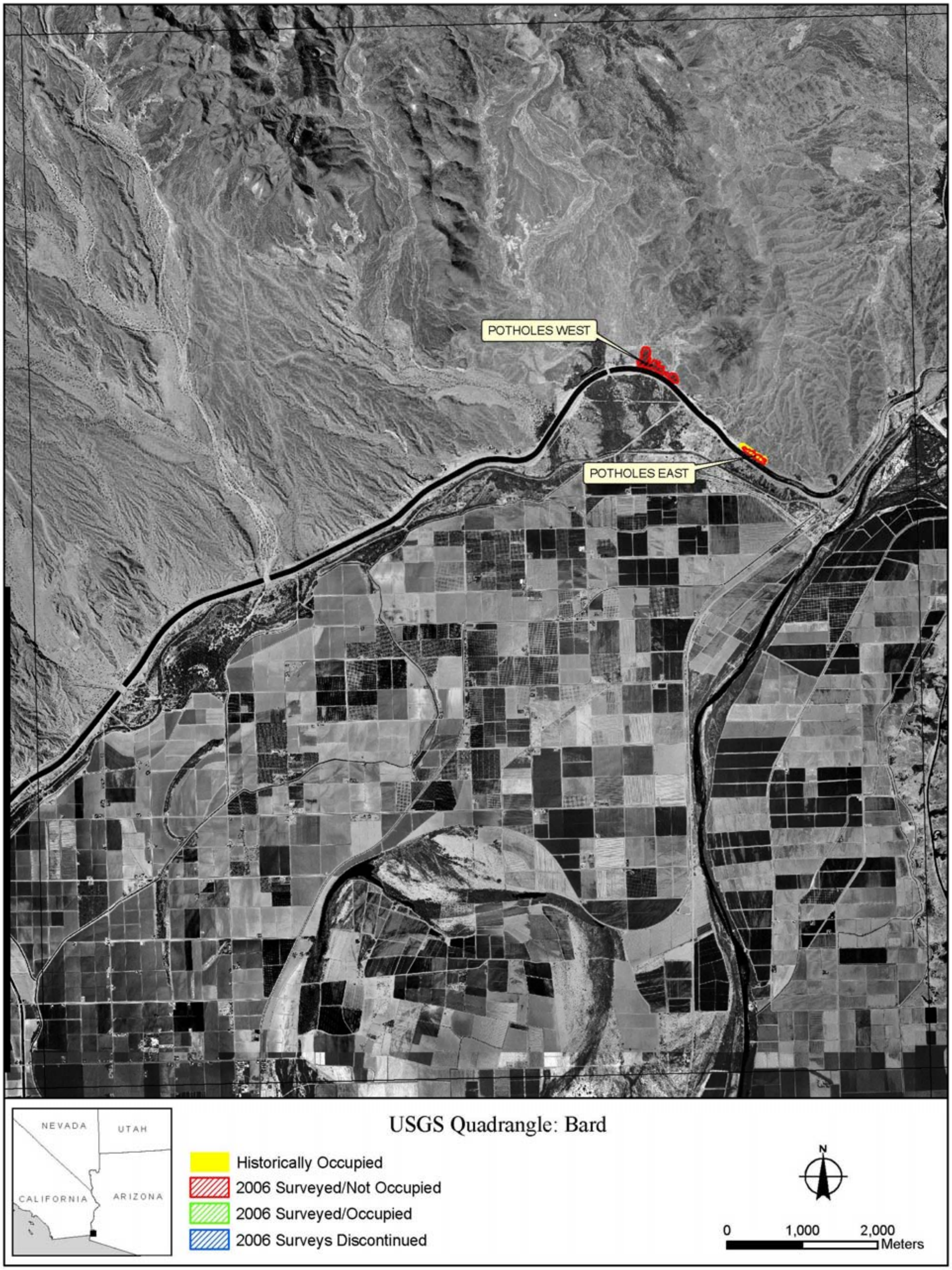

CIBOLA LAKE NORTH
CIBOLA LAKE EAST
CIBOLA LAKE WEST
WALKER LAKE
DRAPER LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho NW
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters


PARADISE
HOGE RANCH
RATTLESNAKE
ADOBE LAKE
NORTON SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho SW
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters


MILEMARKER 65
CLEAR LAKE
PICACHO NW
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters


NURSERY NW
IMPERIAL NURSERY
GREAT BLUE HERON
POWERLINE
FERGUSON LAKE
MARTINEZ LAKE
FERGUSON WASH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Imperial Reservoir
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters


MITTRY WEST
MITTRY SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Laguna Dam
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters


POTHOLES WEST
POTHOLES EAST
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Bard
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters


FORTUNA NORTH
GILA RIVER SITE 2
FORTUNA SITE 1
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Fortuna
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters


GILA CONFLUENCE NORTH
GILA RIVER SITE 1
RM 33
GILA CONFLUENCE WEST
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Yuma East
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters


MORELOS DAM
USGS Quadrangle: Yuma West
NEVADA
UTAH
CALIFORNIA
ARIZONA
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters


GADSDEN BEND
GADSDEN
HUNTERS HOLE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Gadsden
Historically Occupied
2006 Surveyed/Not Occupied
2006 Surveyed/Occupied
2006 Surveys Discontinued
N
0
1,000
2,000
Meters

APPENDIX C

All Willow Flycatchers Color-banded and/or Resighted
2003–2006

Appendix C. Willow flycatchers banded and resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2006. 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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1590-97338	OG(M):XX	PAHR	North	AHY	M	16-Jun-97	X				X	X	X	X		
1710-20312	BG(M):Vs	ROOS	Shangri-la	L	M	27-Jun-03							X		X[3]	
1710-20638	YR(M):XX	GRCA	RM 267.0	AHY	M	1-Jul-98		X	X[1]	X	X	X	X	X	X	
2090-42022	GG(P):XX	MOME	South	L	F	1-Jul-98		X					X[2]			
2090-42204	VR(P):YR(P)/XX	MESQ	East	AHY	F	2-Jul-97	X									
2110-78841	B(HP)/Y(HP):BEs	TOPO	800M	HY	F	8-Jul-02						X	X	X	X	
2110-78842	OB(P):BEs	MESQ	West	AHY	M	31-Jul-02						X	X	X		
2110-78855	RK(M):BEs	TOPO	800M	HY	M	7-Jul-02						X	X			
2110-78861	BEs:VK(M)	TOPO	In Between	L	M	6-Jul-02						X	X[4]	X[2]		
2110-78863	R(HP)/V(HP):BEs	TOPO	In Between	L	M	6-Jul-02						X	X	X		
2140-66564	RR(P):Zs	PAHR	North	L	F	4-Jul-02						X	X			
2140-66606	KY(M):Rs	MOME	North	L	M	17-Jul-98		X		X[2]	X		X			
2140-66693	Rs:OK(M)	MOME	Delta West	L	M	2-Aug-01					X	X[2]	X			
2140-66696	Rs:R(HP)/O(HP)	MESQ	West	L	F	3-Aug-01					X		X			
2140-66709	Bs:GW(M)	MESQ	West	AHY	M	22-Jul-02						X	X	X		X[10]
2140-66728	Bs:DD(P)	TOPO	800M	L	M	8-Jul-01					X			X		
2140-66743	OG(M):Bs	TOPO	800M	L	M	7-Jul-99			X					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			
2320-31403	EE:VK(M)	YUMA	Gila 1.5[G]	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			

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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
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	In Between	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	Hell Bird	AHY	U	6-Jul-04								X		
2320-31424	DB(M):EE	TOPO	Hell Bird	L	M	7-Jul-04								X	X	
2320-31425	EE:UB	TOPO	Hell Bird	L	U	7-Jul-04								X		
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	M	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	F	5-Jul-03							X	X[1]		
2320-31441[I]	UB:EE	MOME	Delta West	L	U	9-Jul-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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2320-31442	EE:WD(M)	MESQ	West	L	M	19-Jul-02						X	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	X
2320-31445	EE:WK(M)	MESQ	West	AHY	F	1-Aug-03							X	X	X	X
2320-31446	UB:EE	PAHR	North	L	U	29-Jun-04								X		
2320-31447[I]	UB:EE	PAHR	North	L	U	25-Jul-04								X		
2320-31448	UB:EE	PAHR	North	L	U	29-Jun-04								X		
2320-31449[I]	UB:EE	PAHR	North	L	U	25-Jul-04								X		
2320-31450[I]	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:WB(M)	PAHR	North	L	F	26-Jun-03							X			X[6]
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	X
2320-31468	EE:RO(M)	PAHR	North	L	M	27-Jun-03							X		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			
2320-31473	EE:OKO(M)	MESQ	West	L	M	29-Jun-03							X	X		
2320-31474[I]	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]		

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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2320-31476	DD(M):EE	MESQ	West	SY	F	17-Jun-03							X			
2320-31477[I]	EE:UB	MESQ	West	L	U	25-Jun-03							X			
2320-31478	DW(M):EE	MESQ	West	AHY	M	25-Jul-02						X	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		X
2320-31486	YV(M):EE	MESQ	West	L	F	23-Jul-03							X	X[7]	X[2]	X[1]
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]	X
2320-31491	GK(M):EE	MESQ	Electric Ave	AHY	M	4-Jun-04								X		
2320-31492	EE:RG(M)	MESQ	West	L	F	19-Jul-02						X		X		
2320-31493	DO(M):EE	MUDD	Overton WMA	AHY	M	9-Jun-04								X		
2320-31494	EE:OG(M)	MESQ	Riverside West	AHY	U	19-Jun-04								X		
2320-31495	DY(M):EE	TOPO	Lost Lake	AHY	M	16-Jun-04								X		
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	KW(M):EE	MOME	North	L	F	23-Jun-04								X		X[12]
2320-31499	KO(M):EE	MESQ	West	SY	M	25-Jun-04								X		
2320-31500[I]	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	In Between	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		

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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
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	X
2320-31516	EE:RD(M)	GRCA	RM 274.5N	SY	F	15-Jul-04								X		
2320-31517	EE:OR(M)	GRCA	RM 274.5N	SY	M	15-Jul-04								X	X[1]	X
2320-31518	UB:EE	TOPO	800M	L	U	30-Jul-04								X		
2320-31519	UB:EE	TOPO	800M	L	U	30-Jul-04								X		
2320-31520	UB:EE	TOPO	800M	L	U	30-Jul-04								X		
2320-31521	EE:DY(M)	TOPO	In Between	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	In Between	AHY	F	21-Jun-03							X			
2320-31528	EE:YV(M)	TOPO	In Between	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	In Between	L	U	27-Jun-03							X			
2320-31533	UB:EE	TOPO	In Between	L	U	27-Jun-03							X			
2320-31534	UB:EE	TOPO	In Between	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	In Between	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	In Between	L	U	2-Aug-04								X		
2320-31543	UB:EE	TOPO	In Between	L	U	2-Aug-04								X		
2320-31544	EE:UB	TOPO	In Between	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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2320-31553	EE:GW(M)	MOME	Virgin River #1North	SY	U	7-Jun-04								X		X
2320-31554	UB:EE	TOPO	In Between	L	U	22-Jun-04								X		
2320-31555	EE:UB	TOPO	In Between	L	U	22-Jun-04								X		
2320-31556	UB:EE	TOPO	In Between	L	U	22-Jun-04								X		
2320-31557[I]	EE:UB	TOPO	In Between	L	U	30-Jul-04								X		
2320-31558	UB:EE	TOPO	In Between	L	U	30-Jul-04								X		
2320-31559	OK(M):EE	TOPO	Hell Bird	SY	M	25-Jul-04								X	X	X
2320-31560	EE:GY(M)	TOPO	Hell Bird	SY	M	25-Jul-04								X	X	X
2320-31561	EE:UB	TOPO	Pipes 3	L	U	22-Jul-04								X		
2320-31562	KY(M):EE	TOPO	Pipes 3	L	M	22-Jul-04								X		X
2320-31563	EE:UB	TOPO	Pipes 3	L	U	22-Jul-04								X		
2320-31564	EE:UB	TOPO	In Between	L	U	25-Jun-04								X		
2320-31565	EE:KD(M)	TOPO	800M	AHY	F	23-Jun-04								X	X	
2320-31566	UB:EE	TOPO	Glory Hole	L	U	27-Jul-06										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	X
2320-31574	EE:UB	PAHR	North	L	U	22-Jul-05									X	
2320-31575	UB:EE	MESQ	West	L	U	28-Jun-06										X
2320-31576	KK(M):EE	TOPO	In Between	AHY	M	19-May-03							X	X		
2320-31577	GW(M):EE	TOPO	In Between	AHY	F	1-Jun-03							X	X	X	
2320-31578	KG(M):EE	GADS	Hunters Hole	SY	U	15-Jun-03							X			
2320-31579	KD(M):EE	YUMA	River Mile 33	SY	U	18-Jun-03							X			
2320-31580	GZ(M):EE	YUMA	River Mile 33	SY	U	18-Jun-03							X			
2320-31581	UB:EE	TOPO	In Between	L	U	3-Jul-03							X			
2320-31582	UB:EE	TOPO	In Between	L	U	3-Jul-03							X			
2320-31583	UB:EE	TOPO	In Between	L	U	3-Jul-03							X			
2320-31584	EE:YK(M)	TOPO	In Between	SY	F	3-Jul-03							X	X	X	X
2320-31585	UB:EE	TOPO	In Between	L	U	3-Jul-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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2320-31586	UB:EE	TOPO	In Between	L	U	3-Jul-03							X			
2320-31587	UB:EE	TOPO	In Between	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	X
2320-31590	GR(M):EE	PAHR	North	AHY	M	15-May-04								X	X	X
2320-31591	GY(M):EE	PAHR	North	AHY	M	15-May-04								X	X	X
2320-31592	GO(M):EE	MESQ	West	L	M	6-Aug-01					X			X[5]	X	X
2320-31593	EE:WV(M)	PAHR	North	AHY	M	18-May-04								X	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	X
2320-31596	EE:YG(M)	PAHR	North	SY	M	19-May-04								X		
2320-31597[H]	EE:BW(M)	9 E Alamo	unknown	AHY	M	14-Jul-01					X		X[5]	X	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		
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	KR(M):EE	PAHR	North	L	M	25-Jun-04								X		X[6]
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[I]	EE:UB	MESQ	West	L	U	25-Jun-04								X		
2320-31612[I]	EE:UB	MESQ	West	L	U	25-Jun-04								X		
2320-31613[J]	DR(M):EE	MESQ	West	AHY	F	24-Jul-02						X	X	X	X[9]	
2320-31614[K]	VY(M):EE	TOPO	800M	L	M	4-Aug-00				X	X[1]		X[2]	X	X	
2320-31615	EE:OY(M)	MESQ	West	L	M	21-Jun-04								X		X[9]
2320-31616	EE:BY(M)	MESQ	West	L	F	8-Jul-04								X		X[9]
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]	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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2320-31619[I]	UB:EE	MOME	Virgin River #1North	L	U	10-Jul-04								X		
2320-31620[I]	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		
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	MESQ	Bunker Farm	L	U	16-Jul-04								X		
2320-31631	BB(M):EE	MESQ	Bunker Farm	L	F	16-Jul-04								X		X[9]
2320-31632	RZ(M):EE	MESQ	Bunker Farm	SY	F	16-Jul-04								X		X[1]
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		
2320-31650	EE:UB	TOPO	Pierced Egg	L	U	23-Jul-06										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]	X
2320-31653	WV(M):EE	MOME	Delta West	SY	M	27-May-04								X	X	X
2320-31654	EE:KY(M)	MESQ	Electric Ave	AHY	M	4-Jun-04								X		
2320-31655	VW(M):EE	MESQ	West	SY	F	14-Jun-04								X	X	X
2320-31656	WD(M):EE	PAHR	North	AHY	F	19-Jun-04								X	X	X
2320-31657	WO(M):EE	PAHR	North	AHY	F	20-Jun-04								X	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		
2320-31661	EE:DW(M)	PAHR	North	SY	F	17-Jun-04								X	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		

