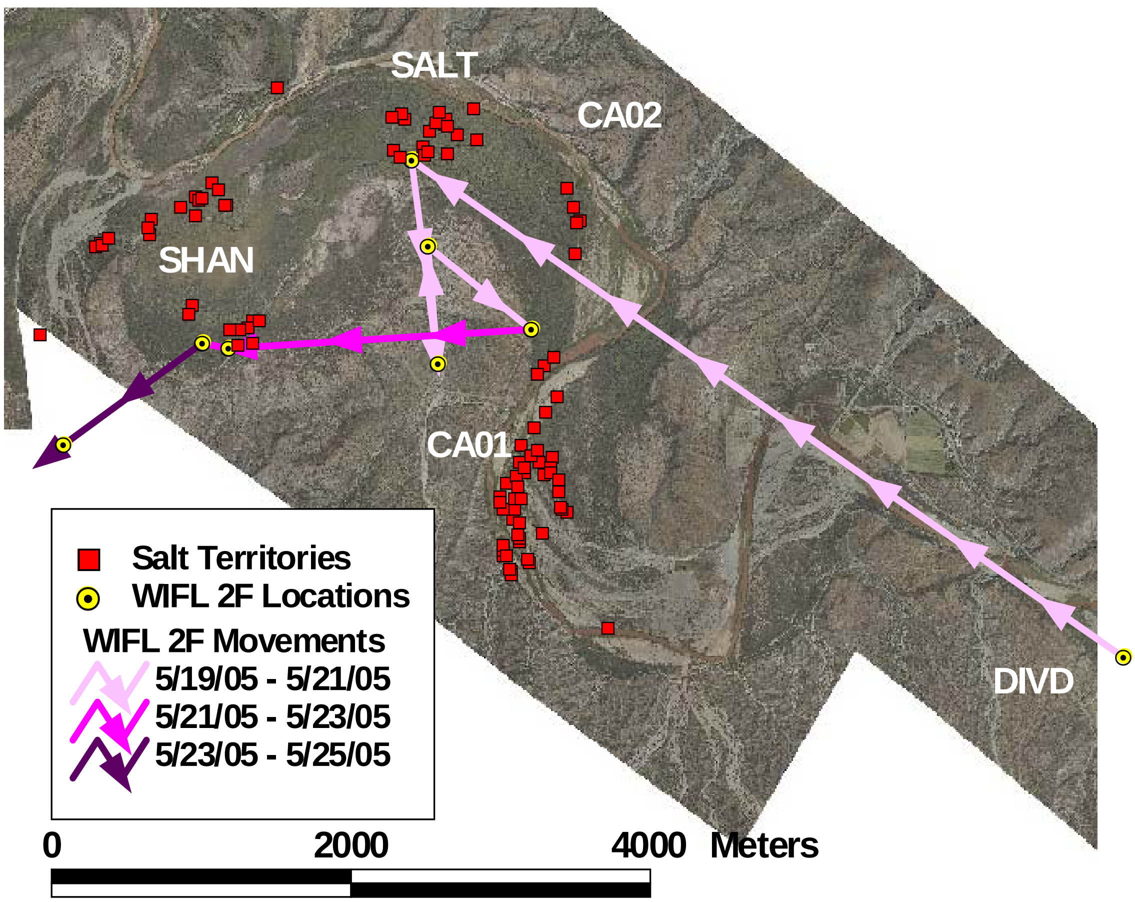
Home range, Movement, and Habitat Use of the Southwestern Willow Flycatcher, Roosevelt Lake, AZ - 2005



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EXECUTIVE SUMMARY

In 2005, USGS conducted a third year of radio telemetry research on the Southwestern Willow Flycatcher at Roosevelt Lake, Arizona. Twenty-three adult flycatchers were telemetered and tracked, from May through August, with nearly 400 hours spent collecting 534 locations. Of these, 15 were territorial for part or all of the tracking period, 5 were non-territorial for the entire tracking period, and 3 were detected for less than four days. As in past years, the return rate of previously telemetered individuals was higher than the population mean, suggesting minimal or no long-term impacts from telemetry research on flycatchers.

In 2005 Roosevelt Lake filled to near capacity due to heavy winter precipitation, destroying or partially inundating most 2004 flycatcher breeding habitat. We found that despite the displacement effects of the inundation, general patterns of movement and home range estimates were similar to the two previous years. However, several differences were detected. Movement in 2005 was farther in the early and late periods of the breeding season compared to 2003 and 2004, perhaps reflecting a response to the habitat loss and the need to prospect for suitable habitat. Three individuals that were territorial when telemetered left their territories, and were not detected again; this was not observed in any of the earlier years, and these individuals may have left the site. Habitat use of mesquite, not recorded in previous years at Roosevelt Lake, was documented in multiple individuals, presumably reflecting responses to inundation and high winter precipitation. Finally, tracking of non-territorial individuals indicated high degrees of movement, including trans-lake movements, compared to territorial adults.

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INTRODUCTION

The Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (Willow Flycatcher, flycatcher) is a small, endangered bird that breeds primarily in dense riparian habitats of the southwestern United States (Marshall 2000, Unitt 1987). The flycatcher has suffered serious declines as riparian habitats have been lost or modified (Marshall and Stoleson 2000, USFWS 1993), and was listed as a federal endangered species in 1995 (USFWS 1995). During the past 10 years, the Southwestern Willow Flycatcher has been the subject of extensive life history research. Most of this research has been focused on the abundance, distribution, survivorship, mortality, large-scale movements, and breeding productivity of Southwestern Willow Flycatchers. These studies have yielded critical information about the flycatcher's ecology, but several important habitat-use questions, all with direct conservation and management implications, remain.

The importance of non-nesting habitat for flycatchers, including both riparian and non-riparian habitats, remains unresolved. Flycatcher habitat is sometimes considered as only the vegetation where nesting occurs, although the recovery plan has a more expansive definition of habitat (USFWS 2002). Incidental observations of flycatchers outside of their nesting habitat, along with GIS models predicting flycatcher breeding habitat (Hatten and Paradzick 2002), suggest that the non-nesting areas within and around the riparian breeding sites may be an important component of flycatcher habitat. However, the importance of these non-nesting habitats could vary from incidental to crucial, depending on the degree that flycatchers rely on them for basic habitat needs. Effective conservation and management of the flycatcher will require a more thorough understanding of the types of nesting and non-nesting habitats used, the degree to which they are used, and the temporal and spatial extent of non-nesting habitat used.

