Studies in Avian Biology No. 26:185–189, 2003.

USING RADIOTELEMETRY TO DETERMINE HOME RANGE SIZE, HABITAT USE, AND MOVEMENT PATTERNS OF WILLOW FLYCATCHERS

EBEN H. PAXTON, SUZANNE N. CARDINAL, AND THOMAS J. KORONKIEWICZ

Abstract. In 2002, we tracked four Willow Flycatchers (*Empidonax traillii*) for eight days with radio-transmitters. Although conducted for only a brief period of time and on a small number of individuals, this is the first radiotelemetry study of Willow Flycatchers, and the information gleaned has potentially important implications for current and future Willow Flycatcher research and management. An average of 30 locations were collected on each individual, yielding insight into home range, habitat use, and movements. The average size of the home range of three of the four flycatchers was 1.2 ha (based on the minimum convex polygon method). The fourth individual was tracked over a much larger area than the other three, with movements of up to 2.5 km documented. Home range estimates for all four flycatchers were still rapidly increasing by the end of the study, indicating that the documented sizes are under-estimates. All flycatchers used a variety of habitat types, including the mature riparian vegetation that they nest in, surrounding sparsely vegetated young riparian habitat, and non-riparian upland habitat. This study found that telemetry is a viable research technique for the Willow Flycatcher, and can provide important information on home range, habitat use, and movement patterns. Further study is needed to evaluate how common or rare our findings are for the Willow Flycatcher across its range.

Key Words: *Empidonax traillii;* habitat use; home range; movements; radiotelemetry; Willow Flycatcher.

Understanding the habitat requirements of a species requires information on the size of area it occupies, types of habitat it uses, and how it moves throughout its environment. Willow Flycatchers (*Empidonax traillii*) are small neotropical migrants that breed only in riparian habitat in the arid West. They nest in dense riparian vegetation patches, which are typically surrounded by a patchwork of multiple habitat types. Willow Flycatcher habitat is sometimes considered as only that habitat in which nesting occurs; however, observations of breeding flycatchers outside of the riparian nesting area (E. Paxton, unpubl. data) suggest that flycatchers may use a much larger area and a broader range of habitats than is commonly assumed. Habitat that is not used for nesting, but is interspersed with it, may be an important component of breeding site selection and overall patch use. Flycatchers may move outside of their nesting area to acquire resources (e.g., food, water) or to obtain extra-pair copulations (EPCs). Documenting these possible uses is important for understanding habitat needs, local population estimates (under- or over-counting), and genetic diversity patterns.

Radiotelemetry has proven to be an important tool for answering questions about habitat requirements and other important aspects of a species' natural history (Kenward 2001). Furthermore, telemetry is the best method for finding and tracking flycatchers in the dense riparian habitat in which they breed, as flycatchers are difficult to detect unless near a nest or vocalizing. However, some studies have found harmful effects of transmitters on birds (Bowman and Aborn 2001, Hooge 1991), which argues for a pilot study to evaluate the technique, for each species, before application on a large group of individuals (Brigham 1989). This study was undertaken to evaluate the feasibility of applying radiotelemetry techniques to the Willow Flycatcher and to gather preliminary information on home range size, habitat use, and movement patterns.

STUDY AREA AND METHODS

This study was conducted at Fish Creek, Utah County, Utah (39°46′N, 110°15′W). Fish Creek is a high elevation (2560 m) meandering creek, with a narrow floodplain situated at the base of a steep mountain valley. Three general habitat types were identified at the study area. Mature riparian habitat was characterized by a single, dense vegetative layer of willow (*Salix* spp.) with a canopy height of 3 to 6 m. This habitat type was interspersed and surrounded by young riparian scrub, which consisted of a mix of short willow (< 2 m), herbaceous plants, grass, and open areas. Immediately adjacent to the riparian floodplain, on the steep mountain slopes, was non-riparian upland habitat. The upland habitat consisted primarily of sagebrush (*Artemisia* spp.), with fir (*Abies* spp.) and spruce (*Picea* spp.) present on the north-facing slopes.