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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2320-31666	UB:EE	PAHR	North	L	U	22-Jun-04								X		
2320-31667	UB:EE	PAHR	North	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		
2320-31671	EE:UB	MOME	Virgin River #2	L	U	26-Jun-06										X
2320-31673	EE:UB	TOPO	Pierced Egg	L	U	2-Aug-06										X
2320-31674	UB:EE	PAHR	North	L	U	27-Jun-06										X
2320-31675	UB:EE	TOPO	In Between	L	U	16-Jul-05									X	
2320-31676	EE:UB	TOPO	In Between	L	U	16-Jul-05									X	
2320-31677	UB:EE	TOPO	Pierced Egg	L	U	23-Jul-06										X
2320-31678	UB:EE	PAHR	North	L	U	27-Jun-06										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	OB(M):EE	PAHR	North	L	M	16-Jul-05									X	X
2320-31687	EE:UB	PAHR	North	L	U	16-Jul-05									X	
2320-31688	EE:BG(M)	MESQ	West	L	M	15-Jul-05									X	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:ZW(M)	PAHR	North	L	M	3-Jul-05									X	X[6]
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:ZZ(M)	PAHR	North	L	F	3-Jul-05									X	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	ZW(M):EE	MESQ	Bunker Farm	L	F	21-Jun-05									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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2360-59702	WB(M):EE	MESQ	Bunker Farm	L	M	21-Jun-05									X	X[9]
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	KEPI	L	U	6-Jul-05									X	
2360-59707	EE:YB(M)	PAHR	South	L	F	26-Jun-05									X	X
2360-59708	EE:KK(M)	PAHR	South	L	F	26-Jun-05									X	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	KEPI	L	U	6-Jul-05									X	
2360-59712	EE:UB	KEPI	KEPI	L	U	6-Jul-05									X	
2360-59713	EE:UB	KEPI	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	
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	In Between	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	ZB(M):EE	PAHR	North	L	F	1-Aug-04								X		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	In Between	L	U	18-Jul-05									X	
2360-59730	UB:EE	TOPO	In Between	L	U	18-Jul-05									X	
2360-59731	EE:UB	TOPO	In Between	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	
2360-59735	EE:UB	PAHR	North	L	U	27-Jun-06										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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2360-59736	UB:EE	PAHR	North	L	U	27-Jun-06										X
2360-59737	EE:UB	MUDD	Overton WMA	L	U	4-Jul-06										X
2360-59738	UB:EE	MUDD	Overton WMA	L	U	4-Jul-06										X
2360-59739	EE:UB	MESQ	West	L	U	4-Jul-06										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	
2360-59744	UB:EE	TOPO	Pierced Egg	L	U	2-Aug-06										X
2360-59745	EE:UB	PAHR	North	L	U	27-Jun-06										X
2360-59746	UB:EE	GRCA	RM 274.5N	L	U	17-Jul-04								X		
2360-59747	EE:UB	MUDD	Overton WMA	L	U	29-Jun-06										X
2360-59748	EE:UB	MUDD	Overton WMA	L	U	29-Jun-06										X
2360-59749	UB:EE	MUDD	Overton WMA	L	U	29-Jun-06										X
2360-59750	EE:UB	MOME	Virgin River #2	L	U	6-Jul-06										X
2360-59751	UB:EE	MOME	Virgin River #2	L	U	6-Jul-06										X
2360-59752	EE:UB	MESQ	West	L	U	7-Jul-06										X
2360-59753	EE:UB	MESQ	West	L	U	7-Jul-06										X
2360-59754	UB:EE	MESQ	West	L	U	7-Jul-06										X
2360-59755	UB:EE	MESQ	West	L	U	7-Jul-06										X
2360-59756	EE:UB	PAHR	North	L	U	9-Jul-06										X
2360-59757	UB:EE	KEPI	KEPI	L	U	17-Jul-04								X		
2360-59758	UB:EE	PAHR	North	L	U	9-Jul-06										X
2360-59759	UB:EE	PAHR	North	L	U	27-Jun-06										X
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		
2360-59768	EE:UB	TOPO	Glory Hole	L	U	31-Jul-06										X
2360-59769	UB:EE	MOME	Virgin River #2	L	U	26-Jun-06										X
2360-59770	EE:UB	KEPI	KEPI	L	U	11-Aug-04								X		
2360-59771	UB:EE	GRCA	RM 274.5N	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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2360-59772	YR(M):EE	KEPI	KEPI	AHY	F	12-Aug-04								X		
2360-59785	EE:UB	MUDD	Overton WMA	L	U	6-Aug-05									X	
2360-59786	EE:UB	MUDD	Overton WMA	L	U	6-Aug-05									X	
2360-59787	UB:EE	MUDD	Overton WMA	L	U	3-Aug-05									X	
2360-59788	BO(M):EE	MUDD	Overton WMA	L	F	6-Aug-05									X	X
2360-59789	UB:EE	MESQ	West	L	U	28-Jun-06										X
2360-59790	EE:UB	MESQ	West	L	U	28-Jun-06										X
2360-59791[I]	UB:EE	PAHR	North	L	U	3-Jul-06										X
2360-59792	UB:EE	PAHR	North	L	U	3-Jul-06										X
2360-59793[I]	EE:UB	PAHR	North	L	U	3-Jul-06										X
2360-59794	UB:EE	PAHR	North	L	U	3-Jul-06										X
2360-59795	EE:UB	PAHR	North	L	U	3-Jul-06										X
2360-59796	UB:EE	PAHR	North	L	U	5-Jul-06										X
2360-59797	EE:UB	PAHR	North	L	U	5-Jul-06										X
2360-59798	EE:UB	PAHR	North	L	U	5-Jul-06										X
2360-59799	EE:UB	MOME	Virgin River #2	L	U	6-Jul-06										X
2360-59800	UB:EE	GRCA	RM 274.5N	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	South	AHY	F	10-Aug-00				X	X	X		X		
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	RM 274.5N	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	X
2370-39916	PU:YD(M)	TOPO	Pierced Egg	AHY	M	1-Jun-06										X
2370-39917	DD(M):PU	YUMA	Gadsden	SY	U	10-Jun-06										X
2370-39918	DD(M):PU	YUMA	Gadsden	SY	U	10-Jun-06										X
2370-39919	DD(M):PU	YUMA	Gadsden	SY	U	10-Jun-06										X
2370-39920	DD(M):PU	YUMA	Gadsden	SY	U	10-Jun-06										X
2370-39921	DD(M):PU	YUMA	Gadsden	SY	U	10-Jun-06										X
2370-39922	DD(M):PU	YUMA	Gadsden	SY	U	10-Jun-06										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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2370-39923	DD(M):PU	YUMA	Gadsden	SY	U	11-Jun-06										X
2370-39924	DD(M):PU	YUMA	Gadsden	SY	U	11-Jun-06										X
2370-39925	DD(M):PU	YUMA	Gadsden	SY	U	11-Jun-06										X
2370-39926	DD(M):PU	YUMA	Gadsden	SY	U	11-Jun-06										X
2370-39927	DD(M):PU	YUMA	Gadsden	AHY	U	12-Jun-06										X
2370-39928	DD(M):PU	YUMA	Gadsden	SY	U	12-Jun-06										X
2370-39929	PU:YG(M)	GRCA	RM 274.5N	AHY	M	4-Jul-06										X
2370-39932	BK(M):PU	BIWI	Site 3	AHY	F	24-May-05									X	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	
2370-39935	VV(M):PU	YUMA	Gadsden Bend	AHY	U	17-Jun-05									X	
2370-39937	KK(M):PU	MESQ	West	SY	M	18-May-06										X
2370-39938	KG(M):PU	MOME	Virgin River #1South	SY	M	8-Jun-06										X
2370-39939	KD(M):PU	MESQ	West	AHY	F	22-Jun-06										X
2370-39940	GY(M):PU	MOME	Virgin River #2	AHY	M	23-Jun-06										X
2370-39941	UB:PU	MESQ	West	L	U	4-Jul-06										X
2370-39942	PU:UB	MUDD	Overton WMA	L	U	5-Jul-06										X
2370-39943	PU:UB	MUDD	Overton WMA	L	U	5-Jul-06										X
2370-39944	UB:PU	MUDD	Overton WMA	L	U	5-Jul-06										X
2370-39945	UB:PU	PAHR	North	L	U	9-Jul-06										X
2370-39946	GW(M):PU	PAHR	North	HY	U	11-Jul-06										X
2370-39947	PU:OW(M)	PAHR	North	HY	U	21-Jul-06										X
2370-39948	PU:OR(M)	MOME	Virgin River #2	SY	F	23-Jul-06										X
2370-39949	UB:PU	MESQ	West	L	U	27-Jul-06										X
2370-39950	PU:UB	MESQ	West	L	U	27-Jul-06										X
2370-39951	PU:OZ(M)	PAHR	North	AHY	M	1-Jun-05									X	X
2370-39952	BB(M):PU	PAHR	North	AHY	M	23-Jul-02						X	X		X	X
2370-39953	OB(M):PU	PAHR	South	AHY	M	2-Jun-05									X	X
2370-39954	BO(M):PU	MESQ	Bunker Farm	AHY	M	8-Jun-05									X	X
2370-39955	BV(M):PU	ROOS	Northshore 1-East	L	M	26-Jun-03							X		X[9]	X
2370-39956	PU:ZZ(M)	MUDD	Overton WMA	SY	F	9-Jun-05									X	X
2370-39957	PU:YB(M)	MESQ	Bunker Farm	AHY	F	21-Jun-05									X	X
2370-39958	PU:ZW(M)	PAHR	South	AHY	F	26-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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2370-39959	VB(M):PU	PAHR	North	SY	M	28-Jun-05									X	
2370-39960	BW(M):PU	KEPI	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	South	L	M	5-Jul-02						X			X	
2370-39964	BY(M):PU	PAHR	North	AHY	F	8-Jul-05									X	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	
2370-39967	KO(M):PU	MOME	Virgin River #2	AHY	M	7-Jun-06										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	X[1]
2370-39976	PU:KV(M)	MUDD	Overton WMA	SY	M	9-Jul-05									X	
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	X[6]
2370-39981	PU:GW(M)	PAHR	North	HY	U	29-Jul-05									X	
2370-39982	UB:PU	YUMA	Gadsden	SY	U	16-Jun-06										X
2370-39983	PU:UB	YUMA	Gadsden	SY	U	16-Jun-06										X
2370-39984	UB:PU	YUMA	Gadsden	SY	U	17-Jun-06										X
2370-39985	PU:UB	YUMA	Gadsden	SY	U	16-Jun-06										X
2370-39986	GO(M):PU	GRCA	Twin Coves	AHY	M	19-Jun-06										X
2370-39987	GW(M):PU	GRCA	Pearce Ferry	SY	M	20-Jun-06										X
2370-39988	DW(M):PU	GRCA	Chuckwalla Cove	SY	M	21-Jun-06										X
2370-39989	PU:OZ(M)	GRCA	Chuckwalla Cove	SY	M	21-Jun-06										X
2370-39990	WB(M):PU	GRCA	Chuckwalla Cove	SY	F	22-Jun-06										X
2370-39992	GK(M):PU	TOPO	The Wallows	SY	M	6-Jun-06										X
2370-39993	UB:PU	YUMA	Gadsden	SY	U	17-Jun-06										X
2370-39994	PU:UB	YUMA	Gadsden	SY	U	17-Jun-06										X
2370-39995	UB:PU	YUMA	Gadsden	SY	U	17-Jun-06										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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2370-39996	DD(M):PU	YUMA	Gadsden	SY	U	18-Jun-06										X
2370-39997	DD(M):PU	YUMA	Gadsden	SY	U	18-Jun-06										X
2370-39998	DD(M):PU	YUMA	Gadsden	AHY	U	18-Jun-06										X
2370-40106	UB:PU	MESQ	West	L	U	11-Aug-06										X
2370-40107	PU:UB	MESQ	West	L	U	11-Aug-06										X
2370-40108	UB:PU	MESQ	West	L	U	11-Aug-06										X
2370-40003	PU:RR(M)	TOPO	Pipes 3	SY	M	27-Jun-06										X
2370-40004	PU:RW(M)	BIWI	Site 3	AHY	F	2-Jul-06										X
2370-40012	OY(M):PU	MESQ	West	AHY	M	3-Jun-05									X	X
2370-40013	PU:WD(M)	PAHR	North	SY	M	22-Jun-05									X	X
2370-40014	PU:VY(M)	PAHR	North	AHY	F	3-Jul-05									X	X
2370-40015	PU:WG(M)	PAHR	South	AHY	M	4-Jun-02						X			X	X
2370-40016	UB:PU	PAHR	South	L	U	21-Jul-05									X	
2370-40017	PU:WR(M)	MOME	Virgin River #2	SY	M	26-Jul-05									X	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	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	
2370-40036	PU:GR(M)	GRCA	RM 285.3N	AHY	M	2-Jun-06										X[12]
2370-40037	PU:DR(M)	GRCA	RM 285.3N	AHY	F	2-Jun-06										X
2370-40038	PU:DO(M)	GRCA	RM 285.3N	AHY	M	3-Jun-06										X
2370-40039	DD(M):PU	YUMA	Hunter's Hole	SY	U	7-Jun-06										X
2370-40040	DD(M):PU	YUMA	Hunter's Hole	SY	U	7-Jun-06										X
2370-40041	DD(M):PU	YUMA	Hunter's Hole	SY	U	8-Jun-06										X
2370-40042	DD(M):PU	YUMA	Hunter's Hole	SY	U	8-Jun-06										X
2370-40043	DD(M):PU	YUMA	Hunter's Hole	SY	U	9-Jun-06										X
2370-40044	DD(M):PU	YUMA	Gadsden	SY	U	9-Jun-06										X
2370-40045	DD(M):PU	YUMA	Gadsden	SY	U	9-Jun-06										X
2370-40046	PU:DK(M)	GRCA	RM 274.5N	SY	M	14-Jun-06										X
2370-40047	PU:DD(M)	PAHR	North	AHY	F	1-Jul-06										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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2370-40052	KV(M):PU	BIWI	Site 3	AHY	M	24-May-05									X	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	
2370-40057	YD(M):PU	MUDD	Overton WMA	AHY	M	11-May-06										X
2370-40058	PU:BK(M)	MOME	Virgin River #2	AHY	M	7-Jun-06										X
2370-40059	PU:BY(M)	MUDD	Overton WMA	AHY	F	14-Jun-06										X
2370-40060	YG(M):PU	PAHR	North	AHY	M	21-Jun-06										X
2370-40061	YR(M):PU	PAHR	North	SY	F	4-Jul-06										X
2370-40062	YK(M):PU	PAHR	North	SY	F	5-Jul-06										X
2370-40063	PU:UB	MESQ	West	L	U	19-Jul-06										X
2370-40064	PU:UB	PAHR	North	L	U	13-Jul-06										X
2370-40065	UB:PU	MESQ	West	L	U	20-Jul-06										X
2370-40066	YO(M):PU	MESQ	West	SY	F	20-Jul-06										X
2370-40067	PU:UB	MESQ	West	L	U	20-Jul-06										X
2370-40068	PU:UB	MESQ	West	L	U	20-Jul-06										X
2370-40069	UB:PU	MOME	Virgin River #2	L	U	25-Jul-06										X
2370-40070	PU:UB	MOME	Virgin River #2	L	U	25-Jul-06										X
2370-40071	PU:WB(M)	PAHR	North	HY	U	27-Jul-06										X
2370-40080	UB:PU	MESQ	West	L	U	27-Jul-06										X
2370-40081	PU:OO(M)	KEPI	KEPI	SY	M	5-Aug-06										X
2370-40082	PU:OK(M)	KEPI	KEPI	SY	F	6-Aug-06										X
2370-40083	PU:UB	MESQ	West	L	U	13-Aug-06										X
2370-40084	PU:UB	MESQ	West	L	U	13-Aug-06										X
2370-40100	UB:PU	KEPI	KEPI	L	U	1-Aug-06										X
2370-40101	PU:UB	KEPI	KEPI	L	U	1-Aug-06										X
2370-40102	PU:UB	KEPI	KEPI	L	U	1-Aug-06										X
2370-40103	PU:UB	MESQ	West	L	U	4-Aug-06										X
2370-40104	PU:UB	MESQ	West	L	U	4-Aug-06										X
2370-40105	UB:PU	MESQ	West	L	U	4-Aug-06										X
2390-92348	YY(P):XX	TOPO	1000M	L	F	25-Jul-98		X						X		
2390-92350	XX:DY(M)	MOME	South	AHY	M	17-May-00				X	X[2]		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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2390-92365	RG(M):XX	MUDD	Overton WMA	L	M	7-Jul-00				X			X[2]	X	X	
2390-92410	XX:DD(P)	MESQ	West	AHY	M	29-May-01					X		X			
2390-92420	XX:ZK(M)	MESQ	West	L	M	27-Jun-01					X	X	X			
2390-92421	XX:WR(M)	MESQ	West	L	M	27-Jun-01					X	X	X	X	X[1]	X
2390-92427	XX:O(HP)/W(HP)	MOME	North	L	F	29-Jun-01					X		X[2]			
2390-92433	XX:ZR(M)	MESQ	West	L	M	4-Jul-01					X		X	X		
2390-92434	UB:XX	MESQ	West	L	M	4-Jul-01					X	X		X	X	X[13]
2390-92451	KW(M):XX	MOME	South	L	F	2-Jul-99			X	X		X[2]		X		
2390-92470	KR(M):XX	MESQ	West	L	F	24-Jul-01					X			X		
2390-92475	XX:WY(M)	MOME	Delta West	L	M	26-Jul-01					X	X[2]	X	X	X	X
3500-68963	XX:UB	TOPO	Hell Bird	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[L]	XX:DD(M)	PAHR	South	AHY	M	17-May-03							X	X	X	X
3500-68972	GG(M):XX	PAHR	South	HY	F	6-Aug-04								X	X	X
none	WR(M):UB[E]	PAHR	North	AHY	F	18-Jul-00				X	X	X	X	X		
none	RR(M):no foot[F]	PAHR	North	AHY	F	18-Jun-04								X	X	X
INA	Rs:UB	INA	INA	AHY	F	INA							X			
INA	UB:XX	INA	INA	INA	F	INA							X			
INA	KY(HP):XX	INA	INA	INA	F	INA							X			
INA	Bs:banded[M]	INA	INA	INA	M	INA							X			
INA	banded:EE[M]	INA	INA	INA	F	INA								X		
INA	Bs:banded[M]	INA	INA	INA	M	INA									X	
INA	no foot:EE	INA	INA	INA	M	INA									X	
INA	banded:XX[N]	INA	INA	INA	M	INA									X	
INA	banded:XX[O]	INA	INA	INA	F	INA									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									
							1997	1998	1999	2000	2001	2002	2003	2004	2005	2006

[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, INA = information not available.

[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 = Lower Grand Canyon, AZ; TOPO = Topock Marsh, Havasu National Wildlife Refuge, AZ; BIWI = Bill Williams River National Wildlife Refuge, AZ; IMPE = Imperial National Wildlife Refuge, AZ; YUMA = Yuma, AZ; 9 E ALAMO = 9 miles east of Alamo, NV (per Federal Bird Banding Laboratory); KEPI = Key Pittman Wildlife Management Area, NV; ROOS = Roosevelt Lake Reservoir, AZ, INA = information not available.

[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] Original federal band (2140-66621) removed due to a leg injury; no federal band on right leg.

[F] Original federal band (2320-31663) removed due to a leg injury; right foot missing.

[G] Site is located between Gila River Site 2 and Gila River Site 1.

[H] Original federal band (2190-76604) replaced.

[I] Individual known to have died before fledging.

[J] Original federal band (2140-66517) replaced.

[K] Original federal band (2140-66775) replaced.

[L] Original federal band (2320-31451) replaced.

[M] Color combination could not be determined due to a leg injury masking the band.

[N] Color combination could not be determined.

[O] Color combination could not be determined because of faded plastic bands.

[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.

[10] Exhibited within season movement in 2006, Mesquite then to Mormon Mesa.

[11] Bill Williams.

[12] Exhibited within season movement in 2006, Grand Canyon then to Mesquite.

[13] Band number likely 2390-92434 but cannot be confirmed because bird was not captured in 2006. Bird had a visible injury on left leg.

APPENDIX D

Hydrographs for Piezometers at Habitat Monitoring Sites

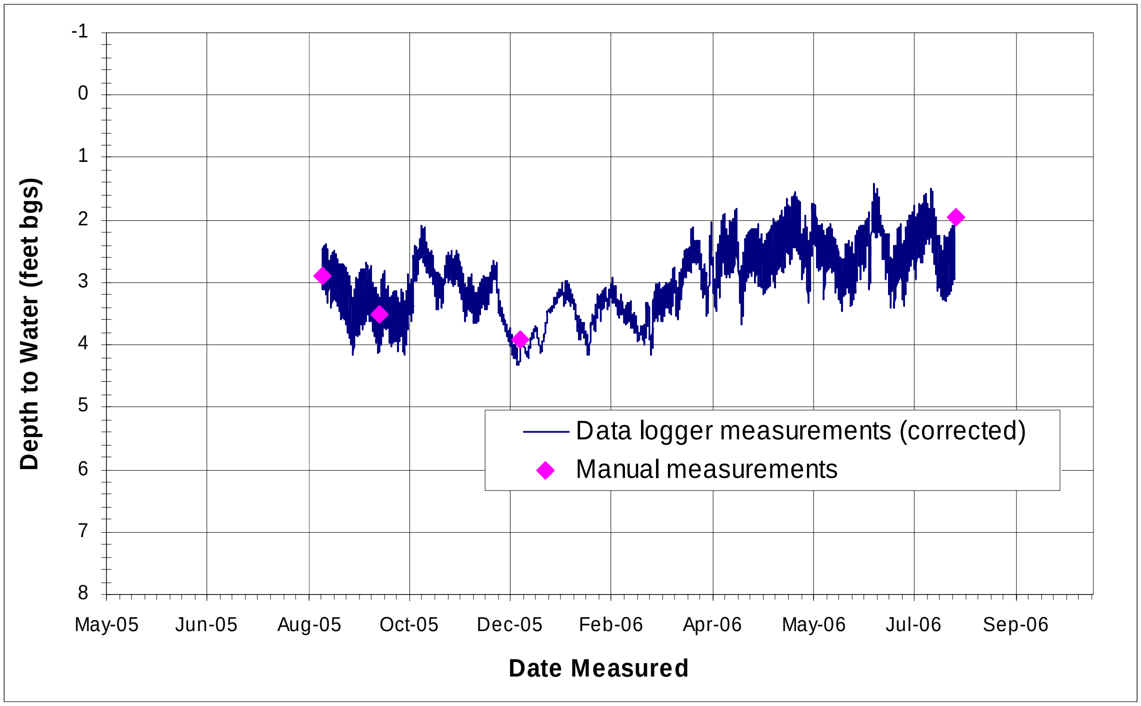


Figure D1. Hydrograph for piezometer at Blankenship Bend.

