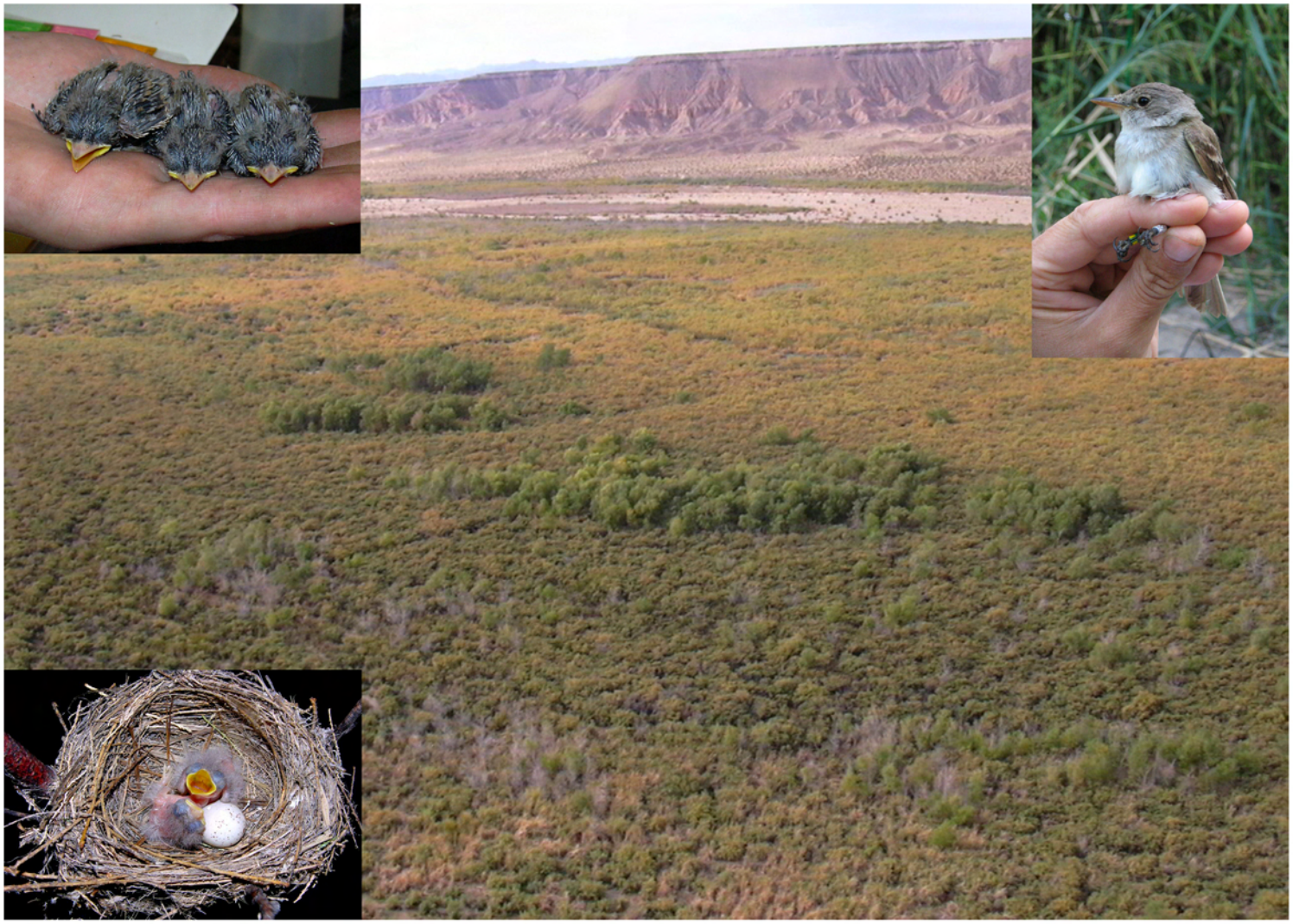
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Southwestern Willow Flycatcher Surveys, Demography, and Ecology along the Lower Colorado River and Tributaries, 2009. 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, 2009. 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 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 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 2009.

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 Environmental Consultants (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 is anticipated to commence in 2010. Monitoring of vegetation, microclimate, and hydrologic condition in the target area was initiated in 2009 to obtain baseline conditions in the target area.

Breeding flycatchers have been documented annually in 1997–2008 at Pahranagat National Wildlife Refuge in southern Nevada. The primary breeding site at this study area was flooded by Upper Pahranagat Lake during each breeding season until 2008, when structural problems with a levee required draining the lake. USFWS retained SWCA to collect microclimate and vegetation data at Pahranagat in

2009 to compare conditions during inundated periods to the conditions in 2009 when the site was not inundated. Results of this study are presented in a separate chapter in this report.

Approximately 100 sites are included in the study of flycatchers along the Virgin and lower Colorado Rivers, but a portion of the sites are surveyed on a biennial basis rather than annually. In 2009, we completed presence/absence surveys and site descriptions at 69 sites in 15 study areas from the Pahranagat National Wildlife Refuge (NWR), Nevada, south to Yuma, Arizona. We also conducted more intensive studies at the seven study areas where territorial flycatchers were detected in 2009: Pahranagat NWR, Mesquite, Mormon Mesa, and Muddy River Nevada; and Littlefield, Topock Marsh, and Bill Williams River NWR, Arizona. At these study areas, 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; color-banded and resighted as many willow flycatchers as possible to determine the breeding status of territorial flycatchers and document movement and recruitment; and measured characteristics of vegetation and microclimate in occupied territories and at old flycatcher nests in abandoned areas where we had collected similar data when the nest was active.

We used recorded broadcasts of willow flycatcher song and calls to elicit responses from willow flycatchers at 69 sites, ranging in size from <1 to 47 ha, along the Virgin and lower Colorado Rivers and tributaries between 15 May and 26 July 2009, following a 5-survey protocol. We detected willow flycatchers on at least one occasion at 41 of these sites. Breeding or resident flycatchers were detected at 19 sites within the Pahranagat NWR, Littlefield, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams study areas. South of Bill Williams, 44 willow flycatcher detections were recorded between 15 May and 16 June; no flycatcher detections were recorded at any of these sites after 16 June. Monitoring results suggest these flycatchers were not resident, breeding individuals and were most likely spring migrants.

We used targeted mist-net and passive netting techniques to capture and uniquely color-band adult and fledgling willow flycatchers at all survey 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.

We color-banded 17 new adult flycatchers and recaptured 8 individuals previously banded as adults. An additional 55 adults were identified to individual via resighting, while 10 individuals were resighted but did not have their color combinations confirmed. One individual had federal band on one leg and an injury on the other leg, and one adult had a duplicate color-band combination. We detected eight individuals identified as returning nestlings by the presence of a single federal band, with three (38%) identified to individual via recapture. Thirty-one adult flycatchers remained unbanded, and banding status was undetermined (i.e., we were unable to determine if these individuals were banded) for 19 adults. We banded 44 nestlings from 21 nests. We banded flycatchers opportunistically at Key Pittman Wildlife Management Area and St. George, capturing and color-banding six new adults and recapturing one returning nestling. Twelve nestlings from five nests were banded.

We recorded 76 territories at all monitored sites. Of these, 50 (66%) consisted of paired flycatchers and 22 (29%) consisted of unpaired individuals. In the remaining four territories (5%), a singing male was confirmed as resident and a second flycatcher, suspected to be a female, was detected for only a few days. Nine breeding males were polygynous, each pairing with two females. Three females mated consecutively with two different males.

Of the 75 resident, adult willow flycatchers identified to individual in 2008, 41 (55%) were identified in 2009; 1 (2%) was detected at a different study area from where it was last detected in 2008. We detected no within-year, between-study area movements in 2009.

Of the 73 juveniles banded at the monitored study areas in 2008, 12 (16%) were identified in 2009. Two additional flycatchers banded as nestlings in St. George in 2008 were identified in 2009. Four individuals originally banded as nestlings in previous years were identified for the first time in 2009. Of the 18 returning nestlings identified in 2009, 10 (56%) dispersed away from their natal study area. The median dispersal distance for all returning juvenile flycatchers in 2009 was 13.7 km.

We documented 72 willow flycatcher nesting attempts, 65 of which contained eggs and were used in calculating nest success and productivity. Twenty-three (35%) nests were successful and fledged young; 40 (62%) failed, and fate was unknown for 2 (3%). Mayfield survival probability ranged from 0.053 to 0.519 and was 0.368 for all sites combined. Depredation was the major cause of nest failure, accounting for 40% of all failed nests and 48% of nests that failed after flycatcher eggs were laid.

Sixteen of 56 nests (17%) with flycatcher eggs and known contents were brood parasitized by Brown-headed Cowbirds. Brood parasitism at all study areas ranged from 0 to 100% and was highest at Littlefield. We observed the seventh consecutive year of no brood parasitism at Pahranagat. Nests that contained flycatcher eggs and were brood parasitized were less likely to fledge flycatcher young than nests that were not parasitized.

At Littlefield, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams, we gathered data on vegetation and microclimate characteristics at one location for each of 56 territorial male flycatchers we identified, regardless of the length of time the male was resident and whether or not he obtained a mate. We delineated the following habitat types: 1) coyote willow, 2) tamarisk with coyote willow, 3) Goodding willow, 4) Goodding willow with tamarisk understory, 5) tamarisk with scattered Goodding willow, 6) tamarisk, and 7) cottonwood with mesquite. Coyote willow and Goodding willow are the only habitat types likely to be created at restoration areas, but we summarize vegetation and microclimate characteristics for all habitat types. Sample sizes in 2009 are likely too small to provide an accurate representation of the range and variance in vegetation and microclimate characteristics in each habitat type.

Territories within most vegetation types exhibited moist or inundated soil conditions throughout the breeding season. Several habitat types showed a general drying trend in soil conditions as the breeding season progressed. Daily maximum temperatures spanned a range of <10°C among habitat types, while daily minimum temperatures spanned <5°C. Vapor pressure increased through the end of July for all habitat types.

In addition to collecting vegetation and microclimate data at occupied territories, we investigated whether changes in vegetation and microclimate might have contributed to the abandonment of some areas by flycatchers. We identified areas at Mormon Mesa and Topock Marsh that had been occupied by nesting flycatchers in at least one previous year from 2003 to 2007 but were unoccupied in 2009, and we relocated old nests at which we had collected vegetation and microclimate information in the year the nest was active. We resampled microclimate and vegetation at these nests in 2009.

We had not noted dramatic, qualitative changes in vegetation in abandoned areas at Mormon Mesa or Topock Marsh. Vegetation data showed a decrease in the proportion of live stems 2.5–8 cm dbh at both study areas, which could reduce the suitability of the vegetation for flycatchers. The proportion of live stems >8 cm dbh increased at Topock, but this variable did not differ between the occupied year and 2009 at Mormon Mesa or when both study areas were combined. Canopy height increased at both Mormon Mesa and Topock between occupied and unoccupied periods, but this increase in canopy height is likely

the result of vegetation maturing over the years and probably did not contribute to abandonment of the area. Canopy closure increased at Mormon Mesa between occupied and unoccupied periods but showed a decreasing trend at Topock. Given that flycatchers typically nest in areas with very high canopy closure, it is unlikely that an increase in canopy closure would contribute to site abandonment. The apparent changes in canopy closure at both Mormon Mesa and Topock were small (<6%) and may be the result of observer variation.

Microclimate at old nests sites differed between occupied and unoccupied periods in at least one variable at both Mormon Mesa and Topock Marsh. At Mormon Mesa, nest sites had higher diurnal and nocturnal vapor pressure when they were occupied versus when they were abandoned. At Topock Marsh, nest sites had higher nocturnal vapor pressure when the nest was occupied. The differences in microclimate we observed between 2009 and the year the nest was occupied at both Topock and Mormon Mesa are likely the result of interannual climatic differences, as recorded at regional weather stations, and not the result of localized changes at the nest sites.

In 2005, we selected 11 sites between Parker and Imperial Dams for inclusion in the habitat monitoring study addressing how changes in water transfer actions might affect riparian habitat. We also selected two control sites above Parker Dam and two below Imperial Dam. At each site we installed 3–5 temperature/humidity data loggers and one groundwater observation well (piezometer). All logger and piezometer locations selected in 2005 were retained in 2006. In August 2006, we installed a piezometer and two temperature/humidity data loggers within occupied flycatcher habitat at Topock Marsh. Two loggers and one piezometer were damaged or destroyed in a fire in December 2006 and were replaced in 2007, and one piezometer that was destroyed by a bulldozer in 2007 was replaced in 2008. At sites that were surveyed for flycatchers in 2009, soil moisture measurements were collected at each data logger location during each of five flycatcher surveys between 15 May and 25 July. At sites that were not surveyed in 2009, soil moisture measurements were collected at the beginning and end of the survey season. Vegetation measurements were also collected at each data logger location after surveys were completed. We used data from piezometers that were located within the woody, riparian vegetation to evaluate whether the evapotranspiration signature in June–August changed over time from 2005 to present. We also compared microclimate characteristics at the habitat monitoring sites to those found within flycatcher territories at Topock Marsh.

Several microclimatic variables at the combined habitat monitoring sites differed significantly from those at Topock Marsh in 2009, with Topock being cooler and more humid than the habitat monitoring sites. Comparison of microclimate variables at the habitat monitoring sites to those at within flycatcher territories at Topock Marsh in each year from 2005 to 2009 have shown that the habitat monitoring sites consistently have warmer temperatures, greater daily temperature range, and lower humidity than occupied territories.

Comparisons of microclimate characteristics among years in 2005–2009 at the habitat monitoring sites indicated hotter and more humid conditions in 2006 than in the other years and cooler conditions in 2009. These interannual changes 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 and 2007–2008 were not similar between test and control sites, with soil moisture declining more sharply at the control sites. This suggests that local conditions, in addition to regional climate, may have influenced soil moisture. Mean daily temperature range and mean maximum diurnal temperature were higher at test sites but lower at control sites in 2008 versus 2007. These metrics decreased sharply in 2009 at both test and control sites, presumably in response to the unusually cool climate conditions during portions of summer 2009. Thus, there have not been any consistent patterns in the changes in microclimate characteristics at test versus control sites that could be attributed to changes in river flows.

We noted between-year differences at the habitat monitoring sites for several vegetation variables. The only variables that exhibited a consistent change across time were percentage of live stems <2.5 cm dbh, which declined steadily from 2005 to 2009, and percentage of live stems 2.5–8 cm dbh, which was lower in 2008 and 2009 than in the three preceding years. Woody ground cover was the only variable for which there was a significant interaction with location, meaning the changes in all the other variables between years among test sites was not significantly different from the change at control sites. 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.

There was a between-year difference in live vegetation in the fourth meter interval above the ground and between-year differences for the first, second, third, and fourth meter intervals above the ground for dead vegetation. In all four intervals, density of dead vegetation was higher in 2008 than in 2007. There was a significant interaction between live vertical foliage density and location (test vs. control sites) for the fourth meter interval, but there was no clear pattern, with density generally increasing at control plots in years it decreased at test plots, and vice versa. There was also a significant interaction between dead vertical foliage density and location for the first meter interval, with the density of dead vegetation increasing more in 2007 and 2008 at control plots relative to test plots. The percentage of live vegetation in each meter interval differed between years only in the fourth meter interval; in this case, the live percentage was lower in 2008 than in 2007.

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.

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

Of the 10 piezometers that were within the woody, riparian vegetation, only 6 yielded usable evapotranspiration signature data over multiple years. Inspection of the hydrographs revealed that intraday changes in groundwater level were influenced strongly by the cyclic changes in river water levels associated with dam releases. These sharp rises and declines in the river level overwhelmed the evapotranspiration signature, and data from the piezometers along the river could not be used to assess changes in evapotranspiration signature over time. Further analysis of evapotranspiration data was restricted to the piezometer at Topock Marsh.

The evapotranspiration signature was strongly, directly correlated with depth to groundwater and weakly, directly correlated to temperature during May–August, 2007 and 2009. However, temperature was also correlated with depth to groundwater, because both increased over the May–August period each year. The evapotranspiration signature at Topock Marsh was directly related to depth to groundwater, rather than showing the inverse relationship demonstrated in the literature. The magnitude of the

evapotranspiration signature at Topock appears to be driven by local groundwater hydraulics, and changes in the evapotranspiration signature over time cannot by used as a proxy for vegetation change.

We measured baseline vegetation, microclimate, and surface hydrology conditions in an area of Topock Marsh that is scheduled for delivery of supplemental surface water in 2010. We stratified the site into use (occupied by flycatchers) and non-use (unoccupied by flycatchers) areas, as observed in 2003–2008. We deployed temperature/humidity data loggers within both the use and non-use areas, collected soil moisture measurement biweekly at each logger location, mapped surface water throughout the area on a weekly basis, and collected vegetation data at each logger location at the end of flycatcher breeding season. The percentage of the area that was inundated rose rapidly in late March and early April to a high of almost 45% and then declined just as rapidly in May. By early June, <5% of the site had surface water. Vegetation was primarily tamarisk and had high canopy closure. The densest live foliage occurred above average nest height, and the densest dead vegetation occurred within 3 m of the ground. Soil conditions became progressively drier throughout the season for both the use and non-use areas, while vapor pressure values showed the typical rise seen in July with the onset of summer monsoons. Conditions documented in 2009 will be compared to those documented in 2010 when additional surface water is delivered to the site.

The main flycatcher breeding area at Pahranagat National Wildlife Refuge was inundated annually during the flycatcher breeding seasons of 1997–2007, with up to 1 m of water recorded under the vegetation in mid-May. Major structural problems with the levee that impounds Upper Pahranagat Lake resulted in the site being dry during the breeding seasons of 2008 and 2009. We collected microclimate and vegetation data within the site during 2009 and compared these measurements to vegetation and microclimate data collected within flycatcher territories at the site from 2005 to 2007. The only vegetation variable that differed between the inundated and non-inundated periods was the percentage of the foliage that consisted of native species. This difference is entirely attributable to the development in 2009 of herbaceous ground cover consisting partially of a non-native *Chenopodium* species and does not reflect any change in the woody vegetation.

Microclimate conditions differed between the inundated and non-inundated periods by soil moisture and diurnal and nocturnal vapor pressure being higher during the inundated period. Without humidity data from a nearby weather station, it is impossible to determine if the difference in humidity is attributable to changes in water levels or simply lower regional humidity in 2009. We had expected that inundated conditions might serve to moderate daily temperatures, but the data showed a higher maximum temperature and lower minimum temperature during the inundated period. These differences could not be accounted for by between-year differences in regional climate, with the Caliente weather station showing no between-year differences for either maximum or minimum temperature.

Chapter 2

PRESENCE/ABSENCE SURVEYS AND SITE DESCRIPTIONS

INTRODUCTION

Broadcasts of recorded conspecific vocalizations are useful in eliciting responses from nearby willow flycatchers, and multiple broadcast surveys conducted throughout the breeding season are the standard technique for determining the presence or absence of *E. t. extimus* (Sogge et al. 1997). According to Sogge et al. (1997) 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. 1997, 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 2009, we completed multiple broadcast surveys at sites in 15 study areas[2] along the LCR and its tributaries to detect both migrant and resident willow flycatchers (Figure 2.1).

Special Concern Species

The Yuma Clapper Rail (*Rallus longirostris yumanensis*) is listed as federally endangered by the USFWS, and the Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) is a candidate for federal listing. Both species occur along the LCR and its tributaries and are of concern to managing agencies. Nine additional avian species [California Black Rail (*Laterallus jamaicensis coturniculus*), Western Least Bittern (*Ixobrychus exilis*), Elf Owl (*Micrathene whitneyi*), Gila Woodpecker (*Melanerpes uropygialis*), Gilded Northern Flicker (*Colaptes auratus chrysoides*), Vermilion Flycatcher (*Pyrocephalus rubinus*),

[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).

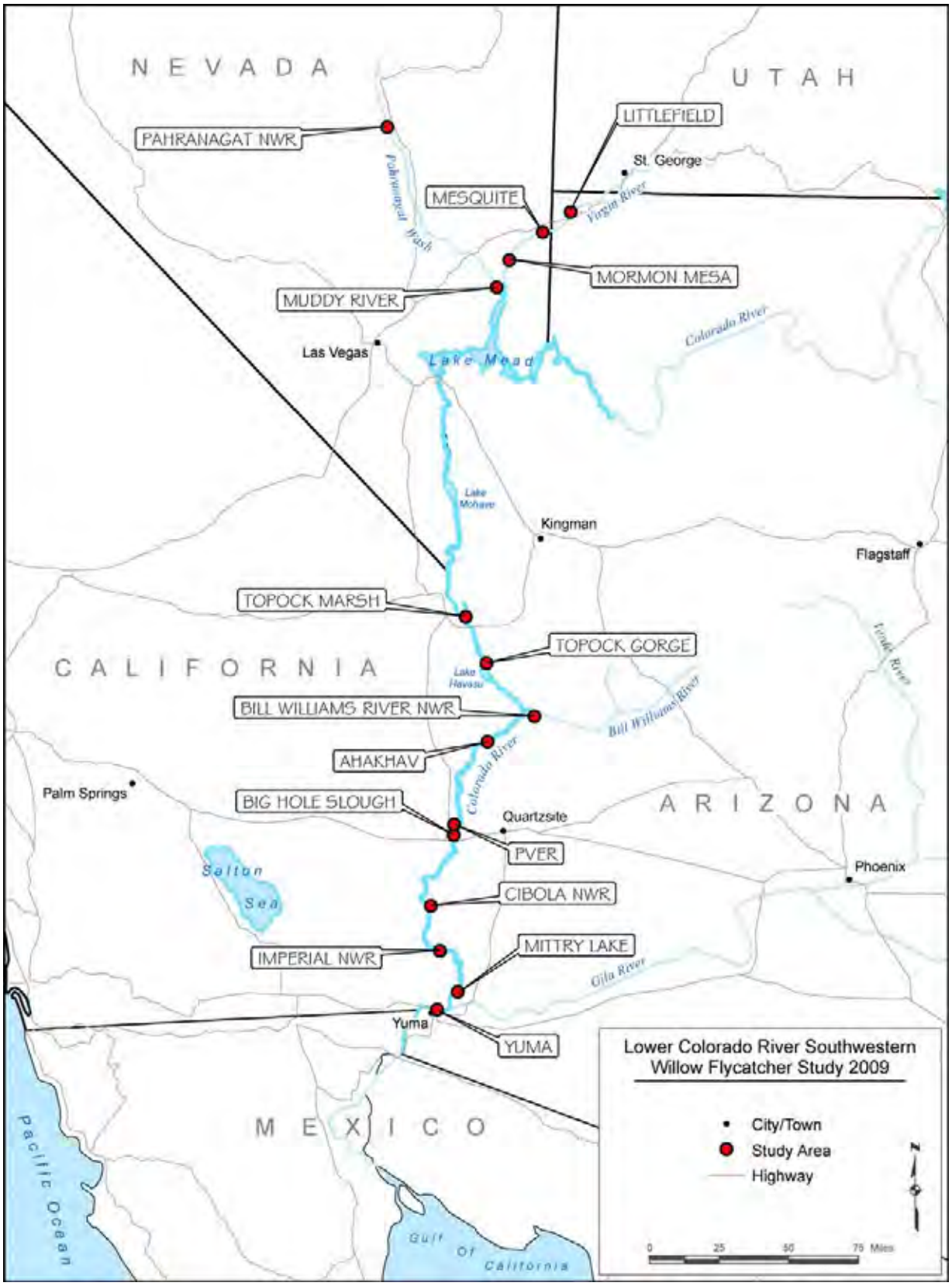

Figure 2.1. Locations of Southwestern Willow Flycatcher study areas along the lower Colorado River and tributaries, 2009. (Note, study area labels represent the approximate center of multiple sites within that region; see Table 2.2)

Arizona Bell's Vireo (*Vireo bellii arizonae*), Yellow Warbler (*Dendroica petechia*), 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 but recorded all incidental detections.

METHODS

Site Selection

Survey sites were selected based on locations surveyed during previous years of willow flycatcher studies on the LCR (McKernan 1997; McKernan and Braden 1998, 1999, 2001a, 2001b, 2002; McLeod et al. 2008, McLeod and Koronkiewicz 2009) and reconnaissance by helicopter and on foot prior to the start of the 2009 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 Theresa Olson guided and approved site selection. 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 2009 survey season is given in Table 2.1 and may be further revised based on conditions observed during 2009.

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	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	
BIWI	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	

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	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		
BIHO	Big Hole Slough	Marshy, new willows coming in.	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 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
	Hart Mine Marsh	Mostly tamarisk, with linear stretches of marsh vegetation. Dry soil under the tamarisk.			X
	Three Fingers Lake	Very dry and hot in interior, vegetation short.		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		

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	Adobe Lake	Perched above river, very dry, dense tamarisk with many dead branches in understory.		X	
	Rattlesnake	Dense willows, wet soils.	X		
	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 is 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 is 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 is dry.			X
	Fortuna North	Mature tamarisk, 80% canopy closure. Interior very dry. Adjacent to Gila River.			X
	Morelos Dam	Recovering from fire, canopy closure less than 50%, widely spaced willow and cottonwood, dense patch of tamarisk on northern end of site.			X

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

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. (1997), 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 portable CD or MP3 player (various models were used) coupled to a Radio Shack 277-1008C mini amplified speaker. Surveyors stopped every 30–40 m and broadcast willow flycatcher primary song (*fitz-bew*) and calls (*breets*). Field personnel watched for flycatchers and listened for vocal responses for approximately one to two minutes before proceeding to the next survey station. Wherever territorial flycatchers were detected, broadcast surveys were discontinued within a radius of 50 m of territories, and territory and nest monitoring commenced (see Chapter 4). If 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. (1997) and the Southwestern Willow Flycatcher Range-wide Database. Vegetation composition was defined as (1) native: >90% of the vegetation at a site was native; (2) exotic: >90% of the vegetation at a site was exotic/introduced; (3) mixed-native: 50 to 90% of the vegetation at a site was native; 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

Field personnel spent 661.2 observer-hours conducting willow flycatcher broadcast surveys at 69 sites along the Virgin and lower Colorado Rivers and tributaries.[3] Willow flycatcher survey 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 2009 are shown on orthophotos in Appendix B, along with historically occupied habitat.[4] Each site that was not occupied by territorial flycatchers was formally surveyed five times. Field personnel spent an additional 45.5 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. 1997, 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 C. Hydrologic characteristics of each site are summarized in Table 2.6.

Table 2.2. Willow Flycatcher Detections at Survey Sites along the Virgin and Colorado Rivers and Tributaries, 2009*

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
PAHR	North	4.6	23 (6 May–13 Aug)
	West	1.5	ND
	MAPS	2.7	ND
	South	2.5	1 (22 Jun)
LIFI	Poles	4.7	5 (1 Jun–26 Jul)
MESQ	East	4.4	ND
	West	11.5	21 (10 May–13 Aug)

[3] We started the survey season with 70 sites scheduled for surveys in 2009. One site had been bulldozed prior to the start of the survey season and was not surveyed. We discontinued surveys at two additional sites, one because of poor habitat quality and another because a fire destroyed vegetation in most of the site.

[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. Willow Flycatcher Detections at Survey Sites along the Virgin and Colorado Rivers and Tributaries, 2009* (Continued)

Study Area1	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)2,3
	Bunker Marsh North	13.6	7 (16 Jun–16 Jul)
MOME	Mormon Mesa North	8.2	ND
	Hedgerow	1.1	ND
	Mormon Mesa South	12.3	ND
	Virgin River #1	46.7	32 (12 May–8 Aug)
	Virgin River #2	36.9	1 (19 May)
MUDD	Overton WMA Pond	0.7	ND
	Overton WMA	14.9	17 (11 May–29 Jul)
TOPO	Pipes #1	5.2	1 (15 May)
	Pipes #3	5.7	2 (8 May–4 Jul)
	The Wallows	0.4	3 (15 May–8 Aug)
	PC6-1	4.8	1 (2–16 Jun)
	Pig Hole	2.4	ND
	In Between	7.7	ND
	800M	6.1	1 (26 May–13 Jul)
	Pierced Egg	6.7	5 (8 May–10 Jul)
	Swine Paradise	1.0	ND
	Barbed Wire	2.4	ND
	Platform	1.3	ND
	250M	1.9	1 (21 May) 1 (3–7 Jun), 1 (25 Jun)
	Hell Bird	3.3	2 (5 Jun–11 Jul)
	Glory Hole	5.0	7 (12 May–6 Aug)
	Beal Lake	13.9	1 (15–23 May), 1 (3 Jun)
	Lost Slough	1.5	ND
	Lost Pond	1.2	ND
	Lost Lake	3.3	1 (29 May)
TOGO	Pulpit Rock	2.1	ND
	Picture Rock	4.6	ND
	Blankenship Bend North	26.7	ND
	Blankenship Bend South	25.9	ND
BIWI	Burn Edge	3.7	ND
	Site #4	9.9	4 (4 Jun–5 Jul)
	Site #3	9.5	8 (10 May–19 Jul)
	Last Gasp	2.1	ND
	Site #5	6.8	1 (5–16 Jun)
	Upstream from Site #8	1.5	2 (12 Jun–14 Jul)
	Planet Ranch Road	2.1	ND
AHAK	Deer Island[4]	15.2	ND

Table 2.2. Willow Flycatcher Detections at Survey Sites along the Virgin and Colorado Rivers and Tributaries, 2009* (Continued)

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
PVER	PVER Phase 2	28.7	1 (27 May), 1 (3 Jun)
BIHO	Big Hole Slough	29.0	1 (17 Jun)
CIBO	CVCA Phase 1[5]	26.2	1 (27 May)
	CVCA Phase 3	41.2	1 (16 May), 1 (27 May), 2 (10 Jun)
	Cibola Nature Trail	13.7	1 (16 May), 2 (27 May), 1 (10 Jun)
	Cibola Island	4.2	4 (26 May), 3 (4 Jun)
	Cibola Site #2	16.4	ND
	Cibola Site #1	7.7	1 (9 Jun)
	Hart Mine Marsh[6]	31.6	ND
	Cibola Lake #2 (East)	4.5	1 (4 Jun)
	Walker Lake	11.4	ND
IMPE	Paradise	7.8	1 (20 May)
	Hoge Ranch	20.7	3 (20 May), 1 (15 Jun)
	Rattlesnake	7.6	1 (19 May)
	Milemarker 65	10.0	ND
	Nursery NW	7.0	1 (16 Jun)
	Ferguson Lake	21.1	3 (21 May), 2 (16 Jun)
	Great Blue Heron	7.1	1 (28 May), 1 (12 Jun)
	Powerline	2.0	1 (28 May)
	Martinez Lake	4.6	ND
MITT	Mittry West	4.4	2 (11 Jun)
YUMA	Gila River Site #2	5.1	3 (30 May), 1 (14 Jun)
	Fortuna Site #1	2.5	2 (31 May)
	Fortuna North	3.4	ND
	Morelos Dam[7]	11.4	ND

* This table includes only sites where regular surveys were scheduled and does not include sites where habitat reconnaissance and opportunistic surveys were conducted.

[1] PAHR = Pahranagat NWR, LIFI = Littlefield, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River , TOPO = Topock Marsh, TOGO = Topock Gorge, BIWI = Bill Williams River NWR, AHAK = Ahakhav Tribal Preserve, PVER = Palo Verde Ecological Reserve, BIHO = Big Hole Slough, EHRE = Ehrenberg, CIBO = Cibola NWR, IMPE = Imperial NWR, 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] Majority of site burned between 2 and 8 July; surveys discontinued.

[5] Named CVCA in previous reports.

[6] Surveys discontinued after fourth survey because of poor quality habitat.

[7] Site completely bulldozed prior to the start of survey season; no surveys completed.

Table 2.3. Detections of Willow Flycatchers Recorded after 15 June 2009 at Sites Where Breeding or Residency Was Not Confirmed

Study Area[1]	Site	Date	Comments
BIHO	Big Hole Slough	17 Jun	Responded briefly to broadcast with primary song (*fitz-bew*)
IMPE	Nursery NW	16 Jun	Responded briefly to broadcast with primary song (*fitz-bew*)
	Ferguson Lake	16 Jun	Two individuals responded briefly to broadcast with primary song (*fitz-bew*)

[1] BIHO = Big Hole Slough, IMPE = Imperial NWR.

Table 2.4. Yellow-Billed Cuckoo Detections along the Virgin, Bill Williams, and Lower Colorado Rivers, 2009

Study Area[1]	Site	Date	Behavioral Observations
MOME	Virgin River #1 South	13 Jul	One individual heard calling continuously for 10 minutes
TOPO	PC6-1	2 Jul	One individual seen flying across the road
	Glory Hole	29 Jun	One individual seen
BIWI	Site #4	20 Jul	One individual heard
	Site #3	30 Jun	One individual heard calling throughout the morning
		7 Jul	One individual heard calling in same location as on 30 Jun
		9 Jul	Two individuals heard calling in same location as on 30 Jun
		12 Jul	One individual heard calling in same location as on 30 Jun
		13 Jul	One individual heard calling in same location as on 30 Jun
		24 Jul	One individual heard calling in same location as on 30 Jun
	Site #5	24 Jun	One individual detected; no notes taken
		9 Jul	Two individuals seen
	Upstream from Site #8	18 Jun	One individual heard
		4 Jul	At least two individuals heard
		14 Jul	One individual heard
		18 Jul	One individual detected; no notes taken
		27 Jul	One individual heard in same location as on 18 Jun
	Planet Ranch Road	12 Jun	One individual heard calling
		8 Jul	At least two individuals heard
		18 Jul	One individual detected; no notes taken
		22 Jul	One adult and one fledgling seen

[1] MOME = Mormon Mesa, TOPO = Topock Marsh, BIWI = Bill Williams River NWR.

Table 2.5. Yuma Clapper Rail Detections along the Virgin, Bill Williams, and Lower Colorado Rivers, 2009

Study Area[1]	Site	Date(s)	Behavioral Observations
MESQ	Bunker Marsh North	27 May	One individual heard calling
TOPO	800M	13 Jul	One individual heard kekking
	250M	21 Jul	Keks heard from marsh
	Hell Bird	5 Jun	Two individuals heard calling
	NW Beal Lake	30 May	One individual heard kekking
	Beal Lake	3 Jun	One individual heard calling in marsh to north of site
	NE Lost Lake	25 May	Three individuals heard calling
		10 Jun	Four individuals heard calling; two were interacting
	Lost Lake	29 May	Two individuals heard calling from cattail marsh
	Lost Lake Slough #4	27 May	One individual recorded; no notes taken
TOGO	Picture Rock	9 Jul	One individual recorded; no notes taken
	Blankenship Bend North	29 May	Three individuals recorded; single bird kekking and pair clatter
	Blankenship Bend South	10 Jun	One individual heard kekking
		24 Jun	One individual recorded; no notes taken
		21 Jul	Two individuals recorded; pair clatter
BIWI	Site #3	14 May	One individual seen
CIBO	Hart Mine Marsh	9 Jun	3 individuals heard calling
	Cibola Lake East	26 May	One individual heard kekking
IMPE	Ferguson Lake	22 Jul	One individual recorded; no notes taken
	Powerline	28 May	One individual heard kekking
YUMA	Fortuna Site #1	28 Jun	One individual heard kekking
	Fortuna North	24 Jul	One individual recorded; no notes taken

[1] MESQ = Mesquite, TOPO = Topock Marsh, TOGO = Topock Gorge, BIWI = Bill Williams River NWR, CIBO = Cibola NWR, IMPE = Imperial NWR, YUMA = Yuma.

Table 2.6. Summary of Hydrologic Conditions at Each Survey Site along the Virgin and Lower Colorado Rivers and Tributaries, 2009*

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]	3/1/0	10/10/0	1/0/0	0/0/30
	West[4]	0/0/0	0/0/0	0/0/0	2/4/15
	MAPS	0/0/0	0/0/0	0/0/0	130/20/200
	South	3/5/0	40/30/0	0/0/0	0/0/--
LIFI	Poles[4]	10/10/10	20/20/20	5/5/5	0/0/0
MESQ	East[4]	0/0/0	0/0/0	0/0/0	5/5/5
	West	0/0/0	0/0/0	0/0/0	25/25/25
	Bunker Marsh North[4]	20/10/0	30/15/0	10/5/0	0/0/10

Table 2.6. Summary of Hydrologic Conditions at Each Survey Site along the Virgin and Lower Colorado Rivers and Tributaries, 2009* (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[4]	0/0/0	0/0/0	0/0/0	0/5/125
	Hedgerow	0/0/0	0/0/0	0/0/0	100/100/100
	Mormon Mesa South	0/0/0	0/0/0	0/0/0	200/200/200
	Virgin River #1	10/10/10	30/20/20	5/5/5	0/0/0
	Virgin River #2[4]	0/0/0	0/0/0	0/0/0	0/0/0
MUDD	Overton WMA Pond	1/1/1	20/20/10	1/1/1	0/0//0
	Overton WMA	25/25/5	30/30/10	2/10/3	0/0/0
TOPO	Pipes #1	0/0/0	0/0/0	0/0/0	50/50/50
	Pipes #3	30/1[5]/1[5]	30/30/10	10/10/0	0/0/0
	The Wallows	50/1/1[5]	25/10/10	10/30/--	0/0/0
	PC6-1	60/1/0	--/3/0	10/10/1	0/0/0
	Pig Hole	15/0/0	10/0/0	15/10/0	0/0/130
	In Between	20/0/0	10/0/0	15/0/0	0/50/50
	800M	40/1/0	10/3/0	25/50/0	0/0/55
	Pierced Egg	40/1[5]/1[5]	10/10/10	15/5/0	0/0/0
	Swine Paradise[6]	0/0/0	0/0/0	0/0/0	0/0/10
	Barbed Wire	1[5]/1[5]/0	10/5/0	0/0/0	0/0/120
	Platform[6]	0/0/0	0/0/0	2/2/0	0/0/10
	250M[6]	15/15/0	10/--/0	5/5/5	0/0/0
	Hell Bird	70/10/00	50/30/0	20/30/40	0/0/0
	Glory Hole	--/35/0	--/50/0	--/10/0	0/0/150
	Beal Lake[9]	0/0/0	0/0/0	0/0/0	30/30/30
	Lost Slough	--/15/5	--/30/10	--/0/3	--/0/0
	Lost Pond[4]	75/0/0	30/0/0	10/5/0	0/0/15
	Lost Lake[6]	0/0/0	0/0/0	10/2/0	2/0/--
TOGO	Pulpit Rock[4]	--/--/--	--/--/--	--/--/--	0/0/0
	Picture Rock[4]	0/0/0	0/0/0	5/10/--	0/0/0
	Blankenship Bend North[4]	15/15/15	50/50/50	5/5/5	0/0/0
	Blankenship Bend South[4]	80/10/40	50/10/10	5/10/--	0/0/0
BIWI	Burn Edge	30/15/1	30/10/30	20/5/0	0/0/0
	Site #4[4]	2/2/1	10/10/30	1/1/1	0/0/0
	Site #3	5/3/0	10/3/0	1/5/0	0/0/300
	Last Gasp	5/1/0	30/30/0	0/2/0	0/0/500
	Site #5	2/2/1	>100/>100/--	5/5/1	0/0/0
	Upstream from Site #8	60/40/50	15/20/10	20/10/1	0/0/0
	Planet Ranch Road	50/30/10	70/505/50	30/5/0	0/0/0

Table 2.6. Summary of Hydrologic Conditions at Each Survey Site along the Virgin and Lower Colorado Rivers and Tributaries, 2009* (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]
AHAK	Deer Island[4]	50/50/50	>100/>100/>100	1/1/1	0/0/0
PVER	PVER Phase 2[7]	0/0/0	0/0/0	0/0/0	0/0/0
BIHO	Big Hole Slough	5/15/25	5/100/50	5/5/5	0/0/0
CIBO	CVCA Phase 1[7]	0/0/0	0/0/0	0/0/0	0/0/0
	CVCA Phase 3[7]	0/0/0	0/0/0	0/0/0	0/0/0
	Cibola Nature Trail[7]	0/80/0	0/10/0	0/10/0	--/0/75
	Cibola Island	20/10/1	30/10/3	10/7/5	0/0/0
	Cibola Site #2	0/0/0	0/0/0	0/5/0	15/0/15
	Cibola Site #1	0/0/0	0/0/0	0/0/0	10/10/10
	Hart Mine Marsh	15/25/30	--/--/--	--/--/--	0/0/0
	Cibola Lake #2 (East)[4]	0/0/0	0/0/0	0/0/0	10/80/50
	Walker Lake[4]	0/0/0	0/0/0	2/0/0	0/10/5
IMPE	Paradise[4]	3/--/0	2/--/0	2/--/0	0/--/0
	Hoge Ranch[4]	0/0/1	0/0/3	0/0/2	0/0/0
	Rattlesnake[6]	0/0/0	0/0/0	0/0/0	200/200/200
	Milemarker 65[4]	--/--/--	--/--/--	--/--/--	0/0/0
	Nursery NW[6]	3/3/--	10/10/--	5/3/--	0/0/--
	Ferguson Lake[4]	0/10/5	0/3/3	3/5/10	0/0/0
	Great Blue Heron[6]	0/0/5	0/0/10	0/0/5	60/150/0
	Powerline[6]	1/0/1	3/0/3	5/0/5	0/50/0
	Martinez Lake[6]	0/0/0	0/0/0	0/0/0	50/50/50
MITT	Mittry West	3/0/0	10/0/0	7/0/0	0/180/180
YUMA	Gila River Site #2[4]	0/0/0	0/0/0	0/0/0	15/0/5
	Fortuna Site #1[4]	6/0/0	10/0/0	10/0/2	0/5/0
	Fortuna North[4]	0/0/0	0/0/0	5/0/0	0/10/10

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

[1] PAHR = Pahranagat NWR, LIFI = Littlefield, MESQ = Mesquite West, MOME = Mormon Mesa, MUDD = Muddy River, TOPO = Topock Marsh, TOGO = Topock Gorge, AHAK = Ahakhav Tribal Preserve, BIWI = Bill Williams River NWR, PVER = Palo Verde Ecological Reserve, BIHO = Big Hole Slough, CIBO = Cibola NWR, IMPE = Imperial NWR, 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.

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. 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 levee 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.

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 15–18 m, and canopy closure is approximately 70%, similar to that recorded in 2008. Canopy closure from 2003 to 2007 was >90%. Reduced canopy closure in 2008–2009 occurred mostly in the northeastern section of the site, where many of the large trees are now dead or dying. During the survey season, standing water and saturated soils were present only 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. The water channel is vegetated with bulrush (*Schoenoplectus* sp.) where it enters the lakebed. Saturated soils were also present within patches of bulrush that border the southern edges of the site.

We detected 20 breeding willow flycatchers, as well as 1 resident, unpaired male. In addition to resident adults, we detected two individuals for which residency and breeding status could not be confirmed. Areas of Pahranagat North not known to be occupied by willow flycatchers were surveyed five times, totaling 6.1 observer-hours. The site lies immediately adjacent to a cattle pasture, but livestock have access only to the cottonwood stringer on the northwestern corner of the lake, which is separated from the survey site by a fence. Cowbirds were detected during one survey and were detected regularly during nest monitoring activities.

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. During the survey season, the interior of the site was dry, but surface water was present nearby in the lakebed.

We detected no willow flycatchers. We surveyed the site five times, totaling 3.2 observer-hours. No cowbirds were detected, and there was no sign of livestock use.

Pahranagat MAPS

Area: 2.7 ha Elevation: 1,026 m

Pahranagat MAPS is a stringer of cottonwood on the western edge of the bed of Upper Pahranagat Lake. Canopy height is 15–20 m, and canopy closure is approximately 60%. There is very little woody vegetation in the understory. Cattail (*Typha* sp.) and bulrush line the eastern edge of the tree line and extend into the lakebed; much of this vegetation is dead. The site was dry throughout the survey season, with the nearest water or saturated soil being at least 20 and up to 200 m away in the lakebed.

No willow flycatchers were detected. We surveyed the site five times, totaling 3.5 observer-hours. Cowbird were detected on two surveys, and there was no evidence of livestock use.

Pahranagat South

Area: 2.5 ha Elevation: 1,023 m

Pahranagat South consists of a relatively small stringer of Goodding willow, coyote willow (*Salix exigua*), and cottonwood lining a human-made channel that carries the outflow from Upper Pahranagat Lake. The cottonwoods reach approximately 20 m in height, while the willows are generally less than 10 m. In 2005, we noted that dense coyote willow was increasing on the western side of the site; this area of willow had very sparse canopy in 2006 and 2007, and the coyote willow was almost completely dead by 2008. The site is bordered to the west by an open marsh and to the east by upland scrub. Tamarisk (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*) form a sparse understory. Overall canopy closure at this site is approximately 50%. The channel held water during site visits in May and June but was dry in mid-July.

We detected one willow flycatcher, for which residency and breeding status could not be confirmed, on 22 June after receiving a report from field personnel from an unrelated project that a flycatcher had been detected at the site. The flycatcher was not detected on any of three subsequent territory monitoring visits or on any of the surveys. We surveyed the site five times, totaling 2.8 observer-hours. Cowbirds were detected during two surveys, and no sign of livestock was observed.

Littlefield, Arizona

In 2007, our survey and monitoring activities focused on an area along Beaver Dam Wash immediately upstream of the Highway 91 Bridge. We expanded the survey area in 2008 to include young Goodding and coyote willow stringers downstream of the bridge and expanded the survey area even farther downstream in 2009.

Littlefield Poles

Area: 4.7 ha Elevation: 565 m

Littlefield Poles consists of primarily native vegetation located on Beaver Dam Wash, immediately upstream and downstream of the Highway 91 Bridge. Vegetation upstream of the bridge consists of a scattered overstory of cottonwood averaging 25 m in height. Cottonwood and Goodding willow averaging 10 m in height are present below the overstory but do not form a continuous canopy. Lower strata vegetation approximately 6 m in height consists of coyote willow, tamarisk, and some Russian olive. Dense stands of coyote willow border the southern edge of the patch, along the stream. Downstream of the bridge, young stringers of Goodding and coyote willow reach 5 m in height and form linear patches 10–15 m wide on the edges of multiple stream channels. Larger Goodding willow is present along the southwestern edge of the site on the edge of a golf course, and a dense patch of Goodding willow is present on the northern edge of the downstream end of the site. The downstream end of the site borders a cattail marsh. Canopy closure in the densest areas of Goodding and coyote willow is >90%, though overall canopy closure ranges from 50 to 70%. Surface water was present in stream channels and in the cattail marsh throughout the survey season.

We detected three breeding willow flycatchers; one resident, unpaired male; and one willow flycatcher for which residency could not be confirmed. Portions of the site not known to be occupied by flycatchers

were surveyed five times, totaling 14.5 observer-hours. Cowbirds were detected on all surveys, and cattle scat and trails were observed in the site.

Mesquite, Nevada

The Mesquite study area is in the floodplain of the Virgin River near Mesquite and Bunkerville, Nevada. The entire area experience flooding, and some areas were scoured, during the 2004–2005 winter floods.

Mesquite East

Area: 4.4 ha Elevation: 468 m

This mixed-native site lies on several terraces within the floodplain of the Virgin River in Mesquite, Nevada. Vegetation on the lowest terrace, on the northern edge of the site adjacent to the river, consists of cottonwood and Goodding willow generally less than 10 m in height. The central portion of the site lies on a slightly higher terrace and is vegetated entirely by dense tamarisk 7–8 m in height with canopy closure around 80%. The uppermost terrace is vegetated with Goodding willow and a few cottonwood 18–25 m in height and an understory of dense clumps of coyote willow about 8 m in height. Canopy closure on this terrace varies from 50% in the cottonwood/Goodding willow areas to over 90% in the coyote willow clumps. The western half of the upper terrace burned over the 2004–2005 winter and grew back with thick stands of coyote willow and cottonwood. The site was completely dry throughout the survey season, and the coyote willow was dead or dying.

We detected no willow flycatchers. We surveyed the site five times throughout the flycatcher breeding season, totaling 8.6 observer-hours. Cowbirds were detected on all surveys. Cattle trails and scat were observed on all surveys, and domestic pigs were seen in the site on one occasion.

Mesquite West

Area: 11.5 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 and bulrush 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%. Hydrology at the site is influenced by irrigation runoff from adjacent golf courses and agriculture. In previous years, the majority of the site was regularly or continuously inundated. At the beginning of the 2009 breeding season, the site was completely dry, and the pond at the western end of the site, which had previously been too deep to wade, had completely dry soil with deep cracks. Water had previously entered the northeastern corner of the site from a deep trench, but in 2009, what little water was flowing had been diverted down the eastern edge of the site in a trench that had been dug the previous year. During the first site visit in early May, we noted premature leaf abscission in the coyote willows. In the last week of June, we noted surface water within the site for the first time during the season, and it was confined to the eastern portion of the site. This portion of the site received surface water for one day at approximately weekly intervals for the remainder of the breeding season, and the willows appeared to respond with new growth. The rest of the site remained dry, though the cracks in the soil at the western end of the site became shallower, suggesting subsurface water.

We detected 16 breeding willow flycatchers, 1 pair for which no nest was located, and 2 resident, unpaired males. In addition to resident adults, we detected one individual for which residency and

breeding status could not be determined. Areas of Mesquite West not known to be occupied by flycatchers were surveyed once at the beginning of the flycatcher breeding season, totaling 2.0 observer-hours. After the initial survey, all areas of the site were covered by territory monitoring, and surveys were discontinued. Cowbirds were detected on the survey and were detected regularly during territory monitoring. Fresh cattle scat was also observed within the site.

Bunker Marsh North

Area: 13.6 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. We explored and surveyed the riparian vegetation along an approximately 1-km reach of the river. The southern end of the site consists of tamarisk 6 m in height with 50–70% canopy closure. This portion of the site is bordered to the north by a small cattail marsh and a strip of 4–5-m-tall Goodding and coyote willow. The tamarisk area was very dry throughout the season and does not represent suitable flycatcher habitat. The willows surrounding the cattail marsh may provide habitat in future years if the area expands and matures. The remainder of the site is a mosaic of 4–6-m-tall tamarisk, scattered Goodding willow, patches of coyote willow 4–5 m in height, and stream channels and marshy areas. Canopy closure ranges from 25 to 90%. One small patch of coyote willow near the center of the site had surface water beneath the woody vegetation; otherwise, the only portions of the site that contained surface water were the marshes, and soils were dry beneath the woody vegetation. The streams and marshes contained surface water through mid-June but were dry in July.

We detected five breeding willow flycatchers and two flycatchers for which residency and breeding status could not be confirmed. Portions of the site not known to be occupied by flycatchers were surveyed five times, totaling 17.0 observer-hours. Cowbirds were detected on four surveys, and cows were observed in the site on multiple occasions.

Mormon Mesa, Nevada

For approximately 15 km upstream of its outflow to Lake Mead, the Virgin River flows through a 1-km-wide floodplain with a mosaic of habitats, including cattail marshes and tamarisk and willow forest. Much of the area is typically seasonally inundated from snowmelt in the spring and monsoon rains in mid and late summer, and the entire study area experienced severe flooding over the 2004–2005 winter. All the areas surveyed at Mormon Mesa are at least 10 km upstream of Lake Mead. The Virgin River did not go completely dry at Mormon Mesa at any point during the survey season of 2009, unlike in some previous years. Much of the tamarisk throughout Mormon Mesa started yellowing in the middle of June as the result of leaf hopper damage. Cattle were encountered at all sites throughout the survey season.

Mormon Mesa North

Area: 8.2 ha Elevation: 390 m

This mixed-exotic site consists primarily of tamarisk 3–5 m in height with areas of emergent Goodding willow up to 12 m in height and patches of coyote willow. Overall canopy closure is around 50%. 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. No standing water or saturated soils were present within the site during the survey season, but surface water was adjacent to the site in May and June in the river channel to the south. The site is perched up to 2 m above the water level. Mormon Mesa North has been completely dry throughout the breeding seasons of 2004 to present, and no flycatchers have been

detected at the site in 2006–2009. Portions of the site, particularly the Goodding willows on the western edge of the site, might provide suitable flycatcher habitat with wetter soil conditions but in recent years have been dry. We recommend visiting this site at the beginning of the survey season to assess hydrologic conditions and discontinuing surveys for the season if the site is completely dry.

We did not detect any flycatchers. We surveyed the site five times, totaling 16.4 observer-hours. Cowbirds were detected on all surveys as was evidence of livestock use.

Hedgerow

Area: 1.1 ha Elevation: 390 m

This mixed-exotic site is east of Mormon Mesa North, on the eastern side of the Virgin River. The site consists of a continuous understory of tamarisk 4–5 m in height with 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 (*Pluchea sericea*) 2–3 m in height. Canopy closure at the site varies from about 50% on the edges of the site up to 80% in the denser areas. Soils within the site were dry throughout the survey season. No flycatchers have been detected in Hedgerow since we began surveys in 2005, and the site has been completely dry in each year. We recommend visiting this site at the beginning of the survey season to assess hydrologic conditions and discontinuing surveys for the season if the site is completely dry.

We did not detect any flycatchers. We surveyed the site five times, totaling 2.3 observer-hours. Cowbirds were detected on three visits.

Mormon Mesa South

North half: Area: 8.9 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. Habitat evaluation at the beginning of the survey season revealed that the Goodding willow in the western third of the area that had been surveyed in previous years was entirely dead, and we discontinued surveys in this portion of the site. The remainder of the site has scattered Goodding willow up to 20 m in height and a patchy understory of tamarisk 4–7 m in height. Clumps of coyote willow are present on the eastern edge of the site, and dead cattail is present in the understory in this area. Canopy closure is widely variable, ranging from >90% in tamarisk thickets to <50% in openings. There was no surface water within the site, but damp soils were noted on the eastern edge of the site in May and June. The presence of dead cattails and deadfall suggest 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. We surveyed the northern and southern halves of the site five times each, totaling 12.3 and 7.5 observer-hours, respectively. Cowbirds were detected on all but one survey.

Virgin River #1

North half: Area: 12.0 ha Elevation: 380 m
South half: Area: 34.7 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. Habitat assessment in Virgin River #1 North at the beginning of the survey season revealed most of the Goodding willow in the northwestern finger of the area that had

been surveyed in 2008 were dead, and surveys in this area were discontinued. The southeastern corner of the formerly surveyed Virgin River #1 North consists of clumps of tamarisk 4–6 m in height, dry soil, and 60% canopy closure; surveys were discontinued in this area as well. The remainder of Virgin River #1 North is primarily tamarisk 4–6 m in height, with areas of emergent Goodding willow and patches of coyote willow in the central and southwestern portions of the site. Canopy closure throughout the site is 50–70%. Surface water and mud were present in May in channels running north to south through the center of the site, and the southwestern corner of the site also contained surface water in May and June.

We detected three breeding flycatchers and one individual for which residency and breeding status could not be confirmed in the southwestern corner of Virgin River #1 North. Areas of this site not known to be occupied by flycatchers were surveyed five times, totaling 23.5 observer-hours. Cowbirds were detected on all but one survey.

We expanded Virgin River #1 South approximately 600 m to the south and east to explore areas where stream channels were noted on the aerial photograph and during aerial reconnaissance. This new area consists of monotypic tamarisk up to 5 m in height with 70–90% canopy closure. Some of the stream channels contained surface water in May and June and damp soil in July. The channels are incised 1–2 m, and soils beneath the tamarisk were entirely dry throughout the survey season. We do not recommend continuing surveys in this area in future years because of the dry soil conditions. The northwestern portion of the site has coyote and Goodding willows interspersed with tamarisk 4–5 m in height. Goodding and coyote willows average 8 and 5 m in height, respectively. This portion of the site contained surface water throughout the survey season and has open, marshy areas. Canopy closure varies from >90% in areas of dense willow and tamarisk to 25% in marshy openings. The middle portion of the site consists of sparser tamarisk 4 m in height with dry, open areas, and the southwestern part of the site consists primarily of tamarisk 3–5 m in height and canopy closure from 60 to 80%. The southwestern part of the site also contains one cluster of emergent Goodding willow 10 m in height with dead coyote willow in the understory, and tamarisk in this area is up to 8 m in height. Soils in this area were damp, but no surface water was noted. For future years we recommend surveying only the northern third of the site and the area immediately around the Goodding willow cluster in the southwestern portion of the site because of the short canopy height and dry soil conditions in the remainder of the site.

We detected 20 breeding willow flycatchers and 4 unpaired, resident males in the northwestern portion of Virgin River #1 South. We detected four 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 five times, totaling 29.5 observer-hours. Cowbirds were observed on all surveys.

Virgin River #2

Area: 36.9 ha Elevation: 380 m

This site is primarily a monotypic stand of tamarisk 6 m in height with 70–90% canopy closure. Widely scattered emergent Goodding willow up to 10 m in height are present in the northern half of the site. A clump of Goodding willow occurs halfway down the eastern edge of the site, and scattered willows extend to the southern end of the site. The tamarisk in the willow area are dry and brittle, and a greater proportion of mid-sized tamarisk stems are dead compared to previous years (see Chapter 5). The site contained no surface water during the breeding season, though portions of the site contained damp soils. The Virgin River, on the eastern edge of the site, had surface water throughout the season. No flycatchers have been detected in the northern half of the site from 2003 to present, and we recommend discontinuing surveys in this area.

We detected one willow flycatcher for which residency could not be confirmed. We surveyed the site five times, totaling 51.5 observer-hours. Cowbirds were observed on all surveys.

Muddy River, Nevada

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

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 150 m wide at the north end of Overton WMA just south of Honeybee Reservoir. The dominant vegetation consists of 10-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. 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 no willow flycatchers. We surveyed the site five times for a total of 3.4 observer-hours. Cowbirds were detected 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 10–12 m in height with an understory of tamarisk and cattail and canopy closure up to 90%. Flowing water was present in the channel of the Muddy River throughout the survey season. Extensive beaver activity resulted in the southern portion of the site being flooded with approximately 30 cm of water through mid-July, at which time water was restricted to channels and the area that had previously been flooded was only muddy. 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 11 breeding willow flycatchers and 2 unpaired, resident males. We also detected four flycatchers for which residency could not be confirmed. Portions of the site not known to be occupied by flycatchers were surveyed five times, totaling 21.9 observer-hours. We observed no signs of livestock but detected cowbirds on all surveys.

Ground Reconnaissance Results

THE NARROWS

The Narrows site is along the Muddy River, immediately upstream of the point where the river enters the Moapa Valley, approximately 1.5 km west of Bowman Reservoir. Aerial photographs show a stretch of dense riparian vegetation along the river in The Narrows. This site consists of an approximately 125-m-wide swath of tamarisk straddling a reach of the Muddy River approximately 900 m in length. The site is bordered to the north and south by upland desert. The site is dominated by very dense tamarisk up to 6 m in height with canopy closure of 70–90%, and areas of saltbush (*Atriplex* sp.) border the tamarisk along the southern uplands. Three small, sparse patches of coyote willow and seep willow (*Baccharis* sp.) are found along the river in the central portion of the site. At points along the river where access was possible, flowing water and saturated soil were present only in the river channel. The widest part of the river channel observed was 2.5 m wide and incised up to 2 m. We recommend visiting this site at the beginning of the survey season to assess hydrologic conditions and discontinuing surveys for the season if water is restricted only to the channel.

We surveyed the site three times for a total of 6.5 observer-hours. Cowbirds were detected on two visits, and no sign of livestock use was observed.

MUDDY RIVER RECON

During aerial reconnaissance in March 2009, we noted a flooded area along the riparian corridor of the Muddy River starting approximately 1 km downstream of the southern end of Overton WMA and continuing downstream for approximately 1 km. Ground reconnaissance in May revealed that the area consists primarily of cattail marsh with scattered tamarisk 3 m in height. A few scattered Goodding willow 8 m in height are also present, and overall canopy closure is <25%. The area was flooded with up to 10 cm of water during the site visit. The sparse woody vegetation and open canopy make this area unsuitable for breeding flycatchers.

We visited the site once for a total of 6.0 observer-hours.

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. Feral pigs are present throughout the Topock study area, and evidence of pigs was observed in all 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 5–7 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 but did contain damp soils along the southern edge of the site throughout the season.

We detected one willow flycatcher, for which residency was not confirmed, on 15 May. Three subsequent territory monitoring visits and four subsequent surveys failed to detect the flycatcher again. We surveyed the site five times, totaling 9.0 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 4–6 m in height. The southeastern portion of the site has a few emergent Goodding willow up to 15 m in height and open, marshy areas. Canopy closure generally exceeds 70%. In May, the portion of the site with Goodding willow and marshes was inundated with up to 10 cm of water, and the central portion of the site had water up to 30 cm in depth beneath the tamarisk. The site progressively dried out through the season but still contained damp soils and standing water in pig wallows in July.

We detected one territorial male flycatcher in Pipes #3. We also detected a second flycatcher at the site on 9 and 13 June. The second flycatcher was interacting with the territorial male and was possibly a female. The second flycatcher was not detected on any of nine territory monitoring visits after 13 June, however. Portions of Pipes #3 not known to be occupied by flycatchers were surveyed five times, totaling 5.3 observer-hours. Cowbirds were detected on three surveys.

The Wallows

Area: 0.4 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. Overall canopy closure ranges from 50% in the marshy area to 90% in the tamarisk. Half the site was inundated in May, but by mid-June water was present only in intermittent puddles in the marsh, and by mid-July the only remaining surface water was in pig wallows.

We detected two breeding flycatchers and detected another individual on a single occasion on 15 May. Portions of the site not known to be occupied were surveyed 5 times, totaling 5.0 hours. Cowbirds were detected on four 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%. Approximately 60% of PC6-1 contained standing water and saturated soils in May. By mid-June only small puddles remained, and <1% of the site had saturated soil in July.

We detected one willow flycatcher between 2 and 6 June. The site was surveyed five times, totaling 11.0 observer-hours. Cowbirds were detected on three 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%. The northern edge of the site has smaller-diameter tamarisk, with many wispy branches, than the remainder of the site. Approximately 5% of the site consists of dense patches of arrowweed. Approximately 15% of the site had standing water in May, and another 15% of the site had saturated soils. The standing water had disappeared and only 10% of the site contained saturated soils by mid-June, and by mid-July there was no saturated soil in Pig Hole.

No willow flycatchers were detected. The site was surveyed five times, totaling 5.3 observer-hours. Cowbirds were detected on two 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. Approximately 25% of the site was inundated in May, but no standing water remained by mid-July.

We detected no flycatchers in In Between. We surveyed the site five times, totaling 9.8 observer-hours. Cowbirds were observed on all surveys.

800M

Area: 6.1 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%. The far southern end of the site, within 50 m of the refuge road, consists of very dry tamarisk 3-5 m in height and is not suitable flycatcher habitat. Approximately 40% of the site was inundated in May, but surface water was restricted to a few puddles within the marsh by mid-June.

We detected one resident male flycatcher. Portions of the site not known to be occupied were surveyed five times, totaling 6.5 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%. Approximately 40% of the site was inundated in May, but by mid-June, the only remaining water was in deep pig wallows.

We located two resident male flycatchers and three additional flycatchers for which residency could not be confirmed. Two of the additional flycatchers were detected on 16 and 19 June, one in each of the occupied territories, and were suspected to be females. They were not detected on any of eight territory monitoring visits after 19 June. The third flycatcher for which occupancy could not be determined was detected along the refuge road on 8 June. We surveyed portions of the site not known to be occupied by flycatchers five times for a total of 8.5 observer-hours. Cowbirds were observed on all surveys.

Swine Paradise

Area: 1.0 ha Elevation: 140 m

This mixed-exotic site borders the open water of Topock Marsh. Vegetation at the 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 interior of the site was dry throughout the survey season, but standing water and saturated soils persisted throughout the season in the marsh on the eastern edge of the site.

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

Barbed Wire

Area: 2.4 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. Canopy closure is approximately 90%. Standing water was present in pig wallows in May and June.

We detected no willow flycatchers. We surveyed the site five times, totaling 7.3 observer-hours. Cowbirds were detected on three visits.

Platform

Area: 1.3 ha Elevation: 140 m

This site forms a narrow strip of vegetation between the main refuge road and the open marsh. Vegetation at the site consists of tamarisk 7 m in height with a few isolated, emergent Goodding willow. Overall canopy closure is approximately 90%. Bulrush and cattail line the eastern edge of the site adjacent to the marsh. The interior of the site was dry in June and July.

No willow flycatchers were detected. We surveyed the site five times, totaling 3.5 observer-hours. Cowbirds were detected on three 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 one emergent Goodding willow approximately 12 m in height. Canopy closure within the site ranges from 70 to 90%. The patch of coyote willow on the northern border of the site was inundated in May and June but dry in July. The remainder of the site was dry throughout the survey season.

