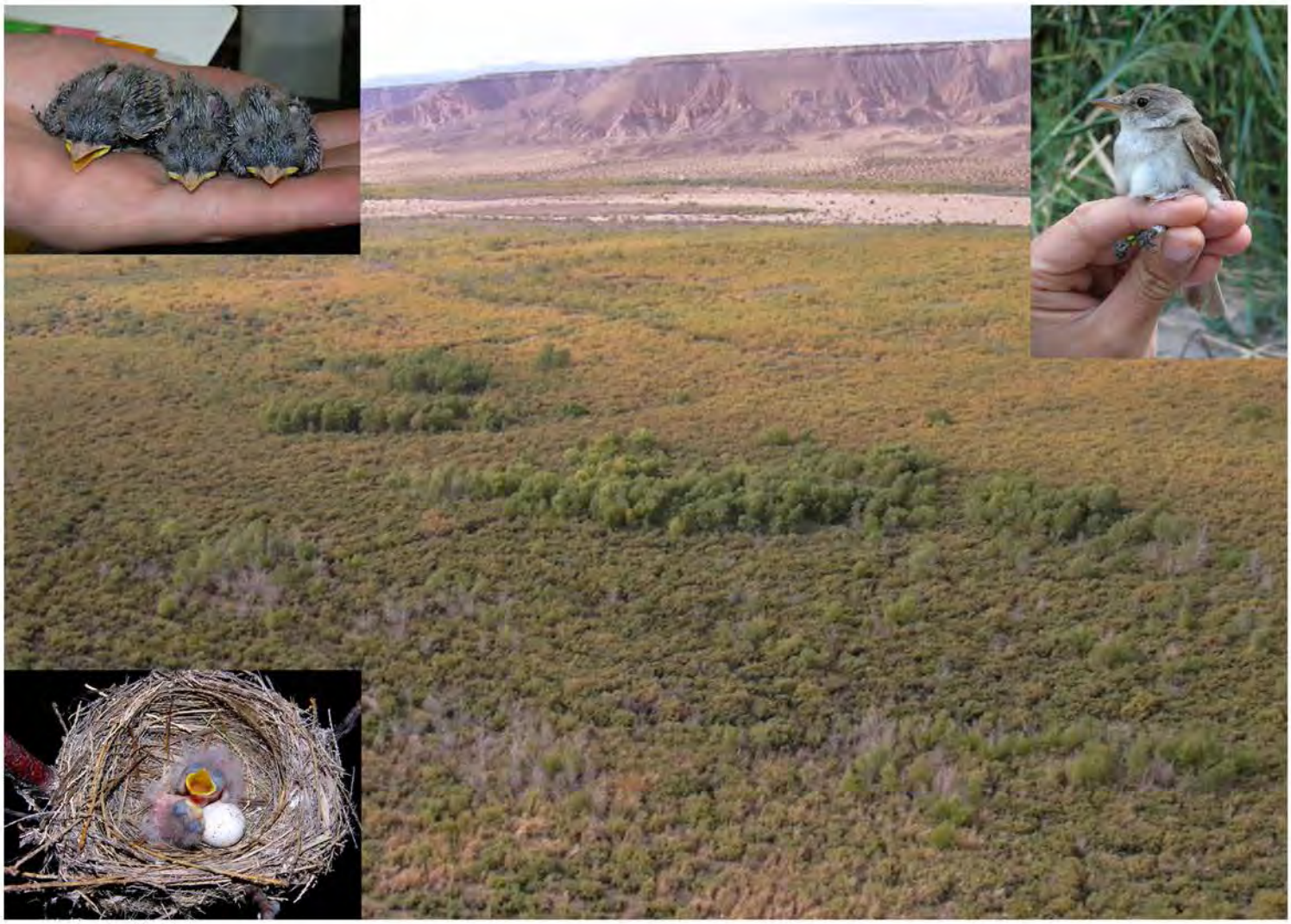
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Southwestern Willow Flycatcher Surveys, Demography, and Ecology along the Lower Colorado River and Tributaries, 2011. Annual Report



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Lower Colorado River
Multi-Species Conservation Program

Southwestern Willow Flycatcher Surveys, Demography, and Ecology along the Lower Colorado River and Tributaries, 2011 Annual Report

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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 (LCR). The LCR MSCP was signed in April 2005, and implementation of the program began in October 2005. The LCR MSCP calls for continued surveys and monitoring of willow flycatchers along the lower Colorado River. SWCA Environmental Consultants (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 2011.

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, would change to a point above Parker Dam. These changes in water regulation could cause a drop in floodplain groundwater levels of 1.55 feet (0.47 m) or less and have the potential to modify riparian habitats below Parker Dam. A Biological Opinion for Interim Surplus Criteria, Secretarial Implementation Agreements, and Conservation Measures was issued in January 2001 and required monitoring of 150.5 ha of existing, occupied Southwestern Willow Flycatcher habitat between Parker and Imperial Dams. In 2004, Reclamation biologists initiated studies of the microclimate within potentially affected areas. In 2005, these studies were continued and expanded by SWCA to address how the hydrological changes might affect riparian habitats along the Parker to Imperial reach.

Following the breeding season of 2008, USFWS and Reclamation initiated discussions regarding the declining number of willow flycatcher territories at Topock Marsh, the importance of the flycatcher population in the Topock area to flycatcher conservation along the LCR, and possible measures to enhance flycatcher habitat at Topock. A plan was developed to pump water into a portion of the flycatcher breeding habitat at Topock beginning in February or March and continuing into the flycatcher breeding season. Water delivery commenced 1 March 2011 and continued into July. Baseline conditions of vegetation, microclimate, and hydrology in the target area were documented in 2009 and 2010, and these studies were continued in 2011 to document conditions during the water delivery period.

SWCA was retained by Nevada Department of Wildlife (NDOW) in 2011 to complete flycatcher surveys, site descriptions, nest monitoring and color-banding at Key Pittman Wildlife Management Area, River Ranch, and Warm Springs Natural Area. We also completed surveys for Yellow-billed Cuckoos at these study areas.

Approximately 100 sites are included in the Reclamation study of flycatchers along the Virgin and lower Colorado Rivers, but a portion of the sites are surveyed biennially rather than annually. In 2011, we completed presence/absence surveys, following a 5-survey protocol, and site descriptions at a subset of the 100 sites. At study areas where territorial flycatchers were detected in 2011, we searched for nests in all areas occupied by territorial flycatchers; monitored willow flycatcher nests to document nest fate, brood parasitism, and causes of nest failure; and color-banded and resighted as many willow flycatchers as possible to determine the breeding status of territorial flycatchers and document movement and recruitment. We also measured characteristics of vegetation and microclimate in occupied territories at one study area.

We used recorded broadcasts of willow flycatcher song and calls to elicit responses from willow flycatchers at 59 Reclamation sites, ranging in size from <1 to 38 ha, along the Virgin and lower Colorado Rivers and tributaries from Pahranagat National Wildlife Refuge (NWR), Nevada, south to Yuma, Arizona between 15 May and 24 July 2011. We detected willow flycatchers on at least one occasion at 47 of these sites. Breeding or resident flycatchers were detected at 13 sites within the Pahranagat NWR, Mesquite, Mormon Mesa, and Muddy River, Nevada; and Topock Marsh and Bill Williams River NWR, Arizona, study areas. South of Bill Williams, 154 willow flycatcher detections were recorded between 15 May and 20 June; no flycatcher detections were recorded at any of these sites after 20 June. Monitoring results suggest these flycatchers were not resident, breeding individuals and were most likely spring migrants.

We completed broadcast surveys for flycatchers at 3 sites and monitored an additional 17 sites within the three NDOW study areas and detected breeding flycatchers within 15 sites. We also completed surveys for Yellow-billed Cuckoos at these study areas. No cuckoos were detected during surveys or incidentally.

We used targeted mist-net and passive netting techniques to capture and uniquely color-band adult and fledgling willow flycatchers at all sites where resident willow flycatchers were detected. Nestlings were banded between 8 and 10 days of age. We banded each willow flycatcher with a single, numbered U.S. federal aluminum band on one leg and one pin-striped, aluminum band on the other. 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 Reclamation study areas, we color-banded 15 new adult flycatchers and recaptured 11 individuals detected in previous years as adults. An additional 31 adults were identified to individual via resighting, while 3 individuals were resighted but did not have their color combinations confirmed. We detected two individuals identified as returning nestlings by the presence of a single federal band, with one (50%) identified to individual via recapture. Two additional returning nestlings with full combinations were recaptured. Thirty adult flycatchers remained unbanded, and banding status was undetermined (i.e., we were unable to determine if these individuals were banded) for 30 adults. We banded 40 nestlings from 17 nests. Of the 40 nestlings banded, 5 were known or suspected to have died before fledging. We banded flycatchers opportunistically at St. George, Utah, capturing and color-banding two new adults and one nestling.

At NDOW study areas, we color-banded 13 new adult flycatchers and recaptured 3 individuals detected in previous years as adults. An additional 25 adults were identified to individual via resighting, while 2 individuals were resighted but did not have their color combinations confirmed. We recaptured one individual identified as a returning nestling by the presence of a single federal band. Three additional adults were captured with a full color combination and identified as returning nestlings from 2009 or 2010. Five adult flycatchers remained unbanded, and banding status was undetermined for one adult. We banded 34 nestlings from 13 nests. Of the 34 nestlings banded, 3 were suspected to have died before fledging.

Of the 96 resident, adult willow flycatchers identified to individual at monitored study areas in 2010, 55 (57%) were identified in 2011; 5 (9%) were detected at a different study area from where they were last detected in 2010. We detected seven within-year, between-study area movements in 2011.

Of the 51 juveniles banded and not known or suspected to have died at Reclamation study areas in 2010, 2 (4%) were identified in 2011. An additional 36 juveniles were banded at NDOW study areas and not known or suspected to have died in 2010; nine (25%) were identified in 2011. Sixteen individuals originally banded as nestlings in previous years were identified for the first time in 2011. Of the 16 returning nestlings identified in 2011, 12 (75%) dispersed away from their natal study area. The median dispersal distance for all returning juvenile flycatchers in 2011 was 12.8 km.

We recorded 50 territories at all Reclamation study areas. Of these, 36 (72%) consisted of paired flycatchers and 14 (28%) consisted of unpaired individuals. Eight breeding males were polygynous, two pairing with three females and six pairing with two females. One female mated consecutively with two different males. One male moved and established a second territory within the same study area. We recorded 24 territories at NDOW study areas. Of these, 21 (88%) consisted of breeding individuals, 1 (4%) consisted of paired individuals with no documented breeding activity, and 2 (8%) consisted of unpaired males. Three males were polygynous; each mated with two females.

At Reclamation study areas, we documented 49 willow flycatcher nesting attempts, 43 of which contained eggs and were used in calculating nest success and productivity. Eighteen (42%) nests were successful and fledged young; and 25 (58%) failed. Mayfield survival probability ranged from 0.198 to 1.000, and was 0.467 for all sites combined (except Topock Marsh where Mayfield nest success could not be calculated due to a lack of data). Depredation was the major cause of nest failure, accounting for 52% of all failed nests and 65% of nests that failed after flycatcher eggs were laid.

We documented 38 flycatcher nesting attempts at NDOW study areas; 36 of these were known to contain flycatcher eggs and were used in calculating nest success and productivity. Of nests known to contain flycatcher eggs, fourteen (39%) were successful and fledged young, and 22 (61%) failed. Depredation accounted for the majority (59%) of all nest failures. Mayfield survival probability was 0.447 at Key Pittman and could not be calculated at River Ranch or Warm Springs due to lack of data.

At Reclamation study areas, 7 of 37 nests (19%) with flycatcher eggs and known contents were brood parasitized by Brown-headed Cowbirds. Brood parasitism at Reclamation study areas ranged from 0 to 60% and was highest at Muddy River. At NDOW study areas, 4 of 34 nests (12%) with flycatcher eggs and known contents were brood parasitized. Brood parasitism was 11% at Key Pittman, 75% at River Ranch, and 0% at Warm Springs. We addled cowbird eggs via vigorous shaking at all easily accessible flycatcher nests. Egg addling appeared to reduce the hatch rate of cowbird eggs, though small sample size precluded rigorous comparisons. Nests that contained flycatcher eggs and were brood parasitized were less likely to fledge flycatcher young than nests that were not parasitized. This is not necessarily due to the success or failure of the addling program as parasitized nests often failed for other reasons (e.g., depredation or failure of flycatcher eggs to hatch).

At Bill Williams River NWR, we gathered data on microclimate characteristics at one location each for two of the territorial male flycatchers we identified; both males obtained mates and had nesting attempts. We also gathered data on vegetation characteristics at these two territories, plus an additional two territories; one of the additional territories was occupied by a nesting pair and the other by an unpaired male. We delineated the following habitat types: 1) Goodding willow with tamarisk understory, and 2) cottonwood/willow. Both of these vegetation types fall within the definition of cottonwood-willow habitat (cottonwoods and willows constituting at least 10% of total trees) as used in the LCR MSCP. We present results for each of our delineated habitat types as well as for the cottonwood-willow vegetation types used in the LCR MSCP. Sample sizes in 2011 are too small to provide an accurate

representation of the range and variance in vegetation and microclimate characteristics in each habitat type.

Both vegetation types (Goodding willow with tamarisk understory and cottonwood/willow) exhibited moist or inundated soil conditions at some point in the breeding season. Daily maximum temperatures spanned a range of ~5°C among habitat types, while daily minimum temperatures spanned <3°C. Vapor pressure increased through the end of July for both habitat types and was higher in Gooding willow with tamarisk understory than in cottonwood/willow.

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. Soil moisture measurements were collected at each data logger location in 2011 during each flycatcher survey at the site and when logger data were downloaded. Vegetation measurements were also collected at each data logger location after surveys were completed.

Comparisons of microclimate characteristics among years in 2005–2011 at the habitat monitoring sites indicated hotter and more humid conditions in 2006 and cooler conditions in 2009 than in the other years. The interannual changes in temperature were similar between test and control sites, suggesting that these changes were regional, rather than being influenced by local conditions. The interannual changes in soil moisture in 2005–2006, 2007–2008, and 2009–2010 were not similar between test and control sites, with soil moisture declining more sharply at the control sites during the first two periods and then rising sharply during the third. This suggests that local conditions, in addition to regional climate, may have influenced soil moisture. Although vapor pressure fluctuated more sharply between years at test versus control sites, both test and control sites exhibited fluctuations in vapor pressure that were consistent with the annual fluctuations in dew point recorded at the Needles, California weather station. Thus, regional weather appears to have an overriding influence on humidity within both test and control sites.

We noted between-year differences at the habitat monitoring sites for several vegetation variables, but none of the variables exhibited a unidirectional change across time. Many vegetation characteristics that varied over time showed parallel changes at control and test sites, suggesting either widespread yearly variation or observer variation between years. Few variables showed changes that were specific to control or test sites, and several of those variables had marginally significant (> 0.01) *P*-values. Only woody ground cover and dead vertical foliage had *P*-values < 0.01. Ground cover did not differ from 2005 to 2007 at test locations but increased at control plots in 2006 and then decreased in 2007. It is not clear whether this represents actual changes in the amount of woody ground cover or whether it is a result of observer variation. Vertical foliage counts of dead vegetation have increased overall over the last several years at test plots, although there has been considerable yearly fluctuation, and the percentage of the vertical foliage that consists of live vegetation has dropped accordingly. The interannual fluctuations make it difficult to draw inferences about general trends in vegetation health. In addition, we have not recorded an increase in the number of dead stems, suggesting that there has been no noticeable increase in plant mortality.

It has become apparent, after measuring the same vegetation plots for several consecutive years, that stem counts in very dense vegetation are inherently inaccurate and imprecise and can vary widely from year to year when there has likely been no appreciable change in stem density. Given the difficulties in producing repeatable stem counts, absolute stem counts are likely not a suitable metric for detecting subtle changes in vegetation. The proportion of live stems may provide a more sensitive metric by which to detect change; the accuracy of this measure depends only on each observer counting live stems in a manner consistent with how s/he counts dead stems. Similarly, the proportion of live vertical foliage is likely to provide a more sensitive measure of changes in vegetation than do the absolute vertical foliage counts.

The detection of changes in vegetation as the result of the diversion of water at Parker rather than Imperial Dam is further hampered by the complete lack of vegetation measurements prior to the beginning of the diversion in 2002. Vegetation measurements did not commence until 2005, by which time it is possible that some changes in vegetation, particularly in sensitive species such as coyote willow, had already occurred.

Supplemental water delivery to support habitat enhancement commenced at Topock Marsh in 2011, periodically flooding portions of In Between and 800M. The flooded area at those two sites was the only area surveyed for flycatchers within Topock Marsh that contained surface water during the 2011 breeding season. Water delivery did not appear to have any effects on vegetation that would influence flycatcher occupancy. Water delivery had the expected effect of raising soil moisture, decreasing distance to water, and increasing the percentage of the area surrounding each sample point that was inundated or saturated. Water delivery also increased humidity within the flooded area. Flood events produced a lower maximum temperature, higher minimum temperature, and smaller daily temperature range in the flooded area in comparison to the non-flooded area, but these effects did not seem to persist across two-week periods. Areas occupied by flycatchers typically have higher soil moisture, higher humidity, and more moderate temperatures than unoccupied areas; thus, water delivery appeared to change the conditions within the flooded area in ways that would favor flycatcher occupancy. Water delivery was the most effective at creating conditions favored by flycatchers when the underlying water table was high. Despite the presence of favorable conditions, flycatcher occupancy in the target area did not increase in 2011, possibly because dry conditions elsewhere in Topock Marsh and a low flycatcher population may have limited the ability of flycatchers to colonize the area.

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 (LCR). As a step to developing the LCR MSCP, Reclamation prepared a Biological Assessment (BA) in August 1996, evaluating the effects of dam operations and maintenance activities on threatened, endangered, and sensitive (TES) species. These species included the 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 LCR 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 LCR. The USFWS responded with a BO in April 2002 requiring continued Southwestern Willow Flycatcher studies along the LCR 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 LCR MSCP is a 50-year program that seeks to protect 26 TES species and their habitats along the LCR while maintaining river regulation and water management required by law. The LCR MSCP was approved in April 2005 with the signing of a Record of Decision by the Secretary of the Department of the Interior, and implementation of the program began in October 2005. Documentation for the LCR MSCP includes a Habitat Conservation Plan (HCP), BA/BO, and an Environmental Impact Statement. The HCP specifies monitoring and research measures that call for surveys and research to better define habitat requirements for the Southwestern Willow Flycatcher and studies to determine the effects of cowbird nest parasitism on flycatcher reproduction.

Reclamation initiated willow flycatcher studies along the LCR in 1996, in anticipation of the requirements outlined in the BOs that were part of LCR MSCP development. These studies have been conducted annually since 1996. From 1997 to 2010,[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 at Littlefield, Arizona; (3) Mesquite and (4) Mormon Mesa on the Virgin River, Nevada; (5) Overton

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

Wildlife Management Area (WMA) 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 (McLeod et al. 2008a; McLeod and Koronkiewicz 2009, 2010; McLeod and Pellegrini 2011; Braden and McKernan unpubl. data). From 1997 to 2010, 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.

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 annual monitoring of groundwater levels, vegetation, and soil moisture in addition to temperature and humidity.

Following the breeding season of 2008, USFWS and Reclamation initiated discussions regarding the declining number of willow flycatcher territories at Topock Marsh in 2004–2008, the importance of the flycatcher population in the Topock area to flycatcher conservation along the LCR, and possible measures to enhance flycatcher habitat at Topock. A plan was developed to pump water into a portion of the flycatcher breeding habitat at Topock beginning in February or March and continuing into the flycatcher breeding season. The selected area at Topock had seen the greatest decline in numbers of resident flycatchers but had not experienced any dramatic changes in vegetation. Water delivery was anticipated to commence in 2010, and monitoring of vegetation, microclimate, and hydrologic condition in the target area was initiated in 2009 to obtain baseline conditions in the target area. Water delivery was delayed until 2011, so additional monitoring of baseline conditions occurred in 2010.

RELATED STUDIES

Prior to 2010, Nevada Department of Wildlife (NDOW) completed nest monitoring at Key Pittman WMA, and SWCA Environmental Consultants (SWCA) banded flycatcher nestlings and adults opportunistically in cooperation with the monitoring efforts. In 2010, NDOW retained SWCA to conduct surveys, site descriptions, nest monitoring, and banding at flycatcher breeding areas at Key Pittman WMA and Warm Springs Natural Area. This work was expanded in 2011 to include River Ranch in the Pahranagat Valley. SWCA also completed surveys for Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) at Key Pittman and River Ranch. Results of surveys, site descriptions, nest monitoring, and banding efforts at Key Pittman, River Ranch, and Warm Springs are presented in Chapters 2, 3, and 4.

Utah Division of Wildlife Resources monitored breeding flycatchers in St. George, Utah. SWCA banded adults and nestlings opportunistically in St. George in cooperation with the monitoring efforts. Banding results from St. George are presented in a separate table in Chapter 3.

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 and western Texas (Unitt 1987).

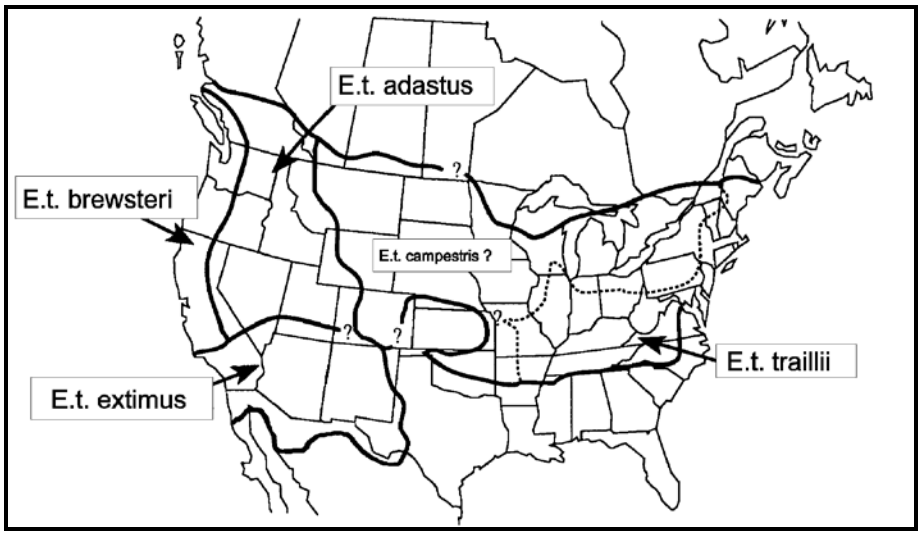

Figure 1.1. Breeding range distribution of the subspecies of the willow flycatcher (*Empidonax traillii*). Adapted from Unitt (1987), Browning (1993), and Sogge et al. (1997).

In the Southwest, most willow flycatcher breeding territories are found within small breeding sites containing five or fewer territories (Durst et al. 2006). 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 LCR region (Unitt 1987). However, no nests have been located south of the Bill Williams River, Arizona, in over 65 years (Unitt 1987), though northbound and southbound migrant willow flycatchers use the riparian corridor (Phillips et al. 1964; Brown et al. 1987; McKernan and Braden 2002; McLeod et al. 2008a; McLeod and Koronkiewicz 2009, 2010; McLeod and Pellegrini 2011; 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).

Tamarisk beetles (*Diorhabda* spp.) may pose an additional threat to Southwestern Willow Flycatchers. Tamarisk beetles defoliate tamarisk (*Tamarix* spp.) plants during flycatcher breeding season, likely exposing flycatcher nests to adverse microclimate conditions and increased risk of depredation and parasitism. Tamarisk beetles were released in St. George, Utah, in 2006, and widespread defoliation was first observed in St. George in 2008. The area of defoliation on the Virgin River has expanded downstream annually since then, encompassing Littlefield, Arizona, in 2009; the Highway 170 bridge

downstream of Bunkerville, Nevada, in 2010; and the entire stretch of the Virgin River to Lake Mead by the end of the breeding season in 2011.

PURPOSE AND DESCRIPTION OF STUDY

The purpose of the 2011 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. Lower Grand Canyon was not visited in 2009–2011 because the declining level of Lake Mead dramatically reduced the amount of potential flycatcher habitat, and the formation of rapids at Pearce Ferry and Iceberg Canyon made access difficult and dangerous. This project encompasses four types of studies: (1) presence/absence surveys, including site descriptions, at preselected sites along the lower Colorado River and portions of major tributaries; (2) intensive studies at all study areas where breeding flycatchers are located to assess Southwestern Willow Flycatcher demographics and ecology, habitat selection, and the effects of Brown-headed Cowbird brood parasitism; (3) monitoring of microclimate, vegetation, and groundwater conditions of currently occupied[2] Southwestern Willow Flycatcher habitat between Parker and Imperial Dams; and (4) monitoring microclimate, vegetation, and surface hydrology in a selected portion of flycatcher habitat within Topock Marsh to document the effects of habitat enhancement efforts. SWCA's contract specifies the following field tasks:

Presence/absence Surveys. At approximately 100 sites along the LCR, conduct presence/absence surveys, following a 5-survey protocol (per USFWS 2000).

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

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

Banding. Band as many adult and juvenile flycatchers as possible at sites with territorial flycatchers.

Vegetation, Soils, and Microclimate. Collect vegetation, soil, and microclimate data at the within-territory level at breeding locations in order to quantify conditions at flycatcher territories for replication at restoration areas.

Habitat Monitoring. At 15 previously identified sites, monitor vegetation, microclimate, and groundwater conditions to determine how these may be affected by water transfer actions at Parker Dam.

Surface Hydrology, Vegetation, and Microclimate Monitoring. Within a selected portion of Topock Marsh, monitor surface hydrology, microclimate, and vegetation conditions.

Each distinct aspect of the 2011 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.

[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, 1996–2011.

Chapter 3 – Color-banding and Resighting. Details of banding activities and resighting of previously banded flycatchers are presented in this chapter. Also included are 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.

Chapter 5 – Vegetation and Habitat Characteristics. Vegetation sampling methods are described, and vegetation characteristics are summarized for territories in different habitat types.

Chapter 6 – Microclimate. The methodology of monitoring temperature, humidity, and soil moisture is described, and microclimate characteristics are summarized for flycatcher territories in different habitat types.

Chapter 7 – Habitat Monitoring: Parker to Imperial Dams. The methodology and results of monitoring microclimate, vegetation, and groundwater conditions at occupied sites between Parker and Imperial Dams are presented.

Chapter 8 – Surface Hydrology, Microclimate, and Vegetation Monitoring: Topock Marsh. This chapter describes sampling methods and compares baseline conditions documented in 2009 and 2010 to those documented in 2011 in an area targeted for habitat enhancement.

Chapter 9 – Management and Study Design Recommendations. Recommendations from all previous report chapters are summarized for ease of reference.

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Chapter 2

PRESENCE/ABSENCE SURVEYS AND SITE DESCRIPTIONS

INTRODUCTION

Broadcasts of recorded conspecific vocalizations are useful in eliciting responses from nearby willow flycatchers, and multiple broadcast surveys conducted throughout the breeding season are the standard technique for determining the presence or absence of *E. t. extimus* (Sogge et al. 2010). According to Sogge et al. (2010) and USFWS (2002), willow flycatchers detected between approximately 15 June and 20 July in the breeding range of *E. t. extimus* probably belong to the southwestern subspecies. However, because northbound individuals of all western subspecies of the willow flycatcher migrate through areas where *E. t. extimus* are actively nesting, and southbound migrants occur where *E. t. extimus* are still breeding (Sogge et al. 2010, USFWS 2002), field confirmation of the southwestern subspecies is problematic.[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 flycatchers are more vocal in spring and can therefore be distinguished from other *Empidonax* species. During northbound migration, all subspecies of willow flycatchers use riparian habitats similar to breeding habitat along major river drainages in the Southwest such as the Rio Grande (Finch and Kelly 1999), Colorado River (McKernan and Braden 1999), San Juan River (Johnson and Sogge 1997), and the Green River (M. Johnson unpubl. data). Although migrating willow flycatchers may favor young, native willow habitats (Yong and Finch 1997), migrants are also found in both spring and fall in a variety of habitats that are unsuitable for breeding. These migration stopover habitats, even though not used for breeding, are likely important for both reproduction and survival. For most long-distance Neotropical migrant passerines, migration stopover habitats are needed to replenish energy reserves to continue northbound or southbound migration.

In 2011, as part of our contract with Reclamation, we completed multiple broadcast surveys at sites in 11 study areas[2] (hereafter Reclamation study areas) along the LCR and its tributaries to detect both migrant and resident willow flycatchers (Figure 2.1). We also completed surveys in three additional study areas (Key Pittman, River Ranch, and Warm Springs; hereafter NDOW study areas) as part of our contract with NDOW.

Special Concern Species

The Yuma Clapper Rail (*Rallus longirostris yumanensis*) is listed as federally endangered by the USFWS, and the Yellow-billed Cuckoo is a candidate for federal listing. Both species occur along the LCR and its tributaries and are of concern to managing agencies. Nine additional avian species [California Black Rail (*Laterallus jamaicensis coturniculus*), Least Bittern (*Ixobrychus exilis*), Elf Owl (*Micrathene whitneyi*),

[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 1–18 survey sites that are grouped geographically (see Table 2.2).

Figure 2.1. Locations of Southwestern Willow Flycatcher study areas along the lower Colorado River and tributaries, 2011. (Note, study area labels represent the approximate center of multiple sites within that region; see Table 2.2)

Gila Woodpecker (*Melanerpes uropygialis*), Gilded Flicker (*Colaptes auratus chrysoides*), Vermilion Flycatcher (*Pyrocephalus rubinus*), Arizona Bell's Vireo (*Vireo bellii arizonae*), Sonoran Yellow Warbler (*Setophaga petechia sonorana*), and Summer Tanager (*Piranga rubra*)] are considered to be special-concern species under the LCR MSCP. The Yellow-breasted Chat (*Icteria virens*) is also considered a special concern species in California. We did not survey specifically for these species at the 11 Reclamation study areas but recorded all incidental detections. We recorded all incidental detections of special concern species at all three NDOW study areas and completed surveys for Yellow-billed Cuckoos at Key Pittman and River Ranch.

METHODS

Site Selection

Survey sites were selected based on locations surveyed during previous years of willow flycatcher studies on the LCR (McKernan 1997; McKernan and Braden 1998, 1999, 2001a, 2001b, 2002; McLeod et al. 2008a; McLeod and Koronkiewicz 2009, 2010; McLeod and Pellegrini 2011) and reconnaissance on foot prior to the start of the 2011 survey period. Sites consisting of mature native or exotic woody riparian vegetation with high canopy closure (>50%) and standing water or saturated soil under or adjacent to the vegetation were considered the most suitable habitats for flycatchers. Early successional stands of young riparian vegetation >3 m in height in proximity to surface water or saturated soil were also considered potentially suitable flycatcher habitat. Riparian vegetation contiguous with suitable habitat was often included as part of survey areas. Reclamation biologist Chris Dodge guided and approved site selection at the 11 Reclamation study areas. For sites surveyed in previous years, we retained original site names.

In 2008 we implemented a biennial survey schedule at selected sites in study areas where resident flycatchers had not been documented in the previous 10 years of surveys. Sites were selected for biennial surveys based on the absence of damp or wet soils within the site and/or the relative absence of dense vegetation that might provide suitable nesting habitat for flycatchers. After the 2008 survey season, we revised the survey schedule based on conditions observed in the field and added several sites at Bill Williams to the biennial schedule. These sites were ones at which no resident flycatchers had been detected since 2003. The proposed schedule at the beginning of the 2011 survey season is given in Table 2.1 and may be further revised based on conditions observed during 2011.

Table 2.1. Proposed Survey Schedule for Selected Sites

Study Area[1]	Site	Habitat Comments	Proposed Survey Schedule		
			Annual	2008, 2010, 2012	2009, 2011
TOGO[2]	Pulpit Rock	Tiny. Wet soil adjacent to river; upland edge dry.			X
	Picture Rock	Wet soil adjacent to river; interior dry.			X
	Blankenship Bend North	Stand of willow adjacent to marsh.	X		
	Blankenship Bend South	Mosaic of cattail, bulrush, willow. Areas with water under vegetation.	X		
	Havasu NE	Mature vegetation; interior of site is completely dry, no water beneath the vegetation.		X	

Table 2.1. Proposed Survey Schedule for Selected Sites (Continued)

Study Area[1]	Site	Habitat Comments	Proposed Survey Schedule		
			Annual	2008, 2010, 2012	2009, 2011
BIWI	Site #1	Mixed-native vegetation; dry soils and stands of dense arrowweed in the center of the site; coyote willow and surface water along the site edge, bordering an arm of Lake Havasu.		X	
	Site #2	Mature mixed-native vegetation; dry soils and extensive deadfall within the site; bordered by an arm of Lake Havasu.		X	
	Site #11	Mature mixed-native vegetation; dry soils and extensive deadfall within the site; bordered by an arm of Lake Havasu.		X	
	Black Rail	Mixed-native vegetation; generally sparse understory; narrow strip of dense vegetation.		X	
	Mineral Wash	Mixed-native vegetation; sparse canopy closure; dry soil underneath the vegetation; water only within river channels.		X	
	Beaver Pond	Mixed-native vegetation; sparse canopy closure; dry soil underneath the vegetation; water only within river channels.		X	
	Site #8	Mixed-native vegetation; sparse canopy closure; dry soil underneath the vegetation; water only within the river channel.		X	
PVER	PVER Phase 2	Restoration area.	X		
	PVER Phase 3	Restoration area.	X		
EHRE	Ehrenberg	Emergent cottonwood and Goodding willow; understory primarily arrowweed and *Baccharis* sp.; formerly contained a dense stand of coyote willow but these willows have all died.		X	
CIBO	CVCA Phase 1	Restoration area.	X		
	CVCA Phase 2	Restoration area.	X		
	CVCA Phase 3	Restoration area.	X		
	Cibola Nature Trail	Generally dry and sparse. Restoration area; habitat improvements taking place, may improve.	X		
	Cibola Island	Narrow, linear site; patches of dense Goodding willow adjacent to marsh.	X		
	Cibola Site 2	No dense canopy. Mostly tamarisk with some emergent willow. Cattail marshes in parts of the site, but dry soil under the tamarisk.			X
	Cibola Site 1	No dense canopy. Mostly tamarisk with some emergent willow. Cattail marshes in parts of the site, but dry soil under the tamarisk.			X
	Three Fingers Lake	Vegetation short, very dry and hot in interior.		X	
	Cibola Lake #1 (North)	Patchy vegetation, hot and dry in interior.		X	
	Cibola Lake #2 (East)	Patchy vegetation, hot and dry in interior.			X
	Cibola Lake #3 (West)	Patchy vegetation, hot and dry in interior.		X	
	Walker Lake	Tamarisk with emergent willows; water under vegetation along lake edge.	X		
IMPE	Paradise	Some big willows with tamarisk understory, sometimes has water in marshes.	X		
	Hoge Ranch	Mosaic of tamarisk, willow, and marshes. Sometimes wet.	X		
	Adobe Lake	Perched above river, very dry; dense tamarisk with many dead branches in understory.		X	
	Rattlesnake	Dense willows, wet soils.	X		

Table 2.1. Proposed Survey Schedule for Selected Sites (Continued)

Study Area[1]	Site	Habitat Comments	Proposed Survey Schedule		
			Annual	2008, 2010, 2012	2009, 2011
IMPE	Milemarker 65	Very narrow strip (<50m) of tamarisk adjacent to bulrush marsh. Understory of *Phragmites* creates extremely dense vegetation within 3 m of ground.			X
	Clear Lake/The Alley	Mature tamarisk, very dense understory. Very dry except immediately next to backwater channel.		X	
	Nursery NW	Dense tamarisk interspersed with marsh areas.	X		
	Imperial Nursery	Plantation. No understory.		X	
	Ferguson Lake	Mix of willow and tamarisk with water under vegetation on west side of site. East side dry and scrubby.	X		
	Ferguson Wash	Mature tamarisk with emergent willow. Very dry in interior of site. Borders backwater channel and Ferguson Lake. Moist soils only along channel edge.		X	
	Great Blue Heron	Goodding willow overstory, tamarisk understory; moist soils in parts of the site.	X		
	Powerline	Very small. Stringer of trees around cattail marsh that sometimes contains water. Sparse canopy.			X
	Martinez Lake	Scattered willows, tamarisk and arrowweed understory, sparse canopy closure.			X
MITT	Mittry West	Willow overstory, tamarisk understory, 80% canopy closure; sometimes wet.	X		
	Mittry South	Monotypic tamarisk, lots of deadfall. Interior dry. Adjacent to lake.		X	
YUMA	Gila Confluence North	Patchy. A few small stands of mature willows around cattail marshes. Marshes sometimes contain water. Half of site burned in 2006. Overall canopy closure 50%.		X	
	Gila River Site #2	Cottonwood/willow overstory, tamarisk and arrowweed understory; dry soils in interior; canopy closure 50%.			X
	Fortuna Site #1	Narrow (30m) strip of cottonwood/willow. Patchy understory of tamarisk and arrowweed on periphery, no understory within cottonwood/willow. Interior dry.			X
	Fortuna North	Mature tamarisk, 80% canopy closure. Interior very dry. Adjacent to Gila River.			X

[1] TOGO = Topock Gorge, BIWI = Bill Williams River NWR, PVER = Palo Verde Ecological Reserve, EHRE = Ehrenberg, CIBO = Cibola, IMPE = Imperial, MITT = Mittry Lake, YUMA = Yuma.

[2] No surveys were completed in Topock Gorge in 2011 because effort was redirected to hydrology monitoring at Topock Marsh (see Chapter 8).

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 using a Garmin Rino 110 GPS unit and were in NAD 83 to comply with Federal Geographic Data Committee standards.

Additional Site Evaluation

During the survey season, we conducted on-the-ground habitat reconnaissance and evaluation to locate additional potentially suitable willow flycatcher habitat and to reevaluate areas we had visited in previous years and had noted as having the potential to become suitable habitat. 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 and evaluation 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). Broadcast surveys were conducted opportunistically during ground reconnaissance. Field personnel formulated qualitative site descriptions of all evaluated areas.

Broadcast Surveys

To elicit responses from nearby willow flycatchers, 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. (2010), and we followed a 5-survey protocol, as recommended by the U.S. Fish and Wildlife Service (USFWS 2000). We completed at least one survey between 15 and 31 May, at least one survey between 1 and 15 June, and three 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 Sansa® ClipMP3 player 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, we discontinued broadcast surveys within a radius of 50 m of territories and commenced territory and nest monitoring, which involves more frequent visits (see Chapter 4). If an unidentified *Empidonax* 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 are 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 (hereafter cowbirds) and livestock, as requested by the Arizona Game and Fish Department. Cowbirds may affect flycatcher populations by decreasing flycatcher productivity (see Chapter 4), while livestock may substantially alter the vegetation in an area (USFWS 2002).

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), mid-season (mid-June), and late season (mid-July). Vegetation composition (native vs. exotic) at survey sites followed the definitions of Sogge et al. (2010) 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; or (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

Reclamation Study Areas

Field personnel spent 469.6 observer-hours conducting willow flycatcher broadcast surveys at 59 sites along the Virgin and lower Colorado Rivers and tributaries.[3] Willow flycatcher survey and monitoring results are summarized in Table 2.2 and are presented below along with site descriptions. Details of occupancy, pairing, color-banding, and breeding are presented in Chapters 3 and 4. The boundaries of survey sites and occupancy in 2011 are shown on orthophotos in Appendix B, along with historically occupied habitat.[4] We did not complete surveys at sites in Topock Gorge because effort was redirected toward hydrology monitoring within Topock (see Chapter 8). Each site that was not occupied by territorial flycatchers was formally surveyed three to six times. A summary of willow flycatcher survey effort and survey site occupancy status is presented in Appendix C. Field personnel spent an additional 24.3 observer-hours completing habitat reconnaissance and evaluation and opportunistic surveys. The results of reconnaissance for each study area are presented below following the results for the regularly surveyed sites. Because subspecies identification of willow flycatchers detected between approximately 15 June and 20 July in the breeding range of *E. t. extimus* is problematic (Sogge et al. 2010, USFWS 2002), flycatcher detections after 15 June at sites where breeding or residency was not confirmed are summarized in Table 2.3. Yellow-billed Cuckoo and Yuma Clapper Rail detections are listed in Tables 2.4 and 2.5, respectively, and overall numbers of detections of all special concern species are listed in Appendix D. Hydrologic characteristics of each site are summarized in Table 2.6.

Table 2.2. Adult Willow Flycatcher Detections at Reclamation Study Areas, 2011*

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3,4,5]
PAHR	North	4.6	14 (15 May–16 Aug), 2 (18 May), 1 (17–19 Jun), 2 (12 Jul), 1 (13 Jul), 1 (4 Aug)
	West	1.5	1 (21 Jul)[6]
MESQ	Hafen Lane	6.1	2 (30 Jun–23 Jul), 1 (21–23 Jul)
	West	10.4	11 (17 May–17 Aug)
	Bunker Marsh North	7.1	ND[7]
MOME	Mormon Mesa South	11.8	ND
	Virgin River #1	22.5	23 (14 May–17 Aug), 1 (26 Jun), 1 (10–14 Jul), 1 (24 Jul)
	Virgin River #2	11.2	ND
MUDD	Overton WMA Pond	0.7	1 (2–5 Jul)
	Overton WMA	14.9	13 (14 May–7 Aug), 1 (6 Jul), 1 (2–3 Aug)

[3] We started the survey season with 57 sites scheduled for surveys in 2011. Two sites were added after reconnaissance revealed potential flycatcher habitat. We discontinued surveys at one site because of poor habitat quality.

[4] 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 2.2. Adult Willow Flycatcher Detections at Reclamation Study Areas, 2011* (Continued)

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3,4]
TOPO	Pipes #1	5.2	1 (23 Jun–1 Jul)
	Pipes #3	5.7	2 (23–27 Jun), 1 (6–8 Jul)[8]
	The Wallows	0.7	1 (1–5 Jun), 1 (9–13 Jun), 1 (25 Jun–9 Jul)[9]
	PC6-1	4.8	1 (1 Jun)
	Pig Hole	2.4	ND
	In Between	7.7	1 (21 May)
	800M	4.7	1 (7 May–28 Jun)[8], 1 (5–7 Jun), 1 (18 Jun)
	Pierced Egg	6.7	1 (24 May), 2 (29 May), 1 (3 Jun)
	Swine Paradise	0.9	1 (9 Jun)
	Barbed Wire	2.1	ND
	Platform	1.9	1 (16 May–10 Jun)[9]
	250M	1.9	ND
	Hell Bird	6.3	2 (16 May), 4 (29 May), 2 (4 Jun), 2 (8 Jun)
	Glory Hole	5.0	ND
	Spaghetti	5.4	2 (30 May)
	Beal Lake	18.0	1 (7 Jun)
	Lost Lake	3.3	1 (26 May)
	Dock[10]		3 (29 May)
BIWI	Wispy Willow[11]	0.5	1 (27 May)
	Burn Edge	4.1	1 (30 Jun)
	Site #4	9.9	1 (16 Jun), 1 (20–26 Jun), 1 (20 Jun–5 Jul)
	Site #3	13.0	2 (13 May–1 Aug), 1 (27 May)
	Last Gasp	2.1	ND
	Site #5	6.8	1 (21 May), 1 (29 May)
	Cougar Point[12]	1.3	2 (10–16 Jul)[13]
	Upstream from Site #8	1.5	ND
	Planet Ranch Road	3.3	3 (15 May–30 Jul), 1 (1 Jun), 1 (1–6 Jun)
	New River	0.6	ND
PVER	PVER Phase 2	21.4	3 (16 May), 6 (26 May), 2 (9 Jun)
	PVER Phase 3	21.4	1 (16 May), 3 (26 May)
CIBO	CVCA Phase 1	26.2	6 (23 May), 3 (31 May), 3 (8 Jun)
	CVCA Phase 2	25.5	11 (23 May)
	CVCA Phase 3	38.4	16 (24 May), 2 (1 Jun)
	Cibola Nature Trail	13.7	1 (1 Jun)
	Cibola Island	4.2	ND
	Cibola Site #2	16.4	3 (25 May), 2 (14 Jun)
	Cibola Site #1	7.7	ND
	Cibola Lake #2 (East)	4.5	1 (25 May), 1 (20 Jun)
	Walker Lake	11.4	1 (15 Jun)

Table 2.2. Adult Willow Flycatcher Detections at Reclamation Study Areas, 2011* (Continued)

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
IMPE	Paradise	7.8	3 (18 May)
	Hoge Ranch	20.7	8 (21 May), 6 (2 Jun)
	Rattlesnake	7.6	3 (21 May), 2 (2 Jun)
	Milemarker 65	10.0	1 (18 May)
	Nursery NW	7.0	4 (22 May), 2 (5 Jun)
	Ferguson Lake	21.1	2 (19 May)
	Great Blue Heron	7.1	3 (17 May), 9 (20 May), 4 (3 Jun), 5 (5 Jun)
	Powerline	1.0	2 (17 May), 1 (3 Jun)
	Martinez Lake	4.6	2 (3 Jun)
MITT	Mittry West	4.4	3 (17 May)
YUMA	Gila River Site #2	2.9	7 (4 Jun)
	Fortuna Site #1	3.2	15 (4 Jun)
	Fortuna North	3.8	6 (4 Jun), 1 (5 Jun)

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

[1] PAHR = Pahranagat NWR, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams River NWR, PVER = Palo Verde Ecological Reserve, CIBO = Cibola, IMPE = Imperial, 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] Flycatchers in territories that were occupied throughout the breeding season are shown as being present throughout the season. Flycatchers detected on a single occasion or for a short period of time are listed separately.

[5] We detected several within-season movements between study areas in 2011. For details on movements see Table 3.9.

[6] Detection was of a banded family group (one adult with fledges) from Pahranagat North.

[7] Surveys discontinued because of poor quality habitat.

[8] This individual detected 7 May–28 Jun in 800M and 6–8 Jul in Pipes #3.

[9] This individual detected 16 May–10 Jun in Platform and 25 Jun–9 Jul in The Wallows.

[10] Not an official survey site. Incidental detections recorded.

[11] Site surveyed at beginning of season for reconnaissance. Not added to formal survey list due to unsuitable habitat.

[12] Site discovered with breeding flycatchers toward end of survey season.

[13] A singing male was reported at this territory by personnel from an unrelated field crew prior to 10 Jul; only the female was detected during nest monitoring visits 10–16 Jul.

Table 2.3. Detections of Willow Flycatchers Recorded after 15 June 2011 at Sites Where Breeding or Residency Was Not Confirmed

Study Area[1]	Site	Date	Comments
MUDD	Overton WMA Pond	2 Jul	Singing spontaneously (*fitz-bew*)
BIWI	Burn Edge	30 Jun	Occasional unsolicited vocalizations (*fitz-bew* and *wheeo*)
CIBO	Cibola Lake #2 (East)	20 Jun	Brief primary song (*fitz-bew*)

[1] MUDD = Muddy River, BIWI = Bill Williams River NWR, CIBO = Cibola.

Table 2.4. Yellow-billed Cuckoo Detections at Reclamation Study Areas, 2011

Study Area[1]	Site	Date	Behavioral Observations
MESQ	Hafen Lane	23 Jun	One individual detected
	West	19–22 Jul	Repeated detections of one or two individuals
MUDD	Overton WMA	14 Jul	One individual heard
TOPO	Beal Lake	29 Jun	One individual detected
		13 Jul	Two individuals detected
BIWI	Site #3	30 Jun	One individual heard
		16 Jul	Two individuals heard (*coo* and *kowlp*)
	Site #5	10 Jul	One individual detected
	Planet Ranch Road	2–17 Jul	Repeated detections of one or two cuckoos
	New River	7 Jul	One individual detected
		17 Jul	One individual detected
PVER	Phase 2	13 Jun	One individual seen and heard (*kuk* and *kowlp*)
		12 Jul	Two or three individuals heard (*kuk* and *coo*)
	Phase 3	12 Jul	One individual heard
CIBO	CVCA Phase 1	17 Jun	One individual detected
		13 Jul	Two individuals heard
	CVCA Phase 2	17 Jun	One individual heard (*coo*)
		13 Jul	Three or four individuals detected
	CVCA Phase 3	8 Jun	One individual seen
	Cibola Island	7 Jul	Two individuals heard (*kuk* and *coo*), one silent cuckoo seen

[1] MESQ = Mesquite, MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams River NWR, PVER = Palo Verde Ecological Reserve; CIBO = Cibola.

Table 2.5. Yuma Clapper Rail Detections at Reclamation Study Areas, 2011

Study Area[1]	Site	Date(s)	Behavioral Observations
BIWI	Wispy Willow	13 Jun	One individual heard
CIBO	Cibola Site #2	28 Jun	One individual heard
IMPE	Powerline	5 Jul	One individual heard

[1] BIWI = Bill Williams River NWR, CIBO = Cibola, IMPE = Imperial.

Table 2.6. Summary of Hydrologic Conditions at Each Survey Site at Reclamation Study Areas, 2011*

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]	8/--/2	15/--/5	4/--/1	0/--/0
	West[4]	0/0/0	0/0/0	0/0/0	2/5/15
MESQ	Hafen Lane[4]	0/0/0	0/0/0	0/0/0	1/1/1
	West[4]	2/--/0	15/--/0	15/--/0	0/--/0
	Bunker Marsh North[4]	5/--/--	15/--/--	0/--/--	0/--/--

Table 2.6. Summary of Hydrologic Conditions at Each Survey Site at Reclamation Study Areas, 2011* (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]
MOME	Mormon Mesa North	0/--/--	0/--/--	0/--/--	40/--/--
	Hedgerow	0/--/--	0/--/--	0/--/--	300/--/--
	Mormon Mesa South[4]	--/0/0	--/0/0	--/0/0	--/0/0
	Virgin River #1	--/10/10	--/10/20	--/5/8	--/--/0
	Virgin River #2	0/0/0	0/0/0	0/0/0	20/20/20
MUDD	Overton WMA Pond	2/--/2	40/--/10	0/--/0	0/--/0
	Overton WMA	--/--/10	--/--/30	--/--/8	--/0/0
TOPO	Pipes #1	0/0/0	0/0/0	0/0/0	40/40/40
	Pipes #3	0/0/0	0/0/0	0/0/0	40/40/40
	The Wallows	0/0/0	0/0/0	1/0/0	0/80/80
	PC6-1	0/0/0	0/0/0	0/0/0	40/40/40
	Pig Hole	0/0/0	0/0/0	0/0/0	120/120/120
	In Between	25/15/20	30/40/10	30/10/5	0/0/0
	800M	0/0/0	0/0/0	0/10/0	70/0/70
	Pierced Egg	1[5]/1[5]/0	10/3/0	0/0/0	0/0/30
	Swine Paradise[6]	0/0/0	0/0/0	0/0/0	40/40/40
	Barbed Wire	0/2/0	0/10/0	0/0/0	150/0/150
	Platform[6]	0/0/0	0/0/0	0/0/0	20/20/20
	250M[6]	0/0/0	0/0/0	0/0/0	0/0/0
	Hell Bird[6]	0/0/0	0/0/0	0/0/0	0/0/0
	Glory Hole	0/0/0	0/0/0	0/0/0	70/70/70
	Spaghetti	--/--/--	--/--/--	--/--/--	0/0/0
	Beal Lake[7]	0/0/45	0/0/3	0/0/0	20/20/0
	Lost Lake[6]	0/0/0	0/0/0	0/0/0	20/20/20
BIWI	Burn Edge	20/1/<1	10/10/40	30/1/0	0/0/0
	Site #4[4]	5/1/1	10/>100/>100	0/2/0	0/0/0
	Site #3	4/0/0	10/0/0	2/5/0	0/0/250
	Last Gasp	10/1/0	30/3/0	5/0/0	0/0/>1000
	Site #5	10/5/5	30/100/100	3/0/0	0/0/0
	Cougar Point[8]	--/--/70	--/--/10	--/--/25	--/--/0
	Upstream from Site #8[6]	10/10/10	10/10/10	5/5/5	0/0/0
	Planet Ranch Road	50/40/50	40/60/50	30/10/3	0/0/0
	New River	15/15/15	10/10/10	5/10/--	0/0/0

Table 2.6. Summary of Hydrologic Conditions at Each Survey Site at Reclamation Study Areas, 2011* (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]
PVER	PVER Phase 2[7]	0/10/0	0/3/0	0/5/0	300/0/5
	PVER Phase 3[7]	0/25/30	0/10/10	0/40/10	10/0/0
CIBO	CVCA Phase 1[7]	20/0/15	10/0/10	40/0/5	0/10/0
	CVCA Phase 2[7]	0/0/0	0/0/0	0/0/5	5/5/0
CIBO	CVCA Phase 3[7]	0/75/0	0/10/0	0/15/0	10/0/5
	Cibola Nature Trail[7]	0/0/0	0/0/0	0/0/0	12/15/15
	Cibola Island	--/0/0	--/0/0	--/0/0	--/--/5
	Cibola Site #2	0/10/10	0/10/--	--/5/5	100/0/0
	Cibola Site #1	30/15/30	10/10/--	--/10/3	0/0/0
	Cibola Lake #2 (East)[4]	0/0/0	0/0/0	0/0/0	0/0/0
	Walker Lake[4]	--/20/5	--/3/3	--/--/5	--/0/0
IMPE	Paradise[4]	40/--/0	25/--/0	--/--/3	0/0/0
	Hoge Ranch[4]	--/5/5	--/25/20	--/3/3	0/0/0
	Rattlesnake[6]	0/10/0	0/10/0	30/10/0	0/0/5
	Milemarker 65[4]	--/--/--	--/--/--	--/--/--	0/0/0
	Nursery NW[6]	30/50/15	30/30/10	10/10/10	0/0/0
	Ferguson Lake[4]	5/--/25	25/--/25	5/--/5	0/0/0
	Great Blue Heron[6]	0/0/--	0/0/--	0/0/--	100/100/--
	Powerline[6]	10/20/--	10/25/--	40/10/--	0/0/--
	Martinez Lake	0/10/--	0/10/--	25/8/--	0/0/--
MITT	Mittry West	90/5/--	40/5/--	5/25/--	0/0/--
YUMA	Gila River Site #2[4]	--/0/0	--/0/0	--/0/0	--/5/5
	Fortuna Site #1[4]	--/0/0	--/0/0	--/5/0	--/0/0
	Fortuna North[4]	--/10/10	--/10/15	--/5/5	--/0/0

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

[1] PAHR = Pahranagat NWR, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams River NWR, PVER = Palo Verde Ecological Reserve, CIBO = Cibola, IMPE = Imperial, 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] Saturated soil or water was present only in pig wallows.

[6] Site borders marsh.

[7] Site is irrigated as part of restoration efforts; amount of standing water highly variable throughout survey season.

[8] Site not visited until July; not formally surveyed.

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 and along the lakeshore. Prior to the 2008 survey season, the majority of the riparian vegetation along the north side of the upper lake (Pahranagat North) was

inundated annually with up to 1 m of water, with the highest water levels occurring in May. Major structural problems with the dam that impounds the upper lake resulted in the upper lake being drained in early 2008, and the riparian vegetation at the north end of the lake was not flooded during the 2008 or 2009 breeding seasons. The dam was repaired prior to the 2010 breeding season, and lake levels in 2010 and 2011 were higher than they had been in the two previous years but not as high as they had been prior to 2008.

PAHRANAGAT NORTH

Area: 4.6 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*; hereafter cottonwood) lines the northern, upland edge of the site and extends in narrow stringers around the edge of the lakebed. Canopy height within the patch is around 20 m, and canopy closure is approximately 80%. Many of the large trees in the northeastern section of the site are dead or dying. Additional scattered cottonwood trees have fallen throughout the site creating multiple small clearings. Standing water and saturated soils were present within the southern portion of the site in May, and the site slowly dried out during the survey season, with no water or saturated soils present by the middle of July except in an inflow channel that runs along the northern side of the site and drains into the lakebed at the southeastern corner of the site.

We detected 10 breeding willow flycatchers, as well as 4 resident, unpaired males and 7 individuals for which residency could not be determined. The site lies immediately adjacent to a cattle pasture, and a lack of fencing coupled with low lake levels allowed cattle to periodically access to the site for a portion of the breeding season. We surveyed the unoccupied east arm of the site four times, totaling 1.5 observer-hours.

PAHRANAGAT WEST

Area: 1.5 ha Elevation: 1,026 m

This native site consists of a stringer of cottonwood, one to three trees wide and 20 m in height, on the western edge of Upper Pahranagat Lake. The site has no significant understory vegetation, and canopy closure varies from <50 to 80%. The eastern edge of the site is vegetated with bulrush, which extends into the lakebed to the east. The western edge of the site is vegetated in yerba mansa (*Anemopsis californica*) extending into dry, upland desert. During the survey season, the interior of the site was dry, but surface water was present adjacent to the site in the lakebed.

We detected one adult and one hatch year willow flycatcher on 21 July and two additional hatch year willow flycatchers on 21–25 July; all individuals were known or suspected to have come from Pahranagat North. We surveyed the site five times, totaling 3.1 observer-hours. No cowbirds were detected, and there was no sign of livestock use.

GROUND RECONNAISSANCE RESULTS

Pahranagat South

The majority of this site was affected by a fire prior to the start of the 2010 survey season. The fire removed all understory vegetation and charred the trunks and lower branches of the overstory trees. The site now consists of a stringer of cottonwood, 20 m tall, along a human-made channel that carries the outflow from Upper Pahranagat Lake. The understory contains Indian hemp (*Apocynum cannabinum*) and some small patches of coyote willow (*Salix exigua*) 3 m in height. Canopy closure within the cottonwood stringer is approximately 50%. The channel held water during the site visit in May; surrounding soils were dry. While suitable understory components are now present, they are not currently of sufficient size

to resemble typical occupied willow flycatcher habitat. We recommend reassessing this site in future years. We surveyed the site once, totaling 0.25 observer-hours. No willow flycatchers were detected.

Littlefield, Arizona

In recent years, our survey and monitoring activities focused on Beaver Dam Wash near the Highway 91 Bridge. In December 2010, a flood scoured much of the area, and we evaluated the site (Littlefield Poles) at the beginning of the season for suitability.

GROUND RECONNAISSANCE RESULTS

Littlefield Poles

The site consists of primarily native vegetation and is located on Beaver Dam Wash, immediately upstream of the Highway 91 Bridge. Overall changes to the site as a result of the flood in December 2010 include a reduction in vegetation density and height and a significant change in hydrology. Vegetation along the northern edge of the site consists of a scattered overstory of cottonwood averaging 25 m in height. The previously documented lower strata vegetation of tamarisk and Russian olive (*Elaeagnus angustifolia*) in the cottonwood area are significantly reduced or absent. The southern portion of the site consists of stands of coyote willow and young Goodding willow and cottonwood approximately 5 m in height. These stands have thinned significantly, and canopy closure is now 30 to 50% overall. Extensive sedimentation of the site has also reduced canopy height. No surface water was present in May or June, and the nearest water was Beaver Dam Wash, which was restricted to a channel roughly 80 m from the site. We surveyed the site twice, totaling 1.0 observer-hours. No willow flycatchers were detected. Because of the lack of surface water within the site and the reduction in vegetation density, this site does not currently resemble typical occupied flycatcher breeding habitat. We recommend reassessing the site at the beginning of future breeding seasons.

Mesquite, Nevada

The Mesquite study area is in the floodplain of the Virgin River near Mesquite and Bunkerville, Nevada.

HAFEN LANE

Area: 6.1 ha Elevation: 475 m

This mixed-exotic site lies within the floodplain of the Virgin River in Mesquite, Nevada, between Hafen Lane and the active river channel. Two drainage ditches that pass underneath Hafen Lane flow into the site; the eastern inflow supports a dense stand of cottonwood and Goodding willow, 10 m in height, with some coyote willow 5 m in height in the understory. The western inflow supports a stringer of coyote willow 4–6 m in height and scattered Goodding willow 15–18 m in height, with 70% canopy closure. The coyote willow in the western stringer is of varying health and density. Between the stringers, the site is vegetated by 6-m-tall tamarisk with 90% canopy closure. No water was documented within the site, but damp soils were noted on all visits within the drainage ditches. Tamarisk beetles and heavily defoliated tamarisk were noted at the site in mid-June.

We detected three breeding flycatchers, one of which was a male from Muddy River that displaced the resident male. Portions of the site not known to be occupied were surveyed five times for a total of 16.2 observer-hours. Cowbirds were detected on all surveys, and no sign of livestock use was observed.

MESQUITE WEST

Area: 10.4 ha Elevation: 470 m

This mixed-native site lies within the floodplain of the Virgin River in Mesquite, Nevada. Golf courses and housing developments border the site to the north, and the Virgin River borders the site to the south. This large site is primarily a mosaic of cattail (*Typha* spp.) and bulrush (*Schoenoplectus californicus*) marshes separated by narrow (40–50 m) strips of dense coyote willow with interspersed tamarisk. The coyote willows are generally 5–6 m in height, and canopy closure varies from 50 to >90%. The eastern portion of the site is primarily coyote willow, while the western portion contains a mix of willow and tamarisk. Hydrology at the site is influenced by irrigation runoff from adjacent golf courses and agriculture. The site was regularly inundated through early June. Thereafter, a change in the access point of water into the site diverted all water straight into the Virgin River, bypassing the site altogether. Tamarisk beetles and defoliated tamarisk were noted within the site in mid- to late June.

We detected 10 breeding willow flycatchers and 1 resident, unpaired male. Areas of Mesquite West not known to be occupied by flycatchers were surveyed five times, totaling 7.4 observer-hours. Cowbirds were detected on all surveys. Some signs of cattle were observed early in the season in the eastern portion of the site near the river.

BUNKER MARSH NORTH

Area: 7.1 ha Elevation: 456 m

This mixed-exotic site lies within the floodplain of the Virgin River near Bunkerville, Nevada, approximately 4 km downstream of Mesquite West. The site is between agricultural fields to the southeast and the Virgin River to the northwest. The site is primarily 5–7-m-tall tamarisk, with scattered Goodding willow primarily in the southern portion of the site. Some Goodding willows are also present along the western and northern ends of the site. Canopy closure ranges from 25 to 80%. Surface water was noted within the site in May in a small stream in the northern portion of the site and a small puddle in the center of the site, but no water was noted in mid-June. Dry marshes were present adjacent to the site. Tamarisk beetle larvae but no defoliation were observed in mid-May, and extensive defoliation was observed by mid-June. Surveys at this site were discontinued in mid-June because of the lack of surface water within the vegetation and extensive defoliation. We recommend reassessing the site at the beginning of the next breeding season and discontinuing surveys if the site is dry.

We detected no willow flycatchers. The site was visited twice, for a total of 3.7 observer-hours. Cowbirds were detected on both surveys, and signs of cattle were observed within the site.

Mormon Mesa, Nevada

For approximately 15 km upstream of its confluence with the Muddy River, 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. All the areas surveyed at Mormon Mesa are at least 10 km upstream of the Muddy River confluence. In December 2010, the study area experienced another severe flood. Part of the river shifted its course, and river levels remained elevated (in the 75th percentile) throughout the breeding season, limiting access to portions of the study area during May and early June. Tamarisk beetles and heavy defoliation were noted throughout the study area by mid-July.

MORMON MESA SOUTH

North half: Area: 8.4 ha Elevation: 385 m

South half: Area: 3.4 ha Elevation: 385 m

This mixed-exotic site was split into two contiguous areas to facilitate tracking of survey activity. The site has scattered Goodding willow up to 20 m, but more typically 12–15 m, in height and a patchy understory of tamarisk 3–6 m in height. Dead cattail and arrowweed (*Pluchea sericea*) are present in the understory in this area. Canopy closure is widely variable, ranging from >80% in tamarisk thickets to <50% in openings. There was no surface water within the site, but damp soils were noted in the center of the northern half of the site in May and June. The presence of dead cattails and deadfall suggests that this site was formerly considerably wetter, and portions of the site still have the structure to provide potential flycatcher habitat with wetter soil conditions.

No willow flycatchers were detected. Due to elevated river levels, we surveyed the northern half four times and the southern half three times, totaling 9.3 and 4.8 observer-hours, respectively. Cowbirds were detected on all surveys in the northern half and none of the surveys in the southern half. Signs of cattle were noted within the site on all occasions.

VIRGIN RIVER #1

North half: Area: 11.4 ha Elevation: 380 m

South half: Area: 11.1 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 is primarily tamarisk 4–6 m in height, with areas of emergent Goodding willow in the central and southwestern portions of the site. Canopy closure throughout the site is 70–90%. Some surface water was present in June in channels running north to south through the center of the site and in the southwestern corner of the site. By July only a few spots of saturated soil remained in these areas.

We detected four breeding willow flycatchers in the southwestern corner of Virgin River #1 North. We also detected one additional flycatcher for which residency and breeding status could not be determined. Areas of this site not known to be occupied by flycatchers were surveyed four times, totaling 12.9 observer-hours. Cowbirds were detected on all surveys and cattle were observed in the site on multiple occasions.

Virgin River #1 South consists of two disjunct sections; the northern section is immediately south of Virgin River #1 North, while the southern portion is approximately 700 m SSE of Virgin River #1 North. The northern section is primarily tamarisk 4–6 m in height with patches of coyote willow 6 m in height and scattered Goodding willow 8–12 m in height. Canopy closure varies from >90% in areas of dense willow and tamarisk to 25% in marshy openings. The northern section contained standing water throughout the survey season. The southern section consists of tamarisk 6–7 m in height, with a cluster of emergent Goodding willow and dead coyote willow. Canopy closure is 70–90%. Soils in the southern section were dry throughout the survey season. We recommend visiting the southern section at the beginning of the next breeding season and discontinuing surveys in this portion if soils are dry.

We detected 18 breeding willow flycatchers and one unpaired, resident male in the northern section of Virgin River #1 South. We detected two additional willow flycatchers for which residency and breeding status could not be confirmed. Areas of the site not known to be occupied by willow flycatchers were surveyed three times, totaling 5.5 observer-hours. Cowbirds were observed on two surveys, and signs of cattle were observed.

VIRGIN RIVER #2

Area: 11.2 ha Elevation: 380 m

This site received extensive sedimentation from the flood in December 2010. The depth of new sediment ranged from 15 to 60 cm and was most extensive in the southern portion of the site. The site consists of mixed-exotic vegetation with tamarisk 4–6 m in height with a cluster of emergent Goodding willow at the northern end of the site and scattered, emergent Goodding willow at the southern end of the site. Many of the Goodding willow, particularly in the southern third of the site, are dead or dying, and we recommend discontinuing surveys in this portion of the site. Overall canopy closure is 70–90%. The site contained no surface water during the breeding season, though a small area at the very northern end of the site contained damp soil in May and June. The Virgin River, on the eastern edge of the site, had surface water throughout the season.

No willow flycatchers were detected. We surveyed the site five times, totaling 16.8 observer-hours. Cowbirds were observed on all surveys, and cattle sign were observed at the site.

GROUND RECONNAISSANCE RESULTS

Mormon Mesa North

We discontinued surveys after the initial visit at this site in 2010 due to dry conditions and a lack of flycatcher detections since 2005. In December 2010, the study area experienced significant flooding, with the potential to alter the hydrology within the site. We reassessed the site at the beginning of 2011. This site consists of mixed-exotic vegetation, primarily tamarisk 3–5 m in height with areas of emergent Goodding willow up to 12 m in height and patches of coyote willow. Canopy closure varies from 70% in the taller tamarisk to around 50% in the shorter tamarisk. The western edge of the site has a 100 x 50-m patch of Goodding willow, 8 m in height, with up to 75% canopy closure and dead cattails in the understory. Soils were completely dry within the site during a visit in early June, and the nearest water was in the river channel approximately 40 m away. We did not formally survey the site in 2011, though no flycatchers were detected during the site visit. We recommend discontinuing surveys at this site until another flood event occurs that has the potential to alter the hydrology within the site.

Hedgerow

We discontinued surveys after the initial visit at this site in 2010 because of completely dry conditions and a lack of flycatcher detections since surveys began in 2005. In December 2010, the entire study area experienced a significant flood that had the potential to change the hydrology within the site. We reassessed the site at the beginning of 2011. The site is east of Mormon Mesa North, on the eastern side of the Virgin River. It consists of mixed-exotic vegetation with a continuous understory of tamarisk 4–5 m in height and scattered emergent Goodding willow up to 12 m in height. Many of the willows have dead branches. The site is surrounded by tamarisk and arrowweed 2–3 m in height. Canopy closure in the tamarisk varies from about 50% on the edges of the site up to 80% in the denser areas. Soils within the site were completely dry during a visit in May. We did not formally survey the site in 2011, but no flycatchers were detected during the May site visit. We recommend discontinuing surveys at this site until another flood event occurs that has the potential to alter hydrologic conditions.

Muddy River, Nevada

The Muddy River study area is along the Muddy River in the Overton Wildlife Management Area (WMA) near Overton, Nevada.

OVERTON WMA POND

Area: 0.7 ha Elevation: 378 m

This site consists of a patch of mixed-native vegetation approximately 150 m long and 75 m wide at the north end of Overton WMA just south of Honeybee Reservoir. The dominant vegetation consists of 12-m-tall Goodding willow with a sparse 5-m-tall tamarisk understory. Cattail and sedges (*Carex* sp.) are also present on the edges of the site. Arrowweed is present in scattered, dense patches within and along the edges of the site. Canopy closure is variable, ranging up to 90%. A small stream channel runs through the site, and it held surface water throughout the season.

We detected one willow flycatcher for which residency could not be determined. We surveyed the site five times for a total of 2.5 observer-hours. Cowbirds were detected on two visits, and no sign of livestock use was observed.

OVERTON WMA

Area: 14.9 ha Elevation: 378 m

This site consists of a 150-m-wide strip of riparian vegetation spanning 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 10–15 m in height with an understory of tamarisk and cattail. Canopy closure in this area is up to 90%. Flowing water was present in the channels of the Muddy River throughout the survey season. Soils in the northern portion of the site outside of the river channel were dry throughout the season. Soils in the southern portion were saturated early in the season and dry at the end of the season in areas adjacent to the channels. Beavers have felled swaths of Goodding willow in the southern portion of the site, resulting in gaps in the canopy. 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. Two stretches of the channel of the Muddy River within the site were dredged with heavy equipment over the 2007–2008 winter, resulting in a cleared swath 10–15 m wide on the western bank of the river.

We located 10 breeding willow flycatchers and three unpaired, resident males. We also detected two flycatchers for which residency could not be confirmed. Portions of the site not known to be occupied by flycatchers were surveyed six times, totaling 18.0 observer-hours. We observed no signs of livestock but detected cowbirds on all surveys.

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. Seasonally wet, low-lying areas are interspersed throughout the riparian area. Water levels within Topock Marsh were unusually low in 2011 because the intake valve at the upstream end of the marsh was closed for construction purposes. Feral pigs are present throughout the Topock study area, and evidence of pigs was observed in most survey sites.

PIPES #1

Area: 5.2 ha Elevation: 140 m

This exotic site is bordered to the east by the refuge road and consists primarily of monotypic tamarisk 6–9 m in height. Arrowweed occurs in dense patches within 50 m of the refuge road. The tamarisk is densest within 100 m of the refuge road and becomes more open toward the western edge of the site. The northern edge of the site has the tallest canopy, and there is relatively little deadfall in this area compared to the rest of the site. The central and southern portions of the site have many dead stems and clusters of fallen trees. Canopy closure is 70–90%. The site contained no standing water during the survey season.

We detected one unpaired, resident willow flycatcher from 23 June to 1 July. We surveyed the site five times, totaling 8.5 observer-hours. Cowbirds were detected on all surveys.

PIPES #3

Area: 5.7 ha Elevation: 140 m

This site is bordered to the east by the refuge road. Arrowweed occurs in dense patches within 50 m of the road. Most of the site is vegetated by tamarisk 5–7 m in height. The southeastern portion of the site has a few emergent Goodding willow up to 15 m in height and open areas with marsh vegetation. Canopy closure generally exceeds 70%. The site contained no standing water during the survey season.

We detected two breeding flycatchers and one individual that moved to Pipes #3 after holding a territory in 800M. Portions of Pipes #3 not known to be occupied by flycatchers were surveyed five times, totaling 4.6 observer-hours. Cowbirds were detected on all surveys.

THE WALLOWS

Area: 0.7 ha Elevation: 140 m

The Wallows is primarily vegetated by tamarisk 5–6 m in height with emergent Goodding willow on the western side of the site. The northwestern edge of the site borders an open cattail marsh. The eastern side is dry and grades from 2-m-tall arrowweed along the refuge road to tamarisk up to 8 m in height in the center of the site. Overall canopy closure ranges from 50% in the marshy area to 90% in the tamarisk. Approximately 1% of the site had saturated soil in mid-May, but the site was entirely dry by mid-June.

We detected one resident, unpaired male that moved to The Wallows from Platform. We also detected two individuals for which residency could not be confirmed. Portions of the site not known to be occupied were surveyed five times, totaling 2.1 hours. Cowbirds were detected on three surveys.

PC6-1

Area: 4.8 ha Elevation: 140 m

PC6-1 is a mixed-exotic site consisting primarily of tamarisk 6–7 m in height, with a few patches of arrowweed and cattails present in the understory. A scattered overstory of Goodding willow approximately 10–15 m in height is present in the southwestern corner of the site. Arrowweed 1–2 m in height is present under the willow. 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%. The site was completely dry throughout the survey season.

We detected one willow flycatcher across the road from PC6-1 on 1 June. The site was surveyed five times, totaling 8.1 observer-hours. Cowbirds were detected on all surveys.

PIG HOLE

Area: 2.4 ha Elevation: 140 m

Pig Hole consists of monotypic tamarisk 6–7 m in height, with canopy closure ranging from 70 to 90%. Tamarisk along the northern edge has many wispy branches and smaller diameter stems than the rest of the site. A few dense patches of arrowweed are present on the eastern edge. No standing water or saturated soil was observed within the site during the survey season.

No willow flycatchers were detected. The site was surveyed five times, totaling 5.1 observer-hours. Cowbirds were detected on all surveys.

IN BETWEEN

Area: 7.7 ha Elevation: 140 m

In Between consists of monotypic tamarisk 6–8 m in height. The lowest 3 m of the stand generally lacks foliage, resulting in a relatively open understory. Canopy closure is 70–90%, and the western edge of the site borders a marsh. In Between was affected by water delivery in 2011 (see Chapter 8) and contained varying amounts of surface water through the middle of July.

We detected one flycatcher for which residency could not be confirmed. We surveyed the site five times, totaling 9.9 observer-hours. Cowbirds were observed on four surveys.

800M

Area: 4.7 ha Elevation: 140 m

800M adjoins the western edge of In Between, and the eastern half of the site consists of a cattail and bulrush marsh with clumps of tamarisk 5–7 m in height and scattered, emergent Goodding willow. The remainder of the site is vegetated by tamarisk 4–7 m in height. Canopy closure in the tamarisk is generally >90%, while canopy closure in the marsh is around 50%. 800M was affected by water delivery in 2011 (see Chapter 8) and contained varying amounts of surface water and saturated soil in the marsh through early July.

We located one resident, unpaired male flycatcher and two additional individuals for which residency could not be confirmed. Portions of the site not known to be occupied were surveyed five times, totaling 4.7 observer-hours. Cowbirds were observed on all surveys.

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 cattail and bulrush. Overall canopy closure is approximately 80%. The only water or saturated soil within the site was in deep pig wallows.

We detected four flycatchers for which residency could not be confirmed. We surveyed the site five times for a total of 8.5 observer-hours. Cowbirds were observed on all surveys.

SWINE PARADISE

Area: 0.9 ha Elevation: 140 m

Vegetation at this mixed-exotic site consists of tamarisk 6–8 m in height and scattered, emergent Goodding willow up to 15 m in height, with patches of coyote willow. Overall canopy closure is approximately 80%. The northern tip of the site was bulldozed prior to the survey season for a new water conveyance channel. The site was dry throughout the survey season.

We detected one willow flycatcher for which residency could not be determined. We surveyed the site five times, totaling 4.0 observer-hours. Cowbirds were detected on three visits.

BARBED WIRE

Area: 2.1 ha Elevation: 140 m

One large, emergent Goodding willow occurs at the site; otherwise, the site is vegetated by tamarisk 6–10 m in height and of varying 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. A 40-m-wide strip was bulldozed through the center of the site east to west for a new water conveyance channel prior to the start of the survey season. Canopy closure outside the bulldozed area is approximately 70–90%. The only standing water or saturated soil observed in the site was within the new channel.

No willow flycatchers were detected. We surveyed the site five times, totaling 4.0 observer-hours. Cowbirds were detected on four visits.

PLATFORM

Area: 1.9 ha Elevation: 140 m

This site lies between the main refuge road to the west and open bulrush and cattail marsh to the east. Vegetation at the site consists of tamarisk 8 m in height with a few emergent Goodding willow. A narrow line of 5-m-tall coyote willow approximately 5 m wide runs along the eastern edge of portions of the site. Overall canopy closure is approximately 90%. Soils within the site were very dry throughout the survey season.

We detected one resident, unpaired male willow flycatcher. Portions of the site not known to be occupied were surveyed five times, totaling 4.6 observer-hours. Cowbirds were detected on all visits.

250M

Area: 1.9 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 (*Prosopis* sp.) 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 a few emergent Goodding willows approximately 12 m in height. Canopy closure within the site ranges from 70 to 90%. The site was completely dry throughout the survey season.

No willow flycatchers were detected. The site was surveyed five times, totaling 3.3 observer-hours. Cowbirds were detected on three surveys.