Another important question involves the movement of individuals within riparian habitats. Preliminary banding data and anecdotal observations show that territorial flycatchers may move outside of their defended territories, in some cases covering distances over several hundred meters (USGS, *unpub. data*). However, the nature and extent of such movements are unknown. Flycatchers may move outside their territories in order to acquire resources (e.g., food, water) or to obtain copulations with birds other than their mates (extra-pair copulations; Pearson 2002). The extent to which movements occur, for these or other reasons, has direct management implications in terms of habitat needs, local population estimates (under- or over-counting), and genetic diversity.

Southwestern Willow Flycatcher conservation and management is also hindered by a lack of information on flycatcher breeding territory and home range size, factors that are important in understanding habitat requirements and population trends, determining mitigation and compensation for habitat needs, and planning habitat creation and restoration projects. The answers to these questions may also be critical to understanding current population dynamics and habitat use (USFWS 2002). Such data are scarce because it is not possible to effectively follow (visually and physically) color-banded individuals as they move through the dense riparian vegetation where they breed.

In the 2003 and 2004 breeding seasons we studied home range, movement, and habitat use of male Willow Flycatchers at Roosevelt Lake (Cardinal and Paxton 2004, 2005). We found that male flycatcher home range size changed dramatically over the season, with largest home ranges in the pre- and post-nesting seasons. Similarly, we found that flycatchers made the longest movements in the pre-nesting and post-nesting periods, while the shortest movements occurred during the nesting period. Also, flycatchers used a variety of riparian habitat types in terms of both age and plant composition, but were never observed using upland habitat.

Our initial goal for the telemetry study in 2005 was to telemeter and track non-territorial flycatchers (i.e., floaters) to better understand their ecology in relation to the general flycatcher population. Understanding how non-territorial flycatchers move through the breeding site may help us to estimate their numbers, and understanding how frequently they transition into territorial status, if at all, may help us to understand their importance to the breeding population. However, in 2005 Roosevelt Lake rose to near capacity following a winter of high precipitation, resulting in the loss of most of the riparian habitat used by flycatchers in 2004. Much of the remaining habitat that was not completely destroyed was partially inundated, often with only the tops of tall trees exposed above the lake level. Because of the habitat inundation, we could not assume that flycatchers would exhibit typical behavior and therefore we needed to study both territorial and non-territorial birds in 2005 to make a direct comparison in their behavior and ecology. To understand the impacts of this inundation event, we set out to examine how the change in lake levels and the loss of habitat affected movement and home range of both territorial and non-territorial flycatchers. In this report, the third year of the telemetry study, we examine the similarities and differences observed in movement and home range patterns of telemetered flycatchers in 2005 compared to 2003 and 2004.

METHODS

Study Area

This study was conducted at Roosevelt Lake, Gila County, Arizona, from May through July 2005. The flycatcher breeding habitat at Roosevelt Lake is found in the riparian vegetation along the lake's Salt River and Tonto Creek inflows. Dominant vegetation in the riparian floodplain consists of exotic saltcedar (*Tamarix ramosissima)* and native Goodding's willow (*Salix gooddingii),* forming a mosaic of patches of different size, age, and vegetation composition. Radio-tracking was conducted on both sides of the lake, primarily in the breeding areas.

Following an unusually wet winter, the water level of Roosevelt Lake dramatically rose in 2005, resulting in the inundation of approximately 90% of the Southwestern Willow Flycatcher habitat occupied in 2004. Almost all of the habitat patches used in the 2003 and 2004 telemetry studies were completely submerged, necessitating the use of different study areas for this third year of telemetry research. We chose study areas that were easily accessible to ensure a large number of locations per telemetered flycatcher. We used study sites that were accessible by vehicle, with either a short 20-30 minute walk or canoe/kayak paddle from the parking area, and sites that had small hills or higher ground surrounding the site to help locate flycatchers that had moved from their usual locations and were not detectable from the floodplain level. With these criteria, we were able to use study areas on both ends of the lake, in both inundated habitat (partially submerged vegetation) and dry habitat (no inundation). On the Salt River Inflow we captured and telemetered birds at Cottonwood Acres 1 (inundated) and Diversion Dam (dry) and on the Tonto Creek Inflow we captured birds at Bar X (dry), A+ Cross Road (dry), Orange Peel Campground (inundated), and Tonto (inundated)(See Causey et al. 2006 for Roosevelt Lake site descriptions).

Capture and Banding

The study's initial aim to examine only floaters was confounded by the inundation of Roosevelt Lake in 2005. With the potential for many displaced and non-territorial flycatchers, it was important to have some territorial flycatchers telemetered for comparison with previous years to examine the effect of the inundation on territory holders.

Territorial flycatchers were captured both by using passive- and target-netting techniques (Sogge et al. 2001), while non-territorial flycatchers were caught using only passive nets. To capture both territorial and non-territorial birds using passive nets, we erected multiple mist nets (5-12) in a section of a study patch, typically where there was a high density of flycatcher territories. Passive nets were used without any vocalizations to draw in flycatchers and checked frequently (every 15-30 minutes) for captured birds. We used resight data to determine if passively captured flycatchers were territorial or non-territorial. Birds captured passively with multiple resights in a particular area were considered territorial, while those that were never or rarely resighted were classified as floaters.

In previous years we studied only males, but in 2005 we telemetered both sexes. To determine sex of captured flycatchers we used one or more of the following methods:

I. Many previously banded, recaptured flycatchers have been genetically sexed.
II. Nesting females have a brood patch.
III. Birds with ≥ 70 mm wing chord length were considered males and those ≤ 66 mm were considered female; wing chord lengths ≥ 70 mm have a > 90% likelihood of being male, and wing chords ≤ 66 mm were > 90% likely female (USGS, *unpubl. data*).
IV. Some previously banded birds were associated with behavioral characteristics, such as defending a territory or brooding eggs recorded in the resight data or field observations, that indicated their appropriate sex .

Telemetered flycatchers were banded with a uniquely numbered color-anodized Federal Bird Band on one leg, and one metal color-band on the other (Koronkiewicz et al. 2005), such that the pair of bands yielded a unique color combination.

We assigned telemetered flycatchers to one of three categories: territorial, floater, or transient. Territorial flycatchers are those that held and defended a territory regardless of breeding status. A floater was a flycatcher that we never observed exhibiting territorial behavior, but that remained in the study area for at least the period that we tracked them. A transient was a flycatcher detected for less than four days, and may have left the Roosevelt Lake area, dispersed to an area where the transmitter could not be detected, or had a faulty transmitter and was never again detected via resighting.

