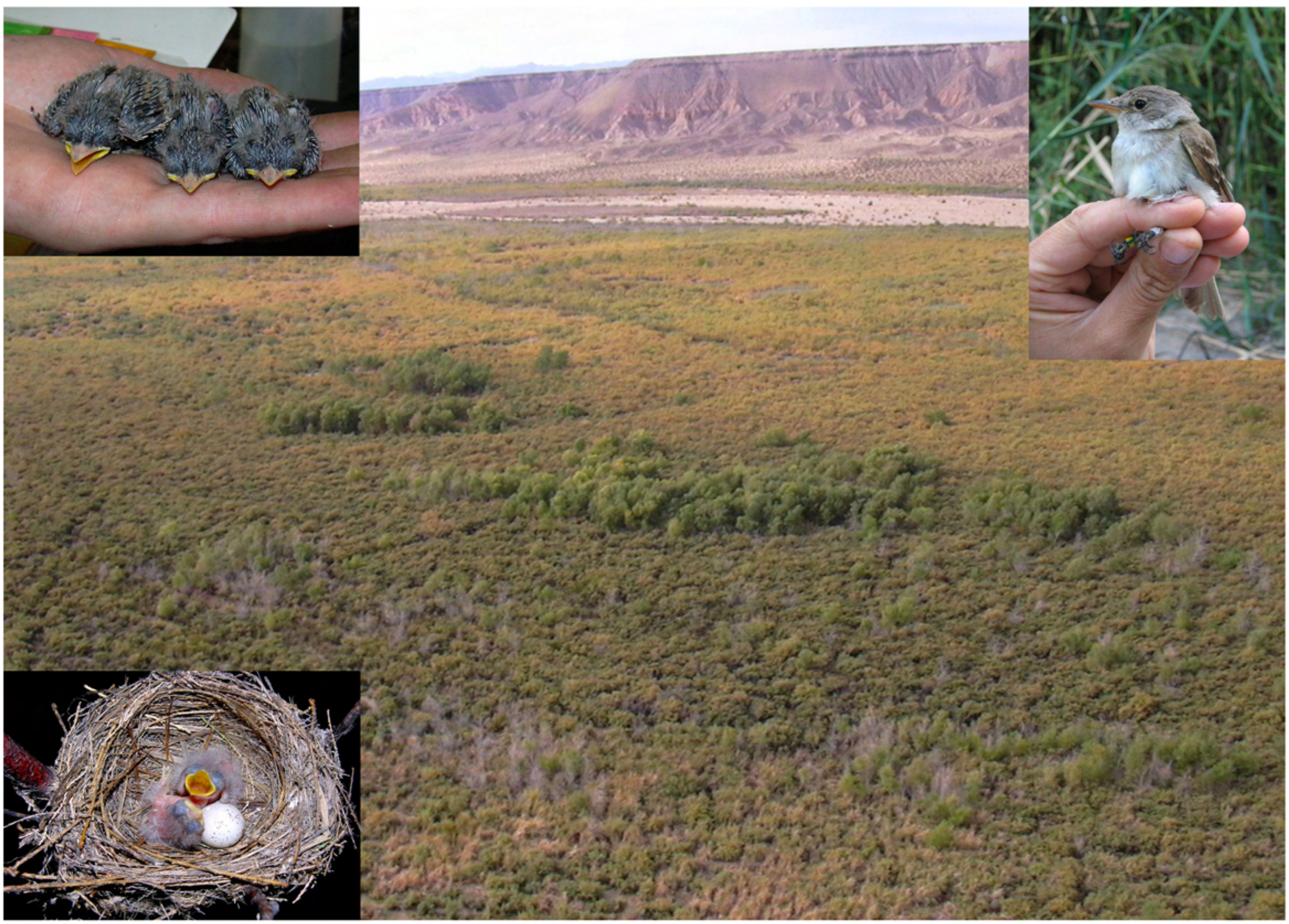
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Southwestern Willow Flycatcher Surveys, Demography, and Ecology along the Lower Colorado River and Tributaries, 2010. 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, 2010. Annual Report

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EXECUTIVE SUMMARY

The Southwestern Willow Flycatcher (*Empidonax traillii extimus*), listed as federally endangered in 1995, breeds in dense, mesic riparian habitats at scattered, isolated sites in New Mexico, Arizona, southern California, southern Nevada, southern Utah, southwestern Colorado, and, at least historically, extreme northwestern Mexico. Historical breeding records and museum collections indicate a sizable population of Southwestern Willow Flycatchers may have existed along the extreme southern stretches of the lower Colorado River region. Factors contributing to the decline of flycatchers on the breeding grounds include loss, degradation, and/or fragmentation of riparian habitat; invasion of riparian habitat by nonnative plants; and brood parasitism by Brown-headed Cowbirds (*Molothrus ater*).

Willow flycatcher studies have been conducted along the Virgin and lower Colorado Rivers and tributaries annually since 1996, in compliance with requirements set forth by the U.S. Fish and Wildlife Service (USFWS) regarding U.S. Bureau of Reclamation (Reclamation) routine operations and maintenance along the lower Colorado River. Biological Assessments and the resulting Biological Opinions on operations and maintenance were prepared as steps to developing a Multi-Species Conservation Program (MSCP) for long-term endangered species compliance and management in the historical floodplain of the lower Colorado River (LCR). The LCR MSCP was signed in April 2005, and implementation of the program began in October 2005. The LCR MSCP calls for continued surveys and monitoring of willow flycatchers along the lower Colorado River. SWCA Environmental Consultants (SWCA) was contracted by Reclamation to continue surveys, monitoring, and demographic and ecological studies of the Southwestern Willow Flycatcher in suitable and/or historical riparian and wetland habitats throughout the Virgin and lower Colorado River regions in 2010.

Reclamation and USFWS completed a separate consultation on the potential effects to threatened and endangered species from implementation of surplus guidelines through 2016 and an annual change in the point of diversion for up to 400,000 acre-feet of California apportionment water for 75 years. The point of diversion, previously located below Parker Dam, would change to a point above Parker Dam. These changes in water regulation could cause a drop in floodplain groundwater levels of 1.55 feet (0.47 m) or less and have the potential to modify riparian habitats below Parker Dam. A Biological Opinion for Interim Surplus Criteria, Secretarial Implementation Agreements, and Conservation Measures was issued in January 2001 and required monitoring of 150.5 ha of existing, occupied Southwestern Willow Flycatcher habitat between Parker and Imperial Dams. In 2004, Reclamation biologists initiated studies of the microclimate within potentially affected areas. In 2005, these studies were continued and expanded by SWCA to address how the hydrological changes might affect riparian habitats along the Parker to Imperial reach.

Following the breeding season of 2008, USFWS and Reclamation initiated discussions regarding the declining number of willow flycatcher territories at Topock Marsh, the importance of the flycatcher population in the Topock area to flycatcher conservation along the LCR, and possible measures to enhance flycatcher habitat at Topock. A plan was developed to pump water into a portion of the flycatcher breeding habitat at Topock beginning in February or March and continuing into the flycatcher breeding season. Water delivery was anticipated to commence in 2010 but has been postponed to 2011. Monitoring of vegetation, microclimate, and hydrologic conditions in the target area was initiated in 2009 and continued in 2010 to obtain baseline conditions in the target area.

Breeding flycatchers have been documented annually in 1997–2009 at Pahranagat National Wildlife Refuge (NWR) 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 dam 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. The dam was repaired in 2010, but the lake will be maintained at a lower level than it was prior to 2008, and water levels within the breeding site will not return to their former depth. USFWS retained SWCA to continue monitoring microclimate and vegetation at Pahranagat in 2010. 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 2010, we completed presence/absence surveys and site descriptions at 75 sites in 15 study areas from the Pahranagat NWR, Nevada, south to Yuma, Arizona. We also conducted more intensive studies at the seven study areas where territorial flycatchers were detected in 2010: 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; and color-banded and resighted as many willow flycatchers as possible to determine the breeding status of territorial flycatchers and document movement and recruitment. We also measured characteristics of vegetation and microclimate in occupied territories at Mesquite and Bill Williams.

We used recorded broadcasts of willow flycatcher song and calls to elicit responses from willow flycatchers at 75 sites, ranging in size from <1 to 68 ha, along the Virgin and lower Colorado Rivers and tributaries between 13 May and 24 July 2010, following a 5-survey protocol. We detected willow flycatchers on at least one occasion at 44 of these sites. Breeding or resident flycatchers were detected at 16 sites within the Pahranagat NWR, Littlefield, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams study areas. South of Bill Williams, 78 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 3 individuals previously banded as adults. An additional 50 adults were identified to individual via resighting, while 8 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 seven individuals identified as returning nestlings by the presence of a single federal band, with three (43%) identified to individual via recapture. Twenty-eight adult flycatchers remained unbanded, and banding status was undetermined (i.e., we were unable to determine if these individuals were banded) for 17 adults. We banded 52 nestlings from 22 nests. Of the 52 nestlings banded, 2 were known or suspected to have died before fledging. We banded flycatchers opportunistically at St. George, Utah, capturing and color-banding three new adults and five nestlings from two nests.

We recorded 64 territories at all monitored sites. Of these, 39 (61%) consisted of paired flycatchers and 25 (39%) consisted of unpaired individuals. Two breeding males were polygynous, each pairing with two females. Two females mated consecutively with two different males.

Of the 78 resident, adult willow flycatchers identified to individual in 2009, 38 (49%) were identified in 2010; 5 (13%) were detected at a different study area from where they were last detected in 2009. We detected no within-year, between-study area movements in 2010.

Of the 40 juveniles banded at the monitored study areas in 2009, 8 (20%) were identified in 2010. Two additional flycatchers banded as nestlings at Key Pittman in 2009 were identified in 2010. Thirteen individuals originally banded as nestlings in previous years were identified for the first time in 2010. Of the 23 returning nestlings identified in 2010, 16 (70%) dispersed away from their natal study area. The median dispersal distance for all returning juvenile flycatchers in 2009 was 30.0 km.

We documented 70 willow flycatcher nesting attempts, 60 of which contained eggs and were used in calculating nest success and productivity. Twenty-six (43%) nests were successful and fledged young; and 34 (57%) failed. Mayfield survival probability ranged from 0.165 to 1.000 and was 0.402 for all sites combined. Depredation was the major cause of nest failure, accounting for 45% of all failed nests and 59% of nests that failed after flycatcher eggs were laid.

Twelve of 56 nests (21%) with flycatcher eggs and known contents were brood parasitized by Brown-headed Cowbirds. Brood parasitism at all study areas ranged from 0 to 62% and was highest at Mesquite. We addled cowbird eggs via vigorous shaking at all easily accessible flycatcher nests. Egg addling appeared to reduce the hatch rate of cowbird eggs and may have improved success rates for parasitized nests, though small sample size precluded rigorous comparisons. One flycatcher nest at Pahranagat was brood parasitized and subsequently abandoned by the flycatchers; this is the first recorded instance of brood parasitism at Pahranagat since a 5-year cowbird trapping program was implemented in 2003. Nests that contained flycatcher eggs and were brood parasitized were not less likely to fledge flycatcher young than nests that were not parasitized.

SWCA was retained by Nevada Department of Wildlife in 2010 to complete flycatcher surveys, site descriptions, nest monitoring, and color-banding at Key Pittman Wildlife Management Area and Warm Springs Natural Area. We surveyed 21 sites within the two study areas and detected breeding flycatchers within 15 of the sites. We also completed surveys for yellow-billed cuckoos at these study areas. No cuckoos were detected during surveys, but one cuckoo was detected incidentally at Warm Springs. Surveys at Warm Springs were discontinued following a fire on 1 July that affected the entire study area.

At Key Pittman and Warm Springs, we color-banded 14 new adult flycatchers are recaptured 2 individuals previously captured as adults. An additional eight adults were identified to individual via resighting, while one individual was resighted but did not have its color combination confirmed. We detected one individual identified as a returning nestling by the presence of a single federal band, but we were unable to capture it. Four additional adults were captured with full color combinations and identified as returning nestlings from 2008 or 2009. Eleven adult flycatchers remained unbanded, and banding status was undetermined for one adult. We banded 41 nestlings from 16 nests. Of the 41 nestlings banded, 5 were known or suspected to have died before fledging.

We recorded 22 territories at Key Pittman and Warm Springs. Of these, 20 (91%) consisted of breeding individuals and 2 (9%) consisted of unpaired males. Four males were polygynous; two mated with two females and two mated with three females. One female mated consecutively with two different males. We documented 31 flycatcher nesting attempts at Key Pittman and 3 at Warm Springs; 33 of these were known to contain flycatcher eggs and were used in calculating nest success and productivity. Fifteen (45%) nests were successful and fledged young, and 18 (55%) failed. Depredation accounted for the majority (68%) of all nest failures. Mayfield survival probability was 0.407 at Key Pittman and 0.095 at Warm Springs. All three nests at Warm Springs failed; two of these failures were attributable to the fire.

At Mesquite and Bill Williams, we gathered data on vegetation and microclimate characteristics at one location for each of 12 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 with tamarisk understory, and 4) cottonwood/willow. All of these vegetation types fall within the definition of cottonwood-willow habitat (cottonwoods and willows constituting at least 10% of total trees) as used in the LCR MSCP. We present results for each of our delineated habitat types as well as the cottonwood-willow vegetation types used in the LCR MSCP. Sample sizes in 2010 are likely too small to provide an accurate representation of the range and variance in vegetation and microclimate characteristics in each habitat type.

All vegetation types exhibited moist or inundated soil conditions at some point in the breeding season. 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.

We qualitatively compared microclimate data collected within coyote willow habitat at Mesquite West across years from 2008 to 2010 to determine whether the dry habitat conditions observed in 2009 were apparent in the microclimate data. The data clearly showed that soil moisture, diurnal humidity, and nocturnal humidity were lower in 2009 than in either of the other two years. We anticipated that wet conditions might have a moderating influence on temperature, either directly through the presence of water or indirectly through the production of denser foliage. These expectations were supported by the data, with dry conditions in 2009 producing the highest maximum daily temperatures, exceeding those recorded at a local weather station; and wet conditions in 2010 producing the lowest maximum daily temperatures, not reaching those recorded at the same weather station.

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. Soil moisture measurements were collected at each data logger location in 2010 during each of five flycatcher surveys between 15 May and 25 July. Vegetation measurements were also collected at each data logger location after surveys were completed. Previous analyses of evapotranspiration signature showed that groundwater levels could not be used to evaluate changes in evapotranspiration at the habitat monitoring sites because of the overriding influence of fluctuating river levels. Thus, we determined that the piezometers had fulfilled their original function and were no longer collecting useful information. Because of this and consistent equipment failure, all piezometers at the test and control habitat monitoring sites were removed in 2010. The piezometer at Topock Marsh was left in place as the only remaining piezometer. All piezometers were downloaded before removal and the corresponding hydrographs were updated.

Comparisons of microclimate characteristics among years in 2005–2010 at the habitat monitoring sites indicated hotter and more humid conditions in 2006, cooler conditions in 2009, and less humid conditions in 2010 than in the other years. 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, 2007–2008, and 2009–2010 were not similar between test and control sites, with soil moisture declining more sharply at the control sites during the first two periods and then rising sharply during the third. This suggests that local conditions, in addition to regional climate, may have influenced soil moisture. 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 and then increased in 2010 at both test and control sites, presumably in response to climate conditions during portions of each summer. 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, but none of the variables exhibited a consistent change across time. Woody ground cover and the percentage of basal area comprising native vegetation were the only variables for which there was a significant interaction with location, meaning the changes in all the other variables between years among test sites were not significantly different from the changes 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. The percentage of basal area comprising native vegetation rose at control sites in 2010 but not at test sites.

There were between-year differences in dead vegetation in the first, second, third, and fourth meter intervals above the ground. In all four intervals, density of dead vegetation was higher in 2008 and 2010 than in 2007. The percentage of live vegetation did not differ significantly between years for any meter interval. There was a significant interaction between live vertical foliage density and location (test vs. control sites) for the second and fourth meter intervals, and there was also a significant interaction between dead vertical foliage density and location for the first and second meter intervals. There was no clear pattern for either live or dead counts, with density generally increasing at control plots in years it decreased at test plots, and vice versa. Thus, vertical foliage counts did not show any consistent differences between control and test locations, and it does not appear that between-year variation in vertical foliage counts can be attributed the changes in river regulation.

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, with low water levels in the winter and highest water levels in the spring.

We measured baseline vegetation, microclimate, and surface hydrology conditions for a second year in an area of Topock Marsh that is scheduled for delivery of supplemental surface water in 2011. 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 measurements 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 23% and then declined just as rapidly in late April and early May. By mid-May, <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 and 2010 will be compared to those documented in 2011 when additional surface water is delivered to the site.

The main flycatcher breeding area at Pahranagat NWR 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 dam that impounds Upper Pahranagat Lake resulted in the site being dry during the breeding seasons of 2008 and 2009. The dam was repaired prior to the 2010 breeding season, and although lake levels were higher in 2010 than in 2008 or 2009, they did not return to the levels maintained prior to dam failure. We collected microclimate and vegetation data within the site during 2009 and 2010 and compared these measurements to vegetation and microclimate data collected within flycatcher territories at the site from 2005 to 2007.

Vegetation characteristics in 2010 differed from those recorded in 2005–2007 in having less canopy closure, less woody ground cover, more live foliage below nest height, less dead foliage in all height categories, a greater percentage of live foliage below the nest, and a lower percentage of the foliage that consisted of native species. Vegetation characteristics measured in 2010 also differed from those measured in 2009 in many of the same variables. Compared to vegetation in 2009, vegetation in 2010 had less canopy closure, more live foliage below nest height, less dead foliage in all height categories, and a greater percentage of live foliage in all height categories. The difference in the percentage of native vegetation between 2010 and 2005–2007 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. The increase in live foliage below nest height between 2009 and 2010 may also be the result of continued development of the herbaceous ground cover. The differences between 2009 and 2010 in absolute counts of dead foliage and percentage of live foliage may be the result of observer variation and should be interpreted with caution.

We anticipated that soil moisture and humidity at Pahranagat North would be lower in 2009 than in 2005–2007 when the site was inundated, and that soil moisture and humidity might be higher in 2010 than in 2009 given the higher lake levels in 2010. These expectations were borne out by the data, with both soil moisture and humidity levels being intermediate in 2010. Soil moisture recorded in July–August was higher in 2010 than in 2009 and lower in 2010 than in 2005–2007. Soil moisture recorded in June 2010 was also significantly lower than that recorded in June 2005–2007. Even in years when Pahranagat North was inundated, the site had dried significantly by the beginning of July. Thus, an examination of soil moisture values during the latter part of the breeding season showed less of a difference between 2010 and the inundated years, while soil moisture conditions in June showed a greater difference between 2010 and 2005–2007.

Humidity in July–August 2010 differed significantly from both 2009 and 2005–2007, with 2010 values being intermediate between the higher values recorded in 2005–2007 and the lower values recorded in 2009. However, without humidity data from a nearby weather station, it is impossible to determine whether changes in humidity were caused by changes in groundwater levels or variation in regional climate conditions. We had expected that inundated conditions might serve to moderate daily temperatures, but the data showed the highest temperatures in 2010 and the lowest temperatures in 2009. These differences could not be accounted for by between-year differences in regional climate, with the Caliente weather station showing no difference between 2010 and any other year for either maximum or minimum temperature.

We compared a variety of metrics at Pahranagat (annual fecundity, number of nesting attempts per female, number of successful attempts per female, proportion of successful first attempts, mean fledge date, and depredation rates) between 2003–2007 and 2008–2010 to determine whether changes in hydrology might be associated with any change in flycatcher reproduction. Although annual fecundity did not change between time periods, females in 2008–2010 made more nesting attempts to achieve that fecundity, possibly as the result of increased depredation, and fledged young later in the season. Young that fledge later in the season have been shown to have a reduced probability of survival and recruitment, and the increased number of nesting attempts and potentially later migration date may have effects on adult survival as well. These changes cannot be solely attributed to changes in hydrology, however. Brown-headed cowbird trapping was completed at Pahranagat in 2003–2007 but not in 2008–2010, so it is unclear whether the differences we observed in flycatcher reproduction metrics between 2003–2007 and 2008–2010 are due to the change in hydrology and growth of understory vegetation or the cessation of cowbird trapping. Flycatcher reproduction in 1998–2002, when the site was inundated but there was no cowbird trapping, showed similar differences with respect to the 2003–2007 period, with a higher number of annual nesting attempts per female, increased depredation, and later fledge dates in 1998–2002.

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EXECUTIVE SUMMARY

The Southwestern Willow Flycatcher (*Empidonax traillii extimus*), listed as federally endangered in 1995, breeds in dense, mesic riparian habitats at scattered, isolated sites in New Mexico, Arizona, southern California, southern Nevada, southern Utah, southwestern Colorado, and, at least historically, extreme northwestern Mexico. Historical breeding records and museum collections indicate a sizable population of Southwestern Willow Flycatchers may have existed along the extreme southern stretches of the lower Colorado River region. Factors contributing to the decline of flycatchers on the breeding grounds include loss, degradation, and/or fragmentation of riparian habitat; invasion of riparian habitat by nonnative plants; and brood parasitism by Brown-headed Cowbirds (*Molothrus ater*).

Willow flycatcher studies have been conducted along the Virgin and lower Colorado Rivers and tributaries annually since 1996, in compliance with requirements set forth by the U.S. Fish and Wildlife Service (USFWS) regarding U.S. Bureau of Reclamation (Reclamation) routine operations and maintenance along the lower Colorado River. Biological Assessments and the resulting Biological Opinions on operations and maintenance were prepared as steps to developing a Multi-Species Conservation Program (MSCP) for long-term endangered species compliance and management in the historical floodplain of the lower Colorado River (LCR). The LCR MSCP was signed in April 2005, and implementation of the program began in October 2005. The LCR MSCP calls for continued surveys and monitoring of willow flycatchers along the lower Colorado River. SWCA Environmental Consultants (SWCA) was contracted by Reclamation to continue surveys, monitoring, and demographic and ecological studies of the Southwestern Willow Flycatcher in suitable and/or historical riparian and wetland habitats throughout the Virgin and lower Colorado River regions in 2010.

Reclamation and USFWS completed a separate consultation on the potential effects to threatened and endangered species from implementation of surplus guidelines through 2016 and an annual change in the point of diversion for up to 400,000 acre-feet of California apportionment water for 75 years. The point of diversion, previously located below Parker Dam, would change to a point above Parker Dam. These changes in water regulation could cause a drop in floodplain groundwater levels of 1.55 feet (0.47 m) or less and have the potential to modify riparian habitats below Parker Dam. A Biological Opinion for Interim Surplus Criteria, Secretarial Implementation Agreements, and Conservation Measures was issued in January 2001 and required monitoring of 150.5 ha of existing, occupied Southwestern Willow Flycatcher habitat between Parker and Imperial Dams. In 2004, Reclamation biologists initiated studies of the microclimate within potentially affected areas. In 2005, these studies were continued and expanded by SWCA to address how the hydrological changes might affect riparian habitats along the Parker to Imperial reach.

Following the breeding season of 2008, USFWS and Reclamation initiated discussions regarding the declining number of willow flycatcher territories at Topock Marsh, the importance of the flycatcher population in the Topock area to flycatcher conservation along the LCR, and possible measures to enhance flycatcher habitat at Topock. A plan was developed to pump water into a portion of the flycatcher breeding habitat at Topock beginning in February or March and continuing into the flycatcher breeding season. Water delivery was anticipated to commence in 2010 but has been postponed to 2011. Monitoring of vegetation, microclimate, and hydrologic conditions in the target area was initiated in 2009 and continued in 2010 to obtain baseline conditions in the target area.

Breeding flycatchers have been documented annually in 1997–2009 at Pahranagat National Wildlife Refuge (NWR) 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 dam 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. The dam was repaired in 2010, but the lake will be maintained at a lower level than it was prior to 2008, and water levels within the breeding site will not return to their former depth. USFWS retained SWCA to continue monitoring microclimate and vegetation at Pahranagat in 2010. 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 2010, we completed presence/absence surveys and site descriptions at 75 sites in 15 study areas from the Pahranagat NWR, Nevada, south to Yuma, Arizona. We also conducted more intensive studies at the seven study areas where territorial flycatchers were detected in 2010: 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; and color-banded and resighted as many willow flycatchers as possible to determine the breeding status of territorial flycatchers and document movement and recruitment. We also measured characteristics of vegetation and microclimate in occupied territories at Mesquite and Bill Williams.

We used recorded broadcasts of willow flycatcher song and calls to elicit responses from willow flycatchers at 75 sites, ranging in size from <1 to 68 ha, along the Virgin and lower Colorado Rivers and tributaries between 13 May and 24 July 2010, following a 5-survey protocol. We detected willow flycatchers on at least one occasion at 44 of these sites. Breeding or resident flycatchers were detected at 16 sites within the Pahranagat NWR, Littlefield, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams study areas. South of Bill Williams, 78 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 3 individuals previously banded as adults. An additional 50 adults were identified to individual via resighting, while 8 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 seven individuals identified as returning nestlings by the presence of a single federal band, with three (43%) identified to individual via recapture. Twenty-eight adult flycatchers remained unbanded, and banding status was undetermined (i.e., we were unable to determine if these individuals were banded) for 17 adults. We banded 52 nestlings from 22 nests. Of the 52 nestlings banded, 2 were known or suspected to have died before fledging. We banded flycatchers opportunistically at St. George, Utah, capturing and color-banding three new adults and five nestlings from two nests.

We recorded 64 territories at all monitored sites. Of these, 39 (61%) consisted of paired flycatchers and 25 (39%) consisted of unpaired individuals. Two breeding males were polygynous, each pairing with two females. Two females mated consecutively with two different males.

Of the 78 resident, adult willow flycatchers identified to individual in 2009, 38 (49%) were identified in 2010; 5 (13%) were detected at a different study area from where they were last detected in 2009. We detected no within-year, between-study area movements in 2010.

Of the 40 juveniles banded at the monitored study areas in 2009, 8 (20%) were identified in 2010. Two additional flycatchers banded as nestlings at Key Pittman in 2009 were identified in 2010. Thirteen individuals originally banded as nestlings in previous years were identified for the first time in 2010. Of the 23 returning nestlings identified in 2010, 16 (70%) dispersed away from their natal study area. The median dispersal distance for all returning juvenile flycatchers in 2009 was 30.0 km.

We documented 70 willow flycatcher nesting attempts, 60 of which contained eggs and were used in calculating nest success and productivity. Twenty-six (43%) nests were successful and fledged young; and 34 (57%) failed. Mayfield survival probability ranged from 0.165 to 1.000 and was 0.402 for all sites combined. Depredation was the major cause of nest failure, accounting for 45% of all failed nests and 59% of nests that failed after flycatcher eggs were laid.

Twelve of 56 nests (21%) with flycatcher eggs and known contents were brood parasitized by Brown-headed Cowbirds. Brood parasitism at all study areas ranged from 0 to 62% and was highest at Mesquite. We addled cowbird eggs via vigorous shaking at all easily accessible flycatcher nests. Egg addling appeared to reduce the hatch rate of cowbird eggs and may have improved success rates for parasitized nests, though small sample size precluded rigorous comparisons. One flycatcher nest at Pahranagat was brood parasitized and subsequently abandoned by the flycatchers; this is the first recorded instance of brood parasitism at Pahranagat since a 5-year cowbird trapping program was implemented in 2003. Nests that contained flycatcher eggs and were brood parasitized were not less likely to fledge flycatcher young than nests that were not parasitized.

SWCA was retained by Nevada Department of Wildlife in 2010 to complete flycatcher surveys, site descriptions, nest monitoring, and color-banding at Key Pittman Wildlife Management Area and Warm Springs Natural Area. We surveyed 21 sites within the two study areas and detected breeding flycatchers within 15 of the sites. We also completed surveys for yellow-billed cuckoos at these study areas. No cuckoos were detected during surveys, but one cuckoo was detected incidentally at Warm Springs. Surveys at Warm Springs were discontinued following a fire on 1 July that affected the entire study area.

At Key Pittman and Warm Springs, we color-banded 14 new adult flycatchers are recaptured 2 individuals previously captured as adults. An additional eight adults were identified to individual via resighting, while one individual was resighted but did not have its color combination confirmed. We detected one individual identified as a returning nestling by the presence of a single federal band, but we were unable to capture it. Four additional adults were captured with full color combinations and identified as returning nestlings from 2008 or 2009. Eleven adult flycatchers remained unbanded, and banding status was undetermined for one adult. We banded 41 nestlings from 16 nests. Of the 41 nestlings banded, 5 were known or suspected to have died before fledging.

We recorded 22 territories at Key Pittman and Warm Springs. Of these, 20 (91%) consisted of breeding individuals and 2 (9%) consisted of unpaired males. Four males were polygynous; two mated with two females and two mated with three females. One female mated consecutively with two different males. We documented 31 flycatcher nesting attempts at Key Pittman and 3 at Warm Springs; 33 of these were known to contain flycatcher eggs and were used in calculating nest success and productivity. Fifteen (45%) nests were successful and fledged young, and 18 (55%) failed. Depredation accounted for the majority (68%) of all nest failures. Mayfield survival probability was 0.407 at Key Pittman and 0.095 at Warm Springs. All three nests at Warm Springs failed; two of these failures were attributable to the fire.

At Mesquite and Bill Williams, we gathered data on vegetation and microclimate characteristics at one location for each of 12 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 with tamarisk understory, and 4) cottonwood/willow. All of these vegetation types fall within the definition of cottonwood-willow habitat (cottonwoods and willows constituting at least 10% of total trees) as used in the LCR MSCP. We present results for each of our delineated habitat types as well as the cottonwood-willow vegetation types used in the LCR MSCP. Sample sizes in 2010 are likely too small to provide an accurate representation of the range and variance in vegetation and microclimate characteristics in each habitat type.

All vegetation types exhibited moist or inundated soil conditions at some point in the breeding season. 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.

We qualitatively compared microclimate data collected within coyote willow habitat at Mesquite West across years from 2008 to 2010 to determine whether the dry habitat conditions observed in 2009 were apparent in the microclimate data. The data clearly showed that soil moisture, diurnal humidity, and nocturnal humidity were lower in 2009 than in either of the other two years. We anticipated that wet conditions might have a moderating influence on temperature, either directly through the presence of water or indirectly through the production of denser foliage. These expectations were supported by the data, with dry conditions in 2009 producing the highest maximum daily temperatures, exceeding those recorded at a local weather station; and wet conditions in 2010 producing the lowest maximum daily temperatures, not reaching those recorded at the same weather station.

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. Soil moisture measurements were collected at each data logger location in 2010 during each of five flycatcher surveys between 15 May and 25 July. Vegetation measurements were also collected at each data logger location after surveys were completed. Previous analyses of evapotranspiration signature showed that groundwater levels could not be used to evaluate changes in evapotranspiration at the habitat monitoring sites because of the overriding influence of fluctuating river levels. Thus, we determined that the piezometers had fulfilled their original function and were no longer collecting useful information. Because of this and consistent equipment failure, all piezometers at the test and control habitat monitoring sites were removed in 2010. The piezometer at Topock Marsh was left in place as the only remaining piezometer. All piezometers were downloaded before removal and the corresponding hydrographs were updated.

Comparisons of microclimate characteristics among years in 2005–2010 at the habitat monitoring sites indicated hotter and more humid conditions in 2006, cooler conditions in 2009, and less humid conditions in 2010 than in the other years. 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, 2007–2008, and 2009–2010 were not similar between test and control sites, with soil moisture declining more sharply at the control sites during the first two periods and then rising sharply during the third. This suggests that local conditions, in addition to regional climate, may have influenced soil moisture. 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 and then increased in 2010 at both test and control sites, presumably in response to climate conditions during portions of each summer. 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, but none of the variables exhibited a consistent change across time. Woody ground cover and the percentage of basal area comprising native vegetation were the only variables for which there was a significant interaction with location, meaning the changes in all the other variables between years among test sites were not significantly different from the changes 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. The percentage of basal area comprising native vegetation rose at control sites in 2010 but not at test sites.

There were between-year differences in dead vegetation in the first, second, third, and fourth meter intervals above the ground. In all four intervals, density of dead vegetation was higher in 2008 and 2010 than in 2007. The percentage of live vegetation did not differ significantly between years for any meter interval. There was a significant interaction between live vertical foliage density and location (test vs. control sites) for the second and fourth meter intervals, and there was also a significant interaction between dead vertical foliage density and location for the first and second meter intervals. There was no clear pattern for either live or dead counts, with density generally increasing at control plots in years it decreased at test plots, and vice versa. Thus, vertical foliage counts did not show any consistent differences between control and test locations, and it does not appear that between-year variation in vertical foliage counts can be attributed the changes in river regulation.

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, with low water levels in the winter and highest water levels in the spring.

We measured baseline vegetation, microclimate, and surface hydrology conditions for a second year in an area of Topock Marsh that is scheduled for delivery of supplemental surface water in 2011. 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 measurements 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 23% and then declined just as rapidly in late April and early May. By mid-May, <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 and 2010 will be compared to those documented in 2011 when additional surface water is delivered to the site.

The main flycatcher breeding area at Pahranagat NWR 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 dam that impounds Upper Pahranagat Lake resulted in the site being dry during the breeding seasons of 2008 and 2009. The dam was repaired prior to the 2010 breeding season, and although lake levels were higher in 2010 than in 2008 or 2009, they did not return to the levels maintained prior to dam failure. We collected microclimate and vegetation data within the site during 2009 and 2010 and compared these measurements to vegetation and microclimate data collected within flycatcher territories at the site from 2005 to 2007.

Vegetation characteristics in 2010 differed from those recorded in 2005–2007 in having less canopy closure, less woody ground cover, more live foliage below nest height, less dead foliage in all height categories, a greater percentage of live foliage below the nest, and a lower percentage of the foliage that consisted of native species. Vegetation characteristics measured in 2010 also differed from those measured in 2009 in many of the same variables. Compared to vegetation in 2009, vegetation in 2010 had less canopy closure, more live foliage below nest height, less dead foliage in all height categories, and a greater percentage of live foliage in all height categories. The difference in the percentage of native vegetation between 2010 and 2005–2007 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. The increase in live foliage below nest height between 2009 and 2010 may also be the result of continued development of the herbaceous ground cover. The differences between 2009 and 2010 in absolute counts of dead foliage and percentage of live foliage may be the result of observer variation and should be interpreted with caution.

We anticipated that soil moisture and humidity at Pahranagat North would be lower in 2009 than in 2005–2007 when the site was inundated, and that soil moisture and humidity might be higher in 2010 than in 2009 given the higher lake levels in 2010. These expectations were borne out by the data, with both soil moisture and humidity levels being intermediate in 2010. Soil moisture recorded in July–August was higher in 2010 than in 2009 and lower in 2010 than in 2005–2007. Soil moisture recorded in June 2010 was also significantly lower than that recorded in June 2005–2007. Even in years when Pahranagat North was inundated, the site had dried significantly by the beginning of July. Thus, an examination of soil moisture values during the latter part of the breeding season showed less of a difference between 2010 and the inundated years, while soil moisture conditions in June showed a greater difference between 2010 and 2005–2007.

Humidity in July–August 2010 differed significantly from both 2009 and 2005–2007, with 2010 values being intermediate between the higher values recorded in 2005–2007 and the lower values recorded in 2009. However, without humidity data from a nearby weather station, it is impossible to determine whether changes in humidity were caused by changes in groundwater levels or variation in regional climate conditions. We had expected that inundated conditions might serve to moderate daily temperatures, but the data showed the highest temperatures in 2010 and the lowest temperatures in 2009. These differences could not be accounted for by between-year differences in regional climate, with the Caliente weather station showing no difference between 2010 and any other year for either maximum or minimum temperature.

We compared a variety of metrics at Pahranagat (annual fecundity, number of nesting attempts per female, number of successful attempts per female, proportion of successful first attempts, mean fledge date, and depredation rates) between 2003–2007 and 2008–2010 to determine whether changes in hydrology might be associated with any change in flycatcher reproduction. Although annual fecundity did not change between time periods, females in 2008–2010 made more nesting attempts to achieve that fecundity, possibly as the result of increased depredation, and fledged young later in the season. Young that fledge later in the season have been shown to have a reduced probability of survival and recruitment, and the increased number of nesting attempts and potentially later migration date may have effects on adult survival as well. These changes cannot be solely attributed to changes in hydrology, however. Brown-headed cowbird trapping was completed at Pahranagat in 2003–2007 but not in 2008–2010, so it is unclear whether the differences we observed in flycatcher reproduction metrics between 2003–2007 and 2008–2010 are due to the change in hydrology and growth of understory vegetation or the cessation of cowbird trapping. Flycatcher reproduction in 1998–2002, when the site was inundated but there was no cowbird trapping, showed similar differences with respect to the 2003–2007 period, with a higher number of annual nesting attempts per female, increased depredation, and later fledge dates in 1998–2002.

Chapter 1

INTRODUCTION

PROJECT HISTORY

In 1995, the U.S. Bureau of Reclamation (Reclamation), other federal, state, and tribal agencies, and environmental and recreational interests agreed to form a partnership to develop and implement a Multi-Species Conservation Program (MSCP) for long-term endangered species compliance and management in the historical floodplain of the lower Colorado River (LCR). As a step to developing the LCR MSCP, Reclamation prepared a Biological Assessment (BA) in August 1996, evaluating the effects of dam operations and maintenance activities on threatened, endangered, and sensitive (TES) species. These species included the Southwestern Willow Flycatcher (*Empidonax traillii extimus*), which was listed by the U.S. Fish and Wildlife Service (USFWS) as endangered in 1995 (60 FR 10694–10715). In response to the BA, the USFWS issued a Biological Opinion (BO) in April 1997 outlining several terms and conditions Reclamation must implement in order not to jeopardize the species. Among these terms and conditions was the requirement to survey and monitor occupied and potential habitat for Southwestern Willow Flycatchers along the LCR for a period of five years. The studies were intended to determine the number of willow flycatcher territories, status of breeding pairs, flycatcher nest success, the biotic and abiotic characteristics of occupied willow flycatcher sites, and Brown-headed Cowbird (*Molothrus ater*) brood parasitism rates. In 2002, Reclamation reinitiated consultation with USFWS on the effects of continued dam operations and maintenance on TES species along the LCR. The USFWS responded with a BO in April 2002 requiring continued Southwestern Willow Flycatcher studies along the LCR through April 2005. The BO also required implementation of a study to evaluate the effectiveness of Brown-headed Cowbird trapping for conservation of the flycatcher.

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

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

Reclamation initiated willow flycatcher studies along the LCR in 1996, in anticipation of the requirements outlined in the BOs that were part of LCR MSCP development. These studies have been conducted annually since 1996. From 1997 to 2010,[1] breeding populations of Southwestern Willow Flycatchers were documented at eight study areas along the Virgin and lower Colorado Rivers and tributaries: (1) Pahranagat National Wildlife Refuge (NWR), Nevada; (2) Beaver Dam Wash at Littlefield, Arizona; (3) Mesquite and (4) Mormon Mesa on the Virgin River, Nevada; (5) Overton

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

Wildlife Management Area (WMA) along the Muddy River, Nevada; (6) Grand Canyon, Arizona; (7) Topock Marsh on the Colorado River, Havasu NWR, Arizona; and (8) Bill Williams River NWR (Bill Williams), Arizona (McLeod et al. 2008, Braden and McKernan unpubl. data). From 1997 to 2009, willow flycatchers, including one banded migrant Southwestern Willow Flycatcher (Koronkiewicz et al. 2006a), were detected during the breeding season at several sites along the Colorado River south of the Bill Williams River to the Mexico border, but no nesting activity was confirmed.

In compliance with the consultation on Interim Surplus Criteria and Secretarial Implementation Agreements, Reclamation biologists deployed temperature/humidity data loggers in 2004 at a subset of sites currently monitored for Southwestern Willow Flycatcher along the Colorado River in California and Arizona. These studies were expanded in 2005 to include annual monitoring of groundwater levels, vegetation, and soil moisture in addition to temperature and humidity.

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

Breeding flycatchers have been documented annually at Pahranagat NWR in southern Nevada. The primary breeding site at this study area is at the northern end of Upper Pahranagat Lake, and the site was flooded by the lake during each breeding season until 2008, when structural problems with the levee that impounds the lake required draining the lake. We measured microclimate and vegetation characteristics within flycatcher territories at Pahranagat in 2003–2007 but discontinued these studies in 2008 because Pahranagat is at least 650 m higher in elevation than the LCR MSCP planning area and thus is not a suitable template for LCR MSCP restoration areas. USFWS retained SWCA Environmental Consultants (SWCA) to collect microclimate and vegetation data at Pahranagat in 2009 and 2010 to compare conditions during inundated and non-inundated periods. Results of this study are presented in a separate chapter in this report.

Nevada Department of Wildlife (NDOW) retained SWCA to conduct surveys, site descriptions, nest monitoring, and banding at flycatcher breeding areas at Key Pittman WMA and Warm Springs Natural Area. In previous years, NDOW completed nest monitoring at Key Pittman, and SWCA banded flycatcher nestlings and adults opportunistically in cooperation with the monitoring efforts. SWCA also completed surveys for Yellow-Billed Cuckoo (*Coccyzus americanus occidentalis*) at Key Pittman and Warm Springs. Results of surveys, site descriptions, nest monitoring, and banding efforts at Key Pittman and Warm Springs are presented in Chapters 2, 3, and 4.

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

SPECIES INTRODUCTION

The Southwestern Willow Flycatcher is one of four subspecies of willow flycatcher currently recognized (Unitt 1987), although Browning (1993) posits a fifth subspecies (*E. t. campestris*) occurring in the central portions of the United States (Figure 1.1). The Southwestern Willow Flycatcher breeds in dense, mesic riparian habitats at scattered, isolated sites in New Mexico, Arizona, southern California, southern Nevada, southern Utah, southwestern Colorado, and, at least historically, extreme northwestern Mexico and western Texas (Unitt 1987).

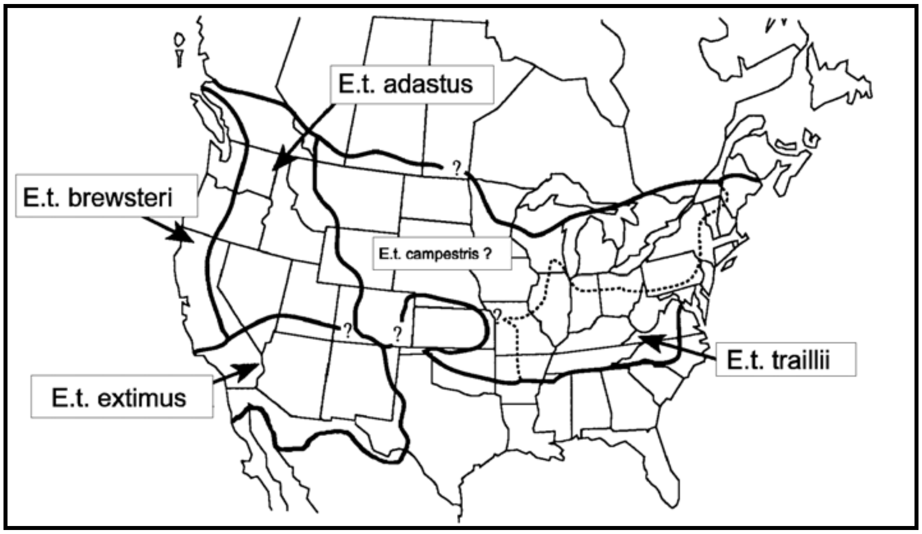

Figure 1.1. Breeding range distribution of the subspecies of the willow flycatcher (*Empidonax traillii*). Adapted from Unitt (1987), Browning (1993), and Sogge et al. (1997).

In the Southwest, most willow flycatcher breeding territories are found within small breeding sites containing five or fewer territories (Durst et al. 2006). One of the last long-distance Neotropical migrants to arrive in North America in spring, Southwestern Willow Flycatchers have a short, approximately 100-day breeding season, with individuals typically arriving in May or June and departing in August (Sogge et al. 1997). All four subspecies of willow flycatchers spend the non-breeding season in portions of southern Mexico, Central America, and northwestern South America (Stiles and Skutch 1989, Ridgely and Tudor 1994, Howell and Webb 1995, Unitt 1997), with wintering ground habitat similar to the breeding grounds (Lynn et al. 2003). Willow flycatchers have been recorded on the wintering grounds from central Mexico to southern Central America as early as mid-August (Stiles and Skutch 1989, Howell and Webb 1995), and wintering, resident individuals have been recorded in southern Central America as late as the end of May (Koronkiewicz et al. 2006b).

Historical breeding records and museum collections indicate that a sizable population of Southwestern Willow Flycatchers may have existed along the extreme southern stretches of the LCR region (Unitt 1987). However, no nests have been located south of the Bill Williams River, Arizona, in over 65 years (Unitt 1987), though northbound and southbound migrant willow flycatchers use the riparian corridor (Phillips et al. 1964, Brown et al. 1987, McKernan and Braden 2002, McLeod et al. 2008, McLeod and Koronkiewicz 2009, this document). Factors contributing to the decline of flycatchers on the breeding grounds include loss, degradation, and/or fragmentation of riparian habitat; invasion of riparian habitat by nonnative plants; and brood parasitism by Brown-headed Cowbirds (USFWS 1995, Marshall and Stoleson 2000). Because of low population numbers range-wide, identifying and conserving willow flycatcher breeding sites is thought to be crucial to the recovery of the species (USFWS 2002).

Tamarisk beetles (*Diorhabda* spp.) may pose an additional threat to Southwestern Willow Flycatchers. Tamarisk beetles defoliate tamarisk (*Tamarix* spp.) plants during flycatcher breeding season, likely exposing flycatcher nests to adverse microclimate conditions and increased risk of depredation and parasitism. Tamarisk beetles were released in St. George, Utah, in 2006, and widespread defoliation was first observed in St. George in 2008. The area of defoliation expanded dramatically in 2009 to encompass the Virgin River downstream of Littlefield, Arizona. The area of defoliation expanded again in 2010 to affect areas as far downstream as the Highway 170 bridge downstream of Bunkerville, Nevada, including the Mesquite breeding site. This represents a downstream expansion of over 25 km, and beetles were detected on a casual survey over 7 km downstream of the Highway 170 bridge, only 10 km upstream of the Mormon Mesa breeding site (McLeod and Pellegrini, pers. obs.).

PURPOSE AND DESCRIPTION OF STUDY

The purpose of the 2010 study is to continue surveys, monitoring, and demographic and ecological studies of the Southwestern Willow Flycatcher in suitable and/or historical riparian and wetland habitats throughout the lower Colorado and Virgin River region. Lower Grand Canyon was not visited in 2010 because the declining level of Lake Mead had dramatically reduced the amount of potential flycatcher habitat, and the formation of rapids at Pearce Ferry and Iceberg Canyon made access difficult. This project encompasses four types of studies: (1) presence/absence surveys, including site descriptions, at preselected sites along the lower Colorado and Virgin Rivers and tributaries, including the Bill Williams River; (2) intensive studies at all study areas where breeding flycatchers are located to assess Southwestern Willow Flycatcher demographics and ecology, habitat selection, and the effects of Brown-headed Cowbird brood parasitism; (3) monitoring of microclimate, vegetation, and groundwater conditions of currently occupied[2] Southwestern Willow Flycatcher habitat between Parker and Imperial Dams; and (4) monitoring microclimate, vegetation, and surface hydrology in a selected portion of flycatcher habitat within Topock Marsh to document the effects of habitat enhancement efforts. SWCA's contract specifies the following field tasks:

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

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

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

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

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

[2] As per Reclamation (1999), we defined occupied Southwestern Willow Flycatcher habitat as patches of vegetation that are similar to and contiguous with areas where willow flycatchers were detected after 15 June in any year, 1996–2008.

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

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

Each distinct aspect of the 2010 study is addressed in a separate chapter in this report, as follows:

Chapter 2 – Presence/absence Surveys and Site Descriptions. This chapter presents the methodology and results for presence/absence surveys and gives a general site description for each survey site.

Chapter 3 – Color-banding and Resighting. Details of banding activities and resighting of previously banded flycatchers are presented in this chapter. Also included are discussions of within- and between-year movement of individual flycatchers.

Chapter 4 – Nest Monitoring. This chapter summarizes nesting attempts, nest fates, and productivity for all Southwestern Willow Flycatcher nesting activity.

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

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

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

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

Chapter 9 – Microclimate and Vegetation Monitoring: Pahranagat. Sampling methodology for microclimate and vegetation conditions at Pahranagat are described, and data collected in 2010, when the site was not inundated, are compared to those collected in 2003–2007, when the site was inundated annually.

Chapter 10 – Management and Study Design Recommendations. Recommendations from all previous report chapters are summarized for ease of reference.

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Chapter 2

PRESENCE/ABSENCE SURVEYS AND SITE DESCRIPTIONS

INTRODUCTION

Broadcasts of recorded conspecific vocalizations are useful in eliciting responses from nearby willow flycatchers, and multiple broadcast surveys conducted throughout the breeding season are the standard technique for determining the presence or absence of *E. t. extimus* (Sogge et al. 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 2010, as part of our contract with Reclamation, we completed multiple broadcast surveys at sites in 14 study areas[2] (hereafter Reclamation study areas) along the LCR and its tributaries to detect both migrant and resident willow flycatchers (Figure 2.1). We also completed surveys in two additional study areas (Key Pittman and Warm Springs; hereafter NDOW study areas) as part of our contract with NDOW.

Special Concern Species

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

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

[2] Study areas consist of 1–18 survey sites that are grouped geographically (see Table 2.2).

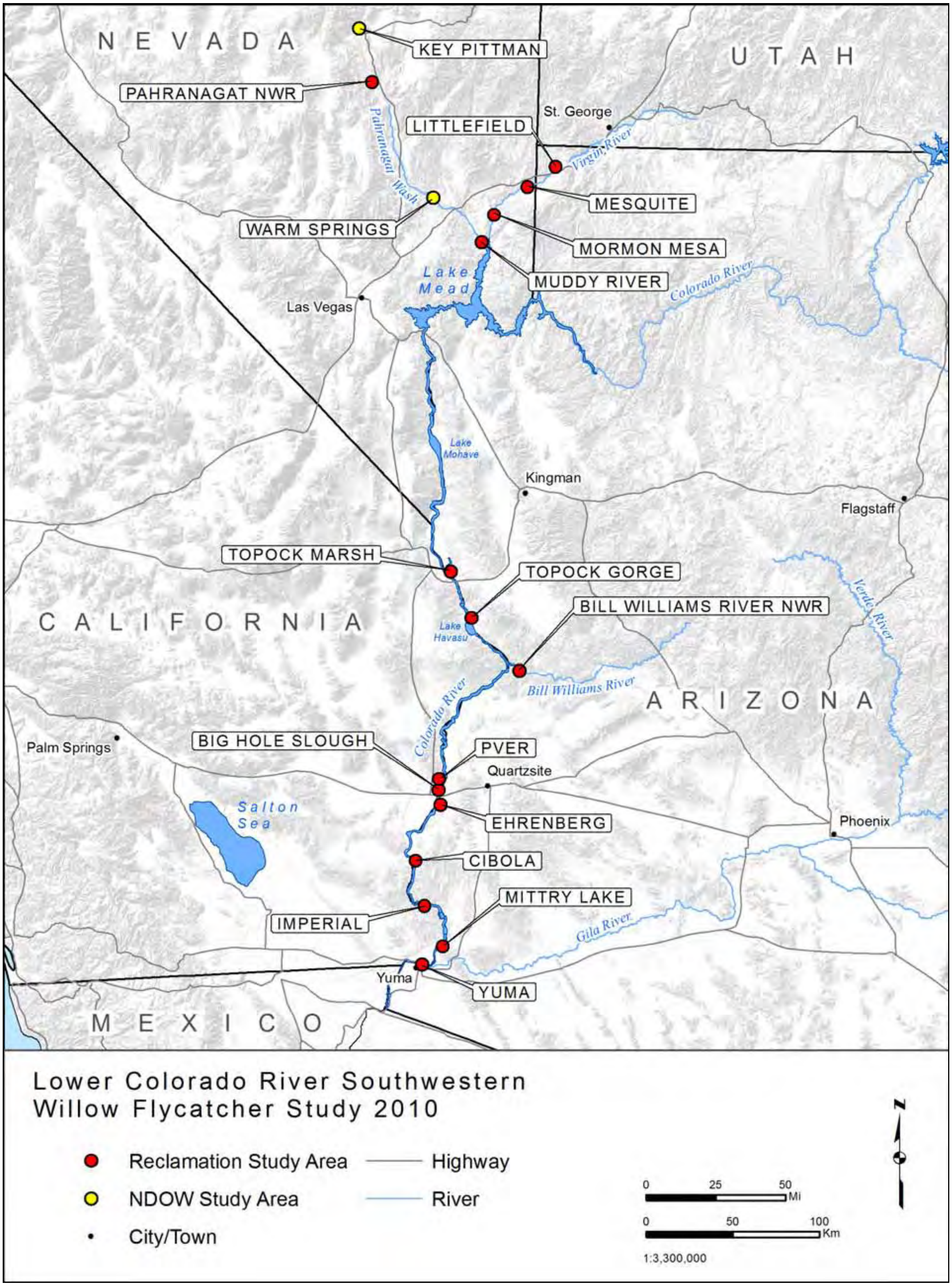

Figure 2.1. Locations of Southwestern Willow Flycatcher study areas along the lower Colorado River and tributaries, 2010. (Note, study area labels represent the approximate center of multiple sites within that region; see Table 2.2)

(*Micrathene whitneyi*), Gila Woodpecker (*Melanerpes uropygialis*), Gilded Northern Flicker (*Colaptes auratus chrysoides*), Vermilion Flycatcher (*Pyrocephalus rubinus*), 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 at the 14 Reclamation study areas but recorded all incidental detections. At the two NDOW study areas, we recorded all incidental detections of special concern species and completed surveys for Yellow-billed Cuckoos.

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, 2010) and reconnaissance by helicopter and on foot prior to the start of the 2010 survey period. Sites consisting of mature native or exotic woody riparian vegetation with high canopy closure (>50%) and standing water or saturated soil under or adjacent to the vegetation were considered the most suitable habitats for flycatchers. Early successional stands of young riparian vegetation >3 m in height in proximity to surface water or saturated soil were also considered potentially suitable flycatcher habitat. Riparian vegetation contiguous with suitable habitat was often included as part of survey areas. Reclamation biologist Chris Dodge guided and approved site selection at the 14 Reclamation study areas. For sites surveyed in previous years, we retained original site names.

In 2008 we implemented a biennial survey schedule at selected sites in study areas where resident flycatchers had not been documented in the previous 10 years of surveys. Sites were selected for biennial surveys based on the absence of damp or wet soils within the site and/or the relative absence of dense vegetation that might provide suitable nesting habitat for flycatchers. After the 2008 survey season, we revised the survey schedule based on conditions observed in the field and added several sites at Bill Williams to the biennial schedule. These sites were ones at which no resident flycatchers had been detected since 2003. The proposed schedule at the beginning of the 2010 survey season is given in Table 2.1 and may be further revised based on conditions observed during 2010.

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	

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

Study Area[1]	Site	Habitat Comments	Proposed Survey Schedule		
			Annual	2008, 2010, 2012	2009, 2011
BIWI	Site #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	
	Mineral Wash	Mixed-native vegetation; sparse canopy closure; dry soil underneath the vegetation; water only within river channels.		X	
	Beaver Pond	Mixed-native vegetation; sparse canopy closure; dry soil underneath the vegetation; water only within river channels.		X	
	Site #8	Mixed-native vegetation; sparse canopy closure; dry soil underneath the vegetation; water only within the river channel.		X	
PVER	PVER Phase 2	Restoration area.	X		
	PVER Phase 3	Restoration area.	X		
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 2	Restoration area.	X		
	CVCA Phase 3	Restoration area.	X		
	Cibola Nature Trail	Generally dry and sparse. Restoration area; habitat improvements taking place, may improve.	X		
	Cibola Island	Narrow, linear site; patches of dense Goodding willow adjacent to marsh.	X		
	Cibola Site 2	No dense canopy. Mostly tamarisk with some emergent willow. Cattail marshes in parts of the site, but dry soil under the tamarisk.			X
	Cibola Site 1	No dense canopy. Mostly tamarisk with some emergent willow. Cattail marshes in parts of the site, but dry soil under the tamarisk.			X
	Three Fingers Lake	Vegetation short, very dry and hot in interior.		X	
	Cibola Lake #1 (North)	Patchy vegetation, hot and dry in interior.		X	
	Cibola Lake #2 (East)	Patchy vegetation, hot and dry in interior.			X
	Cibola Lake #3 (West)	Patchy vegetation, hot and dry in interior.		X	
	Walker Lake	Tamarisk with emergent willows; water under vegetation along lake edge.	X		
IMPE	Paradise	Some big willows with tamarisk understory, sometimes has water in marshes.	X		
	Hoge Ranch	Mosaic of tamarisk, willow, and marshes. Sometimes wet.	X		
	Adobe Lake	Perched above river, very dry; dense tamarisk with many dead branches in understory.		X	
	Rattlesnake	Dense willows, wet soils.	X		
	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

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

[1] TOGO = Topock Gorge, BIWI = Bill Williams River NWR, PVER = Palo Verde Ecological Reserve, BIHO = Big Hole Slough, EHRE = Ehrenberg, CIBO = Cibola, IMPE = Imperial, 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 Sansa® ClipMP3 player coupled to a Radio Shack 277-1008C mini amplified speaker. Surveyors stopped every 30–40 m and broadcast willow flycatcher primary song (*fitz-bew*) and calls (*breets*). Field personnel watched for flycatchers and listened for vocal responses for approximately one to two minutes before proceeding to the next survey station. Wherever territorial flycatchers were detected, 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

Reclamation Study Areas

Field personnel spent 701.8 observer-hours conducting willow flycatcher broadcast surveys at 75 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 2010 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 four to six times. A summary of willow flycatcher survey effort and survey site occupancy status is presented in Appendix C. Field personnel spent an additional 27.2 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 D. Hydrologic characteristics of each site are summarized in Table 2.6.

Table 2.2. Willow Flycatcher Detections at Reclamation Study Areas, 2010*

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
PAHR	North	4.6	23 (16 May–16 Aug)
	West	1.5	1 (12 Jun), 1 (24 Jul)[4]
	MAPS	1.4	ND[5]
	South	2.5	ND
LIFI	Poles	1.2	4 (15 May–2 Aug)
MESQ	Hafen Lane	6.1	3 (3 Jun–21 Jul)
	East	4.4	ND[5]
	West	10.5	17 (15 May–7 Aug)
	Bunker Marsh North	8.0	ND
MOME	Mormon Mesa North	8.2	ND[5]
	Hedgerow	1.1	ND[5]
	Mormon Mesa South	11.9	1 (16 Jun)
	Virgin River #1	22.5	29 (13 May–30 Jul)
	Virgin River #2	11.2	1 (2 Jun), 1 (16 Jun), 1 (6–14 Jun)[6]
MUDD	Overton WMA Pond	0.7	ND
	Overton WMA	14.9	14 (13 May–3 Aug)

[3] We started the survey season with 72 sites scheduled for surveys in 2010. Three sites were added after reconnaissance revealed potential flycatcher habitat. We discontinued surveys at five sites, four because of poor habitat quality and another because of safety concerns.

[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 Reclamation Study Areas, 2010* (Continued)

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
TOPO	Pipes #1	5.2	1 (29 May), 1 (2 Jun)
	Pipes #3	5.7	2 (11 May–30 Jun), 1 (16 Jun)
	The Wallows	0.7	1 (8 May–2 Jun), 1 (23 May), 1 (6–27 Jun), 1 (8 Jul)
	PC6-1	4.8	2 (21 May)
	Pig Hole	2.4	ND
	In Between	7.7	ND
	800M	4.7	1 (11–13 May), 1 (19–23 May), 2 (29 May–18 Jun)
	Pierced Egg	6.7	1 (13–19 May), 1 (15–19 May), 1 (31 May–24 Jun)
	Swine Paradise	1.0	1 (6–10 Jun)
	Barbed Wire	2.4	ND
	Platform	1.9	2 (11 Jun–11 Jul)
	250M	1.9	ND
	Hell Bird	3.3	1 (6 Jun)
	Glory Hole	5.0	2 (19 May–8 Aug), 1 (5–16 Jul)[7]
	Beal Lake	13.9	1 (21 May), 1 (2 Jun)
	Lost Lake	3.3	ND
	MAM[8]		1 (23 May), 1 (2 Jun)
TOGO	Blankenship Bend North	19.0	ND
	Blankenship Bend South	11.8	ND
	Havasu NE	12.6	ND
BIWI	Site #1	2.2	ND
	Site #2	3.1	ND
	Site #11	6.3	ND
	Burn Edge	4.1	2 (9 Jun–5 Jul)
	Site #4	9.9	1 (27 Jun), 1 (27 Jun–3 Jul)
	Site #3	9.5	4 (14 May–6 Aug)
	Last Gasp	2.1	ND
	Site #5	6.8	ND
	Black Rail	1.2	ND
	Mineral Wash	18.8	1 (12 Jun), 1 (12–17 Jun)
	Beaver Pond	21.7	1 (17–21 Jun)
	Site #8	10.3	ND
	Upstream from Site #8	1.5	1 (18 May)
	Planet Ranch Road	3.3	2 (18 May–28 Jul)
PVER	PVER Phase 2	28.7	2 (25 May), 1 (10 Jun)
	PVER Phase 3	15.8	ND
BIHO	Big Hole Slough	29.0	ND[9]
EHRE	Ehrenberg	4.7	ND

Table 2.2. Willow Flycatcher Detections at Reclamation Study Areas, 2010* (Continued)

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
CIBO	CVCA Phase 1	26.2	15 (17 May), 2 (9 Jun)
	CVCA Phase 2	25.5	18 (24 May)
	CVCA Phase 3	38.4	4 (9 Jun)
	Cibola Nature Trail	13.7	1 (26 May), 1 (10 Jun)
	Cibola Island	4.2	ND
	Three Fingers Lake	67.9	3 (27 May), 2 (2 Jun)
	Cibola Lake #1 (North)	8.5	ND
	Cibola Lake #3 (West)	6.8	ND
	Walker Lake	11.4	1 (2 Jun)
IMPE	Paradise	7.8	1 (8 Jun)
	Hoge Ranch	20.7	1 (20 May), 1 (5 Jun)
	Adobe Lake	7.6	ND
	Rattlesnake	7.6	1 (18 May), 1 (8 Jun)
	Clear Lake	8.3	1 (22 May)
	Nursery NW	7.0	ND
	Imperial Nursery	1.4	ND
	Ferguson Lake	21.1	7 (22 May)
	Ferguson Wash	6.8	3 (19 May)
	Great Blue Heron	7.1	ND
MITT	Mittry West	4.4	2 (23 May), 2 (4 Jun)
	Mittry South	15.2	5 (23 May)
YUMA	Gila Confluence North	2.2	3 (3 Jun)

* 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, PVER = Palo Verde Ecological Reserve, BIHO = Big Hole Slough, EHRE = Ehrenberg, CIBO = Cibola, IMPE = Imperial, MITT = Mittry Lake, YUMA = Yuma.

2 ND = No willow flycatchers were detected.

3 See Chapter 3 for details on territories, residency, pairing, and color-banding; see Chapter 4 for details on nesting activity.

4 Detection on 24 Jul was of an adult that had held a territory at Pahranagat North until 14 Jul.

5 Surveys discontinued because of poor quality habitat.

6 This individual was also detected in Virgin River #1 on 2 Jun and 12 Jun–4 Jul.

7 This individual in Pipes #3 19 May–25 Jun.

8 Not an official survey site. Incidental detections recorded.

9 Surveys discontinued after 1 Jun because of safety concerns.

Table 2.3. Detections of Willow Flycatchers Recorded after 15 June 2010 at Sites Where Breeding or Residency Was Not Confirmed

Study Area[1]	Site	Date	Comments
MOME	South	16 Jun	Responded to broadcast with *wheeos* and primary song (*fitz-bew*)
BIWI	Site #4	27 Jun–3 Jul	Singing spontaneously (*fitz-bew*)
		27 Jun	Responded briefly to broadcast with *wheeos* and primary song (*fitz-bew*)

1 MOME = Mormon Mesa, BIWI = Bill Williams River NWR.

Table 2.4. Yellow-Billed Cuckoo Detections at Reclamation Study Areas, 2010

Study Area[1]	Site	Date	Behavioral Observations
PAHR	North	27 Jun	One individual heard (*kowlp*)
MESQ	Hafen Lane	21 Jul	One individual heard
	West	14 Jul	One individual seen and heard (*kuk* and *kowlp*)
		16 Jul	One individual heard (*kuk*)
		18 Jul	Two individuals (one seen) counter-calling (*kuk* and *kowlp*)
MOME	Virgin River #1 South	12 Jul	One silent individual seen
MUDD	Overton WMA	6 Jul	One silent individual seen
TOPO	Barbed Wire	2 Jul	One individual heard (*kuk* and *kowlp*)
	Beal Lake	8 Jul	Two individuals heard (*kuk* and *kowlp*)
	Lost Lake	9 Jul	Two individuals heard (*kuk* and *kowlp*)
		18 Jul	One individual heard (*kuk* and *kowlp*)
BIWI	Site #4	21 Jun	One individual heard
		27 Jun	Two individuals heard (*kuk* and *kowlp*)
	Site #3	18 Jun	One individual heard
		29 Jun	One individual heard (*kuk* and *kowlp*) several times in two hours
		1 Jul	One individual heard
		11 Jul	One individual heard (*kuk* and *kowlp*)
	Last Gasp	20 Jul	One individual heard (*kuk*, *kowlp*, and *coo*)
	Mineral Wash	21 Jun	One individual heard (*kuk* and *kowlp*)
		30 Jun	One individual heard (*kuk* and *kowlp*)
	Beaver Pond	21 Jun	Two individuals heard (*kuk*, *kowlp*, and *coo*)
		9 Jul	One individual heard
		20 Jul	One individual heard (*kuk* and *kowlp*)
		26 Jul	One individual heard
	Site #8	29 Jun	One individual heard (*kuk* and *kowlp*)
		14 Jul	One individual heard (*kuk* and *kowlp*)
	Upstream from Site #8	3 Jun	One individual heard (*coo*)
		14 Jul	One individual heard
	Planet Ranch Road	30 May–21 Jul	Repeated detections of one or two cuckoos (*kuk*, *kowlp*, and *coo*)
PVER	Phase 2	21 Jun	One individual heard
		29 Jun	One individual heard
		13 Jul	Three individuals heard (*kuk* and *kowlp*)
	Phase 3	21 Jun	One individual heard
		29 Jun	Four individuals heard (*kuk* and *kowlp*)
CIBO	Phase 1	24 Jun	One individual heard
		8 Jul	Four individuals heard (*kuk* and *kowlp*)
	Phase 2	24 Jun	Two individuals heard (*kuk* and *kowlp*)
		8 Jul	Four detections; unclear if four separate individuals

Table 2.4. Yellow-Billed Cuckoo Detections at Reclamation Study Areas, 2010 (Continued)

Study Area[1]	Site	Date	Behavioral Observations
CIBO	Phase 3	15 Jun	One individual heard
		13 Jul	One individual heard (*kuk* and *kowlp*)
	Three Fingers Lake	22 Jun	One individual heard (*kuk* and *kowlp*)
MITT	Mittry West	17 Jun	One individual heard (*kuk*, *kowlp*, and repeated *coo*)
		16 Jul	One individual heard (*kuk*, *kowlp*, and repeated *coo*)
	Mittry South	17 Jun	Two individuals heard (*kuk* and *kowlp*)
YUMA	Gila Confluence North	4 Jul	One individual heard (*kuk* and *kowlp*)
		20 Jul	Two individuals heard (*kuk* and *kowlp*)

[1] PAHR = Pahranagat NWR, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, TOPO = Topock Marsh, BIWI = Bill Williams River NWR, PVER = Palo Verde Ecological Reserve; CIBO = Cibola, MITT = Mittry, YUMA = Yuma.

Table 2.5. Yuma Clapper Rail Detections at Reclamation Study Areas, 2010

Study Area[1]	Site	Date(s)	Behavioral Observations
TOPO	800M	13 May	One individual heard
	Pierced Egg	27 May	Two or three individuals clattering
		4 Jun	Two individuals clattering on marsh edge
	Platform	11 Jun	Two individuals heard kekking
		30 Jun	One individual heard kekking on marsh edge
	250M	15 May	One individual heard
	Glory Hole	23 May	Three to four individuals heard clattering
		26 Jun	One individual heard
	Lost Lake	27 May	Two pairs heard clattering
		30 Jun	One individual heard
		9 Jul	Two pairs heard clattering
	Lost Lake Slough #2	13 Jun	One individual heard kekking
	Lost Lake Slough #3	13 May	Pair heard clattering
		13 Jun	Pair heard clattering
TOGO	Blankenship Bend North	17 May	Multiple pairs heard clattering
		1 Jun	One individual heard kekking
		24 Jun	One individual seen, second individual heard kekking
	Blankenship Bend South	1 Jun	Pair heard clattering
		24 Jun	Pair heard clattering
BIWI	Site #1	15 Jun	Two individuals heard
	Site #5	14 May	Pair heard clattering
	Mineral Wash	16 May	One individual seen
CIBO	Three Fingers Lake	27 May	One individual heard
		2 Jun	One individual heard
	Cibola Lake North	23 Jun	One individual heard
		14 Jul	Three individuals heard
	Cibola Lake West	23 Jun	One individual heard

[1] TOPO = Topock Marsh, TOGO = Topock Gorge, BIWI = Bill Williams River NWR, CIBO = Cibola.

Table 2.6. Summary of Hydrologic Conditions at Each Survey Site at Reclamation Study Areas, 2010*

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]	10/3/1	10/25/25	--/20/20	0/0/0
	West[4]	0/0/0	0/0/0	5/1/0	0/0/0
	MAPS	0/0/--	0/0/--	0/0/--	25/10/--
	South	2/1/0	10/3/0	0/1/0	0/0/115
LIFI	Poles[4]	50/50/50	25/25/25	10/10/1	0/0/0
MESQ	Hafen Lane	1/25/1	3/10/3	0/5/0	0/0/0
	East[4]	0/--/--	0/--/--	0/--/--	0/--/--
	West	50/50/50	30/30/30	20/20/20	0/0/0
	Bunker Marsh North	2/0/0	25/0/0	1/0/0	0/150/150
MOME	Mormon Mesa North	0/--/--	0/--/--	0/--/--	100/--/--
	Hedgerow	0/--/--	0/--/--	0/--/--	100/--/--
	Mormon Mesa South	0/0/0	0/0/0	0/0/0	200/200/200
	Virgin River #1	20/15/10	30/20/10	10/15/10	0/0/0
	Virgin River #2[4]	0/0/0	0/0/0	0/0/0	0/0/0
MUDD	Overton WMA Pond	5/5/5	10/10/10	--/--/--	0/0//0
	Overton WMA	5/5/5	30/30/30	2/2/2	0/0/0
TOPO	Pipes #1	0/0/0	0/0/0	0/0/0	40/40/40
	Pipes #3	5/<1[5]/0	15/30/0	20/<1/0	0/0/40
	The Wallows	25/<1/<1[5]	15/3/15	5/50/2	0/0/0
	PC6-1	<1[5]/0/0	--/0/0	0/<1/0	0/0/40
	Pig Hole	0/0/0	0/0/0	0/0/0	120/120/120
	In Between	0/0/0	0/0/0	0/0/0	0/30/50
	800M	5/0/0	5/0/0	5/10/1	0/0/0
	Pierced Egg	3/2[5]/1[5]	3/30/30	15/5/0	0/0/0
	Swine Paradise[6]	0/0/0	0/0/0	0/0/0	10/40/40
	Barbed Wire	0/0/0	0/0/0	<1/0/0	150/150/150
	Platform[6]	0/0/0	0/0/0	0/0/0	5/0/5
	250M[6]	0/0/0	0/0/0	0/0/0	0/0/0
	Hell Bird	5/15/5	15/30/20	2/4/5	0/0/0
	Glory Hole	1/4/3	5/20/20	1/5/3	0/0/0
	Beal Lake[9]	0/0/0	0/0/0	0/0/0	20/20/20
	Lost Lake[6]	0/3/0	0/0/0	0/0/0	5/0/10
TOGO	Blankenship Bend North[4]	15/15/15	50/50/50	5/--/5	0/0/0
	Blankenship Bend South[4]	5/33/30	60/30/30	3/15/5	0/0/0
	Havasu NE[4]	0/0/0	0/0/0	0/0/0	0/0/0
BIWI	Site 1[4]	10/0/0	3/0/0	3/2/0	0/0/0
	Site 2[4]	15/5/3	5/--/5	1/0/0	0/0/0
	Site 11[4]	18/18/18	>100/>100/>100	0/0/0	0/0/0
	Burn Edge[4]	25/5/1	40/30/15	1/15/1	0/0/0
	Site #4[4]	5/5/1	7/7/>100	10/3/1	0/0/0
	Site #3	15/15/3	10/5/3	10/5/5	0/0/0
	Last Gasp[4]	10/5/1	90/50/3	1/0/2	0/0/0

Table 2.6. Summary of Hydrologic Conditions at Each Survey Site at Reclamation Study Areas, 2010* (Continued)

Study Area[1]	Survey Site	% Site Inundated[2]	Depth (cm) of Surface Water[2]	% Site with Saturated Soil[2,3]	Distance (m) to Surface Water or Saturated Soil[2]
BIWI	Site #5	15/5/2	1515/15	5/10/5	0/0/0
	Black Rail	45/5/0	10/15/0	25/70/60	0/0/0
	Mineral Wash Complex[4]	5/5/5	40/40/40	3/3/1	0/0/0
	Beaver Pond[4]	13/10/5	20/15/15	0/5/2	0/0/0
	Site 8[4]	8/8/8	15/40/40	1/0/0	0/0/0
	Upstream from Site #8[4]	25/20/20	10/10/10	10/15/10	0/0/0
	Planet Ranch Road[4]	15/10/8	40/40/40	0/2/5	0/0/0
PVER	PVER Phase 2[7]	0/0/0	0/0/0	0/5/0	5/5/5
	PVER Phase 3[7]	0/12/0	0/5/0	0/5/0	8/0/8
BIHO	Big Hole Slough	--/5/--	--/--/--	--/--/--	--/0/--
CIBO	CVCA Phase 1[7]	0/0/10	0/0/5	0/0/3	10/10/0
	CVCA Phase 2[7]	0/0/0	0/0/0	0/0/0	5/5/2
	CVCA Phase 3[7]	9/0/0	7/0/0	10/0/0	0/0/0
	Cibola Nature Trail[7]	15/0/0	7/0/0	10/0/0	0/10/10
	Cibola Island	0/0/0	0/0/0	0/0/0	5/5/5
	Three Fingers Lake	15/15/15	100/100/100	0/0/0	0/0/0
	Cibola Lake #1 (North)[4]	--/0/5	--/0/5	--/5/5	--/0/0
	Cibola Lake #3 (West)[4]	--/0/5	--/0/5	--/5/5	--/0/0
	Walker Lake[4]	0/0/0	0/0/0	1/1/1	0/0/0
IMPE	Paradise[4]	25/2/3	11/--/--	10/0/5	0/0/0
	Hoge Ranch[4]	3/4/5	40/--/70	15/10/0	0/0/0
	Adobe Lake[4]	--/--/--	--/--/--	--/--/--	0/0/0
	Rattlesnake[6]	0/0/35	0/0/20	0/0/3	200/200/0
	Clear Lake	3/3/3	60/60/60	0/0/0	0/0/0
	Nursery NW[6]	--/1/0	--/5/0	--/--/--	--/0/2
	Imperial Nursery	0/0/0	0/0/0	0/0/0	25/25/5
	Ferguson Lake[4]	5/1/5	3/5/5	5/2/10	0/0/0
	Ferguson Wash[4]	1/1/1	100/100/100	1/1/1	0/0/0
	Great Blue Heron[6]	0/0/0	0/0/0	0/0/0	100/100/100
MITT	Mittry West	5/0/0	4/0/0	10/15/0	0/0/180
	Mittry South[4]	0/0/0	0/0/0	0/0/0	5/5/5
YUMA	Gila Confluence North[4]	--/3/5	--/5/5	--/0/5	--/0/0

* 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, BIWI = Bill Williams River NWR, PVER = Palo Verde Ecological Reserve, BIHO = Big Hole Slough, CIBO = Cibola, IMPE = Imperial, MITT = Mittry Lake, YUMA = Yuma.