We detected three willow flycatchers; one on 21 May, one on 3–7 June, and one on 25 June. Residency could not be confirmed for any of these individuals. The site was surveyed five times, totaling 5.3 observer-hours. Cowbirds were detected on all surveys.

Hell Bird and Glory Hole

Hell Bird: Area: 3.3 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. Canopy closure ranges from 50 to 90%. The survey areas are bordered on the west by a sand dune and on other sides by dense bulrush. Large swampy areas vegetated by cattail and bulrush are interspersed throughout the survey areas. The proportion of Hell Bird covered by surface water declined from 70% in May to 10% in mid-June and 0% in mid-July. Water levels in Glory Hole declined similarly throughout the season, with 30% of the site being inundated with up to 70 cm of water in early June and only damp soils remaining by mid-July.

We detected two unpaired, resident male flycatchers in Hell Bird and four unpaired, resident males in Glory Hole. In Glory Hole, we detected three additional flycatchers for which residency was not confirmed. Hell Bird was surveyed five times, totaling 10.0 observer-hours. Portions of Glory Hole not known to be occupied by flycatchers were surveyed five times, totaling 1.9 observer-hours. Cowbirds were detected on all surveys in Hell Bird and two surveys in Glory Hole.

Beal Lake

Area: 13.9 ha Elevation: 140 m

This mixed-native restoration site consists of a mosaic of cottonwood, Goodding willow, coyote willow, and arrowweed, with some tamarisk and mesquite scattered throughout the site. Canopy height is highly variable and averages approximately 5 m; canopy closure is sparse, averaging 35%. The amount of standing water and saturated soil is highly variable because it is flood irrigated. Sandy soil at the site allows the water to drain rapidly after irrigation, and the site was dry on all survey visits.

We detected one willow flycatcher on 15–23 May and another on 3 June. A third flycatcher was caught in a mist net at Reclamation's MAPS station on 15 May; this flycatcher was later confirmed to be the breeding male in The Wallows. We surveyed this site five times, totaling 9.3 observer-hours. Cowbirds were detected on four surveys.

Lost Slough

Area: 1.5 ha Elevation: 140 m

Lost Slough is located approximately 4 km south of Glory Hole and Hell Bird. This mixed-exotic site runs northeast to southwest for approximately 250 m, and measures 100 m wide at the broadest point. There is a marshy area in the center of the site; a small area of bulrush is present in the marsh, along with stands of coyote willow 6 m in height. Vegetation around the marsh is composed mainly of 6- to 8-m-tall tamarisk with a few emergent Goodding willow and scattered screwbean mesquite (*Prosopis pubescens*). Arrowweed up to 2 m in height makes up the understory vegetation. Canopy closure at the site is variable, with open areas toward the edges of the site and over 70% closure in areas with thick vegetation. Hydrologic conditions at the site were not assessed in May. In mid-June, the marshy area was inundated, and by mid-July small pools remained in the marsh.

We did not detect any willow flycatchers. We surveyed Lost Slough five times, totaling 5.0 observer-hours. Cowbirds were detected during one survey.

Lost Pond

Area: 1.2 ha Elevation: 140 m

This mixed-exotic site is located approximately 700 m southeast of Lost Slough. The site is approximately 200 m long and 125 m wide, with a small pond at the southern edge of the site and a marshy area at the northern end of the site. The edges of the pond are vegetated with a 30-m-wide border of cattail, bulrush, and sedges. Vegetation within the site consists primarily of tamarisk 4 to 7 m in height with canopy closure approximately 90%. The area surrounding the site consists of arrowweed, 3-m-tall tamarisk, and screwbean mesquite. In May, 75% of the site was inundated, but by mid-June water remained only in the pond and marshy areas adjacent to the site.

No willow flycatchers were detected. We surveyed the site five times, totaling 6.3 observer-hours. Cowbirds were detected during one survey.

Lost Lake

Area: 3.3 ha Elevation: 140 m

This site lies approximately 850 m southeast of Lost Pond. It is 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. In previous years, the southeastern end of the site was dominated by dense stands of coyote willow. These willows are now all dead, dramatically reducing the suitability of the site for breeding flycatchers. Overall canopy closure is approximately 80%. The only surface water or saturated soil at Lost Lake was immediately adjacent to the marsh on the northern edge of the site; the interior of the site was dry throughout the survey season.

We detected one willow flycatcher on 29 May. The flycatcher responded to broadcasts but did not vocalize spontaneously. The flycatcher was not detected on three subsequent territory monitoring visits or any of the four subsequent surveys. We surveyed the site five times, totaling 4.5 observer-hours. Cowbirds were detected on four visits.

Ground Reconnaissance Results

NW BEAL LAKE

We explored this area, approximately 600 m northwest of the Beal Lake site, in 2006 after noting a large area of inundated vegetation during aerial reconnaissance. In 2006, vegetation in the area consisted primarily of tamarisk 2–3 m in height with some areas reaching 4 m in height. We returned to this area in 2009 to assess whether vegetation had matured. In 2009, the area was vegetated by tamarisk 3–5 m in height, scattered screwbean mesquite 5–7 m in height, and an understory of arrowweed. Canopy closure was continuous only in low-lying swales; elsewhere, the canopy was broken by open, dry areas in the northwestern portion of the reconnaissance site and by marshes to the southeast. The tamarisk had not grown to a size typical of flycatcher breeding habitat along the LCR. We visited the site once in 2009 for a total of 2.0 observer-hours.

NE LOST LAKE

We explored and surveyed the northern and eastern borders of Lost Lake. Woody vegetation consists entirely of a strip of tamarisk 4 m in height with >90% canopy closure. This strip of tamarisk is 600 m long and generally <50 m wide and is bordered to the west by the cattail marsh on the edge of Lost Lake and to the east by dry uplands vegetated by arrowweed and scattered mesquite. Water from Lost Lake extended into the tamarisk during the site visit in May, but by mid-June surface water was restricted to the cattails and did not extend under the woody vegetation. This site does not have the canopy height typical of occupied flycatcher habitat along the LCR. We surveyed the site four times, for a total of 9.0 observer-hours. No flycatchers were detected. Cowbirds were detected on all visits.

LOST LAKE SOUTH

We explored the area between the southern end of NE Lost Lake and the western tip of the Lost Lake polygon. We had noted this area as being inundated during aerial reconnaissance in March 2009. Vegetation consists of a mosaic of cattail marshes in low-lying areas and a mix of screwbean mesquite, arrowweed, and bulrush in higher areas. Overall canopy closure is <25%, and the vegetation does not resemble that found in occupied flycatcher habitat.

LOST LAKE SLOUGH #1

During aerial reconnaissance in March 2009, we noted several patches of vegetation between the South Dike and New South Dike roads. Lost Lake Slough #1 consists of a 25- x 50-m patch of tamarisk, 4 m in height, 100 m south of the bridge on South Dike Road. The site is surrounded by marsh, but hydrologic conditions within the site were not assessed. Vegetation at the site is too short to resemble typical occupied flycatcher habitat along the LCR. We surveyed the site twice, for a total of 0.5 observer-hour. No flycatchers were detected.

LOST LAKE SLOUGH #2

This native site is approximately 200 m south-southeast of Lost Lake Slough #1. It consists of a 100- x 50-m patch of coyote willow 4 m in height. Canopy closure within the site is around 80%, and the site is surrounded by open marsh. The site was completely inundated in May and had saturated soil in mid-June. Vegetation at the site is currently shorter than that typically found in occupied flycatcher habitat along the LCR, but the site should be monitored in future years to determine if the willows continue to grow or expand to a greater area. We surveyed the site twice, for a total of 1.5 observer-hours. We did not detect any flycatchers and did not detect any other terrestrial birds.

LOST LAKE SLOUGH #3

This mixed-native site is between Lost Lake Slough #2 and New South Dike Road. The site is bordered to the north by marsh and to the south by dry uplands adjacent to the road. Vegetation within the site is a mix of coyote willow and tamarisk, both around 4 m in height. Canopy closure is around 65% at the eastern edge of the site and decreases toward the west. Approximately half the site was inundated in May, but only the edge adjacent to the marsh had standing water in mid-June. This site does not currently have the canopy height or canopy closure typical of occupied flycatcher habitat along the LCR but should be monitored for changes in vegetation in future years. We surveyed the site twice, for a total of 1.0 observer-hour.

LOST LAKE SLOUGH #4

This mixed-native site is approximately 100 m west of Lost Lake Slough #3 and lies between marsh to the north and dry uplands to the south. Vegetation at the site grades from a mix of coyote willow and bulrush on the northern border to coyote willow in the middle of the site and tamarisk on the upland edge of the site. Canopy height in the willows is 3 m while the tamarisk reaches 4 m. Canopy closure is around 90%. This site does not currently have the canopy height typical of occupied flycatcher habitat along the LCR but should be monitored for changes in vegetation in future years. We surveyed the site twice, for a total of 2.0 observer-hours.

MARINA

This site is immediately north of the Topock Gorge Marina and extends for approximately 500 m north, between marsh to the east and dry uplands to the west. The site is less than 50 m wide and grades from a mix of coyote willow and arrowweed along the eastern border to a mix of tamarisk, arrowweed, and screwbean mesquite on the western edge. Canopy height ranges from 3 m in the willows to 4–6 m in the tamarisk, and canopy closure is highly variable, averaging around 60%. Surface water was present only along the eastern edge of the site and did not extend more than a few meters under the woody vegetation. This site does not have the canopy closure typical of occupied flycatcher habitat along the LCR. We surveyed the site three times, totaling 7.3 observer-hours.

Topock Gorge, Arizona and California

Between Topock Marsh and Lake Havasu, the Colorado River winds through Topock Gorge. Throughout the Gorge, the river is confined between steep cliffs and high bluffs, and little vegetation grows along the river. We surveyed backwater areas that support marsh and riparian vegetation.

Pulpit Rock

Area: 2.1 ha Elevation: 140 m

This mixed-exotic site lies where an unnamed wash enters the Colorado River from the Mohave Mountains. The northwestern edge of the site is vegetated by cattails and borders a backwater, and the upland edge is vegetated by arrowweed, honey mesquite (*Prosopis glandulosa*), and ironwood (*Olneya tesota*). Vegetation within the site consists primarily of tamarisk up to 5 m in height, with small patches of coyote willow near the marsh edge. Canopy closure is around 80% near the marsh but only 30% at the upland edges of the site. Hydrologic conditions at the marsh interface were not assessed, but the majority of site appeared to by dry.

No willow flycatchers were detected. We surveyed the site five times, for a total of 2.5 observer-hours. Cowbirds were detected on one survey, and we observed burro tracks and trails around the site. One migrant willow flycatcher has been detected at this site since we began surveying it in 2003. The small size of the site, its isolation from other riparian habitat, and its predominantly dry soils make this site unlikely to support resident flycatchers. We recommend discontinuing surveys at this site.

Picture Rock

Area: 4.6 ha Elevation: 138 m

This mixed-exotic site consists of two patches of riparian vegetation where an unnamed wash enters the Colorado River from the west. Vegetation within the site consists primarily of tamarisk 5–6 m in height, scattered Goodding willow 12 m in height, and one small patch of coyote willow. Bulrush and cattail are present on the edge of the site along the river, and the upland edges of the site contain arrowweed, mesquite, and paloverde (*Parkinsonia* sp.). Canopy closure within the tamarisk is 70–90%. During surveys, surface water was confined to the edge of the site adjacent to the marsh and did not extend under the woody vegetation.

No willow flycatchers were detected. We surveyed the site five times, for a total of 7.3 observer-hours. Cowbirds were detected on two surveys, and burro tracks and trails were observed around the site.

Blankenship Bend North

Area: 26.7 ha Elevation: 138 m

Blankenship Bend contains riparian and marsh vegetation along the eastern bank of the Colorado River adjacent to the Blankenship Valley. The eastern edge of Blankenship Bend North consists of a 100-m-wide strip of vegetation that grades from mesquite 7 m in height at the upland edge to tamarisk and then to a narrow strip of coyote willow 5 m in height. The coyote willow borders a bulrush marsh, and the western edge of the marsh is also vegetated by a narrow (5–10-m-wide) strip of coyote willow as well as several emergent Goodding willow 12 m in height. The remainder of Blankenship Bend North extends for another 400 m to the west until it reaches the open water of the Colorado River. This portion of the site consists of a mosaic of marshes, tamarisk, coyote willow, arrowweed, and mesquite. Vegetation height generally does not exceed 5 m, and canopy closure within the woody vegetation varies between 60 and 80%.

We detected no flycatchers at Blankenship Bend North. We surveyed the site five times, totaling 18.3 observer-hours. We detected cowbirds on all surveys, and evidence of feral pigs and burros was observed.

Blankenship Bend South

Area: 25.9 ha Elevation: 138 m

The eastern edge of Blankenship Bend South consists of a 100-m-wide strip of tamarisk up to 6 m in height with clumps of emergent Goodding willow up to 12 m in height. This strip of vegetation is bordered to the east by dry, upland vegetation and to the west by bulrush marsh and open water. Between this strip of vegetation and the river, approximately 600 m to the west, the site consists primarily of bulrush marsh with widely scattered clumps of tamarisk up to 5 m in height. Canopy closure is approximately 80% in the eastern portion of the site and less than 50% in the remainder of the site. Because woody vegetation in the western portion of the site is widely scattered, we recommend

discontinuing surveys in this portion of the site in future years. The site contained standing water throughout the survey season, with up to 80% of the site inundated.

We detected no flycatchers at Blankenship Bend South. We surveyed the site five times, totaling 14.3 observer-hours. We detected cowbirds on all surveys but did not observe signs of livestock.

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.

In addition to the regularly scheduled surveys, we revisited one site located in previous years that was determined to be potentially suitable flycatcher habitat. Results of this habitat evaluation are presented following the survey results.

Burn Edge

Area: 3.7 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. The entire marshy area was inundated in May to a depth up to 40 cm. Intermittent pools were present in mid-June, and by late July only two puddles remained.

No willow flycatchers were detected at Burn Edge. We surveyed the site five times, totaling 5.8 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: 9.5 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 in May, but these had dried to damp soil by July. The marshes in Site #3 were dry by July, and the only surface water remaining in Mosquito Flats was in the northwestern corner of Site #4 in a deep backwater channel.

We detected two resident, male flycatchers in Site #4 and detected two additional flycatchers for which residency was not confirmed. One of these was observed on 16–18 June in one of the occupied territories

and was suspected to be a female, though it was not observed on any of five subsequent territory monitoring visits. Eight breeding flycatchers were detected in Site #3. Portions of the sites not known to be occupied by flycatchers were visited five times, totaling 14.3 observer-hours at Site #4 and 7.3 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. The bottom of the channel is 1–2 m below the surrounding ground surface. Canopy closure varies from 50% in the channel to 80–90% in the surrounding tamarisk. The channel contained intermittent pools in May. One pool remained in mid-June, and by mid-July no surface water was present.

No willow flycatchers were detected at Last Gasp. We surveyed the site five times, totaling 7.0 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. The survey site was expanded in 2008 approximately 350 m upstream, and in 2009 we ceased surveying the most downstream 250 m of the site. The discontinued area consists of deep pools surrounded by completely dry, patchy tamarisk 4 m in height and does not resemble occupied flycatcher habitat. 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. Soils in the majority of the site were dry, although a couple of small ponds and marshy areas along the cliff on the northeastern edge of the site contained water through July.

We detected one unpaired, male flycatcher in Site #5. Portions of the site not known to be occupied were surveyed five times, totaling 10.0 observer-hours. Cowbirds were detected on four surveys.

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 northern edge of the site borders a cattail marsh. Canopy cover is variable and ranges from 50 to 80%. The central portion of the site was inundated throughout the breeding season.

We detected two breeding flycatchers. Portions of the site not known to be occupied were surveyed five times, totaling 4.0 observer-hours. Cowbirds were detected on three visits.

Planet Ranch Road

Area: 2.1 ha Elevation: 170 m

This mixed-native site follows the Bill Williams River at the southern edge of the riparian area. The northern bank of the river is steep and is vegetated by tamarisk and arrowweed perched well above the level of the river. The southern bank is more gradual, and beaver activity along the river has resulted in flooding on this bank. Vegetation on this side of the river consists of an overstory of Goodding willow and cottonwood up to 15 m in height and an understory of tamarisk 5 m in height. Overall canopy closure in this portion of the site is 70–90%. The river and the willow stand on the southern bank had surface water throughout the survey season.

No flycatchers were detected. We surveyed the site five times, totaling 5.8 observer-hours. We detected cowbirds on all surveys.

Ground Reconnaissance Results

PLANET RANCH

This site starts 200 m east of Upstream from Site #8, and extends 400 m east of the starting point. We visited this site in 2007 and 2008 and noted that the central portion of it had vegetation structure resembling that of occupied flycatcher habitat but that surface water was generally lacking. We revisited the site in late May and early July 2009 to determine whether hydrologic conditions had changed. Surface water was present in small pools along approximately 25 m of a stream channel near the north edge of the site, which borders a cattail marsh. Overall, <1% of the site contained surface water. We surveyed the site twice, totaling 2.8 observer-hours.

Ahakhav Tribal Preserve, Arizona

The Ahakhav Tribal Preserve encompasses backwater areas along the Colorado River near Parker, Arizona, and includes restoration sites. We surveyed a portion of Deer Island.

Deer Island

Area: 15.2 ha Elevation: 104 m

This site consists of a narrow strip of mixed-native vegetation on the edge of a long backwater slough. The only dense, woody vegetation occurs in a strip approximately 5 m wide on the edge of the slough and consists of tamarisk and screwbean mesquite up to 6 m in height and an understory of arrowweed. More than 5 m from the water, vegetation is primarily arrowweed with widely scattered tamarisk and mesquite. Canopy closure is <50%. The southern side of the slough has a steep, high bank, and woody vegetation is perched several meters above the water level. The north bank is not as high, with woody vegetation approximately 1 m above the water level. Although extensive areas of inundated soils existed in the slough and the adjacent cattails, water did not extend into the woody vegetation at any time during the survey season. The majority of the site burned between 2 and 8 July, and surveys were discontinued.

We detected no willow flycatchers. We surveyed the site four times, totaling 4.0 observer-hours. Cowbirds were detected on all visits. No evidence of livestock use was observed.

Palo Verde Ecological Reserve, California

PVER Phase 2

Area: 28.7 ha Elevation: 85 m

This habitat creation site is vegetated with a mosaic of cottonwood, Goodding willow, and coyote willow, which reach heights of 8, 7, and 4 m, respectively. Height and density of the vegetation varies within as well as between cells of the site. Canopy closure is highly variable, ranging from <25 to 80%. The entire site has a ground covering of alfalfa (*Medicado sativa*). The site is flood irrigated but did not contain surface water during any of our site description visits. The irrigation canal adjacent to the site contained water throughout the season.

We detected one willow flycatcher on 27 May and one on 3 June. We surveyed the site five times, totaling 15.0 observer-hours. Large numbers of cowbirds were detected on all visits, and no evidence of livestock use was recorded.

Big Hole Slough, California

Big Hole Slough

Area: 29.0 ha Elevation: 82 m

This mixed-native site consists of cattail marshes edged with narrow bands of coyote willow 5 m in height. In upland areas away from the marshes, the site contains tamarisk and honey and screwbean mesquite up to 8 m in height with an understory of arrowweed. A few tall Goodding willow and cottonwood are present at the site. Overall canopy closure is approximately 50%. The site is surrounded by agricultural fields. The marsh contained standing water throughout the survey season.

We detected one willow flycatcher on 17 June. The site was surveyed five times, totaling 17.0 observer-hours. Cowbirds were detected on all visits, often in large flocks. No livestock use was observed.

Cibola National Wildlife Refuge, 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 9 m in height, and canopy closure in the densest areas is 80–90%. Coyote willow reaches 3–5 m in height. The site is flood irrigated but did not contain standing water during any of our site description visits. The Colorado River is about 100 m from the northern edge of the site, and the remaining three sides are surrounded by agriculture. The irrigation canal adjacent to the site held surface water throughout the season.

We detected one willow flycatcher on 27 May. The site was surveyed five times, totaling 17.0 observer-hours. Large flocks of cowbirds were detected on all visits, and no evidence of livestock use was observed.

CVCA Phase 3

Area: 41.2 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. The tallest cottonwoods reach 7–8 m, Goodding willow reach 6 m, and coyote willow reach 3 m. Canopy closure varies from 20 to 80%. The site is flood irrigated but did not contain standing water during any of our site description visits. The site is surrounded by agricultural fields. The irrigation canal adjacent to the site held water throughout the season.

We detected one willow flycatcher on 16 May, one on 27 May, and two on 10 June. The site was surveyed five times, totaling 15.8 observer-hours. Large flocks of 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 up to 5 m in height with a thick understory of seep willow. 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 and contained varying amounts of surface water through the season.

We detected one willow flycatcher on 16 May, two on 27 May, and one on 10 June. The site was surveyed five times, totaling 4.6 observer-hours. 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. The site runs north to south, extending approximately 500 m lengthwise, with a width of 100 m. Dirt roads border the site to the north, east, and west. Open farm fields lie across the eastern road, with irrigation channels alongside the road. 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 inundated with up to 50 cm of water in May, but in June and July the marsh contained only small pools.

We detected four willow flycatchers on 26 May and three on 4 June. The site was surveyed five times, totaling 5.1 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%. No surface water was present within the sites during the survey season.

We detected one willow flycatcher on 9 June at Cibola Site #1. We surveyed each site five times, totaling 7.1 hours at Cibola Site #2 and 5.3 hours at Cibola Site #1. Numerous cowbirds were detected on all surveys, and burros were observed using the periphery of the sites.

Hart Mine Marsh

Area: 31.6 ha Elevation: 65 m

This mixed-exotic site parallels the channelized Colorado River immediately south of Cibola Site #1. The site consists of a mix of tamarisk and linear stretches of marsh, which make up about 30% of the site. Height of the tamarisk does not exceed approximately 5 m, and reaches this height only within 20 m of the marshes. Away from the marshes, the tamarisk is 3 m in height and partially dead. Canopy closure within the densest tamarisk is 80–90%. An open channel had been dredged down the middle of the northern third of the site. The marshes contained standing water throughout the survey season, but water did not extend under the woody vegetation. The site lacks the height and extent of woody vegetation typical of occupied flycatcher habitat along the LCR, and surveys were discontinued in July.

No willow flycatchers were detected. We surveyed the site four times, for total of 7.8 observer-hours. Cowbirds were detected on all surveys, and burros were observed on the periphery of the site.

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 4 June. We surveyed the site five times, totaling 6.3 observer-hours. Cowbirds were detected on all visits, and burro sign was observed 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. Areas of the site adjacent to Walker Lake had saturated soils in May, though these soils were only damp in June and July. Soils in the interior of the site were dry throughout the survey season.

We detected no willow flycatchers. The site was visited five times, totaling 11.4 observer-hours. Cowbirds were detected on all surveys, and no evidence of livestock use was observed.

Imperial National Wildlife Refuge, 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 narrow (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 one willow flycatcher on 20 May. The site was surveyed five times, totaling 6.8 observer-hours. Cowbirds were detected on every visit, and burros were noted near the site.

Hoge Ranch

Area: 20.7 ha Elevation: 61 m

This mixed-exotic site 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 contained small pools of water in July. The site also borders the Colorado River.

We detected three willow flycatchers on 20 May and one on 15 June. The site was surveyed five times, totaling 9.7 observer-hours. Cowbirds were detected on four surveys, and there was evidence of burros using 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. Canopy closure is 70–90%. Extensive cattail marshes separate this site from the Colorado River. The interior of the site contained no standing water during the survey season.

We detected one willow flycatcher on 19 May. The site was surveyed five times, totaling 6.1 observer-hours. Cowbirds were detected on all surveys, and there was no evidence of livestock use.

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.

No willow flycatchers were detected. We surveyed the site five times for a total of 2.9 observer-hours. Cowbirds were detected on all 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 the adjacent marsh in May and June.

We detected one willow flycatcher on 16 June. The site was surveyed five times, totaling 4.4 observer-hours. Cowbirds were detected on all 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 northwestern corner of the site up to 50 m from the lakeshore had damp soils in May and standing water in June and July.

We detected three willow flycatchers on 21 May and two on 16 June. The site was surveyed five times, totaling 16.8 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%. The site and the adjacent marsh were dry in

May and June. Pools of water within the woody vegetation were noted in July after thunderstorms the previous night.

We detected one willow flycatcher on 28 May and one on 12 June. The site was surveyed five times, totaling 19.4 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was observed.

Powerline

Area: 2.0 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 <50%. Tamarisk and arrowweed are present in the understory, and honey mesquite is mixed with the tamarisk on the upland edge of the site. Small pools of water were present within the marsh in May and July, but the marsh was dry in June.

We detected one willow flycatcher on 28 May. We surveyed the site five times, totaling 6.3 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. No surface water was recording within the site at any time during the survey season, and the marsh edge adjacent to the site was also dry.

No willow flycatchers were detected. We surveyed the site five times, totaling 6.0 observer-hours. Cowbirds were detected on all visits, and burro tracks and scat were observed at the site.

Ground Reconnaissance Results

IMPERIAL BURN

This area is between Nursery NW and the uplands to the northeast. A prescribed burn is being considered for this area, and Reclamation requested that we evaluate it. We visited the area on 30 May. It consists of a mosaic of tamarisk and marshy openings. Scattered mesquite trees emerge 1–3 m above the tamarisk, and the area also contains a few widely scattered Goodding willow, which also emerge a few meters above the tamarisk. Surface water did not appear to extend beyond the borders of the marshes. Canopy height and density were not recorded during the site visit, and it is difficult to determine the suitability of the site for willow flycatchers from the limited data available.

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. Canopy closure is approximately 80%. Honey and screwbean mesquite are scattered throughout the site but are more common near the periphery. Surface water was present in the site during May, but the site was dry in June and July and a small patch of cattails within the site was noted in June as being primarily dead.

We detected two willow flycatchers on 11 June. The site was visited five times, totaling 7.9 observer-hours. Cowbirds were detected during all surveys, and no evidence of livestock use was observed.

Ground Reconnaissance Results

LAGUNA DAM NORTH

We investigated this area, northwest of Mittry West between Imperial Road and the All American Canal, after receiving reports of willow flycatcher detections from personnel from an unrelated project. Vegetation in the area consists of a mix of honey mesquite up to 8 m in height and tamarisk 4 m in height. Scattered Goodding willow up to 6 m in height is also present. Canopy closure is 50–70%. Soils within the site were completely dry at the end of May. The site does not have the vegetation density or mesic conditions typical of occupied flycatcher habitat, and we discontinued surveys after three visits.
We detected one willow flycatcher on 29 May and one on 11 June. No flycatchers were detected on 26 June.

Yuma, Arizona

Gila River Site #2

Area: 5.1 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 70–90%. 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 three willow flycatchers on 30 May and one on 14 June. The site was surveyed five times, totaling 8.2 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was observed.

Fortuna Site #1

Area: 5.1 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. Surface water was recorded in the lowest portion of the site in May, but the entire site was dry in June and July.

We detected two willow flycatchers on 31 May. We surveyed the site five times, totaling 5.3 observer-hours. Large numbers of cowbirds were detected on all visits, and no evidence of livestock use was observed.

Fortuna North

Area: 3.4 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%. The western edge of the site borders the Gila River. No surface water was noted within the site during the survey season.

We detected no willow flycatchers at this site. We surveyed the site five times, totaling 6.3 observer-hours. Large numbers of cowbirds were detected on all visits, and no evidence of livestock use was observed.

DISCUSSION

Six areas occupied in 2009 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. 2008, McLeod and Koronkiewicz 2009; details of residency and breeding in 2009 are presented in Chapters 3 and 4 of this document). In 2009, breeding flycatchers were recorded along Beaver Dam Wash at Littlefield (Littlefield Poles) for the first time since 2004. We detected breeding flycatchers for the first time at Bunker Marsh North on the Virgin River. SWCA personnel from an unrelated flycatcher survey project detected no flycatchers at Bunker Marsh North in 2004, and we did not detect flycatchers at the site during habitat reconnaissance and opportunistic surveys in 2006. Bunker Marsh North was surveyed in 2009 based on findings of aerial reconnaissance prior to the survey season when we noted areas of inundated vegetation. Along the Bill Williams River, breeding flycatchers were detected at a new breeding site, Upstream from Site #8. We did not detect flycatchers at Upstream from Site #8 during habitat reconnaissance and opportunistic surveys in 2007 and 2008.

Factors in addition to the presence of standing water during the breeding season appear to be influencing the presence and numbers of breeding flycatchers at Topock Marsh. The amount of standing water throughout the entire Topock study area was markedly reduced in 2005 compared to 2003–2004 and 2006–2008. In 2009, water levels at Topock were as high during flycatcher settlement in May and early June as they had been in previous wet years, but sites dried out earlier in the season than in previous years. The number of flycatchers recorded at Topock since 2003 does not appear to be related solely to

the amount of standing water present during the breeding season, with 25, 67, 41, 37, 31, 30, and 28 adults recorded in 2003–2009, respectively. Factors such as reproductive rates, survival, changes in breeding habitat (see Chapter 5), or other abiotic conditions may be influencing the demographics of this local population. Hydrologic conditions within the sites at Topock prior to mid-May of each year are largely unknown and may influence habitat conditions and flycatcher occupancy. Marsh elevation data obtained for 2006 to 2009 suggest no interannual changes in the amount of water present in the vegetation prior to flycatcher arrival in those years. Marsh elevation data for years prior to 2006 are not available.

In an effort to locate all potentially suitable willow flycatcher habitat at Topock Marsh, we conducted habitat reconnaissance and opportunistic surveys at eight sites. Of the eight sites, one was visited in 2006 and seven were noted as containing areas of inundated vegetation during aerial reconnaissance in 2009. Three of the eight sites currently do not have the vegetation structure typical of occupied flycatcher habitat along the LCR but should be monitored for changes in vegetation in future years. Five of the areas we visited are unlikely to support flycatchers in future years, as it is unlikely that habitat conditions will improve.

Although 40 flycatchers were recorded at sites surveyed south of the Bill Williams on or before 15 June, and four detections were recorded post 15 June, 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 2003–2008 (McLeod et al. 2008, McLeod and Koronkiewicz 2009).

In 2008, we implemented a biennial survey schedule at selected sites. At this time, we are not recommending the addition of any sites to the biennial schedule for 2010.

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 seventh 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 opportunistic banding at Key Pittman Wildlife Management Area in Nevada (in cooperation with Nevada Division of Wildlife) and 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 replication of color combinations. For each color-banded bird recaptured, we visually inspected the legs and noted any evidence of irritation or injury that may be related to the presence of leg bands.

Nestlings were banded at 8 to 10 days of age, when they were large enough to retain the leg bands, yet young enough that they would not prematurely fledge from the nest (Whitfield 1990, Paxton et al. 1997). Nestlings were banded only when the location of the nest was such that nest access and removal/replacement of the nestlings would not endanger the nest, nest plant, or nestlings. Nestlings were 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., one 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 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. Flycatchers were determined to be unpaired if none of the following breeding behaviors were observed: presence of another unchallenged flycatcher in the immediate vicinity, counter calling (*whitts*) with a nearby flycatcher, interaction twitter calls (*churr/kitters*) with a nearby flycatcher, a flycatcher in the immediate vicinity carrying nesting material, a flycatcher in the immediate vicinity carrying food or fecal sac, or adult flycatchers feeding young (per Sogge et al. 1997).

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

RESULTS

All Monitoring Sites

Color-Banding and Resighting – Field personnel color-banded 17 new adult flycatchers and recaptured 8 individuals previously captured as adults. An additional 55 adults were identified to individual via resighting, while 10 individuals were resighted but did not have their color combinations confirmed.

One adult had federal band on one leg and an injury on the other leg, and one adult had a duplicate color-band combination. We detected eight individuals identified as returning nestlings by the presence of a single federal band, with three (38%) identified to individual via recapture. Thirty-one adult flycatchers remained unbanded, and banding status was undetermined (i.e., we were unable to determine if these individuals were banded) for 19 adults. Overall, 67% 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 44 nestlings from 21 nests. Of the 44 nestlings banded, 5 were known or suspected to have died before fledging. For details on all banded flycatchers detected at the study areas from 2003 to 2009, see Appendix D.

Site-by-Site Color-Banding and Resighting

Monitoring Sites

Pahranagat – We detected 21 resident, adult willow flycatchers from 12 territories at Pahranagat. In addition to resident adults, we detected three individuals for which residency and/or breeding status could not be confirmed (Table 3.2). Of the 12 territories recorded at Pahranagat, 10 consisted of breeding pairs and 2 consisted of unpaired males. Of the breeding individuals, one male was polygynous with two females, and one female mated consecutively with two males.

Field personnel captured and color-banded five new adults and recaptured six flycatchers previously captured as an adult. We resighted and confirmed band combinations for an additional 11 adults. Of the resighted adults, one was originally banded as a nestling in 2008 (see Table 3.6 for juvenile dispersal data). The presence of bands could not be determined for two adults. We banded 11 nestlings from five nests, and 2 of these nestlings were recaptured as fledglings. We resighted 13 unbanded fledglings from four additional nests.

Littlefield – We detected four resident, adult willow flycatchers from three territories at Littlefield. In addition to resident adults, we detected one individual for which residency and/or breeding status could not be confirmed (Table 3.2). Of the three territories, two consisted of breeding pairs and one consisted of an unpaired male. Of the breeding individuals, one male was polygynous with two females.

Field personnel captured and color-banded one new adult. We resighted and confirmed band combinations for an additional adult, which was originally banded as a nestling in 2008 (see Table 3.6). One resident adult remained unbanded, and band status could not be determined for another. Band status also could not be determined for the individual for which residency and/or breeding status could not be confirmed.

Mesquite – We detected 25 resident, adult willow flycatchers from 15 territories at Mesquite. In addition to resident adults, we detected three individuals for which residency and/or breeding status could not be determined. Of the 15 territories recorded at Mesquite, 12 consisted of paired individuals and 3 consisted of unpaired males (Table 3.2). Of the breeding individuals, two males were polygynous with two females and one female mated consecutively with two males.

Field personnel recaptured two flycatchers previously captured as adults. We confirmed the identities of an additional 14 adults via resighting. One additional adult had a federal band on one leg and an injury on the opposite leg, and another adult had a duplicate color combination. Of the resighted adults, three were originally banded as nestlings in 2008 (see Table 3.6). Eight adults remained unbanded, and three adults were banded but band combinations could not be confirmed. We banded four nestlings from four nests.

Mormon Mesa – We detected 27 resident, adult willow flycatchers from 17 territories at Mormon Mesa. In addition to resident adults, we detected six individuals for which residency could not be confirmed (Table 3.2). Of the 17 territories recorded at Mormon Mesa, 13 consisted of breeding individuals and 4 consisted of unpaired males. Of the breeding individuals, three males were each polygynous with two females.

Field personnel captured and color-banded two new adults. We resighted and identified 21 additional returning adults; of these, five were banded as nestlings in 2008 (see Table 3.6). We captured one returning nestling originally banded as a juvenile in 2007 and resighted one additional returning nestling with a single federal band that we were unable to recapture. Four adults remained unbanded, and band combinations could not be confirmed for four adults. We banded 22 nestlings from nine nests. Three of these nestlings were known to have died before fledging. We 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 four individuals for which residency could not be confirmed. Of the eight territories recorded, six consisted of breeding individuals and two consisted of unpaired males (Table 3.2). Of the resident individuals, one female mated consecutively with two males, both of which were consecutively mated with two females.

Field personnel captured and color-banded two new adults. We resighted and identified four other adults, three of which were banded as nestlings in 2008 (see Table 3.6). We resighted one adult for which the band combination could not be confirmed. We resighted two returning nestlings with single federal bands but could not capture these individuals to determine year and study area of origin. Seven adults remained unbanded, and band status could not be determined for one individual. We banded one nestling, which died before fledging.

Topock – We detected 14 resident, adult willow flycatchers from 13 territories at Topock. In addition to resident adults, we detected 14 individuals for which residency and/or breeding status could not be confirmed (Table 3.2). Of the 13 territories recorded at Topock, 1 consisted of paired individuals, 8 consisted of unpaired males, and 1 contained an individual for which gender could not be determined. In each of the remaining three territories, a singing male was detected throughout the breeding season and an unchallenged flycatcher, suspected to be a female, was detected for only a few days in June.

Field personnel captured and color-banded one new adult and resighted and identified two other banded adults. We captured two returning nestlings originally banded in 2007 (see Table 3.6) and resighted but were unable to recapture two additional returning nestlings with single federal bands. Seven adults remained unbanded, and the band status of 12 individuals could not be determined. The color combinations of two banded adults could not be confirmed. We banded three nestlings from one nest.

Table 3.1. Summary of Willow Flycatchers Detected at Monitored Sites during the 2009 Breeding Season*

Study Area	Site	Adults									Nestlings Banded (# nests)	Fledglings Captured	% of All Adults Banded
		Total Adults Detected	New Captured	Recaptured		Resighted							
				Previously Captured as Adults	Returning Nestlings	Color combination confirmed		Unbanded	Band Status Undetermined	Banded (color combinations unconfirmed)			
						Individual Identified	Individual Not Identified						
Pahranagat	North	23	5	6	0	11	0	0	1	0	11(5)	2[1]	**96**
	South	1	0	0	0	0	0	0	1	0	0	0	**0**
	Study Area Total	**24**	**5**	**6**	**0**	**11**	**0**	**0**	**2**	**0**	**11(5)**	**2**	**92**
Littlefield	Poles	5	1	0	0	1	0	1	2	0	0	0	40
	Study Area Total	**5**	**1**	**0**	**0**	**1**	**0**	**1**	**2**	**0**	**0**	**0**	**40**
Mesquite	West	21	0	2	0	10	2[2]	5	0	2	4(4)	0	73
	Bunker Marsh North	7	0	0	0	3	0	3	0	1	0	0	57
	Study Area Total	**28**	**0**	**2**	**0**	**13**	**2**	**8**	**0**	**3**	**4(4)**	**0**	**71**
Mormon Mesa	Virgin River #1 (North)	4	1	0	0	1	0	1	0	1	0	0	75
	Virgin River #1 (South)	28	1	0	1	20	1[3]	3	0	2	22(9)	0	89
	Virgin River #2	1	0	0	0	0	0	0	0	1	0	0	0
	Study Area Total	**33**	**2**	**0**	**1**	**21**	**1**	**4**	**0**	**4**	**22(9)**	**0**	**89**
Muddy River	Overton WMA	17	2	0	0	4	2[3]	7	1	1	1(1)	0	53
	Study Area Total	**17**	**2**	**0**	**0**	**4**	**2**	**7**	**1**	**1**	**1(1)**	**0**	**53**
Topock	Pipes #1	1	0	0	0	0	0	0	1	0	0	0	0
	Pipes #3	2	0	0	0	0	1[3]	0	1	0	0	0	0
	The Wallows	3	0	0	1	0	0	1	1	0	3(1)	0	33
	PC6-1	1	0	0	0	0	0	1	0	0	0	0	0
	800M	1	0	0	0	0	0	1	0	0	0	0	0
	Pierced Egg	5	0	0	0	1	1[3]	0	2	1	0	0	60
	250M	3	0	0	0	0	0	0	3	0	0	0	0
	Hell Bird	2	0	0	0	0	0	1	1	0	0	0	0
	Glory Hole	7	1	0	1	1	0	2	1	1	0	0	57
	Beal Lake	2	0	0	0	0	0	0	2	0	0	0	0
	Lost Lake	1	0	0	0	0	0	1	0	0	0	0	0
	Study Area Total	**28**	**1**	**0**	**2**	**2**	**2**	**7**	**12**	**2**	**3(1)**	**0**	**32**
Bill Williams	Site #4	4	1	0	0	0	0	1	2	0	0	0	25
	Site #3	8	2	0	0	3	0	3	0	0	3(1)	0	63
	Site #5	1	1	0	0	0	0	0	0	0	0	0	100
	Upstream from Site #8	2	2	0	0	0	0	0	0	0	0	0	100
	Study Area Total	**15**	**6**	**0**	**0**	**3**	**0**	**4**	**2**	**0**	**3(1)**	**0**	**60**
Total		**150**	**17**	**8**	**3**	**55**	**7**	**31**	**19**	**10**	**44(21)**	**2**	**67**

* 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] Both individuals banded as nestlings and recaptured as fledglings.

[2] One individual had silver federal band only and had a visible injury on the unbanded left leg; a male with silver federal band number 2390-92434 and a visible injury on the unbanded left leg was captured at Mesquite in 2005, and this is likely the same individual. Other individual had a duplicate color combination.

[3] Returning nestling(s).

Table 3.2. Willow Flycatchers Detected at All Monitored Study Areas with Resident Flycatchers, 2009

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	1-Jul-06	2370-40047	PU:DD(M)	N/A	A5Y	F	1	RS
	North	6-Jul-05	236059711	KB(M):EE	N/A	5Y	M	1	RS
	North	3-Aug-09	2430-61271	XX:WD(M)	N/A	L	U	1	N
	North	30-Jun-05	2320-31698	RB(M):EE	N/A	5Y	F	3	RS
	North	19-Jul-08	2430-61080	YY(M):XX	N/A	3Y	M	3, 17	RS
	North	14-Jul-09	2370-40074	PU:KB(M)	N/A	L	U	3	N, R 8 Aug
	North	14-Jul-09	2430-61279	XX:DW(M)	N/A	L	U	3	N
	North	26-Jul-07	2370-40168	PU:KOK(M)	N/A	4Y	F	4	RS
	North	24-Jul-08	2430-61083	XX:YR(M)	XX:RW(M)	3Y	M	4	R 28 Jul
	North	N/A	N/A	UB:UB	N/A	HY	U	4	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	4	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	4	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	4	RS
	North	26-Jun-09	2430-61087	OB(M):XX	N/A	AHY	F	6	N
	North	25-Jul-05	2370-39915	PU:RZ(M)	N/A	A6Y	M	6	R 26 Jun
	North	N/A	N/A	UB:UB	N/A	HY	U	6	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	6	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	6	RS
	North	19-Jun-07	2370-40195	YWY(M):PU	N/A	4Y	F	9	R 13 Aug
	North	3-Aug-08	2430-61127	XX:WG(M)[9]	N/A	A3Y	M	9	R 20 Jul
	North	20-Jul-09	2370-40076	BR(M):PU	N/A	L	U	9	N
	North	20-Jul-09	2430-61277	XX:DB(M)	N/A	L	U	9	N
	North	20-Jul-09	2540-58188	TQ:VY(M)	N/A	L	U	9	N, R 13 Aug
	North	20-Jul-09	2540-58187	TQ:RB(M)	N/A	SY	F	12	N

Table 3.2. Willow Flycatchers Detected at All Monitored Study Areas with Resident Flycatchers, 2009 (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-Aug-01	2320-31592	GO(M):EE	N/A	9Y	M	12	RS
	North	30-Jun-09	2370-40073	PU:KO(M)	N/A	AHY	F	13	N
	North	18-May-04	2320-31595	WKW(M):EE	N/A	A7Y	M	13	R 30 Jun
	North	6-Jul-09	2370-40026	PU:RK(M)	N/A	L	U	13	N
	North	6-Jul-09	2370-40027	YY(M):PU	N/A	L	U	13	N
	North	1-Jul-08	2430-61120	XX:KO(M)	N/A	SY	F	15	RS
	North	29-Jul-07	2370-40157	DWD(M):PU	N/A	A4Y	M	15	RS
	North	14-Jul-09	2370-40075	OW(M):PU	N/A	L	U	15	N[10]
	North	14-Jul-09	2430-61278	XX:GO(M)	N/A	L	U	15	N
	North	14-Jul-09	2540-58185	TQ:RG(M)	N/A	L	U	15	N
	North	17-Jun-07	2370-40194[11]	BR(M):UB	PU:BR(M)	4Y	F	17	R 8 Aug
	North	N/A	N/A	UB:UB	N/A	HY	U	17	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	17	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	17	RS
	North	20-Jun-04	2320-31657	WO(M):EE	N/A	A7Y	F	97[12]	RS
	North	INA	INA	undetermined	N/A	AHY	M	97	
	North	21-Jun-06	2370-40060	YG(M):PU	N/A	A5Y	M	T5, 97	RS; unpaired at T5, then displaced male at 97
	North	N/A	N/A	UB:UB	N/A	HY	U	97	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	97	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	97	RS
	North	25-Jul-08	2430-61179	XX:KB(M)	N/A	A3Y	M	T11	RS; detected 20 May–26 Jul
	South	INA	INA	undetermined	N/A	AHY	U	F19	Detected 22 Jun
	North	13-Aug-09	2370-40140	PU:YO(M)	N/A	AHY	F	F20	N; not detected before or after capture; underside of bill dark, possibly not *extimus*

Table 3.2. Willow Flycatchers Detected at All Monitored Study Areas with Resident Flycatchers, 2009 (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	9-Aug-09	2540-58189	DR(M):TQ	N/A	AHY	U	F21	N; not detected before or after capture
LIFI	Poles	N/A	N/A	UB:UB	N/A	AHY	F	20	RS
	Poles	28-Jun-08	2430-61187	KV(M):XX	N/A	SY	M	20, 105	RS
	Poles	INA	INA	undetermined	N/A	AHY	F	105	
	Poles	8-Jun-09	2370-40155	PU:VB(M)	N/A	AHY	M	T66	N; detected 1–29 Jun
	Poles	INA	INA	undetermined	N/A	AHY	M	F80	Detected 25 Jun
MESQ	West	23-Jun-04	2320-31498	KW(M):EE	N/A	6Y	F	2	RS
	West	4-Jul-01	2390-92434[13]	UB:XX	N/A	9Y	M	2	RS
	West	N/A	N/A	UB:UB	N/A	AHY	F	7	RS
	West	3-Jun-07	2370-40197	OG(M):PU	N/A	A4Y	M	7	RS
	West	1-Aug-03	2320-31445	EE:WK(M)	N/A	A8Y	F	24	RS
	West	N/A	N/A	UB:UB	N/A	AHY	M	24	RS
	West	27-Jun-09	2430-61155	BB(M):XX	N/A	L	U	24	N
	West	6-Aug-09	2540-58219	TQ:RW(M)	N/A	L	U	24	N
	Bunker Marsh North	INA	INA	banded	N/A	AHY	F	39	RS
	Bunker Marsh North	1-Jul-08	2430-61165	XX:RY(M)	N/A	SY	M	39, 101	RS
	West	N/A	N/A	UB:UB	N/A	AHY	F	42	RS
	West	23-Jun-04	2320-31490[11]	UB:WG(M)	EE:OO(M)	A7Y	M	42, 45	R 28 Jun
	West	28-Jun-08	2430-61154	RO(M):XX	N/A	L	U	42	N
	West	20-Jul-06	2370-40066	YO(M):PU	N/A	5Y	F	43	RS
	West	N/A	N/A	UB:UB	N/A	AHY	M	43	RS
	West	26-Jul-07	2370-40087	PU:BZ(M)	N/A	A4Y	F	44	RS
	West	6-Jul-06	2360-59751	OG(M):EE	N/A	4Y	M	44	RS
	West	7-Jul-09	2370-40143	PU:RY(M)	N/A	L	U	44	N

Table 3.2. Willow Flycatchers Detected at All Monitored Study Areas with Resident Flycatchers, 2009 (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	INA	INA	banded	N/A	AHY	F	45	RS
	West	5-Jul-07	2370-40193	GY(M):PU	N/A	A4Y	F	51[12]	RS
	West	INA	INA	GW(M):PU[14]	N/A	AHY	M	51	RS
	West	23-Jun-06	2370-39940	WV(M):PU	GY(M):PU	A5Y	M	T23, 51	R 26 Jun; unpaired at T23 14–26 May, then displaced male at 51
	West	N/A	N/A	UB:UB	N/A	AHY	F	64	RS
	West	7-Jul-06	2370-39967	KO(M):PU	N/A	A5Y	M	64	RS
	Bunker Marsh North	N/A	N/A	UB:UB	N/A	AHY	F	101	RS
	Bunker Marsh North	N/A	N/A	UB:UB	N/A	AHY	U	102	RS
	Bunker Marsh North	6-Jul-08	2430-61198	XX:KR(M)	N/A	SY	U	102	RS
	West	7-Jul-06	2360-59754	OR(M):EE	N/A	4Y	M	T11	RS; detected 20 May–13 Jul
	West	15-Jul-05	2320-31688	EE:BG(M)	N/A	5Y	M	T41	RS; detected 11 May–21 Jul
	Bunker Marsh North	2-Jul-08	2430-61194	VB(M):XX	N/A	SY	U	F40	RS; detected 16 Jun
	Bunker Marsh North	N/A	N/A	UB:UB	N/A	AHY	M	F68	RS; detected 16–21 Jun
	West	INA	INA	banded	N/A	AHY	U	F80	RS; detected 9 Jul
MOME	Virgin River #1 South	2-Jun-06	2370-40037	PU:DR(M)	N/A	A5Y	F	11	RS
	Virgin River #1 South	14-Jun-06	2370-40046	PU:DK(M)	N/A	5Y	M	11	RS
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	L	U	11	RS
	Virgin River #1 South	19-Jun-09	2370-40175	PU:UB[15]	N/A	L	U	11	N
	Virgin River #1 South	19-Jun-09	2370-40174	XX:KG(M)	N/A	L	U	11	N
	Virgin River #1 South	21-Jun-07	2370-40191	PU:RYR(M)	N/A	A4Y	F	12	RS
	Virgin River #1 South	22-Jul-02	2140-66709	Bs:GW(M)	N/A	A9Y	M	12, 13	RS
	Virgin River #1 South	18-Jun-09	2370-40145	PU:YW(M)	N/A	L	U	12	N[16]
	Virgin River #1 South	18-Jun-09	2540-58216	TQ:GB(M)	N/A	L	U	12	N

Table 3.2. Willow Flycatchers Detected at All Monitored Study Areas with Resident Flycatchers, 2009 (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	18-Jun-09	2430-61086	BO(M):XX	N/A	L	U	12	N
	Virgin River #1 South	18-Jun-09	2370-40144	OKO(M):PU	N/A	L	U	12	N
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	L	U	12	RS
	Virgin River #1 South	6-Aug-05	2360-59788	BO(M):EE	N/A	5Y	F	13	RS
	Virgin River #1 South	15-Jul-09	2370-40029	KOK(M):PU	N/A	L	U	13	RS
	Virgin River #1 South	15-Jul-09	2370-40030	PU:RO(M)	N/A	L	U	13	RS
	Virgin River #1 South	29-Jun-09	2430-61153	WO(M):XX	N/A	AHY	F	14	N
	Virgin River #1 South	21-Jun-06	2370-39988	DW(M):PU	N/A	5Y	M	14, 99	RS
	Virgin River #1 South	23-Jun-09	2370-40151	RR(M):PU	N/A	L	U	14	N
	Virgin River #1 South	23-Jun-09	2430-61159	OK(M):XX	N/A	L	U	14	N
	Virgin River #1 South	23-Jun-09	2370-40152	PU:BW(M)	N/A	L	U	14	N
	Virgin River #1 South	INA	INA	banded	N/A	AHY	F	21	RS
	Virgin River #1 South	15-May-07	2370-40161	PU:DY(M)	N/A	A4Y	M	21	RS
	Virgin River #1 South	23-Jun-09	2370-40023	PU:BO(M)	N/A	L	U	21	N
	Virgin River #1 South	23-Jun-09	2370-40150	WG(M):PU	N/A	L	U	21	N
	Virgin River #1 South	2-Jul-08	2430-61116	VV(M):XX	N/A	A3Y	F	32	RS
	Virgin River #1 South	8-Jun-06	2370-39938	KG(M):PU	N/A	5Y	M	32	RS
	Virgin River #1 South	27-Jun-09	2540-58141	TQ:DD(M)	N/A	L	U	32	N[17]
	Virgin River #1 South	27-Jun-09	2540-58142	BV(M):TQ	N/A	L	U	32	N[17]
	Virgin River #1 South	31-Jul-09	2430-61160	KD(M):XX	N/A	L	U	32	N
	Virgin River #1 South	31-Jul-09	2540-58154	DO(M):TQ	N/A	L	U	32	N
	Virgin River #1 South	31-Jul-09	2540-58155	GG(M):TQ	N/A	L	U	32	N
	Virgin River #1 South	31-Jul-03	2320-31444	RW(M):EE	N/A	A8Y	F	36	RS
	Virgin River #1 South	06/29/03	2320-31471	EE:OW(M)	N/A	7Y	M	36	RS

Table 3.2. Willow Flycatchers Detected at All Monitored Study Areas with Resident Flycatchers, 2009 (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	19-Jun-09	2370-40072	OO(M):PU	N/A	L	U	36	N
	Virgin River #1 South	19-Jun-09	2430-61285	XX:GK(M)	N/A	L	U	36	N
	Virgin River #1 South	19-Jun-09	2370-39930	PU:GO(M)	N/A	L	U	36	N
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	L	U	36	RS
	Virgin River #1 North	23-Jun-08	2430-61172	XX:GR(M)	N/A	SY	F	37	RS
	Virgin River #1 North	7-Jun-09	2370-40176	PU:GK(M)	N/A	AHY	M	37, 51	N
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	AHY	F	45	RS
	Virgin River #1 South	29-Jun-07	2370-40124	PU:BB(M)	PU:UB	3Y	M	45	R 27 Jun
	Virgin River #1 North	N/A	N/A	UB:UB	N/A	AHY	F	51	RS
	Virgin River #1 South	INA	INA	UB:EE	N/A	AHY	F	52	RS
	Virgin River #1 South	12-Jun-07	none[18]	RK(M):UB	N/A	A3Y	M	52	RS
	Virgin River #1 South	28-Jun-08	2430-61185	DB(M):XX	N/A	SY	F	67	RS
	Virgin River #1 South		2360-59752	DRD(M):EE	N/A	4Y	M	67	RS
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	AHY	F	99	RS
	Virgin River #1 South	13-Jul-09	2370-40142	PU:VV(M)	N/A	L	U	99	N
	Virgin River #1 South	1-Jul-08	2430-61118	XX:KK(M)	N/A	SY	M	T1	RS; detected 17 Jun–25 Jul
	Virgin River #1 South	23-Jun-08	2430-61174	XX:KG(M)	N/A	SY	M	T2	RS; detected 27 Jun–13 Jul
	Virgin River #1 South	15-Jul-04	2320-31517	EE:OR(M)	N/A	7Y	M	T5	RS; detected 24 May–16 Jun
	Virgin River #1 South	19-Jun-08	2430-61167	XX:KW(M)	N/A	A3Y	M	T7	RS; detected 17 May–4 Aug
	Virgin River #1 South	23-Jun-08	2430-61173	XX:GY(M)	N/A	SY	U	F3	RS; detected 19 Jul
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	AHY	M	F4	RS; detected 21–24 May
	Virgin River #1 South	INA	INA	banded	N/A	AHY	M	F6	RS; detected 17–21 Jul
	Virgin River #1 South	26-Jul-07	2370-40086	WRW(M):PU	N/A	3Y	U	F8	RS; detected 21 Jul
	Virgin River #1 North	INA	INA	banded	N/A	AHY	U	F9	RS; detected 6 Jun

Table 3.2. Willow Flycatchers Detected at All Monitored Study Areas with Resident Flycatchers, 2009 (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 #2	INA	INA	banded	N/A	AHY	U	F46	RS; detected 19 May
MUDD	Overton WMA	INA	INA	PU:UB	N/A	AHY	F	10	RS
	Overton WMA	21-May-09	2430-61085	BV(M):XX	N/A	SY	M	10	N
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	F	16	RS
	Overton WMA	28-Jun-09	2540-58143	RO(M):TQ	N/A	SY	M	16, 51	N
	Overton WMA	27-Jul-08	2370-40147	OR(M):PU	N/A	SY	F	18	RS
	Overton WMA	1-Jul-08	2430-61191	XX:BD(M)	N/A	SY	M	18	RS
	Overton WMA	17-Jul-09	2430-61161	WB(M):XX	N/A	L	U	18	N[17]
	Overton WMA	INA	INA	EE:UB	N/A	AHY	F	31	RS
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	M	31, 51	RS
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	F	38	RS
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	M	38	RS
	Overton WMA	23-Jun-08	2430-61207	GO(M):XX	N/A	SY	F	51[12]	RS
	Overton WMA	25-Jun-09	2430-61209	GY(M):XX	N/A	A3Y	M	T1	RS; detected 22–29 Jul
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	M	T48	RS, detected 4–16 Jul
	Overton WMA	INA	INA	undetermined	N/A	AHY	U	F8	Detected 15 May
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	U	F34	RS; detected 19 May
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	M	F35	RS; detected 19 May
	Overton WMA	INA	INA	banded	N/A	AHY	U	F36	RS; detected 19 May
TOPO	The Wallows	N/A	N/A	UB:UB	N/A	AHY	F	41	RS
	The Wallows	13-Jul-07	2370-40114	VY(M):PU	UB:PU	3Y	M	41	R 15 May and 11 Jun[19]
	The Wallows	29-Jul-09	2370-40048	BG(M):PU	N/A	L	U	41	N
	The Wallows	29-Jul-09	2370-40049	YDY(M):PU	N/A	L	U	41	N
	The Wallows	29-Jul-09	2370-40050	PU:RKR(M)	N/A	L	U	41	N

Table 3.2. Willow Flycatchers Detected at All Monitored Study Areas with Resident Flycatchers, 2009 (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	Pierced Egg	INA	INA	UB:EE	N/A	AHY	M	T1	RS; detected 8 May–6 Jul
	Glory Hole	N/A	N/A	UB:UB	N/A	AHY	M	T3	RS; detected 20 May–7 Jul
	Pierced Egg	22-May-08	2430-61135	XX:OY(M)	N/A	3Y	M	T4	RS; detected 27 May–10 Jul
	PC6-1	N/A	N/A	UB:UB	N/A	AHY	M	T7	RS; detected 2–16 Jun
	Glory Hole	18-Jul-07	2370-40158	WK(M):PU	UB:PU	3Y	M	T22	R 1 Jun; detected 12 May–11 Jul
	Hell Bird	N/A	N/A	UB:UB	N/A	AHY	M	T24	RS; detected 5 Jun–11 Jul
	Hell Bird	INA	INA	undetermined	N/A	AHY	M	T25	Detected 17–25 Jun
	Glory Hole	22-Jul-04	2320-31562	KY(M):EE	N/A	6Y	M	T42	RS; detected 16 May–27 Jul
	Glory Hole	28-May-09	2370-40181	PU:GV(M)	N/A	AHY	M	T43	N; detected 16 May–7 Jul
	Beal Lake	INA	INA	undetermined	N/A	AHY	U	T63	Detected 15–23 May
	800M	N/A	N/A	UB:UB	N/A	AHY	M	T66	RS; detected 26 May–13 July
	Pipes #3	INA	INA	UB:PU	N/A	AHY	M	T93	RS; detected 8 May–4 Jul
	Pipes #1	INA	INA	undetermined	N/A	AHY	U	F2	Detected 15 May
	Lost Lake	N/A	N/A	UB:UB	N/A	AHY	U	F5	Detected 29 May
	250M	INA	INA	undetermined	N/A	AHY	U	F6	Detected 21 May
	Pierced Egg	INA	INA	banded	N/A	AHY	U	F8	RS; detected 16–19 Jun, possibly female for T1
	Pierced Egg	INA	INA	undetermined	N/A	AHY	U	F9	Detected 16–19 Jun; possibly female for T4
	Pipes #3	INA	INA	undetermined	N/A	AHY	U	F10	Detected 9–13 Jun; possibly female for T93
	Glory Hole	INA	INA	banded	N/A	AHY	M	F21	Detected 12–16 May
	Glory Hole	INA	INA	undetermined	N/A	AHY	M	F44	Detected 28 May–1 Jun
	Glory Hole	N/A	N/A	UB:UB	N/A	AHY	U	F45	Detected 6 Aug
	The Wallows	INA	INA	undetermined	N/A	AHY	M	F46	Detected 15 May
	Beal Lake	INA	INA	undetermined	N/A	AHY	M	F65	Detected 3 Jun

Table 3.2. Willow Flycatchers Detected at All Monitored Study Areas with Resident Flycatchers, 2009 (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	250M	INA	INA	undetermined	N/A	AHY	U	F67	Detected 3–7 Jun
	250M	INA	INA	undetermined	N/A	AHY	U	F68	Detected 25 Jun
	Pierced Egg	INA	INA	undetermined	N/A	AHY	U	F70	Detected 8 Jun
BIWI	Site #3	N/A	N/A	UB:UB	N/A	AHY	F	46	RS
	Site #3	11-Jun-09	2370-40180	PU:KG(M)	N/A	AHY	M	46	N
	Site #3	7-Jul-09	2370-40162	PU:DB(M)	N/A	L	U	46	N
	Site #3	7-Jul-09	2370-40163	OK(M):PU	N/A	L	U	46	N
	Site #3	7-Jul-09	2370-40182	GV(M):PU	N/A	L	U	46	N
	Upstream from Site #8	16-Jun-09	2370-40165	DB(M):PU	N/A	AHY	F	47	N
	Upstream from Site #8	4-Jul-09	2370-39969	PU:KYK(M)	N/A	AHY	M	47	N
	Site #3	6-Jun-08	2430-61137	XX:BR(M)	N/A	3Y	F	61	RS
	Site #3	6-Jun-08	2430-61136	XX:BG(M)	N/A	3Y	M	61	RS
	Site #3	4-Jun-09	2370-40130	PU:GWG(M)	N/A	AHY	F	65	N
	Site #3	N/A	N/A	UB:UB	N/A	AHY	M	65	RS
	Site #3	N/A	N/A	UB:UB	N/A	L	U	65	RS
	Site #3	N/A	N/A	UB:UB	N/A	L	U	65	RS
	Site #3	N/A	N/A	UB:UB	N/A	L	U	65	RS
	Site #3	2-Jul-06	2370-40004	PU:RW(M)	N/A	A5Y	F	69	RS
	Site #3	N/A	N/A	UB:UB	N/A	AHY	M	69	RS
	Site #4	5-Jul-09	2540-58146	YR(M):TQ	N/A	SY	M	T26	N; detected 18 Jun–5 Jul
	Site #5	10-Jun-09	2370-40156	PU:OB(M)	N/A	SY	M	T45	N; detected 5–16 Jun
	Site #4	N/A	N/A	UB:UB	N/A	AHY	M	T68	RS; detected 6–24 Jun
	Site #4	INA	INA	undetermined	N/A	AHY	U	F1	Detected 16–18 Jun; possibly female for T68
	Site #4	INA	INA	undetermined	N/A	AHY	U	F27	Detected 20 Jun

Table 3.2. Willow Flycatchers Detected at All Monitored Study Areas with Resident Flycatchers, 2009 (Continued)

[1] PAHR = Pahranagat NWR, LIFI = Littlefield, 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 2009.

[5] **Age in 2009**: 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] Right leg injured, but color-band could not be removed.

[10] Nestling suspected to have died before fledging.

[11] This federal band removed.

[12] Female mated consecutively with two different males.

[13] Band number likely 2390-92434 but cannot be confirmed because bird was not captured in 2009. Bird had visible injury on left leg.

[14] Color combination is a duplicate; federal band number and identity of flycatcher unknown.

[15] Right leg not banded because of pre-existing injury.

[16] Fledgling found dead near nest.

[17] Nestling died before fledging.

[18] Original federal band 2370-40173.

[19] Recapture on 15 May was in a passive net at the Beal Lake MAPS station.

Bill Williams – We detected 13 resident willow flycatchers from eight territories at Bill Williams. In addition to resident adults, we detected two individuals for which residency and/or breeding status could not be determined (Table 3.2). Of the eight territories recorded at Bill Williams, five consisted of paired individuals and two consisted of unpaired males. In the remaining territory a singing male was detected through most of June, and an unchallenged flycatcher, suspected to be a female, was detected for only a few days in June.

Field personnel captured and color-banded six new adults. We resighted and identified three returning banded adults. Four adults remained unbanded, and band status could not be determined for two adults. We banded three nestlings from one nest and resighted three unbanded fledglings from another nest.

Non-Monitoring Sites

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

Key Pittman Wildlife Management Area – Field personnel captured and color-banded two new adults (Table 3.3). We resighted and identified four returning banded adults. We banded seven nestlings from three nests.

St. George – Field personnel captured and color-banded four new adults. We resighted and identified two adult flycatchers, one of which was banded as a nestling in 2008. We recaptured another adult that was banded as a nestling in 2001 and had not been identified since. Another adult was identified as a returning nestling, but we were unable to capture this individual to determine year and study area of origin. We banded five nestlings from two nests; four of these died before fledging (Table 3.3).