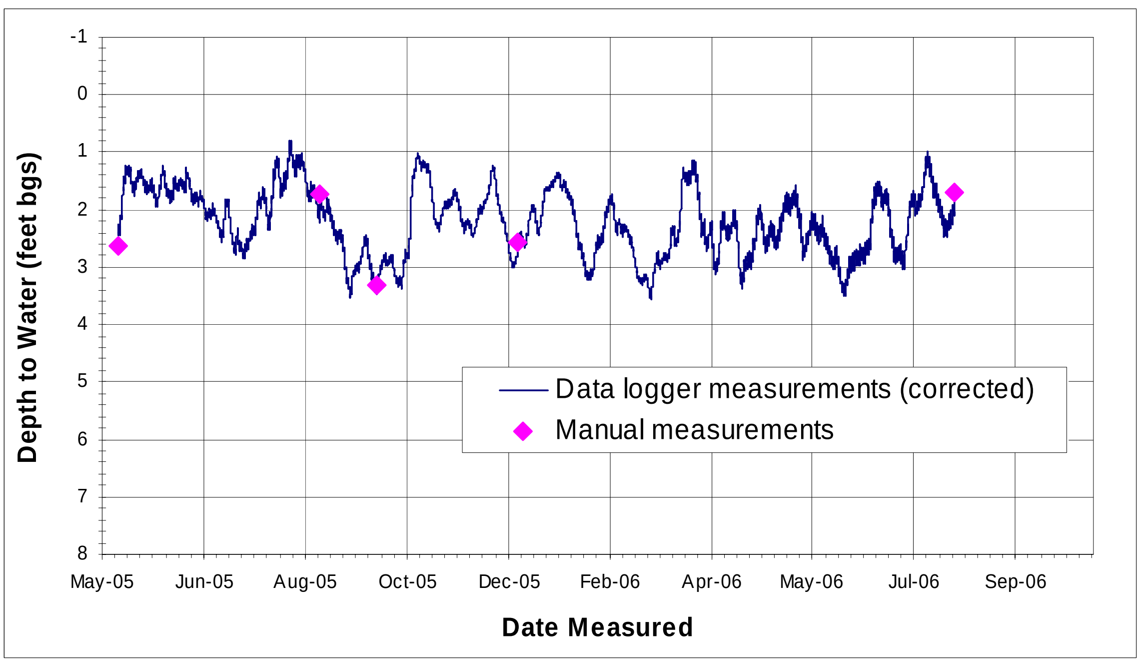


Figure D2. Hydrograph for piezometer at Havasu NE.

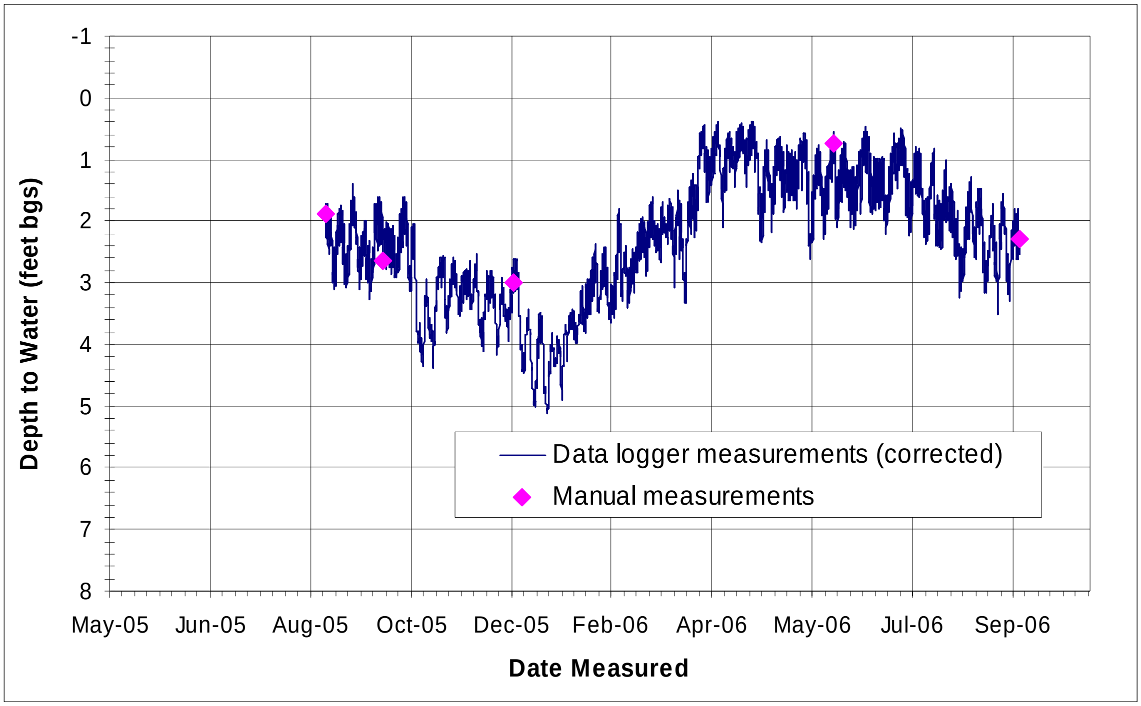


Figure D3. Hydrograph for piezometer at Ehrenberg.

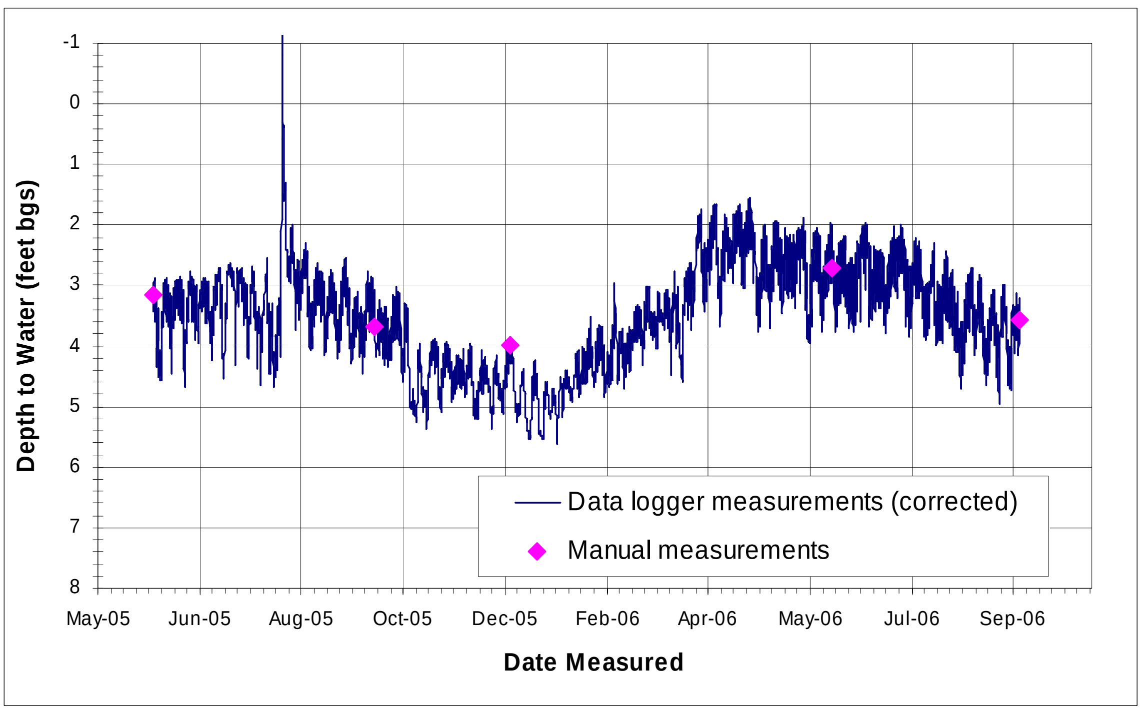


Figure D4. Hydrograph for piezometer at Three Fingers Lake.

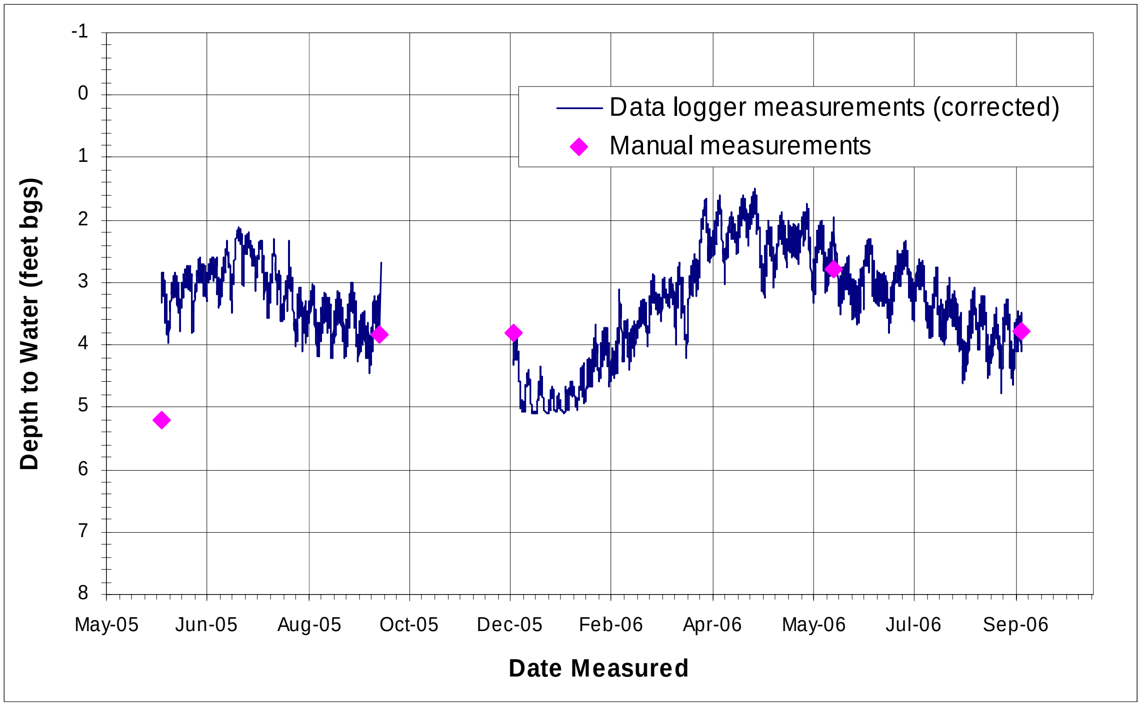


Figure D5. Hydrograph for piezometer at Cibola Lake.

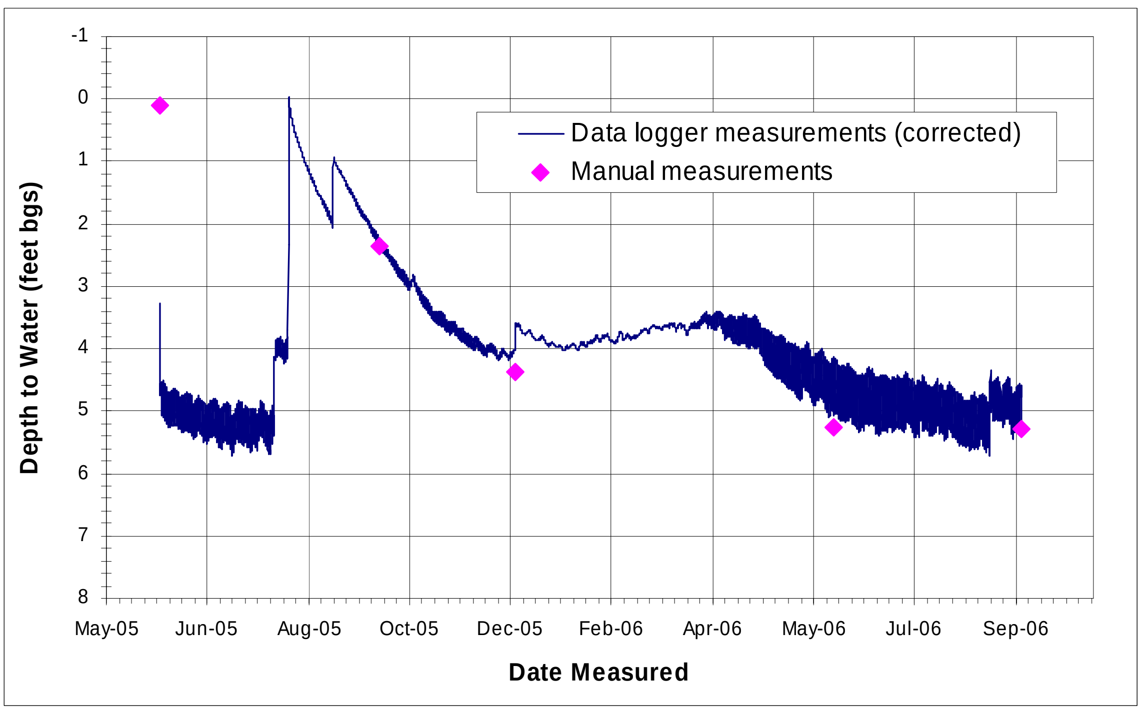


Figure D6. Hydrograph for piezometer at Walker Lake.

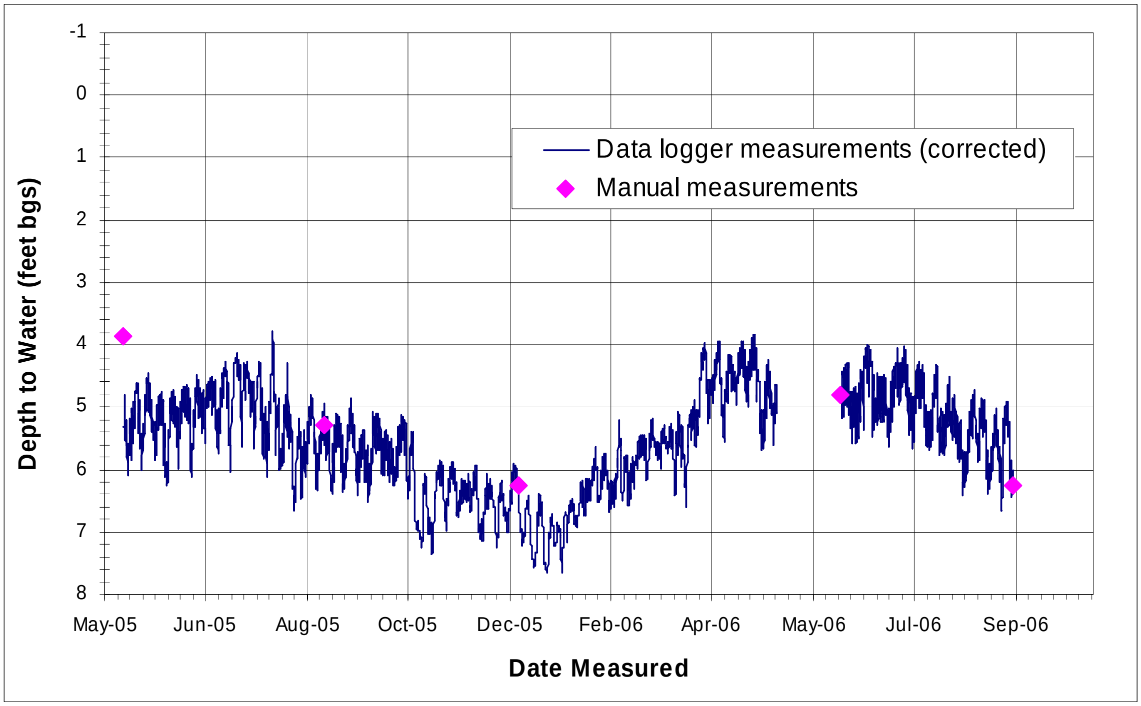


Figure D7. Hydrograph for piezometer at Paradise.

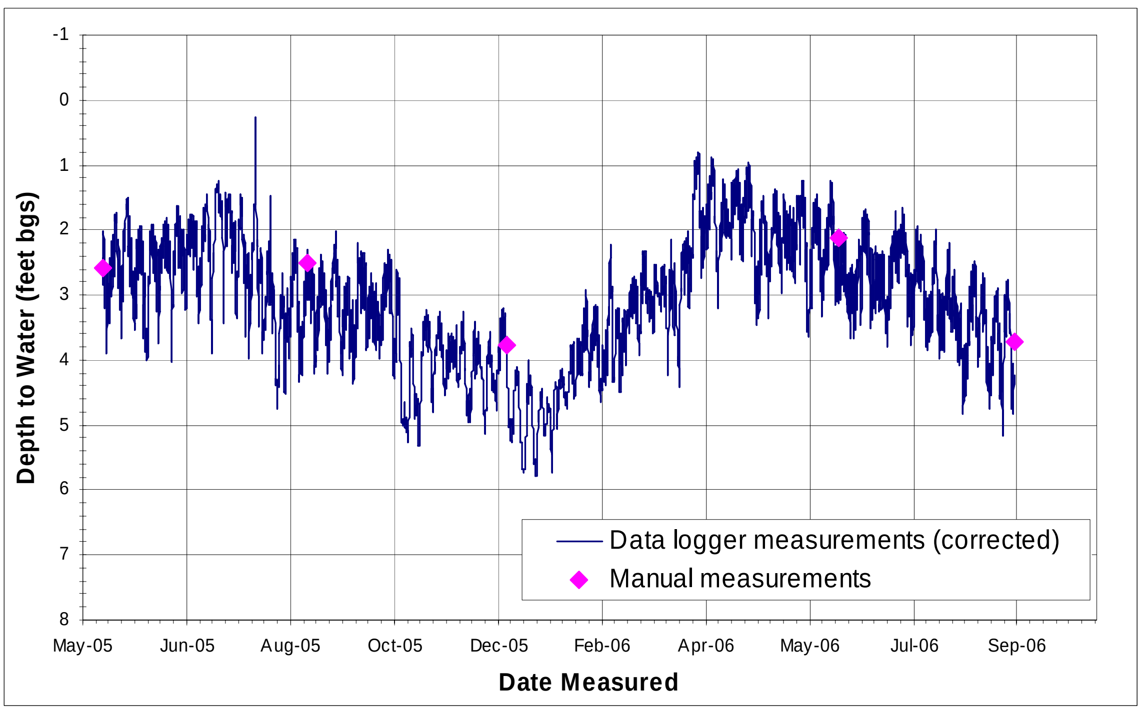


Figure D8. Hydrograph for piezometer at Hoge Ranch.