HELL BIRD AND GLORY HOLE

Hell Bird: Area: 6.3 ha Elevation: 140 m

Glory Hole: Area: 5.0 ha Elevation: 140 m

These contiguous mixed-exotic sites are located on an island separated from the main riparian area by a narrow, deep channel. Vegetation composition and structure are highly variable, with the survey areas vegetated primarily by a mosaic of tamarisk 6–8 m in height and Goodding willow 15 m in height. Screwbean mesquite (*Prosopis pubescens*) is also scattered throughout the sites. 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. Areas vegetated by cattail and bulrush are interspersed throughout the survey sites. Extremely low water levels in Topock Marsh resulted in increased accessibility in 2011, and Hell Bird was expanded approximately 100 m to the northeast to encompass areas of coyote willow. Both sites were completely dry throughout the survey season.

We detected 10 flycatchers in Hell Bird for which residency could not be confirmed. No flycatchers were detected in Glory Hole. Hell Bird and Glory Hole were surveyed five times each, totaling 6.0 and 8.3 observer-hours, respectively. Cowbirds were detected during four surveys in each site.

SPAGHETTI

Area: 5.4 ha Elevation: 140 m

Spaghetti is a long, narrow site, generally no more than 30 m wide, running along the Farm Ditch to the west of Glory Hole. The site is vegetated by patches of dense coyote willow up to 7 m in height, scattered Goodding willow up to 12 m in height, and mesquite approximately 8 m in height, with tamarisk interspersed throughout the site. Canopy closure in the coyote willow patches is approximately 80%. Deep water in the ditch made the site inaccessible on foot throughout the survey season, and hydrologic conditions within the site were not assessed.

We detected two willow flycatchers for which residency could not be confirmed. We surveyed this site five times, totaling 3.4 observer-hours. Cowbirds were detected on two visits.

BEAL LAKE

Area: 18.0 ha Elevation: 140 m

This mixed-native restoration site consists of a mosaic of cottonwood, Goodding willow, coyote willow, mesquite, and arrowweed, with some tamarisk scattered throughout the site. Canopy height is highly variable and averages approximately 3–4 m over most of the site and up to 10 m in the cottonwood stands; canopy closure is sparse and averages 35%, reaching 85% in the cottonwood stands. The amount of standing water and saturated soil is highly variable because the site is flood irrigated. Sandy soil at the site allows the water to drain rapidly after irrigation.

We detected one willow flycatcher for which residency could not be confirmed. We surveyed this site five times, totaling 10.6 observer-hours. Cowbirds were detected on all surveys.

LOST LAKE

Area: 3.3 ha Elevation: 140 m

This site consists of a narrow (<100-m-wide) strip of riparian vegetation separated from the Colorado River to the southwest by a low ridge of barren sand dunes and bordered to the northeast by marshy areas. The northern edge of the site consists of an overstory of planted cottonwoods 10–15 m in height, with an

understory of tamarisk 5 m in height, on the edge of a cattail marsh. South of the cottonwoods, the site is primarily tamarisk, 5–8 m in height, with small openings vegetated by arrowweed. Overall canopy closure is approximately 80%. Surface water or saturated soil was present in the marsh on the northern edge of the site throughout the season, but the interior of the site was dry.

We detected one willow flycatcher for which residency could not be confirmed. We surveyed the site five times, totaling 3.4 observer-hours. Cowbirds were detected on four visits.

GROUND RECONNAISSANCE RESULTS

Tractor

This mixed-native site is approximately 1 km north of the inlet ditch at the northern end of Topock Marsh and consists of a 300-m-long stringer of cottonwood 15 m in height with an understory of *Baccharis* sp., mesquite, and 4-m-tall tamarisk bordering a 15-m-wide cattail marsh. The site is bordered by hayfields to the north and south, a dry concrete channel to the west, and a road and a slough to the east. The site was dry during our visit on 26 May except for one small puddle at the far western end of the site, and surveys were discontinued. We visited the site once, totaling 0.3 observer hours. No willow flycatchers or cowbirds were detected. We do not recommend future visits to this site.

Bill Williams River National Wildlife Refuge, Arizona

The Bill Williams River NWR contains the last expanse of native cottonwood-willow forest in the LCR region. The refuge encompasses over 2,500 ha along the Bill Williams River upstream 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. We did not observe evidence of livestock use at any of the Bill Williams sites.

BURN EDGE

Area: 4.1 ha Elevation: 140 m

Burn Edge is near the northern edge of the Bill Williams riparian corridor, on the eastern edge of an area that burned in 2006. A cattail marsh with Goodding willow and cottonwood 15 m in height runs east-west through the center of the site. This portion of the site also has clumps of tamarisk up to 6 m in height. Canopy closure in the marshy area varies from around 60% at the eastern end to 25% at the western end. The area on either side of the marsh consists of tamarisk 6 m in height with up to 90% canopy closure. An area of the marsh approximately 100 m long was inundated or saturated in May, but only a small puddle remained at the western end of the marsh in June and July.

On 30 June, we detected one willow flycatcher for which residency could not be confirmed. The site was surveyed five times, totaling 6.3 observer-hours. Cowbirds were detected on four visits.

BILL WILLIAMS SITE #4 AND SITE #3

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

Site #3: Area: 13.0 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 15–20 m in height and patches of monotypic tamarisk up to 8 m in height. Patches of coyote willow are also present. Canopy closure is variable and overall is approximately 50%. Stands of cattails and marshy areas occupy approximately 10% of Site #3.

The understory in some areas is very open, and the ground in these areas is covered with herbaceous vegetation. Many large willows and cottonwoods have fallen over the past several years, leaving large gaps in the canopy and creating patches of thick, dead, fallen woody vegetation. Mosquito Flats had a network of small, flowing streams with some open marshes in May. By mid-June, the streams and marshes were muddy but contained no standing water, and the only surface water remaining was in a deep, backwater channel on the western side of Site #4.

We detected one resident, unpaired flycatcher and two flycatchers for which residency could not be confirmed in Site #4. Two breeding flycatchers and one individual for which residency could not be confirmed were detected in Site #3. Portions of the sites not known to be occupied by flycatchers were visited five times, totaling 16.8 observer-hours at Site #4 and 19.6 observer-hours at Site #3. Cowbirds were detected on all surveys of Mosquito Flats.

LAST GASP

Area: 2.1 ha Elevation: 140 m

Last Gasp is a narrow, mixed-native site along a channel on the northern edge of the Bill Williams riparian area, approximately 250 m east of Burn Edge. Vegetation within the site consists of a broken overstory of cottonwood and Goodding willow 15–20 m in height and a tamarisk understory 5–7 m in height. Canopy closure varies from 50% in the channel to 80–90% in the surrounding tamarisk. Surface water was present in ponds and puddles within the channel in May. One small puddle remained in mid-June, and the site was completely dry in July.

No willow flycatchers were detected at Last Gasp. We surveyed the site five times, totaling 4.6 observer-hours. Cowbirds were detected on all visits.

BILL WILLIAMS SITE #5

Area: 6.8 ha Elevation: 143 m

Site #5 is located on the eastern edge of the Bill Williams River floodplain and is bordered to the northeast by steep cliffs and to the west by a dry river channel. Vegetation in the site is mixed-native, with Goodding willow and cottonwood 15–20 m in height in the overstory. The understory consists of tamarisk 7 m in height as well as some young Goodding willow and cottonwood. Ground cover in portions of the site consists of thick, dead, fallen woody vegetation. Canopy closure in the site is variable, ranging from 25% in open areas to 70–90% in the denser vegetation. Standing water was present throughout the survey season along the northeastern edge of the site in the form of a small stream with deep beaver ponds. Soils in the majority of the site were dry.

We detected one willow flycatcher on 21 May and one individual on 29 May; residency could not be determined for these individuals. We surveyed the site five times, totaling 8.9 observer-hours. Cowbirds were detected on all surveys.

COUGAR POINT

Area: 1.3 ha Elevation: 157 m

This site was visited in early July after personnel from an unrelated field crew reported hearing a willow flycatcher singing. The site consists of dense, young, even-age stands of Goodding willow and cottonwood approximately 6 m in height along a channel of the Bill Williams River. Seep willow (*Baccharis salicifolia*) is present in the understory but appears to be dying back as it becomes shaded by the taller cottonwoods and willows. Cattail marshes are present within and around the site. Canopy

closure within the woody vegetation exceeds 80%. Surface water was present within the marshes and the woody vegetation when the site was visited in July and August.

We detected one nesting female flycatcher, but the male was not detected during nest monitoring visits. No formal surveys were completed.

UPSTREAM FROM SITE #8

Area: 1.5 ha Elevation: 170 m

Vegetation in the majority of the site consists of an overstory of cottonwood and Goodding willow up to 15 m in height and an understory of tamarisk. The western third and southern edge of the site are vegetated by Goodding willow and cottonwood up to 10 m in height. The eastern third is dominated by dry tamarisk 4–6 m in height with scattered, emergent Goodding willow and cottonwoods. The northern edge of the site borders a cattail marsh. Canopy cover is variable and ranges from 50 to 80%. The western portion of the site contained surface water throughout the breeding season.

We detected no willow flycatchers. We surveyed the site five times, totaling 5.1 observer-hours. Cowbirds were detected on two visits.

PLANET RANCH ROAD

Area: 3.3 ha Elevation: 170 m

This mixed-native site follows the Bill Williams River at the southern edge of the riparian area. The vegetation immediately adjacent to the river is dominated by Goodding willow and cottonwood up to 15 m in height. Both riverbanks are steep, and vegetation on top of the banks more than a few meters from the water is dominated by arrowweed and tamarisk 4–5 m in height. Canopy closure within the site is highly variable, ranging from <50% on the dry banks to 90% within dense willow and cottonwood stands. The river had surface water throughout the survey season and was impounded in multiple locations by beaver dams.

We detected three breeding willow flycatchers and two individuals for which residency could not be confirmed. Portions of the site not known to be occupied by flycatchers were surveyed five times, totaling 12.0 observer-hours. We detected cowbirds on four surveys.

NEW RIVER

Area: 0.6 ha Elevation: 180 m

We first visited this site in 2008, at which time the vegetation appeared too young and sparse to support willow flycatchers, and determined that the site should be reevaluated in future years. The site consists of narrow stringers of cottonwood and Goodding willow along both sides of a channel of the Bill Williams River. Some patches of vegetation reach 8 m in height, but average height is approximately 5 m. Vegetation closest to the water is typically 3–4 m in height with 90% canopy closure, while the cottonwoods and willows on the periphery of the site reach 8 m in height but only 25% canopy closure. Soils within and around the site are very sandy. The western portion of the site contained surface water within the river channel throughout the survey season. Vegetation at the site has matured somewhat since the visit in 2008 but still lacks the combination of extent, size, and density typical of occupied flycatcher habitat. The site should be reevaluated in another two or three years.

No willow flycatchers were detected. We surveyed the site five times, totaling 3.9 observer-hours. Cowbirds were detected on one survey.

GROUND RECONNAISSANCE AND OPPORTUNISTIC SURVEY RESULTS

Wispy Willow

This site is approximately 200 m downstream of Site #1 along the north bank of the Bill Williams River. The site consists of a patch of coyote willow approximately 60 x 30 m in size. Canopy height is 4–5 m, and stem diameter is generally ~ 3 cm. Canopy closure is 70–90%. Water from the channel extended under the willows during the site visit in May. The vegetation is not currently of sufficient size to resemble typical occupied willow flycatcher habitat along the LCR, but the site should be evaluated in future years. We surveyed the site three times, totaling 2.8 observer-hours. We detected one flycatcher on 27 May between Wispy Willow and Site #1.

Site #1, Site #2, and Site #11

These sites are scheduled for biennial surveys in 2012. We completed one opportunistic survey on 13 June at each site, as the field schedule allowed. All three sites are at the mouth of the Bill Williams River, along an arm of Lake Havasu that follows the river channel, and are vegetated by Goodding willow and cottonwood up to 20 m in height and an understory of tamarisk. Canopy closure is approximately 70%. No flycatchers were detected, but cowbirds were detected at all three sites. The survey totaled 1.8 observer-hours for the three sites combined.

Mineral Wash and Beaver Pond

These sites are scheduled for biennial surveys in 2012. We completed one opportunistic survey on 12 June at each site, as the field schedule allowed. Mineral Wash and Beaver Pond are adjacent sites, approximately 3 km upstream of Site #5, and follow channels of the Bill Williams River. Both sites contain mixed-native vegetation consisting of an overstory of Goodding willow and cottonwood up to 18 m in height and an understory of tamarisk averaging 5 m in height. Each site contained surface water within at least one river channel at the time of the survey. We detected no willow flycatchers but did detect cowbirds at both sites. The survey of Mineral Wash and Beaver Pond totaled 2.3 and 5.5 observer-hours, respectively.

Palo Verde Ecological Reserve, California

PVER PHASE 2

Area: 21.4 ha Elevation: 85 m

This habitat creation site is vegetated with a mosaic of cottonwood, Goodding willow, and coyote willow, which reach heights of 10, 8, and 5 m, respectively. Height and density of the vegetation varies within and between cells of the site. Canopy closure is highly variable, ranging from <25 to 85%. The entire site has a ground covering of alfalfa (*Medicado sativa*). The site is flood irrigated and contained surface water in a portion of the site during one visit in June.

We detected three willow flycatchers on 16 May, six on 26 May, and two on 9 June. One of the flycatchers detected on 9 June was determined to be color-banded. The combination could not be confirmed with 100% confidence, but it was likely an individual originally banded in southern Nevada. We could not relocate the banded individual on subsequent visits to the site. We surveyed the site six times, totaling 16.5 observer-hours. Large numbers of cowbirds were detected on all visits, and no evidence of livestock use was recorded.

PVER PHASE 3

Area: 21.4 ha Elevation: 85 m

This habitat creation site is vegetated with a mosaic of rectangular cells of cottonwood, Goodding willow, and coyote willow that reach heights of approximately 10, 5, and 4 m, respectively. Height and density of the vegetation varies within and between the cells of the site. Canopy closure is highly variable, ranging from 50 to 80%. The entire site has a ground covering of alfalfa. The site is flood irrigated and contained surface water in approximately one quarter of the site on visits in June and July.

We detected one willow flycatcher on 16 May and three on 26 May. We surveyed the site six times, totaling 14.5 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock was recorded.

Cibola, Arizona and California

CVCA PHASE 1

Area: 26.2 ha Elevation: 73 m

This habitat creation area consists of a mosaic of rectangular cells of cottonwood, Goodding willow, and coyote willow of varying size and density. Each cell generally contains a single species and age class. The tallest cottonwoods and willows are around 12 m in height, and canopy closure in the densest areas is 85–90%. Coyote willow reaches 3–6 m in height. The site is flood irrigated and contained standing water in approximately 20% of the site during visits in May and July. The Colorado River is about 100 m from the northern edge of the site; the southern edge is adjacent to CVCA Phase 2; and the remaining two sides are surrounded by agriculture. The irrigation canal adjacent to the site held surface water throughout the season.

We detected six willow flycatchers on 23 May, three on 31 May, and three on 8 June. The site was surveyed six times, totaling 16.0 observer-hours. Large flocks of cowbirds were detected on all visits, and no evidence of livestock use was observed.

CVCA PHASE 2

Area: 25.5 ha Elevation: 73 m

This habitat creation area consists of a mosaic of rectangular cells of cottonwood, Goodding willow, and coyote willow of varying size and density. The tallest cottonwoods and Goodding willow reach approximately 12 m, and canopy closure reaches 95% in the densest areas. Coyote willow reaches 3–6 m in height. The site is flood irrigated but did not contain standing water during any of our site description visits. The northern edge of the site is adjacent to CVCA Phase 1, and the remaining sides are surrounded by agriculture. The irrigation canal adjacent to the site held surface water throughout the season.

We detected 11 willow flycatchers on 23 May. The site was surveyed six times totaling 16.0 observer-hours. Large flocks of cowbirds were detected on all visits, and no evidence of livestock use was observed.

CVCA PHASE 3

Area: 38.4 ha Elevation: 73 m

This habitat creation area consists of a mosaic of rectangular cells of cottonwood, Goodding willow, and coyote willow of varying size and density. The tallest cottonwoods reach approximately 10 m in height,

Goodding willows reach 7 m, and coyote willows reach 4 m. Canopy closure varies from 20 to 80%. The site is flood irrigated and contained surface water during a visit in June. The irrigation canal adjacent to the site held water during a visit in July. The site is surrounded by agricultural fields.

We detected 16 willow flycatchers on 24 May and 2 on 1 June. The site was surveyed five times, totaling 14.0 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was observed.

CIBOLA NATURE TRAIL

Area: 13.7 ha Elevation: 70 m

This habitat creation site consists of a mosaic of cottonwood, Goodding willow, and mesquite. Approximately half the site consists of scattered screwbean and honey mesquite (*Prosopis glandulosa*) up to 5 m in height with a thick understory of Emory baccharis (*Baccharis emoryii*). The northern half of the site contains an extensive stand of Goodding willow 8 m in height. The northern edge of the willow stand has canopy closure <25%, and many of the willow are dead. The southern half of the willow stand has canopy closure around 70%. The southwestern corner of the site has a small stand of cottonwoods, and stringers of cottonwoods up to 18 m in height occur throughout the site. The site is flood irrigated but did not contain surface water during any of our site description visits.

We detected one willow flycatcher on 1 June. The site was surveyed five times, totaling 6.0 observer-hours. Large numbers of cowbirds were detected on all surveys, and no evidence of livestock use was observed.

CIBOLA ISLAND

Area: 4.2 ha Elevation: 70 m

This mixed-native site is approximately 9.5 km southwest of Cibola Nature Trail. Dirt roads border the site to the north, east, and west. Open farm fields lie to the east and west, with irrigation channels alongside the roads. An irrigation canal empties into the northern end of the site, creating an open, marshy area down the center of the site. Between this marshy area and the western road, vegetation consists of an overstory of Goodding willow 10–12 m in height with an understory of tamarisk 5–7 m in height. Canopy closure within the willows is 80%. The eastern edge of the marsh is lined with a narrow strip of tamarisk 5–6 m in height with a few emergent Goodding willows on the marsh edge. Between the tamarisk strip and the eastern road, vegetation consists of honey mesquite and bushy arrowweed. The marsh was dry in mid-June and mid-July but had some surface water in early July. The irrigation canal running along the northern border of the site held water in mid-July. This site burned in a fire that started at the end of August.

No willow flycatchers were detected. The site was surveyed three times, totaling 2.3 observer-hours. Cowbirds were detected on all surveys, and no evidence of livestock use was observed.

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 riparian vegetation between the channelized Colorado River to the west and a levee road to the east. Woody vegetation consists of a mix of tamarisk and arrowweed, 3–4 m in height, which is dry and scrubby on the eastern edge of the sites and becomes denser toward cattail marshes on the western edge of the sites. Emergent Goodding willow and

cottonwood are scattered along the eastern edge of the marshes. Overall canopy closure is less than 50%. The marshes contained surface water throughout the survey season.

We detected three willow flycatchers at Cibola Site #2 on 25 May and two on 14 June. No willow flycatchers were detected at Cibola Site #1. We surveyed each site five times, totaling 6.2 and 4.1 observer-hours for Cibola Site #2 and Cibola Site #1, respectively. Cowbirds were detected on all surveys, and no evidence of livestock use was observed.

CIBOLA LAKE EAST

Area: 4.5 ha Elevation: 64 m

This site borders the marsh on the eastern edge of Cibola Lake. Vegetation within the site consists primarily of tamarisk. Within 30 m of the marsh edge, tamarisk reaches 6–7 m in height and 90% canopy closure. As distance from the marsh increases, the height and density of the tamarisk decreases, and the tamarisk becomes mixed with arrowweed. Soil within the site was dry throughout the survey season.

We detected one willow flycatcher on 25 May and one on 20 June. The site was surveyed five times, totaling 5.0 observer-hours. Cowbirds were detected on four visits, and burros were heard on the periphery of the site.

WALKER LAKE

Area: 11.4 ha Elevation: 64 m

This mixed-exotic site is located along the northeastern edge of Walker Lake. The majority of the site consists of very dense tamarisk approximately 5 m in height with 90% canopy closure. The southeastern end of the site contains scattered emergent Goodding willow up to 20 m in height, as well as a couple of emergent cottonwoods. This portion of the site also contains a small opening with dead cattails and a small patch of half-dead coyote willow. Walker Lake contained standing water and saturated soil throughout the survey season, and the interior of the southern end of the site also contained surface water in both June and July.

We detected one willow flycatcher on 15 June. The site was visited three times, totaling 4.9 observer-hours. Cowbirds were detected on two surveys, and no evidence of livestock use was observed.

Imperial, Arizona and California

PARADISE

Area: 7.8 ha Elevation: 62 m

The center of this mixed-native site consists of stringers of cottonwood and Goodding willow 15–20 m in height. 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 50-m-wide strip of dense tamarisk. A marsh borders the western side of the southern third of the site. This marsh had been vegetated by cattails in previous years but now consists primarily of common reed (*Phragmites australis*). Canopy closure within the site is variable. Standing water was present within the marsh in May.

We detected three willow flycatchers on 18 May. The site was surveyed three times, totaling 3.3 observer-hours. Cowbirds were detected on every visit, and no evidence of livestock was noted.

HOGE RANCH

Area: 20.7 ha Elevation: 61 m

This mixed-exotic site borders the Colorado River and is dominated by tamarisk 4–6 m in height, with a few emergent cottonwood and Goodding willow (15 to 18 m in height) at the southern end of the site near the old ranch. Linear marshes with cattail, bulrush, and common reed occupy less than 20% of the interior of the site, and there are a few patches of coyote willow. Canopy closure is variable and reaches 70–90% in areas of dense, woody vegetation. The marshes in the interior of the site were inundated in June and July.

We detected eight willow flycatchers on 21 May and six on 2 June. The site was surveyed five times, totaling 5.9 observer-hours. Cowbirds were detected on every visit, and burros were heard near the site.

RATTLESNAKE

Area: 7.6 ha Elevation: 60 m

This mixed-exotic site is a patchwork of tamarisk 7 m in height with emergent Goodding willow up to 15 m in height and strips of dense coyote willow 6–8 m in height. Dense deadfall and debris within the coyote willows reduce the suitability of the area for willow flycatchers. Canopy closure is 70–90%. Extensive cattail marshes separate this site from the Colorado River. Standing water was present in the interior of the site in June.

We detected three willow flycatchers on 21 May and two on 2 June. The site was surveyed five times, totaling 6.4 observer-hours. Cowbirds were detected on all surveys, and burros were heard at the site.

MILEMARKER 65

Area: 10.0 ha Elevation: 58 m

The site is a narrow strip of mixed-exotic vegetation between the Colorado River and a backwater marsh. 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 the site, we surveyed it from the river, and hydrologic conditions in the interior of the site during the surveys are unknown.

We detected one willow flycatcher on 18 May. We surveyed the site twice for a total of 0.9 observer-hours. Cowbirds were detected on both visits, and no evidence of livestock use was observed.

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 approximately 5 m in height with an understory of common reed. Mesquite trees are scattered along the western edge of the site. The eastern edge of the site, adjacent to the cattail marsh, has a stand of Goodding willow 9 m in height. Overall canopy closure is around 70%, and the densest portions of the site have canopy closure >90%. Surface water was present in marsh and the eastern edge of the site throughout the survey season.

We detected four willow flycatchers on 22 May and two on 5 June. The site was surveyed five times, totaling 6.9 observer-hours. Cowbirds were detected on four visits, and there was no evidence of livestock use.

FERGUSON LAKE

Area: 21.1 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 scattered, emergent Goodding willow 10 m in height along the western edge of the site bordering Ferguson Lake. Tamarisk 5–6 m in height is the dominant understory species, and it forms a continuous canopy in portions of the site. The site also contains patches of arrowweed with scattered screwbean mesquite and little canopy cover. The western edge of the site up to 50 m from the lakeshore had standing water in June and July.

We detected two willow flycatchers on 19 May. The site was surveyed three times, totaling 7.4 observer-hours. Cowbirds were detected on all visits, and no signs of livestock use were observed.

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 willow forms 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%. Portions of the site contain thickets of willow deadfall. Farther from the lake, the site is vegetated by scattered arrowweed and tamarisk 6 m in height, with canopy closure <50%. Soils within the site were dry throughout the survey season.

We detected three willow flycatchers on 17 May, nine on 20 May, four on 3 June, and five on 5 June. The site was surveyed five times, totaling 15.9 observer-hours. Cowbirds were detected on all visits, and burros were detected on the periphery of the site.

POWERLINE

Area: 1.0 ha Elevation: 58 m

This mixed-native site consists of a strip of Goodding willow and cottonwood along the border of a cattail marsh. Overstory height is approximately 12 m and canopy closure is approximately 50%. Tamarisk and arrowweed are present in the understory, and honey mesquite is mixed with the tamarisk on the upland edge of the site. Surface water was present in the marsh and in the southern portion of the site in May and June.

We detected two willow flycatchers on 17 May and one on 3 June. We surveyed the site five times, totaling 4.2 observer-hours. Cowbirds were detected on all visits, and burro tracks and scat were noted within the site.

MARTINEZ LAKE

Area: 4.6 ha Elevation: 58 m

This mixed-native site borders the eastern shore of Martinez Lake. The eastern edge of the site, adjacent to the upland, is dominated by arrowweed with scattered Goodding willow, cottonwood, and tamarisk. Goodding willow <10 m in height and cottonwood up to 15 m in height are more prevalent on the western edge of the site, adjacent to cattails and common reed along the lakeshore. Canopy closure is highly variable. The western edge of the site contained saturated soil in May and surface water in June.

We detected two willow flycatchers on 3 June. We surveyed the site five times, totaling 8.8 observer-hours. Cowbirds were detected on all visits, and burros were heard on the periphery of the site.

Mittry Lake, 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. Deadfall is common throughout the site, and canopy closure varies from 30 to 70%. Honey and screwbean mesquite are scattered throughout the site but are more common near the periphery. A clump of coyote willow 6 m in height and 50 m in diameter is present in the northeastern corner of the site. Surface water was extensive in the site in May with a few puddles remaining in June.

We detected three willow flycatchers on 17 May. The site was visited three times, totaling 4.3 observer-hours. Cowbirds were detected during all surveys, and no evidence of livestock use was observed.

GROUND RECONNAISSANCE RESULTS

Laguna

Laguna encompasses 449 ha between Imperial and Laguna Dams, on the east side of the Laguna dredge discharge area. This area will be included in future riparian restoration efforts, and we evaluated the existing habitat to determine whether it is suitable for willow flycatchers. Vegetation at the site consists primarily of tamarisk < 4 m in height, arrowweed, and quail bush (*Atriplex lentiformis*). A small cattail marsh is present on the eastern edge of the site; surrounding vegetation consists of tamarisk, arrowweed, and a few 5-m-tall Goodding willow. A patch of Goodding willow 7 m in height with an understory of common reed and tamarisk is present along an old backwater channel in the north-central part of the site, but soils in this area were completely dry during the site visit on 6 June. Overall, the site is lacking in vegetation of sufficient height and density to resemble suitable flycatcher habitat, and surface water was present only in one small area. Soils in most of the site were complete dry. We visited the site once, for a total of 8.0 observer-hours. No willow flycatchers were detected. We discontinued surveys after the initial visit because of the complete lack of potential flycatcher habitat.

Yuma, Arizona

GILA RIVER SITE #2

Area: 2.9 ha Elevation: 45 m

The center of this mixed-native site consists of an overstory of cottonwood up to 15 m in height and Goodding willow approximately 8 m in height, with an understory of arrowweed. Canopy closure in the center of the site is approximately 50%, and there is deadfall in the understory. The remainder of the site is vegetated by tamarisk 4 m in height and arrowweed, with canopy closure <50%. The site is bordered to the north by agricultural fields and to the south by an open, sandy area vegetated by arrowweed. There was no standing water within the vegetation during the survey season, but the northwestern edge of the site borders a marsh, which held water throughout the season.

We detected seven willow flycatchers on 4 June. The site was surveyed four times, totaling 5.3 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was observed.

FORTUNA SITE #1

Area: 3.2 ha Elevation: 45 m

This mixed-native site consists of a narrow strip of cottonwood and Goodding willow up to 15 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. The site is bordered to the north by agricultural fields and to the south by a cattail marsh and the Gila River. The interior of the site was dry in June and July, but the adjoining marsh contained surface water.

We detected 15 willow flycatchers on 4 June. We surveyed the site four times, totaling 6.1 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was observed.

FORTUNA NORTH

Area: 3.8 ha Elevation: 46 m

This site is vegetated primarily by mature tamarisk approximately 7 m in height. Goodding willow and mesquite, also 7 m in height, are scattered throughout the site but make up less than 10% of the vegetation. Canopy closure is approximately 80% in the densest areas. The Gila River runs along the western edge and through the northwestern corner of the site. No surface water was noted within the woody vegetation during the survey season, but the river contained water.

We detected six willow flycatchers on 4 June and one on 5 June. We surveyed the site four times, totaling 9.5 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was observed.

NDOW Study Areas

Field personnel spent 1.0 observer-hour completing broadcast surveys for willow flycatchers at 3 of 19 sites at Key Pittman WMA, River Ranch, and Warm Springs Natural Area. The remaining 17 sites were occupied by resident flycatchers from the beginning of the season and were monitored but not surveyed. Willow flycatcher survey and monitoring results are summarized in Table 2.7 and are presented below along with site descriptions. Details of occupancy, pairing, color-banding, and breeding are presented in Chapters 3 and 4. The boundaries of survey sites and occupancy in 2011 are shown on orthophotos in Appendix B.

In addition to willow flycatcher surveys, field personnel spent 9.0 observer-hours completing broadcast surveys for Yellow-billed Cuckoo at both Key Pittman and River Ranch. The results of cuckoo surveys are summarized below.

Table 2.7. Willow Flycatcher Detections at NDOW Study Areas, 2011

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3,4,5]
KEPI	Patch 0	0.04	2 (6 Jun–8 Aug)
	Patch 1	0.1	2 (29 May–4 Aug)
	Patch 2	0.1	2 (18 May–8 Aug)
	Patch 3	0.1	1 (16 May–27 Jul) [6], 1 (31 Jul)
	Patch 4	0.1	2 (25 May–31 Jul), 3 (27 Jul)[6,7]
	Patch 4.5	0.02	ND

Table 2.7. Willow Flycatcher Detections at NDOW Study Areas, 2011 (Continued)

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3,4,5]
KEPI	Patch 5	0.1	2 (21 May–11 Aug)
	Patch 6	0.2	2 (16 May–6 Jul), 3 (18 Jun–31 Jul), 1 (12 Jul)[8]
	Patch 7	0.1	2 (16 May–11 Aug)
	Patch 8	0.1	2 (1 Jun–4 Aug)
	Patch 9	0.3	2 (16 May–31 Jul), 2 (18 Jun–2 Aug)
	Patch 10	0.1	3 (16 May–8 Aug)
	Patch 10.5	0.02	1 (26 Jun)[9], 1 (24 Jul)[7]
	Patch 11	0.1	4 (6 Jun – 11 Aug), 1 (30 Jun)[8]
	Patch 12	0.1	3 (21 May–14 Aug), 1 (30 Jun), 2 (27 Jul)[9]
	Fence[10]		1 (29 May)
RIRA	West Side	0.3	2 (15 Jun–3 Jul), 1 (23 Jun–13 Jul), 1 (19 Jun), 1 (23–27 Jul)
	East Side	0.4	2 (15 Jun–27 Jul)
	Smalls	0.5	1 (15 Jun–16 Jul), 1 (27–29 Jun)
WMSP	Muddy Mac	0.7	2 (15 May–28 Jul), 3 (26 May)

[1] KEPI = Key Pittman WMA, RIRA = River Ranch, WMSP = Warm Springs Natural Area.

[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] Flycatchers in territories that were occupied throughout the breeding season are shown as being present throughout the season. Flycatchers detected on a single occasion or for a short period of time are listed separately.

[5] We detected several within-season movements between study areas in 2011. See Table 3.9 for details.

[6] One individual detected 16 May–27 Jul in Patch 3 and recaptured 27 Jul in Patch 4.

[7] One individual detected 26 Jun in Patch 10.5 and recaptured 27 Jul in Patch 4

[8] This individual detected 30 Jun in Patch 11 and12 Jul in Patch 6.

[9] One individual recaptured 26 Jun in Patch 10.5 and 27 Jul in Patch 12.

[10] Not an official survey site. Incidental detections recorded.

Key Pittman Wildlife Management Area, Nevada

PATCHES 0–12

Area: 1.4 ha Elevation: 1,169 m

This study area is divided into 15 small stands of coyote willow. These stands form a strip of habitat between bulrush marsh on the edge of Nesbitt Lake to the east and dry upland scrub dominated by saltbush and grasses to the west. Most of the stands are independent of each other, but four stands (Patches 6–9) have grown together, forming a larger contiguous stand. Each stand is characterized by very dense, large-diameter stems of coyote willow. Some areas have fallen or leaning stems with wispy growth in the lower 2 m, making traversing those areas difficult. Canopy height ranges from 4 to 8 m with the taller stems occurring in the center of each site, giving each stand a rounded look. Canopy closure is 70–90%. Surface water was present along the eastern edge in May and June, though no more than 10% of the area within the sites was inundated, with an additional 5% saturated. Soils were damp in July with no saturated soil or standing water.

We located 33 breeding willow flycatchers across 13 of the 15 sites. We detected one resident, unpaired male and an additional seven individuals for which we could not determine residency. An additional individual of undetermined residency was detected on a fence adjacent to the sites. Only the unoccupied site, Patch 4.5, was surveyed, totaling 0.3 observer-hours. Cowbirds were detected during one survey but were noted throughout the season during nest monitoring activities. Signs of cattle were present in the dry upland scrub, but the sites have been fenced off to prevent damage. Deer were present within the sites, but do not appear to heavily impact the vegetation structure.

YELLOW-BILLED CUCKOO SURVEYS

We completed four surveys for Yellow-billed Cuckoo at Key Pittman, totaling 6.5 observer-hours. The first survey included Patches 0–4.5 as well as the cottonwood stand at the southern end of Nesbitt Lake. The final three surveys covered the cottonwood stand and Patches 0–12. No Yellow-billed Cuckoos were detected.

River Ranch

River Ranch is in the Pahranagat Valley, approximately 12 km south of Key Pittman, and consists of several isolated patches of vegetation. Each patch is surrounded on all sides by grazed, irrigated cattle pasture, and the perimeter of each site has a distinct browse line at 1.5 m in height.

WEST SIDE

Area: 0.3 ha Elevation: 1,100 m

This site is composed primarily of dense, large-diameter coyote willow 7 m in height. Shorter coyote willow approximately 4 m in height is present around the perimeter, giving the site a rounded look. A gap 3 to 5 m wide runs diagonally through the site from the northwestern to the southeastern corner. Some Russian olive is scattered along the perimeter of this gap. There is little to no understory, except where willows are regenerating and in the gap, where grasses and other herbaceous plants dominate. Canopy closure is 90% throughout most of the site, except in the gap where it varies from 0 to 30%. Areas of deadfall up to 1 m deep are scattered throughout the site, making travel difficult in places. Water levels fluctuated throughout the season depending on irrigation activity. Maximum water extent included flowing, 10-cm-deep water covering approximately 50% of the site, saturated soils covering an additional 30%, and 20% with damp soils. Minimum water extent included damp soils throughout the site. Water tended to pool in a ditch approximately 1 m wide and 0.2 m deep surrounding the site.

We detected two breeding flycatchers and one male for which breeding status could not be confirmed. We also detected an additional two individuals for which residency could not be determined. Due to flycatcher occupancy, this site was surveyed only once, totaling 0.4 observer-hours. No cowbirds were detected during the survey, but they were noted intermittently throughout the breeding season in low numbers. Signs of cattle were present in and surrounding the site, but the cattle do not appear to use the interior of the site extensively.

EAST SIDE

Area: 0.4 ha Elevation: 1,100 m

This site is composed primarily of dense, large-diameter coyote willow 6 to 7 m in height. Tree height is shorter at the perimeter, giving the site a rounded appearance. Russian olive and velvet ash (*Fraxinus velutina*) occur in low numbers. There are numerous piles of deadfall scattered throughout the site. Little to no understory is present, except where the willow is able to regenerate and also in some small clearings

where herbaceous vegetation dominates. Canopy closure is primarily 70–80%, except in a few scattered clearings where it ranges from 0 to 25%. Water levels fluctuated throughout the season depending on irrigation activity. Maximum water extent included damp to almost saturated soils throughout and a ditch of water 1 m wide and 0.2 m deep surrounding the site. Minimum water extent included dry soils throughout the site.

We detected two breeding flycatchers. Due to flycatcher occupancy, no formal surveys were conducted. Brown-headed cowbirds were noted intermittently throughout the breeding season in low numbers. Signs of cattle were present throughout and surrounding the site, with cattle trails throughout the interior of the site.

SMALLS

Area: 0.5 ha Elevation: 1,100 m

This site is composed primarily of coyote willow 5 m tall. There is little understory except sparse, regenerating willow in the densely vegetated areas. A large gap in the vegetation, totaling approximately 25% of the site, dominates the northern half of the site. This gap is ringed by a stand of shorter coyote willow approximately 4 m in height and 4 m wide on the western, northern, and eastern sides. Canopy closure averages 80-85% in the vegetated areas. Deadfall is scattered throughout the site but typically does not occur in piles as it does in West Side and East Side. Water levels were variable throughout the season depending on irrigation activity. Maximum water extent included a pool of water at the northern end of the site and saturated soils throughout the remainder of the site. Minimum water extent included completely dry soils throughout the site.

We detected one male for which breeding status could not be confirmed and an additional individual for which we could not determine residency. Due to flycatcher occupancy, this site was surveyed only once, totaling 0.4 observer-hours. No cowbirds were detected during the survey, though they were noted at other times during the breeding season. Signs of heavy cattle use were present throughout the site.

YELLOW-BILLED CUCKOO SURVEYS

We completed three surveys for Yellow-billed Cuckoo at River Ranch, totaling 2.5 observer-hours. All suitable habitat was covered in each survey. No Yellow-billed Cuckoos were detected.

Warm Springs Natural Area

On 1 July 2010, a wildfire burned at least part of all the survey sites at Warm Springs. At the beginning of the breeding season of 2011, ground reconnaissance was conducted at all sites to assess the extent of the damage and suitability of habitat for flycatchers. The degree of damage varied from site to site and ranged from almost complete consumption of all vegetation to consumption of the understory with overstory structure intact but the canopy reduced by 80–90%. Regeneration of woody vegetation was noted at all sites, but vegetation was generally sparse and less than 2 m in height. One site was partially damaged in the fire with the remainder largely undamaged. Due to the degree of fire damage, surveys were discontinued at all sites except for the one partially damaged site.

MUDDY MAC

Area: 0.7 ha Elevation: 548 m

This native site is near the head of Apcar Stream. The northern portion of the site was heavily damaged in the 2010 fire, with the overstory being completely killed. Dense basal regeneration of velvet ash is occurring, but live vegetation is only 2 m in height. The southern half of the site is characterized by a

very dense velvet ash stand 8–9 m in height with no understory and ≥80% canopy closure. The extreme southern end of this site was also damaged in the 2010 fire with most of the trees consumed and only grass growing under the snags. Surface water was present throughout the survey season in the form of a flowing stream near the southern edge of the site. Soils were saturated in May with some standing water, but by June interior soils were completely dry.

We detected two breeding flycatchers and three individuals for which residency could not be determined. Due to flycatcher occupancy, this site was not formally surveyed. A cowbird was detected during one nest monitoring visit. No evidence of livestock was observed.

YELLOW-BILLED CUCKOO SURVEYS

No Yellow-billed Cuckoo surveys were conducted at Warm Springs in 2011 due to lack of suitable habitat.

DISCUSSION

The six Reclamation study areas occupied in 2011 by breeding flycatchers (Pahranagat NWR, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams River NWR) consistently held resident and breeding flycatchers in previous years (McKernan and Braden 2002; McLeod et al. 2008a; McLeod and Koronkiewicz 2009, 2010; McLeod and Pellegrini 2011; details of residency and breeding in 2011 are presented in Chapters 3 and 4 of this document). In 2009 and 2010, breeding flycatchers were recorded along Beaver Dam Wash at Littlefield (Littlefield Poles) for the first time since 2004. Vegetation at Littlefield Poles was scoured during floods in December 2010, and the hydrology was altered so that no surface water was present at the site during visits in May and June. Surveys were discontinued at the site after the visit in June because of these changes. No flycatchers were recorded at the site in 2011.

A single pair of breeding flycatchers was detected at a new site in 2011. Along the Bill Williams River, breeding flycatchers were detected at Cougar Point, which had not previously been surveyed. The site consists of young, even-aged vegetation that likely only recently reached sufficient size to be suitable flycatcher breeding habitat.

Hydrologic conditions at Mesquite West in May and early June 2011 were similar to those observed in all prior years except 2009. In 2009, the site was largely dry, and premature leaf abscission was observed as early as May. In 2011, the site was wet through the beginning of the breeding season In mid-June, earthwork at the inflow to the site diverted water along the edge of the site and into the Virgin River. Although the site became dry, the canopy remained largely intact with only a minor amount of leaf abscission detected in August. Despite the presence of wet conditions in early 2011, the number of resident flycatchers (11) detected at Mesquite West in 2011 was lower than the numbers detected in previous years (25, 25, 24, 20, and 16 in 2006 through 2010, respectively). The decline in flycatcher numbers between 2009 and 2010 was likely influenced by poor nest success and poor habitat conditions in 2009 (McLeod and Pellegrini 2011). Reasons for the continued decline remain undetermined, but habitat suitability in the western portion of Mesquite West, which was not occupied in 2011, may be influenced by the defoliation of tamarisk.

Marsh elevations at Topock were lower than in any year since 2005. The number of resident adults detected at Topock continued to decline, with 5 resident adults detected in 2011, versus 36, 29, 18, 20, 14, and 11 detected in each year in 2005 through 2010, respectively. Changes over the years in the timing and magnitude of fluctuations in marsh levels may have contributed to the decline in the Topock flycatcher population (see Chapter 8). We continued our efforts to locate all potentially suitable willow

flycatcher habitat at Topock Marsh. We revisited two sites that were visited briefly in 2010; one site was surveyed regularly, and visits to the other site were discontinued because of lack of suitable habitat.

Tamarisk beetles were present at both Mesquite and Mormon Mesa in 2011. Extensive defoliation was noted in the vicinity of the Mesquite sites in June, but the areas currently occupied by willow flycatchers are primarily native, and defoliation did not have any noticeable effect on breeding. Defoliation was noted in the Mormon Mesa study area at all sites starting in July, with extensive defoliation noted by late July. Roughly half of the nests in Mormon Mesa are located in primarily native stands. The remaining nests are located in either mixed stands with a primarily native canopy, or in primarily non-native vegetation. Defoliation from tamarisk beetle activity therefore potentially affected only some of the nest stands at Mormon Mesa. In addition, the majority of flycatcher nesting attempts had either fledged or failed by the time defoliation became widespread, and there was no evidence that flycatcher nesting was affected by defoliation. Defoliation will presumably occur earlier in the year in 2012 at the Mormon Mesa sites now that tamarisk beetles are established in the area and thus may have greater effects on flycatcher nesting next year. Tamarisk beetles were noted as far downstream on the Virgin River as Lake Mead by the end of August, and defoliation was also observed on the Muddy River as far downstream as Overton and as far upstream as Warm Springs. The Muddy River study area may be affected by tamarisk beetles in 2012.

Although 154 flycatcher detections were recorded at sites surveyed south of the Bill Williams, monitoring results and behavioral observations (lack of territorial, aggressive behaviors exhibited toward conspecific broadcasts) at these sites suggest these flycatchers were not resident or breeding individuals but migrants. These results are consistent with those recorded in 2003–2010 (McLeod et al. 2008a; McLeod and Koronkiewicz 2009, 2010; McLeod and Pellegrini 2011). Banding studies in the Yuma area completed in 2003–2007 also suggested that willow flycatchers detected in mid-June were migrants (McLeod et al. 2008a). Migrant willow flycatchers along the lower Colorado River could belong to one of several subspecies (*E. t. extimus*, *E. t. adastus*, or *E. t. brewsteri*), and unless an individual is banded, it is impossible to determine in the field whether a migrant is *E. t. extimus* or one of the other two subspecies. A model based on plumage color variation predicted that approximately half of 96 willow flycatchers captured in the Yuma area in mid-June in 2004–2007 were *E. t. extimus* (Paxton et al. 2010), indicating that the southwestern subspecies does use the lower Colorado River as a migration corridor. In addition, two flycatchers banded at breeding sites monitored as part of the lower Colorado River study have been detected at sites south of the Bill Williams. Both individuals were detected for only one day and did not exhibit territorial behavior, suggesting they were migrants. The first individual was detected along the Gila River in Yuma in May 2005. It was identified by the presence of a single anodized federal band as having been banded as a nestling at one of the Reclamation study areas in either 2003 or 2004. In June 2011, a fully banded flycatcher was detected in PVER 2, one of the Reclamation habitat creation sites along the LCR. While the identity of the individual could not be confirmed by repeated observations, it was very likely banded in southern Nevada. This is the first confirmed sighting of a Southwestern Willow Flycatcher in one of the habitat creation sites south of the Bill Williams. Although the bird was likely a migrant, this detection demonstrates the importance of the habitat creation sites as stopover habitat for migrating Southwestern Willow Flycatchers. Flycatchers from breeding areas along the lower Colorado River and its tributaries may also provide a potential source population for the colonization of habitat creation sites (see Discussion in Chapter 3).

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 our 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 ninth consecutive year of color-banding studies and builds upon color-banding initiated at these sites in 1997 (McKernan and Braden 1998).

METHODS

Color-Banding

From early May through mid-August, we captured, uniquely color-banded, and subsequently monitored adult and nestling willow flycatchers at all study areas where resident willow flycatchers were detected. The color-banding effort also included Key Pittman Wildlife Management Area, River Ranch, and Warm Springs Natural Area in Nevada (in cooperation with Nevada Department of Wildlife) and opportunistic banding in St. George, Utah (in cooperation with Utah Division of Wildlife Resources).

Adult 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 were 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 were erected and periodically checked, with no broadcast of conspecific vocalizations. We banded each adult willow flycatcher with a single, 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 duplication 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 also banded with a single, numbered federal band on one leg and a metal color-band on the other leg. Prior to 2008, we banded each nestling only with a single federal band, identifying it as a returning nestling in the event it returned in a subsequent year.

For each captured adult 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. Captured flycatchers lacking breeding characteristics and not observed engaging in male advertising song (see below) were sexed as unknown. Flycatchers with retained primary, secondary, and/or primary covert feathers (multiple aged remiges) were aged as second year adults, and those without (uniformly aged remiges) were aged as after 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 directed their efforts to resighting as daylight increased and flycatchers became more difficult to capture. All banding, monitoring, and survey field personnel coordinated resighting efforts and recorded observations of color-banded and unbanded flycatchers onto standardized data forms (Appendix A). For resighted flycatchers (i.e., ones for which at least one leg was seen clearly enough to determine the presence or absence of a band), 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. Flycatchers observed engaging in breeding behaviors (e.g., carrying nest material) were also considered resident regardless of the period of time over which they were observed. Flycatchers observed engaging in lengthy, primary song from high perches (male advertising song) were sexed as male, and flycatchers observed carrying nest material or constructing or incubating a nest were sexed as female. Flycatchers not observed engaging in one of these diagnostic activities were sexed as unknown.

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. If multiple females were paired with a single male, each female received a unique territory number. Flycatchers were determined to be unpaired if none of the following breeding behaviors were observed: presence of another unchallenged flycatcher in the immediate vicinity, counter calling (*whitts*) with a nearby flycatcher, interaction twitter calls (*churr/kitters*) with a nearby flycatcher, a flycatcher in the immediate vicinity carrying nesting material, a flycatcher in the immediate vicinity carrying food or fecal sac, or adult flycatchers feeding young (per Sogge et al. 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 or a flycatcher whose legs were not observed was detected at a given location on multiple visits but one or more intervening visits failed to detect a flycatcher, the detections were considered to be different individuals in the absence of behavioral observations indicating the flycatcher was actively defending a territory or was a member of a breeding pair.

RESULTS

Reclamation Study Areas

Color-Banding and Resighting – Field personnel color-banded 15 new adult flycatchers and recaptured 11 individuals previously captured as adults. An additional 31 adults were identified to individual via resighting, while 3 individuals were resighted but did not have their color combinations confirmed. Of the 31 adults that were resighted and identified, one was identified for the first time since it was banded as a nestling. We identified two additional individuals as returning nestlings by the presence of a single federal band, with one (50%) identified to individual via recapture. We recaptured two additional returning nestlings with full color combinations. Thirty adult flycatchers remained unbanded, and banding status was undetermined (i.e., we were unable to determine if these individuals were banded) for 30 adults. Overall, 52% of the adult flycatchers detected at the monitoring sites were known to be color-banded by the end of the breeding season (Table 3.1). We banded 40 nestlings from 17 nests. Of the 40 nestlings banded, 5 were known or suspected to have died before fledging. We resighted an additional 10 unbanded fledglings from six nests; one fledgling was captured and banded. For details on all banded flycatchers detected at the study areas from 2003 to 2011, see Appendix E.

Site-by-Site Color-Banding and Resighting

Pahranagat – We detected 14 resident, adult willow flycatchers from 10 territories at Pahranagat. In addition to resident adults, we detected seven individuals for which residency and/or breeding status could not be confirmed (Table 3.2). Of the 10 territories recorded at Pahranagat, 6 consisted of breeding pairs, and 4 consisted of unpaired males. Of the breeding individuals, one male was polygynous with three females. One resident female moved from her territory in Pahranagat North and was resighted at Pahranagat West along with three banded fledges.

Field personnel captured and color-banded four new adults and recaptured three flycatchers previously captured as adults. We resighted and identified an additional 10 adults. Three adults remained unbanded. Of the resighted adults, one was originally banded as a nestling in 2010 (see Table 3.8 for juvenile dispersal data). The color combination could not be determined for one adult. We banded 11 nestlings from four nests. We resighted seven unbanded fledglings from three additional nests; one fledgling was captured and banded.

Mesquite – We detected 14 resident, adult willow flycatchers from eight territories at Mesquite. Of the eight territories recorded at Mesquite, seven consisted of paired individuals and one consisted of an unpaired male (Table 3.2). Of the breeding individuals, two males were each polygynous with two females. The male at one territory was displaced by another male that moved from Muddy River (Table 3.9).

Field personnel captured and color-banded three new adults and confirmed the identities of an additional six adults via resighting. Three adults remained unbanded, and band status could not be determined for two adults. We banded five nestlings from two nests.

Mormon Mesa – We detected 23 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 (Table 3.2). Of the 14 territories recorded at Mormon Mesa, 13 consisted of breeding individuals and 1 consisted of an unpaired male. One breeding male moved from Muddy River, and one male for which residency could not be confirmed moved from Mesquite West (Table 3.9). One female mated

consecutively with two males and four males were polygynous, one with three females and three with two females.

Field personnel captured and color-banded one new adult and recaptured five flycatchers previously captured as adults. We resighted and identified nine additional adults. We captured one returning nestling originally banded as a juvenile in 2007 (see Table 3.8) and resighted one returning nestling with a single federal band that we were unable to recapture. Eight adults remained unbanded, and band combination could not be confirmed for one adult. We banded 16 nestlings, two of which were suspected to have died before fledging, from seven nests and resighted three unbanded fledglings from three nests.

Muddy River – We detected 13 resident, adult willow flycatchers from eight territories at Muddy River. In addition to resident adults, we detected three individuals for which residency could not be confirmed. Of the eight territories recorded, five consisted of breeding pairs and three consisted of unpaired males (Table 3.2). One breeding male moved to Mormon Mesa and one unpaired male moved to Mesquite (Table 3.9).

Field personnel captured and color-banded three new adults and recaptured two flycatchers previously captured as adults. We recaptured two returning nestlings; one was originally banded in 2009 and the other in 2010 (see Table 3.8). We resighted and identified four other adults. Four adults remained unbanded, and band status could not be confirmed for one adult. We banded four nestlings from two nests; three of these nestlings died before fledging.

Topock – We detected five resident, adult willow flycatchers from five territories at Topock. In addition to resident adults, we detected 28 individuals for which residency could not be confirmed (Table 3.2). Of the five territories recorded at Topock, one consisted of a breeding pair and four consisted of unpaired males. One of the unpaired males established a territory at Platform and then moved to The Wallows and established a second territory.

Field personnel captured and color-banded two new adults and recaptured one flycatcher originally captured as an adult. We resighted and identified one other banded adult. Nine adults remained unbanded, and the band status of 19 individuals could not be determined. The color combination of one banded adult could not be confirmed.

Bill Williams – We detected eight resident willow flycatchers from five territories at Bill Williams. In addition to resident adults, we detected nine individuals for which residency could not be determined (Table 3.2). Of the five territories recorded at Bill Williams, four consisted of breeding individuals and one consisted of an unpaired male. One male was polygynous with two females. At one breeding territory, personnel from an unrelated field crew reported a singing male, but only the female was detected during nest monitoring visits.

Field personnel captured and color-banded two new adults. We resighted and identified four returning banded adults. Three adults remained unbanded, and band status could not be determined for eight adults. We banded four nestlings from two nests.

Table 3.1. Willow Flycatchers Detected at Reclamation Study Areas Where Resident Flycatchers Were Observed during the 2011 Breeding Season*

Study Area	Site	Adults									Nestlings Banded (# nests)	Fledglings Captured	% of All Adults Banded
		Total Adults Detected	New Captured	Recaptured		Resighted							
				Detected in Previous Year(s) as Adults	Returning Nestlings	Color combination confirmed		Unbanded	Band Status Undetermined	Banded (color combinations unconfirmed)			
						Individual Identified	Individual Not Identified						
Pahranagat	North	21	4	3	0	10	0	3	0	1	11(4)	1	86
	West	1[1]	0	0	0	1[1]	0	0	0	0	0	3[2]	100
	Study Area Total	**21**	**4**	**3**	**0**	**10**	**0**	**3**	**0**	**1**	**11(4)**	**1**	**86**
Mesquite	Hafen Lane	3	2	0	0	1[3]	0	0	0	0	0	0	100
	West	11	1	0	0	5[4]	0	3	2	0	5(2)	0	55
	Study Area Total	**14**	**3**	**0**	**0**	**6**	**0**	**3**	**2**	**0**	**5(2)**	**0**	**64**
Mormon Mesa	Virgin River #1 (North)	5	0	0	0	1	0	3	0	1	0	0	40
	Virgin River #1 (South)	21	1	5[4]	1	8[5]	1[6]	5	0	0	16(7)[7]	0	76
	Study Area Total	**26**	**1**	**5**	**1**	**9**	**1**	**8**	**0**	**1**	**16(7)**	**0**	**69**
Muddy River	Overton Pond	1	0	0	0	0	0	1	0	0	0	0	0
	Overton WMA	15	3	2[3,5]	2	4	0	3	1	0	4(2)[8]	0	73
	Study Area Total	**16**	**3**	**2**	**2**	**4**	**0**	**4**	**1**	**0**	**4(2)**	**0**	**69**
Topock	Pipes #1	1	0	0	0	0	0	0	0	1	0	0	100
	Pipes #3	3	1	0	0	1[9]	0	0	1	0	0	0	67
	The Wallows	3	0	0	0	1[10]	0	2	0	0	0	0	33
	PC6-1	1	0	0	0	0	0	1	0	0	0	0	0
	In Between	1	0	0	0	0	0	0	1	0	0	0	0
	800M	3	0	1[9]	0	0	0	1	1	0	0	0	33
	Pierced Egg	4	0	0	0	0	0	0	4	0	0	0	0
	Swine Paradise	1	0	0	0	0	0	1	0	0	0	0	0
	Platform	1	0	0	0	1[10]	0	0	0	0	0	0	100
	Hell Bird	10	1	0	0	0	0	2	7	0	0	0	10
	Spaghetti	2	0	0	0	0	0	0	2	0	0	0	0
	Beal Lake	1	0	0	0	0	0	0	1	0	0	0	0
	Lost Lake	1	0	0	0	0	0	1	0	0	0	0	0
	Dock[11]	3	0	0	0	0	0	1	2	0	0	0	0
	Study Area Total	**33**	**2**	**1**	**0**	**1**	**0**	**9**	**19**	**1**	**0**	**0**	**15**
Bill Williams	Wispy Willow	1	0	0	0	0	0	0	1	0	0	0	0
	Burn Edge	1	0	0	0	0	0	0	1	0	0	0	0
	Site #4	3	0	0	0	0	0	2	1	0	0	0	0
	Site #3	3	0	0	0	2	0	0	1	0	1(1)	0	67
	Site #5	2	0	0	0	0	0	0	2	0	0	0	0
	Cougar Point	2	1	0	0	0	0	0	1	0	0	0	50
	Planet Ranch Rd	5	1	0	0	2	0	1	1	0	3(1)	0	60
	Study Area Total	**17**	**2**	**0**	**0**	**4**	**0**	**3**	**8**	**0**	**4(2)**	**0**	**35**
Total		**124**	**15**	**11**	**3**	**31**	**1**	**30**	**30**	**3**	**40(17)**	**1**	**52**

* 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 Table 3.2.

[1] One individual moved from North to West and is tallied only once in the total.

[2] Three HY individuals moved from North to West. These individuals were resighted, not captured, at West and are not tallied in the total.

[3] One individual moved from Muddy River Overton WMA to Mesquite Hafen Lane and is tallied only once in the total.

[4] One individual moved from Mesquite West to Mormon Mesa Virgin River #1 South and is tallied only once in the total.

[5] One individual moved from Muddy River Overton WMA to Mormon Mesa Virgin River #1 South and is tallied only once in the total.

[6] Returning nestling.

[7] Two nestlings suspected to have died before fledging.

[8] Three nestlings died before fledging.

[9] One individual moved from 800M to Pipes #3 and is tallied only once in the total.

[10] One individual moved from Platform to The Wallows and is tallied only once in the total.

[11] Not a formal survey site. Flycatchers detected en route.

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2011

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[3]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
PAHR	North	26-Jun-09	2430-61087	OB(M):XX	N/A	A4Y	F	12	R 12 Jul
	North	24-Jun-08	2430-61176	DK(M):XX	N/A	4Y	M	12	R 19 Jun
	North	N/A	N/A	UB:UB	N/A	HY	U	12	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	12	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	12	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	12	RS
	North	26-Jun-11	2540-58111	TQ:RYR(M)	N/A	AHY	F	13	N
	North	19-Jul-08	2430-61080	YY(M):XX	N/A	5Y	M	13	RS
	North	8-Jul-11	2590-53104	XX:GVG(M)	N/A	L	U	13	N
	North	8-Jul-11	2590-53102	XX:RV(M)	N/A	L	U	13	N
	North	8-Jul-11	2590-53103	XX:BRB(M)	N/A	L	U	13	N
	North	8-Jul-11	2590-53101	XX:DOD(M)	N/A	L	U	13	N
	North	24-Jun-11	2540-58110	RKR(M):TQ	N/A	AHY	F	23,F84	N; detected 21 Jul at F84 in PAHR West
	North	25-Jun-08	2430-61179	XX:KB(M)	N/A	A5Y	M	23,43,128	RS
	North	2-Jul-11	2430-61215	WBW(M):XX	N/A	L	U	23	N
	North	2-Jul-11	2430-61218	XX:OYO(M)	N/A	L	U	23,F81	N; detected 21–25 Jul at F81 in PAHR West
	North	1-Jul-08	2430-61120	XX:KO(M)	N/A	4Y	F	31	R 12 Jul
	North	21-Jun-06	2370-40060	YG(M):PU	N/A	A7Y	M	31	RS
	North	20-Jul-11	2590-53109	XX:WKW(M)	N/A	HY	U	31	N
	North	N/A	N/A	UB:UB	N/A	HY	U	31	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	31	RS
	North	1-Jul-06	2370-40047	PU:DD(M)	N/A	A7Y	F	43	RS
	North	3-Jul-11	2430-61220	RGR(M):XX	N/A	L	U	43	N
	North	3-Jul-11	2540-58114	YDY(M):TQ	N/A	L	U	43	N
	North	18-Jul-10	2540-58293	BO(M):TQ	N/A	3Y	F	128	RS
	North	6-Jul-11	2540-58286	TQ:DYD(M)	N/A	L	U	128	N

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2011 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[3]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
PAHR	North	6-Jul-11	2540-58284	GW(M):TQ	N/A	L	U	128	N
	North	6-Jul-11	2540-58285	TQ:YG(M)	N/A	L	U	128	N
	North	24-Jul-08	2430-61083	XX:YR(M)	N/A	5Y	M	T21	RS; detected 18 May–28 Jul
	North	7-Jul-06	2360-59754	OR(M):EE	N/A	6Y	M	T41	RS; detected 28 May–9 Jun
	North	18-May-04	2320-31595	WKW(M):EE	N/A	A9Y	M	T48	RS; detected 24 May–1 Aug
	North	6-Jul-05	2360-59712	EE:GKG(M)	N/A	7Y	M	T64	RS; detected 28 May–19 Jul
	North	13-Jun-11	2540-58245	TQ:KYK(M)	N/A	SY	M	F73	N; detected 13 Jun
	North	N/A	N/A	UB:UB	N/A	AHY	U	F76	RS; detected 18 May
	North	21-Jul-10	2540-58201	TQ:BO(M)	N/A	SY	U	F77	RS; detected 12 Jul
	North	INA	INA	banded	N/A	AHY	M	F78	RS; detected 4 Aug
	North	N/A	N/A	UB:UB	N/A	AHY	M	F79	RS; detected 18 May
	West	INA	INA	banded	N/A	HY	U	F80	RS; detected 21–25 Jul, probably from 128
	West	N/A	N/A	UB:UB	N/A	HY	U	F82	RS; detected 21 Jul, probably from PAHR North
	North	N/A	N/A	UB:UB	N/A	AHY	U	F83	RS; detected 12 Jul
	North	17-Jun-11	2540-58109	WK(M):TQ	N/A	SY	M	F120	N; detected 17–19 Jun, detected 23 Jun–13 Jul at T109 in RIRA West Side
MESQ	West	N/A	N/A	UB:UB	N/A	AHY	F	30	RS
	West	15-Jul-05	2320-31688	EE:BG(M)	N/A	7Y	M	30	RS
	West	13-Aug-11	2590-53152	XX:OKO(M)	N/A	L	U	30	N
	West	13-Aug-11	2590-53154	XX:GRG(M)	N/A	L	U	30	N
	Hafen Lane	22-Jul-11	2540-58152	TQ:KWK(M)	N/A	AHY	F	32	N
	Hafen Lane	30-Jun-11	2540-58176	TQ:WG(M)	N/A	SY	M	32	N; detected 30 Jun–17 Jul
	Hafen Lane	19-Jun-09	2370-39930	PU:GO(M)	N/A	3Y	M	32	RS; detected 21–23 Jul, detected 17 May–17 Jul at T22 in MUDD Overton WMA
	West	INA	INA	undetermined	N/A	AHY	F	40	
	West	6-Jun-10	2540-58192	TQ:BG(M)	N/A	A3Y	M	40, 103	RS; captured 24 Jul at F20 in MOME Virgin River #1 South

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2011 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[3]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
MESQ	West	26-Jul-07	2370-40087	PU:BZ(M)	N/A	A6Y	F	72	RS
	West	N/A	N/A	UB:UB	N/A	AHY	M	72	RS
	West	N/A	N/A	UB:UB	N/A	AHY	F	80	RS
	West	16-Jun-09	2370-40175	PU:OKO(M)	N/A	3Y	M	80, 127	RS
	West	21-Jul-10	2430-61234	XX:WGW(M)	N/A	A3Y	F	103	RS
	West	1-Jul-11	2430-61216	OKO(M):XX	N/A	L	U	103	N
	West	1-Jul-11	2430-61217	XX:YVY(M)	N/A	L	U	103	N
	West	1-Jul-11	2540-58112	WW(M):TQ	N/A	L	U	103	N
	West	INA	INA	undetermined	N/A	AHY	F	127	
	West	14-Jun-11	2540-58172	TQ:VV(M)	N/A	AHY	M	T102	N
MOME	Virgin River #1 South	6-Aug-05	2360-59788	BO(M):EE	N/A	7Y	F	1	RS
	Virgin River #1 South	22-Jul-02	2140-66709	Bs:GW(M)	N/A	A11Y	M	1, 91	RS
	Virgin River #1 South	15-Jun-11	2540-58174	TQ:WK(M)	N/A	L	U	1	N
	Virgin River #1 South	15-Jun-11	2540-58173	TQ:VW(M)	N/A	L	U	1	N, R 12 Jul
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	HY	U	1	RS
	Virgin River #1 South	25-Jun-07	2360-59777	EE:YKY(M)	EE:UB	5Y	F	2	R 19 Jul
	Virgin River #1 South	4-Jul-01	none[9]	UB:GY(M)	UB:XX	11Y	M	2, 7, 90	R 20 Jun and 19 Jul
	Virgin River #1 South	22-Jul-11	2590-53116	YDY(M):XX	N/A	L	U	2	N
	Virgin River #1 South	22-Jul-11	2590-56115	RKR(M):XX	N/A	L	U	2	N
	Virgin River #1 South	22-Jul-11	2590-53117	YGY(M):XX	N/A	L	U	2	N
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	AHY	F	5	RS
	Virgin River #1 South	3-Jun-07	2370-40197	OG(M):PU	N/A	A6Y	M	5, 50	RS
	Virgin River #1 South	INA	INA	PU:UB	N/A	AHY	F	7	RS
	Virgin River #1 North	INA	INA	banded	N/A	AHY	F	19	RS
	Virgin River #1 North	19-Jun-08	none[10]	UB:KW(M)	XX:KW(M)	A5Y	M	19	RS
	Virgin River #1 South	29-Jun-10	2540-58231	TQ:GR(M)	N/A	3Y	F	50	RS
	Virgin River #1 South	2-Jul-11	2590-53141	RK(M):XX	N/A	L	U	50	N; suspected to have died

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2011 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[3]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
MOME	Virgin River #1 South	2-Jul-11	2590-53142	XX:BWB(M)	N/A	L	U	50	N; suspected to have died
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	AHY	F	65	RS
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	AHY	M	65	RS
	Virgin River #1 North	N/A	N/A	UB:UB	N/A	AHY	F	66	RS
	Virgin River #1 North	N/A	N/A	UB:UB	N/A	AHY	M	66	RS
	Virgin River #1 South	2-Jun-06	2370-40037	PU:DR(M)	N/A	A7Y	F	70	R 19 Jul
	Virgin River #1 South	14-Jun-06	2370-40046	PU:DK(M)	N/A	7Y	M	70, 104	RS
	Virgin River #1 South	19-Jul-11	2370-39970	PU:RWR(M)	N/A	L	U	70	N
	Virgin River #1 South	19-Jul-11	2540-58213	KWK(M):TQ	N/A	L	U	70	N
	Virgin River #1 South	9-Jun-05	2370-39956	PU:YWY(M)	PU:ZZ(M)	8Y	F	90	R 24 and 25 Jul
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	HY	U	90	RS
	Virgin River #1 South	16-Jul-04	2320-31632	RZ(M):EE	N/A	9Y	F	91	RS; mated consecutively with 2 males
	Virgin River #1 South	31-Jul-09	2540-58154	DO(M):TQ	N/A	3Y	M	91	RS; breeding through 17 Jul at 18 in MUDD Overton WMA
	Virgin River #1 South	3-Jul-11	2540-58113	WY(M):TQ	N/A	L	U	91	N
	Virgin River #1 South	3-Jul-11	2430-61219	BVB(M):XX	N/A	L	U	91	N
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	HY	U	91	RS
	Virgin River #1 South	12-Aug-11	2590-53119	GWG(M):XX	N/A	L	U	91	N
	Virgin River #1 South	12-Aug-11	2590-53151	GDG(M):XX	N/A	L	U	91	N
	Virgin River #1 South	12-Aug-11	2590-53150	KVK(M):XX	N/A	L	U	91	N
	Virgin River #1 South	12-Jul-11	2540-58184	YGY(M):TQ	N/A	SY	F	92	N 12 Jul
	Virgin River #1 South	30-Jun-08	2430-61106	XX:KV(M)	N/A	4Y	M	92	R 2 and 12 Jul
	Virgin River #1 South	12-Jul-11	2590-53106	XX:OGO(M)	N/A	L	U	92	N
	Virgin River #1 South	12-Jul-11	2590-53107	XX:VKV(M)	N/A	L	U	92	N
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	AHY	F	104	RS
	Virgin River #1 South	8-Jun-06	2370-39938	KG(M):PU	N/A	7Y	M	T51	RS; detected 19 May–18 Jul
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	AHY	U	F8	RS; detected 26 Jun

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2011 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[3]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
MOME	Virgin River #1 South	6-Jun-10	2540-58192	TQ:BG(M)	N/A	A3Y	M	F20	R 24 Jul; breeding through 19 Jul at 40 and 103 in MESQ West
	Virgin River #1 North	N/A	N/A	UB:UB	N/A	AHY	M	F199	RS; detected 10–14 Jul
MUDD	Overton WMA	14-Jul-11	2590-53108	XX:YOY(M)	N/A	SY	F	3	N
	Overton WMA	25-Jul-09	2370-40029	KOK(M):PU	N/A	3Y	M	3	R 11Jul
	Overton WMA	18-Jul-11	2590-53126	XX:GOG(M)	N/A	L	U	3	N
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	F	4	RS
	Overton WMA	21-Jun-10	2370-40088	PU:VG(M)	N/A	3Y	M	4	RS
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	F	11	RS
	Overton WMA	21-May-09	2430-61085	BV(M):XX	N/A	4Y	M	11	RS
	Overton WMA	11-Jul-11	2590-53105	XX:KGK(M)	N/A	SY	F	18	N
	Overton WMA	31-Jul-09	2540-58154	DO(M):TQ[11]	N/A	3Y	M	18	R 11 Jul; breeding 2–17 Aug at 91 in MOME Virgin River #1 South
	Overton WMA	22-Jun-10	2370-40091	PU:DRD(M)	N/A	SY	F	101	R 18 Jul
	Overton WMA	18-Jul-11	2370-39968	VG(M):PU	N/A	SY	M	101	N
	Overton WMA	20-Jul-11	2590-53147	YKY(M):XX	N/A	L	U	101	N; died before fledging
	Overton WMA	20-Jul-11	2540-58279	TQ:WW(M)	N/A	L	U	101	N; died before fledging
	Overton WMA	20-Jul-11	2540-58278	RR(M):TQ	N/A	L	U	101	N; died before fledging
	Overton WMA	8-Jun-10	2430-61088	XX:BKB(M)	N/A	A3Y	M	T10	RS; detected 14 May–13 Jul
	Overton WMA	19-Jun-09	2370-39930	PU:GO(M)	N/A	3Y	M	T22	R 25 Jun; detected 17 May–17 Jul, detected 21–23 Jul at 32 in MESQ Hafen Lane
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	M	T42	RS; detected 19 May–29 Jun
	Overton WMA	25-Jun-10	2370-40000	PU:WW(M)	N/A	3Y	M	F5	RS; detected 2–3 Aug
	Overton WMA	INA	INA	undetermined	N/A	AHY	U	F9	Detected 6 Jul
	Overton Pond	N/A	N/A	UB:UB	N/A	AHY	M	F111	RS; detected 2–5 Jul

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2011 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[3]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
TOPO	Pipes #3	INA	INA	undetermined	N/A	AHY	F	8	
	Pipes #3	27-Jun-11	2590-53162	XX:GD(M)	N/A	SY	M	8	N
	800M	12-Jun-08	2430-61072	XX:RK(M)	N/A	5Y	M	T1, F9	R 8 May; detected 7 May–28 Jun, detected 6–8 Jul at F9 in Pipes #3
	Platform	20-Jun-10	2540-58228	TQ:KO(M)	N/A	3Y	M	T3, T18, F72	RS; detected 16 May–10 June, detected 9–15 June at F72 north of Platform; detected 25 Jun–9 Jul at T18 in The Wallows
	Pipes #1	INA	INA	banded	N/A	AHY	M	T7	RS; detected 23 Jun–1 Jul
	800M	INA	INA	undetermined	N/A	AHY	U	F2	Detected 5–7 Jun
	In Between	INA	INA	undetermined	N/A	AHY	U	F4	Detected 21 May
	800M	N/A	N/A	UB:UB	N/A	AHY	U	F5	Detected 18 Jun
	PC6-1	N/A	N/A	UB:UB	N/A	AHY	U	F6	RS: detected 1 Jun
	Lost Lake	N/A	N/A	UB:UB	N/A	AHY	U	F11	RS: detected 26 May
	Beal Lake	INA	INA	undetermined	N/A	AHY	U	F22	Detected 7 Jun
	Hell Bird	16-May-11	2540-58108	TQ:GK(M)	N/A	AHY	U	F42	N; detected 16 May
	Hell Bird	INA	INA	undetermined	N/A	AHY	M	F43	Detected 16 May
	Hell Bird	INA	INA	undetermined	N/A	AHY	U	F44	Detected 29 May
	Dock	INA	INA	undetermined	N/A	AHY	U	F45	Detected 28 May
	Dock	N/A	N/A	UB:UB	N/A	AHY	U	F46	RS; detected 28 May
	Dock	INA	INA	undetermined	N/A	AHY	U	F47	Detected 28 May
	Pierced Egg	INA	INA	undetermined	N/A	AHY	U	F48	Detected 29 May
	Pierced Egg	INA	INA	undetermined	N/A	AHY	U	F49	Detected 29 May
	Hell Bird	N/A	N/A	UB:UB	N/A	AHY	M	F50	RS; detected 29 May
	Hell Bird	INA	INA	undetermined	N/A	AHY	U	F51	Detected 29 May
	Hell Bird	INA	INA	undetermined	N/A	AHY	U	F52	Detected 29 May
	Hell Bird	N/A	N/A	UB:UB	N/A	AHY	U	F53	RS: detected 4 Jun
	Hell Bird	INA	INA	undetermined	N/A	AHY	U	F54	Detected 4 Jun

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2011 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[3]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
TOPO	Hell Bird	INA	INA	undetermined	N/A	AHY	U	F55	Detected 8 Jun
	Hell Bird	INA	INA	undetermined	N/A	AHY	U	F56	Detected 8 Jun
	Pierced Egg	INA	INA	undetermined	N/A	AHY	U	F57	Detected 3 Jun
	Spaghetti	INA	INA	undetermined	N/A	AHY	U	F70	Detected 30 May
	Swine Paradise	N/A	N/A	UB:UB	N/A	AHY	M	F71	RS; detected 9 Jun
	Spaghetti	INA	INA	undetermined	N/A	AHY	U	F73	Detected 30 May
	Pierced Egg	INA	INA	undetermined	N/A	AHY	U	F100	Detected 24 May
	The Wallows	N/A	N/A	UB:UB	N/A	AHY	U	F101	RS; detected 1–5 Jun
	The Wallows	N/A	N/A	UB:UB	N/A	AHY	M	F102	RS; detected 9–13 Jun
BIWI	Site #3	6-Jun-08	2430-61137	XX:BR(M)	N/A	5Y	F	2	RS
	Site #3	6-Jun-08	2430-61136	XX:BG(M)	N/A	5Y	M	2	RS
	Site #3	14-Jul-11	2590-53164	RV(M):XX	N/A	L	U	2	N
	Cougar Point	14-Jul-11	2540-58120	TQ:YKY(M)	N/A	AHY	F	33	N
	Cougar Point	INA	INA	undetermined	N/A	AHY	M	33	Detected by an unrelated field crew; not detected during nest monitoring
	Planet Ranch Road	10-Jul-10	2540-58230	YD(M):TQ	N/A	3Y	F	41	RS
	Planet Ranch Road	12-Jun-10	2540-58220	TQ:DY(M)	N/A	A3Y	M	41, 103	RS
	Planet Ranch Road	2-Jul-11	2590-53163	XX:KVK(M)	N/A	SY	F	103	N
	Planet Ranch Road	17-Jul-11	2590-53182	XX:RBR(M)	N/A	L	U	103	N
	Planet Ranch Road	17-Jul-11	2430-61237	XX:VRV(M)	N/A	L	U	103	N
	Planet Ranch Road	17-Jul-11	2540-58115	TQ:WKW(M)	N/A	L	U	103	N
	Site #4	N/A	N/A	UB:UB	N/A	AHY	M	T17	RS; detected 20 Jun–5 Jul
	Planet Ranch Road	INA	INA	undetermined	N/A	AHY	U	F12	Detected 1 Jun
	Planet Ranch Road	N/A	N/A	UB:UB	N/A	AHY	U	F13	RS; detected 1–6 Jun
	Site #4	INA	INA	undetermined	N/A	AHY	U	F15	Detected 16 Jun
	Site #4	N/A	N/A	UB:UB	N/A	AHY	M	F16	RS; detected 20–26 Jun
	Site #5	INA	INA	undetermined	N/A	AHY	U	F21	Detected 21 May

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2011 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[3]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
BIWI	Site #5	INA	INA	undetermined	N/A	AHY	U	F22	Detected 29 May
	Wispy Willow	INA	INA	undetermined	N/A	AHY	U	F31	Detected 27 May
	Burn Edge	INA	INA	undetermined	N/A	AHY	M	F32	Detected 30 Jun
	Site #3	INA	INA	undetermined	N/A	AHY	U	F44	Detected 27 May

[1] PAHR = Pahranagat NWR, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams River NWR.

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

[3] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, Bs = blue federal band, XX = standard silver federal band, TQ = turquoise federal band, (M) = metal pin striped band, UB = unbanded, R = red, O = orange, Y = yellow, G = green, D = dark blue, B = light blue, V = violet, W = white, K = black, Z = gold, banded = bird was banded but combination could not be determined, undetermined = presence of bands could not be determined. Color combinations are read as the bird's left leg and right leg, top to bottom; two or three letters designate every band; color-band designations for right and left legs are separated with a colon.