Table 3.3. Banded Willow Flycatchers, Non-Monitoring Sites, 2009

Study Area[1]	Site	Date Banded	Federal Band #	Color Combination[2]	Old Color Combination[2,3]	Age[4]	Sex[5]	Observation Status[6]
KEPI	Patch 1	29-Jul-09	2370-40141	PU:YK(M)	N/A	SY	U	N
	Patch 2	30-Jun-05	2370-39980	WO(M):PU	N/A	5Y	M	RS
	Patch 7	27-Jun-06	2320-31674	BW(M):EE	N/A	4Y	M	RS
	Patch 7	23-Jun-04	2320-31484	YB(M):EE	N/A	6Y	M	RS
	Patch 7	27-Jun-09	2540-58145	TQ:DO(M)	N/A	L	U	N
	Patch 7	27-Jun-09	2540-58144	TQ:OG(M)	N/A	L	U	N
	Patch 8	2-Jul-09	2370-40024	PU:BV(M)	N/A	L	U	N
	Patch 8	2-Jul-09	2370-40025	YW(M):PU	N/A	L	U	N
	Patch 9	16-Jul-09	2370-40031	OGO(M):PU	N/A	L	U	N
	Patch 9	16-Jul-09	2430-61156	GK(M):XX	N/A	L	U	N
	Patch 9	16-Jul-09	2430-61157	YB(M):XX	N/A	L	U	N
	Patch 10	16-Jul-09	2430-61158	RB(M):XX	N/A	AHY	M	N
	Patch 10	26-Jun-08	2430-61181	XX:RD(M)	N/A	A3Y	F	RS
STGE	Seegmiller Marsh	2-Aug-01	2540-58131[7]	TQ:KY(M)	Rs:W(HP)/B(HP)	AHY	F	R 22 Jun
	Seegmiller Marsh	22-Jun-09	2540-58132	TQ:OD(M)	N/A	AHY	M	N
	Seegmiller Marsh	21-Jun-04	2320-31660	BZ(M):EE	N/A	6Y	F	RS

Table 3.3. Banded Willow Flycatchers, Non-Monitoring Sites, 2009 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #	Color Combination[2]	Old Color Combination[2,3]	Age[4]	Sex[5]	Observation Status[6]
	Seegmiller Marsh	INA	INA	UB:PU	N/A	AHY	M	RS
	Seegmiller Marsh	22-Jun-09	2370-40099	PU:VW(M)	N/A	L	U	N[8]
	Seegmiller Marsh	22-Jun-09	2370-40146	PU:WV(M)	N/A	L	U	N[8]
	Seegmiller Marsh	22-Jun-09	2370-40154	PU:YV(M)	N/A	L	U	N[8]
	Seegmiller Marsh	22-Jun-09	2370-40153	PU:YY(M)	N/A	L	U	N[8]
	Riverside East	27-Jul-08	2370-40148	PU:KR(M)	N/A	SY	F	RS
	Riverside East	14-Jul-09	2540-58217	TQ:BR(M)	N/A	SY	M	N
	Riverside East	14-Jul-09	2540-58218	KG(M):TQ	N/A	L	U	N
	River Road Bridge	4-Aug-09	2430-61162	BW(M):XX	N/A	AHY	M	N
	Riverside	15-Jul-09	2540-58186	TQ:YB(M)	N/A	AHY	M	N

[1] KEPI = Key Pittman Wildlife Management Area, 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] Old combination included only if rebanded in 2009.

[4] **Age in 2009:** L = nestling, SY = 2 years, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = 4 years, A4Y = 4 years or older, etc.

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

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

[7] Original federal band number 2140-66690.

[8] Nestling died before fledging.

Adult Between-Year Return and Dispersal

In 2008 we individually identified 75 adult, resident willow flycatchers at our monitored study areas, of which 41 (55%) were detected in 2009 (Table 3.4). Of the returning resident adults, one (2%) was detected at a different study area than where it was last detected in 2008 (Table 3.5). One adult flycatcher that was detected in 2008 but not confirmed to be a resident was detected at a different study area in 2009. Two flycatchers that were banded in 2008 at study areas monitored by other agencies were detected at our monitored study areas in 2009. One additional adult, which was last detected in 2006, exhibited between-year movement in 2009. The median dispersal distance for all returning adult flycatchers exhibiting between-year movements in 2009 was 29.1 km (min = 26.9 km, max = 70.2 km).

Table 3.4. Resident Adult Willow Flycatcher Annual Return from 2008 to 2009

Study Area	# Identified in 2008	# of 2008 Birds Detected in 2009	% Return	% Return to Same Study Area
Pahranagat	21[1]	14	67	100
Mesquite	18	12	67	100
Mormon Mesa	18	11	61	91
Muddy River	4	0	0	--
Grand Canyon	1	0	0[2]	--
Topock	7	2	30	100
Bill Williams	5	2	40	100
Total	**75**	**41**	**55**	**98**

[1] One individual that moved from Pahranagat to Key Pittman during the 2008 breeding season is not included.

[2] Grand Canyon study area was not monitored in 2009.

Table 3.5. Summary of Adult Willow Flycatcher Between-Year Movements for All Individuals Identified in a Previous Year and Recaptured or Resighted at a Different Study Area in 2009

Study Area/Site/Year Detected[1]	Study Area/Site Detected 2009[1]	Distance Moved (km)	Federal Band #	Color Combination[2]	Sex[3]
KEPI/Patch 10/2008[4]	PAHR/North	30.1	2370-39915	PU:RZ(M)	M
MESQ/West/2008	MOME/VR #1S	26.9	2360-59752	DRD(M):EE	M
LVWA/UPSLP/2008	MUDD/Overton WMA	70.2	2430-61209	GY(M):XX	M
KEPI/Patch 4/2008	PAHR/North	29.6	2430-61179	XX:KB(M)	M
MOME/VR #2/2008	MESQ/West	28.6	2370-39940	WV(M):PU	M
MESQ/West/2006	MOME/VR #1S	27.2	2320-31444	RW(M):EE	F

[1] PAHR = Pahranagat NWR, KEPI = Key Pittman WMA, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, LVWA = Las Vegas Wash.

[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, XX = standard silver federal band, (M) = metal pin striped band, R = red, 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 letters designate every band; color-band designations for right and left legs are separated with a colon.

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

[4] This individual was at Pahranagat North through 11 Jul but was detected at Key Pittman on 26 Jul 2008.

Juvenile Between-Year Return and Dispersal

In 2008, we banded 74 nestlings at the monitored study areas. One of these nestlings was known to have died before fledging. Of the 73 remaining juveniles, 12 (16%) were identified in 2009. Two additional flycatchers banded as nestlings in St. George in 2008 were identified in 2009. Three individuals originally banded as nestlings in 2007 were identified for the first time in 2009, and one individual banded as a nestling in 2001 was identified breeding in St. George (Table 3.6). Of the 18 returning nestlings identified in 2009, 10 (56%) dispersed away from their natal study area. The median dispersal distance for all returning juvenile flycatchers in 2009 was 13.7 km (min = 0.03 km, max = 202.8 km).

Table 3.6. Summary of Juvenile Flycatchers Banded as Hatch Year Birds in 2001, 2007, or 2008 and Identified for the First Time in 2009

Study Area/ Site Banded	Year Hatched	Study Area/Site Detected 2009	Distance Moved (km)	Federal Band #	Color Combination[2]	Sex[3]
PAHR/North	2001	STGE/Seegmiller Marsh	143.5	2540-58131	TQ:KY(M)	F
TOPO/Glory Hole	2007	MOME/Virgin River #1 South	202.8	2370-40124	PU:BB(M)	M
TOPO/Glory Hole	2007	TOPO/The Wallows	3.6	2370-40114	VY(M):PU	M
BIWI/Site #3	2007	TOPO/Glory Hole	71.1	2370-40158	WK(M):PU	M
STGE/Seegmiller Marsh	2008	MUDD/Overton WMA	100.6	2370-40147	OR(M):PU	F
STGE/Seegmiller Marsh	2008	STGE/Riverside East	2.6	2370-40148	PU:KR(M)	F
PAHR/North	2008	MOME/Virgin River #1 South	104.8	2430-61118	XX:KK(M)	M
PAHR/North	2008	MESQ/Bunker Marsh North	105.7	2430-61198	XX:KR(M)	U
PAHR/North	2008	PAHR/North	0.3	2430-61120	XX:KO(M)	F
MESQ/West	2008	MESQ/ Bunker Marsh North	4.7	2430-61165	XX:RY(M)	M
MESQ/West	2008	MOME/Virgin River #1 South	27.1	2430-61185	DB(M):XX	F
MESQ/West	2008	LIFI/Poles	19.8	2430-61187	KV(M):XX	M
MESQ/West	2008	MESQ/ Bunker Marsh North	4.3	2430-61194	VB(M):XX	U
MOME/Virgin River #1 South	2008	MOME/Virgin River #1 North	0.1	2430-61172	XX:GR(M)	F
MOME/Virgin River #1 South	2008	MOME/Virgin River #1 South	0.03	2430-61173	XX:GY(M)	U
MOME/Virgin River #1 South	2008	MOME/Virgin River #1 South	0.03	2430-61174	XX:KG(M)	M
MOME/Virgin River #1 North	2008	MUDD/Overton WMA	13.8	2430-61191	XX:BD(M)	M
MOME/Virgin River #1 South	2008	MUDD/Overton WMA	13.6	2430-60207	GO(M):XX	F

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

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

Five additional returning nestlings from 2003–2007 were resighted in 2009 (one at Mormon Mesa, two at Muddy River, and two at Topock), but the identity of these individuals was undetermined because we were unable to recapture them.

Within-Year, Between-Study Area Movements

We detected no within-year, between-study area movements in 2009.

DISCUSSION

Color-Banding Effort

Overall, 67% of the adult flycatchers detected at the monitoring sites during 2009 were banded by the end of the breeding season. This compares to 55, 57, 75, 70, 73, and 69% in 2003–2008, respectively.

Unbanded migrant willow flycatchers 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. We have maintained high overall percentages of banded birds annually over the seven years, which has enabled us to detect movements, generate dispersal data, and determine survival and detection probabilities across study areas (McLeod et al. 2008). Differences between study areas in the percentage of banded individuals are directly related to vegetation density and overall structure, which affect our ability to erect mist-nets in the habitat. Topock Marsh typically has the lowest percentage of color-banded flycatchers because dense vegetation limits the number and size of possible net locations.

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. Returning nestlings are particularly difficult to recapture at Topock. 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 2008–2009 we applied unique color combinations to all nestlings. The use of full color combinations on nestlings in 2008 resulted in approximately half as many adults with single federal bands being detected in 2009 than in previous years. Additionally, we recorded juvenile dispersal movements that might otherwise have gone undetected. Although a large number (118) of unique color combinations were used on nestlings in 2008–2009, the benefits in terms of high resolution demographic data outweigh the loss of unique color combinations.

Adult and Juvenile Between-Year Dispersal

Adult and juvenile dispersal data for the 2009 field season show high site fidelity exhibited by adult flycatchers and lower natal site fidelity exhibited by juveniles, with juveniles dispersing among study areas annually. These dispersal data are consistent with the patterns observed in the LCR region from 1998 to 2009, over which period 92% of adult returns were to the same study area while only 55% of all juvenile returns were to the natal study area (McKernan and Braden unpubl. data, McLeod et al. 2008, McLeod and Koronkiewicz 2009). 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. 2008), 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).

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 both gene flow and possibly the establishment of new flycatcher populations. These juvenile movements contribute to an understanding of the observed patterns of high genetic diversity within and low genetic isolation among Southwestern Willow Flycatcher populations (Busch et al. 2000). Physical connectivity of riparian habitats within the greater landscape is crucial in enabling these long-distance movements. Without adequate stop-over habitats and

foraging areas, flycatchers attempting long-distance movements are more likely to be exposed to adverse environmental conditions.

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-five percent of the adult, resident willow flycatchers identified in 2008 were detected again in 2009, while of the 73 juveniles banded in 2008, only 12 (16%) were identified in 2009. Thus, minimum estimated adult and juvenile survival from 2008 to 2009 was 55 and 16%, 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.

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 2009, 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 2009 were compared with those at the study areas from 1996 to 2008 (Braden and McKernan unpubl. data, McLeod et al. 2008, McLeod and Koronkiewicz 2009). 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. 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) the nest was destroyed due to weather (weather); or (5) the entire clutch was incubated for an excess of 20 days (infertile/addled). For nests containing flycatcher eggs, parasitism was considered the cause of nest failure if (1) cowbird young outlived any flycatcher eggs or young, or (2) the nest was parasitized during egg laying and the disappearance of flycatcher eggs coincided with the appearance of cowbird eggs.

During each nest check, we recorded date and time of the visit, observer initials, monitoring method (observation via binoculars or mirror pole), nesting stage, nest contents, and number and behavior of adults and/or fledges present onto standardized data forms (Appendix A) that included the nest or territory number and UTM coordinates. We calculated flycatcher nest success using both 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 (2.12, 12.86, and 13.75 days for laying, incubation, and nestling stages, respectively) as observed in this study in 2003–2009 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.

RESULTS

Nest Monitoring

We documented 72 willow flycatcher nesting attempts at Pahranagat, Littlefield, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams; 65 of these nests were known to contain flycatcher eggs and were used in calculating nest success and productivity. Twenty-three (35%) nests were successful and fledged young, 40 (62%) failed, and fate was unknown for 2 (3%). Nest success ranged from 0% at Littlefield and Muddy River to 53% at Mormon Mesa (Table 4.1). For a comparison of apparent nest success at all monitoring sites from 1997 to 2009, see Table 4.2.

Forty-eight 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 detected for which no nesting attempt could be confirmed. Of the 48 nesting females, 26 had one nesting attempt, 21 had two nesting attempts, and 1 had four nesting attempts. Of the 22 females with multiple nesting attempts, 19 renested after failed nests and 3 renested after successful nests.

Table 4.1. Summary of Willow Flycatcher Nest Monitoring Results at Pahranagat, Littlefield, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams Study Areas, 2009

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]
PAHR	North	10	18	17	8 (47)	8 (47)	1 (6)	0
	Total	*10*	*18*	*17*	*8 (47)*	*8 (47)*	*1 (6)*	*0*
LIFI	Poles	2	2	1	0	1 (100)	0	1 (100)
	Total	*2*	*2*	*1*	*0*	*1 (100)*	*0*	*1 (100)*
MESQ	West	9	13	11	3 (27)	7 (64)	1 (9)	6 (55)
	Bunker Marsh North	3	3	3	0	3 (100)	0	1 (33)
	Total	*12*	*16*	*14*	*3 (21)*	*10 (72)*	*1 (7)*	*7 (50)*
MOME	Virgin River #1 North	2	2	2	0	2 (100)	0	0
	Virgin River #1 South	11	16	15	9 (60)	6 (40)	0	0
	Total	*13*	*18*	*17*	*9 (53)*	*8 (47)*	*0*	*0*
MUDD	Overton WMA	6	9	8	0	8 (100)	0	6 (75)
	Total	*6*	*9*	*8*	*0*	*8 (100)*	*0*	*6 (75)*
TOPO	The Wallows	1	2	2	1 (50)	1 (50)	0	0
	Total	*1*	*2*	*2*	*1 (50)*	*1 (50)*	*0*	*0*
BIWI	Site 3	4	5	5	2 (40)	3 (60)	0	2 (40)
	Upstream from Site #8	1	2	1	0	1 (100)	0	0
	Total	*6*	*7*	*6*	*2 (33)*	*4 (67)*	*0*	*2 (33)*
Overall Total		**49**	**72**	**65**	**23 (35)**	**40 (62)**	**2 (3)**	**16 (29)**

[1] PAHR = Pahranagat NWR, LIFI = Littlefield, 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 Breeding Sites along the Virgin and Lower Colorado Rivers and Tributaries from 1996 to 2009*

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[7]	Nc[6]	Nm[3]
1997	Nm[3]	Nd[4]	67 (3)	42 (12)	Bc[9]	Nc[7]	Nc[6]	Nd[4]
1998	47 (19)	Nd[4]	0 (7)	70 (10)	Nm[3]	Nd[4]	53 (15)	Nd[4]
1999	60 (15)	Nm[3]	Nm[3]	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[6]	Nc[6]	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[7]	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)[8]	20 (5)
2007	67 (12)	Nd[4]	57 (14)	27 (11)	0 (6)	0 (1)	75 (8)	25 (8)

Table 4.2. Willow Flycatcher Percent Apparent Nest Success Recorded at Breeding Sites along the Virgin and Lower Colorado Rivers and Tributaries from 1996 to 2009* (Continued)

Year	Pahranagat	Littlefield	Mesquite[1]	Mormon Mesa[2]	Muddy River	Grand Canyon	Topock	Bill Williams
2008	80 (10)	Nd[4]	82 (11)	62 (13)	25 (8)	Nd[4]	13 (8)[9]	40 (5)[9]
2009	47 (17)[9]	0 (1)	21 (14)[9]	53 (17)	0 (8)	Nm[3]	50 (2)	33 (6)

* 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. 2008, data from 2008 are in McLeod and Koronkiewicz 2009, and data from 2009 are in this document. Data are presented as percent apparent nest success with total number of nests containing at least one flycatcher egg indicated in parentheses.

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

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

[3] Study area not monitored.

[4] Study area surveyed, no breeding documented.

[5] Breeding suspected, nest success not calculated.

[6] Breeding confirmed, nest success not calculated.

[7] Breeding confirmed, undetermined if nestlings from a single nest fledged.

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

[9] Fate of one nest was unknown.

Nest Failure

Depredation was the major cause of nest failure, accounting for 40% (19 of 47) of all failed nests (Table 4.3) and 48% (19 of 40) of nests that failed after flycatcher eggs were laid. Seven nesting attempts (15% of all failed nests) were abandoned prior to willow flycatcher eggs being laid, and 10 nests (21%) were deserted. Six nests (13%) failed because of Brown-headed Cowbird parasitism (see below for more details on parasitism).

Table 4.3. Summary of Causes of Willow Flycatcher Nest Failure at Pahranagat, Littlefield, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams Study Areas, 2009*

Study Area[1]	Total # Nests	All Failed Nests	Abandoned	Deserted	Depredated	Parasitized	Addled	Unknown
PAHR	18	9	1 (11)	0	5 (56)	0	0	3 (33)[2]
LIFI	2	2	1 (50)	0	0	1 (50)	0	0
MESQ	16	12	2 (17)	4 (33)[3]	4 (33)	1 (8)	1 (8)	0
MOME	18	9	1 (11)	3 (33)[4]	5 (56)	0	0	0
MUDD	9	9	1 (11)	2 (22)[5]	2 (22)	3 (33)	1 (11)	0
TOPO	2	1	0	0	1 (50)	0	0	0
BIWI	7	5	1 (20)	1 (20)[6]	2 (40)	1 (20)	0	0
Total	**72**	**47**	**7 (15)**	**10 (21)**	**19 (40)**	**6 (13)**	**2 (4)**	**3 (6)**

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

[2] Nests were too high to use a mirror pole; depredation likely.

[3] One nest deserted after 14 days incubation, one deserted after 16 days incubation, one nest already deserted when found with one flycatcher egg and one cowbird egg, one nest deserted after partial depredation.

[4] One nest deserted with nestlings, one deserted after 16 days incubation, one deserted after partial depredation.

[5] One nest deserted after being parasitized, one deserted after partial depredation.

[6] Nest deserted after 17 days incubation.

Brood Parasitism

Sixteen of 56[1] nests (17%) 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 six nests. In four of these cases, the parasitism event coincided with the disappearance of all flycatcher eggs. One nest fledged a cowbird, and another likely fledged a cowbird although the fledgling could not be located. In both of these cases, the one flycatcher egg remaining after the parasitism event did not hatch. Two parasitized nests (13%) successfully fledged at least one flycatcher. Of the remaining six parasitized nests that contained flycatcher eggs, three were deserted, three were depredated, one contained addled eggs, and one had unknown fate. Brood parasitism ranged from 0 to 100% and was highest at Littlefield (see Table 4.1). In 2009, nests that contained flycatcher eggs and were brood parasitized were less likely to fledge flycatcher young than nests that were not parasitized (Chi-square = 3.93, P = 0.047).

Table 4.4. Fates of Willow Flycatcher Nests Parasitized by Brown-Headed Cowbirds, 2009*

Study Area[1]	Nest ID Code	Outcome[2]
LIFI	20A	Probably fledged a cowbird, but fledging not confirmed. WE did not hatch
	105A	Abandoned with one CE
MESQ	7A	Depredated with two WE and one cowbird nestling
	7B	Abandoned with three CE
	24B	Fledged one flycatcher and one cowbird
	39A	Found deserted with one WE and one CE
	43A	Deserted after partial depredation reduced nest contents from three WE and one CE to one WE and one CE
	43B	Depredated during incubation
	44A	Parasitized during incubation; all three WE disappeared, one CE appeared
	44B	Nest fate unknown; possibly fledged one flycatcher
MUDD	10A	All eggs addled; deserted after 21 days incubation with two CE and one WE
	16A	Parasitized during incubation; both WE disappeared and two CE appeared
	18A	Depredated during nestling period; possibly fledged a cowbird prior to flycatcher nestling being depredated, but no fledgling seen
	38A	Deserted during incubation after parasitism changed clutch from three WE to one WE and two CE
	38B	Parasitized during incubation; all three WE disappeared and one CE appeared
	51B	Parasitized during incubation; all three WE disappeared and one CE appeared
BIWI	46A	Fledged three flycatchers; CE did not hatch
	61B	Fledged one cowbird; WE did not hatch

* All nesting attempts are included.

[1] LIFI = Littlefield, MESQ = Mesquite, MUDD = Muddy River, BIWI = Bill Williams River NWR.

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

[1] Table 4.1 shows a total of 65 nests known to contain at least one flycatcher egg. When calculating brood parasitism rates, however, nine nests whose contents could not be determined were excluded from calculations (i.e., nests that were too high to check contents to determine presence/absence of cowbird eggs).

Mayfield Nest Success and Nest Productivity

Mayfield survival probability (MSP) ranged from 0.053 at Muddy River to 0.519 at Topock and was 0.368 for all sites combined (Table 4.5). At all sites, 56 nestlings were confirmed to have fledged from 63 nests of known outcome (mean number of fledglings/nest = 0.89, SE = 0.16). Fecundity across study areas ranged from 0 to 3.00 young per female and averaged 1.14 (SE = 0.21) (Table 4.6).

Table 4.5. Daily Survival Rates and Mayfield Survival Probabilities (MSP) for Willow Flycatcher Nest Stages at Pahranagat, Littlefield, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams Study Areas, 2009*

Study Area	Nest Stage[1]	Nest Losses/ Observation Days	Daily Survival Rate	Mayfield Survival Probability
Pahranagat	1	0/23	1.000	1.000
	2	7/134	0.948	0.502
	3	1/120.5	0.992	0.892
	MSP all stages = 0.447			
Littlefield	1	0/0	--	--
	2	1/11.5	0.913	0.310
	3	0/0	--	--
	MSP all stages = --			
Mesquite	1	0/19	1.000	1.000
	2	9/140	0.936	0.426
	3	1/72	0.986	0.825
	MSP all stages = 0.351			
Mormon Mesa	1	0/27	1.000	1.000
	2	3/169	0.982	0.794
	3	5/138	0.964	0.602
	MSP all stages = 0.478			
Muddy River	1	1/13	0.923	0.844
	2	6/58.5	0.897	0.249
	3	1/10.5	0.905	0.252
	MSP all stages = 0.053			
Topock	1	0/4	1.000	1.000
	2	0/23	1.000	1.000
	3	1/21.5	0.953	0.519
	MSP all stages = 0.519			
Bill Williams	1	0/13	1.000	1.000
	2	3/78.5	0.962	0.606
	3	1/28.5	0.965	0.612
	MSP all stages = 0.371			
Total	**1**	**1/99**	**0.990**	**0.979**
	2	**29/614.5**	**0.953**	**0.537**
	3	**10/391**	**0.974**	**0.700**
	MSP all stages = 0.368			

* Mayfield survival probability was calculated using 2.12-day egg laying, 12.86-day incubation, and 13.75-day nestling stages.

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

Table 4.6. Willow Flycatcher Nest Productivity (Young Fledged per Nest) and Fecundity (Young Fledged per Female) at Pahranagat, Littlefield, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams Study Areas, 2009*

Study Area	Young Fledged	# Nests	Productivity Mean (SE)	# Females	Fecundity Mean (SE)
Pahranagat	22	16	1.38 (0.38)	10	2.20 (0.42)
Littlefield	0	1	0	2	0 (0)
Mesquite	3	13	0.23 (0.12)	12	0.25 (0.18)
Mormon Mesa	22	17	1.45 (0.35)	13	1.69 (0.44)
Muddy River	0	8	0 (0)	6	0 (0)
Topock	3	2	1.50 (0.38)	1	3.00
Bill Williams	6	6	1.00 (0.63)	5	1.20 (0.73)
Total	**56**	**63**	**0.89 (0.16)**	**49**	**1.14 (0.21)**

* Productivity calculations include nests that contained flycatcher eggs and had a known outcome. Fecundity calculations include all females, and nests with unknown outcome are assumed not to have fledged, thus producing a conservative fecundity estimate.

DISCUSSION

In 2009, willow flycatcher nesting was documented at Pahranagat, Littlefield, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams. The number of flycatcher pairs recorded at Pahranagat, Mesquite, and Mormon Mesa was nearly identical to that recorded in 2008. Bill Williams and Muddy River both had six pairs in 2009 versus four in 2008. Breeding was recorded at Littlefield for the first time since 2004. 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.

Topock Marsh had 14 resident flycatchers, which consisted of 12 unpaired individuals and only one breeding pair, the lowest number of breeding pairs recorded since monitoring began in 1997. In three other territories at Topock, we detected a second flycatcher in addition to the territorial male. In each case, the additional flycatcher was detected for less than one week and suspected to be female, based on interactions with the male and lack of defensive behavior on the part of the male. Gender was not confirmed, however, and no breeding activity was detected. The three suspected females are not included in calculations of fecundity.

Female willow flycatchers are more discriminating in habitat selection than males, with females having to choose habitat conducive to the complexities of nesting (e.g., concealment, microclimate requirements) versus choosing habitat favorable to male advertising and territory defense (Sedgwick and Knopf 1992). Willow flycatcher nest sites at study areas in the LCR region differed from within-territory locations in several vegetation and microclimate variables, suggesting that females are discriminating among potential nest sites on a very local scale (McLeod et al. 2008). Thus, the male skew in the sex ratio of residents at Topock and presence of suspected non-breeding, floater females may be indicative of poor breeding habitat quality. A similar pattern was observed at Roosevelt Lake, Arizona, during the severe drought of 2002, when declines in vegetation vigor and prey availability dramatically decreased female nesting behavior, resulting in almost complete reproductive failure (Paxton et al. 2007). Males arrived in May and set up territories, but the majority of females detected were floaters, did not nest, or abandoned nests before they were complete (E.H. Paxton pers. comm.). Whether other factors such as annual reproductive rates, survival, population recruitment, or other abiotic conditions contributed to reduced breeding at Topock remains unclear.

Nest Success

As in previous years, Mayfield nest success differed little (4% or less) from apparent nest success at most study areas. At Mesquite, apparent nest success (21%) was lower than Mayfield nest success (35%). The high Mayfield estimate was influenced by several nests having long incubation periods before being deserted and by one nest having an uncertain nest fate. Nests with uncertain fates are not counted as a success in apparent nest success but are not counted as a nest loss in the Mayfield estimate. The close agreement between apparent and Mayfield nest success at most study areas suggests that most nests are found early in the nesting cycle and thus relatively few nests fail before they are found.

Nest success at Pahranagat (apparent nest success = 47%, MSP = 45%), while still higher than the average for all study areas, was the lowest recorded since 2003. Nest success alone, however, is an incomplete measure of the production of young. Successful nests produce from one to four young, and variations in nest productivity are not reflected in 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. Productivity at Pahranagat in 2009 (1.38 young per nest) was the lowest recorded since 2003 but did not differ significantly from that recorded in any other year (ANOVA $F_{6,93} = 0.570$, $P = 0.7530$). Fecundity (2.20 young per female) was in the middle of the range of fecundity values (1.6–3.0) recorded at the site in 2003–2009. Thus, although nest success in 2009 at Pahranagat was lower than in past years, females renested after unsuccessful first nest attempts, and fecundity did not appear to be affected.

Nest success and fecundity at Mormon Mesa were high for the second consecutive year, while productivity and fecundity at Mesquite dropped from the highest ever recorded in 2008 to the lowest recorded since 1999. Flycatchers at Muddy River experienced complete reproductive failure, as they did in 2007, and this study area has the lowest overall productivity and fecundity for any study area where breeding has been documented regularly. Nest success at Bill Williams continued to exhibit the yearly fluctuations observed since nest monitoring began in 1999. Sample sizes at Topock and Littlefield are too low to attribute much significance to the reproductive rates observed in 2009. 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 2003–2008, depredation was the major cause of willow flycatcher nest failure, accounting for 40% of all failed nests in 2009. These results are consistent with those reported at the monitored 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 (Mesquite, Pahranagat, Topock, Bill Williams) 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. Problems with both video and still cameras in 2008 affected the detection of depredation events and the identification of nest predators, but both Brown-headed Cowbirds and Yellow-breasted Chats were identified by still cameras as depredating artificial nests, and marks on clay eggs in depredated nests were consistent with these avian predators. This study was continued in 2009, with still cameras deployed at artificial nests and video cameras deployed at real nests at two flycatcher breeding areas (Pahranagat and Mesquite). Marks on clay eggs at these two study areas indicated that most depredation events at Mesquite were from birds, while at Pahranagat both birds and rodents depredated artificial nests (NAU unpubl. data). Video cameras were deployed at five flycatcher nests at Pahranagat and three at Mesquite. Of the five nests at Pahranagat, three successfully fledged flycatcher young, one was depredated during incubation by a Bewick's Wren (*Thyromanes bewickii*), and one was depredated during the nestling period by a red-shouldered hawk (*Buteo lineatus*). At Mesquite, one nest fledged one flycatcher and one cowbird, one nest was depredated during incubation by a cowbird, and the third nest was partially depredated by a cowbird during the nestling period. The cowbird removed two of three nestlings; the remaining nestling fledged successfully (NAU unpubl. data). Results of this study suggest that avian species may be important predators on flycatcher nests. 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 study areas ranged from 0 to 100% and averaged 29% (see Table 4.1). These results are consistent with those reported at the study areas from 1998 to 2007 (Braden and McKernan unpubl. data, McLeod et al. 2008, McLeod and Koronkiewicz 2009), 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 2008–2009 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 (21%) for parasitized nests in 2003–2009 was less than half that of unparasitized nests (51%). 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 2003–2009 produced on average fewer young (1.3 young/nest) than did unparasitized nests (2.2 young/nest; $F_{1,183} = 18.55$, $P < 0.001$). 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 2009, 42% 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).

The inverse relationship of parasitism rates and nest success was particularly apparent at Mesquite in 2008 and 2009. In 2008, Mesquite experienced the lowest parasitism rate and highest nest success recorded at the site since 1999, and then in 2009 experienced the highest parasitism rate and lowest success rate recorded since 1999. High parasitism rates at Mesquite in 2009 may be related to changes in the habitat at Mesquite West, with dry soil conditions causing premature leaf abscission in coyote willows (see Chapter 2).

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. 2008, McLeod and Koronkiewicz 2009, this document) and renest most often after failed nests (Sedgwick 2000), females returning to sites with high brood parasitism are likely to reduce lifetime fecundity because they are expending energy on multiple failed nesting attempts over many years. 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. 2008), 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. 2008). No cowbird trapping was completed in 2008 or 2009, but even in the absence of cowbird trapping, no parasitism events were detected at Pahranagat in either year. We did, however, regularly detect cowbirds within Pahranagat North in 2009, avoided mirror-poling nests on multiple occasions because of the presence of cowbirds, and observed other bird species feeding juvenile cowbirds. These observations suggest that although cowbird trapping may have lingering effects beyond the years in which trapping is completed, cowbirds seemed to be more numerous at Pahranagat in 2009 than in previous years.

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 four of the five years when flycatchers have been monitored at the study area, and overall nest success was 23%, well below the average of 45% 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 addition to cowbird trapping at Muddy River, addling cowbird eggs and/or removing cowbird eggs and young from easily accessible flycatcher nests would likely increase flycatcher nest success and productivity. We do not advise these activities at Pahranagat, which is still part of the five-year post-cowbird-trapping experiment. However, at study areas that were not part of the cowbird trapping experiment (Littlefield, Mormon Mesa, Muddy River, Bill Williams), addling eggs or removing eggs and young would not interfere with ongoing experiments and would likely benefit the flycatcher. At Mesquite and Topock, cowbird trapping was shown not to have any effect on parasitism rates and flycatcher nest success, and thus the post-trapping period will not reveal any lingering effects of trapping. Addling and/or removal of cowbird eggs and nestlings could thus be implemented at these study areas as well.

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 addition, we investigated whether changes in vegetation characteristics might have contributed to the abandonment of some areas by flycatchers. We identified several areas that had been occupied by nesting flycatchers in at least one previous year from 2003 to 2007 but were unoccupied in 2009, and we relocated old nest sites at which we had collected vegetation information in the year the nest was active. We resampled the vegetation at these nests and compared the vegetation data collected in 2009 to that collected when the nest site was active to elucidate how changes in vegetation through time may influence flycatcher occupancy. These results will provide additional quantitative information on the characteristics of vegetation within flycatcher nesting territories.

METHODS

Currently Occupied Territories

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. These points were marked in the field with flagging, which remained in place over the 2008–2009 winter.

In 2009, we identified the territory center for each resident male as described above. If an existing sampling point 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. Sampling points that were identified in 2008 but were not within 20 m of a territory center in 2009 were resampled in 2009. Data from these points are not included in the

2009 data presented below but may be used in future analyses to identify any changes in vegetation that may lead to territory abandonment.

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 10.5–15 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. In 2009, 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 and 2009 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.

Nests in Formerly Occupied Areas

The same measurements that were completed at occupied territories were also taken at old nest sites. We used the UTM coordinates of the nest, nest tree species, nest height, and nest flags that remained in the field to locate the old nests. Vegetation plots were centered on the nest location. Each old nest was at least 50 m from any nest or territory center that was active in 2009.

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. The habitat types delineated in this report do not follow the classification system used by Anderson and Ohmart (1984) and will be related to Anderson and Ohmart (1984) classifications in a future report. 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, 2.5–8 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. 2008). 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. 2008), vertical foliage data were grouped into three categories of above, at, and below the nest. We used average nest height as measured in 2003–2009 in each vegetation type to demarcate vertical foliage categories in 2009. 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. For data collected in 2003–2007 (reported in McLeod et al. 2008), 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 2009 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.

We used non-parametric Wilcoxon signed rank tests for related samples to compare vegetation measurements collected at old nests to the measurements collected during the year the nest was active. We chose non-parametric tests because several parameters had non-normal distributions. Vertical foliage data used in these comparisons were restricted to data collected within 1 m of plot center so as to be directly comparable to data collected prior to 2008. A statistical significance level of $P \leq 0.05$ was chosen to reject null hypotheses.

RESULTS

Currently Occupied Territories

We measured vegetation at 56 occupied territories and 15 territories that were occupied in 2008 but not in 2009 at Littlefield, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams. We delineated the following habitat types: 1) coyote willow, 2) tamarisk/coyote willow mix, 3) Goodding willow, 4) Goodding willow with tamarisk understory, 5) tamarisk with scattered Goodding willow, 6) tamarisk, and 7) cottonwood/mesquite mix. Coyote willow and tamarisk/coyote willow mix occurred at Mesquite, with coyote willow dominating the eastern half of the site while tamarisk and

coyote willow were mixed in the western half of the site. One location at Topock also consisted of a mix of tamarisk and coyote willow, but exceedingly dense vegetation at this location prevented us from collecting stem count data. Goodding willow occurred in the southern portion of Muddy River, in a small stand readily discernible on high-resolution aerial photographs, and at Littlefield. Goodding willow with tamarisk understory occurred at Bill Williams. Tamarisk with scattered, emergent Goodding willow occurred both at Mormon Mesa and Topock; these two study areas were summarized separately because several variables, including canopy height and canopy closure, differed between the two areas. Tamarisk habitats lacking emergent willows occurred at Mesquite, Muddy River, and Topock, while cottonwood with mesquite occurred at the Beal Lake restoration site at Topock. Average nest height recorded in 2003–2009 and used to assign vertical foliage strata for each vegetation category were 2.1, 2.4, 2.8, 4.2, 2.5, 3.5, and 3.7 m for coyote willow, tamarisk/coyote willow mix, Goodding willow, Goodding willow with tamarisk understory, tamarisk with scattered Goodding willow at Mormon Mesa, tamarisk with scattered Goodding willow at Topock, and tamarisk, respectively. No nests were known from cottonwood/mesquite habitat, so the overall mean nest height of 2.9 m was used to assign vertical foliage categories for that vegetation type.

Vegetation characteristics of each habitat type are summarized in Table 5.1. Habitat types varied widely in many characteristics, and plots within each habitat type also showed a wide range in most habitat variables.

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). Tamarisk had the highest proportion of omitted stems, and larger stems had more branches that were omitted.

Vertical foliage profiles for each habitat type are shown in Figures 5.1–5.8. Average nest height in each habitat type, as recorded in 2003–2009, is also shown on each graph. No nests were recorded in cottonwood/mesquite habitat, so average nest height across all habitat types is shown on this graph. In all habitat types, the proportion of dead vegetation in the vertical profile was highest immediately above the ground and declined with increasing height. In most habitat types, the densest live foliage occurred between 2 and 4 m above the ground and was near average nest height.

Nests in Formerly Occupied Areas

We gathered vegetation data at 26 old nests at Mormon Mesa and Topock. We were able to locate the exact nest fork in 17 cases and located the nest tree but were unsure of the correct fork in 5 additional cases. In four cases we located the nest vicinity (within 5 m of the nest location) but were unable to verify that we had located the exact nest tree.

Vegetation at nest sites differed between occupied and unoccupied periods in more than one variable at each study area; however, the characteristics that differed were not consistent among sites (Table 5.3). At Mormon Mesa, nest sites had shorter canopy, less canopy closure, more woody ground cover, fewer dead stems 2.5–8 cm dbh, more dead stems >8 cm dbh, and less dead foliage above nest height when they were active compared to when the area was abandoned. At Topock, nest sites had shorter canopy, less woody ground cover, fewer live stems >8 cm dbh, and fewer dead stems 2.5–8 cm dbh when they were occupied. When both study areas were combined (Table 5.4), nest sites had shorter canopy height, fewer live stems <2.5 cm dbh, more live stems >8 cm dbh, and fewer dead stems 2.5–8 cm dbh when they were active versus when the territory was abandoned. The only variables that differed consistently across the two study areas were canopy height and number of dead stems 2.5–8 cm dbh, both of which were greater in 2009 than in the year the nest was active.

Table 5.1. Summary of Vegetation Characteristics at Occupied Southwestern Willow Flycatcher Territories in Varying Habitat Types, Lower Colorado River and Tributaries, 2009*

Parameter	SAEX (n=8)	TASP and SAEX (n=4)	SAGO (n=5)	SAGO with TASP understory (n=8)	TASP with scattered SAGO (MOME) (n=12)	TASP with scattered SAGO (TOPO) (n=11)	TASP (n=7)	POFR and PRSP (n=1)
Average canopy height (m)	4.9 (0.3)	5.1 (0.5)	10.0 (2.2)	9.4 (2.1)	4.8 (0.4)	6.1 (0.2)	5.0 (0.3)	4.7
	3.5–5.8	4.0–65.5	3.8–14.2	5.1–21.0	2.8–7.5	4.7–7.0	4.1–6.5	
% total canopy closure	89.0 (5.9)	89.6 (5.5)	86.6 (8.2)	84.6 (5.0)	89.4 (3.6)	86.4 (6.1)	93.6 (1.2)	63.5
	57.3–99.0	74.5–98.4	54.7–100.0	53.1–97.4	50.5–98.4	34.9–99.0	89.6–97.9	
% woody ground cover	13.3 (2.4)	12.1 (3.5)	9.7 (2.5)	27.2 (6.8)	15.7 (6.0)	22.9 (4.0)	15.5 (5.8)	6.5
	3.5–24.2	5.8–18.8	2.5–15.0	1.5–48.8	1.5–76.2	7.0–46.2	1.0–38.8	
# live stems <2.5 cm dbh per ha	3247 (784)	4923 (744)	3132 (1855)	589 (412)	2504 (594)	1181 (311)	2383 (340)	382
	509–7639	3438–5730	0–10313	0–3437	0–7894	127–3565	764–3310	
# live stems 2.5–8 cm dbh per ha	8419 (1484)	7682 (1014)	3998 (1490)	1257 (551)	4988 (692)	2917 (765)	4875 (555)	637
	1146–13242	6366–9677	764–8403	0–3820	1655–8912	0–8785	2928–6748	
# live stems >8 cm dbh per ha	143 (126)	0 (0)	942 (275)	398 (515)	340 (118)	718 (178)	291 (126)	0
	0–1018	0–0	127–1783	0–1528	0–1273	0–1528	0–891	
# dead stems <2.5 cm dbh per ha	6398 (1651)	3565 (989)	1986 (881)	127 (110)	3682 (784)	1366 (607)	4456 (1282)	0
	1401–15534	1655–4966	0–4456	0–891	637–10695	0–6112	255–10441	
# dead stems 2.5–8 cm dbh per ha	8563 (2004)	2249 (552)	4533 (1848)	302 (250)	3363 (912)	1157 (357)	4766 (1774)	0
	637–16170	1273–3183	127–9040	0–2037	0–9167	0–3820	127–10950	
# dead stems >8 cm dbh per ha	32 (32)	42 (42)	229 (102)	48 (48)	53 (33)	23 (16)	36.4 (23.5)	0
	0–255	0–127	0–509	0–382	0–382	0–127	0–127	
Percent native	79.9 (5.36)	38.6 (7.1)	91.8 (4.7)	55.3 (15.7)	39.8 (9.9)	14.4 (5.7)	16.6 (10.7)	100.0
	49.9–95.6	28.2–51.7	74.8–100.0	0–98.7	0–91.9	0–50.0	0–62.0	
Live vertical foliage (hits) below nest	4.3 (0.6)	5.3 (1.0)	3.4 (1.2)	13.3 (3.0)	3.5 (0.8)	6.1 (1.0)	4.9 (1.1)	9.2
	2.2–6.6	3.1–7.9	0.8–6.9	2.7–26.8	0–9.2	1.8–12.6	0.7–9.6	
Live vertical foliage (hits) at nest	3.3 (0.7)	3.0 (0.9)	2.4 (0.7)	2.8 (0.8)	2.8 (0.5)	3.2 (0.4)	2.9 (0.5)	4.1
	0.4–6.6	0.9–4.8	1.1–4.6)	1.3–7.6	0.9–6.3	1.0–5.0	1.1–5.1	
Live vertical foliage (hits) above nest	5.1 (1.0)	8.0 (2.5)	14.9 (1.8)	14.0 (6.1)	8.0 (2.2)	8.0 (1.6)	4.9 (0.9)	5.4
	0–8.8	3.6–15.1	8.2–18.8	0.9–50.5	1.8–29.8	0.3–20.8	1.6–7.4	
Dead vertical foliage (hits) below nest	6.3 (0.6)	6.6 (1.0)	5.3 (1.6)	4.4 (1.5)	6.3 (1.0)	8.8 (0.9)	9.5 (0.8)	0.2
	3.7–8.3	3.9–8.4	0.9–5.0	0.4–13.6	2.0–14.7	4.6–13.0	5.8–12.4	
Dead vertical foliage (hits) at nest	2.5 (0.3)	3.0 (0.5)	2.8 (1.2)	0.2 (0.2)	3.2 (0.4)	0.9 (0.4)	1.4 (0.3)	0.1
	1.4–3.9	2.1–4.0	0–6.4	0–1.7	1.4–5.8	0–4.0	0.6–2.3	
Dead vertical foliage (hits) above nest	2.1 (0.8)	1.7 (0.3)	1.4 (0.8)	0.8 (0.4)	1.1 (0.3)	0.5 (0.2)	0.7 (0.3)	0
	0.3–6.7	1.3–2.7	0–3.3	0–2.9	0–2.9	0–2.1	0–2.3	

* 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. SAEX = coyote willow, SAGO = Goodding willow, TASP = tamarisk, PRSP = mesquite, POFR = cottonwood.

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	0.19	0.03	0.10	0.20
2.5–8 cm dbh	0.65	0.29	0.00	0.32
>8 cm dbh	2.0	0.44	0.54	0.99

[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.

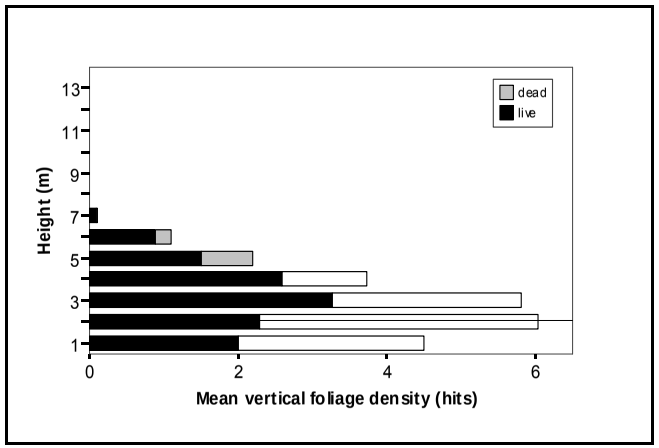

Figure 5.1. Vertical foliage density at occupied willow flycatcher territories in coyote willow habitat type, 2009. Horizontal line shows average nest height in this habitat type in 2003–2009.

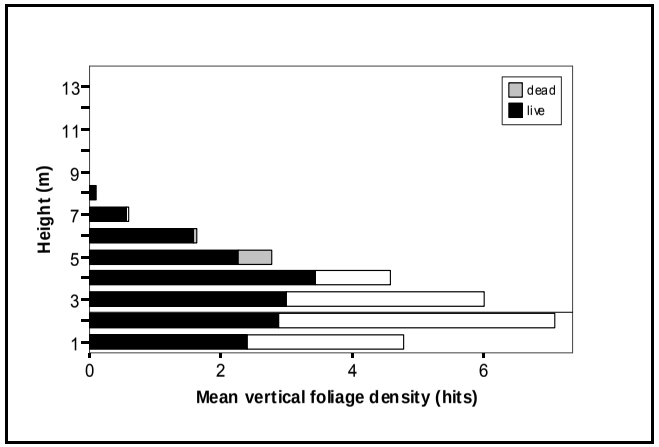

Figure 5.2. Vertical foliage density at occupied willow flycatcher territories in tamarisk/coyote willow habitat type, 2009. Horizontal line shows average nest height in this habitat type in 2003–2009.

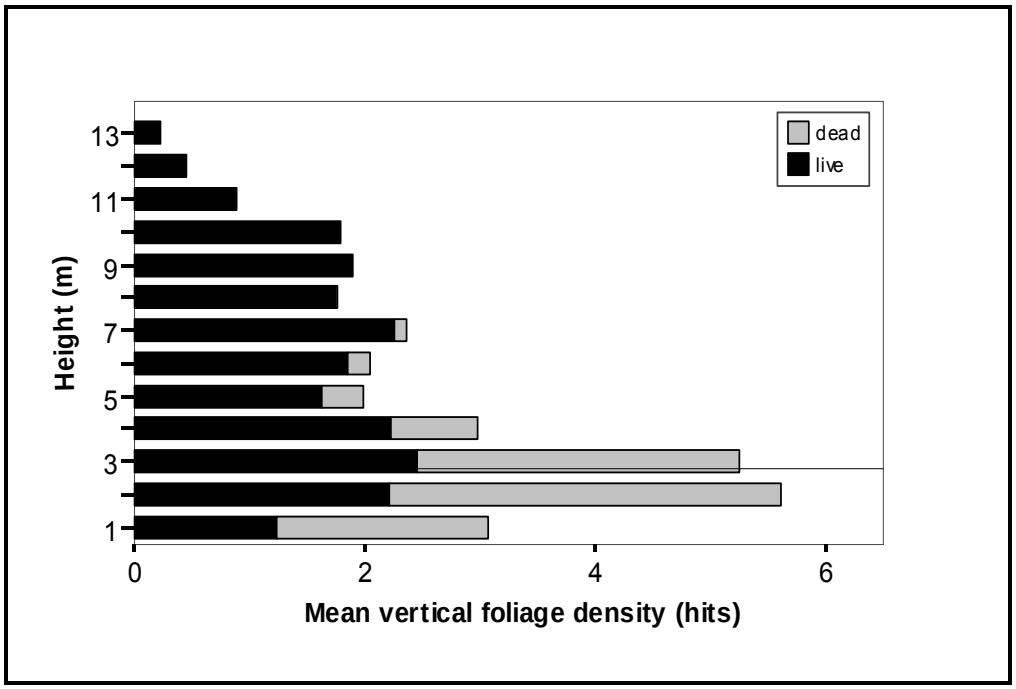

Figure 5.3. Vertical foliage density at occupied willow flycatcher territories in Goodding willow habitat type, 2009. Horizontal line shows average nest height in this habitat type in 2003–2009.

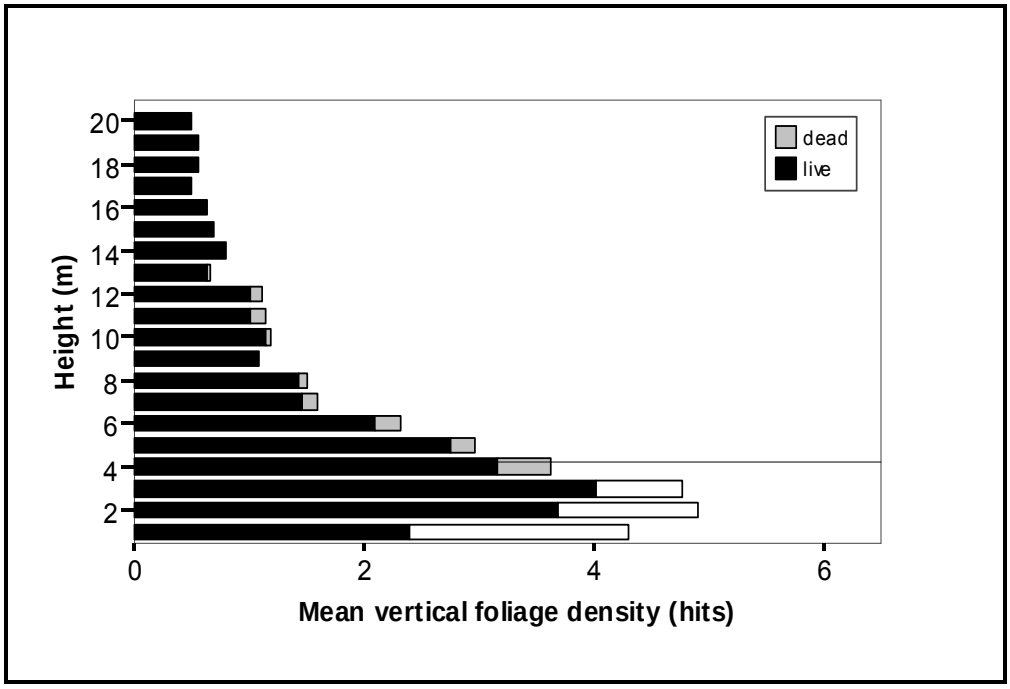

Figure 5.4. Vertical foliage density at occupied willow flycatcher territories in Goodding willow with tamarisk understory habitat type, 2009. Horizontal line shows average nest height in this habitat type in 2003–2009.

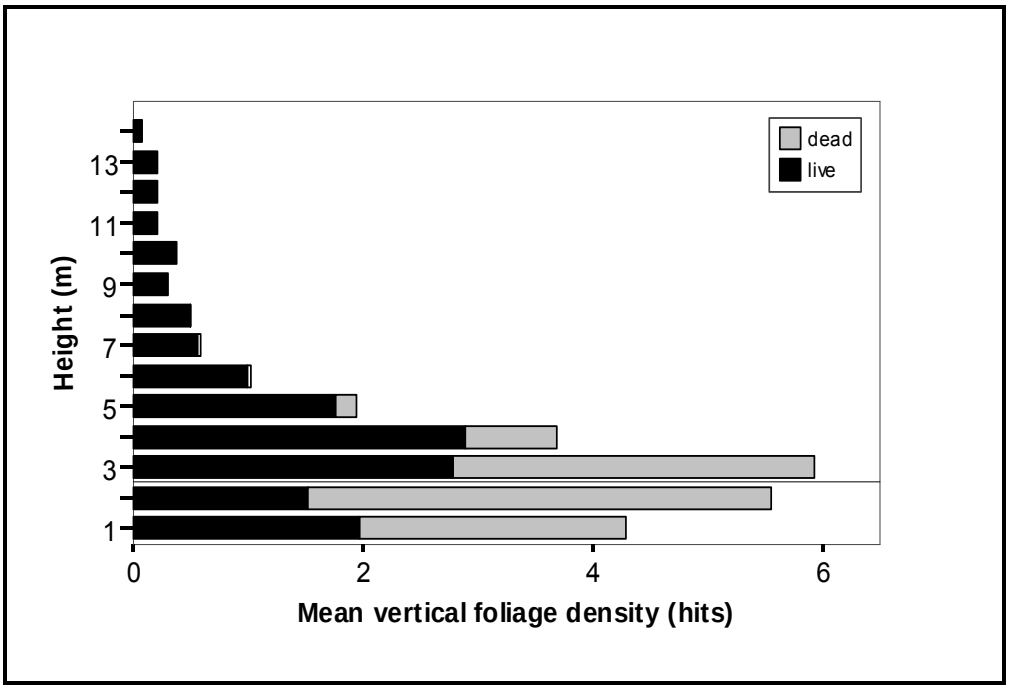

Figure 5.5. Vertical foliage density at occupied willow flycatcher territories in tamarisk with scattered Goodding willow habitat type, Mormon Mesa, 2009. Horizontal line shows average nest height in this habitat type in 2003–2009.

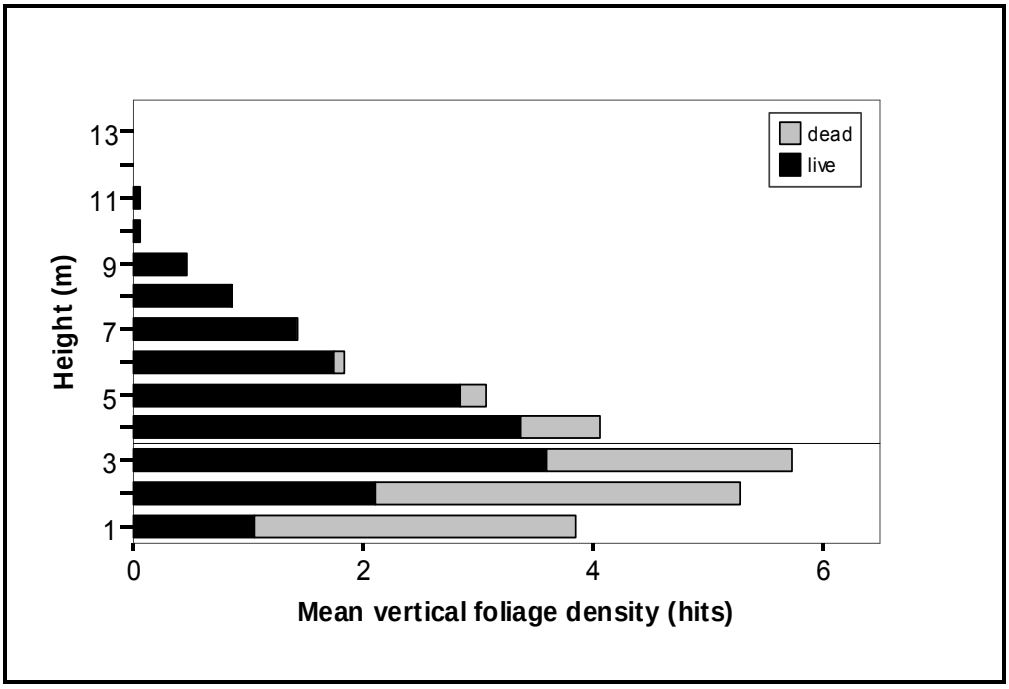

Figure 5.6. Vertical foliage density at occupied willow flycatcher territories in tamarisk with scattered Goodding willow habitat type, Topock Marsh, 2009. Horizontal line shows average nest height in this habitat type in 2003–2009.

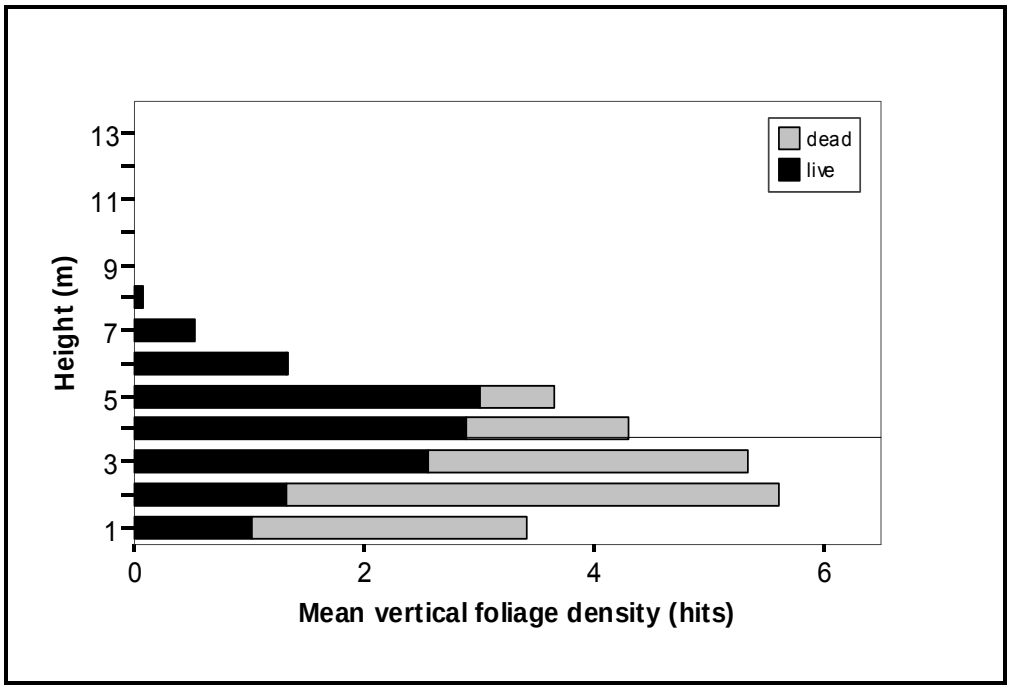

Figure 5.7. Vertical foliage density at occupied willow flycatcher territories in tamarisk habitat type, 2009. Horizontal line shows average nest height in this habitat type in 2003–2009.

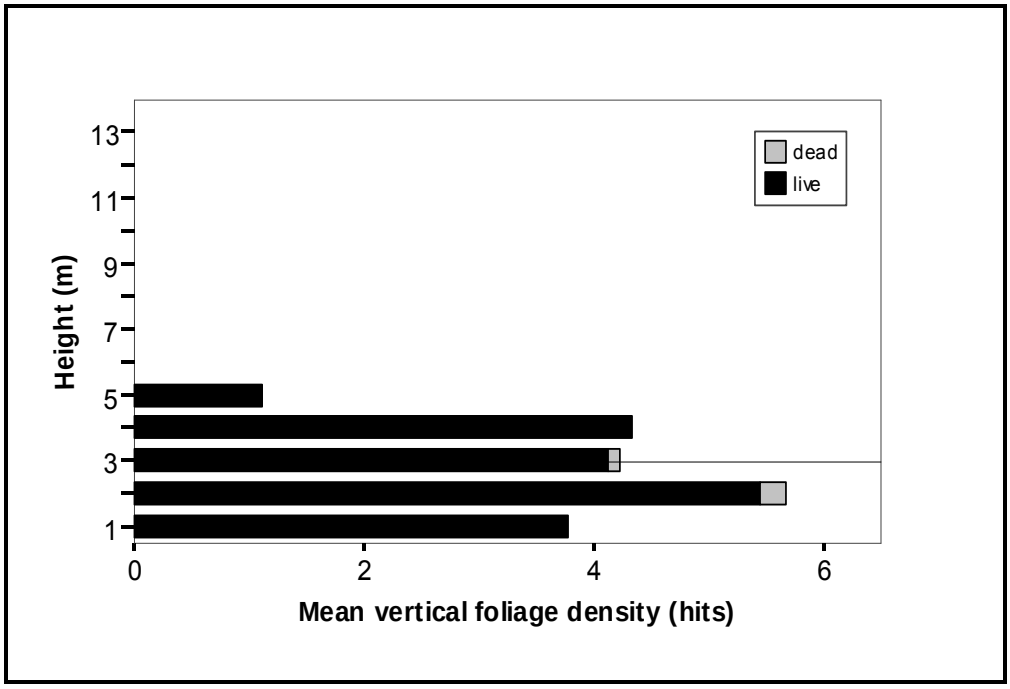

Figure 5.8. Vertical foliage density at occupied willow flycatcher territories in cottonwood/mesquite habitat type, 2009. Horizontal line shows average nest height across all habitat types in 2003–2009.

Table 5.3. Wilcoxon Signed Rank Test Results Comparing Vegetation Characteristics at Willow Flycatcher Nest Sites When the Nest Was Occupied Versus When the Nest Area Was Abandoned, Mormon Mesa and Topock*

Variable	Mormon Mesa (n = 13)				Topock (n = 13)			
	Occupied	Unoccupied	Difference	*P*	Occupied	Unoccupied	Difference	*P*
Canopy height (m)	6.0 (0.3)	6.7 (0.4)	0.7 (0.2)	0.023	6.8 (0.2)	7.8 (0.7)	1.0 (0.5)	0.004
% canopy closure	89.7 (1.5)	95.1 (1.0)	5.5 (1.2)	0.002	95.5 (0.8)	93.3 (0.9)	-2.2 (1.3)	0.064
% woody ground cover	16.9 (2.9)	8.1 (2.4)	-8.8 (3.4)	0.036	10.3 (4.8)	22.9 (5.6)	12.6 (2.3)	0.001
# live stems <2.5 cm dbh per ha	803 (250)	451 (206)	-353 (221)	0.305	1244 (300)	784 (212)	-460 (318)	0.132
# live stems 2.5–8 cm dbh per ha	3790 (608)	3536 (536)	-255 (287)	0.574	5670 (519)	5670 (436)	0 (718)	0.780
# live stems >8 cm dbh per ha	823 (160)	960 (120)	137 (200)	0.397	1832 (254)	2409 (154)	578 (227)	0.045
# dead stems <2.5 cm dbh per ha	4290 (337)	4084 (358)	-206 (597)	0.906	5710 (1101)	3320 (560)	-2390 (1351)	0.208
# dead stems 2.5–8 cm dbh per ha	3154 (445)	4153 (343)	989 (382)	0.023	2801 (817)	5906 (582)	3105 (623)	0.002
# dead stems > 8cm dbh per ha	118 (34)	39 (22)	-78 (27)	0.023	39 (30)	88 (33)	49 (45)	0.301
Live vertical foliage density (hits) below nest	0.6 (0.3)	0.5 (0.2)	-0.1 (0.3)	0.759	2.2 (0.4)	2.9 (0.7)	0.8 (0.8)	0.576
Live vertical foliage density (hits) at nest	1.1 (0.3)	1.1 (0.3)	-0.0 (0.2)	0.722	2.5 (0.5)	2.4 (0.4)	-0.2 (0.6)	0.806
Live vertical foliage density (hits) above nest	11.3 (1.5)	13.3 (1.4)	1.9 (2.0)	0.600	13.8 (1.9)	12.3 (1.5)	-1.5 (1.1)	0.249
Dead vertical foliage density (hits) below nest	6.3 (1.0)	6.4 (1.0)	0.1 (0.8)	0.969	8.2 (1.4)	9.9 (1.4)	1.7 (1.4)	0.311
Dead vertical foliage density (hits) at nest	3.4 (0.6)	4.0 (0.4)	0.6 (0.5)	0.239	2.7 (0.6)	2.1 (0.4)	-0.5 (0.7)	0.423
Dead vertical foliage density (hits) above nest	3.4 (0.7)	5.1 (0.9)	1.6 (0.6)	0.009	2.1 (0.7)	2.0 (0.5)	-0.1 (0.7)	0.861
Percent native	17.5 (9.7)	21.7 (10.4)	4.2 (8.2)	0.465	1.2 (1.2)	0.0 (0.0)	-1.2 (1.2)	0.317

* Data are presented as means (standard error).