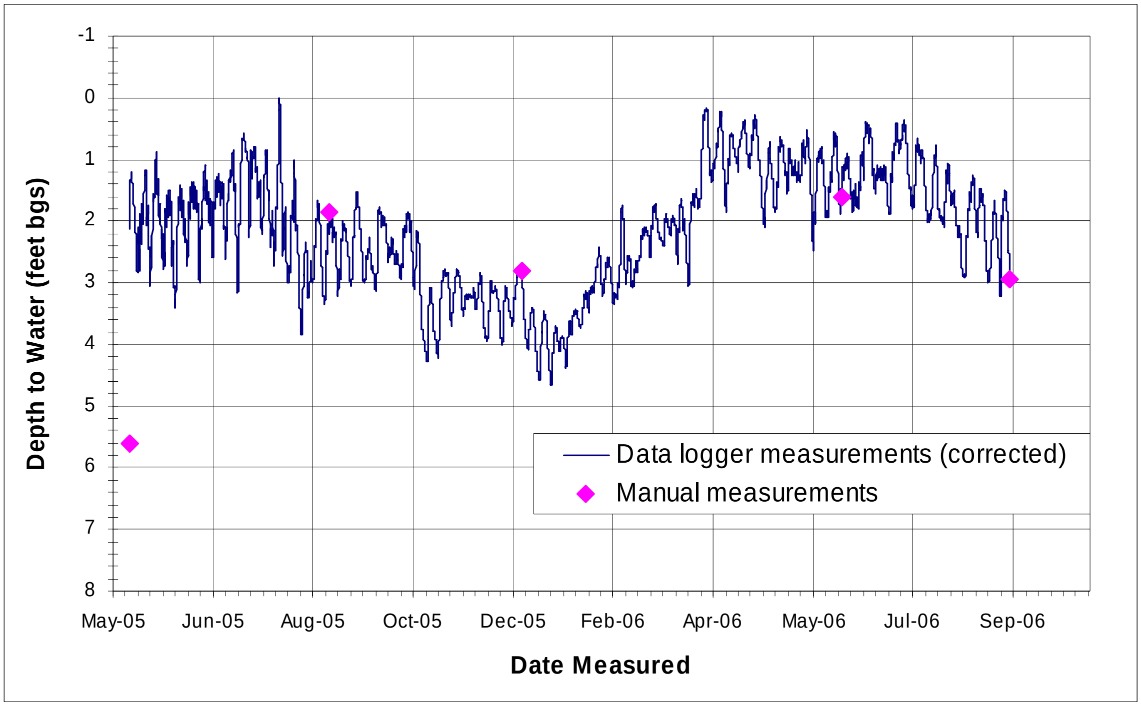


Figure D9. Hydrograph for piezometer at Rattlesnake.

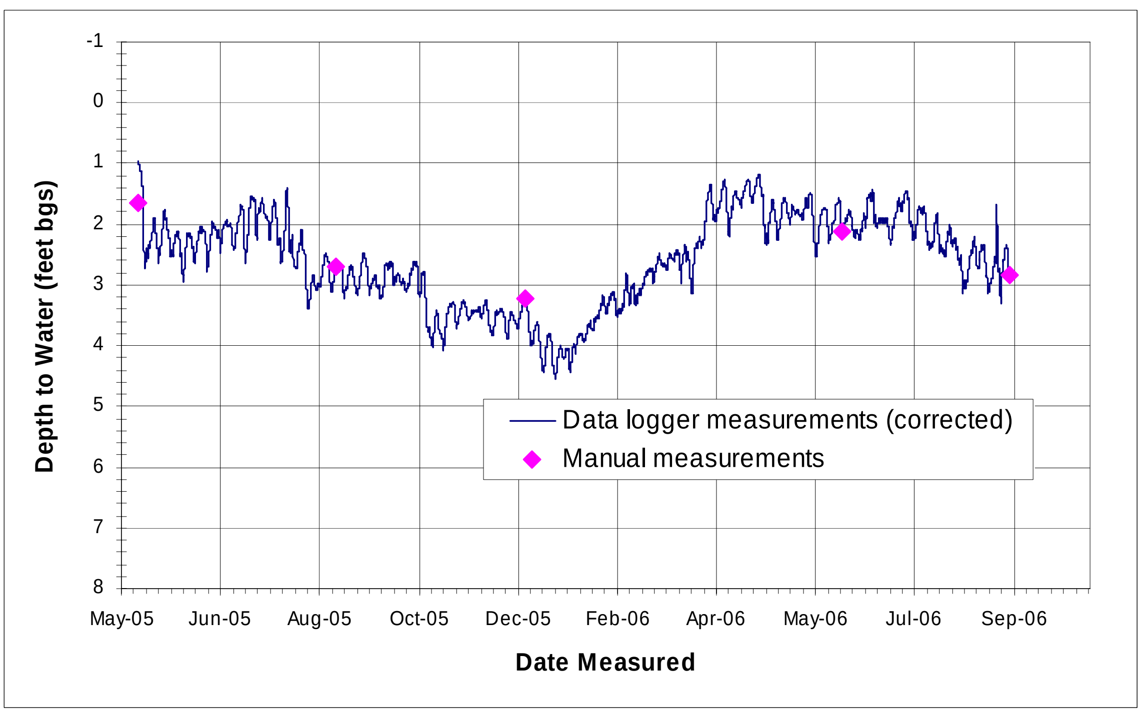


Figure D10. Hydrograph for piezometer at Clear Lake.

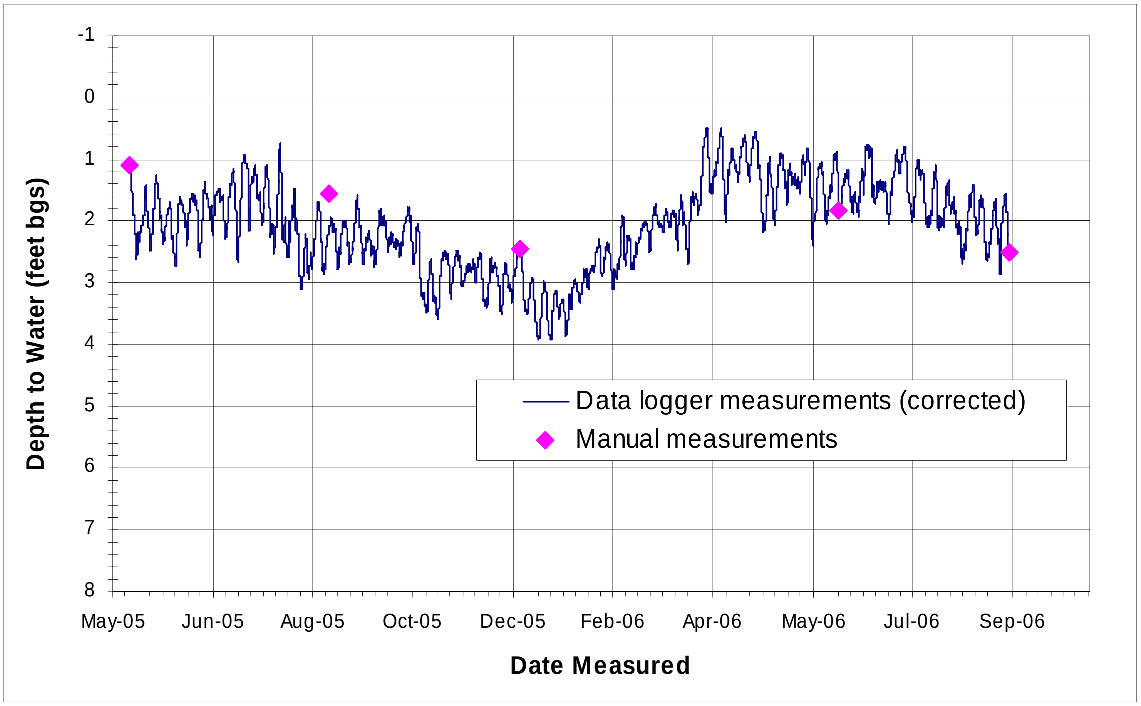


Figure D11. Hydrograph for piezometer at Ferguson Lake.

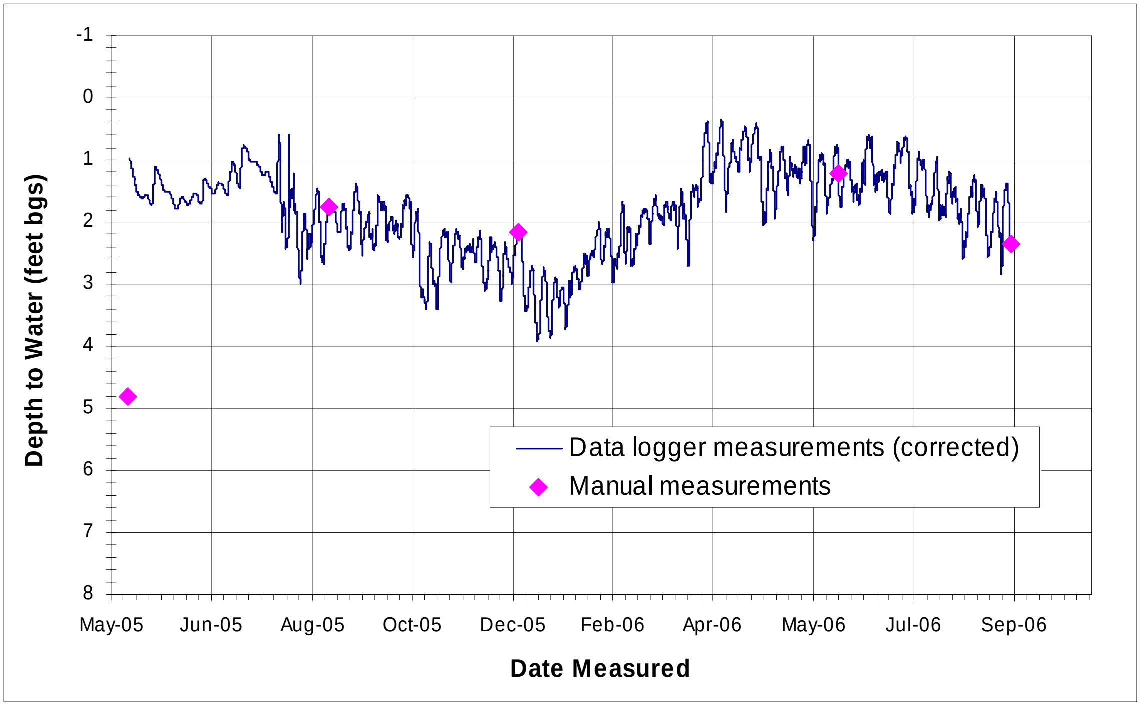


Figure D12. Hydrograph for piezometer at Ferguson Wash.

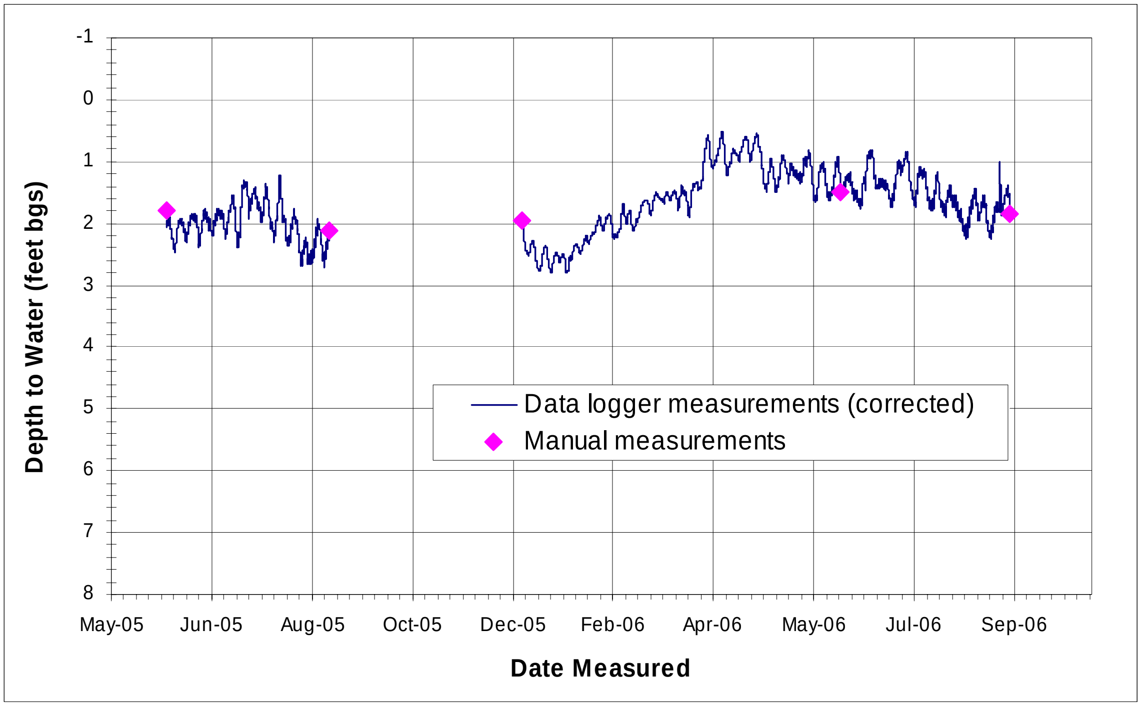


Figure D13. Hydrograph for piezometer at Great Blue Heron.

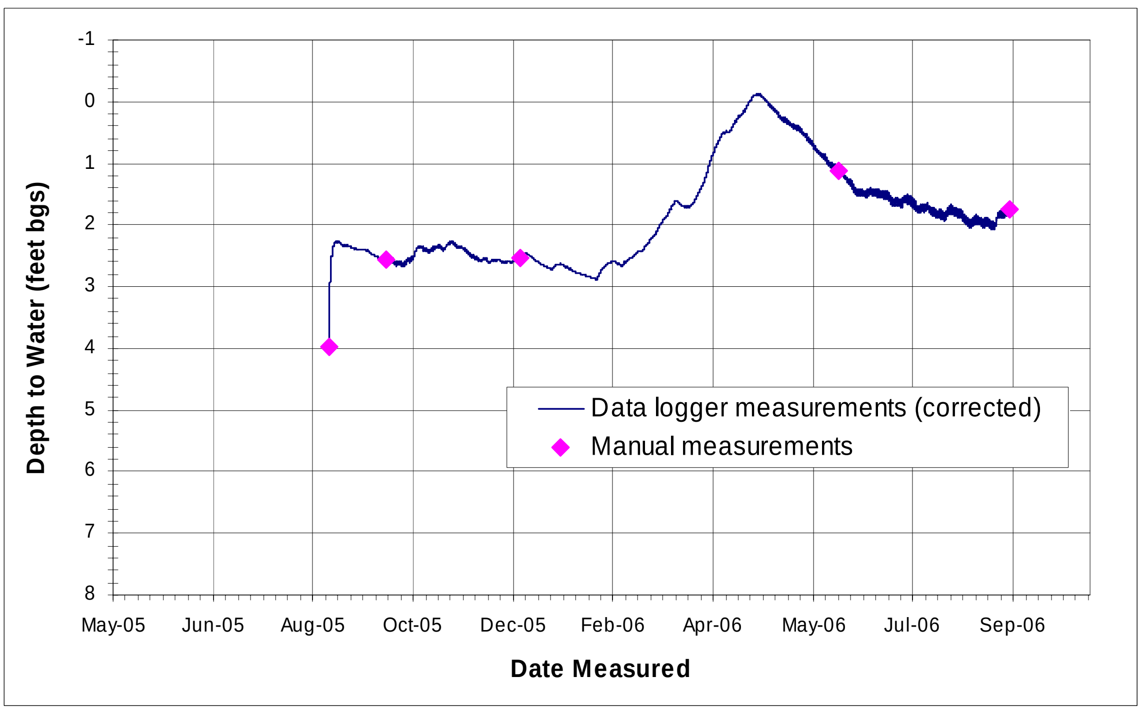


Figure D14. Hydrograph for piezometer at Mittry West.

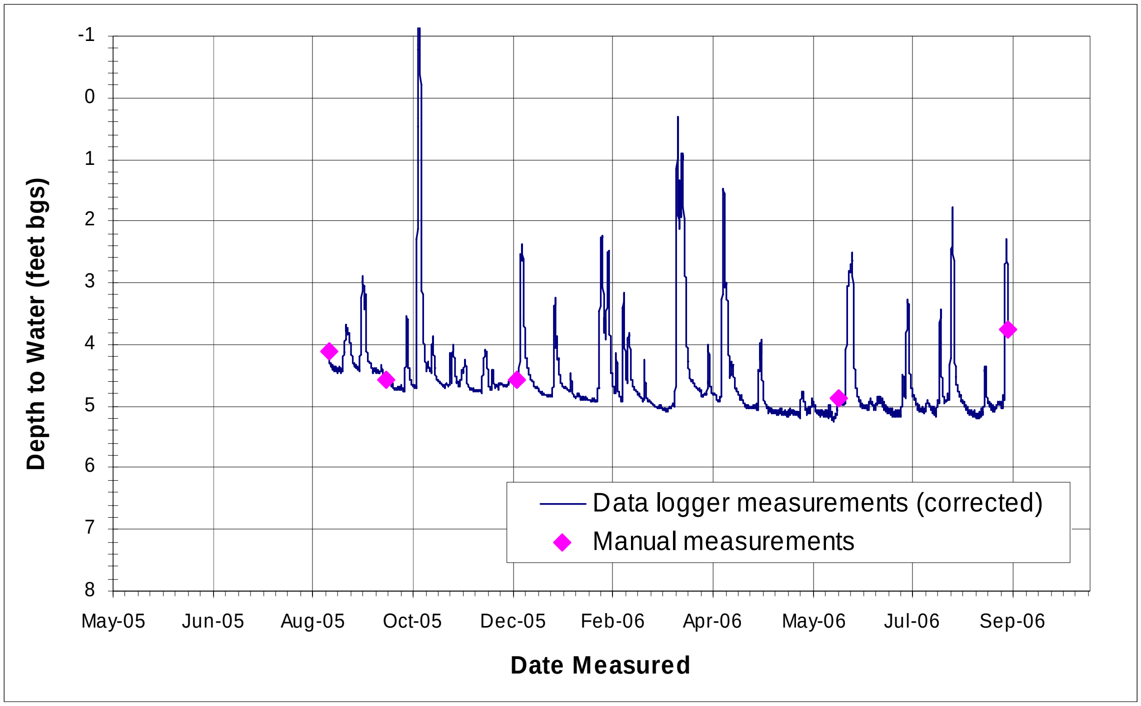


Figure D15. Hydrograph for piezometer at Gila Confluence North.

APPENDIX E

Linear Regression Plots for Average Soil Moisture vs. Average Water Level

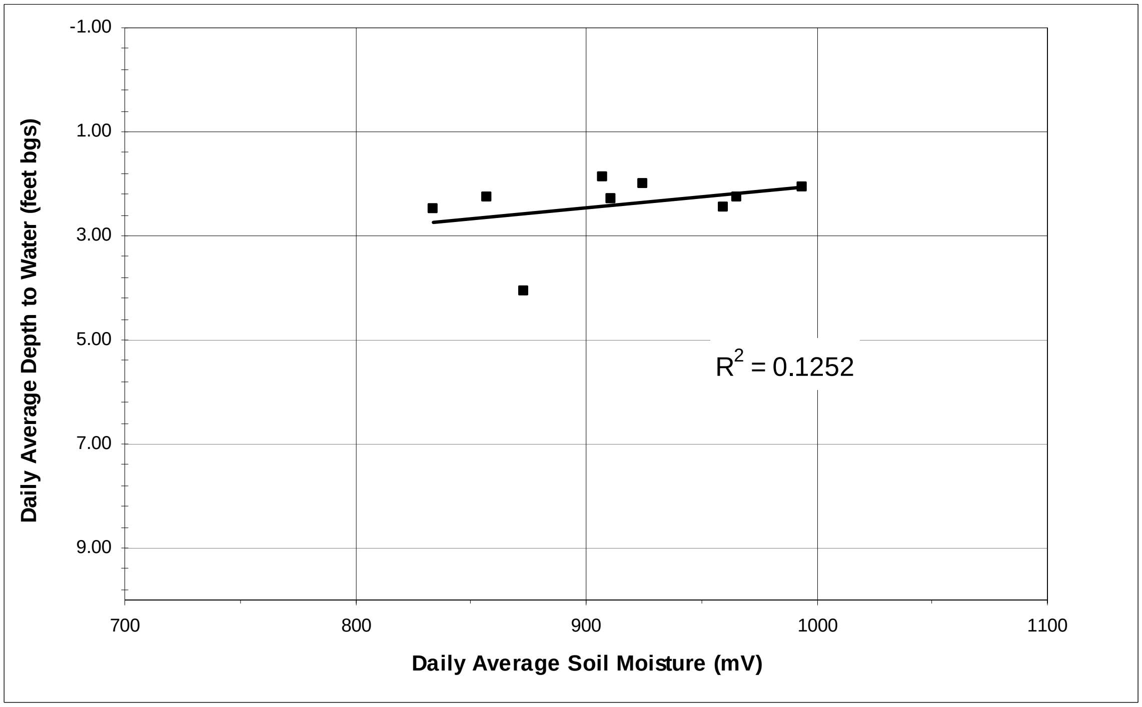


Figure E1. Average soil moisture vs. average water level for Blankenship Bend, 2005–2006.