[4] Old combination included only if rebanded in 2011.

[5] **Age in 2011**: 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.

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

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

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

[9] Original federal band number 2390-92434.

[10] Original federal band number 2430-61167. Individual resighted at the beginning of the season with XX:KW(M) with an injured left leg but subsequently lost the left foot and federal band.

[11] Further review of data suggests this individual likely present at MUDD 9 Jul–3 Aug 2010 and erroneously reported (McLeod and Pellegrini 2011) as DR(M):TQ.

NDOW Study Areas

Color-Banding and Resighting – Field personnel color-banded 13 new adult flycatchers and recaptured 3 individuals previously captured as adults. An additional 25 adults were identified to individual via resighting, while 2 individuals were resighted but did not have color combinations confirmed. We recaptured one individual identified as a returning nestling by the presence of a single federal band from 2007. Three additional adults were captured with full color combinations and identified as returning nestlings from 2009 or 2010 (Table 3.8). Five adult flycatchers remained unbanded, and banding status was undetermined (i.e., we were unable to determine if these individuals were banded) for one adult. Overall, 89% of the adult flycatchers detected at the monitoring sites were known to be color-banded by the end of the breeding season (Table 3.3). We banded 34 nestlings from 13 nests. Of the 34 nestlings banded, 3 were suspected to have died before fledging. For details on all banded flycatchers detected at the study areas from 2003 to 2011, see Appendix E.

Site-by-Site Color-Banding and Resighting

Key Pittman Wildlife Management Area – We detected 34 resident willow flycatchers from 19 territories at Key Pittman Wildlife Management Area. In addition to resident adults, we detected eight individuals for which residency and/or breeding status could not be determined (Table 3.4). Of the 19 territories at Key Pittman, 18 consisted of breeding individuals and 1 consisted of an unpaired male. Three males were each polygynous with two females.

Field personnel captured and color-banded 11 new adults and recaptured five flycatchers previously seen as adults (Table 3.4). We resighted and identified 20 additional adults; 5 of these individuals were detected for the first time since they were banded as nestlings in 2010 (see Table 3.8). We captured two returning nestlings originally banded as juveniles in 2007 and 2009. Two adults remained unbanded, and color combinations could not be confirmed for two adults. We banded 31 nestlings from 12 nests; we suspect three of these nestlings from two nests died before fledging. We resighted four unbanded fledglings from three additional nests.

River Ranch – We detected seven resident willow flycatchers from four territories at River Ranch. In addition to resident adults, we detected two individuals for whom residency and/or breeding status could not be determined (Table 3.4). Of the four territories at River Ranch, two consisted of breeding individuals, one consisted of a pair with no documented breeding activity, and one consisted of an unpaired male.

Field personnel captured and color-banded two new adult flycatchers. We resighted and identified six additional adults, five of which were banded as nestlings in 2010 (Table 3.8). One adult remained unbanded.

Warm Springs Natural Area – We detected two resident willow flycatchers from one territory at Warm Springs Natural Area. In addition to resident adults, we detected three individuals for whom residency and/or breeding status could not be determined (Table 3.4). The single territory at Warm Springs consisted of breeding individuals.

Field personnel did not capture or recapture any adult flycatchers. We resighted and identified two adults. Two adults remained unbanded, and the presence of bands could not be confirmed for one adult. We banded three nestlings from one nest.

Table 3.3. Willow Flycatchers Detected at NDOW Study Areas Where Resident Flycatchers Were Observed during the 2011 Breeding Season*

Study Area	Site	Adults									Nestlings Banded (# nests)	Fledglings Captured	% of All Adults Banded
		Total Adults Detected	New Captured	Recaptured		Resighted							
				Detected in Previous Year(s) as Adults	Returning Nestlings	Color combination confirmed		Unbanded	Band Status Undetermined	Banded (color combinations unconfirmed)			
						Individual Identified	Individual Not Identified						
Key Pittman WMA	Patch 0	2	0	0	0	2[1]	0	0	0	0	1(1)[2]	0	100
	Patch 1	2	1	0	0	1	0	0	0	0	3(1)	0	100
	Patch 2	2	0	0	0	2	0	0	0	0	2(1)	0	100
	Patch 3	2	0	0	0	1[3]	0	0	0	1	0	0	100
	Patch 4	5	1	1[3]	2[4,5]	0	0	1	0	0	2(1)	0	67
	Patch 5	2	0	1	0	0	0	1	0	0	0	0	50
	Patch 6	6	2	0	0	4[6]	0	0	0	0	5(2)[8]	0	100
	Patch 7	2	1	0	1	0	0	0	0	0	4(1)	0	100
	Patch 8	2	0	0	0	2	0	0	0	0	0	0	100
	Patch 9	4	1	0	0	3	0	0	0	0	4(1)	0	100
	Patch 10	3	1	1	0	1	0	0	0	0	5(2)	0	100
	Patch 10.5	2	0	0	1[7]	1[5]	0	0	0	0	0	0	100
	Patch 11	5	1	0	0	4[6]	0	0	0	0	3(1)	0	100
	Patch 12	6	3	0	1[7]	1	0	0	0	1	2(1)	0	100
	Fence[9]	1	0	0	0	1	0	0	0	0	0	0	100
	Study Area Total	**42**	**11**	**3**	**4**	**20**	**0**	**2**	**0**	**2**	**31(12)**	**0**	**95**
River Ranch	East Side	2	0	0	0	2[4]	0	0	0	0	0	0	100
	West Side	5	0	0	0	4[1,5]	0	1	0	0	0	0	80
	Smalls	2	2	0	0	0	0	0	0	0	0	0	100
	Study Area Total	**9**	**2**	**0**	**0**	**6**	**0**	**1**	**0**	**0**	**0**	**0**	**89**
Warm Springs Natural Area	Muddy Mac	5	0	0	0	2	0	2	1	0	3(1)	0	40
	Study Area Total	**5**	**0**	**0**	**0**	**2**	**0**	**2**	**1**	**0**	**3(1)**	**0**	**40**
Total		**53**	**13**	**3**	**4**	**25**	**0**	**5**	**1**	**2**	**34(13)**	**0**	**89**

* 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 Table 3.4.

[1] One individual moved from River Ranch West Side to Key Pittman WMA Patch 0 and is tallied only once in the total.

[2] Nestling suspected to have died in nest.

[3] One individual resighted in Key Pittman Patch 3 was recaptured in Patch 4, and is tallied only once in the total.

[4] One individual moved from River Ranch East Side to Key Pittman WMA Patch 4 and is only tallied once in the total.

[5] One individual moved from River Ranch West Side to Key Pittman WMA Patch 10.5 and is only tallied once in the total. This individual was resighted in Patch 10.5 and later recaptured in Patch 4, and is tallied only once in the total.

[6] One individual was detected in Patch 11 and Patch 6 and is tallied only once in the total.

[7] One individual recaptured in Patch 10.5 and Patch 12 and is tallied only once in the total.

[8] Two nestlings suspected to have died before fledging in one nest.

[9] Not a formal survey area. Individual detected in passing between Patches 5 and 6 on fence-line that runs along highway.

Table 3.4. Willow Flycatchers Detected at NDOW Study Areas, 2011

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[2]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
KEPI	Patch 10	6-Jul-11	2540-58177	TQ:KRK(M)	N/A	AHY	F	15	N
	Patch 10	16-Jul-09	2430-61158	RB(M):XX	N/A	A4Y	M	15,93	R 28 Jun and 6 Jul
	Patch 10	16-Jul-11	2370-40078	YV(M):PU	N/A	L	U	15	N
	Patch 10	16-Jul-11	2590-53144	XX:GDG(M)	N/A	L	U	15	N
	Patch 7	21-Jul-11	2590-53110	OW(M):XX	N/A	AHY	F	16	N
	Patch 7	14-Jul-07	2370-40190	RY(M):PU	UB:PU	5Y	M	16	R 21 Jul
	Patch 7	21-Jul-11	2590-53111	VD(M):XX	N/A	L	U	16	N
	Patch 7	21-Jul-11	2590-53112	BKB(M):XX	N/A	L	U	16	N
	Patch 7	21-Jul-11	2590-53113	BYB(M):XX	N/A	L	U	16	N
	Patch 7	21-Jul-11	2590-53114	KOK(M):XX	N/A	L	U	16	N
	Patch 6	25-Jul-10	2540-58241	TQ:BY(M)	N/A	A3Y	F	17	RS
	Patch 6	18-Jun-11	2430-61214	DV(M):XX	N/A	SY	M	17	N
	Patch 12	28-Jun-11	2540-58175	TQ:WO(M)	N/A	AHY	F	44	N
	Patch 12	27-Jul-11	2540-58387	GWG(M):TQ	N/A	AHY	M	44,107	N
	Patch 12	N/A	N/A	UB:UB	N/A	HY	U	44	RS
	Patch 11	27-Jul-11	2540-58386	OGO(M):TQ	N/A	AHY	F	45	N
	Patch 11	3-Aug-08	2370-40097	PU:GY(M)	N/A	4Y	M	45	RS
	Patch 11	28-Jul-11	2590-53118	RDR(M):XX	N/A	L	U	45	N
	Patch 11	28-Jul-11	2590-53149	YRY(M):XX	N/A	L	U	45	N
	Patch 11	28-Jul-11	2540-58280	OD(M):TQ	N/A	L	U	45	N
	Patch 8	28-Jul-10	2540-58165	DB(M):TQ	N/A	SY	F	46	RS
	Patch 8	1-Jul-08	2430-61118	XX:KK(M)	N/A	4Y	M	46	RS
	Patch 5	N/A	N/A	UB:UB	N/A	AHY	F	47	RS
	Patch 5	16-Jul-09	2370-40031	OGO(M):PU	N/A	3Y	M	47	R 28 Jun
	Patch 5	N/A	N/A	UB:UB	N/A	HY	U	47	RS
	Patch 5	N/A	N/A	UB:UB	N/A	HY	U	47	RS
	Patch 1	14-Jul-11	2590-53173	YBY(M):XX	N/A	SY	F	49	N

Table 3.4. Willow Flycatchers Detected at NDOW Study Areas, 2011 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[2]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
KEPI	Patch 1	29-Jul-09	2370-40140	PU:YK(M)	N/A	4Y	M	49	RS
	Patch 1	17-Jul-11	2540-58211	TQ:OW(M)	N/A	L	U	49	N
	Patch 1	17-Jul-11	2540-58212	YWY(M):TQ	N/A	L	U	49	N
	Patch 1	17-Jul-11	2590-53125	VBV(M):XX	N/A	L	U	49	N
	Patch 0	30-Jun-10	2540-58238	TQ:GOG(M)	N/A	SY	F	57	RS; breeding 23–27 Jun at RIRA West Side then moved to KEPI
	Patch 0	8-Jul-10	2540-58158	RB(M):TQ	N/A	SY	M	57	RS
	Patch 0	2-Aug-11	2540-58298	TQ:RO(M)	N/A	L	U	57	N; suspected to have died in nest
	Patch 2	8-Jul-10	2540-58159	KB(M):TQ	N/A	SY	F	61	RS
	Patch 2	2-Jul-09	2370-40024	PU:BV(M)	N/A	3Y	M	61	RS
	Patch 2	1-Aug-11	2540-58214	TQ:YRY(M)	N/A	L	U	61	N
	Patch 2	1-Aug-11	2590-53127	WGW(M):XX	N/A	L	U	61	N
	Patch 9	8-Jul-10	2540-58156	BG(M):TQ	N/A	A3Y	F	62	RS
	Patch 9	1-Jul-08	2430-61114	WR(M):XX	N/A	4Y	M	62	RS
	Patch 9	7-Jul-11	2540-58182	GR(M):TQ	N/A	L	U	62	N
	Patch 9	7-Jul-11	2540-58183	KK(M):TQ	N/A	L	U	62	N
	Patch 9	7-Jul-11	2540-58282	KV(M):TQ	N/A	L	U	62	N
	Patch 9	7-Jul-11	2540-58283	KW(M):TQ	N/A	L	U	62	N
	Patch 10	21-Jul-10	2430-61100	XX:YKY(M)	N/A	3Y	F	93	RS
	Patch 10	16-Jul-11	2370-40079	PU:KRK(M)	N/A	L	U	93	N
	Patch 10	16-Jul-11	2540-58276	VW(M):TQ	N/A	L	U	93	N
	Patch 10	16-Jul-11	2540-58277	TQ:YY(M)	N/A	L	U	93	N
	Patch 4	27-Jul-11	2540-58297	RYR(M):TQ	N/A	AHY	F	100	N
	Patch 4	N/A	N/A	UB:UB	N/A	AHY	M	100	RS
	Patch 4	10-Jul-11	2540-58247	OKO(M):TQ	N/A	L	U	100	N
	Patch 4	10-Jul-11	2590-53172	XX:VYV(M)	N/A	L	U	100	N; R 27 Jul
	Patch 11	28-Jul-10	2540-58203	TQ:WD(M)	N/A	3Y	F	106	RS

Table 3.4. Willow Flycatchers Detected at NDOW Study Areas, 2011 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[2]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
KEPI	Patch 11	10-Jul-10	2540-58223	YV(M):TQ	N/A	3Y	M	106	RS
	Patch 11	N/A	N/A	UB:UB	N/A	HY	U	106	RS
	Patch 12	10-Jul-10	2540-58224	TQ:RD(M)	N/A	SY	F	107	RS
	Patch 12	8-Aug-11	2540-58378	WD(M):TQ	N/A	L	U	107	N
	Patch 12	8-Aug-11	2540-58299	TQ:YO(M)	N/A	L	U	107	N
	Patch 6	14-Jul-09	2430-61279	XX:DW(M)	N/A	3Y	F	121	RS
	Patch 6	17-Jul-11	2590-53124	XX:VGV(M)	N/A	AHY	M	121,122	N
	Patch 6	16-Jul-11	2590-53122	XX:KWK(M)	N/A	L	U	121	N; suspected to have died in nest
	Patch 6	16-Jul-11	2590-53123	BRB(M):XX	N/A	L	U	121	N; suspected to have died in nest
	Patch 6	20-Jul-09	2540-58187	TQ:RB(M)	N/A	A4Y	F	122	RS[9]
	Patch 6	7-Jul-11	2540-58180	TQ:WY(M)	N/A	L	U	122	N
	Patch 6	7-Jul-11	2540-58178	BD(M):TQ	N/A	L	U	122	N
	Patch 6	7-Jul-11	2540-58179	GK(M):TQ	N/A	L	U	122	N
	Patch 9	5-Jul-11	2590-53121	XX:WRW(M)	N/A	AHY	F	123	N
	Patch 9	26-Jun-08	2430-61180	RD(M):XX	N/A	5Y	M	123	RS
	Patch 3	3-Jul-08	2430-61197	XX:VY(M)	N/A	4Y	M	T14	RS; detected 16 May–27 Jul; R 27 Jul in Patch 4
	Patch 4	13-Jul-10	2430-61099	XX:WOW(M)	N/A	SY	U	F18	R 27 Jul; not detected post capture; breeding 15 Jun–25 Jul at RIRA East Side
	Fence	6-Jul-09	2370-40027	YY(M):PU	N/A	3Y	U	F19	RS; detected 29 May on fence between Patches 5 and 6
	Patch 11	29-Jun-10	2370-40010	KRK(M):PU	N/A	AHY	U	F20	RS; detected 30 Jun, detected 12 Jul in Patch 6
	Patch 3	INA	INA	banded	N/A	AHY	U	F21	RS; detected 31 Jul
	Patch 12	27-Jul-11	2590-53148	RYR(M):TQ	N/A	AHY	U	F22	N; detected 27 Jul
	Patch 12	INA	INA	banded	N/A	AHY	U	F23	RS; detected 30 Jun
	Patch 10.5	23-Jun-09	2430-61159	OK(M):XX	N/A	3Y	M	F75	R 26 Jun, also 27 Jul in Patch 12; otherwise not detected
	Patch 10.5	12-Jul-09	2430-61098	XX:WDW(M)	N/A	SY	M	F112	RS; detected 24 Jul; R 27 Jul in Patch 4; breeding 23 Jun–1 Jul at RIRA West Side

Table 3.4. Willow Flycatchers Detected at NDOW Study Areas, 2011 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[2]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
RIRA	West Side	30-Jun-10	2540-58238	TQ:GOG(M)	N/A	SY	F	95	RS; detected 23–27 Jun; moved to KEPI Patch 0
	West Side	12-Jul-10	2430-61098	XX:WDW(M)	N/A	SY	M	95	RS; detected 24–27 July at KEPI
	Smalls	27-Jun-11	2590-53171	XX:ORO(M)	N/A	SY	F	108	N; detected 27–29 Jun
	Smalls	27-Jun-11	2540-58246	BR(M):TQ	N/A	SY	M	108	N; detected 15 Jun–16 Jul
	East Side	30-Jun-10	2540-58240	KYK(M):TQ	N/A	SY	F	110	RS
	East Side	13-Jul-10	2430-61099	XX:WOW(M)	N/A	SY	U	110	RS; detected 15 Jun–25 Jul; detected 27 Jul at KEPI Patch 4
	West Side	17-Jun-11	2540-58109	WK(M):TQ	N/A	SY	M	T109	RS; detected 23 Jun–13 Jul; detected 17–19 Jun at PAHR North
	West Side	8-Jul-10	2540-58157	OY(M):TQ	N/A	SY	U	F111	RS; detected 23–27 Jul
	West Side	N/A	N/A	UB:UB	N/A	AHY	M	F112	RS; detected 19 Jun
WMSP	Muddy Mac	8-Jun-10	2540-58193	TQ:DB(M)	N/A	A3Y	F	71	RS
	Muddy Mac	20-May-08	2540-58234[10]	KD(M):TQ	N/A	A5Y	M	71	RS
	Muddy Mac	13-Jul-11	2590-53143	XX:RV(M)	N/A	L	U	71	N
	Muddy Mac	13-Jul-11	2540-58275	TQ:YD(M)	N/A	L	U	71	N
	Muddy Mac	13-Jul-11	2540-58274	VG(M):TQ	N/A	L	U	71	N
	Muddy Mac	INA	INA	undetermined	N/A	AHY	M	F54	Detected 26 May
	Muddy Mac	N/A	N/A	UB:UB	N/A	AHY	M	F55	RS; detected 26 May
	Muddy Mac	N/A	N/A	UB:UB	N/A	AHY	U	F56	RS; detected 26 May

[1] KEPI = Key Pittman WMA; RIRA = River Ranch; WMSP = Warm Springs Natural Area.

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

[3] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, Bs = blue federal band, XX = standard silver federal band, TQ = turquoise federal band, (M) = metal pin striped band, UB = unbanded, R = red, O = orange, Y = yellow, G = green, D = dark blue, B = light blue, V = violet, W = white, K = black, Z = gold, banded = bird was banded but combination could not be determined, undetermined = presence of bands could not be determined. Color combinations are read as the bird's left leg and right leg, top to bottom; two or three letters designate every band; color-band designations for right and left legs are separated with a colon.

[4] Old combination included only if rebanded in 2011.

[5] **Age in 2011**: 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.

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

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

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

[9] Further review of data suggests this individual likely present at KEPI during the 2010 breeding season, but this cannot be confirmed.

[10] Original federal band number 2430-61134.

Non-Monitoring Sites

This study area was monitored by another agency, and here we report only banded flycatchers that were captured or resighted. Unbanded individuals or those with unknown band status are not included.

St. George – Field personnel captured and color-banded two new adults and recaptured one individual previously captured as an adult (Table 3.5). We banded one nestling. Personnel from Utah Division of Wildlife Resources resighted and identified an additional four adult flycatchers. Two more banded adults were resighted, but their identities could not be confirmed.

Table 3.5. Banded Willow Flycatchers, Non-Monitoring Sites, 2011

Study Area[1]	Site	Date Banded	Federal Band #	Color Combination[2]	Age[3]	Sex[4]	Observation Status[5]
STGE	Snipe Pond	28-Jun-09	2430-61154	RO(M):XX	3Y	F	R 20 Jul
	Snipe Pond	20-Jul-11	2590-53145	XX:RWR(M)	AHY	M	N
	Snipe Pond	20-Jul-11	2540-58385	TQ:KGK(M)	L	U	N
	Snipe Pond	20-Jul-11	2590-53287	OO(M):TQ	AHY	M	N
	Riverside East	27-Jul-08	2370-40148	PU:KR(M)	4Y	F	RS
	Riverside East	22-Jun-09	2540-58132	TQ:OD(M)	A4Y	M	RS
	Riverside Marsh	9-Jul-10	2430-61230	XX:GWG(M)	A3Y	F	RS
	Riverside Marsh	29-Jun-10	2430-61093	XX:VBV(M)	A3Y	M	RS
	Riverside Marsh	INA	INA	banded	AHY	F	RS
	Riverside Marsh	INA	INA	banded	AHY	M	RS

[1] STGE = St. George.

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

[3] **Age in 2011:** 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**: M = male, F = female, U = unknown.

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

Adult Between-Year Return and Dispersal

In 2010 we individually identified 96 adult, resident willow flycatchers at all monitored study areas, of which 55 (57%) were detected in 2011 (Table 3.6). Of the returning resident adults, five (9%) were detected at a different study area than where they were last detected in 2010 (Table 3.7). One adult flycatcher that was detected in 2010 at a site monitored by NDOW was detected at a different study area in 2011. Two additional flycatchers that were last detected in 2008 or 2009 exhibited between-year movement in 2011. The median dispersal distance for all returning adult flycatchers exhibiting between-year movements in 2011 was 86.8 km (min = 11.9 km, max = 203.1 km).

Table 3.6. Resident Adult Willow Flycatcher Annual Return from 2010 to 2011

Study Area	# Identified in 2010	# of 2010 Birds Detected in 2011	% Return	% Return to Same Study Area
Key Pittman	21	13	62	100
Pahranagat	19	12	63	100
Littlefield	2	0	0	--

Table 3.6. Resident Adult Willow Flycatcher Annual Return from 2010 to 2011 (Continued)

Study Area	# Identified in 2010	# of 2010 Birds Detected in 2011	% Return	% Return to Same Study Area
Mesquite	11	6	55	83
Mormon Mesa	19	12	63	92
Muddy River	6	3	50	100
Warm Springs	3	2	67	50
Topock	8	3	38	33
Bill Williams	7	4	57	100
Total	**96**	**55**	**57**	**91**

Table 3.7. Adult Willow Flycatcher Between-Year Movements for All Individuals Identified in a Previous Year and Recaptured or Resighted at a Different Study Area in 2011

Study Area/Site/Year Detected[1]	Study Area/Site Detected 2011[1]	Distance Moved (km)	Federal Band #	Color Combination[2]	Sex[3]
GRCA/Iceberg Canyon/2008	TOPO/800M	153.6	2430-61072	XX:RK(M)	M
PAHR/North/2009	KEPI/Patch 6	30.1	2540-58187	TQ:RB(M)[4]	F
MOME/Virgin River #1 South/2010	KEPI/Patch 8	132.7	2430-61118	XX:KK(M)	M
RIRA/West Side/2010	KEPI/Patch 5	11.9	2370-40027	YY(M):PU	F
TOPO/Glory Hole/2010	MOME/Virgin River #1 South	203.1	2540-58231	TQ:GR(M)	F
MESQ/West/2010	MUDD/Overton WMA	40.9	2370-39930	PU:GO(M)	M
WMSP/Muddy Mac/2010	MUDD/Overton WMA	35.4	2430-61088	XX:BKB(M)	M
TOPO/800M/2010	MUDD/Overton WMA	189.3	2540-58154	DO(M):TQ[5]	M

[1] KEPI = Key Pittman WMA, RIRA = River Ranch, PAHR = Pahranagat NWR, MESQ = Mesquite, MOME = Mormon Mesa, WMSP = Warm Springs Natural Area, MUDD = Muddy River, TOPO = Topock Marsh.

[2] **Color-band codes**: PU = pumpkin federal band, XX = standard silver federal band, TQ = turquoise federal band, (M) = metal pin striped band, R = red, O = orange, Y = yellow, G = green, D = dark blue, B = light blue, 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.

[4] Further review of data suggests this individual likely present at KEPI during the 2010 breeding season, but this cannot be confirmed.

[5] Further review of data suggests this individual moved from TOPO to MUDD during the 2010 breeding season but this cannot be confirmed.

Juvenile Between-Year Return and Dispersal

In 2010, we banded 52 nestlings at the Reclamation study areas. One of these nestlings was known to have died before fledging. Of the remaining 51 juveniles, 2 (4%) were identified in 2011. Two individuals originally banded as nestlings in 2007 and two individuals originally banded as nestlings in 2009 were identified for the first time in 2011 (Table 3.8). In 2010, we banded an additional 41 nestlings at the NDOW study areas. Five of these nestlings were known to have died before fledging. Of the remaining 36 juveniles, 9 (25%) were identified in 2011 (Table 3.8). No additional nestlings banded in prior years at NDOW sites were identified. Of the 16 returning nestlings identified in 2010, 12 (75%) dispersed away from their natal study area. The median dispersal distance for all returning juvenile flycatchers in 2011 was 12.8 km (min = 0.03 km, max = 138.0 km).

One additional returning nestling from 2003–2007 was resighted in 2011 at Mormon Mesa, but the identity of this individual was undetermined because we were unable to recapture it.

Table 3.8. Juvenile Flycatchers Banded as Hatch Year Birds in 2007, 2009, or 2010 and Identified for the First Time in 2011

Study Area/ Site Banded[1]	Year Hatched	Study Area/Site Detected 2011[1]	Distance Moved (km)	Federal Band #	Color Combination[2]	Sex[3]
PAHR/North	2007	KEPI/Patch 7	30.1	2370-40190	RY(M):PU	M
MESQ/West	2007	MOME/Virgin River #1 South	27.4	2360-59777	EE:YKY(M)	F
MOME/Virgin River #1 South	2009	KEPI/Patch 10.5	132.8	2430-61159	OK(M):XX	M
MOME/Virgin River #1 South	2009	MUDD/Overton WMA	13.6	2370-40029	KOK(M):PU	M
KEPI/Patch 10.5	2010	PAHR/North	30.1	2540-58201	TQ:BO(M)	U
KEPI/Patch 9	2010	KEPI/Patch 12	0.3	2540-58224	TQ:RD(M)	F
KEPI/Patch 9	2010	RIRA/East Side	12.0	2430-61099	XX:WOW(M)	U
KEPI/Patch 8	2010	KEPI/Patch 8	0.03	2540-58165	DB(M):TQ	F
KEPI/Patch 7	2010	RIRA/West Side	11.9	2540-58238	TQ:GOG(M)	F
KEPI/Patch 7	2010	RIRA/East Side	11.9	2540-58240	KYK(M):TQ	F
KEPI/Patch 6	2010	KEPI/Patch 2	0.6	2540-58159	KB(M):TQ	F
KEPI/Patch 6	2010	KEPI/Patch 0	0.7	2540-58158	RB(M):TQ	M
KEPI/Patch 6	2010	RIRA/West Side	11.9	2540-58157	OY(M):TQ	U
PAHR/North	2010	RIRA/West Side	18.2	2430-61098	XX:WDW(M)	M
MOME/Virgin River #1 South	2010	MUDD/Overton WMA	13.6	2370-40091	PU:DRD(M)	F
MUDD/Overton WMA	2010	KEPI/Patch 6	138.0	2370-40010	KRK(M):PU	U

[1] KEPI = Key Pittman WMA, RIRA = River Ranch, PAHR = Pahranagat NWR, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River.

[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, XX = standard silver federal band, TQ = turquoise federal band, (M) = metal pin striped band, R = red, O = orange, G = green, B = light blue, D = dark blue, W = white, Y = yellow, K = black. Color combinations are read as the bird's left leg and right leg, top to bottom; two or three letters designate every band; color-band designations for right and left legs are separated with a colon.

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

Within-Year, Between-Study Area Movements

We detected seven within-year, between-study area movements in 2011 (Table 3.9). Three individuals moved from River Ranch to Key Pittman WMA. One male held a territory in River Ranch West Side (23 June – 1 July), was detected on 24 July at Key Pittman Patch 10.5, and recaptured passively on 27 July in Patch 4. The female from the same territory in River Ranch West Side moved after a failed nesting attempt (23 – 27 June) to Key Pittman Patch 0 where she had another nesting attempt of unknown fate (8 July – 4 August). Another individual, likely a male, was present in River Ranch East Side (15 June – 25 July) and was recaptured passively at Key Pittman Patch 4 on 27 July. A male at Pahranagat North was detected 17 – 19 June and moved to River Ranch West Side where he held a territory from 23 June to 13 July. One male held a territory at Mesquite West (17 May – 19 July) and was recaptured passively on 24 July in Mormon Mesa Virgin River #1 South. Two males moved from Muddy River Overton WMA after holding territories. One male held his territory from 17 May to 17 July and was then detected at Mesquite Hafen Lane from 21 to 23 July. The other male held his territory from 17 June to 17 July and then moved to Mormon Mesa Virgin River #1 South where he was detected from 2 to 17 August.

Table 3.9. Adult Willow Flycatcher Within-Year Movements for All Individuals Identified at Two Different Study Areas in 2011

Start Study Area/Site[1]	End Study Area/Site[1]	Distance Moved (km)	Federal Band #	Color Combination[2]	Sex[3]
RIRA/West Side	KEPI/Patch 4	11.4	2430-61098	XX:WDW(M)	M
RIRA/East Side	KEPI/Patch 4	11.4	2430-61099	XX:WOW(M)	U
RIRA/West Side	KEPI/Patch 0	11.2	2540-58238	TQ:GOG(M)	F
PAHR/North	RIRA/West Side	18.2	2540-58109	WK(M):TQ	M
MESQ/West	MOME/Virgin River #1 South	27.2	2540-58192	TQ:BG(M)	M
MUDD/Overton WMA	MESQ/Hafen Lane	43.9	2370-39930	PU:GO(M)	M
MUDD/Overton WMA	MOME/Virgin River #1 South	13.5	2540-58154	DO(M):TQ	M

[1] KEPI = Key Pittman WMA, RIRA = River Ranch, PAHR = Pahranagat NWR, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River.

[2] **Color-band codes**: PU = pumpkin federal band, XX = standard silver federal band, TQ = turquoise federal band, (M) = metal pin striped band, R = red, O = orange, Y = yellow, G = green, D = dark blue, B = light blue, 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 = unknown.

DISCUSSION

Color-Banding Effort

Overall, 52% of the adult flycatchers detected at the monitoring sites during 2011 were banded by the end of the breeding season. This compares to 55, 57, 75, 70, 73, 69, 67 and 66% in 2003–2010, respectively. Unbanded willow flycatchers with an undetermined residency status are included in calculating these percentages; therefore, in most cases, these numbers under-represent the actual proportion of resident banded flycatchers at a given site. Differences between study areas in the percentage of banded individuals are related to vegetation density and overall structure, which affect our ability to erect mist-nets in the habitat, and the percentage of adults that are residents. Topock Marsh typically has the lowest percentage of color-banded flycatchers because dense vegetation limits the number and size of possible net locations and because, particularly in recent years, the number of resident adults is low in comparison to the total number of flycatchers detected.

Prior to 2008, we banded all nestlings with a single anodized federal band, identifying the bird as a returning nestling in the event it was sighted in a subsequent year. The individual would then have to be recaptured to determine its individual identity and to apply a unique color combination so the bird could be individually identified via resighting. The rationale for banding nestlings with a single anodized band was that the majority of nestlings do not return in subsequent years, resulting in the loss of a large number of unique color combinations. To eliminate the need to recapture returning nestlings, in 2008–2011 we applied unique color combinations to all nestlings. The use of full color combinations on nestlings in 2008–2010 has greatly reduced the number of adults with single federal bands, with only three detected across all study areas in 2011. Banding nestlings with full color combinations also allows us to record juvenile dispersal movements that might otherwise go undetected.

Adult and Juvenile Between-Year Dispersal

Resident adults detected at Topock have historically shown very high site fidelity. Until 2010, when we documented between-year movement of an adult male from Topock to Warm Springs, no between-year movements of resident Topock adults to another study area had been detected. In 2011, two additional between-year movements of resident Topock adults to other study areas were documented. One was a

breeding female identified in Mormon Mesa who had last been identified in 2010 as a breeding female in Topock. The other was a breeding male from Muddy River who was last documented in 2010 as a resident, unpaired male in Topock. These two movements provide further evidence that individuals who do not return to Topock after being documented in a given year may be moving to other locations. When an individual is not identified in a given year, there is no way to distinguish between going undetected, mortality, or emigration from the study area. Documenting emigration allows for an estimation of emigration rates, thereby improving the accuracy of survival estimates. It is possible that there have been movements of resident, unbanded Topock adults to other monitored study areas, but there would be no way to detect these movements. Furthermore, the movement of the female to Mormon Mesa may also be indicative of the poor habitat conditions present in Topock in 2011. Females who breed successfully in a given year typically demonstrate high site fidelity the following year. This female successfully fledged two nestlings in 2010 and was not detected in Topock in 2011.

Adult and juvenile dispersal data for the 2011 field season show overall high site fidelity exhibited by adult flycatchers and lower natal site fidelity exhibited by juveniles, with juveniles dispersing among study areas. These dispersal data are consistent with the patterns observed in the LCR region from 1998 to 2011, over which period 90% of adult returns were to the same study area, while only 48% of all juvenile returns were to the natal study area (McKernan and Braden unpubl. data; McLeod et al. 2008a; McLeod and Koronkiewicz 2009, 2010; McLeod and Pellegrini 2011). These dispersal data are also consistent with range-wide data (Paxton et al. 2007), with adult flycatchers exhibiting high site fidelity to breeding areas. 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 three instances of willow flycatcher immigration from sites outside the Virgin/lower Colorado River region have been recorded since 1997 (McKernan and Braden unpubl. data, McLeod et al. 2008a), with two males originally banded as nestlings in 2003 at Roosevelt Lake recaptured in 2005 at Muddy River and Topock, and one male banded as a nestling in 1999 at Roosevelt Lake recaptured in 2002 in Grand Canyon. Although movements of this magnitude are infrequent, other instances of dispersal distances greater than 140 km have been reported for the Southwestern Willow Flycatcher (Paxton et al. 2007) and have been noted within the Virgin/lower Colorado River population (McLeod et al. 2008a, McLeod and Koronkiewicz 2010, McLeod and Pellegrini 2011). Banding studies at Roosevelt Lake and along the San Pedro River were discontinued after 2005, so immigration of juveniles produced in those areas after 2005 would have gone undetected.

The observed dispersal patterns fit well with the tenets of contemporary metapopulation theory (Hanski and Simberloff 1997), suggesting the 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 gene flow, with movements contributing 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). Dispersal by juveniles or adults is required for the colonization of new breeding sites, and long-distance movements will be required if newly established Reclamation habitat creation sites are to be colonized. The closest known breeding sites are at Bill Williams River NWR and Topock Marsh, approximately 75–150 km from the PVER and CVCA habitat creation sites (see Chapter 2). The habitat creation sites could also be colonized by individuals from more distant breeding areas, such as those along the Virgin River. Although such long-distance movements are relatively infrequent, two adult movements between the lower Colorado and the Virgin River were documented in 2011, and multiple instances of adult and juvenile dispersal between the Virgin River and Topock Marsh and Bill Williams River NWR have been documented in recent years (McLeod et al. 2008b; McLeod and Koronkiewicz 2009, 2010; McLeod and Pellegrini 2011). 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.

Within-year, Between Study Area Movement

Within-year, between study area movements typically occur at low rates in any given year. In 2003–2010, we detected between zero and four (median = 1.5) movements per year. In 2011, we documented the largest number of individuals (seven) moving between study areas within a given year. The increase in the number of documented movements may have been affected by the addition in 2011 of River Ranch to the monitored study areas. Movements to and from River Ranch accounted for four (57%) of the seven movements. One additional within-year movement, which would otherwise likely have gone undetected, was detected via passive netting. Thus, the detection of an unusually high number of within-year movements in 2011 is not necessarily indicative of there being more movements, but rather that we were better able to detect them.

The movement of three of the seven resident or paired adults at River Ranch to another study area is suggestive of poor habitat quality at River Ranch. In addition, eight of the nine individuals detected at River Ranch were known to be second-year individuals (age of the ninth individual was unknown). A high proportion of second-year birds could also be indicative of poor habitat quality. This pattern is seen in multiple species where the best habitat is typically occupied by older individuals, who may be more competitive or arrive sooner on the breeding grounds, leaving habitat of lesser quality for younger birds (Hill 1988, Holmes et al. 1996). Higher proportions of second-year birds also tend to be seen in young, newly developed habitat, such as that seen in the lower Grand Canyon in 2006–2008, possibly as a result of dispersal and colonization (McLeod et al. 2007, McLeod et al. 2008b, McLeod and Koronkiewicz 2009). However, the habitat at River Ranch has been established for several years (C. Tomlinson, NDOW, pers. comm.), and the high proportion of second-year birds is more likely due to habitat quality than stand age.

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. Fifty-seven percent of the adult, resident willow flycatchers identified in 2010 were detected again in 2011, while of the 87 juveniles banded in 2010, only 11 (13%) were identified in 2011. Thus, minimum estimated adult and juvenile survival from 2010 to 2011 at all monitored sites was 57 and 13%, 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. To provide more robust estimates of annual survival, demographic data acquired from 2003 to 2012 will be combined with data collected during 1997–2002. Survival and detection probabilities will be estimated using program MARK (White and Burnham 1999) and presented in a summary report in 2012.

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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 2011, 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), 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 2011 were compared with those at the study areas from 1996 to 2010 (Braden and McKernan unpubl. data; McLeod et al. 2008a; McLeod and Koronkiewicz 2009, 2010; McLeod and Pellegrini 2011). 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 a modification of the methods described by Rourke et al. (1999) and the Breeding Biology Research and Monitoring Database (BBIRD) protocol by Martin et al. (1997).

Nests were located primarily by observing adult flycatchers return to a nest or by systematically searching suspected nest sites. Nests were monitored every two to four days after nest building was complete and incubation was confirmed. Nests at NDOW study areas were monitored less frequently (every four days or more) because of budgetary restrictions. 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.

Per instructions from Reclamation biologists, 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. This method of determining success differs from that recommended by some nest monitoring protocols (e.g., Martin et al. 1997, Rourke et al. 1999), which consider a nest as successful if chicks are observed in the nest within two days of the estimated fledge date. The method we follow produces a conservative estimate of both nest success rate and number of fledges.

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) nestlings died in the nest despite being tended by the adults(nestlings died in nest); or (5) the entire clutch was incubated for an excess of 20 days (infertile/addled). For nests containing flycatcher eggs, parasitism was considered the cause of nest failure if (1) cowbird young outlived any flycatcher eggs or young, or (2) the 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 apparent nesting success (number of successful nests/total number of nests containing at least one flycatcher egg) and the Mayfield method (Mayfield 1961, 1975), which calculates daily nest survival to account for nests that failed before they were found. 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. For nests where fate was unknown, we used the last known date of activity to determine the number of observation days. To calculate Mayfield survival probabilities (MSP), we used the average length of each nest stage (2.14, 12.85, and 13.76 days for laying, incubation, and nestling stages, respectively) as observed in this study in 2003–2011 for nests where transition dates were known. Nest productivity was calculated as the number of young fledged per nesting attempt that produced at least one flycatcher egg. Fecundity was calculated as number of young produced per female over the breeding season. Parasitism rates were calculated as the percentage of nests with known contents that included at least one flycatcher egg and one cowbird egg.

In 2011, we attempted to addle cowbird eggs in easily accessible flycatcher nests at all study areas except Pahranagat. If the nest was accessible without a ladder, the cowbird egg was addled as soon as it was discovered. If a ladder was required, the cowbird egg was addled on the next regularly scheduled nest visit. Cowbird eggs were addled only if we could obtain a direct view of the nest contents from a secure location, either on the ground on or a ladder. We carefully removed the cowbird egg from the nest and placed it in a padded film canister. We then shook the canister vigorously for about one minute, incorporating sharp, jerky movements. The egg was then returned to the nest. The cowbird egg was not permanently removed from the nest so as not to mimic a partial depredation event, which might result in nest desertion. If a nest was found with a cowbird nestling already in the nest, or if a shaken cowbird egg still hatched, we removed the cowbird nestling from the nest.

All field personnel practiced egg addling with several button quail (*Coturnix chinensis*) eggs at the start of field season to determine how vigorously they could shake an egg without breaking it. Button quail eggs are slightly larger than cowbird eggs (19 x 25 mm vs. 16 x 21 mm) but provide a reasonable and easily available substitute. Shaken eggs were carefully opened to determine whether any damage to the internal structure of the egg was apparent. Field personnel varied in their ability to shake an egg to the point of causing internal damage without breaking the shell.

RESULTS

Reclamation Study Areas

Nest Monitoring

We documented 49 willow flycatcher nesting attempts at Pahranagat, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams; 43 of these nests were known to contain flycatcher eggs and were used in calculating nest success and productivity. Eighteen (42%) nests were successful and fledged young, and 23 (53%) failed. The fate of two nests (5%) was unknown. Nest success ranged from 0% at Topock Marsh to 100% at Pahranagat (Table 4.1). For a comparison of apparent nest success at all monitoring sites from 1997 to 2011, see Table 4.2.

Thirty-five nesting females, of which all but three were known to have produced at least one egg, were followed through all of their nesting attempts. One additional female was documented for which no nesting attempt could be confirmed. Of the 35 nesting females, 23 had one nesting attempt, 10 had two nesting attempts, and 2 had three nesting attempts. Of the 12 females with multiple nesting attempts, 9 renested after failed nests and 3 renested after a successful nest.

Table 4.1. Summary of Willow Flycatcher Nest Monitoring Results at Reclamation Study Areas, 2011

Study Area[1]	Site	Pairs	Nests	Nests with 1+ WE[2]	Successful Nests[3]	Failed Nests[3]	Nests with Unknown Fate	Parasitized Nests[4]
PAHR	North	6	7	7	7 (100)	0	0	0
	Total	*6*	*7*	*7*	*7 (100)*	*0*	*0*	*0*
MESQ	Hafen Lane	1	1	1	0	1 (100)	0	1 (100)
	West	6	8	6	2 (33)	4 (67)	0	1 (20)
	Total	*7*	*9*	*7*	*2 (29)*	*5 (71)*	*0*	*2 (33)*
MOME	Virgin River #1 North	2	1	1	0	1 (100)	0	0
	Virgin River #1 South	11	19	17	7 (41)	9 (53)	1 (6)	1 (7)
	Total	*13*	*20*	*18*	*7 (39)*	*10 (55)*	*1 (6)*	*1 (7)*
MUDD	Overton WMA	5	6	5	0	4 (80)	1 (20)	3 (60)
	Total	*5*	*6*	*5*	*0*	*4 (80)*	*1 (20)*	*3 (60)*
TOPO	Pipes #3	1	1	1	0	1	0	0
	Total	*1*	*1*	*1*	*0*	*1 (100)*	*0*	*0*
BIWI	Site #3	1	2	2	1 (50)	1 (50)	0	0
	Cougar Point	1	1	1	0	1 (100)	0	1 (100)
	Planet Ranch Rd	2	3	2	1 (50)	1 (50)	0	0
	Total	*4*	*6*	*5*	*2 (40)*	*3 (60)*	*0*	*1 (20)*
Overall Total		**36**	**49**	**43**	**18 (42)**	**23 (53)**	**2 (5)**	**7 (19)**

[1] PAHR = Pahranagat NWR, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams River NWR.

[2] WE = willow flycatcher egg.

[3] Only nests with at least one flycatcher egg were used in percentage calculations. Percentages are given in parentheses.

[4] Parasitized nests include all nests that contained at least one flycatcher egg and one cowbird egg, regardless of nest fate. Percentages include only nests with at least one flycatcher egg and for which contents could be determined.

Table 4.2. Willow Flycatcher Percent Apparent Nest Success Recorded at Reclamation Study Areas from 1996 to 2011*

Year	Pahranagat	Littlefield	Mesquite[1]	Mormon Mesa[2]	Muddy River	Grand Canyon	Topock	Bill Williams
1996	Nm[3]	Nm[3]	Nm[3]	Nm[3]	Nm[3]	Nc[5]	Nc[5]	Nm[3]
1997	Nm[3]	Nd[4]	67 (3)	42 (12)	Nc[5]	Nc[5]	Nc[5]	Nd[4]
1998	47 (19)	Nd[4]	0 (7)	70 (10)	Nm[3]	Nc[5]	53 (15)	Nd[4]
1999	60 (15)	Nm[3]	Nd[4]	45 (11)	Nm[3]	Nc[5]	38 (16)	100 (1)
2000	63 (16)	Nd[4]	50 (8)	38 (13)	100 (1)	Nc[5]	36 (11)	100 (1)
2001	50 (18)	Nd[4]	53 (17)	54 (13)	Nc[5]	Nc[5]	36 (14)	50 (4)
2002	33 (12)	Nd[4]	59 (17)	0 (9)	Nd[4]	Nd[4]	50 (6)	78 (9)
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[6]	45 (38)	Nd[4]
2005	58 (19)	Nd[4]	42 (12)	17 (6)	38 (8)	Nd[4]	24 (34)	100 (2)
2006	60 (15)	Nd[4]	55 (20)	50 (8)	44 (9)	0 (3)	23 (17)[7]	20 (5)
2007	67 (12)	Nd[4]	57 (14)	27 (11)	0 (6)	0 (1)	75 (8)	25 (8)
2008	80 (10)	Nd[4]	82 (11)	62 (13)	25 (8)	Nd[4]	13 (8)[8]	40 (5)[8]
2009	47 (17)[8]	0 (1)	21 (14)[8]	53 (17)	0 (8)	Nm[3]	50 (2)	33 (6)
2010	59 (17)	50 (2)	31 (13)	42 (12)	100 (3)	Nm[3]	50 (2)	18 (11)
2011	100 (7)	Nd[4]	29 (7)	39 (18)[8]	0 (5)[8]	Nm[3]	0 (1)	40 (5)

* Data from 1997 to 2002 are from Braden and McKernan (unpubl. data); these numbers have been verified with the raw data and may differ from those presented in earlier annual reports. Data from 2003 to 2007 are from McLeod et al. 2008a; data from 2008 are in McLeod and Koronkiewicz 2009; data from 2009 are in McLeod and Koronkiewicz 2010; data from 2010 are in McLeod and Pellegrini 2011, and data from 2011 are in this document. Total number of nests containing at least one flycatcher egg is indicated in parentheses.

[1] Study area includes the Hafen Lane, Mesquite East, Mesquite West, and Bunker Farm sites.

[2] Study area includes the Virgin River Delta at Lake Mead.

[3] Nm = study area not monitored.

[4] Nd = study area surveyed, no breeding documented.

[5] Nc = breeding confirmed, nest success not calculated.

[6] Bc = breeding confirmed, undetermined if nestlings from a single nest fledged.

[7] An additional three nests (18%) were suspected to have fledged but fledglings were not visually confirmed.

[8] Fate of one nest was unknown.

Nest Failure

Depredation was the major cause of nest failure, accounting for 52% (15 of 29) of all failed nests (Table 4.3) and 65% (15 of 23) of nests that failed after flycatcher eggs were laid. Six nesting attempts (21% of all failed nests) were abandoned prior to willow flycatcher eggs being laid, three nests (10%) were deserted, and three nests (10%) were incubated in excess of 20 days. Two nests (7%) failed because of Brown-headed Cowbird parasitism (see below for more details on parasitism).

Brood Parasitism

Seven of 37[1] nests (19%) with flycatcher eggs and known contents were brood parasitized by Brown-headed Cowbirds (Table 4.4). For nests containing flycatcher eggs, parasitism caused nest failure at two nests. In one case, the parasitism event coincided with the disappearance of all flycatcher eggs; in the other, the nest contained one cowbird nestling when it was found. No parasitized nests were known to

[1] Table 4.1 shows a total of 43 nests known to contain at least one flycatcher egg. When calculating brood parasitism rates, however, six nests whose contents could not be determined were excluded from calculations (e.g., nests that were too high to check contents to determine presence/absence of cowbird eggs or nesting attempts that were discovered late in the nesting cycle).

fledge a flycatcher, but the fate of one nest was unknown. Of the remaining four parasitized nests that contained flycatcher eggs, two were depredated and two contained addled flycatcher eggs. Brood parasitism ranged from 0 to 60% and was highest at Muddy River (see Table 4.1). In 2011, nests that contained flycatcher eggs and were brood parasitized were less likely to fledge flycatcher young than nests that were not parasitized (one-sided Fisher's exact test, $P = 0.038$).

Table 4.3. Summary of Causes of Willow Flycatcher Nest Failure at Reclamation Study Areas, 2011*

Study Area[1]	Total # Nests	All Failed Nests	Abandoned	Deserted	Depredated	Parasitized	Addled
PAHR	7	0	0	0	0	0	0
MESQ	9	7	2 (29)	0	4 (57)	0	1 (14)
MOME	20	12	2 (17)	3 (25)[2]	6 (50)	0	1 (8)
MUDD	6	5	1 (20)	0	2 (40)	1 (20)	1 (20)
TOPO	1	1	0	0	1 (100)	0	0
BIWI	6	4	1 (25)	0	2 (50)	1 (25)	0
Total	**49**	**29**	**6 (21)**	**3 (10)**	**15 (52)**	**2 (7)**	**3 (10)**

* 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 NWR, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams River NWR.

[2] One nest deserted after partial depredation, one deserted after 18 days incubation, one deserted during incubation with one flycatcher egg.

Table 4.4. Fates of Willow Flycatcher Nests Parasitized by Brown-headed Cowbirds, 2011*

Study Area[1]	Nest ID Code	Outcome[2]
MESQ	32A	Incubated >20 days. CE was addled and never hatched
	72B	Depredated during incubation
MOME	90A	Depredated during incubation
MUDD	3A	Fate unknown. One 14-day-old WN seen on nest rim, but fledging not confirmed. CE was addled and never hatched
	11A	3 WE disappeared and CE appeared 17 days into incubation
	18A	Incubated >20 days. CE was addled and never hatched
BIWI	33A	Nest found with one CN and no flycatcher nestlings or WE

* All nesting attempts are included.

[1] MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, BIWI = Bill Williams River NWR.

[2] WE = willow flycatcher egg, CE = cowbird egg, WN = willow flycatcher nestling, CN = cowbird nestling.

Cowbird Egg Addling

We attempted to addle cowbird eggs at three of the seven parasitized nests. Two of the remaining four nests were too high to reach; both these nests were depredated during incubation. One nest was found with a cowbird nestling and no other nest contents; the nestling was removed. At the seventh nest, the parasitism event caused nest failure. All three parasitized nests where we attempted to addle cowbird eggs were incubated long enough for any viable cowbird eggs to hatch, though none did (Table 4.5). The 2011 hatch rate of 0% is markedly lower than annual hatch rates of un-addled eggs in 2003–2009 (min = 60; max = 89; median = 75).

In 2011, only one of three parasitized nests that were incubated full-term hatched flycatcher nestlings (Table 4.6); the other two nests were incubated in excess of 20 days without any flycatcher eggs hatching. The fate of the parasitized nest that hatched a flycatcher nestling was unknown; we detected a 14-day-old flycatcher nestling on the nest rim but were unable to confirm that the nestling fledged. Success rates of parasitized nests that hatched at least one flycatcher nestling in 2003–2009 ranged from 44 to 100%. In parasitized nests that hatched flycatchers, the number of nestlings that survived to at least eight days old in 2011 (1.0/nest) was comparable to the numbers seen in 2003–2009 (min = 0.6; max = 1.5; median = 1.3).

Table 4.5. Brown-headed Cowbird Annual Hatch Rate in Willow Flycatcher Nests at Reclamation Study Areas from 2003 to 2011

Year	# Nests[1]	# CE	# CN	Hatch Rate
2003	4	4	3	75
2004	9	9	8	89
2005	9	9	7	78
2006	2	3	2	67
2007	6	8	6	75
2008	5	5	3	60
2009	8	8	5	63
2010[2]	4	4	1	25
2011[2]	3	3	0	0

[1] Total number of nests in which the cowbird egg hatched or was incubated full term (>10 days) are included.

[2] All cowbird eggs were addled at least once.

Table 4.6. Willow Flycatcher Nesting Success for Parasitized Nests at Reclamation Study Areas from 2003 to 2011

Year	# Nests[1]	# Nests with Flycatcher Nestlings[2]	# Nests with Flycatcher Fledges[3]	# Flycatcher Nestlings of Banding Age[4]	# Flycatcher Fledges[5]
2003	3	2 (67)	2 (100)	2 (1.0)	2 (1.0)
2004	10	9 (90)	4 (44)	5 (0.6)	5 (0.6)
2005	10	10 (100)	5 (50)	8 (0.8)	6 (0.6)
2006	4	4 (100)	2 (50)	6 (1.5)	3 (0.8)
2007	5	2 (40)	2 (100)	3 (1.5)	3 (1.5)
2008	5	4 (80)	3 (75)	5 (1.3)	3 (0.8)
2009	6	4 (67)	2 (50)	6 (1.5)	4 (1.0)
2010[6]	4	4 (100)	3 (75)	7 (1.8)	5 (1.3)
2011[6]	3	1 (33)[7]	--[8]	1 (1.0)	--

[1] Total number of parasitized nests in which flycatcher eggs hatched or were incubated long enough to hatch (>14 days).

[2] Total number of parasitized nests that hatched flycatcher nestlings. Percentage of total nests is indicated in parentheses.

[3] Total number of parasitized nests that produced flycatcher fledges. Percentage of nests with nestlings is indicated in parentheses.

[4] Total number of nestlings that reached at least banding age (8 days). Number of nestlings per nest with nestlings is indicated in parentheses.

[5] Total number of nestlings that fledged. Number of nestlings per parasitized nest with nestlings is indicated in parentheses.

[6] All cowbird eggs were addled in these nests.

[7] The eggs in the other two nests failed to hatch; both were incubated at least 20 days.

[8] The flycatcher nestling was last seen in the nest on day 14. It is unclear whether it successfully fledged.

Mayfield Nest Success and Nest Productivity

Mayfield survival probability (MSP) ranged from 0.198 at Mesquite to 1.000 at Pahranagat and was 0.467 for all sites combined (Table 4.7). At all sites, 40 nestlings were confirmed to have fledged from 41 nests of known outcome (mean number of fledglings/nest = 0.98, SE = 0.19). Fecundity across study areas ranged from 0.00 to 2.83 young per female and averaged 1.18 (SE = 0.25) (Table 4.8).

Table 4.7. Daily Survival Rates and Mayfield Survival Probabilities (MSP) for Willow Flycatcher Nest Stages at Reclamation Study Areas, 2011*

Study Area	Nest Stage[1]	Nest Losses/ Observation Days	Daily Survival Rate	Mayfield Survival Probability
Pahranagat	1	0/15	1.000	1.000
	2	0/77.5	1.000	1.000
	3	0/98	1.000	1.000
	MSP all stages = 1.000			
Mesquite	1	1/10	0.900	0.798
	2	2/63.5	0.969	0.663
	3	2/29	0.931	0.374
	MSP all stages = 0.198			
Mormon Mesa	1	0/22	1.000	1.000
	2	10/154.5	0.935	0.423
	3	0/98.5	1.000	1.000
	MSP all stages = 0.423			
Muddy River	1	0/10	1.000	1.000
	2	3/70	0.957	0.570
	3	1/24.5	0.959	0.564
	MSP all stages = 0.321			
Topock	1	0/0		
	2	1/1	0.000	0.000
	3	0/0		
	MSP all stages = N/A[2]			
Bill Williams	1	0/6	1.000	1.000
	2	2/42.5	0.953	0.538
	3	0/28.5	1.000	1.000
	MSP all stages = 0.538			
Total	**1**	**1/63**	**0.984**	**0.966**
	2	**18/409**	**0.956**	**0.561**
	3	**3/278.5**	**0.989**	**0.862**
	MSP all stages = 0.467			

[*] Mayfield survival probability was calculated using 2.14-day egg laying, 12.85-day incubation, and 13.76-day nestling stages.

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

[2] MSP cannot be calculated for all stages because of lack of data.

Table 4.8. Willow Flycatcher Nest Productivity (Young Fledged per Nest) and Fecundity (Young Fledged per Female) at Reclamation Study Areas, 2011*

Study Area	Young Fledged	# Nests	Productivity Mean (SE)	# Females	Fecundity Mean (SE)
Pahranagat	17	7	2.43 (0.30)	6	2.83 (0.31)
Mesquite	3	7	0.43 (0.30)	7	0.43 (0.30)
Mormon Mesa	16	16	0.94 (0.30)	12	1.33 (0.48)
Muddy River	0	4	0.00 (0.00)	4	0.00 (0.00)
Topock	0	1	0.00	1	0.00
Bill Williams	4	5	0.80 (0.58)	4	1.00 (0.71)
Total	**40**	**41**	**0.98 (0.19)**	**34**	**1.18 (0.25)**

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

NDOW Study Areas

Nest Monitoring

We documented 38 willow flycatcher nesting attempts at Key Pittman, River Ranch, and Warm Springs; 36 of these nests were known to contain flycatcher eggs and were used in calculating nest success and productivity. Fourteen (39%) nests were successful and fledged young, and 20 (56%) failed. Fate was unknown at two (5%) nests. Nest success was 42% at Key Pittman, 0% at River Ranch, and 100% at Warm Springs (Table 4.9).

Twenty-one nesting females, all of which were known to have produced at least one egg, were followed through all of their nesting attempts. One additional female was documented for which no nesting attempt was found. Of the 21 nesting females, 9 had one nesting attempt, 7 had two nesting attempts, and 5 had three nesting attempts. All 12 females with multiple nesting attempts renested after failed nests.

Table 4.9. Summary of Willow Flycatcher Nest Monitoring Results at NDOW Study Areas, 2011

Study Area[1]	Site	Pairs	Nests	Nests with 1+ WE[2]	Successful Nests[3]	Failed Nests[3]	Nests with Unknown Fate[3]	Parasitized Nests[4]
KEPI	Patch 0	1	1	1	0	0	1 (100)	0
	Patch 1	1	1	1	1 (100)	0	0	0
	Patch 2	1	2	2	1 (50)	1 (50)	0	0
	Patch 4	1	1	1	1 (100)	0	0	0
	Patch 5	1	2	2	1 (50)	1 (50)	0	0
	Patch 6	3	3	3	1 (33)	1 (33)	1 (33)	0
	Patch 7	1	2	2	1 (50)	1 (50)	0	0
	Patch 8	1	2	2	0	2 (100)	0	1 (50)
	Patch 9	2	3	3	1 (33)	2 (67)	0	0
	Patch 10	2	4	4	2 (50)	2 (50)	0	0
	Patch 11	2	6	5	2 (40)	3 (60)	0	0
	Patch 12	2	6	5	2 (40)	3 (60)	0	0
	Total	*18*	*33*	*31*	*13 (42)*	*16 (52)*	*2 (6)*	*1 (11)*

Table 4.9. Summary of Willow Flycatcher Nest Monitoring Results at NDOW Study Areas, 2011 (Continued)

Study Area[1]	Site	Pairs	Nests	Nests with 1+ WE[2]	Successful Nests[3]	Failed Nests[3]	Nests with Unknown Fate[3]	Parasitized Nests[4]
RIRA	East Side	1	3	3	0	3(100)	0	3 (100)
	West Side	1	1	1	0	1(100)	0	0
	Smalls	1	0	--	--	--	--	--
	Total	*3*	*4*	*4*	*0*	*4 (100)*	*0*	*3 (75)*
WMSP	Muddy Mac	1	1	1	1 (100)	0	0	0
	Total	*1*	*1*	*1*	*1 (100)*	*0*	*0*	*0*
Overall Total		**22**	**38**	**36**	**14 (39)**	**20 (56)**	**2 (5)**	**4 (12)**

[1] KEPI = Key Pittman WMA, RIRA = River Ranch, WMSP = Warm Springs Natural Area.

[2] WE = willow flycatcher egg.

[3] Only nests with at least one flycatcher egg were used in percentage calculations. Percentages are given in parentheses.

[4] Parasitized nests include all nests that contained at least one flycatcher egg and one cowbird egg, regardless of nest fate. Percentages include only nests with at least one flycatcher egg and for which contents could be determined.

Nest Failure

Depredation was the major cause of nest failure, accounting for 59% (13 of 22) of all failed nests (Table 4.10) and 65% (13 of 20) of nests that failed after flycatcher eggs were laid. Two nesting attempts (9% of all failed nests) were abandoned prior to willow flycatcher eggs being laid, and four nests (18%) were deserted. One nest (5%) failed because of Brown-headed Cowbird parasitism (see below for more details on parasitism), and all nestlings died in two nests (9%) that were still being tended by adult flycatchers.

Table 4.10. Summary of Causes of Willow Flycatcher Nest Failure at NDOW Study Areas, 2011*

Study Area[1]	Total # Nests	All Failed Nests	Abandoned	Deserted	Depredated	Parasitized	Addled	Nestling(s) died in nest
KEPI	33	18	2 (11)	3 (17)[2]	11 (61)	0	0	2 (11)
RIRA	4	4	0	1 (25)	2 (50)	1 (25)	0	0
WMSP	1	0	0	0	0	0	0	0
Total	**38**	**22**	**2 (9)**	**4 (18)**	**13 (59)**	**1 (5)**	**0**	**2 (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] KEPI = Key Pittman WMA, RIRA = River Ranch, WMSP = Warm Springs Natural Area.

[2] All nests deserted during incubation; structure of one nest damaged, possibly from a depredation attempt.

Brood Parasitism

Four of 34[2] nests (12%) with flycatcher eggs and known contents were brood parasitized by Brown-headed Cowbirds (Table 4.11). All four nests failed. In one case, the parasitism event coincided with the disappearance of any flycatcher eggs. In another, the parasitism event coincided with the disappearance of two of three flycatcher eggs, and the remaining flycatcher egg disappeared a few days later. The female

[2] Table 4.9 shows 36 nests known to contain at least one flycatcher egg. When calculating brood parasitism rates, however, two nests whose contents could not be determined were excluded from calculations (e.g., nesting attempts that were discovered late in the nesting cycle).

flycatcher continued to incubate the cowbird egg, which had been addled. One nest was deserted with two flycatcher eggs and a cowbird egg. In the remaining nest, the cowbird nestling was removed but the flycatcher nestling developed very slowly and eventually died in the nest. Brood parasitism was 11% at Key Pittman, 75% at River Ranch, and 0% at Warm Springs (see Table 4.9).

Table 4.11. Fates of Willow Flycatcher Nests Parasitized by Brown-headed Cowbirds in Key Pittman, River Ranch, and Warm Springs Study Areas, 2011*

Study Area[1]	Nest ID Code	Outcome[2]
KEPI	46B	CN removed shortly after hatching. WN developed very slowly and eventually died in the nest.
RIRA	110A	WE disappeared when CE appeared.
	110B	Nest deserted with two WE and one CE.
	110C	Two of three WE disappeared when CE appeared. Last WE disappeared a few days later.

* All nesting attempts are included.

[1] KEPI = Key Pittman WMA, RIRA = River Ranch.

[2] WE = willow flycatcher egg, CE = cowbird egg, WN = willow flycatcher nestling, CN = cowbird nestling.

Cowbird Egg Addling

Three nests at River Ranch were parasitized; one nest was too high to reach but was deserted during incubation, and the parasitism event caused failure at another nest. We addled the cowbird egg at the third nest at River Ranch. Partial depredation of this nest resulted in the loss of the remaining flycatcher egg; the female flycatcher continued to incubate the cowbird egg, which never hatched. We removed one cowbird nestling from a nest at Key Pittman that was found late in incubation. This nest also failed, with a lone flycatcher nestling developing very slowly and eventually dying in the nest.

Mayfield Nest Success and Productivity

Mayfield survival probability (MSP) was 0.447 at Key Pittman. MSP could not be calculated across all nest stages at River Ranch and Warm Springs because of lack of data for some stages. MSP was 0.375 for all three sites combined (Table 4.12). At all sites, 33 nestlings were confirmed to have fledged from 34 nests of known outcome (mean number of fledglings/nest = 0.97, SE = 0.22). Fecundity across study areas ranged from 0 to 3.0 young per female and averaged 1.65 (SE = 0.28) (Table 4.13).

Table 4.12. Daily Survival Rates and Mayfield Survival Probabilities (MSP) for Willow Flycatcher Nest Stages NDOW Study Areas, 2011*

Study Area	Nest Stage[1]	Nest Losses/ Observation Days	Daily Survival Rate	Mayfield Survival Probability
Key Pittman	1	1/42	0.976	0.950
	2	12/277	0.957	0.566
	3	3/224	0.987	0.831
	MSP all stages = 0.447			
River Ranch	1	2/5	0.600	0.335
	2	2/13.5	0.852	0.127
	3	0/0		
	MSP all stages = N/A[2]			

Table 4.12. Daily Survival Rates and Mayfield Survival Probabilities (MSP) for Willow Flycatcher Nest Stages NDOW Study Areas, 2011* (Continued)

Study Area	Nest Stage[1]	Nest Losses/ Observation Days	Daily Survival Rate	Mayfield Survival Probability
Warm Springs	1	0/0		
	2	0/13	1.000	1.000
	3	1/14	1.000	1.000
	MSP all stages = N/A[2]			
Total	**1**	**3/47**	**0.936**	**0.868**
	2	**14/303.5**	**0.954**	**0.545**
	3	**4/238**	**0.983**	**0.792**
	MSP all stages = 0.375			

* Mayfield survival probability was calculated using 2.14-day egg laying, 12.85-day incubation, and 13.76-day nestling stages.

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

[2] MSP cannot be calculated for all stages because of lack of data.

Table 4.13. Willow Flycatcher Nest Productivity (Young Fledged per Nest) and Fecundity (Young Fledged per Female) at NDOW Study Areas, 2011*

Study Area	Young Fledged	# Nests	Productivity Mean (SE)	# Females	Fecundity Mean (SE)
Key Pittman	30	29	1.03 (0.24)	16	1.88 (0.29)
River Ranch	0	4	0.00 (0.00)	3	0.00 (0.00)
Warm Springs	3	1	3.00	1	3.00
Total	**33**	**34**	**0.97 (0.22)**	**20**	**1.65 (0.28)**

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

DISCUSSION

Reclamation Study Areas

Number of Breeding Flycatchers

In 2011, willow flycatcher nesting was documented at six Reclamation study areas (Pahranagat, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams). No flycatchers were documented at Littlefield, which held breeding flycatchers in 2009 and 2010 but was scoured by floods in December 2010. 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. The number of flycatcher pairs recorded at Mormon Mesa, Muddy River, and Bill Williams was comparable to that recorded over the last several years. Mesquite had seven pairs in both 2011 and 2010, which was a drop from the number of pairs recorded in the previous four years (range 11–15). The main breeding site at Mesquite was dry in 2009 and nesting success was poor that year (McLeod and Koronkiewicz 2010). Flycatchers appeared to respond to the poor conditions by returning to other breeding sites in 2010 rather than returning to Mesquite (McLeod and Pellegrini 2011), and the number of breeding flycatchers at Mesquite was consequently reduced. It is unclear why the number of breeding pairs at Mesquite remained low in 2011 despite wet conditions at Mesquite West (see Chapter 2) at the beginning of the breeding season. It is possible that habitat suitability in the western portion of

Mesquite West, which is a mix of tamarisk and coyote willow and was unoccupied in 2011, has been reduced by tamarisk beetle defoliation.

Pahranagat had six breeding pairs in 2011, the lowest number recorded since 2003 (range 8–15 pairs). Monitoring in future years will help determine whether this is a temporary decline at Pahranagat or whether the amount of suitable habitat could be decreasing because of the reduced amount of surface water at the site in 2008–2011(see Chapter 2). There is evidence that the spatial distribution of nests within the main breeding site at Pahranagat has shifted over the years, moving away from the interior of the site, which was formerly inundated, and toward the periphery of the site, which is still in close proximity to surface water (NAU, unpubl. data).

Topock Marsh had five resident flycatchers, consisting of three unpaired males and one pair, the lowest number of resident individuals recorded since monitoring began in 1998. The number of resident flycatchers at Topock has been declining steadily since 2004. Water levels were exceptionally low in 2011 (see Chapter 2), which may have contributed to the continuing decline.

Nest Success

Nest success alone is an incomplete measure of the production of young. Successful nests produce from one to four young, and variations in nest productivity are not reflected in nest success rates. In addition, although every failed nest attempt lowers percent nest success and MSP, success of a subsequent nesting attempt may result in the same number of young produced as if the initial nesting attempt had been successful. Thus, nest productivity (young produced per nesting attempt) and fecundity (young produced per female) in conjunction with nest success provide additional information on the success of a given breeding season. Nest success at Pahranagat (100%) was, as it has been every year since 2003, higher than the average for all study areas. Productivity (2.43 young per nest) and fecundity (2.83 young per female) at Pahranagat in 2011 were also the highest recorded at any Reclamation study area, demonstrating that Pahranagat continues to be a highly productive site for willow flycatchers.

Percent nest success was essentially unchanged at Mesquite compared to 2010, but fecundity in 2011 (0.43) was less than half that of 2010 (1.00), and only three fledglings were produced. Fecundity was also low in 2009 (0.25). The main breeding site at Mesquite was dry during much of the breeding season in 2009 and after mid-June 2011, and dry conditions may be related to poor flycatcher reproduction (Moore and Ahlers 2008). Percent nest success, productivity, and fecundity at Mormon Mesa were all similar to what they had been in 2010. Muddy River, Topock, and Bill Williams continued to exhibit annual fluctuations in reproductive metrics, but sample sizes are too low to attribute much significance to the rates observed in 2011. 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 demonstrate the need for long-term data.

Nest Failure

As in 2003–2010, depredation was the major cause of willow flycatcher nest failure, accounting for 52% of all failed nests in 2011. These results are consistent with those reported at the Reclamation study areas from 1998 to 2002 (Braden and McKernan unpubl. data) and at sites across Arizona from 1996 to 2008 (Graber et al. 2007, Ellis et al. 2008, Graber and Koronkiewicz 2009a), 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 monitored study areas are inherently complex and at this time remain undetermined. For open-cup nesting passerines, nest depredation rates can vary year to year, and sometimes substantially, with depredation of eggs and young ultimately linked to landscape

characteristics and fluctuations in predator densities, abundance, and richness (Wiens 1989b, Robinson 1992, Howlett and Stutchbury 1996).

In 2008, Northern Arizona University (NAU) initiated a nest camera study in cooperation with SWCA on open-cup nesting passerines at selected study areas along the lower Colorado River and tributaries. The study used video and still cameras on real and artificial nests to identify depredation rates and nest predators. The study continued in 2009 and 2010, with video cameras deployed at flycatcher nests and still cameras at artificial nests. Marks on clay eggs indicated that most depredation events at Mesquite were from birds, while at Pahranagat both birds and rodents depredated artificial nests (NAU unpubl. data). Both Brown-headed Cowbirds and Yellow-breasted Chats were identified by still cameras as depredating artificial nests. Cowbirds were also documented on video depredating flycatcher nests at Mesquite in both 2009 and 2010. A variety of avian predators were documented depredating flycatcher nests at Pahranagat. The study was continued in 2011, with video cameras deployed at real flycatcher nests at Pahranagat, but all flycatcher nests were successful and no depredation events were documented. Results of this study suggest that avian species may be important predators on flycatcher nests at Reclamation study areas. Ellis et al. (2008) also identified Cooper's Hawks (*Accipiter cooperii*) and Yellow-breasted Chats depredating flycatcher nests at sites in Arizona.

Brood Parasitism

Brood parasitism by Brown-headed Cowbirds across all Reclamation study areas ranged from 0 to 60% and averaged 19% (see Table 4.1). These results are consistent with those reported at the study areas from 1998 to 2010 (Braden and McKernan unpubl. Data; McLeod et al. 2008a; McLeod and Koronkiewicz 2009, 2010; McLeod and Pellegrini 2011), but these parasitism rates are higher than those reported at other monitored sites across Arizona in 1996–2006, which were less than 10% at most sites in most years (Graber et al. 2007, Ellis et al. 2008).

We observed multiple occasions in which the disappearance of flycatcher eggs coincided with the parasitism event. In this case, 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). In addition, cowbirds were photographed removing eggs from artificial nests during the 2008–2010 camera study, and cowbirds were documented on video depredating flycatcher nests during both the incubation and nestling phases. Therefore, it is likely that other depredation events on eggs and nestlings are attributable to cowbirds.

Parasitism does not invariably cause nest failure, but the success rate (18%) for parasitized nests at all study areas in 2003–2011 was less than half that of unparasitized nests (49%). Similar results were recorded for willow flycatchers in Oregon, with parasitism resulting in a 50% decrease in success rates compared to unparasitized nests (Sedgwick and Iko 1999) and at other sites in Arizona, where in 1996–2005, 20% of parasitized nests fledged flycatcher young vs. 57% of unparasitized nests (Ellis et al. 2008). Parasitized nests that did succeed in fledging flycatcher young at all study areas in 2003–2011 produced on average fewer young (1.3 young/nest) than did unparasitized nests (2.2 young/nest; $F_{1,249} = 21.24$, $P < 0.001$). Cowbirds may eject flycatcher eggs during the parasitism event, thus reducing clutch size, and cowbird young also cause interspecific nestling competition, as evidenced by the presence of severely underdeveloped nestlings in some parasitized nests. For all nests monitored from 2003 to 2011, 44% of nests that fledged a cowbird also fledged flycatcher young. This is a higher rate of success than that observed in Southwestern Willow Flycatchers at Kern River, California (9%; Whitfield and Sogge 1999), but comparable to that observed at other Arizona sites (40%; Ellis et al. 2008).

Female flycatchers may desert their nests after parasitism events and thus expend energy renesting and laying additional eggs. Given that adult flycatchers exhibit high site fidelity to breeding areas (Braden and McKernan unpubl. data, McLeod et al. 2008a, McLeod and Koronkiewicz 2009, this document) and renest most often after failed nests (Sedgwick 2000), females returning to sites with high brood parasitism may have reduced lifetime fecundity because they are expending energy on multiple failed nesting attempts over many years. An analysis of lifetime fecundity of females will be included in the summary report in 2012. 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 (Paxton et al. 2007, McLeod et al. 2008a), suggesting additional hidden effects of parasitism and subsequent renesting on flycatcher demography.

Cowbird trapping and removal studies were initiated at Pahranagat, Mesquite, and Topock Marsh in 2003 and continued through 2007. Results of these studies showed that cowbird trapping appeared to lower parasitism rates in comparison to the pre-trapping period of 1998–2002 only at Pahranagat, with no parasitism detected during trapping years (McLeod et al. 2008a). No cowbird trapping was completed in 2008–2011, but even in the absence of cowbird trapping, no parasitism events were detected at Pahranagat in 2008, 2009, or 2011. One parasitism event was noted in 2010, and the nest was abandoned before flycatcher eggs were laid. This nest was located on the very edge of the site, adjacent to open, upland habitat, possibly increasing parasitism probability. These observations suggest that cowbird trapping may have lingering effects beyond the years in which trapping is completed.

We speculated that trapping might have affected the parasitism rate at Pahranagat but not the other study areas because Pahranagat consists of relatively small, isolated patches of riparian habitat rather than existing in a large, contiguous riparian corridor. The breeding site at Muddy River is a relatively small stand of tall trees and is bordered to the north by an extensive valley dominated by residential areas and agriculture and containing little riparian vegetation. Muddy River had 33–75% parasitism in six of the seven years when flycatchers have been monitored at the study area, and overall nest success was 26%, well below the average of 46% across all other study areas in those years. Although the breeding site at Muddy River is not as isolated from surrounding riparian vegetation as the site at Pahranagat, cowbird trapping at Muddy River has the possibility of reducing the parasitism rate and increasing flycatcher nest success, and we recommend that cowbird trapping be instituted at Muddy River.

Cowbird Egg Addling

We addled cowbird eggs and removed cowbird nestlings in all study areas except Pahranagat in 2011. Pahranagat was not included because it is still part of the 5-year post-cowbird-trapping experiment. Though sample size is small, addling cowbird eggs seemed to reduce the hatch rate of cowbird eggs. Furthermore, none of the females deserted their nests after we addled cowbird eggs. One female in a non-Reclamation study area from whose nest a cowbird nestling was removed also continued to raise the remaining flycatcher nestling. While flycatcher hatch rates and productivity were not improved by the program in 2011, this is not necessarily due to the program itself so much as low parasitism rates and high rates of nest failure due to addling where parasitism did occur. We recommend this program be continued in the future. Field personnel should also continue to practice egg addling at the beginning of the season with button quail eggs to maximize the effectiveness of shaking eggs in preventing hatching.

NDOW Study Areas

At Warm Springs, a fire during the breeding season of 2010 affected all sites and reduced the availability of suitable habitat (see Chapter 2), and the number of breeding pairs declined correspondingly from three to one in 2010 and 2011, respectively. Many measures of nesting (number of breeding pairs, Mayfield nest success, and rate of brood parasitism) were similar at Key Pittman between 2010 and 2011.

Productivity and fecundity were lower in 2011 (1.03 and 1.88, respectively) than in 2010 (1.23 and 2.03, respectively), but there was no statistically significant difference in either fecundity or productivity between years.

Cowbird parasitism was high (75%) at River Ranch, and none of the four nests at this site was successful. Low nest success is further indication of poor habitat quality at River Ranch (see Chapter 3 for a discussion of within-year movement and the presence of second-year individuals at River Ranch).

Video cameras were deployed on flycatcher nests in both 2010 and 2011 at Key Pittman. Two depredation events were recorded on video in 2011 (NAU unpubl. data), one by a kingsnake (*Lampropeltis getulus*) and the other by a Sharp-shinned Hawk (*Accipiter striatus*). Field personnel also witnessed a depredation event by a short-tailed weasel (*Mustela frenata*).