Table 5.4. Wilcoxon Signed Rank Test Results Comparing Vegetation Characteristics at Nest Sites When the Nest Was Occupied Versus When the Nest Area Was Abandoned, All Sites Combined*

Variable	All Sites (n = 26)				Direction and Magnitude of Change[1]	
	Occupied	Unoccupied	Difference	P	MOME	TOPO
Canopy height (m)	6.4 (0.2)	7.2 (0.4)	0.8 (0.3)	<0.001	↑	↑
% canopy closure	92.6 (1.0)	94.3 (0.7)	-1.6 (1.1)	0.200	↑	↓
% woody ground cover	13.6 (2.8)	15.5 (3.3)	-1.9 (2.9)	0.409	↓	↑
# live stems <2.5 cm dbh per ha	1023 (196)	617 (149)	-406 (190)	0.042	↓	↓
# live stems 2.5–8 cm dbh per ha	4730 (434)	4603 (400)	-127 (380)	0.951	↓	↑
# live stems >8 cm dbh per ha	1327 (178)	1684 (174)	357 (154)	0.034	↑	↑
# dead stems <2.5 cm dbh per ha	5000 (582)	3702 (335)	-1298 (756)	0.346	↓	↓
# dead stems 2.5–8 cm dbh per ha	2977 (457)	5024 (375)	2047 (416)	<0.001	↑	↑
# dead stems >8 cm dbh per ha	78 (24)	64 (20)	-15 (29)	0.541	↓	↑
Live vertical foliage density (hits) below nest	1.4 (0.3)	1.7 (0.4)	0.3 (0.4)	0.891	↓	↑
Live vertical foliage density (hits) at nest	1.8 (0.3)	1.7 (0.3)	-0.1 (0.8)	0.978	↓	↓
Live vertical foliage density (hits) above nest	12.5 (1.2)	12.8 (1.0)	0.2 (1.2)	0.770	↑	↓
Dead vertical foliage density (hits) below nest	7.3 (0.9)	8.1 (0.9)	0.9 (0.8)	0.443	↑	↑
Dead vertical foliage density (hits) at nest	3.0 (0.3)	3.1 (0.5)	0.0 (0.5)	0.819	↑	↓
Dead vertical foliage density (hits) above nest	2.8 (0.5)	3.5 (0.6)	0.8 (0.5)	0.079	↑	↓
Percent native	9.3 (5.0)	10.8 (5.5)	1.5 (4.1)	0.686	↑	↓

* Data are presented as means (standard error).

[1] Arrows indicate the direction of change of the variable between occupied and unoccupied periods for each study area (MOME = Mormon Mesa, TOPO = Topock Marsh, while color indicates the statistical significance of the change as follows: red is P <0.05, green is 0.05< P <0.10, black is P >0.10.

DISCUSSION

Currently Occupied Territories

The purpose of vegetation measurements of occupied habitat is to provide quantitative guidelines for restoration efforts. Coyote willow and Goodding willow are the two habitat types that are known to support breeding flycatchers and are most likely to be replicated in restoration areas. Mesquite West contains the only extensive stand of coyote willow known to be occupied by territorial willow flycatchers along the lower Colorado River and tributaries in any year since 2003. Occupied coyote willow habitat at Mesquite encompasses approximately 3 ha in the eastern and central portions of Mesquite West and is surrounded by cattail marsh and mixed coyote willow and tamarisk. Occupied even-age Goodding

willow habitat occurred in 2009 on less than 1 ha on the southern end of the Overton WMA site at Muddy River and at Littlefield on Beaver Dam Wash.

Sample sizes for the coyote willow and Goodding willow habitat types in 2009 are small (eight and five, respectively) and likely do not provide an accurate representation of the range and variance in vegetation characteristics in each habitat type. In future reports, data from 2009 will be combined with data collected within active territories between 2003 and 2008 to provide a more comprehensive description of each habitat type.

The cottonwood-mesquite habitat type occurred at the Beal Lake restoration area at Topock. Although flycatchers were detected on multiple occasions at Beal Lake, they responded to broadcast but did not engage in the lengthy, unsolicited song typical of territorial male flycatchers. The flycatchers detected at Beal Lake could not be resighted to determine band combinations, and it is unknown whether a given individual remained at Beal Lake or whether different individuals were detected on different occasions. Beal Lake is a mosaic of vegetation types and densities (see description in Chapter 2). The vegetation plot measured at Beal Lake had less canopy closure and far fewer stems than was typical for flycatcher territories in other habitat types, but more extensive sampling would be required to ascertain whether the plot is representative of the site. Because of the uncertainty of whether the site was truly occupied by resident flycatchers and the dissimilarities between the vegetation characteristics measured at Beal Lake and at other flycatcher territories, the vegetation characteristics reported here for cottonwood-mesquite habitat should not be used as a model for flycatcher habitat.

Although other vegetation types occupied by willow flycatchers are not likely to be created in restoration areas, descriptive data are provided for these habitats to assist in the evaluation of areas to determine their suitability as flycatcher breeding habitat. Data from these other vegetation types may also be useful in illustrating structural similarities between occupied areas in different habitat types. Small sample sizes preclude meaningful comparisons of the 2009 data across habitat types.

Nests in Formerly Occupied Areas

Old nests at Mormon Mesa occurred in Virgin River #2, where we first documented nesting flycatchers in 2005. We had not surveyed the area in 2003–2004, but old flagging suggested that the area could have been occupied by flycatchers in years prior to 2003. The site was occupied by breeding flycatchers in each year from 2005 to 2008. The breeding area contained surface water and saturated soil in 2005 and 2006 but was dry in 2007–2009. No dramatic changes in vegetation were apparent from the site descriptions between 2005 and 2009, but one observer thought a much larger proportion of the tamarisk understory appeared dead in 2009 than in 2006, when she had last visited the site (M.A. McLeod pers. obs.). This observation was supported by there being more dead stems 2.5–8 cm dbh and more dead vegetation above nest height in 2009 than in the year the nest was active. However, the vegetation data also showed there were fewer dead stems >8 cm dbh and greater canopy closure in 2009, which appears to contradict there being more dead foliage.

The majority of old nests at Topock occurred in the adjacent sites of 800M and In Between, with one additional nest in Pipes #3. Paired flycatchers were present at 800M and In Between in 2003–2007, though the number of pairs at the two sites declined from 10 in 2004 to 2 in 2007, with no pairs detected in 2008 or 2009. Pipes #3 was occupied by resident flycatchers in 2004–2006 and again in 2009, though breeding was detected only in 2004. As at Mormon Mesa, no changes in vegetation were apparent over the years from the site descriptions, but one observer thought the tamarisk at In Between and 800M had a higher proportion of dead stems and less canopy closure in 2009 than in years when there were active nests in the area (T.J. Koronkiewicz pers. obs.). This observation was supported by there being more dead stems 2.5–8 cm dbh and a trend toward decreased canopy closure in 2009 than in the year the nest

was active. However, vegetation data also showed an increase in the number of live stems <2.5 cm and >8 cm dbh.

Although the methods for collecting the vegetation data used in these analyses were unchanged among years, observer variation could influence between-year differences in stem counts, vertical foliage counts, and canopy closure. To address observer variation in stem and vertical foliage counts, we calculated the proportion of live stems and live hits in each category and then compared the proportions between the occupied and unoccupied periods. As long as each observer counts live vs. dead stems and, similarly, live vs. dead hits in a consistent manner, this technique accounts for any observer differences in the absolute counts. Results of this analysis showed that the proportion of live stems 2.5–8 cm dbh decreased at both Mormon Mesa (0.57 to 0.44, P = 0.039) and Topock (0.72 to 0.50, P = 0.007) and when both study areas were combined (0.64 to 0.47, P = 0.001) between the occupied year and 2009. A decrease in the proportion of live, medium-sized stems could reduce the suitability of the area for flycatchers. The proportion of live stems >8 cm dbh increased at Topock (0.84 to 0.96, P = 0.025), but this variable did not differ between the occupied year and 2009 at Mormon Mesa or when both study areas were combined. Spatial rather than temporal comparisons of occupied and unoccupied areas in 2003–2007 showed that the number of stems 2.5–8 cm dbh was an important factor distinguishing occupied from unoccupied areas, but live and dead stems were not analyzed separately (McLeod et al. 2008). Reanalysis of the 2003–2007 data incorporating the proportion of live vs. dead vegetation may yield further insight into the vegetation characteristics that contribute to flycatcher occupancy.

Canopy height increased at both Mormon Mesa and Topock between occupied and unoccupied periods, likely as the result of vegetation maturing over the years. This increase in canopy height probably did not contribute to abandonment of the area; McLeod et al. (2008) reported that flycatchers typically occupied areas that had greater canopy height than unoccupied areas. Canopy closure increased at Mormon Mesa between occupied and unoccupied periods but showed a decreasing trend at Topock. Given that flycatchers typically nest in areas with very high canopy closure (McLeod et al. 2008) it is unlikely that an increase in canopy closure would contribute to site abandonment. The apparent changes in canopy closure at both Mormon Mesa and Topock were small (<6%) and may be the result of observer variation.

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 study area.

In addition, we investigated whether changes in microclimate characteristics might have contributed to the abandonment of some areas by flycatchers. We identified several areas that had been occupied by nesting flycatchers in at least one previous year from 2003 to 2007 but were unoccupied in 2009, and we relocated old nest sites at which we had collected microclimate information in the year the nest was active. We resampled the microclimate at these nests to see whether microclimate characteristics had changed. Comparison of microclimate data collected when a nest site was active versus when the area was abandoned may elucidate how changes in microclimate through time may influence flycatcher occupancy. These results will provide additional quantitative information on the characteristics of microclimate within flycatcher nesting territories.

METHODS

Currently Occupied Territories

Temperature and Relative Humidity (T/RH) Measurements

Measurements of temperature and relative humidity (T/RH) were recorded automatically every 15 minutes using a HOBO H8 Pro (Onset Computer Corporation, Pocasset, MA) that combines a thermometer (degrees Celsius), relative humidity monitor, and digital data logger. 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 2008, 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. 2008). 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.

HOBO loggers remained in the field over the 2008–2009 winter at these locations and were downloaded and redeployed in the same location in early May 2009. During the breeding season of 2009, we identified the territory center for each resident male. If an existing sampling point 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. Sampling points that were identified in 2008 but were not within 20 m of a territory center in 2009 were resampled in 2009. Data from these points are not included in the 2009 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 because of the large number of data logger losses experienced over the 2008–2009 winter.

Soil Moisture (SM) 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 (SM) data. The SM readings (nine per site) were recorded directly beneath the HOBO logger (plot center) and at 1.0 and 2.0 m from plot center in each cardinal direction. Soil moisture readings were collected when the HOBO logger was downloaded (for loggers in place since 2008) or deployed (for locations new in 2009) 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 SM measurement point that was underwater, we recorded the depth of standing water and assigned a value of 994 mV, which is equivalent to 50% volumetric water content, or fully saturated soil. All mV values greater than

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

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 and recorded the approximate percentage, as estimated in the field, 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 2009. 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 overall SM (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 site within 20 m that was inundated or saturated
- % of the site within 50 m 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 (2009). 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. 2008). Territories were grouped according to vegetation type (see Chapter 5), and microclimate variables were averaged for each vegetation 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, 16–31 July, and 1–15 August.

Analyses were conducted using SAS® v.9.1.3 (SAS Institute 2003) and Stata® v.9.2 (StataCorp 2006). Data are presented as mean (standard error) unless otherwise noted.

[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.

Nests in Formerly Occupied Areas

We used the UTM coordinates of the nest, nest tree species, nest height, and nest flags that remained in the field to locate old nests. During the year when each nest was active, microclimate data were collected for a two-week period immediately following the nest being vacated. In 2009, we hung a HOBO logger at the old nest location on or before the date on which the HOBO was deployed in the year the nest was active and removed the logger on or after the date the logger was removed in the year the nest was active. Soil moisture measurements were taken at the beginning and the end of the two-week period during which the HOBO was deployed in the year the nest was active.

Statistical Analyses

We truncated the temperature and humidity data collected in 2009 to match the two-week period during which data were collected in the year the nest was active. We summarized the following variables for each HOBO location:

- Mean soil moisture from plot center to 2.0 m from plot center
- Maximum diurnal temperature
- Minimum nocturnal temperature
- Daily temperature range (diurnal maximum minus nocturnal minimum)
- Mean diurnal vapor pressure[3]
- Mean nocturnal vapor pressure

We used paired t-tests to compare measures of microclimate at old nests to the measurements collected during the year the nest was active. P-values were similar to those obtained when a non-parametric test (Wilcoxon signed rank sum) was used to compare matched sites. Analyses were conducted using SAS® v.9.1.3 (SAS Institute 2003) and Stata® v.9.2 (StataCorp 2006). Missing data were excluded test-wise. Data are presented as mean (standard error) unless otherwise noted.

To address whether any observed changes in microclimate between occupied and unoccupied periods could be the result of overall changes in regional climate, we obtained weather station data from the National Climate Data Center (www.ncdc.noaa.gov/oa/ncdc.html) for Overton, Nevada (Station ID #265846) and Needles, California (Station ID #46118) for 2003–2009. Maximum and minimum daily temperature data were available for both weather stations, and dew point data were available for Needles. We used one-way ANOVA to test whether temperature and dew point variables differed between years for the June–August period. We used SPSS® Version 16.0 (SPSS Inc.) software for statistical analyses.

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

RESULTS

Currently Occupied Territories

We collected microclimate data at 56 active territories and 15 territories that were occupied in 2008 but not in 2009. HOBO loggers failed to collect data at four active territories and one location that was occupied in 2008 but not 2009. Four additional loggers at active territories and one logger at an unoccupied location had bad humidity sensors. Microclimate variables are summarized by two-week periods for each vegetation type in Tables 6.1–6.8. These same variables are plotted in Figures 6.1–6.9 to facilitate comparisons between vegetation types.

All vegetation types except cottonwood/mesquite exhibited moist soil conditions at some point during the breeding season. Goodding willow and tamarisk with scattered willow at Mormon Mesa maintained the overall wettest conditions through the season, with high soil moisture readings and a high percentage of the surrounding area being inundated. Goodding willow with tamarisk understory also had high soil moisture content throughout the season, but distance to surface water increased dramatically as the summer progressed. Soil conditions showed a general drying trend in several habitat types, with the inundated percentage of the surrounding area declining through the season in Goodding willow, Goodding willow with tamarisk understory, tamarisk, and tamarisk with scattered Goodding willow at Topock. Coyote willow and tamarisk with coyote willow both had relatively dry soils, particularly at the beginning of the breeding season.

Mean daily maximum temperatures spanned a range of <10°C among habitat types. Daily minimum temperatures showed a smaller range of <5°C. Cottonwood/mesquite, coyote willow, and tamarisk with coyote willow showed the largest daily temperature ranges throughout the season, while Goodding willow with tamarisk understory and tamarisk with scattered willow at Topock had the most moderate temperature ranges.

Vapor pressure increased through the end of July for all habitat types. Vapor pressure was highest in Goodding willow with tamarisk understory and in tamarisk with scattered willow at Topock. Vapor pressure at the beginning of the season was lowest in coyote willow and tamarisk with coyote willow. In July, these two habitat types along with Goodding willow and tamarisk with scattered willow at Mormon Mesa had lower vapor pressure than the other habitat types.

Table 6.1. Microclimate Measures in Southwestern Willow Flycatcher Territories in Coyote Willow (n = 8), 2009*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–-31	August 1–15
Soil Moisture						
Mean soil moisture (mV)	409.5 (54.5)	342.7 (38.8)	607.4 (106.7)	629.8 (104.3)	726.2 (61.8)	737.0 (105.7)
Mean distance to nearest standing water	186.1 (26.2)	183.1 (25.2)	156.8 (35.3)	110.0 (36.4)	165.0 (32.0)	62.2 (18.8)
% of the site within 20 m that was inundated	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	19.4 (7.9)	3.8 (3.8)	8.6 (5.9)
% of the site within 50 m that was inundated	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	21.3 (8.5)	3.8 (3.8)	10.1 (7.2)
Temperature						
Mean maximum diurnal temperature (°C)	43.5 (0.4)	40.2 (0.4)	44.6 (0.5)	46.4 (0.4)	45.7 (0.5)	39.8 (1.3)
Mean minimum nocturnal temperature (°C)	15.0 (0.3)	14.1 (0.3)	16.6 (0.4)	18.2 (0.3)	21.3 (0.1)	17.0 (0.3)
Mean daily temperature range (°C)	28.5 (0.5)	26.1 (0.4)	28.0 (0.7)	28.3 (0.5)	24.4 (0.5)	22.8 (1.3)
Humidity						
Mean diurnal vapor pressure (Pa)	1037.8 (23.2)	867.2 (16.7)	1188.9 (31.1)	1408.3 (39.5)	2026.5 (35.0)	1686.6 (54.1)
Mean nocturnal vapor pressure (Pa)	1047.7 (18.9)	849.2 (10.4)	1214.0 (26.3)	1324.6 (34.8)	1818.3 (27.0)	1569.6 (37.2)

* Data are presented as mean (standard error).

Table 6.2. Microclimate Measures in Southwestern Willow Flycatcher Territories in Tamarisk with Coyote Willow (n = 4), 2009*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture						
Mean soil moisture (mV)	799.5 (63.7)	815.7 (64.2)	592.6 (137.6)	485.6 (98.1)	510.9 (112.8)	751.1 (112.5)
Mean distance to nearest standing water	168.8 (12.0)	147.2 (38.3)	137.5 (38.9)	158.3 (56.7)	167.5 (42.7)	96.7 (64.9)
% of the site within 20 m that was inundated	0.0 (0.0)	10.0 (10.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	13.3 (13.3)
% of the site within 50 m that was inundated	0.0 (0.0)	6.0 (6.0)	8.8 (8.8)	1.0 (1.0)	5.0 (5.0)	16.7 (16.7)
Temperature						
Mean maximum diurnal temperature (°C)	42.5 (0.8)	38.7 (0.6)	45.1 (0.8)	47.1 (0.5)	46.8 (0.8)	41.9 (2.2)
Mean minimum nocturnal temperature (°C)	15.1 (0.4)	15.1 (0.4)	17.6 (0.5)	19.5 (0.4)	22.7 (0.3)	16.4 (0.7)
Mean daily temperature range (°C)	27.4 (1.0)	23.6 (0.6)	27.5 (1.1)	27.6 (0.7)	24.0 (0.9)	25.5 (2.0)
Humidity						
Mean diurnal vapor pressure (Pa)	1190.6 (31.4)	1137.2 (27.2)	1551.7 (84.4)	1745.1 (102.1)	2315.0 (88.6)	1772.4 (114.8)
Mean nocturnal vapor pressure (Pa)	1136.2 (45.0)	1015.2 (28.6)	1343.8 (46.2)	1446.1 (67.4)	1939.4 (53.2)	1461.6 (54.4)

* Data are presented as mean (standard error).

Table 6.3. Microclimate Measures in Southwestern Willow Flycatcher Territories in Goodding Willow (n = 5), 2009*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture						
Mean soil moisture (mV)	994.0 (0.0)	994.0 (0.0)	796.6 (190.2)	981.1 (6.3)	741.5 (173.1)	827.0 (141.7)
Mean distance to nearest standing water	0.0 (0.0)	0.0 (0.0)	0.9 (0.8)	0.3 (0.2)	3.6 (2.5)	3.4 (1.8)
% of the site within 20 m that was inundated	95.0 (5.0)	87.5 (12.5)	41.7 (24.2)	53.8 (16.0)	38.8 (17.7)	33.0 (16.8)
% of the site within 50 m that was inundated	85.0 (15.0)	90.0 (10.0)	34.7 (22.7)	41.3 (13.3)	45.0 (11.9)	42.0 (14.6)
Temperature						
Mean maximum diurnal temperature (°C)	44.7 (1.7)	41.7 (1.8)	43.3 (1.4)	43.8 (1.0)	41.4 (0.8)	38.4 (1.5)
Mean minimum nocturnal temperature (°C)	17.8 (0.4)	16.1 (0.4)	18.3 (0.4)	19.8 (0.3)	22.6 (0.2)	18.3 (0.4)
Mean daily temperature range (°C)	26.9 (1.8)	25.6 (1.7)	25.0 (1.5)	24.0 (1.0)	18.9 (0.7)	20.0 (1.4)
Humidity						
Mean diurnal vapor pressure (Pa)	1345.2 (49.3)	1226.3 (41.4)	1443.4 (51.6)	1475.8 (52.6)	2104.8 (34.8)	1432.6 (48.2)
Mean nocturnal vapor pressure (Pa)	1383.1 (48.7)	1315.5 (28.4)	1506.4 (43.4)	1600.8 (42.0)	1902.0 (36.1)	1510.5 (45.6)

* Data are presented as mean (standard error).

Table 6.4. Microclimate Measures in Southwestern Willow Flycatcher Territories in Goodding Willow with Tamarisk Understory (n = 7), 2009*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture						
Mean soil moisture (mV)	931.7 (62.3)	909.2 (39.6)	847.1 (84.9)	813.3 (85.9)	823.7 (72.8)	724.7 (69.7)
Mean distance to nearest standing water	9.5 (9.5)	9.9 (5.7)	12.3 (5.7)	138.3 (113.0)	272.4 (91.9)	372.8 (113.5)
% of the site within 20 m that was inundated	28.0 (27.0)	25.5 (24.5)	26.6 (13.1)	10.9 (9.9)	17.1 (11.0)	0.4 (0.4)
% of the site within 50 m that was inundated	32.0 (13.7)	19.0 (6.2)	21.8 (9.8)	9.3 (8.5)	14.7 (9.8)	0.2 (0.2)
Temperature						
Mean maximum diurnal temperature (°C)	39.1 (0.9)	35.8 (0.7)	38.5 (0.7)	40.3 (0.5)	40.7 (0.6)	48.0 (4.5)
Mean minimum nocturnal temperature (°C)	16.4 (0.5)	15.8 (0.3)	17.0 (0.3)	20.1 (0.3)	22.7 (0.2)	17.7 (0.5)
Mean daily temperature range (°C)	22.7 (1.0)	20.1 (0.9)	21.5 (0.7)	20.2 (0.6)	18.0 (0.6)	12.2 (4.5)
Humidity						
Mean diurnal vapor pressure (Pa)	1918.7 (49.9)	1666.9 (29.6)	2277.4 (54.6)	2593.7 (53.4)	3138.0 (48.3)	2210.2 (119.9)
Mean nocturnal vapor pressure (Pa)	1558.5 (32.6)	1346.9 (26.3)	1766.1 (32.1)	2048.1 (39.0)	2488.4 (33.1)	2067.1 (26.8)

* Data are presented as mean (standard error).

Table 6.5. Microclimate Measures in Southwestern Willow Flycatcher Territories in Tamarisk with Scattered Goodding Willow – Mormon Mesa (n = 11), 2009*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture						
Mean soil moisture (mV)	954.8 (9.4)	932.8 (13.6)	943.3 (11.3)	928.2 (11.8)	927.7 (10.5)	918.3 (9.5)
Mean distance to nearest standing water	8.4 (7.9)	14.7 (8.4)	12.7 (5.0)	16.1 (11.0)	12.9 (3.8)	8.6 (3.0)
% of the site within 20 m that was inundated	47.0 (18.1)	25.4 (11.9)	31.5 (11.3)	42.0 (10.9)	26.4 (9.6)	39.4 (11.2)
% of the site within 50 m that was inundated	40.0 (13.5)	27.9 (11.3)	51.6 (10.5)	38.5 (8.4)	26.7 (6.7)	56.3 (6.5)
Temperature						
Mean maximum diurnal temperature (°C)	38.2 (0.5)	35.9 (0.5)	41.8 (0.5)	44.3 (0.4)	43.0 (0.5)	38.0 (1.2)
Mean minimum nocturnal temperature (°C)	15.1 (0.2)	13.2 (0.2)	16.3 (0.3)	17.5 (0.2)	21.4 (0.1)	16.0 (0.3)
Mean daily temperature range (°C)	23.1 (0.6)	22.7 (0.5)	25.5 (0.6)	26.8 (0.5)	21.5 (0.5)	22.0 (1.1)
Humidity						
Mean diurnal vapor pressure (Pa)	1288.5 (25.4)	1162.7 (16.2)	1302.5 (25.0)	1355.4 (35.9)	2101.8 (26.6)	1551.9 (48.3)
Mean nocturnal vapor pressure (Pa)	1368.1 (21.5)	1259.2 (12.2)	1405.7 (18.8)	1475.6 (24.2)	1876.4 (24.4)	1529.3 (37.6)

* Data are presented as mean (standard error).

Table 6.6. Microclimate Measures in Southwestern Willow Flycatcher Territories in Tamarisk with Scattered Goodding Willow – Topock Marsh (n = 10), 2009*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture						
Mean soil moisture (mV)	857.5 (80.8)	848.0 (97.7)	822.5 (70.7)	645.8 (72.8)	518.2 (76.6)	564.4 (98.9)
Mean distance to nearest standing water	10.6 (4.4)	11.1 (4.4)	17.0 (6.5)	40.4 (9.8)	158.9 (25.3)	95.0 (20.9)
% of the site within 20 m that was inundated	30.5 (10.4)	31.2 (11.7)	11.4 (3.1)	2.4 (1.8)	0.4 (0.4)	0.0 (0.0)
% of the site within 50 m that was inundated	36.8 (7.3)	37.2 (9.4)	14.0 (4.4)	8.8 (4.7)	0.2 (0.2)	0.3 (0.1)
Temperature						
Mean maximum diurnal temperature (°C)	38.7 (0.3)	35.1 (0.4)	38.2 (0.5)	41.1 (0.5)	41.3 (0.5)	37.7 (0.8)
Mean minimum nocturnal temperature (°C)	17.0 (0.3)	16.0 (0.2)	18.1 (0.3)	19.8 (0.2)	23.5 (0.2)	18.1 (0.4)
Mean daily temperature range (°C)	21.6 (0.5)	19.1 (0.4)	20.1 (0.6)	21.3 (0.6)	17.8 (0.5)	19.6 (1.8)
Humidity						
Mean diurnal vapor pressure (Pa)	1677.4 (36.0)	1535.8 (26.6)	2156.5 (41.5)	2469.4 (39.2)	2825.8 (35.0)	2140.7 (83.0)
Mean nocturnal vapor pressure (Pa)	1465.1 (18.8)	1345.2 (18.8)	1742.8 (25.7)	1989.9 (27.1)	2382.5 (21.7)	1771.3 (36.9)

* Data are presented as mean (standard error).

Table 6.7. Microclimate Measures in Southwestern Willow Flycatcher Territories in Tamarisk (n = 8), 2009*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture						
Mean soil moisture (mV)	988.3 (5.7)	968.8 (18.7)	846.8 (44.2)	669.2 (131.8)	596.3 (148.2)	835.8 (96.1)
Mean distance to nearest standing water	0.2 (0.2)	5.1 (5.0)	105.2 (40.3)	100.1 (34.5)	128.5 (42.2)	85.2 (50.5)
% of the site within 20 m that was inundated	83.3 (12.0)	55.0 (20.5)	16.2 (16.0)	24.2 (16.4)	27.7 (13.7)	20.0 (13.7)
% of the site within 50 m that was inundated	80.0 (10.0)	58.8 (14.2)	16.1 (16.0)	25.0 (15.9)	30.0 (19.1)	36.3 (21.2)
Temperature						
Mean maximum diurnal temperature (°C)	42.2 (1.1)	37.3 (0.6)	41.3 (0.8)	45.6 (0.6)	46.1 (0.8)	37.8 (1.6)
Mean minimum nocturnal temperature (°C)	17.5 (0.4)	15.1 (0.3)	17.2 (0.4)	19.2 (0.3)	22.6 (0.2)	17.2 (0.4)
Mean daily temperature range (°C)	24.7 (1.2)	22.2 (0.7)	24.2 (0.9)	26.5 (0.7)	23.5 (0.8)	20.6 (1.5)
Humidity						
Mean diurnal vapor pressure (Pa)	1331.9 (45.5)	1371.9 (46.8)	1824.3 (77.5)	1850.9 (98.3)	2367.2 (84.6)	1836.1 (117.6)
Mean nocturnal vapor pressure (Pa)	1365.2 (43.5)	1351.3 (24.9)	1665.3 (42.1)	1697.3 (59.9)	2120.6 (56.9)	1681.3 (57.3)

* Data are presented as mean (standard error).

Table 6.8. Microclimate Measures in Southwestern Willow Flycatcher Territories in Cottonwood/Mesquite (n = 1), 2009*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture						
Mean soil moisture (mV)	119.9 (0.0)	129.2 (0.0)	193.1 (33.3)	122.8 (0.0)	148.9 (0.0)	N/A
Mean distance to nearest standing water	150.0 (0.0)	20.0 (0.0)	30.0 (0.0)	55.0 (0.0)	55.0 (0.0)	N/A
% of the site within 20 m that was inundated	0.0 (0.0)	10.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	N/A
% of the site within 50 m that was inundated	0.0 (0.0)	3.0 (0.0)	14.0 (4.0)	0.0 (0.0)	0.0 (0.0)	N/A
Temperature						
Mean maximum diurnal temperature (°C)	44.0 (0.7)	40.9 (0.7)	44.8 (1.1)	48.6 (0.7)	N/A	N/A
Mean minimum nocturnal temperature (°C)	17.7 (1.0)	16.3 (0.6)	18.6 (0.9)	20.8 (0.7)	N/A	N/A
Mean daily temperature range (°C)	26.3 (1.4)	24.6 (1.0)	26.1 (1.3)	27.8 (1.2)	N/A	N/A
Humidity						
Mean diurnal vapor pressure (Pa)	N/A	N/A	N/A	N/A	N/A	N/A
Mean nocturnal vapor pressure (Pa)	N/A	N/A	N/A	N/A	N/A	N/A

* Data are presented as mean (standard error). N/A = not available.

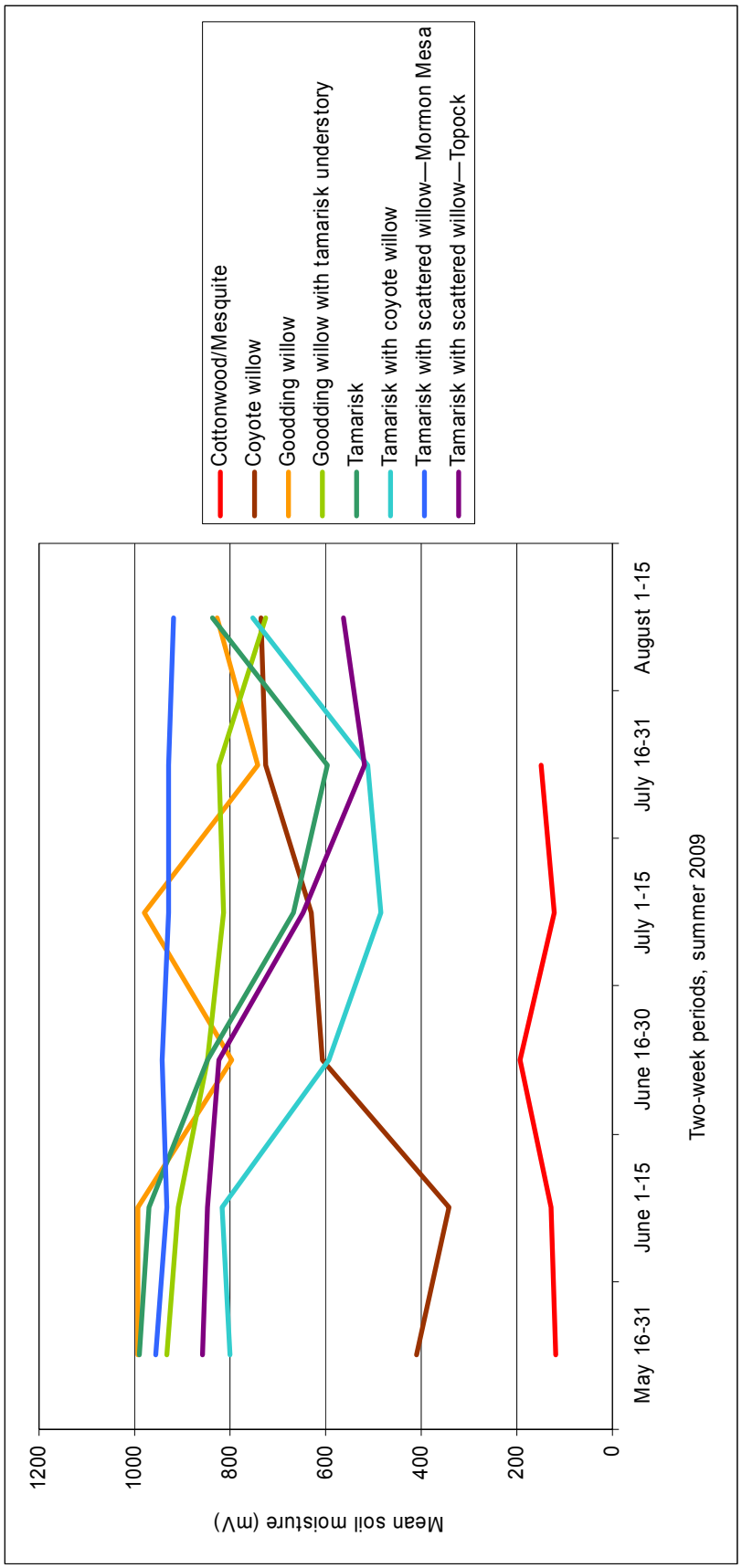

Figure 6.1. Mean soil moisture (mV) in Southwestern Willow Flycatcher territories in various vegetation types, Lower Colorado River and tributaries, 2009. Data are summarized by two-week periods.

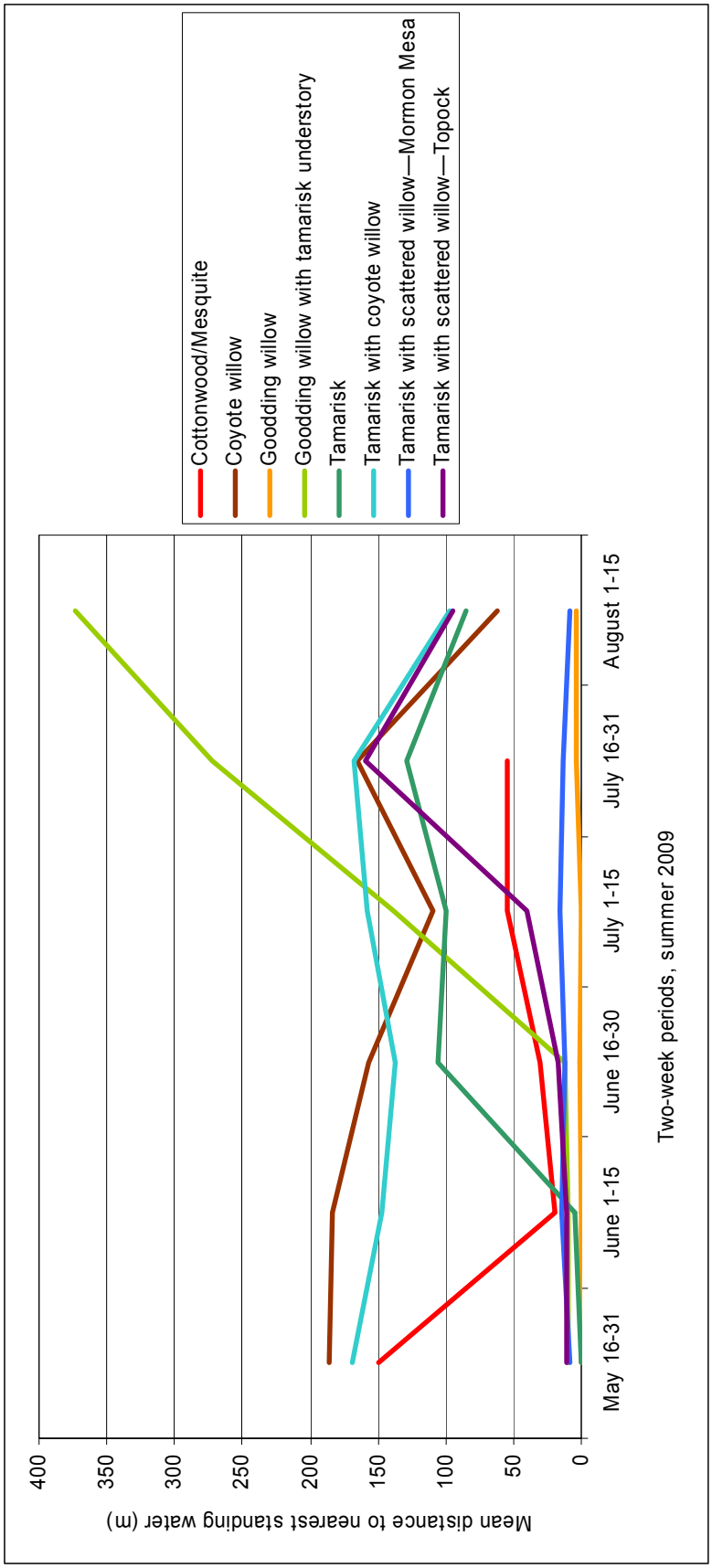

Figure 6.2. Mean distance (m) to standing water or saturated soil from Southwestern Willow Flycatcher territories in various vegetation types, Lower Colorado River and tributaries, 2009. Data are summarized by two-week periods.

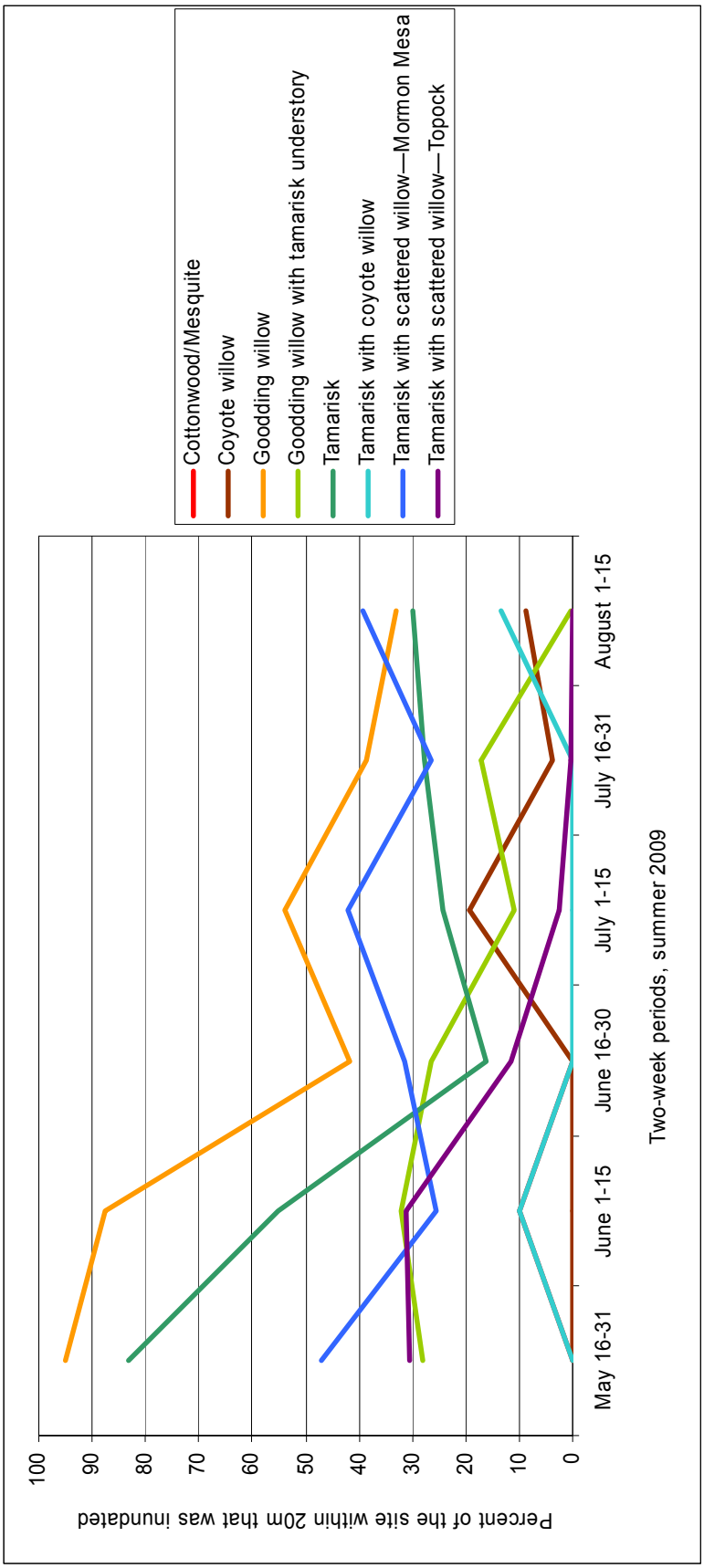

Figure 6.3. Mean percent of the area within 20 m of Southwestern Willow Flycatcher territories that contained standing water or saturated soil in various vegetation types, Lower Colorado River and tributaries, 2009. Data are summarized by two-week periods. Cottonwood/mesquite does not appear on the graph because it is exactly overlain by tamarisk/coyote willow through the end of July.

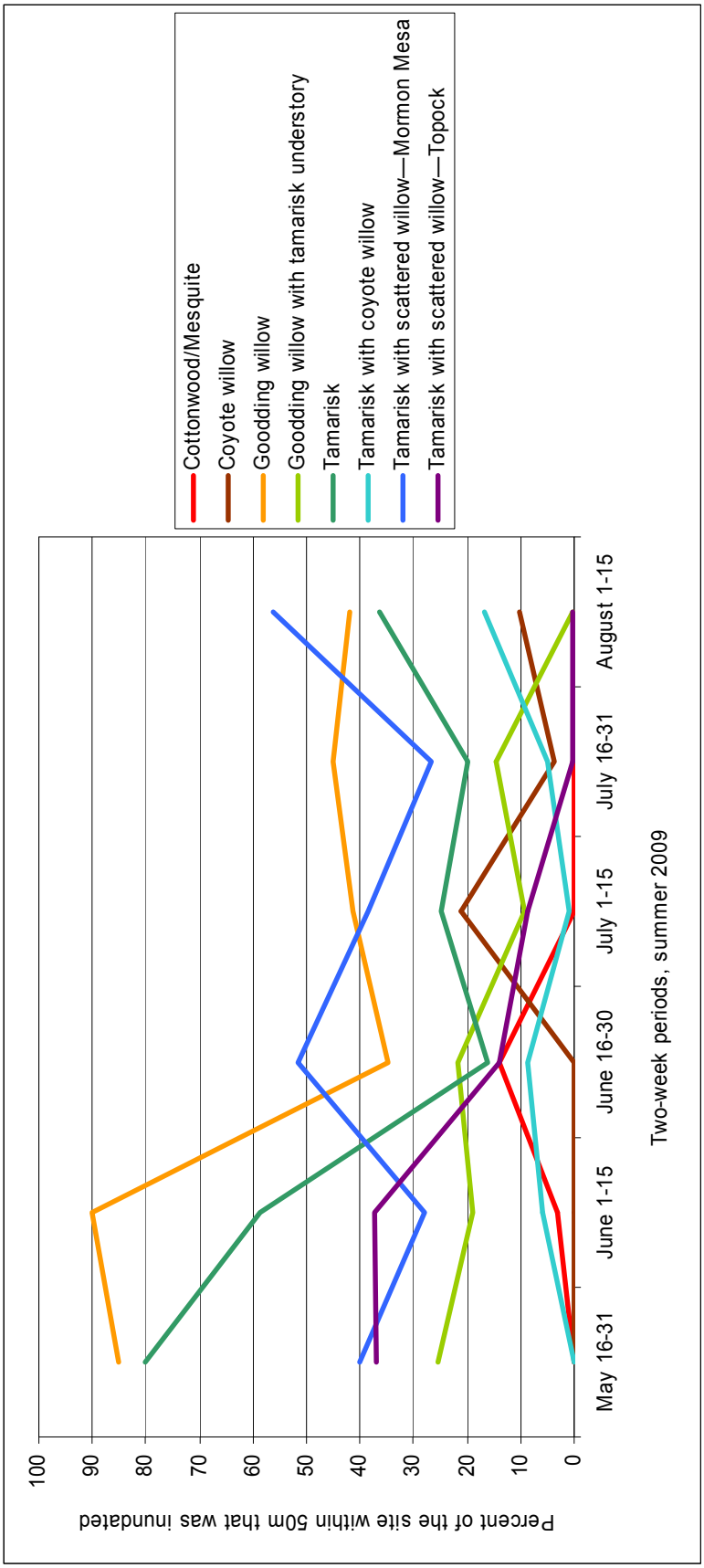

Figure 6.4. Mean percent of the area within 50 m of Southwestern Willow Flycatcher territories that contained standing water or saturated soil in various vegetation types, Lower Colorado River and tributaries, 2009. Data are summarized by two-week periods.

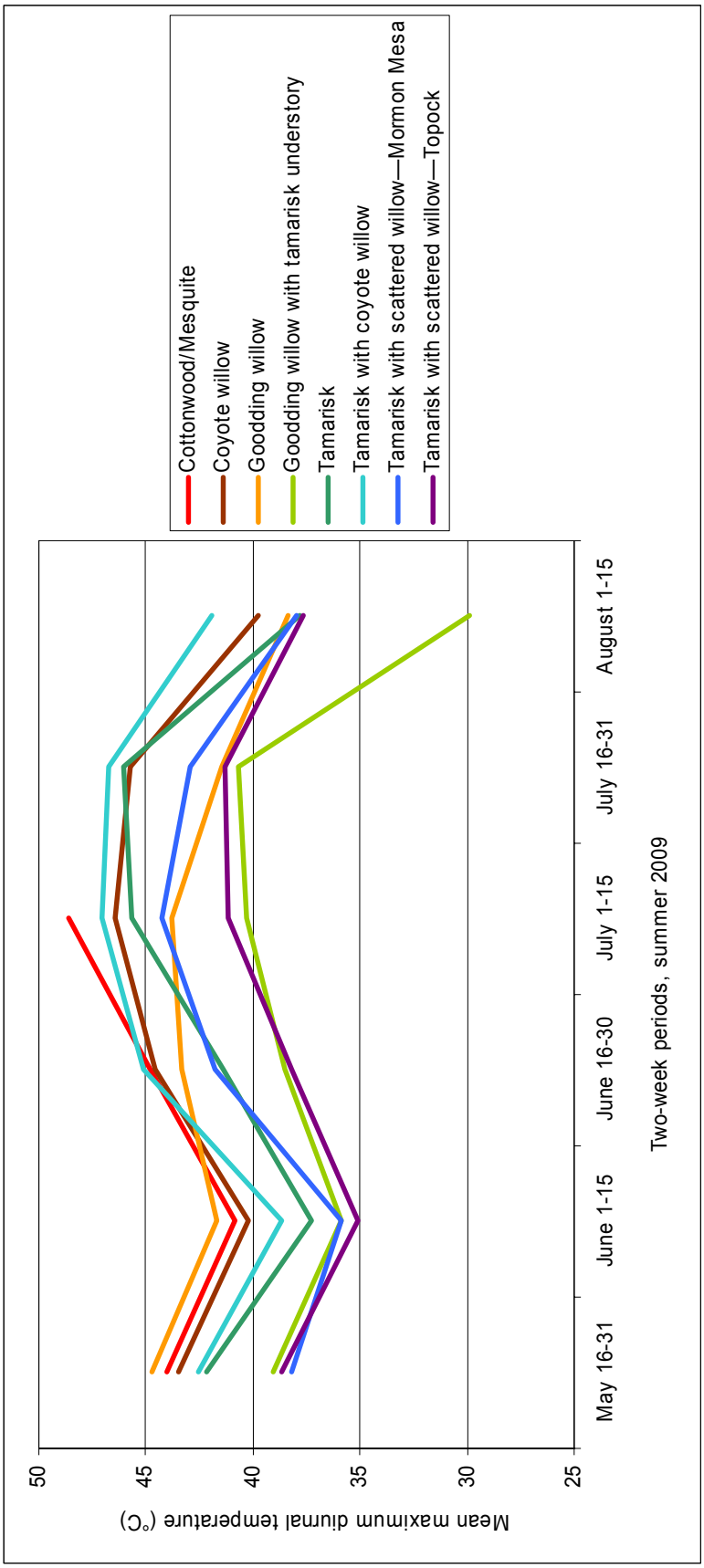

Figure 6.5. Mean maximum diurnal temperature at Southwestern Willow Flycatcher territories in various vegetation types, Lower Colorado River and tributaries, 2009. Data are summarized by two-week periods.

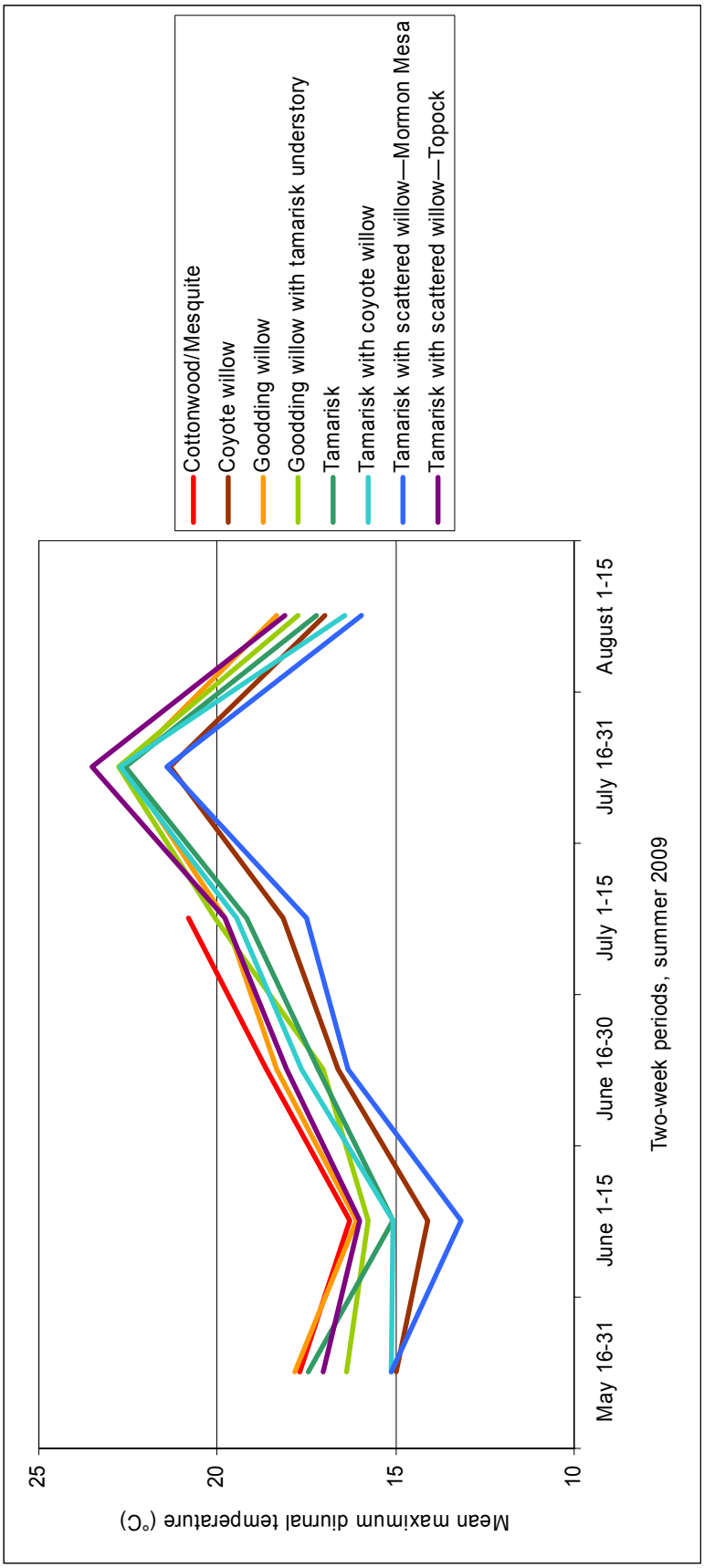

Figure 6.6. Mean minimum nocturnal temperature at Southwestern Willow Flycatcher territories in various vegetation types, Lower Colorado River and tributaries, 2009. Data are summarized by two-week periods.

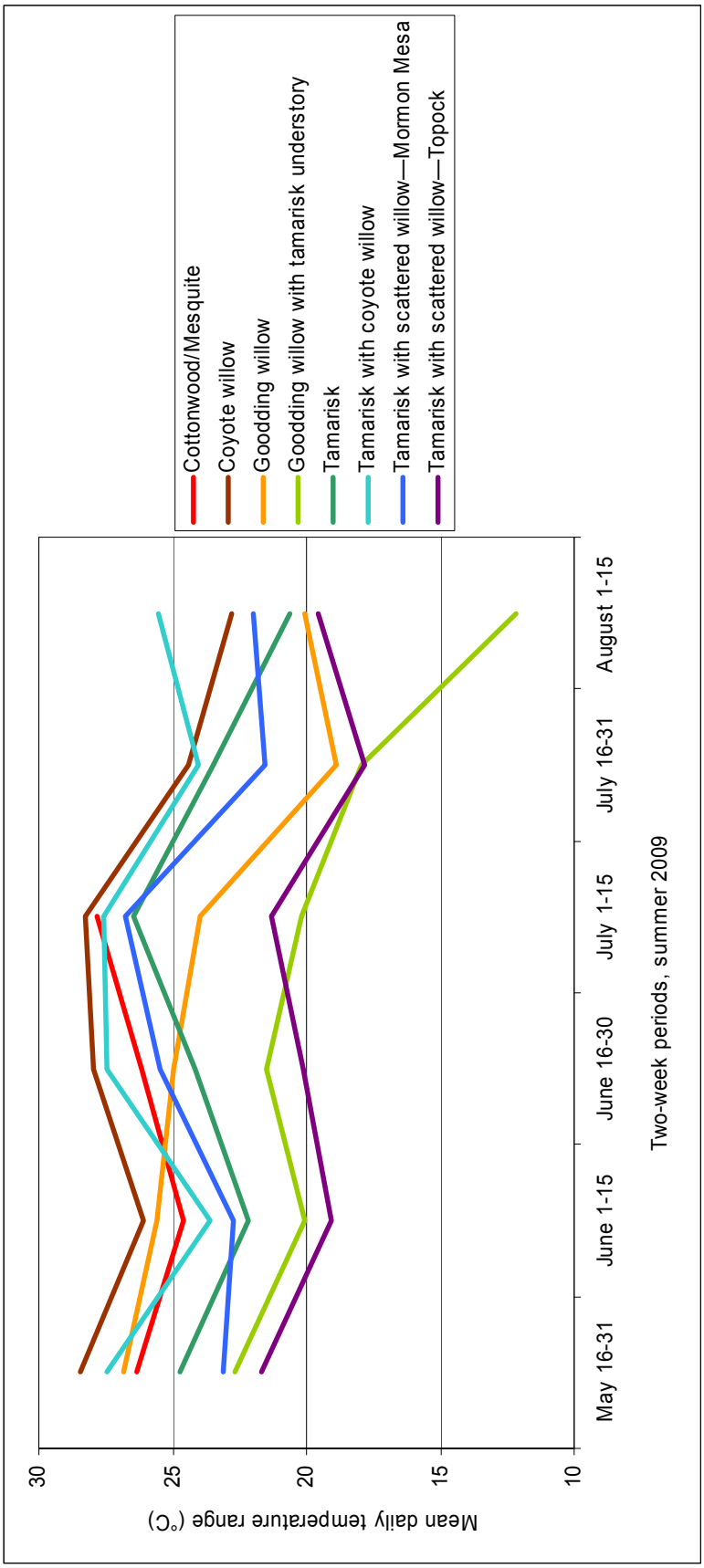

Figure 6.7. Mean daily temperature range at Southwestern Willow Flycatcher territories in various vegetation types, Lower Colorado River and tributaries, 2009. Data are summarized by two-week periods.

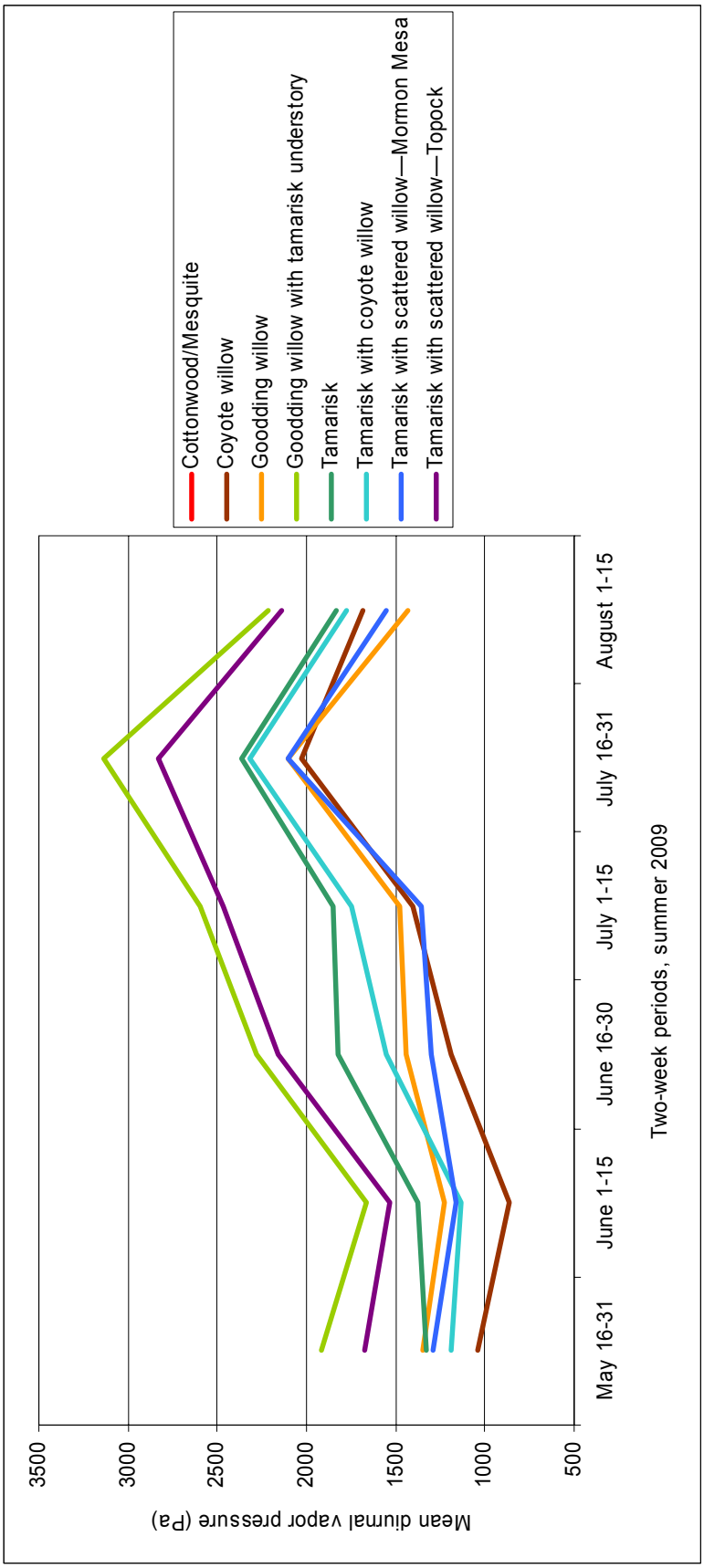

Figure 6.8. Mean diurnal vapor pressure at Southwestern Willow Flycatcher territories in various vegetation types, Lower Colorado River and tributaries, 2009. Data are summarized by two-week periods.

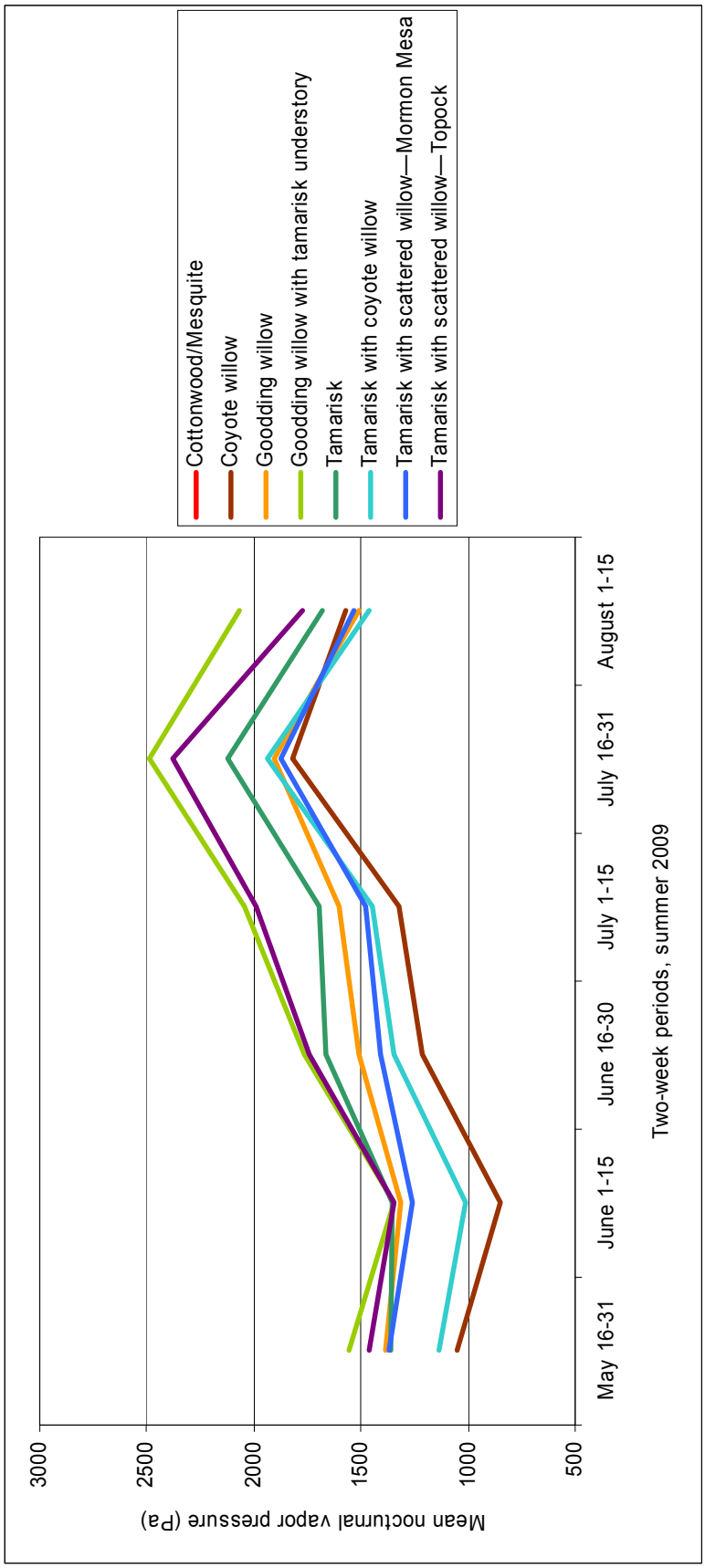

Figure 6.9. Mean nocturnal vapor pressure at Southwestern Willow Flycatcher territories in various vegetation types, Lower Colorado River and tributaries, 2009. Data are summarized by two-week periods.

Nests in Formerly Occupied Areas

We located 26 old nests at Mormon Mesa and Topock Marsh. We were able to locate the exact nest fork in 17 cases and located the nest tree but were unsure of the correct fork in 5 additional cases. In four cases we located the nest vicinity (within 5 m of the nest location) but were unable to verify that we had located the exact nest tree. Three of the 26 HOBO data loggers failed to collect data, while two loggers collected temperature but no humidity data. Soil moisture data from the occupied period were unavailable for the two nests that were active in 2003.

Microclimate at old nests sites differed between occupied and unoccupied periods in at least one variable at both Mormon Mesa (Table 6.9) and Topock Marsh (Table 6.10). At Mormon Mesa, nest sites had higher diurnal and nocturnal vapor pressure when they were occupied versus when they were abandoned. At Topock Marsh, nest sites had higher nocturnal vapor pressure when the nest was occupied. When data from both sites were pooled, mean diurnal and nocturnal vapor pressure were lower in 2009 versus when the nest was occupied (Table 6.11). The only variables that showed a unidirectional change across study areas were soil moisture and nocturnal vapor pressure, both of which were lower in 2009 versus when the nest was occupied.