Transmitter Attachment and Tracking Methods

Transmitters and attachment method

We used Holohil BD-2N transmitters for this study. We used a glue-on technique to attach the transmitters, a technique we found to be safe and effective (see Paxton et al. 2002, 2003). These transmitters have an initial weight of 0.44 g and an expected battery life of 21 days. With the addition of a cloth backing, the final weight of a transmitter was 0.46 g, 3.8% to 4.2% of the weight of telemetered flycatchers, below the 5% maximum weight limit typically deemed safe (Gaunt and Oring 1999).

Tracking

We began tracking 24 hours after transmitter attachment in order to allow time for a telemetered flycatcher to resume normal behavior following handling stress (Suedkamp Wells et al. 2003). We stratified points throughout the day to ensure birds were tracked during all the daylight hours. We randomized the order we tracked birds to avoid tracking birds in the same order each day. During each tracking session we attempted to obtain between 4-6 locations separated by at least 20 minutes for each telemetered flycatcher. We assumed 20 minutes was sufficient to assure independence between each location because a flycatcher could easily move across its home range in this time period, a common guideline to ensure biological independence (White and Garrot 1990).

Territorial birds were tracked via the “homing-in” method when possible, which consisted of following a radio signal to the location of the telemetered flycatcher to obtain a visual sighting (see Cardinal and Paxton 2005). For birds that had territories over water and/or in thick vegetation, "homing-in" was not always possible; in these cases we triangulated from outside the patch to ascertain a bird's approximate position. Other data recorded at each location included: habitat type, substrate the bird was in, the height of the vegetation where the bird was seen, vocalizations, foraging activities, and any observed interactions with other flycatchers.

Transient and floater birds were more difficult to track than territorial birds. We attempted to collect locations via "homing-in" as often as possible, but found that triangulation was a more effective means to obtain locations on these frequently and quickly moving birds. For some birds we were forced to triangulate atop adjacent hills, obtaining two or three azimuths within five minutes of each other to determine the bird's position. Signal strength from the receiver was used to estimate the distance from triangulation point to the bird's location. For these long-range triangulations, we used the Distance and Azimuth tool (v.1.4) in Arcview 3.3 to draw vectors and used the intersection of the vectors to estimate the location.

Data Analysis

Detection rates

We calculated detection rates as the number of days a telemetered flycatcher was tracked out of the entire period it was detected via telemetry, not considering those days when the bird was not tracked. We assume lower detection rates represented high levels of movement or temporary emigration from the study area. To determine if the 2005 flycatchers had lower detection rates, we calculated the detection rates for all years of this study (2003-2005). We tested for differences in detection rates among years using a one-way ANOVA.

Home range analysis

Home range analysis was calculated for territorial flycatchers with at least 27 locations, the approximate minimum number needed for home range estimates (Kenward 2001). As in past reports, we used the fixed kernel contour method for all home range estimates. We calculated fixed kernels by using the Animal Movement extension (Hooge and Eichenlaub 1997) in Arcview 3.3. The least squares cross validation method was used to determine the smoothing factor, which produces an objective and accurate home range estimate (Seaman and Powell 1996). We used a 95% probability kernel to estimate home range, and a 50% probability kernel to estimate a core area within that home range (Vega Rivera et al. 2003). We compared home range sizes from territorial birds in 2003 and 2004 with those territorial in 2005 using a one-way ANOVA. Because we obtained fewer points for non-territorial birds and there was no indication of focal areas, we did not calculate home range for them.

Movement patterns

Using the Animal Movement extension (Hooge and Eichenlaub 1997) in Arcview 3.3, we calculated several measures of movement. First, for each individual, we measured the distance between the two farthest consecutive locations to calculate the magnitude of movement. To characterize the general length of movements, we calculated the average distance between each successive location.

To summarize movements for all years, we calculated the mean of consecutive moments for all birds in each year. We grouped movements by date and calculated a mean for a two week time period to explore how movements changed over the breeding season. We used all birds in all years of the study for this analysis.

Habitat use

We calculated habitat use for all territorial flycatchers from all years of the study. We used only birds that had ≥ 27 locations for the analysis. We did not calculate habitat availability for 2005; the inundation changed the landscape so dramatically that aerial photographs used to map out vegetation in 2003 and 2004 were no longer accurate in 2005. See Cardinal and Paxton (2004) for a description of all habitat types. We used a Chi-square test of habitat differences among all years of the study.

For all statistical tests, significance was assumed at $P<0.05$.

RESULTS

Tracking, Detection, and Return Rates

We telemetered 20 male and three female flycatchers between May and August 2005, and spent nearly 400 hours collecting 534 locations on these telemetered flycatchers. We collected enough locations on individuals (>25) to calculate home range estimates for 8 of 12 territorial male birds (the mean number of locations for these 8 territorial flycatchers was 38; Table 1), and one female (32 locations). Non-territorial birds, both transients and floaters, were more difficult to track; they were detected less frequently (≤ 13 locations collected) because they would periodically disappear from the main breeding areas. We did not estimate home range size for non-territorial birds because they had too few locations to estimate an accurate area of use, and were continually shifting areas.

Detection rates, the number of days an individual was detected during the period that their transmitters were still active, varied significantly among the three years of this study (2003-2005), with the mean days detected identical for 2003 and 2004 (11 ± 0.9 days) but higher than 2005 (8 ± 0.7 days) ($F=6.2$, $p<0.01$). The lower detection rate in 2005 was due to flycatchers that could not be detected for some of the days we attempted to track them, even though the transmitter was still active.

As in past years, return rates (number of individuals in year 1 that returned in year 2) of telemetered flycatchers was high. Twelve of the 17 flycatchers used in the 2004 telemetry study returned to Roosevelt Lake in 2005, a 71% return rate. This rate is higher than the general return rate for banded flycatchers at Roosevelt Lake from 2000-2004 (59-69%; Causey et al. 2006) and substantially higher than the 2005 general population return rate of 48% (Causey et al. 2006). Two flycatchers from the 2004 season were recaptured and fitted with transmitters again in 2005. One of these birds was telemetered in 2003 as well, so we have three consecutive years of telemetry data on this individual (Table 1). As in previous years, all recaptured flycatchers used in the 2004 telemetry study had fully re-grown their back feathers and no transmitters were still attached.