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Chapter 5

VEGETATION AND HABITAT CHARACTERISTICS

INTRODUCTION

Our objective for vegetation sampling is to provide a quantitative summary of the floristic and structural conditions within occupied territories in various vegetation types. These descriptive summaries will provide guidance for managers working to restore and create riparian habitat to meet the obligations of the LCR MSCP and will provide a means to evaluate habitats to determine if they resemble occupied flycatcher territories. The Pahranagat study area was excluded from the characterization of occupied territories because the vegetation consists primarily of very large and widely spaces trees, and these characteristics are unique to the site and not likely to be replicated in restoration areas. In 2011, we completed vegetation sampling within occupied territories only at Bill Williams because of the relatively low sample size of vegetation plots obtained at this study area over previous years. Sampling at all other study areas was discontinued because of adequate sample sizes from previous years. A combined analysis of all years of vegetation data will be presented in a summary report in 2012.

METHODS

We described and measured vegetation and habitat features following a modification of the methods of James and Shugart (1970). Vegetation characteristics were measured within a 5-m-radius circle. To avoid disrupting flycatcher breeding activities, we measured vegetation late in the summer when the nest, territory, and adjacent flycatcher territories were inactive.

In 2008, we measured vegetation and habitat characteristics at one plot for each resident (i.e., detected for at least one week) male flycatcher we identified, regardless of whether or not he obtained a mate. Plot center locations were determined as soon as territories were identified. We estimated the center of the male's activity by observing his use of singing perches and selecting a location that was approximately equidistant from the perches at the perimeter of his use area. We then proceeded in a randomly selected compass direction for a randomly selected distance between 0 and 20 m. We used additional random numbers to select the exact location in which to hang a temperature/humidity data logger (see Chapter 6) and used that location as plot center. This process resulted in the random selection of a point that was still within the male's territory. The sampling points were marked in the field with flagging that remained in place over the winter.

In 2009, we identified the territory center for each resident male as described above. If an existing sampling point from 2008 was within 20 m of the territory center identified in 2009, we assigned that existing point to the current territory. If there was no existing point within 20 m of the territory center, we located a new sampling point as described above. All sampling points that were assigned to active territories in 2009 were marked with flagging that remained in the field over the winter. We repeated this point selection procedure for territories that were active in 2010 and 2011, assigning a sampling point that was used in the previous year if one was within 20 m of the current territory and selecting a new sampling point if no existing point were available. Sampling points that were identified in 2010 but were not within 20 m of a territory center in 2011 were resampled in 2011.

At each plot, we laid out four 5-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 plot center and at 1 m and 5 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 summed 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 8.0 m, we estimated the number of hits as zero, greater than five, or less than five hits per 1-m interval until the canopy vegetation stopped (modified from Rotenberry 1985).

We measured total 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 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 estimated percent woody ground cover, alive and dead, within 0.5 m of the ground 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 stems for each species within 5 m of the center of the plot. Stems were tallied if they were at least 1.4-m tall and >2.5 cm in diameter at 10 cm above the ground. Stems were tallied by the following diameter at breast height (dbh) categories: <1 cm, 1–2.5 cm, 2.6–5.5 cm, 5.6–8 cm, 8.1–10.5 cm, and 10.6–15 cm. Any stems >15 cm dbh were measured and the exact dbh was recorded. Dead stems were also tallied in these categories, but not identified to species. We marked each stem with a piece of chalk after it was tallied to facilitate accurate stem counts.

During vegetation sampling in 2003–2007, if a stem branched above 10 cm but below 1.4 m above the ground, only the largest stem was tallied. In habitats (e.g., tamarisk) where stems frequently branch in this height interval, this method of counting stems may underestimate the density of stems that form an important part of the habitat structure. Therefore, in 2008–2011 we tallied stems as we had in previous years and then for each stem that branched between 10 cm and 1.4 m from the ground, we tallied the number of additional stems that were at least 2.5 cm in diameter at 10 cm above the point where it branched from the main stem.

Additional information recorded at each plot included the date when the measurements were taken, observer initials, and UTM coordinates for each plot center.

Data Analyses

We used high-resolution aerial photography and field knowledge of each study area to delineate clusters of territories that occur within habitat patches of similar floristics and canopy height. Vegetation characteristics were then summarized for each habitat type. For each habitat type, we give the corresponding vegetation classification as defined in Younker and Andersen (1986) and used in the LCR MSCP. We also pooled data across habitat types that fell under a single vegetation classification and present summary statistics for each vegetation classification. We used SPSS® Version 16.0 (SPSS Inc.) software for statistical analyses.

Stem counts were grouped into the following size categories for analysis: ≤2.5 cm dbh, 2.6–8 cm dbh, and >8 cm dbh. For each size category, stem counts are reported separately for live and dead stems; the sum of these is the equivalent of the stem counts per size category that were reported in the 2003–2007 summary report (McLeod et al. 2008a). Vertical foliage density measurements above 8.0 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. Vertical foliage density was calculated for each meter interval as the mean of the number of hits recorded within the interval at the nine locations in the plot.

In 2003–2007, we had measured vertical foliage density only at plot center and 1 m from plot center in each cardinal direction, and foliage density measures per meter interval were presented as the sum of the hits recorded at the five locations in the plot. Thus, vertical foliage data presented in reports from 2003 to 2007 should be divided by 5 to be comparable to data presented here. In the five-year summary report (McLeod et al. 2008a), vertical foliage data were grouped into three categories of above, at, and below the nest. We used average nest height as measured in 2003–2011 in each vegetation type to demarcate vertical foliage categories in 2011. As with stem counts, vertical foliage data are reported separately for live and dead vegetation.

Percent native vegetation was calculated as the average of the percent basal area that was native and the percent native vertical foliage hits. To obtain basal area, we multiplied the number of stems tallied in each size class by the average basal area of a stem in that class, given an even distribution of stems within each size class. For data collected in 2003–2007 (reported in McLeod et al. 2008a), we did not use vertical foliage data to calculate percent native because all vertical foliage data were collected within 1 m of plot center and represented only a small portion of the plot. We included vertical foliage data in the percent native calculations in 2008–2011 to account for the influence of stems that were too small to be tallied or were rooted outside the 5-m-radius circle but overhung the plot.

RESULTS

We measured vegetation at Bill Williams at four occupied territories and four territories that were occupied in 2010 but not in 2011. The eight territories are located in five survey sites at Bill Williams: Site #3, Site #4, Burn Edge, Planet Ranch Road, and Cougar Point. Of the four occupied territories, three had nesting flycatchers and one was occupied by an unpaired male. Small sample sizes preclude any comparison between territories occupied by nesting pairs versus those occupied by unpaired males; data collected in 2011 will be combined with data collected in previous years for this comparison, which will be presented in a five-year summary report in 2012. Data from territories that were occupied in 2010 but not in 2011 are not included in the 2011 data presented below but may be used in future analyses to identify any changes in vegetation that may lead to territory abandonment. This analysis would also be presented in the summary report.

We delineated the following habitat types: 1) Goodding willow with tamarisk understory, and 2) cottonwood/willow. Goodding willow with tamarisk understory occurred in Site #3, Site #4, and Burn Edge, while cottonwood/willow was present at Planet Ranch Road and Cougar Point. Average nest height recorded in 2003–2011 and used to assign vertical foliage strata for each vegetation category were 4.2 m for Goodding willow with tamarisk understory and 2.5 m for cottonwood/willow.

Although the vegetation types delineated in this report differ from one another in vertical structure and floristic composition, all fall within the definition of cottonwood-willow habitat (cottonwoods and willows constituting at least 10% of total trees) as described in Younker and Anderson (1986) and used in the LCR MSCP. The cottonwood/willow habitat type as delineated in this report falls under the definition of cottonwood-willow Type III (no understory, with the canopy layer from 4.5–6.0 m), while Goodding willow with tamarisk understory as delineated in this report falls under the definition of cottonwood-willow Type I (three definitive layers of vegetation with the majority of the vegetation volume at 6.0 m or more).

Vegetation characteristics of each habitat type are summarized in Table 5.1. Habitat characteristics varied between and within habitat types.

Table 5.1. Summary of Vegetation Characteristics at Occupied Southwestern Willow Flycatcher Territories in Varying Habitat Types, Lower Colorado River and Tributaries, 2011*

Parameter	SAGO with TASP understory (C-W Type I) (n=2)	POFR and SAGO (C-W Type III) (n=2)
Average canopy height (m)	6.3 (0.5)	7.4 (0.7)
	5.8–6.8	6.7–8.0
% total canopy closure	90.9 (3.9)	97.4 (1.6)
	87.0–94.8	95.8–99.0
% woody ground cover	33.9 (21.4)	37.1 (31.6)
	12.5–55.3	5.5–68.8
# live stems ≤2.5 cm dbh per ha	1846 (1210)	1210 (1210)
	637–3056	0–2419
# live stems 2.6–8 cm dbh per ha	3183 (764)	9486 (446)
	2419–3947	9040–9931
# live stems >8 cm dbh per ha	573 (318)	1210 (64)
	255–891	1146–1273
# dead stems ≤2.5 cm dbh per ha	446 (191)	1337 (955)
	255–891	382–2292
# dead stems 2.6–8 cm dbh per ha	827 (191)	764 (255)
	637–1019	509–1019
# dead stems >8 cm dbh per ha	64 (64)	0 (0)
	0–127	0–0
Percent native	1.7 (1.2)	99.1 (0.6)
	0.4–2.9	98.8–100.0
Live vertical foliage (hits) below average nest height	6.3 (0.4)	1.9 (1.1)
	5.9–6.7	0.8–3.0
Live vertical foliage (hits) at average nest height	2.7 (0.0)	3.9 (1.9)
	2.7–2.7	2.0–5.8
Live vertical foliage (hits) above average nest height	2.2 (0.8)	13.7 (2.4)
	1.4–3.0	11.2–16.1
Dead vertical foliage (hits) below average nest height	12.7 (1.8)	3.4 (2.7)
	10.9–14.4	0.8–6.1
Dead vertical foliage (hits) at average nest height	0.6 (0.4)	1.8 (1.7)
	0.1–1.0	0.1–3.6
Dead vertical foliage (hits) above average nest height	0.2 (0.2)	1.0 (1.0)
	0–0.4	0–2

* Data are presented as mean, standard error, and range. Stem counts include only the largest stem of any cluster that branched above 10 cm above the ground. SAGO = Goodding willow, TASP = tamarisk, POFR = cottonwood, C-W = cottonwood-willow.

The proportion of stems omitted from stem counts by counting only the largest stem of a cluster that branched between 10 cm and 1.4 m above the ground varied both by size and species of the main stem (Table 5.2). Larger stems typically had more branches that were omitted.

Vertical foliage profiles for each habitat type are shown in Figures 5.1–5.2. Average nest height in each habitat type, as recorded in 2003–2011, is also shown on each graph. In both habitat types, the proportion of dead vegetation in the vertical profile was highest immediately above the ground and declined with increasing height. The densest live foliage occurred 3–5 m above the ground, at or above average nest height.

Table 5.2. Proportion of Stems Omitted from Stem Counts

Size category[1]	Species			
	Tamarisk	Coyote willow	Goodding willow	Dead stems
≤2.5 cm dbh	0.12	--	0.0	0.05
2.6–8 cm dbh	0.67	--	0.0	0.52
>8 cm dbh	1.46	--	0.0	2.0

[1] Size category indicates the size of the main stem that was tallied. All stems that were omitted from the stem count are equal to or smaller than the size of the main stem.

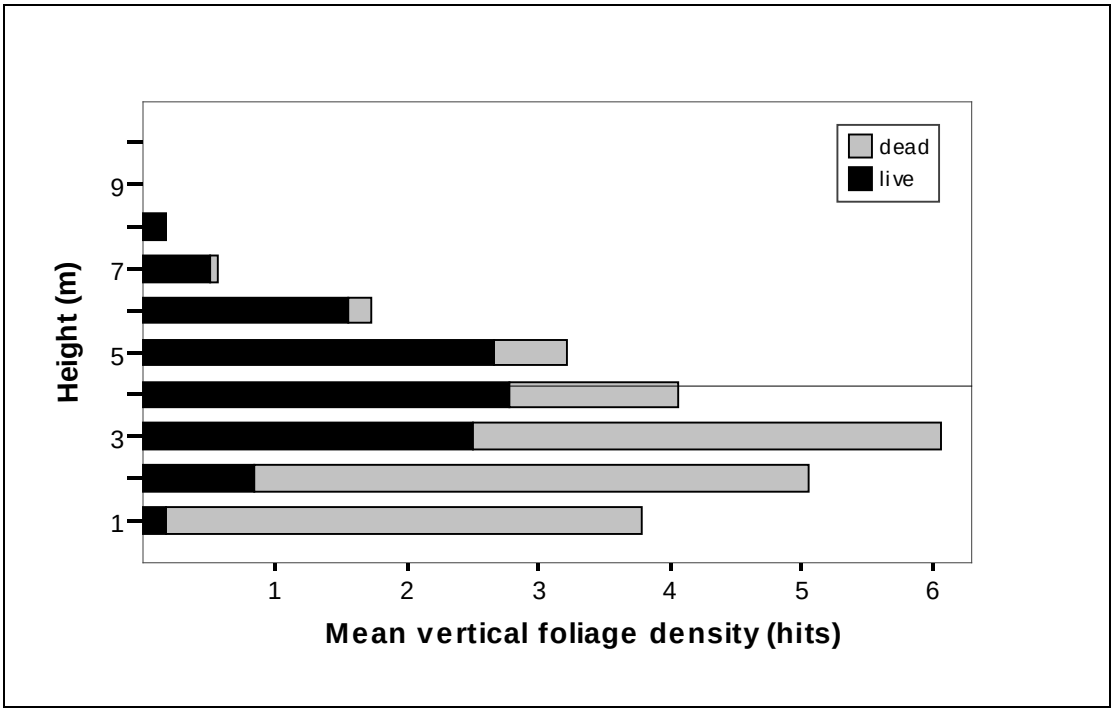

Figure 5.1. Vertical foliage density at occupied willow flycatcher territories in Goodding willow with tamarisk understory habitat type, 2011. Horizontal line shows average nest height in this habitat type in 2003–2011. This habitat type is also cottonwood-willow Type I.

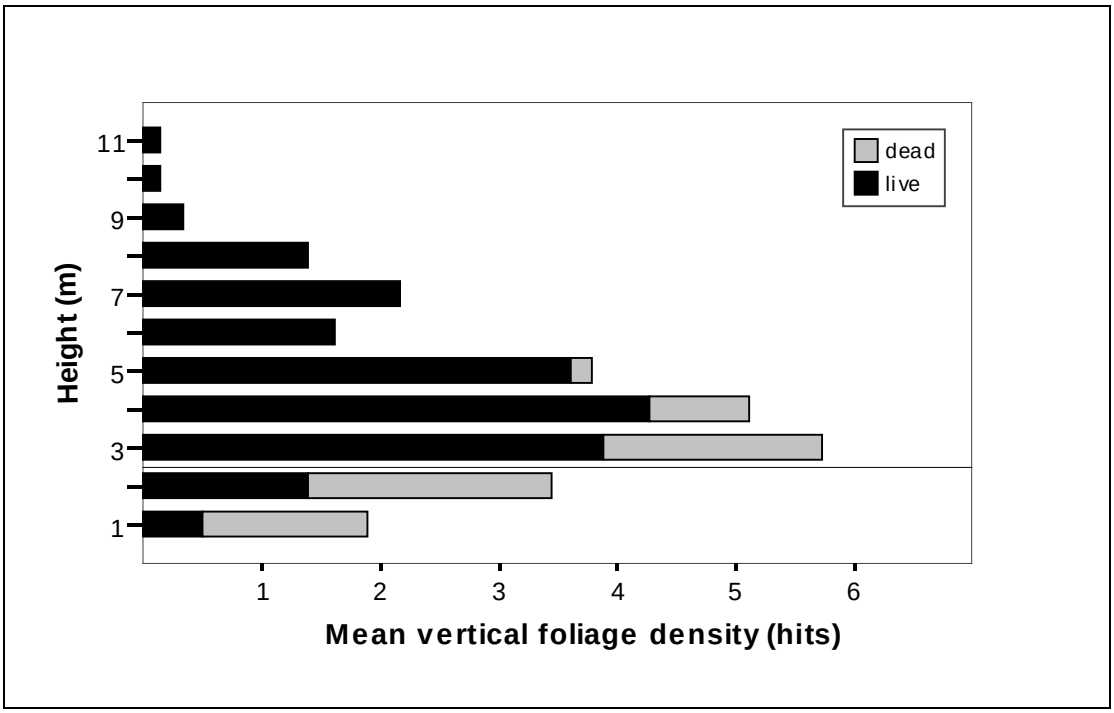

Figure 5.2. Vertical foliage density at occupied willow flycatcher territories in cottonwood/willow habitat type, 2011. Horizontal line shows average nest height in this habitat type in 2010–2011. This habitat type is also cottonwood-willow Type III.

DISCUSSION

The purpose of vegetation measurements of occupied habitat is to provide quantitative guidelines for restoration efforts. The limited data collected in 2011 preclude any meaningful summary of habitat characteristics and any comparison between vegetation types. In a summary report to be completed in 2012, data from 2011 will be combined with other data collected within active territories in prior years to provide a more comprehensive description of each habitat type.

Chapter 6

MICROCLIMATE

INTRODUCTION

Our objective for microclimate sampling is to provide a quantitative summary of microclimate conditions within occupied territories in various vegetation types. These descriptive summaries will provide guidance for managers working to restore and create riparian habitat to meet the obligations of the LCR MSCP and will provide a means to evaluate habitats to determine if the microclimate resembles that in occupied flycatcher territories. The Pahranagat study area was excluded from the characterization of occupied territories because the study area is approximately 650 m higher in elevation and experiences a cooler climate than the LCR MSCP planning area. In 2011, we collected microclimate data only at Bill Williams; adequate sample sizes had been achieved at all other study areas in previous years.

METHODS

Temperature and Humidity Measurements

Measurements of temperature and humidity were recorded automatically every 15 minutes using a HOBO H8 Pro (Onset Computer Corporation, Pocasset, MA) that combines a thermometer (degrees Celsius), humidity monitor, and digital data logger. We camouflaged all HOBO units by placing them in an inverted small, plastic container coated with spray adhesive and local vegetation. The opening at the bottom was covered with shadecloth, allowing free air circulation around the unit.

In 2010, we collected microclimate measurements at one location for each resident male flycatcher we identified, regardless of the length of time the male was resident and whether or not he obtained a mate. One HOBO unit was placed within each active flycatcher territory. We estimated the center of the male's territory (see Chapter 5) and then determined the location of the HOBO unit by means of the following instructions and the use of random number sequences:

1) The compass direction to walk from the territory center, given in degrees from north, was determined from a random number sequence.
2) The distance (between 0 and 20 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 data logger placement.
3) The HOBO unit was placed at a randomly selected height within the range of flycatcher nest heights documented at that study area in 2003–2007 (McLeod et al. 2008a). The distribution of random numbers followed the distribution of nest heights. If the chosen tree or shrub was of insufficient height to accept the height from the random number sequence, then field personnel placed the HOBO unit at the first height in the sequence that was less than the height of the tree or shrub. If no nests had been previously recorded at that study area, field personnel used the height sequences from the nearest study area with known nests.
4) The distance (0–2 m) at which the HOBO 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 unit at the first number in the sequence that was less than the radius of the tree or shrub.

5) The compass direction, given in degrees from north, at which the unit 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 data logger at the height and distance specified in (3) and (4), field personnel proceeded clockwise around the tree or shrub until a suitable branch was located.

If, as presented in (3) and (4), 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 territory center and used the next sequence of random numbers.

The HOBO logger locations representing active territories in 2010 at Bill Williams were marked in the field with flagging, which remained in place over the 2010–2011 winter. HOBO loggers were redeployed in these same locations in early May 2011. During the breeding season of 2011, we identified the territory center for each resident male. If an existing sampling point was within 20 m of the territory center identified in 2010, we assigned that existing point to the current territory. If there was no existing point within 20 m of the territory center, we located a new sampling point as described above. Sampling points that were identified in 2010 but were not within 20 m of a territory center in 2011 were resampled in 2011. Data from these points are not included in the 2011 data presented below but may be used in future analyses to identify any changes in vegetation that may lead to territory abandonment. All HOBO units were removed from the field at the end of the breeding season.

Soil Moisture Measurements

A ThetaProbe ML2x coupled to an HH2 Moisture Meter Readout (Macaulay Land Use Research Institute, Aberdeen, UK, and Delta-T Devices, Cambridge, UK, respectively) was used to gather soil moisture data. The soil moisture 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. Soil moisture readings were collected when the HOBO logger was deployed and at two-week intervals throughout the breeding season until the HOBO logger was removed at the end of the season. Soil moisture was recorded both as voltage (mV) and as volumetric water content (%).[1] Soil type on the HH2 was set to mineral soil. For any soil moisture 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. Each time we collected soil moisture data, we also recorded the distance to the nearest standing water or saturated soil (as measured by visual estimate, GPS, or aerial photo) and recorded the approximate percentage, as estimated in the field by visual observation in combination with aerial photo, of the site within 20 and 50 m of the data logger that contained inundated or saturated soil.

A soil sample was collected from beneath each HOBO location that was new in 2011. 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. These samples will contribute to an ongoing analysis of soil texture, which strongly influences capillary action and therefore

[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 enable the use of all data, we analyzed and report only the mV readings. Both mV and percentage were recorded in the field to facilitate data proofing. Voltage is related to soil moisture as follows: $1.07 + 6.4V - 6.4V^2 + 4.7V^3 = 1.6 + 8.4\theta$, where θ = volumetric soil moisture.

overall soil moisture (Sumner 2000). Results of the soil texture analysis will be presented in the 2012 summary report.

Statistical Analyses

Soil moisture data were entered into a database as they were collected during the field season. We downloaded data from the HOBO data loggers into databases at the end of the field season. We merged all data to create one dataset for further analysis. We summarized the following variables for each HOBO location:

- Mean soil moisture from plot center to 2.0 m from plot center
- Distance to nearest standing water or saturated soil
- % of the area within 20 m of plot center that was inundated or saturated
- % of the area within 50 m of plot center that was inundated or saturated
- Maximum diurnal temperature
- Minimum nocturnal temperature
- Daily temperature range (diurnal maximum minus nocturnal minimum)
- Mean diurnal vapor pressure[2]
- Mean nocturnal vapor pressure

Soil moisture variables were summarized per visit, and temperature/humidity variables were summarized on a daily basis. We determined diurnal and nocturnal periods by using the actual daily sunrise and sunset times reported for the region by the National Weather Service (2011). We selected the above measures of temperature and humidity for analysis because they were the most highly correlated with other variables or were the most useful in distinguishing use areas from non-use locations (McLeod et al. 2008a). Territories were grouped according to habitat type (see Chapter 5), and microclimate variables were averaged for each habitat type over the following two-week periods to show how microclimate conditions changed throughout the breeding season: 16–31 May, 1–15 June, 15–30 June, 1–15 July, and 16–31 July. Data were also summarized by vegetation classification (see Chapter 5).

Analyses were conducted using SAS® Version 9.2 (SAS Institute 2009). Data are presented as mean (standard error) unless otherwise noted.

RESULTS

We collected microclimate data at two active territories that contained nesting pairs and four territories that were occupied in 2010 but not in 2011. Data from territories that were occupied in 2010 but not in 2011 are not included in the 2011 data presented below but may be used in future analyses to identify any changes in microclimate that may lead to territory abandonment. This analysis would be presented in a five-year summary report in 2012. One active territory was in Goodding willow with tamarisk understory, which falls under the cottonwood-willow Type I vegetation classification, and the other territory was in cottonwood/willow, which falls under cottonwood-willow Type III (see Chapter 5). Microclimate variables are summarized by two-week periods for each vegetation type in Tables 6.1 and 6.2. These same variables are plotted in Figures 6.1–6.9 to facilitate comparisons between vegetation types.

[2] 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.

Table 6.1. Microclimate Measures in Southwestern Willow Flycatcher Territories in Goodding Willow with Tamarisk Understory, 2011*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture (n=1)[1]						
Mean soil moisture (mV)	894.7	831.7	750.7	758.0	752.8	731.3
Mean distance to nearest standing water	15.0	15.0	15.0	375.0	393.0	470.0
% of area within 20 m that was inundated	25.0	20.0	5.0	0.0	0.0	0.0
% of area within 50 m that was inundated	30.0	35.0	15.0	0.0	0.0	0.0
Temperature (n=1)[2]						
Mean maximum diurnal temperature (°C)	35.3 (0.8)	37.9 (0.6)	39.7 (0.3)	41.6 (0.7)	39.2 (0.5)	N/A
Mean minimum nocturnal temperature (°C)	11.8 (0.7)	12.3 (0.5)	16.5 (0.6)	19.7 (0.9)	20.6 (0.8)	N/A
Mean daily temperature range (°C)	23.4 (1.0)	25.6 (0.7)	23.2 (0.5)	21.9 (0.9)	18.7 (0.9)	N/A
Humidity (n=1)[2]						
Mean diurnal vapor pressure (Pa)	1309.5 (67.2)	1726.9 (118.4)	2249.5 (113.7)	2991.2 (126.2)	3063.0 (84.2)	N/A
Mean nocturnal vapor pressure (Pa)	1037.0 (48.0)	1308.9 (52.3)	1562.9 (72.3)	2297.7 (116.8)	2339.8 (94.6)	N/A

* Data are presented as mean (standard error). This habitat type is also cottonwood-willow Type I.
[1] Sample size indicates the number of data logger locations. No standard error is reported for periods in which soil moisture variables were measured only once.
[2] Sample size indicates the number of data logger locations. Mean and standard error are reported for daily readings within each time period.

Table 6.2. Microclimate Measures in Southwestern Willow Flycatcher Territories in Cottonwood/Willow, 2011*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture (n=1)[1]						
Mean soil moisture (mV)	951.3	986.7 (0.1)	921.0	957.0	965.3	904.9
Mean distance to nearest standing water	1.0	1.3 (0.3)	0.0	1.0	1.0	1.0
% of area within 20 m that was inundated	55.0	60.0 (20.0)	40.0	85.0	50.0	60.0
% of area within 50 m that was inundated	70.0	50.0 (10.0)	65.0	45.0	60.0	50.0
Temperature (n=1)[2]						
Mean maximum diurnal temperature (°C)	29.9 (0.8)	32.6 (0.6)	35.2 (0.5)	35.0 (0.5)	35.3 (0.7)	N/A
Mean minimum nocturnal temperature (°C)	14.5 (1.0)	13.6 (0.7)	19.1 (0.8)	21.0 (1.0)	22.4 (0.8)	N/A
Mean daily temperature range (°C)	15.4 (1.3)	19.0 (0.9)	16.1 (0.6)	13.9 (1.1)	13.0 (0.9)	N/A
Humidity (n=1)[2]						
Mean diurnal vapor pressure (Pa)	1112.0 (43.0)	1269.8 (64.8)	1516.9 (50.4)	2312.6 (164.7)	2245.6 (114.6)	N/A
Mean nocturnal vapor pressure (Pa)	806.2 (25.2)	904.9 (42.3)	1114.3 (47.0)	1937.9 (147.3)	1873.1 (111.8)	N/A

* Data are presented as mean (standard error). This habitat type is also cottonwood-willow Type III.

[1] Sample size indicates the number of data logger locations. Mean and standard error are reported for time periods in which soil moisture variables were measured twice. No standard error is reported for periods in which soil moisture variables were measured only once.

[2] Sample size indicates the number of data logger locations. Mean and standard error are reported for daily readings within each time period.

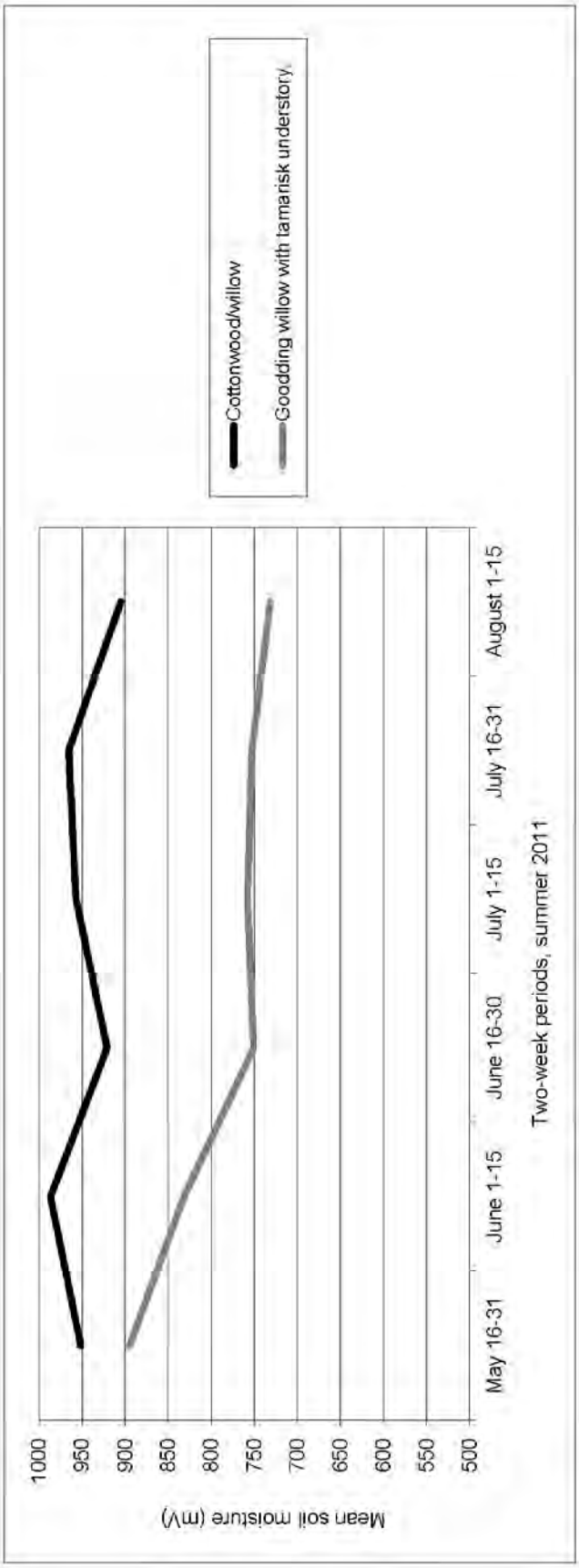

Figure 6.1. Mean soil moisture (mV) in Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2011. Cottonwood/willow = cottonwood-willow Type III, and Goodding willow with tamarisk understory = cottonwood-willow Type I. Data are summarized by two-week periods. Each vegetation type contained a single flycatcher territory.

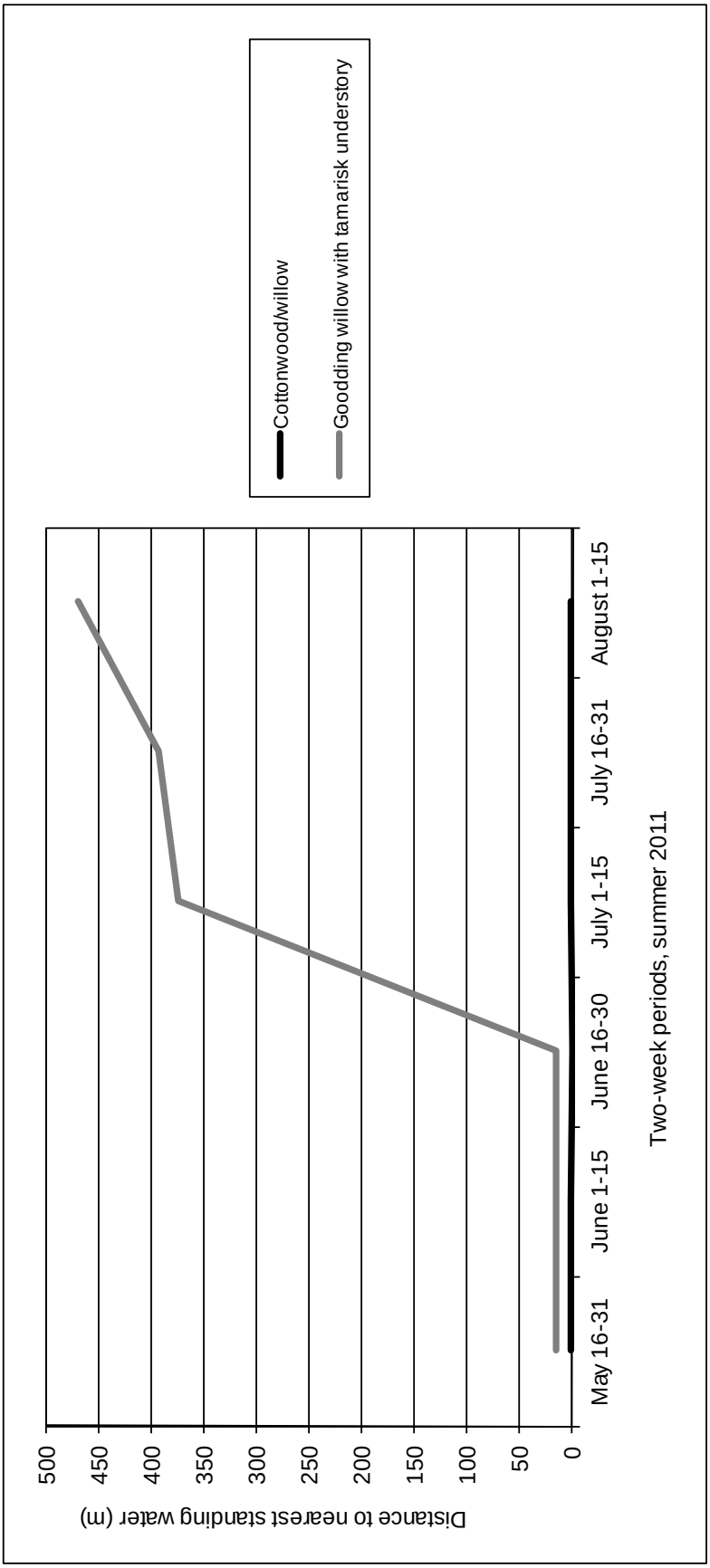

Figure 6.2. Distance (m) to standing water or saturated soil from Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2011. Cottonwood/willow = cottonwood-willow Type III, and Goodding willow with tamarisk understory = cottonwood-willow Type I. Data are summarized by two-week periods. Each vegetation type contained a single flycatcher territory. Data are presented as means for instances in which distance to water was measured more than once in a given two-week period.

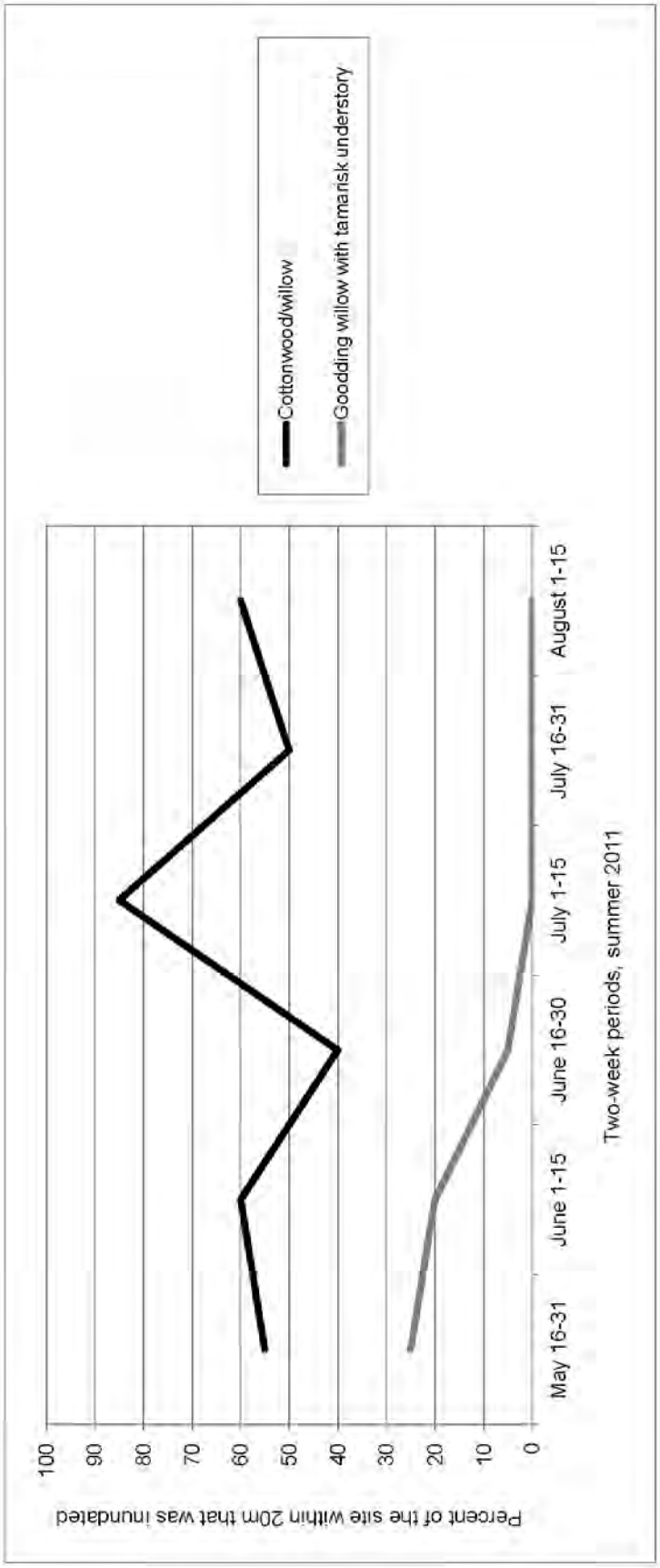

Figure 6.3. Percent of the area within 20 m of Southwestern Willow Flycatcher territories that contained standing water or saturated soil in various vegetation types, lower Colorado River and tributaries, 2011. Cottonwood/willow = cottonwood-willow Type III, and Goodding willow with tamarisk understory = cottonwood-willow Type I. Data are summarized by two-week periods. Each vegetation type contained a single flycatcher territory. Data are presented as means for instances in which percent inundated was measured more than once in a given two-week period.

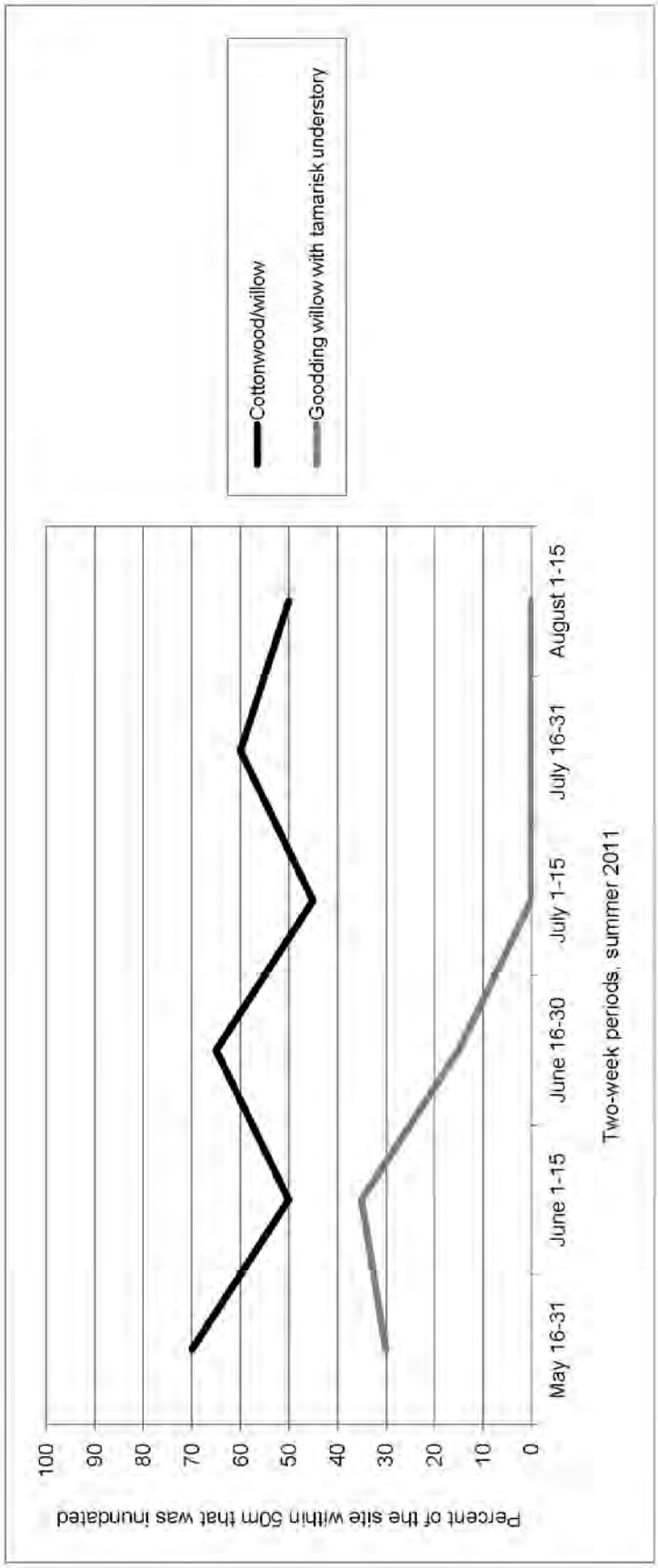

Figure 6.4. Percent of the area within 50 m of Southwestern Willow Flycatcher territories that contained standing water or saturated soil in various vegetation types, lower Colorado River and tributaries, 2011. Cottonwood/willow = cottonwood-willow Type III, and Goodding willow with tamarisk understory = cottonwood-willow Type I. Data are summarized by two-week periods. Each vegetation type contained a single flycatcher territory. Data are presented as means for instances in which percent inundated was measured more than once in a given two-week period.

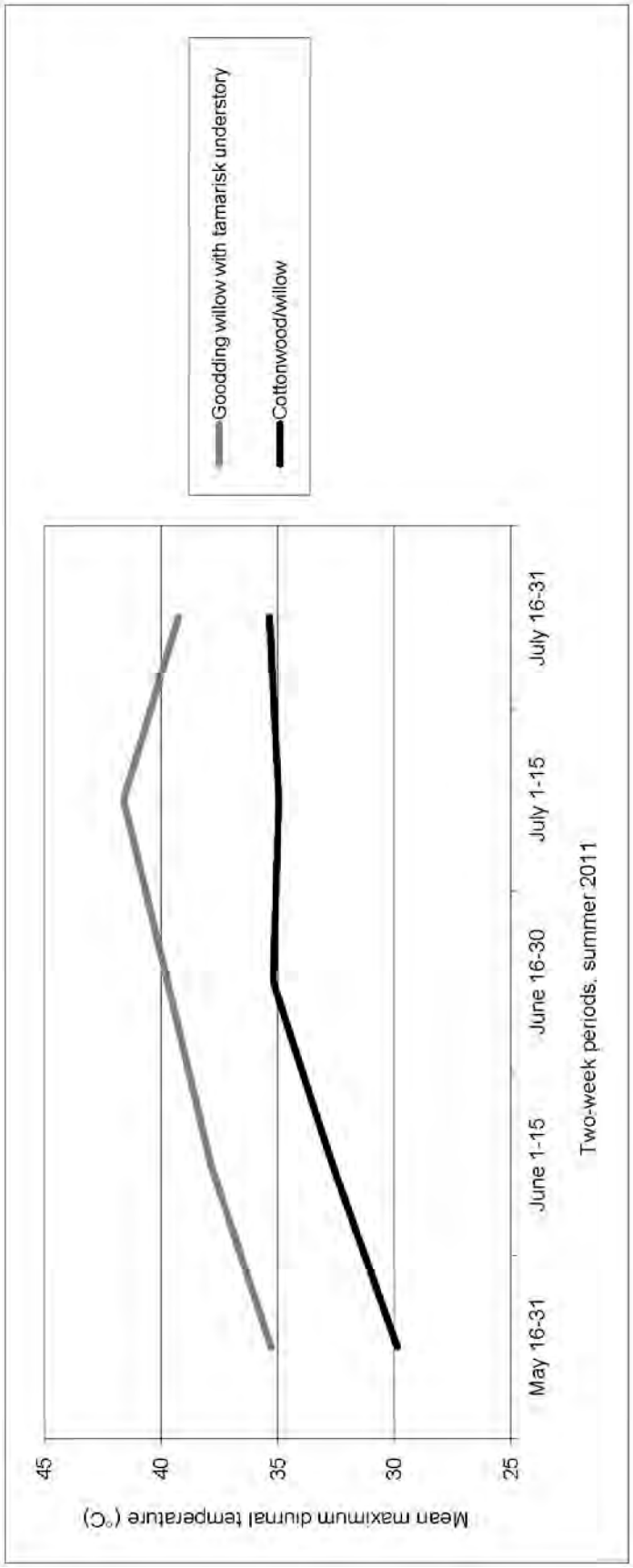

Figure 6.5. Mean maximum diurnal temperature at Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2011. Cottonwood/willow = cottonwood-willow Type III, and Goodding willow with tamarisk understory = cottonwood-willow Type I. Data are summarized by two-week periods.

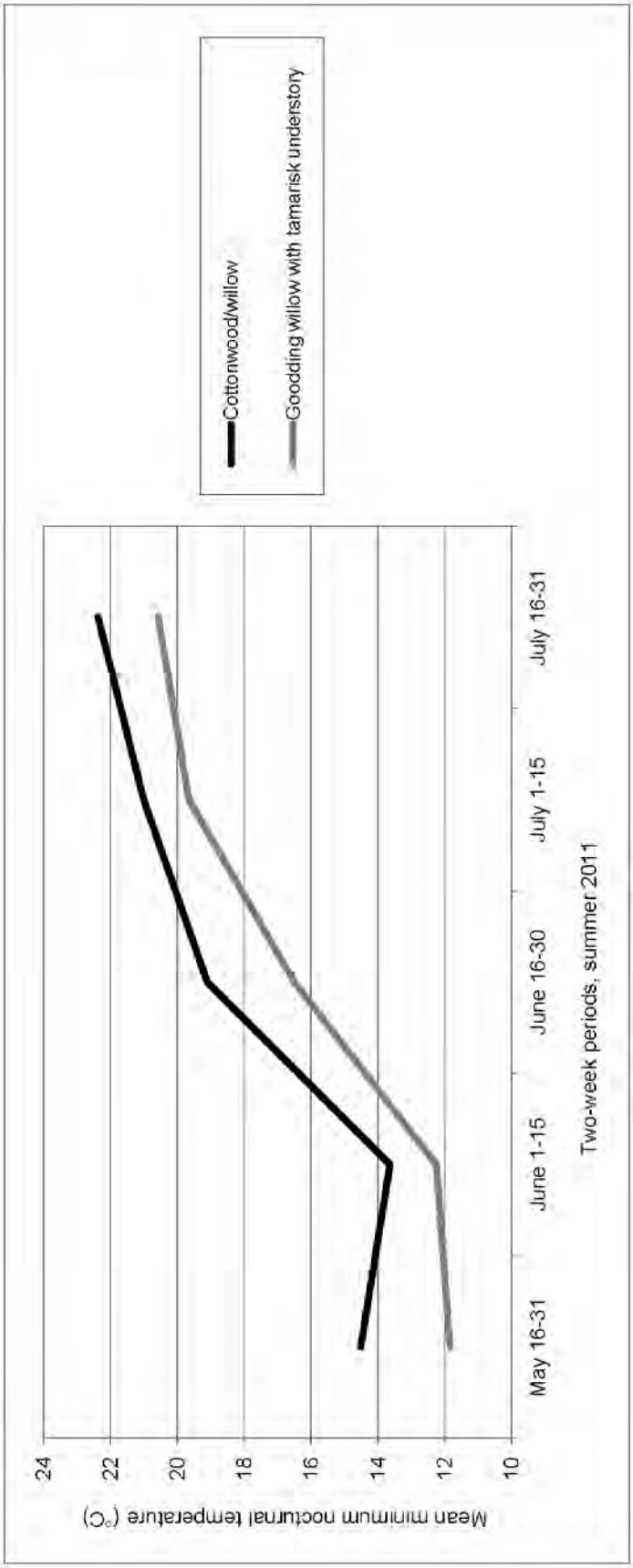

Figure 6.6. Mean minimum nocturnal temperature at Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2011. Cottonwood/willow = cottonwood-willow Type III, and Goodding willow with tamarisk understory = cottonwood-willow Type I. Data are summarized by two-week periods.

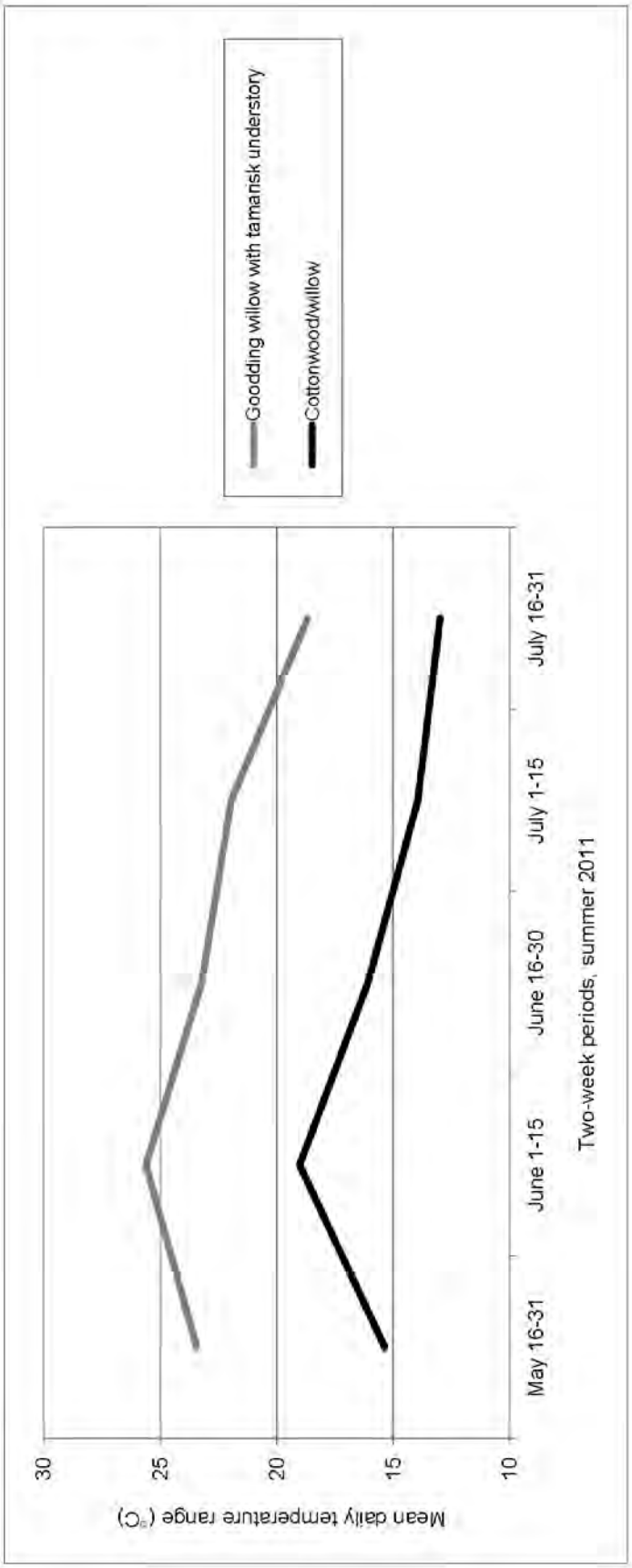

Figure 6.7. Mean daily temperature range at Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2011. Cottonwood/willow = cottonwood-willow Type III, and Goodding willow with tamarisk understory = cottonwood-willow Type I. Data are summarized by two-week periods.

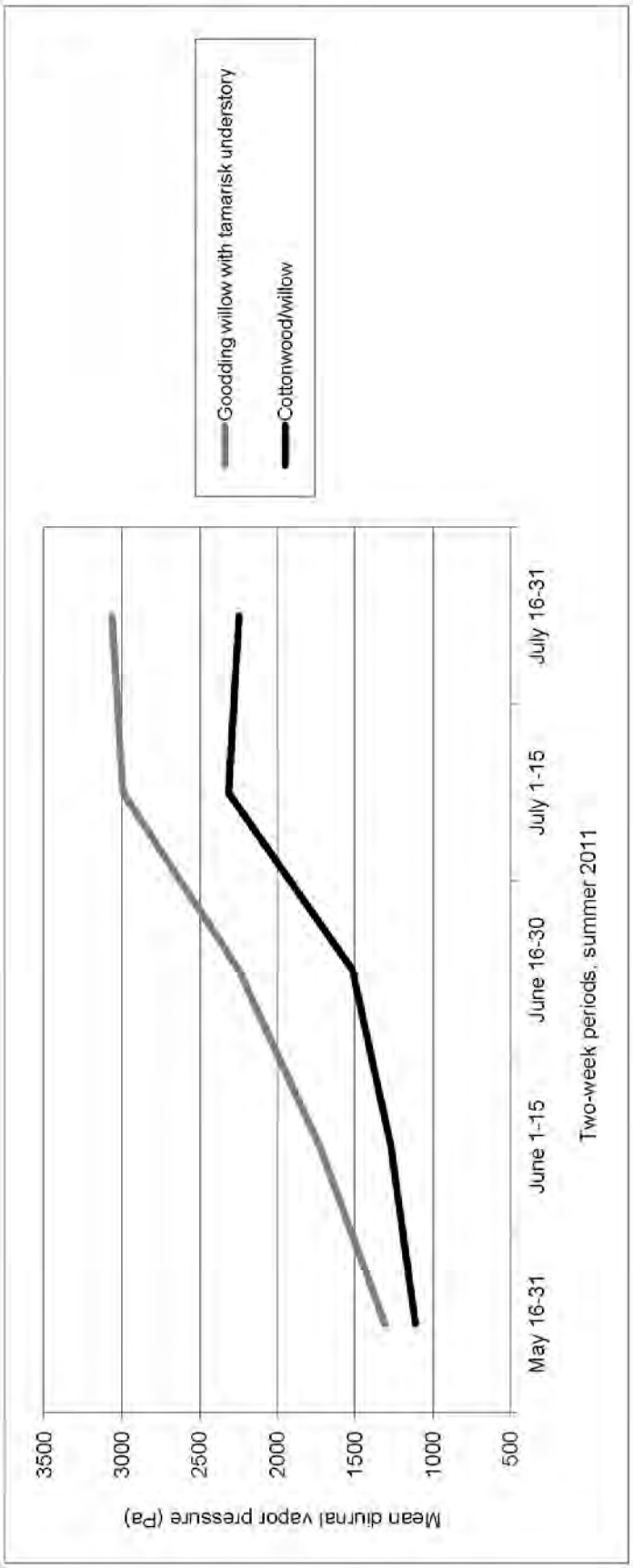

Figure 6.8. Mean diurnal vapor pressure at Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2011. Cottonwood/willow = cottonwood-willow Type III, and Goodding willow with tamarisk understory = cottonwood-willow Type I. Data are summarized by two-week periods.

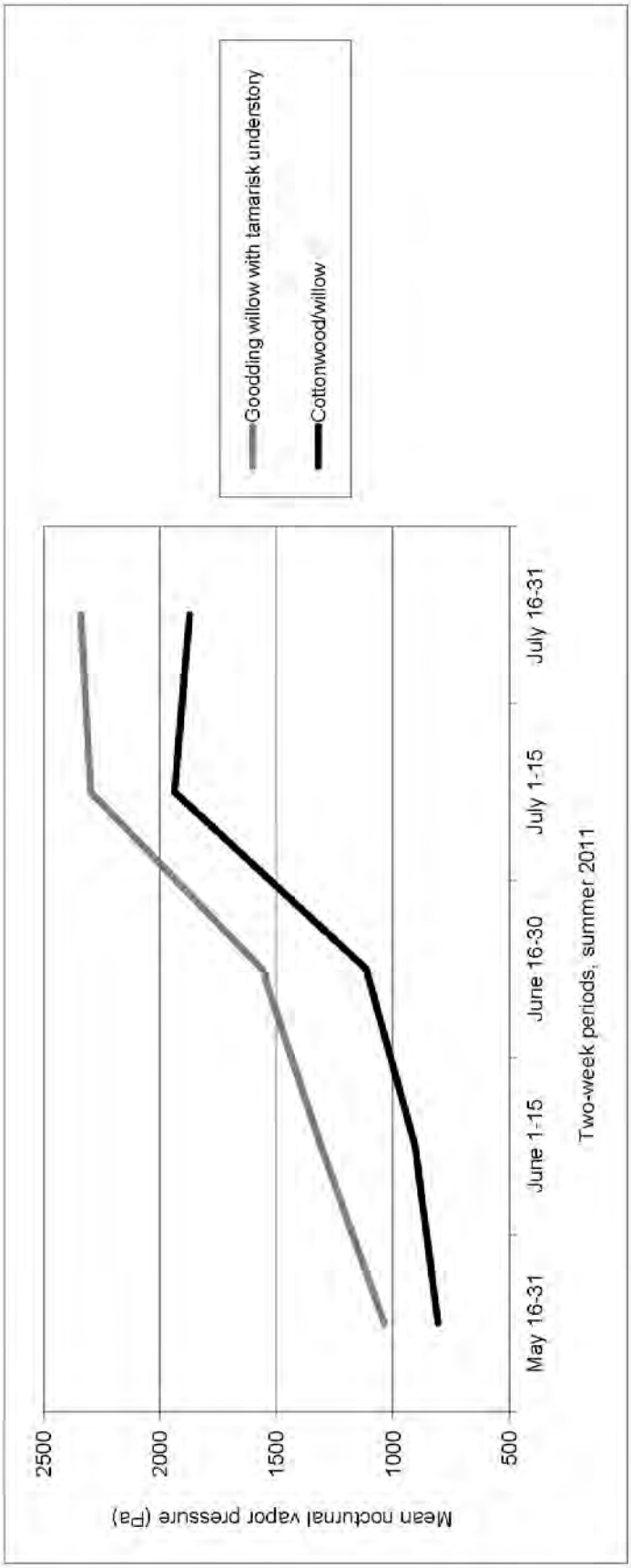

Figure 6.9. Mean nocturnal vapor pressure at Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2011. Cottonwood/willow = cottonwood-willow Type III, and Goodding willow with tamarisk understory = cottonwood-willow Type I. Data are summarized by two-week periods.

Both vegetation types exhibited moist soil conditions at some point during the breeding season. Goodding willow with tamarisk understory had high soil moisture content at the beginning of the breeding season and standing water within the territory through late June. The inundated percentage of the surrounding area declined steadily through May and June, and distance to surface water was over 300 m in July and August. Cottonwood/willow had consistently high soil moisture, and the inundated percentage of the surrounding area was at least 50% throughout the breeding season.

Mean daily maximum temperatures spanned a range of ~5°C among habitat types. Daily minimum temperatures showed a smaller range of <3°C. The daily temperature range in cottonwood/willow was consistently smaller than in Goodding willow with tamarisk understory. Vapor pressure increased through the end of July for both habitat types and was higher in Goodding willow with tamarisk understory than in cottonwood/willow.

DISCUSSION

The limited data collected in 2011 preclude any meaningful comparison between habitat types and any summary of overall microclimate characteristics in flycatcher territories. Data collected in 2011 will be added to data collected in prior years for a combined analysis to be presented in the summary report in 2012.

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Chapter 7

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). 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 fundamental requirement for nesting. A similar pattern was observed along the Gila River in Arizona when decreased streamflow from 2002 to 2004 coincided with the number of flycatcher territories declining by nearly half each year (Munzer et al. 2005). Since 2004, flows within the Gila River have been greater and more consistent, and correspond with a continuing increase in flycatcher territories (14 to 97) from 2004 to 2009 (Graber and Koronkiewicz 2009b).

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 (LCR MSCP 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, previously located below Parker Dam at Imperial Dam, would change to a point above 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 ha) of

[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 in any year since surveys began in 1996.

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, long-term study in 2005 for the purpose of addressing how the above hydrological changes might affect riparian habitats along the Parker to Imperial reach. The objective is to monitor 151 ha (372 acres) of occupied Southwestern Willow Flycatcher habitat between Parker and Imperial Dams for 10–15 years to determine how microclimate, vegetation, and groundwater conditions might be affected by the SIAs water transfer actions. Monitoring did not commence until after diversions started; therefore, antecedent conditions are unknown and monitoring analyses focus on detecting change through time rather than comparing current conditions to a baseline. An additional objective was to compare microclimate characteristics of sites in the Parker to Imperial reach with those at flycatcher breeding areas. This analysis was completed in previous years and is not repeated here. This chapter reports the results of habitat monitoring to date.

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. The 11 test sites are Ehrenberg, Three Fingers Lake, Cibola Lake, Walker Lake, Paradise, Hoge Ranch, Rattlesnake, Clear Lake, Ferguson Lake, Ferguson Wash, and Great Blue Heron, and the four control sites are Blankenship Bend, Havasu NE, Mittry West, and Gila Confluence North (Figure 7.1). We monitored these same 15 sites from 2005 to 2011. In August of 2006, we initiated habitat monitoring within a consistently occupied breeding site at Topock Marsh to obtain groundwater levels and patterns with which we can compare results obtained at the habitat monitoring sites. The analysis comparing Topock to the 15 habitat monitoring sites was completed in previous years and is not repeated here.

Temperature/Humidity 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 6. All 60 logger locations selected in 2005 were retained in 2006. Two additional data loggers were installed in the Topock Marsh monitoring site in August 2006. A portion of Gila Confluence North, one of the control sites below Imperial Dam, burned in December 2006. As a result of the fire, all vegetation at one HOBO location at the site was killed, and vegetation at another HOBO location was dramatically reduced. These two HOBOs were replaced in May 2007 with HOBOs at new locations within unburned portions of the site.

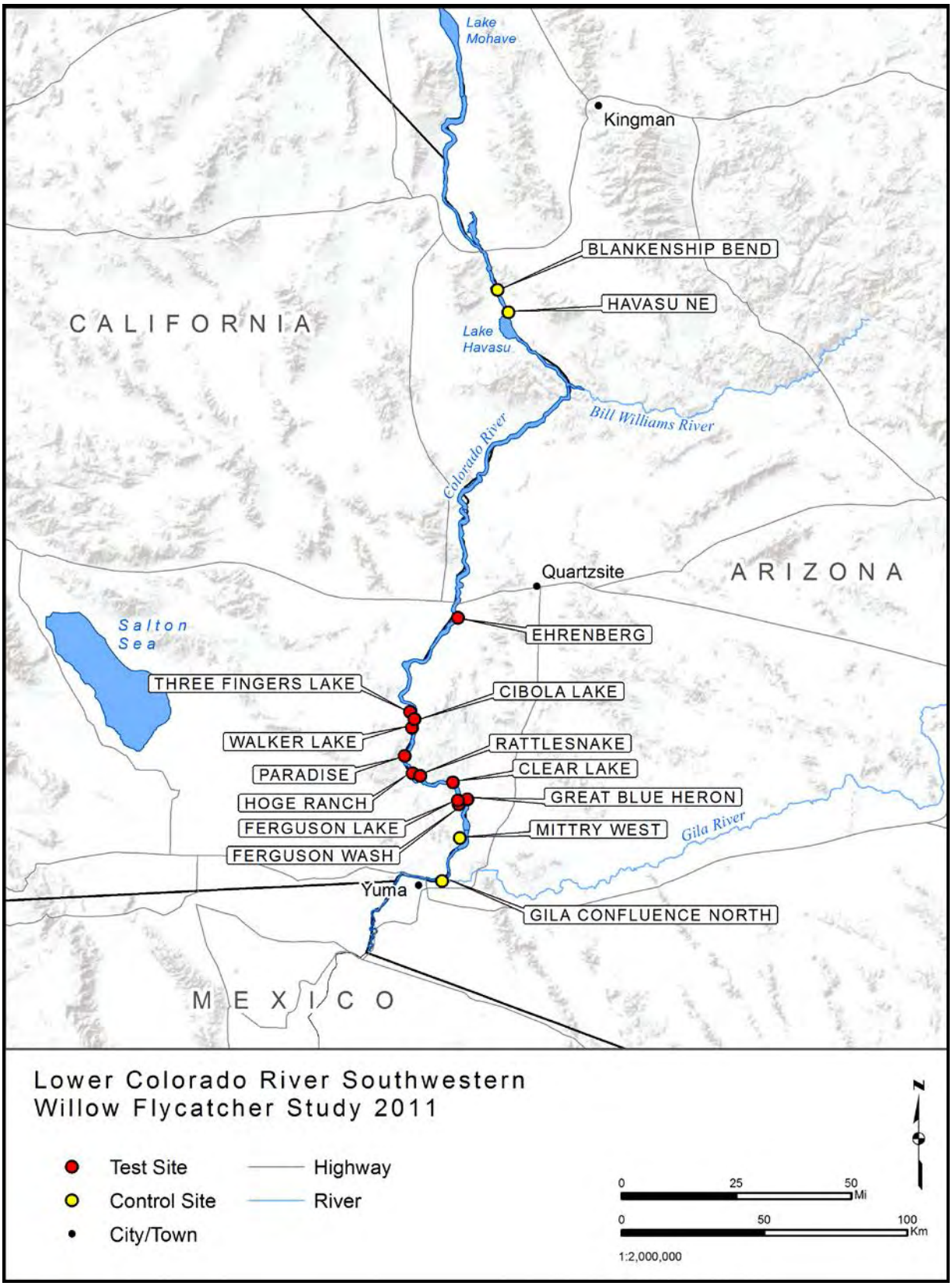

Figure 7.1. Locations of test and control sites, habitat monitoring study, 2005–2011.

HOBO loggers have been downloaded two or three times per year since installation. At each download, we examined the data to determine if there are any problems with data logger function. Data loggers were replaced whenever a potential problem with the sensors was detected. Battery level was also checked at each download, and the battery was replaced if needed.

Soil Moisture 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 presence/absence survey between 15 May and 25 July and when HOBO data were downloaded. Soil moisture measurements, percent of the area containing inundated or saturated soil, and distance to water were recorded as described in Chapter 6.

Vegetation Measurements

We completed vegetation measurements, following the methods described in Chapter 5, 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 as in 2005–2010 with the exception of Gila Confluence North, where vegetation measurements were collected at the two new HOBO locations established in 2007.

Groundwater Measurements

Piezometers were installed in May–August 2005 near each of the 15 sites selected for habitat monitoring. Analyses of groundwater data in previous years showed that releases from Parker Dam can be used to predict the groundwater level beneath the habitat polygons (e.g., McLeod et al. 2007, McLeod and Koronkiewicz 2009); consequently, these piezometers were removed in 2010. Analyses of the piezometer data are not repeated here. One additional piezometer was installed at Topock Marsh within occupied flycatcher habitat in 2006; see Chapter 8 for information regarding this piezometer.

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 maximum diurnal temperature
- Mean minimum nocturnal temperature
- Mean daily temperature range (diurnal maximum minus nocturnal minimum)
- Mean diurnal vapor pressure
- 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 (2011).

We assigned all plots as a control site (above Parker Dam or below Imperial Dam) or as a test site (between Parker and Imperial). We analyzed between-year differences in humidity and soil moisture values within these two groups using linear mixed models and analyzed the between-year differences among the test sites compared to the control sites using repeated measures linear mixed models. These analyses were restricted to 1 June–1 August. Analyses were conducted using SAS® Version 9.2 (SAS Institute 2009).

Vegetation

We analyzed the between-year differences among the test sites compared to the control sites using repeated measures linear mixed models for canopy height, canopy closure, percent woody ground cover, three categories of stem sizes for both live and dead stems, the percentage of each stem size category that consisted of live stems, and the percentage of the basal area within the plot that consisted of native vegetation. In prior years we used repeated measures ANOVA for these analyses; however, repeated measures ANOVA excludes cases with missing values whereas linear mixed models allow for the inclusion of all data. We also used repeated measures linear mixed models to examine foliage density for live and dead vegetation summed over all height intervals. These analyses and all descriptive statistics were produced using SPSS® Version 16.0 (SPSS Inc.) software. We excluded vertical foliage density measurements at 5 m from plot center from the analysis so as to have comparable data across years.

RESULTS

Temperature/Humidity Logger Maintenance

All HOBO loggers were downloaded at the beginning and end of the 2011 field season. Four loggers had fallen to the ground over the winter because of sun damage to the logger housing. Five loggers that were in place over the winter had bad humidity sensors but useable temperature data, and one logger failed to collect data. Of the HOBO loggers in place May–August 2011, three failed to collect data, four had faulty humidity data, and four fell to the ground. Data from fallen loggers were not used in the analysis.

Microclimate

2011 Microclimate Descriptive Statistics

Soil moisture, temperature, and vapor pressure parameters from the 15 study sites monitored in 2011 exhibited substantial variation among sites (Table 7.1). Soil moisture varied from a low of 140.9 mV at Ferguson Wash to a high of 939.4 at Mittry West.

Mean maximum diurnal temperatures ranged from a low of 37.4^{o}C at Rattlesnake to a high of 48.2^{o}C at Cibola Lake. Mean minimum nocturnal temperatures ranged from a low of 15.1^{o}C at Gila Confluence North to a high of 20.0^{o}C at Three Fingers Lake. Mean daily temperature range varied from 19.5^{o}C at Ferguson Lake to 28.9^{o}C at Paradise.

Mean diurnal vapor pressure was lowest at Blankenship Bend (1106.6 Pa) and highest at Three Fingers Lake (1953.5 Pa). Mean nocturnal vapor pressure was lowest at Ferguson Wash (1080.9 Pa) and highest at Three Fingers Lake (1849.7 Pa).

Between-year Comparisons of Microclimate Characteristics

All microclimate characteristics varied significantly over time at test sites (Ehrenberg, Three Fingers Lake, Cibola Lake, Walker Lake, Paradise, Hoge Ranch, Rattlesnake, Clear Lake, Ferguson Lake, Ferguson Wash, and Great Blue Heron; Table 7.2). At control sites (Blankenship Bend, Havasu NE, Mittry West, and Gila Confluence North), mean minimum nocturnal temperature varied significantly over time, along with measures of soil moisture and humidity. Neither test nor control sites showed a unidirectional change in any of the microclimate measures in 2005–2011 (Figures 7.2–7.7), although both measures of humidity showed a generally decreasing trend at both test and control sites since 2006. The changes over time differed between test and control sites for soil moisture, mean diurnal vapor pressure, and mean nocturnal vapor pressure (right-most column of Table 7.2).

Soil moisture fluctuated among years at both test and control sites, but the patterns did not mirror one another (Figure 7.2). Between 2005 and 2006, soil moisture decreased more dramatically at control sites than at test sites, while between 2007 and 2008, soil moisture decreased at control sites but rose at test sites. Between 2009 and 2010, soil moisture decreased at test sites but rose at control sites. Diurnal vapor pressure rose more sharply at test sites than at control sites between 2005 and 2006 and then fell more sharply at test sites than at control sites between 2006 and 2007 (Figure 7.6), and nocturnal vapor pressure also showed larger fluctuations at test sites than at control sites.

Vegetation Measurements

Vegetation characteristics varied widely both between and within the selected habitat monitoring sites (Table 7.3). Average canopy height ranged from 3.3 m (Three Fingers Lake) to 9.8 m (Ehrenberg), and average canopy closure ranged from 66.9% (Ehrenberg) to 98.6% (Clear Lake). Measures of other habitat characteristics were similarly variable. Vertical foliage profiles for each site are shown in Figure 7.8. Sites typically exhibited the densest foliage within 3–5 m of the ground, and the majority of vegetation within 2–3 m of the ground typically consisted of dead branches.

Between-year Comparisons of Vegetation Characteristics

Many vegetation variables varied between years within the test and control groups (Table 7.4), but none of the variables exhibited change in a consistent direction over time (Figures 7.9–7.24). There was a significant interaction between year and location (meaning that the change between years among test sites was significantly different from the change at control sites) for woody ground cover ($P = 0.004$), number of live stems ≤2.5 cm dbh ($P = 0.043$), number of dead stems ≤ 2.5 cm dbh ($P = 0.040$), percent of live stems ≤2.5 cm dbh ($P = 0.022$), and dead vertical foliage hits ($P = 0.003$). Average woody ground cover increased at control plots between 2005 and 2006 and then decreased in 2007, while it did not change at test plots across those years. Overall, the number of live stems ≤2.5 cm dbh decreased through time at both test and control plots (Figure 7.12), while the number of dead stems ≤ 2.5 cm dbh decreased only at control plots (Figure 7.15), though there was considerable annual fluctuation for both variables. The percentage of live stems increased at control plots but decreased at test plots (Figure 7.18). The amount of dead vertical foliage hits increased through time at both test and control plots, but increased more rapidly at test plots (Figure 7.23).

Table 7.1. Microclimatic Data Summaries Collected From Habitat Monitoring Sites, Lower Colorado River, 1 May–31 July 2011*

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)	850.2 (89.7)	267.4 (74.5)	641.3 (106.7)	425. (61.3)	494.6 (114.5)	900.7 (28.6)	707.0 (50.7)	829.5 (21.5)	735.1 (44.4)	424.7 (157.2)	925.7 (15.0)	140.9 (5.5)	876.0 (9.6)	939.4 (10.8)	399.3 (104.2)
Temperature															
Mean maximum diurnal temperature (°C)	42.4 (0.3)	44.9 (0.5)	45.6 (0.4)	46.4 (0.6)	48.2 (0.3)	44.1 (0.3)	45.7 (0.4)	45.1 (0.4)	37.4 (0.2)	40.1 (0.3)	38.9 (0.3)	40.0 (0.3)	39.7 (0.3)	42.2 (0.3)	42.9 (0.4)
Mean minimum nocturnal temperature (°C)	17.2 (0.3)	18.6 (0.3)	18.2 (0.4)	20.0 (0.6)	19.9 (0.3)	16.7 (0.3)	16.8 (0.3)	17.0 (0.3)	16.2 (0.3)	18.4 (0.3)	19.4 (0.2)	19.1 (0.3)	16.3 (0.3)	17.8 (0.3)	15.1 (0.4)
Mean daily temperature range (°C)	25.2 (0.4)	26.4 (0.6)	27.4 (0.5)	26.4 (1.0)	28.3 (0.4)	27.4 (0.4)	28.9 (0.5)	28.2 (0.4)	21.2 (0.3)	21.7 (0.4)	19.5 (0.3)	20.9 (0.3)	23.5 (0.3)	25.4 (0.4)	27.8 (0.4)
Humidity															
Mean diurnal vapor pressure (Pa)	1106.6 (33.8)	1342.7 (38.2)	1133.4 (42.1)	1953.5 (92.7)	1216.0 (44.5)	1139.2 (29.8)	1336.9 (43.3)	1318.2 (33.1)	1670.7 (42.8)	1334.5 (38.9)	1359.7 (30.1)	1244.9 (30.1)	1306.1 (38.3)	1297.5 (34.1)	1269.0 (34.6)
Mean nocturnal vapor pressure (Pa)	1185.3 (32.8)	1215.5 (34.0)	1197.1 (40.0)	1849.7 (81.7)	1321.3 (38.3)	1154.9 (26.0)	1332.9 (34.8)	1316.2 (30.4)	1620.5 (37.8)	1239.3 (32.3)	1378.6 (27.3)	1080.9 (26.3)	1292.7 (33.6)	1235.8 (28.9)	1236.4 (31.8)

* Data are presented as mean (standard error).

Table 7.2. Change in Microclimatic Variables at Habitat Monitoring Sites from 2005 to 2011*

Parameter	Test (n=45)								Control (n=15)								P-value for difference between years among test sites compared to control sites
	2005	2006	2007	2008	2009	2010	2011	P-value for the difference between years	2005	2006	2007	2008	2009	2010	2011	P-value for the difference between years	
Soil Moisture																	
Mean soil moisture (mV)	645.7 (44.8)	634.4 (48.6)	662.9 (44.8)	705.8 (42.7)	699.2 (35.7)	651.4 (20.8)	636.2 (46.5)	<0.001	694.4 (89.8)	582.9 (98.1)	635.3 (98.4)	607.5 (90.7)	591.7 (90.6)	687.5 (36.3)	631.3 (96.4)	<0.001	<0.001
Temperature																	
Mean maximum diurnal temperature (°C)	44.9 (0.1)	46.1 (0.1)	45.2 (0.1)	46.5 (0.1)	43.8 (0.1)	45.0 (0.1)	44.0 (0.1)	<0.001	45.6 (0.2)	48.0 (0.2)	46.4 (0.2)	45.7 (0.2)	44.2 (0.2)	46.2 (0.2)	45.1 (0.2)	0.065	0.245
Mean minimum nocturnal temperature (°C)	20.7 (0.1)	22.7 (0.1)	20.4 (0.1)	20.7 (0.1)	21.2 (0.1)	20.4 (0.1)	20.1 (0.1)	<0.001	20.2 (0.2)	22.1 (0.2)	20.3 (0.2)	20.8 (0.2)	21.2 (0.1)	20.9 (0.2)	19.5 (0.2)	<0.001	0.423
Mean daily temperature range (°C)	24.2 (0.2)	23.5 (0.2)	24.8 (0.2)	25.8 (0.2)	22.6 (0.2)	24.6 (0.2)	23.9 (0.2)	<0.001	25.4 (0.2)	26.0 (0.3)	26.1 (0.3)	24.9 (0.3)	23.0 (0.2)	25.3 (0.3)	25.6 (0.3)	0.345	0.138
Humidity																	
Mean diurnal vapor pressure (Pa)	1797.2 (13.0)	2028.4 (13.5)	1737.9 (16.6)	1770.4 (12.8)	1758.9 (13.4)	1588.3 (12.6)	1556.0 (14.8)	<0.001	1726.3 (20.4)	1863.9 (21.9)	1696.9 (21.7)	1692.3 (20.5)	1701.1 (18.9)	1582.8 (17.3)	1493.4 (23.0)	<0.001	0.010
Mean nocturnal vapor pressure (Pa)	1686.3 (11.2)	1860.4 (10.5)	1852.7 (14.0)	1679.8 (10.2)	1618.0 (10.5)	1484.0 (10.3)	1507.7 (13.0)	<0.001	1638.2 (17.6)	1703.4 (18.7)	1559.9 (20.7)	1582.9 (18.4)	1583.2 (17.0)	1479.8 (15.8)	1431.0 (20.9)	<0.001	0.002

*Data are presented as means (standard error). The analysis was restricted to 1 June–1 August each year.