Mean daily maximum temperature recorded at the Overton weather station in June–August 2009 (105.3 °F) was lower ($F_{6,630} = 2.7$, $P = 0.014$) than in the same period in 2003 or 2007 (both 108.5 °F). Mean daily minimum temperature at Overton was higher ($F_{6,630} = 8.9$, $P < 0.001$) in 2009 (72.5 °F) than in 2005 (69.3 °F) or 2007 (68.8 °F). At the Needles weather station, mean maximum daily temperature was lower ($F_{6,637} = 6.3$, $P < 0.001$) in June–August 2009 (106.9 °F) than during the same period in 2006 (111.0 °F). Mean minimum daily temperature in 2009 (81.4 °F) was also lower than in 2006 (85.5 °F) ($F_{6,637} = 5.9$, $P < 0.001$). Average dew point at Needles was lower ($F_{6,637} = 13.9$, $P < 0.001$) in 2009 (38.8 °F) than in 2003 (55.7 °F), 2004 (48.3 °F), or 2006 (45.6 °F).

Table 6.9. Paired T-test Results Comparing Microclimate Characteristics at Willow Flycatcher Nest Sites When the Nest Was Occupied Versus When the Nest Area Was Abandoned, Mormon Mesa, NV

Microclimate Measure	Occupied	Unoccupied	Difference	*P*
Soil Moisture (n = 8)				
Mean soil moisture (mV)	761.6 (72.4)	722.0 (51.5)	-39.5	0.72
Temperature (n = 13)				
Mean maximum diurnal temperature (°C)	42.6 (0.4)	43.9 (0.4)	1.4	0.22
Mean minimum nocturnal temperature (°C)	22.5 (0.3)	20.9 (0.2)	-1.1	0.16
Mean daily temperature range (°C)	20.0 (0.5)	23.0 (0.4)	2.4	0.10
Humidity (n = 13)				
Mean diurnal vapor pressure (Pa)	1859.5 (46.4)	1303.6 (33.5)	-502.1	0.004
Mean nocturnal vapor pressure (Pa)	1825.7 (38.4)	1312.5 (25.0)	-468.4	0.003

Table 6.10. Paired T-test Results Comparing Microclimate Characteristics at Willow Flycatcher Nest Sites When the Nest Was Occupied Versus When the Nest Area Was Abandoned, Topock Marsh, AZ*

Microclimate Measure	Occupied	Unoccupied	Difference	*P*
Soil Moisture (n = 9)				
Mean soil moisture (mV)	873.5 (28.8)	852.0 (35.9)	-38.0	0.16
Temperature (n = 10)				
Mean maximum diurnal temperature (°C)	39.9 (0.4)	38.7 (0.3)	-1.2	0.39
Mean minimum nocturnal temperature (°C)	21.0 (0.3)	21.2 (0.3)	0.2	0.78
Mean daily temperature range (°C)	18.9 (0.5)	17.5 (0.4)	-1.3	0.34
Humidity (n = 8)				
Mean diurnal vapor pressure (Pa)	2368.6 (43.5)	2433.6 (47.7)	9.9	0.92
Mean nocturnal vapor pressure (Pa)	2128.3 (36.8)	2083.5 (37.4)	-115.6	0.03

* Data are presented as mean (standard error).

Table 6.11. Paired T-test Results Comparing Microclimate Characteristics at Willow Flycatcher Nest Sites When the Nest Was Occupied Versus When the Nest Area Was Abandoned, All Sites Combined*

Microclimate Measure	Occupied	Unoccupied	Difference	*P*	Direction and Magnitude of Change[1]	
					MOME	TOPO
Soil Moisture (n = 17)						
Mean soil moisture (mV)	820.8 (38.7)	802.9 (25.8)	-38.7	0.45	↓	↓
Temperature (n = 23)						
Mean maximum diurnal temperature (°C)	41.3 (0.3)	41.7 (0.3)	0.3	0.77	↑	↓
Mean minimum nocturnal temperature (°C)	21.8 (0.2)	21.1 (0.2)	-0.5	0.28	↓	↑
Mean daily temperature range (°C)	19.5 (0.4)	20.6 (0.3)	0.8	0.45	↑	↓
Humidity (n = 21)						
Mean diurnal vapor pressure (Pa)	2093.2 (35.2)	1964.6 (28.1)	-314.6	0.008	↓	↑
Mean nocturnal vapor pressure (Pa)	1739.2 (40.9)	1609.7 (29.4)	-334.0	0.001	↓	↓

* Data are presented as mean (standard error).

[1] Arrows indicate the direction of change of the variable between occupied and unoccupied periods for each study area (MOME = Mormon Mesa and TOPO = Topock Marsh), while color indicated the statistical significance of the change as follows: red is P <0.05, green is 0.05<P<0.10, black is P >0.10.

DISCUSSION

Currently Occupied Territories

The hydrological conditions recorded in occupied territories in 2009 show that Goodding willow, tamarisk, tamarisk with scattered willow at Topock, and Goodding willow with tamarisk understory habitat types contained the wettest soils at the beginning of the breeding season, with the distance to surface water being less than 30 m and up to 70% of the surrounding area within 50 m containing saturated or inundated soil. Soils became progressively drier throughout the season in all these habitat types, though the speed and extent to which the soils dried out varied among habitat types.

The coyote willow and tamarisk with coyote willow habitat types, both of which are present at Mesquite West, showed a notable departure from the wet conditions observed there in previous years. The Mesquite West site did not receive any surface water until June (see Chapter 2), and the hydrological data show the low soil moisture, low percentage of the area inundated, and high distance to surface water observed at the site in 2009. Despite the dry soil conditions, both habitat types were occupied by breeding flycatchers, though occupancy likely reflects the high site fidelity of adult flycatchers (see Chapter 3) rather than the suitability of the hydrologic conditions for creating and maintaining flycatcher habitat.

The lowest soil moisture values were recorded in the cottonwood/mesquite habitat type at the Beal Lake restoration area. This area is flood irrigated but contains very sandy soil and thus dries quickly. Although flycatchers were detected on multiple occasions at Beal Lake, they responded to broadcast but did not engage in the lengthy, unsolicited song typical of territorial male flycatchers. No flycatcher breeding activity has been detected in this habitat type along the LCR, and this habitat type should not be used as a model for flycatcher habitat

Tamarisk with scattered Goodding willow at Mormon Mesa was the only vegetation type that was influenced by an undammed river. Unlike in most previous years, the Virgin River at Mormon Mesa did not go completely subsurface at any time during the breeding season, and occupied flycatcher habitat at Mormon Mesa did not lose its saturated and inundated soils in 2009 as it had in previous years.

Temperature and humidity varied across habitat types. As in 2008, Goodding willow with tamarisk understory was the most humid, followed by tamarisk with scattered willow at Topock. These two habitat types were also the most thermally stable. In previous years, tamarisk with scattered willow at Mormon Mesa had the highest temperature, largest daily temperature range, and lowest humidity (McLeod et al. 2008, McLeod and Koronkiewicz 2009), but in 2009, coyote willow and tamarisk with coyote willow had daily temperature ranges higher than and humidity comparable to territories at Mormon Mesa. The less humid and less thermally moderate conditions in coyote willow and tamarisk with coyote willow habitat types may be related to the lack of surface water in Mesquite West.

Nests in Formerly Occupied Territories

Willow flycatchers along the lower Colorado River and tributaries selected nest sites that were cooler, wetter, and more thermally moderate than unused sites in the adjacent landscape (McLeod et al. 2008), and we anticipated seeing similar differences when we examined temporal, rather than spatial, variation in habitat use. The only statistically significant differences we observed (lower mean diurnal and nocturnal vapor pressure at Mormon Mesa and lower nocturnal vapor pressure at Topock Marsh in 2009 versus when the nest was active) were consistent with these expectations. However, the mean dew point at the Needles weather station in June–August 2009 was lower than in the corresponding months in 2003, 2004,

or 2006, suggesting that regional climate could have accounted for the observed differences in vapor pressure at nest sites in Topock Marsh. Humidity data were not available for the Overton weather station, but a qualitative comparison of vapor pressure observed at occupied territories at Mormon Mesa in 2009 versus that observed in 2003–2007 (McLeod et al. 2008) suggests that overall humidity was lower in 2009. Thus, the differences in microclimate we observed between 2009 and the year the nest was occupied at both Topock and Mormon Mesa are likely the result of interannual climatic differences and not the result of localized changes at the nest sites. We found some evidence of an increase in the proportion of dead stems at old nests at both Topock and Mormon Mesa (see Chapter 5), but otherwise found no evidence of dramatic changes in vegetation at formerly occupied territories that might result in changes in temperature or humidity. It is possible that subtle changes in vegetation (see Chapter 5) were sufficient to reduce suitability of the sites for flycatchers. It is also possible that changes in occupancy patterns at Topock Marsh may be influenced by an overall decrease, since 2004, in the number of nesting pairs (see Chapter 4).

Soil moisture values did not differ significantly between unoccupied and occupied periods at either study area, and a post-hoc analysis comparing the distance to surface water during occupied vs. unoccupied periods showed no statistical difference at Mormon Mesa (data on distance to water at Topock were too sparse to allow analysis). Surface water conditions at the Virgin River #2 site, where the formerly occupied territories at Mormon Mesa were located, nonetheless differed notably over time, with the occupied territories containing surface water throughout the season in 2005 and at the beginning of the season in 2006 but not in subsequent years. The affinity of willow flycatchers with surface water is well documented in the literature, and the presence of surface water likely affects flycatcher settlement at the beginning of the breeding season. Adult flycatchers also demonstrate high site fidelity, and will return to previously used breeding areas even if conditions are no longer optimal. Thus, it is possible that Virgin River #2 has not represented optimal flycatcher habitat for multiple years, but site fidelity maintained the presence of breeding flycatchers through 2008.

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 372 acres (151 ha) 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 chapter reports the results of this study 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. We monitored these same 15 sites from 2005 to 2009. 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.

Temperature/Humidity (T/RH) Loggers

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

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

Soil Moisture (SM) Measurements

Soil moisture beneath each HOBO logger was measured and recorded using a hand-held ThetaProbe ML2x coupled to an HH2 Moisture Meter Readout (Macaulay Land Use Research Institute, Aberdeen, UK, and Delta-T Devices, Cambridge, UK, respectively). Soil moisture measurements were collected during each presence/absence survey between 15 May and 25 July and when HOBO data were downloaded. For sites that were part of the biennial survey schedule and were not surveyed in 2009 (see Chapter 2), soil moisture measurements were collected only when HOBO data were downloaded at the beginning and end of the survey season. 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 2005–2008, with the exception of Gila Confluence North, where vegetation measurements were collected at the two new HOBO locations established in 2007.

Groundwater Measurements

A small-diameter shallow well, or piezometer, equipped with a pressure transducer/data logger was installed in May–August 2005 near each of the 15 sites selected for habitat monitoring to monitor groundwater levels. These 15 piezometers are described in Koronkiewicz et al. (2006a) and have been downloaded approximately three times per year since installation. One additional piezometer was installed at Topock Marsh within occupied flycatcher habitat in 2006 and has been downloaded on the same schedule as the other piezometers. At each download we check the battery level and function of the data logger. Batteries are replaced as necessary and data are examined to ascertain potential equipment malfunction.

Piezometer Replacement

The piezometer at the Gila Confluence North monitoring site was moved to a new location within the same site in July 2007 because the original station was damaged in a local brush fire. In March 2008, a new piezometer was installed at the Cibola Lake monitoring site to replace the original station, which was bulldozed sometime during the summer of 2007. Several piezometers developed consistent battery failure or other equipment malfunction during 2008. Between the summers of 2008 and 2009, we replaced the original pressure transducers (In-Situ MiniTroll Standard-P) with the newest generation of pressure transducer (In-Situ LevelTroll 500) at sites that appeared to have the worst equipment failure problems.

Data Collection

A pressure transducer/data logger equipped with a vented cable collected data hourly at each 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 transducers, as well as at each data download thereafter, water levels were manually measured in the piezometers using an electric water level sounder (Solinst-brand). These known water levels were then used to program the pressure transducer with a baseline measurement from which all other automatically recorded water levels were calculated.

We obtained additional hydrologic data from the U.S. Geological Survey (USGS) regarding streamflow and stage height in the Colorado River below Parker Dam (09427520).

Data Validation

We have identified several sources of error in the water levels recorded by the 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. For consistency, we applied this data validation protocol retroactively to all data obtained since installation of the piezometers.

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 >0.3 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. 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. This type of error was first recognized in the data following initial piezometer installation and has occurred with increasing frequency due to removing the data logger from the piezometer to change batteries at each download.

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 loggers are 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.

The errors described above did not typically prevent data from being analyzed for evapotranspiration signature (see below). The evapotranspiration analysis relies on relative changes in water level over the course of a single day, and these signatures are not affected by improper setup or correction factors.

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 (2009).

These values were then calculated for all 15 sites combined and compared to the same values for territory locations at Topock Marsh. These analyses were restricted to 6 May–31 July 2008, the dates during which microclimate data were collected both within territories at Topock and at the habitat monitoring locations. One-way ANOVA tests were used to test the difference in means for the T/RH and SM values.

We assigned all plots as a control site (above Parker Dam or below Imperial Dam) or as a test site (between Parker and Imperial), then analyzed between-year differences in T/RH and SM values within these two groups using paired t-tests. We then analyzed the between-year differences among the test sites compared to the control sites using one-way repeated measures ANOVA. These analyses were restricted to 1 June–1 August. Analyses were conducted using SAS® Version 9.1 (SAS Institute 2003).

Vegetation

We analyzed the between-year differences among the test sites compared to the control sites using one-way repeated measures ANOVA 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. We also used repeated measures ANOVA to examine foliage density for live and dead vegetation at each meter interval above the ground. 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.

Groundwater Levels

We calculated monthly high and low water levels for all piezometers. We examined monthly river flow data from below Parker Dam from 2000 to 2009 to determine whether there has been a decrease in water levels since the scheduled implementation of the change in point of diversion from Imperial Dam to above Parker Dam, which began in early 2001.

Evapotranspiration Signature. A distinct daily change in water levels occurs due to removal of water from the shallow aquifer by vegetation. Typically, water levels are lowest in the afternoon, during and following times of peak water use by plants, and water levels are highest in the morning after the shallow aquifer has been able to recharge. For the purposes of this report, we refer to this daily fluctuation as the "evapotranspiration signature." Since the 1930s, various researchers have sought to use this daily fluctuation in groundwater levels to estimate the amount of water lost from the aquifer due to evapotranspiration. Various approaches have been tried, most under highly controlled field conditions (e.g., White 1932, Gatewood et al. 1950, Bowie and Kam 1968, Hays 2003). Several studies refer to this as the "transpiration-well" method.

The transpiration-well method is based on the premise that during the day, water is lost to evapotranspiration at a faster rate than it can be replenished by the hydrostatic pressure of the aquifer. This leads to a decline in the water table between the hours of approximately 6:00 a.m. and 5:00 p.m.

Overnight, the water table rises as evapotranspiration decreases and recharge is greater than losses to vegetation. White (1932) reasoned that if water levels had no net rise or fall over the course of a day, then the net loss of water from the aquifer from evapotranspiration must equal the recharge rate. White assumed that the recharge rate was best estimated between the hours of midnight and 4:00 a.m., when very little, if any, evapotranspiration was occurring. If water levels were falling day to day, then evapotranspiration must exceed recharge, and the evapotranspiration rate would equal the daily recharge rate, plus the amount of decline in day-to-day water levels. White used the following formula (see Figure 7.1):

$$q = y(24r \pm s)$$

Where:

q = the daily evaporation rate (in inches)

y = the specific yield of the soil (unitless)

r = the hourly recharge rate between midnight and 4:00 a.m. (in inches/hour)

s = H2 - H1 = the difference in water levels on consecutive days (in inches). The value s is subtracted when water levels are rising and added when water levels are falling.

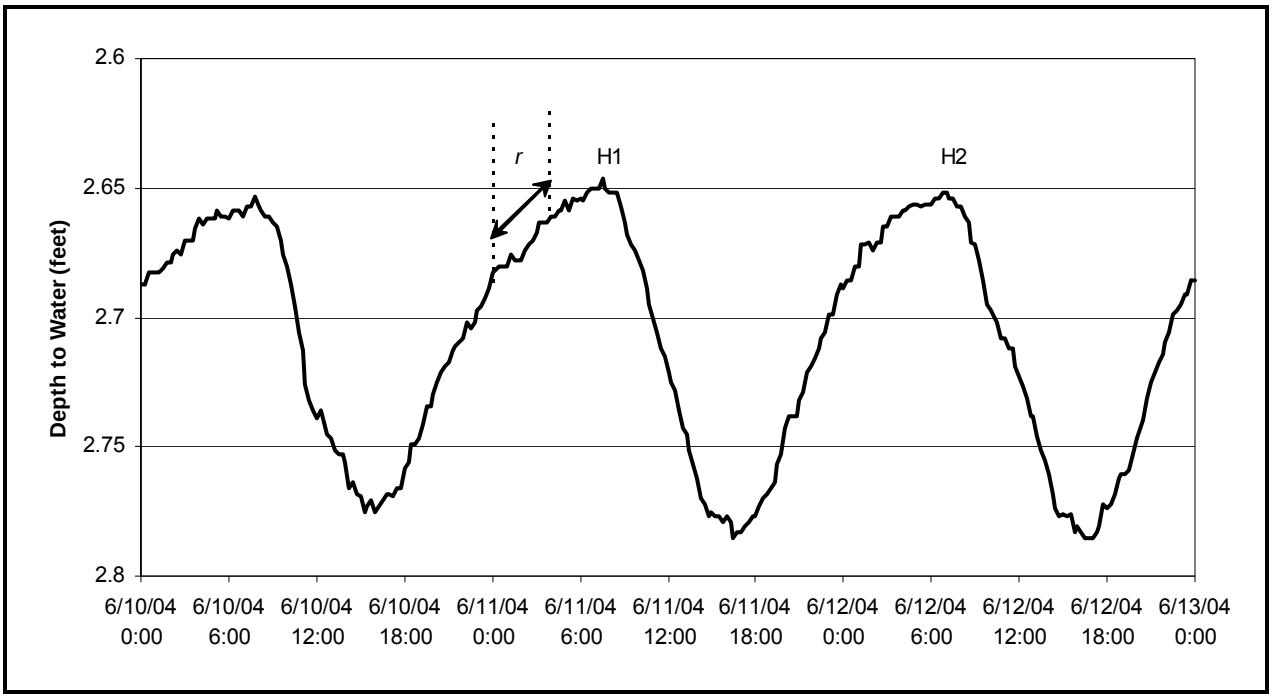

Figure 7.1. Typical daily fluctuation in groundwater levels as the result of evapotranspiration and recharge. H1 and H2 are the maximum water levels on consecutive days, while r is the recharge rate as calculated between midnight and 4 a.m.

The White formula is based on two fundamental assumptions about the shallow aquifer:

- The aquifer has a source of recharge. This source of recharge could be any surface water, either a river or a lake, or it could simply be the surrounding aquifer beyond the influence of the transpiring plants. Without some source of recharge, water levels would only decline and not rebound during the night.

- However, this source of recharge is not close or immediate enough to cause any changes in groundwater levels other than those due to evapotranspiration. Changes in overall water levels from day to day are considered to be indicative of evapotranspiration losses. If water levels rise or fall due to an outside influence (such as changes in river water levels), the calculation of evapotranspiration is rendered invalid.

We used the White formula to calculate evapotranspiration signature, with the following modifications:

- The White formula includes a term for specific yield of the soil. This term allows conversion from water level changes as observed in a piezometer to water level changes as occurring in the actual soil pore space of the aquifer. Because we are only interested in relative changes between years as a method of estimating vegetation health, we dropped the specific yield term from the White formula. Because of this, our calculations of the "evapotranspiration signature" are not directly equivalent to volumetric water loss.

- White did not specify a method for calculating daily water level changes. We have chosen to use the maximum daily water level for each day, in contrast to using the water level at any set hour. This is advantageous because the time of highest water level changes somewhat throughout the season with the changing of day length.

Because evapotranspiration is strongest during the summer months and diminishes over the winter, only the months of May–September were used for this analysis. The evapotranspiration signature reflects changes on an hourly basis, and as such is highly localized, reflecting water use by plants only in the immediate vicinity of the piezometer. The evapotranspiration signature attenuates in the aquifer the further it is from vegetation. Therefore, we limited the evapotranspiration analysis to sites where piezometers are located within the riparian vegetation that is surveyed for flycatchers (Topock Marsh, Blankenship Bend, Havasu NE, Ehrenburg, Cibola Lake, Paradise, Hoge Ranch, Clear Lake, Ferguson Lake, and Ferguson Wash).

The intent of the evapotranspiration analysis was to assess whether changes in the evapotranspiration signature over time could be used as a proxy to detect changes in vegetation density or vegetation cover resulting from changes in river level. Evapotranspiration is affected by other parameters besides vegetation density, including temperature, humidity, groundwater level, solar radiation, and wind. To be effective as a proxy for vegetation density, concurrent changes in these other parameters must be taken into account. As such, we first examined the correlation between the evapotranspiration signature as calculated from the modified White formula and mean diurnal temperature and mean daily water level in the piezometers.

In previous reports we correlated groundwater levels as measured by the piezometers with reservoir releases and soil moisture levels. We do not repeat these analyses here.

RESULTS

Temperature/Humidity Logger Maintenance

All HOBO loggers were downloaded at the beginning and end of the 2009 field season. Eight loggers had fallen to the ground over the winter because of sun damage to the logger housing. Two additional loggers that were in place over the winter had bad humidity sensors but useable temperature data, and one logger would not download. Of the HOBO loggers in place May–August 2009, three had faulty humidity data and one fell to the ground. Data from fallen loggers were not used in the analysis.

Piezometer Installation and Maintenance

The original data loggers (miniTroll models) were replaced with LevelTroll models at Topock Marsh Paradise, Hoge Ranch, Ferguson Wash, and Gila Confluence North in March 2009. Table 7.1 lists details on installation parameters for all piezometers.

All of the data loggers except for Ehrenberg have experienced multiple data breaks over their lifetime due either to battery failure or equipment malfunction. The incidences of battery failure are chronic with all of the originally installed equipment and continuously disrupt data collection. As a result, we have started replacing batteries in the original equipment at each download session regardless of the battery level reading. The LevelTroll models have internal batteries with a manufacturer-reported minimum lifespan of 5 years.

Data Validation

A total of 151 download periods were assessed using the data validation protocol. Of these, 109 download periods (72%) required no correction. An additional 27 download periods (18%) had identifiable errors and a correction factor was applied to the data. Data from 15 download periods (10%) were unable to be validated, and the data were deemed unusable for analysis. Of the 27 download periods with correctable errors, 7 experienced install drift and 3 experienced operational drift. Seventeen download periods required corrections due to improper setup, primarily of reference points. Improper setup errors also caused all 15 of the download periods determined to be unusable; most of these instances resulted from the combination of setup errors and equipment malfunction.

The data validation procedure allows most of the recorded data to be corrected and deemed usable and reliable for analysis; the larger challenge has been equipment loss (Cibola Lake and Gila Confluence North) or outright failure. The new model data logger installed at Hoge Ranch proved to be defective and collected no data in 2009. In addition, hardware communication, software compatibility, and user error issues rendered 2009 data from the new model data loggers unusable at Paradise, Ferguson Wash, and Gila Confluence North. In the September 2009 download, data loggers from Blankenship Bend, Havasu NE, Three Fingers Lake, and Mittry West had to be removed and shipped to the manufacturer for data retrieval. All four data loggers have been deemed by the manufacture to be defective and unrepairable.

Table 7.1. Summary of Piezometer Construction and Data Collection at Habitat Monitoring Sites, Lower Colorado River, 2005–2009*

Site	Depth (ft)	Stickup height (ft)	Date installed	Data breaks	Distance (ft) from habitat
Topock Marsh	INA	2.5	13-Aug-06[1]	Aug 2007–Feb 2008[2] Jun 2008–Mar 2009	Within
Blankenship Bend	7.2	3.4	28-Aug-05	After 12 Aug 2007	Within
Havasu NE	6.1	2.2	09-May-05	Dec 2007–Feb 2008 Jan 2009–March 2009 After April 2009	Within
Ehrenberg	7.4	2.6	29-Aug-05	None[2]	Within
Three Fingers Lake	7.7	4.1	31-May-05	After Mar 2009	540
Cibola Lake	7.2	3.6	30-May-05[3]	Sep–Dec 2005 Feb 2007–Mar 2009	Within
Walker Lake	7.4	2.9	30-May-05	Jul 2008–Mar 2009 After Jun 2009	230
Paradise	11.7	0.6	11-May-05[1]	May–Jun 2006 Aug 2007 Sep 2007–Feb 2008 After 5 Mar 2008	Within
Hoge Ranch	8.7	2.8	11-May-05[1]	Jun–Sep 2006[2] After Sep 2007	Within
Rattlesnake	7.0	2.8	10-May-05	After Apr 2008	1,080
Clear Lake	8.7	2.4	10-May-05	After Apr 2008	Within
Ferguson Lake	7.6	2.7	10-May-05	After Apr 2008	Within
Ferguson Wash	INA	2.2	10-May-05[1]	After Jan 2008[2]	Within
Great Blue Heron	7.3	1.7	31-May-05	Aug–Dec 2005 After Aug 2008[2]	60
Mittry West	5.0	3.0	29-Aug-05	Feb 2008 Dec 2008–May 2009	270
Gila Confluence North	7.9	4.7	29-Aug-05[1,4]	After Jul 2007[2]	50

* INA = information not available, N/A = not applicable.

[1] Original piezometer replaced with new model LevelTroll.

[2] Dates differ from those presented in previous reports due to data validation.

[3] Piezometer destroyed by clearing activity between February and July 2007; replaced 27 March 2008; stick-up height applies to new piezometer.

[4] Location of original piezometer burned in December 2006; piezometer replaced on 5 July 2007; stick-up height applies to new piezometer.

Microclimate

2009 Microclimate Descriptive Statistics

Soil moisture, temperature, and vapor pressure parameters from the 15 study sites monitored in 2009 exhibited substantial variation among sites (Table 7.2). Soil moisture varied by a factor of four among the 2008 study sites, from a low of 227.4 mV at Havasu NE to a high of 917.6 at Great Blue Heron.

Mean maximum diurnal temperatures ranged from a low of 37.4°C at Clear Lake and a high of 50.8°C at Three Fingers Lake. Mean minimum nocturnal temperatures ranged from a low of 18.4°C at Three Fingers Lake to a high of 22.4°C at Ferguson Lake. Mean number of 15-minute intervals above 41°C

each day varied from 1.8 at Rattlesnake to 24.7 at Cibola Lake. Mean daily temperature range varied from 16.0°C at Clear Lake to 32.3°C at Three Fingers Lake.

Mean diurnal vapor pressure was lowest at Three Fingers Lake (1,098.2 Pa) and highest at Rattlesnake (2208.5 Pa). Mean nocturnal vapor pressure was lowest at Three Fingers Lake (1161.2 Pa) and highest at Rattlesnake (1923.6 Pa).

Between-year Comparisons of Microclimate Characteristics

All microclimate characteristics varied significantly over time at test sites (Ehrenberg, Three Fingers Lake, Cibola Lake, Clear Lake, Walker Lake, Ferguson Lake, Ferguson Wash, Great Blue Heron, Hoge Ranch, Paradise, and Rattlesnake; Table 7.3). At control sites (Blankenship Bend, Havasu NE, Mittry West, and Gila Confluence North), only mean minimum nocturnal temperature varied significantly over time. Neither test nor control sites showed a unidirectional change in any of the microclimate measures over time. The changes over time differed between test and control sites for soil moisture, mean maximum diurnal temperature, and daily temperature range (right-most column of Table 7.3). 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 2007 and 2008, both mean maximum diurnal temperature and mean daily temperature range increased at test sites but decreased at control sites.

Table 7.2. Microclimatic Data Summaries Collected From Habitat Monitoring Sites, Lower Colorado River, May–July 2009*

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)	842.4 (51.8)	227.4 (70.8)	699.5 (55.0)	634.4 (55.9)	459.8 (56.6)	869.5 (27.3)	761.5 (41.2)	841.1 (11.9)	786.6 (23.3)	457.0 (146.8)	911.9 (9.4)	356.2 (56.3)	917.3 (4.9)	897.3 (8.2)	335.6 (44.4)
Temperature															
Mean maximum diurnal temperature (C)	44.7 (0.4)	45.0 (0.4)	46.1 (0.4)	50.8 (0.4)	49.4 (0.3)	41.3 (0.3)	44.7 (0.4)	46.5 (0.3)	38.2 (0.3)	37.4 (0.3)	41.5 (0.3)	41.8 (0.4)	40.9 (0.3)	43.0 (0.4)	43.7 (0.4)
Mean minimum nocturnal temperature (C)	20.7 (0.2)	22.1 (0.2)	22.0 (0.3)	18.4 (0.3)	21.2 (0.3)	19.7 (0.3)	20.4 (0.3)	19.7 (0.2)	18.8 (0.2)	21.3 (0.2)	22.4 (0.2)	22.1 (0.2)	20.1 (0.2)	20.5 (0.2)	20.2 (0.3)
Mean daily temperature range (C)	24.0 (0.4)	22.9 (0.5)	24.1 (0.4)	32.3 (0.5)	28.2 (0.4)	21.6 (0.4)	24.3 (0.6)	26.9 (0.4)	19.4 (0.3)	16.0 (0.3)	19.1 (0.3)	19.7 (0.4)	20.8 (0.3)	22.6 (0.5)	23.6 (0.4)
Humidity															
Mean diurnal vapor pressure (Pa)	1425.7 (28.1)	1462.0 (28.7)	1250.8 (31.6)	1098.2 (30.5)	1164.7 (28.0)	1711.5 (34.5)	1585.4 (31.5)	1651.1 (31.5)	2208.5 (43.7)	2205.1 (48.2)	1866.6 (33.3)	1734.1 (32.9)	2088.4 (39.7)	1974.7 (42.6)	1854.7 (36.9)
Mean nocturnal vapor pressure (Pa)	1421.1 (27.5)	1295.0 (25.1)	1305.9 (30.3)	1161.2 (24.3)	1302.2 (23.7)	1515.1 (27.6)	1483.0 (27.1)	1506.4 (26.7)	1923.6 (35.7)	1783.3 (39.6)	1714.2 (28.7)	1436.2 (28.8)	1868.1 (31.9)	1730.9 (35.8)	1792.1 (35.2)

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

Table 7.3. Change in Microclimatic Variables at Habitat Monitoring Sites from 2005 to 2009*

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	Change 2005 to 2006	Change 2006 to 2007	Change 2007 to 2008	Change 2008 to 2009	P-value for the difference between years	2005	2006	2007	2008	2009	Change 2005 to 2006	Change 2006 to 2007	Change 2007 to 2008	Change 2008 to 2009	P-value for the difference between years	
Soil Moisture																					
Mean soil moisture (mV)	645.7	634.4	662.9	705.8	699.2	-11.3	28.5	42.9	-6.6	<0.001	694.4	582.9	635.3	607.5	591.7	-111.5	52.4	-27.8	-15.8	0.590	0.003
Temperature																					
Mean maximum diurnal temperature (C)	44.9	46.1	45.2	46.5	43.8	1.2	-0.9	1.3	-2.7	<0.001	45.6	48.0	46.4	45.7	44.2	2.4	-1.6	-0.7	-1.5	0.053	0.047
Mean minimum nocturnal temperature (C)	20.7	22.7	20.4	20.7	21.2	2.0	-2.3	0.3	0.5	<0.001	20.2	22.1	20.3	20.8	21.2	1.9	-1.8	0.5	0.4	<0.001	0.185
Mean daily temperature range (C)	24.2	23.5	24.8	25.8	22.6	-0.7	1.3	1.0	-3.2	<0.001	25.4	26.0	26.1	24.9	23.0	0.6	0.1	-1.2	-1.9	0.079	0.046
Humidity																					
Mean diurnal vapor pressure (Pa)	1,797.2	2,028.4	1,737.9	1770.4	1758.9	231.2	-290.5	32.5	-11.5	<0.001	1,726.3	1,863.9	1,696.9	1,692.3	1,701.1	137.6	-167.0	-4.6	8.8	0.142	0.283
Mean nocturnal vapor pressure (Pa)	1,686.3	1,860.4	1,852.7	1679.8	1618.0	174.1	-7.7	-172.9	-61.8	<0.001	1,638.2	1,703.4	1,559.9	1,582.9	1583.2	65.2	-143.5	23.0	0.3	0.094	0.139

* *The analysis was restricted to 1 June–1 August each year. Some data differ from those presented in previous reports because of additional data proofing.

Comparison of Parker/Imperial to Topock Marsh: Microclimate

Topock Marsh was cooler and more humid than habitat monitoring sites but did not differ from habitat monitoring sites in average soil moisture (Table 7.4).

Table 7.4. Comparison of Microclimatic Variables at Habitat Monitoring Sites to Territories at Topock Marsh, 2009*

Response variable	Habitat Monitoring Sites	Topock Marsh	*P*
N (Temp./Humidity Sensor Arrays)	57	14	N/A
Soil Moisture			
Mean soil moisture (mV)	674.5 (35.6)	657.3 (73.4)	0.832
Mean maximum diurnal temperature	44.1 (0.8)	41.0 (1.5)	0.077
Mean minimum nocturnal temperature	20.6 (0.2)	19.2 (0.4)	0.002
Mean daily temperature range	23.5 (0.9)	21.8 (1.3)	0.358
Mean diurnal vapor pressure (Pa)	1660.5 (56.1)	2278.0 (87.8)	<0.001
Mean nocturnal vapor pressure (Pa)	1535.0 (37.1)	1891.0 (62.2)	<0.001

* Soil moisture and temperature/humidity values are means (standard error in parentheses). N/A = data not available or not applicable. The analysis was restricted to 6 May–31 July 2009.

Vegetation Measurements

Vegetation characteristics varied widely both between and within the selected habitat monitoring sites (Table 7.5). Average canopy height ranged from 3.3 m (Three Fingers Lake) to 11.8 m (Ehrenberg), and average canopy closure ranged from 63.7% (Cibola Lake) to 96.2% (Walker Lake). Measures of other habitat characteristics were similarly variable. Vertical foliage profiles for each site are shown in Figure 7.2. 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

Repeated measures ANOVA showed an overall between-year difference in canopy closure ($P < 0.001$), woody ground cover ($P < 0.001$), number of live stems < 2.5 cm and 2.5–8 cm dbh ($P = 0.020$ and $P = 0.041$, respectively), number of dead stems <2.5 cm and 2.5–8 cm dbh ($P = 0.022$ and $P = 0.002$, respectively), percentage of live stems <2.5 and 2.5–8 cm dbh ($P < 0.001$ and $P = 0.002$, respectively), and percent native basal area ($P = 0.013$) for all plots combined (Table 7.6). The only variables that exhibited a consistent change across time were percentage of live stems <2.5 cm dbh, which declined steadily from 2005 to 2009, and percentage of live stems 2.5–8 cm dbh, which was lower in 2008 and 2009 than in the three preceding years. Woody ground cover was the only variable for which there was a significant interaction ($P = 0.019$) with location (test vs. control sites), meaning the changes in all the other variables between years among test sites was not significantly different from the change at control sites. 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.

Table 7.5. Summary of Vegetation Characteristics at Habitat Monitoring Sites, Lower Colorado River, 2009*

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)	5.6 (0.4)	5.1 (0.5)	11.8 (4.6)	3.3 (0.3)	4.8 (0.9)	8.9 (4.2)	8.4 (3.8)	6.7 (1.9)	10.2 (2.5)	7.7 (0.72)	5.5 (0.2)	5.6 (0.8)	7.9 (1.3)	8.2 (1.3)	9.7 (0.2)
	5.0–6.5	4.0–6.0	3.0–21.8	2.8–4.5	2.7–8.4	4.7–17.3	3.4–19.9	3.8–12.2	6.0–16.9	6.4–8.5	5.0–5.9	4.2–7.5	5.5–10.5	4.8–11.0	9.3–9.9
% total canopy closure	88.6 (2.5)	66.7 (8.7)	69.4 (5.6)	85.5 (4.0)	63.7 (12.4)	96.2 (1.4)	83.2 (5.2)	89.7 (3.6)	94.9 (0.7)	94.3 (1.8)	96.0 (1.1)	93.0 (0.9)	90.9 (1.9)	88.8 (3.1)	87.2 (7.1)
	83.3–93.8	54.7–92.2	59.4–82.3	75.5–97.4	18.2–85.9	94.8–99.0	68.8–93.8	83.3–100.0	92.7–95.8	90.6–96.4	93.2–100.0	90.6–94.8	86.5–94.8	82.3–94.8	72.9–94.8
% woody ground cover	61.2 (19.4)	22.0 (4.4)	16.5 (3.2)	7.5 (3.0)	15.2 (4.6)	16.9 (8.18)	44.5 (18.8)	32.1 (9.0)	44.1 (1.0)	25.5 (17.9)	9.8 (4.0)	28.6 (6.2)	26.3 (7.1)	24.4 (12.8)	13.4 (4.0)
	13.0–100.0	11.8–30.0	8.5–23.8	3.0–19.3	5.0–31.0	2.5–30.5	10.0–80.0	14.3–54.0	41.3–45.3	7.0–61.3	1.8–24.8	13.0–41.3	17.0 (47.5)	2.3–59.3	9.0–21.5
# live stems <2.5 cm dbh per ha	1019 (653)	159 (159)	2069 (513)	8964 (1978)	2241 (576)	1231 (667)	2833 (796)	2419 (512)	1910 (1011)	424 (424)	2063 (605)	541 (159)	859 (305)	1783 (868)	2037 (555)
	127–2292	0–637	637–3056	2928–15152	255–3310	0–2292	764–4587	1273–3692	0–4584	0–1273	764–3820	127–891	382–1655	255–3947	1019–2928
# live stems 2.5–8 cm dbh per ha	1783 (320)	255 (138)	95 (61)	4074 (752)	1961 (582)	1401 (628)	2387 (1412)	2769 (715)	2515 (1093)	1867 (1103)	2979 (526)	1273 (349)	3279 (775)	1560 (556)	2334 (858)
	1401–2419	0–637	0–255	1783–6366	127–3310	382–2546	891–6621	637–3692	127–4838	764–4074	1146–4074	509–2165	1273–4966	255–2547	1019–3947
# live stems >8 cm dbh per ha	424 (258)	477 (167)	191 (82)	127 (70)	331 (103)	170 (112)	223 (141)	318 (152)	1337 (377)	1910 (555)	611 (110)	1146 (116)	605 (109)	573 (331)	722 (278)
	0–891	0–764	0–382	0–382	0–637	0–382	0–637	0–637	509–2037	1019–2928	255–891	891–1401	382–891	0–1528	382–1273
# dead stems <2.5 cm dbh per ha	212 (85)	446 (191)	1337 (638)	4905 (615)	2012 (393)	594 (331)	1082 (417)	3820 (1349)	700 (404)	1655 (1210)	2521 (724)	923 (380)	573 (247)	2706 (1044)	2377 (1030)
	127–382	255–1019	255–3183	3056–6494	637–3056	0–1146	382–2292	1401–6748	0–1401	382–4074	1146–5220	382–2037	127–1273	255–5348	382–3820
# dead stems 2.5–8 cm dbh per ha	509 (509)	350 (150)	796 (603)	1146 (217)	1299 (527)	764 (441)	477 (109)	1337 (443)	95 (61)	1570 (185)	1935 (340)	1082 (377)	1146 (249)	573 (82)	1103 (557)
	0–1523	127–764	0–2546	382–1655	0–2801	0–1528	255–764	127–2165	0–255	1273–1910	1146–3056	509–2165	637–1782	382–764	0–1783
# dead stems >8 cm dbh per ha	42 (42)	223 (183)	0 (0)	0 (0)	0 (0)	42 (42)	0 (0)	32 (32)	0 (0)	467 (236)	50.93 (31.2)	223 (109)	318 (37)	159 (121)	0 (0)
	0–127	0–764	0–0	0–0	0–0	0–127	0–0	0–127	0–0	0–764	0–127	0–509	255–382	0–509	0–0
Percent basal area native	28.8 (28.8)	0.0 (0.0)	74.1 (24.7)	0.2 (0.2)	0.0 (0.0)	33.1 (33.1)	0.8 (0.6)	50.5 (24.7)	29.8 (23.0)	0.0 (0.0)	4.6 (3.9)	29.6 (19.3)	42.3 (19.9)	69.0 (23.4)	100.0 (0)
	0–86.5	0–0	0–100.0	0–1.1	0–0	0–99.1	0–2.5	2.5–97.0	0.4–97.4	0–0	0–20.2	0–81.0	0–94.0	0–99.9	100.0–100.0

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

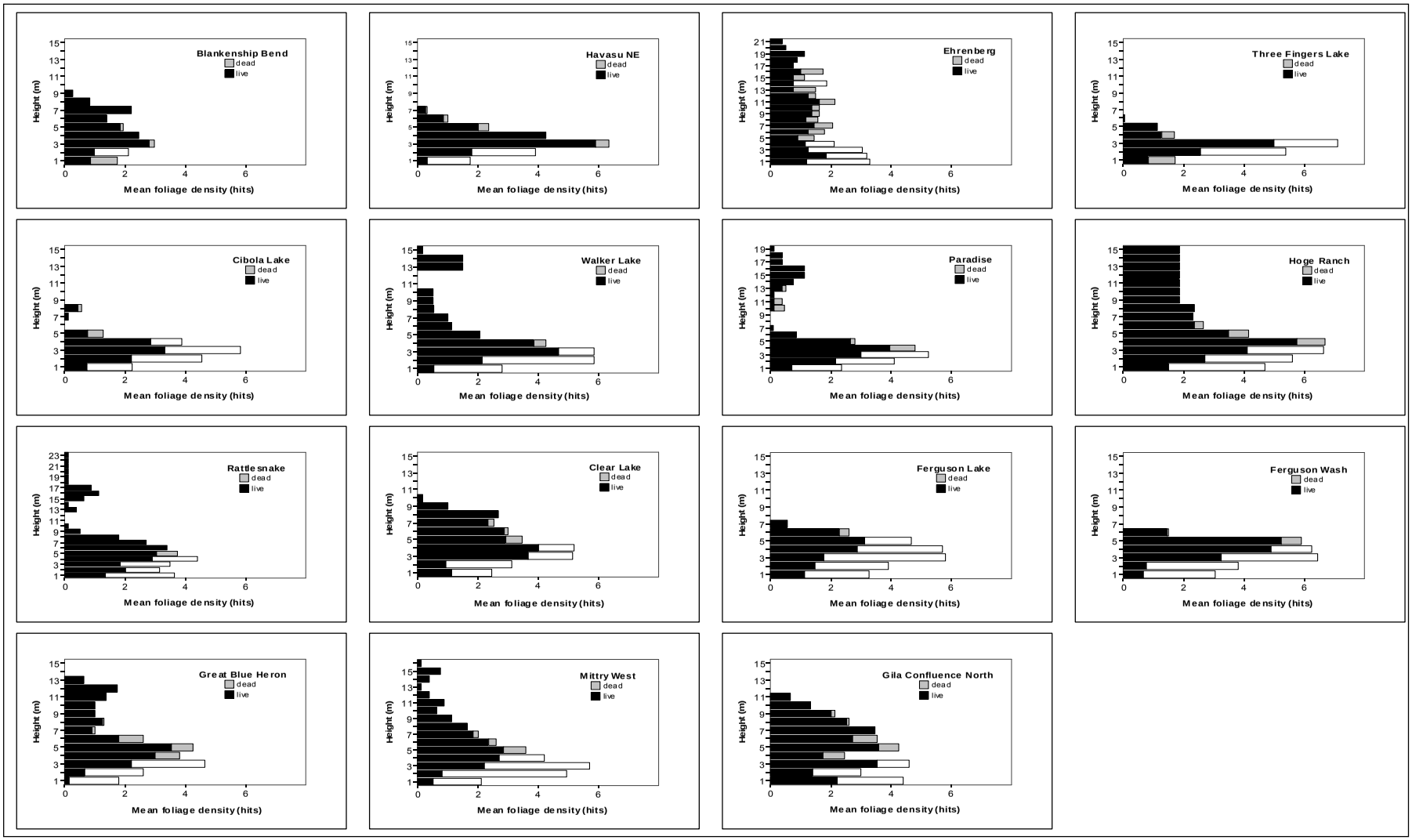

Figure 7.2. Vertical foliage profiles for each habitat monitoring site, lower Colorado River, 2009.

Table 7.6. Annual Means of Vegetation Characteristics at Plots between Parker and Imperial Dams (Test Sites) and Plots above Parker or below Imperial (Control Sites), 2005–2009

Parameter	Test					Control					P-value for overall difference in means between years	P-value for difference in means between years among test sites compared to control sites
	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009		
Average canopy height (m)	6.4	6.8	5.7	6.6	6.7	6.3	6.6	6.9	7.1	6.6	0.7436	0.601
% total canopy closure	84.7	78.3	87.9	88.1	86.7	81.1	76.1	87.1	84.3	80.7	<0.001	0.793
% woody ground cover	31.1	27.2	29.8	41.6	23.0	27.3	48.8	39.3	56.8	34.8	<0.001	0.019
# live stems <2.5 cm dbh per ha	1933	2272	2515	1358	2530	955	2186	1655	743	987	0.020	0.395
# live stems 2.5–8 cm dbh per ha	3107	2722	3143	3899	2314	1613	1984	1910	1963	1220	0.041	0.473
# live stems >8 cm dbh per ha	481	430	654	673	597	668	594	690	753	562	0.195	0.714
# dead stems <2.5 cm dbh per ha	340	1282	1259	1084	1949	803	1305	1294	1422	1348	0.022	0.429
# dead stems 2.5–8 cm dbh per ha	1234	821	925	1879	1081	1284	456	711	1528	562	0.002	0.775
# dead stems >8 cm dbh per ha	48	59	96	108	91	64	95	148	74	138	0.222	0.579
% live stems <2.5 cm dbh	84.1	69.2	67.4	59.3	53.6	65.2	60.9	57.2	43.6	45.7	<0.001	0.808
% live stems 2.5–8 cm dbh	73.6	75.8	77.2	69.2	65.3	66.3	76.4	72.3	53.6	61.3	0.002	0.399
% live stems >8 cm dbh	93.6	86.9	91.2	89.5	89.4	91.0	86.7	85.4	97.1	87.0	0.411	0.520
Percent basal area native	27.2	20.3	28.9	25.9	22.9	36.7	39.5	58.1	45.2	38.5	0.013	0.219

Repeated measures ANOVAs for vertical foliage in each meter interval showed a between-year difference in live vegetation in the fourth meter interval above the ground ($P = 0.048$) and between-year differences for the first, second, third, and fourth meter intervals above the ground for dead vegetation ($P < 0.001$ for each interval). In all four intervals, density of dead vegetation was higher in 2008 than in 2007. There was a significant interaction ($P = 0.039$) between live vertical foliage density and location (test vs. control sites) for the fourth meter interval, but there was no clear pattern, with density generally increasing at control plots in years it decreased at test plots, and vice versa. There was also a significant interaction ($P = 0.001$) between dead vertical foliage density and location for the first meter interval, with the density of dead vegetation increasing more in 2007 and 2008 at control plots relative to test plots. The percentage of live vegetation in each meter interval differed between years only in the fourth meter interval ($P = 0.005$); in this case, the live percentage was lower in 2008 than in 2007.

Groundwater Monitoring

Overview of Piezometer Groundwater Levels

Data collected from fall 2005 to spring 2007 are relatively complete with sporadic recording errors. Many data from 2008 and 2009 are unreliable and eight sites have no data for 2009 (see Table 7.1). The sites that have remained functional (Havasu NE, Ehrenberg, Three Fingers Lake, Walker Lake, Great Blue Heron, and Mittry West) throughout most of the study period show similar patterns across years.

Daily and weekly cycles are still apparent in the piezometer hydrographs. General daily trends include low water levels during the afternoon hours when vegetation water demands and evapotranspiration are greatest and high water levels in early morning hours. General weekly trends follow the changes in river water levels due to power generation and water delivery demands, with low levels on weekends and higher levels in the middle of the week.

In addition to daily and weekly cycles, a seasonal trend is observed in hydrographs in a majority of the sites. The data trend remains similar to that of previous years, although some sites had slightly higher and lower maximum and minimum water levels. For most of the sites between Parker and Imperial Dams, the lowest water levels occurred in December through February, and highest water levels occurred in April (Table 7.7). Topock Marsh, Havasu NE, Walker Lake, and Gila Confluence North did not display this seasonal trend. The shallowest average monthly water level occurred at Mittry West in April and the deepest occurred at Paradise in December. Seasonal changes in water levels range from 0.94 feet at Walker Lake to almost 3.5 feet at Ehrenberg. Hydrographs for all piezometers are included in Appendix E.

Planned Declines in Parker Releases –Average monthly river flow data below Parker Dam from 2000 to 2009 (Table 7.8) show declines in reservoir releases for most months. While there is variation, average monthly flow throughout the year decreased from 2001 (the year prior to the scheduled change in point of diversion) to 2009 except for January and March, the only months that experienced an increase of average flow for 2009. The percent decrease from 2001 to 2009 was lowest in April (6.4%), greatest in December (35.9%), and ranged from 21.5 to 32.2% in June–August. During the period when groundwater levels were recorded (2005–2009), overall annual river flows did not decrease.

Table 7.7. High and Low Average Monthly Water Depths Recorded at Piezometers at Habitat Monitoring Sites, 2005–2009

Location	Shallowest water level (ft bgs)	Month occurred	Deepest water level (ft bgs)	Month occurred
Topock	1.19	April	2.65	October
Blankenship Bend	1.99	June	3.70	December
Havasu NE	1.66	December	2.84	February
Ehrenberg	0.67	April	4.07	December
Three Fingers Lake	2.10	April	4.83	December
Cibola Lake[1]	1.71	April	4.60	December
Walker Lake	4.74	February	5.62	July
Paradise	4.61	April	6.66	December
Hoge Ranch	1.99	April	4.68	December
Rattlesnake	0.71	April	3.73	December
Clear Lake	1.47	April	3.81	January
Ferguson Lake	0.97	April	3.15	December
Ferguson Wash	0.77	April	2.86	December
Great Blue Heron	0.28	April	2.43	December
Mittry West	-0.22	April	2.13	January
Gila Confluence North	3.17	October	4.93	July

[1] Data from two locations.

Table 7.8. Average Monthly Flows (cfs) Below Parker Dam, 2000–2009

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	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	578	10.30%
February	9,123	8,505	8,978	6,881	7,129	4,888	7,798	8,491	8,232	7,137	-1,368	-16.10%
March	11,594	10,524	11,334	12,360	11,523	9,699	9,752	11,122	12,180	11,973	1,449	13.80%
April	14,613	14,090	13,610	13,803	12,824	11,356	11,985	12,618	14,293	13,184	-906	-6.40%
May	14,174	14,068	12,826	11,990	12,252	11,428	11,998	11,718	11,339	10,533	-3,535	-25.10%
June	13,803	14,733	13,713	12,778	12,741	12,444	12,383	12,116	11,957	9,992	-4,741	-32.20%
July	14,210	14,974	14,439	13,100	12,331	13,842	11,688	12,180	12,226	10,645	-4,329	-28.90%
August	11,441	12,047	12,118	10,803	11,420	10,316	10,141	10,317	10,720	9,459	-2,588	-21.50%
September	11,233	10,837	10,429	11,159	9,566	9,048	7,334	9,195	9,072	8,492	-2,345	-21.60%
October	9,362	8,852	8,765	9,761	7,405	6,967	7,424	7,204	7,568	7,241	-1,611	-18.20%
November	7,437	7,357	7,049	6,153	5,163	6,335	6,094	5,420	6,369		-988	-13.40%
December	6,706	5,970	5,615	5,737	4,129	4,841	5,507	4,079	3,829		-2,141	-35.90%

Evapotranspiration Signature

Of the10 sites within the riparian vegetation that is surveyed for flycatchers, 6 (Topock Marsh, Blankenship Bend, Havasu NE, Cibola Lake, Paradise, and Hoge Ranch) yielded usable evapotranspiration signature data over multiple years (Table 7.9). The evapotranspiration signature was calculated for these six piezometers; however, several anomalous patterns became apparent in the piezometers along the river (Blankenship Bend, Havasu NE, Cibola Lake, Paradise, and Hoge Ranch). Notably, sharp reductions in the evapotranspiration signature were occurring with regularity every seven days, suggesting some control other than a seasonal change. Upon close inspection of the hydrographs, we realized that the intraday groundwater level changes in the piezometers were influenced much more strongly by river water levels than anticipated. As reported above, the river experiences a strong weekly pattern in water levels, with low levels on the weekend and higher levels during the week. The sharp rise and fall of the river level during the transitions between week and weekend overwhelmed any water level changes due to the evapotranspiration of water by riparian vegetation. The White formula requires that the source of recharge be distant and consistent; the recharge provided by the river is too strong and immediate to allow use of the White method at these piezometers.

The piezometer within Topock Marsh was deemed the sole location at which the recharge source appeared to be consistent enough to meet the assumptions for the White formula, and we limited further analysis of the evapotranspiration signature to this location. Complete piezometer and temperature data were available at Topock Marsh only for May–August in 2007 and 2009.

Over the course of each season, the White evapotranspiration signature increased steadily while the groundwater level in the aquifer steadily declined (Figures 7.3 and 7.4). The linear regression for mean diurnal temperature versus evapotranspiration signature showed a weak, direct correlation, with coefficients of determination of 0.41 and 0.30 for 2007 and 2009, respectively (Figures 7.5 and 7.6). The linear regression for mean daily water level versus evapotranspiration signature showed a strong, direct correlation, with a coefficient of determination of 0.67 and 0.95 for 2007 and 2009, respectively (Figures 7.7 and 7.8). The direct relationship between depth to water and evapotranspiration (i.e.; the deeper the water dropped over the season, the greater the evapotranspiration from the vegetation) is the opposite of the relationship indicated in the literature, which shows decreasing evapotranspiration with increasing depth to groundwater (e.g., Blaney 1954).

The remaining four piezometers within flycatcher habitat (Ehrenberg, Clear Lake, Ferguson Lake, and Ferguson Wash) yielded water levels that did not consistently reflect daily changes in evapotranspiration. This lack of signature is likely the result of imperfect or delayed communication with the aquifer, caused by tight sediments surrounding the well screen, or possibly plugged well screens. Negative values shown in Table 7.9 are indicative of those piezometers that do not follow the typical daily signature caused by evapotranspiration losses from the aquifer. In these cases, either changes in water levels are significantly delayed (resulting in a reversal of the evapotranspiration signature) or show no daily pattern at all (resulting in a random evapotranspiration signature).

Table 7.9. Median Daily Evapotranspiration Signature by Month, May–Sep, 2005–2009

Site	Median Daily Fluctuation of Groundwater Level (feet)																								
	2005					2006					2007					2008					2009				
	May	Jun	Jul	Aug	Sep	May	Jun	Jul	Aug	Sep	May	Jun	Jul	Aug	Sep	May	Jun	Jul	Aug	Sep	May	Jun	Jul	Aug	Sep
Topock Marsh	-	-	-	-	-	-	-	-	0.499	2.466	0.948	0.266	0.358	0.45	-	2.757	-	-	-	-	-1.317	0.218	0.479	0.563	1.056
Blankenship Bend	-	-	-	-	0.772	0.793	0.715	0.787	0.76	0.683	0.706	0.607	0.678	0.67*	-	-	-	-	-	-	-	-	-	-	-
Havasu NE	1.096*	0.077	0.088	0.13	2.83	2.308	0.182	0.171	0.156	2.168	1.313	0.215	0.236	0.214	1.862	2.03	0.04	0.046	0.071	0.802	0.58	0.036	0.078	0.08	1.252
Ehrenberg	-	-	-	-	-0.503	-0.409	-0.571	-0.482	-0.598	-0.503	-0.286	-0.318	-0.162	-0.558	-0.434	0.103	0.017	0.068	0.053*	-0.324	-0.28	-0.353	-0.445	-0.447	-0.323
Cibola Lake	-	0.043	0.02	0.309	0.388	0.355	0.436	0.37	0.483	0.481	-	-	-	-	-	-	-	-	-	-	0.002	0.018	0.021	0.03	0.033
Paradise	0.314*	0.311	0.202	0.451	0.487	0.611*	0.70*	0.625	0.521	0.457	0.621	0.617	0.546	0.73*	0.518*	-	-	-	-	-	-	0.391	0.489	0.476	-
Hoge Ranch	0.634*	0.483	0.383	0.513	0.521	0.78	0.814	0.727	0.627	0.056*	0.936	0.903	0.802	0.943	0.586*	-	-	-	-	-	-	-	-	-	-
Clear Lake	0.046*	0.013	0.017	0.019	-0.046	-0.02	-0.047	-0.035	-0.071	-0.069	0.003	-0.022	0.026	-0.041	-0.012	-	-	-	-	-	-	0.002	0.003	0.01*	-
Ferguson Lake	-0.035*	-0.067	-0.03	-0.082	-0.055	-0.104	-0.107	-0.098	-0.125	-0.065	-0.113	-0.166	-0.076	-0.127	-0.07	-	-	-	-	0.033*	-	-	-	-	-
Ferguson Wash	0.02*	0.002	0.011	-0.112	-0.059	-0.092	-0.098	-0.107	-0.133	-0.093	-0.098	-0.15	-0.069	-	-0.013	-	-0.053	-0.034	0.04*	-	-	-0.054	-0.059	-0.088	-

* Data for the month not complete.

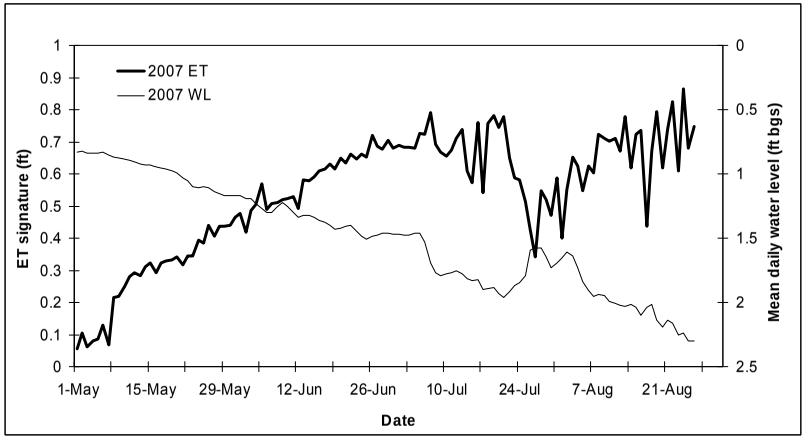

Figure 7.3. Daily evapotranspiration (ET) signature (ft) and mean daily water level [WL; feet below ground surface (bgs)] at Topock Marsh, May–August, 2007.

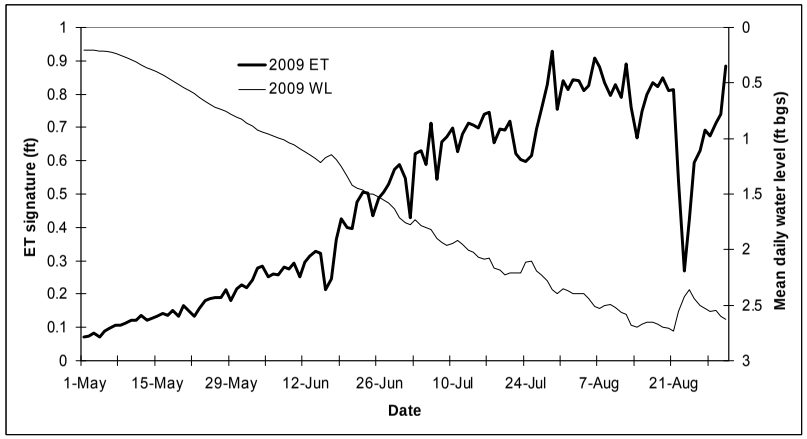

Figure 7.4. Daily evapotranspiration (ET) signature (ft) and mean daily water level [WL; feet below ground surface (bgs)] at Topock Marsh, May–August, 2009.

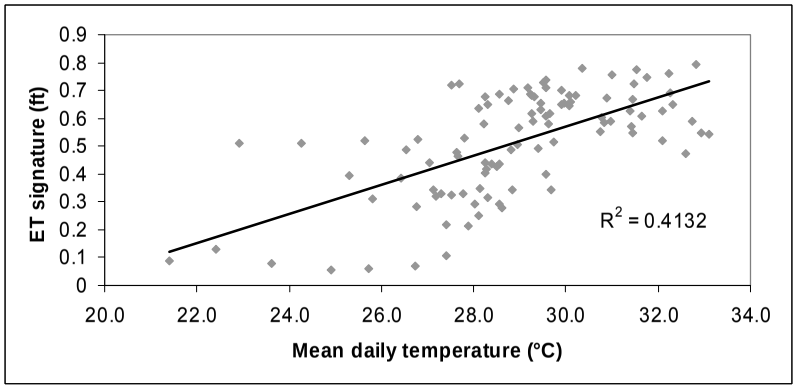

Figure 7.5. Linear regression between daily evapotranspiration (ET) signature (ft) and mean daily temperature (°C) at Topock Marsh, May–August, 2007.

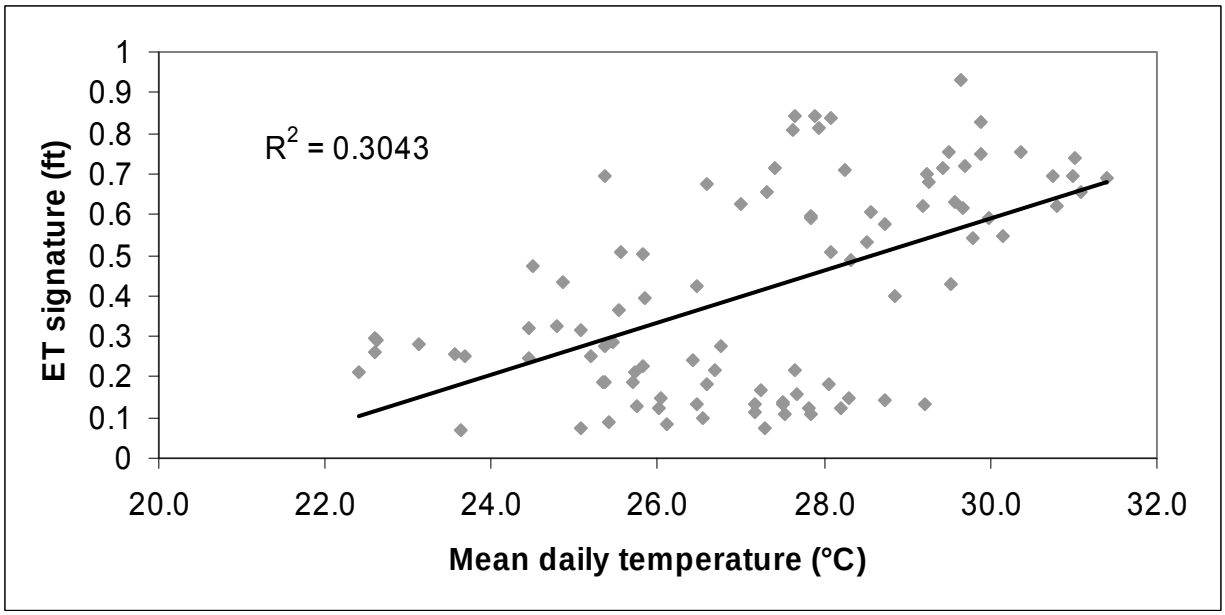

Figure 7.6. Linear regression between daily evapotranspiration (ET) signature (ft) and mean daily temperature (°C) at Topock Marsh, May–August, 2009.

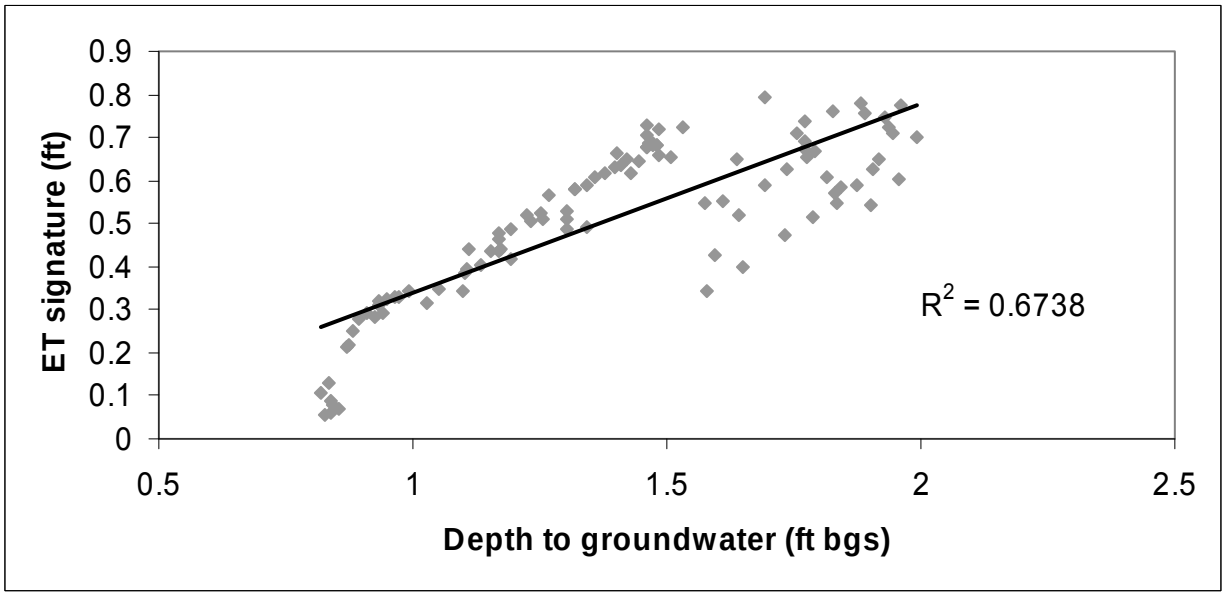

Figure 7.7. Linear regression between daily evapotranspiration (ET) signature (ft) and mean daily depth to groundwater (feet below ground surface) at Topock Marsh, May–August, 2007.