We captured Willow Flycatchers via mist-nets and a targeted capture technique (Sogge et al. 2001), and each flycatcher was color-banded to facilitate individual identification. We determined sex based on the presence of a cloacal protuberance for males or brood patch for females. Breeding status was determined by

TABLE 1. HOME RANGE SIZE, MOVEMENT DISTANCES, AND HABITAT USED BY WILLOW FLYCATCHERS AT FISH CREEK, UTAH 2002

Bird	Sex	Territory	No. of locations	Home range size (ha)[a]	Distance among all locations (m)		Percent of locations in each habitat type (number of locations)		
					Maximum	Average	Mature	Young	Upland
WIFL1	M	A	41	[b]	2900	218	41% (17)	39% (16)	20% (8)
WIFL2	F	B	23	0.94	128	47	39% (9)	35% (8)	26% (6)
WIFL3	M	B	29	1.07	107	49	59% (17)	34% (10)	7% (2)
WIFL4	M	C	27	1.66	149	52	52% (14)	26% (7)	22% (6)

[a] Home range sizes were estimated using the minimum convex polygon method and all locations.
[b] WIFL1 was documented traveling over large distances, resulting in a minimum convex polygon area estimate of 106 ha; it is not apparent which subset of this area should be considered as home range.

observation of pair interaction and/or nest attendance, and nests were located by searching areas frequented by vocalizing females.

We used a glue-on method (Johnson et al. 1992) for attaching LB-2 transmitters (Holohil, Inc., 0.47 g) to the backs of flycatchers. Prior to capture, we glued a small piece of grid cloth to the bottom of the transmitters to facilitate a greater surface area for contact with the bird. We then trimmed the cloth to a size just larger than the transmitter's footprint. We held captured flycatchers in one hand and clipped the feathers from an area slightly larger than the circumference of the transmitter, approximately 20 mm above the uryopygial gland. A moderate and even amount of Skin-Bond was applied with a soft brush to the transmitter and exposed skin, and allowed to dry for 5 mins. The transmitter was then pressed into place on the bird and held with light pressure for 2–5 min. After a gentle pull to ensure the transmitter was in place, the contour feathers were rearranged to cover the transmitter, and the bird was released.

We tracked flycatchers using an R-1000 Telemetry receiver (Communications Specialists, Inc.) and a standard hand-held 3-element yagi antenna. Locations of flycatchers were determined by moving in the direction of a radio signal until an individual was seen. When an individual was observed, we looked for any apparent effects of the transmitters and noted its behavior (e.g., perching, foraging, singing, interactions, flight). After the bird moved, we recorded the location's coordinates via a Garmin E-trek Legend GPS unit, accurate to 3.5 m ± 2.5 m. Our sampling regime consisted of tracking flycatchers from dawn to dusk, in a random order, with at least one hour between successive locations of a particular individual (to eliminate auto-correlation of data points). However, one flycatcher (WIFL1, see below) was tracked continuously while it conducted long-distance forays out of its territory.

We defined home range as the area encompassed within a polygon drawn from the outermost points of all locations (minimum convex polygon method; White and Garrott 1990). We could not define home range for the one flycatcher that traveled over large areas. Habitat was determined by field observations and overlaying the location coordinates onto a rectified aerial photograph of the study area using Arcview (v. 3.2) software. We also used Arcview with the Animal Movement extension (Hooge and Eichenlaub 1997) to calculate home range, average and maximum distance between all locations, and to produce Figures 1 and 2.

RESULTS

Four Willow Flycatchers were tracked with radio-transmitters for eight days from July 8 to July 15, 2002. WIFL1 was a paired male from territory A, with an approximate nest location identified based on the female's behavior. WIFL2 and WIFL3, female and male, respectively, were paired in territory B. Their nest contained eggs at the beginning of the study but was depredated mid-way through the study; the female re-nested by the end of the study. WIFL4 was a male paired in territory C, with its nest containing 2–3 day old young at the beginning of the study (Table 1).