Table 1: Capture and status information for Southwestern Willow Flycatchers telemetered at Roosevelt Lake, Arizona, 2005. The table includes band combination, band number, age, sex, site (where the bird was territorial and/or first captured), territory number, territorial status, dates detected, number of days detected, and number of telemetry locations collected.

WIFL	Color Combo	Band Number	Age	Sex	Site	Territory number	Territorial Status	Dates Detected	Days Detected	Locations
1	D:OWO	2210-57315	ASY	MALE	ACRS	NA	Floater	5/13-5/26	9	25
2	V:VY	1490-89776	AHY	FEMALE	DIVD	NA	Floater	5/17-5/25	6	8
3	D:YWY	2290-24342	SY	MALE	BARX	NA	Floater-> Terr.*	5/27-6/10	6	10
4	KGK:Z	2350-24013	SY	MALE	BARX	61	Floater-> Terr.*	5/31-6/10	8	26
5	N:WV	2350-24436	AHY	FEMALE	ACRS	600	Territorial	6/9-6/19	8	32
80	VK:G	2280-96679	ASY	MALE	ACRS	57	Territorial	5/10-5/24	10	49
81	D:WZW[1]	2290-24301	A4Y	MALE	ACRS	76	Territorial	5/14-5/31	10	40
82	RDR:D[2]	2290-24317	TY	MALE	TONT	81	Territorial	5/20-6/2	7	13
83	KD:V	1490-89774	TY	MALE	OPCA	800	Territorial	5/25-6/8	10	23
84	K:VG	2350-24230	AHY	MALE	BARX	07	Territorial	5/27-6/8	8	19
85	V:KY	1740-51622	AHY	MALE	SHAN	15	Territorial	6/4-6/11	5	16
86	D:RKR	2290-24345	AHY	MALE	CA01	448/48	Territorial	6/12-6/26	11	42
87	N:VV	2350-24428	AHY	MALE	CA01	NA	Transient	6/12-6/14	3	3
88	OWO:D	2290-24346	ATY	MALE	CA01	35	Territorial	6/12-6/29	12	41
89	Z:YW	1710-20497	A5Y	MALE	CA01	46	Territorial	6/16-6/29	10	37
90	G:VW	2280-96661	SY	MALE	CA01	NA	Transient	6/16-6/19	3	5
91	OKO:D	2290-24347	SY	MALE	ACRS	93	Territorial	7/6-7/15	9	33
92	K:RKR	2210-57029	ASY	MALE	ACRS	343	Territorial	7/7-7/18	8	27
93	D:VWV	2290-24350	SY	MALE	ACRS	NA	Floater	7/8-7/15	5	17
94	G:KGK	2350-24164	SY	MALE	ACRS	7/202	Territorial	7/8-7/19	9	31
95	G:WRW	2280-96689	ASY	MALE	ACRS	NA	Floater	7/8-7/20	8	20
96	KR:Z	1490-89946	SY	MALE	ACRS	55	Transient	7/17-7/19	3	6
97	YRY:V	1490-89827	TY	FEMALE	ACRS	52	Floater	7/21-7/27	4	11

*Birds that started as floaters but became territory holders during the period they were telemetered.
[1] This individual was a 2003 and 2004 Telemetry bird.
[2] This individual was a 2004 Telemetry bird.
Color band color codes: **Z**=gold, **K**=black, **D**=blue, **G**=green, **O**=orange, **R**=red, **W**=white, **Y**=yellow, **V**=violet, **N**=bronze
Age: **SY**= 2 years, **AHY**=2 years or older, **TY**=3 years, **ASY**=3 years or older, **ATY**=4 years or older, **A4Y**=5 years or older, **A5Y**= 6 years or older.
Site codes: **ACRS**: A+ Cross Road, **BARX**: Bar X Road, **CA01:** Cottonwood Acres 1, **DIVD:** Diversion Dam, **OPCA:** Orange Peel Campground, **SHAN:** Shangri-la, **TONT=** Tonto Creek Inflow. For Site Descriptions see Causey et al. (2006).

Movement Patterns

We observed four different movement patterns in 2005 (Fig. 1). (1) Territorial birds in 2005 showed similar patterns to those in previous years, rarely making movements over 50 m between consecutive locations while telemetered (mean = 29 ± 3 m). (2) Floater (i.e., non-territorial) flycatchers made the longest movements, with consecutive movements averaging 3517 (±1009) m. (3) Two flycatchers (WIFLs 3 and 4) were non-territorial birds when first telemetered, but after making several long-distance movements they settled into a small area and began exhibiting behavior typical of other territorial birds (pattern 1). Their consecutive movements over the entire period they were tracked averaged 115 (± 35) m; this average is larger than territorial birds yet much smaller than floaters. (4) Lastly there were three transient flycatchers. We observed two flycatchers (WIFLs 87 and 90) defending territories and one flycatcher (WIFL 96) that never exhibited territorial behavior before these birds either disappeared from the Roosevelt Lake study site or their transmitters failed within three days of being telemetered. None of these birds were detected again via telemetry or resighting, suggesting they either left the study area or their transmitters failed and they became/remained part of the floater population at Roosevelt Lake.