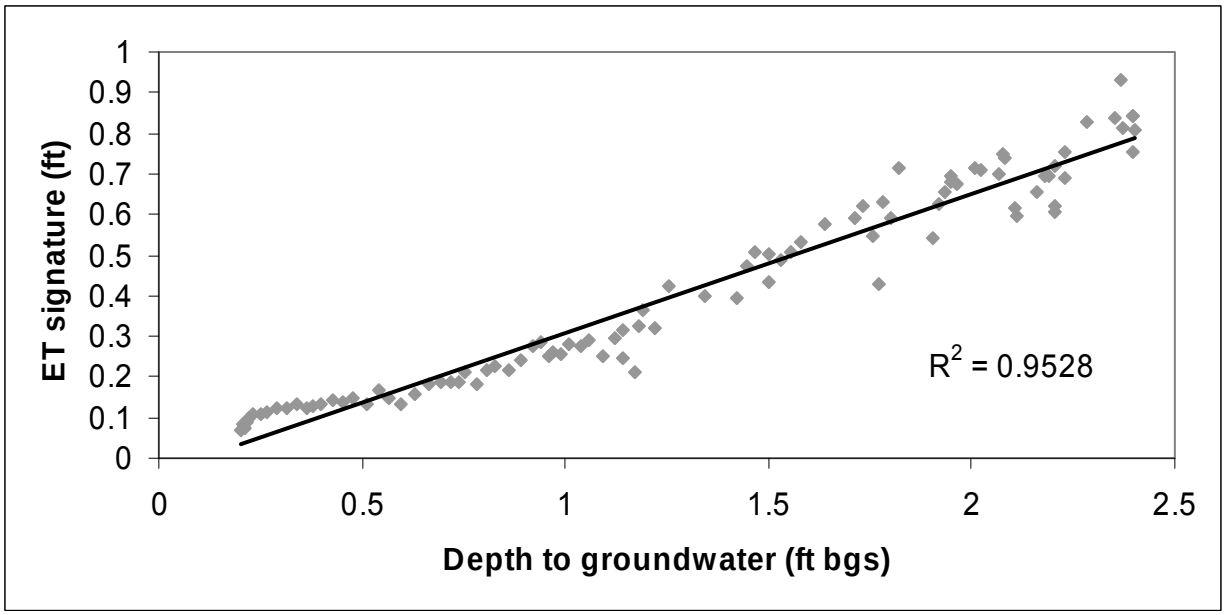

Figure 7.8. Linear regression between daily evapotranspiration (ET) signature (ft) and mean daily depth to groundwater (feet below ground surface) at Topock Marsh, May–August, 2009.

DISCUSSION

Microclimate

Comparison of Parker/Imperial to Topock Marsh

In each year from 2005 to 2009, the 15 habitat monitoring sites consistently had warmer temperatures, greater daily temperature range, and lower humidity than occupied territories at Topock Marsh. In addition, soil moisture within the habitat monitoring sites was consistently lower than that recorded within occupied territories at Topock in 2005–2007. Soil moisture at the habitat monitoring sites did not differ from that measured within occupied territories at Topock in 2008 and 2009. This may be the result of a change in site selection methods at Topock, with soil moisture readings collected in 2008 and 2009 at a point within 20 m of each territory center, regardless of whether the territory remained occupied throughout the season or had a breeding pair, thus resulting in measurements being taken in a wider range of habitat conditions. The hot, dry conditions at the habitat monitoring sites may contribute to these areas not being occupied by resident flycatchers. Because the relationship of microclimate conditions between the habitat monitoring sites and Topock Marsh is well established, we recommend discontinuing this analysis in future years.

Between-year Comparisons of Microclimate Characteristics

Comparisons of microclimate characteristics among years in 2005–2009 at the habitat monitoring sites indicated hotter and more humid conditions in 2006 than in the other years and cooler conditions in 2009. These interannual changes 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 and 2007–2008 were not similar between test and control sites, with soil moisture declining

more sharply at the control sites. 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) and the lack of consistent piezometer data at many sites in 2008 and 2009. Mean daily temperature range and mean maximum diurnal temperature were higher at test sites but lower at control sites in 2008 versus 2007. These metrics decreased sharply in 2009 at both test and control sites, presumably in response to the unusually cool climate conditions during portions of summer 2009. Thus, we have not seen any consistent patterns in the changes in microclimate characteristics at test versus control sites that could be attributed to changes in river flows.

Vegetation

Between-year differences across all sites were noted for many variables, but the only ones that showed unidirectional trends were the percentage of live stems <2.5 cm dbh and the percentage of live stems 2.5–8 cm dbh, both of which declined over time. The percentage of live stems should be less susceptible to observer variation than the absolute stem counts, and it is likely these data represent a true decline in the percentage of live stems. The decline occurred in both test and control sites and could be the result of regional drought.

Few variables showed changes that were specific to control or test sites. Ground cover did not differ between 2005 and 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 did not show any consistent differences between control and test locations.

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.

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, it 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. 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. 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

Piezometer Groundwater Levels

In previous years we examined correlations between piezometer levels and reservoir operations. Groundwater levels in the piezometers between Parker and Imperial Dams, with the exception of Walker Lake, showed strong linear relationships with Parker Dam releases, which are in turn related in a nearly linear fashion to river stage (McLeod and Koronkiewicz 2009). Reclamation (2000) estimated the expected change in river stage between Parker and Imperial Dams that would result from a 400,000 acre-foot reduction in releases from Parker Dam. In a previous report (McLeod et al. 2007), we used this expected reduction in river stage in combination with regression equations developed from the piezometer measurements to predict the corresponding change in groundwater level below each habitat polygon. Thus, releases from Parker Dam can be used to predict the groundwater level beneath the habitat polygons, and the piezometers are no longer needed for measuring groundwater levels as related to river operations.

In general, the daily, weekly, and seasonal cycles observed in previous years' data are still visible in 2009 data. The early morning rise and afternoon drop in water level is attributed to daily evapotranspiration; the mid-week rise and weekend drop of water levels is attributed to river operations. River operation is the primary contributing factor for the seasonal fluctuation in groundwater levels observed in the hydrographs for sites between Parker and Imperial Dams. Seasonal trends can even be detected in the manual measurements at those sites lacking in recent data logger data (Blankenship Bend, Paradise, Clear Lake, and Ferguson Lake).

Several anomalous hydrograph features deserve discussion:

Blankenship Bend, Cibola Lake, and Gila Confluence North – The hydrograph for three piezometers clearly show where equipment has malfunctioned. The Blankenship Bend data logger began to act erratically in the summer of 2007 and has not collected reliable data since. The pressure transducer finally failed entirely and has been removed. The hydrograph for Gila Confluence North has not been normal since the piezometer was moved to the new location after the fire. Even though the equipment has been replaced at this site, the hydrograph indicate the piezometer may not be communicating with the aquifer and most likely needs to be reinstalled. Cibola Lake displayed seasonal fluctuations similar to those observed at other piezometers between Parker and Imperial Dams until the well was destroyed by ground clearing activities. Water levels have remained

essentially flat for the monitoring period since installation of the replacement piezometer. This well may need a re-install or warrant a change in location closer to the selected habitat area.

Walker Lake – Since two apparent inundations in the summer of 2005, the water level at Walker Lake has steadily decreased through the period of record. The seasonal signature continues to be strong and appears to match the pattern at most of the piezometer locations between Parker and Imperial Dams. Though there are breaks in the 2008 and 2009 data, the downward trend and the seasonal highs and lows can be seen. The hydrograph displays periods of spiked water levels on several occasions, including the winter and fall of 2006, fall of 2007, and summer of 2008, indicating Walker Lake may be prone to flashy response time.

Mittry West – While the hydrograph for the Mittry West piezometer was almost flat from installation through December 2005, the data show a seasonal trend in 2006–2008, with peak water levels occurring in the spring of each year. Weekly fluctuations and daily fluctuations are not as apparent on the rising leg of the seasonal curves, but reappear on the declining leg of the curves. A second peak in water levels occurred during the summer of 2007. Apparent inundations have occurred at Mittry West in the spring of 2006, 2007, and 2008 and in winter 2008. Water levels in Mittry West may be influenced by the All American Canal, which is adjacent to the site.

Only 1 of the original 16 piezometers is still functioning, and it has become apparent that the original piezometer data loggers have exceeded their lifespan. The relationship between groundwater levels and river operations has been established, and the strong influence of daily changes in river discharge on groundwater levels renders the piezometer data unsuitable for tracking changes in evapotranspiration over time. Thus, we recommend removing all the piezometers except the one at Topock Marsh, which may be useful in tracking changes in water levels at part of planned water deliveries to a portion of the flycatcher habitat (see Chapter 8).

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 were 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.

Evapotranspiration Signature

The evapotranspiration signature at Topock Marsh was weakly correlated with temperature; i.e., increasing temperature was associated with an increased evapotranspiration signature. However, temperature was also correlated with depth to groundwater, because both increased over the May–August period each year. Data from the fall months—when plants are still active, depth to groundwater is high, but temperatures are dropping—may be helpful in distinguishing the effects of temperature from those of depth to groundwater. Fall data are lacking from 2007 but may be available from 2009 after the temperature/humidity loggers are downloaded in spring of 2010.

The evapotranspiration signature at Topock Marsh was directly related to depth to groundwater, rather than showing the inverse relationship demonstrated in the literature. We therefore suspected that the relationship was coincidental, rather than causal. To determine why evapotranspiration might be

increasing in the face of a lowered water table, we deconstructed the White formula. We determined that two fundamental assumptions of the formula likely had been glossed over in previous applications reported in the literature:

- The recharge of the aquifer as measured at the piezometer is driven by basic groundwater hydraulics, and is a function of the aquifer material and the hydraulic gradient between the source of recharge (surface water) and the piezometer. The aquifer material does not change over the season, but the hydraulic gradient does. We realized that as water levels dropped through the season at the piezometer, that lowering of the water table likely affected the overall hydraulic gradient, increasing recharge to the aquifer. The effect of this increasing recharge cannot be controlled for or easily extracted from the evapotranspiration signature.

- Similarly, we realized that the source of recharge to the aquifer, specifically the standing water within Topock Marsh, might also change in location or amount through the season. This would cause a change in hydraulic gradient as well.

These hydraulic effects had not been considered in previous literature on the technique of using the evapotranspiration signature; those studies focused largely on monthly snapshots of evapotranspiration with an eye towards estimating gross volumes of water used by riparian vegetation, without being concerned with stability of the formula through the season. While these findings do not invalidate the White technique, we found that being unable to correct for the changing hydraulic effects likely rendered ineffective the use of the evapotranspiration technique to track vegetation changes over time.

Chapter 8

SURFACE HYDROLOGY, MICROCLIMATE, AND VEGETATION MONITORING: TOPOCK MARSH

INTRODUCTION

Monitoring of Southwester Willow Flycatcher populations at Topock Marsh began in 1997, and data on number of flycatcher pairs and nest success are available for 1998–2008. 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. 2008, 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). 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.

Two adjacent areas, known as In Between and 800M, have had declining numbers of flycatchers in recent years, with the number of breeding pairs declining steadily from 10 in 2004 to 0 in 2008. These adjacent areas were selected as the location for habitat enhancement via supplemental water delivery because these areas have supported breeding willow flycatchers within the last several years and the vegetation in the area has not changed markedly since the sites were occupied (see Chapter 5 for analysis of vegetation data from formerly occupied nest sites). The addition of surface water and saturated soil to this area may make it more attractive to flycatchers and may increase nest success and productivity of any flycatchers that nest in the area. In addition, widespread inundation of the area may make portions of In Between, 800M, and the surrounding area that typically have been dry during surveys since 2003 and not occupied by flycatchers more suitable for flycatcher occupancy.

Supplemental water delivery is not expected to commence until early 2010. We monitored hydrological, microclimate, and vegetation conditions at In Between, 800M, and the adjacent area of Pierced Egg in 2009 to assess baseline habitat conditions. Similar monitoring will be completed in 2010, and data will be compared to those collected in 2009 to assess the effects of supplemental water delivery on hydrology, microclimate, and vegetation in the target area.

METHODS

Surface Water Mapping

Beginning in early March 2009 and continuing through early August, we visited In Between, 800 M, and Pierced Egg at approximately weekly intervals. 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 weekly 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.

Microclimate

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 used HOBO H8 Pro data loggers (see Chapter 6) to record temperature and humidity at each sample point at 15-minute intervals. We determined the exact location of each HOBO unit by means of random number sequences as described in Chapter 6. Each logger remained in place until the end of the flycatcher breeding season. We had originally intended to leave the loggers in place over the winter but decided to remove them at the end of the season after experiencing a large number of losses among the HOBO units that were left in place at occupied territories over the 2008–2009 winter. We collected soil moisture readings, as described in Chapter 6, below each data logger at bi-weekly intervals.

Vegetation

In August 2009, 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 planned implementation of water delivery (March 2010) and the subsequent vegetation measurements (August 2010), any responses in vegetation are more likely to be apparent in canopy closure and vertical foliage density than in stem counts.

Data Analyses

Microclimate

Microclimate data were summarized as described in Chapter 6. All data were summarized separately for occupied and unoccupied areas.

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 occupied and unoccupied areas.

RESULTS

Surface Water Mapping

We mapped surface water at weekly intervals from 10 March to 8 August. The percentage of the site that was inundated rose rapidly in late March and early April to a high of almost 45% and then declined just as rapidly in May (Figures 8.1 and 8.2). By early June, <5% of the site had surface water.

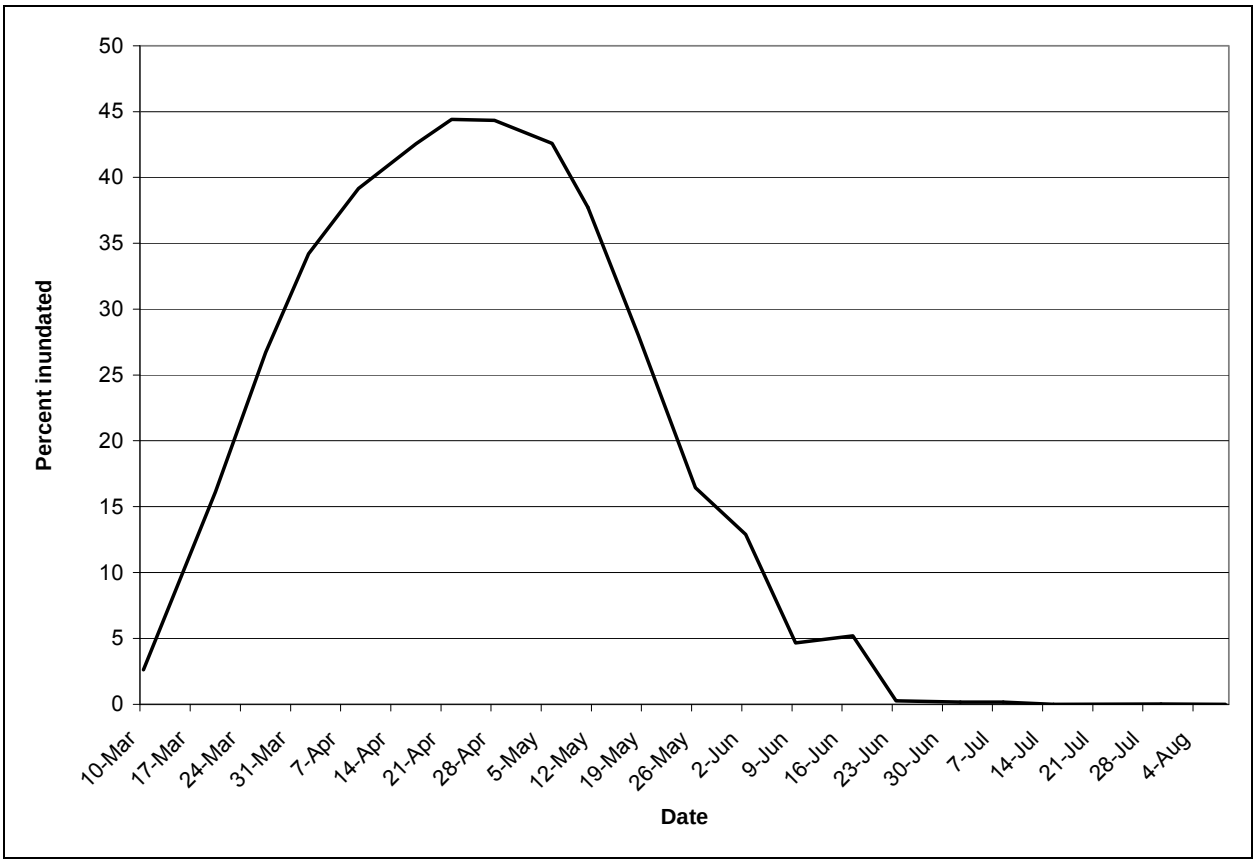

Figure 8.1. Percentage of In Between, 800M, and Pierced Egg, combined, that was inundated in March–August 2009.

Microclimate

We deployed 15 HOBO loggers in use areas and 17 loggers in non-use areas between 10 March and 9 April. One use logger and three non-use loggers failed to collect data. Soil conditions became progressively drier throughout the season for both the use and non-use areas, while vapor pressure values showed the typical rise seen in July with the onset of summer monsoons (Tables 8.1 and 8.2). Qualitative comparison of the use and non-use areas shows that the use area had greater soil moisture, lower and more moderate temperatures, and higher humidity consistently through the season, as would be expected (see McLeod et al. 2008).

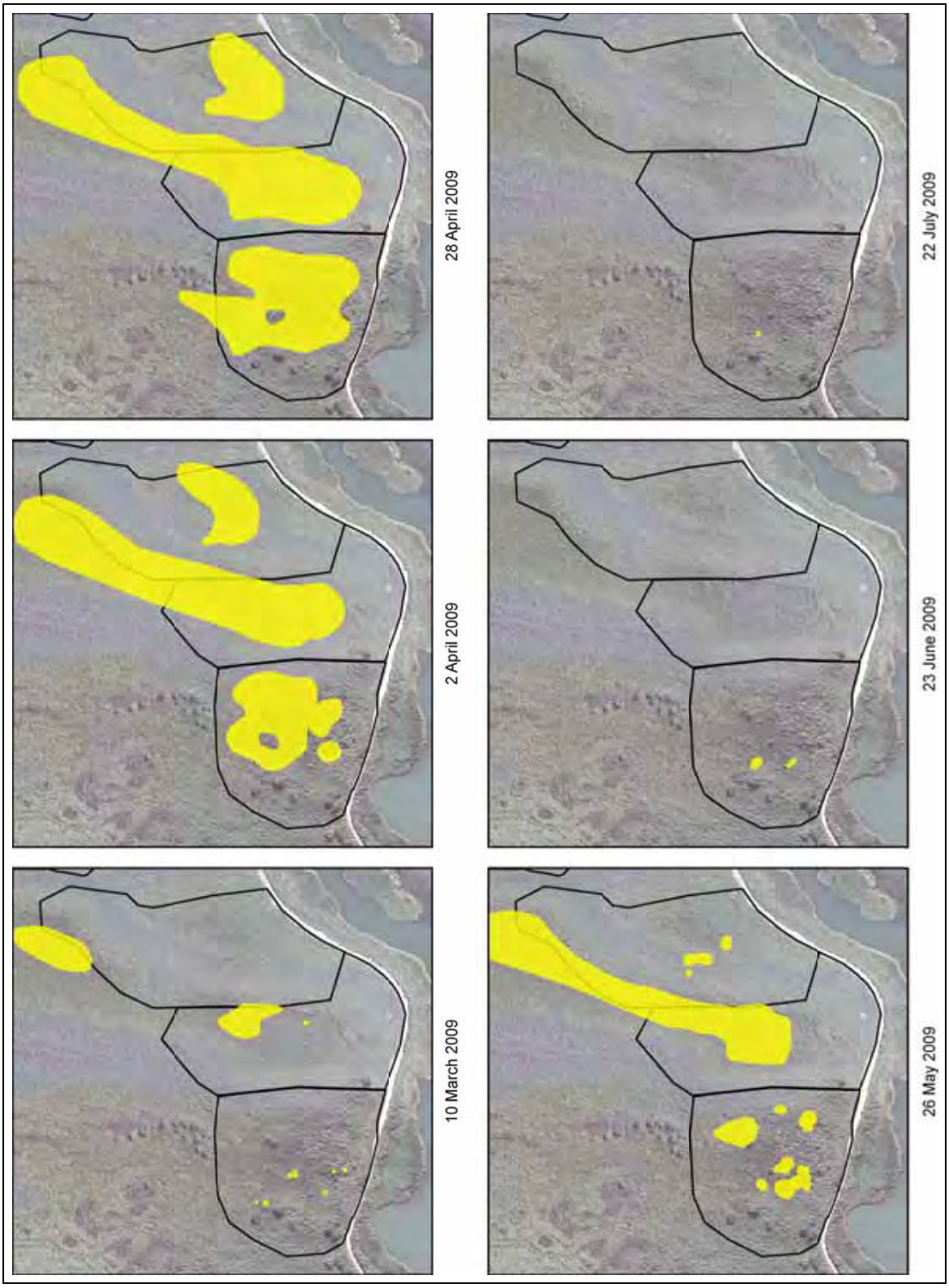

Figure 8.2. Extent of surface water within In Between, 800M, and Pierced Egg at approximately monthly intervals, March–July 2009.

Table 8.1. Microclimate Measures at Topock Hydrology Monitoring Sites – Use Area (n = 14), 2009*

Microclimate Measure	May 12–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture						
Mean soil moisture (mV)	954.1 (8.9)	935.0 (8.5)	920.2 (7.7)	877.7 (15.5)	805.7 (22.1)	842.8 (30.8)
Mean distance to nearest standing water	20.1 (5.3)	48.8 (11.4)	134.9 (24.0)	138.5 (14.2)	154.5 (16.1)	164.0 (10.6)
% of the site within 20 m that was inundated	13.1 (4.6)	1.6 (1.1)	0.4 (0.4)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
% of the site within 50 m that was inundated	27.9 (5.9)	8.0 (3.7)	1.9 (1.0)	0.3 (0.3)	0.1 (0.1)	0.0 (0.0)
Temperature						
Mean maximum diurnal temperature (°C)	39.6 (0.4)	35.1 (0.4)	37.3 (0.4)	39.9 (0.4)	40.4 (0.4)	38.6 (0.6)
Mean minimum nocturnal temperature (°C)	16.9 (0.2)	16.5 (0.1)	17.9 (0.2)	20.0(0.2)	23.8 (0.1)	17.3 (0.2)
Mean daily temperature range (°C)	22.8 (0.5)	18.6 (0.4)	19.4 (0.5)	19.9 (0.4)	16.6 (0.4)	21.3 (0.6)
Humidity						
Mean diurnal vapor pressure (Pa)	1668.2 (17.4)	1520.1 (14.8)	2133.6 (28.4)	2471.9 (25.7)	2889.4 (22.9)	2264.1 (36.3)
Mean nocturnal vapor pressure (Pa)	1541.7 (9.9)	1412.6 (11.3)	1796.1 (19.1)	2068.8 (18.3)	2465.4 (16.0)	1825.8 (24.5)

* Data are presented as mean (standard error).

Table 8.2. Microclimate Measures at Topock Hydrology Monitoring Sites – Non-use Area (n = 14), 2009*

Microclimate Measure	May 12–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture						
Mean soil moisture (mV)	901.3 (29.2)	901.3 (13.0)	837.8 (22.7)	792.6 (27.1)	767.9 (44.4)	747.9 (54.0)
Mean distance to nearest standing water	34.7 (10.1)	136.9 (40.9)	150.8 (34.5)	170.2 (23.9)	190.0 (33.4)	230.7 (27.4)
% of the site within 20 m that was inundated	19.5 (9.1)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
% of the site within 50 m that was inundated	14.9 (4.6)	4.1 (2.2)	1.3 (1.1)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Temperature						
Mean maximum diurnal temperature (°C)	42.0 (0.3)	37.2 (0.4)	40.1 (0.5)	42.4 (0.4)	42.2 (0.4)	40.0 (0.6)
Mean minimum nocturnal temperature (°C)	15.5 (0.2)	15.1 (0.2)	16.8 (0.3)	18.7 (0.2)	22.9 (0.2)	15.8 (0.3)
Mean daily temperature range (°C)	26.5 (0.5)	22.1 (0.4)	23.3 (0.5)	23.7 (0.5)	19.3 (0.4)	24.2 (0.7)
Humidity						
Mean diurnal vapor pressure (Pa)	1623.2 (21.2)	1483.6 (18.8)	2088.5 (34.1)	2431.8 (33.0)	2874.9 (30.2)	2235.1 (41.1)
Mean nocturnal vapor pressure (Pa)	1509.5 (13.2)	1363.1 (13.4)	1766.6 (21.3)	2042.4 (20.3)	2480.0 (18.4)	1806.2 (25.3)

* Data are presented as mean (standard error)

Vegetation

We collected vegetation data at all 15 use and 17 non-use locations. Vegetation characteristics are summarized in Table 8.3, and vertical foliage profiles for use and non-use locations are shown in Figures 8.3 and 8.4, respectively. Vegetation characteristics are typical of those documented in dense, tamarisk stands at Topock Marsh in previous years (McLeod et al. 2008), with dense canopy closure and a small percentage of native vegetation. As would be expected (McLeod et al. 2008), canopy height was greater in the use area than in the non-use area.

Table 8.3. Summary of Vegetation Characteristics within Portions of Topock Marsh Selected for Habitat Enhancement, 2009*

Parameter	Use (n=15)	Non-use (n=17)
Average canopy height (m)	6.7 (0.3)	5.6 (0.3)
	4.7 –8.5	3.3 –8.0
% total canopy closure	96.6 (0.6)	94.0 (0.9)
	91.1 –100.0	82.3 –99.0
% woody ground cover	22.1 (5.5)	26.9 (4.3)
	3.8 –75.0	5.3 –65.0
Live vertical foliage (hits) below nest	2.2 (0.5)	5.3 (0.9)
	0 –6.9	1.6 –14.3
Live vertical foliage (hits) at nest	2.3 (0.3)	4.1 (0.4)
	0.3 –4.4	0.9 –6.6
Live vertical foliage (hits) above nest	11.8 (0.9)	6.4 (1.0)
	4.4 –17.1	0.4 –15.4
Dead vertical foliage (hits) below nest	11.0 (0.7)	11.2 (0.4)
	5.7 –16.7	8.1 –13.7
Dead vertical foliage (hits) at nest	3.0 (0.3)	1.3 (0.2)
	1.7 –5.9	0.0 –2.6
Dead vertical foliage (hits) above nest	2.3 (0.4)	0.4 (0.1)
	0.3 –6.1	0.0 –1.8
Percent native	0.0 (0.0)	8.2 (5.0)
	0 –0.6	0.0 –64.6

* The selected area was stratified into areas occupied and unoccupied by flycatchers in 2003–2008. Data are presented as mean, standard error, and range.

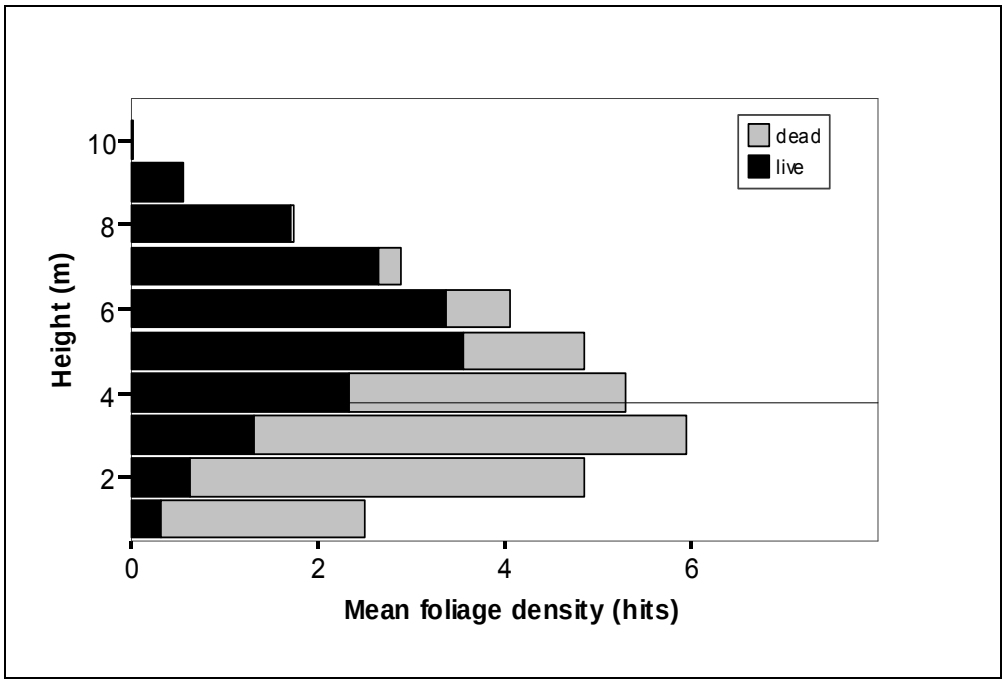

Figure 8.3. Vertical foliage density in areas occupied by flycatchers in at least one year between 2003 and 2009 within the habitat enhancement project area, Topock Marsh, 2009. Horizontal line shows average nest height in the project area, 2003–2008.

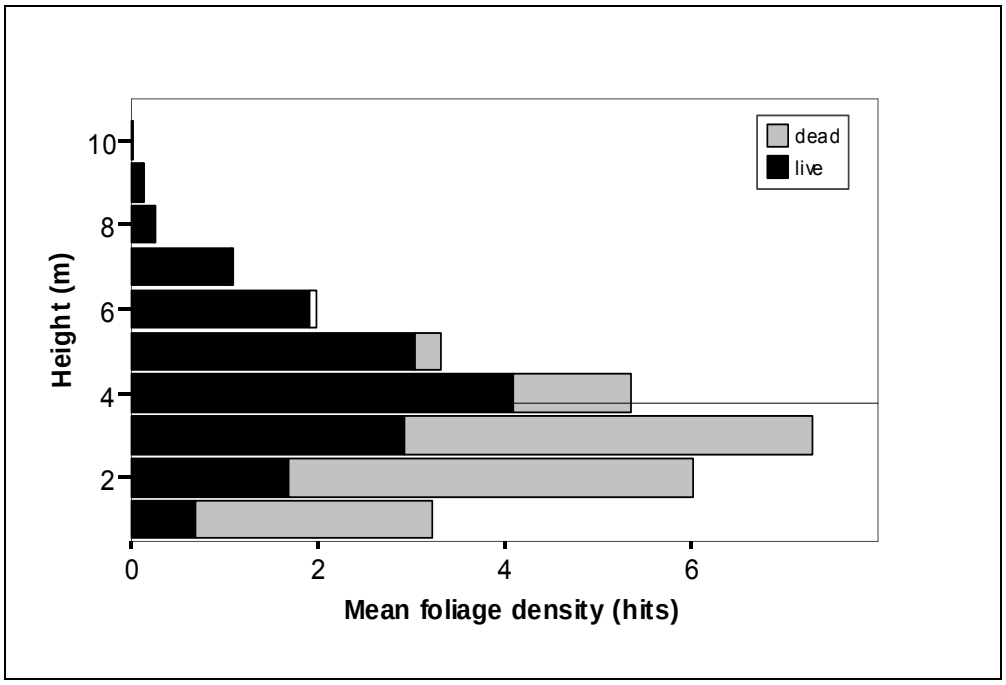

Figure 8.4. Vertical foliage density in areas not occupied by flycatchers between 2003 and 2009 within the habitat enhancement project area, Topock Marsh, 2009. Horizontal line shows average nest height in the project area, 2003–2008.

DISCUSSION

The hydrology, vegetation, and microclimate data collected in 2009 show the pretreatment conditions within the portion of Topock Marsh selected for habitat enhancement via water delivery. Identical methods will be used in 2010 to collect data during the water delivery period, and data from 2010 will be compared to those collected in 2009 to identify any changes in surface hydrology, microclimate, and vegetation.

Chapter 9

MICROCLIMATE AND VEGETATION MONITORING: PAHRANAGAT

INTRODUCTION

From the start of flycatcher monitoring at Pahranagat NWR in 1997 through 2007, occupied flycatcher habitat at Pahranagat North, near the inflow to Upper Pahranagat Lake, has been inundated annually with up to 1 m of water recorded under the vegetation in mid-May. From 2003 to 2007, as much as 100% of the site contained standing water in mid-May, and as much as 95% of the site contained standing water and saturated soil until mid-July. Major structural problems with the levee 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 and 2009 flycatcher breeding seasons as it had been in previous years.

We collected vegetation and microclimate data within 5–10 m from flycatcher nests (within flycatcher territories) at Pahranagat North in 2005–2007. In 2008, the focus of microclimate and vegetation data collection shifted from comparing conditions in occupied vs. unoccupied habitat to characterizing conditions within flycatcher territories for the purpose of providing data that would inform habitat creation and restoration efforts along the LCR. Data collection at Pahranagat was discontinued in 2008 because the study area is approximately 650 m higher in elevation and experiences a cooler climate than the highest elevation portion of the LCR MSCP study area. In addition, the vegetation at Pahranagat 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. Thus, microclimate and vegetation data were not collected in 2008, the first year Pahranagat North was not inundated, and data collection was not planned for the breeding season of 2009.

In 2009, USFWS retained SWCA to complete microclimate and vegetation measurements at Pahranagat North during the 2009 breeding season and to compare conditions during the inundated period (2005–2007) to those documented in 2009.

METHODS

Microclimate

We deployed HOBO Pro v2 temp/RH data loggers (Onset Computer Corporation, Pocasset, MA) within the area of Pahranagat North that has consistently been occupied by breeding flycatchers. Plot center locations were selected by superimposing a 25 × 25–m grid on an ArcGIS 9.1 software shapefile of the flycatcher breeding area boundary, numbering the grid blocks, selecting blocks by using a random number generator, and using the centroid of each selected block. Plot centers were located in the field by navigating to the given coordinates using a Rino 110 GPS unit. For each HOBO unit we determined the exact height and distance from the tree bole by means of random number sequences as described in Chapter 6. Each logger recorded temperature and humidity at 15-minute intervals and remained in place until the end of the flycatcher breeding season in early August. Soil moisture readings were collected beneath each HOBO logger every two weeks, as described in Chapter 6, from HOBO deployment through HOBO removal.

Vegetation

We completed vegetation measurements in August, after the end of flycatcher nesting activity at Pahranagat North. We used each HOBO as the center for a vegetation plot and collected the same measurements as at the monitoring plots at Topock Marsh (see Chapter 8).

Data Analyses

Microclimate

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 and summarized microclimate variables for each HOBO location following the methods presented in Chapter 6. We used one-way ANOVA to compare microclimate measures at within-territory locations from 2005 to 2007 when the site inundated versus 2009 when it was not. Analyses were conducted using SAS® v.9.1.3 (SAS Institute 2003). Data are presented as mean (standard error).

To address whether any observed changes in microclimate could be the result of overall changes in regional climate, we obtained weather station data from the National Climate Data Center (www.ncdc.noaa.gov/oa/ncdc.html) for Caliente, Nevada (Station ID #261358) for 2005–2009. Maximum and minimum daily temperature data were available. We used one-way ANOVA to test whether temperature variables differed between years for the 1 July–15 August period. We used SPSS® Version 16.0 (SPSS Inc.) software for statistical analyses.

Vegetation

Vertical foliage data were restricted to data collected within 1 m of plot center so as to be directly comparable to data collected prior to 2008 and 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 (3.9 m) recorded at Pahranagat from 2003 to 2009 to delineate below, at, and above nest categories. We used one-way ANOVA to compare vegetation characteristics in 2005–2007 versus 2009. We used SPSS® Version 16.0 (SPSS Inc.) software for statistical analyses.

RESULTS

Microclimate

Twenty-eight HOBO loggers were deployed within flycatcher territories at Pahranagat North in early July. They remained in place until 9 August. Six humidity sensors failed to collect data. These data were compared to data collected at 20 within-territory locations in 2005–2007. We included only those within-territory locations where at least half of the 14 day recording period fell between 2 July and 9 August. Soil moisture was higher during the inundated vs. non-inundated period, as was nocturnal and diurnal vapor pressure (Table 9.1). Temperatures differed between the two periods by mean maximum daily temperature being higher and mean minimum nocturnal temperature being lower during the inundated period. Mean daily maximum and minimum temperatures between 1 July and 15 August at the Caliente weather station did not differ between 2009 and any year from 2005 to 2007.

Table 9.1. Descriptive Statistics and Single Effects for Comparison of Microclimate Characteristics, 2005–2007 versus 2009, Pahranagat North*

Response Variable	2005–2007 (n=20)	2009 (n=28)	Difference	*P*
Soil Moisture				
Mean soil moisture (mV)	826.5 (27.9)	741.7 (24.2)	-84.8	0.03
Temperature				
Mean maximum diurnal temperature	38.4 (1.0)	33.9 (0.1)	-4.5	<0.01
Mean minimum nocturnal temperature	15.1 (0.5)	17.1 (0.1)	2.0	<0.01
Mean daily temperature range	16.3 (0.9)	16.8 (0.1)	0.5	0.54
Humidity				
Mean diurnal vapor pressure (Pa)	1648.0 (60.3)	1385.2 (14.6)	-262.8	<0.01
Mean nocturnal vapor pressure (Pa)	1465.0 (53.0)	1149.3 (13.8)	-315.7	<0.01

* Data are presented as mean (standard error).

Vegetation

We collected vegetation data at 28 locations in 2009. These data were compared to vegetation data collected at 26 within-territory locations in 2005–2007. The only variable that differed between the inundated and non-inundated periods was the percentage of the foliage that consisted of native species (Table 9.2).

DISCUSSION

We anticipated that soil moisture and humidity would be lower in 2009 than when the site was inundated, and these expectations are confirmed by the data. However, without humidity data from a nearby weather station, it is impossible to determine whether lower humidity in 2009 was caused by there being less water under the vegetation or if regional humidity was simply lower in 2009. We had expected that inundated conditions might serve to moderate daily temperatures, but the data showed a higher maximum temperature and lower minimum temperature during the inundated period. These differences could not be accounted for by between-year differences in regional climate, with the Caliente weather station showing no between-year differences for either maximum or minimum temperature.

The difference in percent native foliage between the inundated and non-inundated periods is entirely attributable to the development in 2009 of herbaceous ground cover consisting partially of a non-native *Chenopodium* species and does not reflect any change in the woody vegetation. Vertical foliage density below nest height was greater in 2009 than in 2005–2007; however, the increase was not statistically significant. In each year in 2005–2007, vegetation measurements were collected at the end of the flycatcher breeding season, by which time a dense herbaceous layer consisting primarily of Indian hemp (*Apocynum cannabinum*) had developed throughout the drier parts of the site. Thus, although the herbaceous vegetation in 2009 was present throughout the season rather than developing in mid-summer, these between-year changes are not reflected by vegetation measurements collected in August of each year.

Many of the large trees in the northeastern corner of Pahranagat North have died since 2007 (see Chapter 2), but the area of dead trees comprises a small percentage of the site, and only four of the points sampled

in 2009 were near this area. Thus, any changes in vegetation and corresponding changes in microclimate in the northeastern corner of the site did not appear in the data when points across the site were combined.

Although a comparison of vegetation characteristics from when the site was inundated versus was it was not showed no major changes in woody vegetation, two years may be too short of a time for the vegetation to respond to non-inundated conditions. The trees at Pahranagat North are large and presumably have extensive root systems, and although only a small portion of the site contained surface water during 2008 and 2009, the water table beneath the vegetation throughout the site is presumably high. It may take a longer period of time, or a larger drop in the water table, for any changes in the woody vegetation to be detectable.

Table 9.2. Descriptive Statistics and Single Effects for Comparison of Habitat Characteristics between 2005–2007 and 2009, Pahranagat North *

Parameter	**2005–2007** (n=26)	**2009** (n=28)	**P**
Average canopy height (m)	17.6 (1.1)	18.8 (0.8)	0.388
	5.0–30.0	12.3–30.8	
% total canopy closure	91.3 (1.1)	93.0 (1.0)	0.251
	76.0–99.0	78.1–100.0	
% woody ground cover	43.2 (5.8)	30.0 (3.7)	0.059
	2.0–98.0	1.1–80.3	
Live vertical foliage (hits) below nest	2.6 (0.4)	3.4 (0.5)	0.230
	0–8.2	0–9.8	
Live vertical foliage (hits) at nest	1.6 (0.3)	1.3 (0.2)	0.545
	0–5.2	0–4.2	
Live vertical foliage (hits) above nest	21.6 (3.3)	24.7 (2.2)	0.425
	3.8–69.9	6.8–53.6	
Dead vertical foliage (hits) below nest	3.9 (0.6)	3.0 (0.4)	0.190
	0–10.8	0.2–7.6	
Dead vertical foliage (hits) at nest	0.9 (0.2)	1.2 (0.2)	0.318
	0–3.2	0–4.0	
Dead vertical foliage (hits) above nest	2.0 (0.6)	2.8 (0.5)	0.307
	0–15.1	0–12.3	
% live foliage (hits) below nest	42.5 (6.0)	52.7 (4.9)	0.188
	0–100.0	0–94.6	
% live foliage (hits) at nest	63.0 (6.1)	51.1 (6.9)	0.216
	0–100.0	0–100.0	
% live foliage (hits) above nest	90.2 (3.3)	91.1 (1.3)	0.800
	29.8–100.0	74.1–100.0	
Percent native	100.0 (0.0)	97.0 (1.0)	0.005
	100.0–100.0	81.2–100.0	

* Data are presented as mean, standard error, and range.

Chapter 10

MANAGEMENT AND STUDY DESIGN RECOMMENDATIONS

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

BROADCAST SURVEYS

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 recommend visiting each site at the beginning of the breeding season, when sites are typically wettest, and discontinuing surveys if no surface water or saturated soils are present.

We expanded Virgin River #1 South at Mormon Mesa to explore areas where stream channels were noted on the aerial photograph and during aerial reconnaissance. The channels are incised 1–2 m, and the soils beneath the tamarisk were entirely dry throughout the survey season. We do not recommend continuing surveys in this area in future years because of the dry soil conditions. We recommend surveying only the northern third of the site and the area immediately around the Goodding willow cluster in the southwestern portion of the site because of the short canopy height and dry soil conditions in the remainder of the site.

We completed habitat reconnaissance at several new sites at Muddy River and Topock Marsh. We recommend visiting The Narrows site along the Muddy River at the beginning of the season to assess hydrologic conditions and discontinuing surveys for the season if water is restricted to the active river channel. At Topock Marsh, three sites (Lost Lake Slough #2, Lost Lake Slough #3, and Lost Lake Slough #4) had potential to develop into suitable flycatcher habitat if the vegetation matures. We recommend revisiting these sites in 2010 to assess any changes in the vegetation. The remaining reconnaissance sites (Muddy River Recon, NW Beal Lake, NE Lost Lake, Lost Lake South, and Marina) lacked either the vegetation or hydrologic conditions typical of occupied flycatcher habitat, and we do not recommend revisiting these sites.

We recommend discontinuing surveys at Pulpit Rock in Topock Gorge. The small size of the site, its isolation from other riparian habitat, and its predominantly dry soils make this site unlikely to support resident flycatchers. We also recommend discontinuing surveys in the western portion of Blankenship Bend South because woody vegetation in this portion of the site is widely scattered.

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 four of the five years when flycatchers have been monitored at the study area, and overall nest success was 23%, well below the average of 45% 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 addition to cowbird trapping at Muddy River, addling cowbird eggs and removing cowbird young from easily accessible flycatcher nests would likely increase flycatcher nest success and productivity. We do not advise these activities at Pahranagat, which is still part of the five-year post-cowbird-trapping experiment. However, at study areas that were not part of the cowbird trapping experiment (Littlefield, Mormon Mesa, Muddy River, Bill Williams), addling eggs and removing young would not interfere with ongoing experiments and would likely benefit the flycatcher. At Mesquite and Topock, cowbird trapping was shown not to have any effect on parasitism rates and flycatcher nest success, and thus the post-trapping period will not reveal any lingering effects of trapping. Addling cowbird eggs and removing nestlings could thus be implemented at these study areas as well, and we recommend addling cowbird eggs and removing cowbird nestlings from easily accessible flycatcher nests at all sites but Pahranagat.

VEGETATION

The vegetation plot measured at Beal Lake had less canopy closure and far fewer stems than was typical for flycatcher territories in other habitat types, but more extensive sampling would be required to ascertain whether the plot is representative of the site. Because of the uncertainty of whether the site was truly occupied by resident flycatchers and the dissimilarities between the vegetation characteristics measured at Beal Lake and at other flycatcher territories, the vegetation characteristics reported here for cottonwood-mesquite habitat should not be used as a model for flycatcher habitat.

Although the methods for collecting the vegetation data were unchanged among years, observer variation could influence between-year differences in stem counts, vertical foliage counts, and canopy closure. To address observer variation in stem and vertical foliage counts, we calculated the proportion of live stems and live hits in each category and then compared the proportions between the occupied and unoccupied periods. As long as each observer counts live vs. dead stems and, similarly, live vs. dead hits in a consistent manner, this technique accounts for any observer differences in the absolute counts. Reanalysis of the 2003–2007 data incorporating the proportion of live vs. dead vegetation may yield further insight into the vegetation characteristics that contribute to flycatcher occupancy.

HABITAT MONITORING: PARKER TO IMPERIAL DAMS

The relationship of microclimate conditions between the habitat monitoring sites and Topock is well established, and we recommend discontinuing this analysis in future years.

The detection of changes in vegetation as the result of the diversion of water at Parker rather than Imperial Dam is 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 was possible that some changes in vegetation, particularly in sensitive species such as coyote willow, had already occurred. Other methods, such as analysis of satellite imagery, should be considered to detect any changes in vegetation that might have occurred prior to 2005.

The relationship between groundwater levels and river operations has been established, and the strong influence of daily changes in river discharge on groundwater levels renders the piezometer data unsuitable for tracking changes in evapotranspiration over time. Thus, we recommend removing all the piezometers except the one at Topock Marsh, which may be useful in tracking changes in water levels as part of planned water deliveries to a portion of the flycatcher habitat.

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 were 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 Cibola Lake, Havasu NE, Clear Lake, Ferguson Wash, and Gila Confluence North, where soil moisture values are consistently below 600 mV.

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Appendix A

FIELD DATA FORMS

Willow Flycatcher Survey and Detection Form (revised April, 2004)

Site Name_____ State_____ County _____
USGS Quad Name _____ Elevation _____ feet / meters (circle one)

Is copy of USGS map marked with survey area and WIFL sightings attached (as required)? ☐ ***Yes*** ☐ ***No***

Site Coordinates: Start: N_____ E_____ UTM Datum_____ (NAD27 preferred)
Stop: N_____ E_____ UTM Zone _____

***** 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	Cowbirds Detected? Y or N	Presence of Livestock, Recent sign, If Yes, Describe Y or N	Comments about this survey (e.g., bird behavior, evidence of pairs or breeding, number of nests, nest contents or number of fledges seen; potential threats)
1_____	Date							
_____	Start							
_____	Stop							
_____	Total hrs ____							
2_____	Date							
_____	Start							
_____	Stop							
_____	Total hrs ____							
3_____	Date							
_____	Start							
_____	Stop							
_____	Total hrs ____							
4_____	Date							
_____	Start							
_____	Stop							
_____	Total hrs ____							
5_____	Date							
_____	Start							
_____	Stop							
_____	Total hrs ____							
Overall Site Summary (Total **resident** WIFLs only)		Adults	Pairs	Territories	Nests	Were any WIFLs color-banded? Yes No		
Total survey hrs_____						If yes, report color combination(s) in the comments section on back of form		

Reporting Individual _____ Date Report Completed _____
US Fish and Wildlife Service Permit #_____ AZ Game and Fish Department (or other state) Permit # _____

<u>Submit original</u> form by August 1st. Retain a copy for your records.

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

Reporting Individual _____ Phone # _____
Affiliation _____ E-mail _____
Site Name _____ Date Report Completed _____

Did you verify that this site name is consistent with that used in previous years? Yes / No (circle one)
If 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 in comments below.
Did you survey the same general area during each visit to this site this year? Yes / No If no, summarize in comments below.

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

Length of area surveyed: _____ (specify units, e.g., miles = mi, kilometers = km, meters = m)

Vegetation Characteristics: Overall, are the species in tree/shrub layer at this site comprised predominantly of (check one):

- ☐ Native broadleaf plants (entirely or almost entirely, includes high-elevation willow)
- ☐ Mixed native and exotic plants (mostly native)
- ☐ Mixed native and exotic plants (mostly exotic)
- ☐ Exotic/introduced plants (entirely or almost entirely)

Identify the 2-3 predominant tree/shrub species: _____

Average height of canopy (Do not put a range): _____ (specify units)

Was surface water or saturated soil present at or adjacent to site? Yes / No (circle one)
Distance from the site to surface water or saturated soil: _____ (specify units)

Did hydrological conditions change significantly among visits (did the site flood or dry out)? Yes / No (circle one)
If yes, describe in comments section below.

Remember to attach a copy of a USGS quad/topographical map (REQUIRED) of the survey area, outlining the survey site and location of WIFL detections. Also include a sketch or aerial photograph showing details of site location, patch shape, survey route in relation to patch, and location of any willow flycatchers or willow flycatcher nests detected. Such sketches or photographs are welcomed, but DO NOT substitute for the required USGS quad map. Please include photos of the interior of the patch, exterior of the patch, and overall site and describe any unique habitat features.

Comments (attach additional sheets if necessary)

_____
_____
_____
_____
_____
_____
_____

WIFL Detection Locations:

Date Detected	N UTM	E UTM	Date Detected	N UTM	E UTM

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 ____ WN banded **WN developmental age**:_____

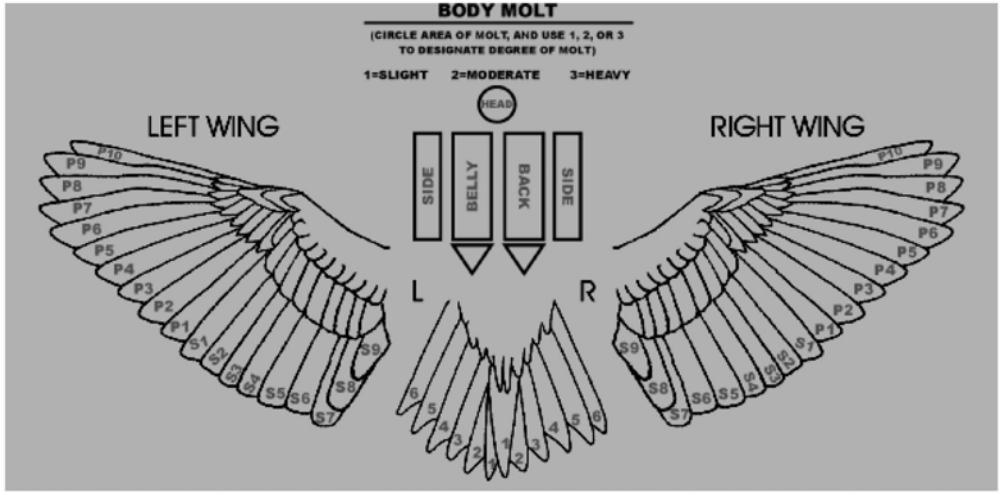
NOTES:_____

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

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

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

STATUS: NCP = new cap passive, NCT = new cap target, RCP = recap passive, RCT = recap target, NBN = nestling banded
SEX: U = unknown, F = female, M = male
CP: 0 = non-breeding, S = partial breeding, M = full breeding
BP: 0 = none, 1 = smooth, 2 = vascularized and filled with fluid, 3 = wrinkled, 4 = molting
AGE: AHY = after hatch year; SY = second year; L = nestling banded in nest; HY = hatch year/young of the year
FAT: 0 = no fat; 1 = trace of fat in furculum, deeply concave, scattered patches, less than 5 percent filled; 2 = thin layer of fat in furculum, less than a third filled, trace of thin layer of fat in abdomen; 3 = furculum is ½ filled or more; small patches, not covering some areas, on abdomen; 4 = furculum more than 2/3 filled, level with clavicles, slightly mounded on abdomen



DETAIL ALL MOLTS AND RETAINED FEATHERS ONTO DIAGRAM AND DETAIL IN NOTES

Date:_____ Page ____ of _____

				COLOR COMBO							
OBS	STUDY AREA	TERR	NEST	LEFT LEG	RIGHT LEG	CONF LEVL	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

Study Area:_____ Survey Site:_____ Territory/Nest no.:_____

Territory/Nest Location:
NAD:_____ Zone:_____

Territory UTMs:

Easting:_____

Northing:_____

GPS Accuracy: _____m

Nest UTMs:

Easting:_____

Northing:_____

GPS Accuracy: _____m

Nest Height:_____m (approximate)

Nest Substrate:_____(e.g., TASP=tamarisk, SAGO=Goodding willow, POFR=cottonwood, SAEX = coyote willow, etc.)

Distance to standing water or saturated soil when nest found: _____(m)

How was distance determined?_____

Date distance to water determined: _____

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

dry damp muddy toes (<5cm) ankles (5-15 cm)

calves (15-40 cm) knees (40-60 cm) thighs (60-80 cm)

waist (100 cm) too deep to wade (>100 cm)

PLEASE DO NOT FILL OUT ANYTHING BELOW

Bird 1: Color band combination:_____ **Band Number:**_____ Female

Bird 2: Color band combination:_____ **Band Number:**_____ Male

Willow Flycatcher

Trans dates	B D	(T/F)	
			Found
			First egg
			Clutch completion
			Hatching
			Fledged or Failed

Willow Flycatcher

No.	Presumed	Confirmed	
			Eggs
			Nestlings
			Fledglings

Cowbird

Trans dates	B D	(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	N	E	S	W	Canopy closure	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							
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							
20							
21							
22							
23							
24							
25							

Record number of decimeters with hits on pole (within 10-cm radius) per 1-m interval up to 8 m; above 8 m, estimate 0, < 5, or > 5 or hits per meter interval.