2 -- = Hydrologic information not recorded.

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

4 Site bordered by a river, lake, or pond.

5 Saturated soil or water was present only in pig wallows.

6 Site borders marsh.

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

Pahranagat National Wildlife Refuge, Nevada

Pahranagat National Wildlife Refuge consists of a series of lakes and marshes in Pahranagat Valley approximately 150 km north of Las Vegas, Nevada. Patches of primarily native vegetation exist at the inflow and outflow of Upper Pahranagat Lake and along the lakeshore. Prior to the 2008 survey season, the majority of the riparian vegetation along the north side of the upper lake (Pahranagat North) was inundated annually with up to 1 m of water, with the highest water levels occurring in May. Major structural problems with the 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. The levee was repaired prior to the 2010 breeding season, and lake levels in 2010 were higher than they had been in the two previous years but not as high as they had been prior to 2008.

PAHRANAGAT NORTH

Area: 4.6 ha Elevation: 1,026 m

Pahranagat North is a stand of large-diameter Goodding willow (*Salix gooddingii*) at the inflow of Upper Pahranagat Lake. Fremont cottonwood (*Populus fremontii*; hereafter cottonwood) lines the northern, upland edge of the site and extends in narrow stringers around the edge of the lakebed. Canopy height within the patch is around 20 m, and canopy closure is approximately 80%. Many of the large trees in the northeastern section of the site are dead or dying. Standing water and saturated soils were present within the southern portion of the site in May, and the site slowly dried out during the survey season, with no water or saturated soils present by the end of July except in an inflow channel that runs along the northern side of the site and drains into the lakebed at the southeastern corner of the site. Standing water and saturated soils were also present within patches of bulrush (*Schoenoplectus* sp.) that border the southern edges of the site.

We detected 19 breeding willow flycatchers, as well as 3 resident, unpaired males and 1 resident individual for which gender could not be determined. The site lies immediately adjacent to a cattle pasture, and a breach in the fence allowed cattle access to the site for a portion of the breeding season. No formal surveys were conducted at the site. Cowbirds were detected periodically through the season during nest monitoring visits.

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 adjacent to the site in the lakebed.

We detected one willow flycatchers for which residency could not be confirmed and another willow flycatcher that had held a territory in Pahranagat North. We surveyed the site five times, totaling 4.0 observer-hours. No cowbirds were detected, and there was no sign of livestock use.

PAHRANAGAT MAPS

Area: 1.4 ha Elevation: 1,026 m

Pahranagat MAPS is a stringer of cottonwood on the western edge of the bed of Upper Pahranagat Lake. The southern half the stringer was burned prior to the start of the survey season, and the fire removed between 50 and 100% of the overstory canopy in the affected area. Surveys were therefore restricted to the northern half of the stringer. Canopy height is 15–20 m, and canopy closure within the stringer is approximately 70%. The stringer is 20 m wide at the widest point and in most places is narrower. There is no woody vegetation in the understory. Bulrush lines the eastern edge of the tree line and extends into the lakebed. The site was dry throughout the survey season, with the nearest water or saturated soil being at least 10 and up to 80 m away in the lakebed.

No willow flycatchers were detected. We surveyed the site four times, totaling 4.1 observer-hours. Cowbirds were detected on one survey, and there was no evidence of livestock use. Surveys at this site were discontinued because of the extent of the fire and the complete lack of understory vegetation in the portion of the site that retained an overstory canopy. We do not recommend surveying this site in 2011, but the burned area should be reassessed in 2–3 years.

PAHRANAGAT SOUTH

Area: 2.5 ha   Elevation: 1,023 m

The majority of this site was affected by a fire prior to the start of the 2010 survey season. The fire removed all understory vegetation and charred the trunks and lower branches of the overstory trees. The site now consists of a stringer of cottonwood, 20 m tall, along a human-made channel that carries the outflow from Upper Pahranagat Lake. The understory contains Indian hemp (*Apocynum cannabinum*) but no woody species. Canopy closure within the cottonwood stringer is approximately 50%. The channel held water during site visits in May and June but was dry in mid-July.

No willow flycatchers were detected. We surveyed the site five times, totaling 2.7 observer-hours. No cowbirds were detected, and no sign of livestock was observed. We do not recommend surveying this site in 2011 because of the complete lack of understory, but the area should be reassessed in 2–3 years.

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 (*Salix exigua*) stringers downstream of the bridge and expanded the survey area even farther downstream in 2009. In 2010, we were unable to obtain landowner permission to access the portion of the site downstream of the bridge and therefore surveyed only the portion upstream of the bridge.

LITTLEFIELD POLES

Area: 1.2 ha   Elevation: 565 m

Littlefield Poles consists of primarily native vegetation and is located on Beaver Dam Wash, immediately upstream of the Highway 91 Bridge. Vegetation along the northern edge of the site consists of a scattered overstory of cottonwood averaging 25 m in height. Lower strata vegetation in the cottonwood area consists of tamarisk and Russian olive (*Elaeagnus angustifolia*) approximately 6 m in height. The southern portion of the site consists of dense stands of coyote willow and young Goodding willow and cottonwood along a network of streams and beaver ponds. 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 beaver ponds throughout the survey season. Tamarisk beetles and extensive defoliation of tamarisk were noted at the site starting in June. Much of this site was scoured by floods in December 2010, and the site will be evaluated at the beginning of the 2011 breeding season.

We detected two 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 10.0 observer-hours. Cowbirds were detected on three surveys, and signs of livestock were observed on one visit.

GROUND RECONNAISSANCE RESULTS

Pioneer Road

We investigated an area on Beaver Dam Wash approximately 1.2 km upstream of Littlefield Poles. Vegetation within 4 m on either side of the stream consists of dense coyote willow 3–4 m tall. Farther from the stream, soils are very dry and vegetation consists of scattered cottonwood up to 15 m tall. Overall canopy closure is between 50 and 70%. This site does not currently have dense vegetation that is extensive or mature enough to support breeding flycatchers but should be monitored in future years.

Mesquite, Nevada

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

HAFEN LANE

Area: 6.1 ha Elevation: 475 m

This mixed-exotic site lies within the floodplain of the Virgin River in Mesquite, Nevada, between Hafen Lane and the active river channel. Two drainage ditches that pass underneath Hafen Lane flow into the site; the eastern inflow supports a dense stand of cottonwood and Goodding willow, 8 m in height with 90% canopy closure. The western inflow supports a stringer of coyote willow 4–6 m in height and scattered Goodding willow 15–18 m in height. The coyote willow in the western stringer is of varying health and density. Between the stringers, the site is vegetated by 6-m-tall tamarisk with 90% canopy closure. The amount of water within the site varied with inflow from the drainage ditches; the interior of the site was typically dry but on one occasion the entire western stringer was inundated. Tamarisk beetles and defoliated tamarisk were noted at the site starting in July.

We detected two breeding flycatchers and another male flycatcher that later held a breeding territory at Mesquite West. Portions of the site not known to be occupied were surveyed five times for a total of 6.8 observer-hours. Cowbirds were detected on all surveys, and no sign of livestock use was observed.

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. The vegetation on this upper terrace is mostly dead, with live branches remaining only on the cottonwood and some Goodding willow. Canopy closure on the upper terrace is approximately 50%. The site was completely dry during the site visit in May.

We surveyed the site once, totaling 1.0 observer-hour, and then discontinued surveys because of the lack of wet soils and live vegetation on the upper terrace. Cowbirds were detected during the site visit and signs of livestock were observed.

MESQUITE WEST

Area: 10.5 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 (*Typha* spp.) 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. During the 2009 breeding season, the site was primarily dry (see McLeod and Koronkiewicz 2010), unlike in previous years when the majority of the site was regularly or continuously inundated. During the 2010 breeding season, the site was again regularly inundated. Tamarisk beetles and defoliated tamarisk were noted on the edges of the site in early July and in the interior of the site by late July.

We detected 14 breeding willow flycatchers and 2 resident, unpaired males. One of these males moved to Hafen Lane where it held a breeding territory. 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 five times, totaling 14.4 observer-hours. Cowbirds were detected on four surveys and were detected regularly during territory monitoring. Recent cattle sign was observed along the southern edge of the site near the river.

BUNKER MARSH NORTH

Area: 8.0 ha Elevation: 456 m

This mixed-exotic site lies within the floodplain of the Virgin River near Bunkerville, Nevada, approximately 4 km downstream of Mesquite West. The site is between agricultural fields to the southeast and the Virgin River to the northwest. The site is a mosaic of 4–6-m-tall tamarisk, scattered Goodding willow, small patches of coyote willow 4–5 m in height, and stream channels and marshy areas. Canopy closure ranges from 25 to 80%. Surface water was noted within the site only in May in a small stream in the southern portion of the site; the marshes that contained water during the 2009 breeding season were dry in 2010. The portion of the site that contained breeding flycatchers in 2009 was completely dry and had dead or dying vegetation.

We detected no willow flycatchers. The site was surveyed five times, for a total of 15.4 observer-hours. Cowbirds were detected on four surveys, and cows were observed on the edge of the site.

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 2010, unlike in some previous years.

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 a visit in May, and the nearest water was in the river channel approximately 100 m away. The site is perched up to 2 m above the water level. Because the site was completely dry and no flycatchers have been detected at the site since 2005, surveys were discontinued after the initial visit. Heavy flooding occurred on the Virgin River in December 2010, and this site will be revisited at the beginning of the 2011 season to determine whether the hydrology of the site was altered. If hydrology has not changed and the site is still dry, we recommend discontinuing surveys at this site.

We did not detect any flycatchers. We surveyed the site once, totaling 3.8 observer-hours. Cowbirds were detected on the survey, and evidence of livestock use was noted on the periphery of the site.

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 during a visit in May. Because the site was completely dry and no flycatchers have been detected at the site since surveys began in 2005, surveys were discontinued after the initial visit. Heavy flooding occurred on the Virgin River in December 2010, and this site will be revisited at the beginning of the 2011 season to determine whether the hydrology of the site was altered. If hydrology has not changed and the site is still dry, we recommend discontinuing surveys at this site.

We did not detect any flycatchers. We surveyed the site once, totaling 1.5 observer-hours. Cowbirds were detected, and no sign of livestock use was observed.

MORMON MESA SOUTH

North half: Area: 8.6 ha Elevation: 385 m
South half: Area: 3.4 ha Elevation: 385 m

This mixed-exotic site was split into two contiguous areas to facilitate tracking of survey activity. The site has scattered Goodding willow up to 20 m but more typically 12–15 m in height and a patchy understory of tamarisk 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 suggests that this site was formerly considerably wetter, and portions of the site still have the structure to provide potential flycatcher habitat with wetter soil conditions.

We detected one willow flycatcher for which residency could not be confirmed. We surveyed the northern and southern halves of the site five times each, totaling 13.8 and 7.5 observer-hours, respectively. Cowbirds were detected on all but one survey, and cattle were noted within the site on multiple occasions.

VIRGIN RIVER #1

North half: Area: 11.4 ha Elevation: 380 m
South half: Area: 11.1 ha Elevation: 380 m

Virgin River #1 was also divided into two areas, Virgin River #1 North and Virgin River #1 South, to facilitate streamlining of field logistics. Virgin River #1 North is primarily tamarisk 4–6 m in height, with areas of emergent Goodding willow and patches of coyote willow in the central and southwestern portions of the site. Canopy closure throughout the site is 70–90%. Surface water and mud were present in May in channels running north to south through the center of the site and in the southwestern corner of the site.

We detected three flycatchers for which residency and breeding status could not be confirmed in the southwestern corner of Virgin River #1 North. We also detected a male flycatcher that ultimately held a territory in Virgin River #1 South. Areas of this site not known to be occupied by flycatchers were surveyed five times, totaling 30.3 observer-hours. Cowbirds were detected on all surveys and cattle were observed in the site on multiple occasions.

Virgin River #1 South consists of two disjunct sections; the northern section is immediately south of Virgin River #1 North while the southern portion is approximately 700 m SSE of Virgin River #1 North. The northern section is primarily tamarisk 4–5 m in height with patches of coyote willow 6 m in height and scattered Goodding willow 8–12 m in height. Canopy closure varies from >90% in areas of dense willow and tamarisk to 25% in marshy openings. The northern section contained standing water throughout the survey season. The southern section consists of tamarisk 7–8 m in height, with a cluster of emergent Goodding willow and dead coyote willow. Canopy closure is 70–90%. Soils in the southern section were dry throughout the survey season, though water was present in May in an incised channel immediately to the east.

We detected 20 breeding willow flycatchers and 5 unpaired, resident males in the northern section of Virgin River #1 South. We detected one additional willow flycatcher 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 17.5 observer-hours. Cowbirds were observed on all surveys, and signs of cattle were observed.

VIRGIN RIVER #2

Area: 11.2 ha Elevation: 380 m

This mixed-exotic consists of tamarisk 6-7 m in height with a cluster of emergent Goodding willow at the northern end of the site and scattered, emergent Goodding willow at the southern end of the site. Many of the Goodding willow, particularly in the southern part of the site, are dead or dying. Overall canopy closure is 70–90%. The site contained no surface water during the breeding season, though a small portion of the site contained damp soil in May. The Virgin River, on the eastern edge of the site, had surface water throughout the season.

We detected one resident willow flycatcher that later held a territory in Virgin River #1 South. We detected an additional flycatcher for which residency could not be confirmed. Another flycatcher for which residency could not be confirmed was detected to the north of Virgin River #2, outside the formally surveyed area. We surveyed the site five times, totaling 12.7 observer-hours. Cowbirds were observed on all surveys, and cattle were observed at the site.

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 3.5 observer-hours. Cowbirds were detected on one visit, 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 channels of the Muddy River throughout the survey season. 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 eight breeding willow flycatchers and four unpaired, resident males. We also detected two flycatchers for which residency could not be confirmed. Portions of the site not known to be occupied by flycatchers were surveyed five times, totaling 19.8 observer-hours. We observed no signs of livestock but detected cowbirds on four 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. 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 8 m in height with canopy closure of 70–90%, and areas of saltbush (*Atriplex* sp.) border the tamarisk along the southern uplands. Small patches of willow 3–4 m in height are found along the river in the central portion of the site. Soils throughout most of the site were dry during the reconnaissance visit in May, with surface water confined to the incised river channel. Two small areas of saturated soil were noted at the eastern end of the site. We do not recommend further visits to this site unless flood events occur that have the potential to alter the hydrology.

We surveyed the site once for a total of 4.5 observer-hours. Cowbirds were detected, and no sign of livestock use was observed.

Overton Willows

This mixed-exotic site is approximately 150 m east of the Overton WMA site. We visited this site in 2007 and determined that the vegetation was too short and sparse to support flycatchers. We reevaluated the site in 2010. The site is dominated by dense tamarisk typically 3–4 m in height but with patches up to 6 m in height. Patches of willow, most of which are dead or dying, are present throughout the site, and stands of common reed (*Phragmites australis*), most of which are also dead, are scattered through the southern portion of the site. Overall canopy closure is 50–70%. Soils within the site were completely dry during the visit in May. The quality of the site for willow flycatchers had not improved since 2007, and we do not recommend further visits to this site.

We surveyed the site once for a total of 2.5 observer-hours. One cowbird was detected and no sign of livestock use was noted.

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 in May and June.

We detected two willow flycatchers for which residency could not be confirmed. We surveyed the site five times, totaling 10.8 observer-hours. Cowbirds were detected on four 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%. Standing water was present in May in the form of a few small, scattered pools. In June the water was restricted to pig wallows and by July, no standing water remained.

We detected two resident, male flycatchers and one additional individual for whom residency and breeding status could not be confirmed. This additional individual was sexed as female because it was seen carrying nesting material, but was only detected once and no nest was located. Portions of Pipes #3 not known to be occupied by flycatchers were surveyed six times, totaling 7.3 observer-hours. Cowbirds were detected on five surveys.

THE WALLOWS

Area: 0.7 ha Elevation: 140 m

The Wallows is primarily vegetated by tamarisk 5–6 m in height with emergent Goodding willow on the western side of the site. The northwestern edge of the site borders an open cattail marsh. The eastern side is dry and grades from 2-m-tall arrowweed along the refuge road to tamarisk up to 8 m in height. Overall canopy closure ranges from 50% in the marshy area to 90% in the tamarisk. A quarter of the site was inundated in May. In mid-June water remained in intermittent puddles in the marsh, and in mid-July surface water was present only in pig wallows.

We detected two resident, unpaired males and two individuals on single occasions. Portions of the site not known to be occupied were surveyed 5 times, totaling 3.1 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%. Standing water was noted only in May and was restricted to pig wallows. A small patch of saturated soil was noted in late June. The site was completely dry by July.

We detected two willow flycatchers on 21 May. The site was surveyed five times, totaling 9.8 observer-hours. Cowbirds were detected on four surveys.

PIG HOLE

Area: 2.4 ha Elevation: 140 m

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

No willow flycatchers were detected. The site was surveyed five times, totaling 5 observer-hours. Cowbirds were detected on all surveys.

IN BETWEEN

Area: 7.7 ha Elevation: 140 m

In Between consists of monotypic tamarisk 6–8 m in height. The lowest 3 m of the stand generally lacks foliage, resulting in a relatively open understory. Canopy closure is 70–90%, and the western edge of the site borders a marsh. No surface water or saturated soil was noted during the survey period. Damp soil was present along the western and eastern edges during May.

No flycatchers were detected. We surveyed the site five times, totaling 9.3 observer-hours. Cowbirds were observed on all surveys.

800M

Area: 4.7 ha Elevation: 140 m

800M adjoins the western edge of In Between, and the eastern half of the site consists of a cattail and bulrush marsh with clumps of tamarisk 5–7 m in height and scattered, emergent Goodding willow. The remainder of the site is vegetated by tamarisk 4–7 m in height. Canopy closure in the tamarisk is generally >90%, while canopy closure in the marsh is around 50%. Surface water was present in the marsh in May, but by July only a small patch of saturated soil remained. Soils surrounding the marsh were damp to dry in May and very dry by July.

We located two resident, unpaired male flycatchers and two additional individuals for which residency could not be confirmed. Portions of the site not known to be occupied were surveyed five times, totaling 7.8 observer-hours. Cowbirds were observed on four 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%. There were some shallow pools of standing water in May, but by mid-June the only remaining water was in deep pig wallows.

We located one resident male flycatcher and two additional flycatchers for which residency could not be confirmed. We surveyed portions of the site not known to be occupied by flycatchers five times for a total of 9.7 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.

We detected one willow flycatcher for which residency could not be determined. We surveyed the site five times, totaling 6.0 observer-hours. Cowbirds were detected on all 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 70–90%. No standing water was present during the survey period. A small amount of saturated soil was observed in May.

No willow flycatchers were detected. We surveyed the site five times, totaling 5.6 observer-hours. Cowbirds were detected on three visits.

PLATFORM

Area: 1.9 ha Elevation: 140 m

This site lies between the main refuge road to the west and open bulrush and cattail marsh to the east. We extended the site approximately 120 m to the south of its former boundary to include willows that were observed on the edge of the marsh during aerial reconnaissance. Vegetation at the site consists of tamarisk 8 m in height with a few emergent Goodding willow. A narrow line of 5-m-tall coyote willow approximately 5 m wide runs along the eastern edge of portions of the site. Overall canopy closure is approximately 90%. Soils within the site were very dry throughout the survey season, except for damp soil adjacent to the marsh near the southern end of the site.

We detected two breeding willow flycatchers. Portions of the site not known to be occupied were surveyed five times, totaling 3.8 observer-hours. Cowbirds were detected on four visits.

250M

Area: 1.9 ha Elevation: 140 m

This site lies between the main refuge road and the open marsh. Vegetation composition and structure varies with distance from the marsh. Closest to the refuge road the site is dominated by mesquite trees (*Prosopis* sp.) with an understory of arrowweed. The center of the site is dominated by tamarisk approximately 7 m in height. Closest to the marsh, the site contains patches of coyote willow and a few emergent Goodding willows approximately 12 m in height. Canopy closure within the site ranges from 70 to 90%. The site was completely dry throughout the survey season.

No willow flycatchers were detected. The site was surveyed five times, totaling 4.4 observer-hours. Cowbirds were detected on four 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. Very little standing water was present in Hell Bird throughout the survey season and was restricted to a small pool in a marsh on the eastern side of the site. Water was also present in Glory Hole throughout the survey season and was similarly restricted to a single pool in a cattail marsh on the southern end of the site.

We detected one flycatcher in Hell Bird for which residency could not be confirmed. Two breeding flycatchers and one resident male were located in Glory Hole. Hell Bird was surveyed five times, totaling 5.8 observer-hours. Portions of Glory Hole not known to be occupied by flycatchers were surveyed five times, totaling 7.1 observer-hours. Cowbirds were detected on all surveys in both sites.

BEAL LAKE

Area: 13.9 ha Elevation: 140 m

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

We detected one willow flycatcher on 21 May and another on 2 June. Reclamation biologists reported detecting a willow flycatcher on 30 Jul, but we were unable to locate any flycatchers on a follow-up visit. We surveyed this site five times, totaling 10.7 observer-hours. Cowbirds were detected on all surveys.

LOST LAKE

Area: 3.3 ha Elevation: 140 m

This site consists of a narrow (<100-m-wide) strip of riparian vegetation separated from the Colorado River to the southwest by a low ridge of barren sand dunes and bordered to the northeast by marshy areas. The northern edge of the site consists of an overstory of planted cottonwoods 10–15 m in height, with an understory of tamarisk 5 m in height, on the edge of a cattail marsh. South of the cottonwoods, the site is primarily tamarisk, 5–8 m in height, with small openings vegetated by arrowweed. In previous years, the southeastern end of the site was dominated by dense stands of coyote willow which have since died and been replaced by tamarisk and *Baccharis* sp. mixed with arrowweed. Overall canopy closure is approximately 80%. Surface water or saturated soil at Lost Lake was present immediately adjacent to the marsh on the northern edge of the site throughout the season, and a few small pools were present just within the interior of the site along the northern edge in June. The interior of the site was mostly dry, but did contain varying amounts of damp soil throughout the season.

No willow flycatchers were detected. We surveyed the site five times, totaling 6.5 observer-hours. Cowbirds were detected on all visits.

GROUND RECONNAISSANCE RESULTS

Tractor

This mixed-native site is approximately 1 km north of the inlet ditch at the north end of Topock Marsh and consists of a dense, 300-m-long stringer of cottonwood 14 m in height with an understory of saltbush, mesquite, and 4-m-tall tamarisk bordering a 15-m-wide cattail marsh. The site is bordered by hayfields to the north and south, a dry concrete channel to the west, and a road and a slough to the east. The site was dry during our site visit, but the marsh appeared to have been wet earlier in the season. The site is too narrow to represent typical breeding habitat for willow flycatchers, but might attract transient or territorial flycatchers if there is water in the marsh. We recommend visiting the site at the beginning of the next breeding season and surveying it if the marsh contains water. We visited the site on 11 July, totaling 0.5 observer hours. No willow flycatchers or cowbirds were detected.

Spaghetti

During aerial reconnaissance, we noted an area of riparian vegetation along a wet channel adjacent to the refuge road due west of the boat launch to the Glory Hole/Hell Bird island. The area we wanted to evaluate starts approximately 400 m west of the boat launch and continues another 500 m to the west. A portion of this site was explored in May. Surface water was noted only in the channel that runs along the refuge road. The site was determined by the observer to be unsuitable as flycatcher habitat, but no other information was recorded. This site should be explored further and in greater detail next year.

Lost Lake Slough #1

This site was visited several times in 2009 and determined to lack the canopy height typical of occupied flycatcher habitat. However, the site is en route to Lost Lake Slough #2 and thus was visited again in 2010. Lost Lake Slough #1 consists of a 25- x 50-m patch of tamarisk, 6 m in height, 100 m south of the bridge on South Dike Road. A few mesquite trees are scattered through the site. The site is surrounded by marsh, and a finger of the marsh extends into the center of the site. Water extended under the woody vegetation at the marsh edges during visits in May and June. Vegetation structure is possibly suitable for willow flycatchers, but the site is very small and surrounded by non-suitable marsh habitat or open water. This site should be monitored in two or three years for any change or increase in vegetation. No surveys were conducted during the survey season.

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 with some stems emerging 2 m above the main canopy. Canopy closure within the site is around 85%, and the site is surrounded by open marsh. The site was completely inundated in May and mid-June. Vegetation at the site is currently shorter than that typically found in occupied flycatcher habitat along the LCR. Large stem diameters indicate that the stand is not young, and growth to a suitable height is unlikely. Despite this, the site should be monitored for changes in vegetation in two or three years. We surveyed the site twice, for a total of 2.2 observer-hours. We did not detect any flycatchers, and cowbirds were detected on one visit.

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 primarily tamarisk 6 m in height with some mesquite and an understory of patchy arrowweed and Emory baccharis (*Baccharis emoryii*). A strip of coyote willow 4–5 m in height runs along the northern edge and varies in width from 5 to 20 m. Canopy closure is around 80–90%. Approximately 25% of the site along the northern edge was inundated in May and mid-June. There was an abrupt transition to dry soil where the vegetation changed from coyote willow to tamarisk. The interior of the site is too dry and patchy to resemble typical occupied flycatcher habitat, and the strip of coyote willow along the marsh edge is too narrow and short. The site should be monitored in two or three years to determine whether the coyote willow area has expanded. We surveyed the site twice, for a total of 3.0 observer-hours. No willow flycatchers were detected, and cowbirds were observed on one visit.

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 a very dense mix of coyote willow, tamarisk, and snags on the southern border. Canopy height in the willows is 5 m, while the tamarisk reaches 4 m. Canopy closure is approximately 50–70%. The site was completely inundated in mid-June. 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 two or three years. We surveyed the site twice, for a total of 2.0 observer-hours. No willow flycatchers were detected, and cowbirds were observed on both visits.

Topock Gorge, Arizona

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.

BLANKENSHIP BEND NORTH

Area: 19.0 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%. Soils were dry along the eastern border of the site, but the marshes contained surface water throughout the season.

We detected no flycatchers at Blankenship Bend North. We surveyed the site five times, totaling 12.2 observer-hours. We detected cowbirds on four surveys, and evidence of feral pigs and burros was observed.

BLANKENSHIP BEND SOUTH

Area: 11.8 ha Elevation: 138 m

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. The central third of the site contains coyote willow 4–6 m in height scattered through the understory. The eastern side of the site is bordered by dry upland and is primarily vegetated by 4–6-m-tall honey mesquite (*Prosopis glandulosa*) and 2–3-m-tall arrowweed. The western side of the site is bordered by bulrush marsh and open water. Canopy closure is approximately 80%. Standing water was present throughout the survey season, with up to a third of the site inundated.

No flycatchers were detected at Blankenship Bend South. We surveyed the site five times, totaling 10 observer-hours. We detected cowbirds on four surveys but did not observe signs of livestock.

HAVASU NE

Area: 12.6 ha   Elevation: 136 m

This mixed-native site consists of a 1.3-km-long and <100-m-wide strip of riparian vegetation along the northeastern shore of Lake Havasu. Vegetation at the site grades from cattails along the lakeshore to Goodding willow and tamarisk in the center of the site and a mix of tamarisk and mesquite on the upland edge. Vegetation is very dense and canopy closure is approximately 90%. Many Goodding willows at the site are mature, but show signs of die-back with dead tops and/or branches; most of the willows stand 5 m above the tamarisk and mesquite, which are 6–8 m in height. Soils in the interior of the site were extremely dry throughout the survey season, and water from the lake did not extend under the vegetation.

We did not detect any willow flycatchers. We surveyed the site five times, totaling 12.8 observer-hours.

Cowbirds were detected on all visits, as was evidence of use by feral pigs.

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.

BILL WILLIAMS SITE #1

Area: 2.2 ha   Elevation: 140 m

Site #1 is a mixed-native site near the mouth of the Bill Williams River, on the southern edge of an area that burned in 2006. We surveyed this site annually through 2006 and then discontinued surveys because much of the site had been affected by the fire. The northern edge of the former survey area still shows evidence of the fire, with charred snags and little understory, and we did not survey this portion. The remainder of the site appears to have recovered from any fire effects. Goodding willow dominates the overstory at a height of 20 m but does not form a continuous canopy. Tamarisk and Goodding willow 8 m in height dominate the understory. Towards the center of the site, there are patches of dense arrowweed. The western end of the site, along the arm of Lake Havasu that follows the Bill Williams River, contains a stand of large-diameter coyote willow 8–10 m in height. Canopy closure is approximately 70–80%. Standing water was present within the coyote willow stand in May, but the site was damp to dry in June and July. We recommend adding this site to the biennial survey schedule.

No willow flycatchers were detected. The site was surveyed five times, totaling 10.5 observer-hours. Cowbirds were detected on all visits.

BILL WILLIAMS SITE #2

Area: 3.1 ha   Elevation: 140 m

This mixed-native site has an overstory of large Goodding willow and cottonwood up to 15 m in height and an understory of tamarisk 5 m in height. Overall canopy closure is 50–70%. The western portion of the site contains open cattail marshes. The site contains much dead, woody vegetation in the understory. The site is bordered on the southwest by a narrow channel of open water where an arm of Lake Havasu follows the channel of the Bill Williams River, and vegetation is densest near this channel. The site is separated from the channel by a steep bank approximately 0.5 m high. There was standing water in the cattail marsh in May and July, as well as a few small pools in the southeastern corner of the site. Soils in the remainder of the site were completely dry throughout the survey season.

No willow flycatchers were detected. We surveyed the site six times, totaling 4.3 observer-hours. Cowbirds were detected on all visits.

BILL WILLIAMS SITE #11

Area: 6.3 ha Elevation: 140 m

This mixed-native site has an overstory of Goodding willow and cottonwood trees up to 20 m in height. Tamarisk ranging from 3 to 5 m in height is the dominant species in the understory, and the ground is covered by thick deadfall. Canopy closure is approximately 75%. Large areas of standing water are present within the survey site because an arm of Lake Havasu follows the channel of the Bill Williams River through the center of the site. The banks of the channel are steep and approximately 1 m high and do not allow for water to flow under the woody vegetation, leaving soils very dry throughout the survey season.

No willow flycatchers were observed. We surveyed the site six times, totaling 6.4 observer-hours. Cowbirds were detected on all visits.

BURN EDGE

Area: 4.1 ha Elevation: 140 m

Burn Edge is near the northern edge of the Bill Williams riparian corridor, on the eastern edge of an area that burned in 2006. A cattail marsh with Goodding willow and cottonwood 15 m in height runs east-west through the center of the site. This portion of the site also has clumps of tamarisk up to 6 m in height. Canopy closure in the marshy area varies from around 60% at the eastern end to 25% at the western end. The area on either side of the marsh consists of tamarisk 6 m in height with up to 90% canopy closure. The entire marshy area was inundated in May to a depth up to 40 cm. Intermittent pools were present in mid-June, and by mid July only one puddle remained.

We located two breeding willow flycatchers. Portions of the site not known to be occupied by flycatchers were surveyed 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 with some open marshes in May. By July much of the water was gone, and the only water remaining in Site #4 was a deep, backwater channel on the western side. Site #3 was mostly dry in July, except for a couple of small, flowing streams and one marsh with some standing water.

We detected two flycatchers in Site #4 for which residency could not be confirmed. One was observed on 27 June and the other from 27 June to 3 July. Three breeding flycatchers and one unpaired male were detected in Site #3. Portions of the sites not known to be occupied by flycatchers were visited five times, totaling 12.8 observer-hours at Site #4 and 13.8 observer-hours at Site #3. Cowbirds were detected on all surveys of Mosquito Flats.

LAST GASP

Area: 2.1 ha Elevation: 140 m

Last Gasp is a narrow, mixed-native site along a channel on the northern edge of the Bill Williams riparian area, approximately 250 m east of Burn Edge. Vegetation within the site consists of a broken overstory of cottonwood and Goodding willow 15–20 m in height and a tamarisk understory 5–7 m in height. Canopy closure varies from 50% in the channel to 80–90% in the surrounding tamarisk. Surface water, over waist deep in places, was present in the channel in May. The water was knee deep in June, and by July, only a few remnant puddles remained. Soils immediately adjacent to the channel were dry in June and July.

No willow flycatchers were detected at Last Gasp. We surveyed the site five times, totaling 7.3 observer-hours. Cowbirds were detected on four visits.

BILL WILLIAMS SITE #5

Area: 6.8 ha Elevation: 143 m

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

No willow flycatchers were detected. We surveyed the site five times, totaling 11.5 observer-hours. Cowbirds were detected on all surveys.

BLACK RAIL

Area: 1.2 ha Elevation: 146 m

We visited Black Rail in 2006 and determined that although the site had suitable hydrology, the site was small and the willows were likely too short to support breeding flycatchers, and we recommended revisiting the site in the future to assess any changes. Vegetation in this mixed-native site is composed of cottonwood and Goodding willow up to 20 m in height in the overstory. The tallest trees are located around the perimeter of the site. The understory is sparse in most places and is composed of tamarisk or young Goodding willow 4–5 m in height. Cattails also dominate the interior of the site. The northwestern corner of the site is dominated by dry, dense tamarisk 4–7 m in height with 40% canopy cover. A few scattered Goodding willows 15 m in height emerge above the tamarisk. Canopy cover in the remainder of the site varies from 70% around the perimeter to as low as 30% in the interior. The portion of the site that seems the most likely to support breeding flycatchers is the southwestern edge of the site, which is vegetated by 6–8-m-tall Goodding willow with a dense tamarisk understory. This portion of the site is approximately 100 m long and up to 20 m wide. Standing water was present throughout the site in May, but only a small pool remained in June. By July, there was no standing water within the site, only saturated soils. We recommend adding this site to the biennial survey schedule.

No willow flycatchers were detected. We surveyed the site five times, totaling 6.1 observer-hours. Cowbirds were detected on 3 visits.

MINERAL WASH

Area: 18.8 ha Elevation: 162 m

This mixed-native site is approximately 3 km upstream of Site #5. The northern third of the site is a mix of tamarisk, honey mesquite, and arrowweed with a few emergent cottonwood. The remainder of the site has an overstory of cottonwood and Goodding willow up to 20 m in height and an understory of tamarisk averaging 5 m in height. The site contains two channels of the Bill Williams River, one along the southwestern edge of the site and the other through the center of the site. Areas of bulrush and cattail are present in both channels. Overall canopy closure is <50%. Both channels of the Bill Williams River contained surface water through July, with beaver dams creating deep pools and marshy areas, but soils away from the channels were dry and sandy.

We detected two willow flycatchers for which residency could not be determined. We surveyed the site five times, totaling 14.8 observer-hours. Cowbirds were detected on all visits.

BEAVER POND

Area: 21.7 ha Elevation: 165 m

This mixed-native site consists of cottonwood and Goodding willow averaging 15 m in height with an understory of tamarisk along two channels of the Bill Williams River. One channel runs along the southern border of the site and the other through the center. Areas not immediately adjacent to the channels are vegetated by tamarisk and honey mesquite 5–7 m in height. Cattail and bulrush are present along most of the channels. Overall canopy closure at the site is <50%. Both channels held running surface water throughout the survey season, but soils away from either channel were dry and sandy.

We located one willow flycatcher for which residency could not be determined. We surveyed the site six times, totaling 8.9 observer-hours. Cowbirds were detected on five visits.

BILL WILLIAMS SITE #8

Area: 10.3 ha Elevation: 168 m

This narrow, linear site encompasses the river channel approximately 3 km upstream from the Mineral Wash Complex, at the confluence of Mohave Wash and the Bill Williams River. This section of the river is confined between high cliffs on both banks. Cottonwood and willow trees 18 m in height line a flowing river channel, with clumps of tamarisk also present in the understory throughout the site. Overall canopy closure is 25–50%. This site had flowing water in the river channel throughout the survey season, but soils beneath the vegetation were very dry.

No willow flycatchers were detected. We surveyed the site five times, totaling 10.8 observer-hours. Cowbirds were detected on all visits.

UPSTREAM FROM SITE #8

Area: 1.5 ha Elevation: 170 m

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

We detected one willow flycatcher on 18 May. We surveyed the site five times, totaling 4.0 observer-hours. Cowbirds were detected on four visits.

PLANET RANCH ROAD

Area: 3.3 ha Elevation: 170 m

This mixed-native site follows the Bill Williams River at the southern edge of the riparian area. We extended the survey site approximately 300 m upstream from its previous extent to include dense stands of young cottonwood and Goodding willow. The vegetation immediately adjacent to the river is dominated by Goodding willow and cottonwood up to 15 m in height. Both river banks are steep, and vegetation on top of the banks more than a few meters from the water is dominated by arrowweed and tamarisk 4–5 m in height. Canopy closure within the site is highly variable, ranging from <50% on the dry banks to 90% within dense willow and cottonwood stands. The river had surface water throughout the survey season.

We detected two breeding willow flycatchers. Portions of the site not known to be occupied by flycatchers were surveyed five times, totaling 4.8 observer-hours. We detected cowbirds on three surveys.

GROUND RECONNAISSANCE RESULTS

Wispy Willow

This site is approximately 200 m downstream of Site #1 along the north bank of the Bill Williams River. It was mentioned by refuge biologist Kathleen Blair as an area of new willow growth that we should investigate. The site consists of a patch of coyote willow approximately 60 x 30 m in size. Canopy height is 4–5 m, and stem diameter is generally small. Canopy closure is 70–90%. Water from the channel extended under the willows during the site visit in May. The vegetation is not currently of sufficient size to resemble typical occupied willow flycatcher habitat along the LCR, but the site should be evaluated in future years. We surveyed the site once, totaling 0.5 observer-hours. No flycatchers or cowbirds were detected.

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, 2008, and 2009 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 June 2010 to determine whether hydrologic conditions had changed as a result of the spring releases from Alamo Dam. Surface water was present in small pools along a line of cattail that borders the north edge of the site. A larger cattail marsh is present on the northeastern border of the site. Overall, <1% of the site contained surface water, and hydrologic conditions seemed unchanged from previous years. We do not recommend visiting this site again unless a flood event occurs that has the potential to change the hydrology of the area. We surveyed the site twice, totaling 5.5 observer-hours. No willow flycatchers were detected, and cowbirds were observed on both visits.

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 9, 8, and 5 m, respectively. Height and density of the vegetation varies within and between cells of the site. Canopy closure is highly variable, ranging from <25 to 85%. The entire site has a ground covering of alfalfa (*Medicado sativa*). The site is flood irrigated 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 two willow flycatchers on 25 May and one on 10 June. We surveyed the site five times, totaling 14.2 observer-hours. Large numbers of cowbirds were detected on all visits, and no evidence of livestock use was recorded.

PVER PHASE 3

Area: 15.8 ha Elevation: 85 m

This habitat creation site is vegetated with a mosaic of rectangular cells of cottonwood, Goodding willow, and coyote willow that reach heights of 7, 4, and 3 m, respectively. Height and density of the vegetation varies within and between the cells of the site. Canopy closure is highly variable, ranging from 50 to 80%. The entire site has a ground covering of alfalfa. The site is flood irrigated but only contained surface water in approximately one quarter of the site on one visit in June. The irrigation canal adjacent to the site contained water throughout the season.

No willow flycatchers were detected. We surveyed the site five times, totaling 12.3 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock 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 (*Prosopis pubescens*) 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 in June. Surveys at the site were discontinued due to safety concerns. We do not recommend surveys at this site in future years unless it can be confirmed that these safety concerns no longer exist.

No willow flycatchers were detected. The site was surveyed once, totaling 1.25 observer-hours. Cowbirds were detected on the one visit, and no livestock use was observed.

Ehrenberg, Arizona

EHRENBERG

Area: 4.7 ha Elevation: 78 m

This mixed-native site consists primarily of a canopy of cottonwood and Goodding willow 15 m in height with an understory of arrowweed. Approximately 5% of the site contains a cattail marsh surrounded by mostly dead stands of coyote willow. A few sparse, wispy coyote willow 3 m in height are growing immediately adjacent to the marsh on the eastern and western sides. The periphery of the site is vegetated with a mix of tamarisk and mesquite 3–5 m in height. Canopy closure at the site is approximately 50%. The cattail marsh contained saturated soil throughout the survey season, and the site is separated from the Colorado River by a levee. The lack of a live understory other than arrowweed makes this site unsuitable for breeding flycatchers, and we recommend discontinuing surveys at this site.

No willow flycatchers were detected. The site was surveyed five times, totaling 5.1 observer-hours. Cowbirds were detected on three visits, and no evidence of livestock use was observed.

Cibola, Arizona and California

CVCA PHASE 1

Area: 26.2 ha Elevation: 73 m

This habitat creation area consists of a mosaic of rectangular cells of cottonwood, Goodding willow, and coyote willow of varying size and density. Each cell generally contains a single species and age class. The tallest cottonwoods and willows are around 10 m in height, and canopy closure in the densest areas is 85–90%. Coyote willow reaches 3–5 m in height. The site is flood irrigated and contained standing water only during one visit in July, and then only in approximately 10% of the site. The Colorado River is about 100 m from the northern edge of the site; the southern edge is adjacent to CVCA Phase 2; and the remaining two sides are surrounded by agriculture. The irrigation canal adjacent to the site held surface water throughout the season.

We detected 15 willow flycatchers on 17 May and 2 on 9 June. The site was surveyed five times, totaling 14.8 observer-hours. Large flocks of cowbirds were detected on all visits, and no evidence of livestock use was observed.

CVCA PHASE 2

Area: 25.5 ha Elevation: 73 m

This habitat creation area consists of a mosaic of rectangular cells of cottonwood, Goodding willow, and coyote willow of varying size and density. The tallest cottonwoods and Goodding willow reach 10 m, and canopy closure reaches 95% in the densest areas. Coyote willow reaches 3–6 m in height. The site is flood irrigated but did not contain standing water during any of our site description visits. The northern edge of the site is adjacent to CVCA Phase 1, and the remaining sides are surrounded by agriculture. The irrigation canal adjacent to the site held surface water throughout the season.

We detected 18 willow flycatchers on 24 May. The site was surveyed five times totaling 16.5 observer-hours. Large flocks of cowbirds were detected on all visits, and no evidence of livestock use was observed.

CVCA PHASE 3

Area: 38.4 ha Elevation: 73 m

This habitat creation area consists of a mosaic of rectangular cells of cottonwood, Goodding willow, and coyote willow of varying size and density. The tallest cottonwoods reach 8 m, Goodding willow reach 7 m, and coyote willow reach 4 m. Canopy closure varies from 20 to 80%. The site is flood irrigated but only contained standing water in a small portion of the site during the visit in May. The site is surrounded by agricultural fields. The irrigation canal adjacent to the site held water throughout the season.

We detected four willow flycatchers on 9 June. The site was surveyed five times, totaling 17 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was observed.

CIBOLA NATURE TRAIL

Area: 13.7 ha Elevation: 70 m

This habitat creation site consists of a mosaic of cottonwood, Goodding willow, and mesquite. Approximately half the site consists of scattered screwbean and honey mesquite up to 5 m in height with a thick understory of Emory baccharis. The northern half of the site contains an extensive stand of Goodding willow 8 m in height. The northern edge of the willow stand has canopy closure <25%, and many of the willow are dead. The southern half of the willow stand has canopy closure around 70%. The southwestern corner of the site has a small stand of cottonwoods, and stringers of cottonwoods up to 18 m in height occur throughout the site. The site is flood irrigated, but contained surface water only in a small portion of the site during the visit in May.

We detected one willow flycatcher on 26 May and one on 10 June. The site was surveyed five times, totaling 9.0 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. Dirt roads border the site to the north, east, and west. Open farm fields lie to the east and west, with irrigation channels alongside the roads. An irrigation canal empties into the northern end of the site, creating an open, marshy area down the center of the site. Between this marshy area and the western road, vegetation consists of an overstory of Goodding willow 10–12 m in height with an understory of tamarisk 5–7 m in height. Canopy closure within the willows is 80%. The eastern edge of the marsh is lined with a narrow strip of tamarisk 5–6 m in height with a few emergent Goodding willows on the marsh edge. Between the tamarisk strip and the eastern road, vegetation consists of honey mesquite and bushy arrowweed. The marsh was dry during the entire survey season. The irrigation canal running along the northern border of the site held water throughout the season.

No willow flycatchers were detected. The site was surveyed five times, totaling 5.8 observer-hours. Cowbirds were detected on all surveys, and no evidence of livestock use was observed.

THREE FINGERS LAKE

Area: 67.9 ha Elevation: 65 m

This mixed-exotic site consists of the area immediately surrounding a dredged backwater channel of the Colorado River. The edges of the channel are vegetated by cattail and bulrush. The dominant woody vegetation is tamarisk, which is densest immediately adjacent to the channel and reaches heights of 6 m. A few large Goodding willow are also present. Away from the channel, the tamarisk is shorter and sparser and is mixed with honey and screwbean mesquite with an understory of arrowweed. Canopy closure along the shore is approximately 50%. Water was present in the backwater channel throughout the season, but there was no water under the woody vegetation.

We detected three willow flycatchers on 27 May and two on 2 June. The site was surveyed five times, totaling 20.2 observer-hours. Large numbers of cowbirds were detected on all visits, and no evidence of livestock use was observed.

CIBOLA LAKE NORTH

Area: 8.5 ha Elevation: 64 m

This mixed-exotic site borders Cibola Lake. The perimeter of the site adjacent to the lake is vegetated by cattail and bulrush. The area immediately inland from the cattail marshes is vegetated by dense tamarisk 4–6 m in height with scattered Goodding willow. A stringer of Gooding willow and cottonwood 15 m in height runs along the northern border. The interior of the site has patchy vegetation with a mix of tamarisk, arrowweed, screwbean mesquite, and open sandy areas. Canopy closure along the marsh edges is 50–70%, while the interior of the site has canopy closure <25%. Except for along the shore, soils within the interior of the site were dry throughout the survey period.

No willow flycatchers were detected. The site was surveyed five times, totaling 6.75 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was observed.

CIBOLA LAKE WEST

Area: 6.8 ha Elevation: 64 m

This mixed-exotic site borders Cibola Lake. The perimeter of the site adjacent to the lake is vegetated by cattail and bulrush. Areas immediately inland from the cattail marshes are vegetated by dense tamarisk 5–6 m in height. Gooding willow and cottonwood 18 m in height are scattered throughout the southern portion of the site. The interior of the site has patchy vegetation with a mix of tamarisk, arrowweed, screwbean mesquite, and open sandy areas. Canopy closure along the marsh edges is 50–70%, while the interior of the site has canopy closure <25%. Except for along the shores, soils within the interior of the site were dry throughout the survey period.

No willow flycatchers were detected. The site was surveyed five times, totaling 9.5 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was observed.

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 throughout the survey season. Soils in the interior of the site were dry throughout the survey season.

We detected one willow flycatcher on 2 June. The site was visited four times, totaling 10.8 observer-hours. Cowbirds were detected on all surveys, and no evidence of livestock use was observed.

Imperial, Arizona and California

PARADISE

Area: 7.8 ha   Elevation: 62 m

The center of this mixed-native site consists of stringers of cottonwood and Goodding willow 15–20 m in height. Tamarisk (5 m in height) and arrowweed (3 m in height) make up the understory. The cottonwoods and willows are separated from the Colorado River by a 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. Canopy closure within the site is variable. Standing water was present within the marsh in May.

We detected one willow flycatcher on 8 June. The site was surveyed five times, totaling 9.0 observer-hours. Cowbirds were detected on every visit, and no evidence of livestock was noted.

HOGE RANCH

Area: 20.7 ha   Elevation: 61 m

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

We detected one willow flycatcher on 20 May and one on 5 June. The site was surveyed five times, totaling 12.7 observer-hours. Cowbirds were detected on every visit, and there was evidence of burros using the site.

ADOBE LAKE

Area: 7.6 ha   Elevation: 60 m

This mixed-exotic site consists primarily of dense tamarisk (5 to 7 m in height) with many dead branches in the understory. There are scattered Goodding willows up to 10 m in height. Canopy closure within the site is 70–90%. The site is adjacent to the Colorado River, but hydrological conditions in the interior of the site were undetermined.

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

RATTLESNAKE

Area: 7.6 ha   Elevation: 60 m

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

We detected one willow flycatcher on 18 May and one on 8 June. The site was surveyed five times, totaling 7.4 observer-hours. Cowbirds were detected on all surveys, and there was no evidence of livestock use.

CLEAR LAKE

Area: 8.3 ha   Elevation: 59 m

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

We detected one willow flycatcher on 22 May. We surveyed the site five times for a total of 9.75 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 June.

No willow flycatchers were detected. The site was surveyed five times, totaling 5.6 observer-hours. Cowbirds were detected on all visits, and there was no evidence of livestock use.

IMPERIAL NURSERY

Area: 1.4 ha   Elevation: 58 m

This site is a cottonwood planting managed by the Imperial NWR. The cottonwoods are approximately 12 m in height, and two clumps of Goodding willow, <20 m in diameter and 5 m in height, grow in the understory. The edges of the site are vegetated by arrowweed and *Baccharis* sp. with a few honey mesquite in the northwestern corner of the site. The understory is very sparse, except for the willows, and canopy closure is approximately 90%. The site is bordered to the north by a patchwork of cattails, common reed, and tamarisk. This site is flood irrigated and was completely dry during all site visits.

No willow flycatchers were detected. The site was surveyed five times, totaling 1.4 observer-hours. Cowbirds were detected on three visits, and no evidence of livestock use was observed.

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 June and standing water in May and July.

We detected seven willow flycatchers on 22 May. The site was surveyed five times, totaling 15.1 observer-hours. Cowbirds were detected on all visits, and no signs of livestock use were observed.

FERGUSON WASH

Area: 6.8 ha Elevation: 58 m

This mixed-exotic site, at the outflow of Ferguson Wash into Ferguson Lake, is dominated by dense, mature tamarisk approximately 7 m in height, with dense deadfall in the understory. A few scattered, emergent Goodding willows 10 m in height are present near the lake, and canopy closure is around 90%. The site is bordered on the lakeside by cattails and bulrush and on the upland side by desertscrub. A backwater channel penetrates to the interior of the site, although the banks along the channel are abrupt and do not allow water to flow under the vegetation in this area. Soils in the interior of the site were dry throughout the survey season.

We detected three willow flycatchers on 19 May. The site was surveyed five times, totaling 7.25 observer-hours. Cowbirds were recorded on all visits, and evidence of burros was noted in the site.

GREAT BLUE HERON

Area: 7.1 ha Elevation: 58 m

This site, on the eastern shore of Martinez Lake, consists of mixed-exotic vegetation. Near the shore of Martinez Lake, Goodding willow forms an overstory 15 m in height, with an understory of tamarisk, common reed, and giant reed (*Arundo* sp.). Canopy closure in this area is 80%. Portions of the site contain thickets of willow deadfall. Farther from the lake, the site is vegetated by scattered arrowweed and tamarisk 6 m in height, with canopy closure <50%. Soils on the lake side of the site were damp throughout the survey season.

No willow flycatchers were detected. The site was surveyed five times, totaling 18.2 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was observed.

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 19 June and 15 July. The site is dominated by tamarisk with scattered openings of arrowweed and common reed and some mesquite trees that emerge 1–2 m above the tamarisk. Common reed occasionally forms a dense understory in the tamarisk, especially in the southern and western portions of the site. A large stand of athel tamarisk (*Tamarix aphylla*) 11 m in height with 50% canopy closure dominates the northern end of the site. Tamarisk in the rest of the site forms a mosaic of heights and canopy cover, ranging from sparse, open tamarisk 4 m in height to tamarisk 9 m in height with 70% cover and dense understory structure. Surface water is present in the southern portion of the site in contained channels and open marshes bordered by cattail and common reed, and did not appear to extend beyond the borders of the marshes. To the west of the site boundary, the mosaic of tamarisk, open channels, and open marshes continues with a few widely scattered, emergent Goodding willows. Due to lack of water underneath the woody vegetation and the generally dense understory creating a lack of flight paths, we determined that no suitable willow flycatcher habitat was present within the site.

Mittry Lake, Arizona and California

MITTRY WEST

Area: 4.4 ha Elevation: 48 m

The center of this mixed-native site is dominated by Goodding willow 12 m in height with a dense understory of arrowweed and tamarisk. Canopy closure is approximately 80%. Honey and screwbean mesquite are scattered throughout the site but are more common near the periphery. A clump of coyote willow 6 m in height and 50 m in diameter is present in the northeastern corner of the site. Surface water was present in the site during May, and saturated soils were present in June. The site was dry in July.

We detected two willow flycatchers on 23 May and two on 4 June. The site was visited five times, totaling 12.3 observer-hours. Cowbirds were detected during all surveys, and no evidence of livestock use was observed.

MITTRY SOUTH

Area: 15.2 ha Elevation: 46 m

This monotypic tamarisk site lies immediately adjacent to Mittry Lake. Vegetation at the site is very dense, with abundant dead branches and deadfall in the understory. Canopy closure within the tamarisk is >90%, and canopy height is approximately 8 m. The site is bordered to the south by Mittry Lake, and the edge of the lake is vegetated by cattail, bulrush, and common reed. Water from the lake does not extend under the woody vegetation, and soils in the site were very dry throughout the survey season.

We detected five willow flycatchers on 23 May. The site was visited five times, totaling 10 observer-hours. Cowbirds were detected during all surveys, and no evidence of livestock use was observed.

Yuma, Arizona

GILA CONFLUENCE NORTH

Area: 2.2 ha Elevation: 40 m

This mixed-native site borders the northern side of the Colorado River at the confluence of the Gila and Colorado Rivers. Overstory vegetation at the site is a combination of Goodding willow and cottonwood 11 m in height. Dense stands of these trees surround a cattail marsh near the north side of the site. Cattail marsh is also present along the river, and there is an open area of common reed in the center of the site. Canopy closure is variable and averages around 50%. Arrowweed, tamarisk, and Emory baccharis are common in the understory. Surface water was present in northern cattail marsh throughout the survey season. Damp soils were present near the southern cattail marsh and open area of common reed throughout the survey season.

We detected three willow flycatchers on 3 June. The site was surveyed five times, totaling 9.3 observer-hours. Cowbirds were detected on all visits, and no evidence of livestock use was observed.

NDOW Study Areas

Field personnel spent 21.6 observer-hours completing willow flycatcher broadcast surveys at 21 sites at Key Pittman WMA and Warm Springs Natural Area. Willow flycatcher survey results are summarized in Table 2.7 and are presented below along with site descriptions. Details of occupancy, pairing, color-banding, and breeding are presented in Chapters 3 and 4. The boundaries of survey sites and occupancy in 2010 are shown on orthophotos in Appendix B.

In addition to willow flycatcher surveys, field personnel spent 12.3 observer-hours completing broadcast surveys for yellow-billed cuckoo at both Key Pittman and Warm Springs. The results of cuckoo surveys are summarized below.

Table 2.7. Willow Flycatcher Detections at NDOW Study Areas, 2010

Study Area[1]	Survey Site	Area (ha)	Number Detected (Date(s) of Detection)[2,3]
KEPI	Patch 0	0.02	ND
	Patch 1	0.1	2 (3 Jun–4 Aug)
	Patch 2	0.1	2 (16 May–4 Aug), 1 (27 May–30 Jun)
	Patch 3	0.1	3 (3 Jun–4 Aug)
	Patch 4	0.1	2 (15 Jun–4 Aug), 1 (28 Jul)
	Patch 4.5	0.02	ND
	Patch 5	0.1	2 (3 Jun–1 Aug)
	Patch 6	0.2	4 (16 May–8 Aug), 1 (22–30 Jun)
	Patch 7	0.1	2 (16 May–25 Jul), 1 (25 Jul)
	Patch 8	0.1	3 (16 May–2 Aug), 1 (27 Jun–9 Jul)
	Patch 9	0.3	2 (26 Jun–4 Aug)
	Patch 10	0.1	3 (16 May–4 Aug)
	Patch 10.5	0.02	1 (8–10 Jul)
	Patch 11	0.1	2 (16 May–18 Aug)
	Patch 12	0.1	2 (7 Jun–4 Aug)
WMSP	LDS East	0.9	ND
	Muddy Stringer #1	1.4	3 (14 May–1 Jul), 1 (8 Jun)
	Muddy Stringer #2	1.4	ND
	North Fork Muddy[4]	5.5	ND
	Muddy Mac	1.1	3 (5 Jun–1 Jul)
	Apcar	0.7	ND

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

[2] ND = No willow flycatchers were detected.

[3] See Chapter 3 for details on territories, residency, pairing, and color-banding; see Chapter 4 for details on nesting activity.

[4] Surveys discontinued because of poor habitat quality.

Key Pittman Wildlife Management Area, Nevada

PATCHES 0–12

Area: 1.4 ha Elevation: 1,169 m

This study area is divided into 15 small stands of coyote willow. These stands form a strip of habitat between bulrush marsh on the edge of Nesbitt Lake to the east and dry upland scrub dominated by saltbush and grasses to the west. Most of the stands are independent of each other, but four stands (Patches 6–9) have grown together, forming a larger single stand. Each stand is characterized by very dense, large-diameter stems of coyote willow. Some areas have fallen or leaning stems with wispy growth in the lower 2 m, making traversing those areas difficult. Canopy height ranges from 4 to 7 m with the taller stems occurring in the center of each site, giving each stand a rounded look. Canopy closure is >90%. Surface water was present along the eastern edge in May, though less than 10% of the area within the sites was inundated. Soils were primarily damp in June and July with very little saturated soil and no standing water.

We located 30 breeding willow flycatchers across 12 of the 15 sites. We detected one male for which breeding status could not be confirmed and an additional four individuals for which we could not determine residency. Due to the high rate of occupancy, this study area was surveyed only once, on 16 May, totaling 7.0 observer-hours. Cowbirds were detected during the one formal survey. Cattle are present in the dry upland scrub, but most of the sites have been fenced off to prevent damage. One of the smaller sites was not fenced and appeared heavily impacted from grazing, either by cattle or deer, which are also abundant.

YELLOW-BILLED CUCKOO SURVEYS

We completed four surveys for yellow-billed cuckoo at Key Pittman. The first three surveys included Patches 0–12 as well as the cottonwood stand at the south end of Nesbitt Lake. The final survey covered only the cottonwood stand. No yellow-billed cuckoos were detected.

Warm Springs Natural Area

Survey sites at Warm Springs were selected based on recent records of flycatcher and cuckoo detections, aerial reconnaissance, and ground reconnaissance immediately prior to the survey season. All survey sites at Warm Springs were burned on 1 July in a wildfire. At most sites, all understory vegetation was consumed, along with portions of the overstory. Surveys for both flycatchers and cuckoos were discontinued after the fire. Territory monitoring continued at occupied flycatcher territories until no further activity was detected.

LDS EAST

Area: 0.9 ha Elevation: 548 m

This mixed-native site is just south of State Highway 168. The overstory is dominated by velvet ash (*Fraxinus velutina*) up to 15 m in height with a few scattered palms (*Washingtonia* sp.) and cottonwoods. The understory is primarily 5-m-tall tamarisk with some honey mesquite on the margins. The center of the site is dominated by a cattail marsh that held water throughout the season. Canopy closure varied from 25% in the cattail marsh to 90% in the ash/palm stands. The fire that burned the study area on 1 July significantly damaged this site. Evidence of fire was seen well up the trunks of the tall trees and in the cattail marsh. No understory or canopy cover remained immediately post-fire.

No willow flycatchers were detected. The site was surveyed four times, totaling 2.0 observer-hours. No cowbirds or evidence of livestock were detected.

MUDDY STRINGER #1

Area: 1.4 ha Elevation: 548 m

This mixed-native site consists primarily of a stringer of velvet ash and Goodding willow 15 m in height along an irrigation channel. Mesquite, coyote willow, and tamarisk comprise the understory, which is approximately 5 m in height. The very southern portion of the site also contains a stand of coyote willow approximately 6 m in height with very dense stands of tamarisk along the channel bed. Canopy closure is approximately 70%. Standing water was present in May in the form of shallow pools 5–15 cm deep within the channel bed. In June the site was almost entirely dry, except for some moist soil in the channel. Water was noted in the channel again in July. Most of this site, including the two nest sites, was heavily burned in the 1 July fire. The very southwestern corner of the site was unburned, but the leaves appeared dead from proximity to high heat.

We detected three breeding willow flycatchers and one female for which residency and breeding status could not be determined. Areas of the site not known to be occupied were surveyed four times, totaling 2.8 observer-hours. Cowbirds were detected every visit, and evidence of cattle was seen in the area.

MUDDY STRINGER #2

Area: 1.4 ha Elevation: 548 m

This mixed-native site consists of a stringer of trees along an irrigation channel approximately 100 m west of Muddy Stringer #1. The channel forms the shape of a reversed letter “L” with a fork running north-south on the eastern side of the site and another fork running east-west on the southern end. Cottonwoods 20 m in height form the overstory along with a few scattered palm trees. Tamarisk and mesquite up to 6 m in height form the understory. Canopy closure is approximately 25–50%. Standing water was present in May as small pools in the east-west channel, but the site was completely dry in June and July. The majority of the understory within the site was burned in the 1 July fire. A few 10–15-m-radius patches of unburned habitat remained immediately adjacent to the stringers. Fire scars extended high up into the canopy of some of the cottonwoods.

No willow flycatchers were detected. This site was surveyed five times, totaling 4.8 observer-hours. Cowbirds were detected on three visits, and evidence of cattle was observed.

NORTH FORK MUDDY

Area: 5.5 ha Elevation: 548 m

This mixed-native site follows a stretch of the Muddy River immediately south of Muddy Stringers #1 and #2, extending from the confluence with Refuge Stream to approximately 600 m upstream of the confluence. Scattered velvet ash up to 15 m in height is present along the channel but does not form a continuous canopy. California palm and 5-m-tall tamarisk form the remainder of the vegetation along the channel. Honey and screwbean mesquite up to 10 m in height are present along the dry channel margins. Canopy closure along the channel is 80%. The channel has very steep banks and is incised up to 5 m below the surrounding uplands, which are dominated by saltbush with no canopy closure. The stream is perennial, but water is confined to the incised channel.

No willow flycatchers were detected. We surveyed the site once, totaling 2.0 observer-hours. Surveys were then discontinued because of the incised nature of the channel, dry soils, and poor habitat structure. No cowbirds or evidence of livestock were observed.

MUDDY MAC

Area: 1.1 ha Elevation: 548 m

This native site is near the head of Apcar Stream. The southern half of the site is characterized by a very dense velvet ash stand 4–10 m in height with no understory and >70% canopy closure. The northern half of the site has ash trees 10–12 m in height and is less dense, with a scattered understory of Goodding and coyote willow 3–6 m in height. Canopy closure in the northern portion is approximately 25–50%. Surface water was present throughout the survey season in the form of a flowing stream near the southern edge of the site. Soils in the north were saturated in May, but by June interior soils were completely dry. This site was damaged by the 1 July fire. Areas most heavily damaged include the northern end and the extreme southern edge of the site. Vegetation at the southern edge of the site adjacent to the ash stand was completely burned. Burn marks were present up to two-thirds of the way up the trunk on the taller ash trees in the northern end. The dense ash stand in the center of the southern half of the site sustained little fire damage but was coated in flame retardant.

We detected two breeding flycatchers and one resident male at the site. Portions of the site not known to be occupied by flycatchers were surveyed four times, totaling 2.3 observer-hours. Cowbirds were detected on two visits. No evidence of livestock was observed.

APCAR

Area: 0.7 ha Elevation: 548 m

This mixed-native site lies just north of Warm Springs Road along Apcar Stream. It consists primarily of a 50- x 50-m stand of velvet ash 15 m in height with scattered tamarisk 5 m in height in the understory. Upstream of the ash stand, the site becomes narrower, and 100 m from the ash stand the site becomes a narrow stringer, one tree wide, along the stream. Immediately south of the site is a dense grove of palm trees. Canopy closure is 80%. Water was flowing in the stream at a depth of approximately 40 cm throughout the survey season. Soils were dry immediately adjacent to the stream. This site sustained heavy damage in the 1 July fire and was reduced to charred trunks with only a few live velvet ash remaining immediately adjacent to the stream.

No willow flycatchers were detected. This site was added in early June and was surveyed twice, totaling 0.8 observer hours. Cowbirds were detected on one visit. No evidence of livestock was recorded.

YELLOW-BILLED CUCKOO SURVEYS

We surveyed LDS East, Muddy Stringer #1 and #2, Muddy Mac, and Apcar for yellow-billed cuckoos. In addition we surveyed Tilapia Row and Cardy Lamb. Tilapia Row is a stringer of fan palms along the North Fork Muddy, starting at the confluence with the South Fork Muddy and extended 400 m upstream from the confluence. Cardy Lamb consists of a stand of cottonwood and palms near Cardy Lamb Springs. We completed one survey for cuckoos before all survey sites were damaged in the 1 July fire. No cuckoos were detected during the survey, but an incidental detection of a cuckoo was recorded at the southern end of Muddy Mac on 29 June.

DISCUSSION

Six study areas occupied in 2010 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, 2010; details of residency and breeding in 2010 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, and we recorded breeding flycatchers there again in 2010.

A single pair of breeding flycatchers was detected at each of several new sites in 2010. Breeding flycatchers were detected in 2010 for the first time at Hafen Lane in the Mesquite study area. We surveyed this area twice in 2006 but detected no flycatchers. We decided to visit the site again in 2010 based on the observation of potential flycatcher habitat during aerial reconnaissance. Along the Bill Williams River, breeding flycatchers were detected at two sites, Burn Edge and Planet Ranch Road, where breeding had not previously been recorded. Ground reconnaissance and opportunistic surveys at Burn Edge in 2007 and 2008, as well as formal surveys in 2009, had not detected any flycatchers. Planet Ranch Road was surveyed in 2009 with no flycatchers detected, but the survey area was expanded upstream in 2010 to include the area where breeding flycatchers were detected. At Topock Marsh, a breeding pair of flycatchers was detected in Platform; this site was last documented as having breeding flycatchers in 1998 (Braden and McKernan, unpubl. data).

Hydrologic conditions at Mesquite West in 2010 were similar to those observed in all prior years except 2009. The site was largely dry in 2009, and premature leaf abscission was observed as early as May. The site was wet throughout the breeding season in 2010, and the vegetation appeared to respond with dense growth. Despite the improvement in vegetation conditions, the number of resident flycatchers (16) detected at Mesquite West in 2010 was lower than the numbers detected in previous years (25, 25, 24, and 20 in 2006, 2007, 2008, and 2009, respectively). This may be the result of flycatchers responding to the conditions in 2009 and moving to other sites in 2010 (see Adult Between-Year Return and Dispersal in Chapter 3).

Marsh elevations at Topock appeared to peak at a low level in 2010, and sites were notably drier than they had been in any year since 2005. The number of resident adults detected at Topock continued to decline, with 11 resident adults detected in 2010, versus 36, 29, 18, 20, and 14 detected in 2005, 2006, 2007, 2008, and 2009, respectively. We continued our efforts to locate all potentially suitable willow flycatcher habitat at Topock Marsh. We revisited all sites (Lost Lake Slough #2, #3, and #4) we had identified in 2009 as not having the vegetation structure typical of occupied flycatcher habitat but having the potential to develop into more suitable habitat. In 2010, these sites still lacked suitable vegetation structure or areal extent, and we recommend reevaluating these sites in another 2–3 years. We visited two additional sites that had not been previously evaluated; a brief examination of both sites did not reveal habitat that seemed likely to hold breeding flycatchers, but both sites will be reevaluated at the beginning of the 2011 breeding season.

Tamarisk beetles were present at both Littlefield and Mesquite in 2010. Extensive defoliation was noted in the vicinity of the Littlefield site in June, but the area that is occupied by willow flycatchers is primarily native, and defoliation did not have any noticeable effect on the breeding area. Defoliation was noted in the Mesquite study area at Hafen Lane and Mesquite West starting in July, with extensive defoliation noted by late July. The area immediately surrounding the nest site at Hafen Lane is primarily coyote willow, as is much of the Mesquite West site, so tamarisk beetle activity did not result in complete defoliation of nest stands. In addition, the majority of flycatcher nesting attempts had either fledged or failed by the time defoliation became widespread, and there was no evidence that flycatcher nesting was affected by defoliation. Defoliation will presumably occur earlier in the year in 2011 at Hafen Lane and

Mesquite West now that tamarisk beetles are established in the area and thus may have greater effects on flycatcher nesting next year. Tamarisk beetles were noted as far downstream on the Virgin River as Gold Butte (approximately 10 km upstream from Mormon Mesa) by the end of August, and defoliation was also observed on the Muddy River as far downstream as Logandale. Both the Mormon Mesa and Muddy River study areas may be affected by tamarisk beetles in 2011.

Although 78 flycatcher detections were recorded at sites surveyed south of the Bill Williams, monitoring results and behavioral observations (lack of territorial, aggressive behaviors exhibited toward conspecific broadcasts) at these sites suggest these flycatchers were not resident or breeding individuals but migrants. These results are consistent with those recorded in 2003–2008 (McLeod et al. 2008; McLeod and Koronkiewicz 2009, 2010).

In 2008, we implemented a biennial survey schedule at selected sites. We recommend adding Bill Williams Site #1 and Black Rail to the biennial survey schedule.

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

METHODS

Color-Banding

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

Adult flycatchers were captured with mist-nets, which provide the most effective technique for live-capture of adult songbirds (Ralph et al. 1993). We used a targeted capture technique (per Sogge et al. 2001), whereby a variety of conspecific vocalizations were broadcast from a CD player and remote speakers to lure territorial flycatchers into the nets. In addition, we used “passive netting,” whereby several mist-nets were erected and periodically checked, with no broadcast of conspecific vocalizations. We banded each adult willow flycatcher with a single, numbered U.S. federal aluminum band on one leg and a colored metal band on the other. We coordinated all color combinations with the Federal Bird Banding Laboratory and all other Southwestern Willow Flycatcher banding projects to minimize 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., ones for which at least one leg was seen clearly enough to determine the presence or absence of a band), we recorded color-band combinations, territory number, site, standardized confidence levels of the resight, and behavioral observations. Willow flycatchers for which detections spanned one week or longer were considered resident at a site, regardless of the portion of the breeding season in which the bird was observed or whether a possible mate was observed. Flycatchers observed engaging in 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 or a flycatcher whose legs were not observed was detected at a given location on multiple visits but one or more intervening visits failed to detect a flycatcher, the detections were considered to be different individuals in the absence of behavioral observations indicating the flycatcher was actively defending a territory or was a member of a breeding pair.

RESULTS

Reclamation Study Areas

Color-Banding and Resighting – Field personnel color-banded 17 new adult flycatchers and recaptured 3 individuals previously captured as adults. An additional 50 adults were identified to individual via resighting, while 8 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 and thus could not be positively identified to individual. Of the 50 adults that were resighted and identified, 9 were identified for the first time since they were banded as nestlings. We identified seven additional individuals as returning nestlings by the presence of a single federal band, with three (43%) identified to individual via recapture. We recaptured two additional returning nestlings with full color combinations. Twenty-eight adult flycatchers remained unbanded, and banding status was undetermined (i.e., we were unable to determine if these individuals were banded) for 17 adults. Overall, 66% 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 52 nestlings from 22 nests. Of the 52 nestlings banded, 2 were known or suspected to have died before fledging. We resighted an additional 13 unbanded fledglings from five nests. For details on all banded flycatchers detected at the study areas from 2003 to 2010, see Appendix E.

Site-by-Site Color-Banding and Resighting

Pahranagat – We detected 23 resident, adult willow flycatchers from 14 territories at Pahranagat. 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 14 territories recorded at Pahranagat, 10 consisted of breeding pairs, 3 consisted of unpaired males, and 1 contained an individual for which gender could not be determined. Of the breeding individuals, one male was polygynous with two females. One resident male moved from his territory in Pahranagat North and was resighted at Pahranagat West.

Field personnel captured and color-banded two new adults and recaptured one flycatcher previously captured as an adult. We resighted and identified an additional 16 adults. One adult had a duplicate color combination and could not be identified to individual. Three resident adults remained unbanded. Of the resighted adults, two were originally banded as nestlings in 2008 (see Table 3.8 for juvenile dispersal data). The presence of bands could not be determined for one adult. We banded 20 nestlings from seven nests. Two additional nestlings from one of the seven nests suffered fatal injuries after being removed from the nest for banding. We resighted eight unbanded fledglings from three additional nests.

Littlefield – We detected three resident, adult willow flycatchers from two 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 two territories, one consisted of a breeding pair and one consisted of an unpaired male.

Field personnel captured and color-banded one new adult. We resighted and identified an additional adult. One resident adult remained unbanded. The individual for whom residency and/or breeding status could not be confirmed also remained unbanded. We banded three nestlings from one nest.

Mesquite – We detected 17 resident, adult willow flycatchers from 9 territories at Mesquite. In addition to resident adults, we detected one individual for whom residency and/or breeding status could not be determined. Of the nine territories recorded at Mesquite, seven consisted of paired individuals and two consisted of unpaired males (Table 3.2). Of the breeding individuals, two females mated consecutively with two males. One male held a territory at Mesquite West and then moved to Hafen Lane, where he bred. Another male was detected at Hafen Lane and then moved to Mesquite West, where he displaced a resident male and bred.

Field personnel captured and color-banded four new adults and recaptured two returning nestlings, one originally banded in 2008 and one in 2009 (see Table 3.8). We confirmed the identities of an additional five adults via resighting. Of the resighted adults, one was a returning nestling originally banded in 2009. Four adults remained unbanded, and two adults were banded but band combinations could not be confirmed. Band status could not be determined for the individual for whom residency and/or breeding status could not be confirmed. We banded nine nestlings, one of which died before fledging, from five nests.

Mormon Mesa – We detected 25 resident, adult willow flycatchers from 16 territories at Mormon Mesa. In addition to resident adults, we detected seven individuals for which residency could not be confirmed (Table 3.2). Of the 16 territories recorded at Mormon Mesa, 10 consisted of breeding individuals and 6 consisted of unpaired males. One male established a territory at Virgin River #2 and then moved to Virgin River #1 (South) and established a second territory.

Field personnel captured and color-banded one new adult and recaptured one flycatcher previously captured as an adult. We resighted and identified 17 additional adults. Of the resighted adults, four were returning nestlings; three were banded in 2008 and one in 2009 (see Table 3.8). We captured one returning nestling originally banded as a juvenile in 2007 and resighted three returning nestlings with a single federal band that we were unable to recapture. One additional adult had a federal band on one leg and an injury on the opposite leg. One adult remained unbanded, and band combinations could not be confirmed for three adults. Band status could not be confirmed for four adults. We banded nine nestlings from four nests and resighted three unbanded fledglings from one nest.

Muddy River – We detected 12 resident, adult willow flycatchers from eight territories at Muddy River. In addition to resident adults, we detected two individuals for which residency could not be confirmed. Of the eight territories recorded, four consisted of breeding pairs and four consisted of unpaired males (Table 3.2).

Field personnel captured and color-banded two new adults and recaptured one returning nestling originally banded in 2008 (see Table 3.8). We resighted and identified five other adults. We resighted two adults for which the band combination could not be confirmed. Four adults remained unbanded. We banded five nestlings from two nests and resighted two unbanded fledglings from one nest.

Topock – We detected 11 resident, adult willow flycatchers from 10 territories at Topock. In addition to resident adults, we detected 17 individuals for which residency and/or breeding status could not be confirmed (Table 3.2). Of the 10 territories recorded at Topock, 3 consisted of paired individuals and 7 consisted of unpaired males. For one of the pairs, the female was detected only once and the male left the territory nine days later. This male subsequently established a second territory in another site.