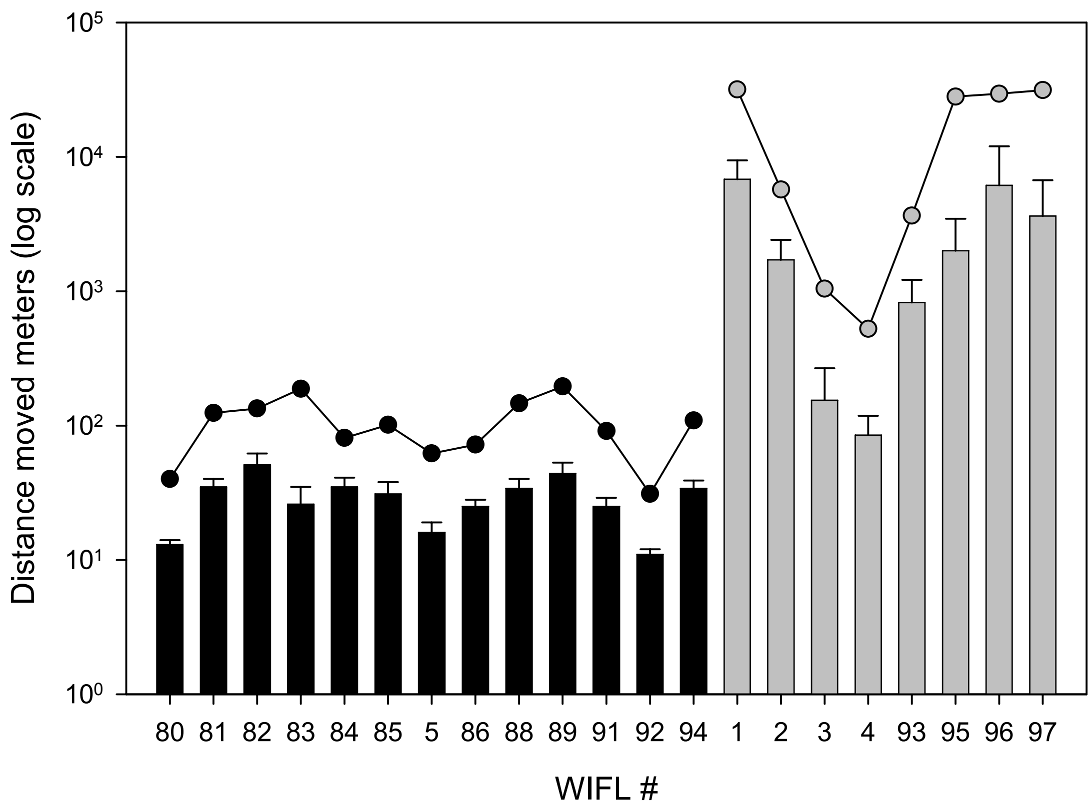

Figure 1. Summary of 2005 movement patterns for flycatchers telemetered with more than five locations. Longest (line and dots) and mean (bars) distance of consecutive movements of 2005 telemetered flycatchers, with territorial flycatchers in black, and non-territorial flycatchers in grey. Order (left to right) indicates relative order of tracking through the season.

The longest distance moved for all birds was over 30 km, occurring when birds moved from Tonto Creek Inflow to the Salt River inflow, or vice versa. Prior to 2005, we did not observe adult flycatchers making trans-lake movements, although we did document one juvenile moving across the lake in 2004 (Cardinal and Paxton 2005). In 2005, we detected four birds (all non-territorial) making trans-lake movements. Three of the four made one-way Tonto Creek to Salt River movements, while the fourth (WIFL 1) made multiple movements back and forth across the lake. The trans-lake movements occurred either before or after the main breeding time period (mid-May through June), except for one movement in the middle of May made by WIFL 1. Territorial birds rarely moved greater than 100 m from the center of their territories in 2005, while transient and floater birds regularly moved more than 100 m between successive locations.

Consecutive movement distances were generally greater in 2005 than in 2003 and 2004, but all three years exhibited similar movement patterns by date. The longest movements (> 100 m) occurred at the beginning and end of the breeding season in all years (Fig. 2), while the shortest movements occurred in the middle of the breeding

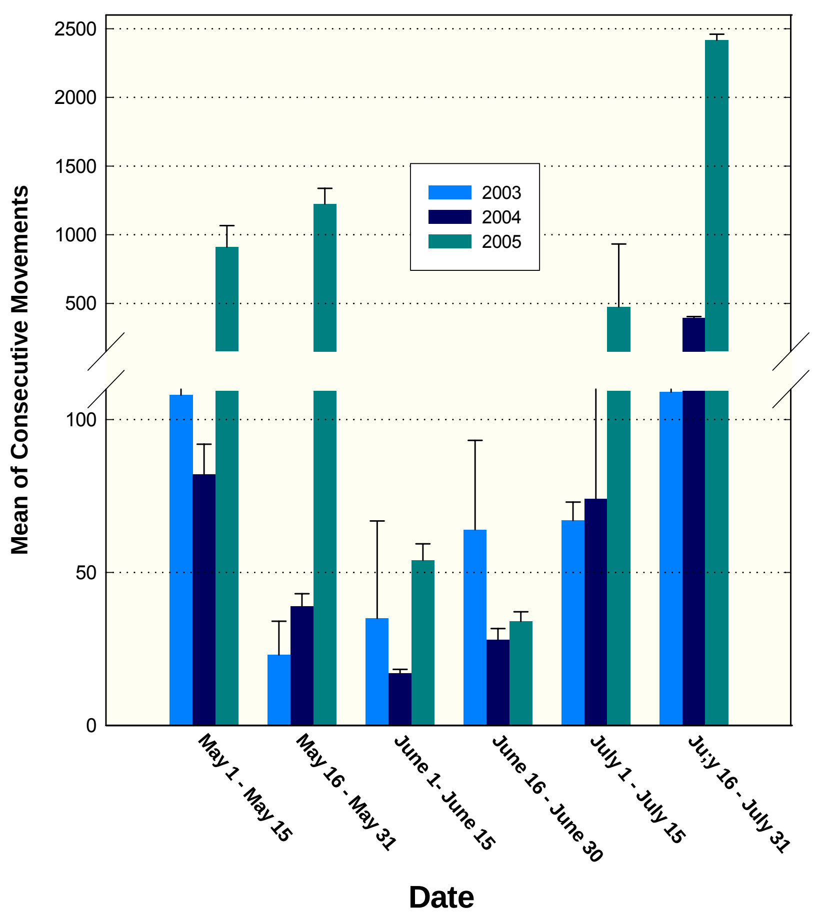

Figure 2. Mean consecutive movements for all birds (territorial and non-territorial) from 2003-2005, grouped by date. Light blue bars indicate 2003 birds' movements; dark blue bars indicate 2004 birds' movements; and the teal green bars indicate 2005 birds' movements. The X-axis represents two-week periods during the breeding season. The Y-Axis is mean consecutive movements (meters).

season from Mid-May through the end of June. The longer movements in 2005 compared to 2003 and 2004, particularly during the May 16- May 31st time period, were probably due to the higher number of non-territorial flycatchers tracked. In previous years most birds had settled into their territories by mid-May and did not make long distance movements, while in 2005 telemetered birds were still making movements of over 1 km during the mid-May nesting period.

Home Range Comparison

Although movement distances were generally greater in 2005, 95% Fixed Kernel home range sizes for the territorial birds in 2005 did not differ from those in 2003 or 2004 ($F=1.8$, $P=0.19$; Fig. 3). Mean home range size for the 2003 telemetered birds was 0.53 (± 0.11) ha, 0.23 (± 0.12) ha in 2004, and 0.42 (± 0.09) ha for 2005 birds (Fig. 3). Combining all years results in a mean home range estimate of 0.39 ha (95% C. I.: 0.26, 0.52). In 2005, three birds were tracked in inundated habitat and five birds over dry land. Birds in inundated habitat had slightly larger home ranges than birds using dry land (mean=0.50 ± 0.17 ha compared to 0.37 ± 0.13 ha), but not significantly different ($F=0.40$, $P=0.50$; Table 2). The one territorial female tracked in 2005 had a home range size of 0.49 ha, which is within the 95% C.I. of home range size for males.