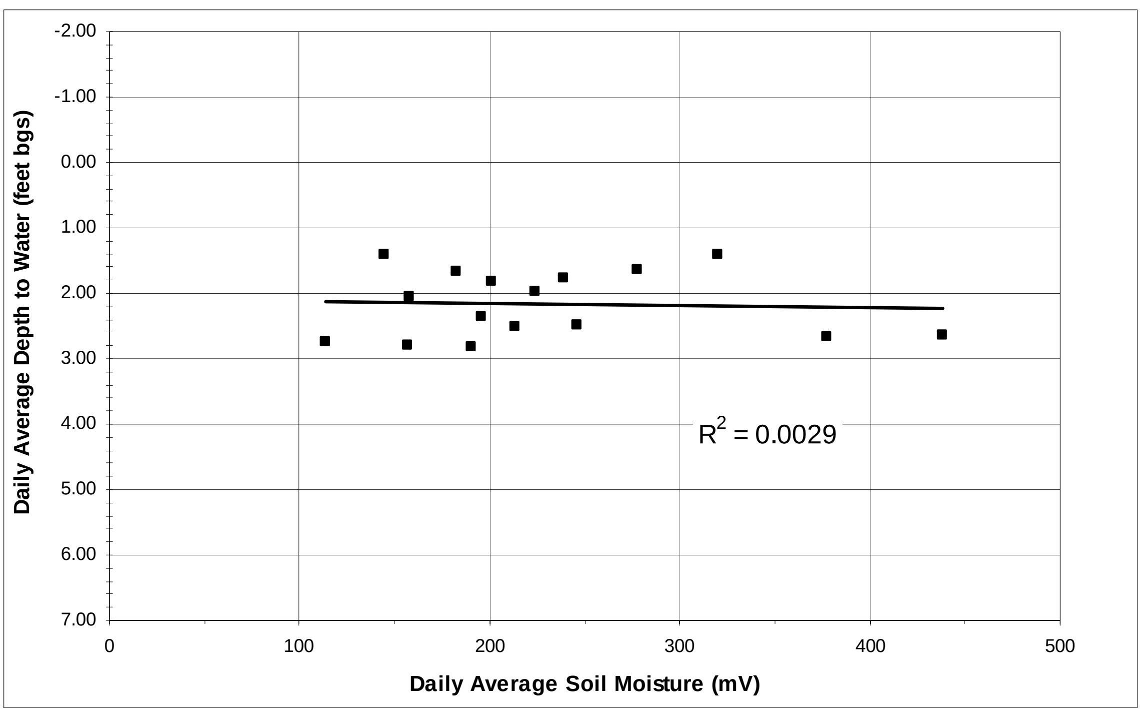


Figure E2. Average soil moisture vs. average water level for Havasu NE, 2005–2006.

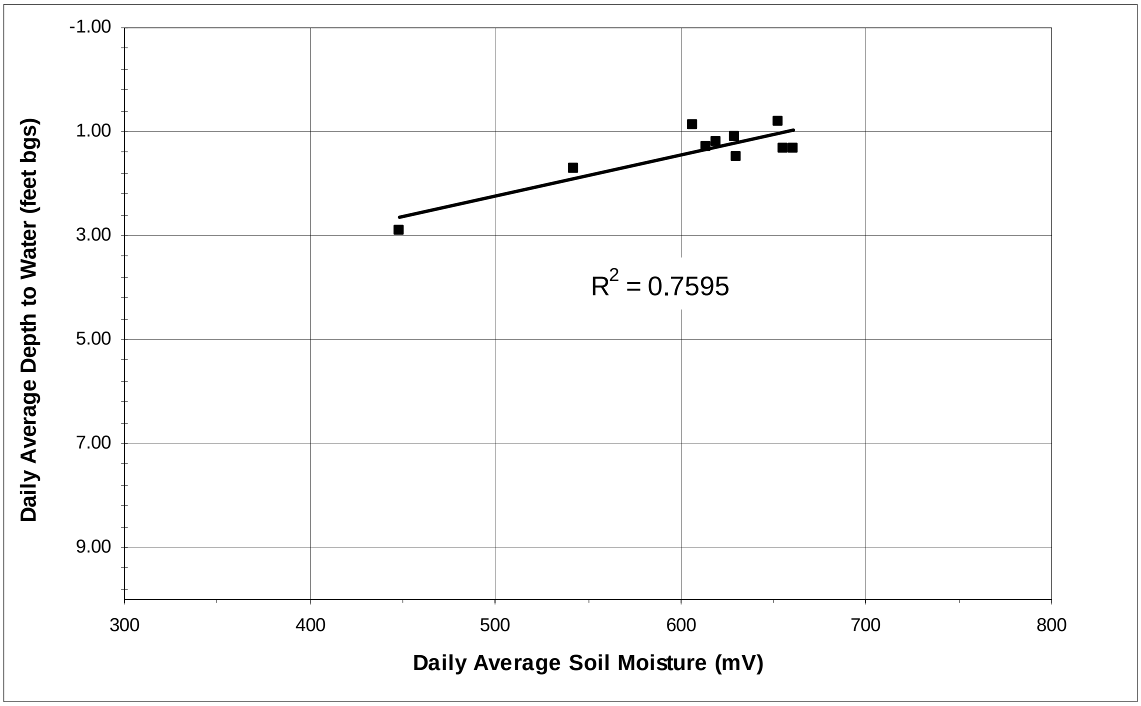


Figure E3. Average soil moisture vs. average water level for Ehrenberg, 2005–2006.

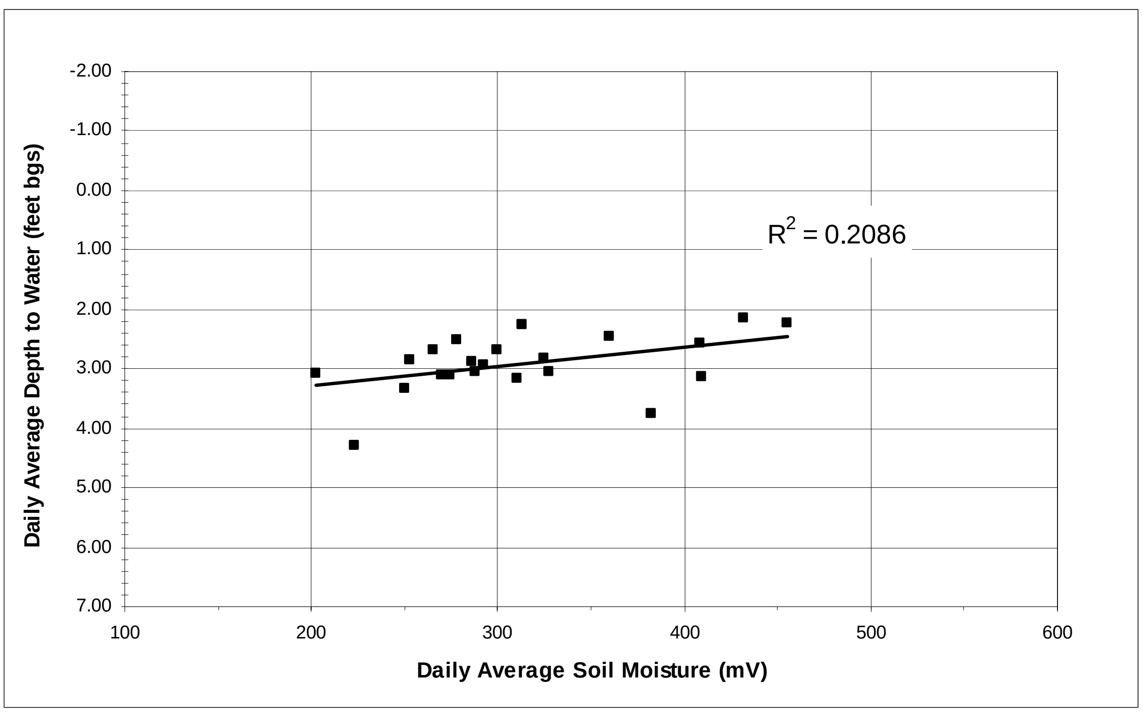


Figure E4. Average soil moisture vs. average water level for Cibola Lake, 2005–2006.

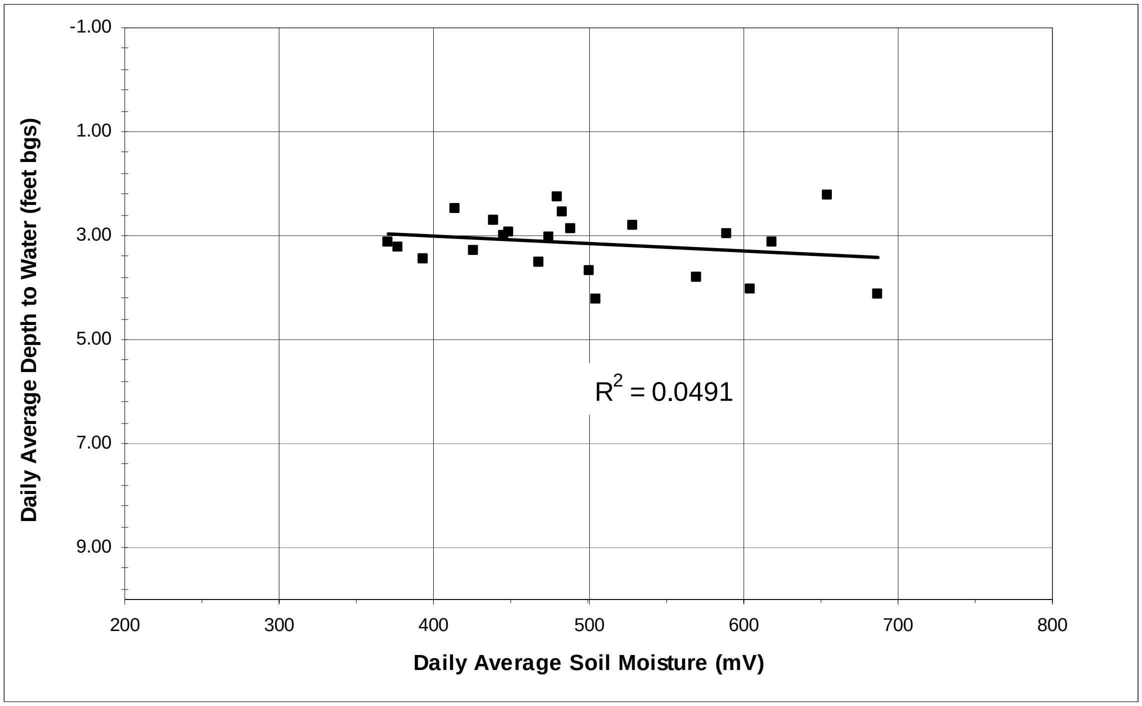


Figure E5. Average soil moisture vs. average water level for Three Fingers Lake, 2005–2006.

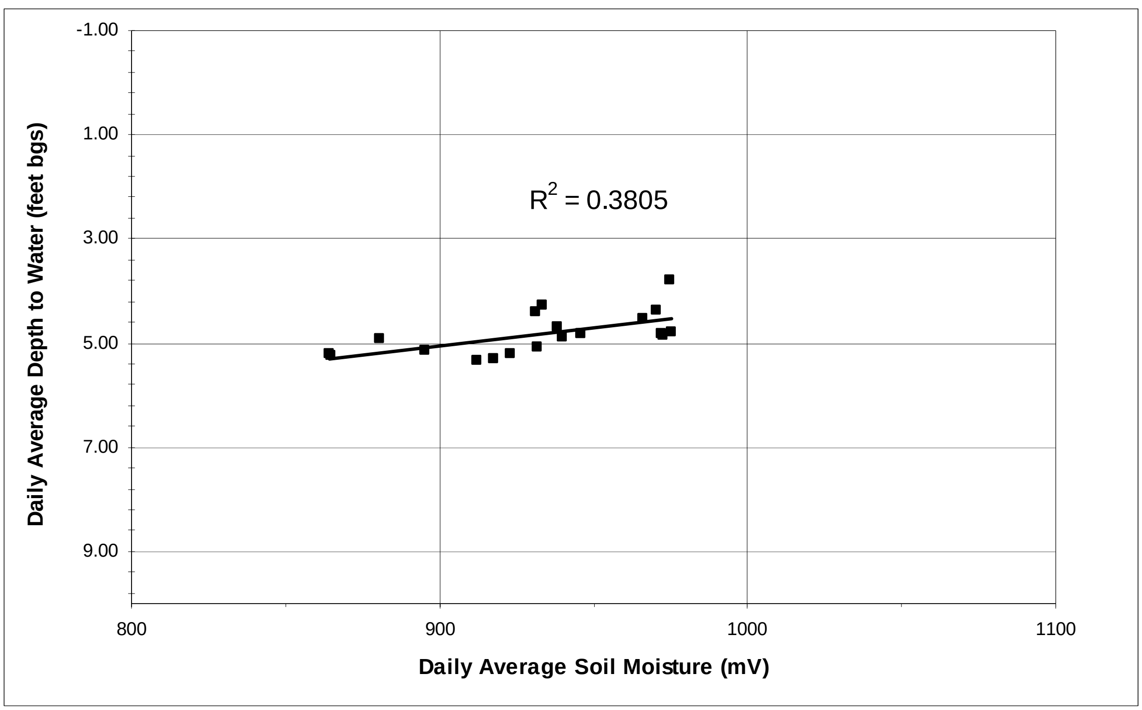


Figure E6. Average soil moisture vs. average water level for Walker Lake, 2005–2006.

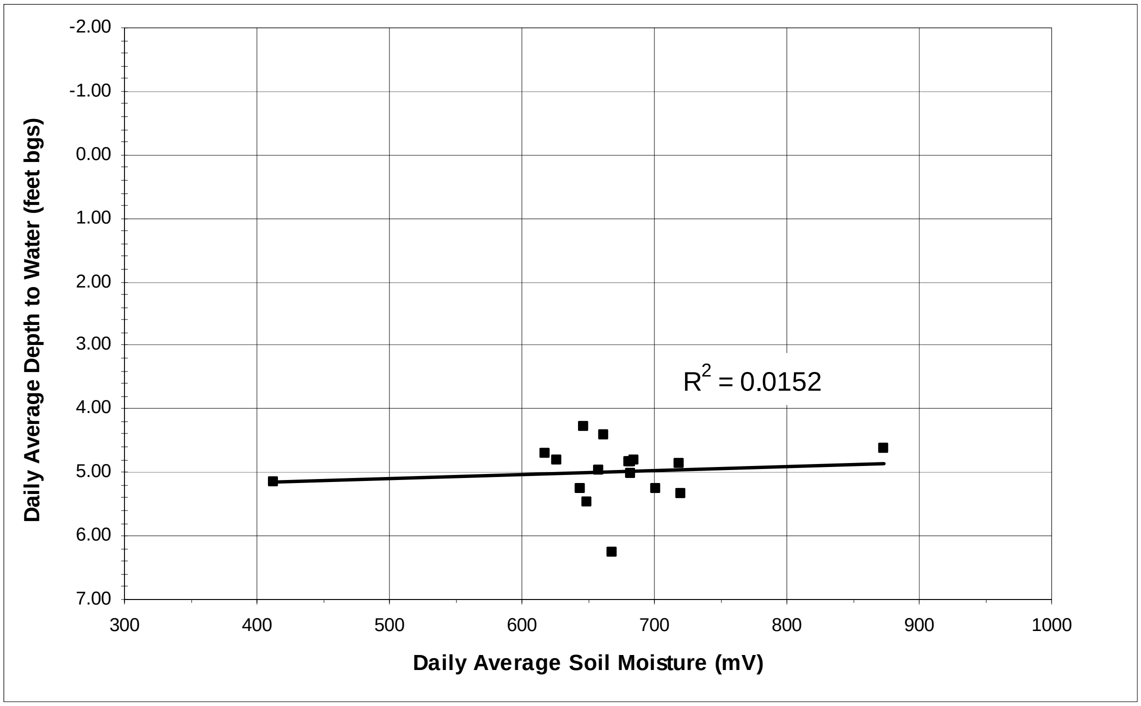


Figure E7. Average soil moisture vs. average water level for Paradise, 2005–2006.

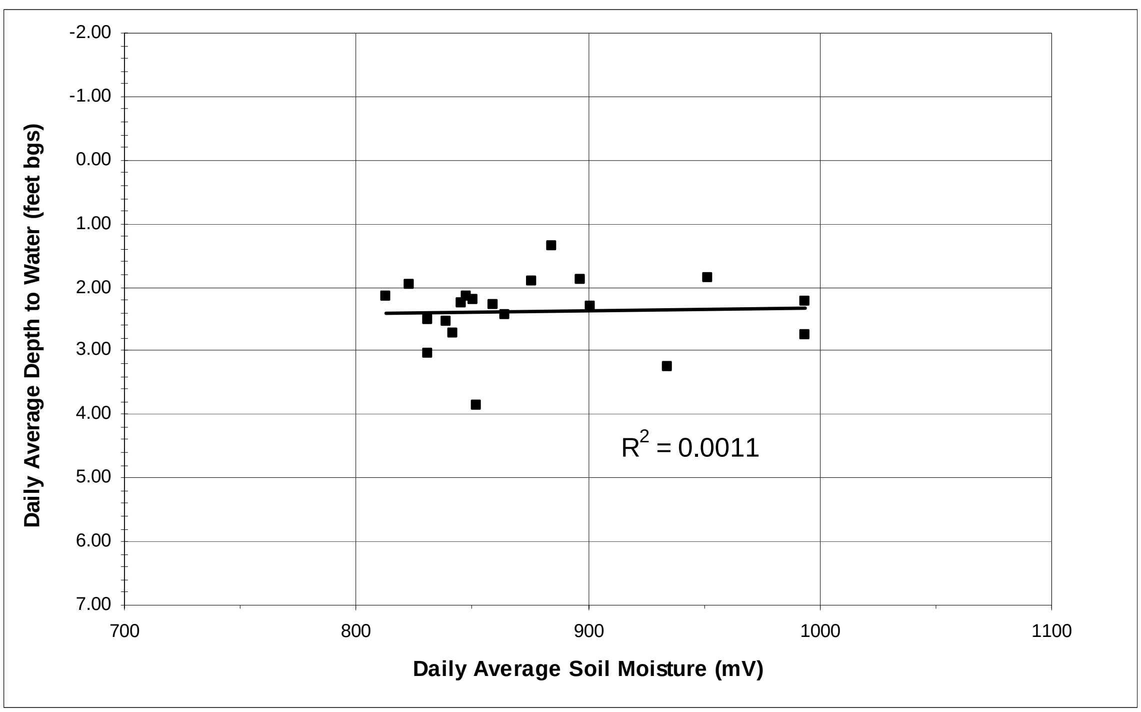


Figure E8. Average soil moisture vs. average water level for Hoge Ranch, 2005–2006.