Field personnel captured and color-banded three new adults and recaptured one flycatcher originally captured as an adult. We resighted and identified three other banded adults, two of which were returning nestlings banded in 2009 (see Table 3.8). We captured one returning nestling originally banded in 2007 and resighted but were unable to recapture one additional returning nestling with a single federal band. Eight adults remained unbanded, and the band status of 10 individuals could not be determined. The color combination of one banded adult could not be confirmed. We banded three nestlings from one nest.

Bill Williams – We detected eight resident willow flycatchers from five territories at Bill Williams. In addition to resident adults, we detected six individuals for which residency and/or breeding status could not be determined (Table 3.2). Of the five territories recorded at Bill Williams, four consisted of breeding individuals and one consisted of an unpaired male. One male was polygynous with two females.

Field personnel captured and color-banded four new adults. We resighted and identified three returning banded adults. Six adults remained unbanded, and band status could not be determined for one adult. We banded three nestlings from two nests; one of these nestlings was suspected to have died before fledging.

Table 3.1. Summary of Willow Flycatchers Detected at Reclamation Study Areas Where Resident Flycatchers Were Observed during the 2010 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	2	1	0	16	1[1]	3	0	0	20(7)	0	87
	West	2	0	0	0	1	0	0	1	0	0	0	50
	Study Area Total	**24[2]**	**2**	**1**	**0**	**16[2]**	**1**	**3**	**1**	**0**	**20(7)**	**0**	**83**
Littlefield	Poles	4	1	0	0	1	0	2	0	0	3(1)	0	50
	Study Area Total	**4**	**1**	**0**	**0**	**1**	**0**	**2**	**0**	**0**	**3(1)**	**0**	**50**
Mesquite	Hafen Lane	3	2	0	0	1[4]	0	0	0	0	1(1)	0	100
	West	17	2	0	2	6[3]	0	4	1	2	8(4)	0	71
	Study Area Total	**18[5]**	**4**	**0**	**2**	**5[5]**	**0**	**4**	**1**	**2**	**9(5)**	**0**	**72**
Mormon Mesa	Mormon Mesa South (North)	1	0	0	0	0	0	0	1	0	0	0	0
	Virgin River #1 (North)	4	0	0	0	2	0	1	0	1	0	0	75
	Virgin River #1 (South)	26	1	1	1	16	4[6]	0	1	2	9(4)	0	96
	Virgin River #2	3	0	0	0	1	0	0	2	0	0	0	33
	Study Area Total	**32[7]**	**1**	**1**	**1**	**17[7]**	**4**	**1**	**4**	**3**	**9(4)**	**0**	**84**
Muddy River	Overton WMA	14	2	0	1	5	0	4	0	2	5(2)	0	71
	Study Area Total	**14**	**2**	**0**	**1**	**5**	**0**	**4**	**0**	**2**	**5(2)**	**0**	**71**
Topock	Pipes #1	2	0	0	0	0	0	0	2	0	0	0	0
	Pipes #3	3	0	0	0	1	1[8]	0	1	0	0	0	67
	The Wallows	4	0	0	1	1	0	1	1	0	0	0	50
	PC6-1	2	0	0	0	0	0	1	1	0	0	0	0
	800M	4	1	0	0	1	0	1	1	0	0	0	50
	Pierced Egg	3	0	0	0	0	0	1	1	1	0	0	33
	Swine Paradise	1	0	0	0	0	0	0	1	0	0	0	0
	Platform	2	1	0	0	0	0	1	0	0	0	0	50
	Hell Bird	1	0	0	0	0	0	1	0	0	0	0	0
	Glory Hole	3	1	1	0	1	0	0	0	0	3(1)	0	100
	Beal Lake	2	0	0	0	0	0	1	1	0	0	0	0
	MAM[9]	2	0	0	0	0	0	1	1	0	0	0	0
	Study Area Total	**28[10]**	**3**	**1**	**1**	**3[10]**	**1**	**8**	**10**	**1**	**3(1)**	**0**	**36**
Bill Williams	Burn Edge	2	1	0	0	0	0	1	0	0	0	0	50
	Site #4	2	1	0	0	0	0	0	1	0	0	0	50
	Site #3	4	0	0	0	3	0	1	0	0	1(1)	0	75
	Mineral Wash	2	0	0	0	0	0	2	0	0	0	0	0
	Beaver Pond	1	0	0	0	0	0	1	0	0	0	0	0
	Upstream from Site #8	1	0	0	0	0	0	1	0	0	0	0	0
	Planet Ranch Rd	2	2	0	0	0	0	0	0	0	2(1)	0	100
	Study Area Total	**14**	**4**	**0**	**0**	**3**	**0**	**6**	**1**	**0**	**3(2)**	**0**	**50**
Total		**134**	**17**	**3**	**5**	**50**	**6**	**28**	**17**	**8**	**52(22)**	**0**	**66**

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

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

[3] One individual was originally banded at Hafen Lane and then moved to Mesquite West.

[4] This individual was originally banded at Mesquite West and then moved to Hafen Lane.

[5] The two individuals who moved between study sites are tallied only once in the total.

[6] 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 individuals were returning nestlings.

[7] One individual moved from Virgin River #1 (North) to Virgin River #2 to Virgin River #1 (South) and is tallied only once in the total.

[8] Returning nestling.

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

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

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2010

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	8-Aug-10	2540-58209	KY(M):TQ	N/A	AHY	F	32	N
	North	7-Jul-06	2360-59754	OR(M):EE	N/A	5Y	M	32	RS
	North	8-Aug-10	2540-58206	TQ:YW(M)	N/A	L	U	32	N
	North	8-Aug-10	2540-58207	GY(M):TQ	N/A	L	U	32	N
	North	8-Aug-10	2540-58208	KR(M):TQ	N/A	L	U	32	N
	North	18-Jul-10	2540-58293	BO(M):TQ	N/A	SY	F	35	N
	North	25-Jun-08	2430-61179	XX:KB(M)	N/A	A4Y	M	35	RS
	North	18-Jul-10	2430-61152	VYV(M):XX	N/A	L	U	35	N
	North	18-Jul-10	2540-58294	BW(M):TQ	N/A	L	U	35	N
	North	18-Jul-10	2540-58295	TQ:BV(M)	N/A	L	U	35	N
	North	1-Jul-06	2370-40047	PU:DD(M)	N/A	A6Y	F	36	RS
	North	6-Jul-05	2360-59711	KB(M):EE	N/A	6Y	M	36	RS
	North	29-Jun-10	2370-40001	PU:YR(M)	N/A	L	U	36	N
	North	29-Jun-10	2370-40002	PU:RDR(M)	N/A	L	U	36	N
	North	29-Jun-10	2430-61226	XX:VV(M)	N/A	L	U	36	N
	North	29-Jun-10	2430-61227	XX:BOB(M)	N/A	L	U	36	N
	North	15-Jul-08	2430-61123	XX:VK(M)	N/A	3Y	F	37	RS
	North	6-Jul-05	2360-59712	EE:GKG(M)	N/A	6Y	M	37	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	37	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	37	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	37	RS
	North	N/A	N/A	UB:UB	N/A	AHY	F	38	RS
	North	24-Jul-08	2430-61083	XX:YR(M)	N/A	4Y	M	38	R 14 Jul
	North	12-Jul-10	2430-61097	XX:RYR(M)	N/A	L	U	38	N
	North	12-Jul-10	2540-58195	TQ:BK(M)	N/A	L	U	38	N
	North	12-Jul-10	2540-58196	DK(M):TQ	N/A	L	U	38	N
	North	26-Jun-09	2430-61087	OB(M):XX	N/A	A3Y	F	39	RS

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2010 (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	25-Jul-05	2370-39915	PU:RZ(M)	N/A	A7Y	M	39	RS
	North	12-Jul-10	2430-61098	XX:WDW(M)	N/A	L	U	39	N
	North	12-Jul-10	2540-58197	TQ:VB(M)	N/A	L	U	39	N
	North	12-Jul-10	2540-58198	DY(M):TQ	N/A	L	U	39	N
	North	1-Jul-08	2430-61120	XX:KO(M)	N/A	3Y	F	55	RS
	North	29-Jul-07	2370-40157	DWD(M):PU	N/A	A5Y	M	55,119	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	55	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	55	RS
	North	30-Jun-09	2370-40073	PU:KO(M)	N/A	A3Y	F	114	RS
	North	18-May-04	2320-31595	WKW(M):EE	N/A	A8Y	M	114	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	114	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	114	RS
	North	N/A	N/A	UB:UB	N/A	HY	U	114	RS
	North	INA	INA	XX:DB(M)	N/A	AHY	F	119	RS; duplicate combination
	North	18-Jul-10	2540-58296	TQ:WB(M)	N/A	L	U	119	N
	North	17-Jun-07	None	BR(M):UB	N/A	5Y	F	134	RS
	North	19-Jul-08	2430-61080	YY(M):XX	N/A	4Y	M	134	RS
	North	16-Jul-10	2540-58191	BK(M):TQ	N/A	L	U	134	N
	North	16-Jul-10	2540-58288	BY(M):TQ	N/A	L	U	134	N
	North	16-Jul-10	2430-61221	OGO(M):XX	N/A	L	U	134	N
	North	24-Jun-08	2430-61176	DK(M):XX	N/A	3Y	M	T31,F97	RS; detected at T31 16 May–14 Jul, then at F97 24 Jul at West
	North	N/A	N/A	UB:UB	N/A	AHY	U	T34	RS; detected 14 Jun–26 Jul
	North	N/A	N/A	UB:UB	N/A	AHY	M	T113	RS; detected 4–25 Jun
	North	21-Jun-06	2370-40060	YG(M):PU	N/A	A6Y	M	T121	RS; detected 20 May–14 Jul
	West	INA	INA	undetermined	N/A	AHY	U	F47	Detected 12 Jun

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2010 (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]
LIFI	Poles	10-Jul-10	2430-61096	XX:OBO(M)	N/A	AHY	F	32	N
	Poles	N/A	N/A	UB:UB	N/A	AHY	M	32	RS
	Poles	13-Jul-10	2430-61232	XX:OWO(M)	N/A	L	U	32	N
	Poles	13-Jul-10	2430-61233	XX:RGR(M)	N/A	L	U	32	N
	Poles	13-Jul-10	2540-58161	TQ:DK(M)	N/A	L	U	32	N
	Poles	28-Jun-08	2430-61187	KV(M):XX	N/A	3Y	M	T33	RS; detected 15 May–27 Jul
	Poles	N/A	N/A	UB:UB	N/A	AHY	U	F31	RS; detected 15 May
MESQ	West	1-Aug-03	2320-31445	EE:WK(M)	N/A	A9Y	F	1	RS; mated consecutively with 2 males
	West	N/A	N/A	UB:UB	N/A	AHY	M	1	RS
	West	06-Jun-10	2540-58192	TQ:BG(M)	N/A	AHY	M	1, F38	N; banded at F38 at Hafen Lane, then displaced male at 1
	West	29-Jul-10	2540-58151	TQ:VWV(M)	N/A	L	U	1	N
	West	1-Jul-10	2370-40011	DYD(M):PU	N/A	AHY	F	31	N
	West	16-Jun-09	2370-40175	PU:OKO(M)	PU:UB	SY	M	31	R 23 Jun
	West	1-Jul-10	2430-61276	KRK(M):XX	N/A	L	U	31	N
	Hafen Lane	21-Jul-10	2430-61234	XX:WGW(M)	N/A	AHY	F	39	N
	Hafen Lane	11-Jun-10	2370-39999	BD(M):PU	N/A	AHY	M	39, T115	N; banded at T115 at West, then breeding at 39
	Hafen Lane	21-Jul-10	2430-61235	XX:YDY(M)	N/A	L	U	39	N; died before fledging
	West	23-Jun-08	2430-61174	XX:VWV(M)	XX:KG(M)	3Y	F	43	R 23 Jul
	West	15-Jul-05	2320-31688	EE:BG(M)	N/A	6Y	M	43	RS
	West	31-Jul-10	2540-58107	YK(M):TQ	N/A	L	U	43	N
	West	31-Jul-10	2540-58105	DRD(M):TQ	N/A	L	U	43	N
	West	31-Jul-10	2540-58106	TQ:GG(M)	N/A	L	U	43	N
	West	23-Jun-04	2320-31498	KW(M):EE	N/A	7Y	F	111	RS
	West	INA	INA	banded	N/A	AHY	M	111	RS
	West	N/A	N/A	UB:UB	N/A	AHY	F	112	RS
	West	N/A	N/A	UB:UB	N/A	AHY	M	112	RS

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2010 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[3]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
MESQ	West	26-Jul-07	2370-40087	PU:BZ(M)	N/A	A5Y	F	113	RS; mated consecutively with 2 males
	West	INA	INA	banded	N/A	AHY	M	113	RS
	West	N/A	N/A	UB:UB	N/A	AHY	M	113	RS
	West	29-Jul-10	2540-58148	TQ:OGO(M)	N/A	L	U	113	N
	West	29-Jul-10	2540-58150	WKW(M):TQ	N/A	L	U	113	N
	West	29-Jul-10	2540-58149	KOK(M):TQ	N/A	L	U	113	N
	West	19-Jun-09	2370-39930	PU:GO(M)	N/A	SY	M	T117, F116	RS; detected at F116 9–13 Jun, then at T117 15 Jun–1 Jul
	West	INA	INA	undetermined	N/A	AHY	U	F118	Detected 23 Jun
MOME	Virgin River #1 South	16-Jul-04	2320-31632	RZ(M):EE	N/A	8Y	F	7	RS
	Virgin River #1 South	1-Jul-08	2430-61118	XX:KK(M)	N/A	3Y	M	7	RS
	Virgin River #1 South	28-Jun-10	2370-40093	PU:RGR(M)	N/A	L	U	7	N
	Virgin River #1 South	28-Jun-10	2430-61090	XX:KBK(M)	N/A	L	U	7	N
	Virgin River #1 South	28-Jun-10	2430-61089	XX:BYB(M)	N/A	L	U	7	N
	Virgin River #1 South	INA	INA	PU:UB	N/A	AHY	F	8	RS
	Virgin River #1 South	8-Jun-06	2370-39938	KG(M):PU	N/A	6Y	M	8	R 24 Jun
	Virgin River #1 South	INA	INA	banded	N/A	AHY	F	9	RS
	Virgin River #1 South	1-Jul-08	2430-61165	XX:RY(M)	N/A	3Y	M	9	RS
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	HY	U	9	RS
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	HY	U	9	RS
	Virgin River #1 South	N/A	N/A	UB:UB	N/A	HY	U	9	RS
	Virgin River #1 South	INA	INA	undetermined	N/A	AHY	F	10	
	Virgin River #1 South	19-Jun-08	2430-61167	XX:KW(M)	N/A	A4Y	M	10	RS
	Virgin River #1 South	2-Jun-06	2370-40037	PU:DR(M)	N/A	A6Y	F	11	RS
	Virgin River #1 South	11-Jul-06	2360-59799	EE:OZ(M)	N/A	5Y	M	11	RS
	Virgin River #1 South	19-Jun-10	2320-31647	BR(M):EE	N/A	L	U	11	N
	Virgin River #1 South	19-Jun-10	2320-31648	BY(M):EE	N/A	L	U	11	N

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2010 (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	INA	INA	EE:UB	N/A	AHY	F	12	RS
	Virgin River #1 South	4-Jul-01	2390-92434[9]	UB:XX	N/A	10Y	M	12	RS
	Virgin River #1 South	2-Jul-10	2430-61280	WRW(M):XX	N/A	L	U	12	N
	Virgin River #1 South	23-Jun-09	2370-40151	RR(M):PU	N/A	SY	F	31	RS
	Virgin River #1 South	INA	INA	banded	N/A	AHY	M	31	RS
	Virgin River #1 South	6-Aug-05	2360-59788	BO(M):EE	N/A	6Y	F	61	RS
	Virgin River #1 South	21-Jun-06	none[10]	DW(M):UB	N/A	6Y	M	61	RS
	Virgin River #1 South	22-Jun-10	2370-40089	PU:KW(M)	N/A	L	U	61	N
	Virgin River #1 South	22-Jun-10	2370-40090	PU:YKY(M)	N/A	L	U	61	N
	Virgin River #1 South	22-Jun-10	2370-40091	PU:DRD(M)	N/A	L	U	61	N
	Virgin River #1 South	27-Jun-07	2360-59782	KGK(M):EE	UB:EE	4Y	F	64	R 26 Jul
	Virgin River #1 South	INA	INA	PU:UB	N/A	AHY	M	64	RS
	Virgin River #1 South	9-Jun-05	2370-39956	PU:ZZ(M)	N/A	7Y	F	131	RS
	Virgin River #1 South	14-Jun-06	2370-40046	PU:DK(M)	N/A	6Y	M	131	RS
	Virgin River #1 South	28-Jun-08	2430-61189	KB(M):XX	N/A	3Y	M	T5	RS; detected 30 Jun–8 Jul
	Virgin River #1 South	3-Jun-07	2370-40197	OG(M):PU	N/A	A5Y	M	T6	RS; detected 17–27 May
	Virgin River #1 South	22-Jul-02	2140-66709	Bs:GW(M)	N/A	A10Y	M	T32, F45, T132	RS; detected 2 Jun in Virgin River #1 North, 6–14 Jun in Virgin River #2, and 12 Jun–4 Jul in Virgin River #1 South
	Virgin River #1 South	30-Jun-08	2430-61106	XX:KV(M)	N/A	3Y	M	T51	RS; detected 23 May–8 Jun
	Virgin River #1 South	8-Jul-10	2430-61095	XX:KOK(M)	N/A	AHY	M	T63	N; detected 12 Jun–24 Jul
	Virgin River #2	INA	INA	undetermined	N/A	AHY	U	F13	Detected 2 Jun
	Virgin River #1 North	INA	INA	banded	N/A	AHY	M	F20	RS; detected 19 May
	Virgin River #1 North	N/A	N/A	UB:UB	N/A	AHY	M	F21	RS; detected 3–6 Jun
	Virgin River #1 North	23-Jun-08	2430-61206	XX:BW(M)	N/A	3Y	M	F22	RS; detected 22–26 Jul
	Virgin River #2[11]	INA	INA	undetermined	N/A	AHY	M	F46	Detected 16 Jun
	MOME South (North)	INA	INA	undetermined	N/A	AHY	U	F62	Detected 16 Jun
	Virgin River #1 South	12-Jun-07	none[12]	RK(M):UB	N/A	A5Y	M	F133	Detected 21–25 May

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2010 (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]
MUDD	Overton WMA	23-Jun-08	2430-61207	GO(M):XX	N/A	3Y	F	31	RS
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	M	31	RS
	Overton WMA	29-Jun-10	2370-40009	RDR(M):PU	N/A	L	U	31	N
	Overton WMA	29-Jun-10	2370-40008	WGW(M):PU	N/A	L	U	31	N
	Overton WMA	29-Jun-10	2370-40010	KRK(M):PU	N/A	L	U	31	N
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	F	33	RS
	Overton WMA	25-Jun-10	2370-40000	PU:WW(M)	N/A	SY	M	33	N
	Overton WMA	5-Jul-07	2370-40193	GY(M):PU	N/A	A5Y	F	41	RS
	Overton WMA	21-May-09	2430-61085	BV(M):XX	N/A	3Y	M	41	RS
	Overton WMA	N/A	N/A	UB:UB	N/A	HY	U	41	RS
	Overton WMA	N/A	N/A	UB:UB	N/A	HY	U	41	RS
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	F	121	RS
	Overton WMA	25-Jul-08	2430-61084	XX:BO(M)	N/A	3Y	M	121	R 5 Jul
	Overton WMA	7-Jul-10	2430-61094	XX:DYD(M)	N/A	L	U	121	N
	Overton WMA	7-Jul-10	2540-58194	TQ:KB(M)	N/A	L	U	121	N
	Overton WMA	N/A	N/A	UB:UB	N/A	AHY	M	T11	RS: detected 13 May–3 Aug
	Overton WMA	INA	INA	banded	N/A	AHY	U	T42	RS; detected 27 Jun–11 Jul
	Overton WMA	9-Aug-09	2540-58189	DR(M):TQ	N/A	A3Y	M	T63	RS; detected 9 Jul–3 Aug
	Overton WMA	21-Jun-10	2370-40088	PU:VG(M)	N/A	SY	M	T92	N; detected 21 Jun–30 Jul
	Overton WMA	21-Jun-04	2320-31615	EE:OY(M)	N/A	7Y	M	F10	RS; detected 3 Jun
	Overton WMA	INA	INA	banded	N/A	AHY	U	F34	RS; detected 17 Jul
TOPO	Glory Hole	29-Jun-10	2540-58231	TQ:GR(M)	N/A	SY	F	3	N
	Glory Hole	22-Jul-04	2370-40095[13]	RGR(M):PU	KY(M):EE	7Y	M	3	R 29 Jun
	Glory Hole	28-Jun-10	2540-58190	TQ:GY(M)	N/A	L	U	3	N
	Glory Hole	28-Jun-10	2370-40177	PU:WKW(M)	N/A	L	U	3	N
	Glory Hole	28-Jun-10	2540-58232	RW(M):TQ	N/A	L	U	3	N
	Pipes #3	INA	INA	undetermined	N/A	AHY	F	51	Detected 16 Jun

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2010 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[3]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
TOPO	Pipes #3	22-May-08	2430-61135	XX:OY(M)	N/A	4Y	M	51, T70	RS; detected at T70 in Glory Hole 5–16 Jul
	Platform	N/A	N/A	UB:UB	N/A	AHY	F	82	RS
	Platform	20-Jun-10	2540-58228	TQ:KO(M)	N/A	SY	M	82	N
	The Wallows	16-Jul-07	2370-40112	RD(M):PU	UB:PU	4Y	M	T1	R 8 May; detected 8 May–2 Jun
	Pipes #3	INA	INA	UB:EE	N/A	AHY	M	T2	RS; detected 11 May–30 Jun
	800M	31-Jul-09	2540-58154	DO(M):TQ	N/A	SY	M	T10	RS; detected 29 May–14 Jun
	800M	29-May-10	2540-58227	TQ:GV(M)	N/A	SY	M	T11	N; detected 29 May–18 Jun
	The Wallows	18-Jun-09	2370-40144	OKO(M):PU	N/A	SY	M	T12	RS; detected 6 Jun–27 Jun
	Pierced Egg	N/A	N/A	UB:UB	N/A	AHY	M	T23	RS; detected 31 May–24 Jun
	MAM	INA	INA	undetermined	N/A	AHY	M	F5	Detected 23 May
	The Wallows	N/A	N/A	UB:UB	N/A	AHY	U	F6	RS; detected 23 May, possibly female for T1
	Swine Paradise	INA	INA	undetermined	N/A	AHY	M	F13	Detected 6–10 Jun
	The Wallows	INA	INA	undetermined	N/A	AHY	U	F16	Detected 8 Jul
	800M	INA	INA	undetermined	N/A	AHY	U	F17	Detected 19–23 May
	800M	N/A	N/A	UB:UB	N/A	AHY	M	F21	RS; detected 11–13 May
	Pierced Egg	INA	INA	undetermined	N/A	AHY	M	F22	Detected 15–19 May
	Pierced Egg	INA	INA	banded	N/A	AHY	M	F24	RS; detected 13–19 May
	Hell Bird	N/A	N/A	UB:UB	N/A	AHY	M	F25	RS; detected 6 Jun
	Beal Lake	INA	INA	undetermined	N/A	AHY	U	F40	Detected 2 Jun
	Beal Lake	N/A	N/A	UB:UB	N/A	AHY	U	F41	RS; detected 21 May
	Pipes #1	INA	INA	undetermined	N/A	AHY	U	F42	Detected 2 Jun
	PC6-1	N/A	N/A	UB:UB	N/A	AHY	M	F63	RS; detected 21 May
	PC6-1	INA	INA	undetermined	N/A	AHY	M	F64	Detected 21 May
	Pipes #1	INA	INA	undetermined	N/A	AHY	U	F68	Detected 29 May
	MAM	N/A	N/A	UB:UB	N/A	AHY	M	F69	RS; detected 2 Jun
BIWI	Planet Ranch Rd	10-Jul-10	2540-58230	YD(M):TQ	N/A	SY	F	3	N

Table 3.2. Willow Flycatchers Detected at All Reclamation Study Areas with Resident Flycatchers, 2010 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[3]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
BIWI	Planet Ranch Rd	12-Jun-10	2540-58220	TQ:DY(M)	N/A	AHY	M	3	N
	Planet Ranch Rd	14-Jul-10	2540-58116	TQ:KR(M)	N/A	L	U	3	N
	Planet Ranch Rd	14-Jul-10	2540-58117	VV(M):TQ	N/A	L	U	3	N; likely died before fledging
	Site #3	6-Jun-08	2430-61137	XX:BR(M)	N/A	4Y	F	10	RS
	Site #3	6-Jun-08	2430-61136	XX:BG(M)	N/A	4Y	M	10,62	RS
	Site #3	24-Jul-10	2540-58147	YO(M):TQ	N/A	L	U	10	N
	Site #3	2-Jun-07	2370-40192	PU:RB(M)	N/A	A5Y	F	62	RS
	Burn Edge	N/A	N/A	UB:UB	N/A	AHY	F	99	RS
	Burn Edge	26-Jun-10	2540-58229	TQ:GO(M)	N/A	AHY	M	99	N
	Site #3	N/A	N/A	UB:UB	N/A	AHY	M	T65	RS; detected 14 May–6 Jul
	Mineral Wash	N/A	N/A	UB:UB	N/A	AHY	M	F11	RS; detected 12–17 Jun
	Mineral Wash	N/A	N/A	UB:UB	N/A	AHY	U	F12	RS; detected 12 Jun
	Upstream from Site #8	N/A	N/A	UB:UB	N/A	AHY	M	F24	RS; detected 18 May
	Beaver Pond	N/A	N/A	UB:UB	N/A	AHY	M	F28	RS; detected 17–21 Jun
	Site #4	INA	INA	undetermined	N/A	AHY	M	F91	Detected 27 Jun
	Site #4	29-Jun-10	2540-58221	TQ:OR(M)	N/A	SY	M	F97	N; detected 27 Jun–3 Jul

[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 2010.

[5] **Age in 2010**: 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] Band number likely 2390-92434 but cannot be confirmed because bird was not captured in 2010. Bird had visible injury on left leg.

[10] Original federal band 2370-39988; male with band combination DW(M):PU occupied this location in 2009; in 2010 bird arrived on territory with right foot and federal band missing.

[11] Location north of Virgin River #2 polygon.

[12] Original federal band 2370-40173.

[13] Original federal band 2320-31562.

NDOW Study Areas

Color-Banding and Resighting – Field personnel color-banded 14 new adult flycatchers and recaptured 2 individuals previously captured as adults. An additional eight adults were identified to individual via resighting, while one individual was resighted but did not have its color combination confirmed. We detected one individual identified as a returning nestling by the presence of a single federal band, but we were unable to capture it. Four additional adults were captured with full color combinations and identified as returning nestlings from 2008 or 2009 (Table 3.8). Eleven adult flycatchers remained unbanded, and banding status was undetermined (i.e., we were unable to determine if these individuals were banded) for one adult. Overall, 71% of the adult flycatchers detected at the monitoring sites were known to be color-banded by the end of the breeding season (Table 3.3). We banded 41 nestlings from 16 nests. Of the 41 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 2010, see Appendix E.

Site-by-Site Color-Banding and Resighting

Key Pittman Wildlife Management Area – We detected 31 resident willow flycatchers from 18 territories at Key Pittman Wildlife Management Area. In addition to resident adults, we detected four individuals for which residency and/or breeding status could not be determined (Table 3.4). Of the 18 territories at Key Pittman, 17 consisted of breeding individuals and 1 consisted of an unpaired male. One male was polygynous with two females and two other males were each polygynous with three females. One female mated consecutively with two different males.

Field personnel captured and color-banded 11 new adults and recaptured one flycatcher previously captured as an adult (Table 3.4). We resighted and identified eight additional adults; two of these individuals were banded as nestlings in 2008 and two were banded as nestlings in 2009 (see Table 3.8). We captured four returning nestlings originally banded as juveniles in 2008 and 2009. We resighted one additional returning nestling with a single federal band but were unable to recapture it. Nine adults remained unbanded, and band combination could not be confirmed for one adult. We banded 39 nestlings from 15 nests; three of these nestlings died before fledging. We resighted three unbanded fledglings from one nest.

Warm Springs Natural Area – We detected six resident willow flycatchers from four territories at Warm Springs Natural Area. In addition to resident adults, we detected one individual for whom residency and/or breeding status could not be determined (Table 3.4). Of the four territories at Warm Springs, three consisted of breeding individuals and one consisted of an unpaired male. One male was polygynous with two females.

Field personnel captured and color-banded three new adults and recaptured one flycatcher previously captured as an adult. Two adults remained unbanded, and band combination could not be confirmed for one adult. We banded two nestlings from one nest; both nestlings died before fledging.

Non-Monitoring Sites

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

St. George – Field personnel captured and color-banded three new adults. Personnel from Utah Division of Wildlife Resources resighted and identified five adult flycatchers, one of which was banded as a nestling in 2009 (see Table 3.8). We banded five nestlings from two nests (Table 3.5).

Table 3.3. Summary of Willow Flycatchers Detected at NDOW Study Areas Where Resident Flycatchers Were Observed during the 2010 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						
Key Pittman WMA	Patch 1	2	2	0	0	0	0	0	0	0	3(1)	0	**100**
	Patch 2	3	0	0	0	2	0	1	0	0	3(1)	0	**67**
	Patch 3	3	1	0	1	1	0	0	0	0	2(1)	0	**100**
	Patch 4	3	1	0	0	0	0	2	0	0	1(1)	0	**33**
	Patch 5	2	0	0	1	0	0	1	0	0	3(1)	0	**50**
	Patch 6	5	1	0	1	1	1[1]	0	1	0	7(3)	0	**80**
	Patch 7	3	1	0	0	1	0	1	0	0	4(1)	0	**67**
	Patch 8	4	0	0	0	2	0	2	0	0	6(2)	0	**50**
	Patch 9	2	1	0	1	0	0	0	0	0	4(1)	0	**100**
	Patch 10	3	2	1	0	0	0	0	0	0	3(2)	0	**100**
	Patch 10.5	1	1	0	0	0	0	0	0	0	0	0	**100**
	Patch 11	2	0	0	0	1	0	1	0	0	3(1)	0	**50**
	Patch 12	2	1	0	0	0	0	1	0	0	0	0	**50**
	Study Area Total	**35**	**11**	**1**	**4**	**8**	**1**	**9**	**1**	**0**	**39(15)**	**0**	**71**
Warm Springs Natural Area	Muddy Stringer #1	4	2	1	0	0	0	1	0	0	2(1)	0	75
	Muddy Mac	3	1	0	0	0	0	1	0	1	0)	0	50
	Study Area Total	**7**	**3**	**1**	**0**	**0**	**0**	**2**	**0**	**1**	**2(1)**	**0**	**71**
Total		**42**	**14**	**2**	**4**	**8**	**1**	**11**	**1**	**1**	**41(16)**	**0**	**71**

* Individuals are identified as new captures (previously unbanded), recaptures of previously banded birds, resightings of previously banded birds for which band combinations were confirmed, birds known to be unbanded, birds for which band status could not be determined, and resighting of previously banded birds for which band combinations were undetermined. Included are total numbers of adults detected and percent of all adults banded. For breeding and/or residency status of adults see Table 3.4.

[1] Returning nestling.

Table 3.4. Willow Flycatchers Detected at NDOW Study Areas, 2010

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[2]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
KEPI	Patch 11	N/A	N/A	UB:UB	N/A	AHY	F	2	RS
	Patch 11	03-Aug-08	2370-40097	PU:GY(M)	N/A	3Y	M	2	RS
	Patch 11	12-Aug-10	2540-58242	TQ:RK(M)	N/A	L	U	2	N
	Patch 11	12-Aug-10	2540-58243	YW(M):TQ	N/A	L	U	2	N
	Patch 11	12-Aug-10	2540-58244	RWR(M):TQ	N/A	L	U	2	N
	Patch 10	10-Jul-10	2540-58226	YY(M):TQ	N/A	SY	F	3	N
	Patch 10	16-Jul-09	2430-61158	RB(M):XX	N/A	A3Y	M	3,46	R 8 Jul
	Patch 10	17-Jul-10	2540-58292	YB(M):TQ	N/A	L	U	3	N
	Patch 10	17-Jul-10	2430-61151	KBK(M):XX	N/A	L	U	3	N
	Patch 8	N/A	N/A	UB:UB	N/A	AHY	F	4	RS
	Patch 8	26-Jun-08	2430-61180	RD(M):XX	N/A	4Y	M	4,120, 136	RS
	Patch 8	28-Jul-10	2540-58162	TQ:DR(M)	N/A	L	U	4	N
	Patch 8	28-Jul-10	2540-58163	DW(M):TQ	N/A	L	U	4	N
	Patch 8	28-Jul-10	2430-61263	BWB(M):XX	N/A	L	U	4	N
	Patch 7	N/A	N/A	UB:UB	N/A	AHY	F	5	RS
	Patch 7	27-Jun-06	2320-31674	BW(M):EE	N/A	5Y	M	5	RS
	Patch 7	30-Jun-10	2540-58237	TQ:BD(M)	N/A	L	U	5	N
	Patch 7	30-Jun-10	2540-58238	TQ:GOG(M)	N/A	L	U	5	N
	Patch 7	30-Jun-10	2540-58239	RD(M):TQ	N/A	L	U	5	N
	Patch 7	30-Jun-10	2540-58240	KYK(M):TQ	N/A	L	U	5	N
	Patch 6	INA	INA	undetermined	N/A	AHY	F	6	
	Patch 6	INA	INA	UB:PU	N/A	AHY	M	6,13,127	RS
	Patch 6	8-Jul-10	2540-58157	OY(M):TQ	N/A	L	U	6	N
	Patch 6	8-Jul-10	2540-58158	RB(M):TQ	N/A	L	U	6	N
	Patch 6	8-Jul-10	2540-58159	KB(M):TQ	N/A	L	U	6	N
	Patch 6	8-Jul-10	2430-61213	RWR(M):XX	N/A	L	U	6	N
	Patch 6	14-Jul-09	2430-61279	XX:DW(M)	N/A	SY	F	13	R 4 Aug

Table 3.4. Willow Flycatchers Detected at NDOW Study Areas, 2010 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[2]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
KEPI	Patch 6	2-Aug-10	2540-58205	GV(M):TQ	N/A	L	U	13	N
	Patch 12	2-Aug-10	2540-58204	TQ:WR(M)	N/A	AHY	F	17	N
	Patch 12	N/A	N/A	UB:UB	N/A	AHY	M	17	RS
	Patch 12	N/A	N/A	UB:UB	N/A	HY	U	17	RS
	Patch 12	N/A	N/A	UB:UB	N/A	HY	U	17	RS
	Patch 12	N/A	N/A	UB:UB	N/A	HY	U	17	RS
	Patch 2	26-Jun-03	2320-31463	EE:WB(M)	N/A	8Y	F	44	RS
	Patch 2	29-Jul-09	2370-40141	PU:YK(M)	N/A	3Y	M	44	RS
	Patch 2	30-Jun-10	2370-40051	WOW(M):PU	N/A	L	U	44	N; died before fledging
	Patch 2	30-Jun-10	2430-61228	XX:BVB(M)	N/A	L	U	44	N; died before fledging
	Patch 2	30-Jun-10	2430-61229	XX:DRD(M)	N/A	L	U	44	N; died before fledging
	Patch 10	21-Jul-10	2430-61100	XX:YKY(M)	N/A	SY	F	46	N
	Patch 10	21-Jul-10	2540-58201	TQ:BO(M)	N/A	L	U	46	N
	Patch 1	28-Jul-10	2540-58203	TQ:WD(M)	N/A	SY	F	52	N
	Patch 1	30-Jun-10	2370-40022	RK(M):PU	N/A	AHY	M	52	N
	Patch 1	24-Jul-10	2540-58101	TQ:KK(M)	N/A	L	U	52	N
	Patch 1	24-Jul-10	2540-58102	TQ:GW(M)	N/A	L	U	52	N
	Patch 1	24-Jul-10	2540-58103	WR(M):TQ	N/A	L	U	52	N
	Patch 3	17-Jul-10	2540-58289	RK(M):TQ	N/A	AHY	F	53	N; mated consecutively with 2 males
	Patch 3	16-Jul-09	2370-40031	OGO(M):PU	N/A	SY	M	53	RS
	Patch 3	2-Jul-09	2370-40024	PU:BV(M)	N/A	SY	M	53	R 17 Jul
	Patch 3	21-Jul-10	2540-58199	TQ:BW(M)	N/A	L	U	53	N
	Patch 3	21-Jul-10	2540-58200	GO(M):TQ	N/A	L	U	53	N
	Patch 5	N/A	N/A	UB:UB	N/A	AHY	F	54	RS
	Patch 5	3-Jul-08	2430-61197	XX:VY(M)	N/A	3Y	M	54	R 28 Jul
	Patch 5	24-Jul-10	2540-58118	TQ:KV(M)	N/A	L	U	54	N
	Patch 5	24-Jul-10	2540-58119	VY(M):TQ	N/A	L	U	54	N

Table 3.4. Willow Flycatchers Detected at NDOW Study Areas, 2010 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[2]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
KEPI	Patch 5	24-Jul-10	2370-40179	PU:GOG(M)	N/A	L	U	54	N
	Patch 4	N/A	N/A	UB:UB	N/A	AHY	F	91	RS
	Patch 4	N/A	N/A	UB:UB	N/A	AHY	M	91	RS
	Patch 4	24-Jul-10	2540-58104	WV(M):TQ	N/A	L	U	91	N
	Patch 8	N/A	N/A	UB:UB	N/A	AHY	F	120	RS
	Patch 8	28-Jul-10	2540-58164	TQ:RR(M)	N/A	L	U	120	N
	Patch 8	28-Jul-10	2540-58165	DB(M):TQ	N/A	L	U	120	N
	Patch 8	28-Jul-10	2540-58166	TQ:VG(M)	N/A	L	U	120	N
	Patch 6	17-Jul-10	2430-61163	DWD(M):XX	N/A	AHY	F	127	N
	Patch 6	17-Jul-10	2540-58290	VB(M):TQ	N/A	L	U	127	N
	Patch 6	17-Jul-10	2540-58291	WB(M):TQ	N/A	L	U	127	N
	Patch 9	8-Jul-10	2540-58156	BG(M):TQ	N/A	AHY	F	135	N
	Patch 9	1-Jul-08	2430-61114	WR(M):XX	N/A	3Y	M	135	R 8 Jul
	Patch 9	10-Jul-10	2540-58222	TQ:OY(M)	N/A	L	U	135	N
	Patch 9	10-Jul-10	2540-58224	TQ:RD(M)	N/A	L	U	135	N
	Patch 9	10-Jul-10	2540-58225	BB(M):TQ	N/A	L	U	135	N
	Patch 9	13-Jul-10	2430-61099	XX:WOW(M)	N/A	L	U	135	N
	Patch 8	15-Jul-08	2430-61124	OY(M):XX	N/A	3Y	F	136	RS
	Patch 2	N/A	N/A	UB:UB	N/A	AHY	M	T40	RS; detected 27 May–30 Jun
	Patch 6	6-Aug-09	2540-58219	TQ:RW(M)	N/A	SY	U	F7	RS; detected 22–30 Jun
	Patch 7	25-Jul-10	2540-58241	TQ:BY(M)	N/A	AHY	F	F8	N; not detected post-capture
	Patch 4	28-Jul-10	2540-58202	TQ:BB(M)	N/A	SY	M	F9	N
	Patch 10.5	10-Jul-10	2540-58223	YV(M):TQ	N/A	SY	M	F47	N; detected 8–10 Jul
WMSP	Muddy Mac	INA	INA	banded	N/A	AHY	F	23	RS
	Muddy Mac	N/A	N/A	UB:UB	N/A	AHY	M	23	RS
	Muddy Stringer #1	29-May-10	2540-58233	TQ:RY(M)	N/A	SY	F	42	N
	Muddy Stringer #1	14-Jul-09	2540-58234[9]	KD(M):TQ	XX:OG(M)	A4Y	M	42,133	R 29 May

Table 3.4. Willow Flycatchers Detected at NDOW Study Areas, 2010 (Continued)

Study Area[1]	Site	Date Banded	Federal Band #[2]	Color Combination[2]	Old Color Combination[2,3,4]	Age[5]	Sex[6]	Territory or Location[7]	Observation Status[8]
WMSP	Muddy Stringer #1	29-Jun-10	2540-58236	TQ:OKO(M)	N/A	L	U	42	N; died before fledging
	Muddy Stringer #1	29-Jun-10	2540-58235	GB(M):TQ	N/A	L	U	42	N; died before fledging
	Muddy Stringer #1	N/A	N/A	UB:UB	N/A	AHY	F	133	RS
	Muddy Mac	8-Jun-10	2430-61088	XX:BKB(M)	N/A	AHY	M	T22	N; detected 5–29 Jun
	Muddy Stringer #1	8-Jun-10	2540-58193	TQ:DB(M)	N/A	AHY	F	F134	N; not detected post-capture

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

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

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

[4] Old combination included only if rebanded in 2010.

[5] **Age in 2010**: L = nestling, HY = hatch year, SY = 2 years, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = 4 years, A4Y = 4 years or older, etc.

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

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

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

[9] Original federal band number 2430-61134.

Table 3.5. Banded Willow Flycatchers, Non-Monitoring Sites, 2010

Study Area[1]	Site	Date Banded	Federal Band #	Color Combination[2]	Age[3]	Sex[4]	Observation Status[5]
STGE	Snipe Pond	22-Jun-09	2540-58132	TQ:OD(M)	A3Y	M	RS
	Snipe Pond	28-Jun-09	2430-61154	RO(M):XX	SY	F	RS
	Snipe Pond	14-Jul-09	2540-58217	TQ:BR(M)	3Y	M	RS
	Seegmiller Marsh	21-Jun-04	2320-31660	BZ(M):EE	7Y	F	RS
	Riverside East	29-Jun-10	2430-61092	XX:RKR(M)	AHY	F	N
	Riverside East	29-Jun-10	2430-61093	XX:VBV(M)	AHY	M	N
	Riverside East	29-Jun-10	2370-40005	RO(M):PU	L	U	N
	Riverside East	29-Jun-10	2370-40007	VW(M):PU	L	U	N
	Riverside East	29-Jun-10	2430-61091	XX:GKG(M)	L	U	N
	Riverside East	27-Jul-08	2370-40148	PU:KR(M)	3Y	F	RS
	Riverside Marsh	9-Jul-10	2430-61230	XX:GWG(M)	AHY	F	N
	Riverside Marsh	9-Jul-10	2430-61231	XX:KYK(M)	L	U	N
	Riverside Marsh	9-Jul-10	2540-58160	DD(M):TQ	L	U	N

[1] STGE = St. George.

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

[3] **Age in 2010:** L = nestling, SY = 2 years, AHY = 2 years or older, 3Y = 3 years, A3Y = 3 years or older, 4Y = 4 years, A4Y = 4 years or older, etc.

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

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

Adult Between-Year Return and Dispersal

In 2009 we individually identified 78 adult, resident willow flycatchers at our monitored study areas, of which 38 (49%) were detected in 2010 (Table 3.6). Of the returning resident adults, five (13%) were detected at a different study area than where they were last detected in 2009 (Table 3.7). One adult flycatcher that was detected in 2009 but not confirmed to be a resident was detected at a different study area in 2010. Four additional flycatchers that were last detected in 2007 or 2008 exhibited between-year movement in 2010. The median dispersal distance for all returning adult flycatchers exhibiting between-year movements in 2010 was 34.0 km (min = 13.6 km, max = 250.3 km).

Table 3.6. Resident Adult Willow Flycatcher Annual Return from 2009 to 2010

Study Area	# Identified in 2009	# of 2009 Birds Detected in 2010	% Return	% Return to Same Study Area
Pahranagat	20	13	65	100
Littlefield	2	1	50	100
Mesquite	15	9	60	44
Mormon Mesa	21	9	43	100
Muddy River	6	2	33	100
Topock	5	2	40	100
Bill Williams	9	2	22	100
Total	**78**	**38**	**49**	**87**

Table 3.7. 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 2010

Study Area/Site/Year Detected[1]	Study Area/Site Detected 2010[1]	Distance Moved (km)	Federal Band #	Color Combination[2]	Sex[3]
MUDD/Overton WMA/2007	MOME/Virgin River #1 South	13.6	2370-39956	PU:ZZ(M)	F
MUDD/Overton WMA/2007	BIWI/Site #3	250.3	2370-40192	PU:RB(M)	F
MUDD/Overton WMA/2008	MOME/Virgin River #1 South	13.7	2320-31632	RZ(M):EE	F
TOPO/Pipes #3/2008[5]	WMSP/Muddy Stringer #1	210.6	2540-58234	KD(M):TQ	M
MESQ/West/2009	PAHR/North	107.7	2360-59754	OR(M):EE	M
MESQ/West/2009[4]	MOME/Virgin River #1 South	27.3	2390-92434	UB:XX	M
MESQ/West/2009	MOME/Virgin River #1 South	27.4	2370-40197	OG(M):PU	M
MESQ/Bunker Marsh/2009	MOME/Virgin River #1 South	22.8	2430-61165	XX:RY(M)	M
PAHR/North/2009	MUDD/Overton WMA	109.5	2540-58189	DR(M):TQ	M
MESQ/West/2009	MUDD/Overton WMA	40.5	2370-40193	GY(M):PU	F

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

[2] **Color-band codes**: EE = electric yellow federal band, PU = pumpkin federal band, XX = standard silver federal band, TQ = turquoise federal band, (M) = metal pin striped band, R = red, O = orange, Y = yellow, G = green, D = dark blue, B = light blue, Z = gold, UB = unbanded. 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] Band number likely 2390-92434 but cannot be confirmed because bird was not captured in 2010. Bird had visible injury on left leg. A male with an injury on the unbanded left leg and a silver federal band on the right was captured in MESQ in 2005. This is likely the same individual.

[5] Original federal band number 2430-61134.

Juvenile Between-Year Return and Dispersal

In 2009, we banded 44 nestlings at the monitored study areas. Four of these nestlings were known to have died before fledging. Of the 40 remaining juveniles, 8 (20%) were identified in 2010. One individual originally banded as a nestling in 2007 and 10 individuals originally banded as nestlings in 2008 were identified for the first time in 2010. Four additional individuals originally banded as nestlings in Key Pittman were identified in 2010; one was originally banded in 2007, one was originally banded in 2008, and two were originally banded in 2009 (Table 3.8). Of the 23 returning nestlings identified in 2010, 16 (70%) dispersed away from their natal study area. The median dispersal distance for all returning juvenile flycatchers in 2010 was 30.0 km (min = 0.02 km, max = 201.2 km).

Four additional returning nestlings from 2003–2007 were resighted in 2010 (three at Mormon Mesa and one 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 2010.

Table 3.8. Summary of Juvenile Flycatchers Banded as Hatch Year Birds in 2007, 2008, or 2009 and Identified for the First Time in 2010

Study Area/ Site Banded[1]	Year Hatched	Study Area/Site Detected 2010[1]	Distance Moved (km)	Federal Band #	Color Combination[2]	Sex[3]
KEPI/Patch 2	2007	MOME/Virgin River #1 South	132.1	2360-59782	KGK(M):EE	F
TOPO/Pierced Egg	2007	TOPO/The Wallows	1.3	2370-40112	RD(M):PU	M
KEPI/Patch 6	2008	KEPI/Patch 11	0.4	2370-40097	PU:GY(M)	M
PAHR/North	2008	KEPI/Patch 5	30.0	2430-61197	XX:VY(M)	M
PAHR/North	2008	KEPI/Patch 8	30.1	2430-61124	OY(M):XX	F
PAHR/North	2008	KEPI/Patch 9	30.1	2430-61114	WR(M):XX	M
PAHR/North	2008	PAHR/North	0.02	2430-61123	XX:VK(M)	F
MESQ/West	2008	PAHR/North	107.5	2430-61176	DK(M):XX	M
MOME/Virgin River #1 South	2008	MESQ/West	27.2	2430-61174	XX:VWV(M)	F
MOME/Virgin River #1 South	2008	MOME/Virgin River #1 North	0.3	2430-61206	XX:BW(M)	U
PAHR/North	2008	MOME/Virgin River #1 South	105.1	2430-61106	XX:KV(M)	M
MESQ/West	2008	MOME/Virgin River #1 South	27.3	2430-61189	KB(M):XX	M
MESQ/West	2008	MUDD/Overton WMA	40.9	2430-61084	XX:BO(M)	M
KEPI/Patch 8	2009	KEPI/Patch 3	0.6	2370-40024	PU:BV(M)	M
KEPI/Patch 9	2009	KEPI/Patch 3	0.6	2370-40031	OGO(M):PU	M
PAHR/North	2009	KEPI/Patch 6	30.1	2430-61279	XX:DW(M)	F
MESQ/West	2009	KEPI/Patch 6	131.9	2540-58219	TQ:RW(M)	U
MESQ/West	2009	STGE/Snipe Pond	63.9	2430-61154	RO(M):XX	F
MOME/Virgin River #1 South	2009	MESQ/West	27.4	2370-40175	PU:OKO(M)	M
MOME/Virgin River #1 South	2009	MESQ/West	27.5	2370-39930	PU:GO(M)	M
MOME/Virgin River #1 South	2009	MOME/Virgin River #1 South	1.1	2370-40151	RR(M):PU	F
MOME/Virgin River #1 South	2009	TOPO/800M	201.2	2540-58154	DO(M):TQ	M
MOME/Virgin River #1 South	2009	TOPO/The Wallows	199.9	2370-40144	OKO(M):PU	M

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

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

DISCUSSION

Color-Banding Effort

Overall, 66% of the adult flycatchers detected at the monitoring sites during 2010 were banded by the end of the breeding season. This compares to 55, 57, 75, 70, 73, 69 and 67% in 2003–2009, 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 eight 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 2008–2010 we applied unique color combinations to all nestlings. The use of full color combinations on nestlings in 2008 and 2009 resulted in approximately half as many adults with single federal bands being detected in 2009 and 2010 than in previous years. Additionally, we recorded juvenile dispersal movements that might otherwise have gone undetected. Although a large number (170) of unique color combinations were used on nestlings in 2008–2010, the benefits in terms of high-resolution demographic data outweigh the loss of unique color combinations.

Two nestlings at Pahranagat were fatally injured during banding in 2010. We notified USFWS immediately and suspended all banding activities until we received clearance from USFWS to proceed. As a result of this incident and ensuing discussions with USFWS, we altered our nestling banding protocol. The protocol originally specified placing the bird bag containing the nestlings on the banding tarp. The protocol has been changed to specify hanging the bird bag containing the nestlings within view and above ground. This protocol change has been approved by the USFWS.

Adult and Juvenile Between-Year Dispersal

Returning adults that were detected at Mesquite in 2009 showed particularly low site fidelity in 2010. This may be the result of poor habitat quality in 2009, when the site was unusually dry and the willows showed premature leaf abscission as early as May (McLeod and Koronkiewicz 2010). Fidelity may also be influenced by the previous year’s productivity, with territory fidelity increasing with the number of young fledged in the previous year (Paxton et al. 2007). All the adults that moved from Mesquite in 2009 to a different study area in 2010 failed to fledge young in 2009.

Resident adults detected at Topock have historically shown very high site fidelity. Until 2010, no between-year movements of resident Topock adults to another study area had been documented. In 2010, a resident, breeding male was identified in Warm Springs who had last been identified in 2008 as a breeding male in Topock. This is the first evidence that individuals who do not return to Topock after being documented in a given year may be moving to other locations. When an individual is not identified in a given year, there is no way to distinguish between going undetected, mortality, or emigration from the study area. Documenting emigration allows for an estimation of emigration rates, thereby improving the accuracy of survival estimates. It is possible that there have been movements of resident, unbanded Topock adults to other monitored study areas, but there would be no way to detect these movements.

Adult and juvenile dispersal data for the 2010 field season show overall high site fidelity exhibited by adult flycatchers and lower natal site fidelity exhibited by juveniles, with juveniles dispersing among study areas annually. These dispersal data are consistent with the patterns observed in the LCR region from 1998 to 2010, over which period 91% of adult returns were to the same study area while only 50% of all juvenile returns were to the natal study area (McKernan and Braden unpubl. data, McLeod et al. 2008; McLeod and Koronkiewicz 2009, 2010). 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). Banding studies at Roosevelt Lake and along the San Pedro River were discontinued after 2005, so immigration of juveniles produced in those areas after 2005 would have gone undetected.

The observed dispersal patterns fit well with the tenets of contemporary metapopulation theory (Hanski and Simberloff 1997), suggesting the Virgin/lower Colorado River population may be a panmictic sub-population of a greater metapopulation. Occasional juvenile dispersal between sub-populations is likely an important population variable in terms of 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. Forty-nine percent of the adult, resident willow flycatchers identified in 2009 were detected again in 2010, while of the 40 juveniles banded in 2009, only 9 (23%) were identified in 2010. Thus, minimum estimated adult and juvenile survival from 2009 to 2010 was 49 and 23%, 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 2010, 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 2010 were compared with those at the study areas from 1996 to 2009 (Braden and McKernan unpubl. data, McLeod et al. 2008, McLeod and Koronkiewicz 2009, McLeod and Koronkiewicz 2010). Although aspects of willow flycatcher breeding ecology can vary widely across its broad geographical and elevational ranges throughout the Southwest (Whitfield et al. 2003), we compared monitoring results with range-wide data to identify specific variables that may contribute to the characterization of flycatcher breeding ecology throughout the lower Colorado and Virgin River riparian systems.

METHODS

Upon locating territorial willow flycatchers, regardless of whether a possible mate was observed, we conducted intensive nest searches following the methods of Rourke et al. (1999). Nest monitoring followed a modification of the methods described by Rourke et al. (1999) and the Breeding Biology Research and Monitoring Database (BBIRD) protocol by Martin et al. (1997).

Nests were located primarily by observing adult flycatchers return to a nest or by systematically searching suspected nest sites. Nests were monitored every two to four days after nest building was complete and incubation was confirmed. Nests at NDOW study areas were monitored less frequently (every four days or more) because of budgetary restrictions. During incubation and after hatching, nest contents were observed directly using a telescoping mirror pole to determine nest contents and transition dates. Nest monitoring during nest building and egg laying stages was limited to reduce the chance of abandonment during these periods. To reduce the risk of depredation (Martin et al. 1997), brood parasitism by the Brown-headed Cowbird, and premature fledging of young (Rourke et al. 1999), we observed nests from a distance with binoculars once the number and age of nestlings were confirmed. If no activity was observed at a previously occupied nest, the nest was checked directly to determine nest contents and cause of failure. If no activity was observed at a nest close to or on the estimated fledge date, we conducted a systematic search of the area to locate possible fledglings.

Per instructions from Reclamation biologists, we considered a willow flycatcher nest successful only if fledglings were observed near the nest or in surrounding areas. The number of young fledged from each nest was counted based on the number of fledglings actually observed. This method of determining success differs from that recommended by some nest monitoring protocols (e.g., Martin et al. 1997, Rourke et al. 1999), which consider a nest as successful if chicks are observed in the nest within two days of the estimated fledge date. The method we follow produces a conservative estimate of both nest success rate and number of fledges.

We considered a nest to have failed if (1) the nest was abandoned prior to egg laying (abandoned); (2) the nest was deserted with flycatcher eggs or young remaining (deserted); (3) the nest was found empty or destroyed more than two days prior to the estimated fledge date (depredated); (4) 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 (2.14, 12.87, and 13.73 days for laying, incubation, and nestling stages, respectively) as observed in this study in 2003–2010 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.

We attempted to addle cowbird eggs in easily accessible flycatcher nests at all study areas except Pahranagat in 2010. If the nest was accessible without a ladder, the cowbird egg was addled as soon as it was discovered. If a ladder was required, the cowbird egg was addled on the next regularly scheduled nest visit. Cowbird eggs were addled only if we could obtain a direct view of the nest contents from a secure location, either on the ground on or a ladder. We carefully removed the cowbird egg from the nest and placed it in a padded film canister. We then shook the canister vigorously for about one minute, incorporating sharp, jerky movements. The egg was then returned to the nest. The cowbird egg was not permanently removed from the nest so as not to mimic a partial depredation event, which might result in nest desertion. If a nest was found with a cowbird nestling already in the nest, or if a shaken cowbird egg still hatched, we removed the cowbird nestling from the nest.

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

RESULTS

Reclamation Study Areas

Nest Monitoring

We documented 70 willow flycatcher nesting attempts at Pahranagat, Littlefield, Mesquite, Mormon Mesa, Muddy River, Topock Marsh, and Bill Williams; 60 of these nests were known to contain flycatcher eggs and were used in calculating nest success and productivity. Twenty-six (43%) nests were successful and fledged young, and 34 (57%) failed. Nest success ranged from 18% at Bill Williams River NWR to 100% at Muddy River (Table 4.1). For a comparison of apparent nest success at all monitoring sites from 1997 to 2010, see Table 4.2.

Thirty-eight nesting females, of which all but one were known to have produced at least one egg, were followed through all of their nesting attempts. One additional female was documented for which no nesting attempt could be confirmed. Of the 38 nesting females, 17 had one nesting attempt, 12 had two nesting attempts, 7 had three nesting attempts, and 2 had four nesting attempts. Of the 21 females with multiple nesting attempts, 20 renested after failed nests and 1 renested after a successful nest.

Table 4.1. Summary of Willow Flycatcher Nest Monitoring Results at Reclamation Study Areas, 2010

Study Area[1]	Site	Pairs	Nests	Nests with 1+ WE[2]	Successful Nests[3]	Failed Nests[3]	Nests with Unknown Fate	Parasitized Nests[4]
PAHR	North	10	20	17	10 (59)	7 (41)	0	0
	Total	*10*	*20*	*17*	*10 (59)*	*7 (41)*	*0*	*0*
LIFI	Poles	1	2	2	1 (50)	1 (50)	0	0
	Total	*1*	*2*	*2*	*1 (50)*	*1 (50)*	*0*	*0*
MESQ	Hafen Lane	1	1	1	0	1 (100)	0	1 (100)
	West	6	15	12	4 (33)	8 (67)	0	7 (58)
	Total	*7*	*16*	*13*	*4 (31)*	*9 (69)*	*0*	*8 (62)*
MOME	Virgin River #1 South	10	15	12	5 (42)	7 (58)	0	0
	Total	*10*	*15*	*12*	*5 (42)*	*7 (58)*	*0*	*0*
MUDD	Overton WMA	4	4	3	3 (100)	0	0	1 (33)
	Total	*4*	*4*	*3*	*3 (100)*	*0*	*0*	*1 (33)*
TOPO	Pipes #3	1	0	0	0	0	0	0
	Platform	1	1	1	0	1 (100)	0	0
	Glory Hole	1	1	1	1 (100)	0	0	0
	Total	*3*	*2*	*2*	*1 (50)*	*1 (50)*	*0*	*0*
BIWI	Burn Edge	1	3	3	0	3 (100)	0	0
	Site 3	2	6	6	1 (17)	5 (83)	0	3 (60)
	Planet Ranch Rd	1	2	2	1 (50)	1 (50)	0	0
	Total	*4*	*11*	*11*	*2 (18)*	*9 (82)*	*0*	*3 (30)*
Overall Total		**39**	**70**	**60**	**26 (43)**	**34 (57)**	**0**	**12 (21)**

[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 Reclamation Study Areas from 1996 to 2010*

Year	Pahranagat	Littlefield	Mesquite[1]	Mormon Mesa[2]	Muddy River	Grand Canyon	Topock	Bill Williams
1996	Nm[3]	Nm[3]	Nm[3]	Nm[3]	Nm[3]	Nc[5]	Nc[5]	Nm[3]
1997	Nm[3]	Nd[4]	67 (3)	42 (12)	Nc[5]	Nc[5]	Nc[5]	Nd[4]
1998	47 (19)	Nd[4]	0 (7)	70 (10)	Nm[3]	Nc[5]	53 (15)	Nd[4]
1999	60 (15)	Nm[3]	Nd[4]	45 (11)	Nm[3]	Nc[5]	38 (16)	100 (1)
2000	63 (16)	Nd[4]	50 (8)	38 (13)	100 (1)	Nc[5]	36 (11)	100 (1)
2001	50 (18)	Nd[4]	53 (17)	54 (13)	Nc[5]	Nc[5]	36 (14)	50 (4)
2002	33 (12)	Nd[4]	59 (17)	0 (9)	Nd[4]	Nd[4]	50 (6)	78 (9)
2003	91 (11)	Nd[4]	44 (18)	0 (10)	Nd[4]	Nd[4]	78 (9)	100 (2)
2004	76 (17)	50 (2)	24 (17)	50 (6)	Nd[4]	Bc[6]	45 (38)	Nd[4]
2005	58 (19)	Nd[4]	42 (12)	17 (6)	38 (8)	Nd[4]	24 (34)	100 (2)
2006	60 (15)	Nd[4]	55 (20)	50 (8)	44 (9)	0 (3)	23 (17)[7]	20 (5)
2007	67 (12)	Nd[4]	57 (14)	27 (11)	0 (6)	0 (1)	75 (8)	25 (8)
2008	80 (10)	Nd[4]	82 (11)	62 (13)	25 (8)	Nd[4]	13 (8)[8]	40 (5)8
2009	47 (17)8	0 (1)	21 (14)[8]	53 (17)	0 (8)	Nm[3]	50 (2)	33 (6)
2010	59 (17)	50 (2)	31 (13)	42 (12)	100 (3)	Nm[3]	50 (2)	18 (11)

* 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; data from 2009 are in McLeod and Koronkiewicz 2010; and data from 2010 are in this document. Total number of nests containing at least one flycatcher egg is indicated in parentheses.

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

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

[3] Nm = study area not monitored.

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

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

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

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

[8] Fate of one nest was unknown.

Nest Failure

Depredation was the major cause of nest failure, accounting for 45% (20 of 44) of all failed nests (Table 4.3) and 59% (20 of 34) of nests that failed after flycatcher eggs were laid. Ten nesting attempts (23% of all failed nests) were abandoned prior to willow flycatcher eggs being laid, and 11 nests (25%) were deserted. Three nests (7%) failed because of Brown-headed Cowbird parasitism (see below for more details on parasitism).

Brood Parasitism

Twelve of 56[1] nests (21%) 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 three nests. In all of these cases, the parasitism event coincided with the disappearance of all flycatcher eggs. No cowbirds fledged. Three parasitized nests (25%) successfully fledged at least one flycatcher. Of the

[1] Table 4.1 shows a total of 60 nests known to contain at least one flycatcher egg. When calculating brood parasitism rates, however, four nests whose contents could not be determined were excluded from calculations (e.g., nests that were too high to check contents to determine presence/absence of cowbird eggs or nesting attempts that were discovered late in the nesting cycle).

remaining six parasitized nests that contained flycatcher eggs, four were deserted and two were depredated. Brood parasitism ranged from 0 to 62% and was highest at Mesquite (see Table 4.1). In 2010, nests that contained flycatcher eggs and were brood parasitized were not less likely to fledge flycatcher young than nests that were not parasitized (Chi-square = 1.99, $P = 0.158$).

Table 4.3. Summary of Causes of Willow Flycatcher Nest Failure at Reclamation Study Areas, 2010*

Study Area[1]	Total # Nests	All Failed Nests	Abandoned	Deserted	Depredated	Parasitized	Addled	Unknown
PAHR	20	10	3 (30)[2]	1 (10)[3]	6 (60)	0	0	0
LIFI	2	1	0	0	1 (100)	0	0	0
MESQ	16	12	3 (25)[4]	2 (17)[5]	4 (33)	3 (25)	0	0
MOME	15	10	3 (30)	2 (20)[6]	5 (50)	0	0	0
MUDD	4	1	1 (100)	0	0	0	0	0
TOPO	2	1	0	1 (100)[7]	0	0	0	0
BIWI	11	9	0	5 (56)[8]	4 (44)	0	0	0
Total	**70**	**44**	**10 (23)**	**11 (25)**	**20 (45)**	**3 (7)**	**0**	**0**

* 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] *One nest abandoned after being parasitized.*

[3] *Nest deserted after partial depredation.*

[4] *Two nests abandoned* after being parasitized.

[5] Both nests deserted after being parasitized.

[6] One nest deserted after partial depredation, one nest deserted after 5 days of incubation.

[7] Nest deserted after 9 days of incubation.

[8] Four nests deserted after partial depredation; for one nest, female rebuilt over original nest. Contents of original nest undetermined.

Table 4.4. Fates of Willow Flycatcher Nests Parasitized by Brown-Headed Cowbirds, 2010*

Study Area[1]	Nest ID Code	Outcome[2]
PAHR	119A	Abandoned after parasitism
MESQ	1A	Found deserted with 1 WE and 2 CE
	1B	Parasitized during incubation of clutch of one WE; WE disappeared, one CE appeared
	39A	Depredated late in nestling stage. CE addled, but still hatched. CN removed at age 1 day
	111A	Abandoned after parasitism
	111A2	Parasitized during incubation; all three WE disappeared, one CE appeared
	111C	Depredated during incubation; camera showed both WE removed by BHCO. CE already in nest
	112B	Parasitized during laying. WE on ground, CE in nest
	113A	Deserted with one WE and one CE
	113B	Abandoned with one CE
	113C	Fledged two, possibly three, flycatchers. CE was addled and never hatched
MUDD	121A	Fledged two flycatchers. CE was addled and never hatched
BIWI	10A	Deserted after partial depredation reduced nest contents from two WE and one CE to one WE
	10B	Deserted after partial depredation reduced nest contents from two WE and one CE to one WE
	10C	Fledged one flycatcher. CE was addled and never hatched

* All nesting attempts are included.

[1] PAHR = Pahranagat NWR, MESQ = Mesquite, MUDD = Muddy River, BIWI = Bill Williams River NWR.

[2] WE = willow flycatcher egg, CE = cowbird egg, CN = cowbird nestling, BHCO = Brown-headed Cowbird.

Cowbird Egg Addling

Four parasitized nests were incubated long enough for the cowbird eggs to hatch (Table 4.5). We addled all four cowbird eggs from these nests and only one (25%) hatched. The cowbird nestling was removed from this nest one day after hatching. The 2010 hatch rate of 25% is lower than annual hatch rates of un-addled eggs in 2003–2009 (min = 60; max = 89; median = 75).

In 2010, all four parasitized nests that were incubated full-term hatched flycatcher nestlings (Table 4.6). Of the four nests, three (75%) were successful and fledged at least one flycatcher. Success rates of parasitized nests that hatched at least one flycatcher nestling in 2003–2009 ranged from 44 to 100%. In parasitized nests that hatched flycatchers, the number of nestlings that survived to at least 8 days old (banding age) was higher in 2010 (1.8/nest) than in 2003–2009 (min = 0.6; max = 1.5; median = 1.3). The 2010 fledge rate (1.3/nest) in these nests was comparable to 2003–2009 fledge rates (min = 0.6; max = 1.5; median = 0.8).

Table 4.5. Brown-headed Cowbird Annual Hatch Rate in Willow Flycatcher Nests at Reclamation Study Areas from 2003 to 2010

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

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

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

Table 4.6. Willow Flycatcher Nesting Success for Parasitized Nests at Reclamation Study Areas from 2003 to 2010

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

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

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

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

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

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

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

Mayfield Nest Success and Nest Productivity

Mayfield survival probability (MSP) ranged from 0.165 at Bill Williams to 1.000 at Muddy River and was 0.402 for all sites combined (Table 4.7). At all sites, 59 nestlings were confirmed to have fledged from 60 nests of known outcome (mean number of fledglings/nest = 0.98, SE = 0.16). Fecundity across study areas ranged from 0.50 to 3.00 young per female and averaged 1.51 (SE = 0.20) (Table 4.8).

Table 4.7. Daily Survival Rates and Mayfield Survival Probabilities (MSP) for Willow Flycatcher Nest Stages at Reclamation Study Areas, 2010*

Study Area	Nest Stage[1]	Nest Losses/ Observation Days	Daily Survival Rate	Mayfield Survival Probability
Pahranagat	1	0/31	1.000	1.000
	2	7/172.5	0.959	0.587
	3	0/137	1.000	1.000
	MSP all stages = 0.587			
Littlefield	1	0/2	1.000	1.000
	2	1/12	0.917	0.326
	3	0/15	1.000	1.000
	MSP all stages = 0.326			
Mesquite	1	3/16	0.813	0.641
	2	4/116	0.966	0.636
	3	2/69.5	0.971	0.670
	MSP all stages = 0.273			
Mormon Mesa	1	1/18	0.944	0.885
	2	5/92	0.946	0.487
	3	1/58	0.983	0.788
	MSP all stages = 0.339			
Muddy River	1	0/2	1.000	1.000
	2	0/31	1.000	1.000
	3	0/44.5	1.000	1.000
	MSP all stages = 1.000			
Topock	1	0/6	1.000	1.000
	2	1/21	0.952	0.534
	3	0/12	1.000	1.000
	MSP all stages = 0.534			
Bill Williams	1	3/16	0.813	0.641
	2	6/60	0.900	0.258
	3	0/24	1.000	1.000
	MSP all stages = 0.165			
Total	**1**	**7/91**	**0.923**	**0.843**
	2	**24/504.5**	**0.952**	**0.535**
	3	**3/360**	**0.992**	**0.891**
	MSP all stages = 0.402			

* Mayfield survival probability was calculated using 2.14-day egg laying, 12.87-day incubation, and 13.73-day nestling stages.
[1] 1 = egg laying, 2 = incubation, 3 = nestling.

Table 4.8. Willow Flycatcher Nest Productivity (Young Fledged per Nest) and Fecundity (Young Fledged per Female) at Reclamation Study Areas, 2010*

Study Area	Young Fledged	# Nests	Productivity Mean (SE)	# Females	Fecundity Mean (SE)
Pahranagat	26	17	1.53 (0.34)	10	2.6 (0.22)
Littlefield	3	2	1.5 (1.5)	1	3.00
Mesquite	7	13	0.54 (0.27)	7	1.00 (0.44)
Mormon Mesa	12	12	1.00 (0.39)	10	1.20 (0.44)
Muddy River	7	3	2.33 (0.33)	4	1.75 (0.63)
Topock	2	2	1.00 (1.00)	3	0.67 (0.67)
Bill Williams	2	11	0.18 (0.12)	4	0.5 (0.29)
Total	**59**	**60**	**0.98 (0.16)**	**39**	**1.51 (0.20)**

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

NDOW Study Areas

Nest Monitoring

We documented 34 willow flycatcher nesting attempts at Key Pittman and Warm Springs; 33 of these nests were known to contain flycatcher eggs and were used in calculating nest success and productivity. Fifteen (45%) nests were successful and fledged young, and 18 (55%) failed. Nest success was 50% at Key Pittman and 0% at Warm Springs (Table 4.9).

Twenty nesting females, all of which were known to have produced at least one egg, were followed through all of their nesting attempts. Two additional females were documented for which pairing status could not be confirmed and no nesting attempt was found. Of the 20 nesting females, 9 had one nesting attempt, 8 had two nesting attempts, and 3 had three nesting attempts. All 11 females with multiple nesting attempts renested after failed nests.

Table 4.9. Summary of Willow Flycatcher Nest Monitoring Results at NDOW Study Areas, 2010

Study Area[1]	Site	Pairs	Nests	Nests with 1+ WE[2]	Successful Nests[3]	Failed Nests[3]	Nests with Unknown Fate[3]	Parasitized Nests[4]
KEPI	Patch 1	1	2	2	1 (50)	1 (50)	0	0
	Patch 2	1	2	2	0	2 (100)	0	0
	Patch 3	1	2	2	1 (50)	1 (50)	0	1 (50)
	Patch 4	1	2	2	1 (50)	1 (50)	0	0
	Patch 5	1	3	3	1 (33)	2 (67)	0	0
	Patch 6	3	4	4	3 (75)	1 (25)	0	0
	Patch 7	1	1	1	1 (100)	0	0	0
	Patch 8	3	5	5	2 (40)	3 (60)	0	1 (20)
	Patch 9	1	1	1	1 (100)	0	0	0
	Patch 10	2	4	3	2 (67)	1 (33)	0	0
	Patch 11	1	3	3	1 (33)	2 (67)	0	1 (33)
	Patch 12	1	2	2	1 (50)	1 (50)	0	0
	Total	*17*	*31*	*30*	*15 (50)*	*15 (50)*	*0*	*3 (11)*

Table 4.9. Summary of Willow Flycatcher Nest Monitoring Results at NDOW Study Areas, 2010 (Continued)

Study Area[1]	Site	Pairs	Nests	Nests with 1+ WE[2]	Successful Nests[3]	Failed Nests[3]	Nests with Unknown Fate[3]	Parasitized Nests[4]
WMSP	Muddy Mac	1	1	1	0	1 (100)	0	0
	Muddy Stringer #1	2	2	2	0	2 (100)	0	0
	Total	*3*	*3*	*3*	*0*	*3 (100)*	*0*	*0*
Overall Total		**20**	**34**	**33**	**15 (45)**	**18 (55)**	**0**	**3 (10)**

[1] KEPI = Key Pittman WMA, WMSP = Warm Springs NA.

[2] WE = willow flycatcher egg.

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

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

Nest Failure

Depredation was the major cause of nest failure, accounting for 68% (13 of 19) of all failed nests (Table 4.10) and 72% (13 of 18) of nests that failed after flycatcher eggs were laid. One nesting attempt (5% of all failed nests) was abandoned prior to willow flycatcher eggs being laid, and one nest (5%) was deserted. Two nests (11%) failed because of Brown-headed Cowbird parasitism (see below for more details on parasitism). Two nests (11%) failed because of fire.

Table 4.10. Summary of Causes of Willow Flycatcher Nest Failure at NDOW Study Areas, 2010*

Study Area[1]	Total # Nests	All Failed Nests	Abandoned	Deserted	Depredated	Parasitized	Addled	Fire	Unknown
KEPI	31	16	1 (7)	1 (7)[2]	12 (80)	2 (13)	0	0	0
WMSP	3	3	0	0	1 (33)		0	2 (67)	0
Total	**34**	**19**	**1 (5)**	**1 (5)**	**13 (68)**	**2 (11)**	**0**	**2 (11)**	**0**

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

[1] KEPI = Key Pittman WMA, WMSP = Warm Springs NA.

[2] Nest deserted after parasitism.

Brood Parasitism

Three of 31[2] nests (10%) with flycatcher eggs and known contents were brood parasitized by Brown-headed Cowbirds (Table 4.11). All three nests failed. In two of these cases, the cowbird nestling outlived any flycatcher nestlings before it was removed. The remaining nest was deserted. Brood parasitism was 11% at Key Pittman and 0% at Warm Springs (see Table 4.9).

[2] Table 4.9 shows 33 nests known to contain at least one flycatcher egg. When calculating brood parasitism rates, however, two nests whose contents could not be determined were excluded from calculations (e.g., nesting attempts that were discovered late in the nesting cycle).

Table 4.11. Fates of Willow Flycatcher Nests Parasitized by Brown-Headed Cowbirds in Key Pittman and Warm Springs Study Areas, 2010*

Study Area[1]	Nest ID Code	Outcome[2]
KEPI	2B	Cowbird nestling removed at age 5 days. Unhatched WE removed same day. One flycatcher nestling disappeared before cowbird nestling was removed.
	53A	Deserted with one WE and one CE
	136A	Cowbird nestling removed at age 9 days. One flycatcher nestling disappeared before cowbird nestling was removed.

* All nesting attempts are included.

[1] KEPI = Key Pittman WMA.