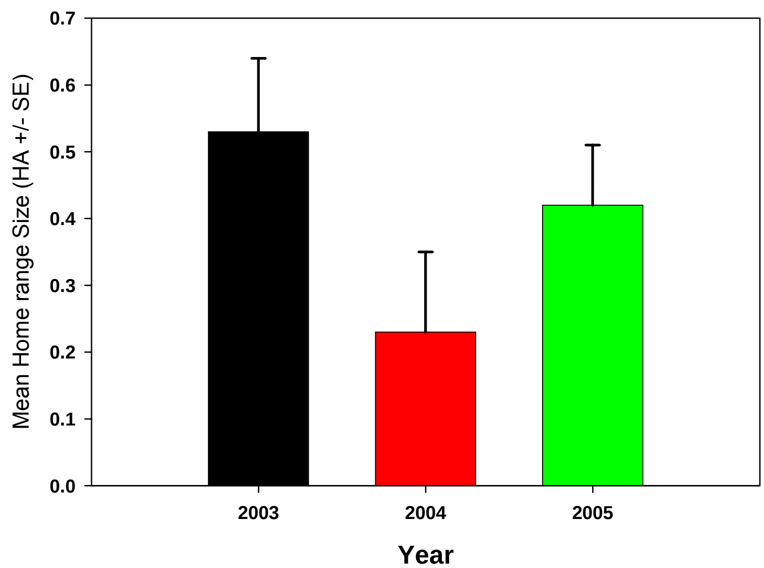

Figure 3. Mean home range sizes (95% fixed kernels) for all breeding birds from 2003-2005. The X-axis is year and the Y-axis is mean home range size in hectares with standard error bars.

Table 2: Area used for male Southwestern Willow Flycatchers with 27 or more locations. Table shows home range sizes using fixed kernel with 95% and 50% contours, mean distance moved, and habitat status (inundated or non-inundated).

	Fixed Kernel			
WIFL #	**95% (ha)**	**50% (ha)**	**Mean distance moved (m)**	**Inundated or Dry land?**
80	0.09	0.01	13	Dry
81	0.9	0.14	35	Dry
86	0.5	0.14	25	Inundated
88	0.42	0.09	34	Inundated
89	0.58	0.12	44	Inundated
91	0.28	0.05	25	Dry
92	0.06	0.01	11	Dry
94	0.51	0.07	34	Dry

Habitat Use

The habitat that telemetered flycatchers used changed significantly each year of this study (Chi-square=260.3, $P<0.01$; Fig. 4), however most of the difference is probably due to different study areas where the flycatchers were telemetered and tracked. Each year the distribution of flycatchers at Roosevelt Lake changed, causing us to track them in different locations which had different habitat characteristics. In 2003 and 2004 breeding males used mixed (willow and tamarisk) mature riparian habitat most frequently (48% in 2003 and 53% in 2004) while in 2005 exotic habitats were most frequently used (67%). In 2005 use of open and immature habitat types also decreased (Fig. 4).

We detected nine individual flycatchers using non-riparian mesquite habitat at Roosevelt Lake for the first time in 2005 (Fig. 4, Table 3). One breeding bird in 2005 (WIFL 85) held a territory within a patch of partially submerged mesquite and used this habitat exclusively. The territories of the other individuals using mesquite were centered within 100 m of mesquite (Table 3). Some of the transient and floater birds made consecutive movements of greater than 100 m in one day from riparian to mesquite-dominated habitat, but since they did not have a focal center, this may not be comparable to territorial flycatchers. While in previous years birds have made movements of similar distance, they have never been found outside riparian vegetation (i.e., willow, cottonwood, tamarisk, and mixes of the three).

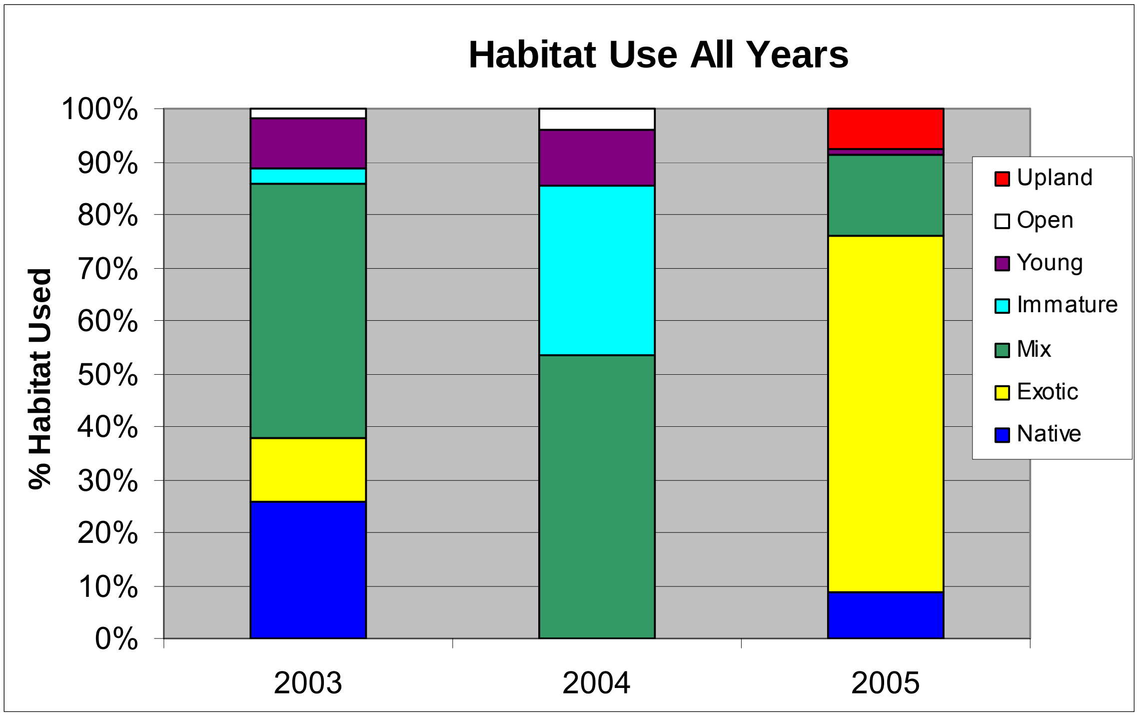

Figure 4. Habitat use for all territorial males (with ≥ 27 locations) studied in 2003, 2004, and 2005. The X-axis shows the year and the Y-axis shows percent of each habitat used. Different colors represent different habitat types. Young and immature habitat classifications can be either native, exotic, or mixed, while mature riparian woodlands are denoted by habitat type. Upland is mesquite habitat, some of which was semi-inundated in 2005.