Radiotelemetry was very successful in tracking the flycatchers over large distances and among the dense riparian habitat that they nested in. We were able to locate individuals over 1 km away, track them through dense vegetation, and track extra-territorial movements that were unlikely to have been detected without telemetry. Furthermore, we did not observe any behaviors indicating problems with the attached transmitters. However, we were not able to evaluate potentially subtle effects of the transmitters, such as reduced productivity, survivorship, and territory maintenance.

HOME RANGE

An average of 30 locations was collected on each flycatcher (Table 1, Figs. 1, 2). WIFL2, WIFL3, and WIFL4 had an average home range of 1.2 ± 0.4 ha. WIFL1 was documented traveling long distances from its defended territory, yielding a minimum convex polygon size of 106 ha. However, the flycatcher appeared to only pass through, rather than use, large areas within the minimum convex polygon (Fig. 2), so we believe its true home range is much smaller than this minimum convex polygon estimate. The average distance between locations of all flycatch-

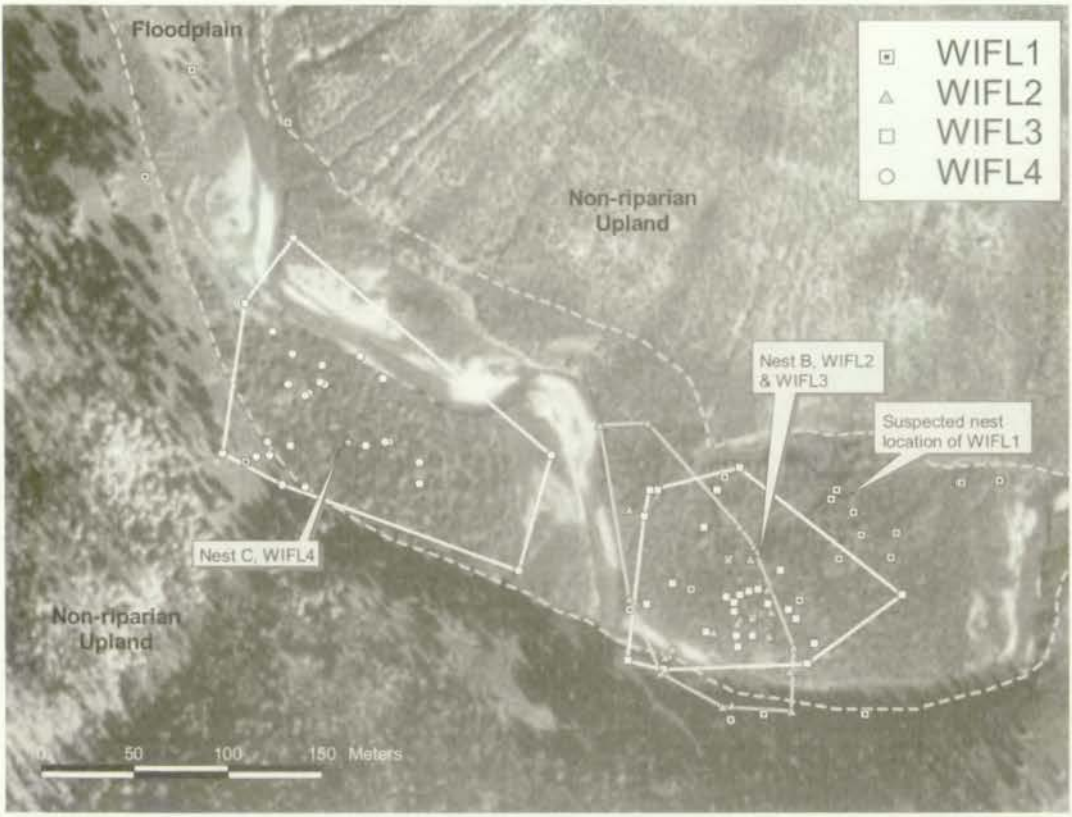

FIGURE 1. Locations of the Willow Flycatchers and nests at the 2002 Fish Creek, UT, core study area. Individual locations and minimum convex polygon home ranges are shown for WIFL2, WIFL3, and WIFL4. Only individual locations are shown for WIFL1. Dashed lines indicate the boundary between the non-riparian upland and the floodplain. Mature willow, young riparian scrub vegetation, and non-vegetated areas occur within the floodplain.