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

Notes:

Vertical Foliage Sampling

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

NORTH 1m								EAST 1m							
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							
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18								18							
19								19							
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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								WEST 1m							
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							
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 2

Vertical Foliage Sampling

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

NORTH 5m								EAST 5m							
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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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 5m								WEST 5m							
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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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 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: _____

SWFL Microclimate at Old Nests

Study Area _____ **Survey Site** _____ **LOCATION ID** _____–_____–_____
(Study area) – (Year active) – (Nest #)

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

How certain are you that the logger is hanging from the fork the nest was in? (check one)

_____Nest still visible, certain of location
_____Nest gone, but found nest flag and certain of location
_____Nest gone, no nest flag, but base of nest tree flagged and nest height adequate to determine exact location
_____Nest gone, base of nest tree flagged, certain in right tree but not sure if right fork
_____Nest gone, nest tree not flagged, not certain if in right tree.
_____Other: _____

Est. actual height of logger _____ m

Comments:

Take-down: Date:_____ Time:_____ Observer(s):_____

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:

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 = CL, 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)

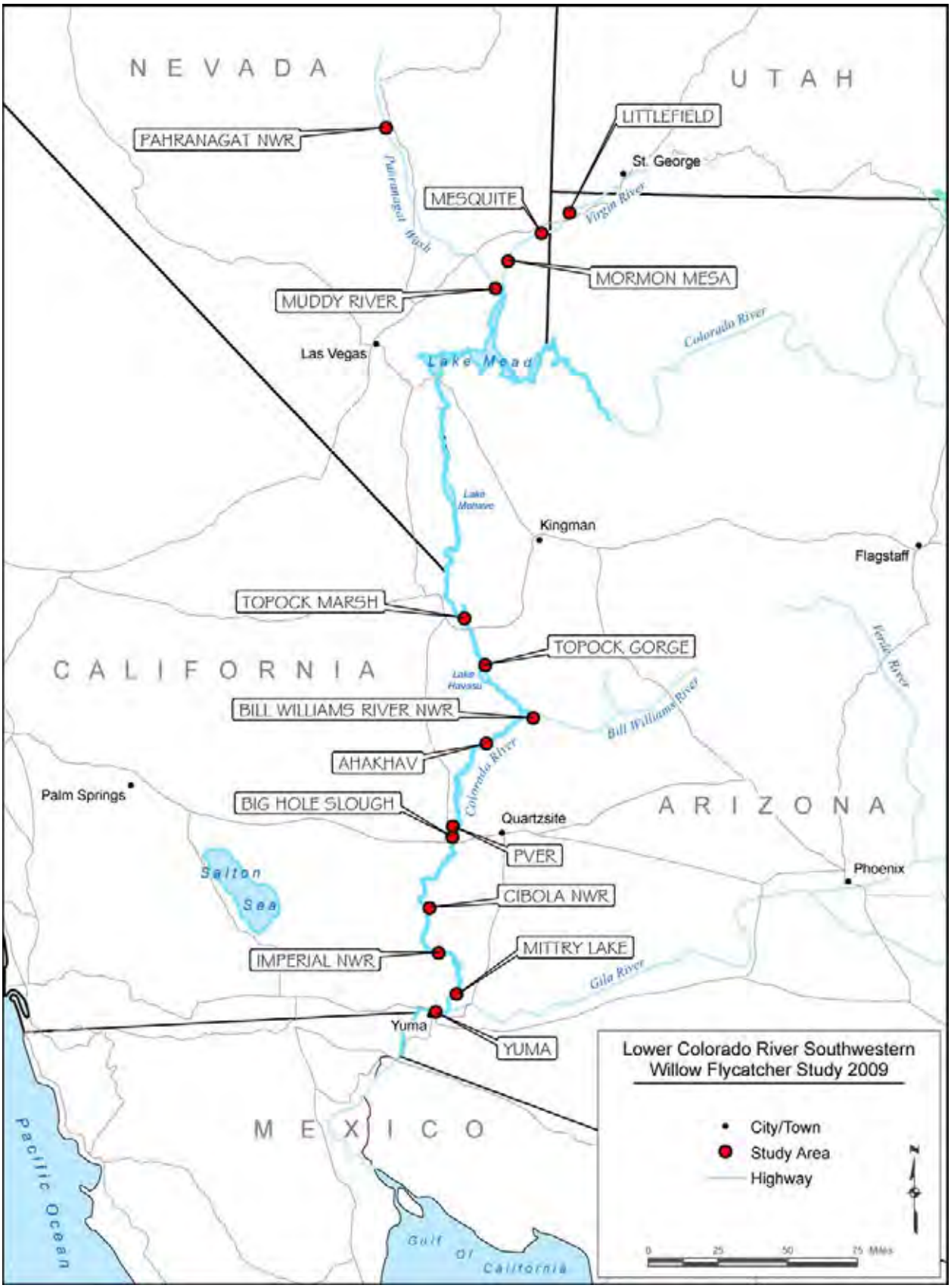
Date **soil sample** collected:_____

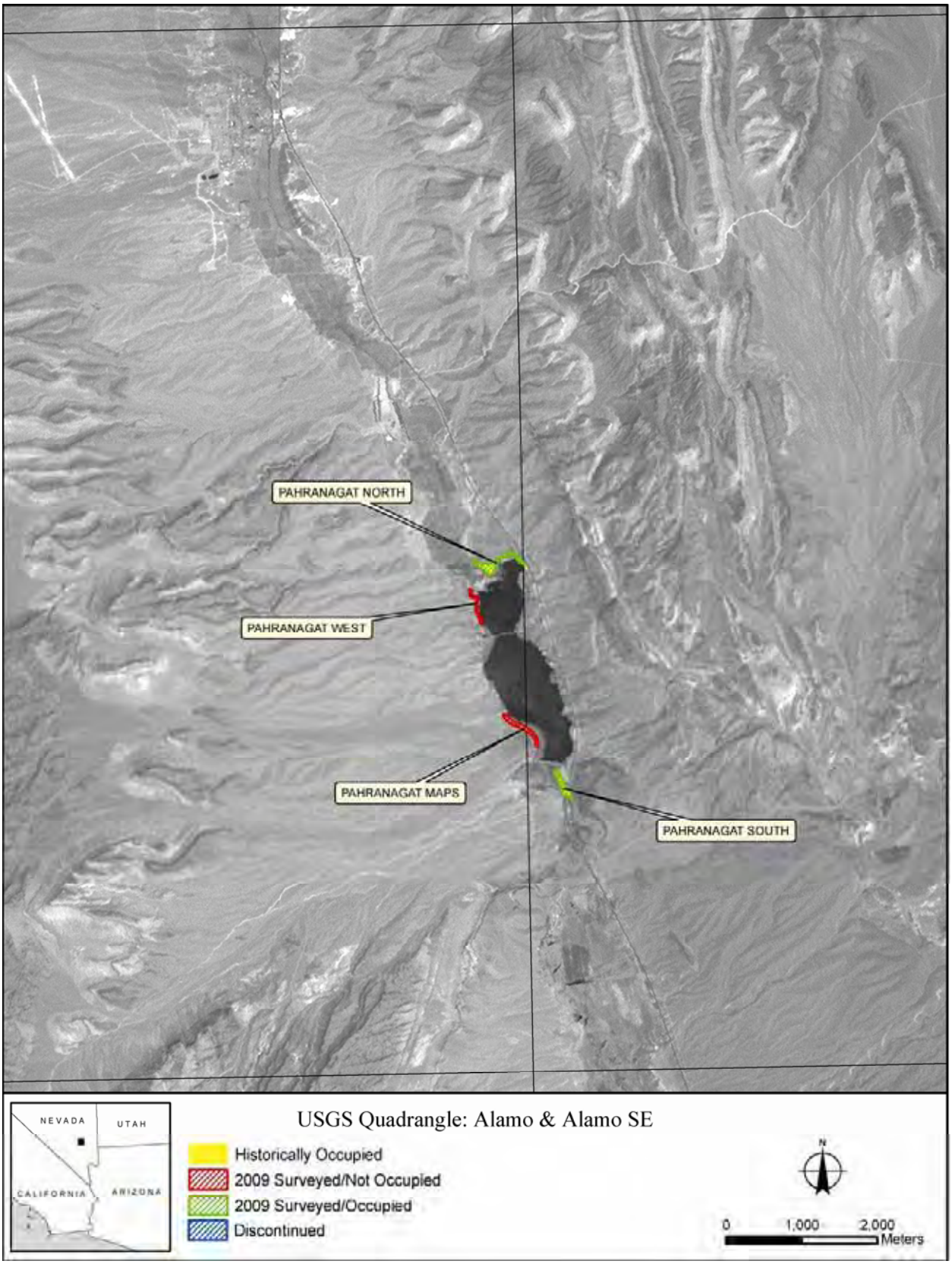
Soil moisture data collected on the following dates (enter SM data directly into database):

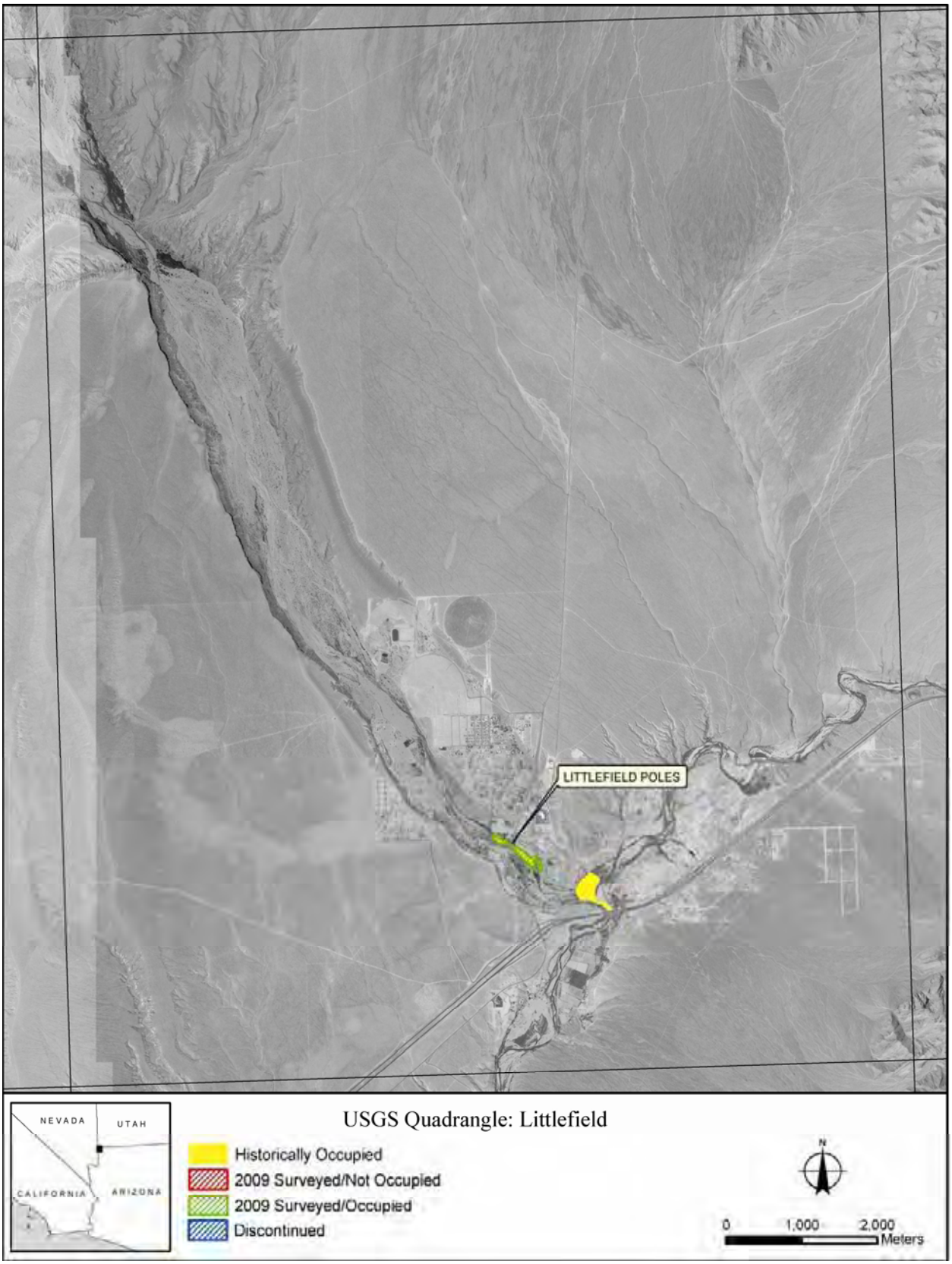
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____
Date: _____	Obs: _____	Date: _____	Obs: _____	Date: _____	Obs: _____

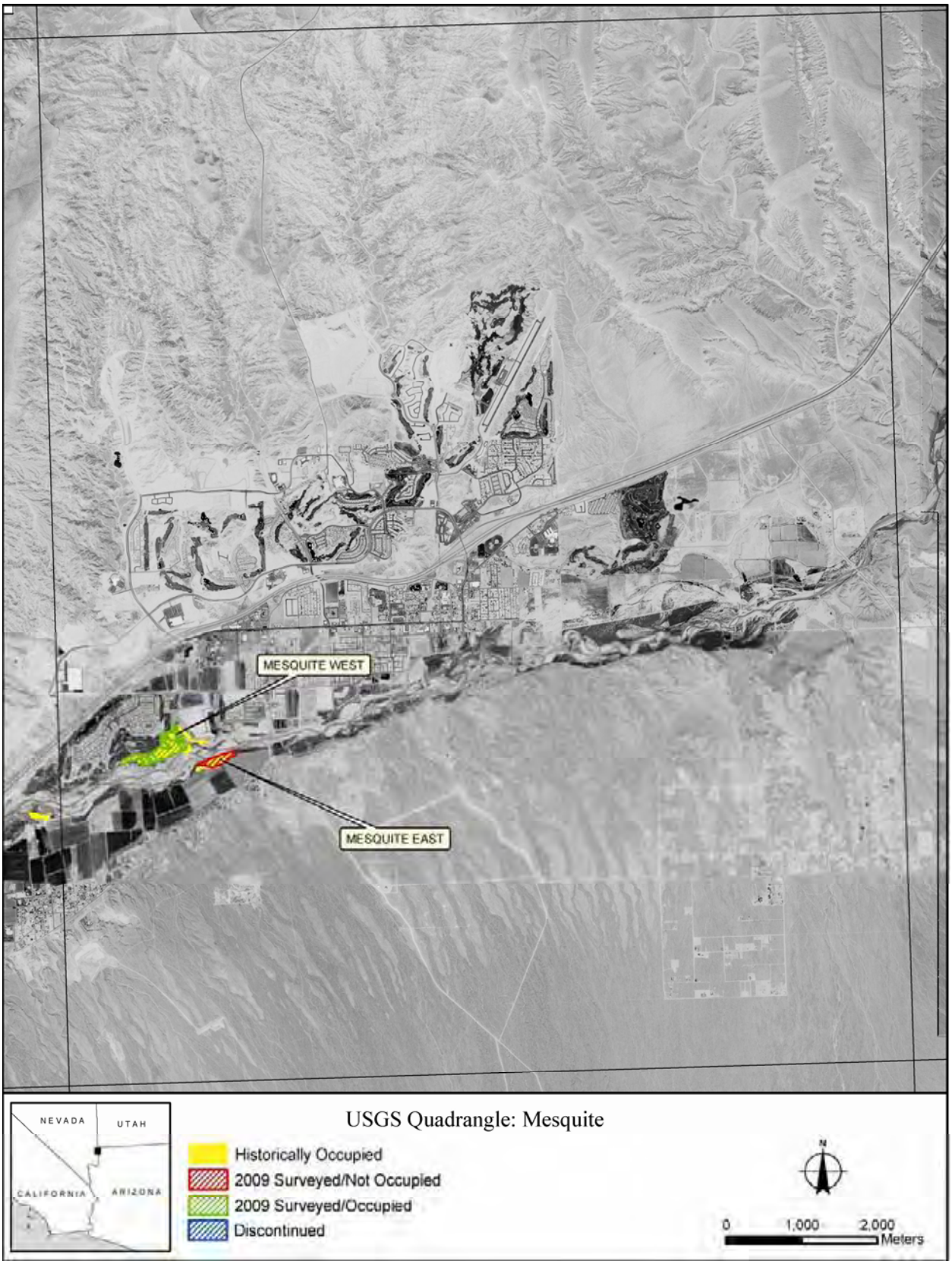
Appendix B

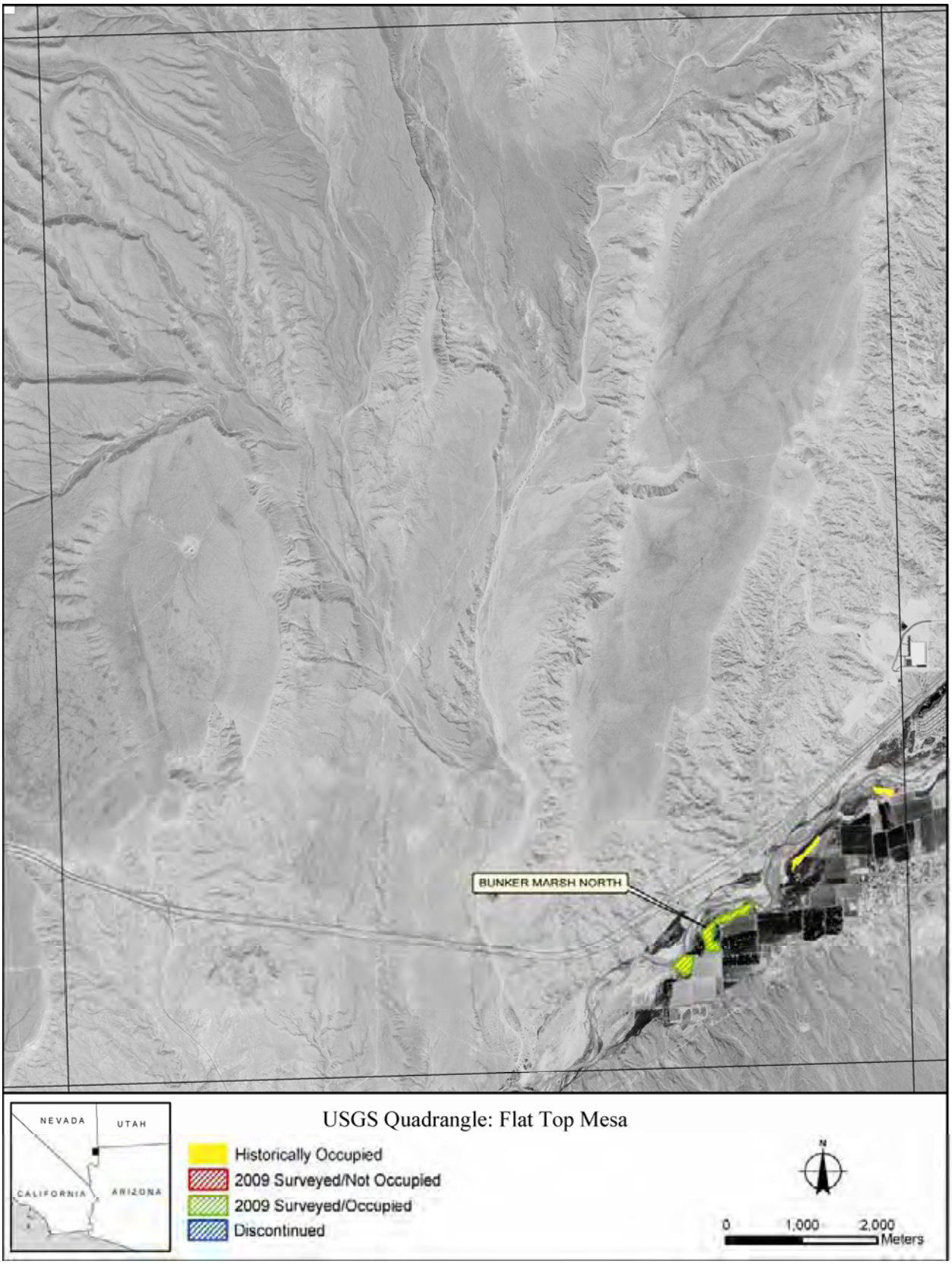
ORTHOPHOTOS SHOWING STUDY SITES

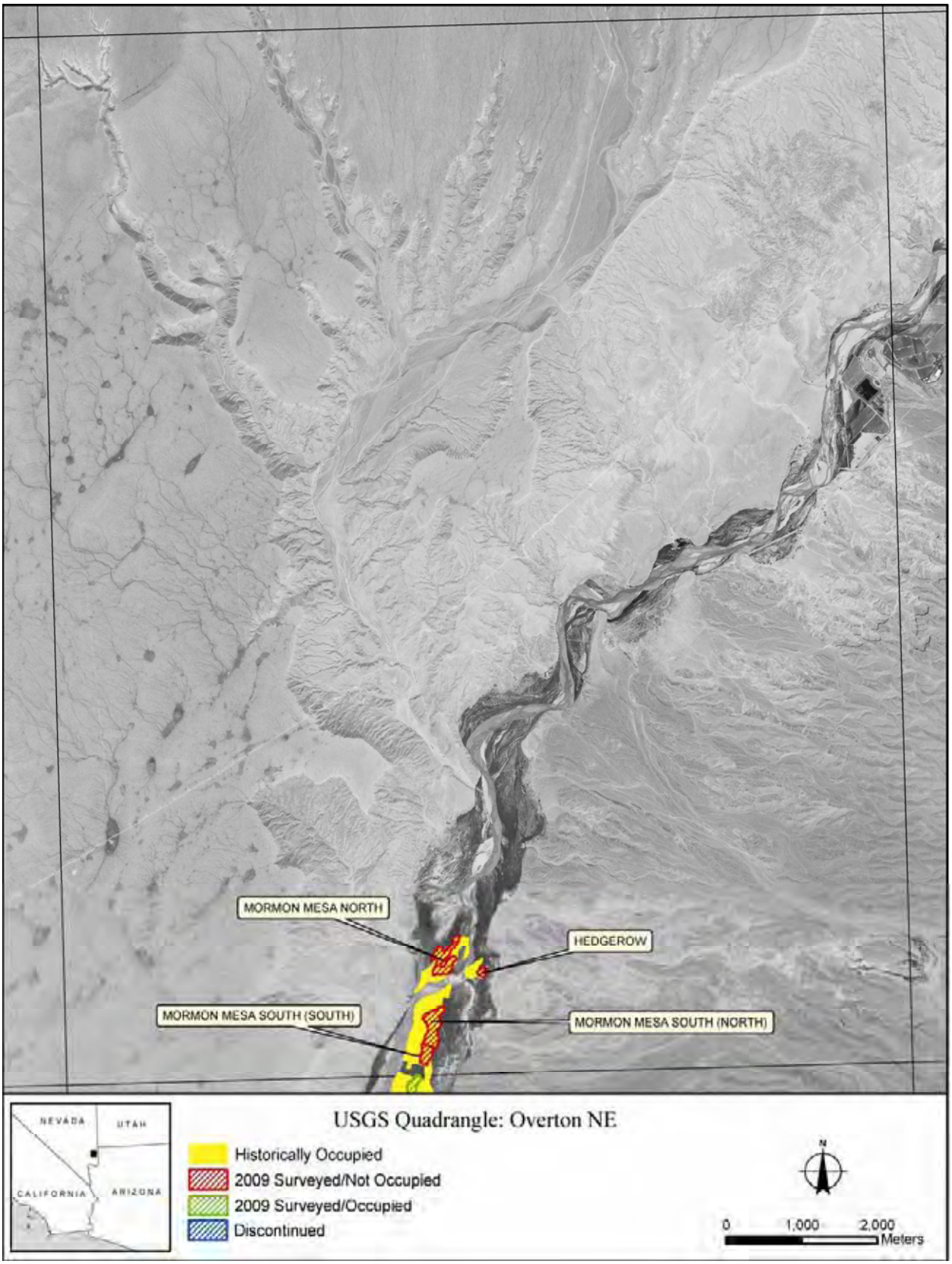

NEVADA
UTAH
CALIFORNIA
ARIZONA
MEXICO
PAHRANAGAT NWR
LITTLEFIELD
St. George
MESQUITE
Virgin River
MORMON MESA
MUDDY RIVER
Colorado River
Las Vegas
Lake Mead
Lake Mohave
Kingman
Flagstaff
TOPOCK MARSH
TOPOCK GORGE
Lake Havasu
BILL WILLIAMS RIVER NWR
Bill Williams River
AHAKHAV
Verde River
Palm Springs
BIG HOLE SLOUGH
Quartzsite
PVER
Phoenix
Salton Sea
CIBOLA NWR
MITTRY LAKE
IMPERIAL NWR
Gila River
Yuma
YUMA
Pacific Ocean
Gulf of California
Lower Colorado River Southwestern
Willow Flycatcher Study 2009
City/Town
Study Area
Highway
0 25 50 75 Miles

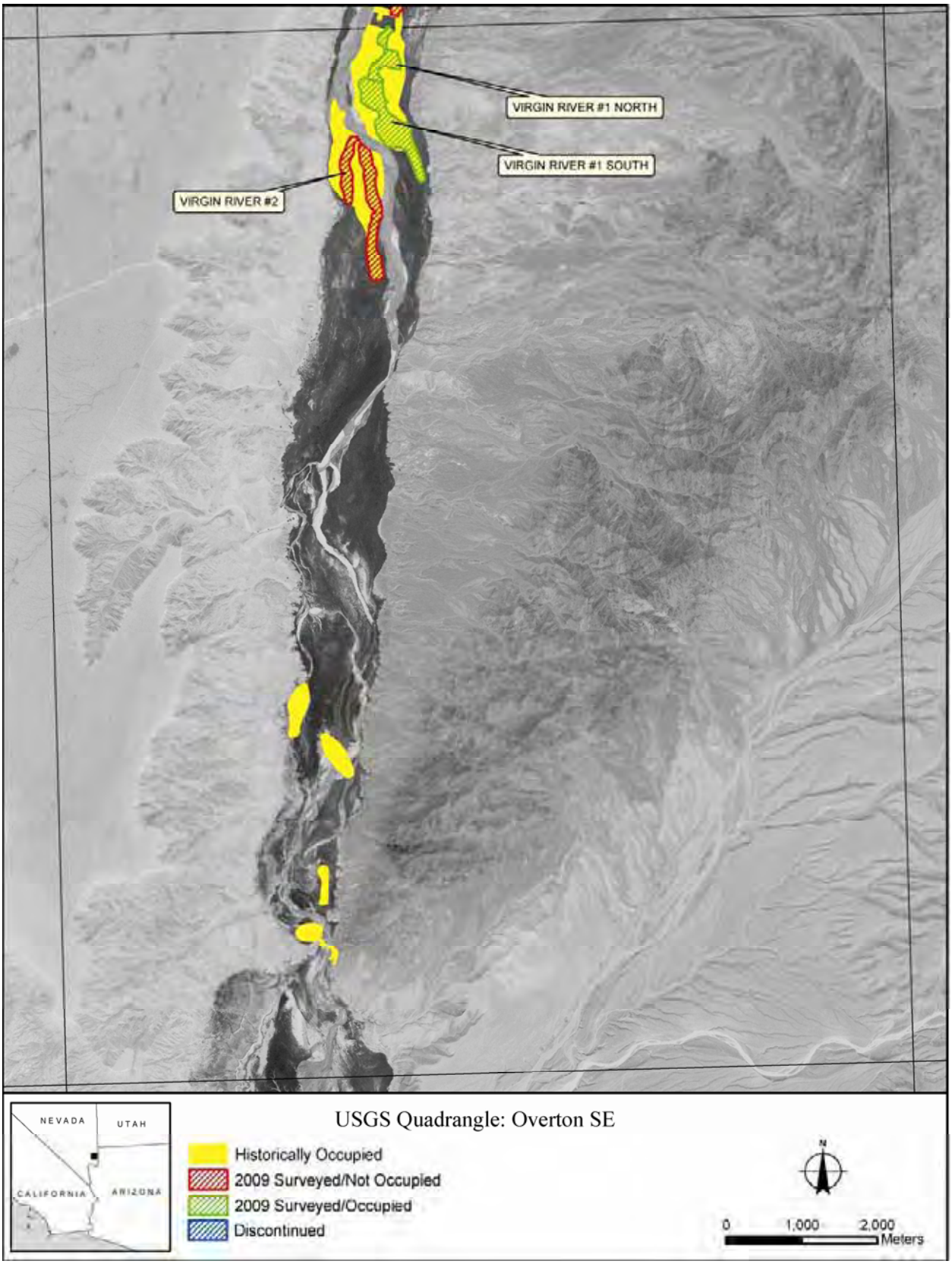

PAHRANAGAT NORTH
PAHRANAGAT WEST
PAHRANAGAT MAPS
PAHRANAGAT SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Alamo & Alamo SE
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

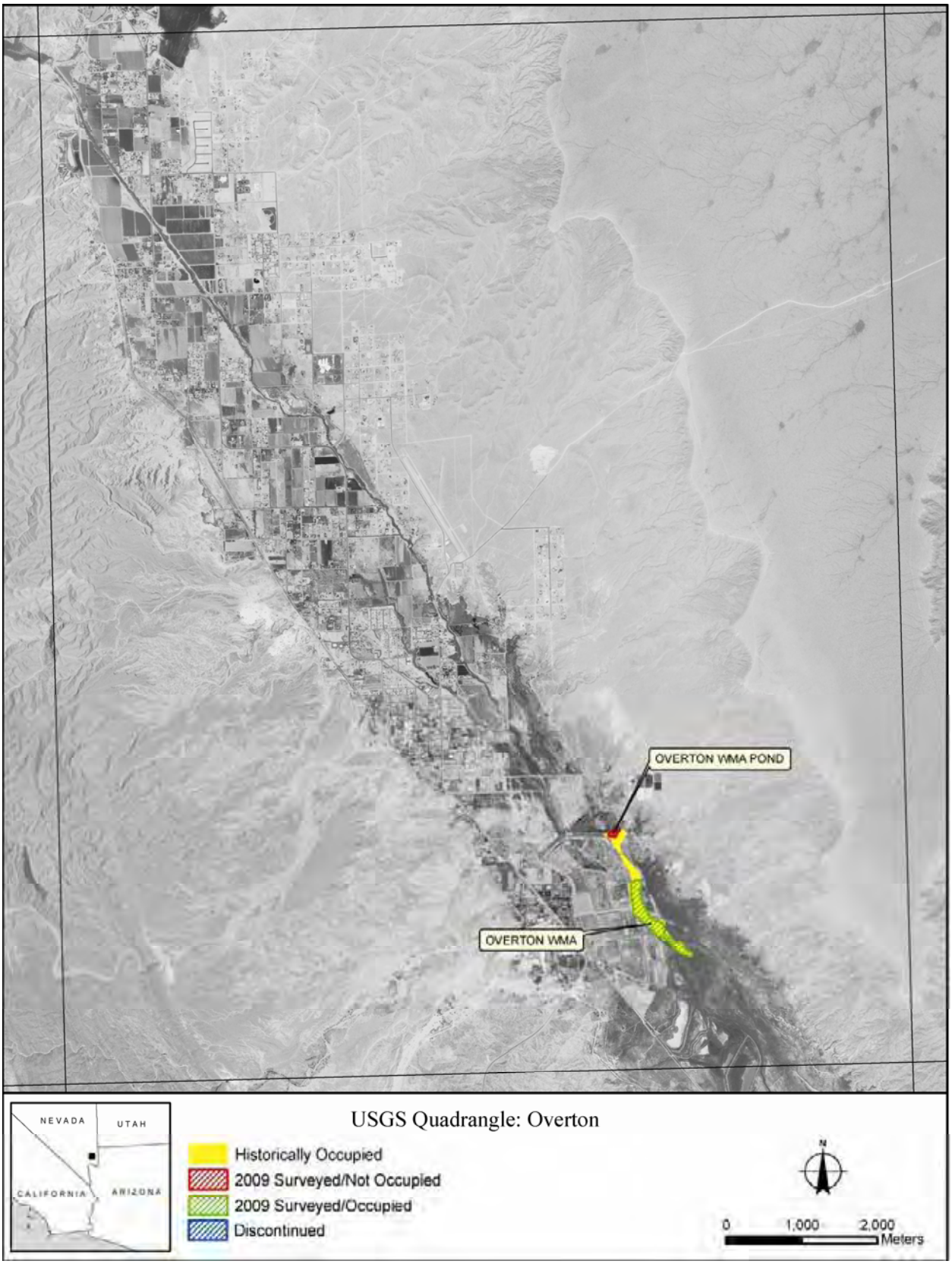

LITTLEFIELD POLES
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Littlefield
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

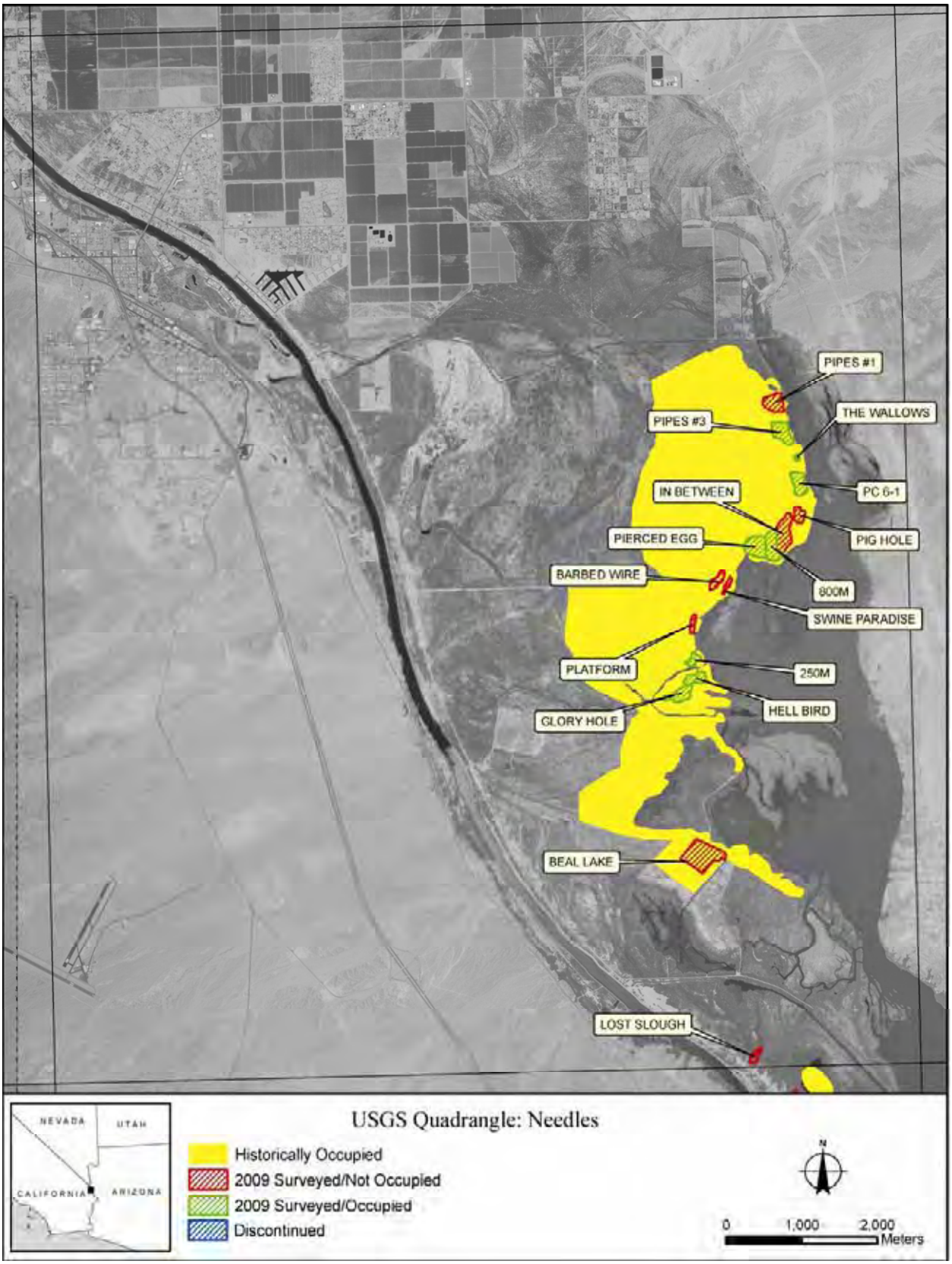

MESQUITE WEST
MESQUITE EAST
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Mesquite
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

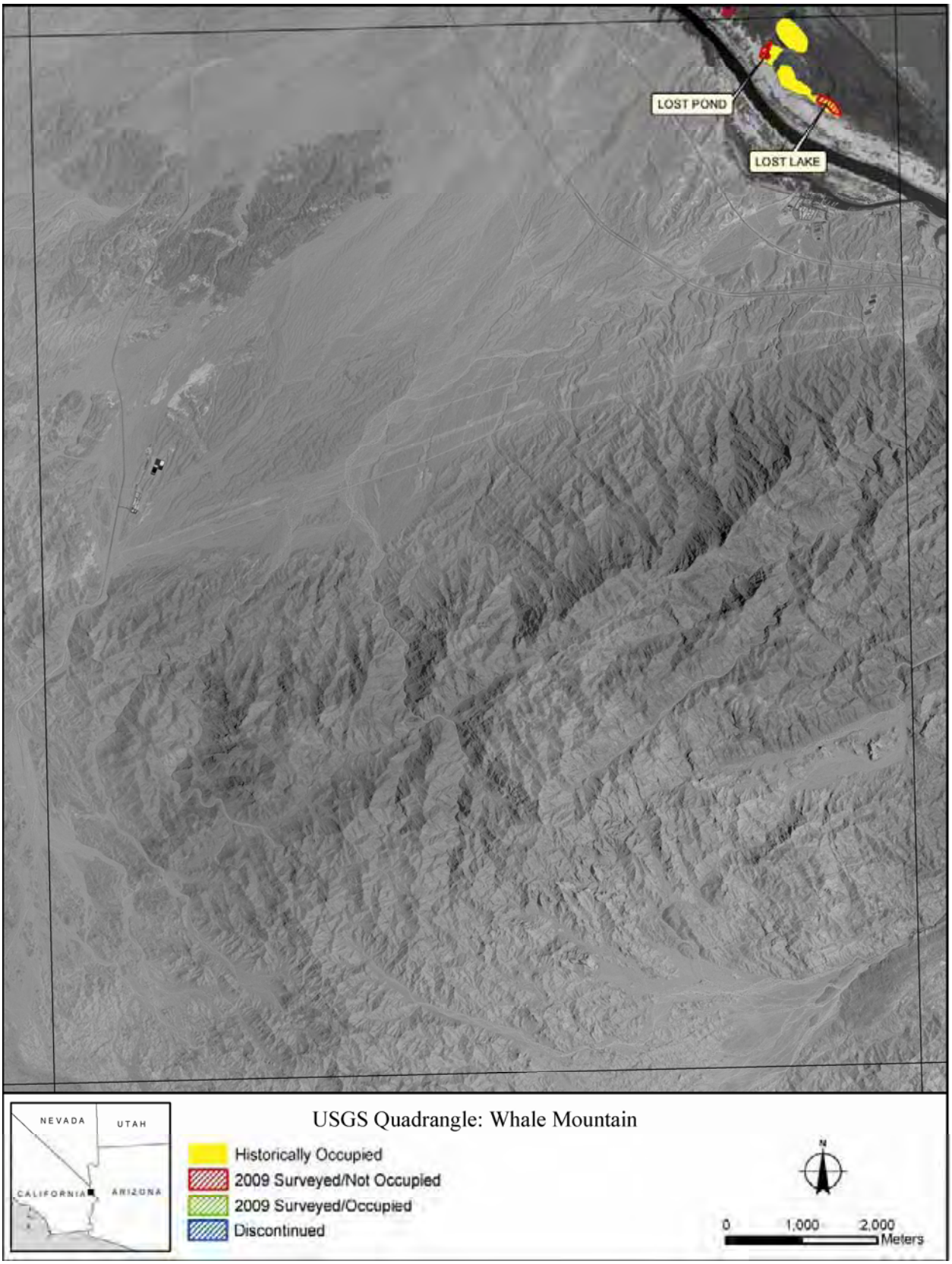

BUNKER MARSH NORTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Flat Top Mesa
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

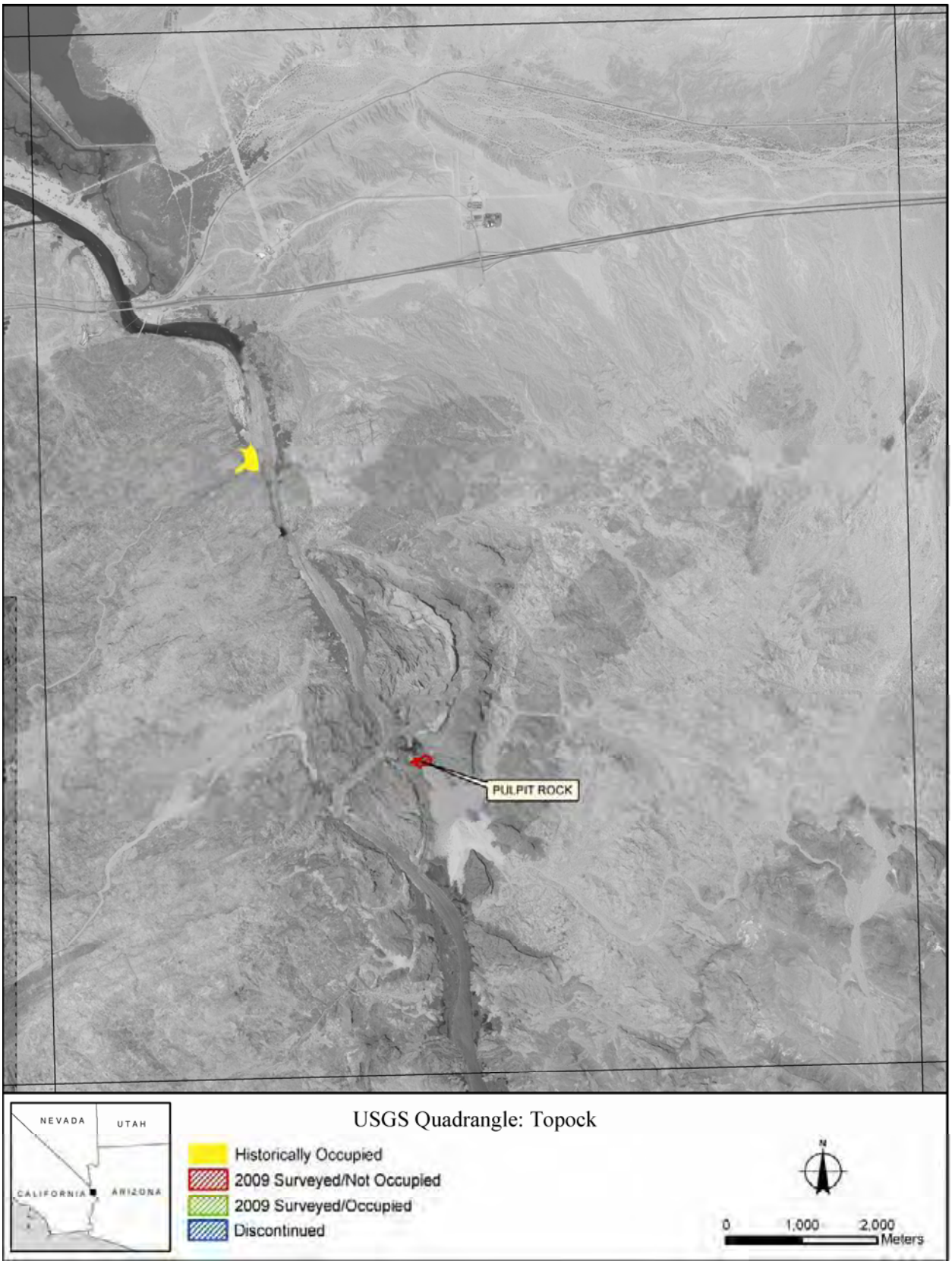

MORMON MESA NORTH
HEDGEROW
MORMON MESA SOUTH (SOUTH)
MORMON MESA SOUTH (NORTH)
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton NE
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

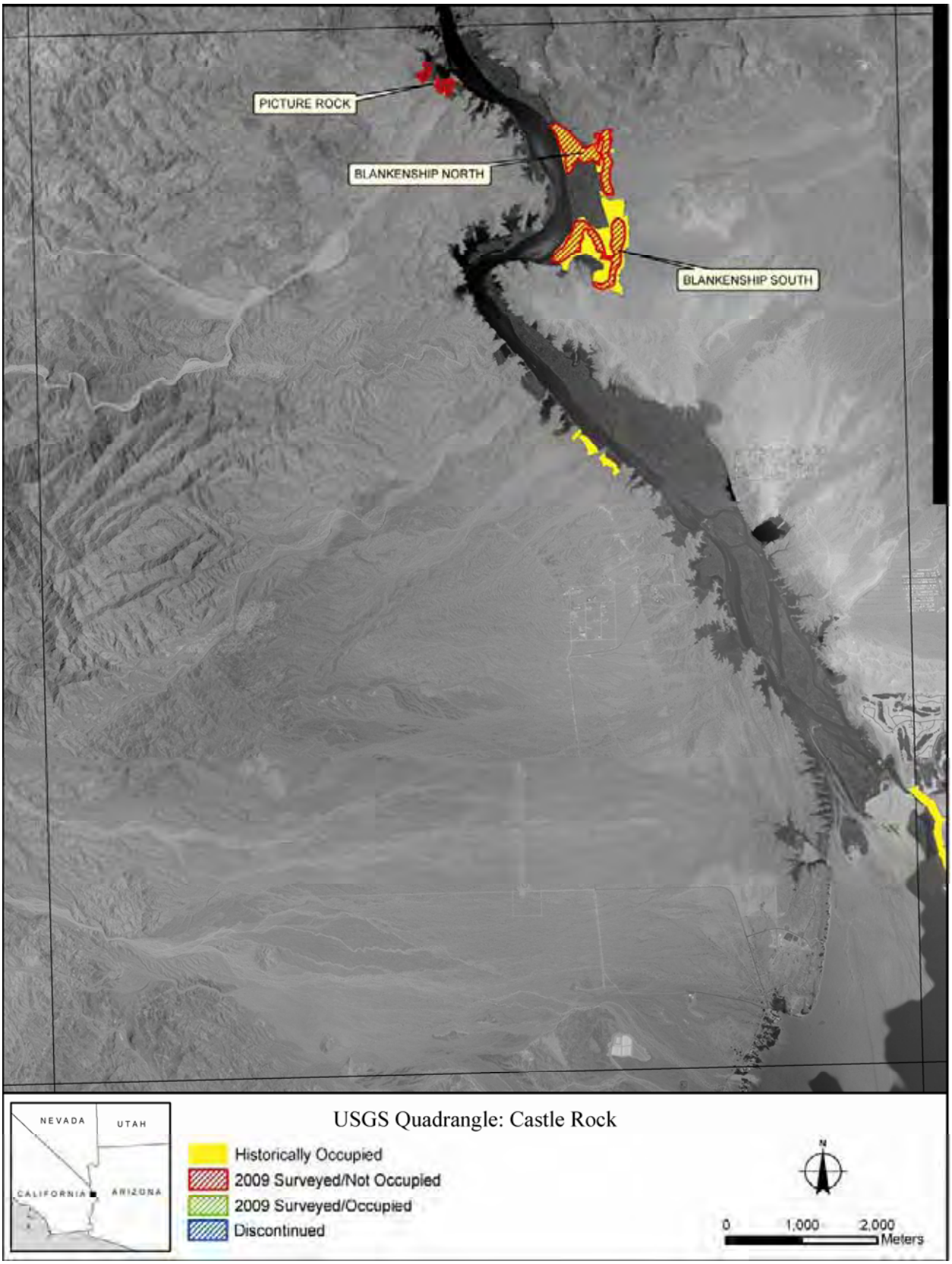

VIRGIN RIVER #1 NORTH
VIRGIN RIVER #1 SOUTH
VIRGIN RIVER #2
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton SE
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

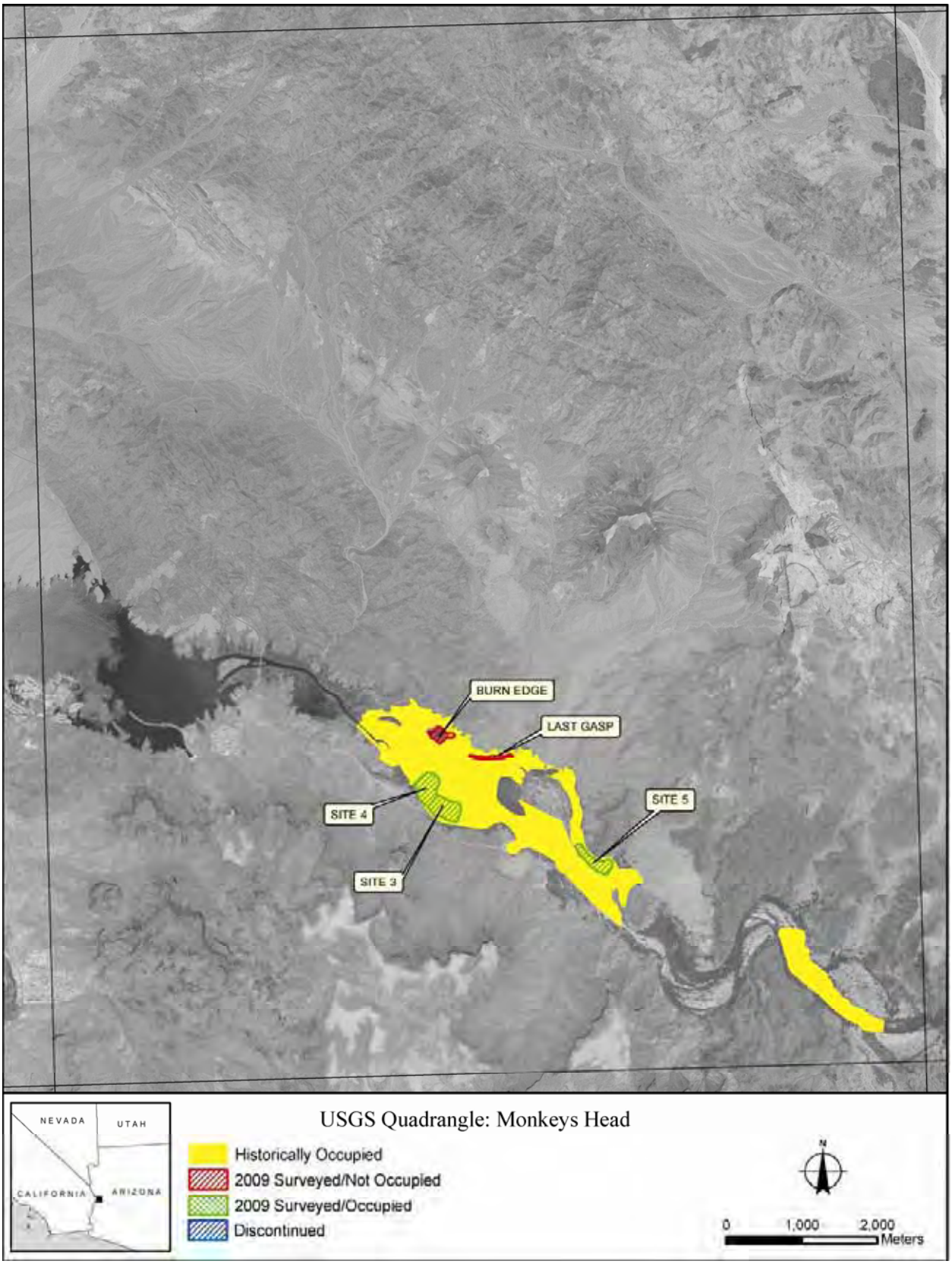

OVERTON WMA POND
OVERTON WMA
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


PIPES #1
THE WALLOWS
PIPES #3
PC 6-1
IN BETWEEN
PIG HOLE
PIERCED EGG
BARBED WIRE
800M
SWINE PARADISE
PLATFORM
250M
HELL BIRD
GLORY HOLE
BEAL LAKE
LOST SLOUGH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Needles
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

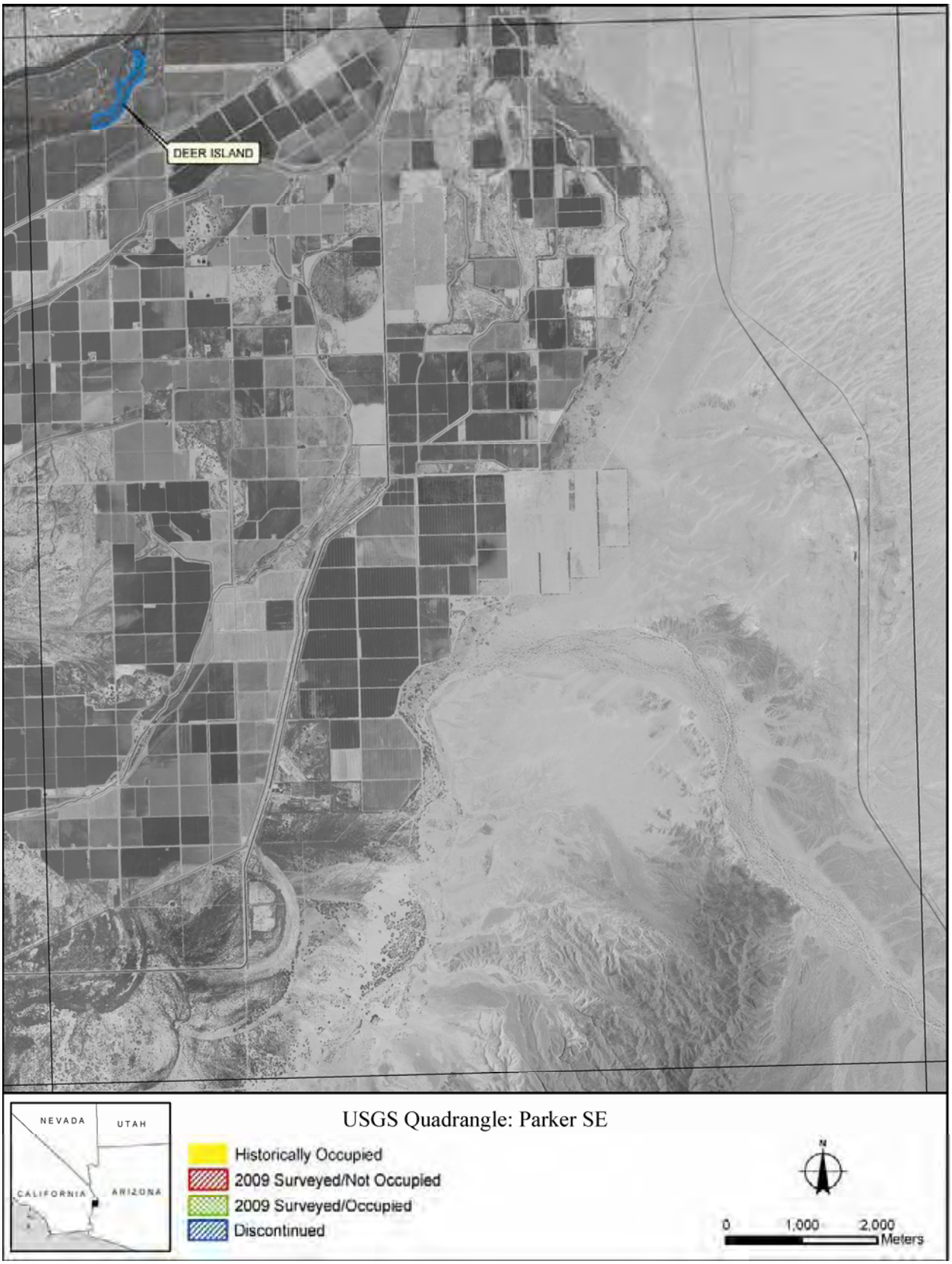

LOST POND
LOST LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Whale Mountain
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


PULPIT ROCK
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Topock
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


PICTURE ROCK
BLANKENSHIP NORTH
BLANKENSHIP SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castle Rock
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

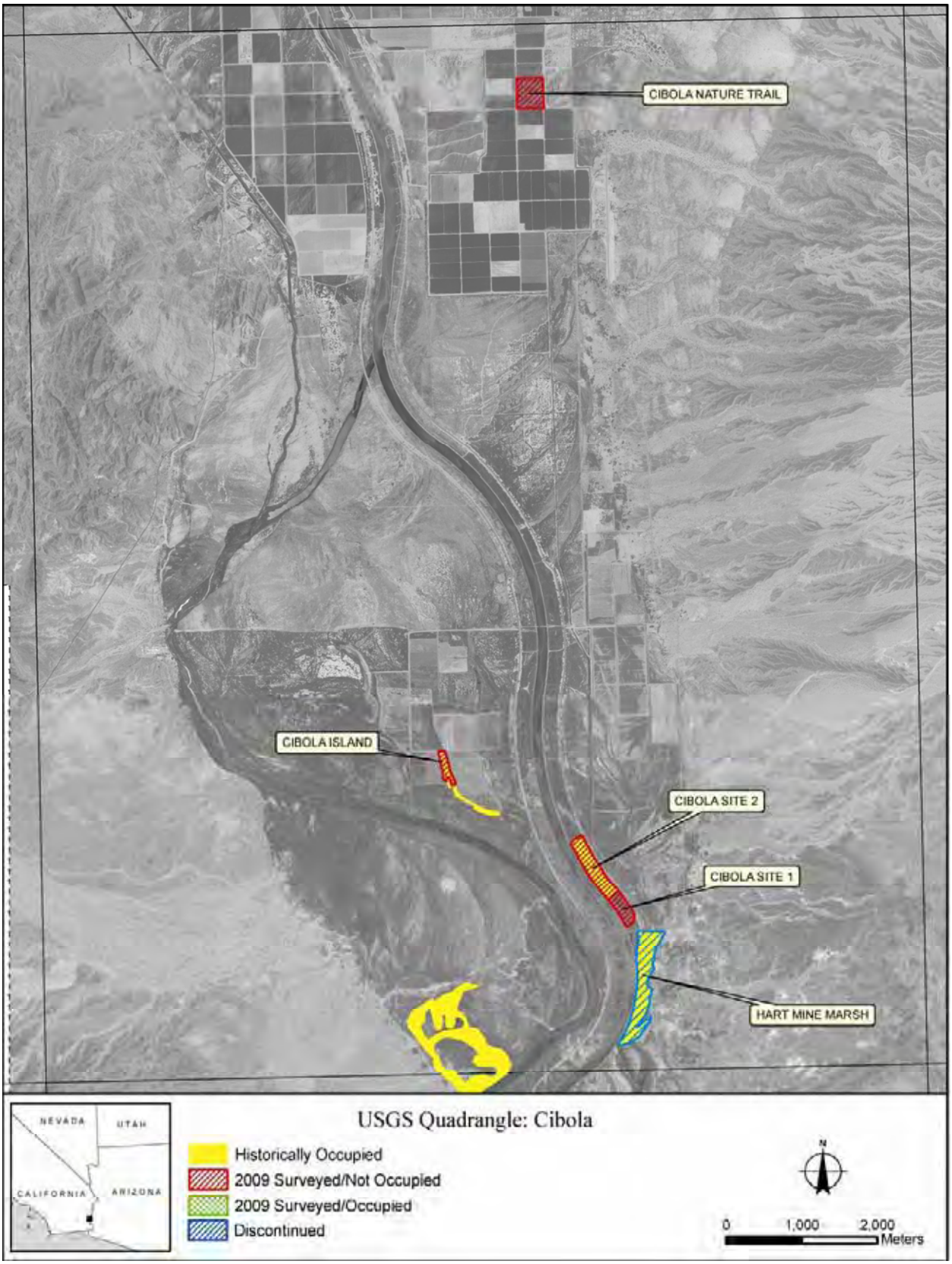

BURN EDGE
LAST GASP
SITE 4
SITE 5
SITE 3
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Monkeys Head
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

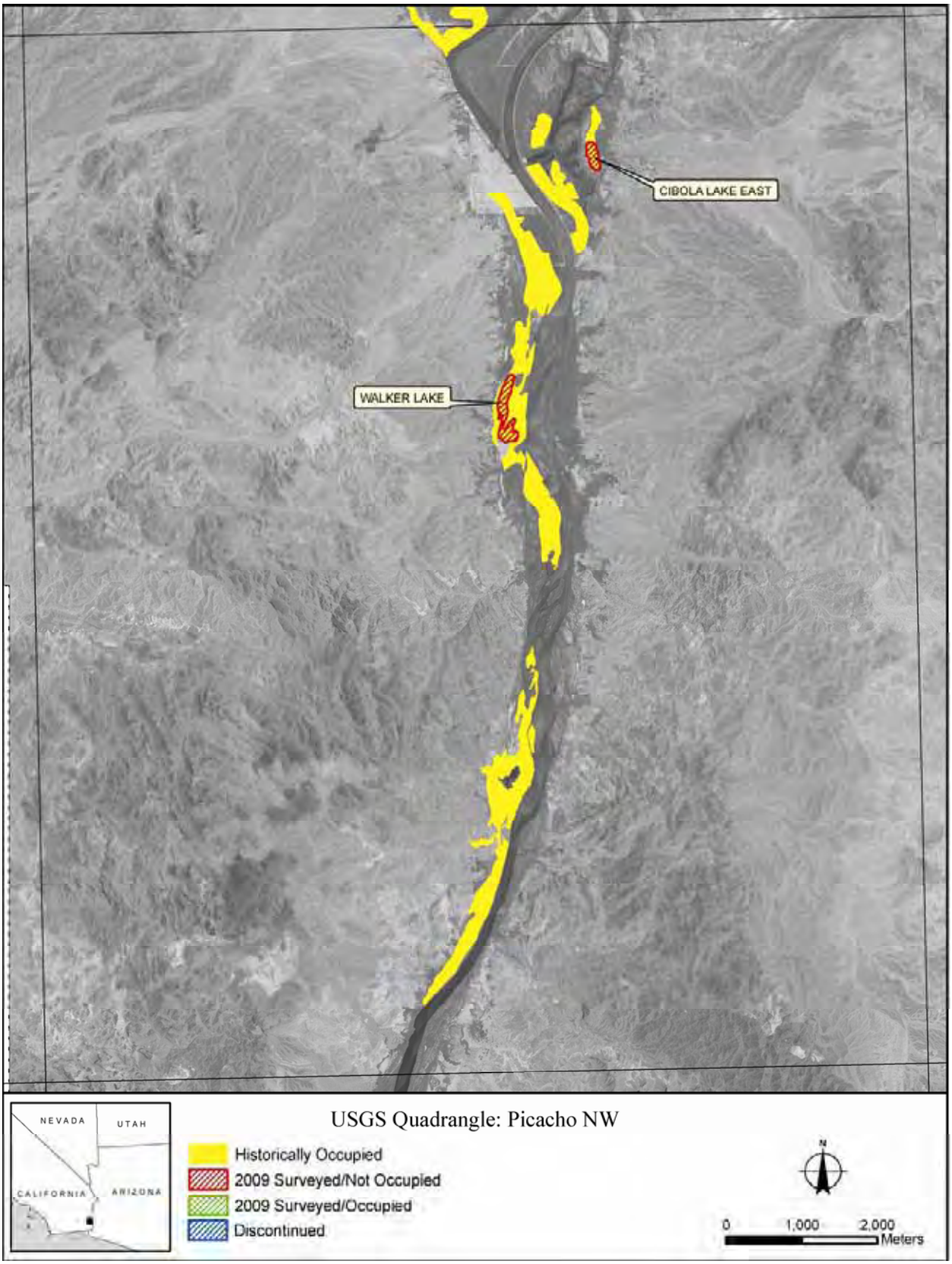
UPSTREAM FROM SITE 8
PLANET RANCH ROAD
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castaneda Hills SW
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

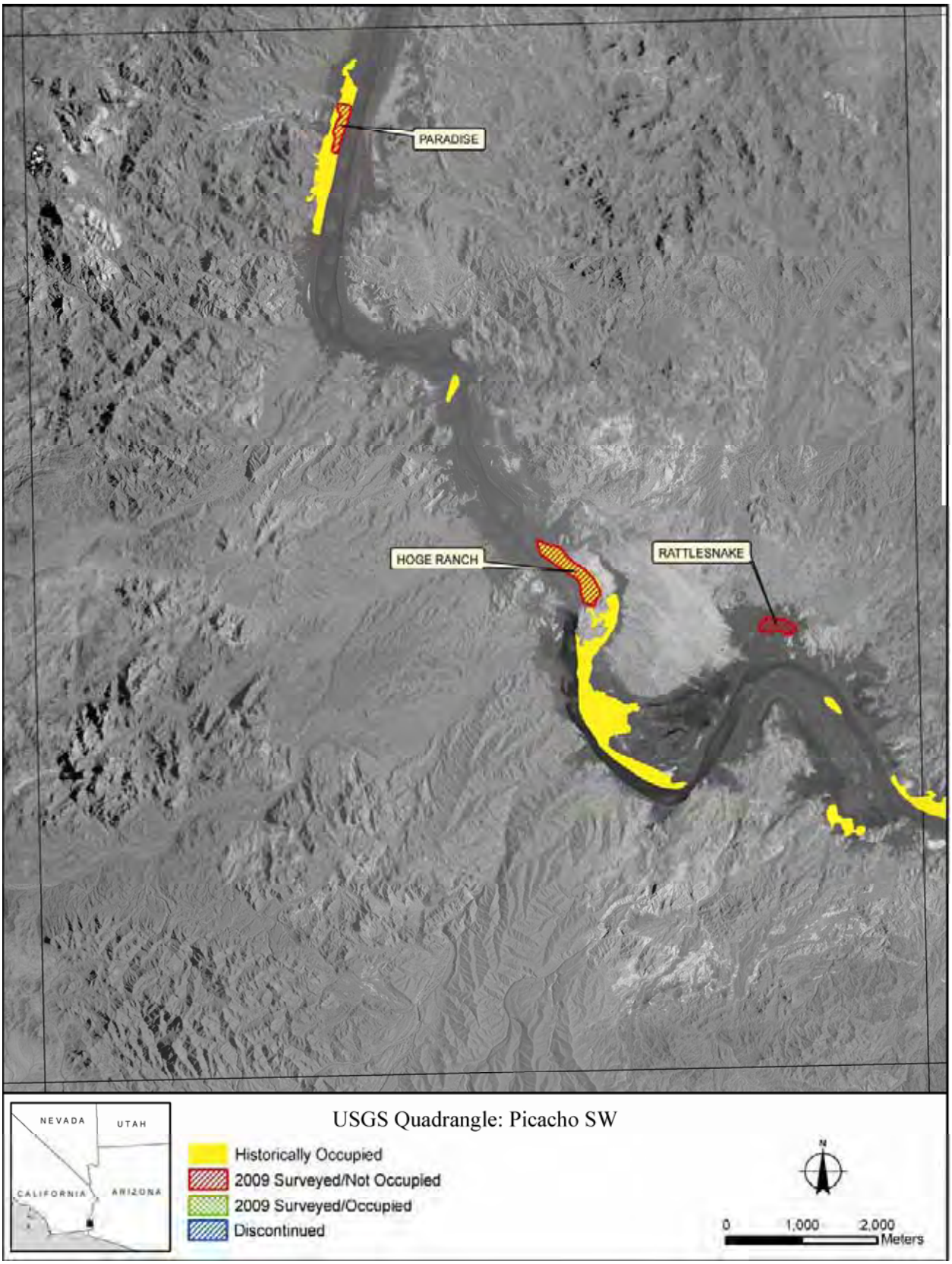

DEER ISLAND
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Parker SE
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

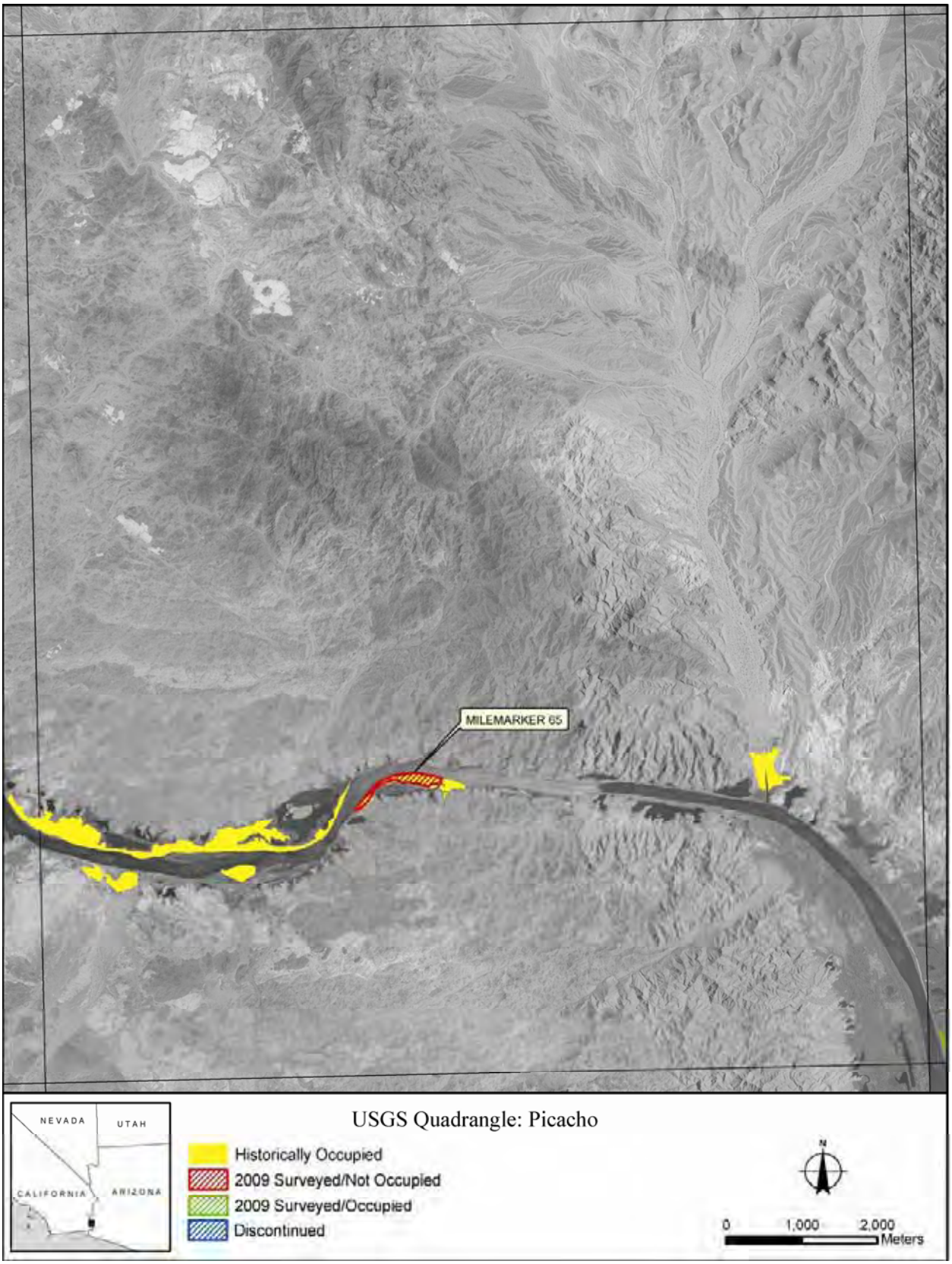
PVER PHASE 2
BIG HOLE SLOUGH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Blythe NE
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

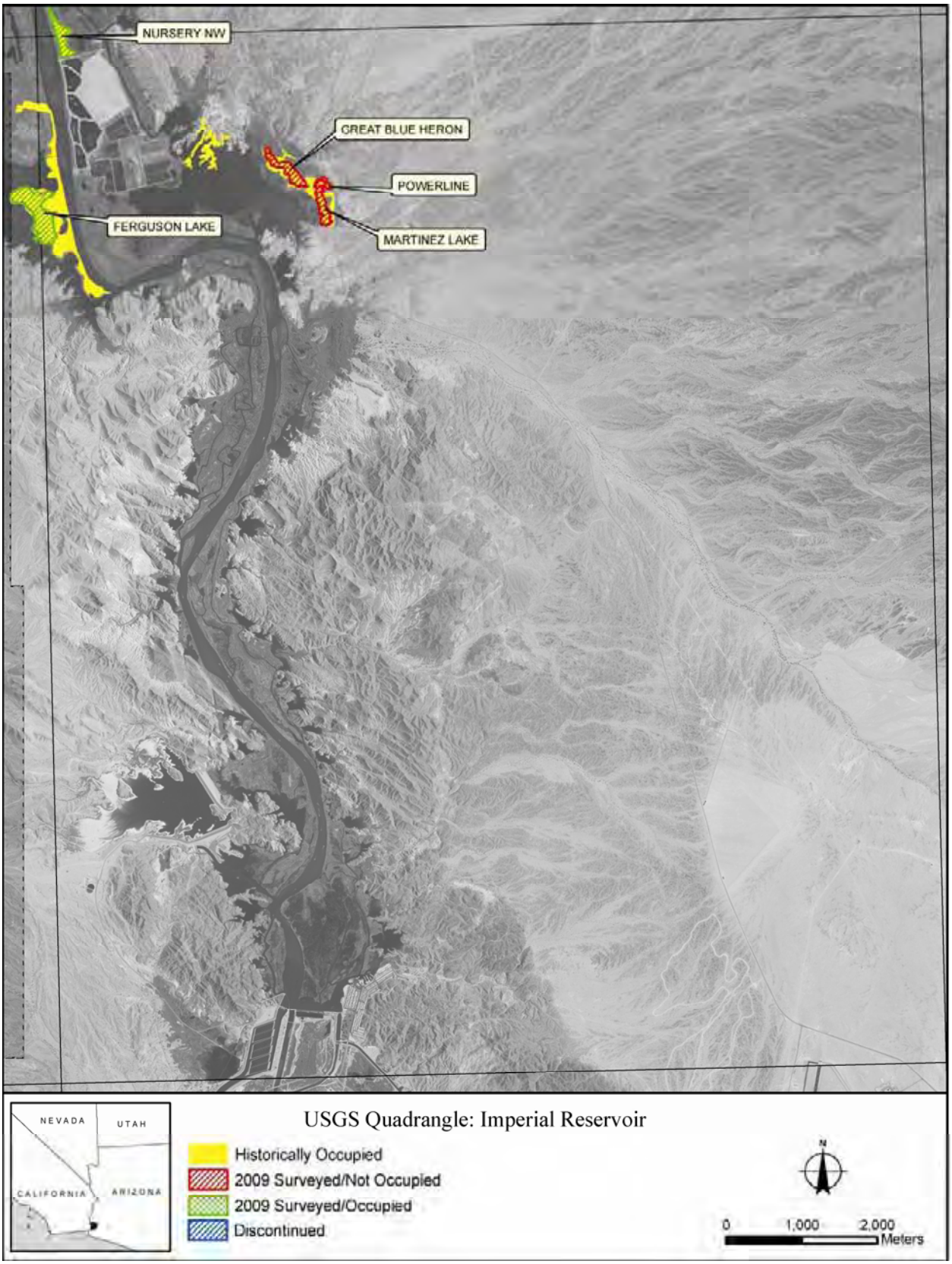
CVCA PHASE 1
CVCA PHASE 3
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Palo Verde
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