Table 3. Flycatcher use of mesquite habitat in 2005. Table shows WIFL number, territorial status, total number of locations, number of locations in riparian habitat, number of locations in mesquite habitat, percent of locations in mesquite, and mean distance to uplands from territory center.

WIFL	Territorial Status	Locations	Locations in Riparian	Location in Mesquite	Percent of Locations in Mesquite	Mean Distance to Mesquite
1	Floater	25	24	1	4.0%	NA
2	Floater	8	4	4	50.0%	NA
4	Floater-> Terr.	26	23	3	11.5%	52
85	Territorial	16	0	16	100.0%	0
91	Territorial	33	22	11	33.3%	9
93	Floater	17	15	2	11.8%	NA
94	Territorial	31	22	9	29.0%	16
95	Floater	20	15	5	25.0%	NA
96	Transient	6	4	2	33.3%	NA

DISCUSSION

Lower detection rates in 2005 made this year more challenging compared to previous years. In 2003 and 2004, we typically detected telemetered territorial birds every day we searched for them; however, in 2005 occasionally non-territorial floaters were not detected for several days before being detected again. This suggests that these birds were temporarily leaving the Roosevelt Lake Basin, or at least moving far from the breeding areas. In previous years, no territorial nesting birds disappeared during the period of time when a transmitter was known to be active. In 2005, three birds that showed territorial behavior disappeared while their transmitters should have still been active and were never resighted or detected again at Roosevelt Lake, suggesting that these birds either departed the study area, became part of the floater population, or their transmitters failed (although if they remained territorial in the same location, they would have been detected via resighting efforts). This difference in detection rates may be in part due to the inundation of the habitat, resulting in displaced flycatchers that were detected at Roosevelt Lake, but also prospected for other available habitat nearby. Also part of the difference in detection rates is certainly due to the different territorial status of birds tracked in 2005, which specifically included non-territorial floaters, compared to 2003 and 2004 when only territorial birds were tracked.

Home Range and Movement Patterns

Chronology of movement

From 2003 to 2005, we detected general patterns that were consistent from year to year, yet still observed other differences in flycatcher movements. Generally, large movements were common at the very beginning (early May) and end of the breeding season (late July), with the shortest movements observed in June. The only exception to this was some very large movements in late May of 2005. The average movement in 2005 was much larger than 2003 and 2004 due to four trans-lake movements exhibited by non-territorial flycatchers. Also, movements at the beginning and end of 2005 were much longer than in the other years. This increase in magnitude of movement was probably due to the habitat inundation, possibly indicating the flycatchers' need to prospect for suitable breeding habitat in the face of the inundation-induced habitat changes at Roosevelt Lake.

Home range of territorial birds

Home range size for territorial birds was not significantly different among all years of this study. Even with the dramatic change in lake levels and habitat inundation in 2005, territorial flycatcher home ranges remained the same as previous years of this study. If flycatcher's home range size is determined by minimum nesting requirements (Vega Rivera et al. 2003), then there was no indication that the quality of nesting territories declined due to the inundation, at least as indicated by size. Had habitat quality declined for nesting flycatchers in 2005, we may have expected a substantial increase in home range size compared to 2003 and 2004.

In previous years, territorial telemetered flycatchers were almost always detected in their territories while transmitters were still active. However, three flycatchers that showed territorial behavior (WIFLs 85, 87 and 90) most likely left the Roosevelt Lake area during the time the transmitters were still active. If the transmitters failed and these birds continued to be territorial, they would most likely have been detected through resighting, but if they became part of the floater population they would have been largely undetectable via resighting. Because we detected these birds for only a few days, they were not included in the home range estimates for 2005.

Floaters

Few studies have addressed how floater behavior relates to a territorial population, and therefore their importance to conservation biology (Verner 1992, Shutler and Weatherhead 1994). While our sample size was small, we observed two movement and behavior patterns that add to our knowledge of the "underworld" of birds (Smith 1978). Two flycatchers (WIFLs 3 and 4) were caught and telemetered as floaters but subsequently became territory holders. These birds left the patch where they were captured, moved more than 500 meters to another occupied patch and started exhibiting territorial behavior. This pattern of floater turned territory owner has been observed in other passerine species, including Red-winged Blackbirds and Ovenbirds (Shutler and Weatherhead 1994; Bayne and Hobson 2001). In these cases, floaters occupied open territories when they became available. The flycatchers that were floaters and became territory-holders were both second-year birds. Second-year birds appear to arrive later to the breeding site, and thus may not immediately find a high quality territory because of competition with older birds that arrived in early May. These young birds may adopt a floating strategy to prospect for unoccupied territories. We observed a similar movement pattern with a pre-nesting bird in 2004 that prospected at the beginning of the season before exhibiting territorial behavior (Cardinal and Paxton 2005), and thus may reflect a frequently used movement pattern and territory establishment strategy for migratory birds. After arriving on unfamiliar breeding grounds, birds likely prospect to gain information on habitat quality by moving to many patches before selecting a suitable and/or vacant breeding territory. The changes in the flycatchers' breeding habitat (via the inundation) created a population of displaced flycatchers, many of which may have adopted a floater strategy to prospect for suitable breeding habitat. It may be advantages for flycatchers to adopt a non-territorial behavior when there is a lack of suitable habitat, rather than leaving an area or drainage in search of habitat elsewhere; unfortunately, this study cannot answer this question.

The other four floaters were not territorial for the period they were tracked, but spent more than half of their time in habitat patches occupied by other territorial flycatchers. Even those flycatchers that made movements across the lake from Tonto Creek to the Salt River were still frequently found in patches where flycatchers were breeding. Two floater flycatchers that never exhibited territorial behavior were radio-tagged at the beginning of the season and two at the end. The two flycatchers at the beginning of the season (WIFLs 1 and 2) were only detected when the transmitters were active (never via resights) and were never observed showing territorial behavior later in the season. Because of the high likelihood of detecting territorial flycatchers via resighting (via the concurrent demographic study, Causey et al. 2006), these birds likely remained floaters, prospecting and assessing habitat at Roosevelt Lake for the entire breeding season or they may have dispersed to another site to attempt to breed after the period that we tracked them. To float or disperse is probably a decision based on a number of environmental cues, and many flycatchers may do both, floating for some period of time before dispersing. In another floater study, most floater Red-winged Blackbirds were hypothesized to have dispersed; floaters were never detected again after vacant territories were created (Shutler and Weatherhead 1994).