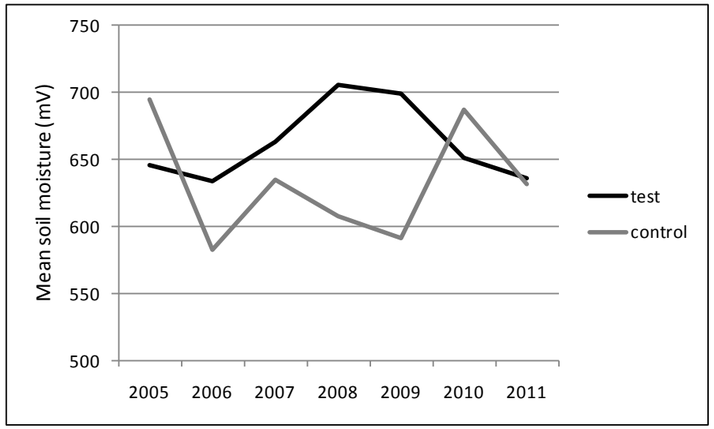

Figure 7.2. Mean soil moisture at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

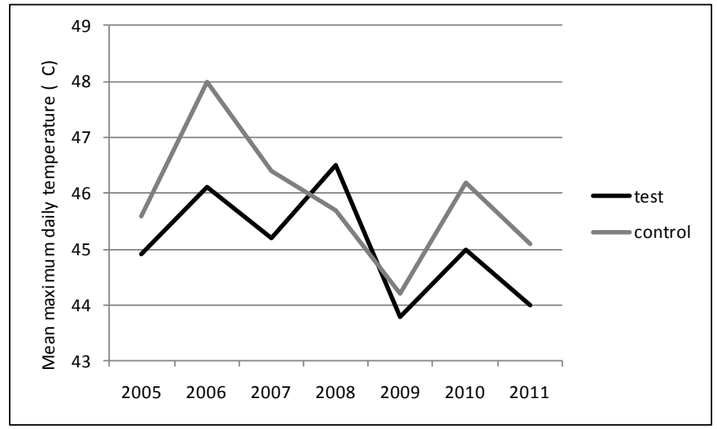

Figure 7.3. Mean maximum daily temperature at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

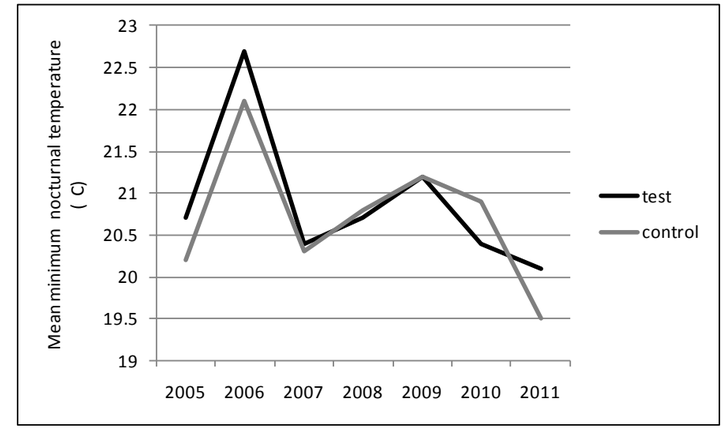

Figure 7.4. Mean minimum nocturnal temperature at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

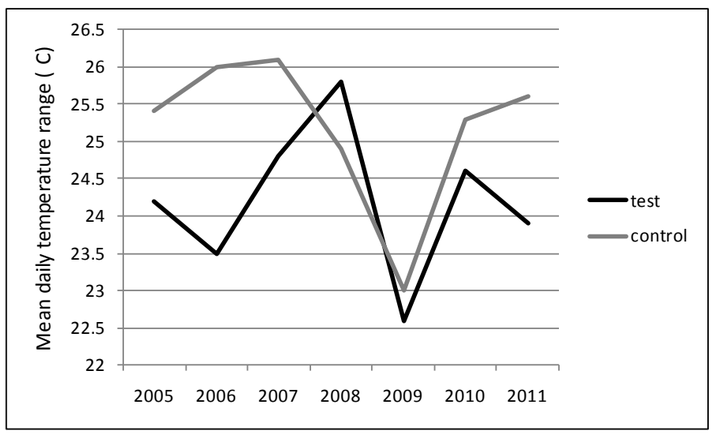

Figure 7.5. Mean daily temperature range at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

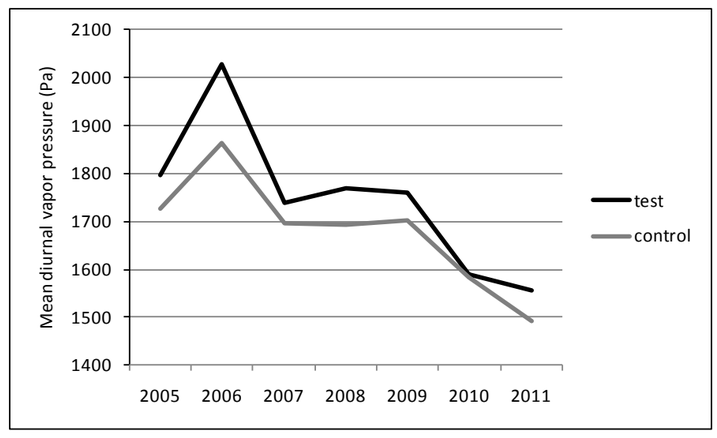

Figure 7.6. Mean diurnal vapor pressure at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

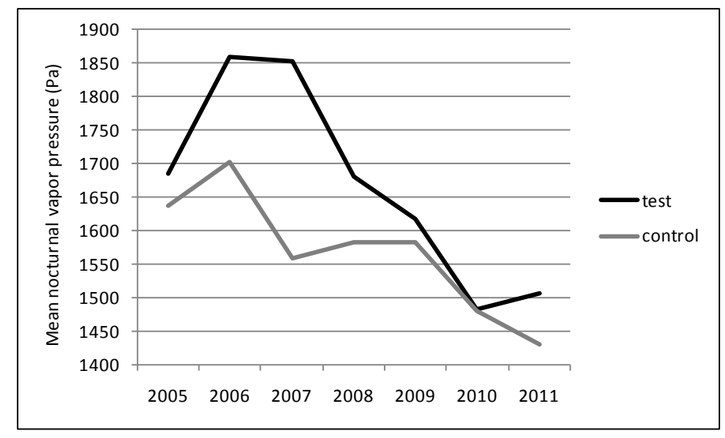

Figure 7.7. Mean nocturnal vapor pressure at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

Table 7.3. Summary of Vegetation Characteristics at Habitat Monitoring Sites, Lower Colorado River, 2011*

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 (n=4)	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)	6.2 (1.1)	3.9 (0.7)	9.8 (2.9)	3.3 (0.3)	3.9 (0.4)	7.2 (1.8)	7.8 (3.0)	4.6 (0.6)	8.1 (1.1)	7.1 (0.1)	5.2 (0.3)	5.9 (0.4)	7.7 (1.3)	7.5 (2.2)	7.4 (2.0)
	4.2–9.0	3.0–6.0	2.1–15.8	2.7–4.3	2.2–4.5	5.3–10.7	4.1–16.7	3.6–6.1	6.5–11.4	7.0–7.2	4.5–5.9	4.7–6.6	5.6–10.9	3.6–13.1	4.8–11.3
% total canopy closure	81.9 (9.6)	88 (6.6)	66.9 (14.5)	82.9 (6)	78.8 (14.5)	93.1 (3.3)	95.1 (2.3)	90.0 (3.5)	98.3 (0.7)	98.6 (1.7)	96.8 (1.6)	96.4 (1.7)	96.2 (1)	88.7 (6.4)	86.3 (6.7)
	53.1–92.2	69.3–97.4	41.1–95.8	59.4–92.7	20.8–96.9	87–98.4	89.6–99.5	82.3–98.4	96.4–100.0	95.3–100.5	92.2–100.0	92.7–99.5	93.2–97.9	69.8–97.4	75.5–98.4
% woody ground cover	76.3 (13.7)	44.7 (13.8)	38.9 (12.1)	13.9 (4.5)	34 (7.5)	79.7 (11.9)	90.9 (7.9)	60.1 (17.8)	65.1 (6.0)	51.6 (12.2)	47.2 (15.8)	35.4 (8.8)	39.8 (8.4)	41.7 (8.2)	55.4 (3.4)
	43.8–99.0	6.3–70.0	9.3–58.8	3.5–30.0	7.5–53.8	57.0–97.0	67.5–100.0	26.3–92.0	51.3–78.8	30.0–72.3	3.5–92.5	21.3–61.3	14.8–50.8	27.5–65.0	48.8–60.0
# live stems ≤2.5 cm dbh per ha	509 (360)	64 (64)	446 (331)	2266 (646)	229 (117)	212 (153)	350 (223)	796 (210)	509 (260)	255 (255)	1171 (415)	286 (210)	223 (109)	1910 (1069)	1188 (112)
	0–1528	0–255	0–1401	382–3820	0–509	0–509	127–1019	382–1273	0–1019	0–764	382–2419	0–891	0–509	0–3947	1019–1401
# live stems 2.6–8 cm dbh per ha	1432 (439)	509 (289)	668 (318)	5628 (1696)	3132 (816)	2080 (552)	3247 (2368)	2674 (597)	2324 (1216)	849 (612)	5195 (1045)	1910 (260)	3629 (1349)	3310 (909)	2928 (1083)
	255–2165	0–1273	0–1528	1783–11968	891–5984	1146–3056	382–10313	1655–3947	0–5475	0–2037	2165–8403	1401–2419	1783–7639	1401–5730	1273–4966
# live stems >8 cm dbh per ha	318 (82)	764 (172)	159 (61)	229 (199)	255 (90)	340 (278)	573 (489)	350 (109)	1337 (433)	1188 (363)	586 (154)	1114 (204)	1050 (141)	637 (356)	1316 (331)
	127–509	255–1019	0–255	0–1019	0–509	0–891	0–2037	127–637	127–2165	764–1910	127–1019	764–1528	637–1273	0–1655	764–1910
# dead stems ≤2.5 cm dbh per ha	95 (61)	0 (0)	159 (159)	331 (154)	76 (31)	0 (0)	191 (152)	64 (37)	255 (116)	0 (0)	306 (204)	127 (127)	127 (90)	1464 (667)	679 (405)
	0–255	0–0	0–637	0–764	0–127	0–0	0–637	0–127	0–509	0–0	0–1019	0–509	0–382	127–3183	0–1401
# dead stems 2.6–8 cm dbh per ha	859 (445)	32 (32)	700 (391)	942 (154)	840 (532)	127 (127)	509 (429)	2260 (1656)	796 (427)	170 (170)	764 (401)	541 (390)	541 (223)	318 (198)	1019 (515)
	0–2037	0–127	0–1655	509–1401	0–2928	0–382	0–1783	0–7130	0–1655	0–509	127–2292	0–1655	0–1019	0–891	0–1655
# dead stems >8 cm dbh per ha	95 (61)	64 (64)	0 (0)	0 (0)	25 (25)	0 (0)	0 (0)	0 (0)	127 (127)	297 (297)	0 (0)	64 (37)	159 (61)	64 (64)	42 (42)
	0–255	0–255	0–0	0–0	0–127	0–0	0–0	0–0	0–509	0–891	0–0	0–127	0–255	0–255	0–127
Percent basal area native	31.7 (19.5)	32.8 (23.6)	96.1 (2.4)	0.5 (0.5)	1.6 (1.3)	29.3 (29.3)	18.7 (18.3)	31.2 (19.2)	39.5 (21.4)	0.0 (0.0)	2.0 (1.9)	22.7 (13.7)	36.1 (15.7)	53.4 (22.4)	100.0 (0.0)
	0–80.0	0–100.0	89.1–99.5	0.0–2.3	0.0–6.8	0.0–87.9	0.0–73.5	0.0–85.1	0.0–100.0	0.0–0.0	0.0–9.6	0.0–55.1	0.0–76.4	0.0–91.4	100.0–100.0

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

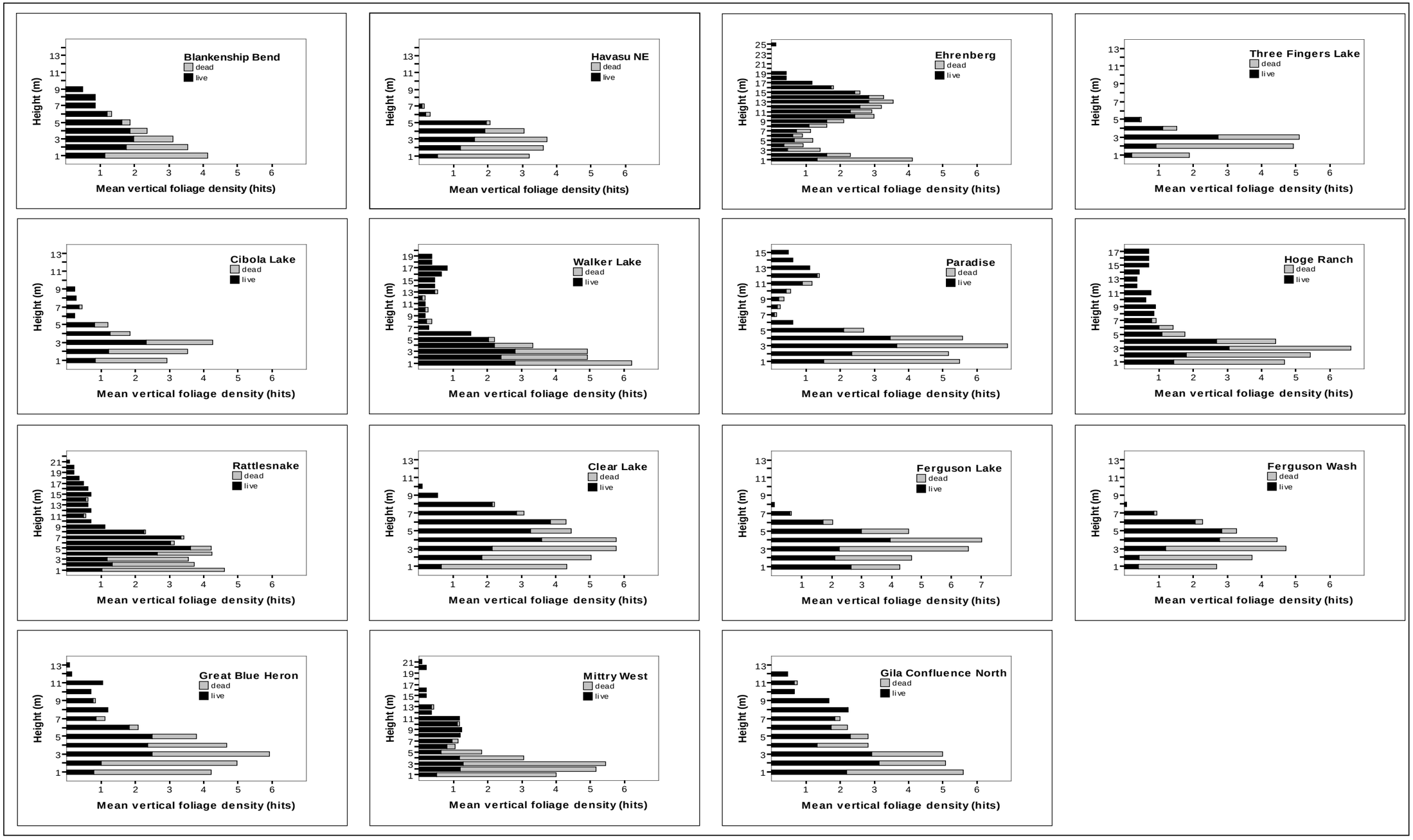

Figure 7.8. Vertical foliage profiles for each habitat monitoring site, lower Colorado River, 2011.

Table 7.4. Annual Means of Vegetation Characteristics at Plots between Parker and Imperial Dams (Test Sites) and Plots above Parker or below Imperial (Control Sites), 2005–2011

Parameter	Test (n=45)								Control (n=15)								P-value for difference in means between years among test sites compared to control sites
	2005	2006	2007	2008	2009	2010	2011	P-value for the difference between years	2005	2006	2007	2008	2009	2010	2011	P-value for the difference between years	
Average canopy height (m)	6.6	7.0	5.8	6.7	7.1	6.5	6.2	0.055	6.6	7.0	6.8	7.7	7.0	6.9	6.2	0.004	0.493
% total canopy closure	84.7	78.3	87.9	88.1	86.7	85.3	89.7	<0.001	80.8	76.9	85.7	85.5	82.5	80.5	86.2	0.008	0.963
% woody ground cover	31.1	27.3	30.0	41.6	23.5	35.6	48.7	<0.001	24.4	46.7	40.2	53.0	31.4	38.0	54.5	<0.001	0.004
# live stems ≤2.5 cm dbh per ha	1932	2272	2515	1358	2530	1316	671	<0.001	985	2574	1842	883	1210	1010	900	<0.001	0.043
# live stems 2.6–8 cm dbh per ha	3107	2722	3143	3899	2314	3271	3030	<0.001	1655	2310	1918	2139	1401	1859	1986	0.002	0.517
# live stems >8 cm dbh per ha	481	430	654	671	597	637	628	0.025	603	646	730	730	546	586	722	0.048	0.587
# dead stems ≤2.5 cm dbh per ha	340	1282	1259	1084	1949	1075	161	<0.001	1214	1492	1367	1384	1455	552	552	<0.001	0.040
# dead stems 2.6–8 cm dbh per ha	1234	821	925	1879	1081	1310	778	0.015	1061	437	747	1392	609	475	526	<0.001	0.790
# dead stems >8 cm dbh per ha	48	59	96	108	91	110	54	0.096	59	82	127	59	118	85	68	0.892	0.866
% live stems ≤2.5 cm dbh	81.7	66.1	66.3	61.0	52.4	57.2	75.2	<0.001	51.9	63.2	55.7	41.4	41.8	70.3	65.8	0.082	0.022
% live stems 2.6–8 cm dbh	72.8	74.6	77.1	68.3	66.1	69.1	77.8	0.033	70.8	79.2	70.2	58.6	64.6	79.5	76.0	<0.001	0.139
% live stems >8 cm dbh	92.8	84.6	87.7	91.8	89.0	88.4	96.0	N/A[1]	90.8	89.1	89.4	89.9	81.9	84.5	86.0	N/A[1]	0.540
Percent basal area native	27.2	20.3	28.9	23.8	21.6	22.1	24.1	0.195	42.7	52.8	59.9	46.9	45.0	57.9	51.4	0.274	0.090
Total live foliage hits	17.4	17.7	11.3	17.0	19.3	17.1	17.8	<0.001	18.1	15.5	16.5	18.4	17.5	16.9	14.3	0.335	0.375
Total dead foliage hits	9.3	10.0	5.1	10.8	9.1	14.1	10.5	<0.001	8.4	6.6	6.1	11.0	6.3	8.5	9.2	0.042	0.003
Percent live foliage hits	62.7	62.0	65.8	58.7	63.8	56.1	59.3	0.006	69.1	70.0	69.6	64.8	72.9	67.6	58.7	0.065	0.281

[1] Model failed to converge; no P-value.

Table 7.5. Average Monthly Flows (cfs) Below Parker Dam, 2000–2011

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Difference (2001–present)	% Change (2001–present)
January	6,820	5,599	6,478	6,327	5,536	4,166	5,842	5,945	4,850	6,177	3,794	5,983	384	6.9%
February	9,123	8,505	8,978	6,881	7,129	4,888	7,798	8,491	8,232	7,137	5,960	6,470	-2,035	-23.9%
March	11,594	10,524	11,334	12,360	11,523	9,699	9,752	11,122	12,180	11,973	10,879	10,881	357	3.4%
April	14,613	14,090	13,610	13,803	12,824	11,356	11,985	12,618	14,293	13,184	11,259	12,594	-1,496	-10.6%
May	14,174	14,068	12,826	11,990	12,252	11,428	11,998	11,718	11,339	10,533	10,765	10,798	-3,270	-23.2%
June	13,803	14,733	13,713	12,778	12,741	12,444	12,383	12,116	11,957	9,992	10,931	11,394	-3,339	-22.7%
July	14,210	14,974	14,439	13,100	12,331	13,842	11,688	12,180	12,226	10,645	12,098	11,438	-3,536	-23.6%
August	11,441	12,047	12,118	10,803	11,420	10,316	10,141	10,317	10,720	9,459	10,508	8,951	-3,096	-25.7%
September	11,233	10,837	10,429	11,159	9,566	9,048	7,334	9,195	9,072	8,492	9,803	7,637	-3,200	-29.5%
October	9,362	8,852	8,765	9,761	7,405	6,967	7,424	7,204	7,568	7,241	7,562	7,111	-1,741	-19.7%
November	7,437	7,357	7,049	6,153	5,163	6,335	6,094	5,420	6,369	6,136	6,435		-922	-12.5%
December	6,706	5,970	5,615	5,737	4,129	4,841	5,507	4,079	3,829	4,872	4,315		-1,655	-27.7%

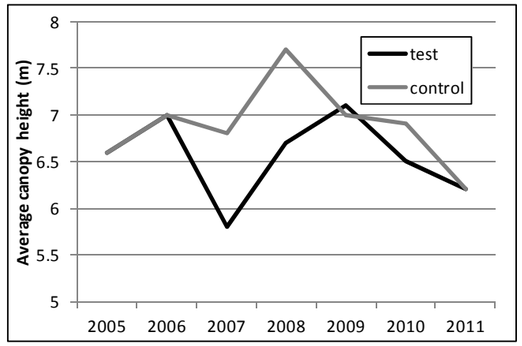

Figure 7.9. Average canopy height at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

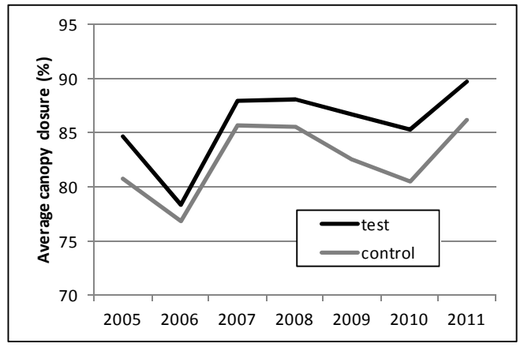

Figure 7.10. Average canopy closure at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

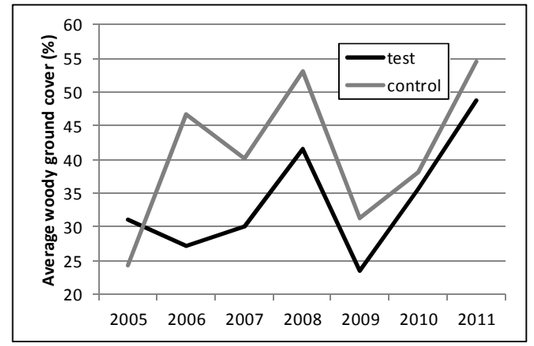

Figure 7.11. Average percent woody ground cover at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

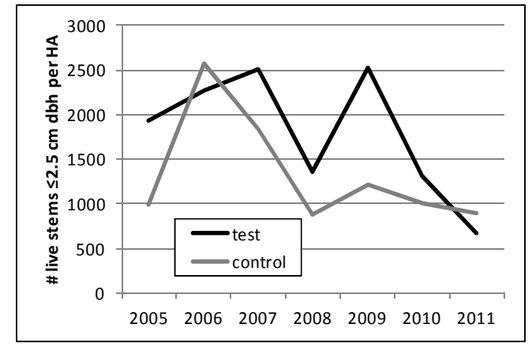

Figure 7.12. Average number of live stems ≤2.5 cm dbh per hectare at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

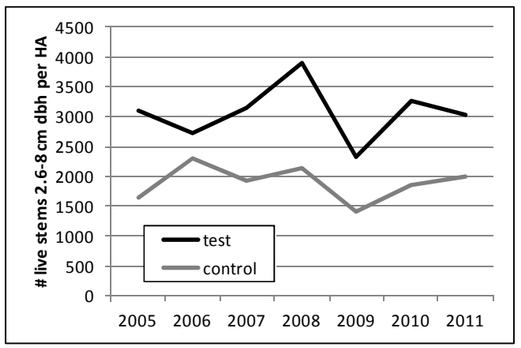

Figure 7.13. Average number of live stems 2.6–8 cm dbh per hectare at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

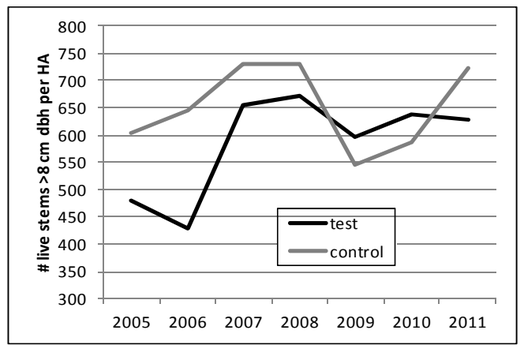

Figure 7.14. Average number of live stems >8 cm dbh per hectare at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

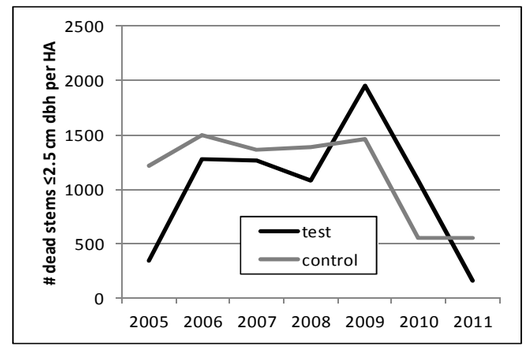

Figure 7.15. Average number of dead stems ≤2.5 cm dbh per hectare at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

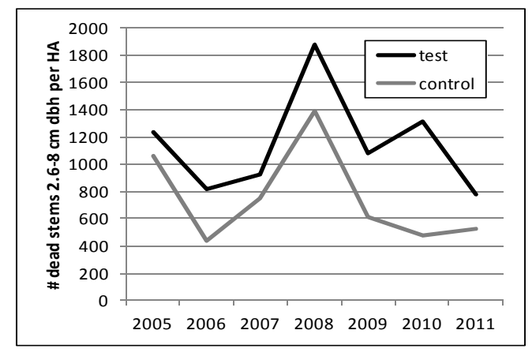

Figure 7.16. Average number of dead stems 2.6–8 cm dbh per hectare at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

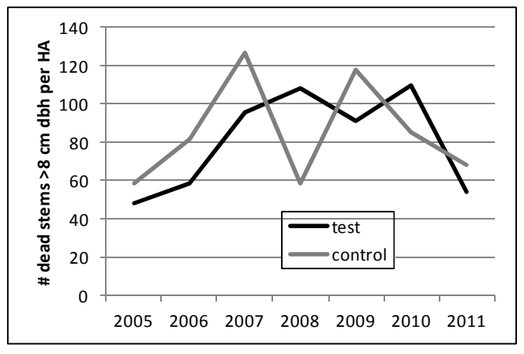

Figure 7.17. Average number of dead stems >8 cm dbh per hectare at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

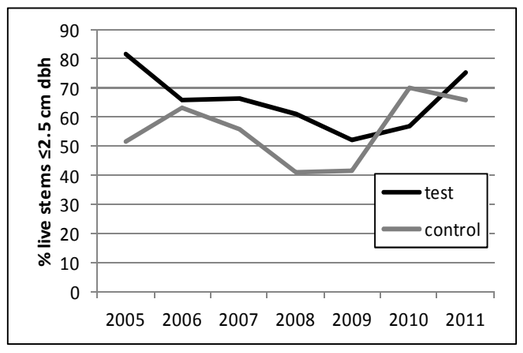

Figure 7.18. Percent of stems ≤2.5 cm dbh that were live at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

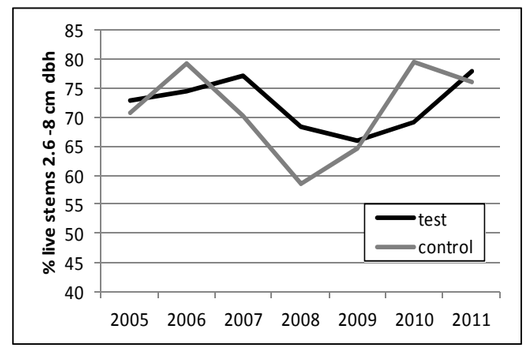

Figure 7.19. Percent of stems 2.6–8 cm dbh that were live at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

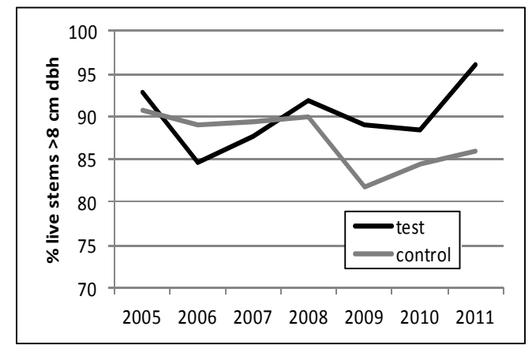

Figure 7.20. Percent of stems >8 cm dbh that were live at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

DISCUSSION

Microclimate

Between-year Comparisons of Microclimate Characteristics

Comparisons of microclimate characteristics among years in 2005–2011 at the habitat monitoring sites indicated hotter and more humid conditions in 2006 than in the other years and cooler conditions in 2009. The interannual changes in temperature were similar between test and control sites, suggesting that these changes were regional rather than being influenced by local conditions. The interannual changes in soil moisture in 2005–2006, 2007–2008, and 2009–2010 were not similar between test and control sites, with soil moisture declining more sharply at the control sites during the first two periods and then rising sharply during the third. This suggests that local conditions, in addition to regional climate, may have influenced soil moisture. However, the role of river flows in influencing soil moisture is unclear, given that no strong relationship was found between piezometer levels and soil moisture (McLeod and Koronkiewicz 2009). Although vapor pressure fluctuated more sharply between years at test versus control sites, both test and control sites exhibited fluctuations in vapor pressure that were consistent with the annual fluctuations in dew point recorded at the Needles, California weather station (Coop ID 46118; Figure 7.25). Thus, regional weather appears to have an overriding influence on humidity within both test and control sites.

Vegetation

Between-year differences across all sites were noted for many variables, but none showed unidirectional trends over time, suggesting there has been no overall, detectable change in vegetation. Many vegetation characteristics that varied over time showed parallel changes at control and test sites, suggesting either widespread yearly variation or observer variation between years.

Few variables showed changes that were specific to control or test sites, and several of those variables had marginally significant (> 0.01) *P*-values. Only woody ground cover and dead vertical foliage had *P*-values < 0.01. Ground cover did not differ from 2005 to 2007 at test locations but increased at control plots in 2006 and then decreased in 2007. It is not clear whether this represents actual changes in the amount of woody ground cover or whether it is a result of observer variation. Vertical foliage counts of dead vegetation have increased overall over the last several years at test plots, although there has been considerable yearly fluctuation, and the percentage of the vertical foliage that consists of live vegetation has dropped accordingly. The interannual fluctuations make it difficult to draw inferences about general trends in vegetation health. In addition, we have not recorded an increase in the number of dead stems, suggesting that there has been no noticeable increase in plant mortality (but see discussion of stem counts, below).

The pooling of all sites into a test vs. control analysis may obscure changes in vegetation at specific sites. For example, one vegetation plot at Ehrenberg contained a significant coyote willow component (98% of the total basal area) in 2005. The willow gradually died over the next several years until no live willow remained in 2009. Most of the vegetation along the LCR, including at the sites selected for habitat monitoring, consists primarily of tamarisk, which is less sensitive than willow to changes in water availability. Measurable changes in overall vegetation as a response to reduced groundwater levels may take several years to develop in tamarisk, or the tamarisk may change very little if at all.

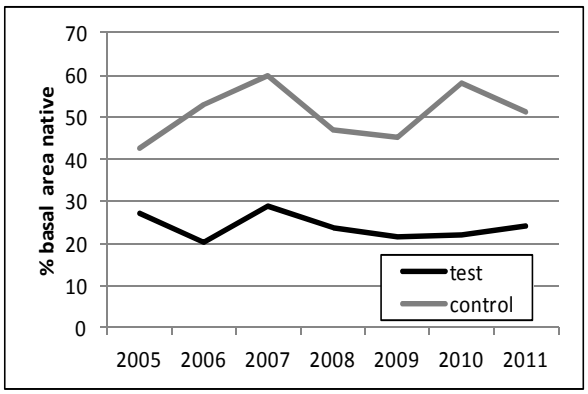

Figure 7.21. Percent of basal area that consisted of native vegetation at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

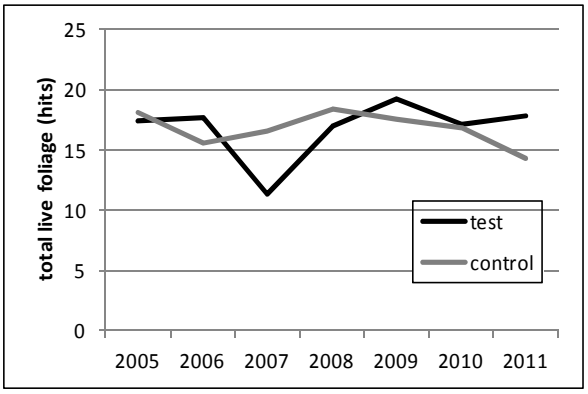

Figure 7.22. Total live vertical foliage hits at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

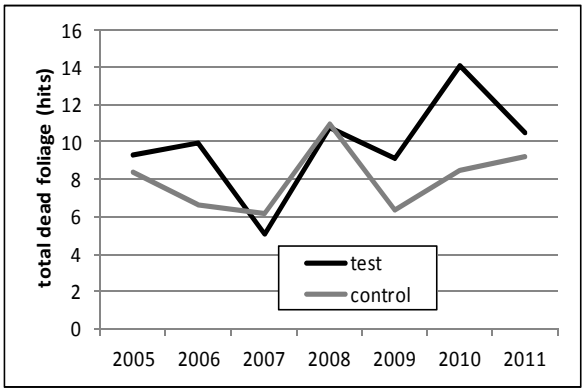

Figure 7.23. Total dead vertical foliage hits at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

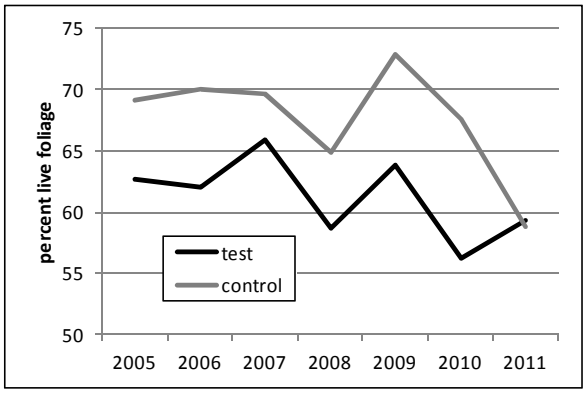

Figure 7.24. Percent live vertical foliage hits at test and control habitat monitoring sites, lower Colorado River, 2005–2011.

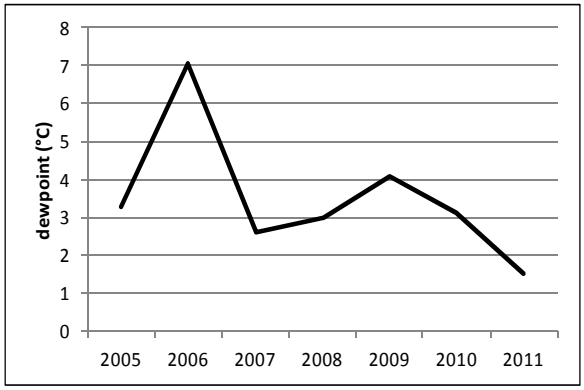

Figure 7.25. Mean dew point recorded at the Needles, California weather station, July and August, 2005–2011.

It has become apparent, after measuring the same vegetation plots for several consecutive years, that stem counts in very dense vegetation are inherently inaccurate and imprecise and can vary widely from year to year when there has likely been no appreciable change in stem density. Repeatability of stem counts depends on having a plot of fixed size. Each plot is divided into quadrants, with a rope having the 5-m distance (the edge of the plot) clearly marked extended in each cardinal direction from plot center. It can be nearly impossible to extend the rope flat or straight, introducing variability into the size of the plot. Even more problematic than this, however, is the inability of the observers, in very dense vegetation, to see the cardinal ropes from the center of the quadrant or to see the center of the plot from the edge to be able to envision an arc connecting the ends of two adjacent cardinal ropes and delineating the edge of the circular plot. Observers vary widely in their ability to estimate distance, and when reference points are not visible, it is very difficult to determine whether a stem near the edge of the plot falls within the plot or not. In 2009, we explicitly instructed observers to use a measuring tape to determine the distance from plot center for any stem for which inclusion in or exclusion from the plot seemed questionable.

This method should help reduce difficulties in producing repeatable stem counts but still depends on observers being able to tell when they are near the edge of the plot and taking the extra time to measure distance if the inclusion of a stem is in question. Another factor that inhibits accurate stem counts in dense vegetation is the difficulty in keeping track of which stems have been counted already and which have not. In 2009, we began using chalk to mark stems that had already been counted to try to minimize omission or double-counting of stems.

Given the difficulties in producing repeatable stem counts, absolute stem counts are likely not a suitable metric for detecting subtle changes in vegetation. The proportion of live stems may provide a more sensitive metric by which to detect change; the accuracy of this measure depends only on each observer counting live stems in a manner consistent with how s/he counts dead stems. Similarly, the proportion of live vertical foliage is likely to provide a more sensitive measure of changes in vegetation than do the absolute vertical foliage counts.

The detection of changes in vegetation as the result of the diversion of water at Parker rather than Imperial Dam is further hampered by the complete lack of vegetation measurements prior to the beginning of the diversion in 2002. Vegetation measurements did not commence until 2005, by which time it is possible that some changes in vegetation, particularly in sensitive species such as coyote willow, had already occurred as the result of decreasing flows from 2001 to 2005 (see Table 7.5). Other methods, such as analysis of satellite imagery, would have to be used to detect any changes in vegetation that might have occurred prior to 2005.

Groundwater Levels

Correlation of Piezometer Groundwater Levels with Soil Moisture Measurements

In previous years we correlated piezometer ground water levels and soil moisture measurements and found no strong linear relationship. The strongest relationships were found at sites that had the highest soil moisture values. This suggests that at sites where soil moisture is low, surface soil moisture content is not influenced by groundwater levels, and soil moisture measurements are unlikely to reflect any changes in water availability caused by changing river levels. We recommend discontinuing soil moisture measurements at Havasu NE, Cibola Lake, Clear Lake, Ferguson Wash, and Gila Confluence North, where soil moisture values are consistently below 600 mV.

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Chapter 8

SURFACE HYDROLOGY, MICROCLIMATE, AND VEGETATION MONITORING: TOPOCK MARSH

INTRODUCTION

Monitoring of Southwestern Willow Flycatcher populations at Topock Marsh began in 1997, and data on number of flycatcher pairs and nest success are available for 1998–2011. The breeding population at Topock declined from a high of 29 pairs in 2004 to fewer than 10 pairs in 2007 and 2008. This decline prompted concern from USFWS about the flycatcher population at Topock, which was presumed to be the likely source population for any flycatchers that would colonize restoration areas on the lower Colorado River. USFWS and Reclamation initiated discussions after the breeding season of 2008 to identify habitat enhancement measures that could be implemented at Topock Marsh in an attempt to raise the number and productivity of flycatchers.

The affinity of breeding Southwestern Willow Flycatchers with standing water and saturated soil is noted consistently in the literature (e.g., Johnson et al. 1999, Munzer et al. 2005, McLeod et al. 2008a, Graber and Koronkiewicz 2009b), and flycatcher nests along the Middle Rio Grande that were above inundated or saturated soil all season produced more young per successful nest than nests that were above dry soil all season (Moore and Ahlers 2008). An examination of water levels within Topock Marsh from 1997 to the present shows that after 2004, water levels peaked at lower levels, high water levels were of shorter duration, and over-winter lows were lower than was the case prior to 2004 (Figure 8.1). Because of the influence of surface water on flycatcher occupancy and productivity, USFWS and Reclamation developed a plan to pump water into a portion of the flycatcher habitat at Topock Marsh.

Two adjacent areas within Topock, known as In Between and 800M, were selected in 2008 as the location for habitat enhancement via supplemental water delivery. The number of breeding flycatcher pairs in these areas declined steadily from 10 in 2004 to 0 in 2008, but the vegetation in the area had not changed markedly during that time (McLeod and Koronkiewicz 2010). The addition of surface water and saturated soil to this area might make it more attractive to flycatchers and increase nest success and productivity of any flycatchers that nest in the area. In addition, widespread inundation could make portions of In Between, 800M, and the surrounding area that typically had been dry during surveys since 2003 and not occupied by flycatchers more suitable for flycatcher occupancy.

Supplemental water delivery commenced in March 2011. We monitored hydrological, microclimate, and vegetation conditions at In Between, 800M, and the adjacent area of Pierced Egg in 2009 and 2010 to assess baseline habitat conditions. We completed the same monitoring in 2011 during water delivery.

METHODS

Water Delivery

Over the winter of 2010–2011, the water delivery system was installed. The system consisted of a Crisafulli trailer pump, modified to be hydraulically driven and capable of moving approximately 41.6 m^3 (11,000 gallons) of water per minute, along with a 0.61 m (24 inch) diameter pipe carrying the water into the target area (In Between, 800M, and Pierced Egg) from the open water of Topock Marsh.

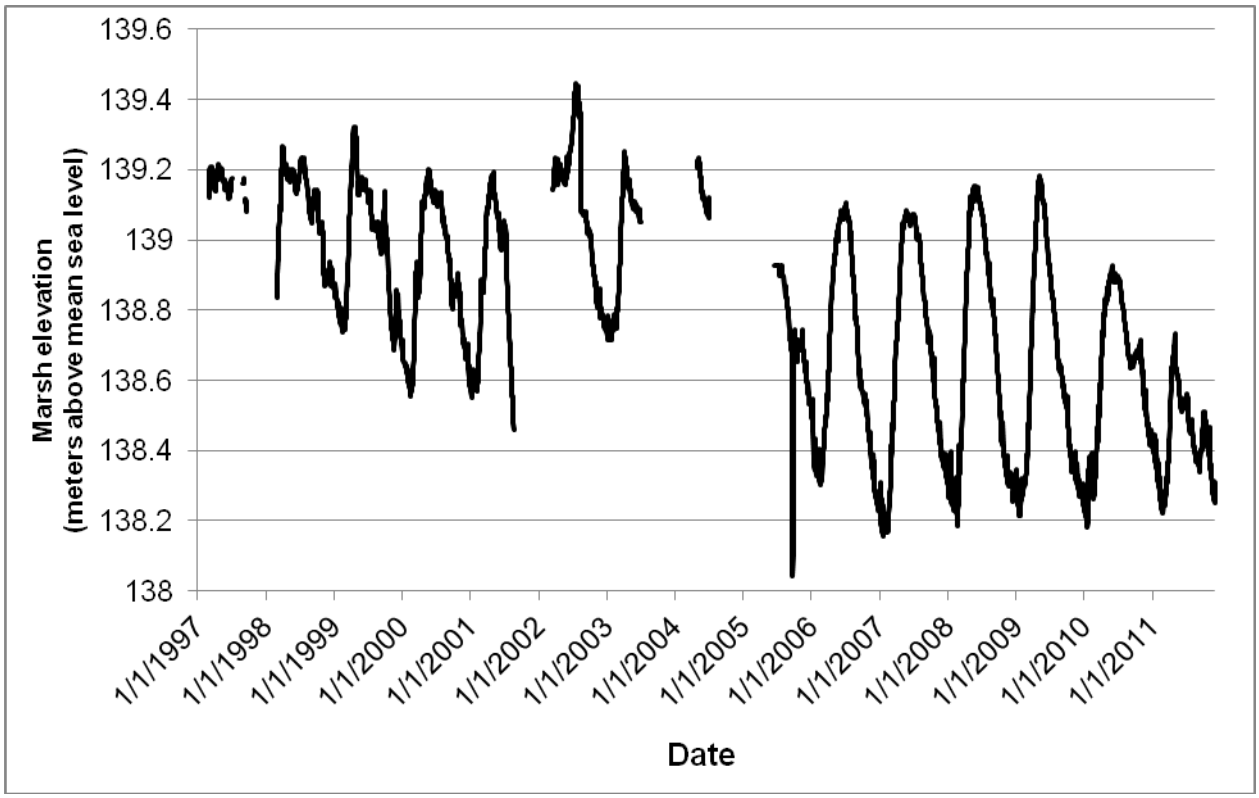

Figure 8.1. Marsh elevation (meters above mean sea level) measured at the South Dike at Topock Marsh, 1997–2011.

Surface Water Mapping

We mapped surface water at weekly intervals between 14 March and 21 July 2010. In 2011, we mapped water within the target area immediately prior to the initiation of water delivery on 1 March and for three days following the initial pumping. This provided baseline data on water levels, the maximum extent of water, and the longevity of water within the target area. We continued visiting In Between, 800M, and Pierced Egg at approximately weekly intervals through mid-July. During each visit, we traversed trails throughout each site and used GPS and aerial photographs to map the extent and depth of surface water within the sites. At the conclusion of each visit, we compiled our GPS points and field notes to prepare a hardcopy map of the sites, with areas of surface water and saturated soils delineated on the map and indexed to a key detailing the nature (e.g., pig wallow, open marsh, flooded forest) and depth of each wet area. All hardcopy maps were digitized after the field season using ArcGIS. From the digitized shapefiles, we calculated the percentage of the target area that contained surface water at each visit.

Groundwater Measurements

A 0.02 m (¾-inch) diameter shallow well, or piezometer, equipped with a pressure transducer and data logger was installed in 2006 in In Between at Topock Marsh as part of habitat monitoring between Parker and Imperial Dams (see Chapter 7). This piezometer is within the target area of water delivery and thus was left in place when the other piezometers used in the study were removed. This piezometer is described in McLeod et al. (2007) and has been downloaded approximately three times per year since installation. At each download we checked the battery level and function of the data logger. Batteries were replaced as necessary and data were examined to ascertain potential equipment malfunction.

Data Collection

A pressure transducer/data logger equipped with a vented cable collected data hourly at the piezometer. These devices measure and record pressure of the water column present in the well, and these pressure measurements are then converted into water levels (in distance below top of casing). With vented cables and data transfer ports 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 transducer, as well as at each data download thereafter, water level was manually measured in the piezometer using an electric water level sounder (Solinst-brand). This known water level was then used to program the pressure transducer with a baseline measurement from which all other automatically recorded water levels were calculated.

Data Validation

We have identified several potential sources of error in the water levels recorded by piezometers. We developed a rigorous protocol to validate each data download, determine if any errors exist with the data, and correct the raw data if possible. Specific sources of error are identified below.

Install Drift. Because piezometers are constructed such that the pressure transducer is almost the same diameter as the inside of the piezometer, removing and inserting the pressure transducers to change batteries can change the water levels in the piezometer temporarily but drastically.

Operational Drift. In rare cases, the accuracy of the data loggers can change in the time period between downloads.

Improper Setup. After downloading data, the data logger is reset for the next round of measurements. Conducting the startup procedure improperly can lead to errors; fortunately, most of these setup errors can be corrected. Common errors include mistakenly setting the type of reference used (i.e., recording water level elevation instead of depth), not resetting the starting water level reference value to the water level value measured manually in the field, and not restarting the data logger but continuing with the previous setup.

At each download, we compared the water level recorded by the piezometer with the manual measurement. We also checked the data logger parameters to determine whether the data logger was initialized properly. If a discrepancy >0.09 m (0.3 feet) existed between the data logger and the manual measurement, and this discrepancy could not be accounted for and corrected by examining the setup parameters and applying an appropriate correction factor, the data were not used for analysis.

Microclimate

In 2009, the In Between, 800M, and Pierced Egg polygons were stratified into use (occupied by flycatchers) and non-use (unoccupied by flycatchers) areas, as observed in 2003–2008. Use areas tend to be wetter than non-use areas and thus are presumably low-lying and more likely to be affected by water delivery into the habitat. We excluded the cattail marsh in the center of the 800M polygon from either the use or non-use areas. We superimposed a 25- x 25-m grid on a GIS software shapefile of the use and non-use areas, numbered the grid blocks, and selected blocks using a random number generator. We used the centroid of the selected block as the sample point and located each point in the field by navigating to the given coordinates using a Rino 110 GPS unit. We determined the exact location of each sample point by means of random number sequences as described in Chapter 6. All sample points used in 2009 were marked in the field with flagging that remained in place over the 2009–2010 and 2010–2011 winters,

allowing for relocation at the beginning of each subsequent season. We relocated each sample point in 2011 and redeployed a data logger in the same location. We used HOBO H8 Pro data loggers (see Chapter 6) to record temperature and humidity at each sample point at 15-minute intervals. Each logger remained in place until the end of the flycatcher breeding season. We collected soil moisture readings, as described in Chapter 6, below each data logger at bi-weekly intervals.

Vegetation

In late July of each year 2009–2011, at the end of the flycatcher breeding season, we collected vegetation measurements at each HOBO logger location. Vegetation plots were centered on the logger, and we collected the vegetation measurements described in Chapter 5, with the exception of stem counts. Given the relatively short time span between the implementation of water delivery and the subsequent vegetation measurements, any responses in vegetation are more likely to be apparent in canopy closure and vertical foliage density than in stem counts.

Data Analyses

We had originally stratified the sample points into use and non-use areas on the assumption that the use areas were more likely to be inundated during water delivery. The water that was pumped into the target area did not reach all the use areas; therefore, we reclassified the points into flooded and non-flooded areas (also referred to as flood groups) according to whether the point was within 20 m (i.e., within a distance that would be encompassed by a flycatcher territory [Sedgwick and Knopf 1992]) of the maximum extent of water recorded immediately post water delivery in 2011. We compared data collected during 2011 to those collected in 2010. We did not include data from 2009 in the comparison because temperature and humidity data collected at the Needles, California weather station (Coop ID 46118) indicated that weather conditions in 2011 were overall more similar to those in 2010 than in 2009, and similar weather data between years may facilitate interpretation of between-year comparisons.

Microclimate

Microclimate data were summarized as described in Chapter 6. All data were summarized separately for flooded and non-flooded areas. We used a repeated measures analysis using a linear mixed model to compare the seasonal changes in flooded versus non-flooded areas in 2010 and 2011. We also used a repeated measures analysis using a linear mixed model to compare temperature and humidity variables the day after a flood event to those recorded the day before the flood event in flooded versus non-flooded areas in 2011. All analyses were completed using SAS® Version 9.2 (SAS Institute 2009).

Vegetation

Vertical foliage data were summarized as described in Chapter 5. Percent native vegetation was calculated as the percent of the foliage hits that consisted of native vegetation. We used the average nest height (3.78 m) recorded at In Between, 800M, and Pierced Egg from 2003 to 2008 to delineate the below, at, and above nest height categories. All data were summarized separately for flooded and non-flooded areas. We used a repeated measures linear mixed model to compare the conditions measured in each flood group in 2011 versus those measured at those same points in 2010. We also used this model to detect any year*flood group interactions, which indicate that the between-year change detected for a given variable in the flooded area differed from the change detected in the non-flooded areas. We used SPSS® Version 16.0 (SPSS Inc.) software for statistical analyses.

RESULTS

Water Delivery

Water delivery was initiated on 1 March and continued through 7 July. The pump was operated once a week for several hours (Table 8.1), and the hours of operation and flowmeter readings were recorded in a log book.

Table 8.1. Dates of Water Mapping and Water Delivery, Length of Pump Operation, and Total Pump Output, Topock Marsh, 2011

Date of Pumping	Hours Operated	Total Pump Output (millions of gallons)	Total Pump Output (cubic meters)	Date(s) of Water Mapping
1 Mar	4.7	3.10	11735	27–28 Feb, 1–3 Mar
10 Mar	5.9	3.89	14725	11 Mar
17 Mar	3.3	2.18	8252	18 Mar
24 Mar	4.8	3.17	12000	25 Mar
31 Mar	5.3	3.50	13249	1 Apr
7 Apr	4.5	2.97	11243	8 Apr
13 Apr	4.3	2.84	10751	15 Apr
21 Apr	4.3	2.84	10751	22 Apr
28 Apr	4.5	2.97	11243	29 Apr
5 May	5.6	3.70	10221	---
12 May	4.0	2.64	9994	14 May
19 May	4.1	2.71	10258	20 May
26 May	1.8	1.19	4505	24 and 29 May
2 Jun	3.5	2.31	8744	3 Jun
9 Jun[1]	4.2	2.77	10493	8 Jun
16 Jun[1]	4.2	2.77	10493	17 Jun
23 Jun	4.0	2.64	9994	22 Jun
30 Jun	4.5	2.97	11243	1 Jul
7 Jul	4.0	2.64	9994	6 and 15 Jul

[1] No data recorded, hours and pump output estimated from flowmeter reading on 23 Jun.

Surface Water Mapping

Immediately prior to the start of water delivery on 1 March, surface water was limited to pig wallows in Pierced Egg (Figure 8.2, map from 28 February). Surface water covered portions of In Between and 800M immediately after pumping on 1 March (Figure 8.2, map from 1 March). There was a noticeable decrease in water extent over the following two days (Figure 8.2, maps from 2 and 3 March; and Figure 8.3), but we determined that weekly pumping would be sufficient to maintain elevated water levels within the target area. From March to late May, all weekly visits occurred on the day immediately following water delivery. Starting in late May, we alternated our weekly visits to fall on the day before water delivery and the day after water delivery so we could document minimum and maximum extent of water (Table 8.1). During this latter part of the season, the extent of the inundated and saturated area in In

Between and 800M remained relatively constant throughout each week following pumping (Figure 8.4). In general, water delivery maintained water levels above those of 2010 (Figure 8.3), despite the markedly lower water levels within Topock Marsh in 2011 compared to 2010 (see Chapter 2).

We noted an increase in surface water within Pierced Egg starting in March and peaking by mid-April; by the end of April, Pierced Egg was completely dry (Figure 8.5). Surface water from the pumping did not flow into Pierced Egg, and the fluctuation of water levels in Pierced Egg was likely the result of a rise in local groundwater levels, which typically peak in April (see Groundwater Monitoring, below) and could also have been influenced by water delivery. The peak in groundwater levels is reflected in the overall percentage of In Between, 800M, and Pierced Egg that was inundated or saturated, which also peaked in mid-April and fell rapidly by early May (Figure 8.3). Water delivery appeared to result in a greater extent of surface water early in the season when overall groundwater levels throughout the area were relatively high. Later in the season, when overall groundwater levels had dropped, surface water was generally restricted to In Between, with portions of 800M sometimes having saturated soil.

Groundwater Monitoring

The piezometer at Topock Marsh shows that local groundwater levels typically peak each year in April (Figure 8.6). Daily cycles are apparent in the hydrograph across all years, showing low water levels during the afternoon hours when vegetation water demands and evapotranspiration are greatest and high water levels in early morning hours. The magnitude of the daily cycle is greatest during the summer months when vegetation demands are greatest and lowest during the winter months when cooler daily temperatures and dormant vegetation result in lower water demands.

Weekly trends in groundwater levels were apparent in March–July 2011 (Figure 8.7) and paralleled the pumping schedule, with groundwater rising on the day of pumping and falling through the week until the next pumping. When groundwater levels were at relatively high levels in March and April, each pumping session increased the groundwater level at the piezometer approximately 0.08 m (0.25 feet) and then the water level fell linearly through the week until the next pumping session. As water levels dropped in May and June, the effect of each pumping session on the water level at the piezometer increased; each pumping session increased the water level by up to 0.23 m (0.75 feet), and water levels fell more rapidly immediately following pumping than they did later in the week. The groundwater level recorded by the piezometer peaked at the highest level recorded in any year since 2006, showing that water delivery raised the local groundwater table within the target area despite the overall lower water table in the marsh (see Chapter 2).

Microclimate

In 2010, we deployed 15 HOBO loggers in the flooded area and 17 loggers in the non-flooded area between 14 and 29 March (Figure 8.8). All loggers functioned correctly in 2010. In 2011, we deployed HOBO loggers in these same locations between 27 February and 11 March. In 2011, two loggers, one in the flooded area and one in the non-flooded area, failed to launch and collected no data; one logger in the flooded area had a faulty humidity sensor, and humidity data from this logger were excluded from the analysis. Data analyses were restricted to the period between 1 April and 15 July to encompass the dates when all loggers were deployed in both years. In 2010, soil conditions became progressively drier throughout the season for both the flooded and non-flooded areas, while temperatures rose throughout the season and vapor pressure values showed the typical rise seen in July with the onset of summer monsoons

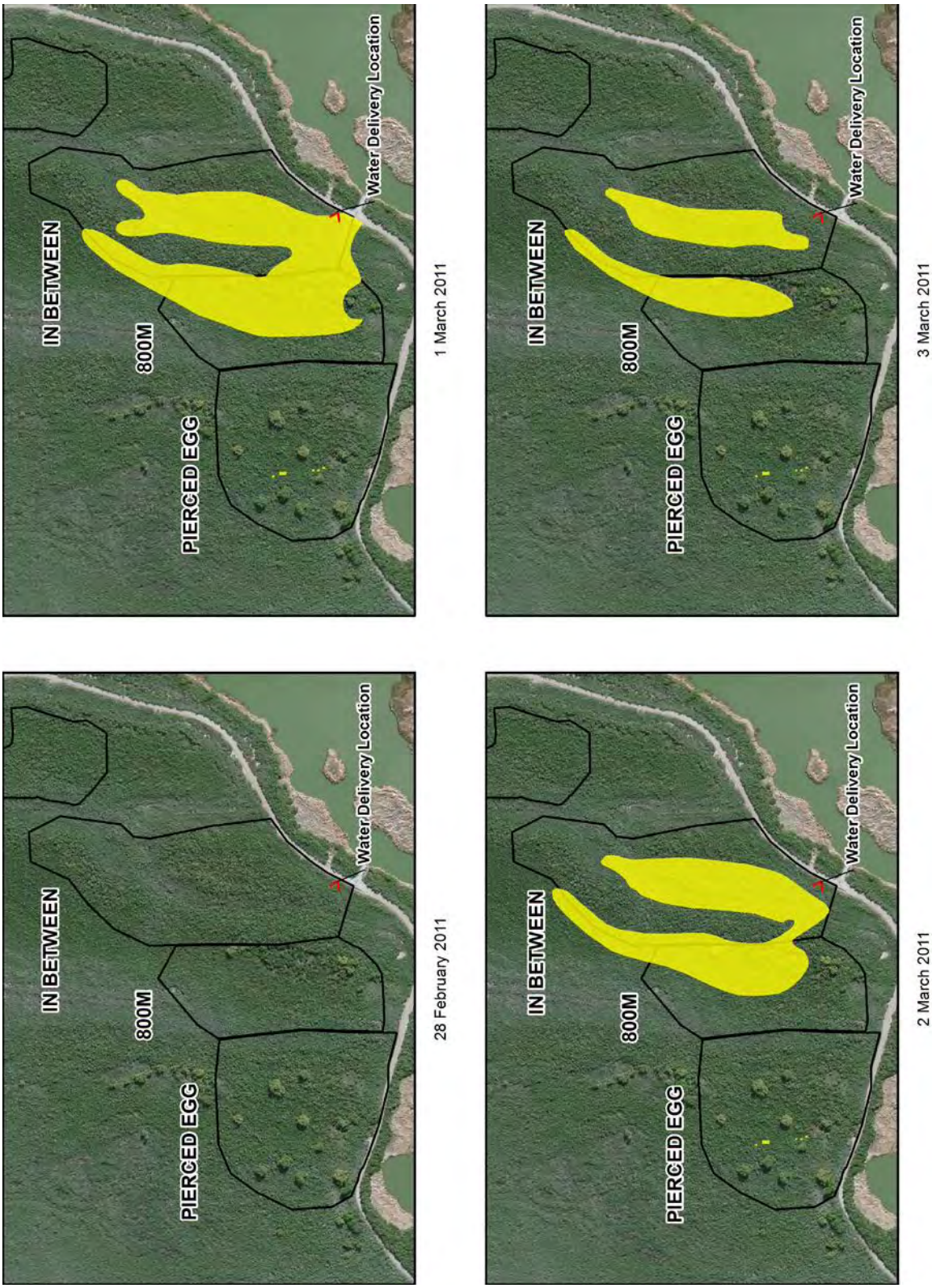

Figure 8.2. Extent of surface water within In Between, 800M, and Pierced Egg for the day before, the day of, and two days after the start of water delivery, 2011.

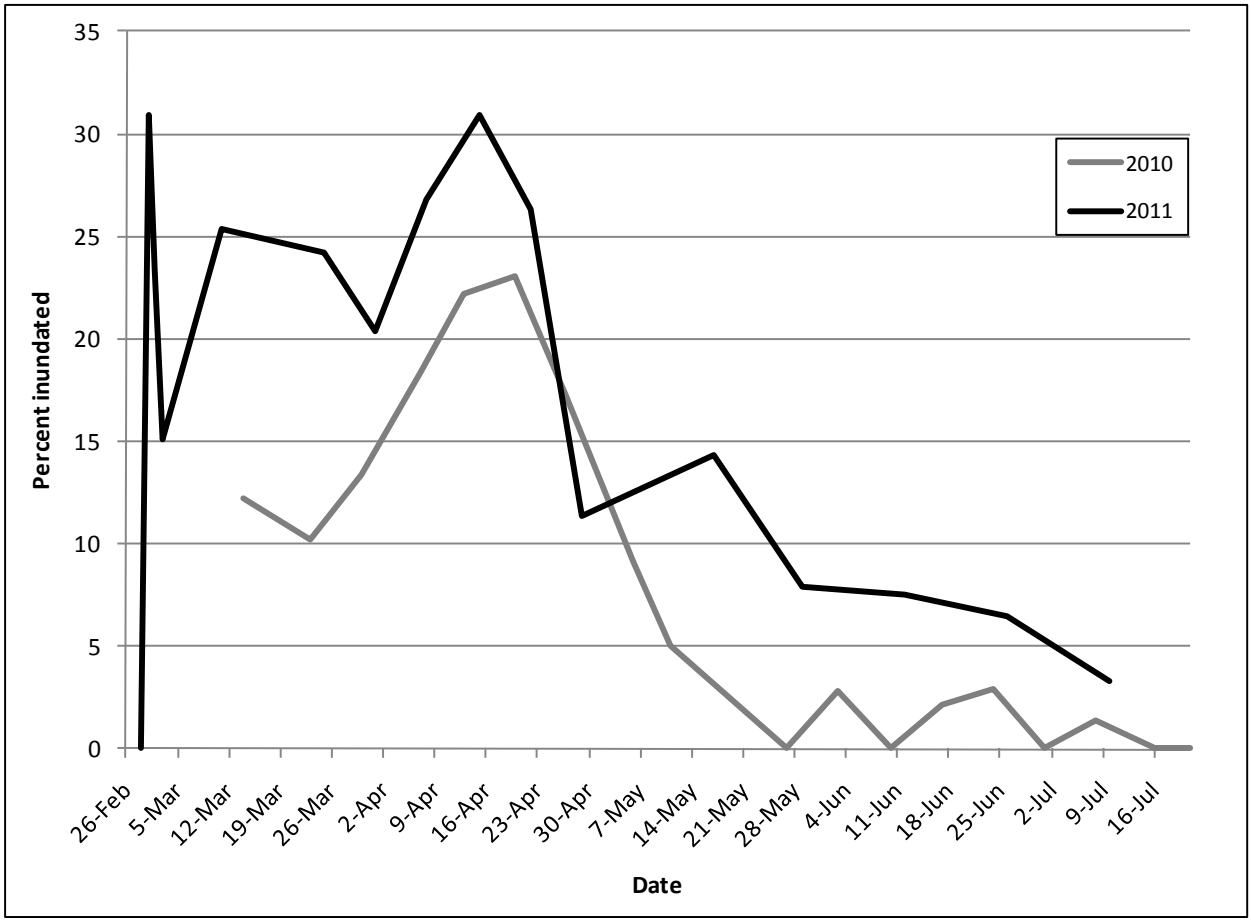

Figure 8.3. Percentage of In Between, 800M, and Pierced Egg, combined, that was inundated in March–July 2010 and 2011. Percentages are averaged over two-week periods for June and July 2011, because weekly visits alternated between the day before and the day after pumping.

(Tables 8.2 and 8.3). These same overall patterns were seen in 2011 (Tables 8.4 and 8.5). These data are shown graphically for easier comparison of data between years (Figures 8.9a–8.17a). Data are also shown as the difference between the flooded and non-flooded areas in both 2010 (the control year) and 2011 (Figures 8.9b–8.17b). If flooding had no effect, we would expect the differences between the flooded and non-flooded areas to be similar in both years.

Table 8.6 presents the significance test results (*P*-values) for the comparison of flooded versus non-flooded areas in 2010 and 2011. The first two columns show the comparison of each microclimate variable, overall across the season, in the flooded versus non-flooded areas in 2010 and 2011, respectively. Baseline data were collected in 2010, so significant *P*-values in this column indicate inherent differences between the flooded and non-flooded areas. A significant *P*-value in the column for a given year indicates a difference between flood groups, and corresponds to a significant gap between the solid (flooded) and dashed (non-flooded) lines for that year in Figures 8.9a–8.17a. A significant *P*-value for a given variable in only one year but not both suggests an effect of flooding.

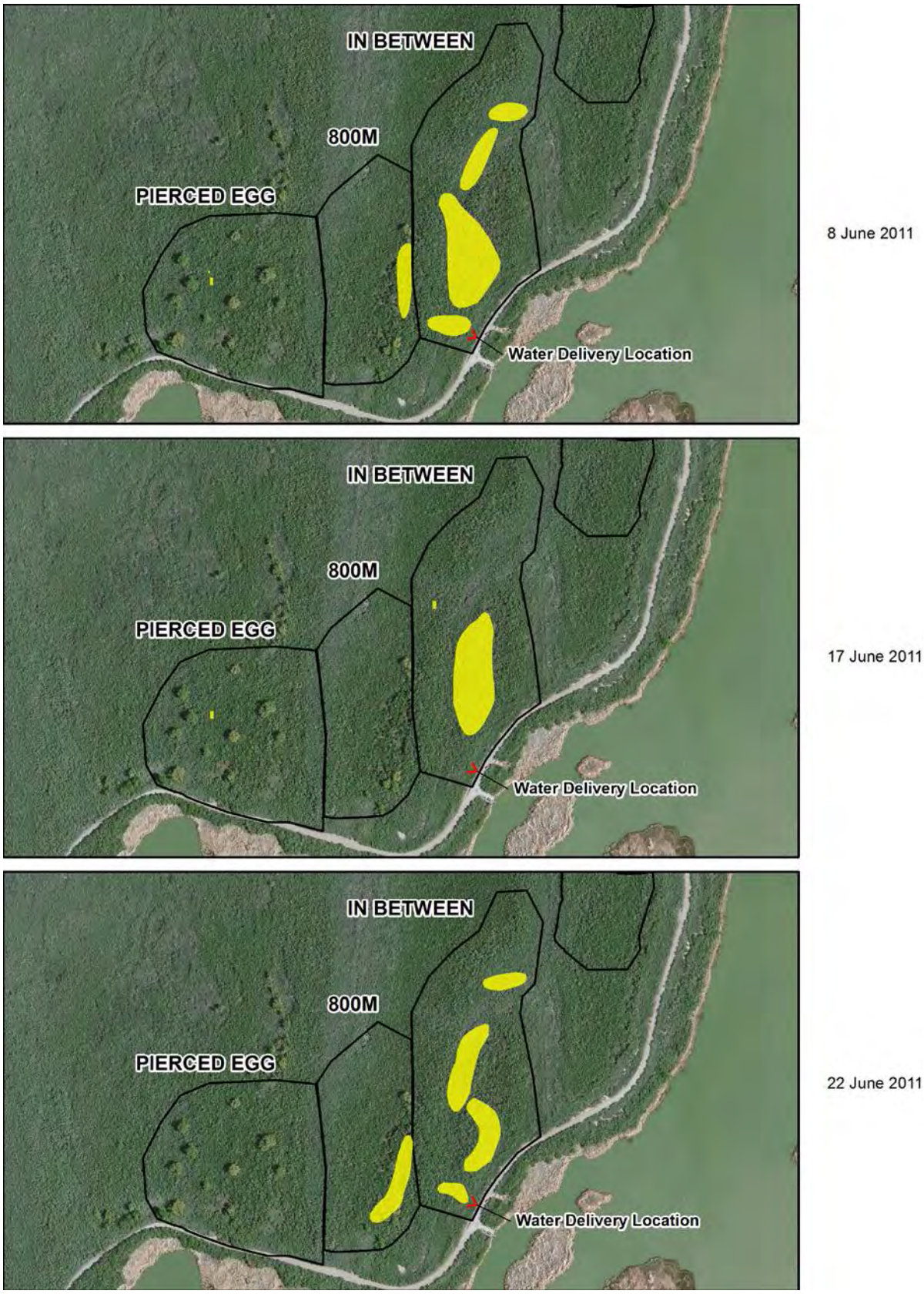

Figure 8.4. Extent of water within In Between, 800M, and Pierced Egg in June 2011.

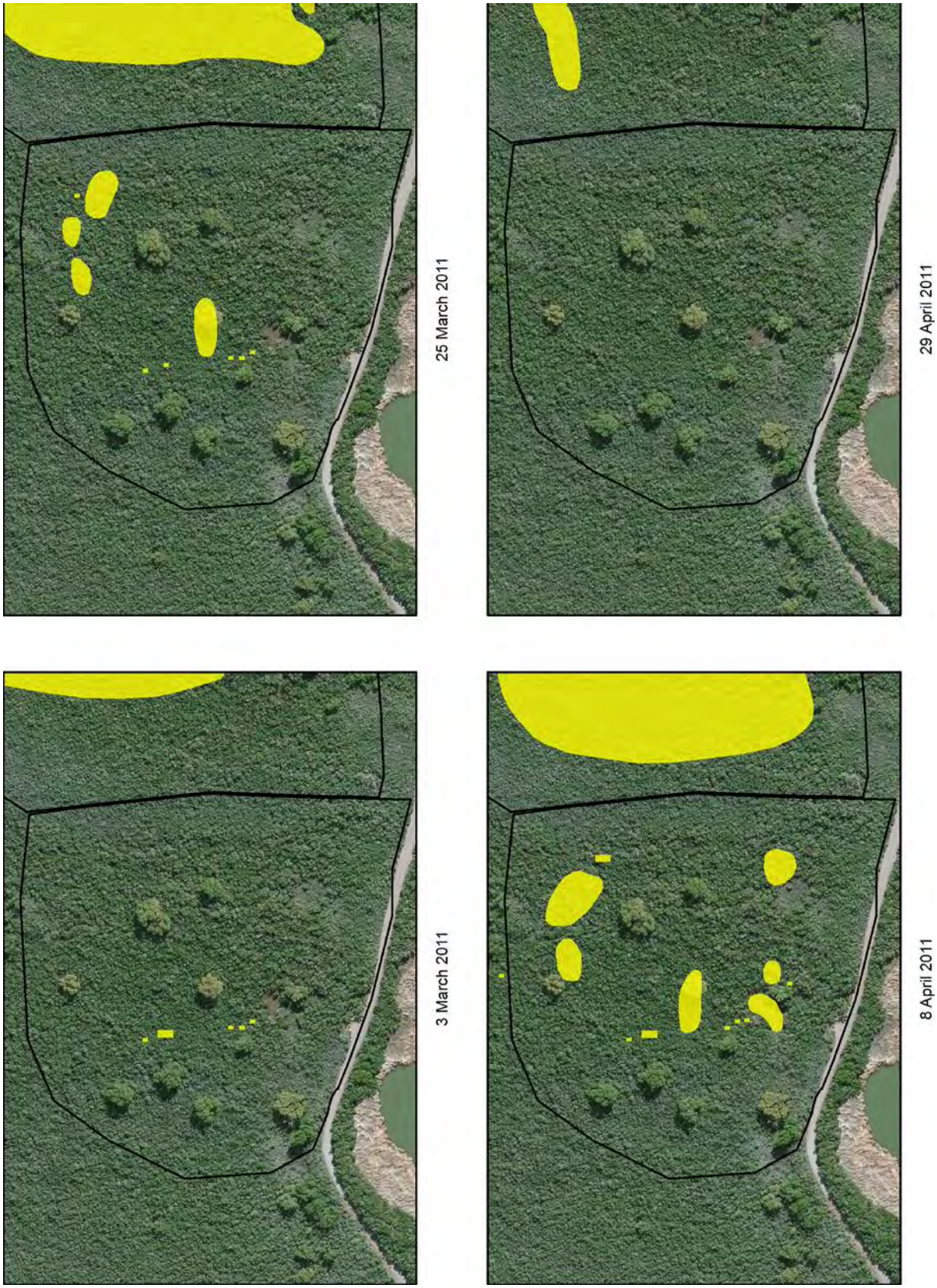

Figure 8.5. Water levels within Pierced Egg at approximately bi-weekly intervals in March and April, 2011.

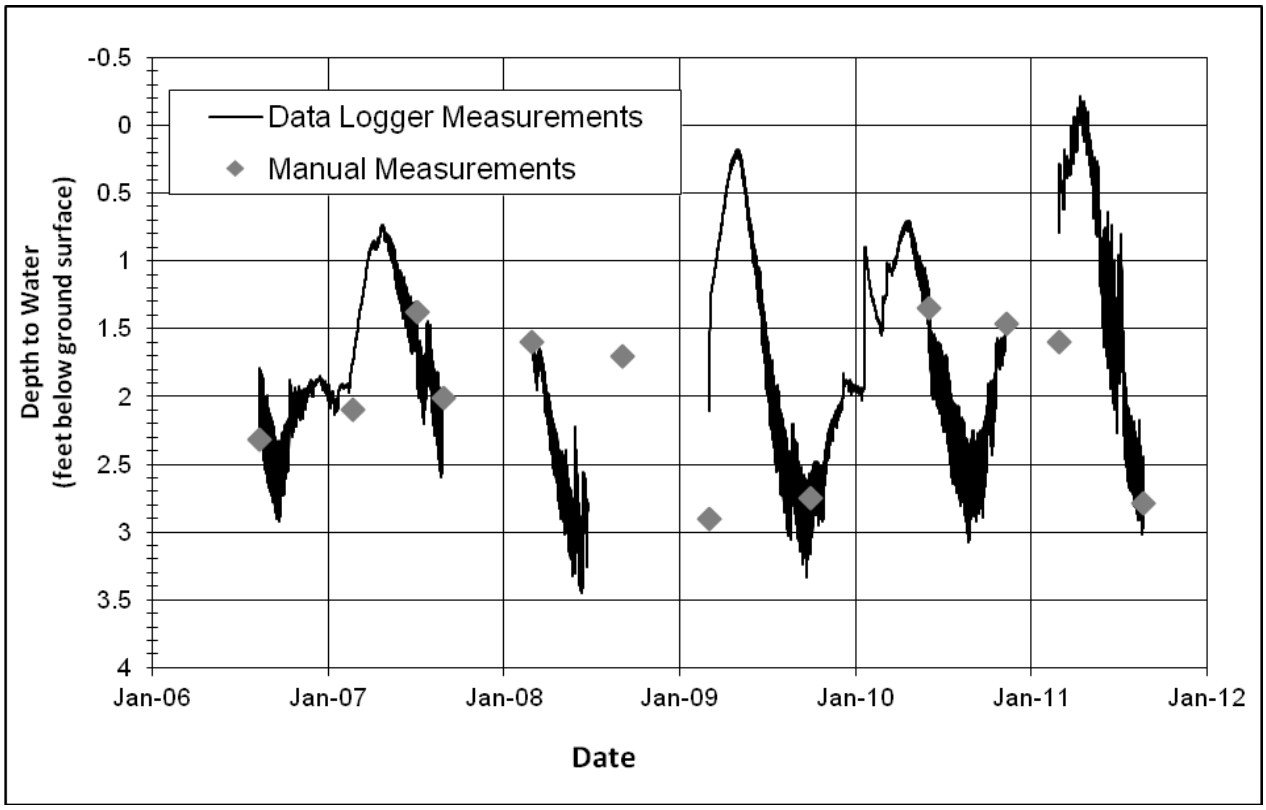

Figure 8.6. Topock Marsh hydrograph, 2006–2011.