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

Cowbird Egg Addling

One Brown-headed Cowbird nestling was removed from each of the two parasitized, active nests found at Key Pittman WMA. One nest was found late in incubation, and the other was found with the cowbird nestling. Due to reduced frequency of visits to this study area and initial misidentification of the cowbird nestlings, both cowbird nestlings were removed from these nests at a minimum age of 5 days. At the time each cowbird nestling was removed, one flycatcher nestling had already disappeared from each nest. These two nests are not included in calculations of cowbird egg hatch rate or parasitized flycatcher nestling success as they do not fit the standardized protocol applied to the other study areas.

Mayfield Nest Success and Productivity

Mayfield survival probability (MSP) was 0.407 at Key Pittman and 0.095 at Warm Springs and was 0.376 for both sites combined (Table 4.12). At all sites, 37 nestlings were confirmed to have fledged from 33 nests of known outcome (mean number of fledglings/nest = 1.12, SE = 0.25). Fecundity across study areas ranged from 0 to 2.06 young per female and averaged 1.68 (SE = 0.31) (Table 4.13).

Table 4.12. Daily Survival Rates and Mayfield Survival Probabilities (MSP) for Willow Flycatcher Nest Stages NDOW Study Areas, 2010*

Study Area	Nest Stage[1]	Nest Losses/ Observation Days	Daily Survival Rate	Mayfield Survival Probability
Key Pittman	1	2/35	0.943	0.882
	2	8/225	0.964	0.627
	3	5/226	0.978	0.735
	MSP all stages = 0.407			
Warm Springs	1	0/5	1.000	1.000
	2	2/29.5	0.932	0.405
	3	1/10	0.900	0.235
	MSP all stages = 0.095			
Total	**1**	**2/40**	**0.950**	**0.896**
	2	**10/254.5**	**0.961**	**0.597**
	3	**6/236**	**0.975**	**0.702**
	MSP all stages = 0.376			

* Mayfield survival probability was calculated using 2.14-day egg laying, 12.87-day incubation, and 13.73-day nestling stages.

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

Table 4.13. Willow Flycatcher Nest Productivity (Young Fledged per Nest) and Fecundity (Young Fledged per Female) at NDOW Study Areas, 2010*

Study Area	Young Fledged	# Nests	Productivity Mean (SE)	# Females	Fecundity Mean (SE)
Key Pittman	37	30	1.23 (0.27)	18	2.06 (0.32)
Warm Springs	0	3	0	4	0 (0)
Total	**37**	**33**	**1.12 (0.25)**	**22**	**1.68 (0.31)**

* 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 2010, 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 and Littlefield was nearly identical to that recorded in 2009. Mormon Mesa had 10 pairs in 2010, down from 13 in 2009. Bill Williams and Muddy River both had four pairs in 2010 versus six in 2009. Mesquite experienced the largest drop in breeding pairs, with 12 in 2009 and 7 in 2010. The number of pairs at Mesquite may have been influence by poor habitat conditions at the site in 2009 (see discussion in Chapters 2 and 3). 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 11 resident flycatchers, which consisted of 6 unpaired individuals and three pairs, the lowest number of resident individuals recorded since 2003. For one of the pairs, the female was seen only once (and thus not counted as a resident), and no nesting attempt was documented; the male left the territory nine days after the female was detected. In one other territory at Topock, we detected a second flycatcher in addition to the territorial male. This individual was seen only once 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 suspected female is 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 a suspected non-breeding female 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 in 2010 differed little (4% or less) from apparent nest success at most study areas. At Littlefield and Mormon Mesa, Mayfield nest success (33 and 34%, respectively) was lower than apparent nest success (50 and 42%, respectively). The low Mayfield estimate at Littlefield was influenced by the one failed nest failing early in incubation. At Mormon Mesa, the low Mayfield estimate was influenced by several nests failing early in incubation and one nest failing early in the nestling stage. The close agreement between Mayfield and apparent 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 = 59%, MSP = 59%), was, as it has been every year since 2003, higher than the average for all study areas. 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 (1.53 young per nest) and fecundity (2.60 young per female) at Pahranagat in 2010 were again among the highest recorded at any study area, demonstrating that Pahranagat continues to be a highly productive site for willow flycatchers. Productivity and fecundity were likely slightly reduced at Pahranagat in 2010 as a result of the two nestling fatalities during banding. See Chapter 9 for a more detailed discussion of flycatcher reproduction at Pahranagat.

Nest success and fecundity at Mormon Mesa were reduced from the high rates documented in 2008 and 2009, while productivity and fecundity at Mesquite increased from the lows recorded in 2009. Nest success at Bill Williams was the lowest recorded since monitoring began in 1999. Sample sizes at Topock, Muddy River, and Littlefield are too low to attribute much significance to the reproductive rates observed in 2010. 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 2003–2009, depredation was the major cause of willow flycatcher nest failure, accounting for 45% of all failed nests in 2010 at Reclamation study areas and 68% of nest failures at NDOW study areas. These results are consistent with those reported at the Reclamation study areas from 1998 to 2002 (Braden and McKernan unpubl. data) and at sites across Arizona from 1996 to 2008 (Graber et al. 2007, Ellis et al. 2008, Graber and Koronkiewicz 2009a), which indicate depredation as accounting for the majority of all willow flycatcher nest failures. Factors influencing the increases and decreases in nest depredation at the monitored study areas are inherently complex and at this time remain undetermined. For open-cup nesting passerines, nest depredation rates can vary year to year, and sometimes substantially, with depredation of eggs and young ultimately linked to landscape characteristics and fluctuations in predator densities, abundance, and richness (Wiens 1989b, Robinson 1992, Howlett and Stutchbury 1996).

In 2008, Northern Arizona University (NAU) initiated a nest camera study in cooperation with SWCA on open-cup nesting passerines at selected study areas (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. In 2009, cameras were deployed at two flycatcher breeding sites (Pahranagat and Mesquite) with still cameras at artificial nests and video cameras at real nests. 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). The video cameras on flycatcher nests documented depredation by a Bewick's Wren (*Thyromanes bewickii*) and a Red-shouldered Hawk (*Buteo lineatus*) at Pahranagat and Brown-headed Cowbirds at Mesquite.

The study was continued in 2010, with video cameras deployed at real flycatcher nests at three breeding sites (Key Pittman, Pahranagat, and Mesquite) and still cameras at artificial nests at Pahranagat and Mesquite. Marks on clay eggs again indicated that most depredation events on artificial nests at Mesquite were from birds, while both birds and rodents depredated artificial nests at Pahranagat. Video cameras were deployed at 13 flycatcher nests at Key Pittman, 11 at Pahranagat, and 5 at Mesquite. Of the 13 nests at Key Pittman, 7 successfully fledged flycatcher young, 1 failed due to parasitism, and 5 were depredated or partially depredated. One nest was depredated during incubation and the other four were depredated during the nestling period. One of the nests with nestlings was depredated by a kingsnake (*Lampropeltis getulus*); due to camera failure, the identity of the other four predators is unknown. At the partially depredated nest, two of three nestlings were removed; the remaining nestling fledged successfully. Of the 11 flycatcher nests at Pahranagat, 8 successfully fledged flycatcher young and 3 were depredated during incubation. Two of the nests were depredated by an American Crow (*Corvus brachyrhynchos*) and the third was depredated by a Gray Catbird (*Dumetella carolinensis*). At Mesquite, two nests successfully fledged, one was deserted, one was depredated during incubation by a Brown-headed Cowbird, and one was partially depredated during the nestling period by a Brown-headed Cowbird. The cowbird removed one nestling and attacked a second, which was later removed from the nest by the female flycatcher; 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 Reclamation study areas ranged from 0 to 62% and averaged 20% (see Table 4.1). These results are consistent with those reported at the study areas from 1998 to 2009 (Braden and McKernan unpubl. data, McLeod et al. 2008, McLeod and Koronkiewicz 2009, McLeod and Koronkiewicz 2010), but these parasitism rates are higher than those reported at other monitored sites across Arizona in 1996–2006, which were less than 10% at most sites in most years (Graber et al. 2007, Ellis et al. 2008).

We observed multiple occasions in which the disappearance of flycatcher eggs coincided with the parasitism event. In this case, cowbirds were suspected of ejecting the eggs. Female Brown-headed Cowbirds are known to physically attack willow flycatcher nestlings (Woodward and Stoleson 2002), remove single eggs, and occasionally destroy entire broods after laying is complete or after hatching (Lowther 1993 as cited in Woodward and Stoleson 2002). In addition, cowbirds were photographed removing eggs from artificial nests during the 2008–2010 camera study, and cowbirds were documented on video depredating flycatcher nests during both the incubation and nestling phases. Therefore, it is likely that other depredation events on eggs and nestlings are attributable to cowbirds.

Parasitism does not invariably cause nest failure, but the success rate (21%) for parasitized nests in 2003–2010 was less than half that of unparasitized nests (52%). 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 2003–2010 produced on average fewer young (1.3 young/nest) than did unparasitized nests (2.2 young/nest; $F_{1,220} = 20.55$, $P < 0.001$). 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 2010, 44% of nests that fledged a cowbird also fledged flycatcher young. This is a higher rate of success than that observed in Southwestern Willow Flycatchers at Kern River, California (9%; Whitfield and Sogge 1999), but comparable to that observed at other Arizona sites (40%; Ellis et al. 2008).

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. In 2010, the parasitism rate at Mesquite (62%) was even higher than in 2009 (50%), but the success rate (31%) was also higher than 2009 (21%). This higher success rate may have been influenced by cowbird egg addling (see next section), as one of the successful nests contained an addled cowbird egg.

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 2008–2010, but even in the absence of cowbird trapping, no parasitism events were detected at Pahranagat in 2008 or 2009. Cowbirds did, however, seem more numerous in 2009 than in previous years, and in 2010, one flycatcher nest was documented with a cowbird egg and was abandoned before flycatcher eggs were laid. These observations suggest that although cowbird trapping may have lingering effects beyond the years in which trapping is completed, these effects may decrease over time.

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 five of the six years when flycatchers have been monitored at the study area, and overall nest success was 29%, well below the average of 44% across all study areas in those years. Although the breeding site at Muddy River is not as isolated from surrounding riparian vegetation as the site at Pahranagat, cowbird trapping at

Muddy River has the possibility of reducing the parasitism rate and increasing flycatcher nest success, and we recommend that cowbird trapping be instituted at Muddy River.

Cowbird Egg Addling

We addled cowbird eggs and removed cowbird nestlings in all study areas except Pahranagat in 2010. Pahranagat was not included because it is still part of the 5-year post-cowbird-trapping experiment. Though sample size is small, addling cowbird eggs seemed to reduce the hatch rate of cowbird eggs. Furthermore, none of the females deserted their nests after we addled cowbird eggs, even when addling occurred on two separate occasions (two nests). The female from whose nest a cowbird nestling was removed also continued to raise the remaining flycatcher nestling. The success rate of parasitized nests that hatched at least one flycatcher nestling in 2010 was comparable to success rates of similar nests in 2003–2009, but results suggested that nestlings might live longer and the number of nestlings fledged per nest might be higher as a result of cowbird egg addling and cowbird nestling removal. We recommend this program be continued in the future. Field personnel should also continue to practice egg addling at the beginning of the season with button quail eggs to maximize the effectiveness of shaking eggs in preventing hatching.

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Chapter 5

VEGETATION AND HABITAT CHARACTERISTICS

INTRODUCTION

Our objective for vegetation sampling is to provide a quantitative summary of the floristic and structural conditions within occupied territories in various vegetation types. These descriptive summaries will provide guidance for managers working to restore and create riparian habitat to meet the obligations of the LCR MSCP and will provide a means to evaluate habitats to determine if they resemble occupied flycatcher territories. The Pahranagat study area was excluded from the characterization of occupied territories because the vegetation consists primarily of very large and widely spaces trees, and these characteristics are unique to the site and not likely to be replicated in restoration areas. In 2010, we completed vegetation sampling within occupied territories only at Mesquite and Bill Williams. We continued sampling at Mesquite because of the changes in habitat (see Chapter 2) observed in 2009. We continued sampling at Bill Williams because of the relatively low sample size of vegetation plots obtained at this study area over previous years. Sampling at all other study areas was discontinued because of adequate sample sizes from previous years.

METHODS

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

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

In 2009, we identified the territory center for each resident male as described above. If an existing sampling point from 2008 was within 20 m of the territory center identified in 2009, we assigned that existing point to the current territory. If there was no existing point within 20 m of the territory center, we located a new sampling point as described above. All sampling points that were assigned to active territories in 2009 were marked with flagging that remained in the field over the winter. We repeated this point selection procedure for territories that were active in 2010, assigning a sampling point that was used in 2009 if one was within 20 m of the current territory and selecting a new sampling point if no existing point were available. Sampling points that were identified in 2009 but were not within 20 m of a territory center in 2010 were resampled in 2010. Data from these points are not included in the 2010 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 2010, 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 2008–2010 we tallied stems as we had in previous years and then for each stem that branched between 10 cm and 1.4 m from the ground, we tallied the number of additional stems that were at least 2.5 cm in diameter at 10 cm above the point where it branched from the main stem.

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

Data Analyses

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

Stem counts were grouped into the following size categories for analysis: <2.5 cm dbh, 2.5–8 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 2003–2010 in each vegetation type to demarcate vertical foliage categories in 2010. 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 2010 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 compared vegetation data collected at Mesquite West across years from 2008 to 2010 in coyote willow to determine whether the habitat changes observed in 2009 were apparent in the vegetation data. We restricted the analysis to the coyote willow habitat type because field observations suggested coyote willow was the species most affected by the changes in water availability. We compared the proportion of live vegetation observed across years to control for possible observer variation in the absolute counts (McLeod and Koronkiewicz 2010).

RESULTS

We measured vegetation at 12 occupied territories and 15 territories that were occupied in 2009 but not in 2010 at Mesquite and Bill Williams. We delineated the following habitat types: 1) coyote willow, 2) tamarisk/coyote willow mix, 3) Goodding willow with tamarisk understory, and 4) cottonwood/willow. 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. Goodding willow with tamarisk understory occurred in Site #3, Site #4, and Burn Edge at Bill Williams, while cottonwood/willow was present at Planet Ranch Road at Bill Williams. Average nest height recorded in 2003–2010 and used to assign vertical foliage strata for each vegetation category were 2.1, 2.4, 4.2, and 2.8 m for coyote willow, tamarisk/coyote willow mix, Goodding willow with tamarisk understory, and cottonwood/willow, respectively.

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

Vegetation characteristics of each habitat type and for the pooled category of cottonwood-willow Type III 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.

Table 5.1. Summary of Vegetation Characteristics at Occupied Southwestern Willow Flycatcher Territories in Varying Habitat Types, Lower Colorado River and Tributaries, 2010*

Parameter	SAEX (n=6)	TASP and SAEX (n=1)	POFR and SAGO (n=1)	SAGO with TASP understory (C-W Type I) (n=4)	C-W Type III (n = 8)
Average canopy height (m)	4.8 (0.2) 4.0–5.3	6.0	8.9	13.6 (5.0) 6.7–28.0	5.5 (0.5) 4.0–8.9
% total canopy closure	81.8 (9.1) 37.5–96.9	82.8	87.5	82.2 (7.2) 68.8–98.4	82.6 (6.7) 37.5–96.9
% woody ground cover	18.7 (5.6) 2.5–43.8	10.8	9.0	28.1 (13.7) 5.6–67.5	16.5 (4.3) 2.5–43.8
# live stems <2.5 cm dbh per ha	4499 (754) 1655–7130	4456	3820	96 (61) 0–255	4409 (559) 1655–7130
# live stems 2.5–8 cm dbh per ha	9252 (1508) 2928–14006	9422	8021	287 (183) 0–764	9120 (1115) 2928–14006
# live stems >8 cm dbh per ha	170 (102) 0–637	0	509	64 (37) 0–127	191 (90) 0–637
# dead stems <2.5 cm dbh per ha	7003 (1538) 1146–12350	1655	127	0 (0) 0–0	5475 (1513) 127–12350
# dead stems 2.5–8 cm dbh per ha	8467 (2471) 637–17189	3310	127	95 (95) 0–382	6780 (2141) 127–17189
# dead stems >8 cm dbh per ha	0 (0) 0–0	0	0	0 (0) 0–0	0 (0) 0–0
Percent native	84.5 (5.8) 63.3–95.4	36.1	97.0	44.7 (19.9) 3.9–99.1	80.0 (7.8) 36.1–97.0
Live vertical foliage (hits) below nest	5.6 (1.1) 2.8–9.9	2.7	5.3	13.8 (1.6) 10.8–17.0	5.2 (0.9) 2.7–9.9
Live vertical foliage (hits) at nest	3.8 (0.7) 2.0–5.8	3.4	5.7	3.0 (0.6) 1.2–4.0	4.0 (0.6) 2.0–5.8
Live vertical foliage (hits) above nest	6.2 (1.6) 1.1–9.9	6.1	14.6	18.4 (10.5) 5.3–49.7	7.2 (1.6) 1.1–14.6
Dead vertical foliage (hits) below nest	3.4 (0.6) 2.1–6.3	5.2	1.8	6.9 (2.2) 2.6–11.7	3.4 (0.6) 1.8–6.3)
Dead vertical foliage (hits) at nest	1.3 (0.2) 0.3–1.9	1.0	0.7	0.1 (0.1) 0–2.2	1.2 (0.2) 0.3–1.9
Dead vertical foliage (hits) above nest	0.9 (0.5) 0.1–3.4	1.3	0	1.3 (1.2) 0–4.8	0.8 (0.4) 0–3.4

* 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, POFR = cottonwood, C-W = cottonwood-willow.

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

Vertical foliage profiles for each habitat type are shown in Figures 5.1–5.4. Average nest height in each habitat type, as recorded in 2003–2010, is also shown on each graph. The vertical foliage profile for all habitat types that fall under the definition of cottonwood-willow Type III is shown in Figure 5.5. 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.

The only vegetation variables that differed between years in coyote willow habitat at Mesquite West were the proportion of live vertical foliage below nest height and the proportion of live vertical foliage at nest height (Table 5.3). In both cases, the proportion of live foliage observed in 2009 was lower than that observed in 2010 but did not differ from that observed in 2008. The proportion of live vertical foliage above the nest and the proportion of live stems in all three size categories were lower in 2009 than in either 2008 or 2010, but the differences were not statistically significant. Canopy closure did not differ significantly among years.

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	0.14	0.12	0.0	0.05
2.5–8 cm dbh	0.14	0.37	0.0	0.23
>8 cm dbh	1.0	1.4	3.5	--

[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.

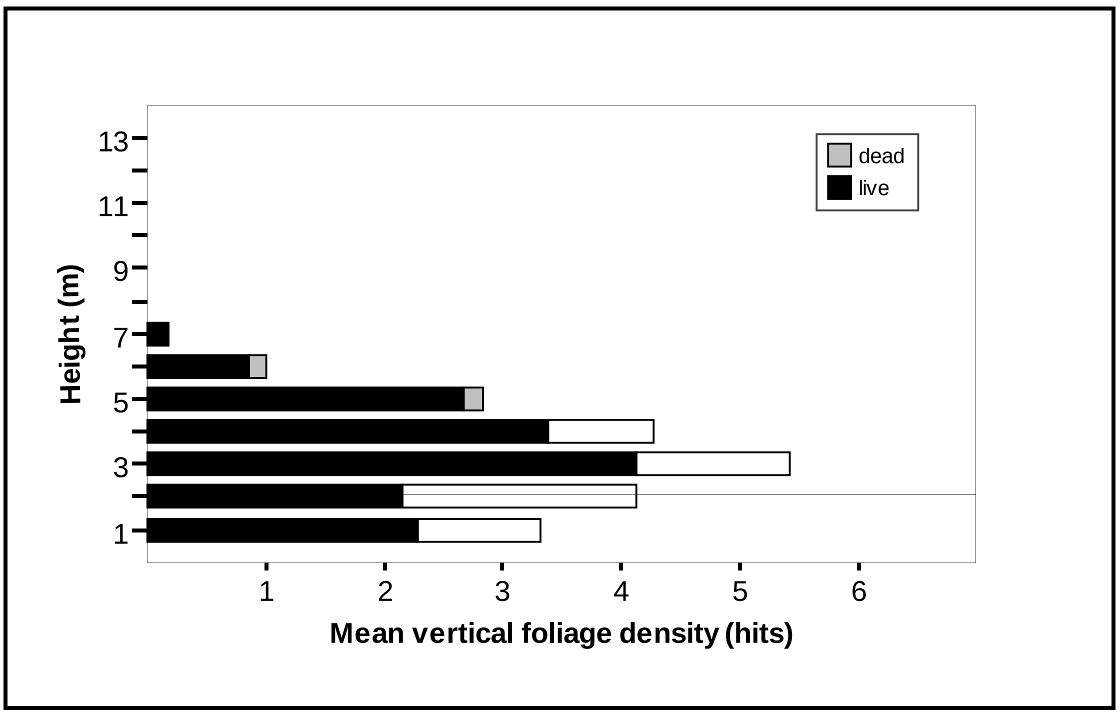

Figure 5.1. Vertical foliage density at occupied willow flycatcher territories in coyote willow habitat type, 2010. Horizontal line shows average nest height in this habitat type in 2003–2010.

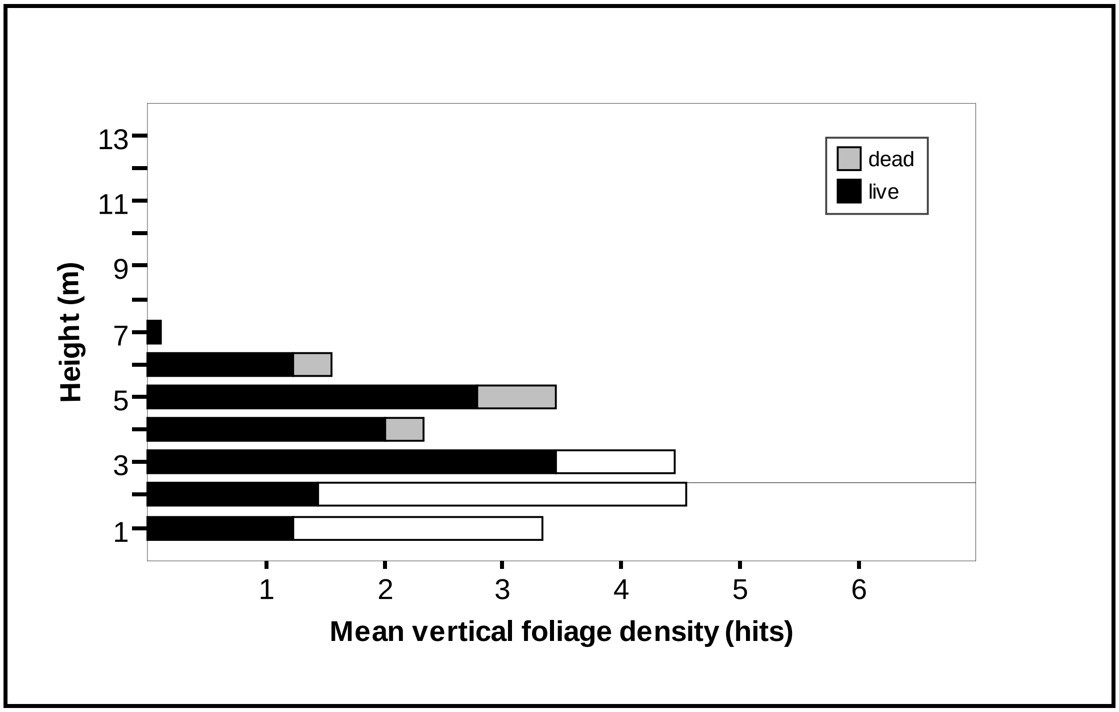

Figure 5.2. Vertical foliage density at occupied willow flycatcher territories in tamarisk/coyote willow habitat type, 2010. Horizontal line shows average nest height in this habitat type in 2003–2010.

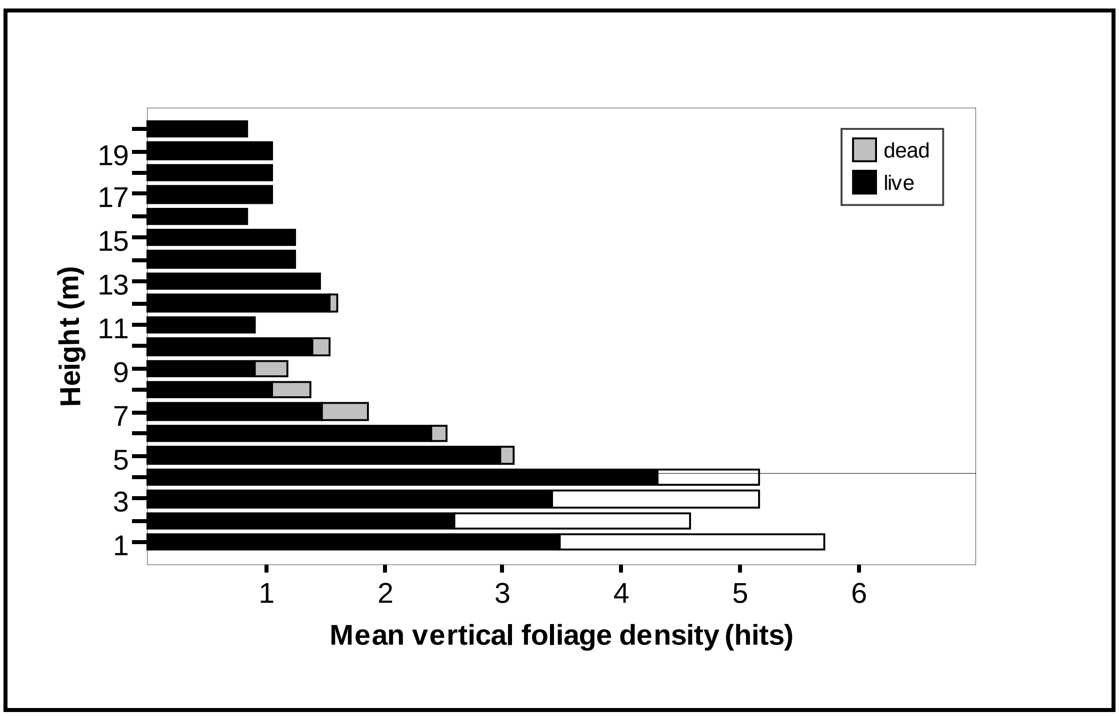

Figure 5.3. Vertical foliage density at occupied willow flycatcher territories in Goodding willow with tamarisk understory habitat type, 2010. Horizontal line shows average nest height in this habitat type in 2003–2010.

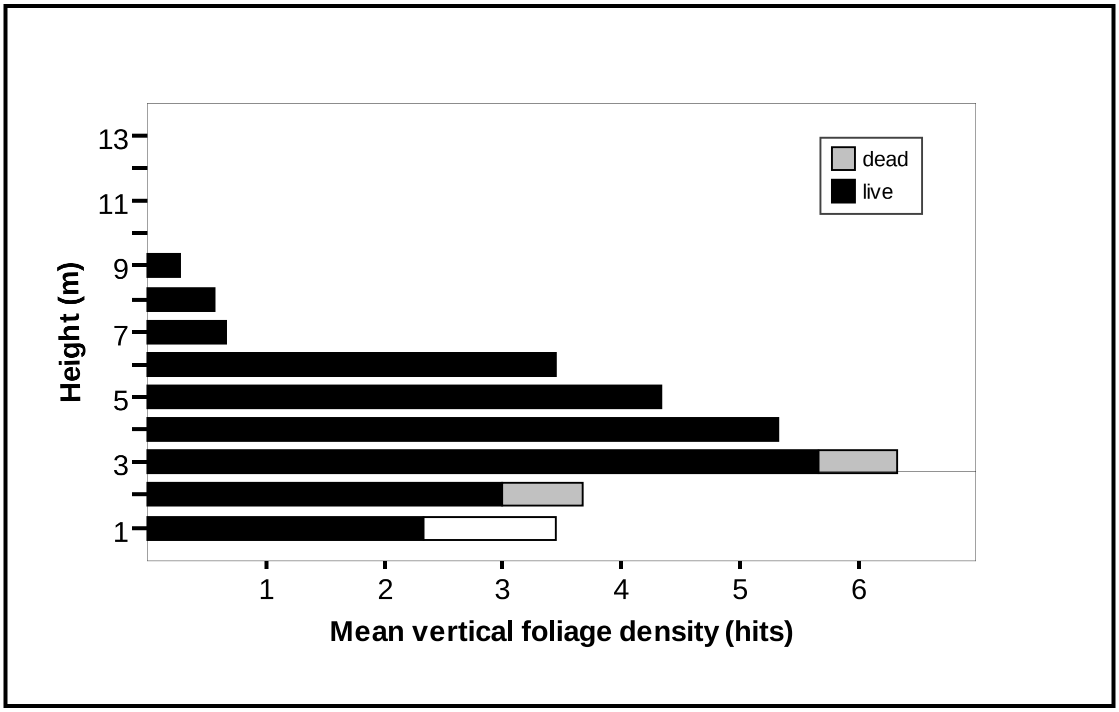

Figure 5.4. Vertical foliage density at occupied willow flycatcher territories in cottonwood/willow habitat type, 2010. Horizontal line shows average nest height in this habitat type in 2010.

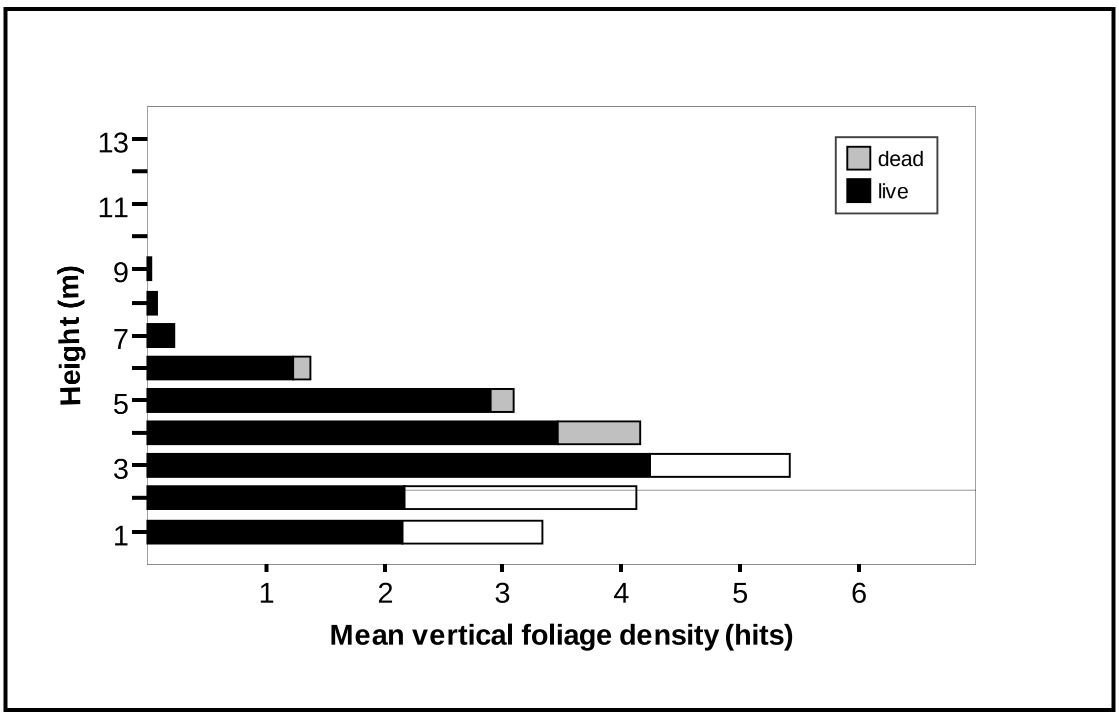

Figure 5.5. Vertical foliage density at occupied willow flycatcher territories in cottonwood-willow habitat Type III, 2010. Horizontal line shows average nest height in this habitat type in 2003–2010.

Table 5.3. Vegetation Characteristics in Coyote Willow at Mesquite West in 2008–2010*

Parameter	**2008** (n=8)	**2009** (n=8)	**2010** (n=6)
Average canopy height (m)	5.0 (0.3) 3.9–6.2 A	4.9 (0.3) 3.5–5.8 A	4.8 (0.2) 4.0–5.3 A
% total canopy closure	86.7 (4.3) 59.4–94.3 A	89.0 (5.9) 57.3–99.0 A	81.2 (9.1) 37.5–96.9 A
% woody ground cover	18.3 (6.5) 5.0–58.8 A	13.3 (2.4) 3.5–24.2 A	18.7 (5.6) 2.5–43.8 A
Percent of stems <2.5 cm dbh that were live	51.4 (5.2) 31–74 A	35.2 (7.0) 11–71 A	43.4 (9.5) 12–80 A
Percent of stems <2.6–8.0 cm dbh that were live	75.8 (4.5) 54–98 A	52.0 (9.2) 7–95 A	56.2 (11.4) 15–94 A
Percent of stems >8.0 cm dbh that were live	97.1 (2.9) 86–100 A	66.7 (33.3) 0–100 A	100 (0.0) 100–100 A
Percent native	92.9 (2.3) 81.7–98.0 A	79.9 (5.4) 49.9–95.6 A	84.5 (5.8) 63.3–95.4 A
Percent of vertical foliage below nest that was live	44.2 (5.5) 30–74 A,B	40.0 (3.0) 27–50 A	61.1 (5.4) 44–82 B
Percent of vertical foliage at nest that was live	65.9 (3.5) 52–83 A,B	52.2 (5.1) 24–72 A	74.3 (5.7) 53–87 B
Percent of vertical foliage above nest that was live	90.0 (2.4) 76–97 A	71.2 (10.7) 0–96 A	80.1 (12.0) 24–99 A

* Data are presented as mean, (standard error), and range. Significant differences (Tukey's test, α=0.05) between years for a given variable are indicated by alpha codes; years with different letters differed from one another, while years with the same letter did not.

DISCUSSION

The purpose of vegetation measurements of occupied habitat is to provide quantitative guidelines for restoration efforts. Coyote willow, Goodding willow, and cottonwood/willow are the three 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 2010 on less than 1 ha on the southern end of the Overton WMA site at Muddy River and at Littlefield on Beaver Dam Wash, but no vegetation sampling was completed in 2010 at these sites. For the first time in 2010, we detected breeding flycatchers in a cottonwood/willow stand at Bill Williams.

Sample sizes for all habitat types in 2010 are small and likely do not provide an accurate representation of the range and variance in vegetation characteristics in each habitat type. In a summary report to be completed in 2012, data from 2010 will be combined with other data collected within active territories between 2003 and 2012 to provide a more comprehensive description of each habitat type.

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 2010 data across habitat types.

Although a comparison between years of vegetation characteristics in coyote willow at Mesquite West in 2008–2010 showed few statistically significant differences, the data showed a consistent trend for 2009 to have the lowest percentage of live stems and live foliage across size and height classes. Small sample sizes may limit our ability to detect statistically significant changes between years, but overall the data support our field observations that the vegetation was less vigorous in 2009.

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Chapter 6

MICROCLIMATE

INTRODUCTION

Our objective for microclimate sampling is to provide a quantitative summary of microclimate conditions within occupied territories in various vegetation types. These descriptive summaries will provide guidance for managers working to restore and create riparian habitat to meet the obligations of the LCR MSCP and will provide a means to evaluate habitats to determine if the microclimate resembles that in occupied flycatcher territories. The Pahranagat study area was excluded from the characterization of occupied territories because the study area is approximately 650 m higher in elevation and experiences a cooler climate than the LCR MSCP planning area.

METHODS

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 2009, 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.

The HOBO logger locations representing active territories in 2009 at Mesquite and Bill Williams were marked in the field with flagging, which remained in place over the 2009–2010 winter. HOBO loggers were redeployed in these same locations in early May 2010. During the breeding season of 2010, we identified the territory center for each resident male. If an existing sampling point was within 20 m of the territory center identified in 2010, we assigned that existing point to the current territory. If there was no existing point within 20 m of the territory center, we located a new sampling point as described above. Sampling points that were identified in 2009 but were not within 20 m of a territory center in 2010 were resampled in 2010. Data from these points are not included in the 2010 data presented below but may be used in future analyses to identify any changes in vegetation that may lead to territory abandonment. All HOBO units were removed from the field at the end of the breeding season.

Soil Moisture (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 deployed and at two-week intervals throughout the breeding season until the HOBO logger was removed at the end of the season. Soil moisture was recorded both as voltage (mV) and as volumetric water content (%).[1] Soil type on the HH2 was set to mineral soil. For any SM measurement point that was underwater, we recorded the depth of standing water and assigned a value of 994 mV, which is equivalent to 50% volumetric water content, or fully saturated soil. All mV values greater than 994 were also reassigned as 994 mV, because this reading represents fully saturated soil and because the mV to percent relationship becomes excessively nonlinear for mV readings above this point. 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 2010. 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.

[1] The soil moisture logger measures the dielectric constant of moist soil via a direct current voltage, which is converted to volumetric soil moisture with conversion tables. For very high (above ~1000 mV) or low (below ~90 mV) voltage readings, the HH2 reports volumetric soil moisture as “above” or “below” the table, respectively. To enable the use of all data, we analyzed and report only the mV readings. Both mV and percentage were recorded in the field to facilitate data proofing. Voltage is related to soil moisture as follows: $1.07 + 6.4V – 6.4V^2 + 4.7V^3 = 1.6 + 8.4\theta$, where θ = volumetric soil moisture.

Statistical Analyses

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

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

Soil moisture variables were summarized per visit, and temperature/humidity variables were summarized on a daily basis. We determined diurnal and nocturnal periods by using the actual daily sunrise and sunset times reported for the region by the National Weather Service (2010). 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 habitat type (see Chapter 5), and microclimate variables were averaged for each habitat type over the following two-week periods to show how microclimate conditions changed throughout the breeding season: 16–31 May, 1–15 June, 15–30 June, 1–15 July, 16–31 July, and 1–15 August. Data were also summarized by vegetation classification (see Chapter 5).

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.

We qualitatively compared microclimate data collected within coyote willow habitat at Mesquite West across years from 2008 to 2010 to determine whether the dry habitat conditions observed in 2009 were apparent in the microclimate data. We compared the temperature data collected in coyote willow habitat in 2008–2010 with those collected at the Bunkerville, NV weather station (Coop ID 261327).

RESULTS

We collected microclimate data at 12 active territories and 15 territories that were occupied in 2009 but not in 2010. HOBO loggers failed to collect data at two active territories. One additional logger at an active territory had a bad humidity sensor. Microclimate variables are summarized by two-week periods for each vegetation type in Tables 6.1–6.4. These same variables are plotted in Figures 6.1–6.9 to facilitate comparisons between vegetation types. Sample size was one for both cottonwood/willow and tamarisk with coyote willow, and the HOBO logger in the latter vegetation type failed to collect data.

[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.

All vegetation types exhibited moist soil conditions at some point during the breeding season. Coyote willow and tamarisk with coyote willow, both of which occurred at Mesquite, maintained overall wet 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 at the end of the breeding season, and the inundated percentage of the surrounding area declined steadily throughout the season.

Mean daily maximum temperatures spanned a range of ~10°C among habitat types. Daily minimum temperatures showed a smaller range of <5°C. Vapor pressure increased through the end of July for all habitat types. Vapor pressure was highest in Goodding willow with tamarisk understory and lowest in cottonwood/willow.

A between-year qualitative comparison of microclimate variables within occupied territories in coyote willow habitat at Mesquite West in 2008–2010 (Figures 6.10–6.15) showed that soil moisture, diurnal humidity, and nocturnal humidity were lower in 2009 than either of the other two years. Maximum daily temperature within coyote willow habitat at Mesquite West was highest throughout the season in 2009 and lowest in 2010. In addition, maximum daily temperature within Mesquite West in 2009 consistently exceeded that recorded at the Bunkerville weather station, while the reverse was true in 2010. In 2008, maximum daily temperatures were comparable within Mesquite West and at the Bunkerville weather station through most of the season. Minimum nocturnal temperature within coyote willow habitat was lowest throughout the season in 2008 and was consistently ~5°C lower than what was recorded at the weather station. In 2009 and 2010, minimum nocturnal temperature also followed the seasonal pattern recorded at the weather station but was only ~2°C lower than what was recorded at the weather station. Daily temperature range within Mesquite West was lower in 2010 than in either 2008 or 2009 throughout the season.

DISCUSSION

The return of wet conditions at Mesquite West in 2010 was readily apparent in the microclimate data, with the coyote willow and tamarisk with coyote willow habitat types exhibiting high soil moisture values and high percentages of the area surrounding each sample point being inundated in 2010 throughout the breeding season. The qualitative comparison of microclimate variables across 2008–2010 within coyote willow habitat at Mesquite West clearly showed lower soil moisture in 2009 compared to the other two years, particularly at the beginning of the breeding season before the site began receiving some water at the end of June 2009. Diurnal and nocturnal humidity were also lower throughout the breeding season in 2009 than in either 2008 or 2010; however, no humidity data were available from local weather stations for comparison. We anticipated that wet conditions might have a moderating influence on temperature, either directly through the presence of water or indirectly through the production of denser foliage. These expectations were supported by the data, with dry conditions in 2009 producing the highest maximum daily temperatures, exceeding those recorded at a local weather station; and wet conditions in 2010 producing the lowest maximum daily temperatures, not reaching those recorded at the same weather station. No obvious relationship was apparent between minimum nocturnal temperatures and water conditions. Daily temperature range was lowest in 2010, showing the influence of the low maximum temperatures recorded that year. These results suggest that the presence of surface water may be an important factor in producing the microclimate conditions of high humidity and moderate temperature that are typically found in flycatcher territories when compared to surrounding but unoccupied riparian vegetation (McLeod et al. 2008).

Table 6.1. Microclimate Measures in Southwestern Willow Flycatcher Territories in Coyote Willow, 2010*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16--31	August 1–15
Soil Moisture (n=6)						
Mean soil moisture (mV)	918.6 (8.8)	896.1 (16.8)	897.6 (33.2)	831.3 (21.5)	918.6 (15.7)	873.1 (37.8)
Mean distance to nearest standing water	1.8 (1.8)	1.5 (0.9)	2.3 (1.6)	2.8 (0.9)	4.0 (2.8)	1.5 (1.5)
% of area within 20 m that was inundated	35.0 (13.7)	57.7 (5.6)	41.7 (10.5)	25.0 (10.7)	28.3 (8.6)	48.8 (21.1)
% of area within 50 m that was inundated	32.5 (12.7)	56.4 (6.2)	48.3 (7.0)	20.0 (6.5)	41.4 (8.6)	52.5 (22.0)
Temperature (n=6)						
Mean maximum diurnal temperature (C)	31.5 (0.4)	34.5 (0.4)	34.9 (0.3)	36.0 (0.3)	37.0 (0.4)	35.7 (0.9)
Mean minimum nocturnal temperature (C)	10.6 (0.3)	17.8 (0.4)	14.4 (0.3)	17.3 (0.3)	23.6 (0.2)	20.9 (0.4)
Mean daily temperature range (C)	20.9 (0.5)	16.7 (0.5)	20.6 (0.5)	18.7 (0.4)	13.4 (0.4)	14.8 (1.0)
Humidity (n=5)						
Mean diurnal vapor pressure (Pa)	1075.9 (31.6)	1754.0 (50.2)	1768.5 (53.3)	2195.8 (45.0)	2783.2 (29.3)	2289.7 (39.8)
Mean nocturnal vapor pressure (Pa)	959.9 (27.3)	1464.9 (41.8)	1374.7 (35.9)	1701.2 (37.2)	2283.2 (29.9)	1833.5 (49.6)

* Data are presented as mean (standard error).

Table 6.2. Microclimate Measures in Southwestern Willow Flycatcher Territories in Tamarisk with Coyote Willow, 2010*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture (n=1)						
Mean soil moisture (mV)	894.3 (0.0)	827.2 (22.8)	655.0 (0.0)	813.3 (0.0)	821.2 (1.4)	N/A
Mean distance to nearest standing water	2.5 (0.0)	5.0 (2.0)	10.0 (0.0)	2.0 (0.0)	6.0 (1.0)	N/A
% of area within 20 m that was inundated	35.0 (0.0)	42.5 (17.5)	40.0 (0.0)	10.0 (0.0)	20.0 (15.0)	N/A
% of area within 50 m that was inundated	25.0 (0.0)	60.0 (20.0)	50.0 (0.0)	10.0 (0.0)	17.5 (7.5)	N/A
Temperature (n=0)						
Mean maximum diurnal temperature (C)	N/A	N/A	N/A	N/A	N/A	N/A
Mean minimum nocturnal temperature (C)	N/A	N/A	N/A	N/A	N/A	N/A
Mean daily temperature range (C)	N/A	N/A	N/A	N/A	N/A	N/A
Humidity (n=0)						
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).

Table 6.3. Microclimate Measures in Southwestern Willow Flycatcher Territories in Goodding Willow with Tamarisk Understory, 2010*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture (n=4)						
Mean soil moisture (mV)	932.0 (35.3)	945.2 (27.0)	915.2 (39.4)	895.4 (33.6)	844.3 (56.4)	N/A
Mean distance to nearest standing water	7.0 (6.5)	9.5 (8.9)	8.6 (7.2)	17.3 (9.1)	480.0 (46.2)	N/A
% of area within 20 m that was inundated	40.0 (20.8)	39.6 (16.3)	25.8 (14.6)	21.8 (16.6)	0.0 (0.0)	N/A
% of area within 50 m that was inundated	34.0 (17.0)	34.0 (13.0)	21.5 (10.7)	11.8 (4.0)	0.0 (0.0)	N/A
Temperature (n=3)						
Mean maximum diurnal temperature (C)	38.7 (0.7)	41.5 (0.6)	42.6 (0.4)	42.9 (0.5)	42.4 (0.6)	34.1 (6.1)
Mean minimum nocturnal temperature (C)	11.4 (0.5)	16.0 (0.4)	14.5 (0.3)	18.5 (0.5)	23.2 (0.2)	21.7 (0.3)
Mean daily temperature range (C)	27.3 (0.8)	25.5 (0.7)	28.1 (0.4)	24.4 (0.5)	19.1 (0.6)	12.4 (6.4)
Humidity (n=3)						
Mean diurnal vapor pressure (Pa)	1291.6 (46.8)	1849.5 (66.0)	1944.3 (62.3)	2525.0 (68.2)	3021.4 (40.2)	2612.8 (55.6)
Mean nocturnal vapor pressure (Pa)	1077.5 (28.9)	1575.4 (36.2)	1535.9 (31.3)	1985.4 (50.8)	2569.8 (29.4)	2374.1 (11.9)

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

Table 6.4. Microclimate Measures in Southwestern Willow Flycatcher Territories in Cottonwood/Willow, 2010*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture (n=1)						
Mean soil moisture (mV)	270.6 (0.0)	337.4 (0.0)	633.0 (33.3)	737.8 (0.0)	780.8 (39.7)	N/A
Mean distance to nearest standing water	15.0 (0.0)	5.0 (0.0)	6.0 (0.0)	15.0 (0.0)	5.5 (1.5)	N/A
% of area within 20 m that was inundated	35.0 (0.0)	5.0 (0.0)	10.0 (0.0)	4.0 (0.0)	5.0 (0.0)	N/A
% of area within 50 m that was inundated	25.0 (0.0)	1.0 (0.0)	5.0 (0.0)	5.0 (0.0)	2.0 (1.0)	N/A
Temperature (n=1)						
Mean maximum diurnal temperature (C)	42.2 (0.2)	41.0 (0.7)	39.7 (0.3)	38.0 (0.4)	38.1 (1.0)	N/A
Mean minimum nocturnal temperature (C)	12.1 (2.7)	17.1 (0.8)	15.1 (0.8)	20.5 (1.2)	25.1 (0.4)	N/A
Mean daily temperature range (C)	30.1 (3.0)	23.9 (0.9)	24.6 (0.9)	17.6 (1.1)	13.0 (1.2)	N/A
Humidity (n=1)						
Mean diurnal vapor pressure (Pa)	712.0 (25.4)	1148.8 (65.2)	1134.3 (69.4)	1697.4 (102.7)	2410.0 (107.8)	N/A
Mean nocturnal vapor pressure (Pa)	668.4 (5.2)	983.8 (53.3)	772.4 (59.1)	1192.7 (87.5)	1922.1 (108.2)	N/A

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

Table 6.5. Microclimate Measures in Southwestern Willow Flycatcher Territories in Cottonwood-Willow Type III (Coyote Willow, Tamarisk with Coyote Willow, and Cottonwood/Willow Combined), 2010*

Microclimate measure	May 16–31	June 1–15	June 16–30	July 1–15	July 16–-31	August 1–15
Soil Moisture (n=6)						
Mean soil moisture (mV)	806.6 (107.4)	846.4 (41.9)	834.2 (48.1)	815.4 (19.8)	875.8 (21.4)	873.1 (37.8)
Mean distance to nearest standing water	4.1 (2.5)	2.3 (0.9)	3.7 (1.5)	4.4 (1.9)	4.6 (1.7)	1.5 (1.5)
% of area within 20 m that was inundated	35.0 (8.7)	51.8 (6.1)	37.5 (8.7)	19.9 (8.1)	22.5 (6.4)	48.8 (21.1)
% of area within 50 m that was inundated	30.0 (8.2)	52.9 (6.6)	43.1 (7.5)	16.4 (5.1)	29.9 (7.4)	52.5 (22.0)
Temperature (n=6)						
Mean maximum diurnal temperature (C)	31.8 (0.5)	35.5 (0.4)	35.6 (0.3)	36.3 (0.3)	37.2 (0.3)	35.7 (0.9)
Mean minimum nocturnal temperature (C)	10.7 (0.3)	17.7 (0.4)	14.5 (0.3)	17.7 (0.3)	23.8 (0.2)	20.9 (0.4)
Mean daily temperature range (C)	21.1 (0.6)	17.8 (0.5)	21.2 (0.4)	18.5 (0.4)	13.3 (0.4)	14.8 (1.0)
Humidity (n=5)						
Mean diurnal vapor pressure (Pa)	1063.8 (31.7)	1634.6 (50.5)	1662.8 (52.2)	2112.8 (45.4)	2719.7 (33.5)	2289.7 (39.8)
Mean nocturnal vapor pressure (Pa)	950.1 (27.2)	1369.9 (41.4)	1274.4 (39.4)	1616.4 (39.5)	2221.7 (33.7)	1833.5 (49.6)

* Data are presented as mean (standard error).

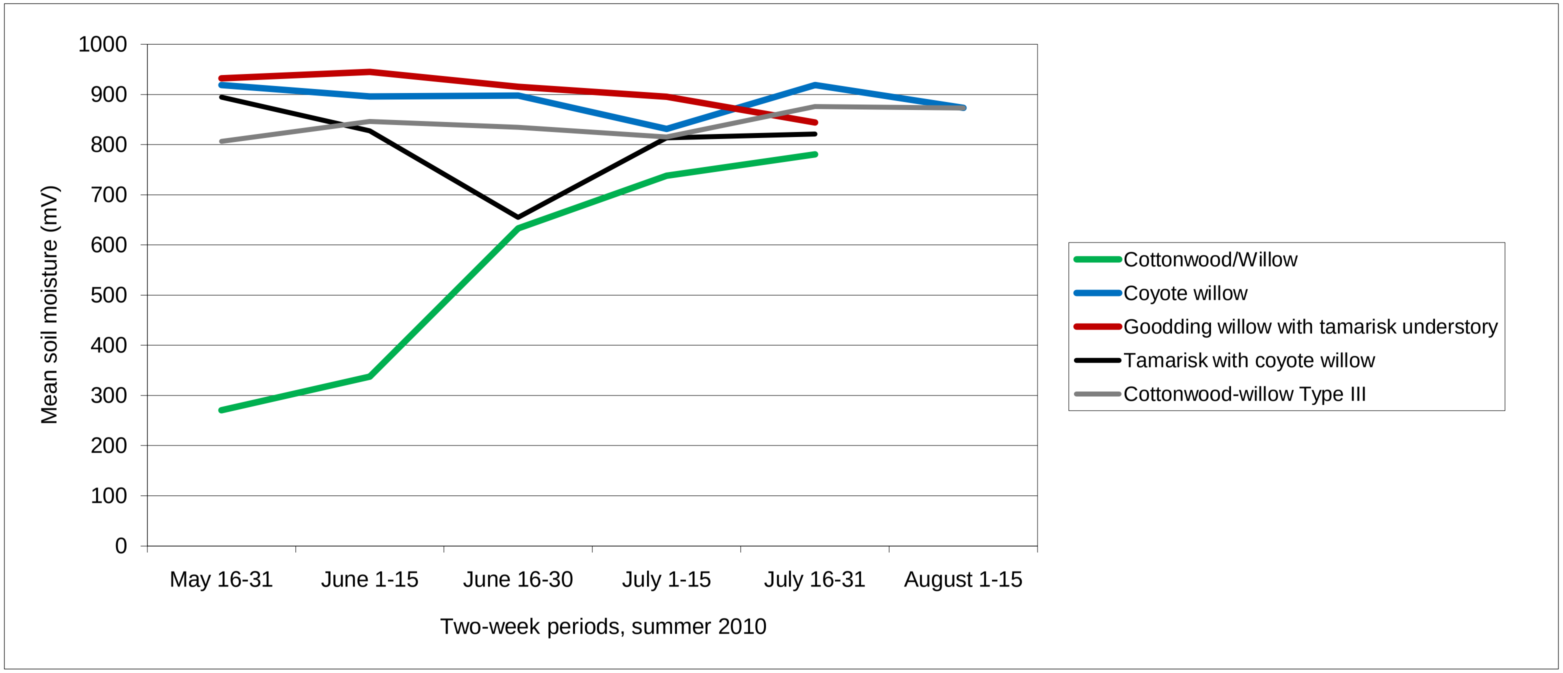

Figure 6.1. Mean soil moisture (mV) in Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2010. Data are summarized by two-week periods.

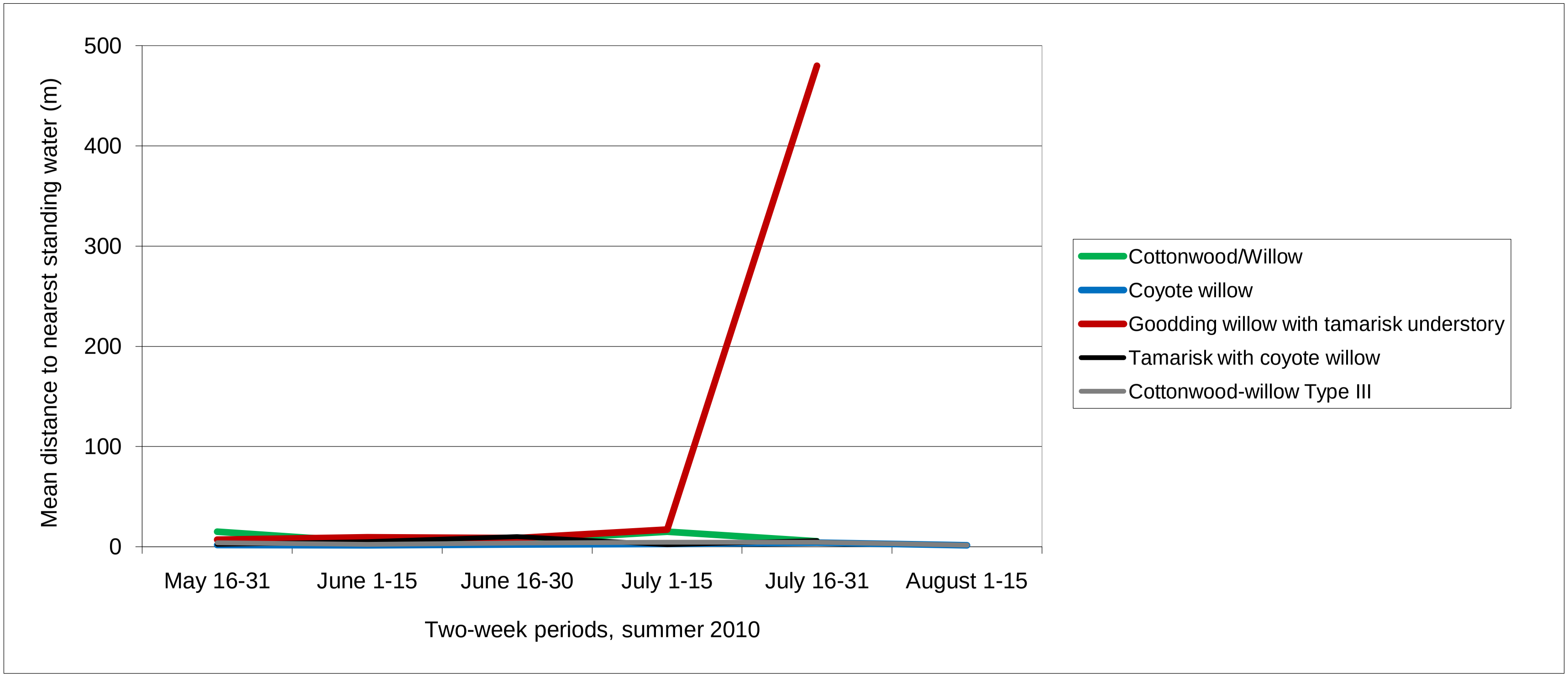

Figure 6.2. Mean distance (m) to standing water or saturated soil from Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2010. Data are summarized by two-week periods.

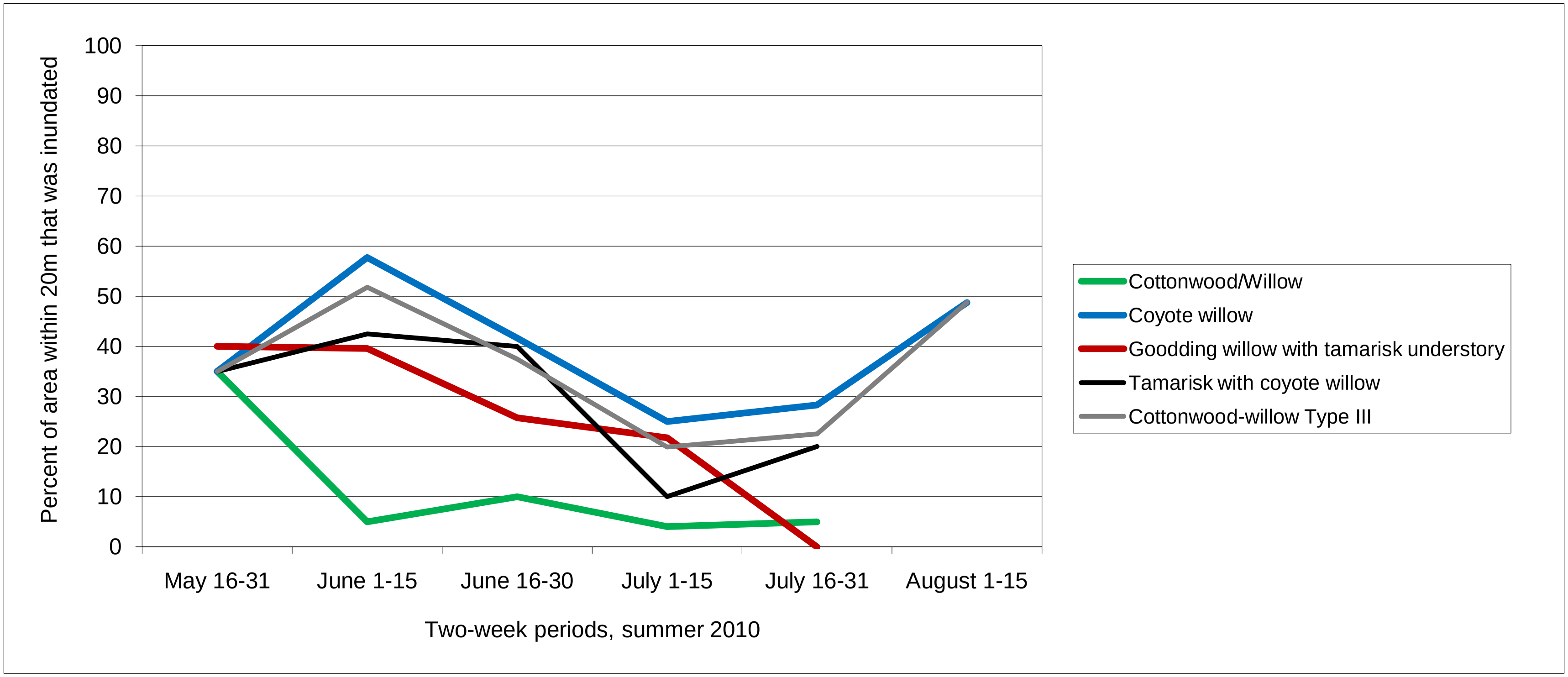

Figure 6.3. Mean percent of the area within 20 m of Southwestern Willow Flycatcher territories that contained standing water or saturated soil in various vegetation types, lower Colorado River and tributaries, 2010. Data are summarized by two-week periods.

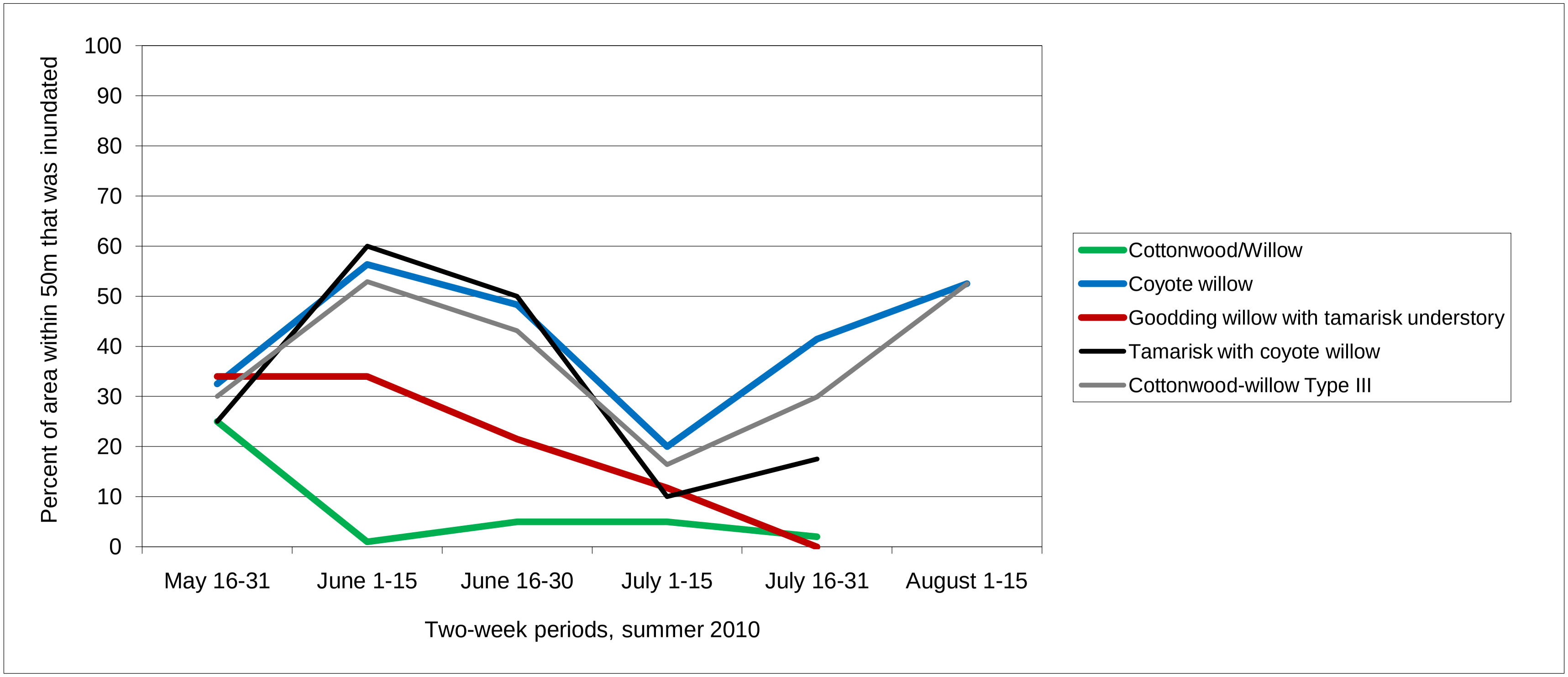

Figure 6.4. Mean percent of the area within 50 m of Southwestern Willow Flycatcher territories that contained standing water or saturated soil in various vegetation types, lower Colorado River and tributaries, 2010. Data are summarized by two-week periods.

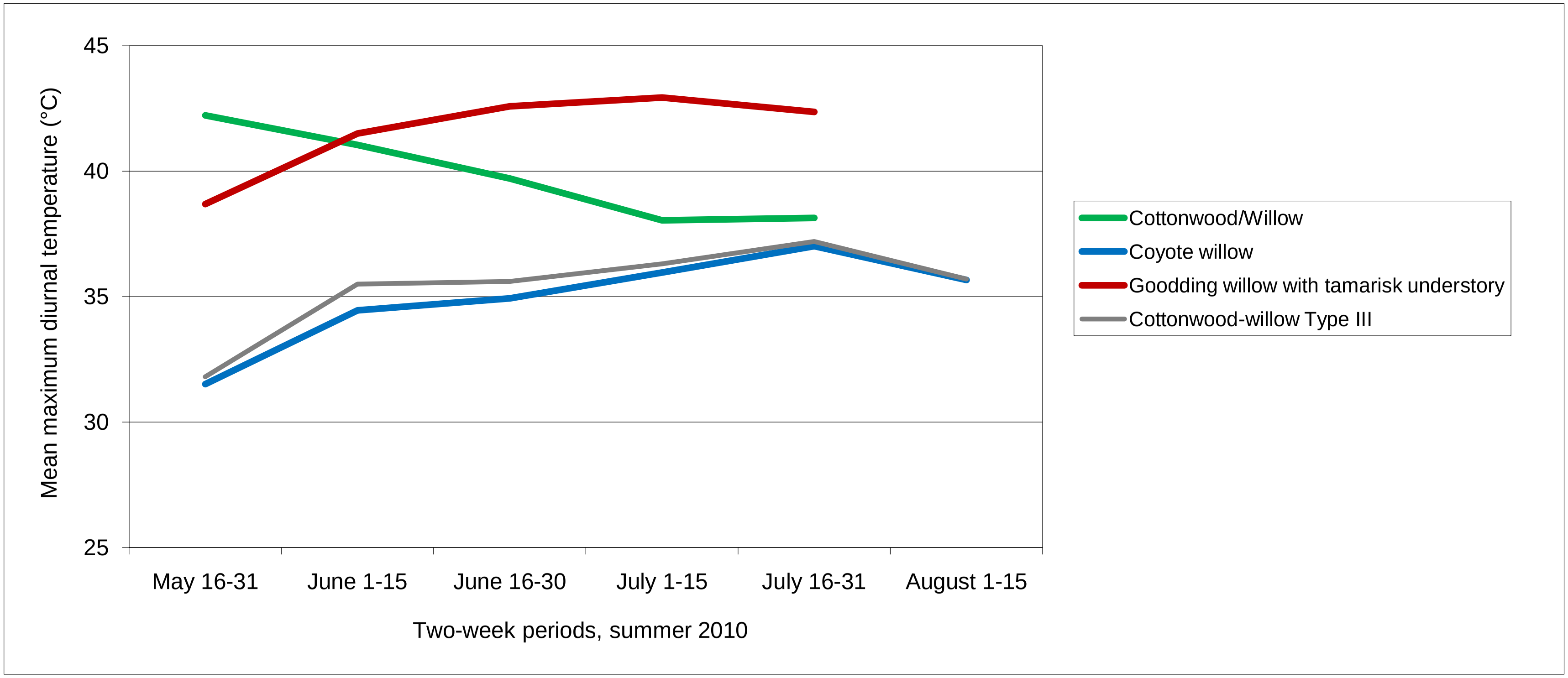

Figure 6.5. Mean maximum diurnal temperature at Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2010. Data are summarized by two-week periods.

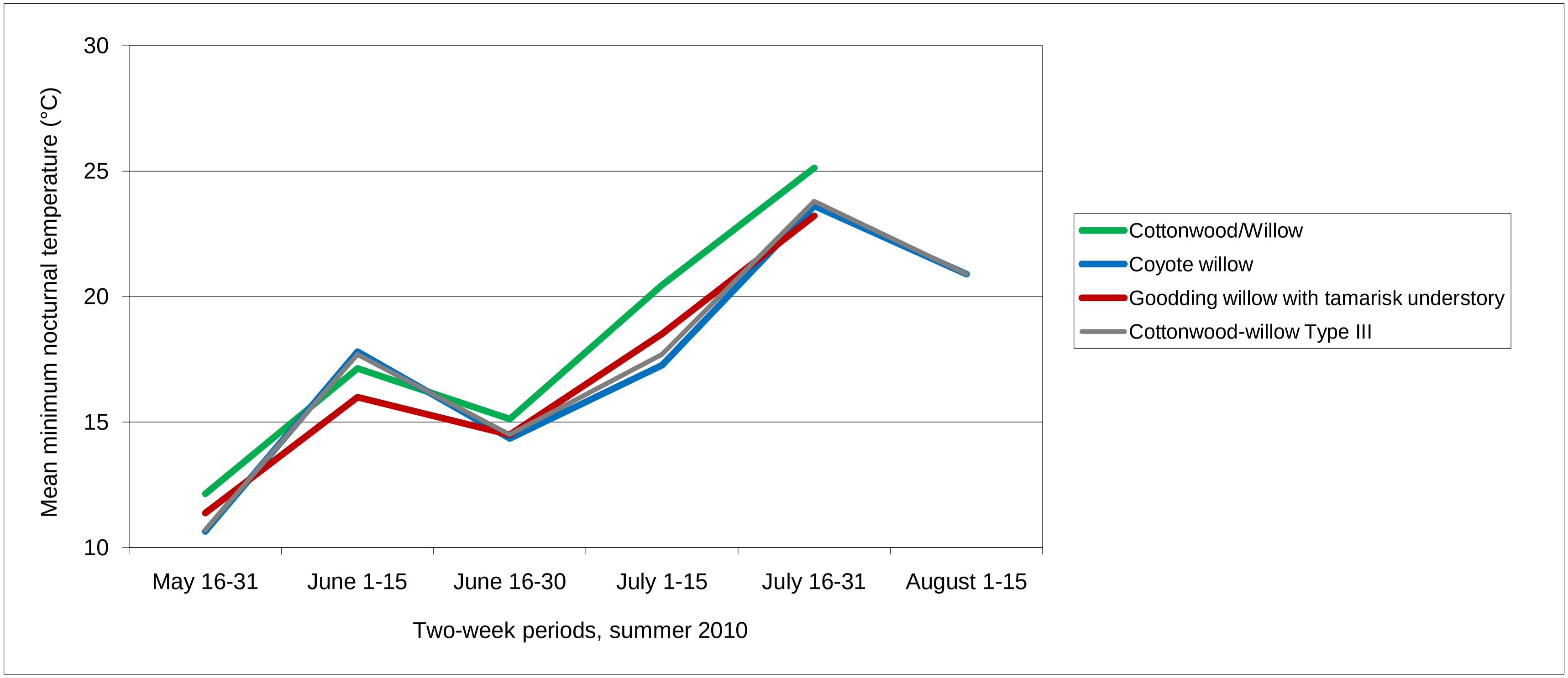

Figure 6.6. Mean minimum nocturnal temperature at Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2010. Data are summarized by two-week periods.

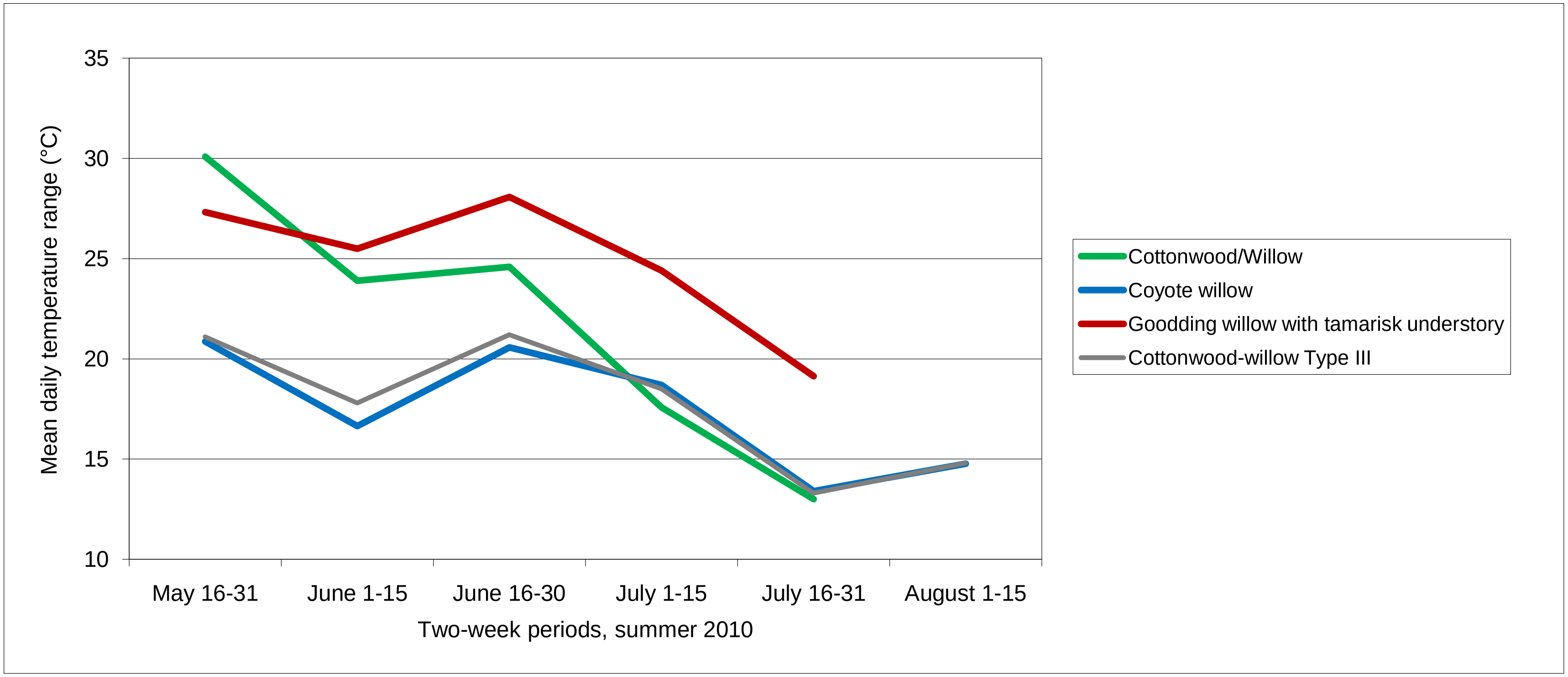

Figure 6.7. Mean daily temperature range at Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2010. Data are summarized by two-week periods.