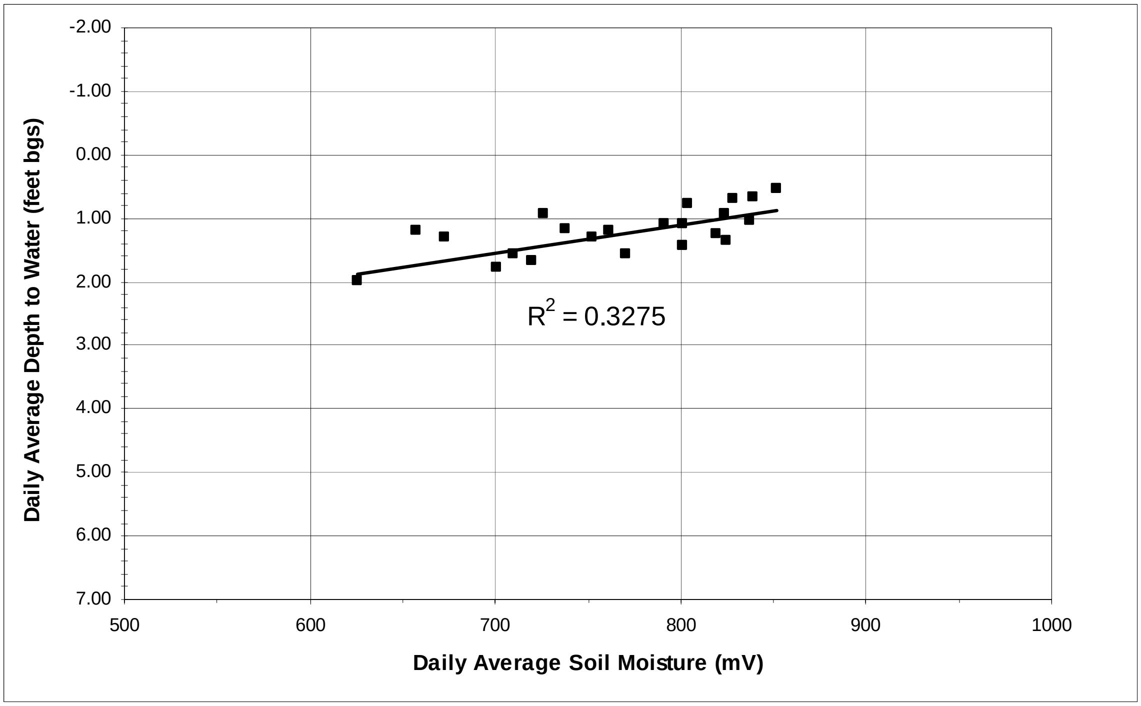


Figure E9. Average soil moisture vs. average water level for Rattlesnake, 2005–2006.

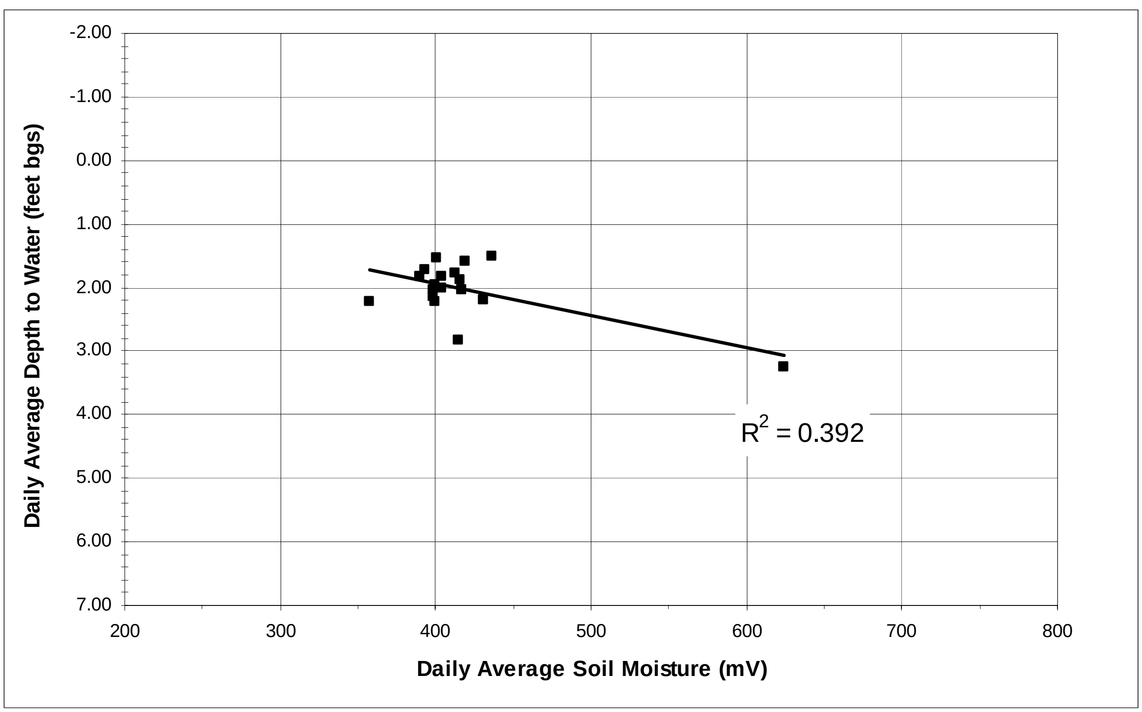


Figure E10. Average soil moisture vs. average water level for Clear Lake, 2005–2006.

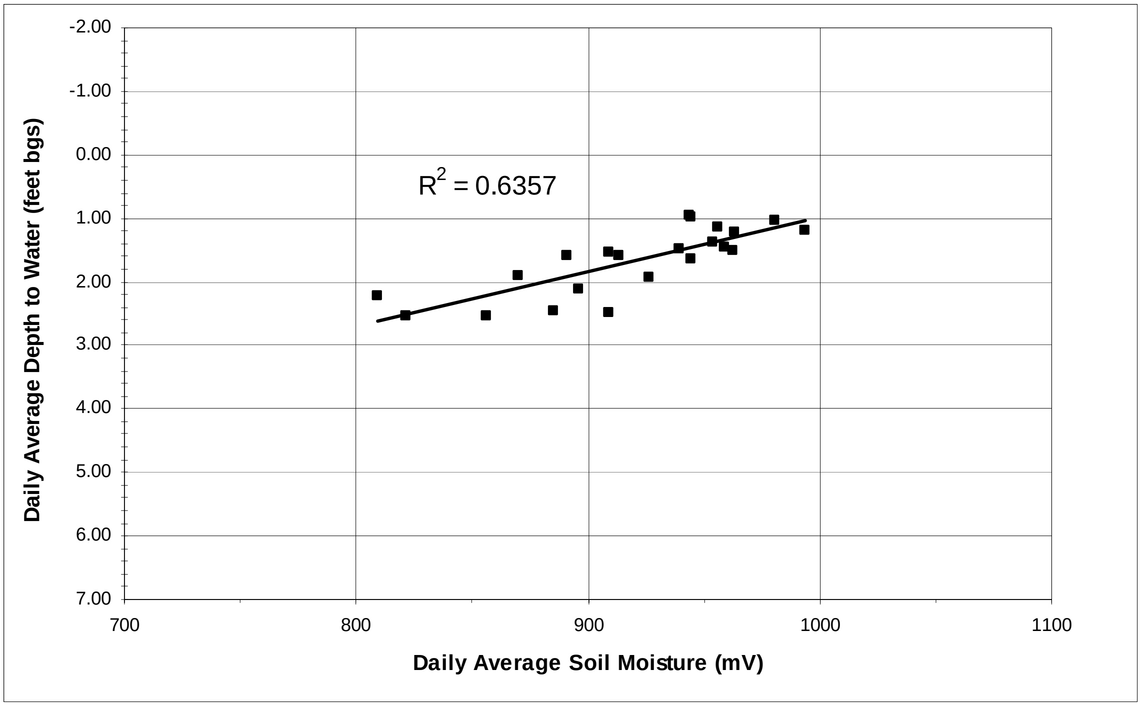


Figure E11. Average soil moisture vs. average water level for Ferguson Lake, 2005–2006.

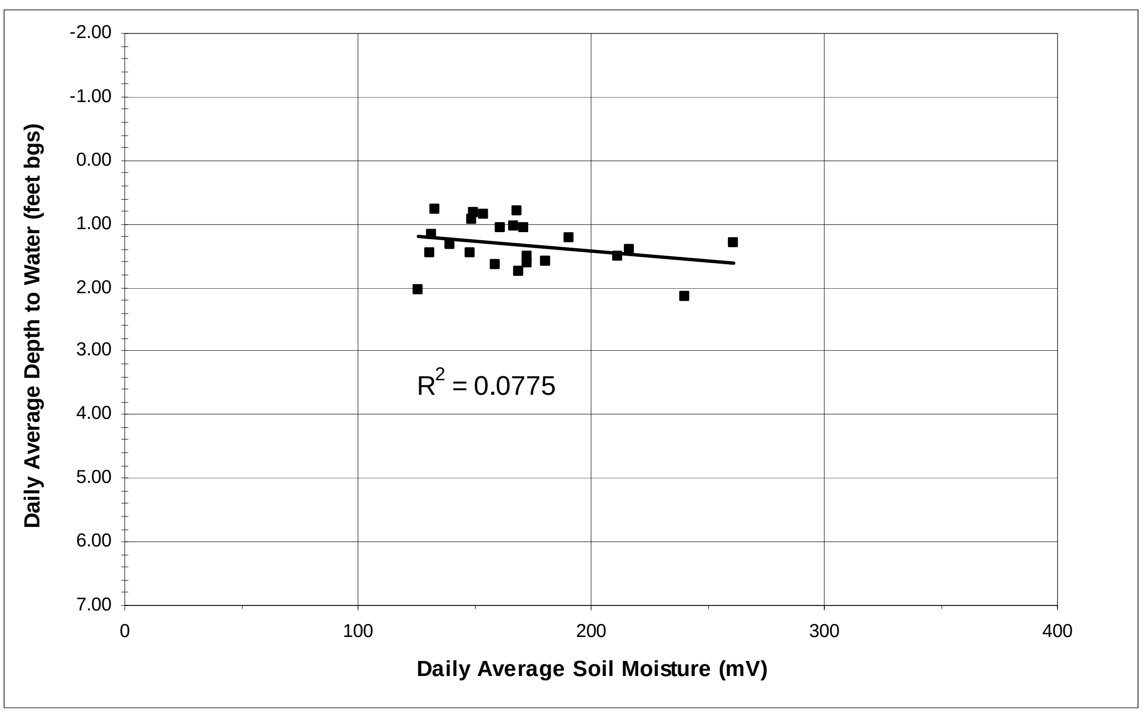


Figure E12. Average soil moisture vs. average water level for Ferguson Wash, 2005–2006.

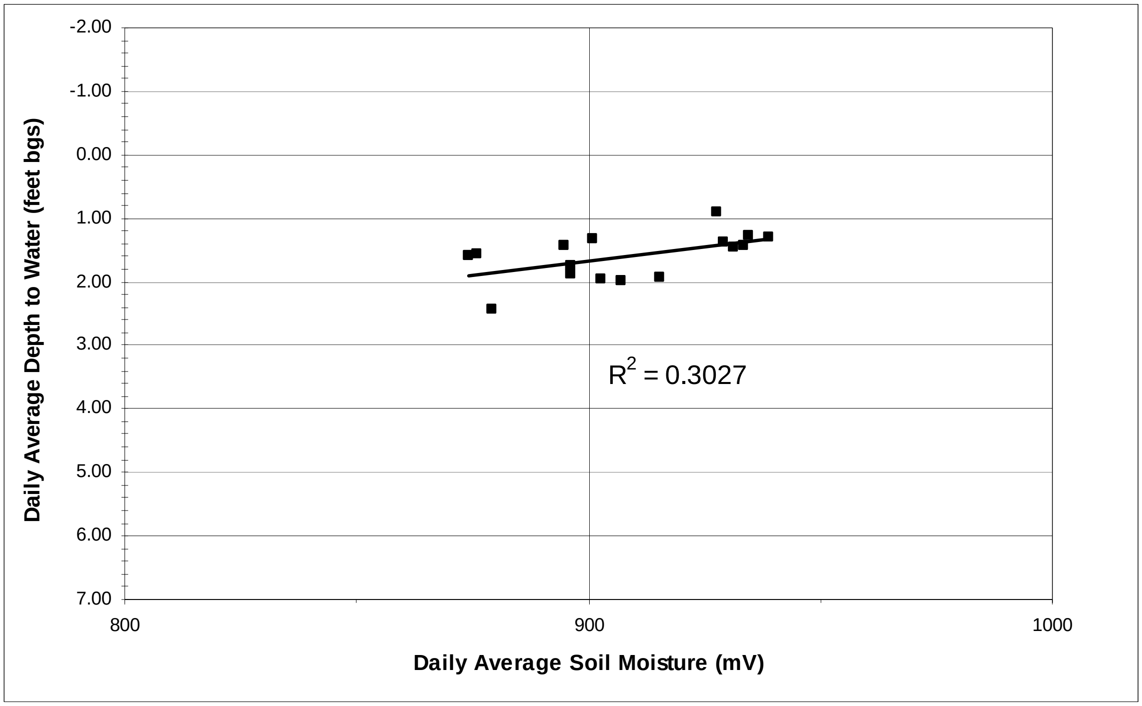


Figure E13. Average soil moisture vs. average water level for Great Blue Heron, 2005–2006.

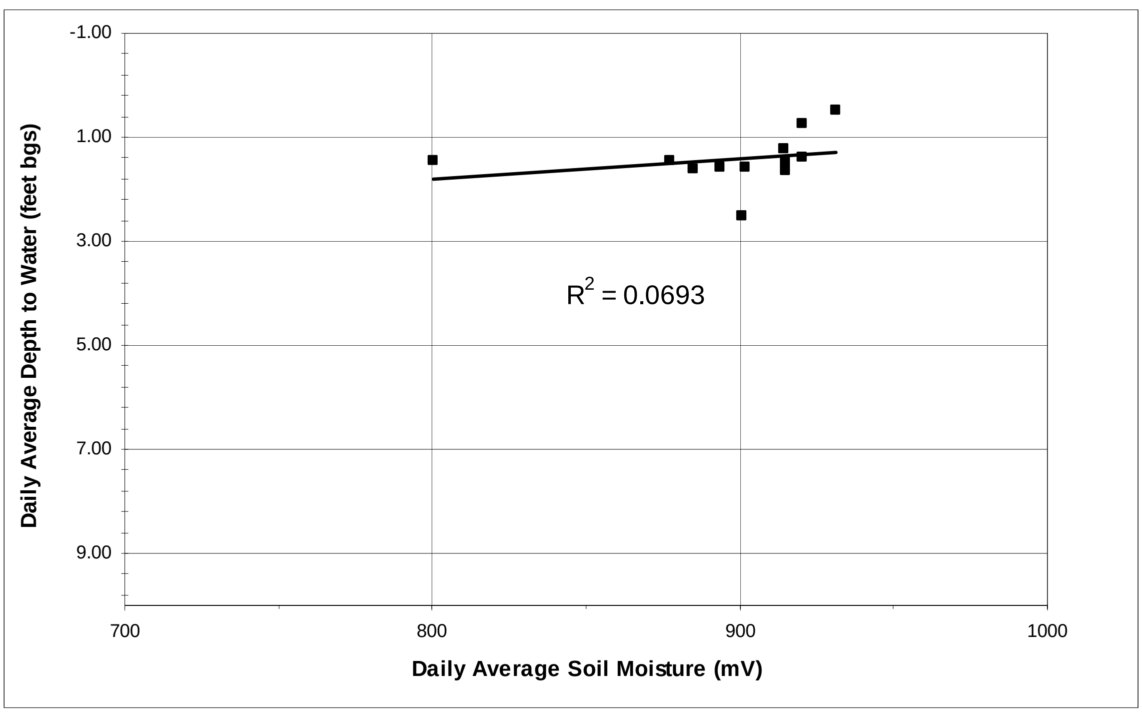


Figure E14. Average soil moisture vs. average water level for Mittry West, 2005–2006.

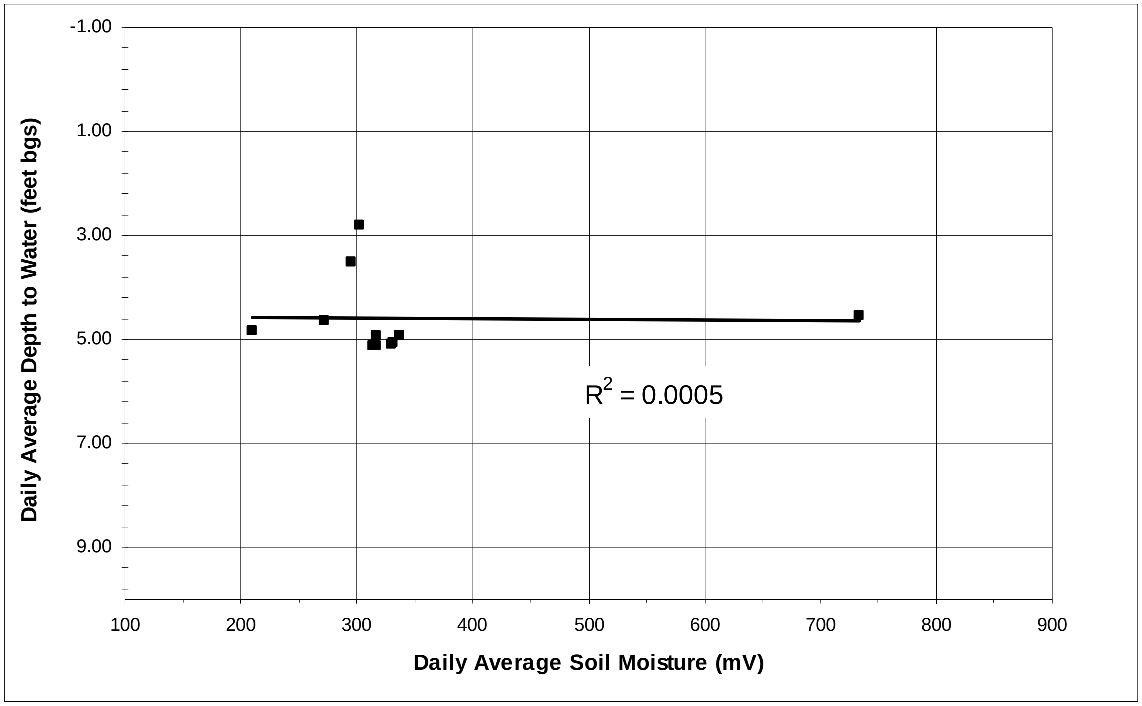


Figure E15. Average soil moisture vs. average water level for Gila Confluence North, 2005–2006.