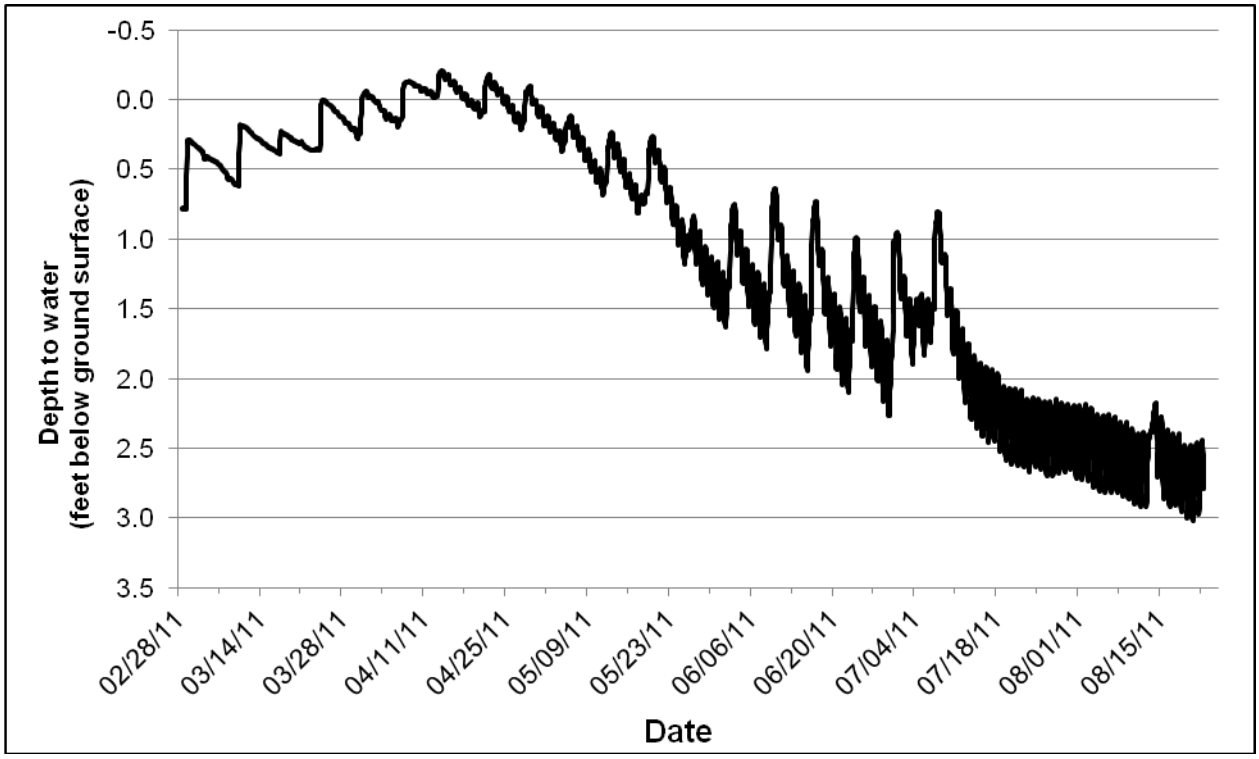

Figure 8.7. Topock Marsh hydrograph, February–July, 2011.

We also examined how each microclimate variable changed through the season. The third and fourth columns of Table 8.6 show *P*-values for the comparison of seasonal change in the flooded vs. non-flooded areas (i.e., the time*flood group interaction) in 2010 and 2011, respectively. Significant *P*-values in either column indicate that the microclimate variable changed through the season in the flooded area in a different way than in the non-flooded area in that year, and corresponds to non-parallel solid (flooded) and dashed (non-flooded) lines for that year in Figures 8.9a–8.17a. Again, a significant *P*-value for a given variable in one year but not the other suggests an effect of flooding.

We also examined between-year differences for soil moisture variables within the non-flooded and flooded areas (columns 5 and 6, respectively, of Table 8.6). We did not include results for the between-year analysis for temperature and humidity variables because significant between-year differences could be the result of variation in climate between years, and any between-year differences are difficult to interpret in a meaningful way. A significant *P*-value indicates an overall between-year difference within the flood group and corresponds to a significant gap between the gray (2010) and black (2011) lines for that flood group in Figures 8.9a–8.12a.

Finally, we compared change through the season for soil moisture variables in 2010 versus 2011 (i.e., the time*year interaction) within the non-flooded and flooded areas (columns 7 and 8, respectively, of Table 8.6). Again, we did not include the results of this analysis for temperature and humidity variables because any between-year differences are difficult to interpret in a meaningful way. A significant *P*-value indicates that, within the given flood group, the variable changed through time in 2010 in a different way than it changed through time in 2011. This corresponds to non-parallel gray (2010) and black (2011) lines for the flood group in Figures 8.9a–8.12a.

None of the measures of soil moisture and presence of surface water differed overall between flooded and non-flooded areas in 2010 under baseline conditions (Table 8.6, column 1). In 2011, three measures of surface water (distance to surface water, percentage of the area within 20 m that was flooded, and percentage of the area within 50 m that was flooded) differed between the flooded and non-flooded area (Table 8.6, column 2), with all three variables indicating wetter overall conditions in the flooded area (Figures 8.10–8.12). Soil moisture and both measures of the percentage of the area inundated showed a significant interaction between flood group and time in 2011 (Table 8.6, column 4); soil moisture declined more rapidly in the flooded versus the non-flooded area as the extent of the flooding decreased through the season (Figure 8.9), and the measures of the percentage inundated decreased throughout the season in the flooded area while they remained constant (at zero) through the season in the non-flooded area (Figures 8.11 and 8.12). The non-flooded area differed significantly between years in soil moisture, distance to water, and percentage of the area within 50 m that was inundated (Table 8.6, column 5); all measures reflected the overall lower marsh levels and resulting drier conditions in 2011. The flooded area differed between years in all measures of surface water (Table 8.6, column 5), with all variables indicating wetter conditions in 2011. Overall soil moisture in the flooded area did not differ significantly between years (Table 8.6, column 6) but did show a significant interaction between year and time (Table 8.6, column 8); soil moisture was higher in 2011 than in 2010 early in the season but had dropped to a lower level in 2011 than in 2010 by early June, again illustrating the overall dry conditions in 2011 (Figure 8.9).

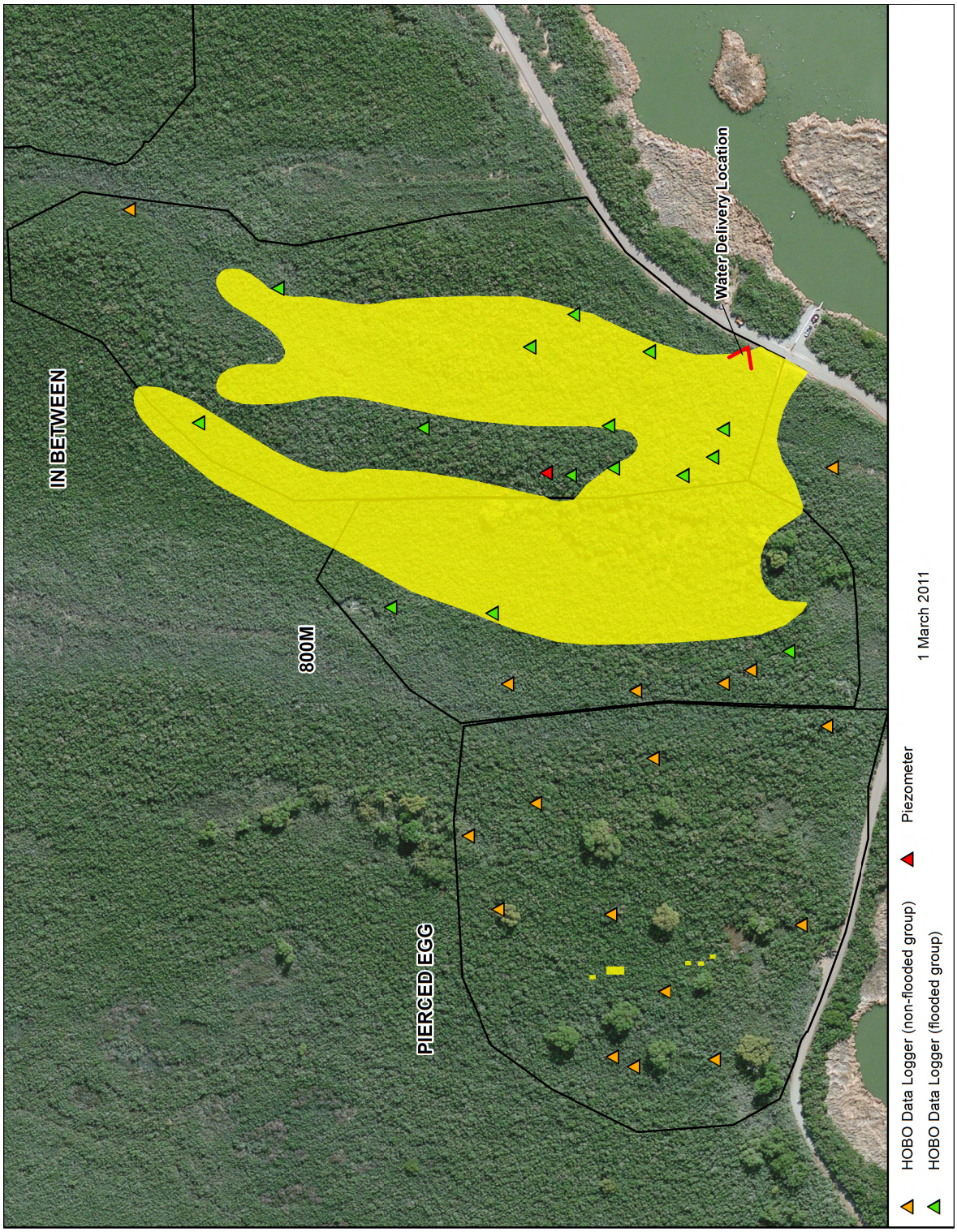

Figure 8.8. Locations of HOBO data loggers and piezometer at Topock Marsh, 2009–2011.

Table 8.2. Microclimate Measures at Topock Hydrology Monitoring Sites – Non-flooded Area (n = 17), 2010*

Microclimate Measure	April 1–15	April 16–30	May 1–15	May 16–31	June 1–15	June 16–30	July 1–15
Soil Moisture							
Mean soil moisture (mV)	911.4 (14.0)	897.9 (13.4)	881.2 (14.0)	878.6 (10.8)	863.2 (9.8)	836.8 (12.1)	867.3 (16.3)
Mean distance to nearest standing water	31.0 (6.2)	31.9 (6.1)	62.5 (8.7)	68.5 (8.1)	101.6 (10.6)	98.4 (10.8)	110.3 (17.9)
% of area within 20 m that was inundated	10.7 (6.3)	10.0 (5.0)	1.9 (1.9)	1.9 (1.2)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
% of area within 50 m that was inundated	18.7 (5.6)	12.4 (3.8)	1.8 (1.0)	2.0 (1.1)	0.0 (0.0)	0.3 (0.3)	0.0 (0.0)
Temperature							
Mean maximum diurnal temperature (°C)	35.3 (0.3)	36.2 (0.4)	38.4 (0.3)	38.5 (0.3)	41.9 (0.3)	43.1 (0.3)	43.4 (0.4)
Mean minimum nocturnal temperature (°C)	5.0 (0.2)	8.5 (0.3)	8.4 (0.2)	9.9 (0.2)	18.0 (0.2)	13.8 (0.2)	18.3 (0.2)
Mean daily temperature range (°C)	30.3 (0.3)	27.7 (0.4)	30.0 (0.3)	28.6(0.4)	23.9 (0.3)	29.4 (0.3)	25.1 (0.4)
Humidity							
Mean diurnal vapor pressure (Pa)	597.4 (9.3)	818.4 (13.4)	798.1 (14.1)	976.4 (16.2)	1588.5 (23.5)	1649.4 (28.5)	2279.7 (36.0)
Mean nocturnal vapor pressure (Pa)	652.2 (8.7)	888.1 (11.9)	890.9 (11.2)	1022.4 (12.4)	1537.7 (17.5)	1423.7 (16.8)	1929.9 (22.3)

* Data are presented as mean (standard error). Sample size indicates the number of data logger locations.

Table 8.3. Microclimate Measures at Topock Hydrology Monitoring Sites – Flooded Area (n = 15), 2010*

Microclimate Measure	April 1–15	April 16–30	May 1–15	May 16–31	June 1–15	June 16–30	July 1–15
Soil Moisture							
Mean soil moisture (mV)	908.1 (13.7)	908.0 (12.9)	892.7 (13.8)	838.4 (20.6)	853.9 (11.8)	834.3 (19.8)	804.5 (17.9)
Mean distance to nearest standing water	44.9 (9.7)	42.8 (9.3)	54.0 (10.2)	60.6 (17.1)	102.8 (11.9)	115.0 (13.4)	192.0 (23.3)
% of area within 20 m that was inundated	8.0 (6.7)	6.2 (4.4)	5.3 (4.6)	6.4 (5.7)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
% of area within 50 m that was inundated	13.5 (4.8)	15.5 (4.8)	10.1 (4.1)	6.7 (4.4)	4.1 (3.0)	0.0 (0.0)	0.0 (0.0)
Temperature							
Mean maximum diurnal temperature (°C)	32.2 (0.3)	33.7 (0.4)	35.7 (0.3)	36.3 (0.4)	39.8 (0.4)	40.9 (0.4)	40.9 (0.4)
Mean minimum nocturnal temperature (°C)	6.0 (0.2)	9.4 (0.3)	9.1 (0.2)	10.6 (0.2)	18.7 (0.2)	14.5 (0.2)	18.9 (0.2)
Mean daily temperature range (°C)	26.2 (0.4)	24.3 (0.5)	26.6 (0.4)	25.7 (0.4)	21.1 (0.4)	26.5 (0.4)	22.0 (0.5)
Humidity							
Mean diurnal vapor pressure (Pa)	611.7 (10.1)	834.7 (14.5)	813.2 (15.4)	998.5 (17.9)	1595.6 (24.6)	1612.9 (26.8)	2209.8 (35.8)
Mean nocturnal vapor pressure (Pa)	676.5 (9.5)	913.3 (12.7)	906.3 (11.5)	1043.2 (13.0)	1535.3 (18.6)	1418.7 (16.8)	1921.6 (23.7)

* Data are presented as mean (standard error). Sample size indicates the number of data logger locations.

Table 8.4. Microclimate Measures at Topock Hydrology Monitoring Sites – Non-flooded Area, 2011*

Microclimate Measure	April 1–15	April 16–30	May 1–15	May 16–31	June 1–15	June 16–30	July 1–15
Soil Moisture (n = 17)							
Mean soil moisture (mV)	883.8 (14.4)	904.1 (13.3)	878.4 (22.7)	835.4 (16.8)	811.4 (19.0)	819.4 (12.1)	817.4 (11.4)
Mean distance to nearest standing water	N/A	N/A	122.0 (61.1)	138.9 (21.6)	149.4 (19.4)	120.4 (16.3)	115.6 (13.9)
% of area within 20 m that was inundated	3.6 (10.9)	N/A	0.0 (1.9)	0.0 (0.0)	0.0 (0.0)	0.0 (40.0)	1.7 (1.7)
% of area within 50 m that was inundated	3.6 (3.6)	N/A	1.9 (1.4)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	0.1 (0.1)
Temperature (n = 16)							
Mean maximum diurnal temperature (°C)	34.8 (0.5)	38.2 (0.3)	38.7 (0.3)	36.6 (0.3)	40.3 (0.3)	43.5 (0.2)	41.3 (0.3)
Mean minimum nocturnal temperature (°C)	6.8 (0.3)	11.0 (0.2)	9.3 (0.3)	11.6 (0.2)	12.5 (0.2)	18.0 (0.2)	20.0 (0.2)
Mean daily temperature range (°C)	28.1 (0.5)	27.2 (0.4)	29.4 (0.4)	25.0 (0.4)	27.8 (0.3)	25.5 (0.3)	21.3 (0.5)
Humidity (n = 16)							
Mean diurnal vapor pressure (Pa)	666.5 (14.2)	761.1 (13.8)	858.8 (15.9)	1066.2 (14.9)	1229.4 (24.5)	1598.9 (20.7)	2467.8 (43.7)
Mean nocturnal vapor pressure (Pa)	666.3 (12.5)	817.0 (13.8)	922.1 (13.6)	1033 (10.4)	1178.1 (19.1)	1436.8 (12.9)	2215.1 (32.2)

* Data are presented as mean (standard error). N/A = data not available. Sample size indicates the number of data logger locations at which useable data were collected.

Table 8.5. Microclimate Measures at Topock Hydrology Monitoring Sites – Flooded Area, 2011*

Microclimate Measure	April 1–15	April 16–30	May 1–15	May 16–31	June 1–15	June 16–30	July 1–15
Soil Moisture (n = 15)							
Mean soil moisture (mV)	955.6 (12.1)	944.3 (14.7)	893.7 (17.8)	867.8 (17.8)	779.1 (28.5)	768.8 (23.4)	809.6 (24.0)
Mean distance to nearest standing water	N/A	N/A	12.0 (4.7)	48.5 (23.6)	84.7 (20.5)	73.0 (18.7)	98.11 (20.0)
% of area within 20 m that was inundated	57.7 (10.9)	N/A	39.6 (10.0)	18.3 (8.1)	18.0 (8.3)	17.5 (6.4)	5.8 (3.2)
% of area within 50 m that was inundated	54.6 (10.5)	N/A	36.1 (7.7)	23.4 (8.3)	20.1 (9.7)	26.3 (8.7)	11.7 (4.9)
Temperature (n = 14)							
Mean maximum diurnal temperature (°C)	31.8 (0.5)	34.8 (0.3)	36.0 (0.4)	34.5 (0.4)	38.5 (0.3)	42.1 (0.3)	40.5 (0.4)
Mean minimum nocturnal temperature (°C)	8.1 (0.3)	12.1 (0.3)	10.3 (0.3)	12.3 (0.2)	13.2 (0.2)	18.9 (0.2)	20.6 (0.2)
Mean daily temperature range (°C)	23.7 (0.5)	22.7 (0.4)	25.6 (0.5)	22.2 (0.4)	25.2 (0.4)	23.2 (0.5)	19.9 (0.5)
Humidity (n = 13)							
Mean diurnal vapor pressure (Pa)	732.4(16.5)	843.4 (16.5)	917.4 (18.5)	1110.9 (16.2)	1250.5 (25.1)	1631.8 (21.3)	2501.8 (49.7)
Mean nocturnal vapor pressure (Pa)	773.6 (14.4)	926.0 (17.1)	1031.2 (16.0)	1112.5 (12.8)	1255.2 (21.5)	1516.9 (16.6)	2251.2 (35.6)

* Data are presented as mean (standard error). N/A = data not available. Sample size indicates the number of data logger locations at which useable data were collected.

All measures of temperature (mean daily maximum, mean daily minimum, mean temperature range) tended toward being different (*P*-values between 0.04 and 0.07) between flooded and non-flooded areas in 2010 under baseline conditions (Table 8.6, column 1), with the flooded area having lower maximum temperatures, higher minimum temperatures, and a smaller daily temperature range than the non-flooded area (Figures 8.13–8.15). This pattern persisted in 2011 (Table 8.6, column 2; Figures 8.13–8.15). The change in temperature variables through the season was similar in the flooded and non-flooded areas in 2010 (Table 8.6, column 3) but not in 2011 (Table 8.6, column 4). In 2011, the flooded area began the season with lower maximum temperatures, higher minimum temperatures, and a smaller daily temperature range when compared to the non-flooded area; these differences diminished steadily as the season progressed (Figures 8.13–8.15).

Diurnal and nocturnal vapor pressure did not differ significantly between flooded and non-flooded areas under baseline conditions in 2010 (Table 8.6, column 1). In 2011, both measures of humidity were higher in the flooded versus non-flooded area (Figures 8.16 and 8.17), but this difference was significant only for nocturnal vapor pressure (Table 8.6, column 2). The difference in nocturnal vapor pressure between flooded and non-flooded areas decreased through the season in 2011 (Table 8.6, column 4; Figure 8.17).

Comparison between day before and day after flood events – A comparison of temperature and humidity variables the day before and the day after each flood event in 2011 showed that, overall, flood events appeared to affect all temperature and humidity variables, and the effect was not constant through the season for any variable except mean diurnal vapor pressure (Table 8.7). The effect of flooding is graphed (Figures 8.18-8.22) to aid in interpretation of flooding effects. In each figure there are three graphs. The first graph shows the difference in the given microclimate variable between the day before and the day after each flood event for the flooded and non-flooded areas. The fluctuation in the non-flooded area between the day before and day after each flood events indicates the baseline change in general weather conditions; deviation in the flooded area from this baseline change suggests an effect of flooding. This deviation (the difference between the non-flooded and flooded areas) is depicted in the second graph in each figure. The third graph in each figure plots this deviation against baseline weather conditions to show whether the direction and magnitude of any effects of flooding varied based on underlying weather conditions.

Overall, the flooded area had a lower maximum diurnal temperature in relation to the non-flooded area on the day after a flood event than on the day before a flood event (Table 8.7, Figures 8.18a and 8.18b). The effect of flooding on the maximum diurnal temperature was related to the maximum temperature recorded on the day after a flood event in the non-flooded area (Figure 8.18c); flooding had the greatest effect of lowering the maximum temperature on hot days but raised the maximum temperature on relatively cool days. Overall, minimum nocturnal temperature on the day after a flood event was higher in the flooded area in relation to the non-flooded area than on the day before a flood event (Table 8.7, Figures 8.19a and 8.19b). The effect of flooding on minimum nocturnal temperature did not appear to be related to minimum nocturnal temperature (Figure 8.19c). Overall, the daily temperature range on the day after a flood event was smaller in the flooded area in relation to the non-flooded area than on the day before a flood event (Table 8.7, Figures 8.20a and 8.20b). This effect was strongly related to the maximum temperature on the day after a flood event, with flooding having the greatest effect of reducing the daily temperature range on hot days (Figure 8.20c).

Both diurnal and nocturnal vapor pressure on the day after a flood event were higher in the flooded area in relation to the non-flooded area than on the day before a flood event (Table 8.7, Figures 8.21a, 8.21b, 8.22a, and 8.22b). Diurnal vapor pressure was affected the most strongly in the middle of the season (Figure 8.21b), but this effect was not related to overall vapor pressure (Figure 8.21c). The effect on nocturnal vapor pressure was weakly, inversely related to ambient vapor pressure.

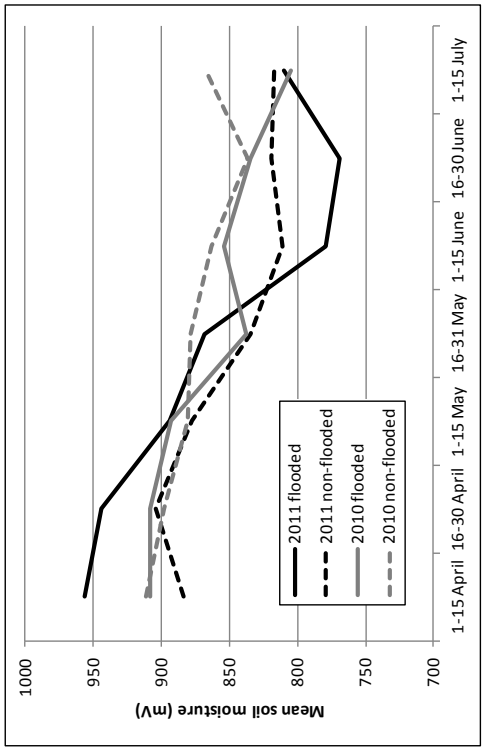

Figure 8.9a. Mean soil moisture by two-week periods in flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

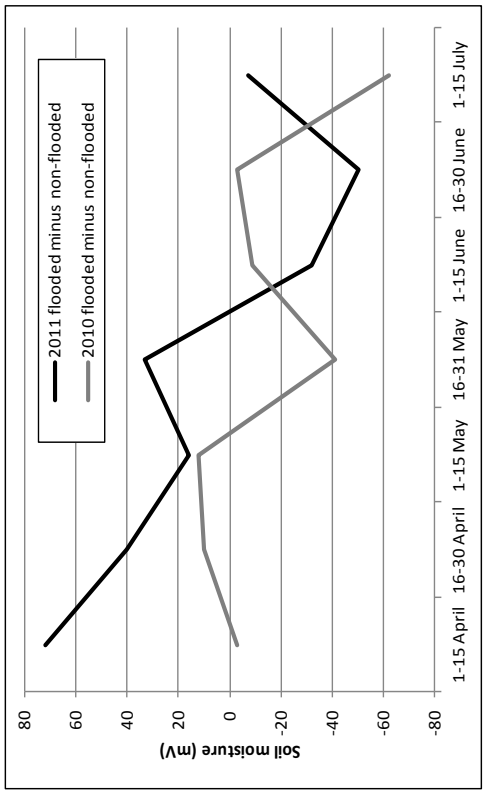

Figure 8.9b. Difference in soil moisture between flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

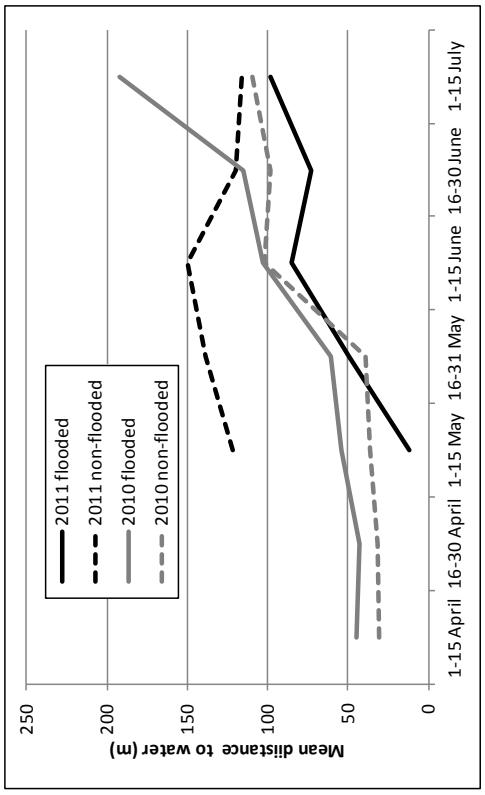

Figure 8.10a. Mean distance to water by two-week periods in flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

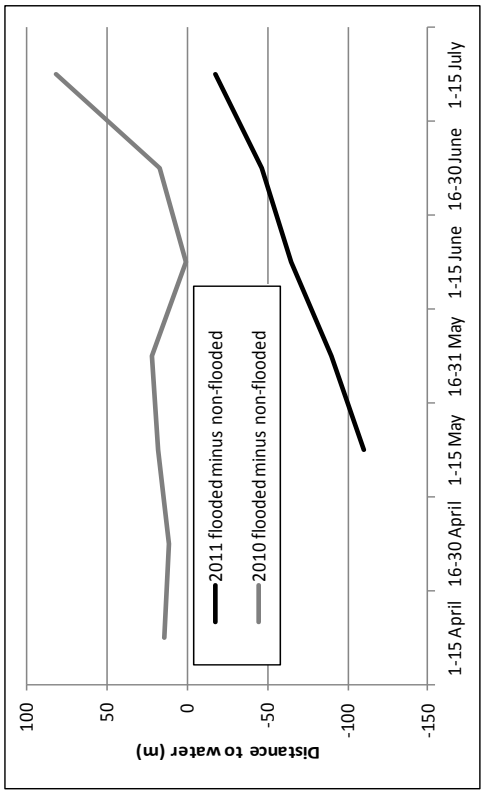

Figure 8.10b. Difference in distance to water between flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

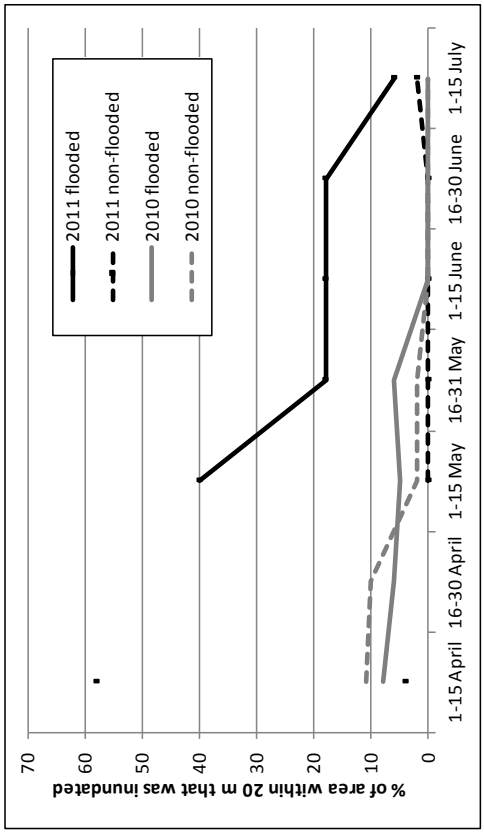

Figure 8.11a. Mean percent of area within 20 m that was inundated by two-week periods in flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

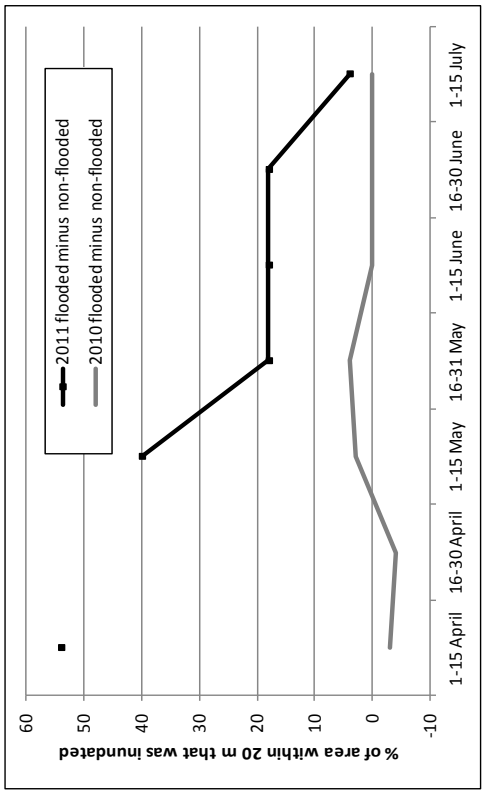

Figure 8.11b. Difference between flooded and non-flooded areas in percent of area within 20 m that was inundated, Topock Marsh, 2010 and 2011.

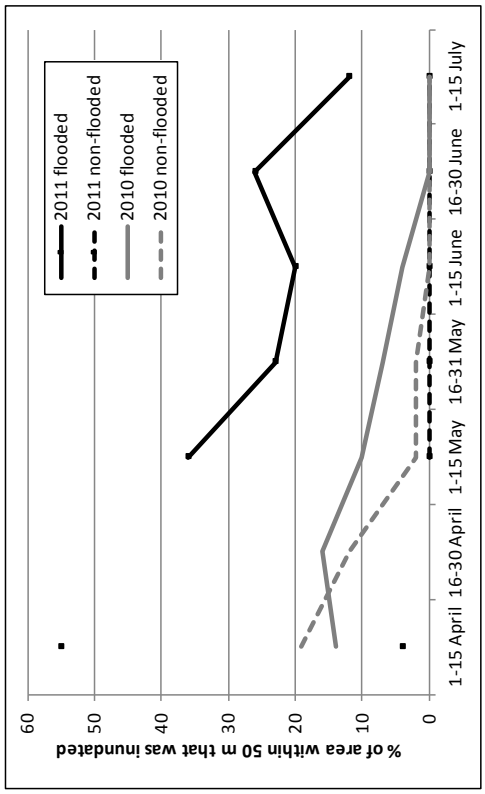

Figure 8.12a. Mean percent of area within 50 m that was inundated by two-week periods in flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

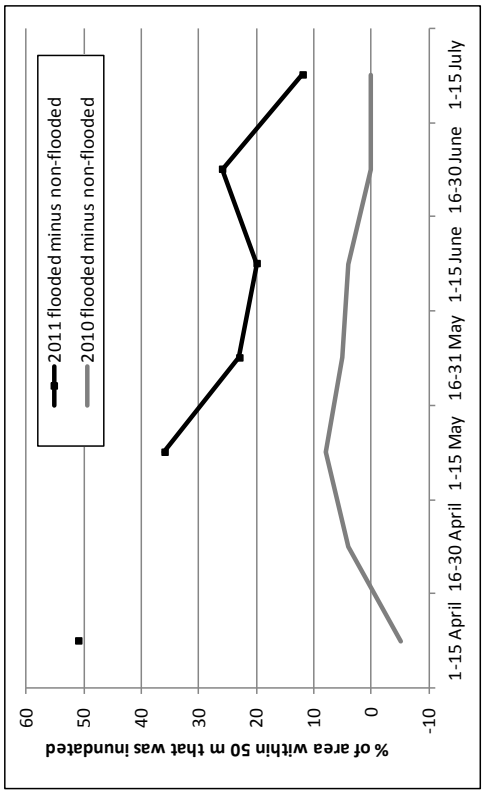

Figure 8.12b. Difference between flooded and non-flooded areas in percent of area within 50 m that was inundated, Topock Marsh, 2010 and 2011.

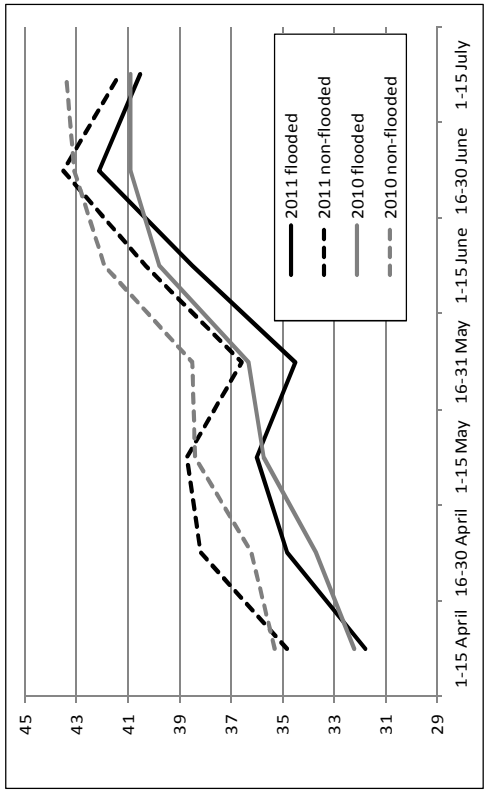

Figure 8.13a. Mean maximum diurnal temperature by two-week periods in flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

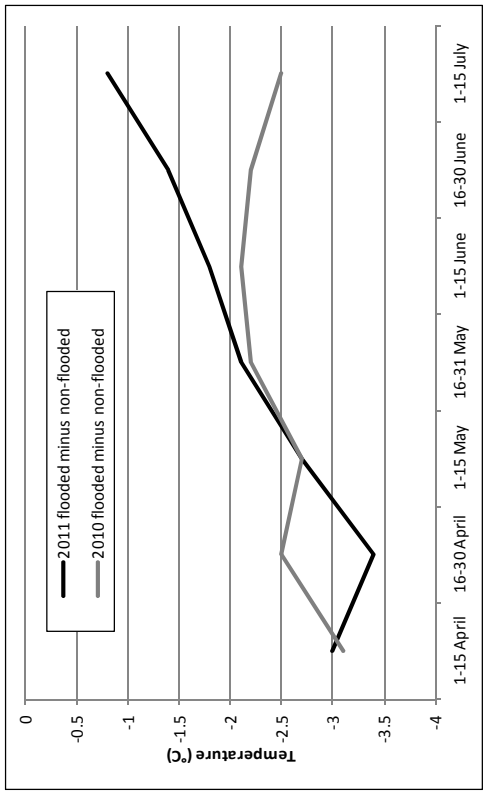

Figure 8.13b. Difference in mean maximum daily temperature between flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

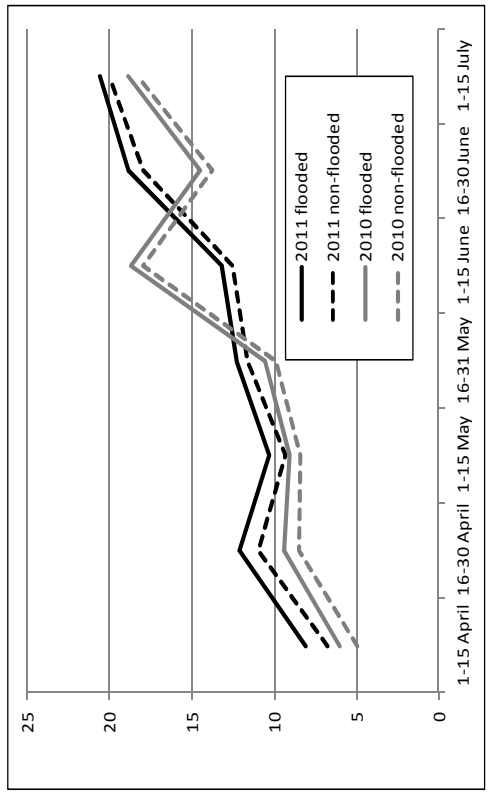

Figure 8.14a. Mean minimum nocturnal temperature by two-week periods in flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

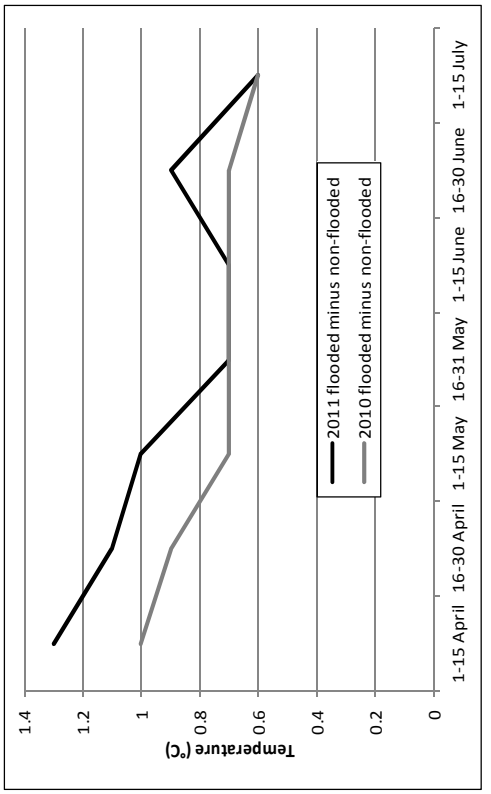

Figure 8.14b. Difference in mean minimum nocturnal temperature between flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

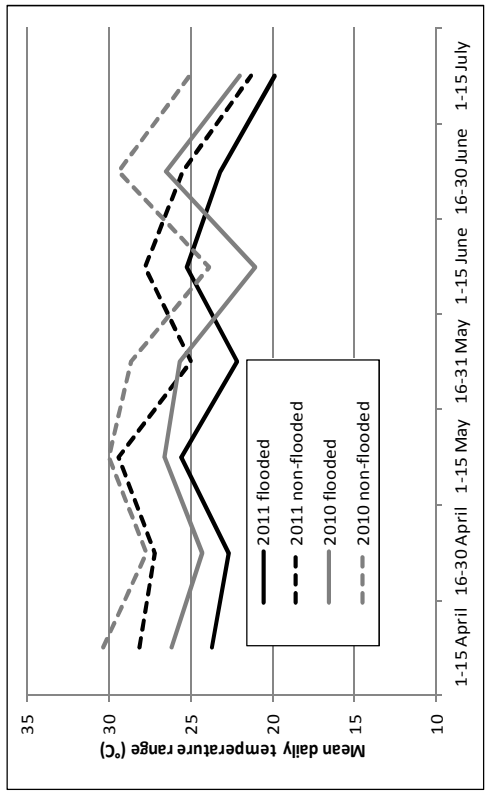

Figure 8.15a. Mean daily temperature range by two-week periods in flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

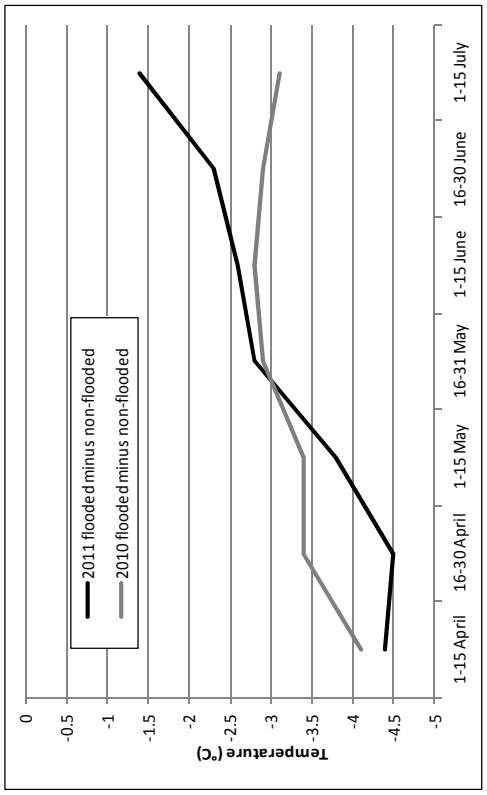

Figure 8.15b. Difference in daily temperature range between flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

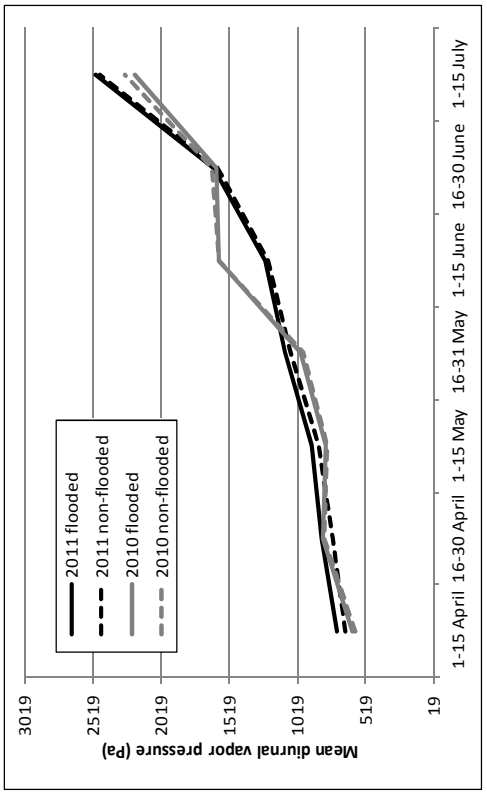

Figure 8.16a. Mean diurnal vapor pressure by two-week periods in flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

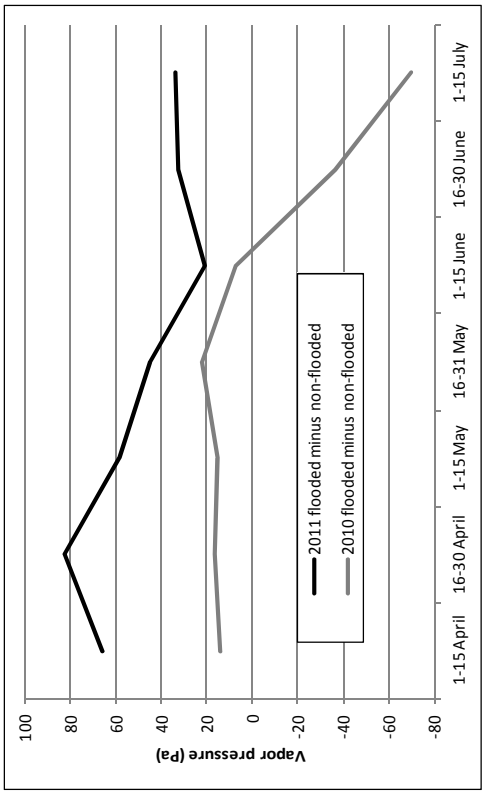

Figure 8.16b. Difference in diurnal vapor pressure between flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

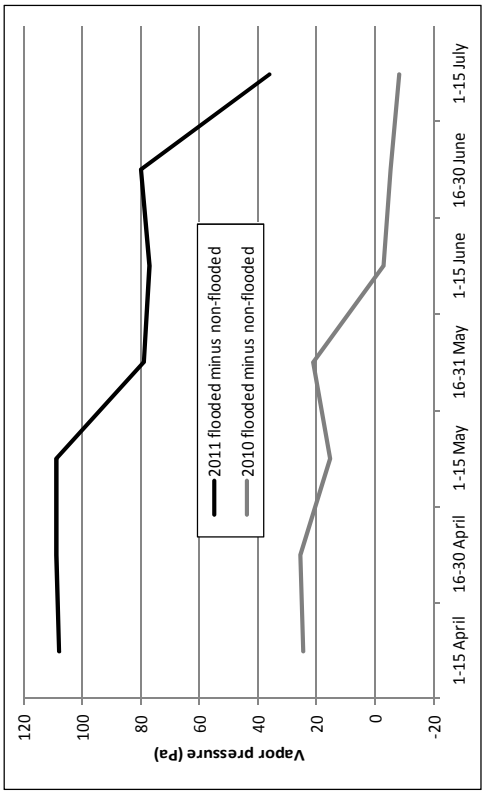

Figure 8.17b. Difference in nocturnal vapor pressure between flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

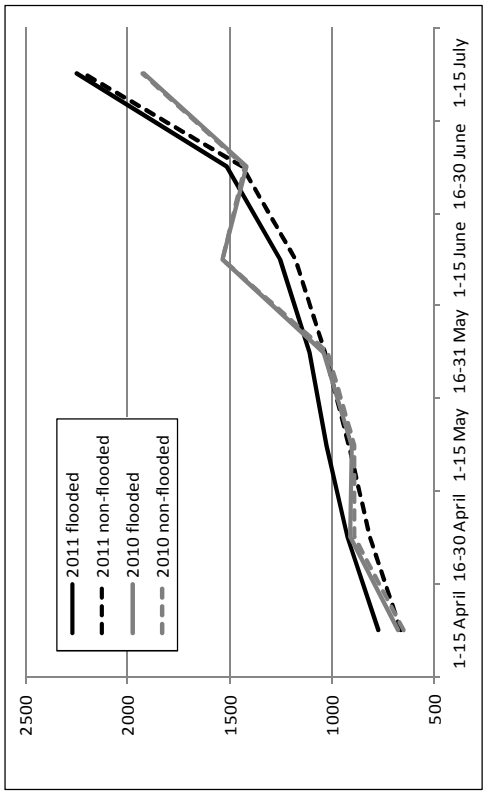

Figure 8.17a. Mean nocturnal vapor pressure by two-week periods in flooded and non-flooded areas, Topock Marsh, 2010 and 2011.

Table 8.6. *P*-values from Repeated Measures Linear Mixed Model Analysis of Flooded and Non-flooded Areas, Topock Marsh, 2010 and 2011.

	Flooded vs. non-flooded areas overall, within the year (between flood group differences)		Change over the season for flooded vs. non-flooded areas, by year (interaction between flood group and time)		2010 vs. 2011 overall, within flood group (between-year differences)		Change over the season for 2010 vs. 2011, by flood group (interaction between year group and time)	
Parameter	**2010**	**2011**	**2010**	**2011**	**Non-flooded**	**Flooded**	**Non-flooded**	**Flooded**
Soil Moisture								
Mean soil moisture (mV)	0.329	0.563	0.014	<0.001	<0.001	0.884	0.131	0.009
Mean distance to nearest standing water	0.124	0.009	<0.001	0.173	<0.001	<0.001	0.066	0.023
% of area within 20 m that was inundated	0.997	<0.001	0.750	<0.001	0.208	<0.001	0.718	0.010
% of area within 50 m that was inundated	0.497	<0.001	0.147	0.001	0.026	<0.001	0.004	0.407
Temperature								
Mean maximum diurnal temperature (°C)	0.067	0.071	0.954	0.009	--	--	--	--
Mean minimum nocturnal temperature (°C)	0.069	0.044	0.088	<0.001	--	--	--	--
Mean daily temperature range (°C)	0.041	0.047	0.802	0.001	--	--	--	--
Humidity								
Mean diurnal vapor pressure (Pa)	0.943	0.349	0.618	0.845	--	--	--	--
Mean nocturnal vapor pressure (Pa)	0.751	0.011	0.170	0.012	--	--	--	--

* Data restricted from April 1 through July 15 for both years. For 2011, distance-to-water measures do not include April and percent inundated measures do not include April 16-30.

Table 8.7. Difference in Temperature and Humidity Measures Between the Day After and Day Before Pumping in Flooded and Non-flooded Areas, Topock Marsh, 2011*

	Maximum diurnal temperature		Minimum nocturnal temperature		Daily temperature range		Mean diurnal vapor pressure		Mean nocturnal vapor pressure	
Day of flooding	**Non-Flooded**	**Flooded**	**Non-Flooded**	**Flooded**	**Non-Flooded**	**Flooded**	**Non-Flooded**	**Flooded**	**Non-Flooded**	**Flooded**
31 March	9.3	8.6	5.8	6.3	3.5	2.3	113.2	190.7	155.2	275.4
7 April	-18.9	-15.5	-1.5	-3.6	-17.4	-11.9	-194.4	-191.8	-443.1	-495.4
13 April	-5.5	-5.0	2.6	2.6	-8.0	-7.6	-263.6	-338.0	-263.7	-292.1
21 April	0.1	-0.9	-3.6	-2.9	3.6	2.0	-193.7	-154.0	-41.8	-21.3
28 April	2.4	1.9	11.1	9.1	-8.7	-7.2	201.0	239.3	-152.9	-264.2
5 May	3.0	2.0	4.5	4.3	-1.3	-2.3	261.9	323.6	260.4	249.5
12 May	5.5	5.0	2.8	4.0	2.7	1.0	95.5	149.7	93.4	175.2
19 May	11.9	11.1	-0.4	0.4	12.2	10.7	-269.0	-170.6	26.8	83.3
26 May	0.6	0.7	4.7	4.7	-4.1	-3.9	57.7	132.3	-38.9	50.1
2 June	4.8	3.6	-3.4	-2.5	8.2	6.1	-150.2	-40.7	93.0	158.1
9 June	3.0	3.0	1.3	2.4	1.8	0.5	196.3	220.0	96.7	157.7
16 June	-3.9	-4.4	3.5	4.4	-7.3	-8.7	-328.5	-223.9	-90.9	-61.9
23 June	-0.8	-1.7	4.8	5.5	-5.6	-7.2	-84.3	-85.4	-7.2	55.6
30 June	0.2	-0.7	-11.4	-11.3	11.6	10.6	522.0	587.7	402.6	565.5
7 July	11.0	8.0	0.7	1.5	10.3	6.5	-190.4	-136.2	-212.0	-178.1
Mean (SE)	1.5 (0.6)	1.0 (0.6)	1.4 (0.4)	1.7 (0.4)	0.1 (0.7)	-0.6 (0.6)	-15.1 (22.3)	33.5 (23.9)	-8.2 (18.3)	30.5 (24.0)
P-values, flooded vs. non-flooded areas, overall	0.034		0.031		0.008		0.011		0.007	
P-values, change over the season for flooded vs. non-flooded areas (interaction between flood group and time)	0.003		<0.001		<0.001		0.542		<0.001	

* Differences are the day after flooding minus the day before flooding.

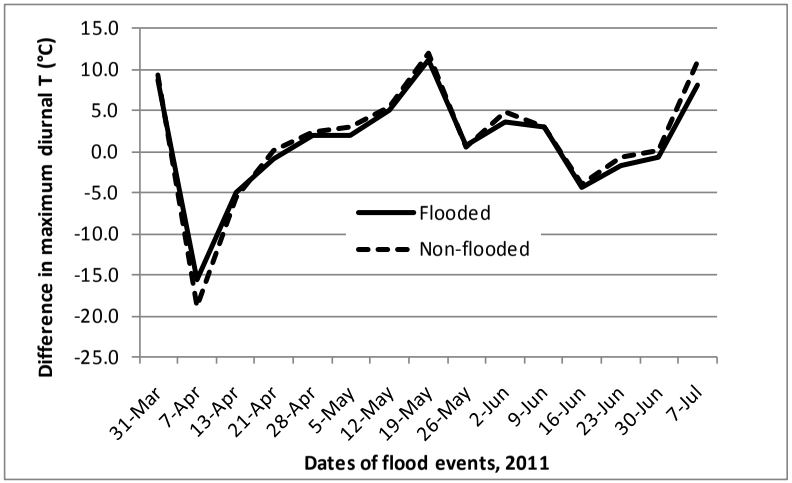

Figure 8.18a. Difference between the day before and day after (day after minus day before) each flood event in maximum diurnal temperature, flooded and non-flooded areas, Topock Marsh, 2011.

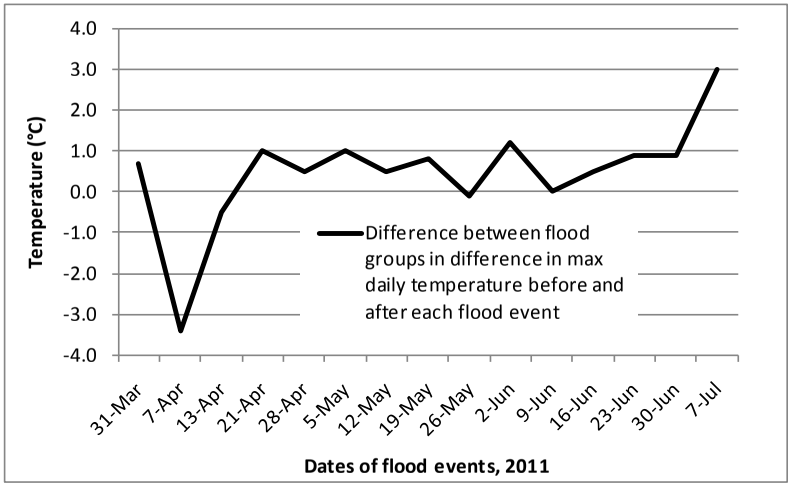

Figure 8.18b. Difference between flood groups (non-flooded minus flooded) in difference in maximum daily temperature before and after each flood event, Topock Marsh, 2011.

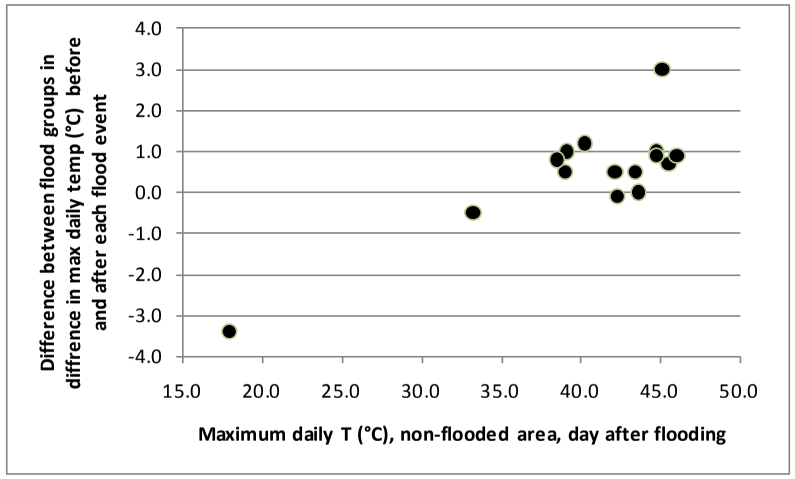

Figure 8.18c. Difference between flood groups in difference in maximum daily temperature before and after each flood event, plotted against maximum daily temperature in the non-flooded area on the day after flooding, Topock Marsh, 2011.

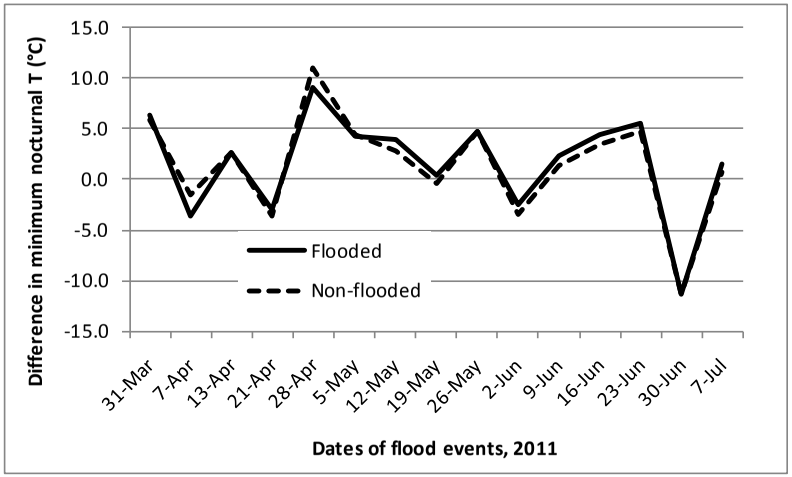

Figure 8.19a. Difference between the day before and day after (day after minus day before) each flood event in minimum nocturnal temperature, flooded and non-flooded areas, Topock Marsh, 2011.

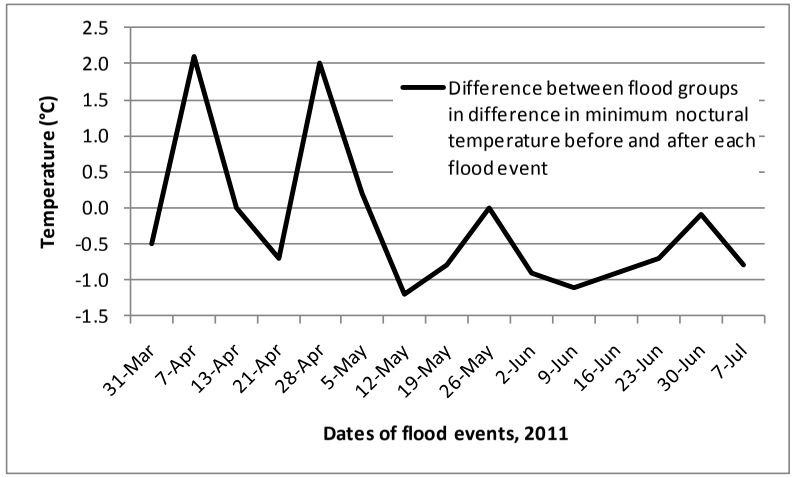

Figure 8.19b. Difference between flood groups (non-flooded minus flooded) in difference in minimum nocturnal temperature before and after each flood event, Topock Marsh, 2011.

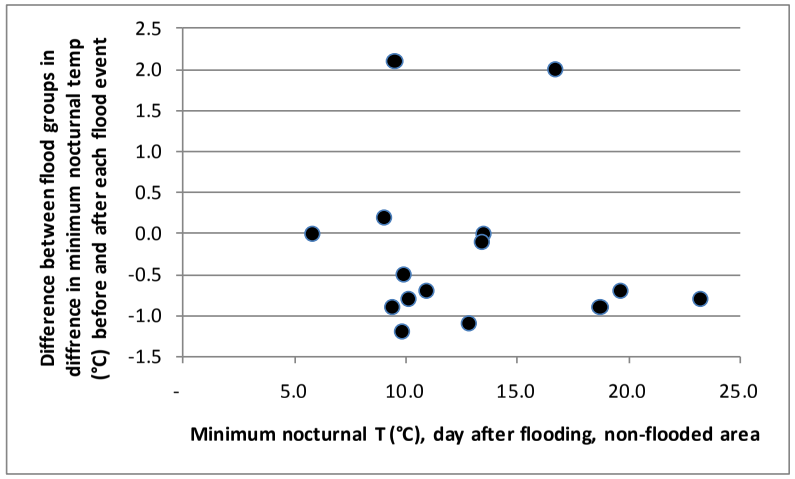

Figure 8.19c. Difference between flood groups in difference in minimum nocturnal temperature before and after each flood event, plotted against minimum daily temperature in the non-flooded area on the day after flooding, Topock Marsh, 2011.

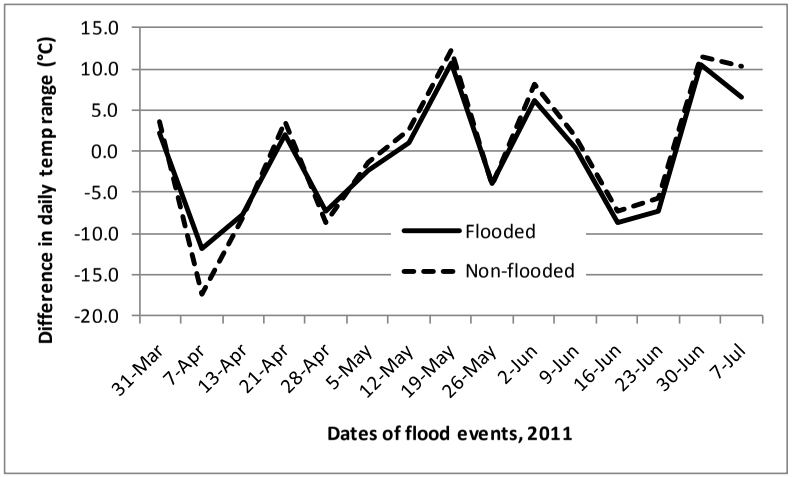

Figure 8.20a. Difference between the day before and day after (day after minus day before) each flood event in daily temperature range, flooded and non-flooded areas, Topock Marsh, 2011.

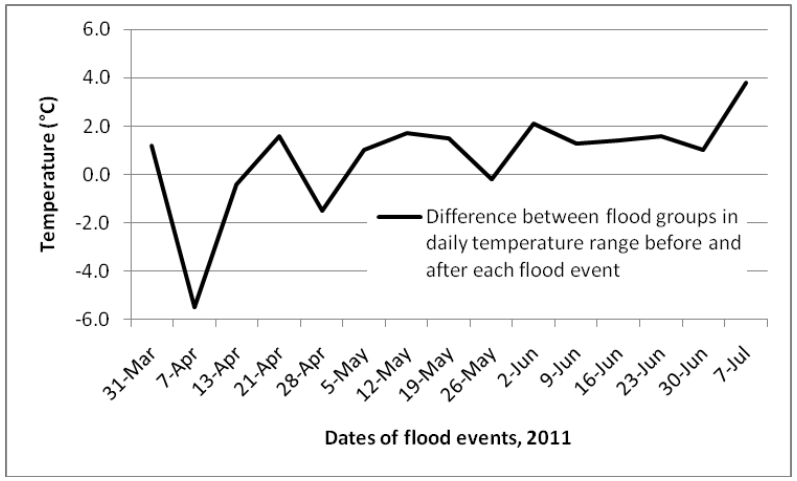

Figure 8.20b. Difference between flood groups (non-flooded minus flooded) in difference in daily temperature range before and after each flood event, Topock Marsh, 2011.

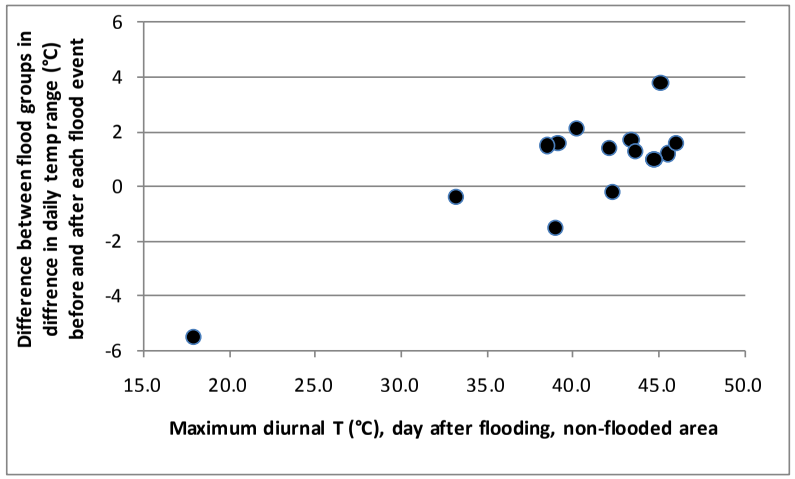

Figure 8.20c. Difference between flood groups in difference in daily temperature range before and after each flood event, plotted against maximum daily temperature in the non-flooded area on the day after flooding, Topock Marsh, 2011.

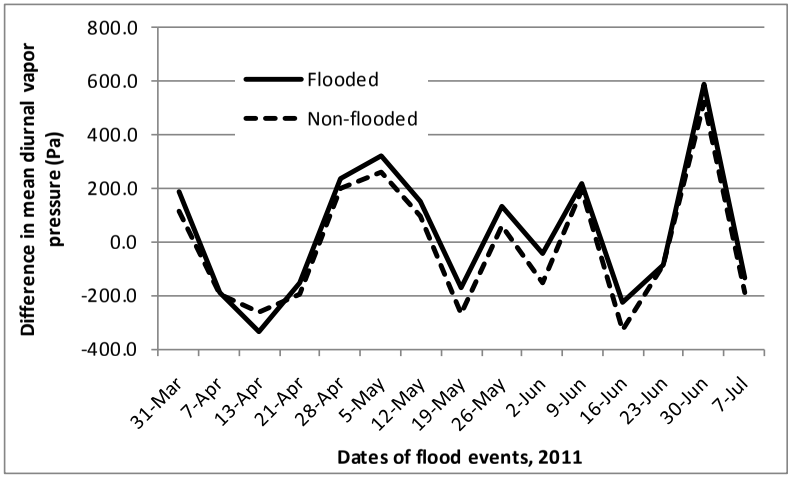

Figure 8.21a. Difference between the day before and day after (day after minus day before) each flood event in mean diurnal vapor pressure, flooded and non-flooded areas, Topock Marsh, 2011.

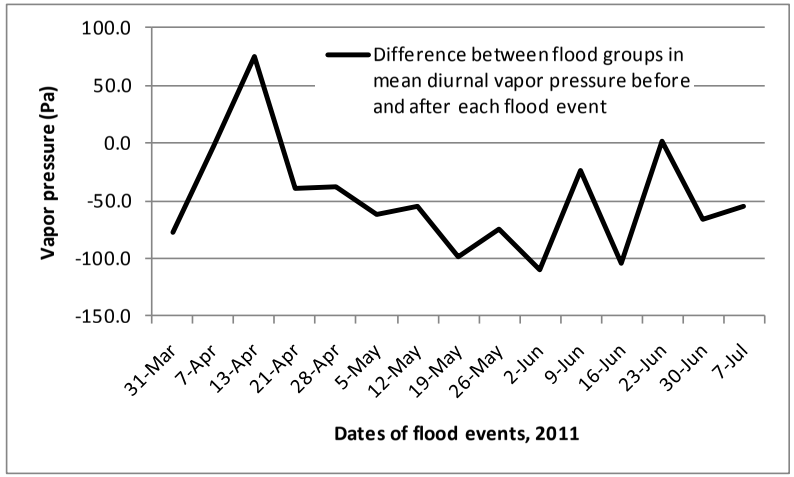

Figure 8.21b. Difference between flood groups (non-flooded minus flooded) in difference in mean diurnal vapor pressure before and after each flood event, Topock Marsh, 2011.

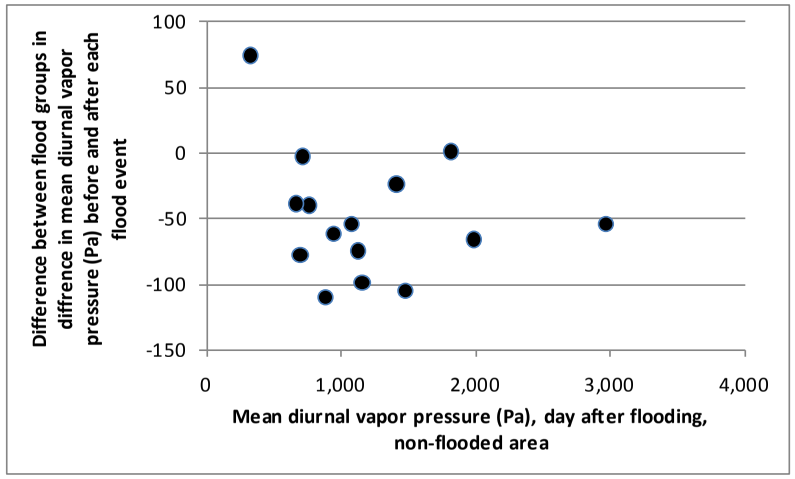

Figure 8.21c. Difference between flood groups in difference in mean diurnal vapor pressure before and after each flood event, plotted against mean diurnal vapor pressure in the non-flooded area on the day after flooding, Topock Marsh, 2011.

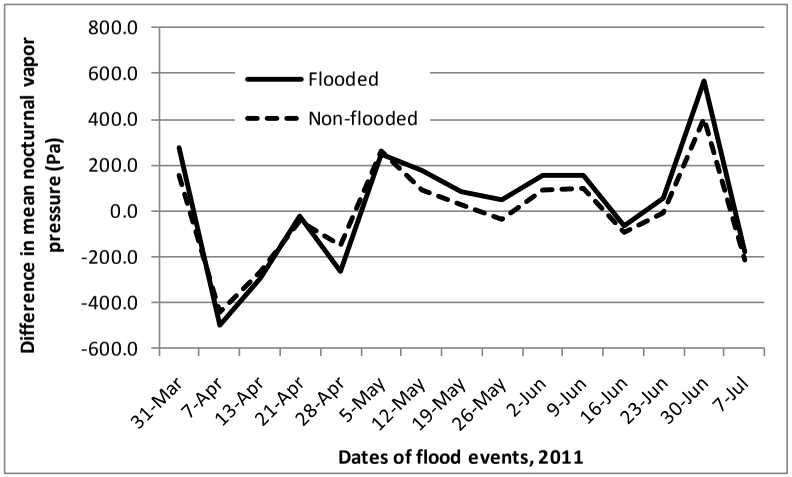

Figure 8.22a. Difference between the day before and day after (day after minus day before) each flood event in mean nocturnal vapor pressure, flooded and non-flooded areas, Topock Marsh, 2011.

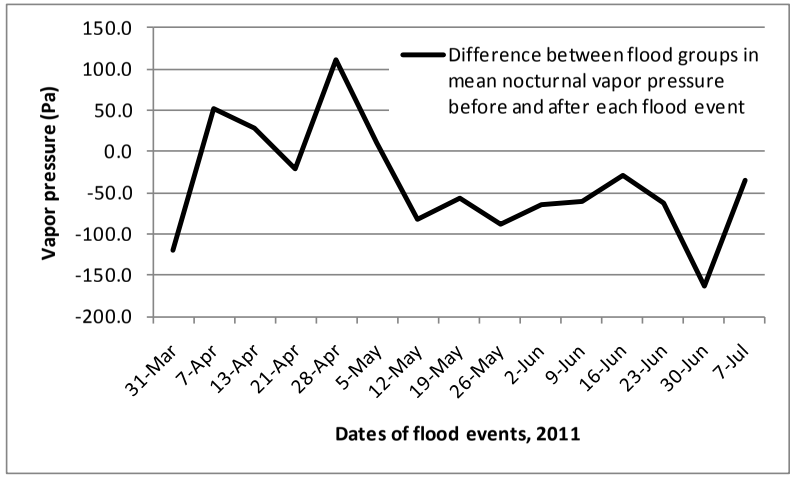

Figure 8.22b. Difference between flood groups (non-flooded minus flooded) in difference in mean nocturnal vapor pressure before and after each flood event, Topock Marsh, 2011.

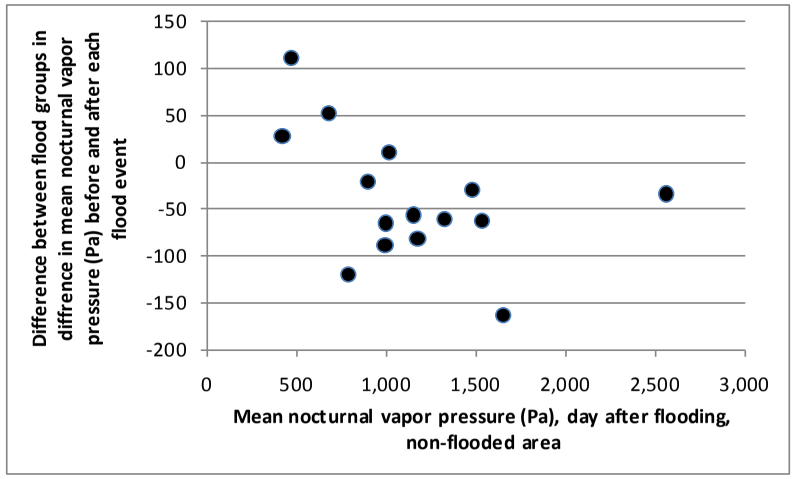

Figure 8.22c. Difference between flood groups in difference in mean nocturnal vapor pressure before and after each flood event, plotted against mean nocturnal vapor pressure in the non-flooded area on the day after flooding, Topock Marsh, 2011.

Vegetation

We collected vegetation data at all 15 flooded and 17 non-flooded locations. Vegetation characteristics in 2010 and 2011 are summarized in Table 8.8, and vertical foliage profiles are shown in Figures 8.23–8.26. Vegetation characteristics are typical of those documented in dense, tamarisk stands at Topock Marsh in previous years (McLeod et al. 2008a), with dense canopy closure and a small percentage of native vegetation.

Vegetation characteristics differed between years in both flooded and non-flooded areas in percent canopy closure, percent woody ground cover, and the amount of live vegetation in all height categories (Table 8.8, *P*-values in "Year" column). Percent canopy closure and percent woody ground cover was higher in 2011 than in 2010, while the number of hits of live vegetation recorded in all height categories was lower in 2011. Woody ground cover was the only variable that showed an interaction between year and flood group, meaning that the change in woody ground cover was different in the flooded area versus the non-flooded area (right-most column of Table 8.8). Woody ground cover increased more dramatically in the non-flooded area than in the flooded area.

Table 8.8. Summary of Vegetation Characteristics within Portions of Topock Marsh Selected for Habitat Enhancement, 2010 and 2011*

Parameter	2010		2011		*P*-value	
	Flooded	Non-flooded	Flooded	Non-flooded	Year	Year*flood group
Average canopy height (m)	6.3 (0.3)	5.9 (0.3)	6.2 (0.2)	5.9 (0.3)	0.725	0.904
	4.2–7.4	3.4–8.3	4.0–7.0	3.5–8.5		
% total canopy closure	89.5 (1.5)	88.7 (2)	94.3 (1)	90.7 (1.4)	0.007	0.260
	78.6–97.9	63–97.4	85.9–100	77.6–97.4		
% woody ground cover	23.7 (5.4)	13.2 (3.6)	45.8 (8.9)	77.1 (5.3)	<0.001	<0.001
	2.5–66.3	1–52.8	5.0–100.0	17.5–100		
Live vertical foliage (hits) below average nest height	2.6 (0.7)	3.0 (0.6)	1.4 (0.3)	2.1 (0.5)	0.018	0.718
	0.3–12.1	0.0–7.4	0.0–3.3	0.0–6.7		
Live vertical foliage (hits) at average nest height	2.6 (0.4)	2.7 (0.4)	1.6 (0.3)	2.0 (0.2)	<0.001	0.335
	0.1–5	0.8–6	0.2–3.8	0.3–3.9		
Live vertical foliage (hits) above average nest height	9.7 (0.7)	7.0 (1.1)	6.0 (0.6)	4.2 (0.7)	<0.001	0.433
	4.7–13.8	0.9–18.4	2.8–10.1	0.2–9.7		
Dead vertical foliage (hits) below average nest height	8.2 (0.7)	9.3 (0.5)	8.1 (0.7)	9.0 (0.6)	0.762	0.858
	2.4–13.1	5.1–13.4	4.8–13.4	5.1–14.2		
Dead vertical foliage (hits) at average nest height	1.9 (0.3)	2.0 (0.3)	2.2 (0.2)	1.9 (0.3)	0.460	0.241
	0.3–5.0	0.1–4.2	0.9–4.0	0.1–4.2		
Dead vertical foliage (hits) above average nest height	1.3 (0.4)	1.0 (0.2)	1.4 (0.3)	1.3 (0.2)	0.358	0.613
	0.0–3.9	0.0–2.9	0.0–3.2	0.0–4.1		
Percent native	0.0 (0.0)	5.3 (3.1)	0.0 (0.0)	7.5 (5)	0.680	0.680
	0.0–0.0	0.0–48.7	0.0–0.0	0.0–78.5		

* Data are presented as mean, standard error, and range. *P*-values for year indicate differences between years for both flooded and non-flooded locations combined. *P*-values for year*flooded indicate whether flooded areas changed between years differently than did non-flooded areas.

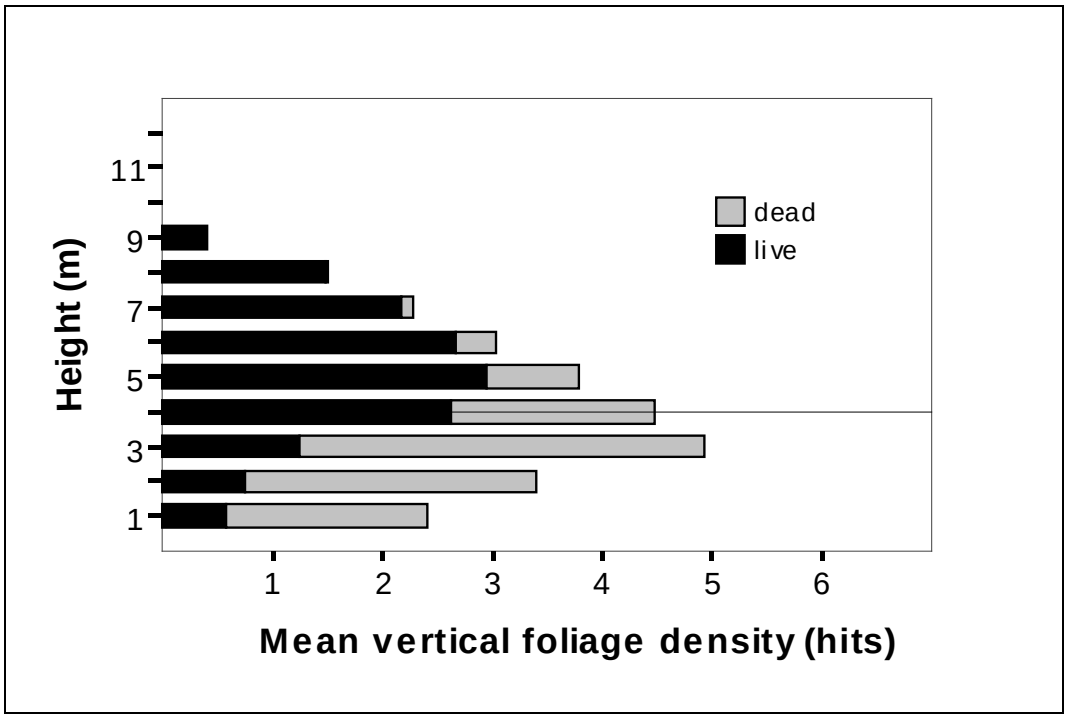

Figure 8.23. Vertical foliage density in flooded areas within the habitat enhancement project area, Topock Marsh, 2010. Horizontal line shows average nest height in the project area, 2003–2008.