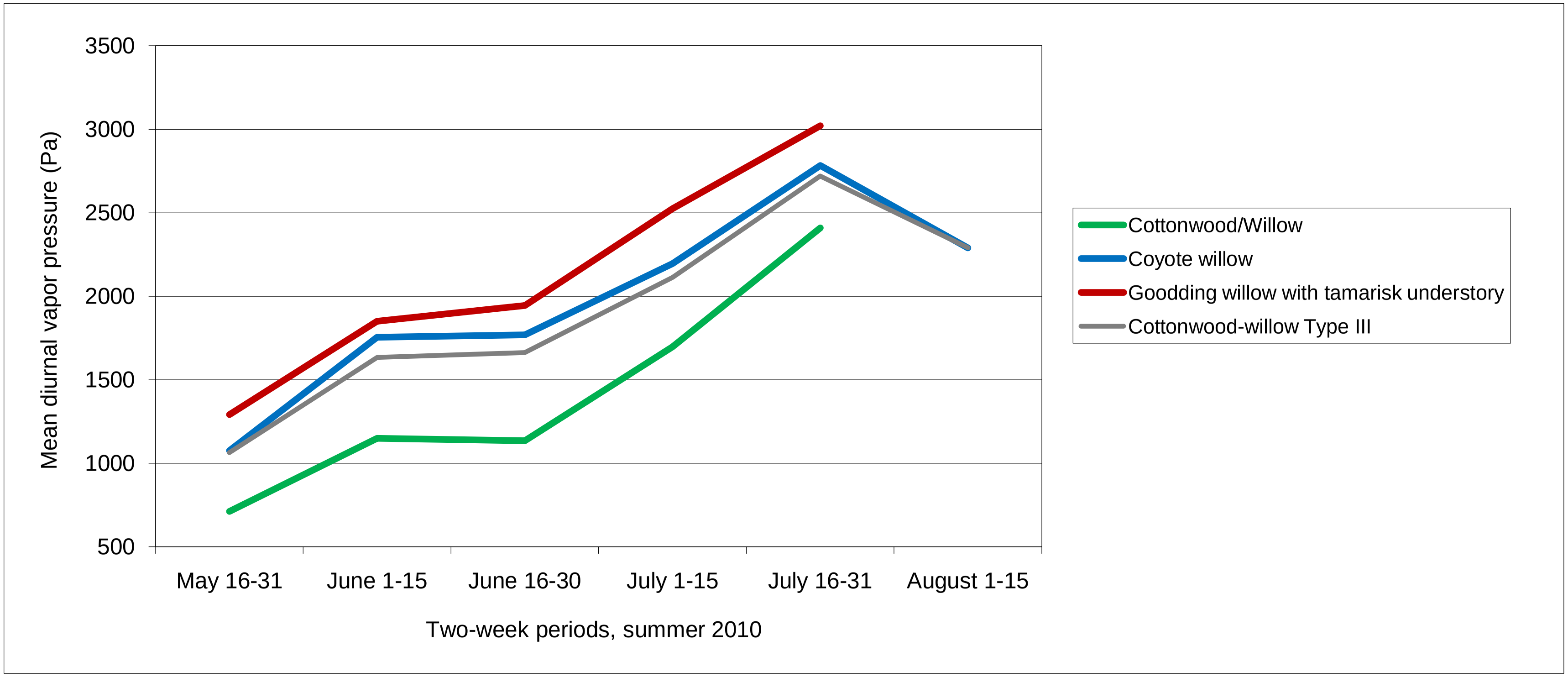

Figure 6.8. Mean diurnal vapor pressure at Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2010. Data are summarized by two-week periods.

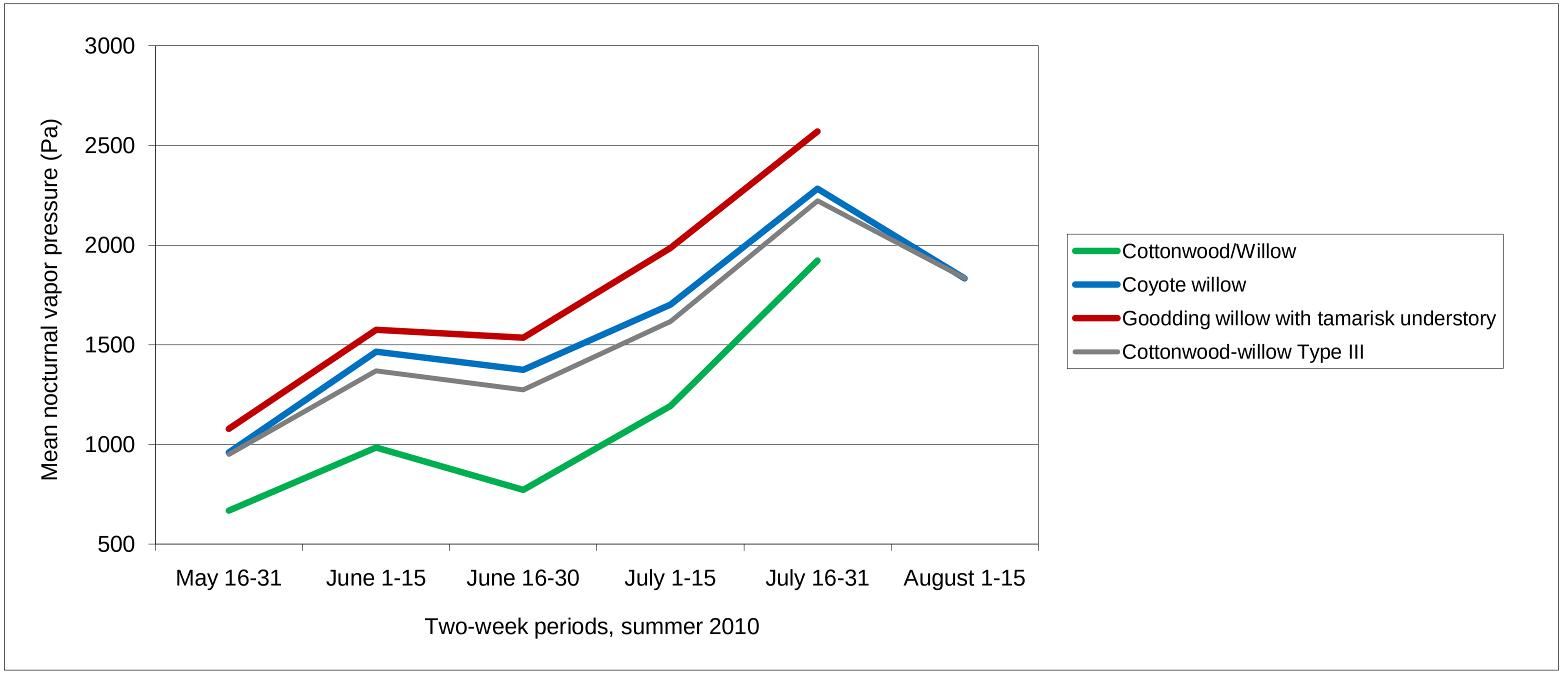

Figure 6.9. Mean nocturnal vapor pressure at Southwestern Willow Flycatcher territories in various vegetation types, lower Colorado River and tributaries, 2010. Data are summarized by two-week periods.

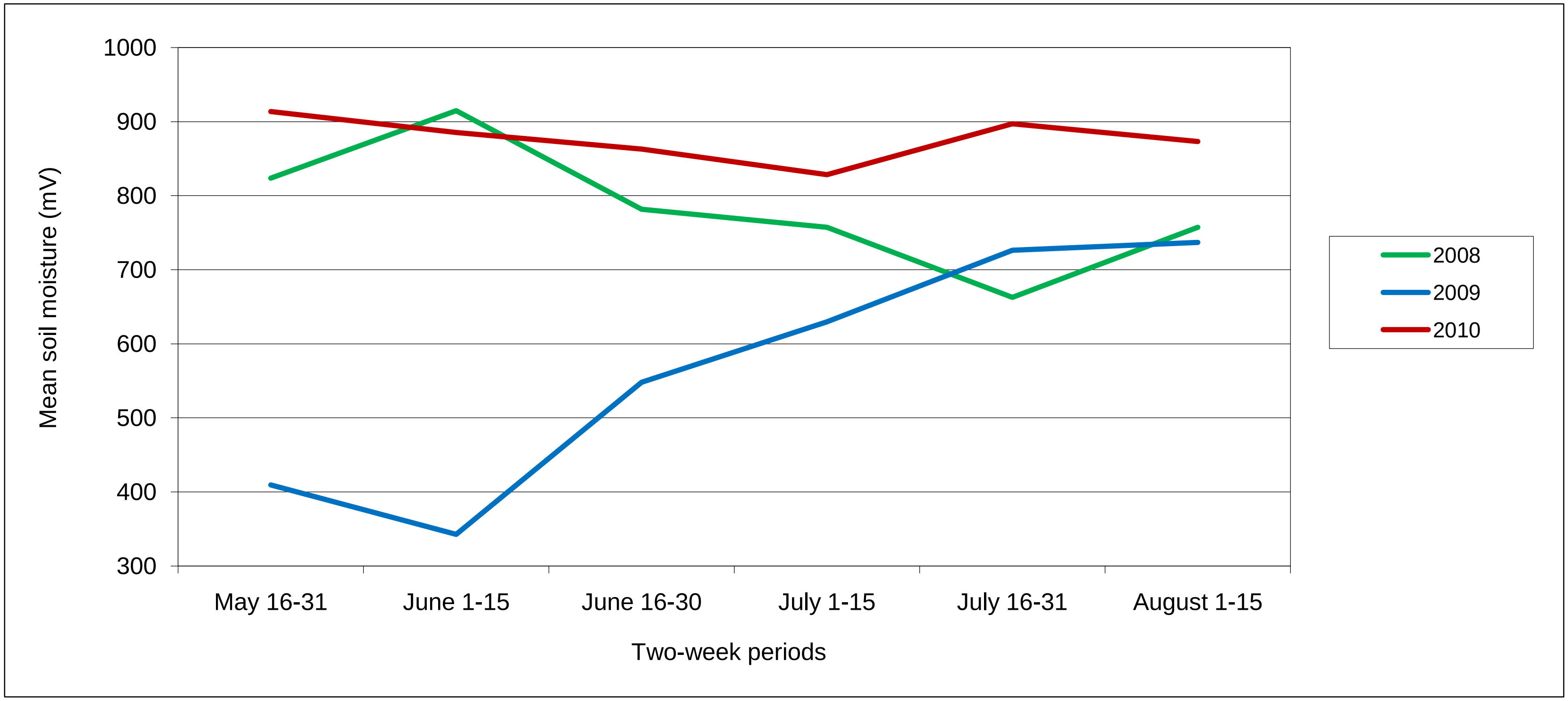

Figure 6.10. Mean soil moisture at Southwestern Willow Flycatcher territories in coyote willow habitat at Mesquite West, 2008–2010. Data are summarized by two-week periods.

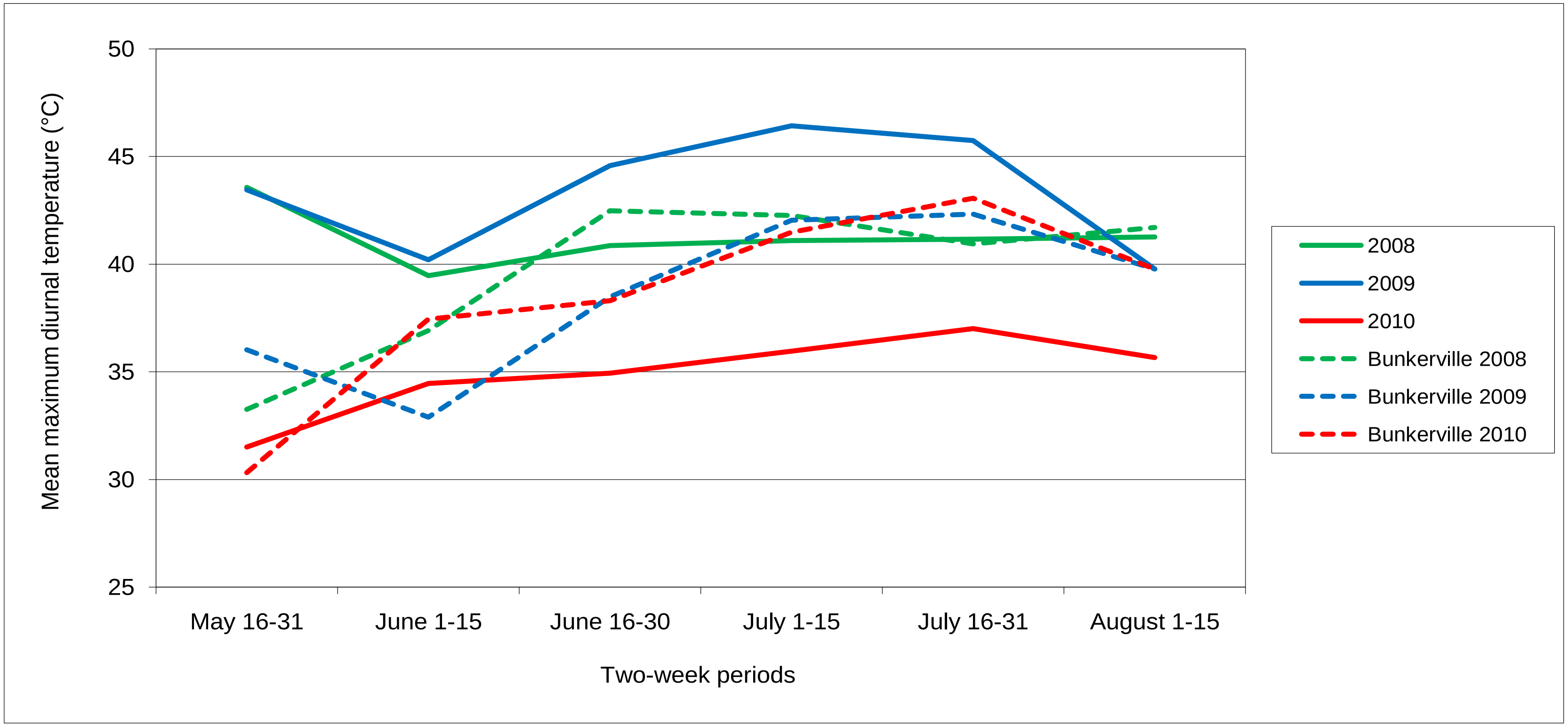

Figure 6.11. Mean maximum diurnal temperature at the Bunkerville weather station and within Southwestern Willow Flycatcher territories in coyote willow habitat at Mesquite West, 2008–2010. Data are summarized by two-week periods.

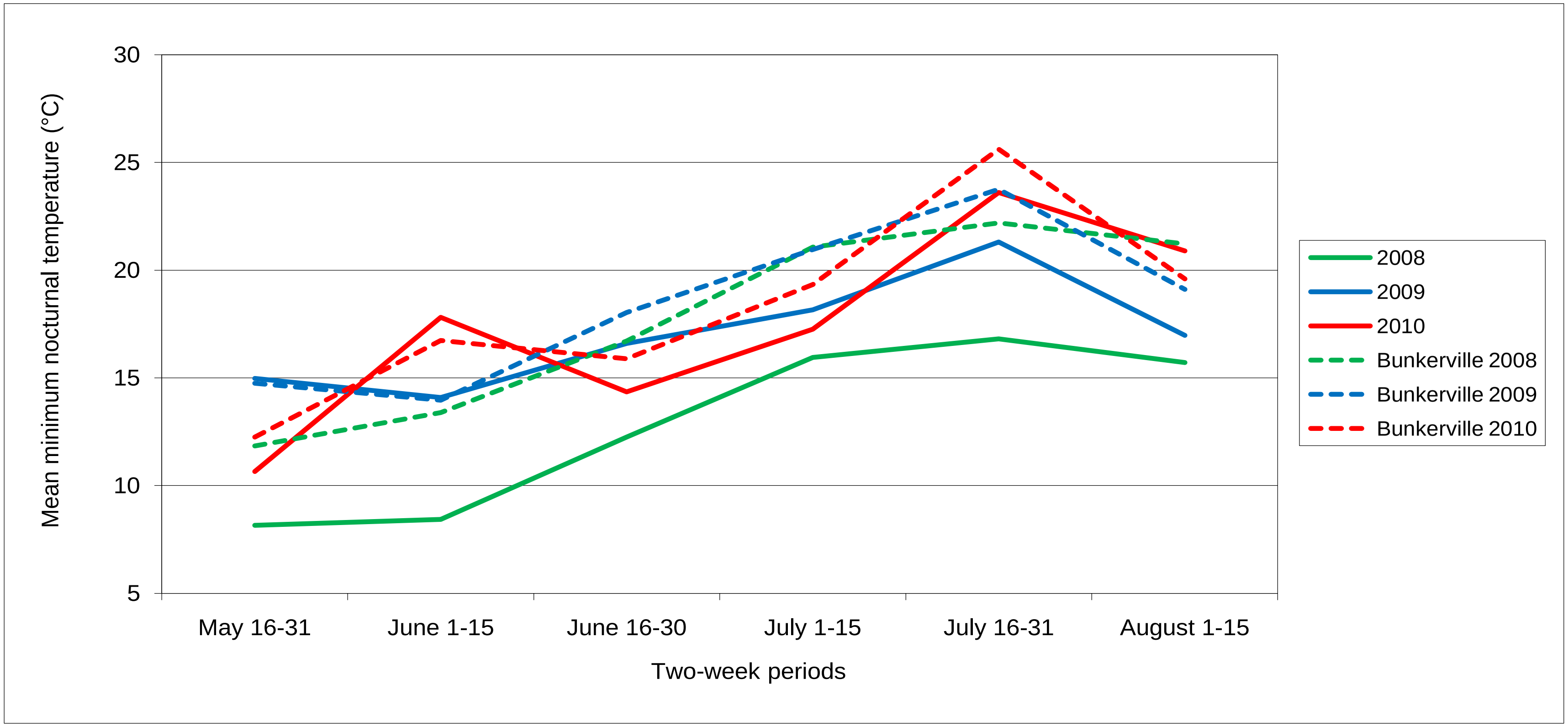

Figure 6.12. Mean minimum nocturnal temperature at the Bunkerville weather station and within Southwestern Willow Flycatcher territories in coyote willow habitat at Mesquite West, 2008–2010. Data are summarized by two-week periods.

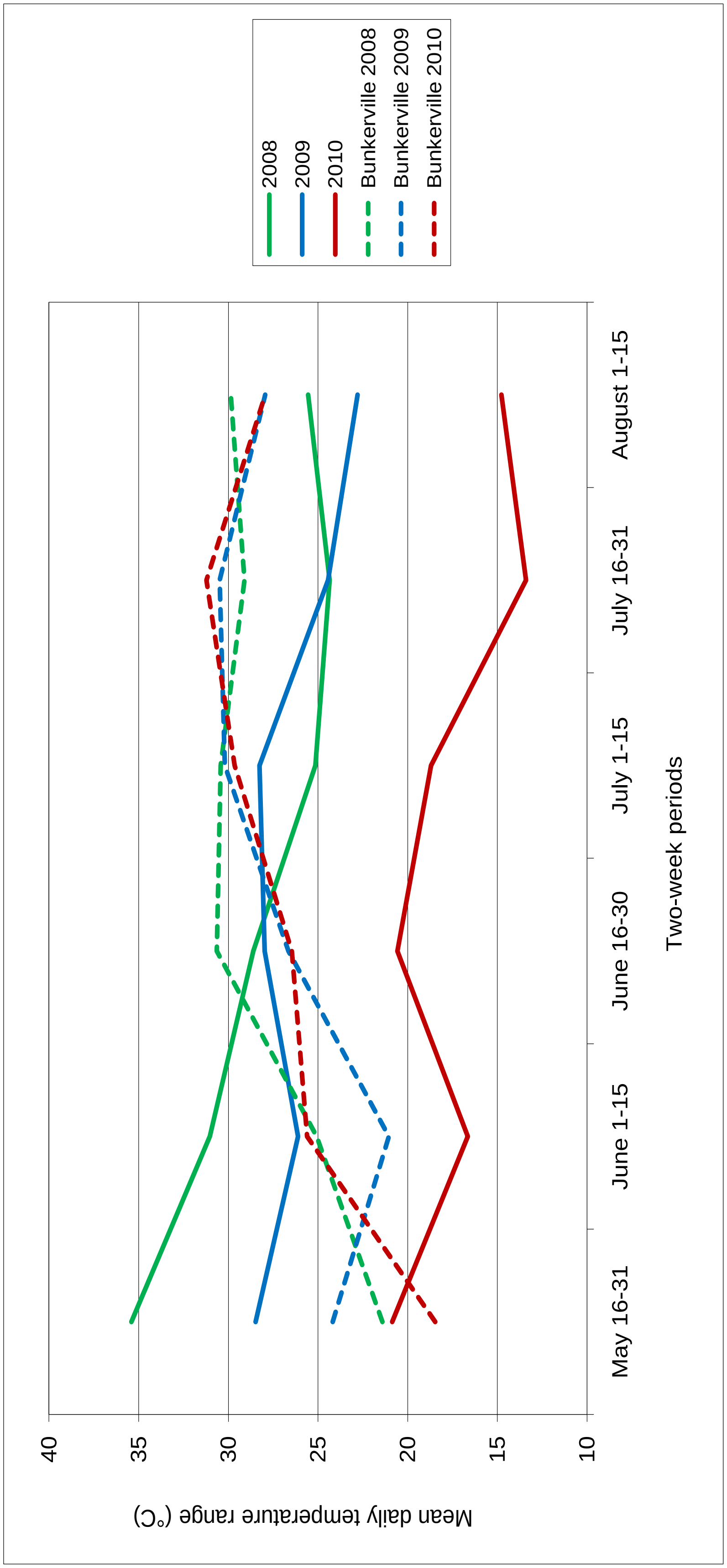

Figure 6.13. Mean daily temperature range at the Bunkerville weather station and within Southwestern Willow Flycatcher territories in coyote willow habitat at Mesquite West, 2008–2010. Data are summarized by two-week periods.

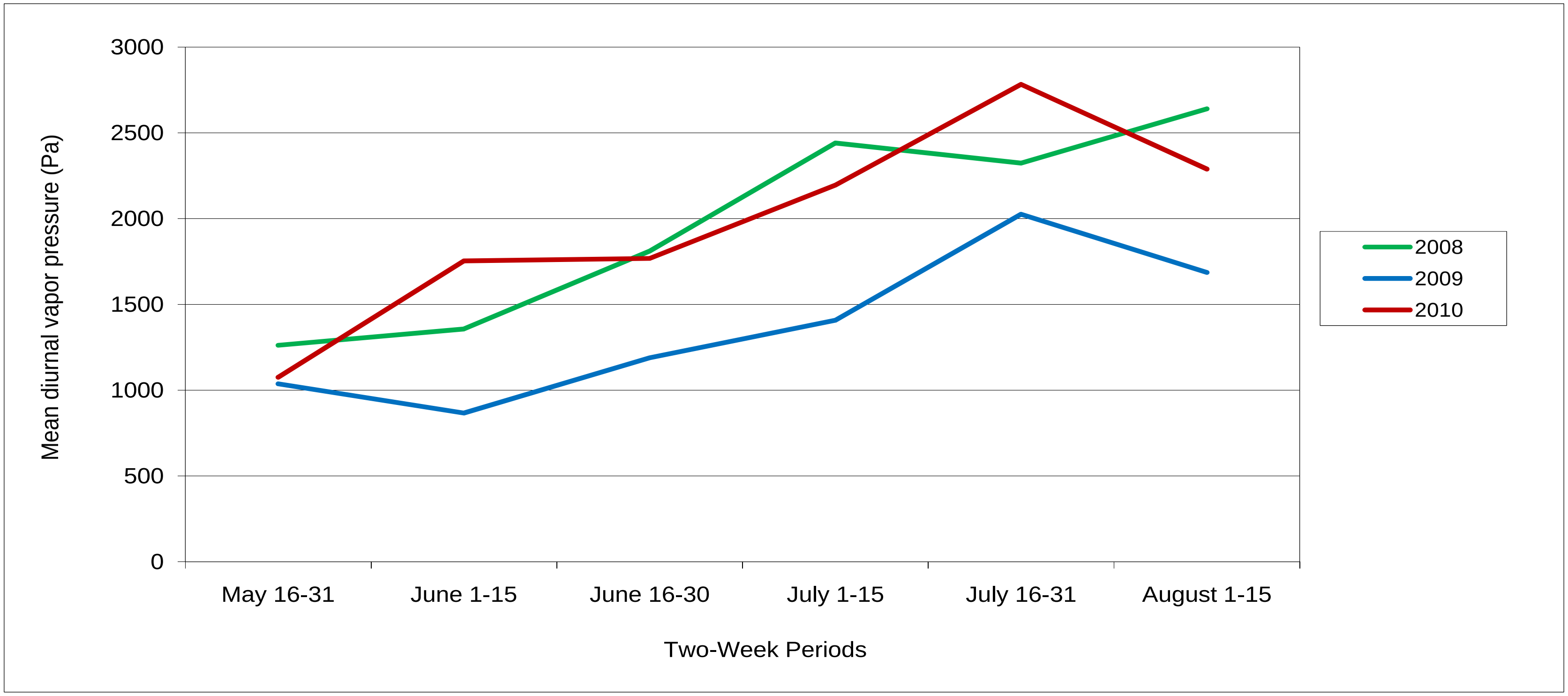

Figure 6.14. Mean diurnal vapor pressure at Southwestern Willow Flycatcher territories in coyote willow habitat at Mesquite West, 2008–2010. Data are summarized by two-week periods.

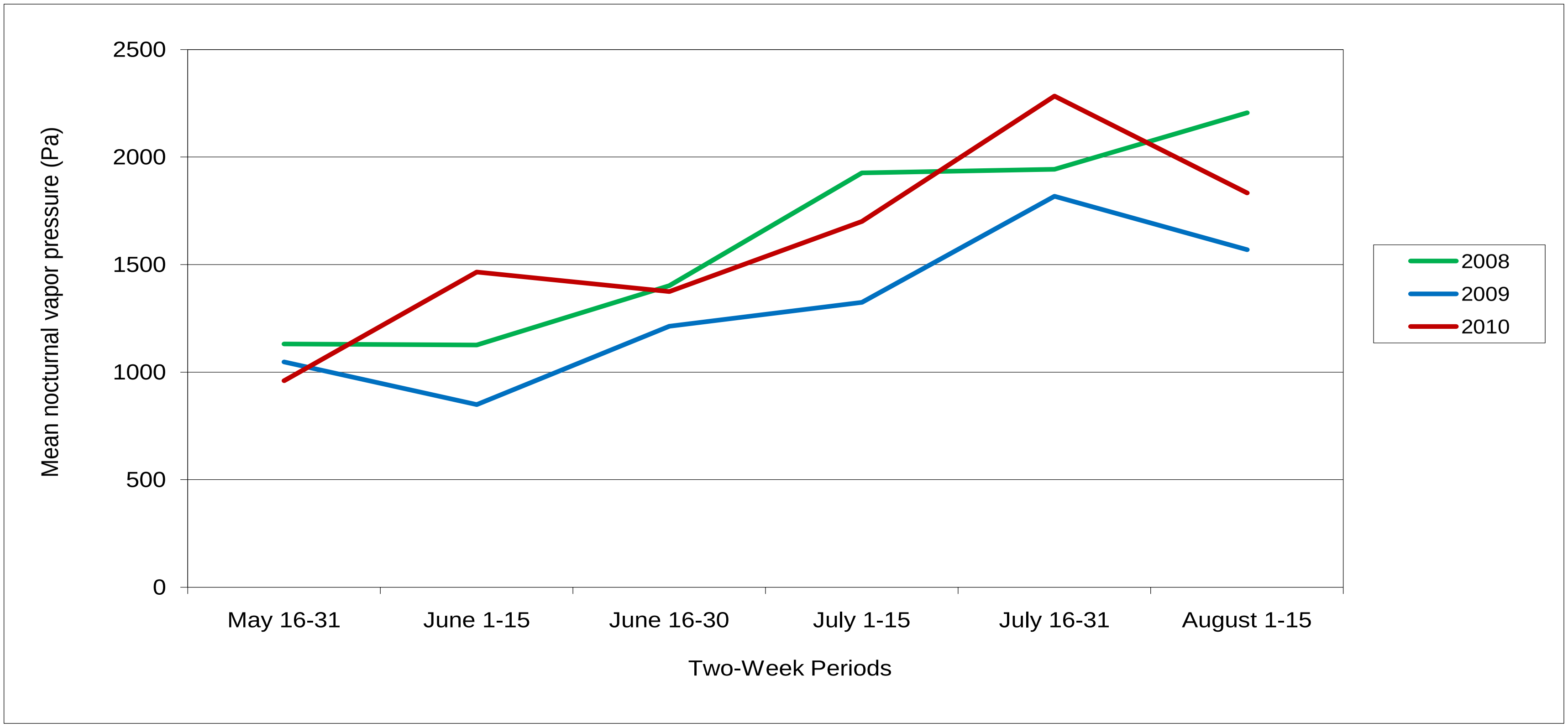

Figure 6.15. Mean nocturnal vapor pressure at Southwestern Willow Flycatcher territories in coyote willow habitat at Mesquite West, 2008–2010. Data are summarized by two-week periods.

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 analysis was completed in previous years and is not repeated here. This chapter reports the results of habitat monitoring to date.

METHODS

In 2005, we selected a subset of sites that are currently surveyed for the presence of willow flycatchers for inclusion in the habitat monitoring study. We chose 11 sites distributed along the Parker to Imperial reach that are reasonably accessible, and where we believed groundwater levels were influenced primarily by river levels and not by outside sources such as irrigation return flows. Chosen sites equated to at least 75.3 ha (186 acres) on the California side of the lower Colorado River and at least 75.3 ha (186 acres) on the Arizona side. We also chose four control sites, two above Parker Dam and two below Imperial Dam, to distinguish any changes in microclimate, groundwater, or vegetation caused by water transfer actions from those caused by fluctuations in climate or rainfall. The 11 test sites are Ehrenberg, Three Fingers Lake, Cibola Lake, Walker Lake, Paradise, Hoge Ranch, Rattlesnake, Clear Lake, Ferguson Lake, Ferguson Wash, and Great Blue Heron, and the four control sites are Blankenship Bend, Havasu NE, Mittry West, and Gila Confluence North. We monitored these same 15 sites from 2005 to 2010. In August of 2006, we initiated habitat monitoring within a consistently occupied breeding site at Topock Marsh to obtain groundwater levels and patterns with which we can compare results obtained at the habitat monitoring sites. The analysis comparing Topock to the 15 habitat monitoring sites was completed in previous years and is not repeated here.

Temperature/Humidity (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. 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 2005–2009, 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.

Piezometer Removal

Analyses of groundwater data in previous years showed that releases from Parker Dam can be used to predict the groundwater level beneath the habitat polygons (McLeod et al. 2007, McLeod and Koronkiewicz 2009), and the piezometers are no longer needed for measuring groundwater levels as related to river operations. Previous analyses also showed that groundwater levels at the habitat monitoring sites are not related to humidity and are only weakly related to soil moisture at sites where soil moisture values are the highest. Analyses of evapotranspiration signature (McLeod and Koronkiewicz 2010) showed that groundwater levels could not be used to evaluate changes in evapotranspiration at the habitat monitoring sites because of the overriding influence of fluctuating river levels. Thus, we determined that the piezometers had fulfilled their original function of evaluating the relationship between river level and groundwater beneath the habitat monitoring sites. In addition, piezometer data were not useful in relating groundwater levels to changes in humidity, soil moisture, or vegetation density. Because the piezometers were experiencing consistent equipment failure and were no longer providing useful data, all piezometers at the 15 habitat monitoring sites were removed in 2010. The piezometer at Topock Marsh was left in place as the only remaining piezometer, in anticipation of monitoring water level changes associated with pumping water into the site in 2011 (see Chapter 8).

After a final data download and manual measurement of water level, the data logger and download cable were removed from the well at each site. The two-inch PVC well housing and three-quarter-inch PVC casing for the data logger were removed either fully or partially, depending on conditions. If possible, the two PVC pipes were simply pulled out of the ground. This was possible if the well was shallow, if sub-surface soil structure was not excessively compacted, and if there was no concrete foundation attached. Otherwise, sediment was cleared from the base of the well and a hacksaw was used to cut both pipes below ground level. The remaining pipe below ground surface was filled with surrounding sediments and left in place. Some wells had concrete foundations that had deteriorated over the years and were removed. If the pipes were cut to ground level and a foundation could not be removed or had not deteriorated, it was left in place and covered with surrounding sediments.

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 (2010).

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 one-way ANOVA. 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 examined monthly river flow data from below Parker Dam from 2000 to 2010 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.

RESULTS

Temperature/Humidity Logger Maintenance

All HOBO loggers were downloaded at the beginning and end of the 2010 field season. Three loggers had fallen to the ground over the winter because of sun damage to the logger housing, and one logger was missing entirely. One logger that was in place over the winter had a bad humidity sensor but useable temperature data, and one logger had faulty data for a portion of the recording period. Of the HOBO loggers in place May–August 2010, two failed to collect data, one had faulty humidity data, and one ceased collecting data part way through the season. Data from fallen loggers were not used in the analysis.

Piezometer Downloads

All piezometers at the 15 habitat monitoring sites were downloaded immediately prior to removal (see next section). The piezometer at Topock Marsh was downloaded in June and November. Seven sites (Topock Marsh, Ehrenberg, Walker Lake, Paradise, Rattlesnake, Clear Lake, and Ferguson Lake) collected usable data since the previous download in 2009, and updated hydrographs for these piezometers are presented in Appendix F. Seven of the nine remaining piezometers (Blankenship Bend, Havasu NE, Three Fingers Lake, Cibola Lake, Hoge Ranch, Mittry West, and Gila Confluence North) experienced equipment failure and did not collect any new data since the previous download in 2009. Data from the remaining two piezometers at Ferguson Wash and Great Blue Heron were ruled unusable because of setup errors. Final hydrographs for these nine piezometers, with the final manual measurement included, are also presented in Appendix F.

Data Validation

A total of 161 download periods were assessed using the data validation protocol. Of these, 115 download periods (71%) required no correction. An additional 28 download periods (17%) had identifiable errors, and a correction factor was applied to the data. Data from 17 download periods (11%) were unable to be validated, and the data were deemed unusable for analysis. Of the 28 download periods with correctable errors, 8 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 17 of the download periods determined to be unusable; most of these instances resulted from the combination of setup errors and equipment malfunction.

Piezometer Removal

In June 2010, the data loggers and piezometer well casings were removed from Blankenship Bend and Havasu NE. The remaining data loggers and associated well casings (Ehrenberg, Three Fingers Lake, Cibola Lake, Walker Lake, Paradise, Hoge Ranch, Rattlesnake, Clear Lake, Ferguson Lake, Ferguson Wash, Great Blue Heron, Mittry West, and Gila Confluence North) were removed in August 2010.

Microclimate

2010 Microclimate Descriptive Statistics

Soil moisture, temperature, and vapor pressure parameters from the 15 study sites monitored in 2010 exhibited substantial variation among sites (Table 7.1). Soil moisture varied by a factor of four among the 2010 study sites, from a low of 169.9 mV at Ferguson Wash to a high of 898.7 at Mittry West.

Mean maximum diurnal temperatures ranged from a low of 37.2^{o}C at Clear Lake to a high of 48.3^{o}C at Cibola Lake. Mean minimum nocturnal temperatures ranged from a low of 15.4^{o}C at Three Fingers Lake to a high of 19.5^{o}C at Ferguson Lake and Havasu NE. Mean daily temperature range varied from 19.1^{o}C at Clear Lake to 32.0^{o}C at Three Fingers Lake.

Mean diurnal vapor pressure was lowest at Three Fingers Lake (937.2 Pa) and highest at Rattlesnake (1674.7 Pa). Mean nocturnal vapor pressure was lowest at Three Fingers Lake (976.6 Pa) and highest at Rattlesnake (1527.1 Pa).

Between-year Comparisons of Microclimate Characteristics

All microclimate characteristics varied significantly over time at test sites (Ehrenberg, Three Fingers Lake, Cibola Lake, Walker Lake, Paradise, Hoge Ranch, Rattlesnake, Clear Lake, Ferguson Lake, Ferguson Wash, and Great Blue Heron; Table 7.2). At control sites (Blankenship Bend, Havasu NE, Mittry West, and Gila Confluence North), only the three measures of 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 only for soil moisture (right-most column of Table 7.2). Between 2005 and 2006, soil moisture decreased more dramatically at control sites than at test sites, while between 2007 and 2008, soil moisture decreased at control sites but rose at test sites. Between 2009 and 2010, soil moisture decreased at test sites but rose at control sites.

Vegetation Measurements

Vegetation characteristics varied widely both between and within the selected habitat monitoring sites (Table 7.3). Average canopy height ranged from 3.2 m (Three Fingers Lake) to 13.7 m (Ehrenberg), and average canopy closure ranged from 53.9% (Cibola Lake) to 99.5% (Walker Lake). Measures of other habitat characteristics were similarly variable. Vertical foliage profiles for each site are shown in Figure 7.1. 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 ($P = 0.008$ and

P = 0.050, respectively), number of dead stems <2.5 cm and 2.5–8 cm dbh (*P* = 0.011 and *P* = 0.003, respectively), percentage of live stems <2.5 and 2.5–8 cm dbh (*P* < 0.001 and *P* = 0.005, respectively), and percent native basal area (P = 0.004) for all plots combined (Table 7.4). None of the variables exhibited change in a consistent direction over time. Woody ground cover and the percent of basal area that was native were the only variables for which there was a significant interaction (*P* = 0.022 and *P* = 0.038, respectively) 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. The percentage of the basal area that consisted of native species rose between 2009 and 2010 at control plots while it did not change at test plots.

Repeated measures ANOVAs for vertical foliage in each meter interval showed no significant between-year differences for live vegetation. There were between-year differences in dead vegetation in the first, second, third, and fourth meter intervals above the ground (P < 0.001 for each interval). In all four intervals, density of dead vegetation was higher in 2008 and 2010 than in 2007. The percentage of live vegetation did not differ significantly between years for any meter interval. There was a significant interaction between live vertical foliage density and location (test vs. control sites) for the second and fourth meter intervals (P = 0.043 and P = 0.033, respectively), 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 and second meter intervals (P < 0.001 and P = 0.003, respectively), with the density of dead vegetation increasing more in 2007 and 2008 and dropping more in 2009 at control plots relative to test plots. There was a significant interaction between the percentage of live foliage and location only for the sixth meter interval; again, there was no clear pattern, with the percentage generally increasing at control plots in years it decreased at test plots, and vice versa.

Groundwater Monitoring

Overview of Piezometer Groundwater Levels

Daily and weekly cycles are 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. 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 (see hydrographs in Appendix F).

Planned Declines in Parker Releases – Average monthly river flow data below Parker Dam from 2000 to 2010 (Table 7.5) 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 2010 except for March, the only month that experienced an increase of average flow for 2010. The percent decrease from 2001 to 2010 was lowest in September (9.5%), greatest in January (32.2%), and ranged from 12.8 to 25.8% in May–August. During the period when groundwater levels were recorded (2005–2010) the overall annual river flows did not show a decreasing trend.

Table 7.1. Microclimatic Data Summaries Collected From Habitat Monitoring Sites, Lower Colorado River, May–July 2010*

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)	794.7 (76.1)	311.2 (42.5)	547.2 (51.1)	569.7 (30.2)	349.4 (43.1)	882.1 (20.4)	768.0 (53.0)	804.7 (25.7)	778.8 (23.7)	439.5 (87.0)	915.4 (12.7)	169.9 (7.6)	890.6 (9.6)	898.7 (10.1)	728.3 (41.4)
Temperature															
Mean maximum diurnal temperature (C)	45.0 (0.5)	45.0 (0.4)	47.7 (0.3)	47.4 (0.3)	48.3 (0.3)	42.0 (0.3)	44.4 (0.3)	47.9 (0.3)	38.6 (0.2)	37.2 (0.3)	40.5 (0.3)	40.9 (0.4)	39.2 (0.3)	43.5 (0.3)	45.0 (0.3)
Mean minimum nocturnal temperature (C)	18.8 (0.4)	19.5 (0.3)	19.3 (0.4)	15.4 (0.4)	18.4 (0.3)	17.2 (0.3)	17.8 (0.3)	17.2 (0.3)	15.8 (0.3)	18.0 (0.3)	19.5 (0.3)	18.8 (0.3)	16.8 (0.3)	17.0 (0.3)	16.4 (0.3)
Mean daily temperature range (C)	26.2 (0.5)	25.6 (0.5)	28.4 (0.4)	32.0 (0.4)	29.9 (0.3)	24.8 (0.4)	26.6 (0.4)	30.7 (0.4)	22.8 (0.3)	19.1 (0.4)	20.9 (0.3)	22.2 (0.5)	22.5 (0.4)	26.5 (0.4)	28.7 (0.4)
Humidity															
Mean diurnal vapor pressure (Pa)	1165.5 (29.3)	1282.0 (27.3)	1084.9 (27.5)	937.2 (31.1)	984.7 (24.4)	1362.3 (33.1)	1316.0 (29.9)	1317.1 (31.6)	1674.7 (40.9)	1656.4 (41.6)	1406.8 (29.0)	1389.6 (33.0)	1598.4 (34.7)	1458.6 (32.5)	1394.2 (32.7)
Mean nocturnal vapor pressure (Pa)	1214.2 (28.9)	1210.3 (24.7)	1179.2 (24.7)	976.6 (25.9)	1130.1 (20.9)	1260.7 (26.2)	1265.0 (26.6)	1273.0 (27.1)	1527.1 (32.6)	1388.8 (33.7)	1385.3 (25.3)	1149.5 (28.3)	1496.0 (27.8)	1280.9 (26.6)	1434.3 (27.9)

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

Table 7.2. Change in Microclimatic Variables at Habitat Monitoring Sites from 2005 to 2010*

Parameter	Test (n=45)												Control (n=15)												P-value for difference between years among test sites compared to control sites
	2005	2006	2007	2008	2009	2010	Change 2005 to 2006	Change 2006 to 2007	Change 2007 to 2008	Change 2008 to 2009	Change 2009 to 2010	P-value for the difference between years	2005	2006	2007	2008	2009	2010	Change 2005 to 2006	Change 2006 to 2007	Change 2007 to 2008	Change 2008 to 2009	Change 2009 to 2010	P-value for the difference between years	
Soil Moisture																									
Mean soil moisture (mV)	645.7	634.4	662.9	705.8	699.2	651.4	-11.3	28.5	42.9	-6.6	-47.8	<0.001	694.4	582.9	635.3	607.5	591.7	687.5	-111.5	52.4	-27.8	-15.8	95.8	0.622	0.001
Temperature																									
Mean maximum diurnal temperature (C)	44.9	46.1	45.2	46.5	43.8	45.0	1.2	-0.9	1.3	-2.7	1.2	<0.001	45.6	48.0	46.4	45.7	44.2	46.2	2.4	-1.6	-0.7	-1.5	2.0	0.002	0.296
Mean minimum nocturnal temperature (C)	20.7	22.7	20.4	20.7	21.2	20.4	2.0	-2.3	0.3	0.5	-0.8	<0.001	20.2	22.1	20.3	20.8	21.2	20.9	1.9	-1.8	0.5	0.4	-0.3	<0.001	0.125
Mean daily temperature range (C)	24.2	23.5	24.8	25.8	22.6	24.6	-0.7	1.3	1.0	-3.2	2.0	<0.001	25.4	26.0	26.1	24.9	23.0	25.3	0.6	0.1	-1.2	-1.9	2.3	0.004	0.257
Humidity																									
Mean diurnal vapor pressure (Pa)	1797.2	2028.4	1737.9	1770.4	1758.9	1588.3	231.2	-290.5	32.5	-11.5	-170.6	<0.001	1726.3	1863.9	1696.9	1692.3	1701.1	1582.8	137.6	-167.0	-4.6	8.8	-118.3	0.061	0.311
Mean nocturnal vapor pressure (Pa)	1686.3	1860.4	1852.7	1679.8	1618.0	1484.0	174.1	-7.7	-172.9	-61.8	-134.0	<0.001	1638.2	1703.4	1559.9	1582.9	1583.2	1479.8	65.2	-143.5	23.0	0.3	-103.4	0.073	0.251

*The analysis was restricted to 1 June–1 August each year.

Table 7.3. Summary of Vegetation Characteristics at Habitat Monitoring Sites, Lower Colorado River, 2010*

Parameter	Blankenship Bend (n=4)	Havasu NE (n=4)	Ehrenberg (n=4)	Three Fingers Lake (n=5)	Cibola Lake (n=5)	Walker Lake (n=3)	Paradise (n=4)	Hoge Ranch (n=4)	Rattlesnake (n=4)	Clear Lake (n=3)	Ferguson Lake (n=5)	Ferguson Wash (n=4)	Great Blue Heron (n=4)	Mittry West (n=4)	Gila Confluence North (n=3)
Average canopy height (m)	6.3 (0.8)	5.6 (0.9)	13.7 (3.5)	3.2 (0.4)	4.1 (0.2)	6.9 (2.8)	8.4 (2.5)	4.1 (0.4)	8.2 (0.4)	7.7 (0.2)	5.2 (0.6)	5.6 (0.6)	7.1 (1.1)	8.1 (1.5)	8.0 (0.3)
	4.3–7.6	3.8–7.9	3.9–20.2	2.4–4.5	3.5–5.0	4.0–12.5	3.7–14.8	3.2–5.2	7.1–9.0	7.5–8.0	3.2–6.5	4.5–6.8	4.8–10.0	4.0–11.5	7.5–8.5
% total canopy closure	86.3 (2.9)	59.0 (6.4)	64.3 (12.3)	78.3 (7.6)	53.9 (13.3)	99.5 (0.5)	99.1 (0.4)	89.8 (3.1)	92.7 (1.8)	97.2 (2.3)	86.4 (6.8)	94.5 (1.0)	98.6 (0.7)	93.2 (2.7)	84.2 (8.8)
	79.7–92.7	43.8–72.4	37.5–88.0	56.8–95.8	5.2–84.9	98.4–100.0	97.9–99.5	84.4–98.4	89.1–97.4	92.7–100.0	59.4–95.8	91.7–95.8	96.9–100.0	85.9–98.4	66.7–94.3
% woody ground cover	47.1 (12.0)	34.9 (8.7)	17.6 (4.9)	16.8 (7.9)	29.4 (9.7)	31.6 (12.1)	66.4 (18.9)	51.0 (6.6)	61.4 (5.6)	48.1 (12.9)	28.1 (14.3)	33.3 (3.0)	18.1 (10.5)	38.5 (10.2)	29.2 (3.7)
	21.0–70.5	14.8–53.5	6.0–29.8	2.8–40.3	7.5–62.5	12.3–53.8	17.8–96.3	41.5–70.0	51.3–76.3	26.5–71.3	4.8–82.5	26.0–40.0	2.0 (48.8)	15.8–63.8	22.3–35.0
# live stems <2.5 cm dbh per ha	1592 (589)	159 (95)	923 (240)	5424 (1818)	738 (186)	849 (306)	1050 (175)	1974 (594)	350 (229)	212 (212)	993 (611)	350 (121)	414 (167)	1114 (682)	1231 (212)
	764–3310	0–382	382–1528	1146–11714	127–1146	255–1273	637–1401	1019–3692	0–1019	0–637	0–3310	0–509	127–891	0–2928	1019–1655
# live stems 2.5–8 cm dbh per ha	2324 (682)	318 (191)	350 (229)	7741 (931)	2878 (745)	2377 (699)	3310 (2069)	4297 (741)	2801 (1390)	1358 (1106)	3743 (955)	1592 (257)	3692 (1055)	2228 (910)	2801 (724)
	382–3565	0–764	0–1019	6116–11205	382–4584	1146–3565	255–9423	2165–5602	382–5857	127–3565	1146–6112	891–2037	1401–6494	637–4838	1401–3920
# live stems >8 cm dbh per ha	318 (110)	318 (133)	159 (61)	204 (204)	509 (276)	255 (127)	637 (356)	318 (241)	1082 (331)	1613 (377)	484 (168)	1082 (184)	987 (167)	764 (385)	1061 (625)
	127–637	0–637	0–255	0–1019	0–1528	127–509	0–1655	0–1019	127–1655	891–2165	127–1019	637–1528	637–1273	0–1783	255–2292
# dead stems <2.5 cm dbh per ha	382 (271)	0 (0)	668 (190)	4049 (1132)	458 (169)	552 (431)	1241 (987)	1305 (804)	127 (74)	212 (112)	1528 (576)	350 (240)	287 (80)	987 (436)	934 (153)
	0–1146	0–0	127–1019	255–6239	0–1019	0–1401	255–4202	0–3438	0–255	0–382	255–3056	0–1019	127–509	0–1783	637–1146
# dead stems 2.5–8 cm dbh per ha	255 (52)	64 (64)	350 (267)	2445 (782)	1935 (705)	467 (258)	796 (414)	1401 (672)	828 (669)	424 (170)	2801 (1253)	828 (347)	891 (52)	1082 (211)	509 (337)
	127–382	0–255	0–1146	0–4711	255–4074	0–891	382–2037	0–3183	0–2801	255–764	0–7257	0–1655	764–1019	509–1401	0–1146
# dead stems >8 cm dbh per ha	64 (37)	95.5 (95.5)	32 (32)	25.5 (25.5)	76 (76)	42 (42)	0 (0)	32 (32)	127 (127)	552 (278)	25.5 (25.5)	159 (121)	286 (131)	159 (96)	0 (0)
	0–127	0–382	0–127	0–127	0–382	0–127	0–0	0–127	0–509	0–891	0–127	0–509	0–509	0–382	0–0
Percent basal area native	19.5 (18.5)	58.7 (21.1)	75.0 (24.5)	0.0 (0.0)	0.3 (0.3)	32.5 (32.5)	20.7 (18.4)	46.0 (21.9)	33.9 (22.1)	0.0 (0.0)	0.4 (0.4)	13.6 (13.6)	34.0 (15.7)	64.0 (22.7)	100.0 (0)
	0.0–74.8	0.3–100.0	1.4–99.7	0.0–0.0	0.0–1.2	0.0–97.6	0.0–75.8	2.0–58.4	0.0–97.8	0.0–0.0	0.0–2.2	0.0–54.3	0.0–76.0	0.0–99.3	100.0–100.0

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

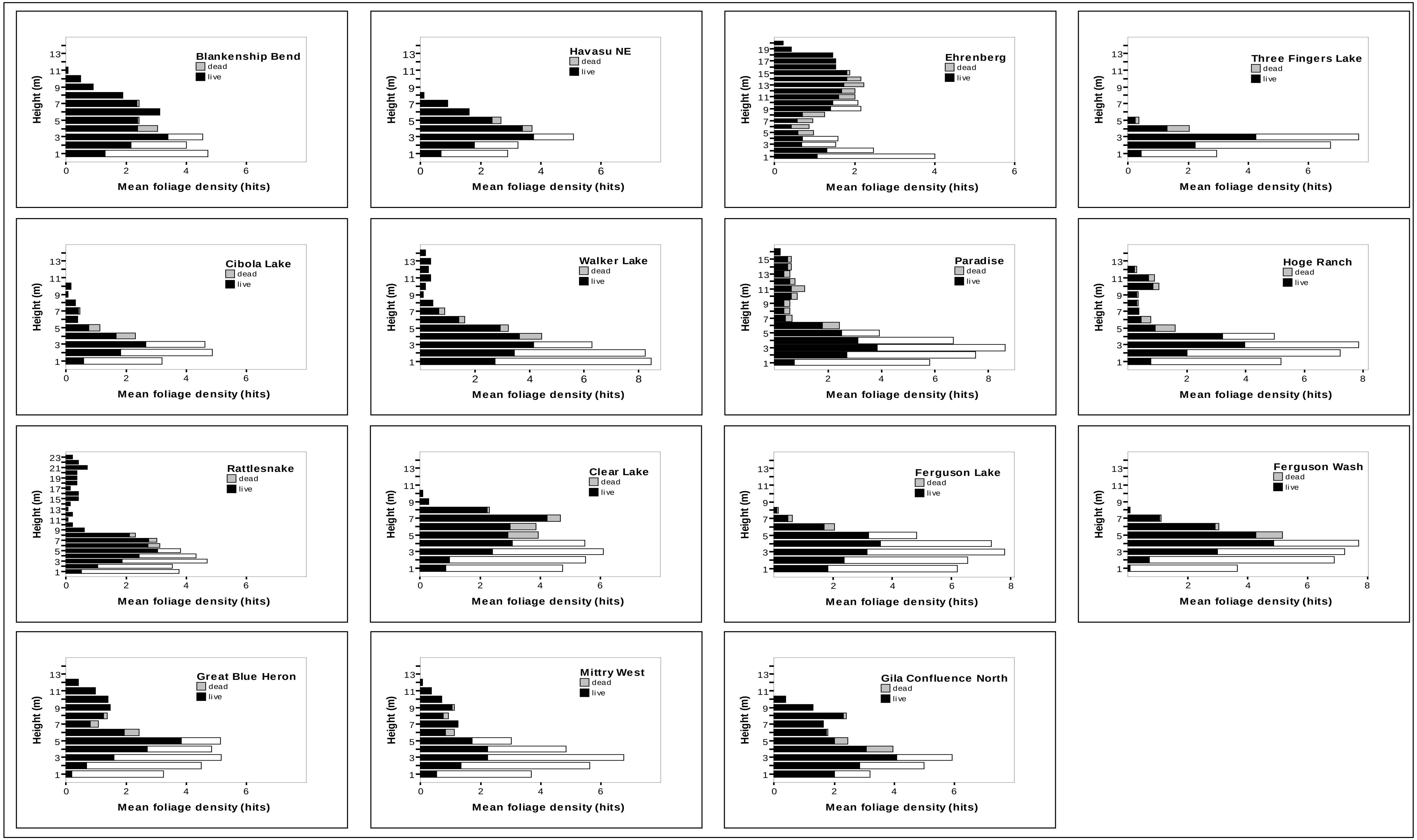

Figure 7.1. Vertical foliage profiles for each habitat monitoring site, lower Colorado River, 2010.

Table 7.4. Annual Means of Vegetation Characteristics at Plots between Parker and Imperial Dams (Test Sites) and Plots above Parker or below Imperial (Control Sites), 2005–2010

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	2010	2005	2006	2007	2008	2009	2010		
Average canopy height (m)	6.4	6.8	5.7	6.6	6.7	6.4	6.3	6.6	6.9	7.1	6.7	6.7	0.805	0.672
% total canopy closure	84.7	78.3	87.9	88.1	86.7	85.3	81.1	76.1	87.1	84.3	80.7	78.5	<0.001	0.727
% woody ground cover	31.1	27.2	29.8	41.6	23.0	35.2	27.3	48.8	39.3	56.8	34.8	39.4	<0.001	0.022
# live stems <2.5 cm dbh per ha	1933	2272	2515	1358	2530	1316	955	2186	1655	743	987	976	0.008	0.366
# live stems 2.5–8 cm dbh per ha	3107	2722	3143	3899	2314	3271	1613	1984	1910	1963	1220	1857	0.050	0.547
# live stems >8 cm dbh per ha	481	430	654	673	597	637	668	594	690	753	562	637	0.272	0.745
# dead stems <2.5 cm dbh per ha	340	1282	1259	1084	1949	1075	803	1305	1294	1422	1348	456	0.011	0.295
# dead stems 2.5–8 cm dbh per ha	1234	821	925	1879	1081	1310	1284	456	711	1528	562	552	0.003	0.656
# dead stems >8 cm dbh per ha	48	59	96	108	91	110	64	95	148	74	138	95	0.286	0.608
% live stems <2.5 cm dbh	84.1	69.2	67.4	59.3	53.6	58.5	69.0	64.2	54.0	38.4	41.9	72.6	<0.001	0.110
% live stems 2.5–8 cm dbh	73.6	75.8	77.2	69.2	65.3	69.9	74.0	81.7	71.7	54.9	68.6	76.8	0.005	0.149
% live stems >8 cm dbh	93.6	86.9	91.2	89.5	89.4	88.7	91.0	86.7	85.4	97.1	87.0	90.7	0.505	0.592
Percent basal area native	27.2	20.3	28.9	23.8	21.6	22.1	36.7	39.5	58.1	41.9	35.9	55.5	0.004	0.038

Table 7.5. Average Monthly Flows (cfs) Below Parker Dam, 2000–2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Difference (2001–present)	% Change (2001–present)
January	6,820	5,599	6,478	6,327	5,536	4,166	5,842	5,945	4,850	6,177	3,794	-1,805	-32.2%
February	9,123	8,505	8,978	6,881	7,129	4,888	7,798	8,491	8,232	7,137	5,960	-2,545	-29.9%
March	11,594	10,524	11,334	12,360	11,523	9,699	9,752	11,122	12,180	11,973	10,879	355	3.4%
April	14,613	14,090	13,610	13,803	12,824	11,356	11,985	12,618	14,293	13,184	11,259	-2,831	-20.1%
May	14,174	14,068	12,826	11,990	12,252	11,428	11,998	11,718	11,339	10,533	10,765	-3,303	-23.5%
June	13,803	14,733	13,713	12,778	12,741	12,444	12,383	12,116	11,957	9,992	10,931	-3,802	-25.8%
July	14,210	14,974	14,439	13,100	12,331	13,842	11,688	12,180	12,226	10,645	12,098	-2,876	-19.2%
August	11,441	12,047	12,118	10,803	11,420	10,316	10,141	10,317	10,720	9,459	10,508	-1,539	-12.8%
September	11,233	10,837	10,429	11,159	9,566	9,048	7,334	9,195	9,072	8,492	9,803	-1,034	-9.5%
October	9,362	8,852	8,765	9,761	7,405	6,967	7,424	7,204	7,568	7,241	7,562	-1,209	-14.6%
November	7,437	7,357	7,049	6,153	5,163	6,335	6,094	5,420	6,369	6,136		-1,221	-16.6%
December	6,706	5,970	5,615	5,737	4,129	4,841	5,507	4,079	3,829	4,872		-1,098	-18.4%

DISCUSSION

Microclimate

Between-year Comparisons of Microclimate Characteristics

Comparisons of microclimate characteristics among years in 2005–2010 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, 2007–2008, and 2009–2010 were not similar between test and control sites, with soil moisture declining more sharply at the control sites during the first two periods and then rising sharply during the third. This suggests that local conditions, in addition to regional climate, may have influenced soil moisture. However, the role of river flows in influencing soil moisture is unclear, given that no strong relationship was found between piezometer levels and soil moisture (McLeod and Koronkiewicz 2009). 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, and then rose again in 2010. 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 none showed unidirectional trends over time, suggesting there has been no overall, detectable change in vegetation. Many vegetation characteristics that varied over time showed parallel changes at control and test sites, suggesting either widespread yearly variation or observer variation between years.

Few variables showed changes that were specific to control or test sites. 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. The percentage of the basal area that comprised native vegetation rose sharply at control sites in 2010 but not at test sites. The sample size for control sites is small relative to the sample size for test sites, and thus control site data may be influenced by changes in vegetation measurements at a few sites. Two plots at Havasu NE were counted as including several large mesquite trees in 2010, whereas the mesquite trees had not been included in the plot in the previous year. This could account for a sizeable portion of the change observed between 2009 and 2010 across all control sites. Vertical foliage counts did not show any consistent differences between control and test locations, and it does not appear that between-year variation in vertical foliage counts can be attributed to the changes in river regulation.

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 and taking the extra time to measure distance if the inclusion of a stem is in question. Another factor that inhibits accurate stem counts in dense vegetation is the difficulty in keeping track of which stems have been counted already and which have not. In 2009, we began using chalk to mark stems that had already been counted to try to minimize omission or double-counting of stems.

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

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

Groundwater Levels

Piezometer Groundwater Levels

In general, the daily, weekly, and seasonal cycles observed in previous years' data are still visible in 2010 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 recent data logger data.

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.

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Chapter 8

SURFACE HYDROLOGY, MICROCLIMATE, AND VEGETATION MONITORING: TOPOCK MARSH

INTRODUCTION

Monitoring of Southwestern Willow Flycatcher populations at Topock Marsh began in 1997, and data on number of flycatcher pairs and nest success are available for 1998–2010. 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 within Topock, 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 2008–2010. 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 (McLeod and Koronkiewicz 2010). 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 was expected to commence early in 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. We commenced similar monitoring in March 2010 in anticipation of water delivery. Water delivery was delayed until 2011, however, and monitoring in 2010 served to provide a second year of baseline data.

METHODS

Surface Water Mapping

Beginning in mid-March 2010 and continuing through late July, we visited In Between, 800M, 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

In 2009, the In Between, 800M, and Pierced Egg polygons were stratified into use (occupied by flycatchers) and non-use (unoccupied by flycatchers) areas, as observed in 2003–2008. Use areas tend to be wetter than non-use areas and thus are presumably low-lying and more likely to be affected by water delivery into the habitat. We excluded the cattail marsh in the center of the 800M polygon from either the use or non-use areas. We superimposed a 25- x 25-m grid on a GIS software shapefile of the use and non-use areas, numbered the grid blocks, and selected blocks using a random number generator. We used the centroid of the selected block as the sample point and located each point in the field by navigating to the given coordinates using a Rino 110 GPS unit. We determined the exact location of each sample point by means of random number sequences as described in Chapter 6. All sample points used in 2009 were marked in the field with flagging that remained in place over the 2009–2010 winter. We relocated each sample point in 2010 and redeployed a data logger in the same location. We used HOBO H8 Pro data loggers (see Chapter 6) to record temperature and humidity at each sample point at 15-minute intervals. Each logger remained in place until the end of the flycatcher breeding season. We collected soil moisture readings, as described in Chapter 6, below each data logger at bi-weekly intervals.

Vegetation

In late July and early August 2010, 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 and the subsequent vegetation measurements, any responses in vegetation are more likely to be apparent in canopy closure and vertical foliage density than in stem counts.

Data Analyses

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. We compared the conditions measured in 2010 versus those measured in 2009 by using paired t-tests for both occupied and unoccupied areas. We used SPSS® Version 16.0 (SPSS Inc.) software for statistical analyses.

RESULTS

Surface Water Mapping

We mapped surface water at weekly intervals from 14 March to 21 July. The percentage of the site that was inundated rose rapidly in late March and early April to a high of 23% and then declined just as rapidly in late April and early May (Figures 8.1 and 8.2). By mid-May, <5% of the site had surface water.

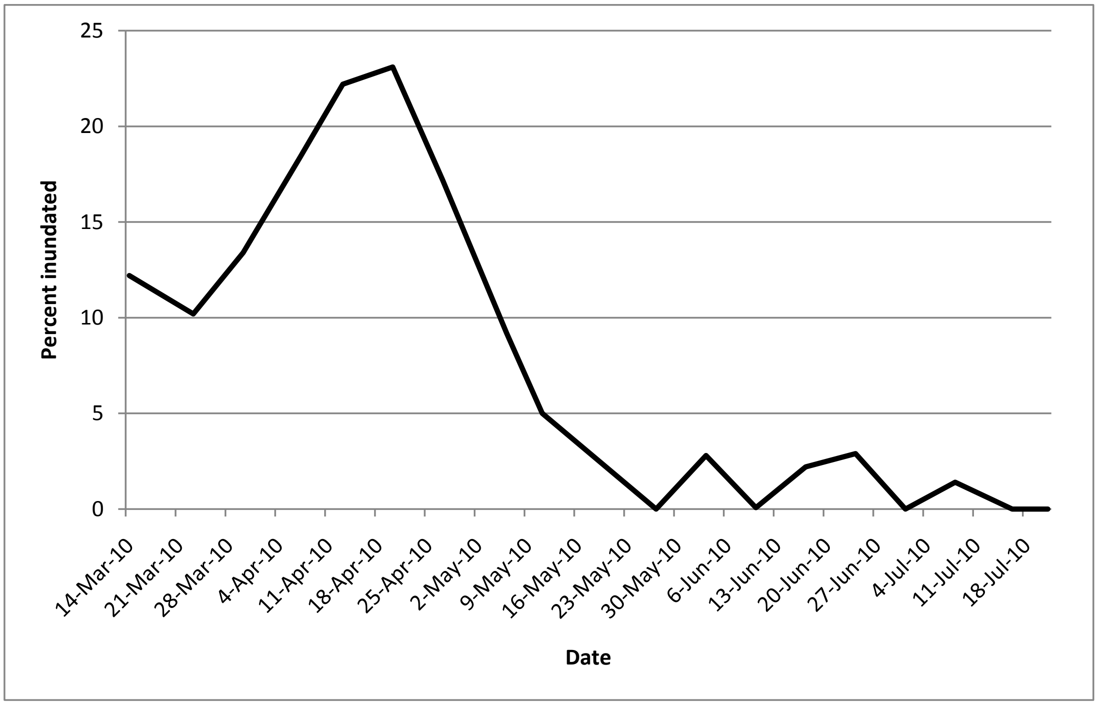

Figure 8.1. Percentage of In Between, 800M, and Pierced Egg, combined, that was inundated in March–July 2010.

Microclimate

We deployed 15 HOBO loggers in use areas and 17 loggers in non-use areas between 14 and 29 March. 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).

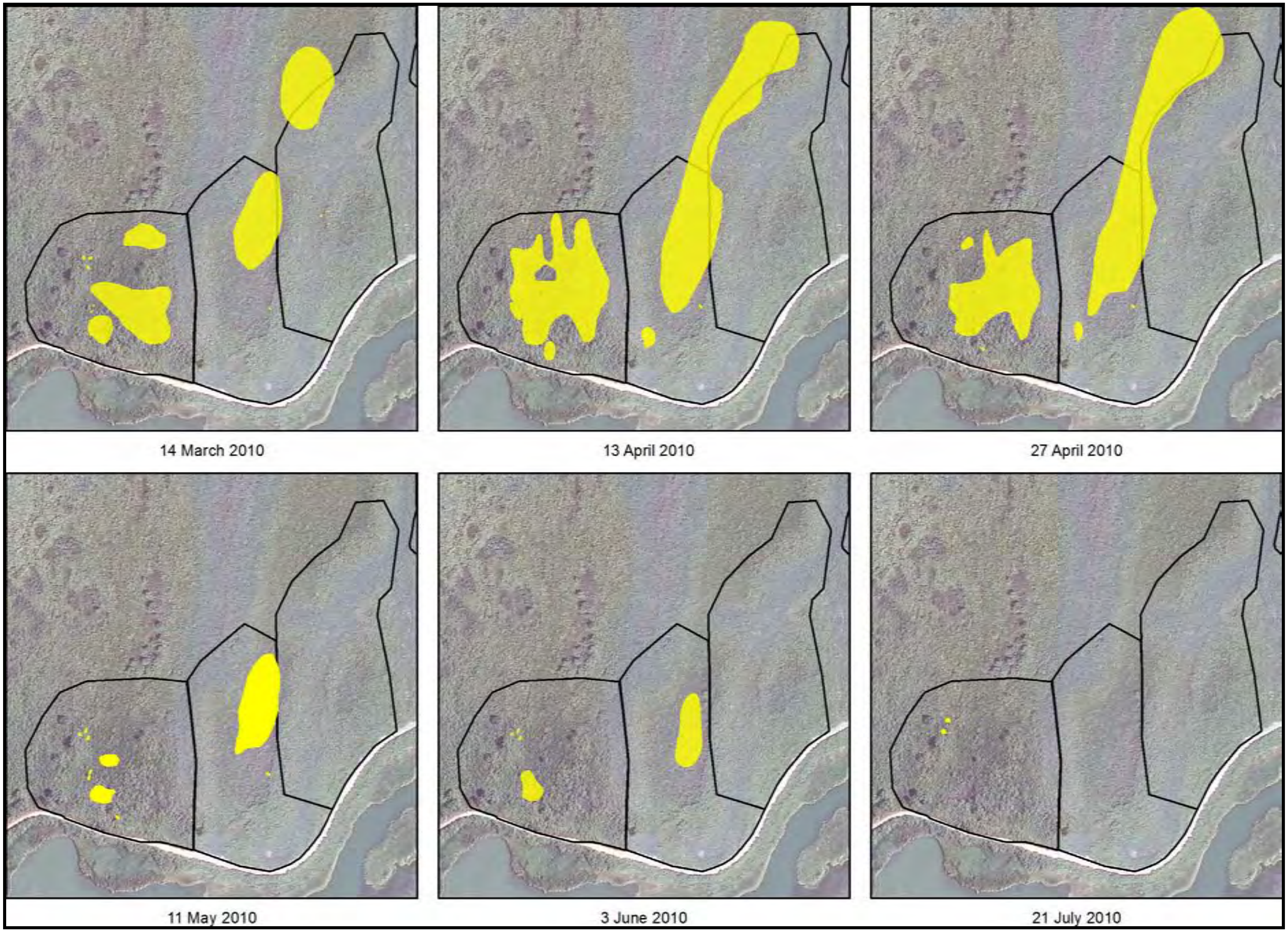

Figure 8.2. Extent of surface water within In Between, 800M, and Pierced Egg at approximately monthly intervals, March–July 2010.

Table 8.1. Microclimate Measures at Topock Hydrology Monitoring Sites – Use Area (n = 15), 2010*

Microclimate Measure	April 1–15	April 16–30	May 1–15	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture									
Mean soil moisture (mV)	924.7 (7.2)	915.9 (10.2)	906.3 (7.0)	863.6 (12.3)	869.5 (8.1)	860.5 (13.1)	861.2 (15.7)	849.9 (11.9)	835.5 (15.0)
Mean distance to nearest standing water	30.7 (5.6)	25.1 (5.2)	41.0 (6.8)	48.6 (9.8)	76.7 (7.2)	82.7 (8.8)	140.0 (17.6)	169.4 (13.5)	153.4 (16.9)
% of area within 20 m that was inundated	5.0 (3.0)	8.0 (3.8)	2.7 (2.1)	1.8 (0.8)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
% of area within 50 m that was inundated	15.6 (5.7)	18.3 (4.5)	5.9 (2.6)	3.9 (1.7)	4.1 (3.0)	0.3 (0.3)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Temperature									
Mean maximum diurnal temperature (C)	33.5 (0.3)	34.2 (0.4)	36.5 (0.3)	36.4 (0.4)	39.8 (0.4)	40.7 (0.4)	40.6 (0.4)	40.4 (0.4)	31.9 (0.9)
Mean minimum nocturnal temperature (C)	6.2 (0.2)	9.6 (0.3)	9.5(0.2)	11.0 (0.2)	18.8 (0.2)	14.8 (0.1)	19.1 (0.2)	26.2 (0.1)	22.6 (0.3)
Mean daily temperature range (C)	27.3 (0.4)	24.7 (0.5)	27.0 (0.4)	25.5 (0.4)	21.0 (0.4)	25.9 (0.4)	21.4 (0.)	14.1 (0.3)	9.3 (0.8)
Humidity									
Mean diurnal vapor pressure (Pa)	612.6 (10.0)	836.6 (14.2)	815.0 (14.8)	1003.9 (16.8)	1615.4 (22.9)	1662.5 (25.4)	2287.5 (34.1)	2683.0 (24.7)	2417.2 (45.8)
Mean nocturnal vapor pressure (Pa)	686.9 (9.4)	925.8 (12.6)	922.5 (11.4)	1062.6 (12.6)	1570.3 (17.9)	1448.9 (16.4)	1950.2 (22.9)	2476.4 (15.5)	2168.6 (20.6)

* Data are presented as mean (standard error).

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

Microclimate Measure	April 1–15	April 16–30	May 1–15	May 16–31	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15
Soil Moisture									
Mean soil moisture (mV)	896.6 (16.5)	891.6 (14.6)	868.4 (16.6)	859.0 (17.8)	848.5 (12.3)	815.1 (15.0)	813.8 (27.9)	754.1 (34.1)	759.1 (44.7)
Mean distance to nearest standing water	44.3 (9.5)	47.5 (8.5)	74.7 (9.5)	78.9 (9.8)	126.1 (10.8)	124.4 (12.0)	160.9 (26.7)	192.4 (23.8)	169.1 (23.0)
% of area within 20 m that was inundated	13.1 (8.1)	8.4 (5.4)	4.4 (4.4)	5.6 (4.5)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
% of area within 50 m that was inundated	16.6 (4.9)	9.9 (3.9)	5.8 (3.5)	4.2 (3.4)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	0.0 (0.0)
Temperature									
Mean maximum diurnal temperature (C)	34.2 (0.3)	35.8 (0.4)	37.8 (0.3)	38.4 (0.3)	41.9 (0.3)	43.4 (0.3)	43.7 (0.3)	43.0 (0.3)	35.0 (1.2)
Mean minimum nocturnal temperature (C)	4.8 (0.2)	8.4 (0.3)	8.1 (0.2)	9.6 (0.2)	17.9 (0.2)	13.5 (0.2)	18.1 (0.2)	25.6 (0.1)	21.8 (0.3)
Mean daily temperature range (C)	29.3 (0.4)	27.4 (0.4)	29.6 (0.4)	28.8 (0.4)	24.0 (0.4)	29.9 (0.4)	25.6 (0.4)	17.3 (0.3)	13.2 (1.1)
Humidity									
Mean diurnal vapor pressure (Pa)	596.6 (9.4)	816.7 (13.6)	796.5 (14.7)	971.7 (17.0)	1571.0 (24.6)	1605.6 (29.4)	2211.1 (37.2)	2615.3 (30.9)	2374.2 (54.7)
Mean nocturnal vapor pressure (Pa)	643.1 (8.7)	877.1 (11.8)	876.6 (11.1)	1005.4 (12.5)	1506.9 (17.9)	1397.0 (17.0)	1904.7 (22.9)	2431.2 (17.8)	2127.3 (23.3)

* 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, 2010*

Parameter	Use (n=15)	Non-use (n=17)
Average canopy height (m)	6.8 (0.2)	5.5 (0.3)
	5.0–8.3	3.4–7.4
% total canopy closure	91.4 (1.2)	87.0 (2.0)
	82.8–97.9	63.0–95.3
% woody ground cover	15.9 (4.2)	20.0 (4.9)
	1.8–54.0	1.0–66.3
Live vertical foliage (hits) below nest	1.6 (0.5)	3.8 (0.7)
	0–6.6	0.0–12.1
Live vertical foliage (hits) at nest	1.6 (0.2)	3.6 (0.3)
	0.1–3.4	0.8–6.0
Live vertical foliage (hits) above nest	10.1 (0.6)	6.6 (1.1)
	4.9–13.8	0.9–18.4
Dead vertical foliage (hits) below nest	7.7 (0.7)	9.7 (0.5)
	2.4–13.1	6.2–13.4
Dead vertical foliage (hits) at nest	2.4 (0.3)	1.4 (0.2)
	0.8–5.0	0.1–3.9
Dead vertical foliage (hits) above nest	2.0 (0.3)	0.4 (0.1)
	0.0–3.9	0.0–1.7
Percent native	1.1 (1.1)	4.4 (3.0)
	0–17.0	0.0–48.7

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

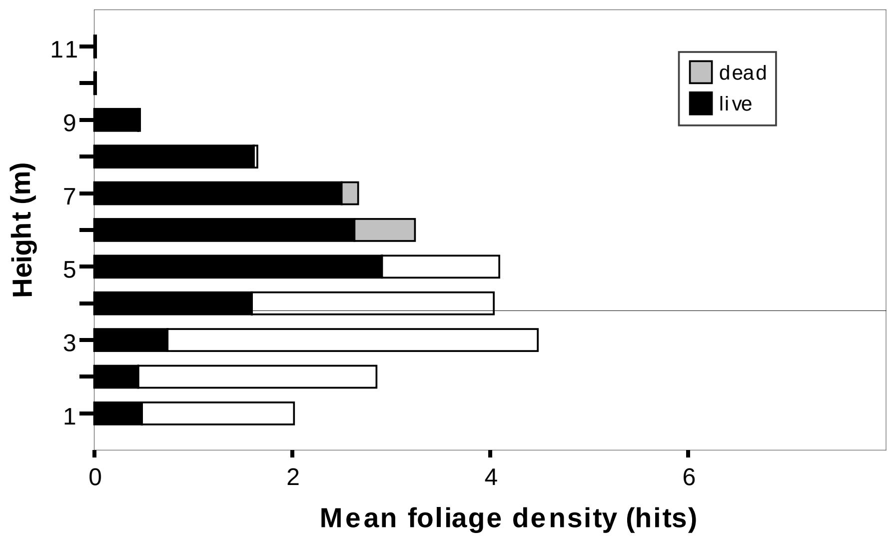

Figure 8.3. Vertical foliage density in areas occupied by flycatchers in at least one year between 2003 and 2010 within the habitat enhancement project area, Topock Marsh, 2010. Horizontal line shows average nest height in the project area, 2003–2008.