The other two floaters and one transient flycatcher were tracked at the end of the breeding season in late July. At least one of these birds was a post-breeding disperser (WIFL 97). This bird was banded as a nestling and fledged at Roosevelt Lake in 2003 (Newell et al. 2003), was not detected in 2004, and was detected as a breeding female from May through July 15, 2005 at Horseshoe Reservoir on the Verde River, where she successfully fledged three young (Dockens and Ashbeck 2005). We caught this bird on July 21st at Bar X with a receding brood patch. After capture, the bird made a trans-lake movement, was never observed showing territorial behavior, and frequently moved over 500 meters every half hour. This bird was detected most often in habitat patches where flycatchers had bred this season. This post-breeding movement was a behavior where the bird may have been prospecting for a future breeding site or possibly staging for migration (Vega Rivera 2003, Cardinal and Paxton 2005). The other floater (WIFL 95) and transient (WIFL 96) flycatchers caught at the end of the season showed similar behavior to WIFL 97. However, neither of these birds were detected at Roosevelt Lake until they were captured and it is unlikely that they were breeders at Roosevelt Lake since most territorial and nesting birds are detected via resighting. Thus they were likely either floaters at Roosevelt Lake or dispersers from another breeding site.

Habitat Use

Changes in habitat use between 2004 and 2005 were evidently due to habitat inundation that destroyed most of the areas where we tracked flycatchers in 2003 and 2004. Those inundated areas were composed primarily of mixed mature (5 to 7 years old) riparian habitat, whereas the 2005 areas above the lake level were primarily exotic vegetation of greater than 8 years in age). Thus, the strong increase in exotic vegetation use in 2005 was probably due to the shift in available habitat and where we telemetered and tracked birds resulting from the impacts of habitat inundation. While these older patches were available to birds in both 2003 and 2004, breeding in them had dwindled to just a few territories (Old Salt) or none (Tonto), and in the case of Cottonwood Acres had not been used for years. This sudden switch to habitat largely unused in the previous year suggests either a “refuge” habitat, used because more preferred habitat was suddenly lost, and/or that the heavy precipitation and partial inundation had made them “suitable” once again.

In previous years, no flycatchers were detected using mesquite habitats even when this habitat was within 200 meters of a flycatcher territory. However, in 2005 nine flycatchers were found in mesquite dominated habitat. All territorial flycatchers that used mesquite had this habitat type relatively close to their territory centers (within 100 meters), although non-territorial flycatchers made longer movements from riparian to mesquite habitats. We suggest three potential explanations for this shift in habitat use. First, the flycatchers occupied habitats not used in previous years, which brought them closer to upland habitat, presumably in part due to lake inundation displacement. This closer proximity facilitated a higher probability of use. Second, the semi-inundated mesquite habitats used may have approximated riparian habitat, thus making them temporarily suitable for breeding activities. Third, the wet winter promoted unusually lush herbaceous growth in the uplands, perhaps supporting more arthropod prey and making it more suitable for flycatcher use. The change in the relative quality of upland to riparian habitats and the closer proximity of flycatcher territories to these upland habitats may have enticed more flycatchers to exploit the arthropod food resources of upland habitats in 2005. One territorial flycatcher (WIFL 94) was frequently observed singing from mesquite, which was directly above the riparian vegetation in this bird's territory. These findings are similar to that of a Utah telemetry study (Bakian et al. 2004), where Willow Flycatchers used upland habitat that was adjacent to flycatcher territories.

Southwestern Willow Flycatcher Response to Habitat Inundation

Telemetry data provides important insights into the response of flycatchers to the inundation of Roosevelt Lake in 2005. One noticeable difference was the significantly lower detection rate for telemetered flycatchers. While this included floaters that are inherently more difficult to track, there were also territorial birds that apparently departed the study site, temporarily and possibly permanently, suggesting individuals were less committed to their breeding area. The lower detection rates in 2005 may also indicate that a greater proportion of the overall population adopted a floater strategy compared to previous years.

Movement patterns were similar in all years, in that longer movements were observed at the beginning and end of the breeding season, but territorial flycatchers made shorter movements during the height of the breeding season. While the movement patterns were similar, 2005 movement distances at the beginning and end of the breeding season were greater than 2003 and 2004, suggesting longer distances needed to prospect for suitable habitat. Much like the movements during the height of the breeding season, home range sizes of these flycatchers did not vary by year, suggesting that resource quality of a nesting territory did not change dramatically among the three years of the study.

We observed flycatchers using different habitat types in all years of the study, but this is primarily an artifact of the habitats where we captured, telemetered, and tracked birds each year. However, it highlights the degree of habitat plasticity for the flycatcher, as flycatchers are able to utilize diverse and multiple habitat types across their breeding range.

The overall impact to the Roosevelt Lake flycatcher population as a result of the inundation is mixed, with some aspects of their behavior, such as detection rates, breeding strategy (territorial versus floater), distance of early and late season movements, and use of upland habitat being different, potentially due to inundation, while other aspects appeared to not be impacted at all, particularly home range size and movement patterns of breeding territorial birds. Thus flycatchers appeared to respond to the inundation, but not always in ways we expected. We expected to find telemetered flycatchers moving even greater distances (and to other drainages) seeking suitable breeding habitat. However, while the detection rates suggest temporary movements away from Roosevelt Lake, we did not directly detect any between-drainage movements, nor did results of resighting for banded flycatchers at other drainages suggest large scale movements away from Roosevelt Basin (Causey et al. 2006). While there are many places a dispersing flycatcher could move to where it would not be detected, many of the nearest and largest breeding sites (e.g., Horseshoe Reservoir, San Pedro/Gila River confluence) had intensive resighting efforts, and would have had a high priority of detecting moving banded flycatchers. It may be that larger scale emigration will occur in future years, as flycatchers begin to prospect for habitat in other drainages, or that flycatchers, adapted to yearly changes in their dynamic riparian habitats, attempt to find alternative habitat closer, rather than farther, from their historic habitat.

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