APPENDIX F

Linear Regression for Average Absolute Humidity vs. Average Water Level

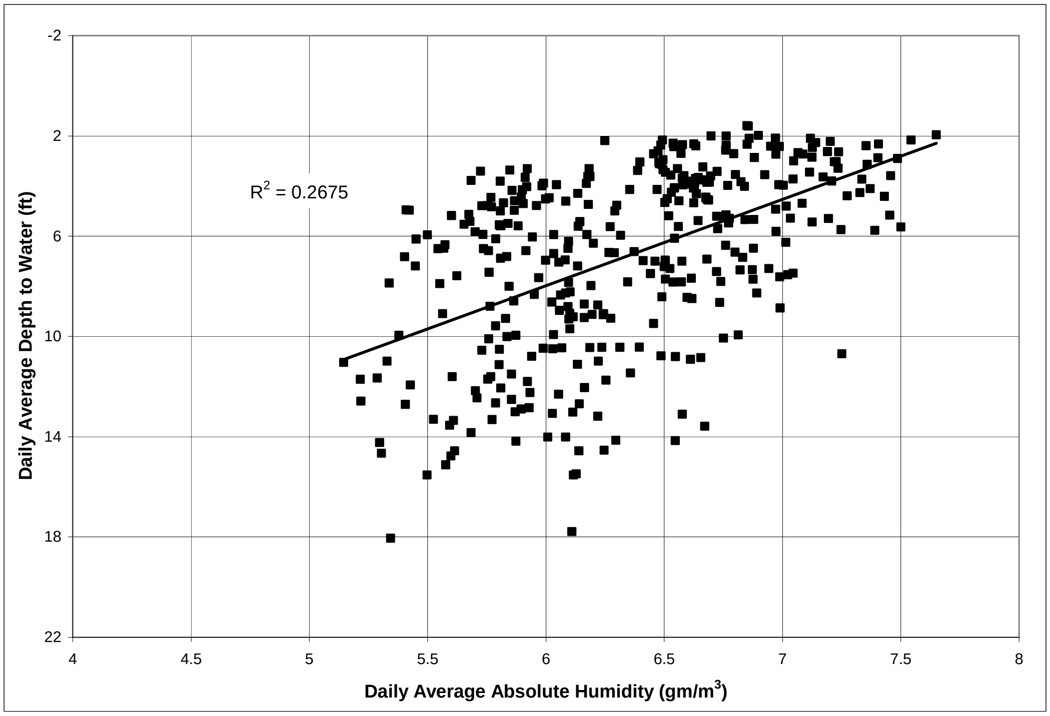


Figure F1. Linear regression of average absolute humidity vs. average piezometer water level, Blankenship Bend, 2005–2006.

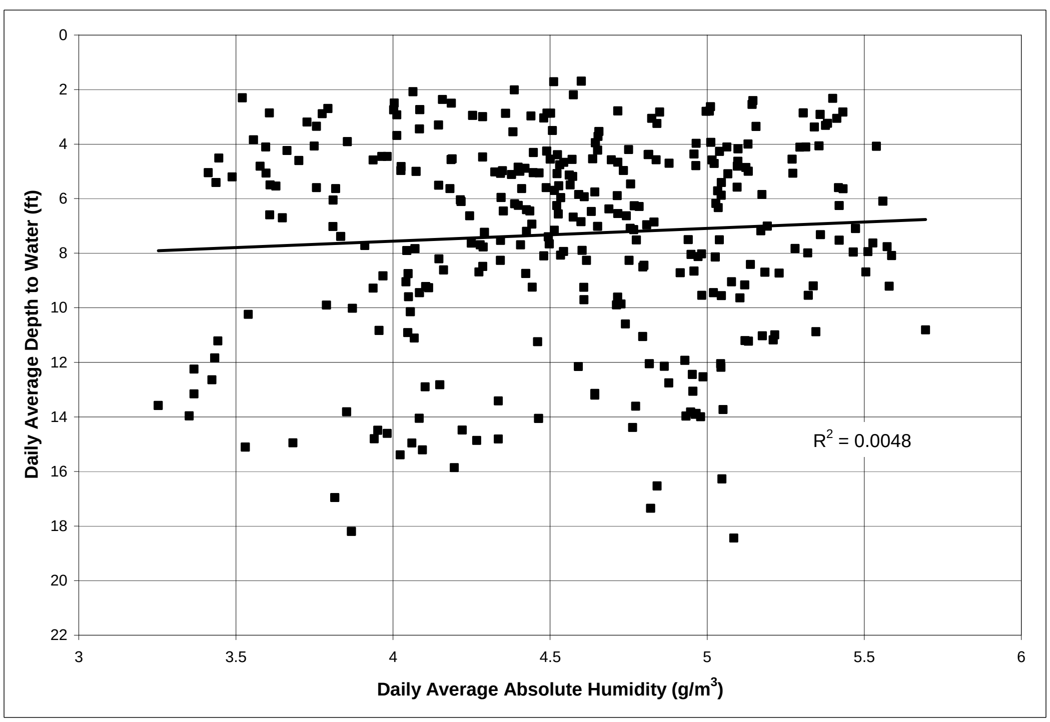


Figure F2. Linear regression of average absolute humidity vs. average piezometer water level, Havasu NE, 2005–2006.

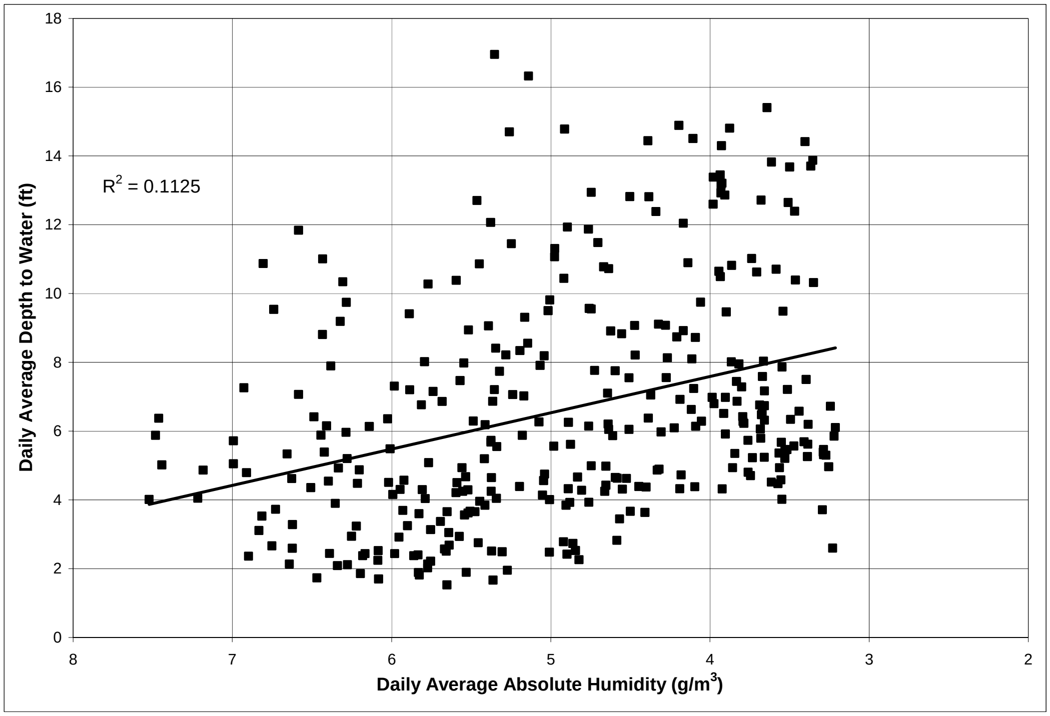


Figure F3. Linear regression of average absolute humidity vs. average piezometer water level, Ehrenberg, 2005–2006.

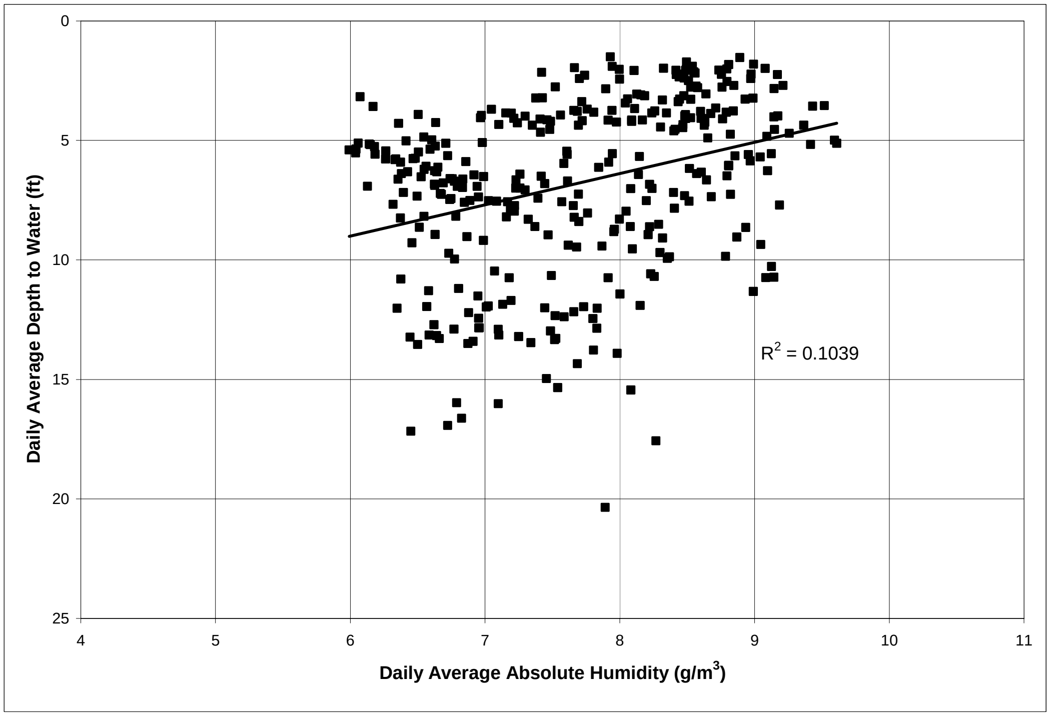


Figure F4. Linear regression of average absolute humidity vs. average piezometer water level, Three Fingers Lake, 2005–2006.

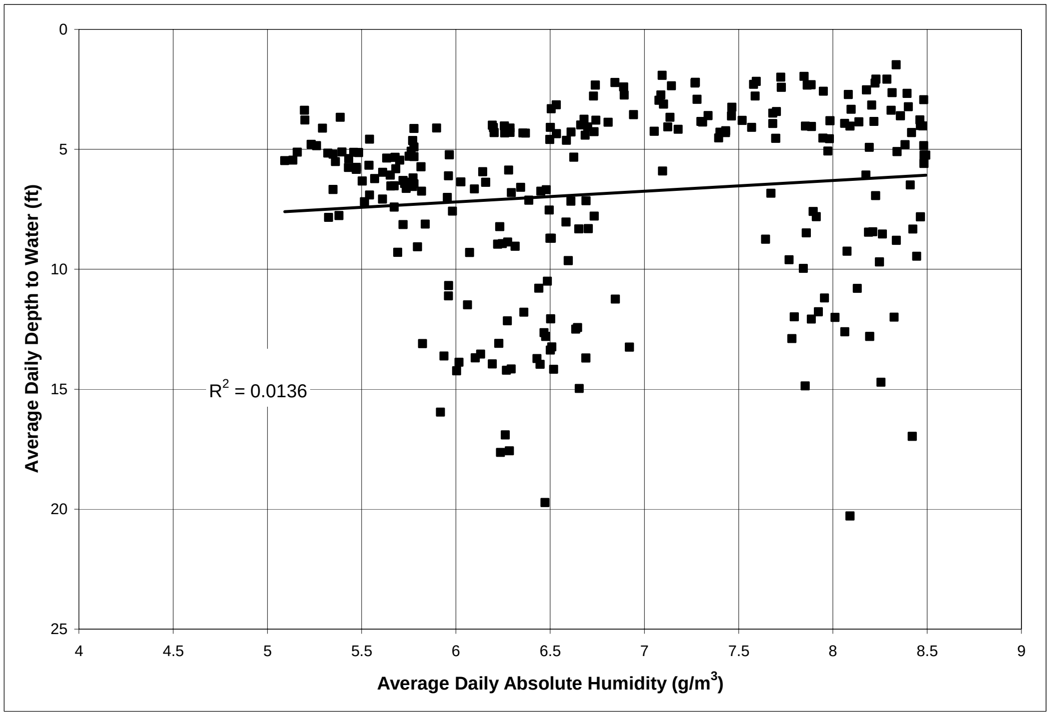


Figure F5. Linear regression of average absolute humidity vs. average piezometer water level, Cibola Lake, 2005–2006.

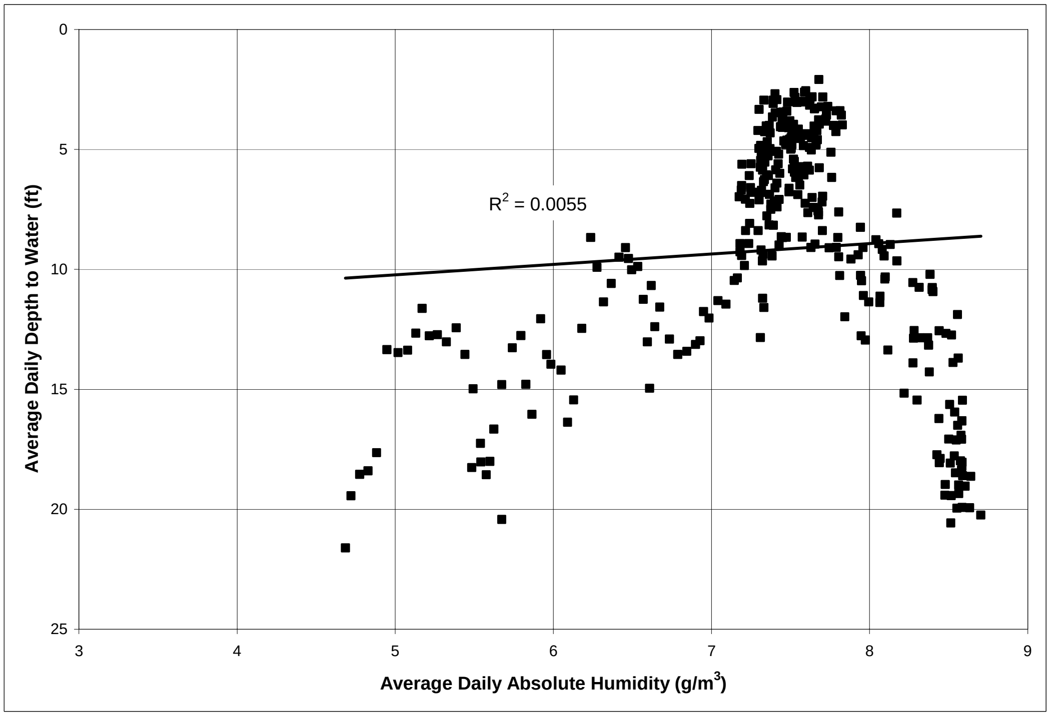


Figure F6. Linear regression of average absolute humidity vs. average piezometer water level, Walker Lake, 2005–2006.

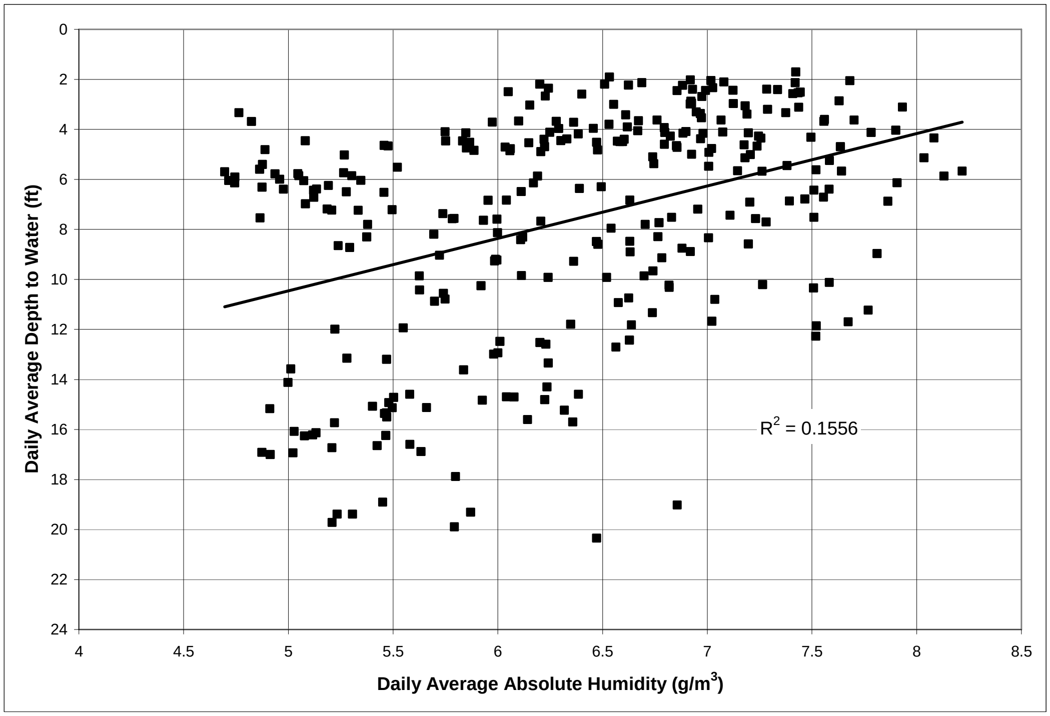


Figure F7. Linear regression of average absolute humidity vs. average piezometer water level, Paradise, 2005–2006.

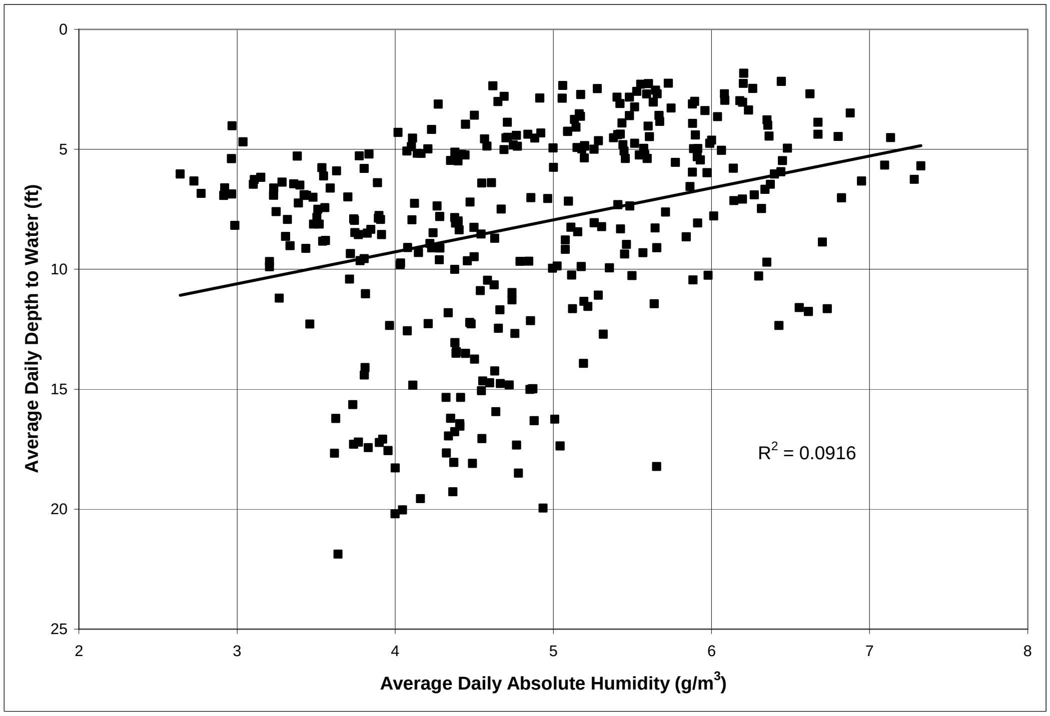


Figure F8. Linear regression of average absolute humidity vs. average piezometer water level, Hoge Ranch, 2005–2006.