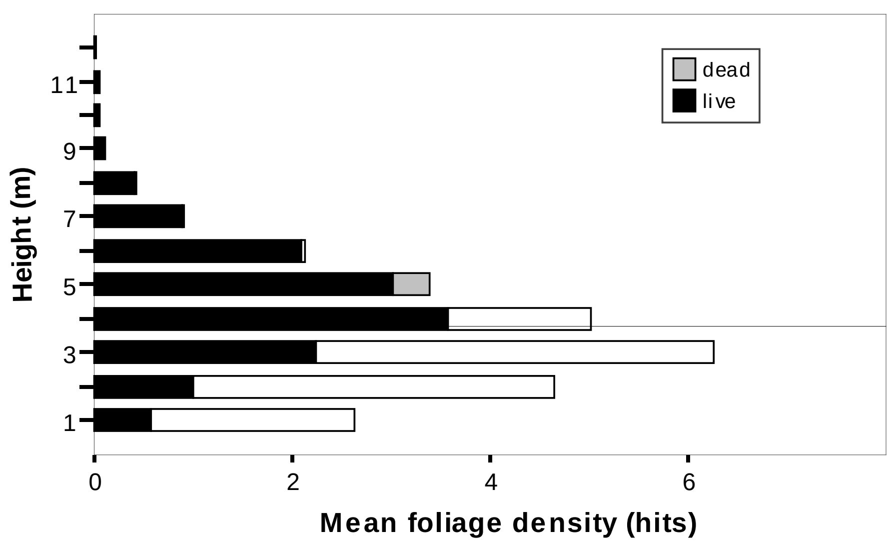

Figure 8.4. Vertical foliage density in areas not occupied by flycatchers between 2003 and 2010 within the habitat enhancement project area, Topock Marsh, 2010. Horizontal line shows average nest height in the project area, 2003–2008.

DISCUSSION

Qualitative observations suggested that surface water peaked at a shallower depth and at a lesser extent in 2010 than in 2009. These observations are supported by the results of surface water mapping, with the percentage of the site that was inundated peaking at nearly 45% in 2009 compared to only 23% in 2010. The hydrograph from the piezometer at Topock Marsh (see Chapter 7 and Appendix F) also confirms that water peaked at a lower level in 2010 than in 2009. The area dried out sooner in 2010 than in 2009, reaching only 5% inundation in mid-May in 2010 versus mid-June in 2009. Soil moisture variables recorded in 2009 and 2010 also show that the area was drier in 2010.

The vegetation characteristics recorded in 2010 differed little from those recorded in 2009 (see McLeod and Koronkiewicz 2010). In the between-year comparison, we attempted to control for observer variation between years by analyzing the percentage of vertical foliage that was alive in each height category; as long as each observer counts live and dead foliage in a similar manner, the proportion of live vegetation should be robust to observer variation effects. The only characteristic that differed between years was canopy closure, with lower canopy closure recorded in 2010.

The hydrology, vegetation, and microclimate data collected in 2009 and 2010 show the pretreatment conditions within the portion of Topock Marsh selected for habitat enhancement via water delivery. Identical methods will be used in 2011 to collect data during the water delivery period, and data from 2011 will be compared to those collected in 2009 and 2010 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, was 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 dam that impounds the upper lake resulted in the upper lake being drained in early 2008, and the riparian vegetation at the north end of the lake was not flooded during the 2008 and 2009 flycatcher breeding seasons as it had been in previous years. The dam was repaired prior to the 2010 breeding season, and although lake levels were higher in 2010 than in 2008 or 2009, they did not return to the levels maintained prior to dam failure. Riparian vegetation at the north end of the lake contained more water in 2010 than in the previous two years, but the site was not inundated as it had been previously.

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 spaced 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 subsequent years.

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. The contract was extended to include the breeding season of 2010.

METHODS

Microclimate

In 2009, 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. All HOBO locations were marked in the field with flagging and rebar. In 2010, we attempted to relocate each HOBO point and deploy a logger in the same location as was used in 2009. If we could not locate the flagging and rebar used to mark the logger location, we attempted to use the UTM coordinates, as recorded for the logger in 2009, to relocate the point. In these instances, we hung the logger at the same height as had been recorded in 2009. 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).

Surface Water Mapping

Beginning in late May 2010 and continuing through early August, we mapped the surface water present in Pahranagat North at approximately bi-weekly intervals. During each visit, we used GPS and aerial photographs to map the extent and depth of surface water. At the conclusion of each visit, we compiled our GPS points and field notes to prepare a hardcopy map of the site, with areas and surface water and saturated soils delineated on the map. All hardcopy maps were digitized after the field season using ArcGIS. From the digitized shapefiles, we calculated the percentage of the site that contained surface water during each visit. We also summarized data on percent site inundation and depth of water for 2003–2010.

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 was inundated versus 2010. We did a separate analysis for June and July–August to determine whether any between-year differences were consistent across the breeding season. We also used one-way ANOVA to compare data collected in 2010 to that collected in 2009. 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 2005–2010. Maximum and minimum daily temperature data were available, but humidity data are not collected at this station. 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 (3.8 m) recorded at Pahranagat from 2003 to 2010 to delineate below, at, and above nest categories. We used one-way ANOVA to compare vegetation characteristics in 2010 versus 2005–2007 and 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 June. They remained in place until early August. One logger was missing from its container upon retrieval, and no data were collected for that point. The exact location of the logger as deployed in 2009 was relocated for 22 points. The original location could not be found for the remaining six points, and the logger in 2010 was deployed in the approximate vicinity (within 100 m) of the 2009 location. These data were compared to data collected at 8 within-territory locations in June 2005–2007 and 28 within-territory locations in July–August 2005–2007.

Soil moisture in 2010 was higher than in 2009 in July–August ($P = 0.03$). Soil moisture in both June and July–August 2010 was lower than that recorded in the same periods in 2005–2007, and the difference between years was greater in June than in July–August (Table 9.1). Humidity in July–August 2010 was intermediate between the values recorded in 2005–2007 and the lower values recorded in 2009, differing significantly from both time periods. Humidity in June 2010 did not differ from that in June 2005–2007, however. Mean maximum diurnal temperature and mean minimum nocturnal temperature were significantly higher in July–August 2010 than during the same months in 2005–2007 or 2009, though mean daily temperature range did not differ. All temperature variables were greater in June 2010 than in June 2009, though the difference in mean minimum nocturnal temperature was of marginal significance ($P = 0.08$). Mean daily maximum and minimum temperatures in June and between 1 July and 15 August at the Caliente weather station did not differ between 2010 and any year from 2005 to 2009.

Vegetation

We collected vegetation data at 28 locations in 2010. These data were compared to vegetation data collected at 28 points in 2009 and 26 within-territory locations in 2005–2007. Vegetation characteristics in 2010 differed from those recorded in 2005–2007 in having less canopy closure, less woody ground cover, more live foliage below nest height, less dead foliage in all height categories, a greater percentage of live foliage below the nest, and a lower percentage of the foliage that consisted of native species (Table 9.2). Vegetation characteristics measured in 2010 also differed from those measured in 2009 in many of the same variables. Compared to vegetation in 2009, vegetation in 2010 had less canopy closure, more live foliage below nest height, less dead foliage in all height categories, and a greater percentage of live foliage in all height categories.

Table 9.1. Descriptive Statistics and Single Effects for Comparison of Microclimate Characteristics, 2010 versus 2005–2007 and 2009, Pahranagat North*

Response Variable	2005–2007 June (n=8)	2005–2007 July–Aug (n=28)	2009 July–Aug (n=28)	2010 June (n=27)	2010 July–Aug (n=27)	Difference 2010 vs. 2005–2007 June	*P*	Difference 2010 vs. 2005–2007 July–Aug	*P*	Difference 2010 vs. 2009 July–Aug	*P*
Soil Moisture											
Mean soil moisture (mV)	972.6 (16.2)	871.4 (18.4)	741.7 (24.2)	857.7 (15.8)	807.3 (15.9)	-115.0	<0.01	-64.1	0.01	65.6	0.03
Temperature											
Mean maximum diurnal temperature (C)	33.1 (0.3)	35.3 (0.2)	33.9 (0.1)	35.2 (0.5)	36.3 (0.4)	2.1	<0.01	1.0	0.03	2.4	<0.01
Mean minimum nocturnal temperature (C)	14.6 (0.3)	18.5 (0.2)	17.1 (0.1)	15.5 (0.4)	19.7 (0.3)	0.9	0.08	1.2	<0.01	2.6	<0.01
Mean daily temperature range (C)	18.5 (0.5)	16.8 (0.3)	16.8 (0.1)	19.7 (0.2)	16.6 (0.2)	1.3	0.02	0.2	0.58	0.2	0.27
Humidity											
Mean diurnal vapor pressure (Pa)	1030.6 (29.7)	1622.3 (25.4)	1385.2 (14.6)	990.5 (9.6)	1499.7 (13.3)	-40.1	0.20	-123.1	<0.01	114.6	<0.01
Mean nocturnal vapor pressure (Pa)	841.1 (23.2)	1434.7 (24.4)	1149.3 (13.8)	859.2 (8.6)	1256.2 (12.2)	18.2	0.46	-178.5	<0.01	106.9	<0.01

* Data are presented as mean (standard error)

Table 9.2. Descriptive Statistics and Single Effects for Comparison of Habitat Characteristics, 2010 versus 2005–2007 and 2009, Pahranagat North *

Parameter	2005–2007 (n=26)	2009 (n=28)	2010 (n=28)	*P* 2010 vs. 2005–2007	*P* 2010 vs. 2009
Average canopy height (m)	17.6 (1.1)	18.8 (0.8)	16.8 (1.1)	0.648	0.177
	5.0–30.0	12.3–30.8	8.4–30.7		
% total canopy closure	91.3 (1.1)	93.0 (1.0)	86.3 (2.0)	0.037	0.003
	76.0–99.0	78.1–100.0	54.7–99.5		
% woody ground cover	43.2 (5.8)	30.0 (3.7)	21.3 (2.7)	0.001	0.062
	2.0–98.0	1.1–80.3	0.8–51.3		
Live vertical foliage (hits) below nest	2.6 (0.4)	3.3 (0.4)	4.9 (0.6)	0.002	0.026
	0–8.2	0–9.4	1.4–12.0		
Live vertical foliage (hits) at nest	1.6 (0.3)	1.4 (0.2)	1.7 (0.3)	0.727	0.353
	0–5.2	0–4.2	0–5.6		
Live vertical foliage (hits) above nest	21.6 (3.3)	24.6 (2.2)	26.3 (2.7)	0.266	0.615
	3.8–69.9	6.8–55.1	3.0–54.8		
Dead vertical foliage (hits) below nest	3.9 (0.6)	3.0 (0.4)	1.1 (0.2)	<0.001	<0.001
	0–10.8	0.2–7.6	0.0–3.6		
Dead vertical foliage (hits) at nest	0.9 (0.2)	1.2 (0.2)	0.3 (0.1)	0.007	0.001
	0–3.2	0–4.0	0–1.8		
Dead vertical foliage (hits) above nest	2.0 (0.6)	2.8 (0.5)	0.7 (0.2)	0.044	0.001
	0–15.1	0–12.3	0–3.7		
% live foliage (hits) below nest	42.5 (6.0)	53.1 (4.8)	79.1 (3.8)	<0.001	<0.001
	0–100.0	0–94.6	30.8–100.0		
% live foliage (hits) at nest	63.0 (6.1)	51.1 (6.9)	77.1 (7.7)	0.165	0.015
	0–100.0	0–100.0	0–100.0		
% live foliage (hits) above nest	90.2 (3.3)	91.1 (1.3)	96.9 (1.1)	0.050	0.002
	29.8–100.0	74.1–100.0	77.5–100.0		
Percent native	100.0 (0.0)	97.0 (1.0)	95.6 (1.3)	0.001	0.394
	100.0–100.0	81.2–100.0	73.8–100.0		

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

Surface Water Mapping

We mapped surface water at bi-weekly intervals from 22 May to 8 August (Figures 9.1 and 9.2). The area of surface water within the site generally decreased as the season progressed. This pattern was also observed during 2003–2007 (Table 9.3), although the percentage of the site inundated in May and June during those years was much higher, ranging from 75 to 100% in May and from 20 to 80% in June, compared to 10% or less in 2008–2010.

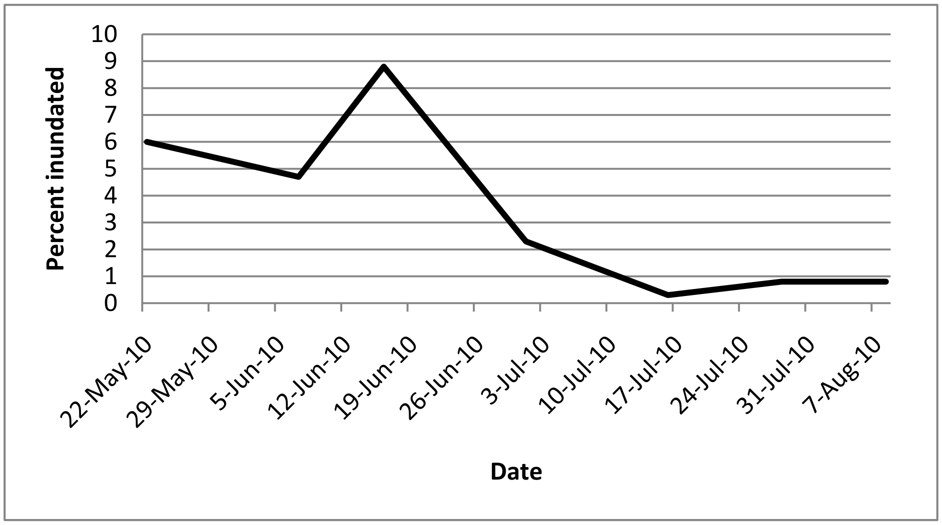

Figure 9.1. Percentage of Pahranagat North with inundated soils, May–August, 2010.

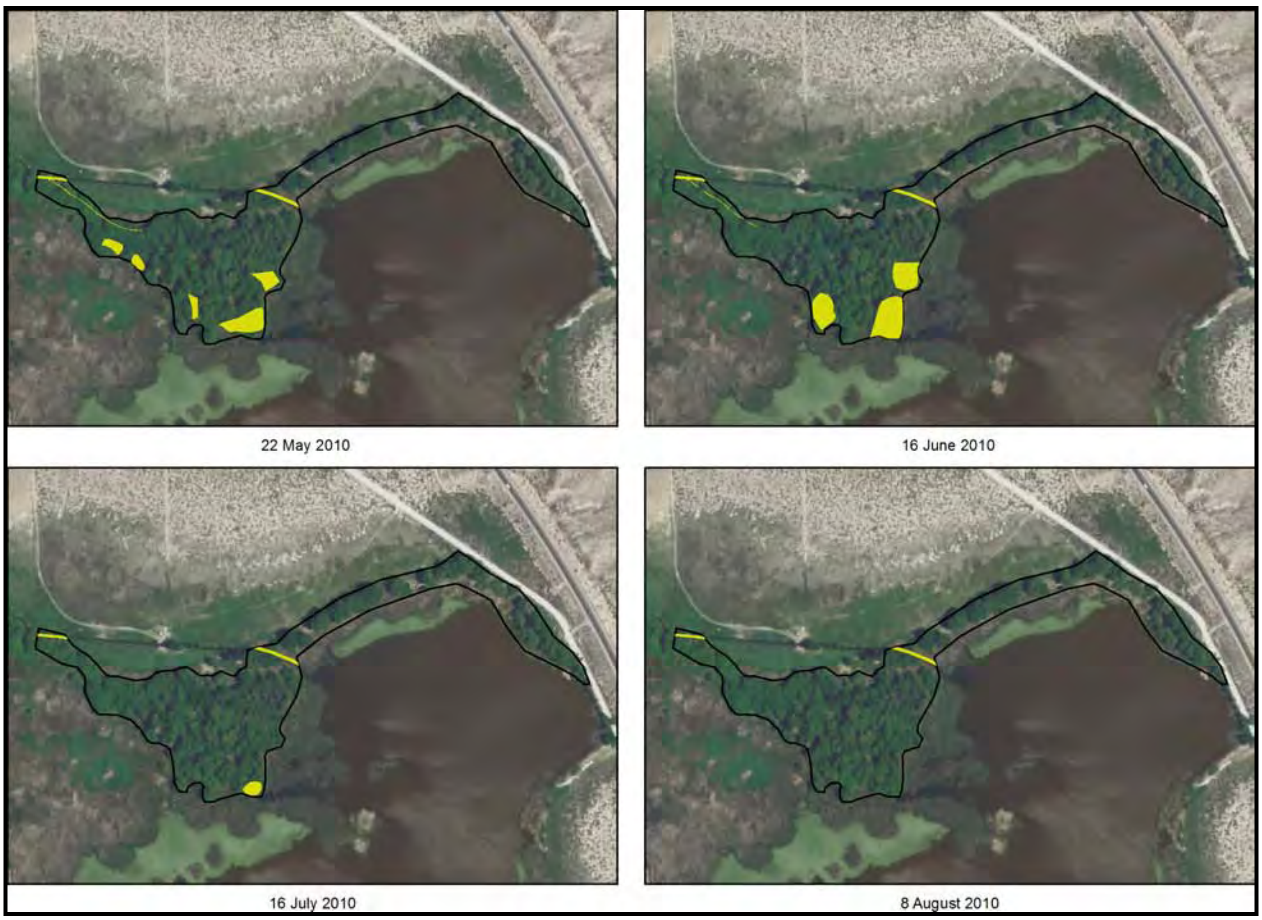

Figure 9.2. Extent of surface water within Pahranagat North at approximately monthly intervals, May–August 2010.

Table 9.3. Summary of Inundated Conditions at Pahranagat North, 2003-2010*

Year	% Site Inundated (Depth (cm) of Surface Water)		
	May	June	July
2003	100 (50)	80 (50)	50 (20)
2004	90 (50)	20 (10)	10 (10)
2005	90 (100)	70 (70)	5 (10)
2006	80 (70)	45 (15)	20 (5)
2007	75 (50)	40 (10)	5 (3)
2008	8 (5)	5 (10)	0 (0)
2009	3 (10)	1 (10)	0 (0)
2010	10 (10)	3 (25)	1 (25)

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

DISCUSSION

We anticipated that soil moisture and humidity would be lower in 2009 than in 2005–2007 when the site was inundated, and that soil moisture and humidity might be higher in 2010 than in 2009 given the higher lake levels in 2010. These expectations were borne out by the data, with both soil moisture and humidity levels being intermediate in 2010. Soil moisture recorded in July–August was higher in 2010 than in 2009 and lower in 2010 than in 2005–2007. Soil moisture recorded in June 2010 was also significantly lower than that recorded in June 2005–2007. Even in years when Pahranagat North was inundated, the site had dried significantly by the beginning of July (see Table 9.3). Thus, an examination of soil moisture values during the latter part of the breeding season showed less of a difference between 2010 and the inundated years, while soil moisture conditions in June showed a greater difference between 2010 and 2005–2007. Humidity in July–August 2010 differed significantly from both 2009 and 2005–2007, with 2010 values being intermediate between the higher values recorded in 2005–2007 and the lower values recorded in 2009. However, without humidity data from a nearby weather station, it is impossible to determine whether changes in humidity were caused by changes in groundwater levels or variation in regional climate conditions.

We had expected that inundated conditions might serve to moderate daily temperatures, but the data showed the highest temperatures in 2010 and the lowest temperatures in 2009. These differences could not be accounted for by between-year differences in regional climate, with the Caliente weather station showing no difference between 2010 and any other year for either maximum or minimum temperature.

Vegetation at Pahranagat North differed between 2009 and 2005–2007 only in having a lower percentage of native foliage in 2009 (McLeod and Koronkiewicz 2010). Vegetation measurements in 2010, however, showed numerous changes in 2010 versus both 2009 and 2005–2007. Absolute counts of live vertical foliage below average nest height were higher in 2010 than in either of the other two periods. This may be the result of continued growth of the herbaceous understory that developed at the site when annual inundation ceased. The difference in percent native foliage between 2010 and 2005–2007 is entirely attributable to the development of herbaceous ground cover consisting partially of a non-native *Chenopodium* species and does not reflect any change in the woody vegetation.

The absolute counts of dead foliage were lower in 2010 in all height categories than in either of the other two periods. The percentage of live foliage was also correspondingly greater in all height categories. These differences may be the result of observer variation and do not necessarily reflect any change in the vegetation. Some of the observers in 2010 counted a dead branch attached to a live tree as being live, whereas in all other years, the branch would have been counted as dead. Therefore, foliage counts at Pahranagat in 2010 should be interpreted with caution. If foliage counts are repeated in 2011, the results will help interpret whether the changes seen in 2010 reflect an actual change in the vegetation.

The main flycatcher breeding site at Pahranagat was completely inundated at the beginning of each breeding season in 2003–2007 but contained little standing water in 2008–2010. The presence of water may affect the accessibility of flycatcher nests to predators, microclimate at the nest, or food availability. The presence of water beneath the nest has been shown to influence nest productivity at other study areas, with flycatcher nests along the Middle Rio Grande that were above inundated or saturated soil producing more young per successful nest than nests that were above dry soil (Moore and Ahlers 2008). The lack of surface water and the development of a dense, herbaceous understory could also affect predator assemblages. We compared a variety of metrics (annual fecundity, number of nesting attempts per female, number of successful attempts per female, proportion of successful first attempts, mean fledge date, and depredation rates) between 2003–2007 and 2008–2010 to determine whether changes in hydrology might be associated with any change in flycatcher reproduction.

There was no difference in fecundity (number of young produced per female), number of successful nesting attempts per female, or the proportion of successful first nesting attempts. However, the number of annual nesting attempts per female was significantly higher in 2008–2010 than in the previous 5 years (Wilcoxon rank sum, $P = 0.038$), and average fledge date was approximately a week earlier in 2003–2007 than in 2008–2010 (ANOVA, $F_{1,70} = 5.9$, $P = 0.018$). Thus, it appears that although annual fecundity has not changed, females are making more nesting attempts to achieve that fecundity and are fledging young later in the season. Nestlings that fledge later in the season have been shown to have a reduced probability of survival and recruitment (Paxton et al. 2007, McLeod et al. 2008), and the increased number of nesting attempts and potentially later migration date may have effects on adult survival as well. Reduced juvenile and/or adult survival could have adverse impacts on the annual growth rate of the flycatcher population. Survival estimates will be examined in a 5-year summary report to be submitted to Reclamation in 2012.

The proportion of nests that failed because of depredation did not differ significantly between 2003–2007 and 2008–2010 ($\chi^2 = 3.25$, $P = 0.07$), although the difference approached statistical significance and annual depredation rate was positively correlated with the annual number of nesting attempts per female (Pearson’s product-moment correlation, r = 0.7886, n = 8, $P = 0.02$). Annual depredation rate was higher in each year 2008–2010 than in four of the five preceding years, but small sample size may have precluded detecting any statistically significant difference. A change in depredation rates could be caused by increased accessibility of nests to ground predators or a change in predator assemblages. Nest camera studies completed by Northern Arizona University showed that artificial nests at Pahranagat were depredated by both birds and rodents, but all depredation events documented at active flycatcher nests were by avian predators (NAU, unpublished data).

Brown-headed cowbird trapping was completed at Pahranagat in 2003–2007 but not in 2008–2010, so it is unclear whether the differences we observed in flycatcher reproduction metrics between 2003–2007 and 2008–2010 are due to the change in hydrology and growth of understory vegetation or the cessation of cowbird trapping. The main flycatcher breeding site at Pahranagat was inundated annually in 1998–2002 as it was in 2003–2007; thus, any changes seen between the two time periods are not the result of changes in hydrology or understory vegetation. Cowbirds are nest predators as well as brood parasites and will depredate nests in both the egg and the nestling stage. Flycatchers may also abandon nests before laying eggs if the nest has been discovered by a cowbird.

We observed differences in several reproduction metrics between 1998–2002 and 2003–2007. The number of annual nesting attempts per female was higher in 1998–2002 than in 2003–2007 (Wilcoxon rank sum, $P = 0.013$), and average fledge date was approximately one week later in 1998–2002 than in 2003–2007 (ANOVA, $F_{1,78} = 7.6$, $P = 0.007$). First nesting attempts were also less likely to be successful in 1998–2002 ($\chi^2 = 4.19$, $P = 0.04$), and the proportion of nests that failed because of depredation was higher in 1998–2002 ($\chi^2 = 7.29$, $P = 0.007$). Fecundity and the number of successful nests per female did not differ between the two time periods. Thus, the overall results comparing 1998–2002 with 2003–2007 were quite similar to the differences seen between 2003–2007 and 2008–2010, with flycatchers requiring fewer nesting attempts before achieving a successful nests and having earlier fledge dates in 2003–2007, when cowbird trapping was occurring. Although the rate of cowbird parasitism in 2008–2010 (3%; 1 of 37 nests; SWCA unpublished data) has not returned to the pre-trapping parasitism rate (15%; 9 of 62 nests; SWCA unpublished data), qualitative observations of cowbirds being present in flycatcher territories during nest monitoring (SWCA unpublished data) suggest that cowbird numbers have increased since the end of cowbird trapping, and cowbirds could be affecting flycatcher nest success.

MANAGEMENT RECOMMENDATIONS

We recommend that mapping of water at Pahranagat be continued to facilitate being able to relate flycatcher nest and territory locations to the presence of water. Qualitative observations suggest that flycatcher territories may be shifting to the edge of the site closest to the marsh, but more quantitative data are needed to evaluate this trend fully.

Data collected over the next two breeding seasons (2011 and 2012) should be incorporated into the analysis of changes in reproduction metrics to provide greater statistical power. Additional analyses, such as examining partial depredation events and differentiating between depredation in the egg stage versus the nestling stage, may also provide insight into the effects of cowbirds versus other nest predators.

The only currently occupied flycatcher breeding site at Pahranagat occurs in the stand of large willows and cottonwoods at the north end of Upper Pahranagat Lake. Because there is only one occupied site, the flycatcher population at Pahranagat is inherently susceptible to stochastic events such as fire and would likely benefit from the creation of additional suitable habitat. This might be accomplished by establishing coyote willow along the lake margin along the south edge of the current breeding site and around the lake edge to Pahranagat West (see Chapter 2 and orthophotos in Appendix B for description and location of Pahranagat West).

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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

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

We investigated Pioneer Road, an area upstream of Littlefield Poles on Beaver Dam Wash. The site does not currently have vegetation that is extensive or mature enough to support breeding flycatchers, but the site should be reevaluated in future years.

Mormon Mesa North and Hedgerow at Mormon Mesa have been completely dry for the last several years, and neither of these sites has supported breeding flycatchers since 2005. We visited each site once at the beginning of the season, when sites are typically the wettest. Both sites were dry during the initial visit and surveys were discontinued. Heavy flooding occurred on the Virgin River in December 2010, and these sites will be revisited at the beginning of the 2011 season to determine whether the hydrology of the sites was altered. If hydrology has not changed and the sites are still dry, we recommend discontinuing surveys at these sites.

We visited The Narrows along the Muddy River at the beginning of the survey season to assess conditions of hydrology and vegetation. Water was confined to the incised river channel, and we do not recommend further visits to this site until flood events that have the potential to alter the hydrology occur. We also visited Overton Willows, which we had assessed in 2007 and determined that vegetation was too short and sparse to support willow flycatchers. A reassessment of the site revealed that the quality of the site for willow flycatchers had not improved, and we do not recommend further visits to this site.

We revisited three sites (Lost Lake Slough #2, #3, and #4) at Topock Marsh that we had identified in 2009 as not having the vegetation structure typical of occupied flycatcher habitat but having the potential to develop into more suitable habitat. In 2010, these sites still lacked suitable vegetation structure or areal extent, and we recommend reevaluating these sites in another 2–3 years. We visited two additional sites (Tractor and Spaghetti) at Topock Marsh; initial inspection of these sites suggests that neither has the characteristics of typical occupied flycatcher habitat, but we recommend reevaluating both sites at the beginning of the 2011 season to obtain more detailed descriptions.

At Bill Williams River NWR, we revisited Site #1 for the first time since the site was affected by a fire in 2006. Portions of the site are recovering, and we recommend adding this site to the biennial survey schedule. We also reevaluated Black Rail, a site we had initially visited in 2006. One edge of the site has vegetation that may be capable of supporting resident flycatchers, and we recommend adding this site to the biennial schedule. Wispy Willow, a small area of new coyote willow growth downstream of Site #1, currently lacks the size to resemble occupied flycatcher habitat along the LCR, but the site should be reassessed in another year or two. We visited Planet Ranch for the fourth consecutive year and noted yet again that while the central portion of the site might have a suitable vegetation structure, surface water was lacking. We do not recommend visiting this site again until a flood event occurs that has the potential to alter the hydrology of the area.

We recommend discontinuing surveys at Big Hole Slough, unless it can be confirmed that the safety concerns we encountered in 2010 no longer exist. We also recommend discontinuing surveys at Ehrenberg because of the complete lack of an understory other than arrowweed.

Ground reconnaissance of Imperial Burn revealed that the area did not contain water underneath the woody vegetation and that understory vegetation was often too dense to resemble typical occupied flycatcher habitat. No flycatchers were detected during the reconnaissance, and the area is unlikely to support flycatchers. We do not recommend further visits to this site, and the area could be burned without any likely detriment to flycatchers.

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 five of the six years when flycatchers have been monitored at the study area, and overall nest success was 29%, well below the average of 44% across all study areas in those years. Although the breeding site at Muddy River is not as isolated from surrounding riparian vegetation as the site at Pahranagat, cowbird trapping at Muddy River has the possibility of reducing the parasitism rate and increasing flycatcher nest success, and we recommend that cowbird trapping be instituted at Muddy River.

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

HABITAT MONITORING: PARKER TO IMPERIAL DAMS

In previous years we correlated piezometer 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 (WIFL) Survey and Detection Form (revised April 2010)

Site Name____ State______ County __________________________
USGS Quad Name ____ Elevation ______________________ (meters)
Creek, River, Wetland, or Lake Name____
Is copy of USGS map marked with survey area and WIFL sightings attached (as required)? ***Yes___*** ***No____***

Survey Coordinates: Start: E__________________ N_____________________ UTM Datum_______(See instructions)
Stop: E__________________ N_____________________ UTM Zone ________
If survey coordinates changed between visits, enter coordinates for each survey in comments section on back of this page.

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

Survey # Observer(s) (Full Name)	Date (m/d/y) Survey time	Number of Adult WIFLs	Estimated Number of Pairs	Estimated Number of Territories	Nest(s) Found? Y or N If Yes, number of nests	Comments (e.g., bird behavior; evidence of pairs or breeding; potential threats [livestock, cowbirds, *Diorhabda* spp.]). If *Diorhabda* found, contact USFWS and State WIFL coordinator	GPS Coordinates for WIFL Detections (this is an optional column for documenting individuals, pairs, or groups of birds found on each survey). Include additional sheets if necessary.
Survey # 1 Observer(s)	Date Start Stop Total hrs ___						# Birds | Sex | UTM E | UTM N
Survey # 2 Observer(s)	Date Start Stop Total hrs ___						# Birds | Sex | UTM E | UTM N
Survey # 3 Observer(s)	Date Start Stop Total hrs ___						# Birds | Sex | UTM E | UTM N
Survey # 4 Observer(s)	Date Start Stop Total hrs ___						# Birds | Sex | UTM E | UTM N
Survey # 5 Observer(s)	Date Start Stop Total hrs ___						# Birds | Sex | UTM E | UTM N
Overall Site Summary Totals do not equal the sum of each column. Include only resident adults. Do not include migrants, nestlings, and fledglings. Be careful not to double count individuals. Total Survey Hrs________		Total Adult Residents	Total Pairs	Total Territories	Total Nests	Were any Willow Flycatchers color-banded? Yes___ No ___ If yes, report color combination(s) in the comments section on back of form and report to USFWS.	

Reporting Individual ____________________________________ Date Report Completed________ ____________________
US Fish and Wildlife Service Permit #_______________________State Wildlife Agency Permit #_____________________
***Submit** form to USFWS and State Wildlife Agency by September 1st. Retain a copy for your records.*

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

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

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

Length of area surveyed: ___________ (km)

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

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

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

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

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

Identify the 2-3 predominant tree/shrub species in order of dominance. Use scientific names.
____

Average height of canopy (Do not include a range): ________________________________ (meters)

Attach the following: 1) copy of USGS quad/topographical map (REQUIRED) of survey area, outlining survey site and location of WIFL detections; 2) sketch or aerial photo showing site location, patch shape, survey route, location of any detected WIFLs or their nests; 3) photos of the interior of the patch, exterior of the patch, and overall site. Describe any unique habitat features in Comments.

Comments (such as start and end coordinates of survey area if changed among surveys, supplemental visits to sites, unique habitat features. Attach additional sheets if necessary.
____
____
____
____
____
____

Territory Summary Table. Provide the following information for each verified territory at your site.

Territory Number	All Dates Detected	UTM E	UTM N	Pair Confirmed? Y or N	Nest Found? Y or N	Description of How You Confirmed Territory and Breeding Status (e.g., vocalization type, pair interactions, nesting attempts, behavior)

Attach additional sheets if necessary

SWFL General Site Description

[Complete at least 3 times during season: early (10–25 May), mid-season (10–25 June), and late season (10–25 July)]

General Info

Study Area: ________ **Survey Site:** ____________________ **Date:** ____________

Observer(s): ____________________ **early**____ **mid**____ **late**____ **other**____

Vegetation

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

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

Overstory height (m): ______ **Dominant overstory species:** TASP SAGO SAEX POFR Other__________

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

Other vegetation types present (e.g., cattail)? Yes No

If yes, type of vegetation: ____________________ **percentage of site:**________

type of vegetation: ____________________ **percentage of site:**________

type of vegetation: ____________________ **percentage of site:**________

Hydrology

% of site inundated: ____________

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

____

Average depth of surface water:

toes (<5cm) ankles (5-15 cm) calves (15-40 cm) knees (40-60 cm)

thighs (60-80 cm) waist (100 cm) too deep to wade (>100 cm)

% of site with saturated soils (do not include inundated areas in percentage!): ____________

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

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

How was distance determined? Visually estimated in field Measured in field using GPS

Measured from aerial photograph Other____________________

Describe type of nearest surface water: ____________________

Narrative and Pictorial Description

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

____

On the reverse, sketch and label the locations of the major vegetation types you observed. Delineate marshes, open areas, and other habitat that may be unsuitable for flycatchers. If water was present, show its location.

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

____

____

____

____

____

____

____

____

Additional comments:______________________________________

____

____

STUDY AREA: __________ **SITE**: ______________________ **BANDER**: _________ **DATE**: __________ **TIME**: __________ **TERR/NEST #**: ____________

UTM NAD___ **Zone**___ ____________ **E** _____________ **N** **NBN:** ____ of ____

NOTES:____

FEDERAL BAND #	COLOR COMBO		STATUS	SEX	AGE	FECAL SAMPLE? (Y or N)	GENETIC SAMPLE? (Y or N)	# PHOTOS TAKEN
	L	R						

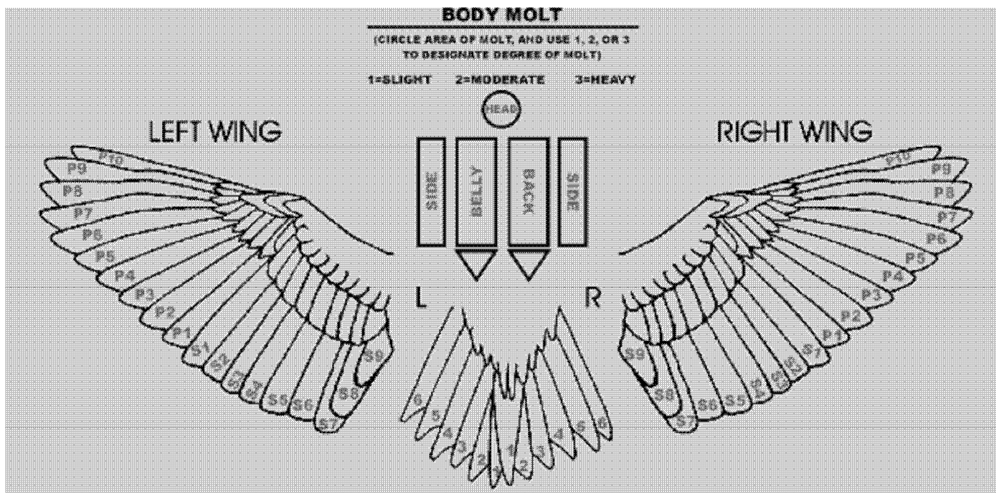
STATUS: NCP = new cap passive, NCT = new cap target, RCP = recap passive, RCT = recap target, NBN = nestling banded
SEX: U = unknown, F = female, M = male
AGE: AHY = after hatch year; SY = second year; L = nestling banded in nest; HY = hatch year/young of the year

Adults								
CP	BP	WING CHORD (mm)	TAIL ~~(mm)~~	CULMEN LENGTH (mm)	CULMEN WIDTH (mm)	FAT	RETAINED FEATHERS?	ACTIVE MOLT?
							Y or N, if Y use diagram, detail in notes	

Nestlings	
Developmental Age (days)	MASS (g)

CP: 0 = non-breeding, S = partial breeding, M = full breeding
BP: 0 = none, 1 = smooth, 2 = vascularized and filled with fluid, 3 = wrinkled, 4 = molting
FAT: 0 = no fat; 1 = trace of fat in furculum, deeply concave, scattered patches, less than 5 percent filled; 2 = thin layer of fat in furculum, less than a third filled, trace of thin layer of fat in abdomen; 3 = furculum is ½ filled or more; small patches, not covering some areas, on abdomen; 4 = furculum more than 2/3 filled, level with clavicles, slightly mounded on abdomen

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



Date: ____________ Page ____ of ____

				COLOR COMBO							
OBS	STUDY AREA	TERR	NEST	LEFT LEG	RIGHT LEG	CONF 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	BD	(T/F)
		Found
		First egg
		Clutch completion
		Hatching
		Fledged or Failed

Willow Flycatcher

No.	Presumed	Confirmed
		Eggs
		Nestlings
		Fledglings

Cowbird

Trans dates	BD	(T/F)
		First egg
		Hatching
		Fledged

Cowbird

No.	Complete? (T/F)	
		Eggs
		Nestlings
		Fledgling

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							
20								20							
21								21							
22								22							
23								23							
24								24							
25								25							

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

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

SIDE 1

Vertical Foliage Sampling

SOUTH 1m								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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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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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							
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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: _______

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)

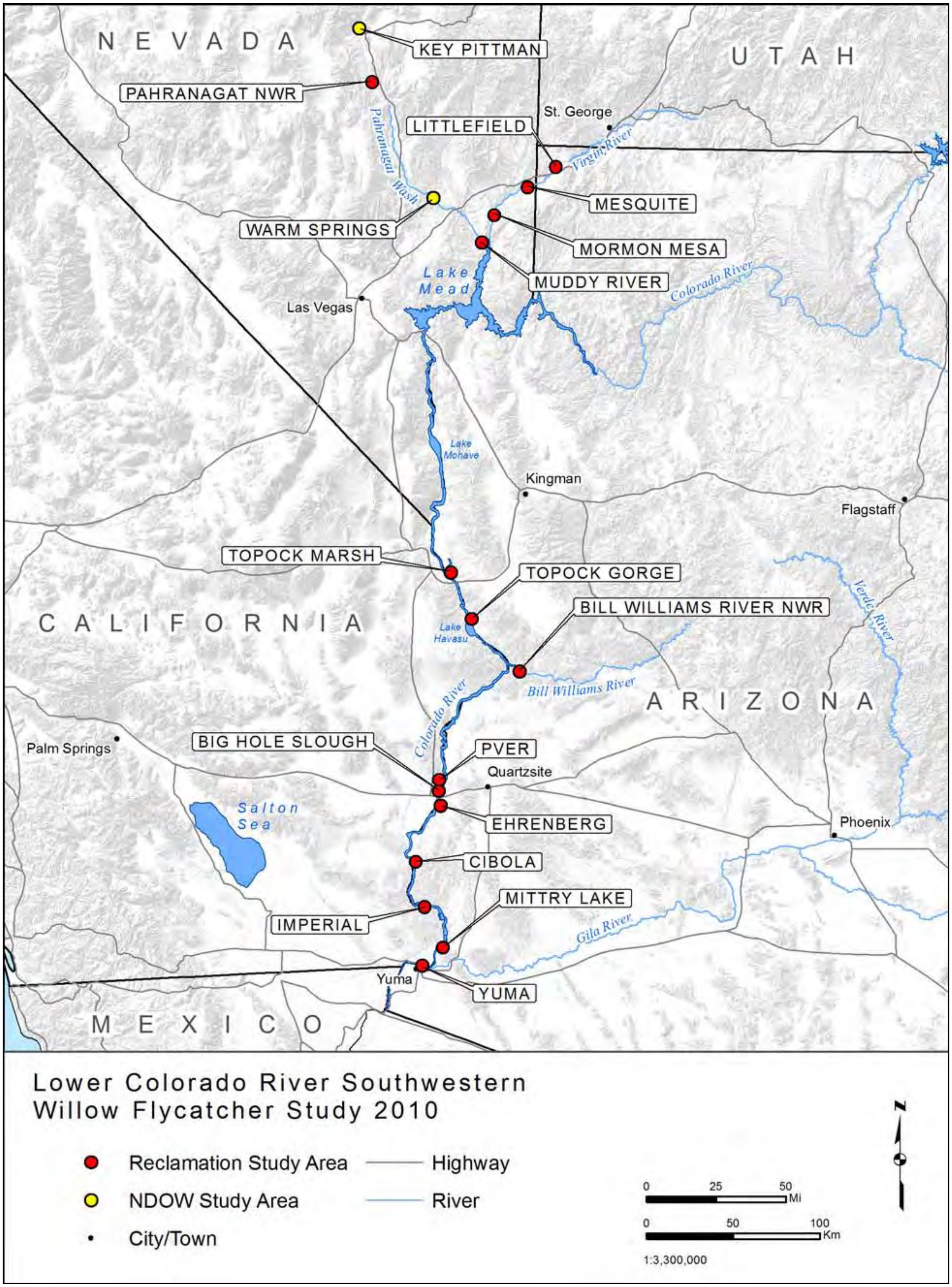
Date **soil sample** collected:____________

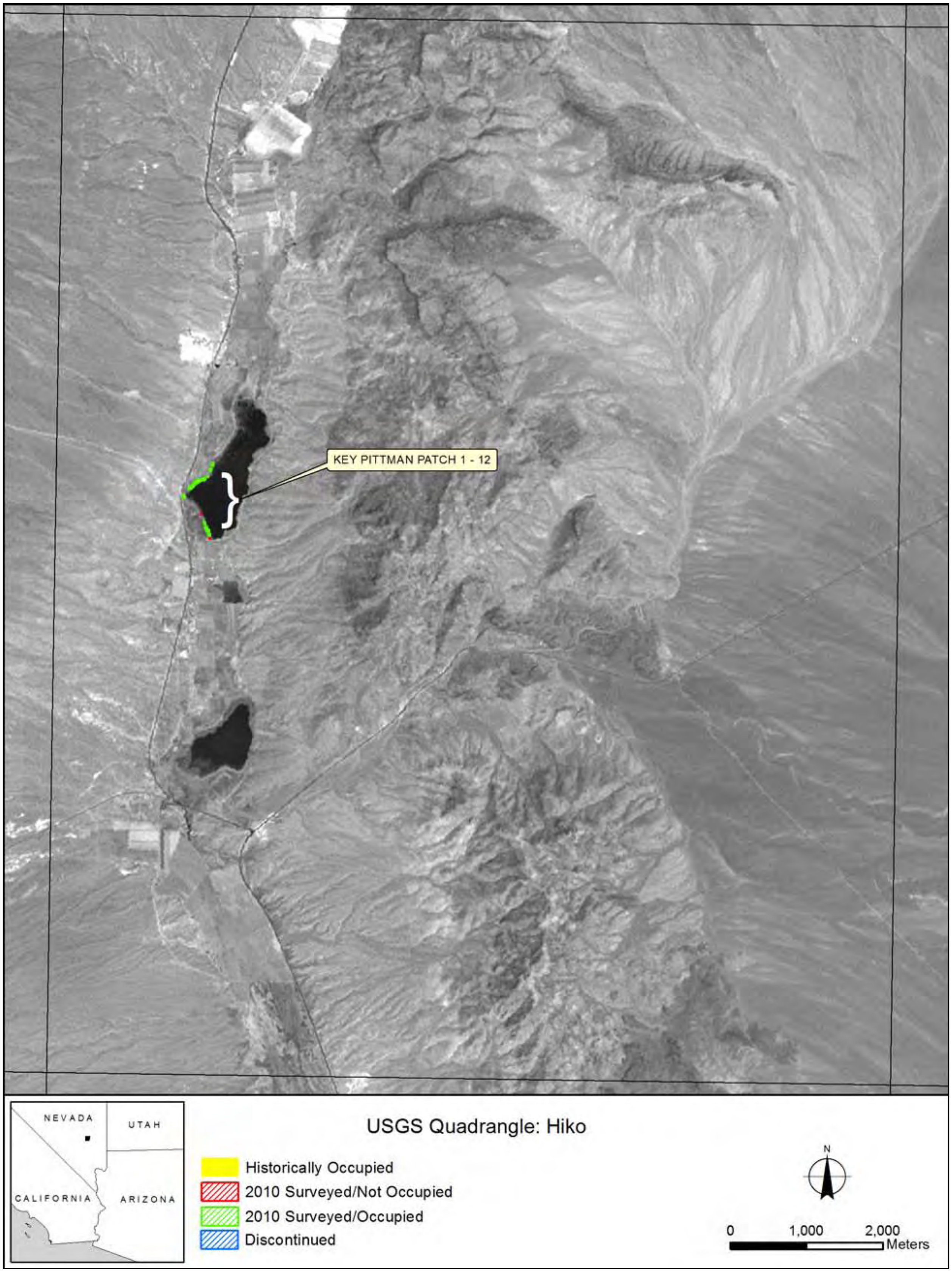
Soil moisture data collected on the following dates (enter SM data directly into database):

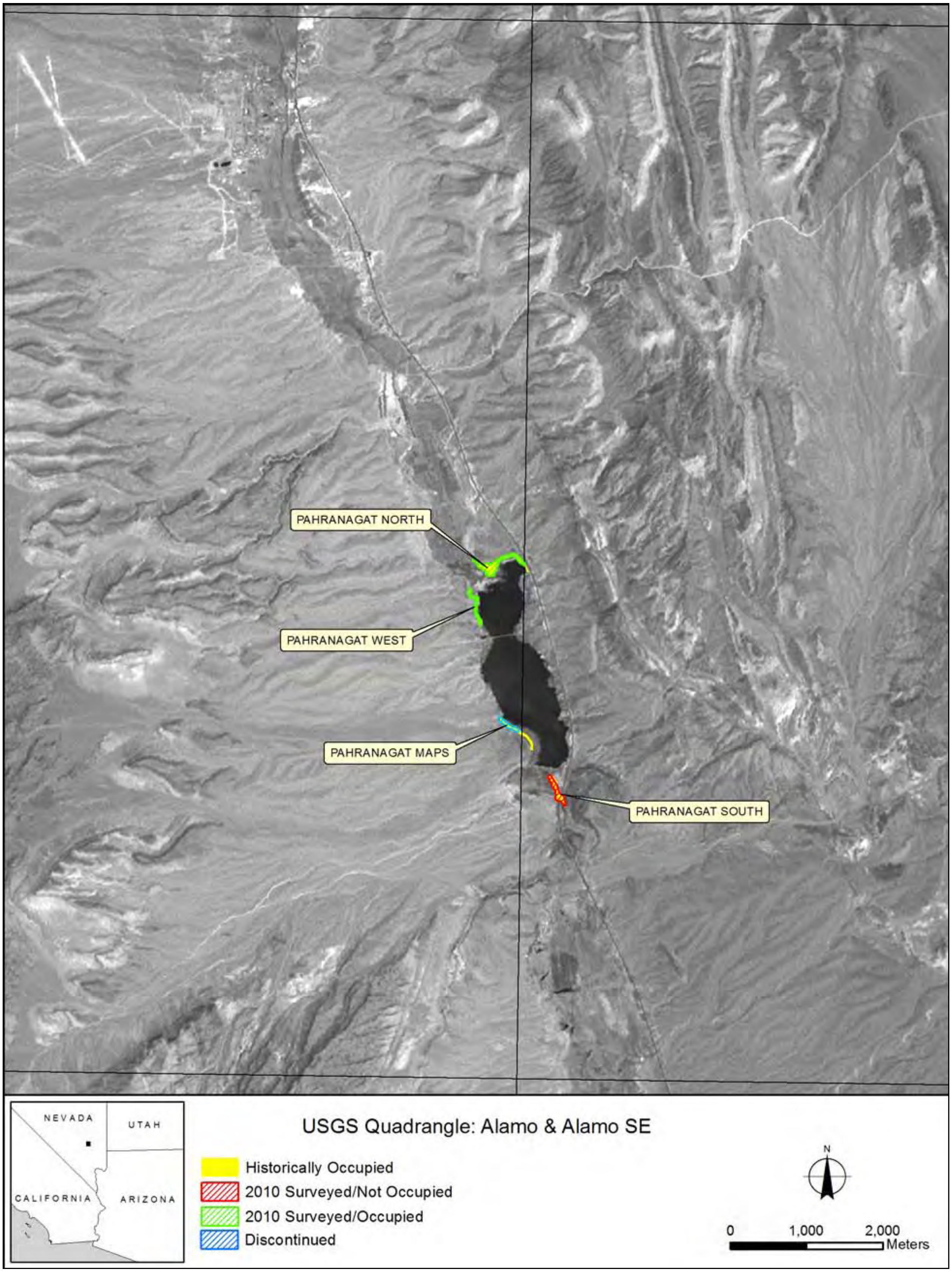
Date: ________	Obs: _______	Date: ________	Obs: _______	Date: ________	Obs: _______
Date: ________	Obs: _______	Date: ________	Obs: _______	Date: ________	Obs: _______
Date: ________	Obs: _______	Date: ________	Obs: _______	Date: ________	Obs: _______
Date: ________	Obs: _______	Date: ________	Obs: _______	Date: ________	Obs: _______
Date: ________	Obs: _______	Date: ________	Obs: _______	Date: ________	Obs: _______
Date: ________	Obs: _______	Date: ________	Obs: _______	Date: ________	Obs: _______
Date: ________	Obs: _______	Date: ________	Obs: _______	Date: ________	Obs: _______

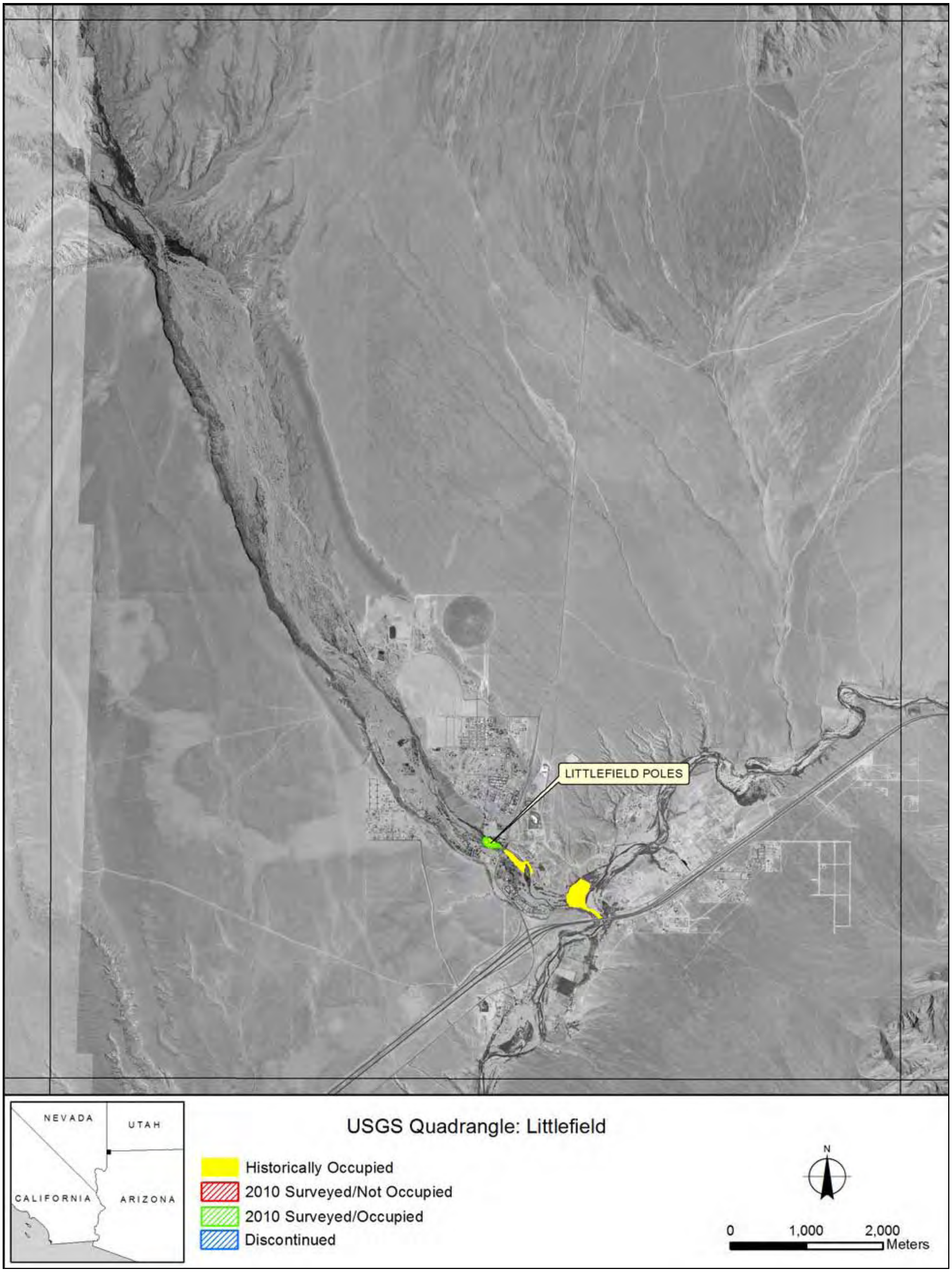
Appendix B

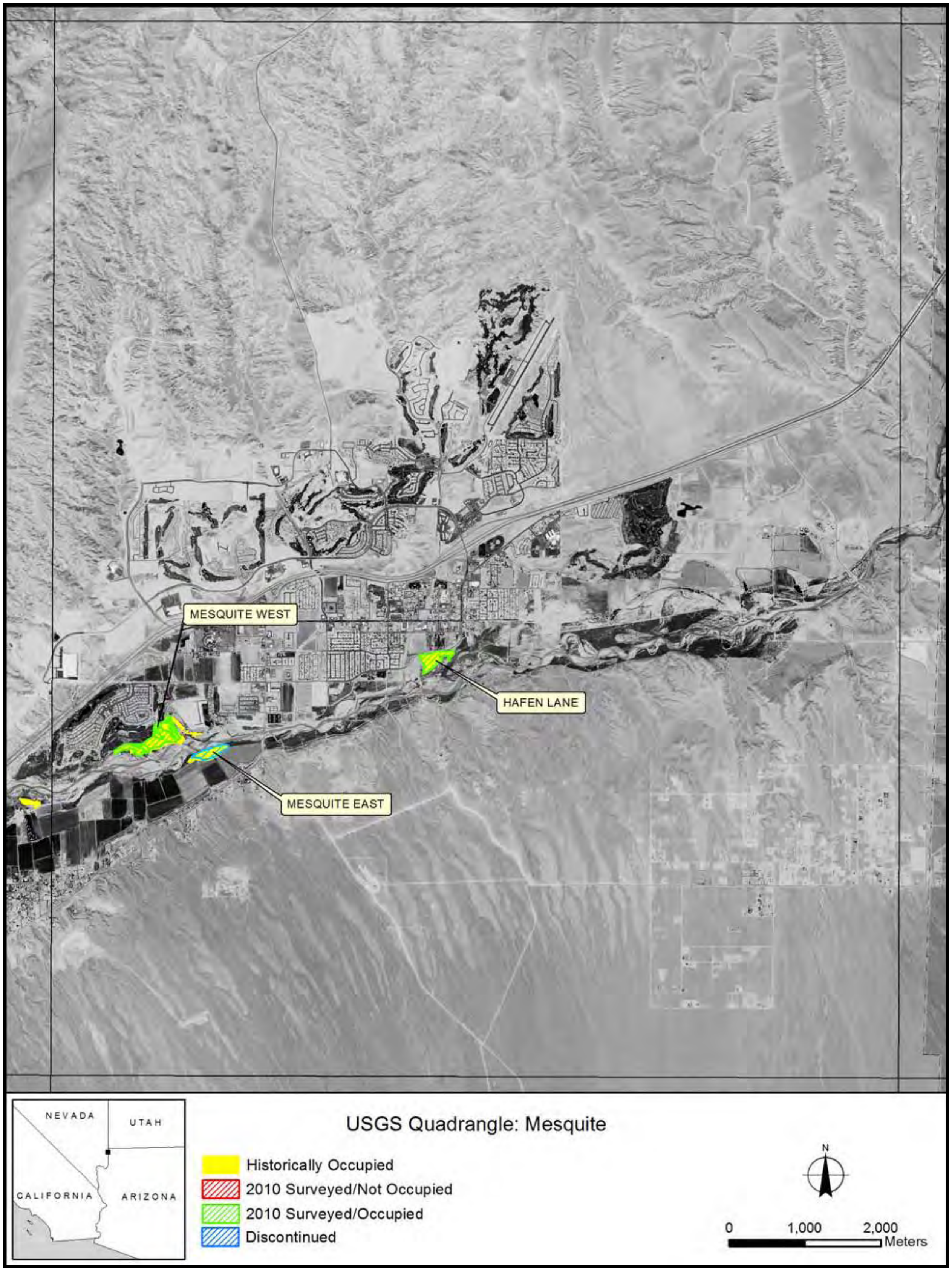
ORTHOPHOTOS SHOWING STUDY SITES


NEVADA
UTAH
CALIFORNIA
ARIZONA
MEXICO
KEY PITTMAN
PAHRANAGAT NWR
LITTLEFIELD
MESQUITE
WARM SPRINGS
MORMON MESA
MUDDY RIVER
St. George
Virgin River
Pahranagat Wash
Lake Mead
Las Vegas
Colorado River
Lake Mohave
Kingman
Flagstaff
TOPOCK MARSH
TOPOCK GORGE
BILL WILLIAMS RIVER NWR
Lake Havasu
Verde River
Bill Williams River
Colorado River
Palm Springs
BIG HOLE SLOUGH
PVER
Quartzsite
Salton Sea
EHRENBERG
Phoenix
CIBOLA
MITTRY LAKE
IMPERIAL
Gila River
Yuma
YUMA
Lower Colorado River Southwestern Willow Flycatcher Study 2010
Reclamation Study Area
NDOW Study Area
City/Town
Highway
River
0 25 50 Mi
0 50 100 Km
1:3,300,000
N


KEY PITTMAN PATCH 1 - 12
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Hiko
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


PAHRANAGAT NORTH
PAHRANAGAT WEST
PAHRANAGAT MAPS
PAHRANAGAT SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Alamo & Alamo SE
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


LITTLEFIELD POLES
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Littlefield
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


MESQUITE WEST
HAFEN LANE
MESQUITE EAST
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Mesquite
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
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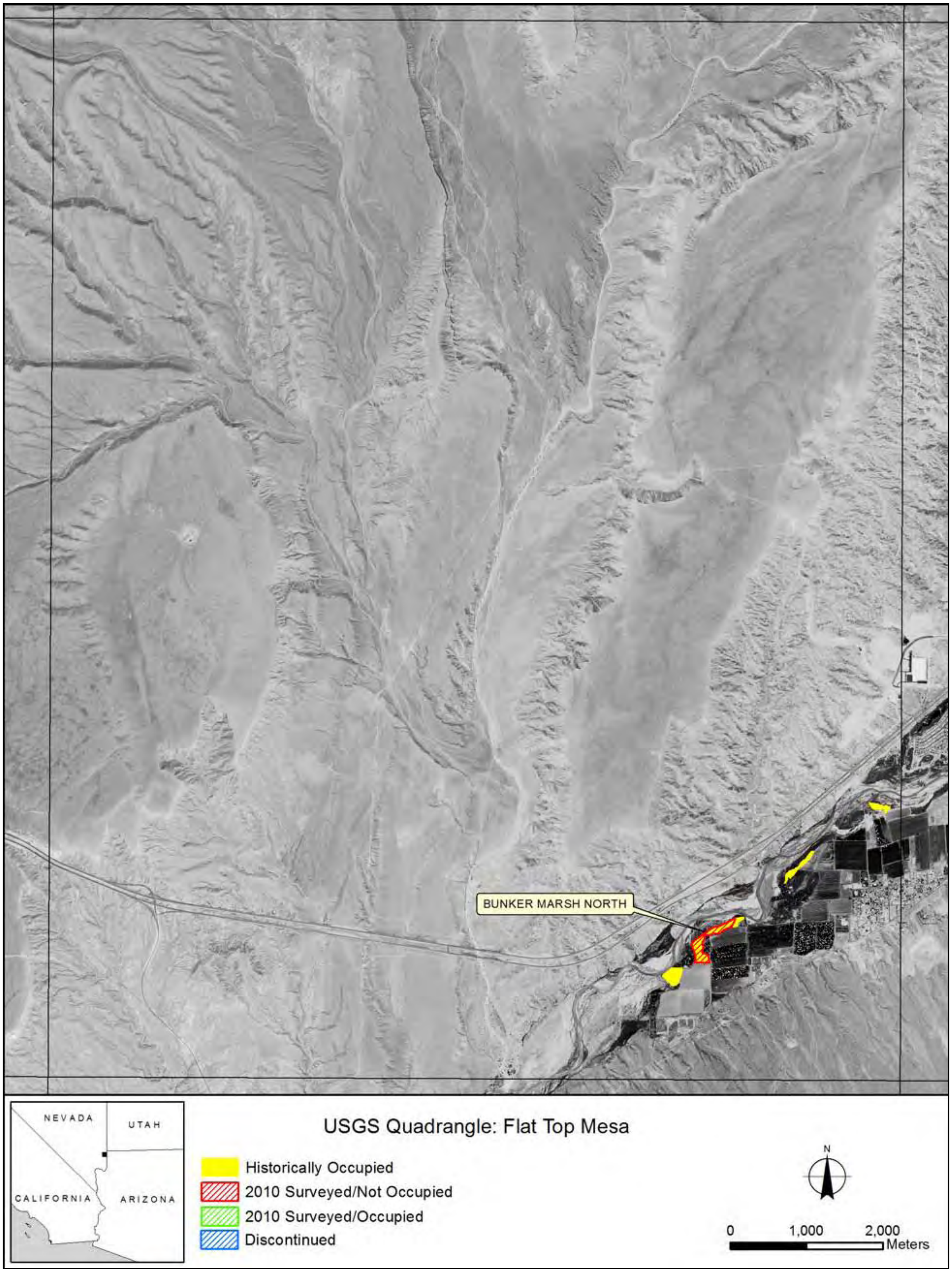
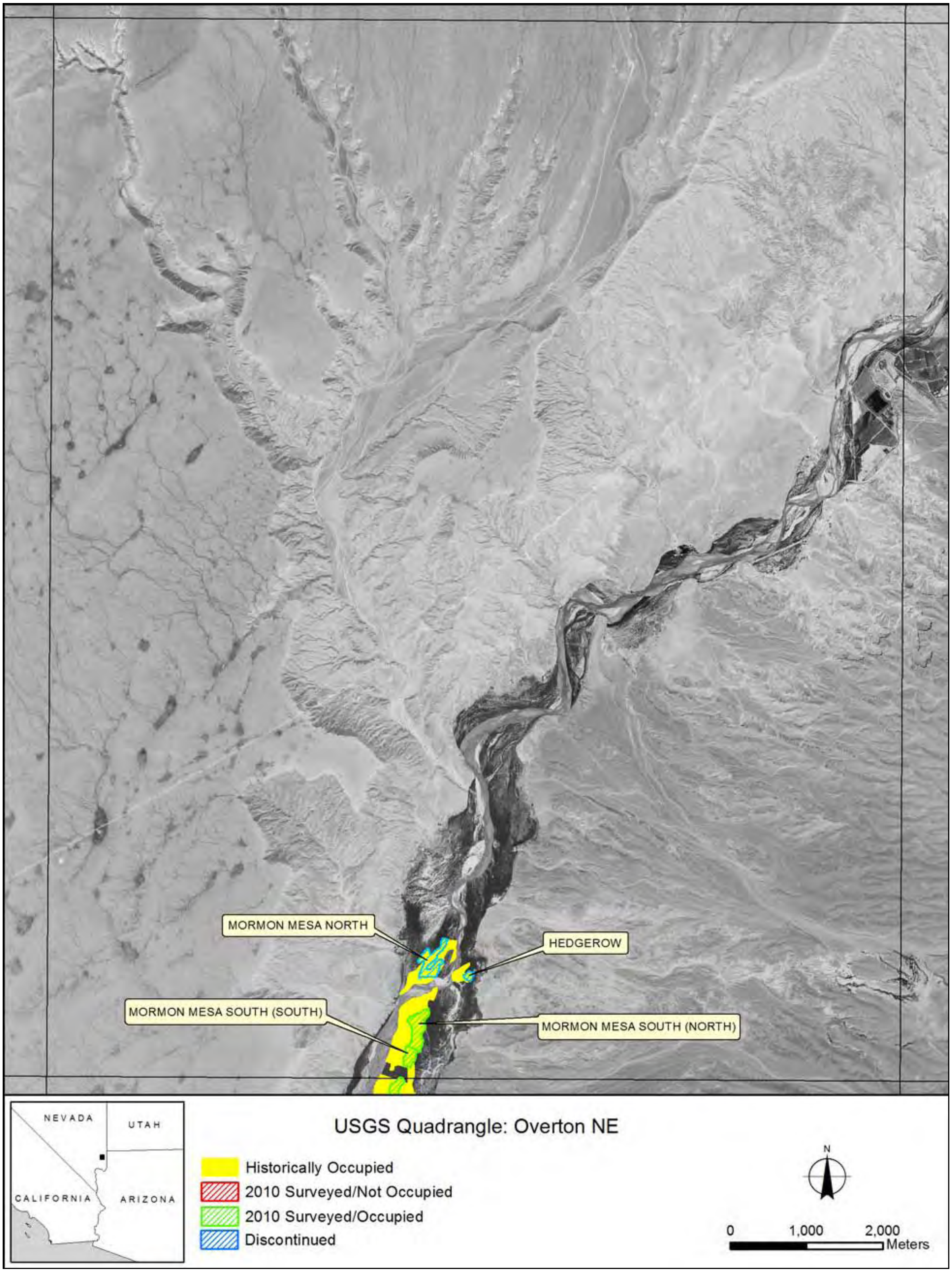
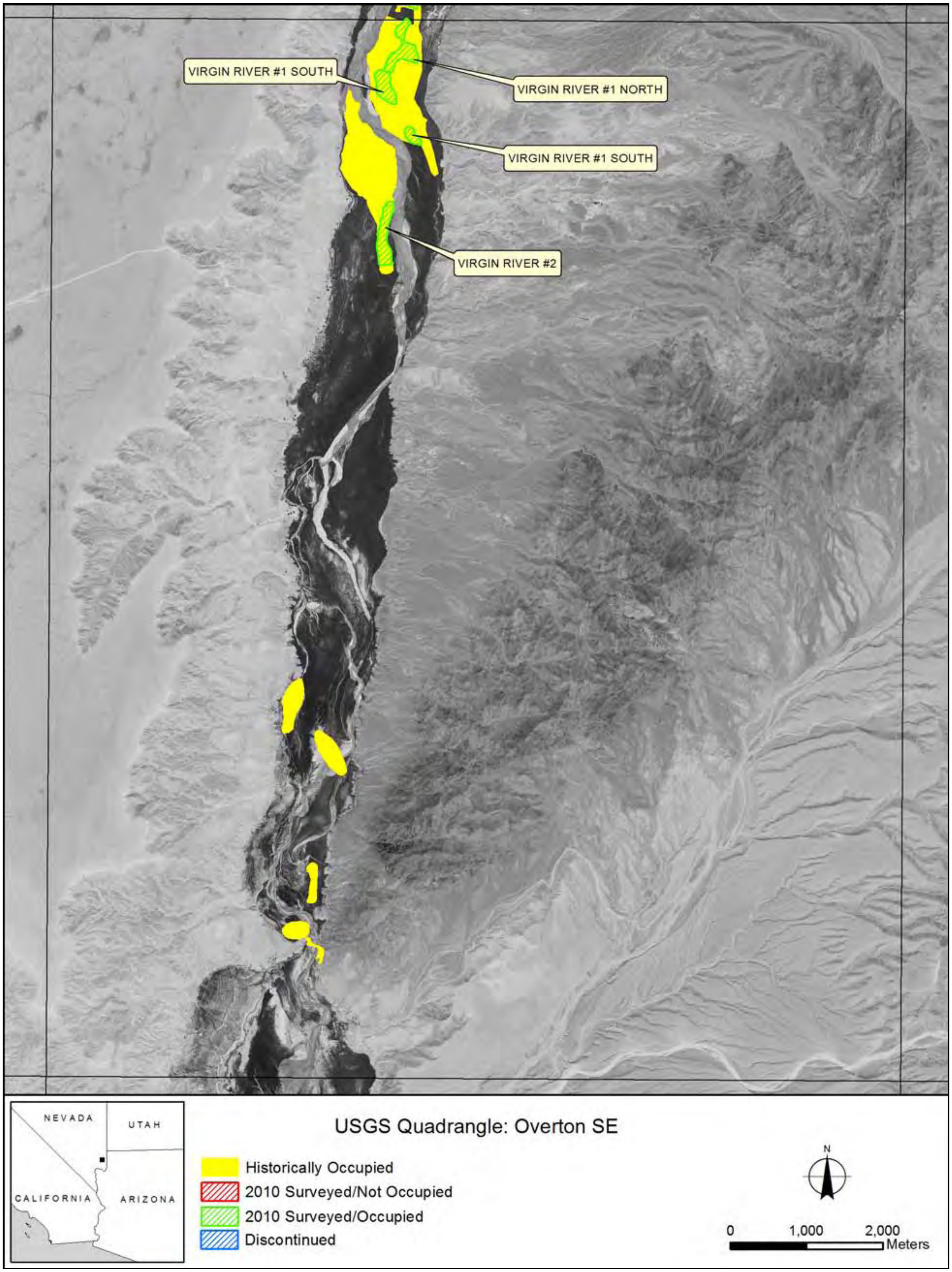
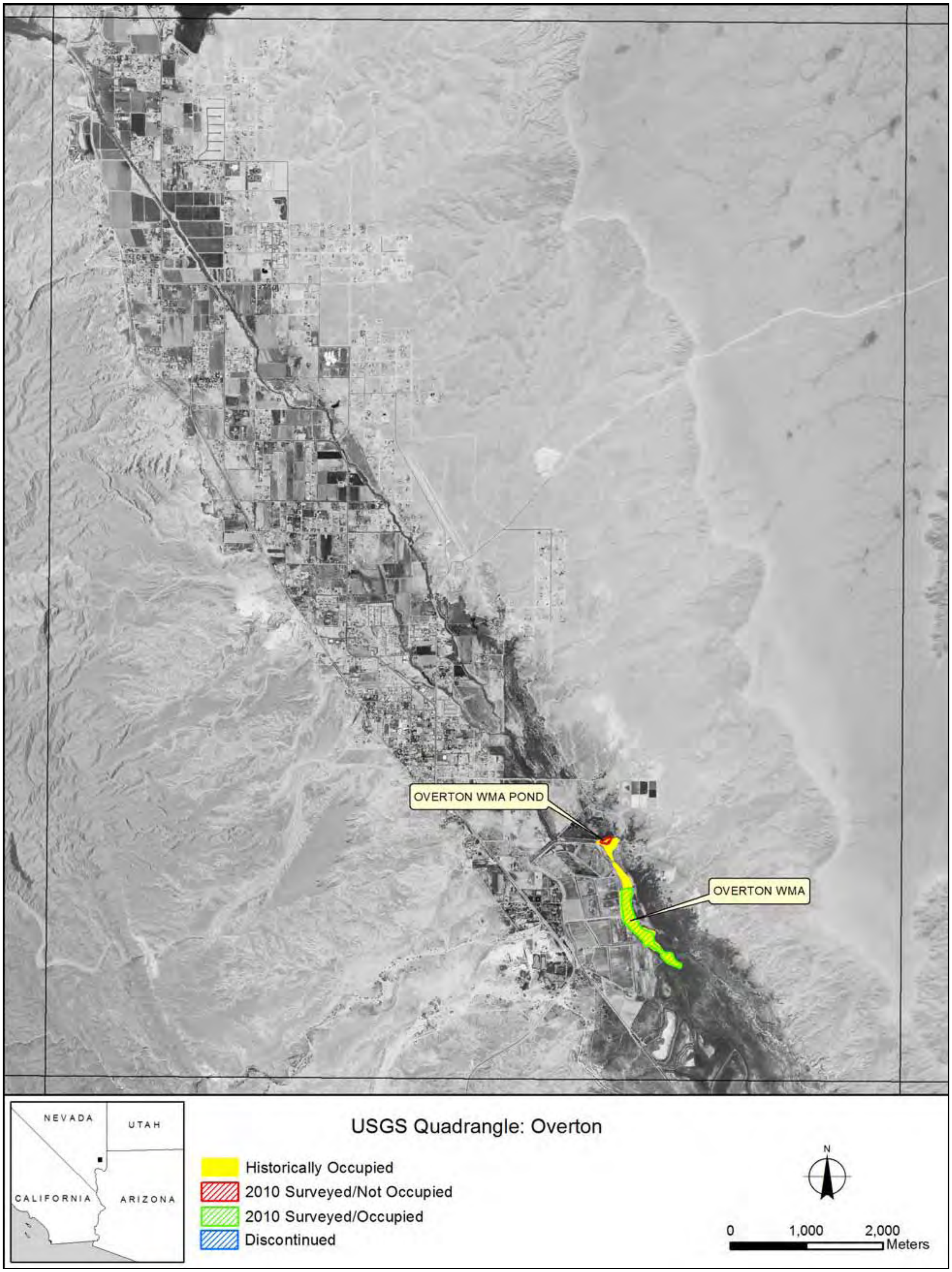
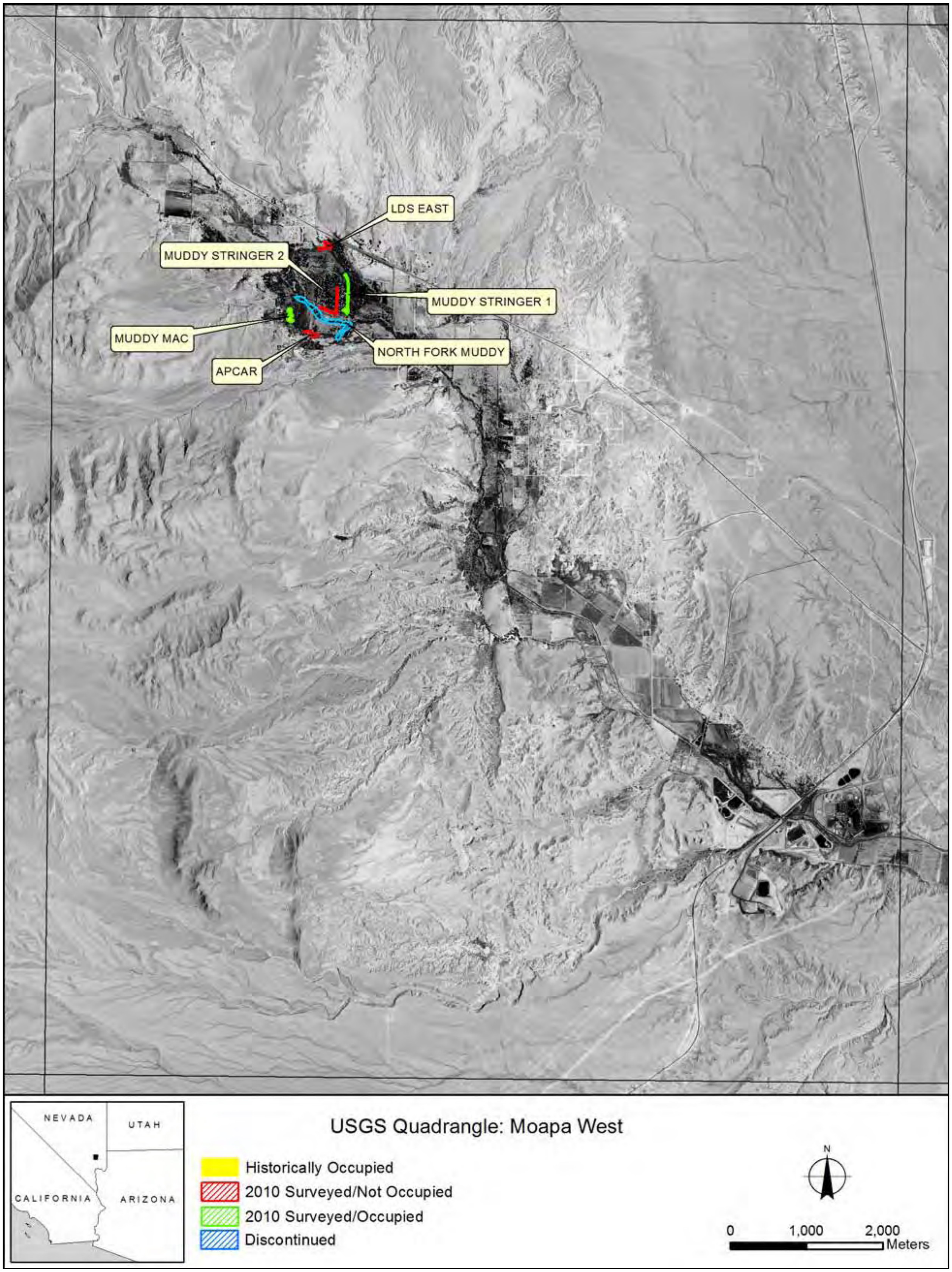
1,000
2,000
Meters