ers except WIFL1 was 49 ± 2.5 m, with an average maximum distance of 128 ± 21 m. WIFL1 averaged 218 m between locations, with a maximum distance of 2.9 km. For all flycatchers, home range estimates continued to increase rapidly by the end of the study, without appearing to reach an asymptote, indicating that these home range sizes are under-estimates.

Habitat Use

All four flycatchers were observed using the three general habitat types identified at the study area (mature riparian, young riparian scrub, non-riparian upland). Almost half (48%) of the four flycatchers' locations were recorded in the mature riparian habitat, and 34% and 18% were

FIGURE 2. All detection locations for WIFL1 (white squares with black centers), and minimum convex polygons for WIFL2, WIFL3, and WIFL4 (white bordered polygons; refer to Fig. 1 for details), at the Fish Creek, UT, study area.

recorded in the young riparian scrub and non-riparian upland habitats, respectively (Table 1).

Activities in the various habitats were not always identifiable, but in general activities in the mature riparian included nest attendance, singing, foraging, resting, and territory intrusion. We observed flycatchers foraging and resting in the young riparian scrub, but only foraging activities were noted in the non-riparian upland habitat type.

Movements

Observed movements varied among the four individuals. All but WIFL1 were consistently found in either their nesting patch, in immediately adjacent young riparian scrub, or in non-riparian habitat near their breeding patches.

During the tracking period, WIFL1 exhibited strikingly different movement activities from the other three flycatchers, with three notable long distance movements observed. The first was a two-hr foraging foray, where the bird progressed gradually upstream from one upland hillside to another. After moving 0.5 km upstream, it flew to the riparian zone and foraged in young riparian scrub habitat. At the end of the two-hr period, it returned to its suspected nesting area. The second notable movement occurred when the flycatcher was located in late morning 1 km downstream from its suspected nesting area. It continued to go downstream, and was tracked all afternoon and into the evening as it moved around the riparian habitat at the mouth of Fish Creek. The flycatcher spent the night at this downstream area, then returned to its defended area within one hr of dawn the next morning. The third long-distance movement occurred several days later, when the flycatcher was detected again in the same downstream area. These downstream movements occurred as far as 2.5 km from the flycatcher's defended territory and suspected nesting location.

Foraging appeared to be the primary activity that occurred when flycatchers moved beyond their defended territories; territory intrusion was a second. During WIFL1's 2.5-km downstream movement, we observed it entering, and being chased out of, another active Willow Flycatcher territory. It was also tracked into WIFL4's nest area, and a territorial interaction was heard just before it flew away. A third activity may have been mate guarding. WIFL3 was twice seen following his mate (WIFL2) across the creek to forage on the upland sagebrush hillsides. The female was rebuilding a depredated nest, and had not yet laid eggs; thus, this concurrent movement may have been extra-territorial mate guarding behavior rather than simply a joint foraging foray.

DISCUSSION

Home Range

Territory size and home range are spatial measures with biological importance, and both are commonly used in defining habitat requirements (White and Garrott 1990). We used the most inclusive definition of home range for this study to evaluate the full extent of habitats used and maximum area utilized. However, home ranges are often presented as a subset of the total number of locations, such as excluding 5% of the outermost locations. Our home range estimates were still rapidly increasing in size by the end of the study, indicating that gathering more locations would have yielded larger area estimates. Although the number of locations and duration of study is minimally adequate for home range estimates (Kenward 2001), we believe it important to track more individuals over a longer period, to evaluate the total area utilized by individuals, to learn whether area used changes over the breeding season, and to determine what subset of locations should be used for home range estimate. Further, more study is needed to determine how frequently long distance forays (such as seen for WIFL1) occur, and whether some areas utilized in such forays should be included in home range estimates.