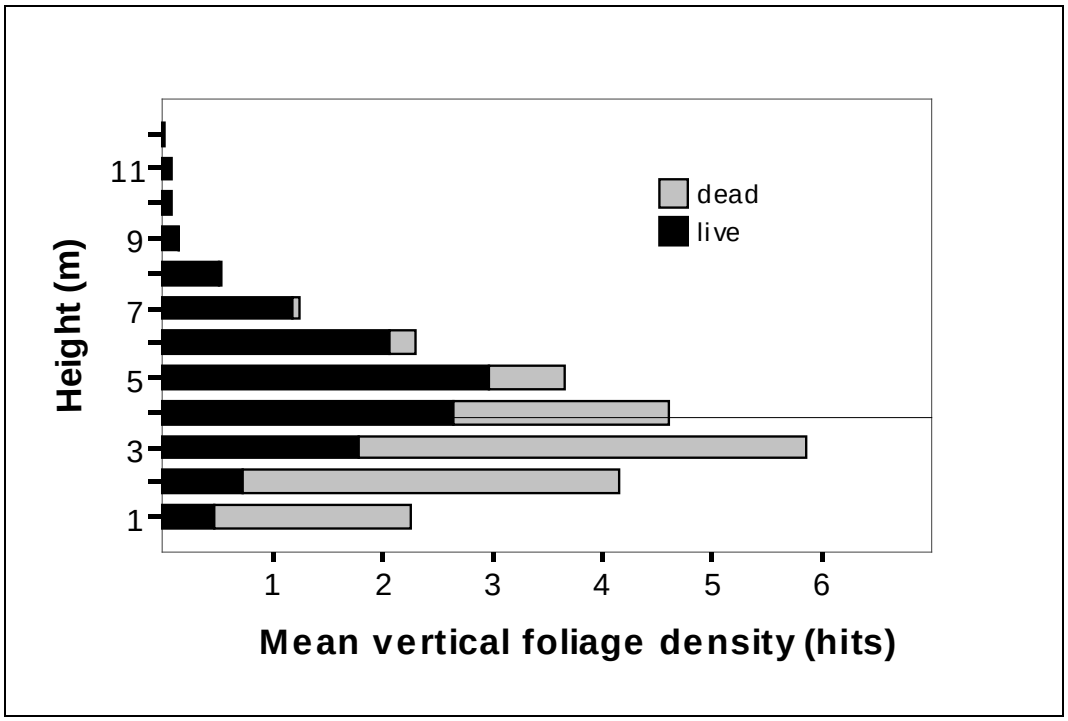

Figure 8.24. Vertical foliage density in non-flooded areas within the habitat enhancement project area, Topock Marsh, 2010. Horizontal line shows average nest height in the project area, 2003–2008.

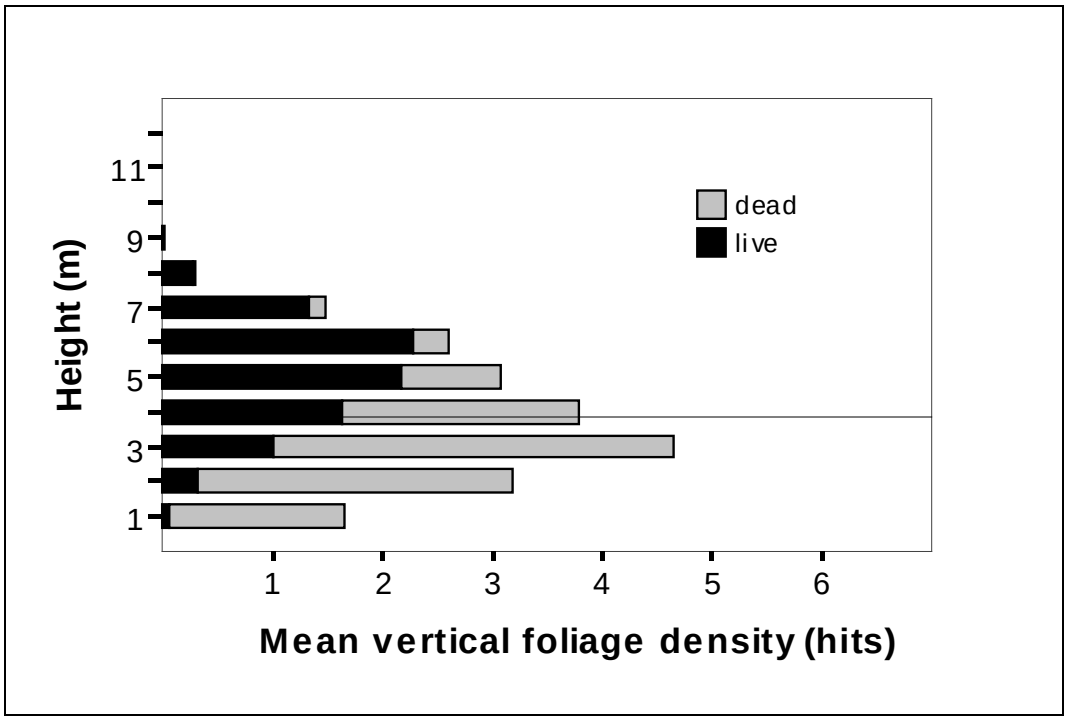

Figure 8.25. Vertical foliage density in flooded areas within the habitat enhancement project area, Topock Marsh, 2011. Horizontal line shows average nest height in the project area, 2003–2008.

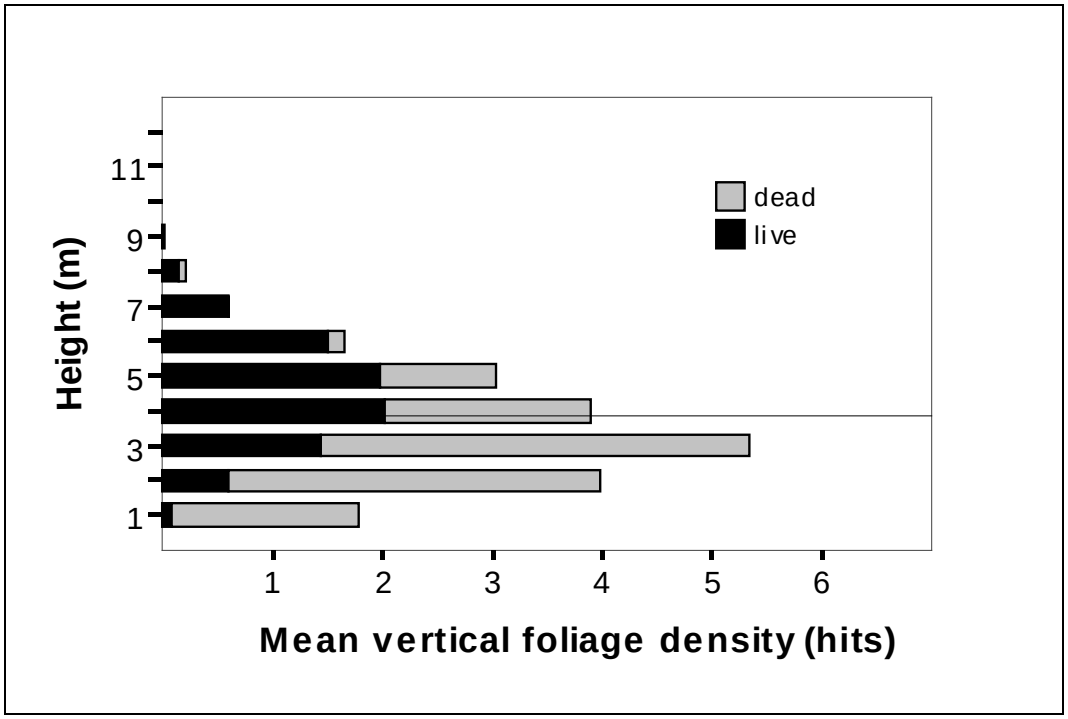

Figure 8.26. Vertical foliage density in non-flooded areas within the habitat enhancement project area, Topock Marsh, 2011. Horizontal line shows average nest height in the project area, 2003–2008.

DISCUSSION

Water delivery had the expected effect of increasing the extent and duration of surface water present within the target area in 2011 in comparison with the previous year, despite the overall lower level of Topock Marsh in 2011. Surface water from a given pumping event covered a larger extent and declined more slowly when the underlying water table was high, indicating that pumping was more effective in creating the surface water conditions favored by flycatchers when coupled with a high underlying water table.

In the area affected by flooding, water delivery had the expected effect of raising soil moisture, decreasing distance to water from the sample points, and increasing the percentage of the area surrounding each sample point that was inundated or saturated. Water delivery also appeared to increase humidity within the flooded area; both diurnal and nocturnal vapor pressure were higher in the flooded area than in the non-flooded area in 2011 but not in 2010. In addition to the overall effect on humidity, flooding also had short-term effects on humidity as shown by the analysis of conditions on the day before versus the day after each flood event. On average, flood events produced higher diurnal and nocturnal vapor pressure in the flooded area in comparison to the non-flooded area.

The effect of water delivery on temperature was not as clear. The analysis comparing the flooded and non-flooded areas throughout the year did not show a statistically significant overall effect of flooding on any of the temperature variables, but there was an interaction between flood group and time in 2011, showing that all temperature variables changed through the year in the flooded area in a different way than they changed in the non-flooded area. In 2011, the difference between the flooded and non-flooded areas in all temperature variables declined as the season progressed. An analysis of temperature variables on the day before versus the day after each flood event showed that, on average, flood events produced a lower maximum temperature, higher minimum temperature, and smaller daily temperature range in the flooded area in comparison to the non-flooded area. Thus, flood events did affect temperature, but these effects did not seem to persist across two-week periods. The interaction between flood group and time in 2011 suggests that the effect on temperature from a given flood event persisted for shorter periods of time as the season progressed.

Areas occupied by flycatchers typically have higher soil moisture, higher humidity, lower maximum temperatures, and smaller daily temperature ranges than unoccupied areas (McLeod et al. 2008a); thus, water delivery appeared to change the microclimate conditions within the flooded area in ways that would favor flycatcher occupancy.

The between-year changes in several of the vegetation variables appear somewhat contradictory, with canopy closure increasing between 2010 and 2011 but the amount of live vertical foliage decreasing between 2010 and 2011 in all height categories. It is difficult to distinguish between true changes in the vegetation and observer variation. The between-year differences were recorded in both flooded and non-flooded areas, indicating that flooding had no effect on changes in canopy closure or density of live vegetation. Woody ground cover increased between 2010 and 2011 in both flooded and non-flooded areas but increased much more dramatically in non-flooded areas. The overall increase in the percentage of woody ground cover could be strongly influenced by observer variation, but the significant interaction between year and flooded category suggests that the presence of surface water had an effect on the amount of woody cover, with flooding resulting in less woody cover. In general, water delivery did not appear to have any effects on vegetation that would influence flycatcher occupancy.

Water delivery resulted in the flooded area of In Between and 800M being the only portion of the sites surveyed for flycatchers within Topock Marsh that contained surface water during the 2011 breeding season (see Chapter 2). Five flycatcher territories were recorded in Topock Marsh in 2011 (see Chapters

2 and 3); one of these territories was within the flooded portion of 800M and consisted of an unpaired male flycatcher. This flycatcher was detected at the territory in 800M through the end of June and then was detected for a few days in early July at another site approximately 1.5 km away. In 2010, the area that was affected by flooding in 2011 contained two resident, unpaired male flycatchers; in 2009, this same area contained one resident, unpaired male flycatcher. Water delivery thus did not result in increased flycatcher occupancy in the target area.

The number of flycatchers at Topock Marsh has been declining since 2004 (see Chapter 2), and few flycatcher young have been produced locally in recent years (see Chapter 4). Thus, there may be few adult flycatchers in the local population, and the lack of response by flycatchers to water delivery may be indicative of there being few adults available to establish territories. In addition, low water levels in 2011 throughout areas of Topock Marsh that have been historically occupied by flycatchers likely reduced the overall suitability of the area for flycatchers. Although supplemental water delivery appeared to produce conditions that would be favorable to flycatcher occupancy, the confounding factors of dry conditions elsewhere in Topock Marsh and a low population may have limited the ability of flycatchers to colonize the area.

The supplemental pumping at Topock Marsh showed that delivering surface water into potentially suitable flycatcher habitat can shift the hydrological and microclimate conditions towards those favored by flycatchers. The effectiveness of pumping depends in part on the underlying water table, with a high water table resulting in a greater extent and longer retention of surface water. Water delivery also had the greatest effect on moderating temperature when the underlying water table was high. Thus, weekly water delivery may be effective only under certain conditions, and more frequent pumping may be required to maintain favorable microclimate and hydrology if the water table is not immediately beneath the ground surface.

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Chapter 9

MANAGEMENT AND STUDY DESIGN RECOMMENDATIONS

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

BROADCAST SURVEYS

Pahranagat MAPS and Pahranagat South were affected prior to the start of the 2010 survey season by a fire that removed the understory and damaged the overstory trees. We did not survey these sites in 2011 but recommend revisiting them in another 2–3 years to determine whether the understory has recovered to the point where it might support breeding flycatchers. We do not recommend surveying these sites in 2012.

Littlefield Poles was affected in December 2010 by a flood that heavily scoured much of the surrounding area. Hydrology, stand density, and vegetation height were all negatively impacted by the flood. We recommend revisiting this site at the beginning of future breeding seasons to determine whether the vegetation and hydrology have recovered to the point where breeding flycatchers might be supported.

Bunker Marsh North was surveyed at the start of 2011, but surveys were discontinued in mid-June due to lack of surface water within the vegetation and extensive defoliation. We recommend reassessing the site at the beginning of the next breeding season and discontinuing surveys if the site is dry.

Mormon Mesa North and Hedgerow at Mormon Mesa have been completely dry for the last several years, and neither of these sites has supported breeding flycatchers since 2005. We visited each site once at the beginning of the 2011 season to determine whether the hydrology of the sites was altered by heavy flooding on the Virgin River in December 2010. Both sites were dry during the initial visit and surveys were discontinued. We recommend discontinuing surveys at these sites until another flood event occurs that has the potential to alter the hydrology within the site. Virgin River #1 South consists of two disjunct areas. The southern section had dry soils throughout the survey season. We recommend visiting the southern section at the beginning of the next breeding season and discontinuing surveys in this portion of the site if no surface water is present. Virgin River #2 received extensive sedimentation ranging in depth from 15 to 60 cm as a result of the December 2010 flood. Many of the Goodding willow, particularly in the southern third of the site, are dead or dying, and we recommend discontinuing surveys in the southern portion of the site.

We revisited Tractor in Topock Marsh at the beginning of the 2011 season. Vegetation structure at the site is not suitable for supporting breeding flycatchers, and we do not recommend future visits to this site.

At Bill Williams River NWR, we revisited New River for the first time since it was initially evaluated in 2008. In 2008, the vegetation appeared too young and sparse to support willow flycatchers. Vegetation at the site has matured somewhat since the visit in 2008 but still lacks the combination of extent, size, and density typical of occupied flycatcher habitat. The site should be reevaluated in another two or three years. Wispy Willow, a small area of new coyote willow growth downstream of Site #1, currently lacks the size to resemble occupied flycatcher habitat along the LCR, but the site should be reassessed in future years.

Ground reconnaissance of Laguna revealed that, overall, the site is lacking in vegetation of sufficient height and density to resemble suitable flycatcher habitat. Surface water was present only in one small area. Soils in most of the site were complete dry. We discontinued surveys after the initial visit because of the complete lack of potential flycatcher habitat.

COWBIRD CONTROL

The breeding site at Muddy River is a relatively small stand of tall trees and is bordered to the north by an extensive valley dominated by residential areas and agriculture and containing little riparian vegetation. Muddy River had 33–75% parasitism in six of the seven years when flycatchers have been monitored at the study area, and overall nest success was 29%, well below the average of 44% across all study areas in those years. Although the breeding site at Muddy River is not as isolated from surrounding riparian vegetation as the site at Pahranagat, cowbird trapping at Muddy River has the possibility of reducing the parasitism rate and increasing flycatcher nest success, and we recommend that cowbird trapping be instituted at Muddy River.

In 2010 and 2011, we addled cowbird eggs in easily accessible flycatcher nests, and this appeared to reduce the hatch rate of the cowbird eggs and did not cause desertion of any nests by the flycatchers. Although sample sizes were small, results also suggested that the number of flycatcher nestlings fledged per nest might be higher as a result of cowbird egg addling and cowbird nestling removal. We recommend this program be continued in the future.

HABITAT MONITORING: PARKER TO IMPERIAL DAMS

In previous years we correlated piezometer groundwater levels and soil moisture measurements and found no strong linear relationship (McLeod and Koronkiewicz 2009). Sites with high soil moisture values tended to show a weak, negative relationship between depth to groundwater and soil moisture, while sites with low soil moisture showed no relationship between depth to groundwater and soil moisture. This suggests that at sites where soil moisture is low, surface soil moisture content is not strongly influenced by groundwater levels, and soil moisture measurements are unlikely to reflect any changes in water availability caused by changing river levels. We recommend discontinuing soil moisture measurements at Havasu NE, Cibola Lake, Clear Lake, Ferguson Wash, and Gila Confluence North, where soil moisture values are consistently below 600 mV.

SURFACE HYDROLOGY, MICROCLIMATE, AND VEGETATION MONITORING: TOPOCK MARSH

The supplemental pumping at Topock Marsh showed that delivering surface water into potentially suitable flycatcher habitat can shift the hydrological and microclimate conditions towards those favored by flycatchers. The effectiveness of pumping depends in part on the underlying water table, with a high water table resulting in a greater extent and longer retention of surface water. Water delivery also had the greatest effect on moderating temperature when the underlying water table was high. Thus, weekly water delivery may be effective only under certain conditions, and more frequent pumping may be required to maintain favorable microclimate and hydrology if the water table is not immediately beneath the ground surface.

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Appendix A

FIELD DATA FORMS

Willow Flycatcher (WIFL) Survey and Detection Form (revised April 2010)

Site Name_____ State_____ County _____
USGS Quad Name _____ Elevation _____ (meters)
Creek, River, Wetland, or Lake Name_____

Is copy of USGS map marked with survey area and WIFL sightings attached (as required)? Yes___ No____

Survey Coordinates: Start: E_____ N_____ UTM Datum_____(See instructions)
Stop: E_____ N_____ UTM Zone _____

If survey coordinates changed between visits, enter coordinates for each survey in comments section on back of this page.

***** Fill in additional site information on back of this page *****

Survey # Observer(s) (Full Name)	Date (m/d/y) Survey time	Number of Adult WIFLs	Estimated Number of Pairs	Estimated Number of Territories	Nest(s) Found? Y or N If Yes, number of nests	Comments (e.g., bird behavior; evidence of pairs or breeding; potential threats [livestock, cowbirds, *Diorhabda* spp.]). If *Diorhabda* found, contact USFWS and State WIFL coordinator	GPS Coordinates for WIFL Detections (this is an optional column for documenting individuals, pairs, or groups of birds found on each survey). Include additional sheets if necessary.			
Survey # 1 Observer(s)	Date						# Birds	Sex	UTM E	UTM N
	Start									
	Stop									
	Total hrs ___									
Survey # 2 Observer(s)	Date						# Birds	Sex	UTM E	UTM N
	Start									
	Stop									
	Total hrs ___									
Survey # 3 Observer(s)	Date						# Birds	Sex	UTM E	UTM N
	Start									
	Stop									
	Total hrs ___									
Survey # 4 Observer(s)	Date						# Birds	Sex	UTM E	UTM N
	Start									
	Stop									
	Total hrs ___									
Survey # 5 Observer(s)	Date						# Birds	Sex	UTM E	UTM N
	Start									
	Stop									
	Total hrs ___									

Overall Site Summary	Total Adult Residents	Total Pairs	Total Territories	Total Nests	
Totals do not equal the sum of each column. Include only resident adults. Do not include migrants, nestlings, and fledglings. Be careful not to double count individuals. Total Survey Hrs _____					Were any Willow Flycatchers color-banded? Yes___ No ___ If yes, report color combination(s) in the comments section on back of form and report to USFWS.

Reporting Individual _____ Date Report Completed_____ _____
US Fish and Wildlife Service Permit #_____ State Wildlife Agency Permit #_____

Submit form to USFWS and State Wildlife Agency by September 1st. Retain a copy for your records.

Fill in the following information completely. Submit form by September 1st. Retain a copy for your records.

Reporting Individual _____Phone # _____
Affiliation _____ E-mail _____
Site Name_____Date Report Completed _____
Was this site surveyed in a previous year? Yes___ No ___ Unknown ____
Did you verify that this site name is consistent with that used in previous years? Yes ____ No _____ Not Applicable ___
If site name is different, what name(s) was used in the past?_____
If site was surveyed last year, did you survey the same general area this year? Yes ____ No ____ If no, summarize below.
Did you survey the same general area during each visit to this site this year? Yes ____ No ____ If no, summarize below.

Management Authority for Survey Area: Federal____ Municipal/County ____ State ____ Tribal ____ Private ____
Name of Management Entity or Owner (e.g., Tonto National Forest) _____

Length of area surveyed: _____ (km)

Vegetation Characteristics: Check (only one) category that best describes the predominant tree/shrub foliar layer at this site:

_____ Native broadleaf plants (entirely or almost entirely, > 90% native)

_____ Mixed native and exotic plants (mostly native, 50 - 90% native)

_____ Mixed native and exotic plants (mostly exotic, 50 - 90% exotic)

_____ Exotic/introduced plants (entirely or almost entirely, > 90% exotic)

Identify the 2-3 predominant tree/shrub species in order of dominance. Use scientific names.
_____

Average height of canopy (Do not include a range): _____ (meters)

Attach the following: 1) copy of USGS quad/topographical map (REQUIRED) of survey area, outlining survey site and location of WIFL detections; 2) sketch or aerial photo showing site location, patch shape, survey route, location of any detected WIFLs or their nests; 3) photos of the interior of the patch, exterior of the patch, and overall site. Describe any unique habitat features in Comments.

Comments (such as start and end coordinates of survey area if changed among surveys, supplemental visits to sites, unique habitat features. Attach additional sheets if necessary.
_____
_____
_____
_____
_____
_____

Territory Summary Table. Provide the following information for each verified territory at your site.

Territory Number	All Dates Detected	UTM E	UTM N	Pair Confirmed? Y or N	Nest Found? Y or N	Description of How You Confirmed Territory and Breeding Status (e.g., vocalization type, pair interactions, nesting attempts, behavior)

Attach additional sheets if necessary

SWFL General Site Description

[Complete at least 3 times during season: early (10–25 May), mid-season (10–25 June), and late season (10–25 July)]

General Info

Study Area: _____ **Survey Site:** _____ **Date:** _____

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

Vegetation

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 _____

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:**_____

Hydrology

% 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: _____

Narrative and Pictorial Description

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

_____

On the reverse, sketch and label the locations of the major vegetation types you observed. Delineate marshes, open areas, and other habitat that may be unsuitable for flycatchers. If water was present, show its location.

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

_____
_____
_____
_____
_____
_____
_____
_____

Additional comments: _____
_____
_____

STUDY AREA: _____ **SITE**: _____ **BANDER**: _____ **DATE**: _____ **TIME**: _____ **TERR/NEST #**: _____

UTM NAD___ **Zone**___ _____ **E** _____ **N** **NBN:** ____ of ____

NOTES:_____

FEDERAL BAND #	COLOR COMBO		STATUS	SEX	AGE	FECAL SAMPLE? (Y or N)	GENETIC SAMPLE? (Y or N)	# PHOTOS TAKEN
	L	R						

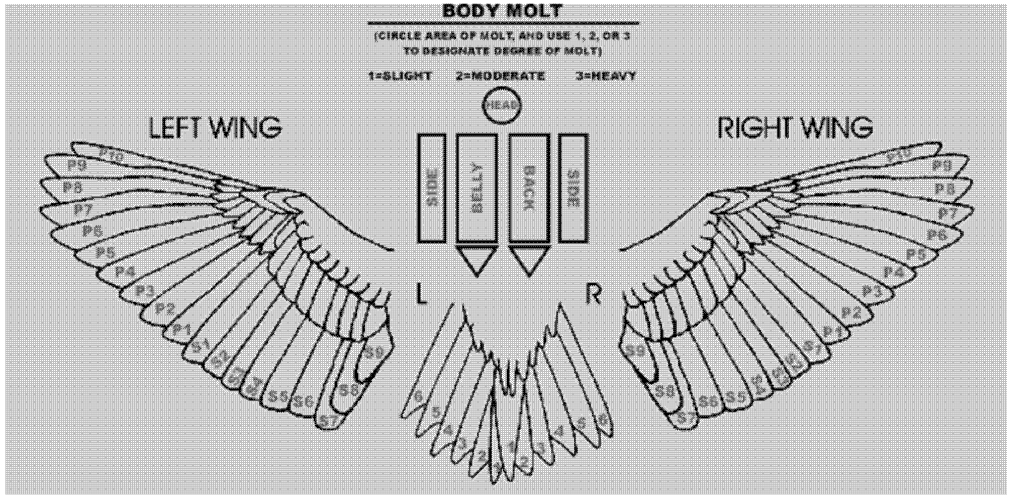
STATUS: NCP = new cap passive, NCT = new cap target, RCP = recap passive, RCT = recap target, NBN = nestling banded
SEX: U = unknown, F = female, M = male
AGE: AHY = after hatch year; SY = second year; L = nestling banded in nest; HY = hatch year/young of the year

Adults								
CP	BP	WING CHORD	TAIL ~~(mm)~~	CULMEN LENGTH	CULMEN WIDTH	FAT	RETAINED FEATHERS?	ACTIVE MOLT?
		(mm)		(mm)	(mm)		Y or N, if Y use diagram, detail in notes	

Nestlings	
Developmental Age (days)	MASS (g)

CP: 0 = non-breeding, S = partial breeding, M = full breeding
BP: 0 = none, 1 = smooth, 2 = vascularized and filled with fluid, 3 = wrinkled, 4 = molting
FAT: 0 = no fat; 1 = trace of fat in furculum, deeply concave, scattered patches, less than 5 percent filled; 2 = thin layer of fat in furculum, less than a third filled, trace of thin layer of fat in abdomen; 3 = furculum is ½ filled or more; small patches, not covering some areas, on abdomen; 4 = furculum more than 2/3 filled, level with clavicles, slightly mounded on abdomen

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



Date: _____ Page ____ of ____

				COLOR COMBO							
OBS	STUDY AREA	TERR	NEST	LEFT LEG	RIGHT LEG	CONF LEVI.	CAP?	# WIFLS	SEX	NBN (__of __)	OBSERVATIONS AND COMMENTS: discuss observations & activities. **If you assign gender, explain!**
											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 =
											Service Band Number =

Willow Flycatcher Territory/Nest Record Form

Year _____ 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 (approx)

Nest Substrate:_____(e.g., TASP=tamarisk, SAGO–Goodding willow, SAEX – coyote willow, etc.)

Distance to standing water or saturated soil:

When nest found: _____(m) Date _____ How determined? _____

UTME_____ UTMN_____ Accuracy _____

Depth of surface water at nest (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)

At hatch: _____(m) Date _____ How determined? _____

UTME_____ UTMN_____ Accuracy _____

At fledge/fail: _____(m) Date _____ How determined? _____

UTME_____ UTMN_____ Accuracy _____

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											

LCR SWFL – Vegetation Datasheet

Observers: _____

Study area	Survey site	Plot type	ID#	UTM: E N	Acc. m	Date

Canopy height	Direct measurement m	Using clinometer Top % - Bottom % × Dist m	Ground cover Obs:	N	E	S	W	Canopy closure Obs:	N	S

Species		TASP single	TASP multi	TASP skipped	SAEX single	SAEX multi	SAEX skipped	SAGO single	SAGO multi	SAGO skipped	SNAG single	SNAG multi	SNAG skipped
Stem Count By cm dbh category	<1												
	1–2.5												
	2.6–5.5												
	5.6–8												
	8.1–10.5												
	10.5–15												
	Measured Trees >15 cm dbh												

Species		OTSP1 single	OTSP1 multi	OTSP1 skipped	OTSP2 single	OTSP2 multi	OTSP2 skipped	OTSP3 single	OTSP3 multi	OTSP3 skipped
Stem Count By cm dbh category	<1									
	1–2.5									
	2.6–5.5									
	5.6–8									
	8.1–10.5									
	10.5–15									
	Measured Trees >15 cm dbh									

Other species (write out full name)

OTSP1_____

OTSP2 _____

OTSP3_____

If stem splits below ankle height, measure and tally each stem in "single" column. If, at ankle height or above, stem splits into multiple branches, measure and tally the biggest stem in "multi" column and record how many stems you did not measure in the "skipped" column (in the size category of the stem you measured).

If stem is not at least breast height, do not count

Vertical Foliage Sampling

CENTER PLOT Observer: _____

Height (m)	Hits/Species						
	TASP	SAGO	SAEX	SNAG	OTSP1*: _____	OTSP2*: _____	OTSP3*: _____
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
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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.**

Notes:

Vertical Foliage Sampling

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

NORTH 1m Observer: _____								EAST 1m Observer: _____							
Height (m)	Hits/Species							Height (m)	Hits/Species						
	TASP	SAGO	SAEX	SNAG	OTSP1	OTSP2	OTSP3		TASP	SAGO	SAEX	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							
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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.**

SIDE 1

Vertical Foliage Sampling

SOUTH 1m Observer: _____								WEST 1m Observer: _____							
Height (m)	Hits/Species							Height (m)	Hits/Species						
	TASP	SAGO	SAEX	SNAG	OTSP1	OTSP2	OTSP3		TASP	SAGO	SAEX	SNAG	OTSP1	OTSP2	OTSP3
1								1							
2								2							
3								3							
4								4							
5								5							
6								6							
7								7							
8								8							
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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.**

SIDE 2

Vertical Foliage Sampling

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

NORTH 5m Observer: _____								EAST 5m Observer: _____							
Height (m)	Hits/Species							Height (m)	Hits/Species						
	TASP	SAGO	SAEX	SNAG	OTSP1	OTSP2	OTSP3		TASP	SAGO	SAEX	SNAG	OTSP1	OTSP2	OTSP3
1								1							
2								2							
3								3							
4								4							
5								5							
6								6							
7								7							
8								8							
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19								19							
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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.**

SIDE 1

Vertical Foliage Sampling

SOUTH 5m Observer: _____								WEST 5m Observer: _____							
Height (m)	Hits/Species							Height (m)	Hits/Species						
	TASP	SAGO	SAEX	SNAG	OTSP1	OTSP2	OTSP3		TASP	SAGO	SAEX	SNAG	OTSP1	OTSP2	OTSP3
1								1							
2								2							
3								3							
4								4							
5								5							
6								6							
7								7							
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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.**

SIDE 2

SWFL Microclimate at Occupied Territories

Study Area _____ **Survey Site** _____ **LOCATION ID** _____–_____–_____
(Study area) – (Year) – (Territory #)

UTM coordinates: E 0_____ **N** _____ **GPS Accuracy**: _____ m

Date territory first occupied: _____ **Date territory vacated** _____

New Location ID (if this logger was already in the field) _____–_____–_____

Temperature/Relative Humidity (T/RH)

Set-up: Date:_____ Time:_____ Observer(s)_____

Logger 6-digit serial number (e.g., #630863):_____ Was red LED checked at set-up? Y or N

What randomization sequence was used? Sequence #: _____

Column 1: _____ Column 2: _____ Column 3:_____ Column 4:_____ Column 5:_____

Est. actual height of logger _____ m

Download: Date:_____ Time:_____ Observer(s):_____

Was red LED blinking at download? Y or N Did you check red LED after (re)launch? Y or N

Logger 6-digit serial number (do NOT copy from above; read the number on the logger!):_____

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:

Was logger downloaded on-site? Y or N If N, date and time of download: Date: _____ Time: _____

Did you replace the existing logger? Y or N If Y, serial number of new logger: _____

Comments:

Download: Date:_____ Time:_____ Observer(s):_____

Was red LED blinking at download? Y or N Did you check red LED after (re)launch? Y or N

Logger 6-digit serial number (do NOT copy from above; read the number on the logger!):_____

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:

Was logger downloaded on-site? Y or N If N, date and time of download: Date: _____ Time: _____

Did you replace the existing logger? Y or N If Y, serial number of new logger: _____

Comments:

Soil Moisture (SM)

Date **soil sample** collected:_____

Soil moisture data collected on the following dates (enter SM data directly into database):

Date: _____ Obs: _____ Date: _____ Obs: _____ Date: _____ Obs: _____

Date: _____ Obs: _____ Date: _____ Obs: _____ Date: _____ Obs: _____

Date: _____ Obs: _____ Date: _____ Obs: _____ Date: _____ Obs: _____

Date: _____ Obs: _____ Date: _____ Obs: _____ Date: _____ Obs: _____

Habitat Monitoring Sites

Study Area _____ **Survey Site** _____ **LOCATION ID** _____-_____-_____
(Study area) – (Survey site) – (Number)

UTM coordinates: E 0_ _ _ _ _ _ _ **N** _ _ _ _ _ _ _ _ **Accuracy**: _____ m

T/RH Downloads

Date:_____ Time:_____ Observer(s):_____ Was red LED blinking at download? Y or N

Logger 6-digit serial number (e.g., #630863):_____ Did you check red LED after (re)launch? 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:

Was logger downloaded on-site? Y or N If N, date and time of download: Date: _____ Time: _____

Did you replace the existing logger? Y or N If Y, serial number of new logger: _____

Comments:

Date:_____ Time:_____ Observer(s):_____ Was red LED blinking at download? Y or N

Logger 6-digit serial number (e.g., #630863):_____ Did you check red LED after (re)launch? 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:

Was logger downloaded on-site? Y or N If N, date and time of download: Date: _____ Time: _____

Did you replace the existing logger? Y or N If Y, serial number of new logger: _____

Comments:

Soil Moisture (SM)

Soil moisture data collected on the following dates (enter SM data directly into database):

Date: _____ Obs: _____	Date: _____ Obs: _____	Date: _____ Obs: _____
Date: _____ Obs: _____	Date: _____ Obs: _____	Date: _____ Obs: _____
Date: _____ Obs: _____	Date: _____ Obs: _____	Date: _____ Obs: _____
Date: _____ Obs: _____	Date: _____ Obs: _____	Date: _____ Obs: _____

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

Microclimate at Hydro Monitoring Sites – Topock

Study Area _TOPO___ Survey Site _____ LOCATION ID: TM –HM–_____
(Location ID)

UTM coordinates: E 0_ _ _ _ _ _ _ N _ _ _ _ _ _ _ _ GPS Accuracy: _____ m

Temperature/Relative Humidity (T/RH)

Set-up: Date:_____ Time:_____ Observer(s)_____

Logger 6-digit serial number (e.g., #630863):_____ Was red LED checked at set-up? Y or N

What randomization sequence was used? Sequence #: _____
Column 1: _____ Column 2: _____ Column 3:_____

Est. actual height of logger _____ m

Download: Date:_____ Time:_____ Observer(s):_____

Was red LED blinking at download? Y or N Did you check red LED after (re)launch? Y or N

Logger 6-digit serial number (do NOT copy from above; read the number on the logger!):_____

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:

Was logger downloaded on-site? Y or N If N, date and time of download: Date: _____ Time: _____

Did you replace the existing logger? Y or N If Y, serial number of new logger: _____

Comments:

Download: Date:_____ Time:_____ Observer(s):_____

Was red LED blinking at download? Y or N Did you check red LED after (re)launch? Y or N

Logger 6-digit serial number (do NOT copy from above; read the number on the logger!):_____

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:

Was logger downloaded on-site? Y or N If N, date and time of download: Date: _____ Time: _____

Did you replace the existing logger? Y or N If Y, serial number of new logger:_____

Comments:

Soil Moisture (SM)

Date **soil sample** collected:_____

Soil moisture data collected on the following dates (enter SM data directly into database):

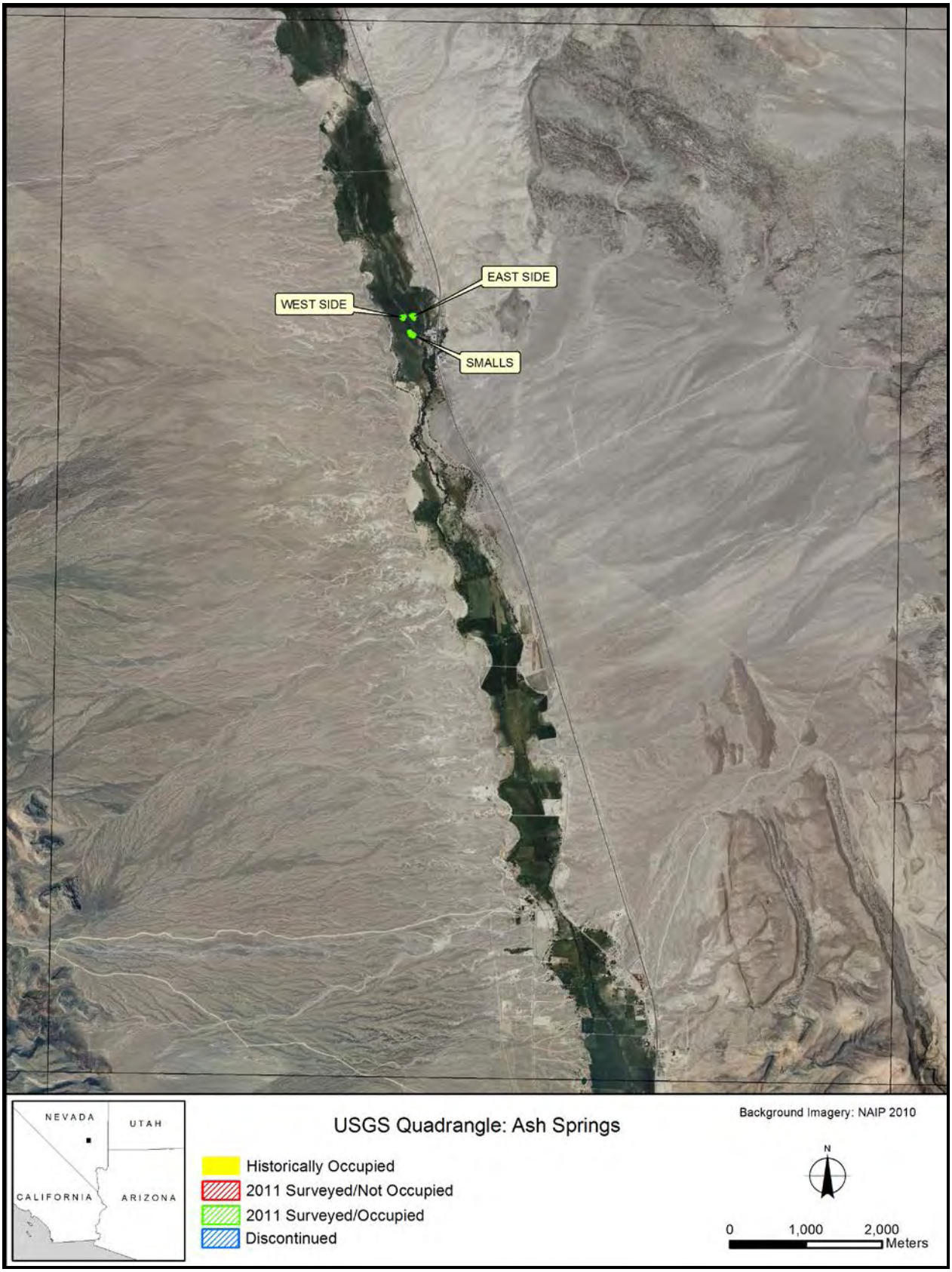
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____

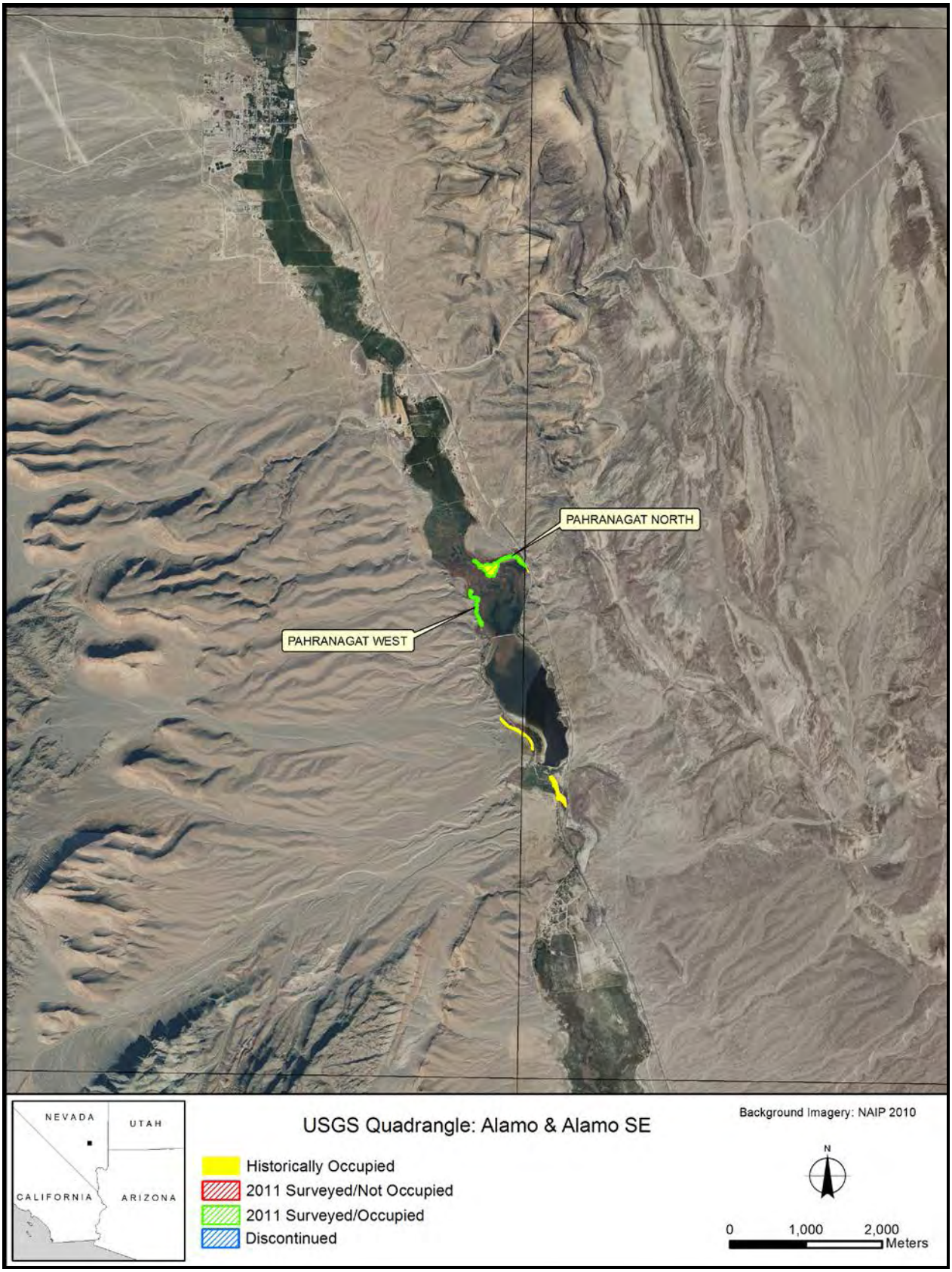
Appendix B

ORTHOPHOTOS SHOWING STUDY SITES

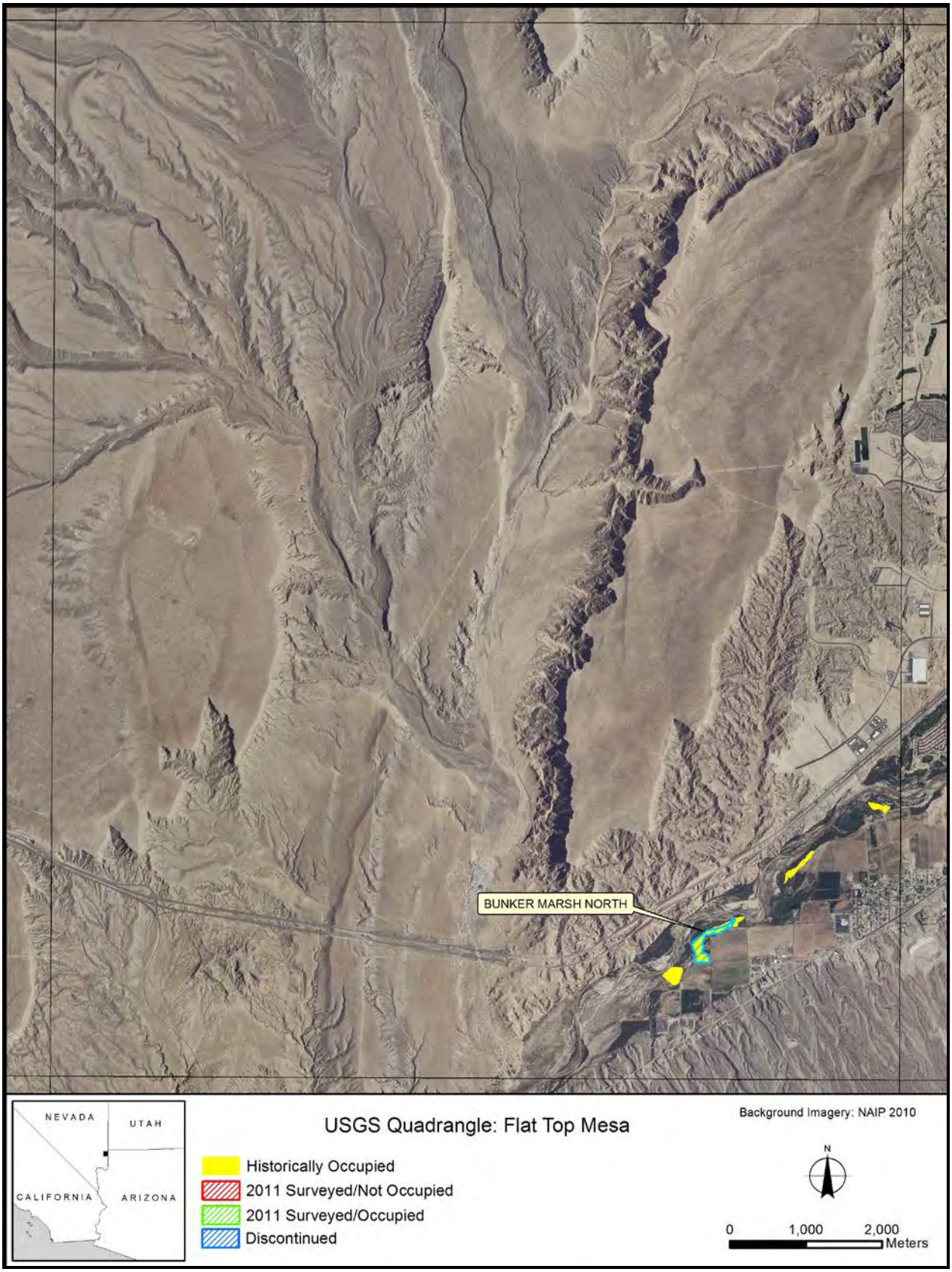
NEVADA
UTAH
CALIFORNIA
ARIZONA
MEXICO
KEY PITTMAN
RIVER RANCH
PAHRANAGAT NWR
WARM SPRINGS
MESQUITE
MORMON MESA
MUDDY RIVER
TOPOCK MARSH
BILL WILLIAMS RIVER NWR
PVER
CIBOLA
IMPERIAL
MITTRY LAKE
YUMA
St. George
Las Vegas
Kingman
Flagstaff
Quartzsite
Phoenix
Palm Springs
Yuma
Lake Mead
Lake Mohave
Lake Havasu
Salton Sea
Pahranagat Wash
Virgin River
Colorado River
Bill Williams River
Verde River
Gila River
Lower Colorado River Southwestern
Willow Flycatcher Study 2011
NDOW Study Area
Reclamation Study Area
City/Town
Highway
River
0 25 50 Mi
0 50 100 Km
1:3,300,000
N

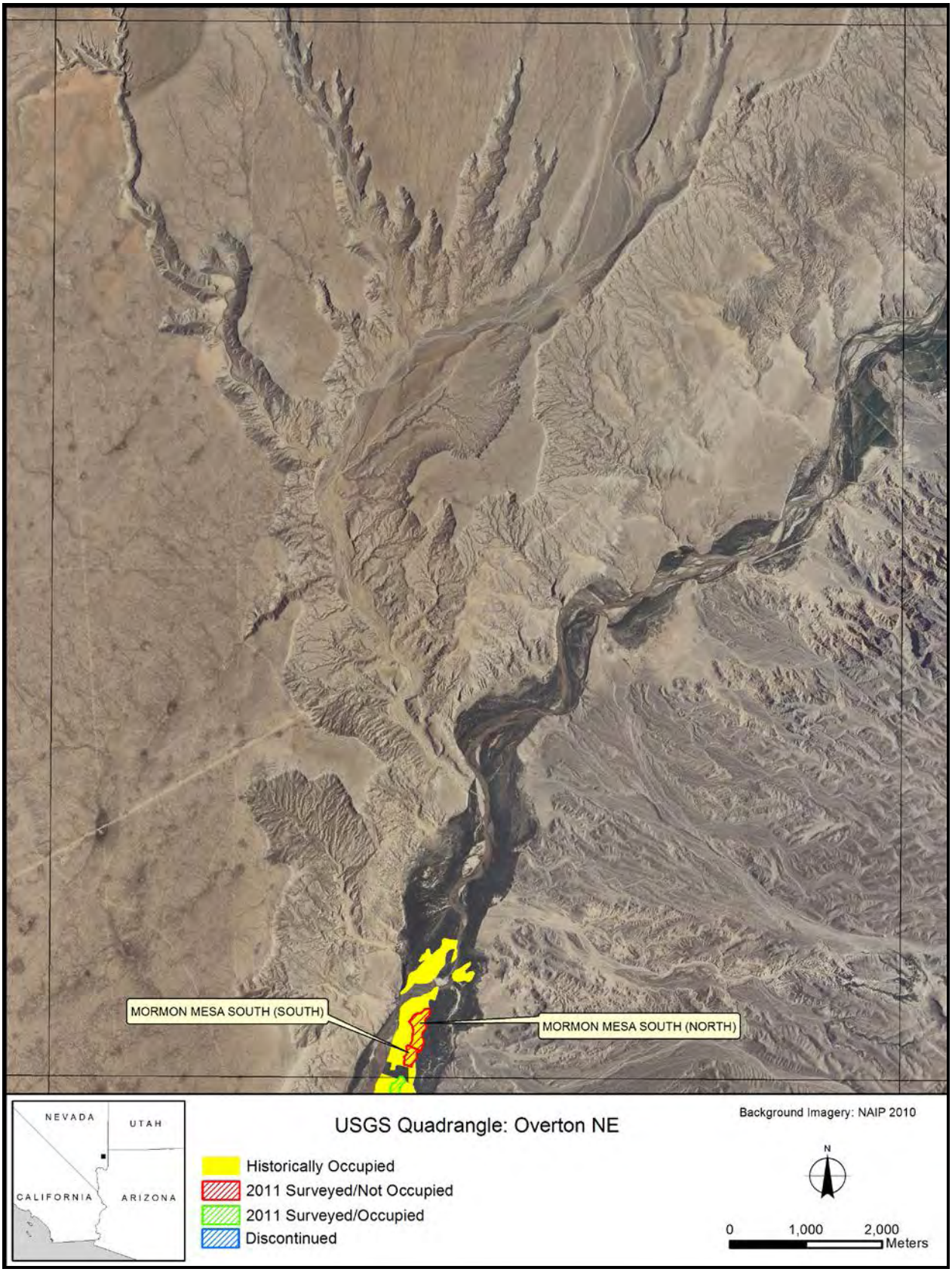
KEY PITTMAN PATCH 1 - 12
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Hiko
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

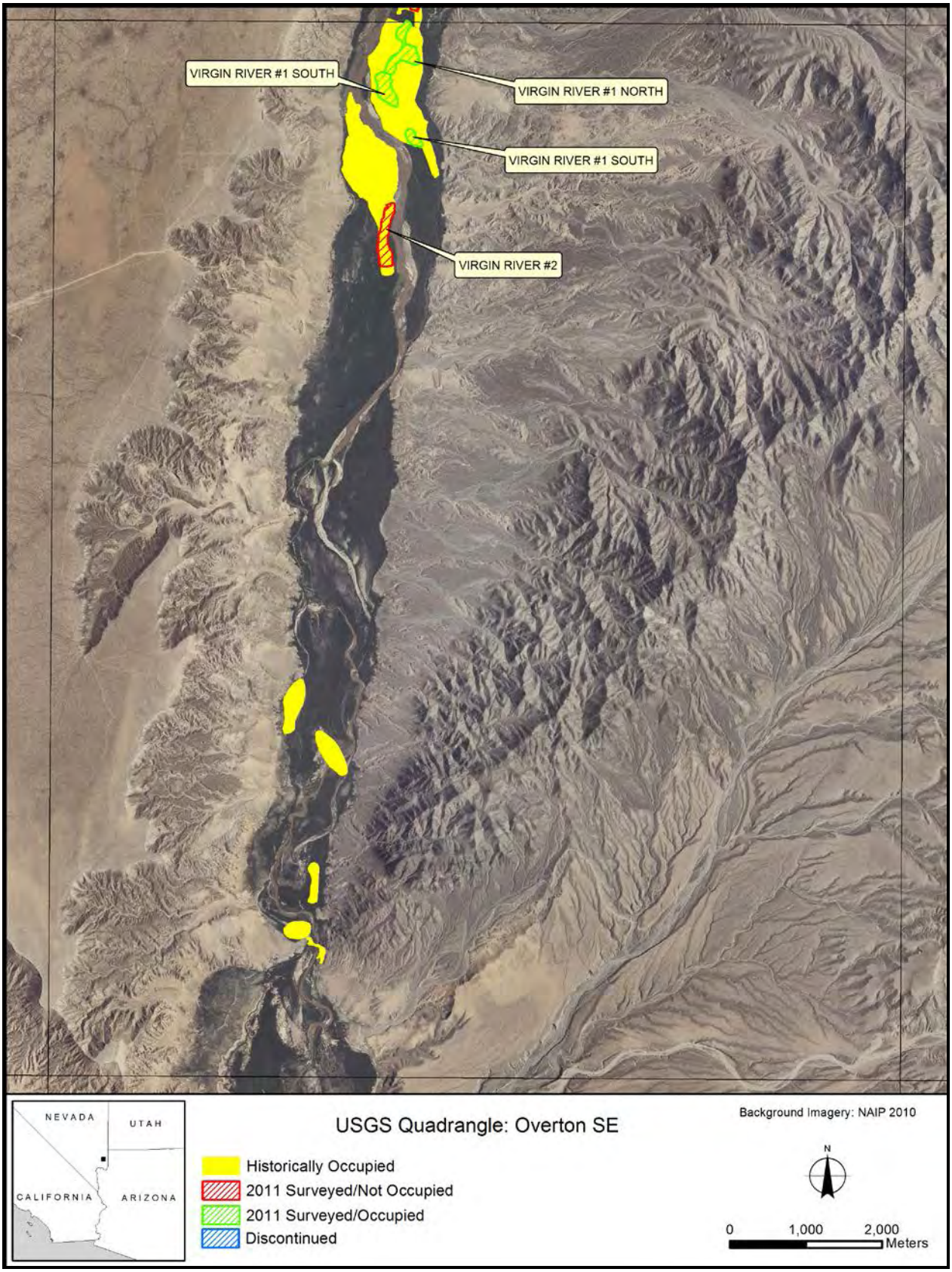

EAST SIDE
WEST SIDE
SMALLS
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Ash Springs
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters


PAHRANAGAT NORTH
PAHRANAGAT WEST
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Alamo & Alamo SE
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

MESQUITE WEST
HAFEN LANE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Mesquite
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background imagery: NAIP 2010
N
0
1,000
2,000
Meters

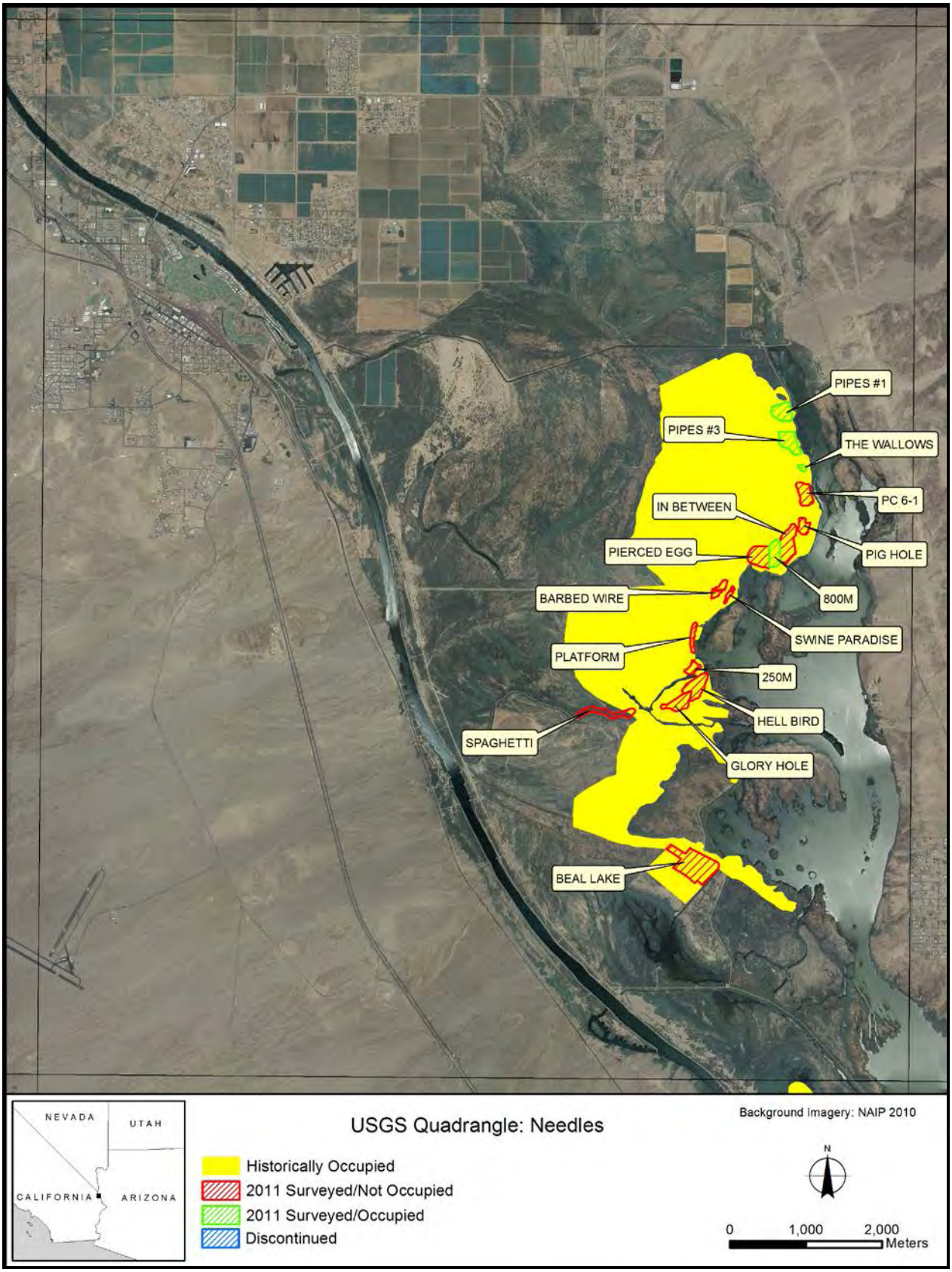

BUNKER MARSH NORTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Flat Top Mesa
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters


MORMON MESA SOUTH (SOUTH)
MORMON MESA SOUTH (NORTH)
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton NE
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

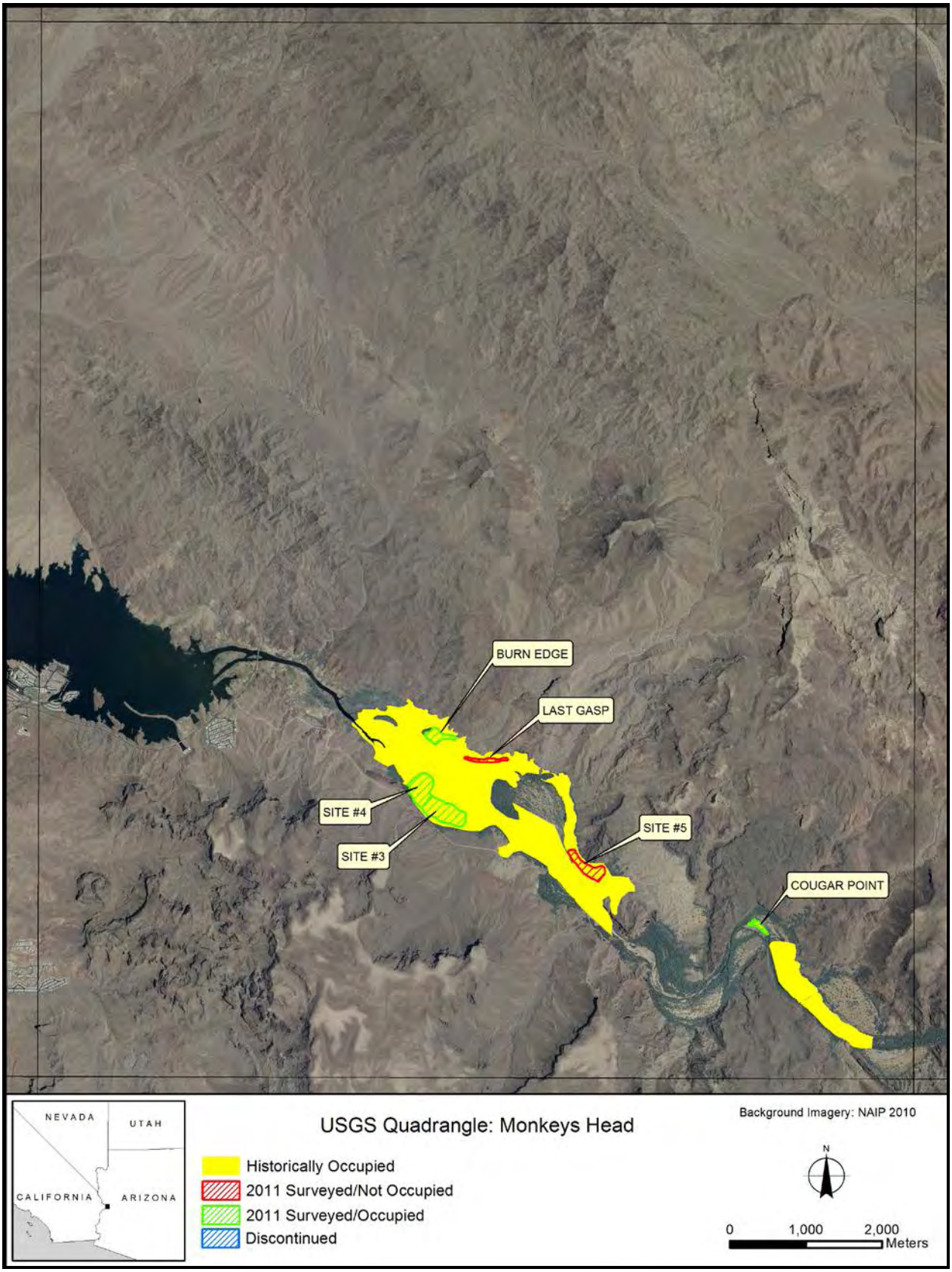

VIRGIN RIVER #1 SOUTH
VIRGIN RIVER #1 NORTH
VIRGIN RIVER #1 SOUTH
VIRGIN RIVER #2
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton SE
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

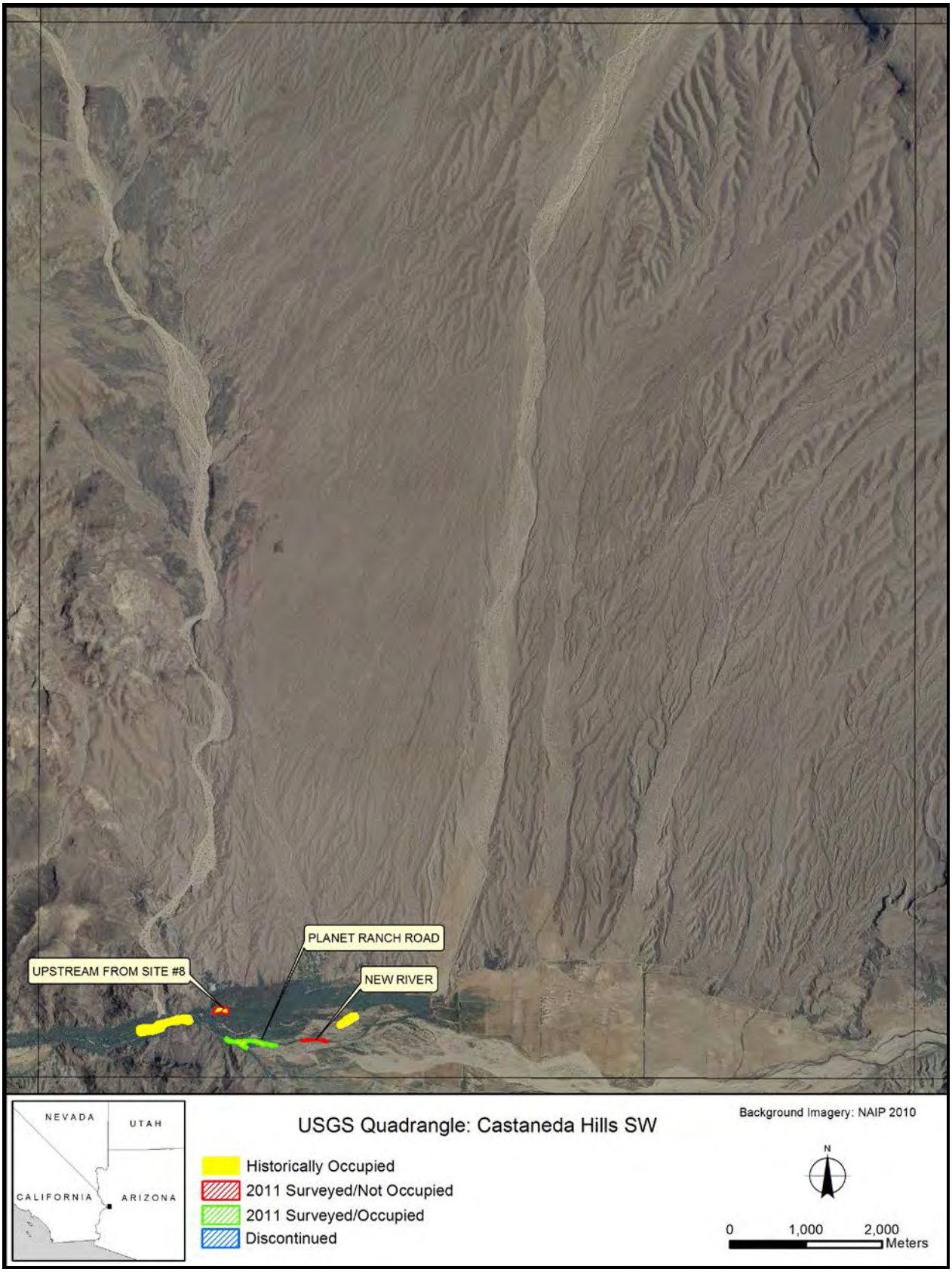
OVERTON WMA POND
OVERTON WMA
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

MUDDY MAC
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Moapa West
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

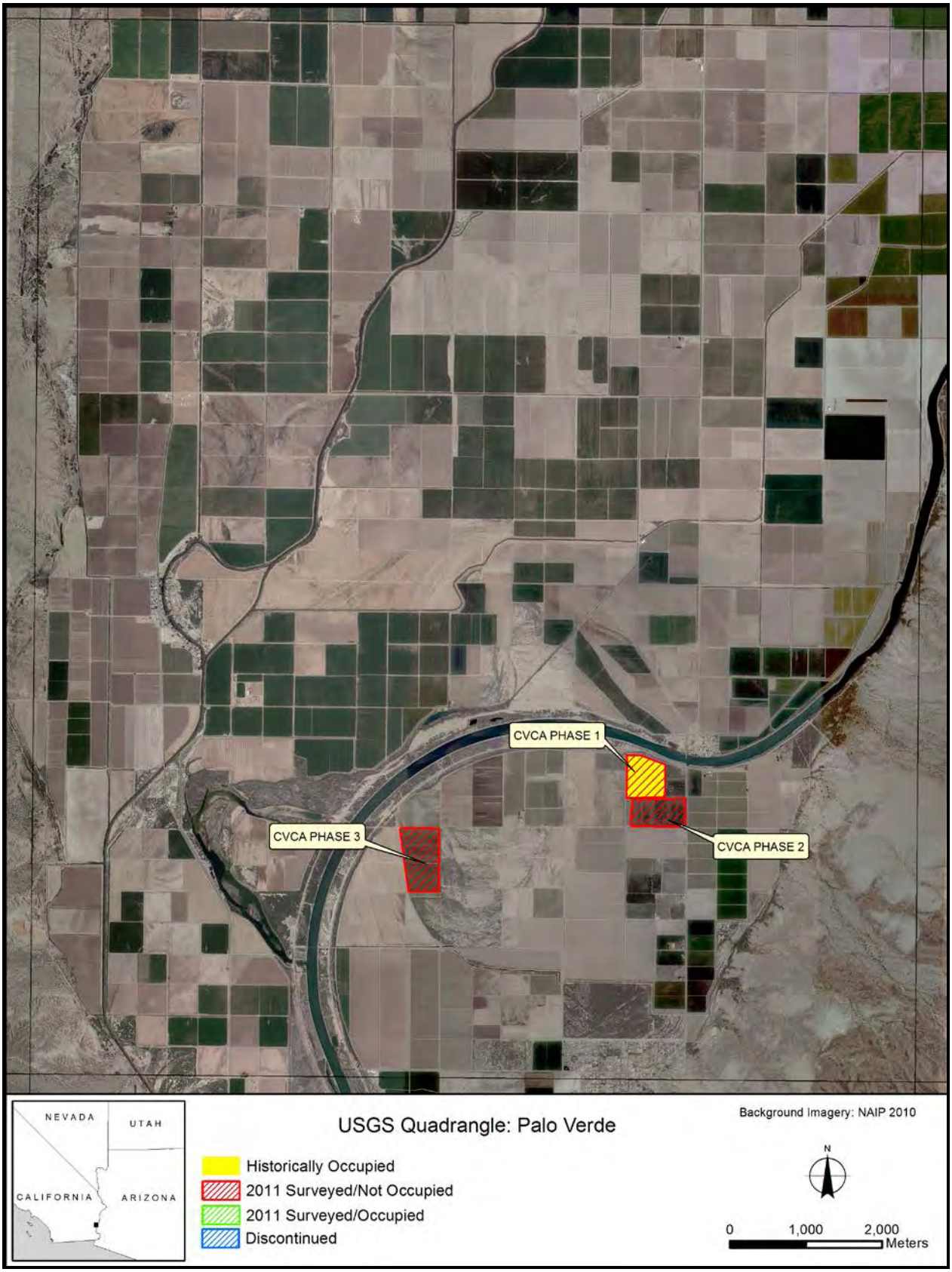

PIPES #1
PIPES #3
THE WALLOWS
PC 6-1
IN BETWEEN
PIG HOLE
PIERCED EGG
800M
BARBED WIRE
SWINE PARADISE
PLATFORM
250M
HELL BIRD
SPAGHETTI
GLORY HOLE
BEAL LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Needles
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

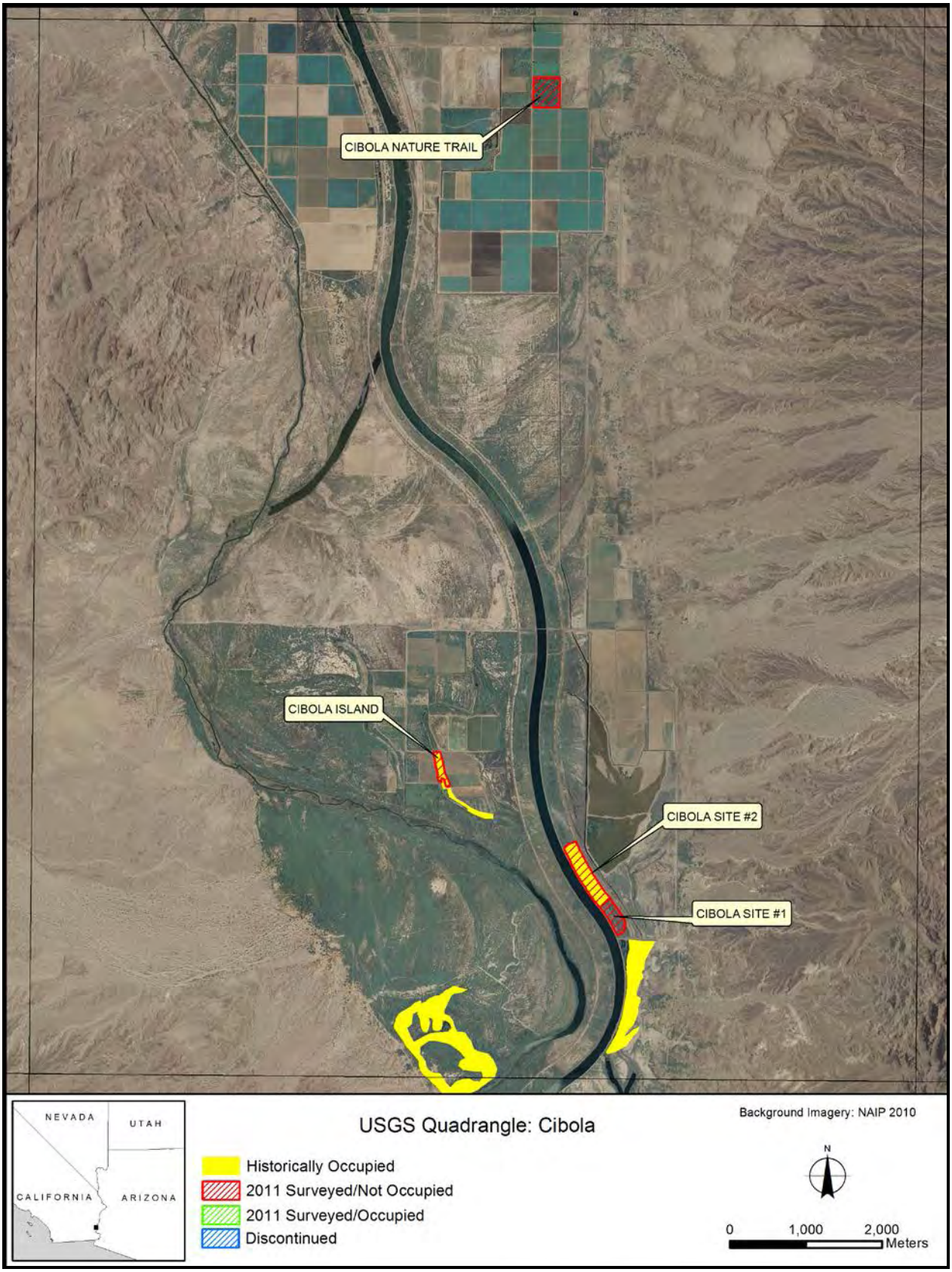
LOST LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Whale Mountain
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