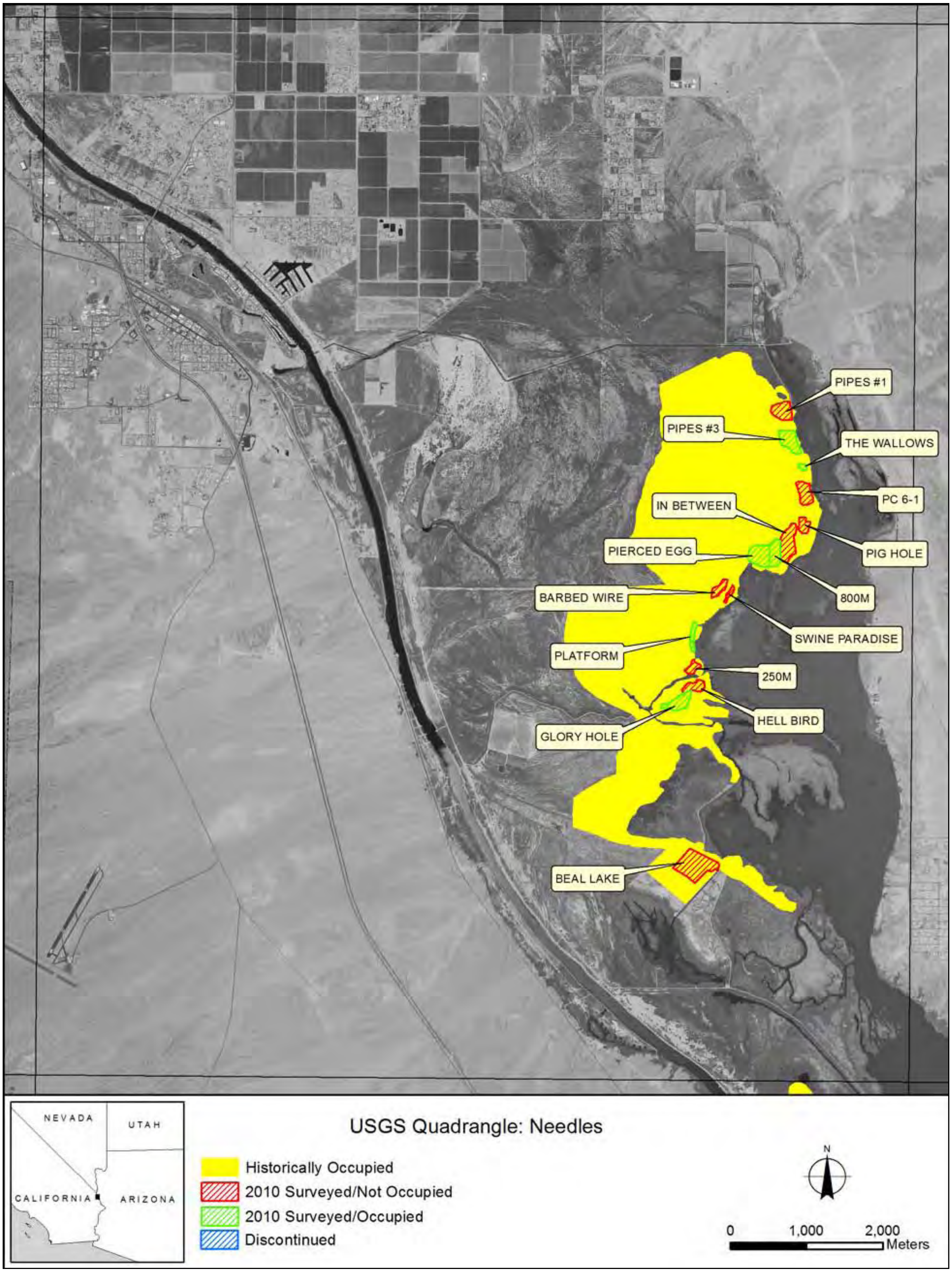

BUNKER MARSH NORTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Flat Top Mesa
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

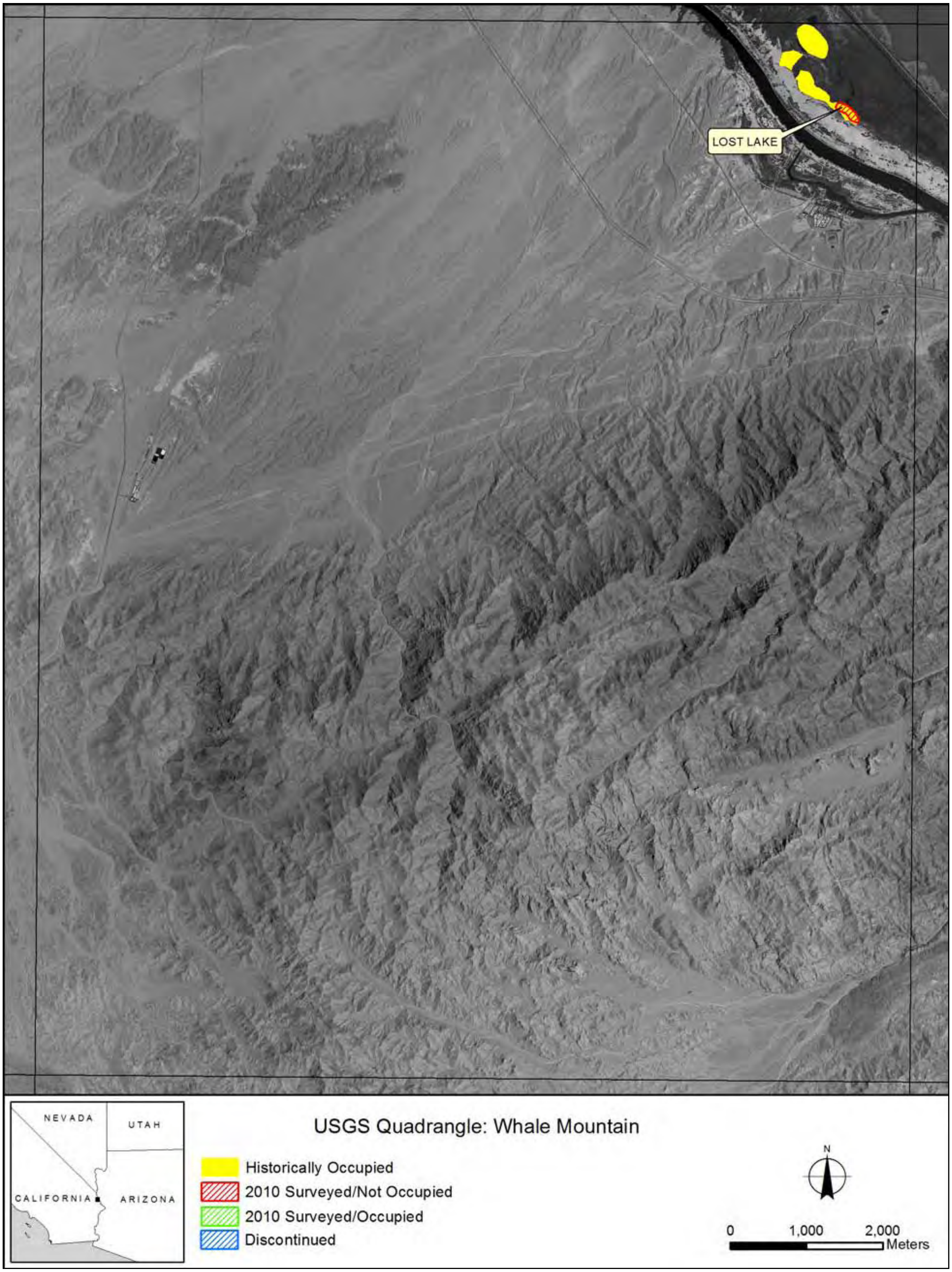

MORMON MESA NORTH
HEDGEROW
MORMON MESA SOUTH (SOUTH)
MORMON MESA SOUTH (NORTH)
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton NE
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


VIRGIN RIVER #1 SOUTH
VIRGIN RIVER #1 NORTH
VIRGIN RIVER #1 SOUTH
VIRGIN RIVER #2
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton SE
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


OVERTON WMA POND
OVERTON WMA
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Overton
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


LDS EAST
MUDDY STRINGER 2
MUDDY STRINGER 1
MUDDY MAC
NORTH FORK MUDDY
APCAR
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Moapa West
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


PIPES #1
PIPES #3
THE WALLOWS
PC 6-1
IN BETWEEN
PIG HOLE
PIERCED EGG
800M
BARBED WIRE
SWINE PARADISE
PLATFORM
250M
HELL BIRD
GLORY HOLE
BEAL LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Needles
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


LOST LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Whale Mountain
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
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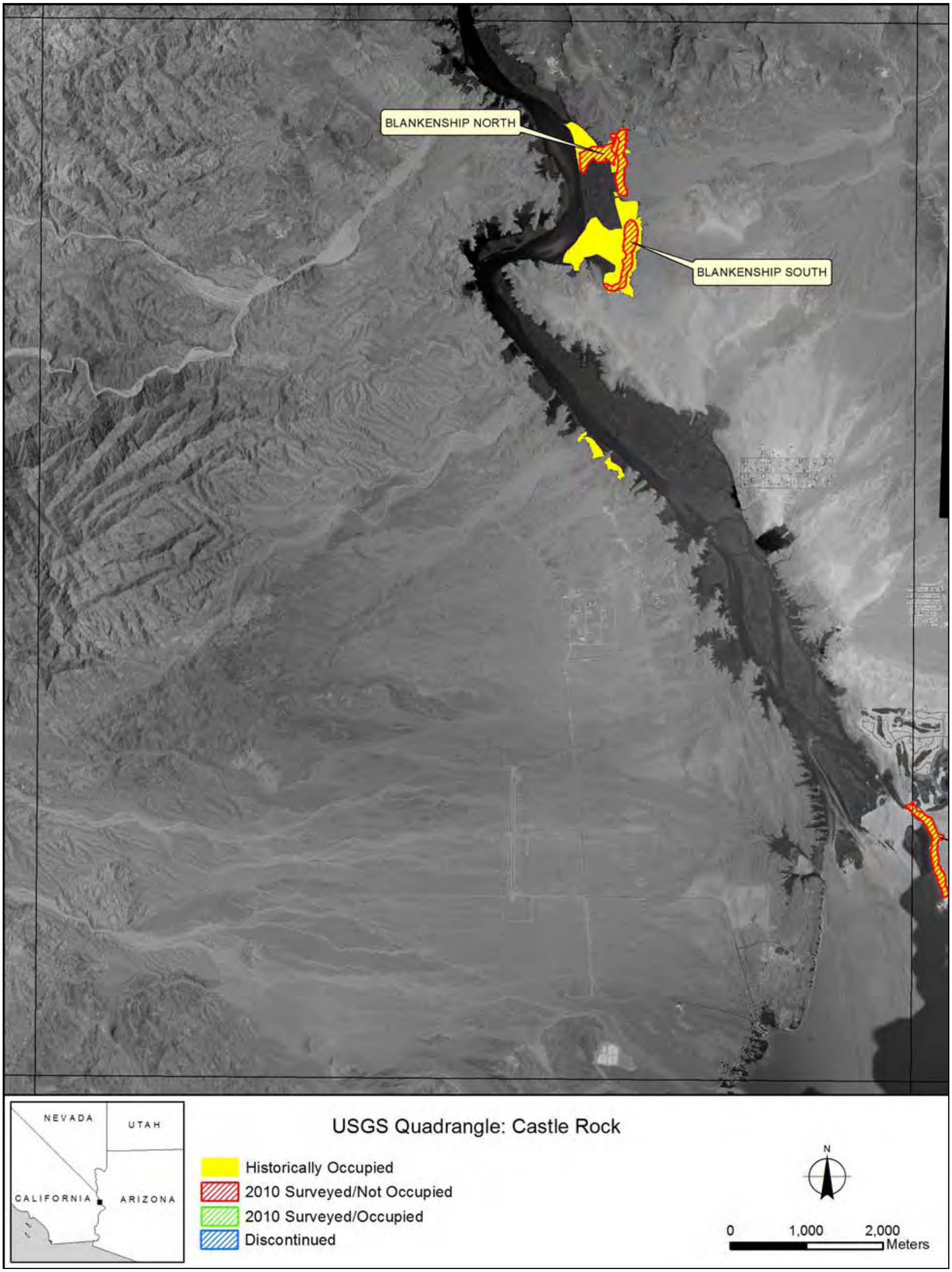
1,000
2,000
Meters


BLANKENSHIP NORTH
BLANKENSHIP SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castle Rock
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
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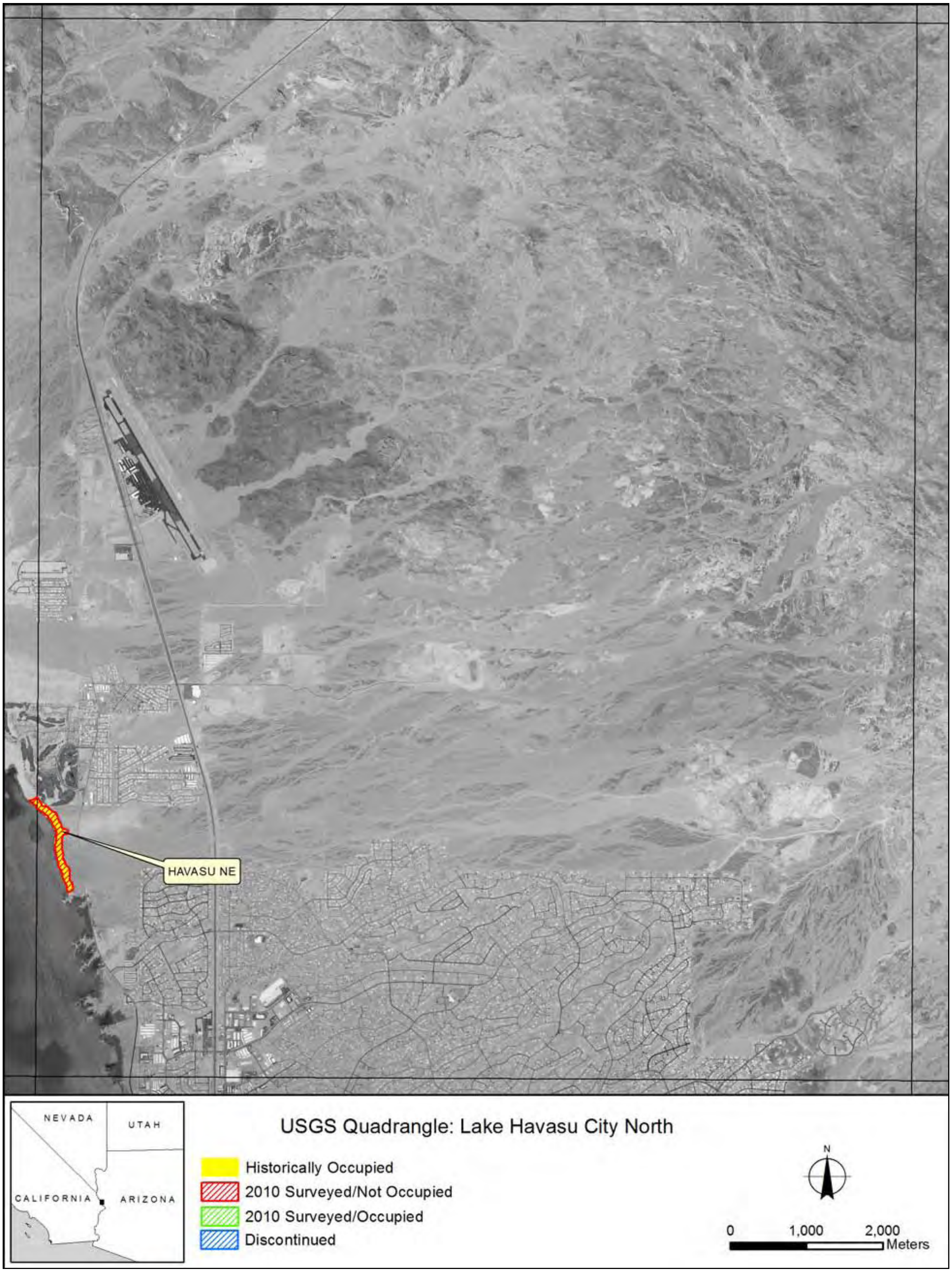
1,000
2,000
Meters


HAVASU NE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Lake Havasu City North
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
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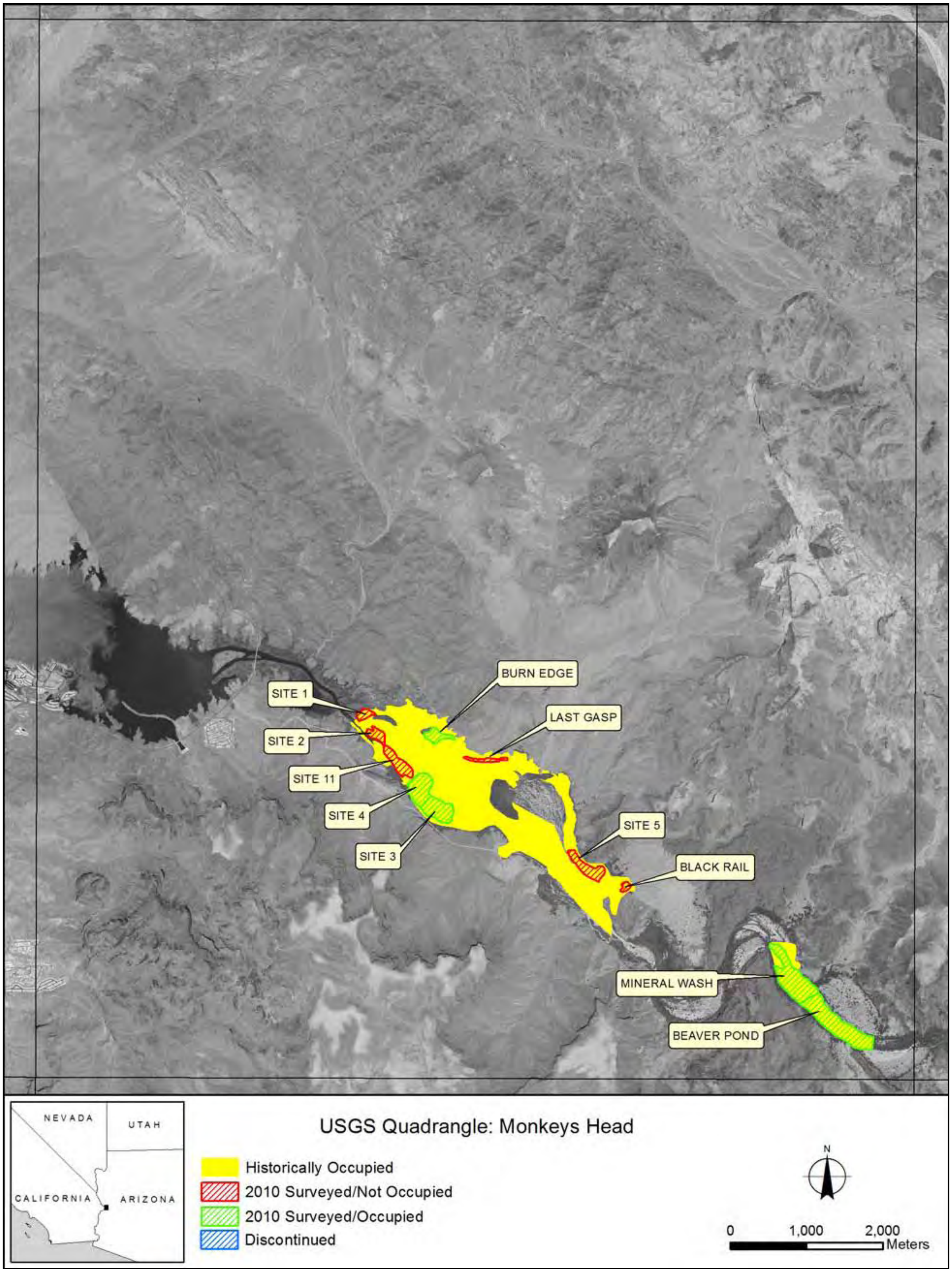
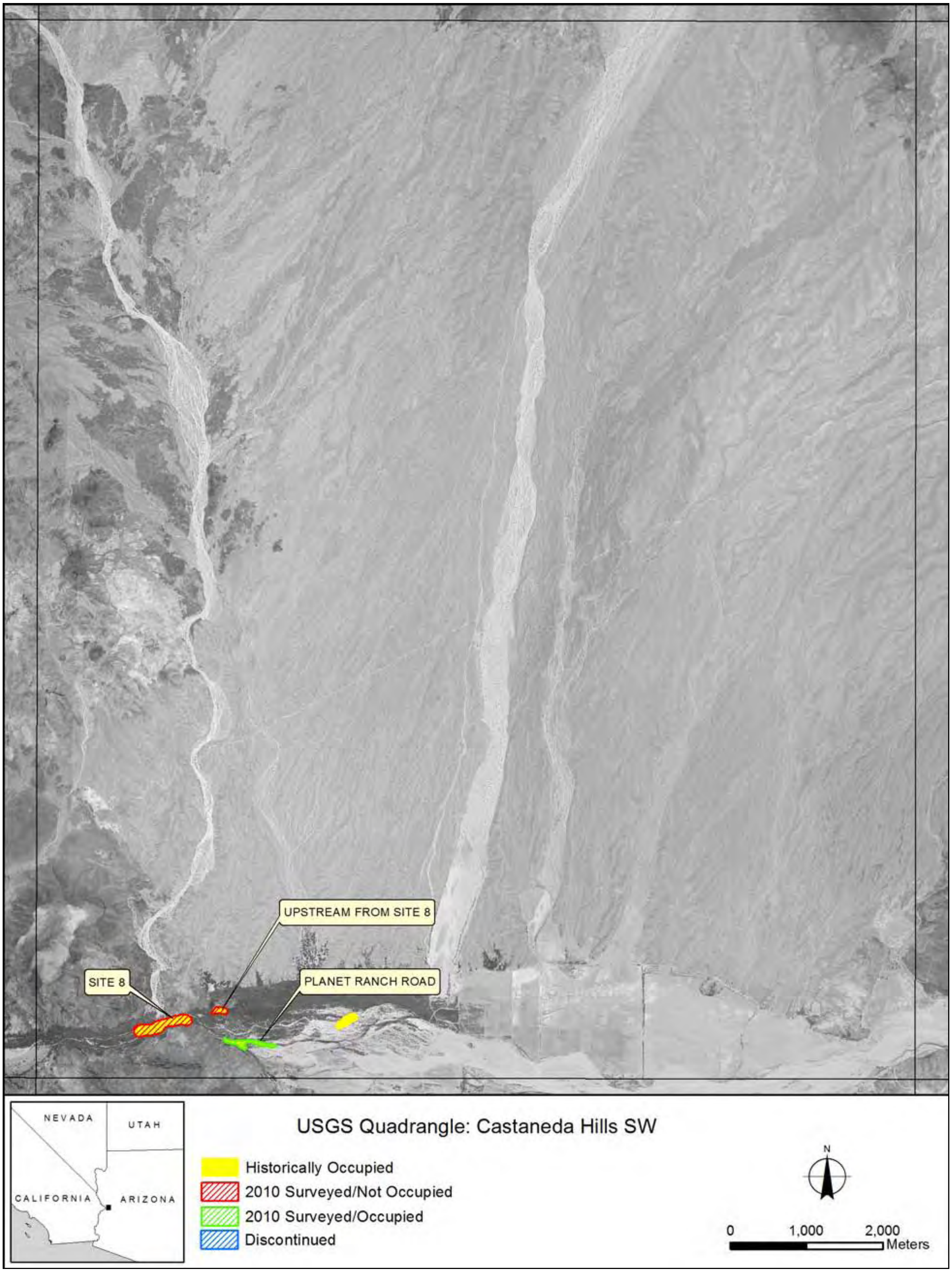
1,000
2,000
Meters

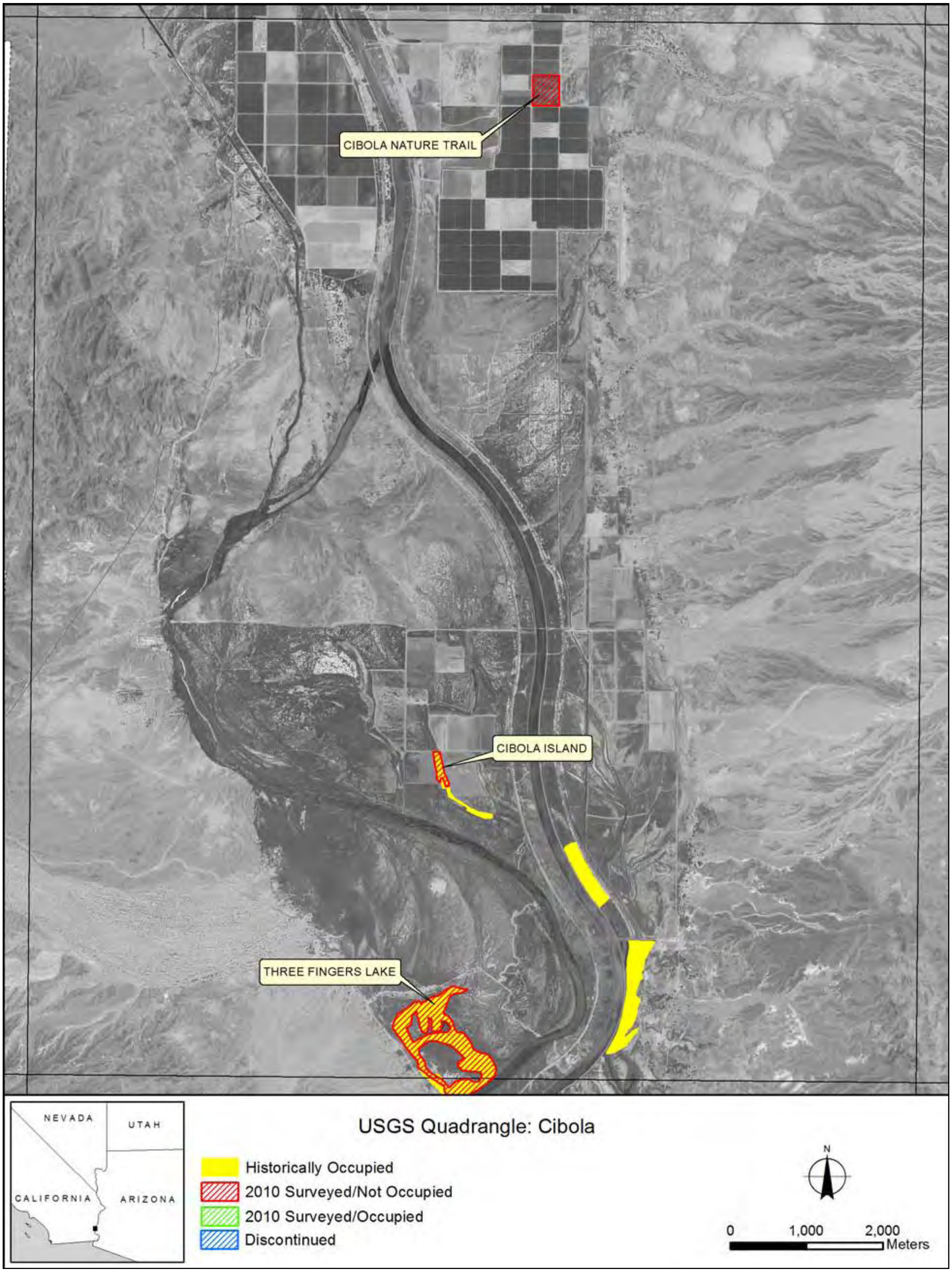

BURN EDGE
SITE 1
LAST GASP
SITE 2
SITE 11
SITE 4
SITE 3
SITE 5
BLACK RAIL
MINERAL WASH
BEAVER POND
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Monkeys Head
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


UPSTREAM FROM SITE 8
SITE 8
PLANET RANCH ROAD
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Castaneda Hills SW
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


PVER PHASE 2
PVER PHASE 3
BIG HOLE SLOUGH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Blythe NE
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


EHRENBERG
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Blythe
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


CVCA PHASE 1
CVCA PHASE 3
CVCA PHASE 2
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Palo Verde
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


CIBOLA NATURE TRAIL
CIBOLA ISLAND
THREE FINGERS LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Cibola
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
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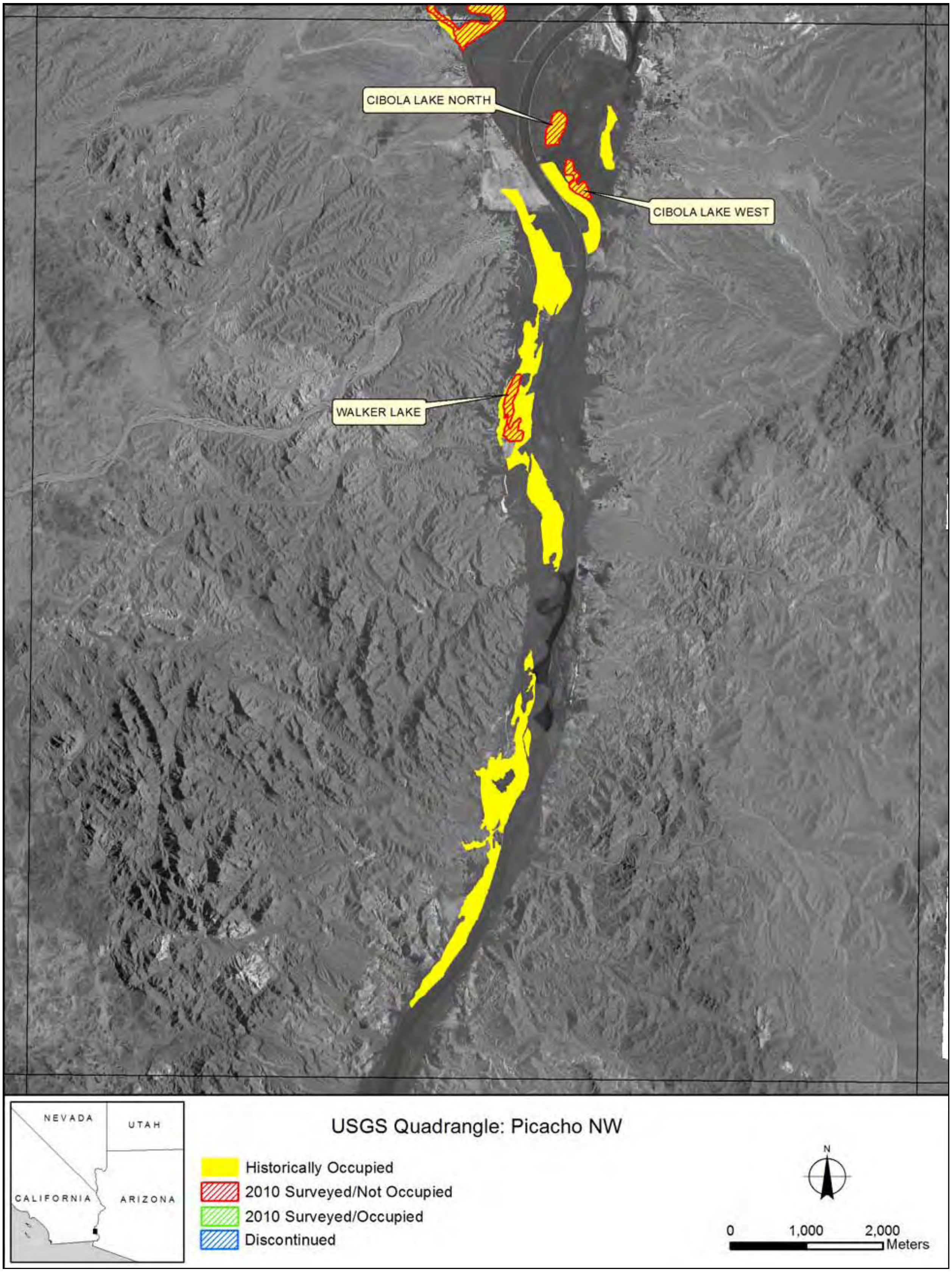
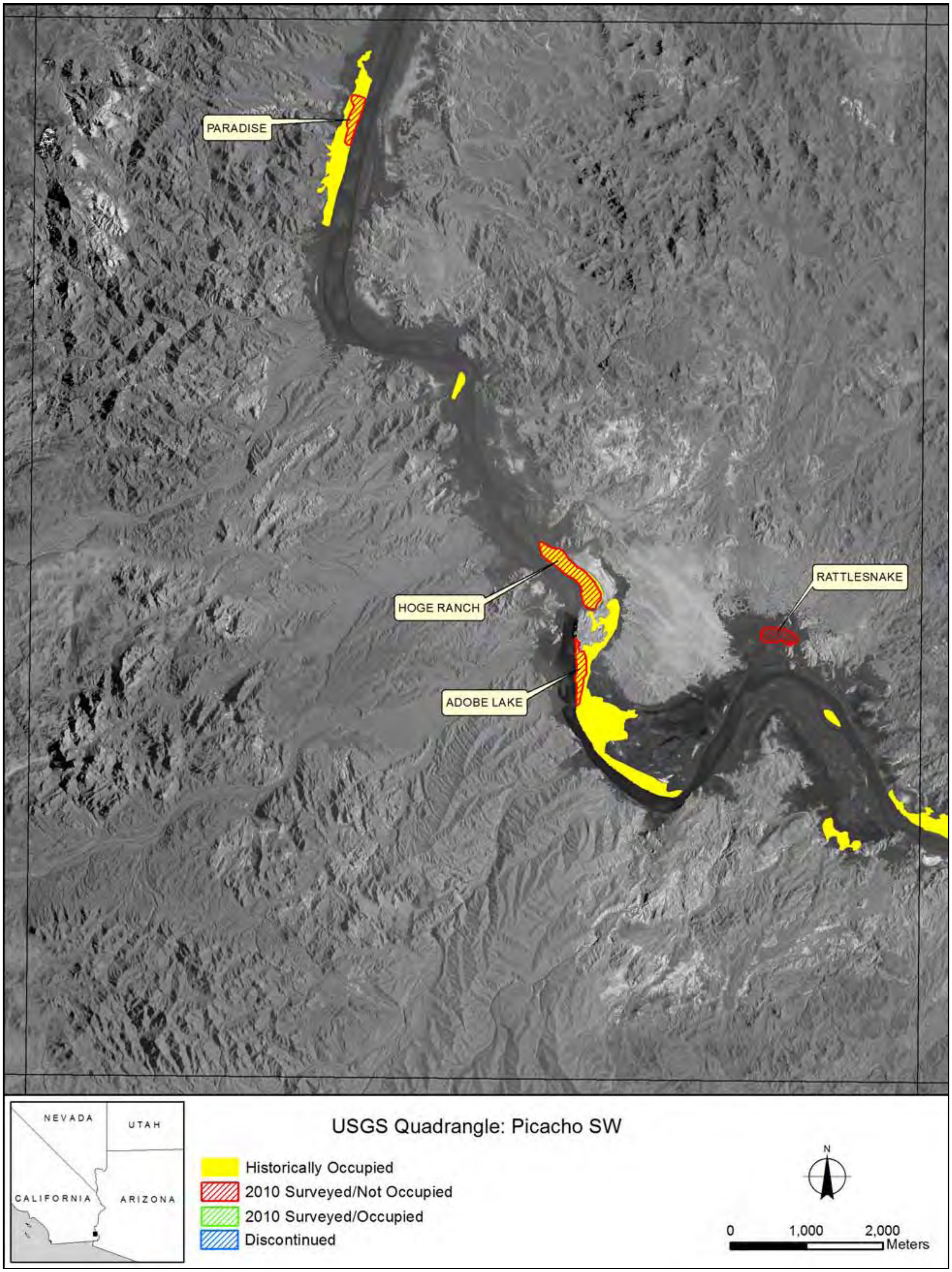
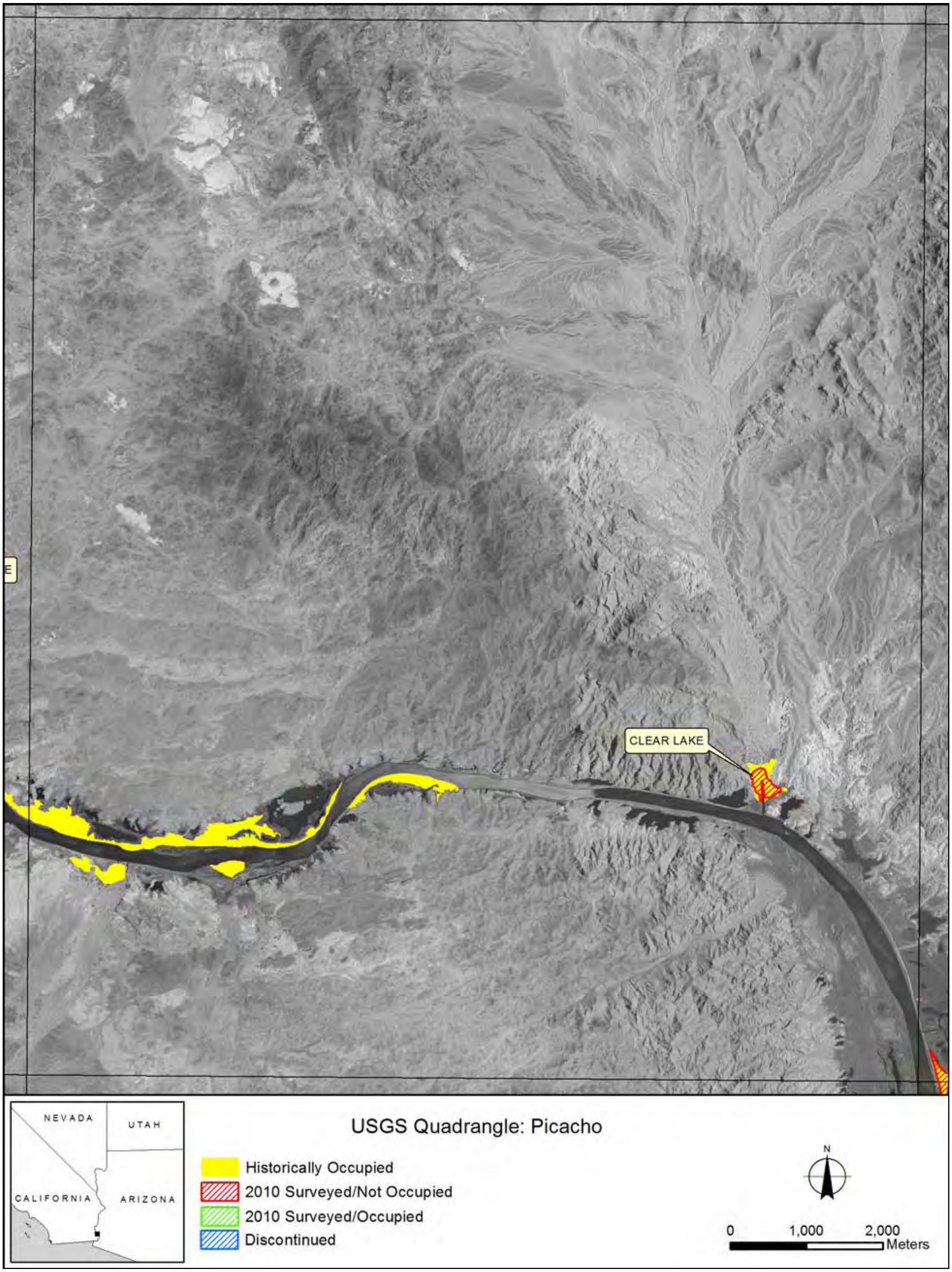
1,000
2,000
Meters


CIBOLA LAKE NORTH
CIBOLA LAKE WEST
WALKER LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho NW
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


PARADISE
HOGE RANCH
RATTLESNAKE
ADOBE LAKE
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho SW
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters


CLEAR LAKE
E
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Picacho
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
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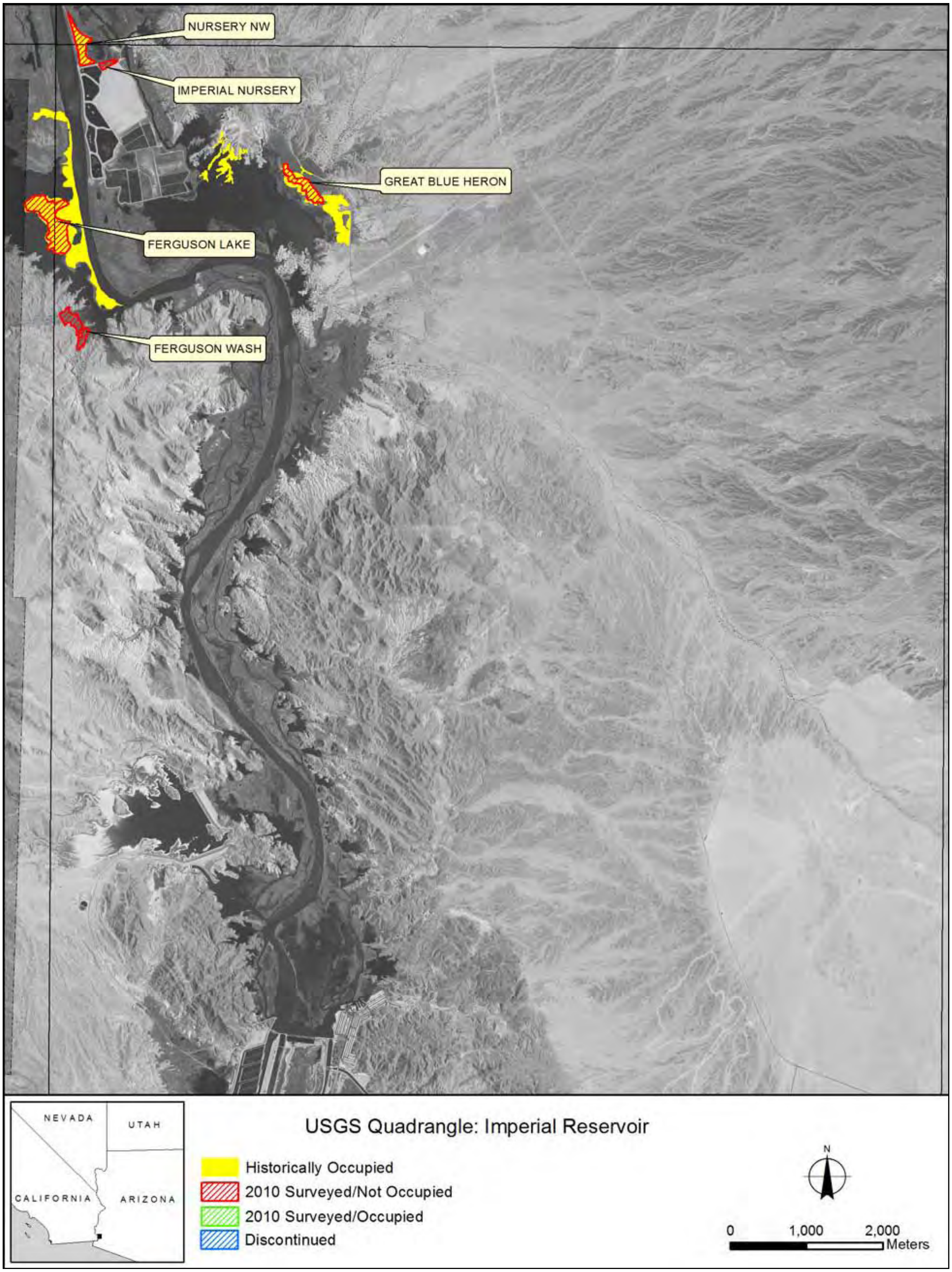
1,000
2,000
Meters


NURSERY NW
IMPERIAL NURSERY
GREAT BLUE HERON
FERGUSON LAKE
FERGUSON WASH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Imperial Reservoir
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
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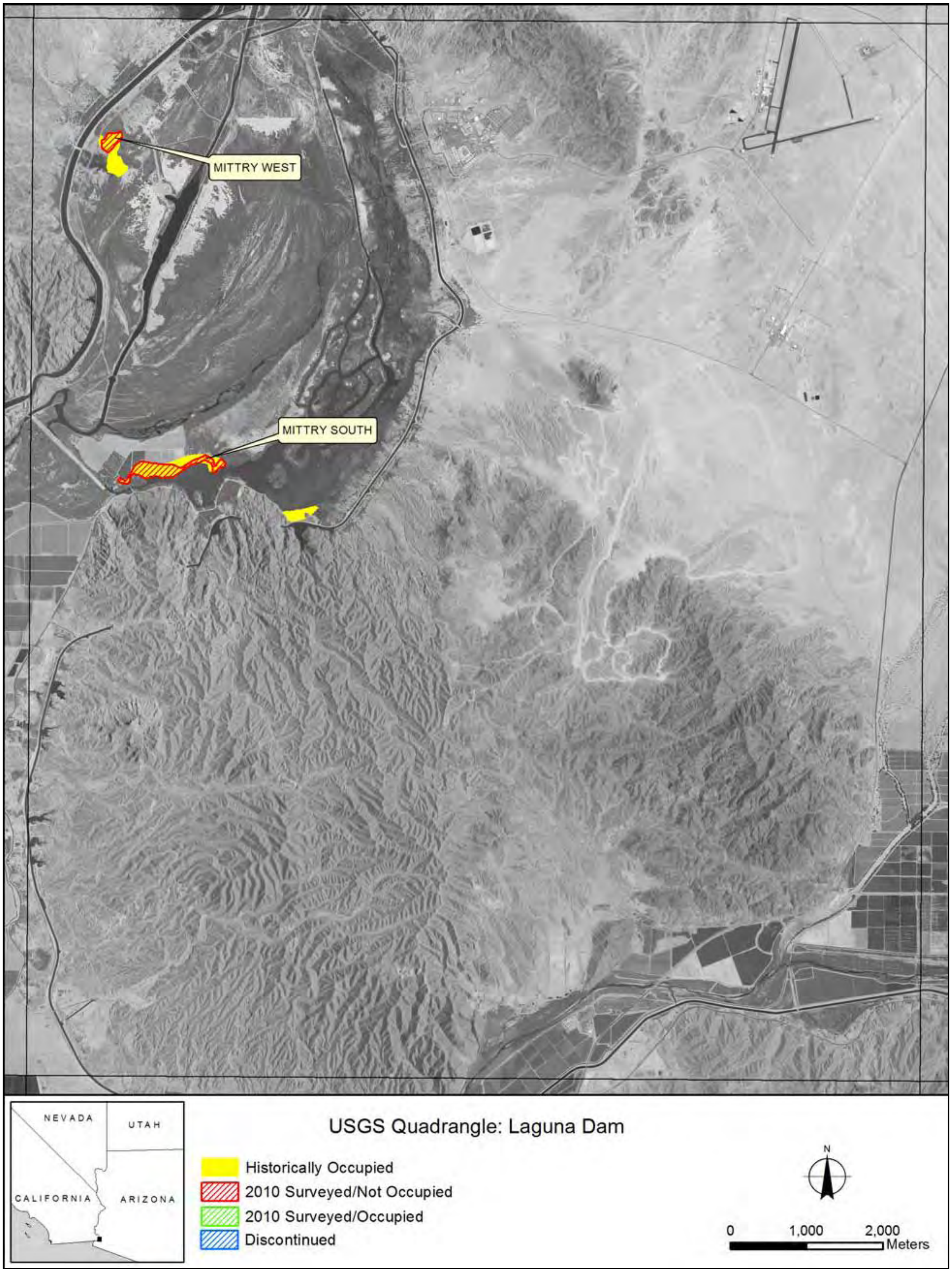
1,000
2,000
Meters


MITTRY WEST
MITTRY SOUTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Laguna Dam
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
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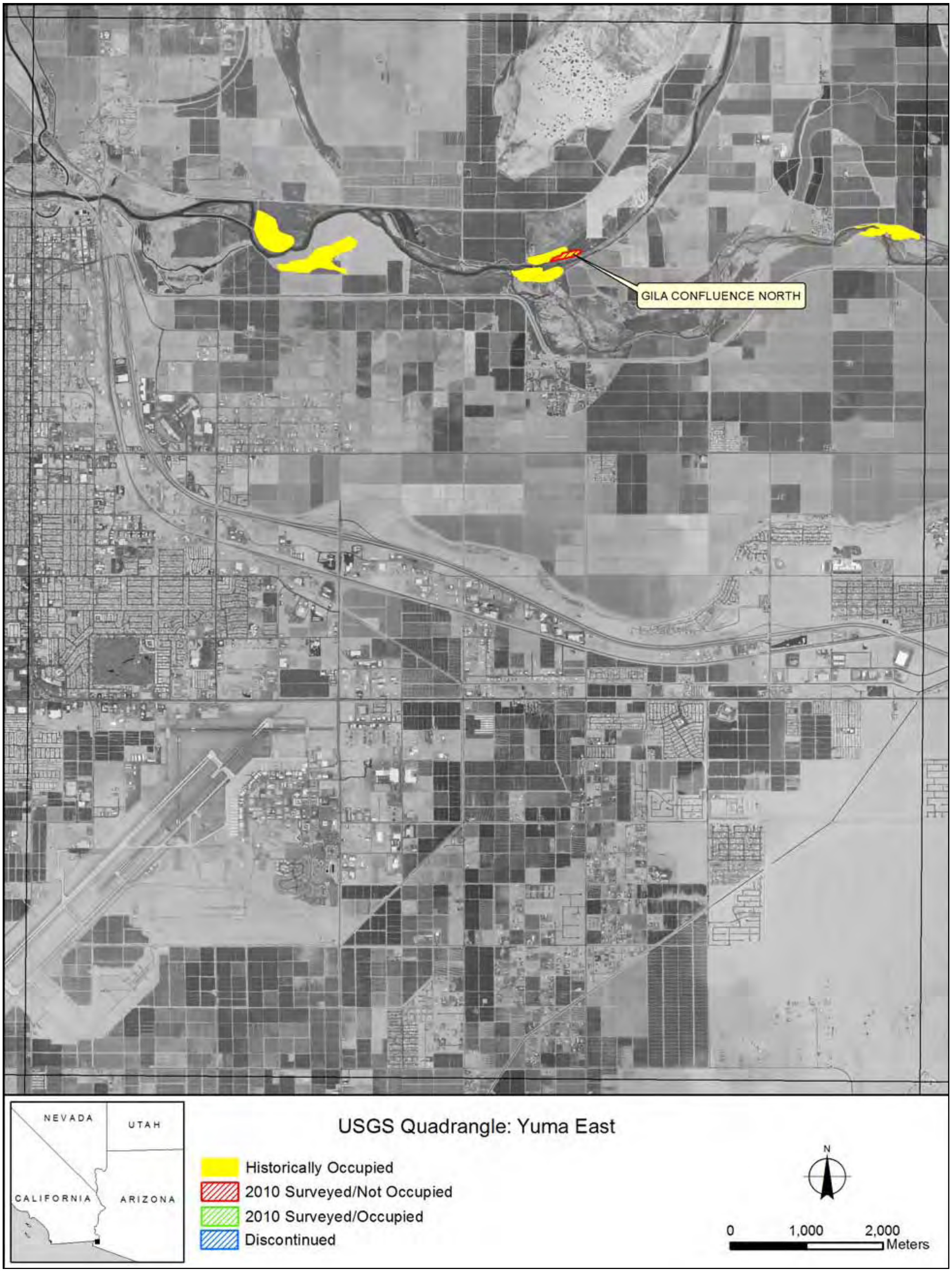
1,000
2,000
Meters


GILA CONFLUENCE NORTH
NEVADA
UTAH
CALIFORNIA
ARIZONA
USGS Quadrangle: Yuma East
Historically Occupied
2010 Surveyed/Not Occupied
2010 Surveyed/Occupied
Discontinued
N
0
1,000
2,000
Meters

Appendix C

SOUTHWESTERN WILLOW FLYCATCHER SURVEY RESULTS, 2010

Table C.1. Southwestern Willow Flycatcher Survey Results by Site along the Lower Colorado River and Tributaries, 2010*

River Drainage	State	Study Area[1]	Survey Site[2]	Area (ha)	# Surveys	Survey Hours	Resident Adults	Territories	Pairs	Nests	Unknown Status[3]	Migrants[4]
Pahranagat Valley	NV	KEPI[5]	Patch 0	0.02	1	7	0	0	0	0	0	0
			Patch 1	0.1	1	---	2	1	1	2	0	0
			Patch 2	0.1	1	---	3	2	1	2	0	0
			Patch 3	0.1	1	---	3	1	1[6]	2	0	0
			Patch 4	0.1	1	---	2	1	1	2	1	0
			Patch 4.5	0.02	1	---	0	0	0	0	0	0
			Patch 5	0.1	1	---	2	1	1	3	0	0
			Patch 6	0.2	1	---	4	3	3	4	1	0
			Patch 7	0.1	1	---	2	1	1	1	1	0
			Patch 8	0.1	1	---	4	3	3	5	0	0
			Patch 9	0.3	1	---	2	1	1	1	0	0
			Patch 10	0.1	1	---	3	2	2	4	0	0
			Patch 10.5	0.02	1	---	0	0	0	0	1	0
			Patch 11	0.1	1	---	2	1	1	3	0	0
			Patch 12	0.1	1	---	2	1	1	2	0	0
Pahranagat Valley	NV	PAHR	North	4.6	0	0	23	14	10	20	0	0
			West	1.5	5	4	0	0	0	0	1[7]	1
			MAPS	1.4	4	4.1	0	0	0	0	0	0
			South	2.5	5	2.7	0	0	0	0	0	0
Beaver Dam Wash	AZ	LIFI	Poles	1.2	5	10	3	2	1	2	0	1
Virgin River	NV	MESQ	Hafen Lane	6.1	5	6.8	2	1	1	1	1[8]	0
			East[9]	4.4	1	1	0	0	0	0	0	0
			West	10.5	5	14.4	16	8	6	15[10]	1	0
			Bunker Marsh North	8.0	5	15.4	0	0	0	0	0	0
Virgin River	NV	MOME	Mormon Mesa North[9]	8.2	1	3.8	0	0	0	0	0	0
			Hedgerow[9]	1.1	1	1.5	0	0	0	0	0	0
			Mormon Mesa South (North)	8.6	5	13.8	0	0	0	0	1	0
			Mormon Mesa South (South)	3.4	5	7.5	0	0	0	0	0	0
			Virgin River #1 (North)	11.4	5	30.3	0	0	0	0	1	3
			Virgin River #1 (South)	11.1	5	17.5	25	16	10	15	0	1

Table C.1. Southwestern Willow Flycatcher Survey Results by Site along the Lower Colorado River and Tributaries, 2010* (Continued)

River Drainage	State	Study Area[1]	Survey Site[2]	Area (ha)	# Surveys	Survey Hours	Resident Adults	Territories	Pairs	Nests	Unknown Status[3]	Migrants[4]
Virgin River	NV	MOME	Virgin River #2	11.2	5	12.7	1[11]	1	0	0	1	1
Muddy River	NV	MUDD	Overton WMA Pond	0.7	5	3.5	0	0	0	0	0	0
			Overton WMA	14.9	5	19.8	12	8	4	4	1	1
Muddy River	NV	WMSP	LDS East	0.9	4	2.0	0	0	0	0	0	0
			Muddy Stringer #1	1.4	4	2.8	3	2	2	2	0	1
			Muddy Stringer #2	1.4	5	4.8	0	0	0	0	0	0
			North Fork Muddy[9]	5.5	1	2.0	0	0	0	0	0	0
			Muddy Mac	1.1	4	2.3	3	2	1	1	0	0
			Apcar[12]	0.7	2	0.8	0	0	0	0	0	0
Colorado River	AZ	TOPO	Pipes #1	5.2	5	10.8	0	0	0	0	0	2
			Pipes #3	5.7	6	7.3	2	2	1	0	1	0
			The Wallows	0.7	5	3.1	2	2	0	0	1	1
			PC6-1	4.8	5	9.8	0	0	0	0	0	2
			Pig Hole	2.4	5	5.0	0	0	0	0	0	0
			In Between	7.7	5	9.3	0	0	0	0	0	0
			800M	4.7	5	7.8	2	2	0	0	0	2
			Pierced Egg	6.7	5	9.7	1	1	0	0	0	2
			Swine Paradise	1.0	5	6.0	0	0	0	0	0	1
			Barbed Wire	2.4	5	5.6	0	0	0	0	0	0
			Platform	1.9	5	3.8	2	1	1	1	0	0
			250M	1.9	5	4.4	0	0	0	0	0	0
			Hell Bird	3.3	5	5.8	0	0	0	0	0	1
			Glory Hole	5.0	5	7.1	3[13]	2	1	1	0	0
			Beal Lake	13.9	5	10.7	0	0	0	0	0	2
			Lost Lake	3.3	5	6.5	0	0	0	0	0	0
			MAM[14]	---	0	0	0	0	0	0	0	2
Colorado River	AZ	TOGO	Blankenship Bend North	19.0	5	12.2	0	0	0	0	0	0
			Blankenship Bend South	11.8	5	10.0	0	0	0	0	0	0
			Havasu NE	12.6	5	12.75	0	0	0	0	0	0
Bill Williams River	AZ	BIWI	Site #1	2.2	5	10.5	0	0	0	0	0	0

Table C.1. Southwestern Willow Flycatcher Survey Results by Site along the Lower Colorado River and Tributaries, 2010* (Continued)

River Drainage	State	Study Area[1]	Survey Site[2]	Area (ha)	# Surveys	Survey Hours	Resident Adults	Territories	Pairs	Nests	Unknown Status[3]	Migrants[4]
Bill Williams River	AZ	BIWI	Site #2	3.1	6	4.3	0	0	0	0	0	0
			Site #11	6.3	6	6.4	0	0	0	0	0	0
			Burn Edge	4.1	5	5.8	2	1	1	3	0	0
			Site #4	9.9	5	12.8	0	0	0	0	2	0
			Site #3	9.5	5	13.8	4	3	2	6	0	0
			Last Gasp	2.1	5	7.3	0	0	0	0	0	0
			Site #5	6.8	5	11.5	0	0	0	0	0	0
			Black Rail	1.2	5	6.1	0	0	0	0	0	0
			Mineral Wash	18.8	5	14.8	0	0	0	0	1	1
			Beaver Pond	21.7	5	8.9	0	0	0	0	1	0
			Site #8	10.3	5	10.8	0	0	0	0	0	0
			Upstream from Site #8	1.5	5	4.0	0	0	0	0	0	1
			Planet Ranch Road	3.3	5	4.8	2	1	1	2	0	0
Colorado River	CA	PVER	PVER Phase 2	28.7	5	14.2	0	0	0	0	0	3
			PVER Phase 3	15.8	5	12.3	0	0	0	0	0	0
Colorado River	CA	BIHO	Big Hole Slough[15]	29.0	1	1.3	0	0	0	0	0	0
Colorado River	AZ	EHRE	Ehrenberg	4.7	5	5.1	0	0	0	0	0	0
Colorado River	AZ	CIBO	CVCA Phase 1	26.2	5	14.8	0	0	0	0	0	17
	AZ	CIBO	CVCA Phase 2	25.5	5	16.5	0	0	0	0	0	18
	AZ	CIBO	CVCA Phase 3	38.4	5	17.0	0	0	0	0	0	4
	AZ	CIBO	Cibola Nature Trail	13.7	5	9.0	0	0	0	0	0	2
	AZ	CIBO	Cibola Island	4.2	5	5.8	0	0	0	0	0	0
	CA	CIBO	Three Fingers Lake	67.9	5	20.2	0	0	0	0	0	5
	AZ	CIBO	Cibola Lake #1 (North)	8.5	5	9.5	0	0	0	0	0	0
	AZ	CIBO	Cibola Lake #3 (West)	6.8	5	6.8	0	0	0	0	0	0
	CA	CIBO	Walker Lake	11.4	4	10.8	0	0	0	0	0	1
Colorado River	CA	IMPE	Paradise	7.8	5	9.0	0	0	0	0	0	1
	AZ	IMPE	Hoge Ranch	20.7	5	12.7	0	0	0	0	0	2
	AZ	IMPE	Adobe Lake	7.6	5	2.3	0	0	0	0	0	0
	AZ	IMPE	Rattlesnake	7.6	5	7.4	0	0	0	0	0	2

Table C.1. Southwestern Willow Flycatcher Survey Results by Site along the Lower Colorado River and Tributaries, 2010* (Continued)

River Drainage	State	Study Area[1]	Survey Site[2]	Area (ha)	# Surveys	Survey Hours	Resident Adults	Territories	Pairs	Nests	Unknown Status[3]	Migrants[4]
Colorado River	AZ	IMPE	Clear Lake	8.3	5	9.8	0	0	0	0	0	1
	AZ	IMPE	Nursery NW	7.0	5	5.6	0	0	0	0	0	0
	AZ	IMPE	Imperial Nursery	1.4	5	1.4	0	0	0	0	0	0
	CA	IMPE	Ferguson Lake	21.1	5	15.1	0	0	0	0	0	7
	CA	IMPE	Ferguson Wash	6.8	5	7.3	0	0	0	0	0	3
	AZ	IMPE	Great Blue Heron	7.1	5	18.2	0	0	0	0	0	0
Colorado River	CA	MITT	Mittry West	4.4	5	10.0	0	0	0	0	0	4
	AZ	MITT	Mittry South	15.2	5	12.4	0	0	0	0	0	5
Colorado River	AZ	YUMA	Gila Confluence North	2.2	5	9.3	0	0	0	0	0	3

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

[1] Study areas consist of 1-18 survey sites that are grouped geographically. Alpha codes are as follows: KEPI = Key Pittman Wildlife Management Area, PAHR = Pahranagat National Wildlife Refuge (NWR), LIFI = Littlefield, MESQ = Mesquite, MOME = Mormon Mesa, MUDD = Muddy River, WMSP = Warm Springs Natural Area, TOPO = Topock Marsh, TOGO = Topock Gorge, BIWI = Bill Williams River NWR, PVER = Palo Verde Ecological Reserve, BIHO = Big Hole Slough, EHRE = Ehrenberg, CIBO = Cibola, IMPE = Imperial, MITT = Mittry Lake, YUMA = Yuma.

[2] Survey site is equivalent to the Arizona Department of Game and Fish site definition.

[3] Total number of individuals recorded that could not be classified as resident or migrant because of brief appearance after 15 June.

[4] Total number of individuals who could not be classified as resident because of brief appearance before 15 June.

[5] Due to high occupancy rate, this study area was only surveyed once. Hours reported are for the whole study area and not one particular site.

[6] This female mated consecutively with two males.

[7] This adult, detected on 24 Jul, had held a territory at Pahranagat North until 14 Jul.

[8] This individual moved to Mesquite West and bred.

[9] Surveys discontinued because of poor quality habitat.

[10] One male held a territory at Mesquite West and then bred at Hafen Lane. Two females mated consecutively with two males.

[11] This individual was also detected in Virgin River #1 (North) on 2 Jun and Virgin River #1 (South) 12 Jun–4 Jul.

[12] This site was added to the survey list in early June.

[13] One resident male was originally in Pipes #3 19 May–25 Jun.

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

[15] Surveys discontinued after 1 Jun because of safety concerns.

Appendix D

DETECTIONS OF SPECIAL CONCERN SPECIES, 2010

Table D.1. Number of Detections of Each Special Concern Species Recorded at Each Survey Site, 2010

Study Area[1]	Survey Site	Special Concern Species[2]											
		BLRA	CLRA	LEBI	YBCU	ELOW	GIFL	GIWO	VEFL	BEVI	YWAR	SUTA	YBCH
PAHR	West	0	0	0	0	0	0	0	0	0	37	0	7
	MAPS	0	0	0	0	0	0	0	0	0	25	0	1
	South	0	0	0	0	0	0	0	2	8	27	0	9
LIFI	Poles	0	0	1	0	0	0	0	1	2	44	2	9
MESQ	Hafen Lane	0	0	0	0	0	0	1	0	1	40	0	16
	West	0	0	0	0	0	0	0	0	1	40	0	20
	Bunker Marsh North	0	0	0	0	0	0	0	0	4	58	0	65
MOME	Mormon Mesa North	0	0	0	0	0	0	0	0	0	8	0	4
	Hedgerow	0	0	0	0	0	0	0	0	0	7	0	5
	Mormon Mesa South	0	0	0	0	0	0	0	0	39	65	0	73
	Virgin River #1	0	0	0	0	0	0	0	0	27	133	0	130
	Virgin River #2	0	0	0	0	0	0	0	0	5	51	2	31
MUDD	Overton WMA	0	0	0	9	0	0	0	0	1	58	1	35
	Overton WMA Pond	0	0	0	0	0	0	0	0	0	11	0	5
TOPO	Pipes #1	0	0	0	0	0	0	0	0	0	1	0	48
	Pipes #3	0	0	0	0	0	0	2	0	0	4	1	51
	The Wallows	0	0	0	0	0	0	0	0	0	5	2	14
	PC6-1	0	0	0	0	0	0	2	0	3	9	4	64
	Pig Hole	0	0	0	0	0	0	1	0	0	0	2	41
	In Between	0	0	0	0	0	0	0	0	0	0	0	42
	800M	0	0	0	0	0	0	2	0	1	6	0	20
	Pierced Egg	0	2	0	0	0	0	2	0	1	9	0	43
	Swine Paradise	0	0	0	0	0	0	1	0	0	6	3	38
	Barbed Wire	0	0	0	1	0	0	3	0	0	3	3	40
	Platform	0	5	1	0	0	0	3	0	0	12	1	16
	250M	0	1	0	0	0	0	2	0	0	8	3	42

Table D.1. Number of Detections of Each Special Concern Species Recorded at Each Survey Site, 2010 (Continued)

Study Area[1]	Survey Site	Special Concern Species[2]											
		BLRA	CLRA	LEBI	YBCU	ELOW	GIFL	GIWO	VEFL	BEVI	YWAR	SUTA	YBCH
TOPO	Hell Bird	0	0	0	0	0	0	8	1	0	23	3	53
	Glory Hole	0	1	0	0	0	0	4	0	0	18	0	23
	Beal Lake	0	0	1	2	0	0	2	0	67	11	1	40
	Lost Lake	0	6	3	3	0	0	0	0	1	3	2	19
TOGO	Blankenship Bend North	3	5	3	0	0	0	1	0	5	12	2	83
	Blankenship Bend South	1	5	4	0	0	0	2	0	4	2	2	36
	Havasu NE	0	0	0	0	0	0	0	0	1	2	0	27
BIWI	Site #1	0	2	0	0	0	0	8	0	15	0	0	42
	Site #2	0	0	1	0	0	0	2	0	4	2	1	22
	Burn Edge	0	0	0	0	0	0	11	0	14	11	1	36
	Site #11	0	0	1	0	1	1	5	1	2	8	1	40
	Site #4	0	0	0	3	0	0	10	0	13	23	2	78
	Site #3	0	0	0	2	0	0	10	0	4	24	3	69
	Last Gasp	0	0	0	1	0	0	6	0	21	5	3	67
	Site #5	0	2	0	0	0	1	13	0	20	21	3	28
	Black Rail	0	0	0	0	0	0	12	0	21	3	3	32
	Mineral Wash	0	1	1	0	0	0	18	0	63	12	5	105
	Beaver Pond	0	0	0	3	1	0	5	0	28	17	6	78
	Site #8	0	0	1	2	0	0	18	0	13	20	2	40
	Upstream from Site #8	0	0	0	2	0	0	7	0	3	4	0	36
	Planet Ranch Road	0	0	0	6	0	0	3	0	40	16	1	60
PVER	PVER Phase 2	0	0	0	5	0	0	0	0	9	13	1	0
	PVER Phase 3	0	0	0	4	0	0	0	0	0	2	1	0
BIHO	Big Hole Slough	0	0	0	0	0	0	0	0	0	0	0	0
EHRE	Ehrenberg	0	0	0	0	0	0	1	0	0	2	0	8
CIBO	CVCA Phase 1	0	0	0	6	0	0	0	0	1	5	0	3

Table D.1. Number of Detections of Each Special Concern Species Recorded at Each Survey Site, 2010 (Continued)

Study Area[1]	Survey Site	Special Concern Species[2]											
		BLRA	CLRA	LEBI	YBCU	ELOW	GIFL	GIWO	VEFL	BEVI	YWAR	SUTA	YBCH
CIBO	CVCA Phase 2	0	0	0	6	0	0	0	0	1	10	0	6
	CVCA Phase 3	0	0	0	2	0	0	0	0	2	0	0	0
	Cibola Nature Trail	0	0	0	0	0	0	1	0	4	28	0	9
	Cibola Island	0	0	0	0	0	0	0	0	0	1	0	6
	Three Fingers Lake	0	2	26	1	0	0	2	0	0	2	0	43
	Cibola Lake #1 (North)	0	1	4	0	0	0	2	0	3	0	4	14
	Cibola Lake #3 (West)	0	1	5	1	0	0	0	0	0	0	0	10
	Walker Lake	0	0	0	0	0	0	10	0	0	0	1	15
IMPE	Paradise	0	0	0	0	0	2	12	0	0	2	0	21
	Hoge Ranch	0	0	2	0	0	0	2	0	0	3	0	21
	Adobe Lake	0	0	0	0	0	0	1	0	0	0	0	7
	Rattlesnake	0	0	0	0	0	0	6	0	0	4	1	38
	Clear Lake	0	0	8	0	0	0	2	0	0	1	0	20
	Nursery Northwest	1	0	0	0	0	0	0	0	0	0	0	23
	Imperial Nursery	0	0	1	0	0	0	0	0	0	1	1	3
	Ferguson Lake	0	0	11	0	0	0	14	0	4	2	0	38
	Ferguson Wash	0	0	0	0	0	0	0	0	0	4	0	17
	Great Blue Heron	0	0	0	0	0	0	8	0	2	5	0	55
MITT	Mittry West	0	0	0	2	0	0	5	0	4	4	0	15
	Mittry South	0	0	3	1	0	0	5	0	0	4	0	9
YUMA	Gila Confluence North	0	0	0	3	0	1	1	0	0	0	0	9

[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; IMPE = Imperial; MITT = Mittry Lake; YUMA = Yuma.

[2] BLRA = Black Rail, CLRA = Clapper Rail, LEBI = Least Bittern, YBCU = Yellow Billed Cuckoo, ELOW = Elf Owl, GIFL = Gilded Flicker, GIWO = Gila Woodpecker, VEFL = Vermilion Flycatcher, BEVI = Bell's Vireo, YWAR = Yellow Warbler, SUTA = Summer Tanager, YBCH = Yellow-breasted Chat.