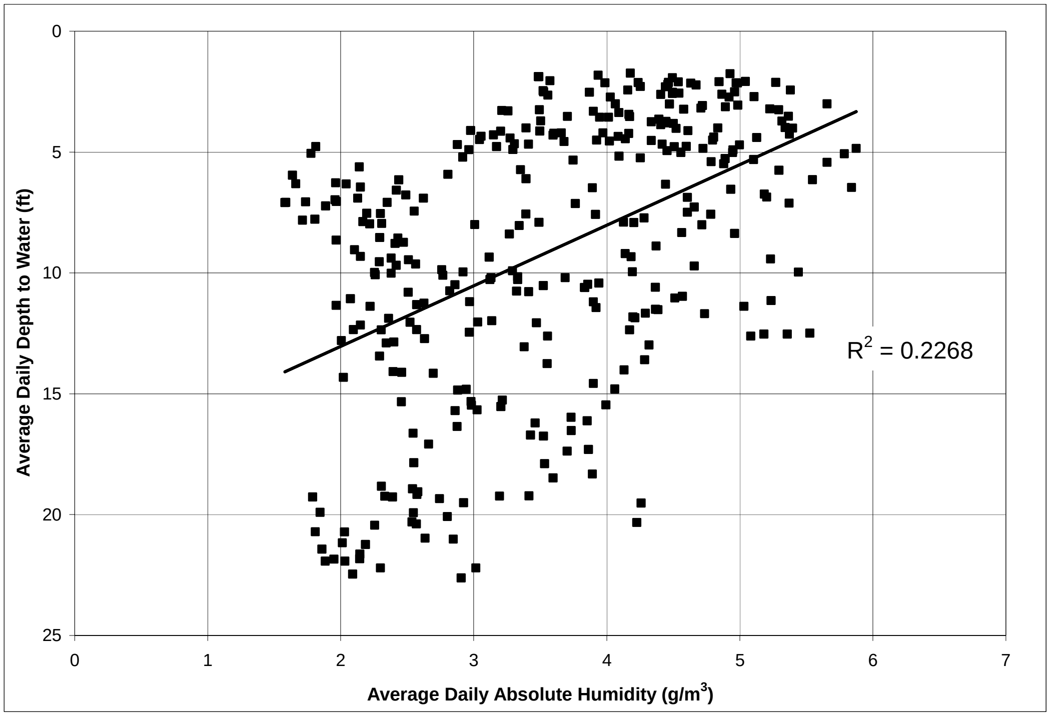


Figure F9. Linear regression of average absolute humidity vs. average piezometer water level, Rattlesnake, 2005–2006.

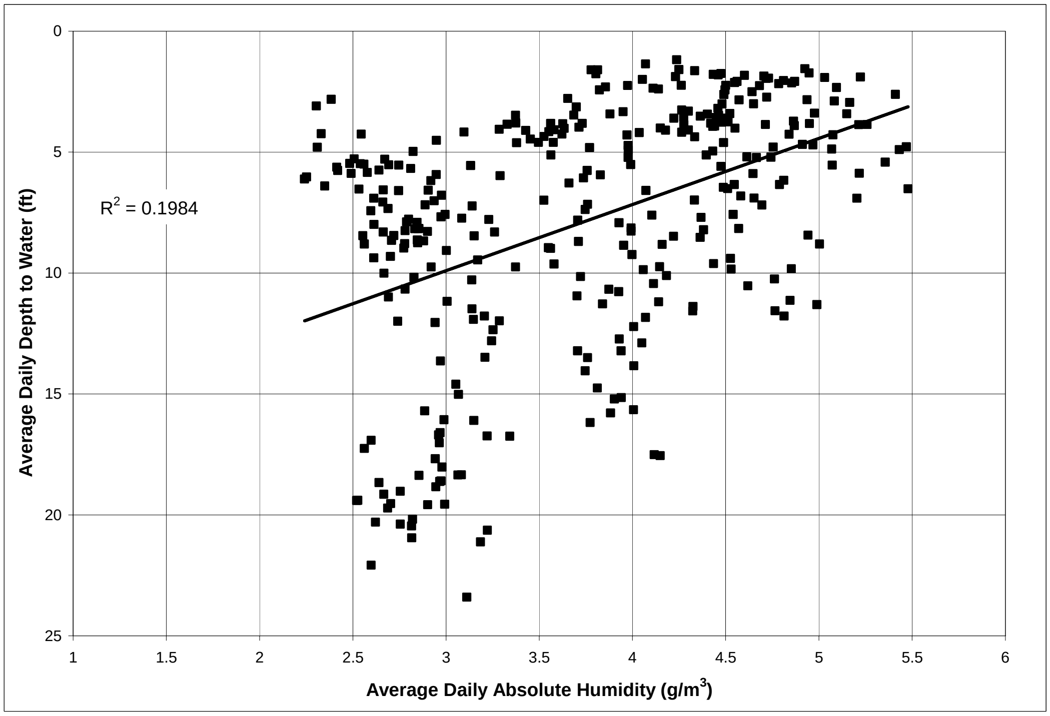


Figure F10. Linear regression of average absolute humidity vs. average piezometer water level, Clear Lake, 2005–2006.

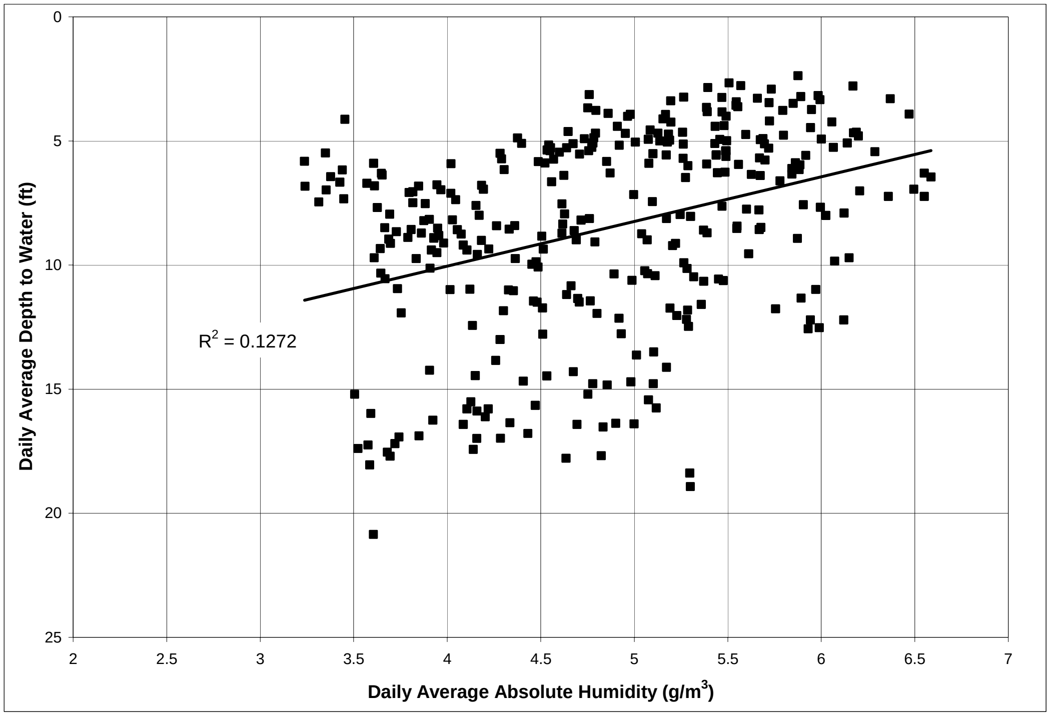


Figure F11. Linear regression of average absolute humidity vs. average piezometer water level, Ferguson Lake, 2005–2006.

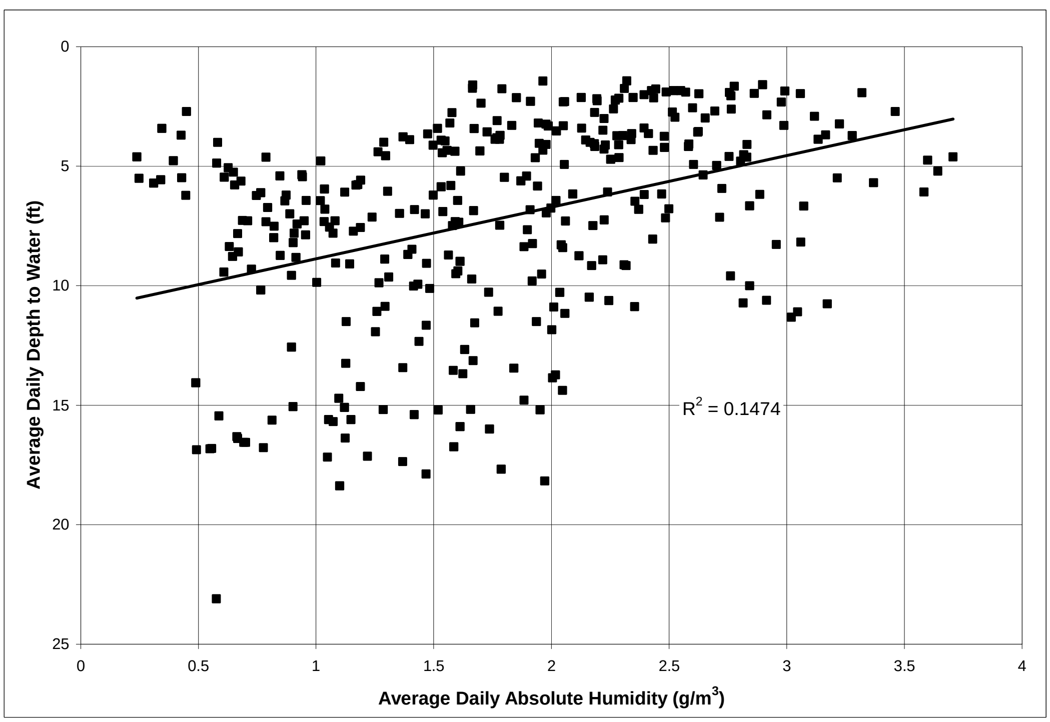


Figure F12. Linear regression of average absolute humidity vs. average piezometer water level, Ferguson Wash, 2005–2006.

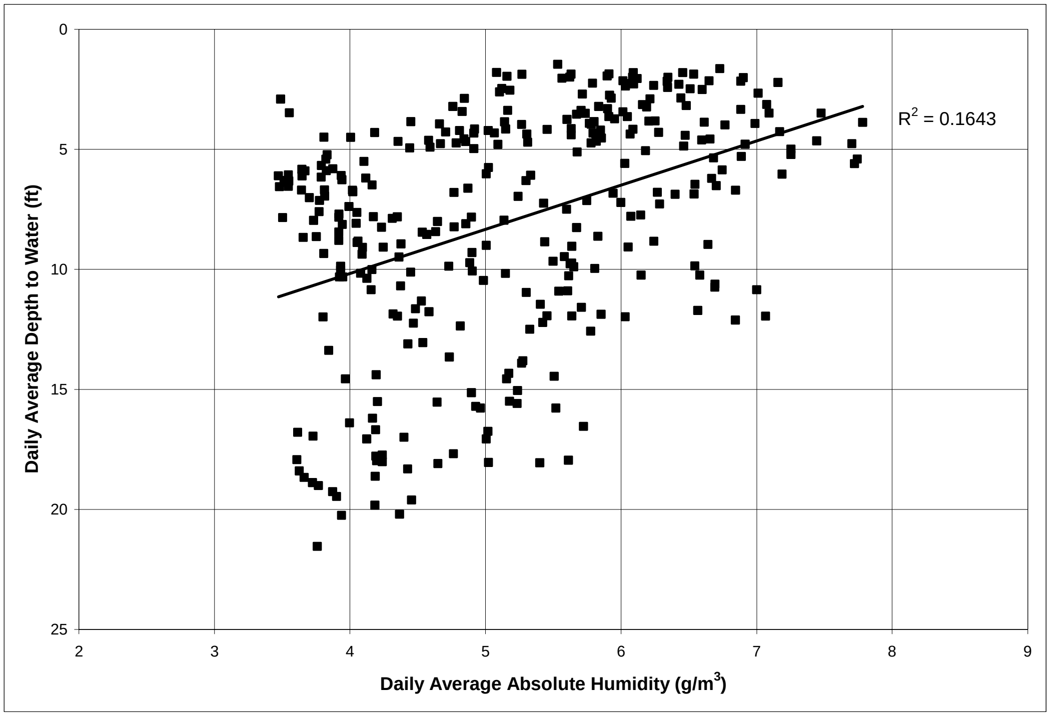


Figure F13. Linear regression of average absolute humidity vs. average piezometer water level, Great Blue Heron, 2005–2006.

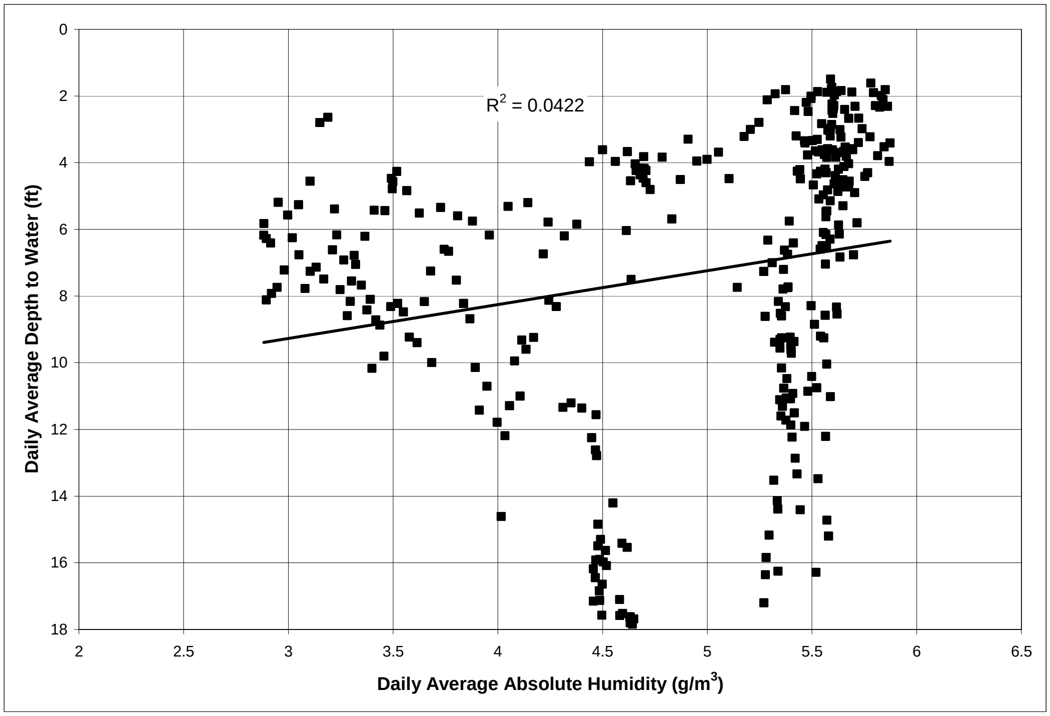


Figure F14. Linear regression of average absolute humidity vs. average piezometer water level, Mittry West, 2005–2006.

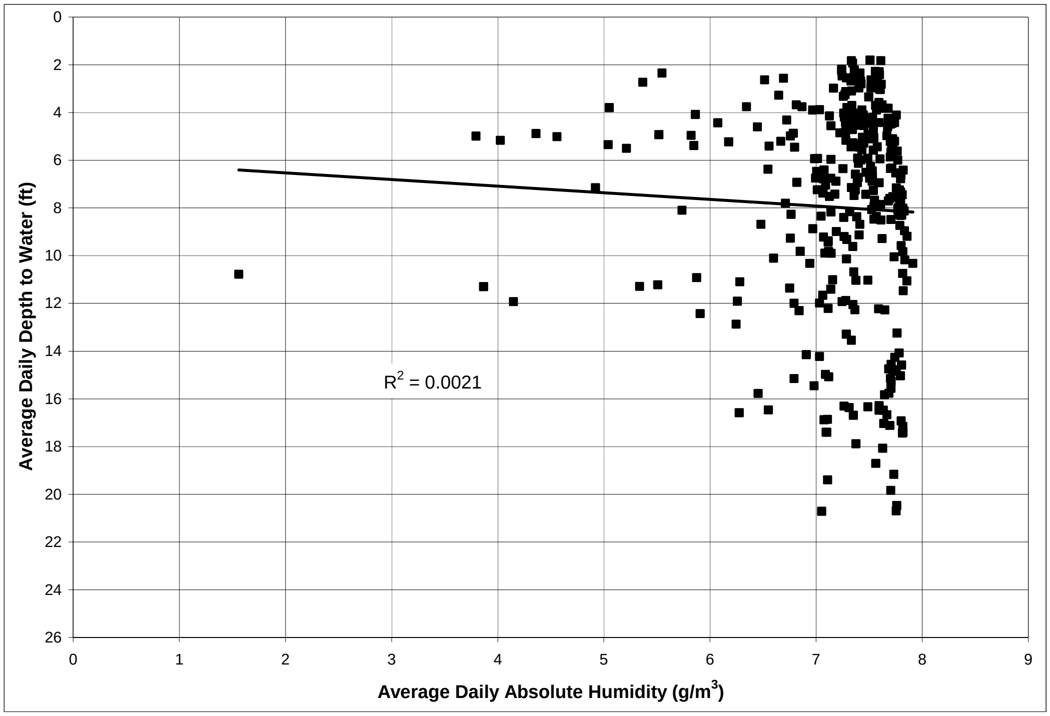


Figure F15. Linear regression of average absolute humidity vs. average piezometer water level, Gila Confluence North, 2005–2006.

APPENDIX G

Contributing Personnel

Contributor	Role
Steven W. Carothers, Ph.D.	Principal-in-Charge
Mary Anne McLeod, M.S.	Project Manager/Scientist/Field Supervisor
Thomas J. Koronkiewicz, M.S.	Senior Scientist/Field Supervisor
Bryan T. Brown, Ph.D.	Microclimate/Habitat Specialist
Wendy Langeberg, M.S.	Statistician
Glenn A. Dunno, M.A.	GIS Specialist
Lisa R. Baca	Project Administrator/Database Design
Jessica Maggio	Administrative Assistant/Data Entry
Casey Wyatt	Administrative Assistant/Data Entry
Dorothy A. House, M.A.	Technical Editor
Katie Stumpf	Field Coordinator/Data Entry
Timothy Hauck.	Field Coordinator
Clifford B. Cordy, Ph.D.	Field Coordinator
Jillian Johnston	Bander/Nest Monitor
Thomas Magarian	Bander/Nest Monitor
Nick Meyer	Bander/Nest Monitor
Sarah Nichols	Bander/Nest Monitor
Alana Demko	Surveyor/Nest Monitor
Danielle Ethier	Surveyor/Nest Monitor
Jessica Eyster	Surveyor/Nest Monitor
Aaron Gallagher	Surveyor/Nest Monitor
Samantha Musgrave	Surveyor/Nest Monitor
Gabrielle Robinson	Surveyor/Nest Monitor
Josh Sayers	Surveyor/Nest Monitor
Paul Smylie	Surveyor/Nest Monitor
Benjamin Wardwell	Surveyor/Nest Monitor
Pete Hosner	Surveyor
Gizelle Hurtado	Surveyor
Collin Schaumburg	Surveyor
Julie Teskie	Surveyor