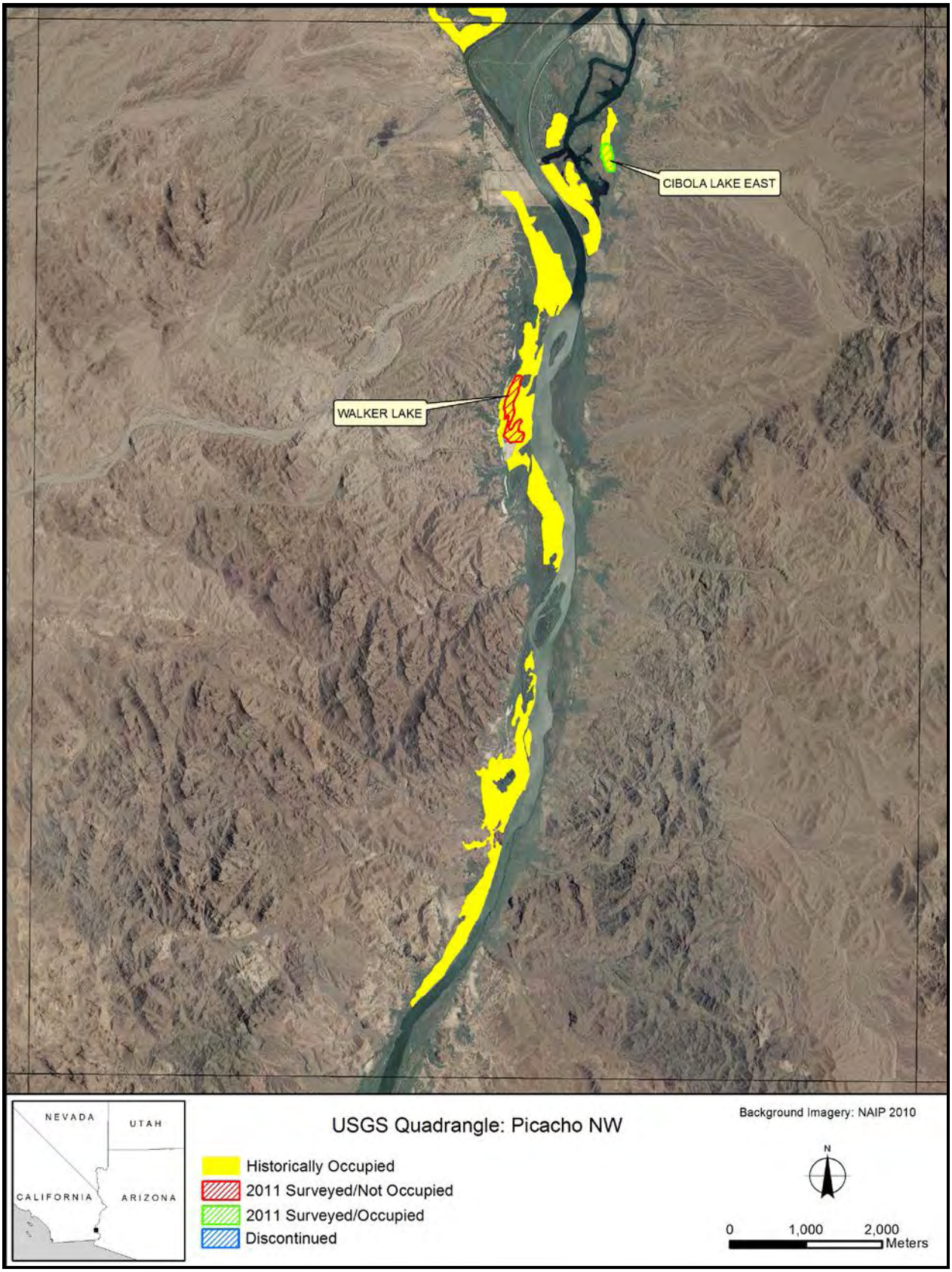

BURN EDGE
LAST GASP
SITE #4
SITE #3
SITE #5
COUGAR POINT
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Monkeys Head
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

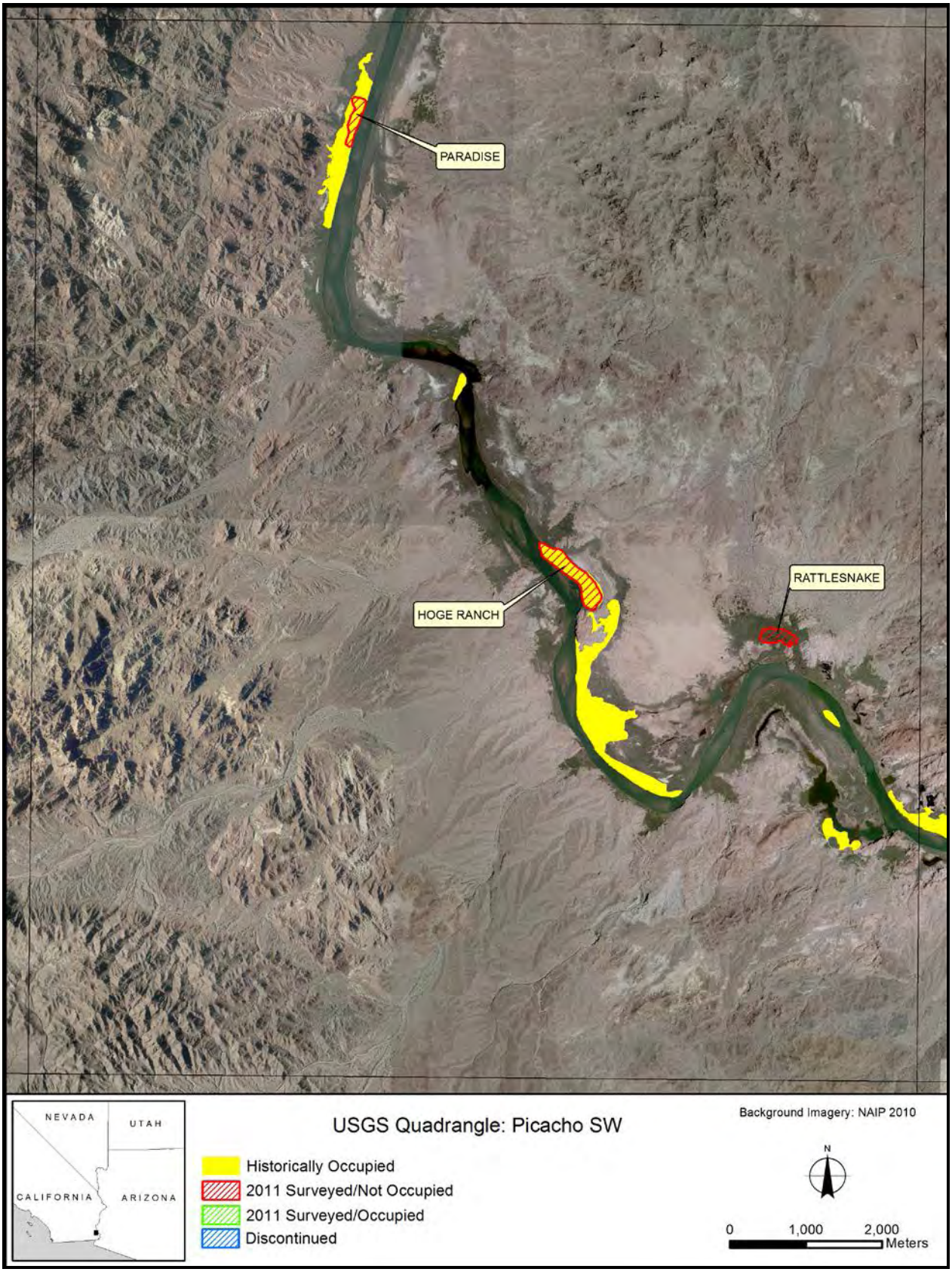

PLANET RANCH ROAD
UPSTREAM FROM SITE #8
NEW RIVER
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castaneda Hills SW
Background Imagery: NAIP 2010
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

PVER PHASE 2
PVER PHASE 3
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Blythe NE
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

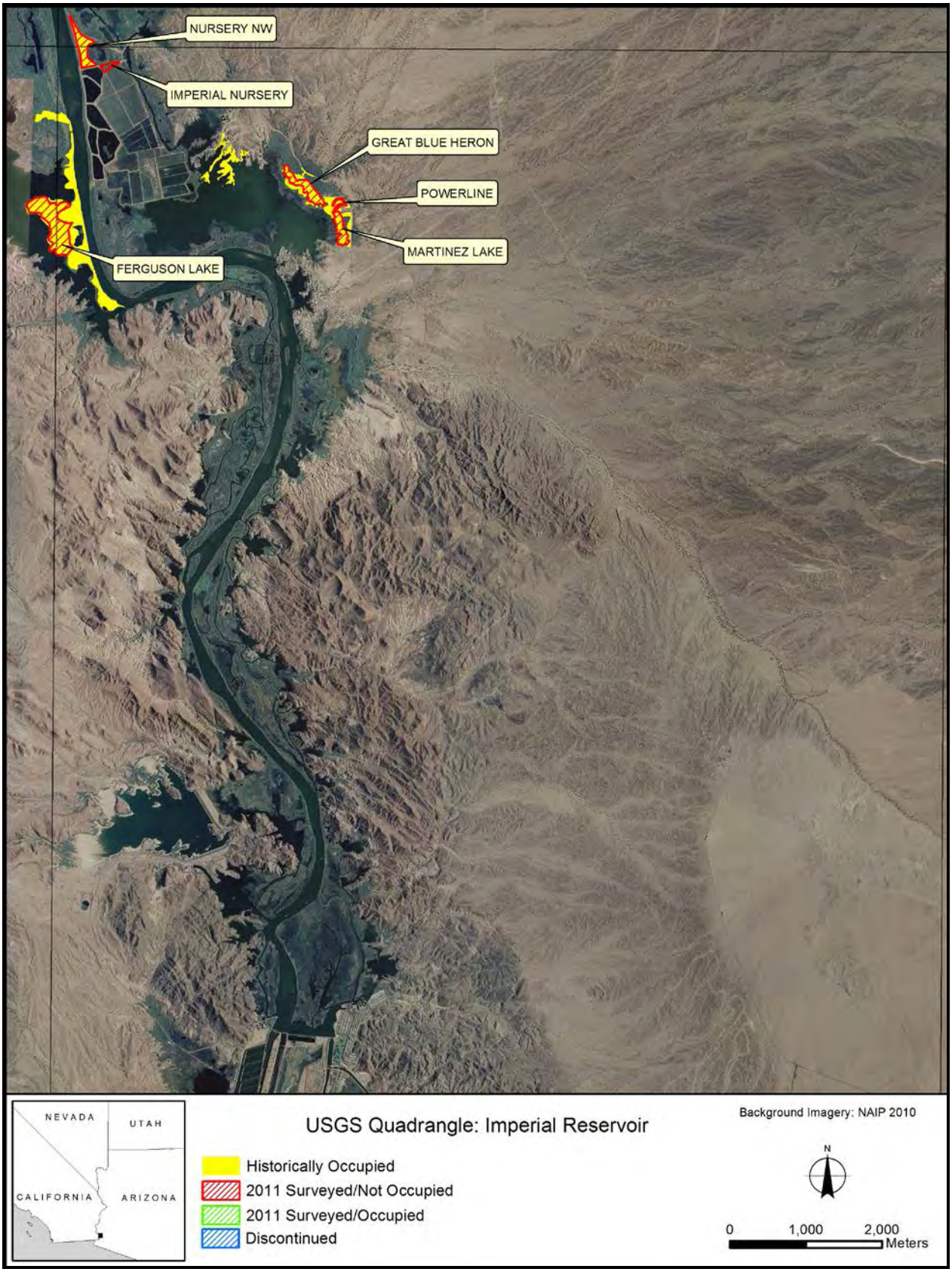

CVCA PHASE 1
CVCA PHASE 2
CVCA PHASE 3
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Palo Verde
Background Imagery: NAIP 2010
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

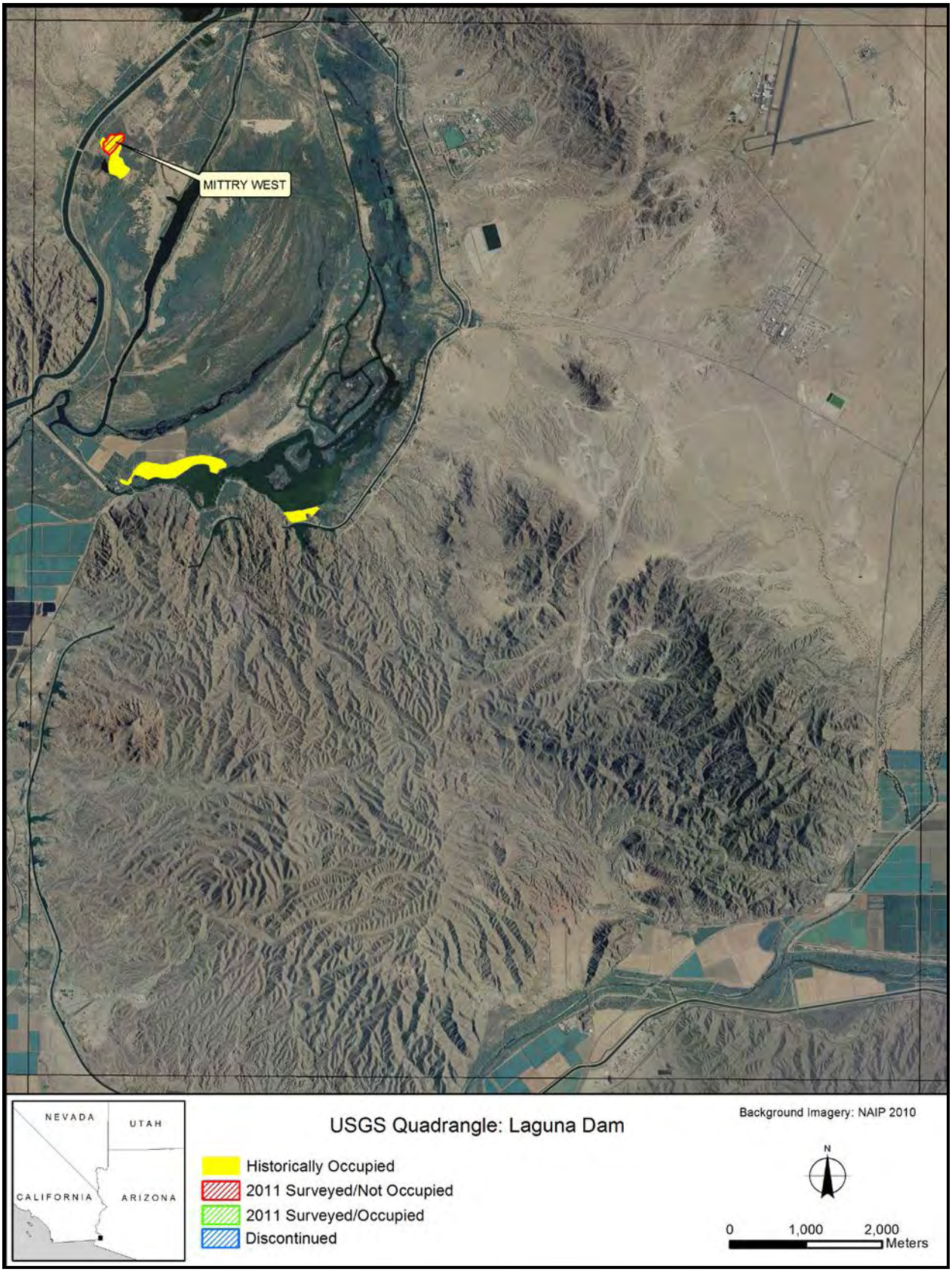

CIBOLA NATURE TRAIL
CIBOLA ISLAND
CIBOLA SITE #2
CIBOLA SITE #1
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Cibola
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

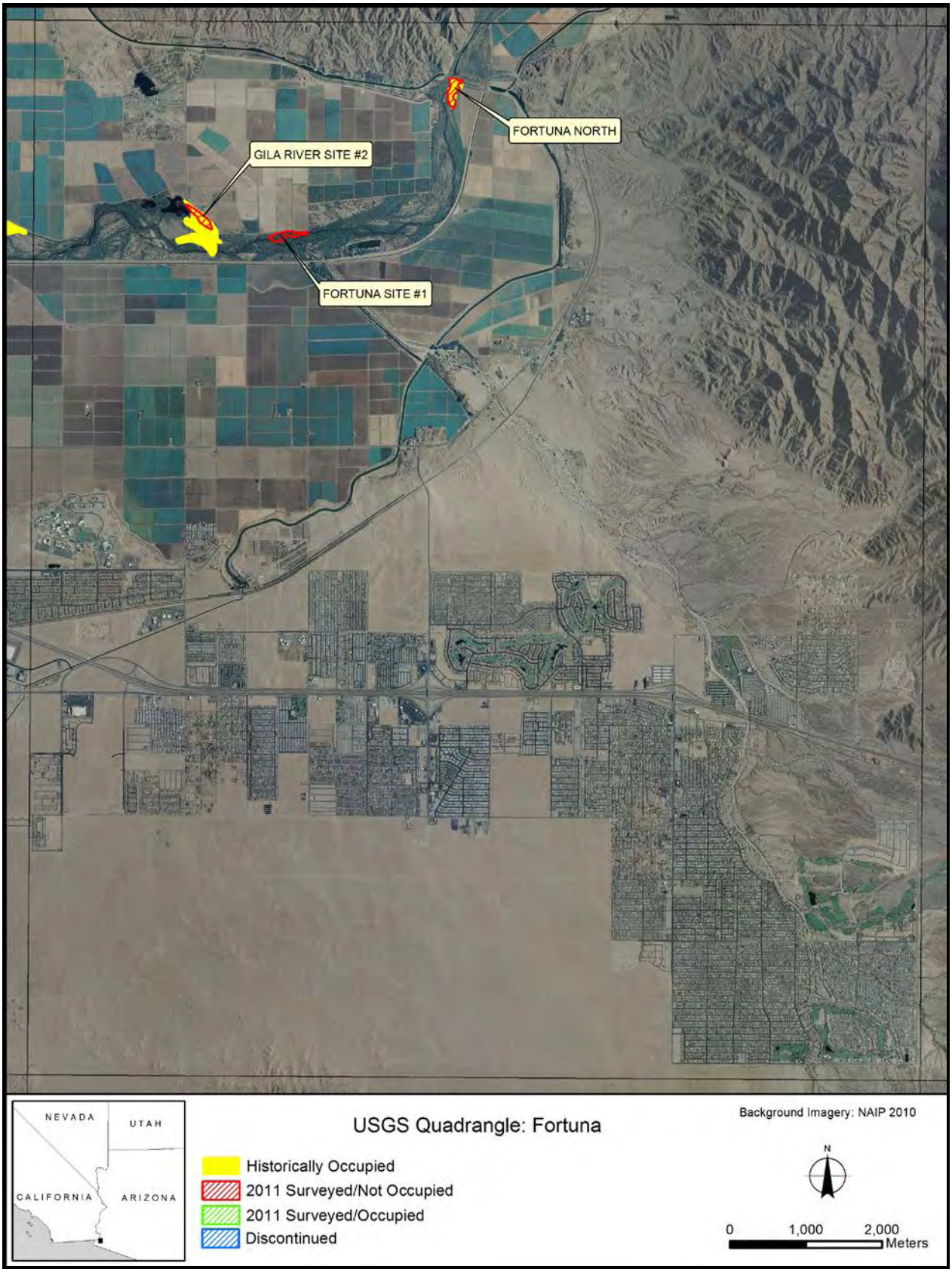

CIBOLA LAKE EAST
WALKER LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho NW
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters


PARADISE
HOGE RANCH
RATTLESNAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho SW
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

MILEMARKER 65
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters


NURSERY NW
IMPERIAL NURSERY
GREAT BLUE HERON
POWERLINE
MARTINEZ LAKE
FERGUSON LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Imperial Reservoir
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters


MITTRY WEST
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Laguna Dam
Background Imagery: NAIP 2010
Historically Occupied
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
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
2011 Surveyed/Not Occupied
2011 Surveyed/Occupied
Discontinued
Background Imagery: NAIP 2010
N
0
1,000
2,000
Meters

Appendix C

SOUTHWESTERN WILLOW FLYCATCHER SURVEY RESULTS, 2011

Table C.1. Southwestern Willow Flycatcher Survey Results by Site along the Lower Colorado River and Tributaries, 2011*

River Drainage	Study Area[1]	State	Survey Site[2]	Area (ha)	# Surveys	Survey Hours	Resident Adults	Territories	Pairs	Nests	Unknown Status	
											Before June 15[3]	After June 15[4]
Pahranagat Valley	KEPI[5]	NV	Patch 0	0.04	0	---	2[6]	1	1	1	0	0
		NV	Patch 1	0.1	0	---	2	1	1	1	0	0
		NV	Patch 2	0.1	0	---	2	1	1	2	0	0
		NV	Patch 3	0.1	0	---	1	1	0	0	1	0
		NV	Patch 4	0.1	0	---	2	1	1	1	3[7]	0
		NV	Patch 4.5	0.02	5	0.3	0	0	0	0	0	0
		NV	Patch 5	0.1	0	---	2	1	1	2	0	0
		NV	Patch 6	0.2	0	---	5[8]	3	3	3	0	0
		NV	Patch 7	0.1	0	---	2	1	1	2	0	0
		NV	Patch 8	0.1	0	---	2	1	1	2	0	0
		NV	Patch 9	0.3	0	---	4	2	2	3	0	0
		NV	Patch 10	0.1	0	---	3[8]	2	2	4	0	0
		NV	Patch 10.5	0.02	0	---	0	0	0	0	2[9]	0
		NV	Patch 11	0.1	0	---	4	2	2	6	1	0
		NV	Patch 12	0.1	0	---	3[8]	2	2	6	2	0
		NV	Fence[10]	---	0	---	0	0	0	0	0	1
Pahranagat Valley	RIRA[11]	NV	East Side	0.4	1	0.8	2[7]	1	1	3	0	0
		NV	West Side	0.3	1	---	3[6,9,12]	2	1	1	2	0
		NV	Smalls	0.5	1	---	1	1	1	0	0	0
Pahranagat Valley	PAHR	NV	North	4.6	4	1.5	14[13,14]	10	6	7	5[12]	2
		NV	West	1.5	5	3.1	0	0	0	0	1[14]	0
Virgin River	MESQ	NV	Hafen Lane	6.1	5	16.2	3[15]	1	1	1	0	0
		NV	West	10.4	5	7.4	11[16,17]	7	6	8	0	0
		NV	Bunker Marsh North[18]	7.1	2	3.7	0	0	0	0	0	0
Virgin River	MOME[19]	NV	Mormon Mesa South (North)	8.4	4	9.3	0	0	0	0	0	0
		NV	Mormon Mesa South (South)	3.4	3	4.8	0	0	0	0	0	0
		NV	Virgin River #1 (North)	11.4	4	12.9	4	2	2	1	1	0
		NV	Virgin River #1 (South)	11.1	3	5.5	19[20]	12	11	19	2[16]	0
		NV	Virgin River #2	11.2	5	16.8	0	0	0	0	0	0

Table C.1. Southwestern Willow Flycatcher Survey Results by Site along the Lower Colorado River and Tributaries, 2011* (Continued)

River Drainage	Study Area[1]	State	Survey Site[2]	Area (ha)	# Surveys	Survey Hours	Resident Adults	Territories	Pairs	Nests	Unknown Status	
											Before June 15[3]	After June 15[4]
Muddy River	MUDD	NV	Overton WMA Pond	0.7	5	2.5	0	0	0	0	1	0
		NV	Overton WMA	14.9	6	18.0	13[15,20]	8	5	6	2	0
Muddy River	WMSP	NV	Muddy Mac[21]	0.7	0	---	2	1	1	1	0	3
Colorado River	TOPO	AZ	Pipes #1	5.2	5	8.5	1	1	0	0	0	0
		AZ	Pipes #3	5.7	5	4.6	2	1	1	1	1	0
		AZ	The Wallows	0.7	5	2.1	1	1	0	0	0	2
		AZ	PC6-1	4.8	5	8.0	0	0	0	0	0	1
		AZ	Pig Hole	2.4	5	5.1	0	0	0	0	0	0
		AZ	In Between	7.7	5	9.9	0	0	0	0	0	1
		AZ	800M	4.7	5	4.7	1	1	0	0	1	1
		AZ	Pierced Egg	6.7	5	8.5	0	0	0	0	0	4
		AZ	Swine Paradise	0.9	5	4.0	0	0	0	0	0	1
		AZ	Barbed Wire	2.1	5	4.0	0	0	0	0	0	0
		AZ	Platform	1.9	5	4.6	1	1	0	0	0	0
		AZ	250M	1.9	5	3.3	0	0	0	0	0	0
		AZ	Hell Bird	6.3	5	6.0	0	0	0	0	0	10
		AZ	Glory Hole	5.0	5	8.3	0	0	0	0	0	0
		AZ	Spaghetti	5.4	5	3.4	0	0	0	0	0	2
		AZ	Beal Lake	18.0	5	10.6	0	0	0	0	0	1
		AZ	Lost Lake	3.3	5	3.4	0	0	0	0	0	1
		AZ	Dock[10]	---	0	---	0	0	0	0	0	3
Bill Williams River	BIWI	AZ	Wispy Willow[18]	0.5	3	2.8	0	0	0	0	0	1
		AZ	Burn Edge	4.1	5	6.3	0	0	0	0	0	1
		AZ	Site #4	9.9	5	16.8	0	0	0	0	3	0
		AZ	Site #3	13.0	5	19.6	2	1	1	2	0	1
		AZ	Last Gasp	2.1	5	4.6	0	0	0	0	0	0
		AZ	Site #5	6.8	5	8.9	0	0	0	0	0	2
		AZ	Cougar Point[22]	1.3	0	---	2	1	1	1	0	0
		AZ	Upstream from Site #8	1.5	5	5.1	0	0	0	0	0	0

Table C.1. Southwestern Willow Flycatcher Survey Results by Site along the Lower Colorado River and Tributaries, 2011* (Continued)

River Drainage	Study Area[1]	State	Survey Site[2]	Area (ha)	# Surveys	Survey Hours	Resident Adults	Territories	Pairs	Nests	Unknown Status	
											Before June 15[3]	After June 15[4]
Bill Williams River	BIWI	AZ	Planet Ranch Road	3.3	5	12.0	3	2	2	3	0	2
		AZ	New River	0.6	5	3.9	0	0	0	0	0	0
Colorado River	PVER	CA	PVER Phase 2	21.4	6	16.5	0	0	0	0	0	11
		CA	PVER Phase 3	21.4	6	14.5	0	0	0	0	0	4
Colorado River	CIBO	AZ	CVCA Phase 1	26.2	6	16.0	0	0	0	0	0	12
		AZ	CVCA Phase 2	25.5	6	16.0	0	0	0	0	0	11
		AZ	CVCA Phase 3	38.4	5	14.0	0	0	0	0	0	18
		AZ	Cibola Nature Trail	13.7	5	6.0	0	0	0	0	0	1
		AZ	Cibola Island	4.2	3	2.3	0	0	0	0	0	0
		AZ	Cibola Site #2	16.4	5	6.2	0	0	0	0	0	5
		AZ	Cibola Site #1	7.7	5	4.1	0	0	0	0	0	0
		AZ	Cibola Lake #2 (East)	4.5	5	5.0	0	0	0	0	0	2
		CA	Walker Lake	11.4	3	4.9	0	0	0	0	0	1
Colorado River	IMPE	CA	Paradise	7.8	3	3.3	0	0	0	0	0	3
		AZ	Hoge Ranch	20.7	5	5.9	0	0	0	0	0	14
		AZ	Rattlesnake	7.6	5	6.4	0	0	0	0	0	5
		CA	Milemarker 65	10.0	2	0.9	0	0	0	0	0	1
		AZ	Nursery NW	7.0	5	6.9	0	0	0	0	0	6
		CA	Ferguson Lake	21.1	3	7.0	0	0	0	0	0	2
		AZ	Great Blue Heron	7.1	5	15.9	0	0	0	0	0	21
		AZ	Powerline	1.0	5	4.2	0	0	0	0	0	3
		AZ	Martinez Lake	4.6	5	8.8	0	0	0	0	0	2

Table C.1. Southwestern Willow Flycatcher Survey Results by Site along the Lower Colorado River and Tributaries, 2011* (Continued)

River Drainage	Study Area[1]	State	Survey Site[2]	Area (ha)	# Surveys	Survey Hours	Resident Adults	Territories	Pairs	Nests	Unknown Status	
											Before June 15[3]	After June 15[4]
Colorado River	MITT	CA	Mittry West	4.4	3	4.3	0	0	0	0	0	3
Colorado River	YUMA	AZ	Gila River Site #2	2.9	4	5.3	0	0	0	0	0	7
		AZ	Fortuna Site #1	3.2	4	6.1	0	0	0	0	0	15
		AZ	Fortuna North	3.8	4	9.5	0	0	0	0	0	7

[*] This table includes only sites where regular surveys were scheduled and does not include sites where habitat reconnaissance and opportunistic surveys were conducted.

[1] Study areas consist of 1-18 survey sites that are grouped geographically. Alpha codes are as follows: KEPI = Key Pittman Wildlife Management Area, RIRA = River Ranch, PAHR = Pahranagat National Wildlife Refuge (NWR), MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs Natural Area, TOPO = Topock Marsh, BIWI = Bill Williams River NWR, PVER = Palo Verde Ecological Reserve, CIBO = Cibola, IMPE = Imperial, MITT = Mittry Lake, YUMA = Yuma.

[2] Survey site is equivalent to the Arizona Department of Game and Fish site definition.

[3] Total number of individuals recorded that could not be classified as resident or migrant because of brief appearance after 15 June.

[4] Total number of individuals who could not be classified as resident or migrant because of brief appearance before 15 June.

[5] Only the one unoccupied site was surveyed.

[6] This female moved from River Ranch West Side after an unsuccessful nesting attempt to Key Pittman Patch 0 where she tried a second nesting attempt of unknown fate.

[7] This adult, detected on 27 July in Key Pittman Patch 4, held a territory at River Ranch East Side until 25 July.

[8] One male was polygynous with two females.

[9] This individual, detected on 24 July in Key Pittman Patch 10.5, held a territory at River Ranch West Side until 1 July.

[10] Not an official survey site. Incidental detections recorded.

[11] Due to flycatcher occupancy, sites were surveyed only once. Survey time represents total survey time at all sites combined.

[12] This individual, detected 17–19 June at Pahranagat North, moved to River Ranch West Side where he held a territory from 23 June to 13 July.

[13] One male was polygynous with three females.

[14] One female moved from Pahranagat North and was detected on 21 July with a group of three fledglings.

[15] One male held a territory at Overton WMA until 17 July and then displaced the male at Hafen Lane.

[16] One male held a territory at Mesquite West and was then recaptured on 24 July at Virgin River #1 South.

[17] Two males polygynous with two females.

[18] Surveys discontinued because of poor quality habitat.

[19] Unusually high water levels within the Virgin River prevented technicians from completing all five surveys.

[20] One male bred at Overton WMA until 17 July, then moved to Virgin River #1 South and bred. His female at Virgin River #1 South mated consecutively with two males.

[21] No surveys conducted; site was occupied the entire season.

[22] Site not formally surveyed; not a formal site until an unrelated field crew reported a flycatcher in the area. When SWCA visited the territory, the male was no longer present (though had been noted by the other crew earlier in the season) and only the female remained, attending the nest.

Appendix D

DETECTIONS OF SPECIAL CONCERN SPECIES, 2011

Table D.1. Number of Detections of Each Special Concern Species Recorded at Each Survey Site, 2011

Study Area[1]	Survey Site	Special Concern Species[2]											
		BLRA	CLRA	LEBI	YBCU	ELOW	GIFL	GIWO	VEFL	BEVI	YWAR	SUTA	YBCH
PAHR	North	0	0	0	0	0	0	0	0	0	1	1	0
	West	0	0	0	0	0	0	0	0	0	10	0	1
MESQ	Hafen Lane	0	0	0	2	0	0	0	0	1	41	2	20
	West	0	0	0	0	0	0	0	0	0	49	0	22
	Bunker Marsh North	0	0	0	0	0	0	0	0	0	3	0	1
MOME	Mormon Mesa South	0	0	0	0	0	0	0	0	18	78	0	98
	Virgin River #1	0	0	0	0	0	0	0	0	2	27	2	37
	Virgin River #2	0	0	0	0	0	0	0	0	12	48	4	54
MUDD	Overton WMA	0	0	0	9	0	0	0	0	0	63	0	64
	Overton WMA Pond	0	0	0	0	0	0	0	0	1	17	2	16
TOPO	Pipes #1	0	0	0	0	0	0	0	0	0	1	1	42
	Pipes #3	0	0	0	0	0	0	4	0	0	11	5	41
	The Wallows	0	0	0	0	0	0	3	0	0	9	2	17
	PC6-1	0	0	0	0	0	0	1	0	1	9	3	60
	Pig Hole	0	0	0	0	0	0	0	0	0	3	0	27
	In Between	0	0	0	0	0	0	0	0	0	4	3	39
	800M	0	0	0	0	0	0	0	0	0	1	3	20
	Pierced Egg	0	0	0	0	0	0	5	0	0	19	5	55
	Swine Paradise	0	0	0	0	0	0	1	0	0	14	4	13
	Barbed Wire	0	0	0	0	0	0	1	0	0	5	6	26
	Platform	0	0	0	0	0	0	1	0	0	6	1	26
	250M	0	0	0	0	0	0	2	0	0	6	1	15
	Spaghetti	0	0	0	0	0	0	1	0	0	2	2	19
	Hell Bird	0	0	0	0	0	0	9	0	0	7	4	23
	Glory Hole	0	0	0	0	0	0	6	0	1	9	2	40

Table D.1. Number of Detections of Each Special Concern Species Recorded at Each Survey Site, 2011 (Continued)

Study Area[1]	Survey Site	Special Concern Species[2]											
		BLRA	CLRA	LEBI	YBCU	ELOW	GIFL	GIWO	VEFL	BEVI	YWAR	SUTA	YBCH
TOPO	Beal Lake	0	0	0	3	0	0	1	0	40	22	10	57
	Lost Lake	0	0	2	0	0	0	0	0	0	5	2	8
BIWI	Wispy Willow	0	1	1	0	0	0	1	0	5	0	2	11
	Site #1[3]	0	0	2	0	0	0	1	0	1	0	1	3
	Site #2[3]	0	0	0	0	0	0	0	0	0	0	1	4
	Burn Edge	0	0	0	0	0	0	2	0	7	8	1	55
	Site #11[3]	0	0	0	0	0	0	2	0	1	0	0	5
	Site #4	0	0	0	0	0	0	22	0	11	32	11	97
	Site #3	0	0	0	3	1	0	4	0	11	51	8	119
	Last Gasp	0	0	0	0	0	0	6	0	1	5	1	70
	Site #5	0	0	0	1	0	0	7	0	13	16	6	81
	Mineral Wash[3]	0	0	0	0	0	0	0	0	8	5	0	9
	Beaver Pond[3]	0	0	0	0	0	0	3	0	8	14	1	35
	Upstream from Site #8	0	0	0	1	0	0	3	0	2	9	0	32
	Planet Ranch Road	1	0	0	3	0	0	6	0	14	22	5	44
	New River	2	0	0	2	0	0	0	0	9	2	1	22
PVER	PVER Phase 2	0	0	0	3	0	0	0	0	3	12	0	2
	PVER Phase 3	0	0	0	3	0	0	0	0	0	5	2	4
CIBO	CVCA Phase 1	0	0	0	5	0	0	1	0	0	10	6	7
	CVCA Phase 2	0	0	0	4	0	0	0	0	0	7	0	4
	CVCA Phase 3	0	0	0	0	0	0	0	0	0	1	4	4
	Cibola Nature Trail	0	0	0	0	0	0	0	0	1	17	1	13
	Cibola Island	0	0	0	3	0	0	0	0	0	0	0	4
	Cibola Site #2	0	1	0	0	0	0	0	0	0	0	0	14
	Cibola Site #1	0	0	3	0	0	0	3	0	0	1	1	10
	Cibola Lake #2 (East)	0	0	0	0	0	0	0	0	0	0	0	14

Table D.1. Number of Detections of Each Special Concern Species Recorded at Each Survey Site, 2011 (Continued)

Study Area[1]	Survey Site	Special Concern Species[2]											
		BLRA	CLRA	LEBI	YBCU	ELOW	GIFL	GIWO	VEFL	BEVI	YWAR	SUTA	YBCH
CIBO	Walker Lake	0	0	0	0	0	0	4	0	0	0	0	8
IMPE	Paradise	0	0	0	0	0	0	4	0	0	0	0	6
	Hoge Ranch	0	0	3	0	0	0	2	0	0	0	0	13
	Rattlesnake	0	0	0	0	0	0	6	0	0	0	1	30
	Milemarker 65	0	0	1	0	0	0	0	0	0	1	0	4
	Nursery Northwest	7	0	2	0	0	0	1	0	1	3	0	22
	Ferguson Lake	0	0	9	0	0	0	2	0	0	0	0	19
	Great Blue Heron	0	0	0	0	0	0	13	0	1	16	2	67
	Powerline	0	1	1	0	0	0	5	0	0	1	1	15
	Martinez Lake	1	0	1	0	0	0	1	0	2	5	0	24
MITT	Mittry West	0	0	0	0	0	0	4	0	1	0	0	8
YUMA	Gila River Site #2	0	0	0	0	0	0	0	0	0	0	0	0
	Fortuna Site #1	0	0	0	0	0	0	0	0	0	1	1	9
	Fortuna North	0	0	0	0	0	0	0	0	0	1	0	14

[1] PAHR = Pahranagat NWR; MESQ = Mesquite; MOME = Mormon Mesa; MUDD = Muddy River; TOPO = Topock Marsh; BIWI = Bill Williams River NWR; PVER = Palo Verde Ecological Reserve; CIBO = Cibola; IMPE = Imperial; MITT = Mittry Lake; YUMA = Yuma.

[2] BLRA = Black Rail, CLRA = Clapper Rail, LEBI = Least Bittern, YBCU = Yellow Billed Cuckoo, ELOW = Elf Owl, GIFL = Gilded Flicker, GIWO = Gila Woodpecker, VEFL = Vermilion Flycatcher, BEVI = Bell's Vireo, YWAR = Yellow Warbler, SUTA = Summer Tanager, YBCH = Yellow-breasted Chat.

[3] Site surveyed only once as part of an opportunistic effort.

Appendix E

ALL WILLOW FLYCATCHERS COLOR-BANDED AND/OR RESIGHTED, 2003–2011

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011*

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1490-89889	M	J							R		D	D	D	D			
1590-97338	M	A	P				P	P	P	P							
1710-20312	M	J							R		T						
1710-20638	M	A		G	M	M	M	M	M	M	M						
2090-42022	F	J		M					Q								
2110-78841	F	J						T	T	T	T						
2110-78842	M	A						Q	Q	Q							
2110-78855	M	J						T	T								
2110-78861	M	J						T	M[4]	Q							
2110-78863	M	J						T	T	T							
2140-66502	M	J						Q	Q								
2140-66503	F	J						Q		Q							
2140-66517	F	A						Q	Q	Q	D						
2140-66518	M	A						Q	Q								
2140-66561	M	A						P			P	P	P	P			
2140-66564	F	J						P	P								
2140-66566	M	J						P			P						
2140-66568	M	A						P	P		P	P	P	P			
2140-66606	M	J		M		Q	Q		Q								
2140-66621	F	A				P	P	P	P	P							
2140-66627	F	A				P	P	P		P							
2140-66690	F	J					P								S		
2140-66693	M	J					M	Q	Q								
2140-66696	F	J					Q		Q								
2140-66697	M	J					Q			P	P	P	P	P	P		
2140-66709	M	A						Q	Q	Q		Q[5]	M	M	M	M	M
2140-66728	M	J					T			T							
2140-66743	M	J			T					T							
2140-66775	M	J				T	M		Q	Q	Q						
2190-76604	M	A					P		P	P	P	P					
2320-31401	M	A							B								
2320-31402	M	A							B								
2320-31403	M	A							Y								
2320-31404	F	A							B								
2320-31405	F	A							B								
2320-31406	U	J							B								
2320-31407	F	J							B	T							
2320-31408	U	J							B								
2320-31409	U	J							B								
2320-31410	U	J							B								
2320-31411	U	J							B								
2320-31412	M	A							B	B							
2320-31413	U	A							Q								
2320-31414	M	A								T	T						

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2320-31415	F	A								T							
2320-31416	U	J								T							
2320-31417	U	J								T							
2320-31418	M	A								T	T						
2320-31419	U	J								T							
2320-31420	U	J								T							
2320-31421	U	J								T							
2320-31422	U	J								T							
2320-31423	U	A								T							
2320-31424	M	J								T	T						
2320-31425	U	J								T							
2320-31426	F	A							M								
2320-31427	M	A							M								
2320-31428	M	J							Q	M	Q[6]		M	M			
2320-31429	U	J							Q								
2320-31430	U	J							P								
2320-31431	U	J							Q								
2320-31432	U	J							P								
2320-31433	U	J							Q								
2320-31434	U	J							Q								
2320-31435	U	J							P								
2320-31436	U	J							P								
2320-31437	U	J							P								
2320-31438	M	J							Q	Q							
2320-31439	U	J							Q								
2320-31440	F	J							Q	M							
2320-31441	U	J							M								
2320-31443	U	J							Q								
2320-31444	F	A							Q	Q	Q	Q			M		
2320-31445	F	A							Q	Q	Q	Q	Q	Q	Q	Q	
2320-31446	U	J								P							
2320-31447	U	J								P							
2320-31448	U	J								P							
2320-31449	U	J								P							
2320-31450	U	J								P							
2320-31451	M	A							P	P	P	P					
2320-31452	M	A							P								
2320-31453	M	A							P	P							
2320-31454	M	A							P	P							
2320-31455	M	A							P								
2320-31456	U	J							P								
2320-31457	M	J							P	K							
2320-31458	M	J							P		P						

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2320-31459	M	J							P	P							
2320-31460	U	J							P								
2320-31461	U	J							P								
2320-31462	U	J							P								
2320-31463	F	J							P			K	K			K	
2320-31464	U	J							P								
2320-31465	U	J							P								
2320-31466	F	A							P								
2320-31467	M	J							P		P	P					
2320-31468	M	J							P		P	P		K			
2320-31469	U	J							P								
2320-31470	U	J							P								
2320-31471	M	J							Q	Q			M		M		
2320-31472	U	J							Q								
2320-31473	M	J							Q	Q							
2320-31474	U	J							Q								
2320-31475	M	J							P	L							
2320-31476	F	A							Q								
2320-31477	U	J							Q								
2320-31479	F	A							Q	Q							
2320-31480	F	J							Q	Q							
2320-31481	U	J							P								
2320-31482	U	J							P								
2320-31483	U	J								Q							
2320-31484	M	J								P	P			K	K		
2320-31485	F	A								M		M	M	M			
2320-31486	F	J							Q	L	Q	M	M	M			
2320-31487	U	J							Q								
2320-31488	U	J							Q								
2320-31489	U	A								M							
2320-31490	M	A								L	L[7]	Q	Q	Q	Q		
2320-31491	M	A								Q							
2320-31493	M	A								D							
2320-31494	U	A								Q							
2320-31495	M	A								T							
2320-31496	U	J								M							
2320-31497	U	J								M							
2320-31498	F	J								M		G[8]	Q	Q	Q	Q	
2320-31499	M	A								Q							
2320-31500	U	J								Q							
2320-31501	M	A							B								
2320-31502	F	A							T	T							
2320-31503	U	A								I							

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2320-31504	U	A								I							
2320-31505	M	A								T							
2320-31506	U	J								T							
2320-31507	U	J								T							
2320-31508	U	J								T							
2320-31510	U	J								T							
2320-31511	U	J								T							
2320-31512	U	J								T							
2320-31513	U	J								T							
2320-31514	U	J								T							
2320-31515	F	A								T	T	T					
2320-31516	F	A								G							
2320-31517	M	A								G	M	M			M		
2320-31518	U	J								T							
2320-31519	U	J								T							
2320-31520	U	J								T							
2320-31521	F	A								T	T						
2320-31522	U	J											Q				
2320-31523	U	J											M				
2320-31524	U	J											P				
2320-31525	U	J											P				
2320-31526	F	A							T	T	T						
2320-31527	F	A							T								
2320-31528	M	A							T								
2320-31529	U	J							T								
2320-31530	U	J							T								
2320-31531	U	J							T								
2320-31532	U	J							T								
2320-31533	U	J							T								
2320-31534	U	J							T								
2320-31535	U	J							T								
2320-31536	U	J							T								
2320-31537	U	J							T								
2320-31538	M	A								T							
2320-31539	M	A								B							
2320-31540	F	A								T							
2320-31541	M	A								T	T						
2320-31542	U	J								T							
2320-31543	U	J								T							
2320-31544	U	J								T							
2320-31545	U	J											P				
2320-31546	U	J											P				
2320-31547	U	J											P				

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2320-31548	U	J											P				
2320-31549	U	J											P				
2320-31550	U	J											P				
2320-31551	M	A								Q							
2320-31552	M	A								M							
2320-31553	M	A								M		M					
2320-31554	U	J								T							
2320-31555	U	J								T							
2320-31556	U	J								T							
2320-31557	U	J								T							
2320-31558	U	J								T							
2320-31559	M	A								T	T	T	T				
2320-31560	M	A								T	T	T	T	T			
2320-31561	U	J								T							
2320-31562	M	J								T		T		T	T	T	
2320-31563	U	J								T							
2320-31564	U	J								T							
2320-31565	F	A								T	T						
2320-31566	U	J										T					
2320-31567	M	A								T	T						
2320-31568	F	A								P							
2320-31569	U	J								P							
2320-31570	U	J								P							
2320-31571	U	J								P							
2320-31572	M	A								M							
2320-31573	F	A								Q	Q	Q	Q	Q			
2320-31574	U	J									P						
2320-31575	U	J										Q					
2320-31576	M	A							T	T							
2320-31577	F	A							T	T	T						
2320-31578	U	A							Y								
2320-31579	U	A							Y								
2320-31580	U	A							Y								
2320-31581	U	J							T								
2320-31582	U	J							T								
2320-31583	U	J							T								
2320-31584	F	A							T	T	T	T					
2320-31585	U	J							T								
2320-31586	U	J							T								
2320-31587	U	J							T								
2320-31588	U	J							T								
2320-31589	M	A								P	P	P	P				
2320-31590	M	A								P	P	P	P	P			

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2320-31591	M	A								P	P	P	P				
2320-31593	M	A								P	P	P					
2320-31594	M	A								P							
2320-31595	M	A								P	P	P	P	P	P	P	P
2320-31596	M	A								P							
2320-31598	M	A								T							
2320-31599	U	A								I							
2320-31600	U	A								I							
2320-31601	U	J								P							
2320-31602	U	J								P							
2320-31603	U	J								P							
2320-31604	M	J								P		K	K				
2320-31605	U	J								P							
2320-31606	U	J								P							
2320-31607	U	J								P							
2320-31608	U	J								P							
2320-31609	U	J								P							
2320-31610	U	J								P							
2320-31611	U	J								Q							
2320-31612	U	J								Q							
2320-31616	F	J								Q		D					
2320-31617	U	J								Q							
2320-31618	F	J								Q	M	M	M				
2320-31619	U	J								M							
2320-31620	U	J								M							
2320-31621	F	A								M							
2320-31622	M	A								Q							
2320-31623	U	J								M							
2320-31624	U	J								M							
2320-31625	F	A								M							
2320-31627	M	A								Q							
2320-31628	U	A								M							
2320-31629	U	J								M							
2320-31630	U	J								Q							
2320-31631	F	J								Q		D	D				
2320-31632	F	A								Q		M	M	M[9]		M	M
2320-31633	U	J								Q							
2320-31634	U	J								Q							
2320-31635	M	A								K							
2320-31636	U	J								K							
2320-31637	F	J								K	P						
2320-31638	U	J								K							
2320-31639	U	J											P				

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2320-31640	U	J											Q				
2320-31641	U	J											Q				
2320-31642	U	J											Q				
2320-31643	U	J											P				
2320-31644	U	J											M				
2320-31645	U	J											M				
2320-31646	U	J											P				
2320-31647	U	J														M	
2320-31648	U	J														M	
2320-31649	U	J											P				
2320-31650	F	J										T	T				
2320-31651	M	A								M							
2320-31652	M	A								M	Q	Q					
2320-31653	M	A								M	M	M	M				
2320-31654	M	A								Q							
2320-31655	F	A								Q	Q	Q					
2320-31656	F	A								P	P	P					
2320-31657	F	A								P	P	P	P	P	P		
2320-31658	F	A								P							
2320-31659	M	J								Q		D	D	D		D	
2320-31660	F	J								Q			M	S	S	S	
2320-31661	F	A								P	P	P	P	P			
2320-31662	F	A								P							
2320-31663	F	A								P	P	P	P	P			
2320-31664	F	A								P							
2320-31665	U	J								P							
2320-31666	U	J								P							
2320-31667	U	J								P							
2320-31668	F	A								P							
2320-31669	F	A								P							
2320-31670	U	J											Q				
2320-31671	U	J										M					
2320-31672	U	J											P				
2320-31673	U	J										T					
2320-31674	M	J										P		K	K	K	
2320-31675	U	J									T						
2320-31676	U	J									T						
2320-31677	U	J										T					
2320-31678	U	J										P					
2320-31679	U	J											P				
2320-31680	U	J									T						
2320-31681	U	J									T						
2320-31682	U	J									P						

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2320-31683	M	J									P		K				
2320-31684	U	J									P						
2320-31685	U	J									P						
2320-31686	M	J									P	P					
2320-31687	U	J									P						
2320-31688	M	J									Q	Q	Q	Q	Q	Q	Q
2320-31689	U	J									Q						
2320-31690	U	J									Q						
2320-31691	U	J									Q						
2320-31692	M	J									P	K					
2320-31693	U	J									P						
2320-31694	M	J									P		K	K			
2320-31695	F	J									P	P					
2320-31696	U	J									Q						
2320-31697	U	J									P						
2320-31698	F	J									P		P	P	P		
2320-31699	U	J									P						
2320-31700	U	J									P						
2360-59701	F	J									Q	Q					
2360-59702	M	J									Q	D	M				
2360-59703	U	J									Q						
2360-59704	U	J									M						
2360-59705	U	J									M						
2360-59706	U	J									K						
2360-59707	F	J									P	P					
2360-59708	F	J									P	P					
2360-59709	U	J									P						
2360-59710	U	J									P						
2360-59711	M	J									K			P	P	P	
2360-59712	M	J									K			P		P	P
2360-59713	U	J									K						
2360-59714	U	J									Q						
2360-59715	U	J									Q						
2360-59716	U	J									Q						
2360-59717	M	A								Q							
2360-59718	U	J									P						
2360-59719	U	J									T						
2360-59720	U	J									T						
2360-59721	U	J								P							
2360-59722	U	J									T						
2360-59723	U	J								P							
2360-59724	F	J								P		P					
2360-59725	U	J									B						

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2360-59727	M	J									B		B				
2360-59728	U	J									B						
2360-59729	U	J									T						
2360-59730	U	J									T						
2360-59731	U	J									T						
2360-59732	U	J									T						
2360-59733	U	J									T						
2360-59734	U	J									T						
2360-59735	U	J										P					
2360-59736	U	J										P					
2360-59737	U	J										D					
2360-59738	U	J										D					
2360-59739	U	J										Q					
2360-59740	U	J									P						
2360-59741	U	J									Q						
2360-59742	U	J									Q						
2360-59743	F	J											P	K			
2360-59744	U	J										T					
2360-59745	U	J										P					
2360-59746	U	J								G							
2360-59747	U	J										D					
2360-59748	U	J										D					
2360-59749	M	J										D	D[10]	M			
2360-59750	F	J										M	Q				
2360-59751	M	J										M	Q	Q	Q		
2360-59752	M	J										Q		Q	M		
2360-59753	U	J										Q					
2360-59754	M	J										Q	Q	Q	Q	P	P
2360-59755	U	J										Q					
2360-59756	U	J										P					
2360-59757	U	J								K							
2360-59758	U	J										P					
2360-59759	U	J										P					
2360-59760	U	J								L							
2360-59761	U	J								L							
2360-59762	U	J								Q							
2360-59763	U	J								Q							
2360-59764	U	J											P				
2360-59765	U	J											P				
2360-59766	U	J								Q							
2360-59767	U	J								K							
2360-59768	U	J										T					
2360-59769	U	J										M					

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2360-59770	U	J								K							
2360-59771	U	J								G							
2360-59772	F	A								K							
2360-59773	U	J											Q				
2360-59775	U	J											Q				
2360-59776	U	J											Q				
2360-59777	F	J											Q				M
2360-59778	U	J											Q				
2360-59779	U	J											K				
2360-59780	U	J											K				
2360-59781	U	J											K				
2360-59782	F	J											K			M	
2360-59785	U	J									D						
2360-59786	U	J									D						
2360-59787	U	J									D						
2360-59788	F	J									D	D	M	M	M	M	M
2360-59789	U	J										Q					
2360-59790	U	J										Q					
2360-59791	U	J										P					
2360-59792	U	J										P					
2360-59793	U	J										P					
2360-59794	U	J										P					
2360-59795	U	J										P					
2360-59796	U	J										P					
2360-59797	M	J										P	P				
2360-59798	U	J										P					
2360-59799	M	J										M	D	M		M	
2360-59800	U	J								G							
2370-39901	U	A								P							
2370-39902	U	J								P							
2370-39904	U	J								P							
2370-39911	M	A									P						
2370-39912	M	A									Q		Q				
2370-39913	M	A									G						
2370-39914	U	J									P						
2370-39915	M	A									P	P	P	P[11]	P	P	
2370-39916	M	A										T	T	T			
2370-39917	U	A										Y					
2370-39918	U	A										Y					
2370-39919	U	A										Y					
2370-39920	U	A										Y					
2370-39921	U	A										Y					
2370-39922	U	A										Y					

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2370-39923	U	A										Y					
2370-39924	U	A										Y					
2370-39925	U	A										Y					
2370-39926	U	A										Y					
2370-39927	U	A										Y					
2370-39928	U	A										Y					
2370-39929	M	A										G	G				
2370-39930	M	J													M	Q	D[12]
2370-39932	F	A									B	B	B				
2370-39933	U	A									Y						
2370-39934	U	A									Y						
2370-39935	U	A									Y						
2370-39937	M	A										Q	Q	Q			
2370-39938	M	A										M	M	M	M	M	M
2370-39939	F	A										Q	Q				
2370-39940	M	A										M	M	M	Q		
2370-39941	M	J										Q	L[13]				
2370-39942	U	J										D					
2370-39943	U	J										D					
2370-39944	U	J										D					
2370-39945	U	J										P					
2370-39946	M	J										P	P				
2370-39947	U	J										P					
2370-39948	F	A										M					
2370-39949	U	J										Q					
2370-39950	U	J										Q					
2370-39951	M	A									P	P	P	P			
2370-39953	M	A									P	P	P	P			
2370-39954	M	A									Q	Q	Q	Q			
2370-39956	F	A									D	D	D			M	M
2370-39957	F	A									Q	Q					
2370-39958	F	A									P						
2370-39959	M	A									P		A				
2370-39960	M	A									K						
2370-39961	M	A									P						
2370-39962	F	A									P						
2370-39964	F	A									P	P	P				
2370-39965	U	A									D						
2370-39966	M	J									D		M				
2370-39967	M	A										M	D[14]	Q	Q		
2370-39968	M	A															D
2370-39969	F	A													B		
2370-39970	U	J															M

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2370-39971	U	A									P						
2370-39972	U	A									I						
2370-39973	U	A									Y						
2370-39974	U	A									I						
2370-39975	M	A									D	M					
2370-39976	M	A									D						
2370-39977	U	J									P						
2370-39978	F	A									P						
2370-39979	U	J									P						
2370-39980	M	J									P	K	K	K	K		
2370-39981	U	J									P						
2370-39982	U	A										Y					
2370-39983	U	A										Y					
2370-39984	U	A										Y					
2370-39985	U	A										Y					
2370-39986	M	A										G					
2370-39987	M	A										G					
2370-39988	M	A										G	M	M	M	M	
2370-39989	M	A										G					
2370-39990	F	A										G					
2370-39992	M	A										T					
2370-39993	U	A										Y					
2370-39994	U	A										Y					
2370-39995	U	A										Y					
2370-39996	U	A										Y					
2370-39997	U	A										Y					
2370-39998	U	A										Y					
2370-39999	M	A														Q	
2370-40000	M	A														D	D
2370-40001	U	J														P	
2370-40002	U	J														P	
2370-40003	M	A										T					
2370-40004	F	A										B			B		
2370-40005	U	J														S	
2370-40007	U	J														S	
2370-40008	U	J														D	
2370-40009	U	J														D	
2370-40010	U	J														D	K
2370-40011	F	A														Q	
2370-40012	M	A									Q	Q	Q				
2370-40013	M	A									P	P					
2370-40014	F	A									P	P	P				
2370-40016	U	J									P						

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2370-40017	M	A									M	M					
2370-40019	U	J									P						
2370-40020	U	J									P						
2370-40021	M	A									P	P					
2370-40022	M	A														K	
2370-40023	U	J													M		
2370-40024	M	J													K	K	K
2370-40025	U	J													K		
2370-40026	U	J													P		
2370-40027	F	J													P	E	K
2370-40029	M	J													M		D
2370-40030	U	J													M		
2370-40031	M	J													K	K	K
2370-40032	M	A									B						
2370-40033	U	A									Y						
2370-40034	U	A									Y						
2370-40035	U	A									Y						
2370-40036	M	A										G[15]					
2370-40037	F	A										G	M		M	M	M
2370-40038	M	A										G					
2370-40039	U	A										Y					
2370-40040	U	A										Y					
2370-40041	U	A										Y					
2370-40042	U	A										Y					
2370-40043	U	A										Y					
2370-40044	U	A										Y					
2370-40045	U	A										Y					
2370-40046	M	A										G	G[16]	M	M	M	M
2370-40047	F	A										P	P	P	P	P	P
2370-40048	U	J													T		
2370-40049	U	J													T		
2370-40050	U	J													T		
2370-40051	U	J														K	
2370-40052	M	A									B	B	B	B			
2370-40053	M	A									B						
2370-40054	M	A									B						
2370-40055	F	A									T						
2370-40056	M	A									T						
2370-40057	M	A										D					
2370-40058	M	A										M	B				
2370-40059	F	A										D	D	D			
2370-40060	M	A										P		P	P	P	P
2370-40061	F	A										P					

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2370-40062	F	A										P	P				
2370-40063	U	J										Q					
2370-40064	U	J										P					
2370-40065	U	J										Q					
2370-40066	F	A										Q	Q	Q	Q		
2370-40067	U	J										Q					
2370-40068	U	J										Q					
2370-40069	U	J										M					
2370-40070	U	J										M					
2370-40071	U	J										P					
2370-40072	U	J													M		
2370-40073	F	A													P	P	
2370-40074	U	J													P		
2370-40075	U	J													P		
2370-40076	U	J													P		
2370-40078	U	J															K
2370-40079	U	J															K
2370-40080	U	J										Q					
2370-40081	M	A										K					
2370-40082	F	A										K					
2370-40083	U	J										Q					
2370-40084	U	J										Q					
2370-40085	U	J											Q				
2370-40086	U	J											Q	M	M		
2370-40087	F	A											Q	Q	Q	Q	Q
2370-40088	M	A														D	D
2370-40089	U	J														M	
2370-40090	U	J														M	
2370-40091	F	J														M	D
2370-40093	U	J														M	
2370-40096	U	J												K			
2370-40097	M	J												K		K	K
2370-40098	U	J												K			
2370-40099	U	J													S		
2370-40100	U	J										K					
2370-40101	U	J										K					
2370-40102	U	J										K					
2370-40103	U	J										Q					
2370-40104	U	J										Q					
2370-40105	U	J										Q					
2370-40106	U	J										Q					
2370-40107	U	J										Q					
2370-40108	U	J										Q					

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2370-40110	U	J											T				
2370-40111	U	J											T				
2370-40112	M	J											T			T	
2370-40113	U	J											B				
2370-40114	M	J											T		T		
2370-40115	U	J											T				
2370-40116	U	J											T				
2370-40117	U	J											T				
2370-40118	U	J											T				
2370-40119	U	J											T				
2370-40120	U	J											T				
2370-40121	U	J											T				
2370-40122	U	J											T				
2370-40123	U	J											T				
2370-40124	M	J											T		M		
2370-40125	U	J											T				
2370-40126	M	A											G				
2370-40127	M	A											G				
2370-40129	M	A											G				
2370-40130	F	A													B		
2370-40132	F	A											T				
2370-40133	F	A											B				
2370-40134	U	A											B				
2370-40135	F	A											B				
2370-40136	F	A											T				
2370-40137	M	A											B				
2370-40138	M	A											T				
2370-40139	M	A											T	T			
2370-40140	F	A													P		
2370-40141	M	A													K	K	K
2370-40142	U	J													M		
2370-40143	U	J													Q		
2370-40144	M	J													M	T	
2370-40145	U	J													M		
2370-40146	U	J													S		
2370-40147	F	J												S	D		
2370-40148	F	J												S	S	S	S
2370-40149	U	J												S			
2370-40150	U	J													M		
2370-40151	F	J													M	M	
2370-40152	U	J													M		
2370-40153	U	J													S		
2370-40154	U	J													S		

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2370-40155	M	A													L		
2370-40156	M	A													B		
2370-40157	M	A											P		P	P	
2370-40158	M	J											B		T		
2370-40159	U	J											B				
2370-40160	F	A											G				
2370-40161	M	A											M	M	M		
2370-40162	U	J													B		
2370-40163	U	J													B		
2370-40164	U	J											Q				
2370-40165	M	A													B		
2370-40166	U	A											P				
2370-40167	U	J											P				
2370-40168	F	A											P	P	P		
2370-40169	U	J											M				
2370-40170	F	A											Q	Q			
2370-40171	F	A											D				
2370-40173	M	A											M	M	M	M	
2370-40174	U	J													M		
2370-40175	M	J													M	Q	Q
2370-40176	M	A													M		
2370-40177	U	J														T	
2370-40179	U	J														K	
2370-40180	M	A													B		
2370-40181	M	A													T		
2370-40182	U	J													B		
2370-40183	F	A											M				
2370-40184	M	A											D				
2370-40185	M	A											P				
2370-40186	M	A											D				
2370-40187	M	A											K				
2370-40188	U	J											Q				
2370-40190	M	J											P				K
2370-40191	F	A											M	M	M		
2370-40192	F	A											D			B	
2370-40193	F	A											Q	Q	Q	D	
2370-40194	F	A											P	P	P	P	
2370-40195	F	A											P	P	P		
2370-40197	M	A											M	Q	Q	M	M
2370-40199	U	J											P				
2390-92348	F	J		T						T							
2390-92350	M	A				M	Q		Q	Q							
2390-92365	M	J				D			Q	Q	Q						

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2390-92410	M	A					Q		Q								
2390-92420	M	J					Q	Q	Q								
2390-92421	M	J					Q	Q	Q	Q	M	M					
2390-92427	F	J					M		Q								
2390-92433	M	J					Q		Q	Q							
2390-92434	M	J					Q	Q		Q	Q	Q	Q	Q	Q	M	M
2390-92451	F	J			M	M		Q		Q							
2390-92470	F	J					Q			Q							
2390-92475	M	J					M	Q	Q	Q	Q	Q	Q	Q			
2430-61006	U	A											Y				
2430-61007	U	A											Y				
2430-61008	U	A											Y				
2430-61009	U	A											Y				
2430-61010	U	A											Y				
2430-61011	U	A											Y				
2430-61012	U	A											Y				
2430-61013	U	A											Y				
2430-61014	U	A											Y				
2430-61015	U	A											Y				
2430-61016	U	A											Y				
2430-61017	U	A											Y				
2430-61018	U	A											Y				
2430-61019	U	A											Y				
2430-61020	U	A											Y				
2430-61021	U	A											Y				
2430-61023	U	A											Y				
2430-61024	U	A											Y				
2430-61025	U	A											Y				
2430-61026	U	A											Y				
2430-61027	U	A											Y				
2430-61028	U	A											Y				
2430-61029	U	A											Y				
2430-61030	U	A											Y				
2430-61031	U	A											Y				
2430-61032	U	A											Y				
2430-61033	U	A											Y				
2430-61034	U	A											Y				
2430-61035	U	A											Y				
2430-61036	U	A											Y				
2430-61037	U	A											Y				
2430-61038	U	A											Y				
2430-61039	U	A											Y				
2430-61040	U	A											Y				

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2430-61041	U	A											Y				
2430-61042	U	A											Y				
2430-61043	U	A											Y				
2430-61044	U	A											Y				
2430-61045	U	A											Y				
2430-61046	U	A											Y				
2430-61047	U	A											Y				
2430-61048	U	A											Y				
2430-61049	U	A											Y				
2430-61050	U	A											Y				
2430-61051	U	A											Y				
2430-61052	U	A											Y				
2430-61053	U	A											Y				
2430-61054	U	A											Y				
2430-61055	U	A											Y				
2430-61056	U	A											Y				
2430-61058	U	A											Y				
2430-61059	U	A											Y				
2430-61060	U	A											Y				
2430-61061	U	A											Y				
2430-61062	U	A											Y				
2430-61063	U	A											Y				
2430-61064	U	A											Y				
2430-61065	U	A											Y				
2430-61067	U	A											Y				
2430-61068	U	A											Y				
2430-61069	U	A											Y				
2430-61070	U	A											Y				
2430-61071	U	A											Y				
2430-61072	M	A												G			T
2430-61073	M	A												B			
2430-61074	U	J												B			
2430-61075	U	J												B			
2430-61076	U	J												B			
2430-61077	U	J												M			
2430-61078	U	J												Q			
2430-61079	F	A												M			
2430-61080	M	A												P	P	P	P
2430-61081	U	J												M			
2430-61082	U	J												Q			
2430-61083	M	A												P	P	P	P
2430-61084	M	J												Q		D	
2430-61085	M	A													D	D	D

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2430-61086	U	J													M		
2430-61087	F	A													P	P	P
2430-61088	M	A														N	D
2430-61089	U	J														M	
2430-61090	U	J														M	
2430-61091	U	J														S	
2430-61092	F	A														S	
2430-61093	M	A														S	S
2430-61094	U	J														D	
2430-61095	M	A														M	
2430-61096	F	A														L	
2430-61097	U	J														P	
2430-61098	M	J														P	E[17]
2430-61099	U	J														K	E[18]
2430-61100	F	A														K	K
2430-61101	U	J												K			
2430-61102	U	J												K			
2430-61103	M	A												D			
2430-61104	M	A												M			
2430-61105	M	A												Q			
2430-61106	M	J												P		M	M
2430-61107	U	J												P			
2430-61108	U	J												P			
2430-61109	F	A												K			
2430-61110	U	J												K			
2430-61111	U	J												P			
2430-61112	U	J												P			
2430-61113	U	J												P			
2430-61114	M	J												P		K	K
2430-61115	U	J												P			
2430-61116	F	A												M	M		
2430-61117	U	J												P			
2430-61118	M	J												P	M	M	K
2430-61119	U	J												P			
2430-61120	F	J												P	P	P	P
2430-61121	U	J												Q			
2430-61122	U	J												P			
2430-61123	F	J												P		P	
2430-61124	F	J												P		K	
2430-61125	M	A												K			
2430-61126	U	J												S			
2430-61127	M	A												P	P		
2430-61128	U	J												M			

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2430-61129	U	J												Q			
2430-61130	U	J												Q			
2430-61131	U	J												M			
2430-61132	U	J												M			
2430-61133	U	J												M			
2430-61134	M	A												T		N	N
2430-61135	M	A												T	T	T	
2430-61136	M	A												B	B	B	B
2430-61137	F	A												B	B	B	B
2430-61138	F	A												B			
2430-61139	F	A												T			
2430-61140	U	J												B			
2430-61141	U	J												B			
2430-61142	U	J												B			
2430-61143	U	J												T			
2430-61144	U	J												T			
2430-61145	U	J												T			
2430-61151	U	J														K	
2430-61152	U	J														P	
2430-61153	F	A													M		
2430-61154	F	J													Q	S	S
2430-61155	U	J													Q		
2430-61156	U	J													K		
2430-61157	U	J													K		
2430-61158	M	A													K	K	K
2430-61159	M	J													M		K
2430-61160	U	J													M		
2430-61161	U	J													D		
2430-61162	M	A													S		
2430-61163	F	A														K	
2430-61165	M	J												Q	Q	M	
2430-61167	M	A												M	M	M	M
2430-61168	U	J												M			
2430-61169	U	J												M			
2430-61170	U	J												M			
2430-61171	U	J												M			
2430-61172	F	J												M	M		
2430-61173	U	J												M	M		
2430-61174	F	J												M		Q	
2430-61175	U	J												Q			
2430-61176	M	J												Q		P	P
2430-61177	U	J												Q			
2430-61178	M	A												K			

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2430-61179	M	A												K	P	P	P
2430-61180	M	A												K		K	K
2430-61181	F	A												K	K		
2430-61182	M	A												K			
2430-61183	M	A												K			
2430-61184	U	J												Q			
2430-61185	F	J												Q	M		
2430-61186	U	J												Q			
2430-61187	M	J												Q	L	L	
2430-61188	U	J												Q			
2430-61189	M	J												Q		M	
2430-61190	U	J												Q			
2430-61191	M	J												M	D		
2430-61192	U	J												M			
2430-61193	U	J												M			
2430-61194	U	J												Q	Q		
2430-61195	U	J												Q			
2430-61196	U	J												Q			
2430-61197	M	J												P		K	K
2430-61198	U	J												P	Q		
2430-61199	U	J												P			
2430-61200	U	J												P			
2430-61202	U	J												M			
2430-61203	U	J												M			
2430-61204	U	J												M			
2430-61205	U	J												M			
2430-61206	M	J												M		M	
2430-61207	F	J												M	D	D	
2430-61208	U	J												D			
2430-61209	M	A												V	D		
2430-61210	U	A												K			
2430-61211	U	J												S			
2430-61212	U	J												M			
2430-61213	U	J														K	
2430-61214	M	A															K
2430-61215	U	J															P
2430-61216	U	J															Q
2430-61217	U	J															Q
2430-61218	U	J															P
2430-61219	U	J															M
2430-61220	U	J															P
2430-61221	U	J														P	
2430-61223	U	J												D			

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2430-61224	U	J												D			
2430-61225	U	J												D			
2430-61226	U	J														P	
2430-61227	U	J														P	
2430-61228	U	J														K	
2430-61229	U	J														K	
2430-61230	F	A														S	S
2430-61231	U	J														S	
2430-61232	U	J														L	
2430-61233	U	J														L	
2430-61234	F	A														Q	Q
2430-61235	U	J														Q	
2430-61236	U	J														K	
2430-61237	U	J															B
2430-61271	U	J													P		
2430-61276	U	J														Q	
2430-61277	U	J													P		
2430-61278	M	J													P		
2430-61279	F	J													P	K	K
2430-61280	U	J														M	
2430-61285	U	J													M		
2540-58101	U	J														K	
2540-58102	U	J														K	
2540-58103	U	J														K	
2540-58104	M	J														K	
2540-58105	U	J														Q	
2540-58106	U	J														Q	
2540-58107	M	J														Q	
2540-58108	U	A															T
2540-58109	M	A															P[19]
2540-58110	F	A															P
2540-58111	F	A															P
2540-58112	U	J															Q
2540-58113	U	J															M
2540-58114	U	J															P
2540-58115	U	J															B
2540-58116	U	J														B	
2540-58117	U	J														B	
2540-58118	U	J														K	
2540-58119	U	J														K	
2540-58120	F	A															B
2540-58132	M	A													S	S	S
2540-58141	U	J													M		

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2540-58142	U	J													M		
2540-58143	M	A													D		
2540-58144	U	J													K		
2540-58145	U	J													K		
2540-58146	M	A													B		
2540-58147	U	J														B	
2540-58148	U	J														Q	
2540-58149	U	J														Q	
2540-58150	U	J														Q	
2540-58151	U	J														Q	
2540-58152	F	A															Q
2540-58154	M	J													M	T	D[20]
2540-58155	U	J													M		
2540-58156	F	A														K	K
2540-58157	U	J														K	E
2540-58158	M	J														K	K
2540-58159	F	J														K	K
2540-58160	U	J														S	
2540-58161	U	J														L	
2540-58162	U	J														K	
2540-58163	U	J														K	
2540-58164	U	J														K	
2540-58165	F	J														K	K
2540-58166	U	J														K	
2540-58172	M	A															Q
2540-58173	U	J															M
2540-58174	U	J															M
2540-58175	F	A															K
2540-58176	M	A															Q
2540-58177	F	A															K
2540-58178	U	J															K
2540-58179	U	J															K
2540-58180	U	J															K
2540-58182	U	J															K
2540-58183	U	J															K
2540-58184	F	A															M
2540-58185	U	J													P		
2540-58186	M	A													S		
2540-58187	F	A													P		K
2540-58188	U	J													P		
2540-58189	F	A													P		
2540-58190	U	J														T	
2540-58191	U	J														P	

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2540-58192	M	A														Q	Q[21]
2540-58193	F	A														N	N
2540-58194	U	J														D	
2540-58195	U	J														P	
2540-58196	U	J														P	
2540-58197	U	J														P	
2540-58198	U	J														P	
2540-58199	U	J														K	
2540-58200	U	J														K	
2540-58201	U	J														K	P
2540-58202	M	A														K	
2540-58203	F	A														K	K
2540-58204	F	A														K	
2540-58205	U	J														K	
2540-58206	U	J														P	
2540-58207	U	J														P	
2540-58208	U	J														P	
2540-58209	F	A														P	
2540-58211	U	J															K
2540-58212	U	J															K
2540-58213	U	J															M
2540-58214	U	J															K
2540-58216	U	J													M		
2540-58217	M	A													S	S	
2540-58218	U	J													S		
2540-58219	U	J													Q		
2540-58220	M	A														B	B
2540-58221	M	A														B	
2540-58222	U	J														K	
2540-58223	M	A														K	K
2540-58224	F	J														K	K
2540-58225	U	J														K	
2540-58226	F	A														K	
2540-58227	M	A														T	
2540-58228	M	A														T	T
2540-58229	M	A														B	
2540-58230	F	A														B	B
2540-58231	F	A														T	M
2540-58232	U	J														T	
2540-58233	F	A														N	
2540-58235	U	J														N	
2540-58236	U	J														N	
2540-58237	U	J														K	

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2540-58238	F	J														K	E[22]
2540-58239	U	J														K	
2540-58240	F	J														K	E
2540-58241	F	A														K	K
2540-58242	U	J														K	
2540-58243	U	J														K	
2540-58244	U	J														K	
2540-58245	M	A															P
2540-58246	M	A															E
2540-58247	U	J															K
2540-58274	U	J															N
2540-58275	U	J															N
2540-58276	U	J															K
2540-58277	U	J															K
2540-58278	U	L															D
2540-58279	U	J															D
2540-58280	U	J															K
2540-58282	U	J															K
2540-58283	U	J															K
2540-58284	U	J															P
2540-58285	U	J															P
2540-58286	U	J															P
2540-58287	M	A															S
2540-58288	U	J														P	
2540-58289	F	A														K	
2540-58290	U	J														K	
2540-58291	U	J														K	
2540-58292	U	J														K	
2540-58293	F	A														P	P
2540-58294	U	J														P	
2540-58295	U	J														P	
2540-58296	U	J														P	
2540-58297	F	A															K
2540-58298	U	J															K
2540-58299	U	J															K
2540-58378	U	J															K
2540-58385	U	J															S
2540-58386	F	A															K
2540-58387	M	A															K
2590-53101	U	J															P
2590-53102	U	J															P
2590-53103	U	J															P
2590-53104	U	J															P

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2590-53105	F	A															D
2590-53106	U	J															M
2590-53107	U	J															M
2590-53108	F	A															D
2590-53109	U	J															P
2590-53110	F	A															K
2590-53111	U	J															K
2590-53112	U	J															K
2590-53113	U	J															K
2590-53114	U	J															K
2590-53115	U	J															M
2590-53116	U	J															M
2590-53117	U	J															M
2590-53118	U	J															K
2590-53119	U	J															M
2590-53121	F	A															K
2590-53122	U	J															K
2590-53123	U	J															K
2590-53124	M	A															K
2590-53125	U	J															K
2590-53126	U	J															D
2590-53127	U	J															K
2590-53141	U	J															M
2590-53142	U	J															M
2590-53143	U	J															N
2590-53144	U	J															K
2590-53145	M	A															S
2590-53147	U	J															D
2590-53148	U	A															K
2590-53149	U	J															K
2590-53150	U	J															M
2590-53151	U	J															M
2590-53152	U	J															Q
2590-53154	U	J															Q
2590-53162	M	A															T
2590-53163	F	A															B
2590-53164	U	J															B
2590-53171	F	A															E
2590-53172	U	J															K
2590-53173	F	A															K
2590-53182	U	J															B

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2011 (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]														
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
3500-68963	U	J								T							
3500-68968	U	J								P							
3500-68969	U	J								P							
3500-68972	F	J								P	P	P					

* Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA.

[1] K = Key Pittman, E = River Ranch, P = Pahranagat NWR, W = Meadow Valley Wash, L = Littlefield, Q = Mesquite, M = Mormon Mesa, D = Muddy River, N = Warm Springs, G = Grand Canyon, T = Topock Marsh, B = Bill Williams River NWR, I = Imperial, Y = Yuma, S = St. George, V = Las Vegas Wash, R = Roosevelt Lake, A = Ash Meadows. Study area indicated is the study area where the individual was first detected during the given season. Within-season movements are indicated with individual footnotes.

[2] M = male, F = female, U = unknown.

[3] A = adult, J = juvenile.

[4] Within-season movement from Mormon Mesa to Mesquite.

[5] Within-season movement from Mesquite to Mormon Mesa.

[6] Within-season movement from Mesquite to Mormon Mesa.

[7] Within-season movement from Littlefield to Mesquite.

[8] Within-season movement from Grand Canyon to Mesquite.

[9] Within-season movement from Mormon Mesa to Muddy River.

[10] Within-season movement from Muddy River to Mormon Mesa.

[11] Within-season movement from Pahranagat to Key Pittman.

[12] Within-season movement from Muddy River to Mesquite.

[13] Within-season movement from Littlefield to Mesquite.

[14] Within-season movement from Muddy River to Mesquite.

[15] Within-season movement from Grand Canyon to Mesquite.

[16] Within-season movement from Grand Canyon to Mormon Mesa.

[17] Within-season movement from River Ranch to Key Pittman.

[18] Within-season movement from River Ranch to Key Pittman.

[19] Within-season movement from Pahranagat to River Ranch.

[20] Within-season movement from Muddy River to Mormon Mesa. Likely also within-season movement from Topock to Muddy River in 2010.

[21] Within-season movement from Mesquite to Mormon Mesa.

[22] Within-season movement from River Ranch to Key Pittman.

Appendix F

CONTRIBUTING PERSONNEL

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