Most studies that have attempted to define the area occupied by Willow Flycatchers are not directly comparable to this study because they used mapping of flycatcher song perches to define a territory, which excludes detection of any extra-territorial movements (Hanski and Haila 1988). Given the difficulty of sighting flycatchers in the dense vegetation, many of the movements outside the core home range would not likely have been detected without telemetry-based research techniques. Flycatchers may require different amounts of area to support their breeding efforts at different sites, and in different years. Documenting these differences, and evaluating potential corollary factors, could provide important insight into general habitat needs of the flycatcher.

Habitat Use

Although flycatchers spent most of their time in the mature riparian habitat, they frequently used the surrounding young riparian scrub and non-riparian upland habitat. All individuals were detected in the upland sagebrush, suggesting that this adjacent non-riparian habitat may be important, although further study is needed to evaluate its importance for breeding success. The narrow, linear structure of the Fish Creek study area may have facilitated flycatcher use of nearby non-riparian habitat types. Flycatchers breeding at

sites in broad floodplains may not utilize more distant non-riparian habitats.

Across its range, the Willow Flycatcher breeds in a wide variety of habitats (Sedgwick 2000, Sogge and Marshall 2000). Documenting flycatcher habitat use, home range, and movement patterns across a range of habitat types would provide much needed insight into habitat requirements of the flycatcher in general, and the interaction of local landscapes and flycatcher movements. Also, because this study covered only a small portion of the breeding season, it will be important to determine how use changes over time. Our findings suggest that studies of flycatcher habitat characteristics and use may need to quantify vegetation beyond nest and song perch locations, and that a broader landscape-scale approach, taking into account adjacent habitats and land uses, may be important.

Movements

Flycatchers displayed a wide variety of movements. The frequent movement of all flycatchers out of the mature riparian habitat into surrounding areas, particularly the non-riparian upland habitat, throughout the day, was notable. Longer-term studies are needed to evaluate whether this frequency of movements occurs throughout the breeding season and at different sites.

The long-distance movements of WIFL1 were also unexpected. Whether the long distance movement of WIFL1 is unusual, or simply seldom observed, cannot be answered by this study. One explanation for this movement might be due to the different nesting stages of the flycatchers. Although we documented that the other three flycatchers were on active nests (eggs, young nestlings, and/or nest rebuilding), the nest of WIFL1 was not found. WIFL1 was paired at the beginning of the study, but it appeared that the pair bond degraded by the end of the study, and no fledglings were observed with either WIFL1 or its mate. Thus, WIFL1's long-distance movement may have been due to the collapse of its pair bond, and its search for other breeding opportunities.

CONCLUSION

We conclude that radiotelemetry is a viable technique for Willow Flycatcher research. We were able to successfully track individuals through dense vegetation and across relatively large distances, and we did not detect any negative effects of the transmitters on Willow Flycatchers. Results from this study suggest that flycatchers at Fish Creek use a much larger area than their defended territory, regularly utilize adjacent non-riparian habitat, and are capable of long-distance movements in a relatively short period of time. Future telemetry studies, especially at other sites, should provide information on how common, or rare, the findings of this study are. Objectives for further study include determining (1) the importance of the different habitat types used, (2) the importance of areas used during extra-territorial forays, and (3) whether the landscape composition at different sites influences flycatcher home range size and habitats use. Finding answers to these questions is particularly important for the management of the endangered Southwestern Willow Flycatcher (*E. t. extimus*).

ACKNOWLEDGMENTS

This study was made possible through funding by the U.S. Bureau of Reclamation, Phoenix office, and the U.S. Geological Survey. Particular thanks to H. Messing, S. Sferra, and M. Sogge. K. Covert and W. Block of the Rocky Mountain Research Station, Flagstaff, provided equipment for an earlier phase of this research that helped pave the way for this study.