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Appendix E

ALL WILLOW FLYCATCHERS COLOR-BANDED AND/OR RESIGHTED, 2003–2010

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. 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	2010
1490-89889	M	J							R		D	D	D	D		
1590-97338	M	A	P				P	P	P	P						
1710-20312	M	J							R		T					
1710-20638	M	A		G	M	M	M	M	M	M	M					
2090-42022	F	J		M					Q							
2110-78841	F	J						T	T	T	T					
2110-78842	M	A						Q	Q	Q						
2110-78855	M	J						T	T							
2110-78861	M	J						T	M[4]	Q						
2110-78863	M	J						T	T	T						
2140-66502	M	J						Q	Q							
2140-66503	F	J						Q		Q						
2140-66517	F	A						Q	Q	Q	D					
2140-66518	M	A						Q	Q							
2140-66561	M	A						P			P	P	P	P		
2140-66564	F	J						P	P							
2140-66566	M	J						P			P					
2140-66568	M	A						P	P		P	P	P	P		
2140-66606	M	J		M		Q	Q		Q							
2140-66621	F	A				P	P	P	P	P						
2140-66627	F	A				P	P	P		P						
2140-66690	F	J					P								S	
2140-66693	M	J					M	Q	Q							
2140-66696	F	J					Q		Q							
2140-66697	M	J					Q			P	P	P	P	P	P	
2140-66709	M	A						Q	Q	Q		Q[5]	M	M	M	M
2140-66728	M	J					T			T						
2140-66743	M	J			T					T						
2140-66775	M	J				T	M		Q	Q	Q					
2190-76604	M	A					P		P	P	P	P				
2320-31401	M	A							B							
2320-31402	M	A							B							
2320-31403	M	A							Y							
2320-31404	F	A							B							
2320-31405	F	A							B							
2320-31406	U	J							B							
2320-31407	F	J							B	T						
2320-31408	U	J							B							
2320-31409	U	J							B							
2320-31410	U	J							B							
2320-31411	U	J							B							
2320-31412	M	A							B	B						
2320-31413	U	A							Q							
2320-31414	M	A								T	T					

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2320-31415	F	A								T						
2320-31416	U	J								T						
2320-31417	U	J								T						
2320-31418	M	A								T	T					
2320-31419	U	J								T						
2320-31420	U	J								T						
2320-31421	U	J								T						
2320-31422	U	J								T						
2320-31423	U	A								T						
2320-31424	M	J								T	T					
2320-31425	U	J								T						
2320-31426	F	A							M							
2320-31427	M	A							M							
2320-31428	M	J							Q	M	Q[6]		M	M		
2320-31429	U	J							Q							
2320-31430	U	J							P							
2320-31431	U	J							Q							
2320-31432	U	J							P							
2320-31433	U	J							Q							
2320-31434	U	J							Q							
2320-31435	U	J							P							
2320-31436	U	J							P							
2320-31437	U	J							P							
2320-31438	M	J							Q	Q						
2320-31439	U	J							Q							
2320-31440	F	J							Q	M						
2320-31441	U	J							M							
2320-31443	U	J							Q							
2320-31444	F	A							Q	Q	Q	Q			M	
2320-31445	F	A							Q	Q	Q	Q	Q	Q	Q	Q
2320-31446	U	J								P						
2320-31447	U	J								P						
2320-31448	U	J								P						
2320-31449	U	J								P						
2320-31450	U	J								P						
2320-31451	M	A							P	P	P	P				
2320-31452	M	A							P							
2320-31453	M	A							P	P						
2320-31454	M	A							P	P						
2320-31455	M	A							P							
2320-31456	U	J							P							
2320-31457	M	J							P	K						
2320-31458	M	J							P		P					
2320-31459	M	J							P	P						
2320-31460	U	J							P							

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2320-31461	U	J							P							
2320-31462	U	J							P							
2320-31463	F	J							P			K	K			K
2320-31464	U	J							P							
2320-31465	U	J							P							
2320-31466	F	A							P							
2320-31467	M	J							P		P	P				
2320-31468	M	J							P		P	P		K		
2320-31469	U	J							P							
2320-31470	U	J							P							
2320-31471	M	J							Q	Q			M		M	
2320-31472	U	J							Q							
2320-31473	M	J							Q	Q						
2320-31474	U	J							Q							
2320-31475	M	J							P	L						
2320-31476	F	A							Q							
2320-31477	U	J							Q							
2320-31479	F	A							Q	Q						
2320-31480	F	J							Q	Q						
2320-31481	U	J							P							
2320-31482	U	J							P							
2320-31483	U	J								Q						
2320-31484	M	J								P	P			K	K	
2320-31485	F	A								M		M	M	M		
2320-31486	F	J							Q	L	Q	M	M	M		
2320-31487	U	J							Q							
2320-31488	U	J							Q							
2320-31489	U	A								M						
2320-31490	M	A								L	L[7]	Q	Q	Q	Q	
2320-31491	M	A								Q						
2320-31493	M	A								D						
2320-31494	U	A								Q						
2320-31495	M	A								T						
2320-31496	U	J								M						
2320-31497	U	J								M						
2320-31498	F	J								M		G[8]	Q	Q	Q	Q
2320-31499	M	A								Q						
2320-31500	U	J								Q						
2320-31501	M	A							B							
2320-31502	F	A							T	T						
2320-31503	U	A								I						
2320-31504	U	A								I						
2320-31505	M	A								T						
2320-31506	U	J								T						
2320-31507	U	J								T						

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2320-31508	U	J								T						
2320-31510	U	J								T						
2320-31511	U	J								T						
2320-31512	U	J								T						
2320-31513	U	J								T						
2320-31514	U	J								T						
2320-31515	F	A								T	T	T				
2320-31516	F	A								G						
2320-31517	M	A								G	M	M			M	
2320-31518	U	J								T						
2320-31519	U	J								T						
2320-31520	U	J								T						
2320-31521	F	A								T	T					
2320-31522	U	J											Q			
2320-31523	U	J											M			
2320-31524	U	J											P			
2320-31525	U	J											P			
2320-31526	F	A							T	T	T					
2320-31527	F	A							T							
2320-31528	M	A							T							
2320-31529	U	J							T							
2320-31530	U	J							T							
2320-31531	U	J							T							
2320-31532	U	J							T							
2320-31533	U	J							T							
2320-31534	U	J							T							
2320-31535	U	J							T							
2320-31536	U	J							T							
2320-31537	U	J							T							
2320-31538	M	A								T						
2320-31539	M	A								B						
2320-31540	F	A								T						
2320-31541	M	A								T	T					
2320-31542	U	J								T						
2320-31543	U	J								T						
2320-31544	U	J								T						
2320-31545	U	J											P			
2320-31546	U	J											P			
2320-31547	U	J											P			
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				

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2320-31554	U	J								T						
2320-31555	U	J								T						
2320-31556	U	J								T						
2320-31557	U	J								T						
2320-31558	U	J								T						
2320-31559	M	A								T	T	T	T			
2320-31560	M	A								T	T	T	T	T		
2320-31561	U	J								T						
2320-31562	M	J								T		T		T	T	T
2320-31563	U	J								T						
2320-31564	U	J								T						
2320-31565	F	A								T	T					
2320-31566	U	J										T				
2320-31567	M	A								T	T					
2320-31568	F	A								P						
2320-31569	U	J								P						
2320-31570	U	J								P						
2320-31571	U	J								P						
2320-31572	M	A								M						
2320-31573	F	A								Q	Q	Q	Q	Q		
2320-31574	U	J									P					
2320-31575	U	J										Q				
2320-31576	M	A							T	T						
2320-31577	F	A							T	T	T					
2320-31578	U	A							Y							
2320-31579	U	A							Y							
2320-31580	U	A							Y							
2320-31581	U	J							T							
2320-31582	U	J							T							
2320-31583	U	J							T							
2320-31584	F	A							T	T	T	T				
2320-31585	U	J							T							
2320-31586	U	J							T							
2320-31587	U	J							T							
2320-31588	U	J							T							
2320-31589	M	A								P	P	P	P			
2320-31590	M	A								P	P	P	P	P		
2320-31591	M	A								P	P	P	P			
2320-31593	M	A								P	P	P				
2320-31594	M	A								P						
2320-31595	M	A								P	P	P	P	P	P	P
2320-31596	M	A								P						
2320-31598	M	A								T						
2320-31599	U	A								I						
2320-31600	U	A								I						

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2320-31601	U	J								P						
2320-31602	U	J								P						
2320-31603	U	J								P						
2320-31604	M	J								P		K	K			
2320-31605	U	J								P						
2320-31606	U	J								P						
2320-31607	U	J								P						
2320-31608	U	J								P						
2320-31609	U	J								P						
2320-31610	U	J								P						
2320-31611	U	J								Q						
2320-31612	U	J								Q						
2320-31616	F	J								Q		D				
2320-31617	U	J								Q						
2320-31618	F	J								Q	M	M	M			
2320-31619	U	J								M						
2320-31620	U	J								M						
2320-31621	F	A								M						
2320-31622	M	A								Q						
2320-31623	U	J								M						
2320-31624	U	J								M						
2320-31625	F	A								M						
2320-31627	M	A								Q						
2320-31628	U	A								M						
2320-31629	U	J								M						
2320-31630	U	J								Q						
2320-31631	F	J								Q		D	D			
2320-31632	F	A								Q		M	M	M[9]		M
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			
2320-31647	U	J														M
2320-31648	U	J														M
2320-31649	U	J											P			

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2320-31650	F	J										T	T			
2320-31651	M	A								M						
2320-31652	M	A								M	Q	Q				
2320-31653	M	A								M	M	M	M			
2320-31654	M	A								Q						
2320-31655	F	A								Q	Q	Q				
2320-31656	F	A								P	P	P				
2320-31657	F	A								P	P	P	P	P	P	
2320-31658	F	A								P						
2320-31659	M	J								Q		D	D	D		D
2320-31660	F	J								Q			M	S	S	
2320-31661	F	A								P	P	P	P	P		
2320-31662	F	A								P						
2320-31663	F	A								P	P	P	P	P		
2320-31664	F	A								P						
2320-31665	U	J								P						
2320-31666	U	J								P						
2320-31667	U	J								P						
2320-31668	F	A								P						
2320-31669	F	A								P						
2320-31670	U	J											Q			
2320-31671	U	J										M				
2320-31672	U	J											P			
2320-31673	U	J										T				
2320-31674	M	J										P		K	K	K
2320-31675	U	J									T					
2320-31676	U	J									T					
2320-31677	U	J										T				
2320-31678	U	J										P				
2320-31679	U	J											P			
2320-31680	U	J									T					
2320-31681	U	J									T					
2320-31682	U	J									P					
2320-31683	M	J									P		K			
2320-31684	U	J									P					
2320-31685	U	J									P					
2320-31686	M	J									P	P				
2320-31687	U	J									P					
2320-31688	M	J									Q	Q	Q	Q	Q	Q
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		

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2320-31695	F	J									P	P				
2320-31696	U	J									Q					
2320-31697	U	J									P					
2320-31698	F	J									P		P	P	P	
2320-31699	U	J									P					
2320-31700	U	J									P					
2360-59701	F	J									Q	Q				
2360-59702	M	J									Q	D	M			
2360-59703	U	J									Q					
2360-59704	U	J									M					
2360-59705	U	J									M					
2360-59706	U	J									K					
2360-59707	F	J									P	P				
2360-59708	F	J									P	P				
2360-59709	U	J									P					
2360-59710	U	J									P					
2360-59711	M	J									K			P	P	P
2360-59712	M	J									K			P		P
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					

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2360-59741	U	J									Q					
2360-59742	U	J									Q					
2360-59743	F	J											P	K		
2360-59744	U	J										T				
2360-59745	U	J										P				
2360-59746	U	J								G						
2360-59747	U	J										D				
2360-59748	U	J										D				
2360-59749	M	J										D	D[10]	M		
2360-59750	F	J										M	Q			
2360-59751	M	J										M	Q	Q	Q	
2360-59752	M	J										Q		Q	M	
2360-59753	U	J										Q				
2360-59754	M	J										Q	Q	Q	Q	P
2360-59755	U	J										Q				
2360-59756	U	J										P				
2360-59757	U	J								K						
2360-59758	U	J										P				
2360-59759	U	J										P				
2360-59760	U	J								L						
2360-59761	U	J								L						
2360-59762	U	J								Q						
2360-59763	U	J								Q						
2360-59764	U	J											P			
2360-59765	U	J											P			
2360-59766	U	J								Q						
2360-59767	U	J								K						
2360-59768	U	J										T				
2360-59769	U	J										M				
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	F	J											K			M
2360-59785	U	J									D					
2360-59786	U	J									D					
2360-59787	U	J									D					
2360-59788	F	J									D	D	M	M	M	M

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2360-59789	U	J										Q				
2360-59790	U	J										Q				
2360-59791	U	J										P				
2360-59792	U	J										P				
2360-59793	U	J										P				
2360-59794	U	J										P				
2360-59795	U	J										P				
2360-59796	U	J										P				
2360-59797	M	J										P	P			
2360-59798	U	J										P				
2360-59799	M	J										M	D	M		M
2360-59800	U	J								G						
2370-39901	U	A								P						
2370-39902	U	J								P						
2370-39904	U	J								P						
2370-39911	M	A									P					
2370-39912	M	A									Q		Q			
2370-39913	M	A									G					
2370-39914	U	J									P					
2370-39915	M	A									P	P	P	P[11]	P	P
2370-39916	M	A										T	T	T		
2370-39917	U	A										Y				
2370-39918	U	A										Y				
2370-39919	U	A										Y				
2370-39920	U	A										Y				
2370-39921	U	A										Y				
2370-39922	U	A										Y				
2370-39923	U	A										Y				
2370-39924	U	A										Y				
2370-39925	U	A										Y				
2370-39926	U	A										Y				
2370-39927	U	A										Y				
2370-39928	U	A										Y				
2370-39929	M	A										G	G			
2370-39930	M	J													M	Q
2370-39932	F	A									B	B	B			
2370-39933	U	A									Y					
2370-39934	U	A									Y					
2370-39935	U	A									Y					
2370-39937	M	A										Q	Q	Q		
2370-39938	M	A										M	M	M	M	M
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				

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2370-39943	U	J										D				
2370-39944	U	J										D				
2370-39945	U	J										P				
2370-39946	M	J										P	P			
2370-39947	U	J										P				
2370-39948	F	A										M				
2370-39949	U	J										Q				
2370-39950	U	J										Q				
2370-39951	M	A									P	P	P	P		
2370-39953	M	A									P	P	P	P		
2370-39954	M	A									Q	Q	Q	Q		
2370-39956	F	A									D	D	D			M
2370-39957	F	A									Q	Q				
2370-39958	F	A									P					
2370-39959	M	A									P		A			
2370-39960	M	A									K					
2370-39961	M	A									P					
2370-39962	F	A									P					
2370-39964	F	A									P	P	P			
2370-39965	U	A									D					
2370-39966	M	J									D		M			
2370-39967	M	A										M	D[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	M
2370-39989	M	A										G				
2370-39990	F	A										G				
2370-39992	M	A										T				
2370-39993	U	A										Y				

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2370-39994	U	A										Y				
2370-39995	U	A										Y				
2370-39996	U	A										Y				
2370-39997	U	A										Y				
2370-39998	U	A										Y				
2370-39999	M	A														Q
2370-40000	M	A														D
2370-40001	U	J														P
2370-40002	U	J														P
2370-40003	M	A										T				
2370-40004	F	A										B			B	
2370-40008	U	J														D
2370-40009	U	J														D
2370-40010	U	J														D
2370-40011	F	A														Q
2370-40012	M	A									Q	Q	Q			
2370-40013	M	A									P	P				
2370-40014	F	A									P	P	P			
2370-40016	U	J									P					
2370-40017	M	A									M	M				
2370-40019	U	J									P					
2370-40020	U	J									P					
2370-40021	M	A									P	P				
2370-40022	M	A														K
2370-40023	U	J													M	
2370-40024	M	J													K	K
2370-40025	U	J													K	
2370-40026	U	J													P	
2370-40027	U	J													P	
2370-40029	U	J													M	
2370-40030	U	J													M	
2370-40031	M	J													K	K
2370-40032	M	A									B					
2370-40033	U	A									Y					
2370-40034	U	A									Y					
2370-40035	U	A									Y					
2370-40036	M	A										G[14]				
2370-40037	F	A										G	M		M	M
2370-40038	M	A										G				
2370-40039	U	A										Y				
2370-40040	U	A										Y				
2370-40041	U	A										Y				
2370-40042	U	A										Y				
2370-40043	U	A										Y				
2370-40044	U	A										Y				

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2370-40045	U	A										Y				
2370-40046	M	A										G	G[15]	M	M	M
2370-40047	F	A										P	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	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	P
2370-40074	U	J													P	
2370-40075	U	J													P	
2370-40076	U	J													P	
2370-40080	U	J										Q				
2370-40081	M	A										K				
2370-40082	F	A										K				
2370-40083	U	J										Q				
2370-40084	U	J										Q				
2370-40085	U	J											Q			
2370-40086	U	J											Q	M	M	
2370-40087	F	A											Q	Q	Q	Q
2370-40088	M	A														D
2370-40089	U	J														M
2370-40090	U	J														M
2370-40091	U	J														M
2370-40093	U	J														M
2370-40096	U	J												K		

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2370-40097	U	J												K		K
2370-40098	U	J												K		
2370-40099	U	J													S	
2370-40100	U	J										K				
2370-40101	U	J										K				
2370-40102	U	J										K				
2370-40103	U	J										Q				
2370-40104	U	J										Q				
2370-40105	U	J										Q				
2370-40106	U	J										Q				
2370-40107	U	J										Q				
2370-40108	U	J										Q				
2370-40110	U	J											T			
2370-40111	U	J											T			
2370-40112	M	J											T			T
2370-40113	U	J											B			
2370-40114	M	J											T		T	
2370-40115	U	J											T			
2370-40116	U	J											T			
2370-40117	U	J											T			
2370-40118	U	J											T			
2370-40119	U	J											T			
2370-40120	U	J											T			
2370-40121	U	J											T			
2370-40122	U	J											T			
2370-40123	U	J											T			
2370-40124	M	J											T		M	
2370-40125	U	J											T			
2370-40126	M	A											G			
2370-40127	M	A											G			
2370-40129	M	A											G			
2370-40130	F	A													B	
2370-40132	F	A											T			
2370-40133	F	A											B			
2370-40134	U	A											B			
2370-40135	F	A											B			
2370-40136	F	A											T			
2370-40137	M	A											B			
2370-40138	M	A											T			
2370-40139	M	A											T	T		
2370-40140	F	A													P	
2370-40141	M	A													K	K
2370-40142	U	J													M	
2370-40143	U	J													Q	
2370-40144	M	J													M	T

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
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	F	J													M	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	P
2370-40158	M	J											B		T	
2370-40159	U	J											B			
2370-40160	F	A											G			
2370-40161	M	A											M	M	M	
2370-40162	U	J													B	
2370-40163	U	J													B	
2370-40164	U	J											Q			
2370-40165	M	A													B	
2370-40166	U	A											P			
2370-40167	U	J											P			
2370-40168	F	A											P	P	P	
2370-40169	U	J											M			
2370-40170	F	A											Q	Q		
2370-40171	F	A											D			
2370-40173	M	A											M	M	M	M
2370-40174	U	J													M	
2370-40175	M	J													M	Q
2370-40176	M	A													M	
2370-40177	U	J														T
2370-40179	U	J														K
2370-40180	M	A													B	
2370-40181	M	A													T	
2370-40182	U	J													B	
2370-40183	F	A											M			
2370-40184	M	A											D			
2370-40185	M	A											P			
2370-40186	M	A											D			
2370-40187	M	A											K			
2370-40188	U	J											Q			
2370-40190	U	J											P			
2370-40191	F	A											M	M	M	
2370-40192	F	A											D			B

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2370-40193	F	A											Q	Q	Q	D
2370-40194	F	A											P	P	P	P
2370-40195	F	A											P	P	P	
2370-40197	M	A											M	Q	Q	M
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	M
2390-92451	F	J			M	M		Q		Q						
2390-92470	F	J					Q			Q						
2390-92475	M	J					M	Q	Q	Q	Q	Q	Q	Q		
2430-31015	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			

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
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	P
2430-61081	U	J												M		

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2430-61082	U	J												Q		
2430-61083	M	A												P	P	P
2430-61084	M	J												Q		D
2430-61085	M	A													D	D
2430-61086	U	J													M	
2430-61087	F	A													P	P
2430-61088	M	A														N
2430-61089	U	J														M
2430-61090	U	J														M
2430-61094	U	J														D
2430-61095	M	A														M
2430-61096	F	A														L
2430-61097	U	J														P
2430-61098	U	J														P
2430-61099	U	J														K
2430-61100	F	A														K
2430-61101	U	J												K		
2430-61102	U	J												K		
2430-61103	M	A												D		
2430-61104	M	A												M		
2430-61105	M	A												Q		
2430-61106	M	J												P		M
2430-61107	U	J												P		
2430-61108	U	J												P		
2430-61109	F	A												K		
2430-61110	U	J												K		
2430-61111	U	J												P		
2430-61112	U	J												P		
2430-61113	U	J												P		
2430-61114	M	J												P		K
2430-61115	U	J												P		
2430-61116	F	A												M	M	
2430-61117	U	J												P		
2430-61118	M	J												P	M	M
2430-61119	U	J												P		
2430-61120	F	J												P	P	P
2430-61121	U	J												Q		
2430-61122	U	J												P		
2430-61123	F	J												P		P
2430-61124	F	J												P		K
2430-61125	M	A												K		
2430-61126	U	J												S		
2430-61127	M	A												P	P	
2430-61128	U	J												M		
2430-61129	U	J												Q		

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
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	T
2430-61136	M	A												B	B	B
2430-61137	F	A												B	B	B
2430-61138	F	A												B		
2430-61139	F	A												T		
2430-61140	U	J												B		
2430-61141	U	J												B		
2430-61142	U	J												B		
2430-61143	U	J												T		
2430-61144	U	J												T		
2430-61145	U	J												T		
2430-61151	U	J														K
2430-61152	U	J														P
2430-61153	F	A													M	
2430-61154	U	J													Q	
2430-61155	U	J													Q	
2430-61156	U	J													K	
2430-61157	U	J													K	
2430-61158	M	A													K	K
2430-61159	U	J													M	
2430-61160	U	J													M	
2430-61161	U	J													D	
2430-61162	M	A													S	
2430-61163	F	A														K
2430-61165	M	J												Q	Q	M
2430-61167	M	A												M	M	M
2430-61168	U	J												M		
2430-61169	U	J												M		
2430-61170	U	J												M		
2430-61171	U	J												M		
2430-61172	F	J												M	M	
2430-61173	U	J												M	M	
2430-61174	F	J												M		Q
2430-61175	U	J												Q		
2430-61176	M	J												Q		P
2430-61177	U	J												Q		
2430-61178	M	A												K		
2430-61179	M	A												K	P	P
2430-61180	M	A												K		K
2430-61181	F	A												K	K	

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2430-61182	M	A												K		
2430-61183	M	A												K		
2430-61184	U	J												Q		
2430-61185	F	J												Q	M	
2430-61186	U	J												Q		
2430-61187	M	J												Q	L	L
2430-61188	U	J												Q		
2430-61189	M	J												Q		M
2430-61190	U	J												Q		
2430-61191	M	J												M	D	
2430-61192	U	J												M		
2430-61193	U	J												M		
2430-61194	U	J												Q	Q	
2430-61195	U	J												Q		
2430-61196	U	J												Q		
2430-61197	M	J												P		K
2430-61198	U	J												P	Q	
2430-61199	U	J												P		
2430-61200	U	J												P		
2430-61202	U	J												M		
2430-61203	U	J												M		
2430-61204	U	J												M		
2430-61205	U	J												M		
2430-61206	M	J												M		M
2430-61207	F	J												M	D	D
2430-61208	U	J												D		
2430-61209	M	A												V	D	
2430-61210	U	A												K		
2430-61211	U	J												S		
2430-61212	U	J												M		
2430-61213	U	J														K
2430-61221	U	J														P
2430-61223	U	J												D		
2430-61224	U	J												D		
2430-61225	U	J												D		
2430-61226	U	J														P
2430-61127	U	J														P
2430-61232	U	J														L
2430-61233	U	J														L
2430-61234	F	A														Q
2430-61236	U	J														K
2430-61271	U	J													P	
2430-61276	U	J														Q
2430-61277	U	J													P	
2430-61278	M	J													P	N

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2430-61279	F	J													P	K
2430-61280	U	J														M
2430-61285	U	J													M	
2540-58101	U	J														K
2540-58102	U	J														K
2540-58103	U	J														K
2540-58104	U	J														K
2540-58105	U	J														Q
2540-58106	U	J														Q
2540-58107	U	J														Q
2540-58116	U	J														B
2540-58118	U	J														K
2540-58119	U	J														K
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	
2540-58147	U	J														B
2540-58148	U	J														Q
2540-58149	U	J														Q
2540-58150	U	J														Q
2540-58151	U	J														Q
2540-58154	M	J													M	T
2540-58155	U	J													M	
2540-58156	F	A														K
2540-58157	U	J														K
2540-58158	U	J														K
2540-58159	U	J														K
2540-58161	U	J														L
2540-58162	U	J														K
2540-58163	U	J														K
2540-58164	U	J														K
2540-58165	U	J														K
2540-58166	U	J														K
2540-58185	U	J													P	
2540-58186	M	A													S	
2540-58187	F	A													P	
2540-58188	U	J													P	
2540-58189	M	A													P	D
2540-58190	U	J														T
2540-58191	U	J														P
2540-58192	M	A														M

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2540-58193	F	A														N
2540-58194	U	J														D
2540-58195	U	J														P
2540-58196	U	J														P
2540-58197	U	J														P
2540-58198	U	J														P
2540-58199	U	J														K
2540-58200	U	J														K
2540-58201	U	J														K
2540-58202	M	A														K
2540-58203	F	A														K
2540-58204	F	A														K
2540-58205	U	J														K
2540-58206	U	J														P
2540-58207	U	J														P
2540-58208	U	J														P
2540-58209	F	A														P
2540-58216	U	J													M	
2540-58217	M	A													S	
2540-58218	U	J													S	
2540-58219	U	J													Q	K
2540-58220	M	A														B
2540-58221	M	A														B
2540-58222	U	J														K
2540-58223	M	A														K
2540-58224	U	J														K
2540-58225	U	J														K
2540-58226	F	A														K
2540-58227	M	A														T
2540-58228	M	A														T
2540-58229	M	A														B
2540-58230	F	A														B
2540-58231	F	A														T
2540-58232	U	J														T
2540-58233	F	A														N
2540-58237	U	J														K
2540-58238	U	J														K
2540-58239	U	J														K
2540-58240	U	J														K
2540-58241	F	A														K
2540-58242	U	J														K
2540-58243	U	J														K
2540-58244	U	J														K
2540-58288	U	J														P
2540-58289	F	A														K

Table E.1. Willow flycatchers banded and/or resighted by SWCA at sites along the Virgin and lower Colorado Rivers in 2003–2010. Table includes individuals banded at sites prior to 2003 (Braden and McKernan, unpubl. data) and recaptured or resighted by SWCA. (Continued)

Original Federal Band Number	Sex[2]	Age When Banded[3]	Study Area Detected[1]													
			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2540-58290	U	J														K
2540-58291	U	J														K
2540-58292	U	J														K
2540-58293	F	A														P
2540-58294	U	J														P
2540-58295	U	J														P
2540-58296	U	J														P
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, N = Warm Springs, G = Grand Canyon, T = Topock Marsh, B = Bill Williams River NWR, I = Imperial, Y = Yuma, S = St. George, V = Las Vegas Wash, R = Roosevelt Lake, A = Ash Meadows. Study area indicated is the study area where the individual was first detected during the given season. Within-season movements are indicated with individual footnotes.

[2] M = male, F = female, U = unknown.

[3] A = adult, J = juvenile.

[4] Within-season movement from Mormon Mesa to Mesquite.

[5] Within-season movement from Mesquite to Mormon Mesa.

[6] Within-season movement from Mesquite to Mormon Mesa.

[7] Within-season movement from Littlefield to Mesquite.

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

[9] Within-season movement from Mormon Mesa to Muddy River.

[10] Within-season movement from Muddy River to Mormon Mesa.

[11] Within-season movement from Pahranagat to Key Pittman.

[12] Within-season movement from 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.

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Appendix F

HYDROGRAPHS FOR PIEZOMETERS AT HABITAT MONITORING SITES

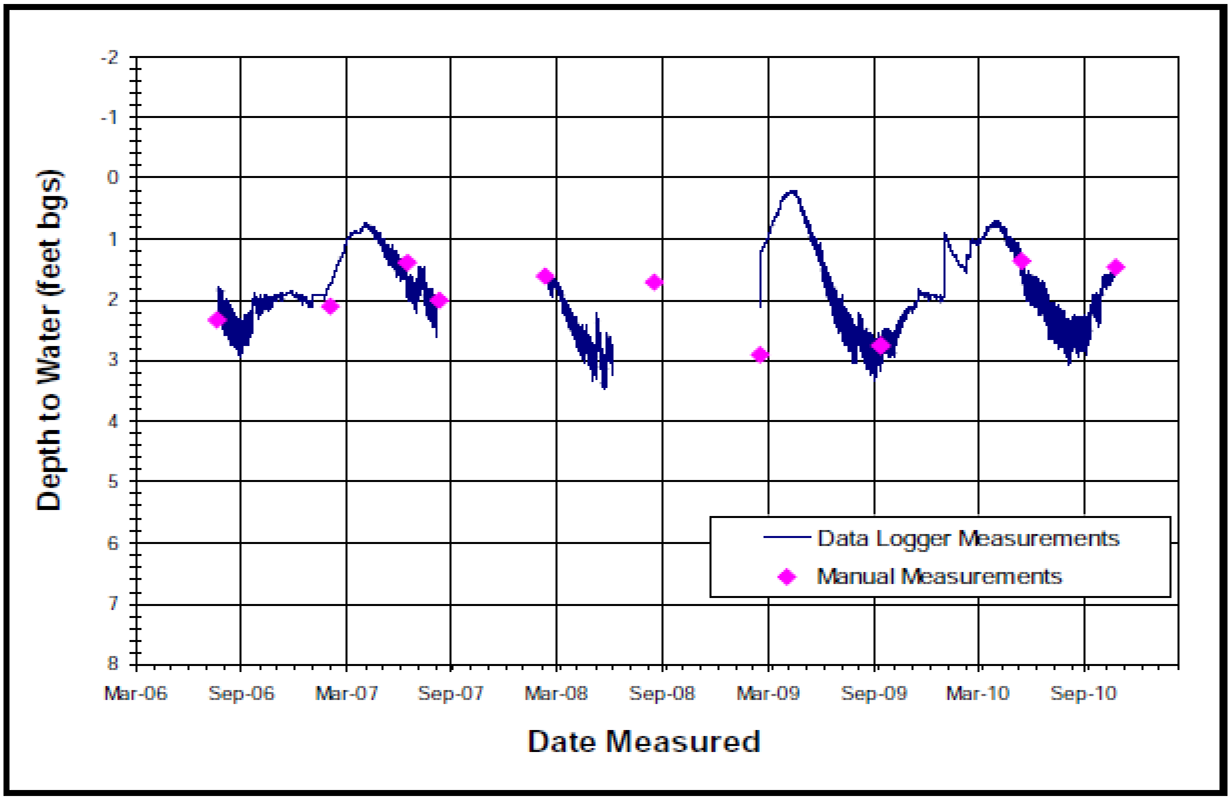

Figure F.1. Hydrograph for Piezometer at Topock Marsh.

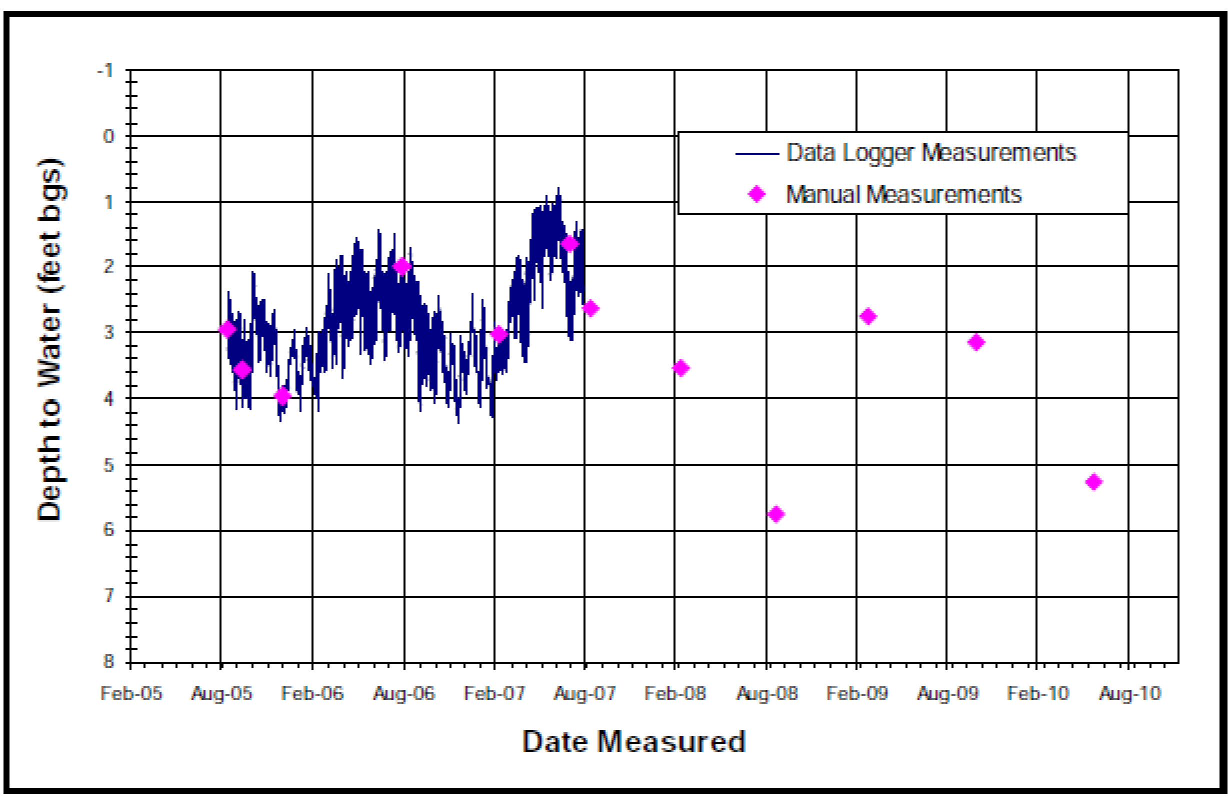

Figure F.2. Hydrograph for piezometer at Blankership Bend.

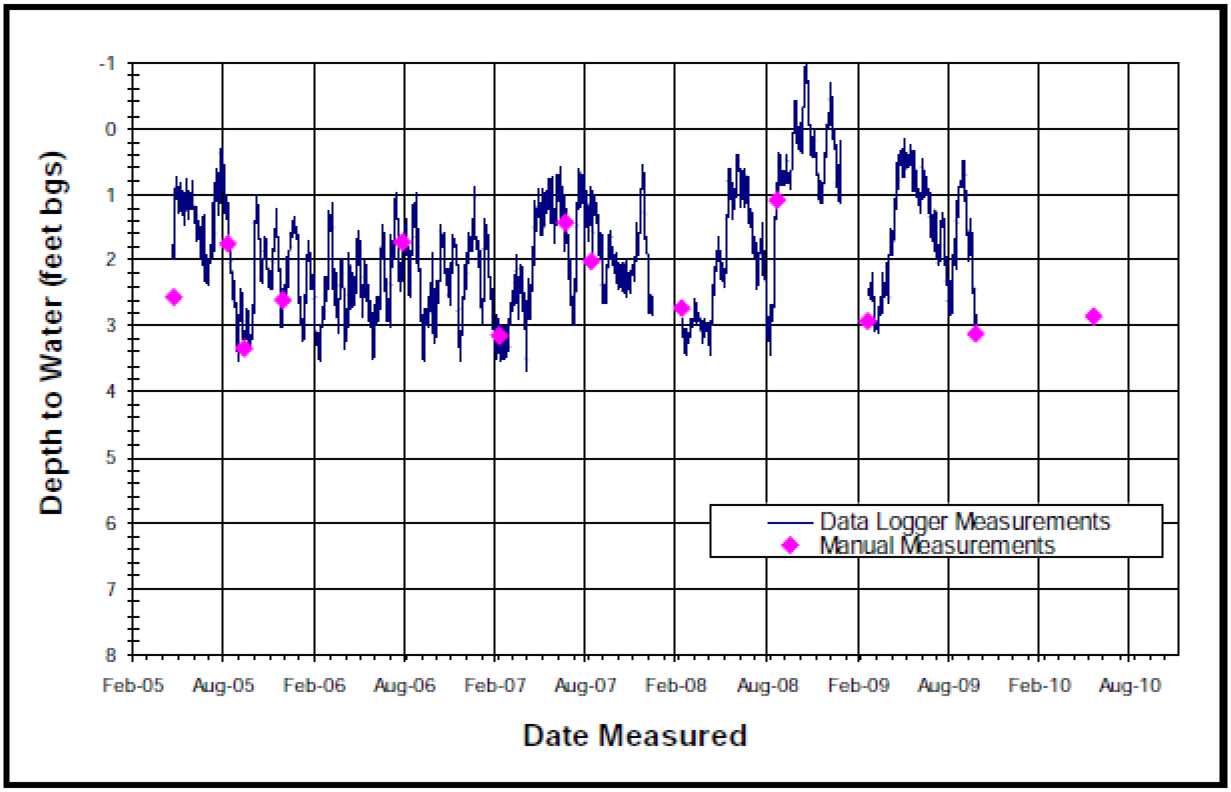

Figure F.3. Hydrograph for piezometer at Havasu NE.

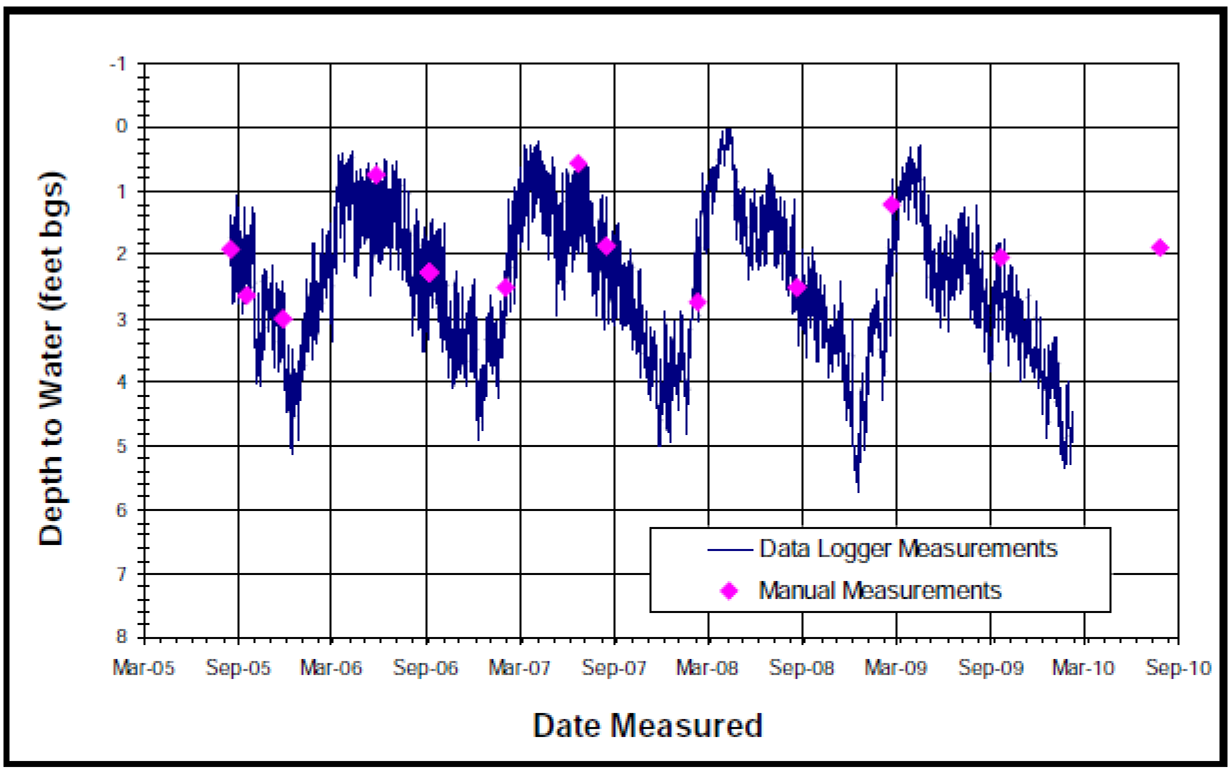

Figure F.4. Hydrograph for piezometer at Ehrenberg.

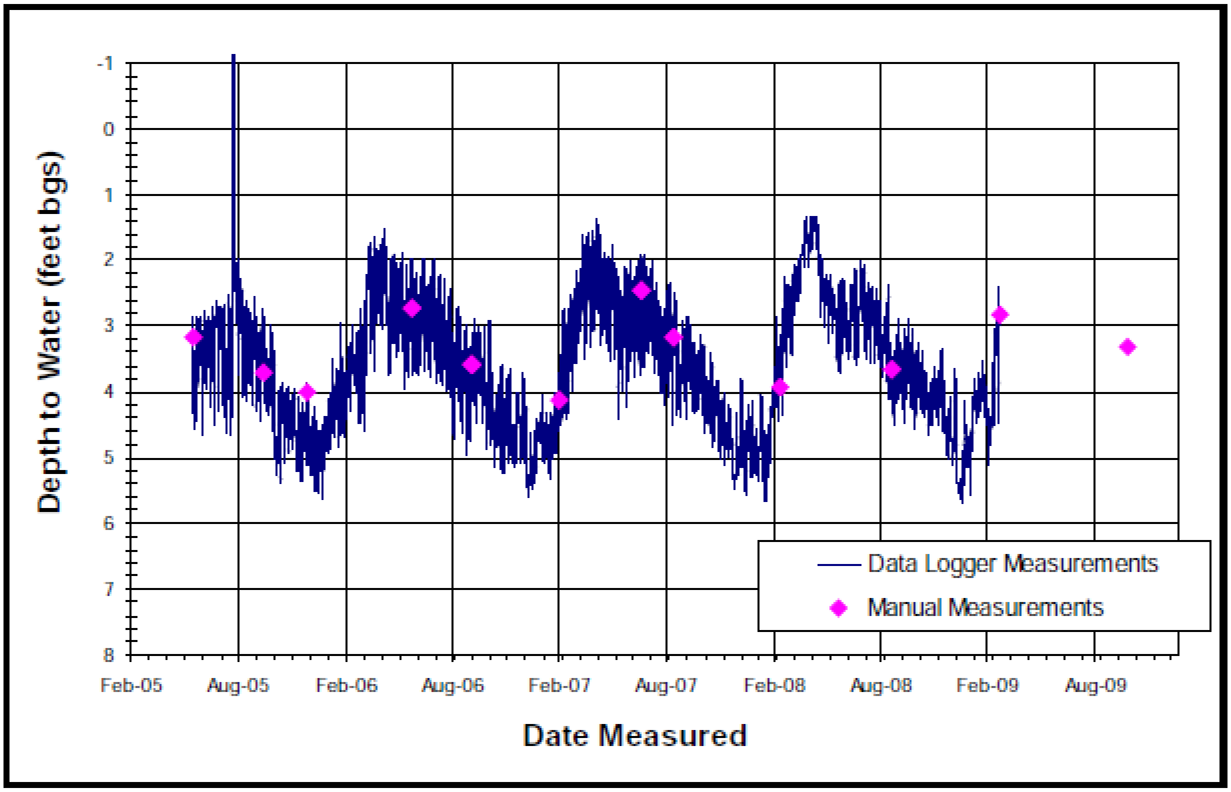

Figure F.5. Hydrograph for piezometer at Three Fingers Lake.

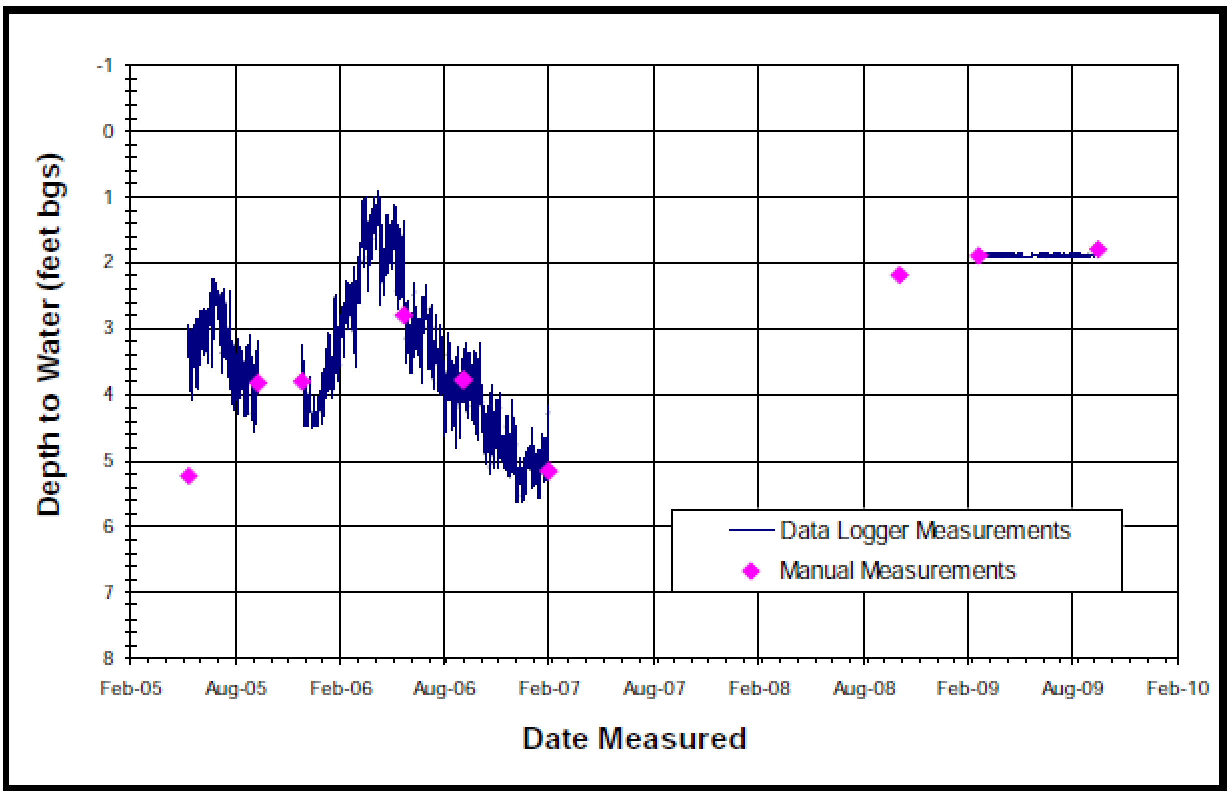

Figure F.6. Hydrograph for Piezometer at Cibola Lake.

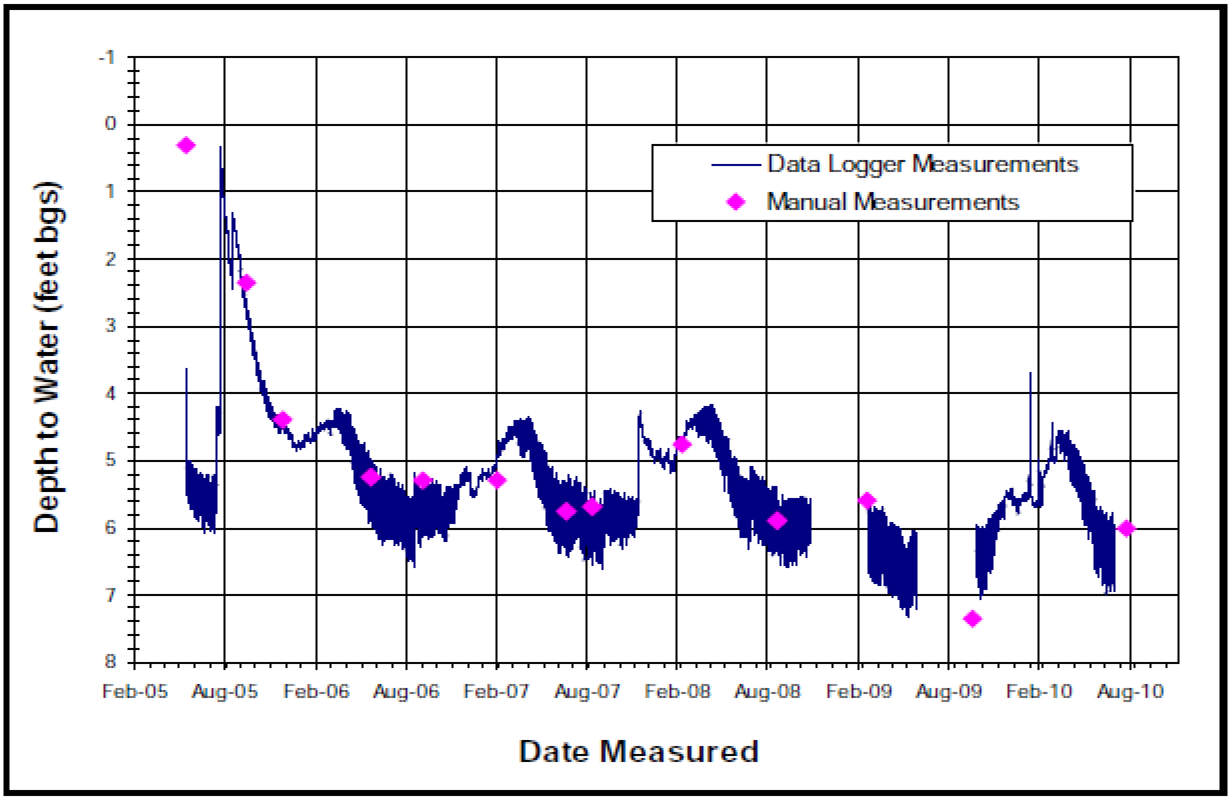

Figure F.7. Hydrograph for piezometer at Walker Lake.

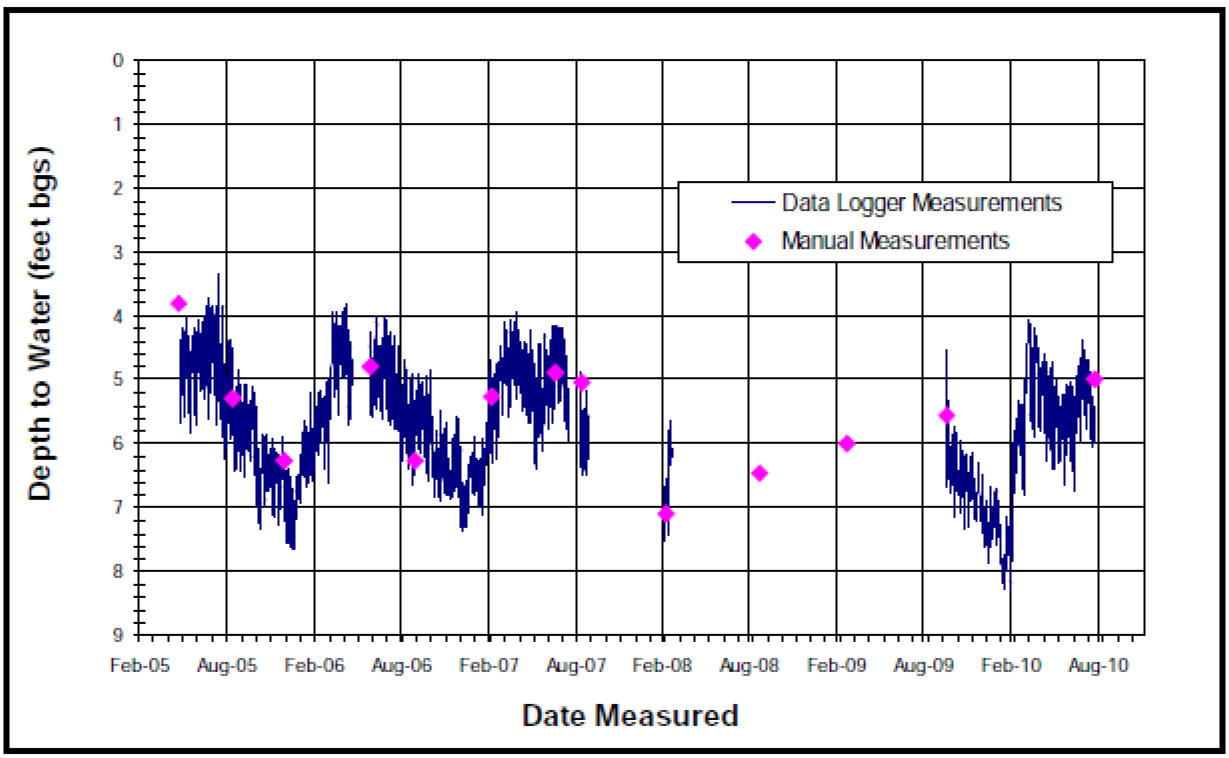

Figure F.8. Hydrograph for piezometer at Paradise.

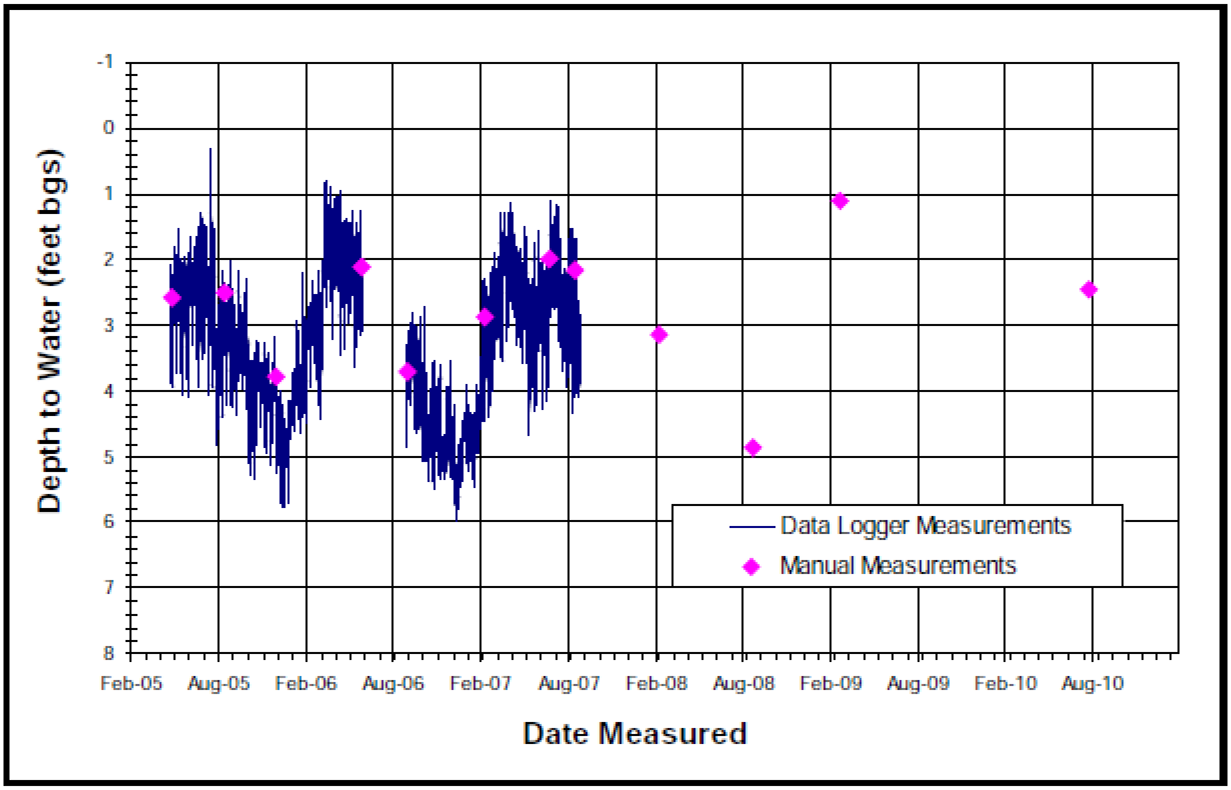

Figure F.9. Hydrograph for piezometer at Hoge Ranch.

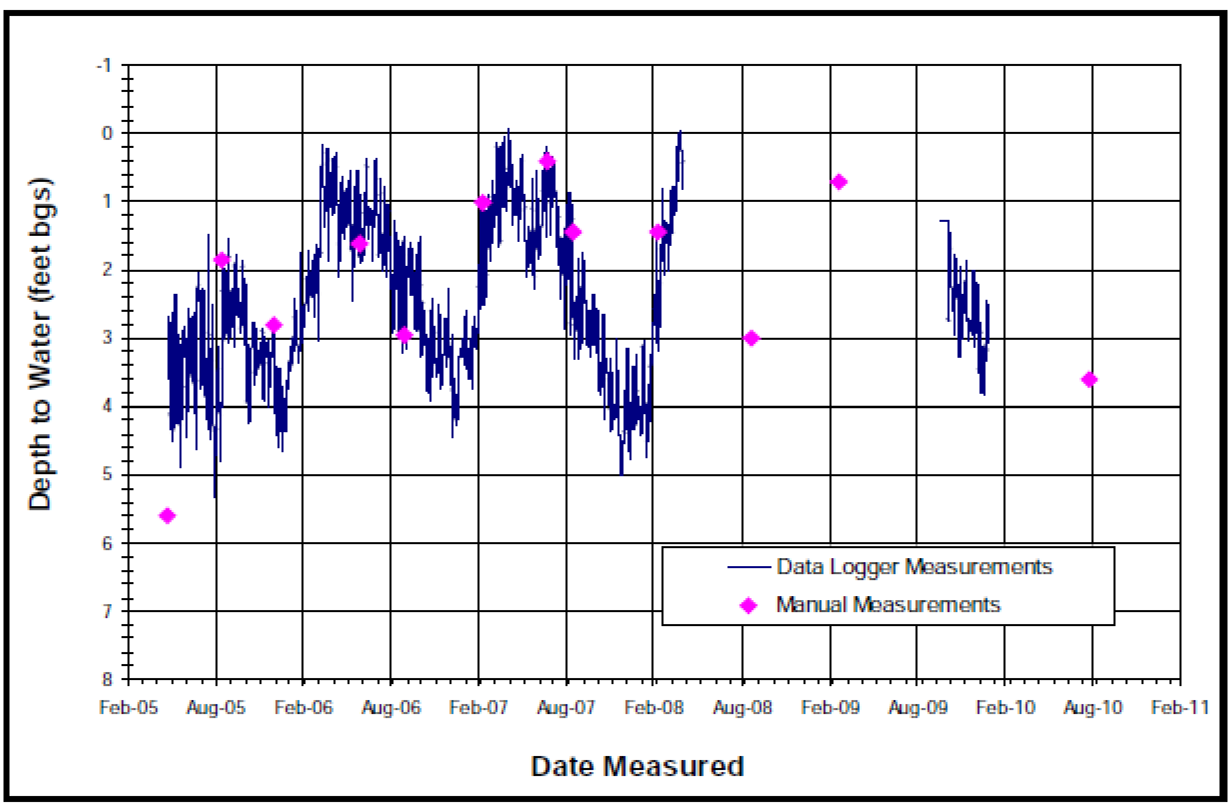

Figure F.10. Hydrograph for piezometer at Rattlesnake.

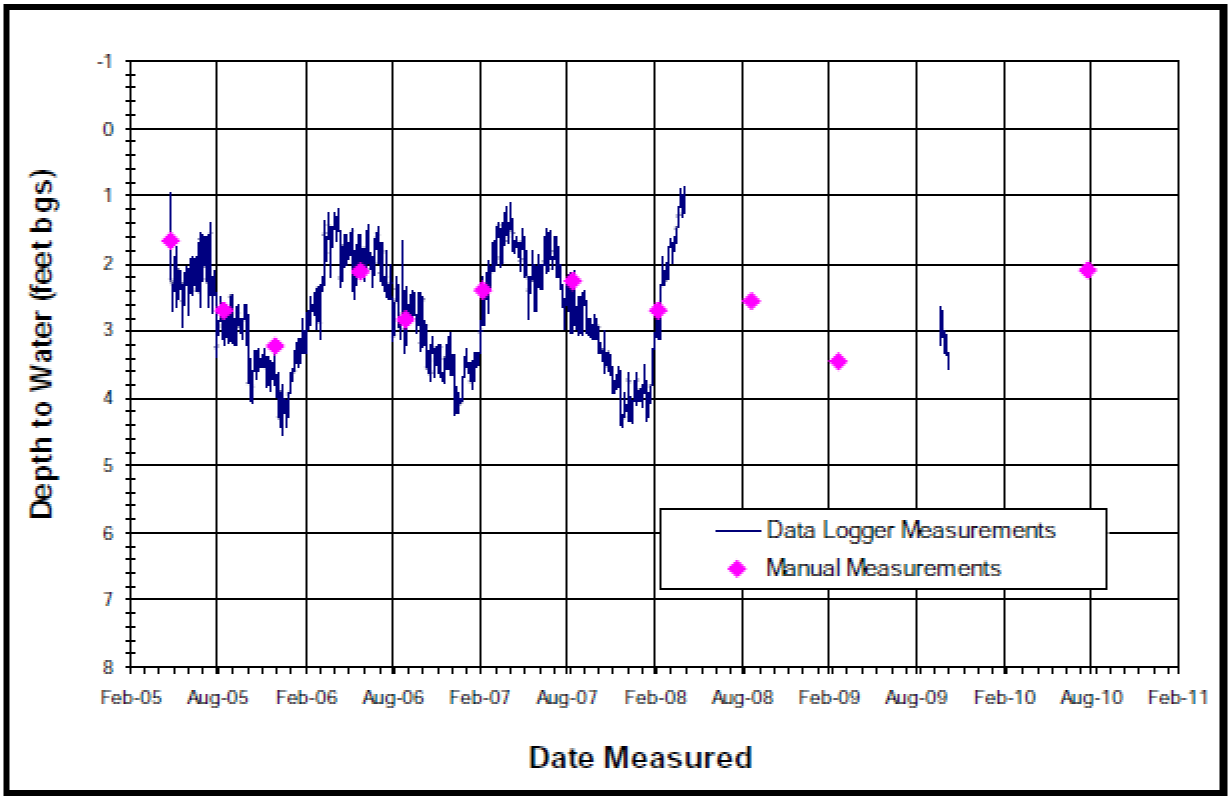

Figure F.11. Hydrograph for piezometer at Clear Lake.

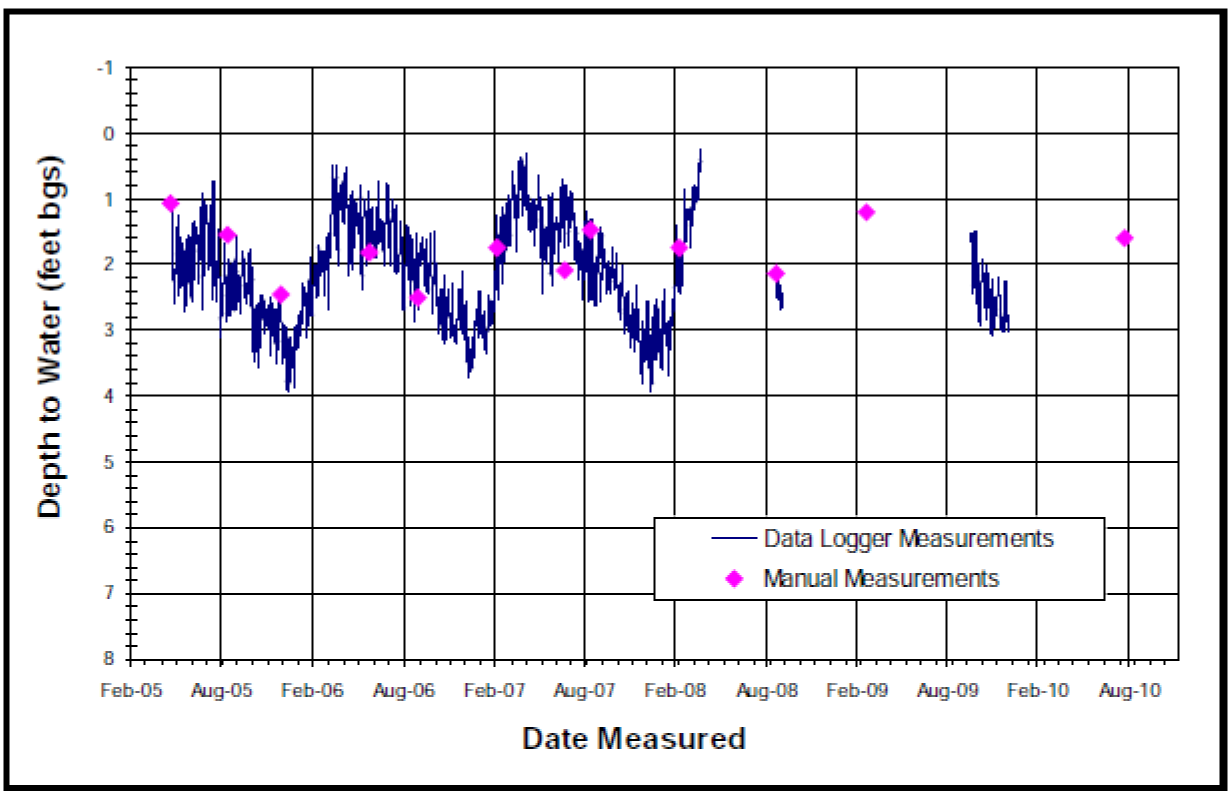

Figure F.12. Hydrograph for piezometer at Ferguson Lake.

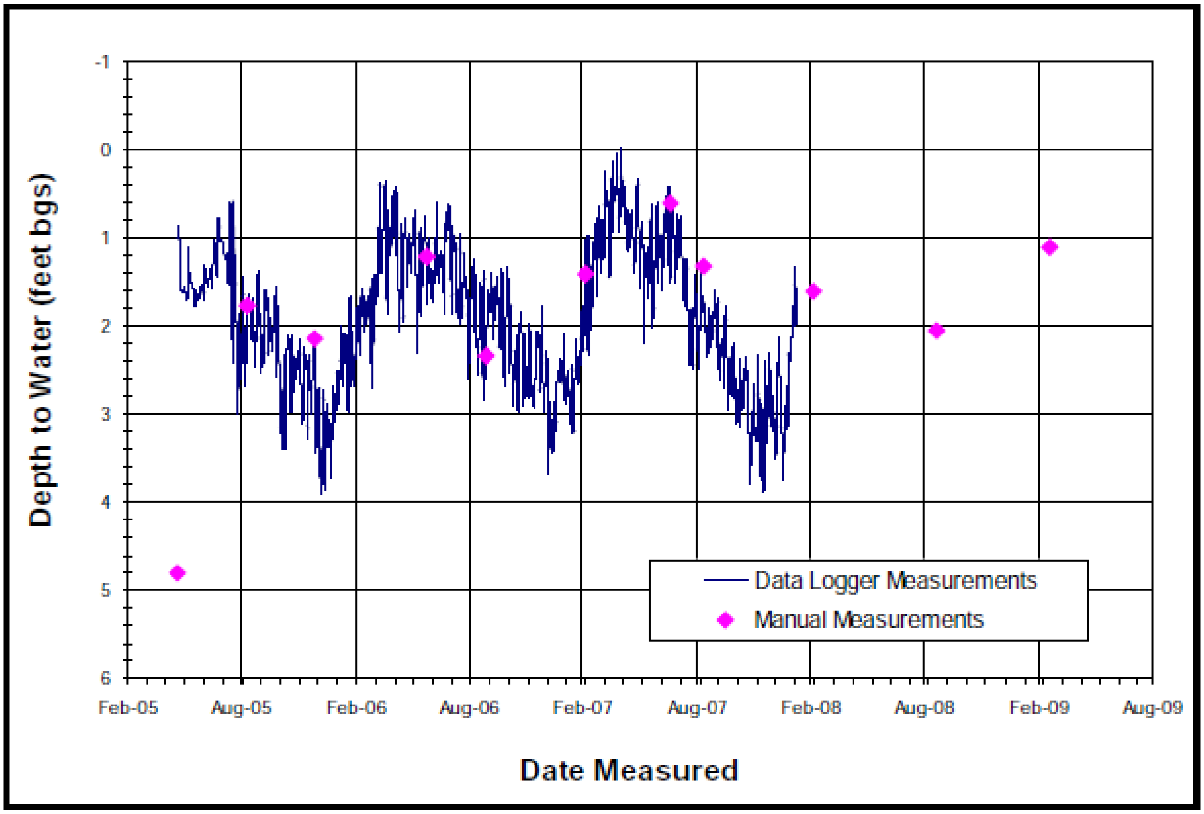

Figure F.13. Hydrograph for piezometer at Ferguson Wash.

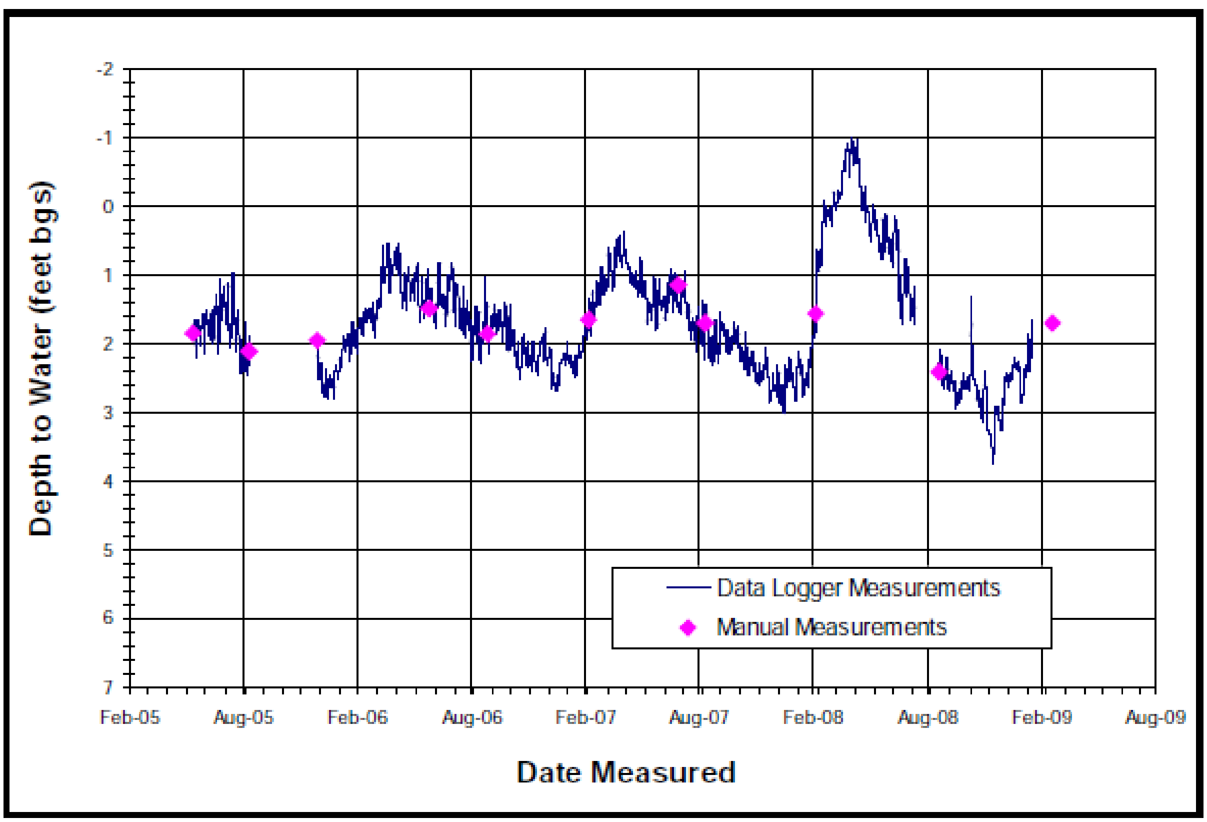

Figure F.14. Hydrograph for piezometer at Great Blue Heron.

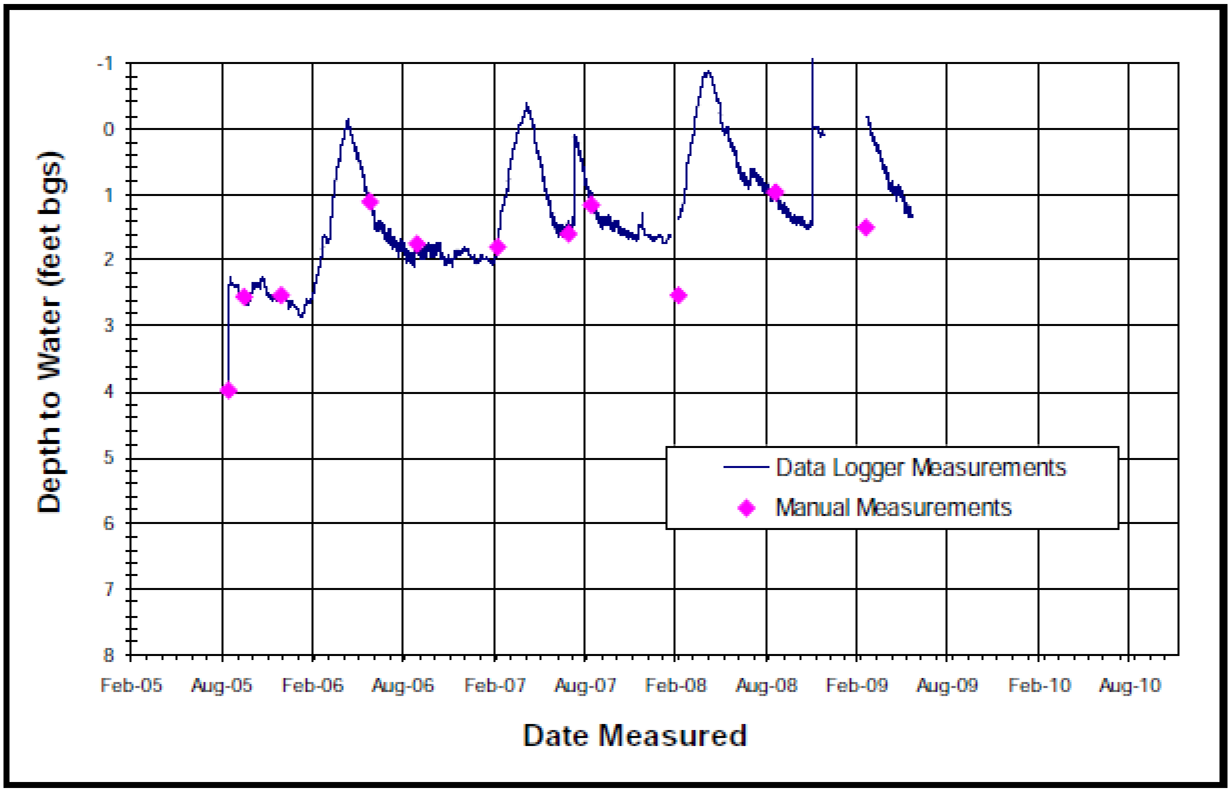

Figure F.15. Hydrograph for piezometer at Mittry West.

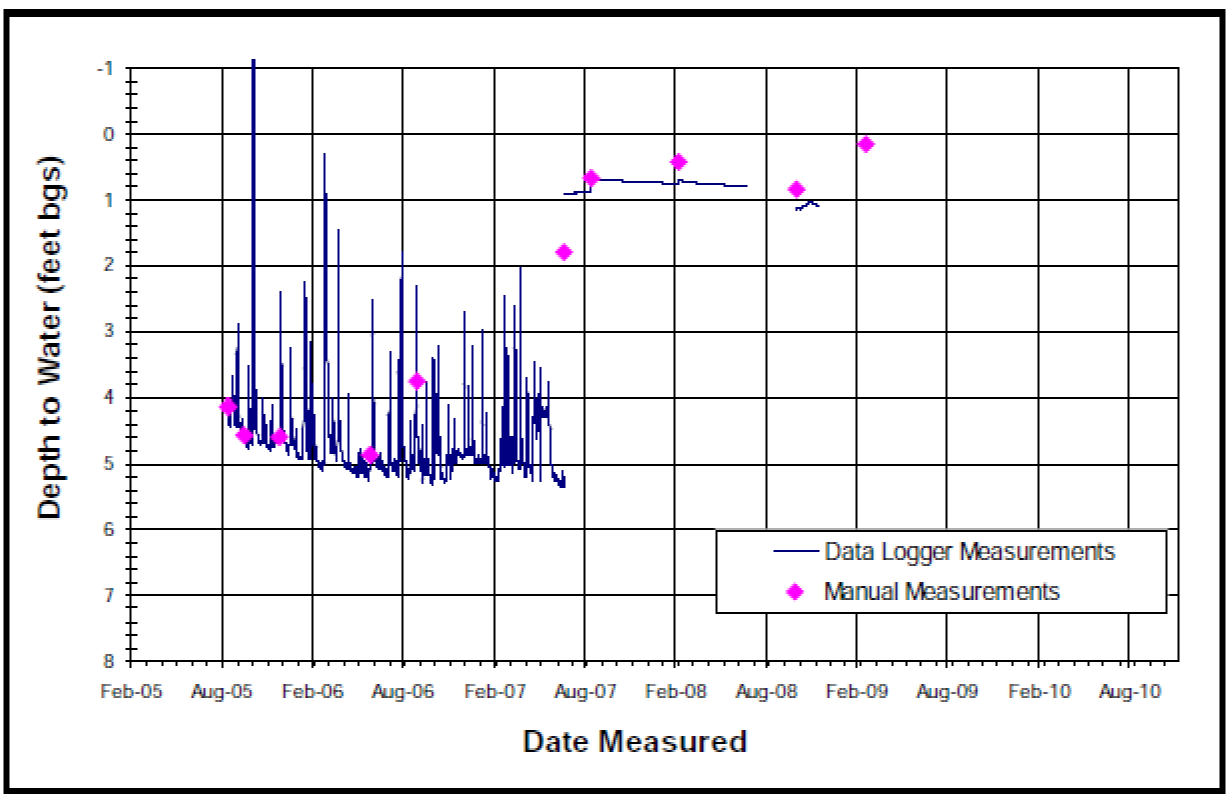

Figure F.16. Hydrograph for piezometer at Gila Confluence North.

Appendix G

CONTRIBUTING PERSONNEL

Contributor	**Role**
Steven W. Carothers, Ph.D.	Principal-in-Charge
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Brad McLeod	Field Coordinator
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Chantal Villeneuve	Bander/Nest Monitor
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Russell Duncan	Surveyor/Nest Monitor
Sam Roberts	Surveyor/Nest Monitor
Rory Larson	Surveyor
Steve Ritt	Surveyor
Devin Keane	Piezometer Maintenance/Data Entry

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