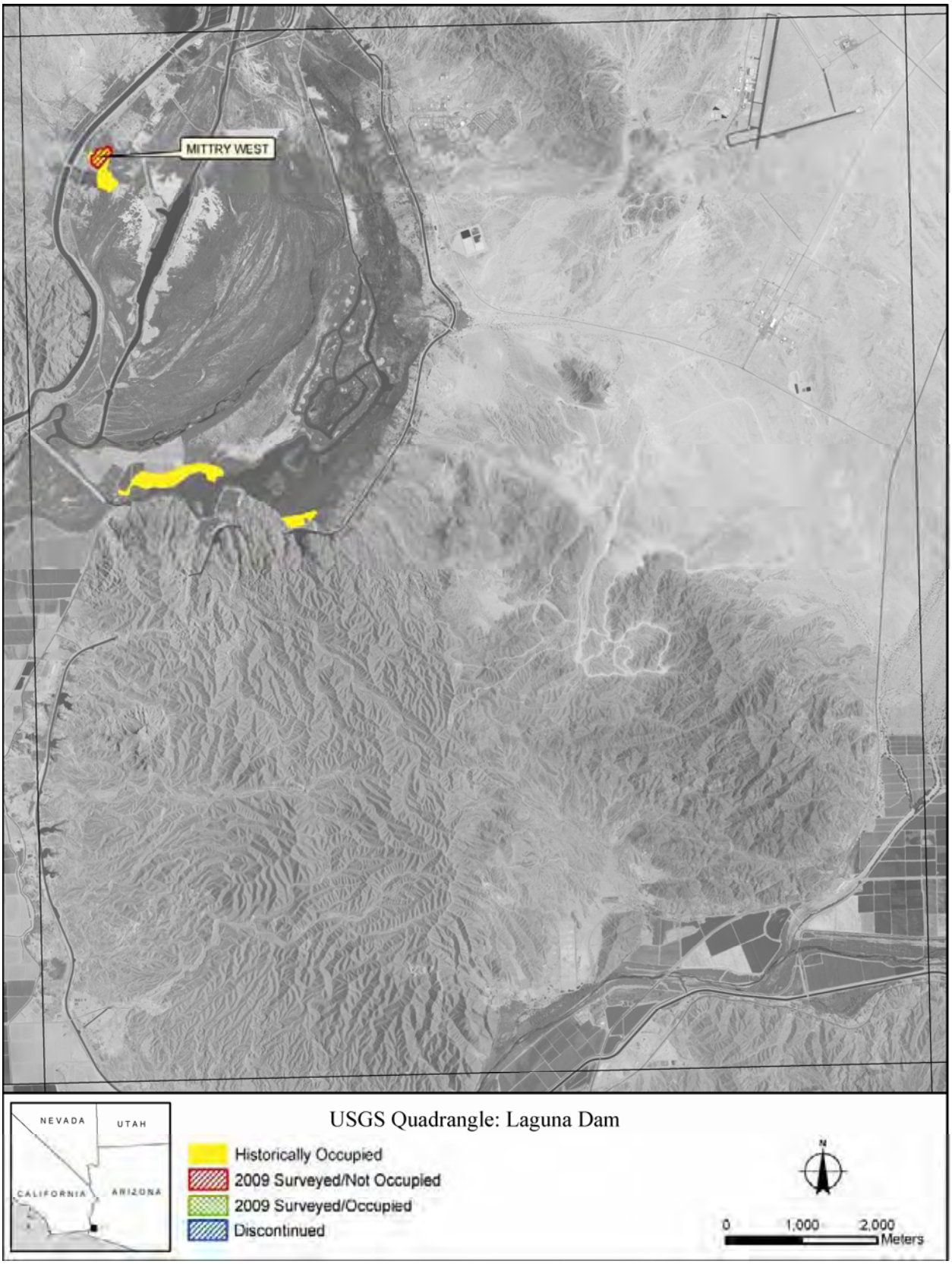

CIBOLA NATURE TRAIL
CIBOLA ISLAND
CIBOLA SITE 2
CIBOLA SITE 1
HART MINE MARSH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Cibola
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


CIBOLA LAKE EAST
WALKER LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho NW
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


PARADISE
HOGE RANCH
RATTLESNAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho SW
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


MILEMARKER 65
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


NURSERY NW
GREAT BLUE HERON
POWERLINE
FERGUSON LAKE
MARTINEZ LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Imperial Reservoir
Historically Occupied
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


MITTRY WEST
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Laguna Dam
Historically Occupied
2009 Surveyed/Not Occupied
2009 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
2009 Surveyed/Not Occupied
2009 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

Appendix C

DETECTIONS OF SPECIAL CONCERN SPECIES, 2009

Appendix C. Number of Detections of Each Special Concern Species Recorded at Each Survey Site, 2009

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	85	1	4
	West	0	0	0	0	0	0	0	1	2	25	0	5
	MAPS	0	0	0	0	0	0	0	0	0	35	0	4
	South	0	0	0	0	0	0	0	0	1	16	0	18
LIFI	Poles	0	0	0	0	0	0	0	0	0	59	10	5
MESQ	East	0	0	0	0	0	0	0	0	1	75	1	40
	West	0	0	0	0	0	0	0	0	1	36	0	3
	Bunker Marsh	0	1	0	0	0	0	0	0	2	43	0	38
MOME	Mormon Mesa North	0	0	0	0	0	0	0	0	13	88	0	66
	Hedgerow	0	0	0	0	0	0	0	0	2	21	0	10
	Mormon Mesa South	0	0	0	0	0	0	0	0	24	114	1	97
	Virgin River #1	0	0	0	0	0	0	0	0	15	201	1	235
	Virgin River #2	0	0	1	0	0	0	0	0	21	197	1	209
MUDD	Overton WMA Pond	0	0	0	0	0	0	0	0	0	26	0	6
	Overton WMA	0	0	0	0	0	0	0	0	4	66	0	50
TOPO	Pipes #1	0	0	0	0	0	0	0	0	0	0	2	18
	Pipes #3	0	0	0	0	0	0	1	0	0	1	1	19
	The Wallows	0	0	0	0	0	0	0	0	5	8	4	14
	PC6-1	0	0	0	0	0	0	5	0	1	8	1	29
	Pig Hole	0	0	0	0	0	0	0	0	0	0	0	7
	In Between	0	0	0	0	0	0	0	0	0	3	1	15
	800M	0	0	0	0	0	0	0	0	0	4	1	12
	Pierced Egg	0	0	0	0	0	0	3	0	0	7	4	17
	Swine Paradise	0	0	0	0	0	0	0	0	0	7	4	14
	Barbed Wire	0	0	0	0	0	0	1	0	0	4	4	20
	Platform	0	0	0	0	0	0	0	0	0	3	2	7
	250M	0	1	0	0	0	0	7	0	0	7	3	13
	Hell Bird	0	2	0	0	0	0	10	0	0	23	6	57
	Glory Hole	1	0	0	0	0	0	2	0	0	4	4	11

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	1	0	0	0	0	0	0	36	9	1	21
	Lost Slough	0	0	0	0	0	0	0	0	1	2	0	10
	Lost Pond	0	0	0	0	0	0	0	0	0	3	0	2
	Lost Lake	0	0	0	0	0	0	0	0	1	3	1	10
TOGO	Pulpit Rock	0	0	0	0	0	0	0	0	0	0	0	4
	Picture Rock	0	1	0	0	0	0	0	0	2	8	1	14
	Blankenship Bend North	2	3	0	0	0	0	0	0	13	0	2	38
	Blankenship Bend South	4	4	4	0	0	0	0	0	9	0	0	25
BIWI	Burn Edge	0	0	0	0	0	0	13	0	7	3	0	31
	Site #4	0	0	0	1	0	0	2	0	32	31	3	66
	Site #3	0	0	0	0	0	0	6	0	8	26	4	50
	Last Gasp	0	0	0	0	0	0	8	0	22	0	1	61
	Site #5	0	0	0	3	0	0	13	0	10	7	2	30
	Upstream from Site #8	3	0	1	5	0	0	6	0	3	5	0	14
	Planet Ranch Road	0	0	0	4	0	0	1	0	23	21	1	19
AHAK	Deer Island	0	0	1	0	0	0	0	0	1	0	0	3
PVER	PVER Phase 2	0	0	0	0	0	0	0	0	2	3	0	5
BIHO	Big Hole Slough	0	0	0	0	0	0	1	0	0	0	0	12
CIBO	CVCA Phase 1	0	0	0	0	0	0	0	0	0	21	0	9
	CVCA Phase 3	0	0	0	0	0	0	0	0	0	5	0	2
	Cibola Nature Trail	0	0	0	0	0	0	0	0	2	4	0	7
	Cibola Island	0	0	0	0	0	0	0	0	0	3	1	7
	Cibola Site #2	0	0	0	0	0	0	1	0	0	0	0	12
	Cibola Site #1	0	0	0	0	0	0	3	0	0	0	0	14
	Hart Mine Marsh	0	3	2	0	0	0	2	0	0	0	0	7
	Cibola Lake #2 (East)	0	1	0	0	0	0	0	0	0	0	0	10
	Walker Lake	0	0	0	0	0	0	5	0	0	0	0	18
IMPE	Paradise	0	0	0	0	0	0	7	0	0	0	0	12
	Hoge Ranch	0	0	0	0	0	0	1	0	0	0	3	25

Study Area[1]	Survey Site	Special Concern Species[2]											
		BLRA	CLRA	LEBI	YBCU	ELOW	GIFL	GIWO	VEFL	BEVI	YWAR	SUTA	YBCH
IMPE	Rattlesnake	0	0	0	0	0	0	0	0	0	2	3	22
	Milemarker 65	0	0	0	0	0	0	0	0	0	0	0	7
	Nursery NW	0	0	0	0	0	0	0	0	0	0	1	24
	Ferguson Lake	0	2	5	0	0	0	8	0	0	0	0	25
	Great Blue Heron	0	0	1	0	0	0	4	0	1	3	0	31
	Powerline	0	1	1	0	0	0	3	0	0	0	0	15
	Martinez Lake	0	0	0	0	0	0	2	0	0	0	1	11
MITT	Mittry West	0	0	0	0	0	0	5	0	1	1	0	15
YUMA	Gila River Site #2	0	0	0	0	0	0	1	0	0	1	0	5
	Fortuna Site #1	0	1	0	0	0	0	1	0	0	3	0	9
	Fortuna North	0	1	2	0	0	0	0	0	0	0	0	2

[1] PAHR = Pahranagat NWR; LIFI = Littlefield; MESQ = Mesquite; MOME = Mormon Mesa; MUDD = Muddy River; TOPO = Topock Marsh; TOGO = Topock Gorge; BIWI = Bill Williams River NWR; AHAK = Ahakhav Tribal Preserve; PVER = Palo Verde Ecological Reserve; BIHO = Big Hole Slough; CIBO = Cibola NWR; IMPE = Imperial NWR; 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.

Appendix D

ALL WILLOW FLYCATCHERS COLOR-BANDED AND/OR RESIGHTED, 2003–2009

Appendix D. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2009. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA.

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
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
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						

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
2320-31414	M	A								T	T				
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
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				
2320-31459	M	J							P	P					
2320-31460	U	J							P						
2320-31461	U	J							P						

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
2320-31462	U	J							P						
2320-31463	F	J							P			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
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					
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					

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
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		
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					

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
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
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	
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
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					

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
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]	
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		
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		
2320-31649	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	
2320-31660	F	J								Q			M	S	S

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
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
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				
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
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			

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
2360-59708	F	J									P	P			
2360-59709	U	J									P				
2360-59710	U	J									P				
2360-59711	M	J									K			P	P
2360-59712	M	J									K			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				
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
2360-59755	U	J										Q			

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
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			
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	U	J											Q		
2360-59778	U	J											Q		
2360-59779	U	J											K		
2360-59780	U	J											K		
2360-59781	U	J											K		
2360-59782	U	J											K		
2360-59785	U	J									D				
2360-59786	U	J									D				
2360-59787	U	J									D				
2360-59788	F	J									D	D	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	
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		

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
2370-39913	M	A									G				
2370-39914	U	J									P				
2370-39915	M	A									P	P	P	P[11]	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			
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	U	J													M
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
2370-39939	F	A										Q	Q		
2370-39940	M	A										M	M	M	Q
2370-39941	M	J										Q	L[12]		
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		
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		

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
2370-39965	U	A									D				
2370-39966	M	J									D		M		
2370-39967	M	A										M	D[13]	Q	Q
2370-39969	F	A													B
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
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			
2370-40003	M	A										T			
2370-40004	F	A										B			B
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				
2370-40017	M	A									M	M			
2370-40019	U	J									P				
2370-40020	U	J									P				
2370-40021	M	A									P	P			
2370-40023	U	J													M
2370-40024	U	J													K
2370-40025	U	J													K
2370-40026	U	J													P
2370-40027	U	J													P
2370-40029	U	J													M

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
2370-40030	U	J													M
2370-40031	U	J													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[14]			
2370-40037	F	A										G	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[15]	M	M
2370-40047	F	A										P	P	P	P
2370-40048	U	J													T
2370-40049	U	J													T
2370-40050	U	J													T
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
2370-40061	F	A										P			
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
2370-40074	U	J													P
2370-40075	U	J													P
2370-40076	U	J													P
2370-40080	U	J										Q			

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
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
2370-40096	U	J												K	
2370-40097	U	J												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			
2370-40110	U	J											T		
2370-40111	U	J											T		
2370-40112	U	J											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		

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
2370-40139	M	A											T	T	
2370-40140	F	A													P
2370-40141	U	A													K
2370-40142	U	J													M
2370-40143	U	J													Q
2370-40144	U	J													M
2370-40145	U	J													M
2370-40146	U	J													S
2370-40147	F	J												S	D
2370-40148	F	J												S	S
2370-40149	U	J												S	
2370-40150	U	J													M
2370-40151	U	J													M
2370-40152	U	J													M
2370-40153	U	J													S
2370-40154	U	J													S
2370-40155	M	A													L
2370-40156	M	A													B
2370-40157	M	A											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
2370-40174	U	J													M
2370-40175	U	J													M
2370-40176	M	A													M
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	U	J											P		

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
2370-40191	F	A											M	M	M
2370-40192	F	A											D		
2370-40193	F	A											Q	Q	Q
2370-40194	F	A											P	P	P
2370-40195	F	A											P	P	P
2370-40197	M	A											M	Q	Q
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				
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
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	
2430-31015	U	A											Y		
2430-31017	U	A											Y		
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		
2430-61016	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		

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
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		
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	
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
2430-61081	U	J												M	
2430-61082	U	J												Q	
2430-61083	M	A												P	P

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
2430-61084	U	J												Q	
2430-61085	M	A													D
2430-61086	U	J													M
2340-61087	F	A													P
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	U	J												P	
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	U	J												P	
2430-61115	U	J												P	
2430-61116	F	A												M	M
2430-61117	U	J												P	
2430-61118	M	J												P	M
2430-61119	U	J												P	
2430-61120	F	J												P	P
2430-61121	U	J												Q	
2430-61122	U	J												P	
2430-61123	U	J												P	
2430-61124	U	J												P	
2430-61125	M	A												K	
2430-61126	U	J												S	
2430-61127	M	A												P	P
2430-61128	U	J												M	
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	
2430-61135	M	A												T	T
2430-61136	M	A												B	B
2430-61137	F	A												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	

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
2430-61144	U	J												T	
2430-61145	U	J												T	
2430-61153	F	A													M
2430-61154	U	J													Q
2430-61155	U	J													Q
2430-61156	U	J													K
2430-61157	U	J													K
2430-61158	M	A													K
2430-61159	U	J													M
2430-61160	U	J													M
2430-61161	U	J													D
2430-61162	M	A													S
2430-61165	M	J												Q	Q
2430-61167	M	A												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	M	J												M	M
2430-61175	U	J												Q	
2430-61176	U	J												Q	
2430-61177	U	J												Q	
2430-61178	M	A												K	
2430-61179	M	A												K	P
2430-61180	M	A												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
2430-61188	U	J												Q	
2430-61189	U	J												Q	
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	U	J												P	
2430-61198	U	J												P	Q
2430-61199	U	J												P	
2430-61200	U	J												P	

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
2430-61202	U	J												M	
2430-61203	U	J												M	
2430-61204	U	J												M	
2430-61205	U	J												M	
2430-61206	U	J												M	
2430-61207	F	J												M	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	
2430-61223	U	J												D	
2430-61224	U	J												D	
2430-61225	U	J												D	
2430-61271	U	J													P
2430-61277	U	J													P
2430-61278	U	J													P
2430-61279	U	J													P
2430-61285	U	J													M
2540-58132	M	A													S
2540-58141	U	J													M
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
2540-58154	U	J													M
2540-58155	U	J													M
2540-58185	U	J													P
2540-58186	M	A													S
2540-58187	F	A													P
2540-58188	U	J													P
2540-58189	U	A													P
2540-58216	U	J													M
2540-58217	M	A													S
2540-58218	U	J													S
2540-58219	U	J													Q
3500-68963	U	J								T					
3500-68968	U	J								P					
3500-68969	U	J								P					
3500-68972	F	J								P	P	P			

[1] K = Key Pittman, P = Pahranagat NWR, W = Meadow Valley Wash, L = Littlefield, Q = Mesquite, M = Mormon Mesa, D = Muddy River, G = Grand Canyon, T = Topock Marsh, B = Bill Williams River NWR, I = Imperial NWR, 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.

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

[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 Littlefield to Mesquite.

[13] Within-season movement from Muddy River to Mesquite.

[14] Within-season movement from Grand Canyon to Mesquite.

[15] Within-season movement from Grand Canyon to Mormon Mesa.

Appendix E

HYDROGRAPHS FOR PIEZOMETERS AT HABITAT MONITORING SITES

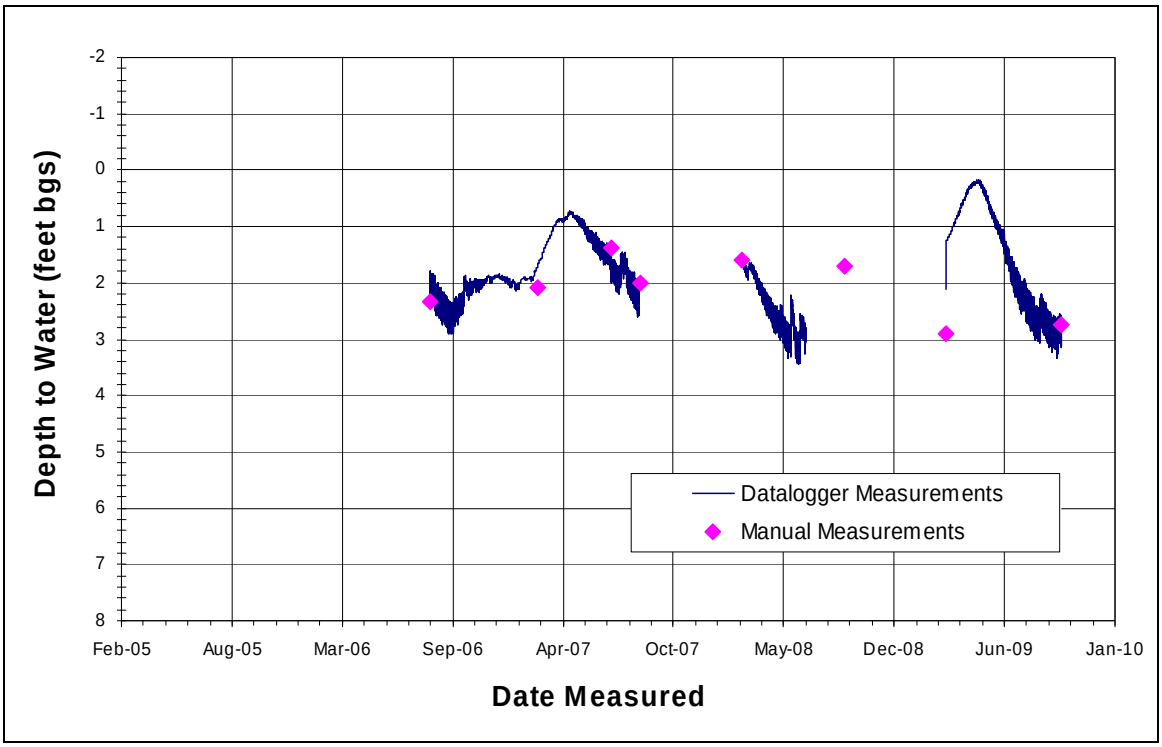


Figure E1. Hydrograph for piezometer at Topock Marsh.

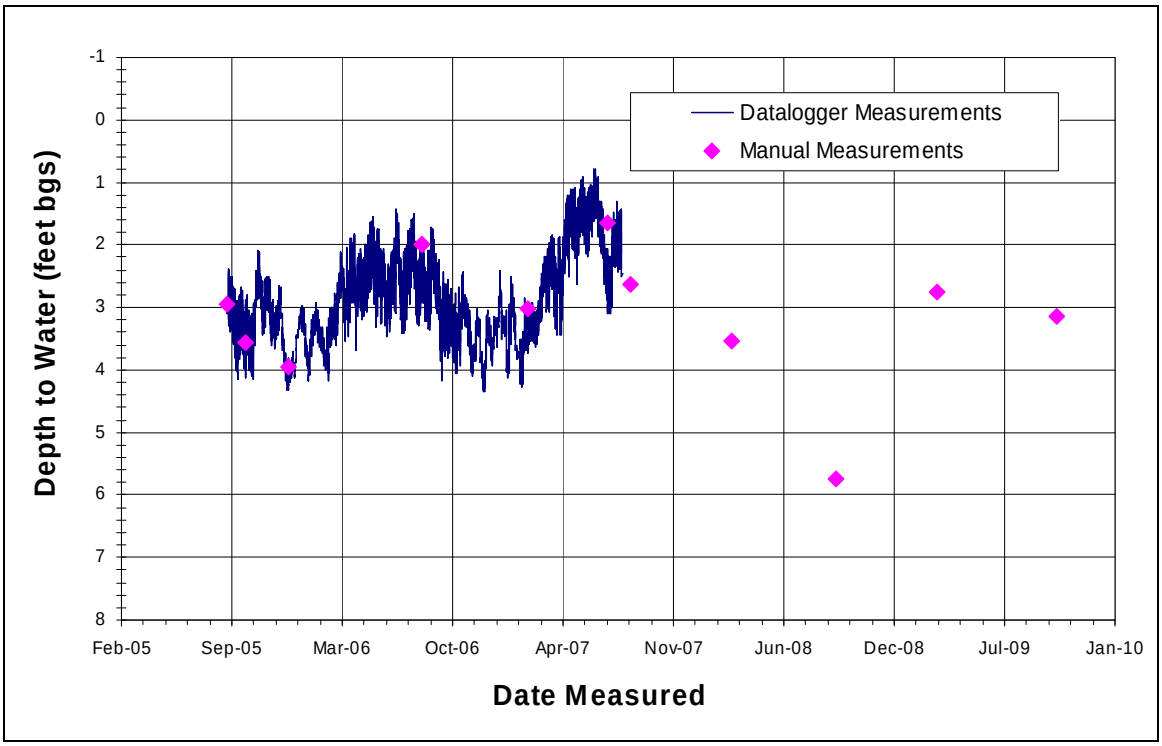


Figure E2. Hydrograph for piezometer at Blankenship Bend.

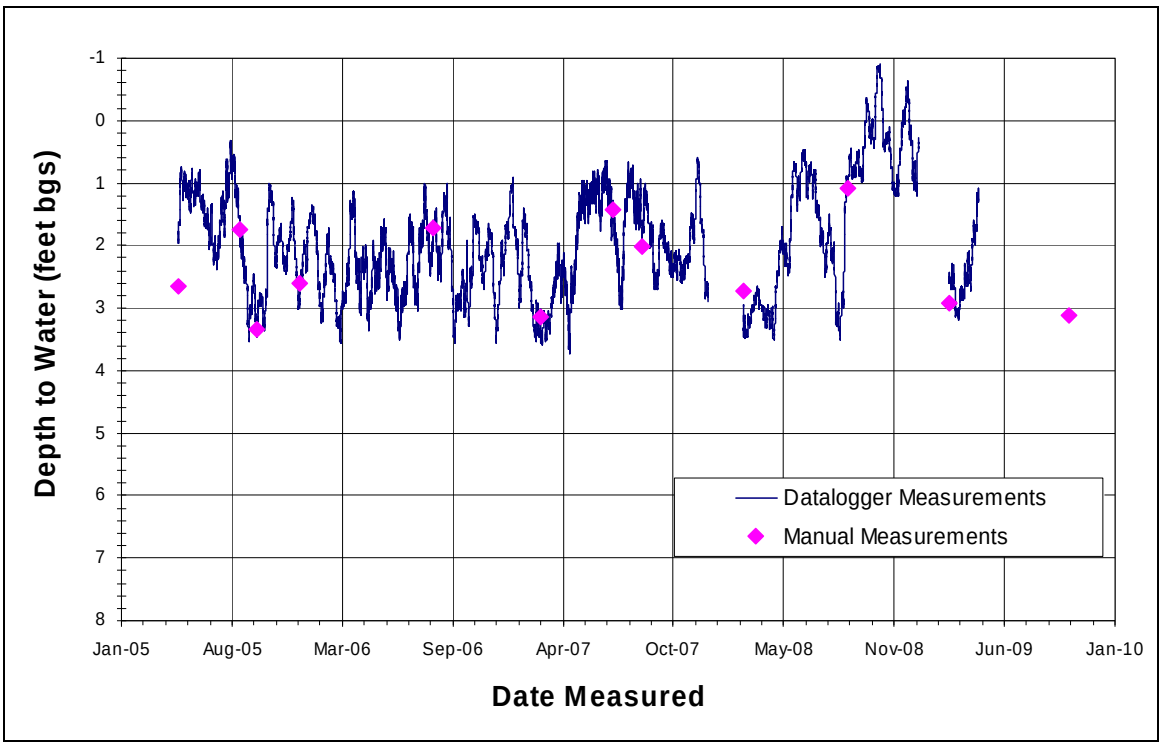


Figure E3. Hydrograph for piezometer at Havasu NE.

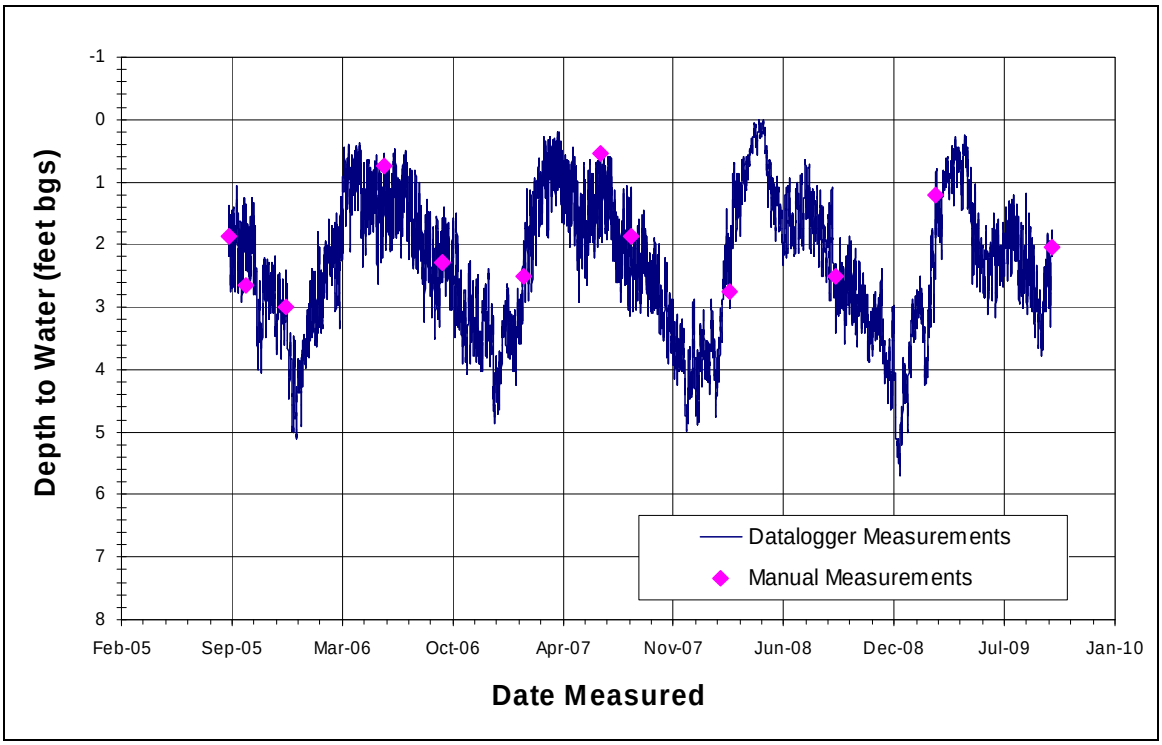


Figure E4. Hydrograph for piezometer at Ehrenberg.

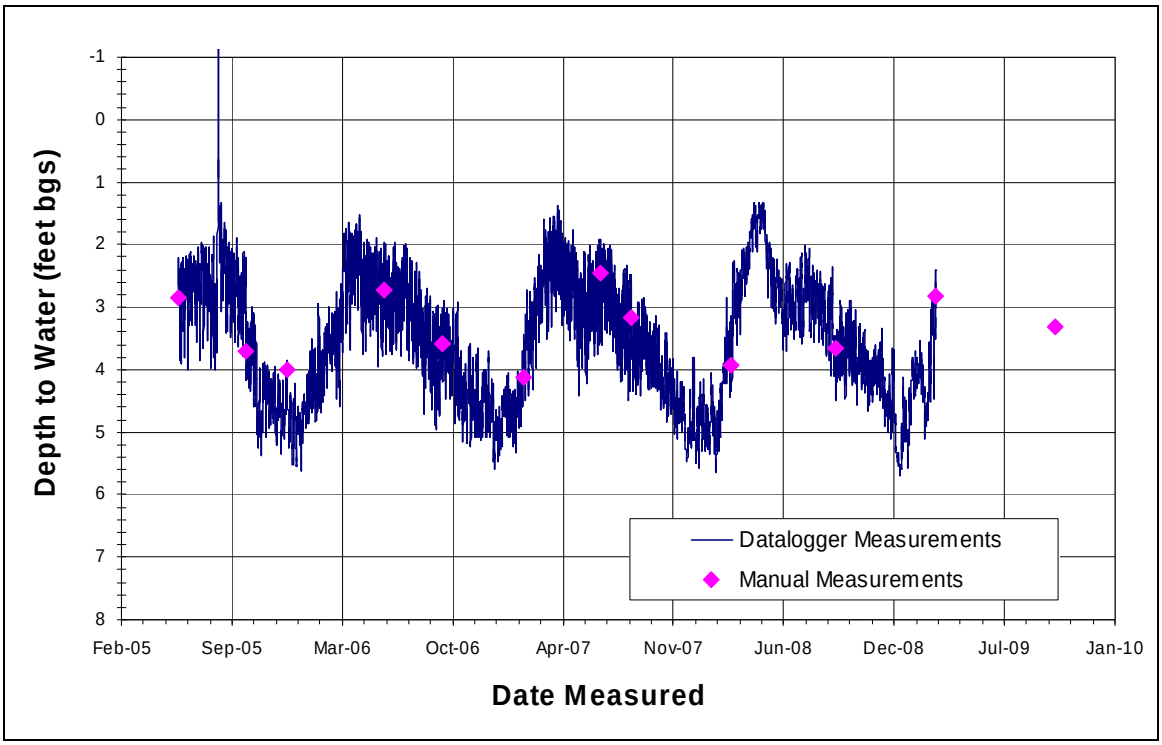


Figure E5. Hydrograph for piezometer at Three Fingers Lake.

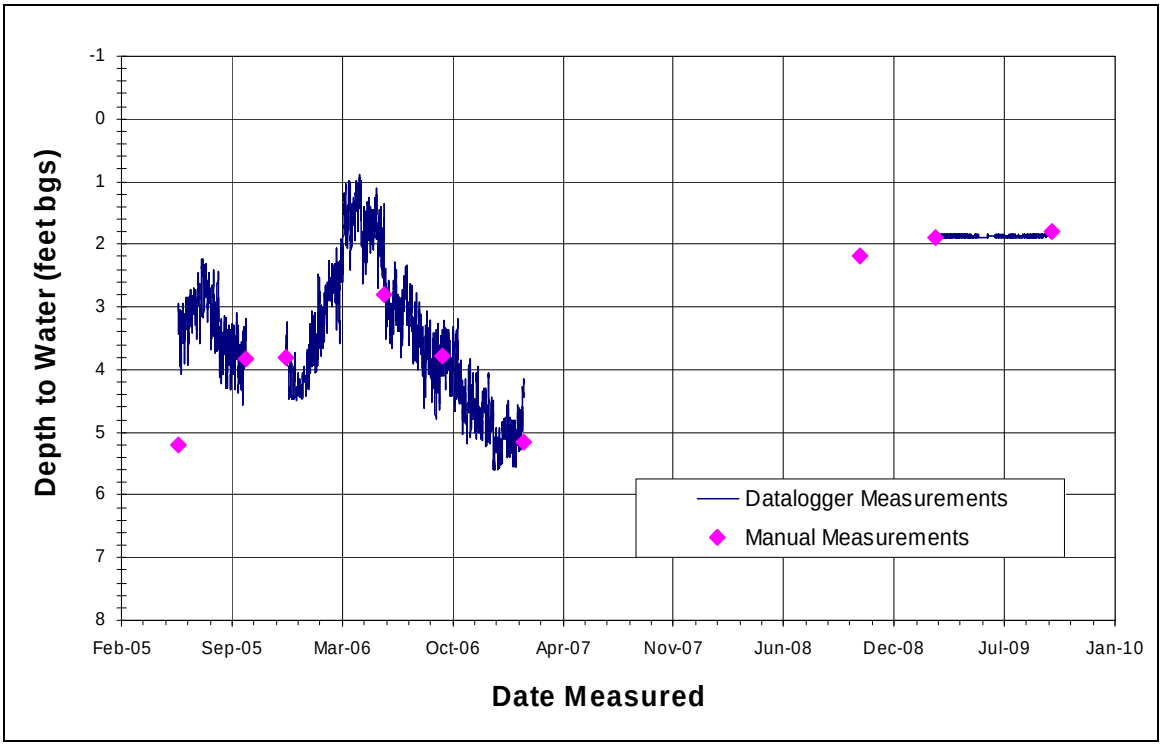


Figure E6. Hydrograph for piezometer at Cibola Lake.

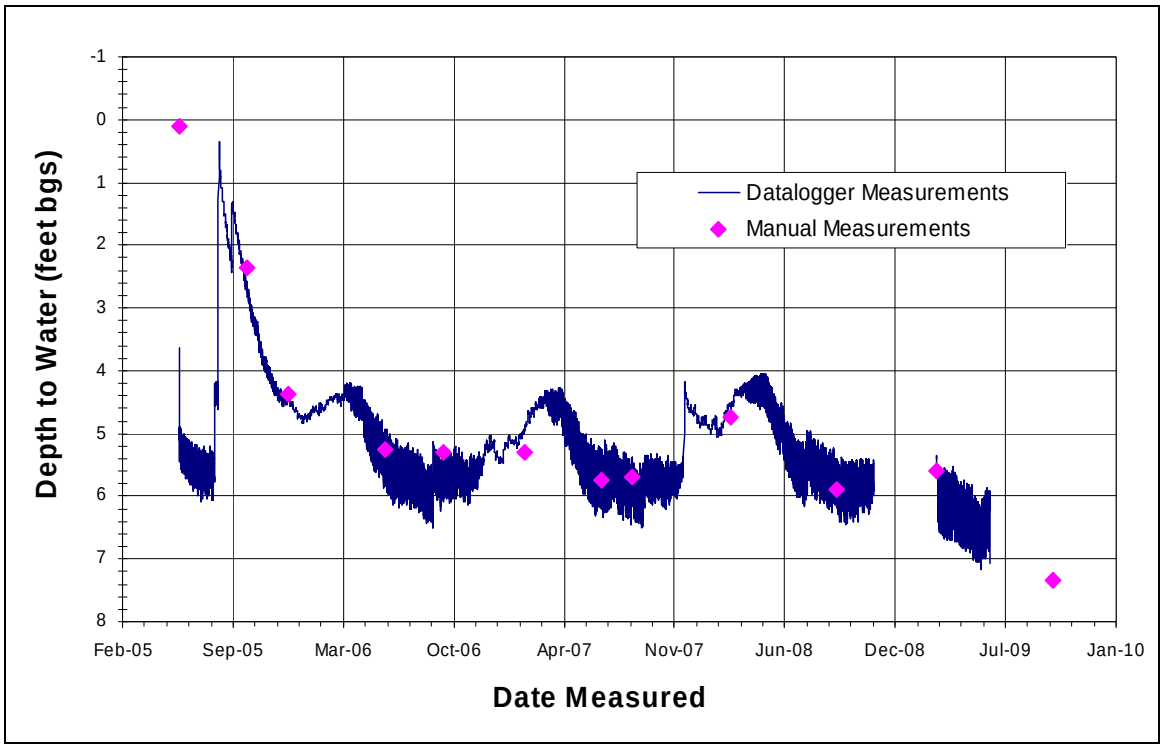


Figure E7. Hydrograph for piezometer at Walker Lake.

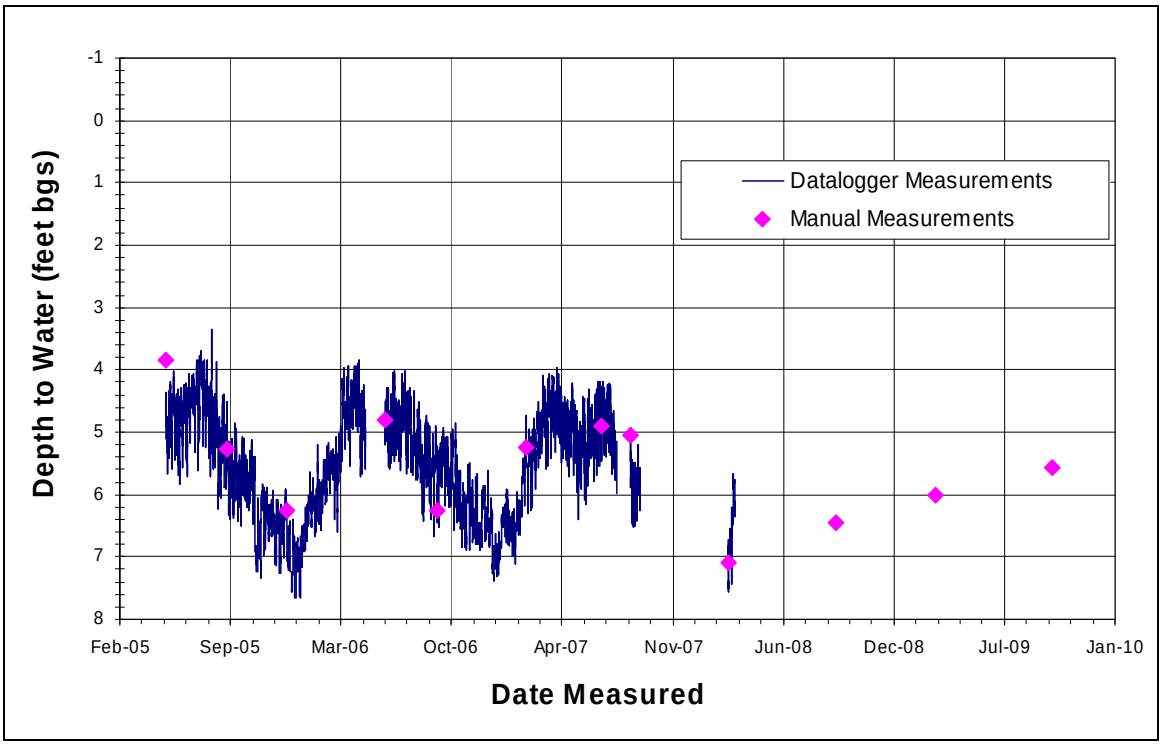


Figure E8. Hydrograph for piezometer at Paradise.

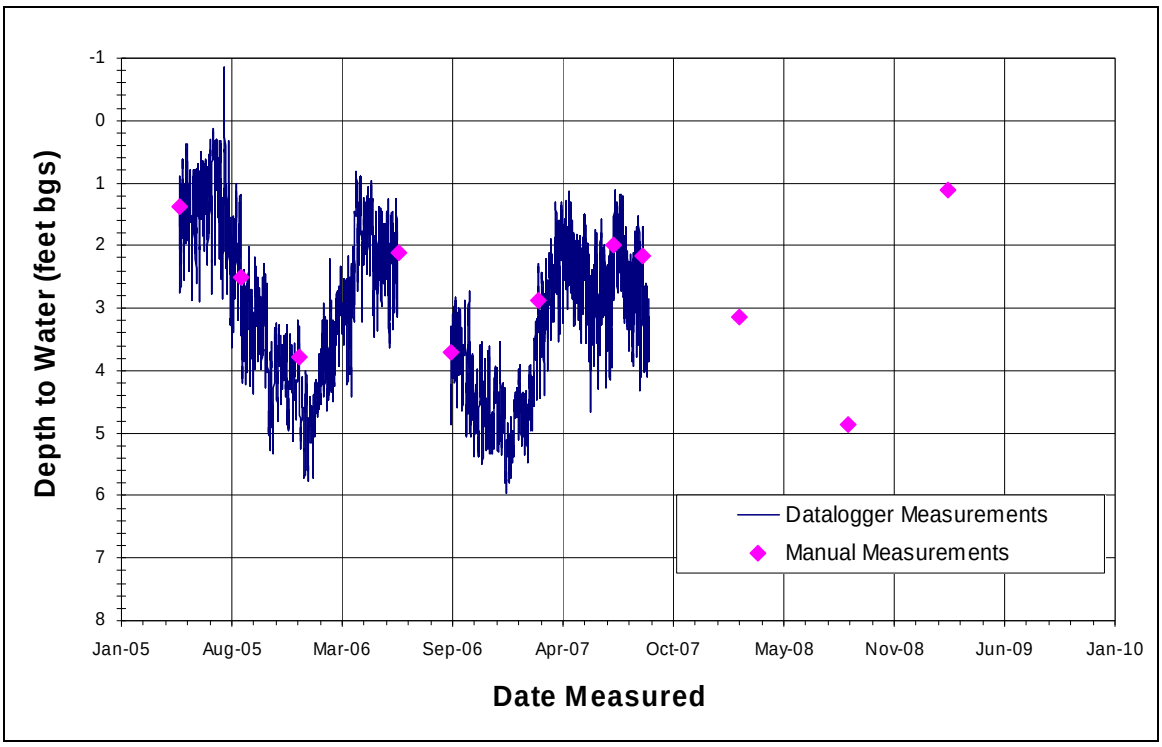


Figure E9. Hydrograph for piezometer at Hoge Ranch.

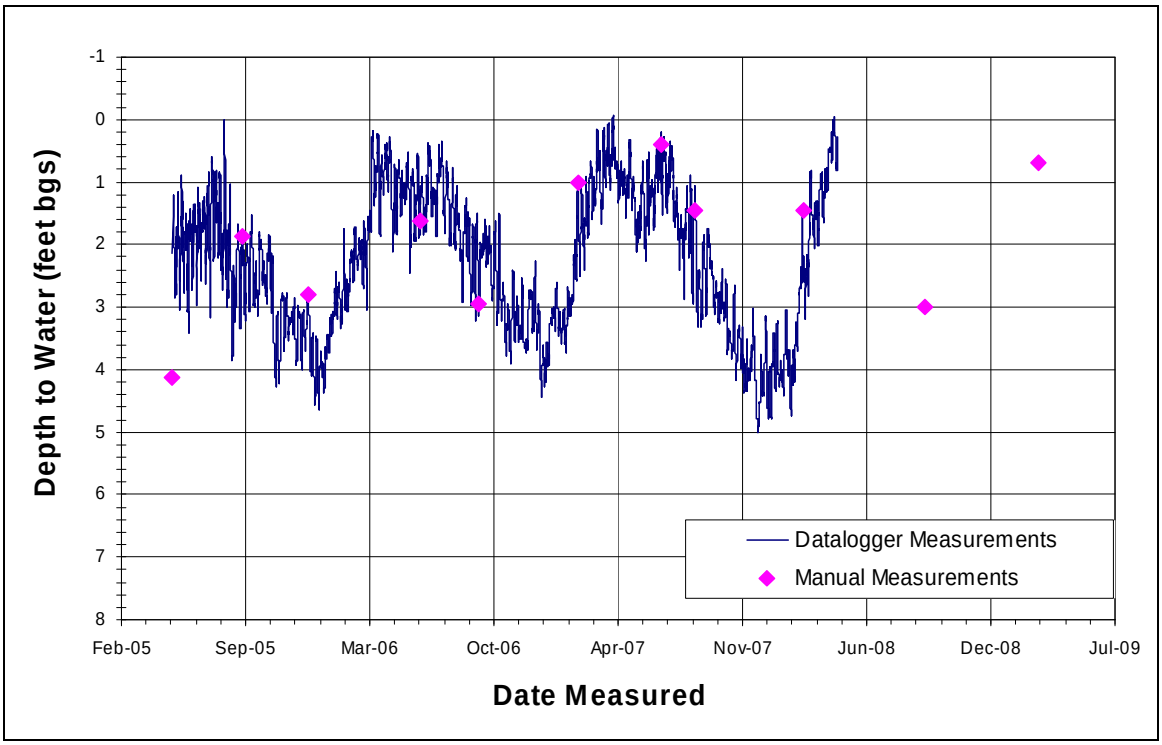


Figure E10. Hydrograph for piezometer at Rattlesnake.

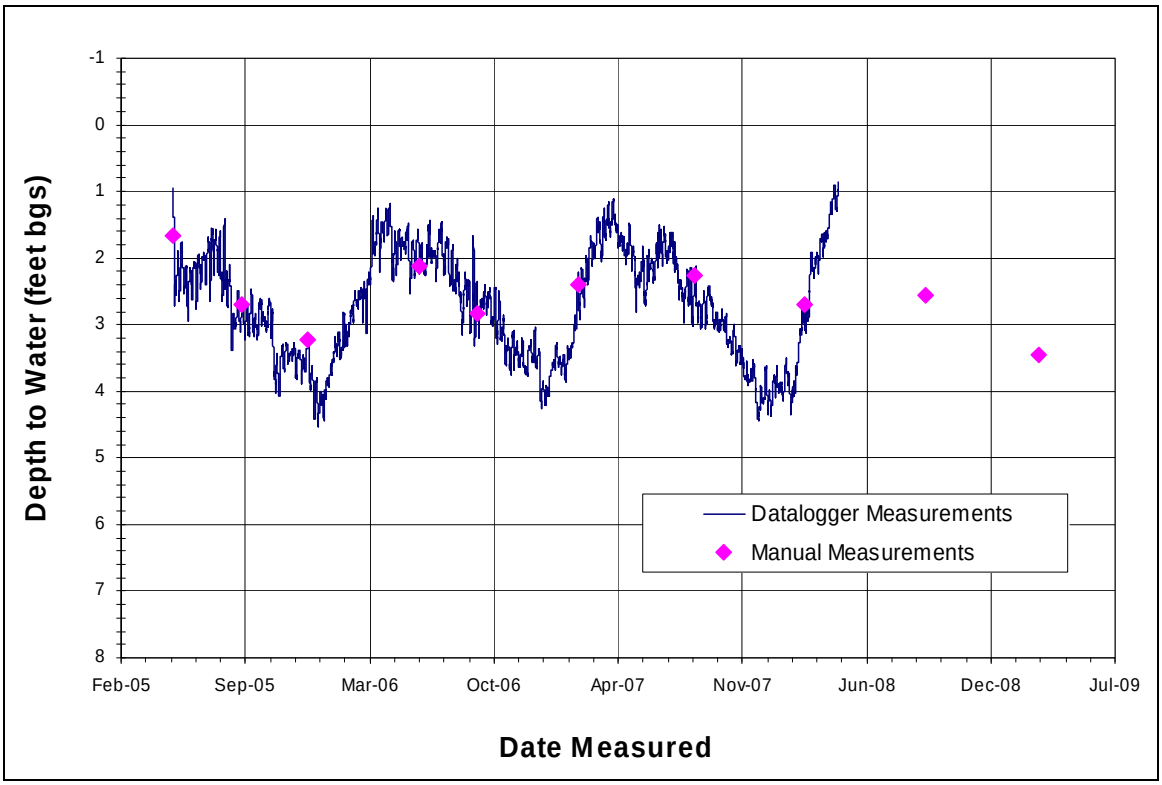


Figure E11. Hydrograph for piezometer at Clear Lake.

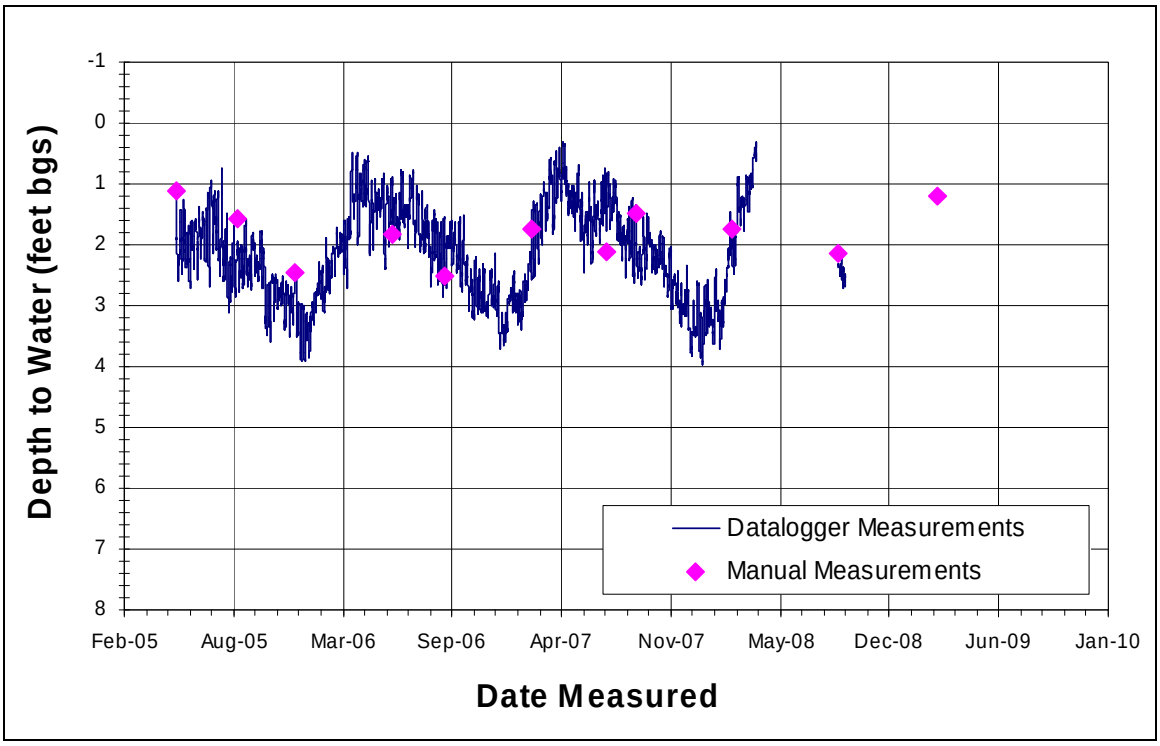


Figure E12. Hydrograph for piezometer at Ferguson Lake.

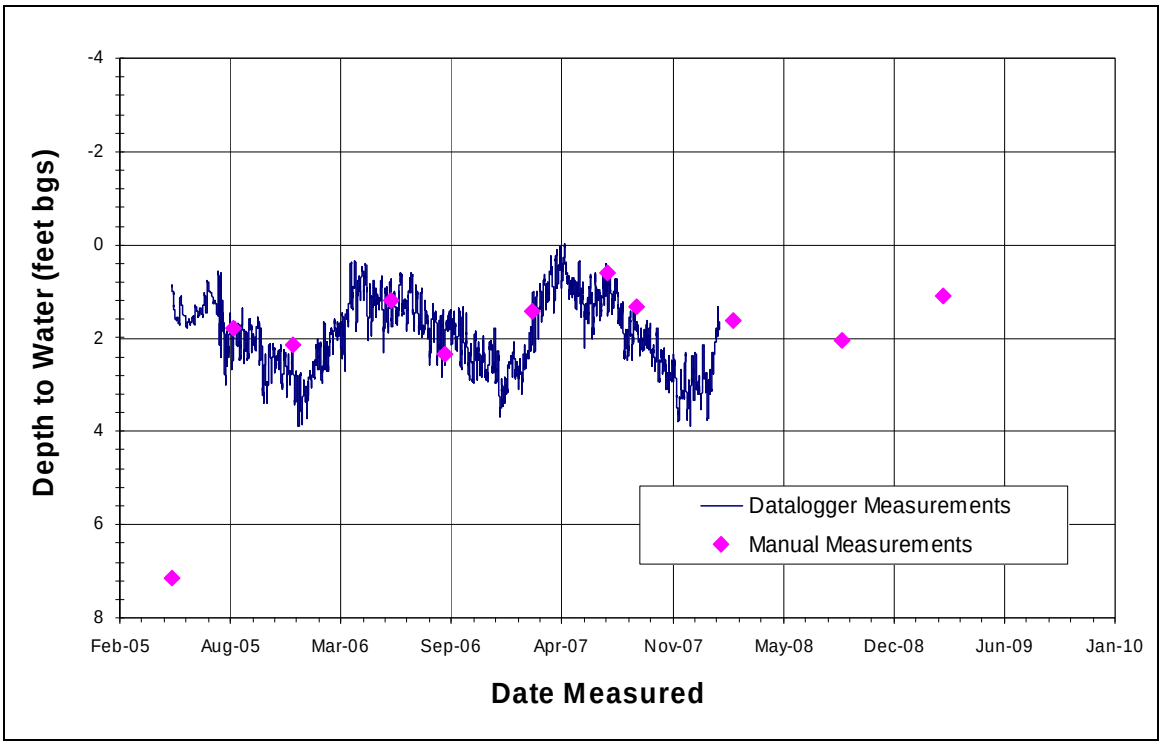


Figure E13. Hydrograph for piezometer at Ferguson Wash.

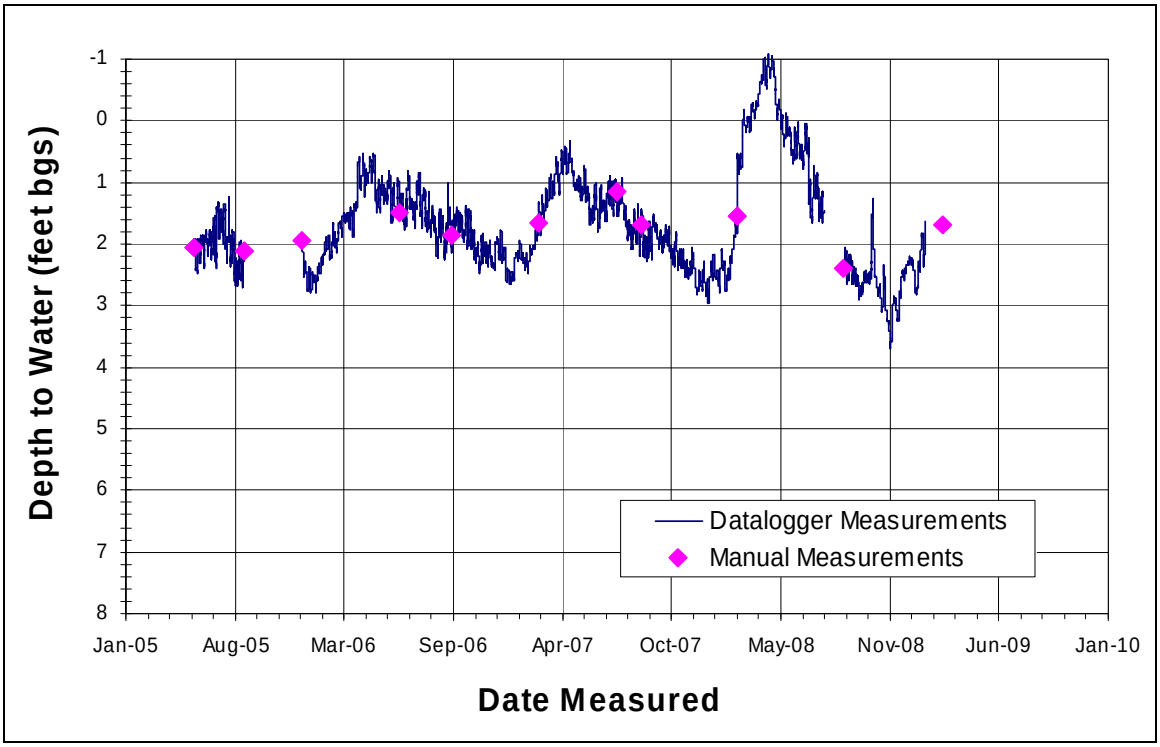


Figure E14. Hydrograph for piezometer at Great Blue Heron.

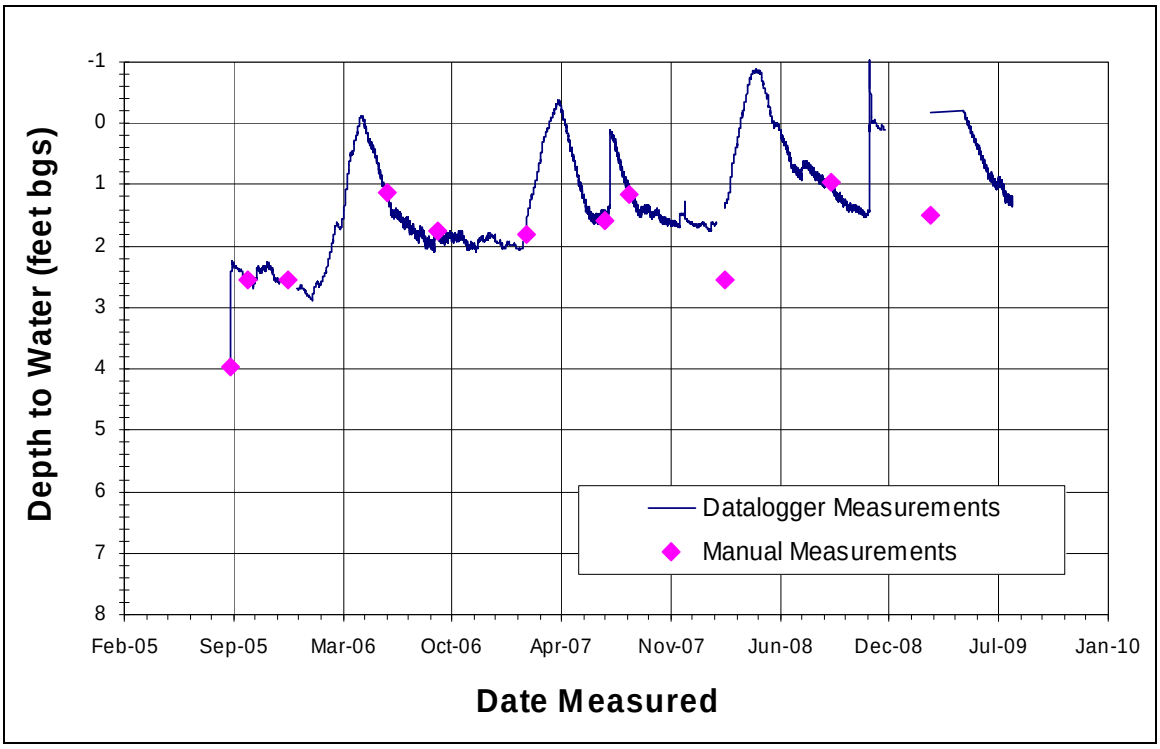


Figure E15. Hydrograph for piezometer at Mittry West.

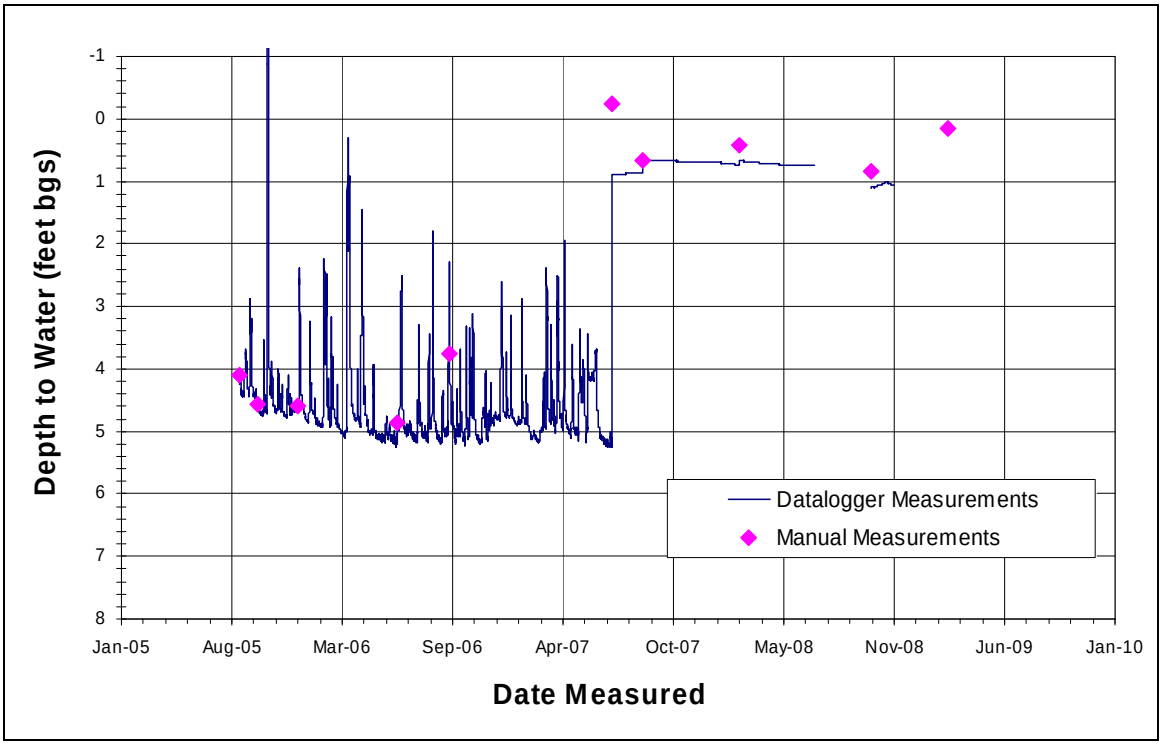


Figure E16. Hydrograph for piezometer at Gila Confluence North.

Appendix F

CONTRIBUTING PERSONNEL

Contributor	**Role**
Steven W. Carothers, Ph.D.	Principal-in-Charge
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Jillian Johnston	Field Coordinator
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Elly Knight	Bander/Nest Monitor
Anne Pellegrini	Bander/Nest Monitor
Corina Anderson	Surveyor/Nest Monitor
Alicia Andes	Surveyor/Nest Monitor
Ryan Davis	Surveyor/Nest Monitor
Dayna LeClair	Surveyor/Nest Monitor
David Cranmer	Surveyor
Kathryn Riley	Surveyor
Devin Keane	Piezometer Maintenance/Data Entry