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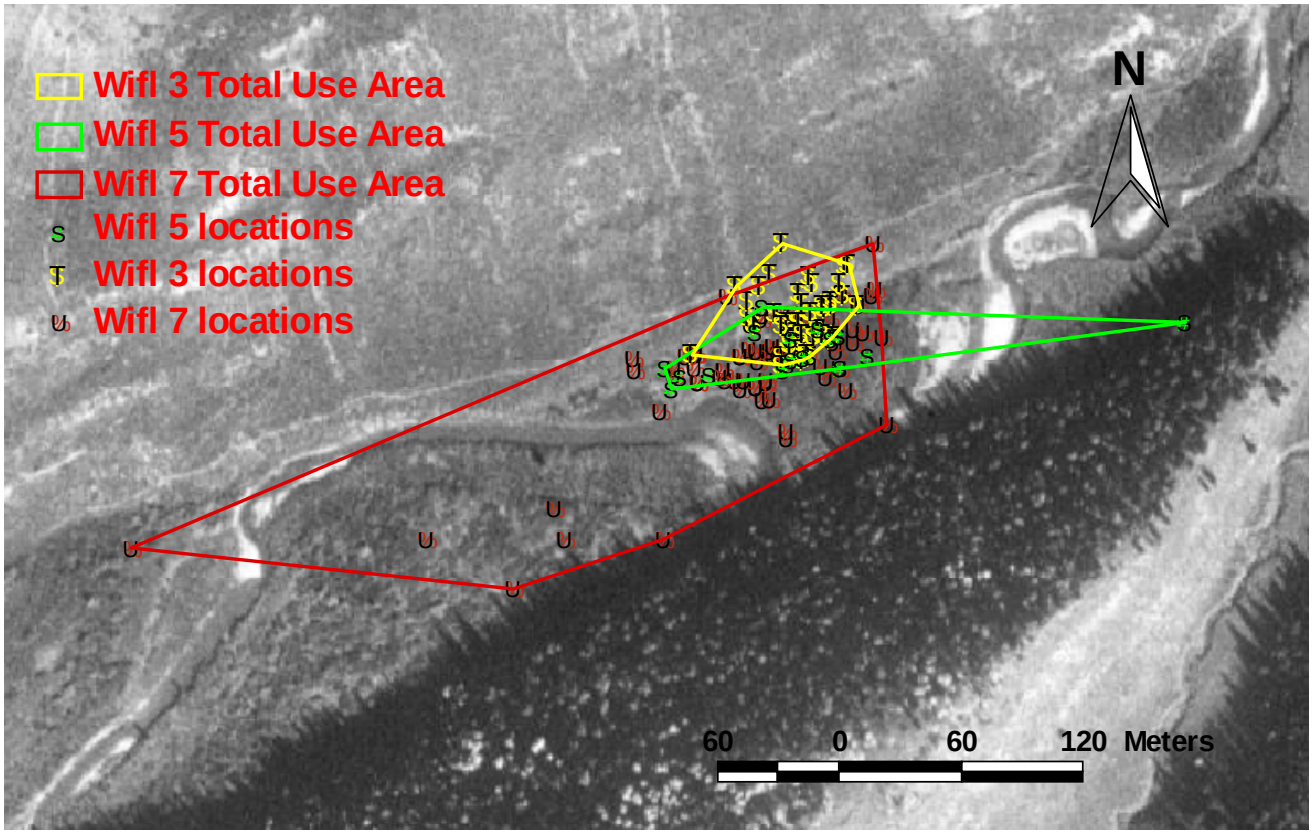
Home Range, Movement, and Habitat Use of Willow Flycatchers, Fish Creek, Utah - 2003



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Introduction

Riparian habitat is the transitional vegetation zone located between aquatic and upland habitats. Such habitat provides essential sources of water, food, cover, shade, and nest sites for a considerable proportion of the neotropical migrant land birds breeding in the southwestern and intermountain regions of the United States. Within the Great Basin, 82% of bird species depend, to some degree, upon resources provided by riparian areas (Ohmart and Anderson 1982). Anthropogenic activities such as water impoundment and diversion, grazing, recreation, timber harvesting, and land development place large demands on riparian systems, leaving riparian areas vulnerable to deterioration and loss (Gardner et al. 1999). It is estimated that as much as 95% of riparian habitats have already been lost or severely degraded in Utah, Arizona, and New Mexico (Ohmart and Anderson 1982, Krueper 1992).

The Willow Flycatcher (*Empidonax traillii*) is a small, neotropical migrant land bird that, in the arid west, is an obligate riparian breeder. The Southwestern Willow Flycatcher (*E.t. extimus*) has suffered serious population decline as the result of habitat loss and modification (Marshall and Stoleson 2000). The non-endangered northern subspecies, *E.t. adastus*, may also be suffering from habitat loss and degradation in parts of its range, yet has received considerably less research attention.

Willow Flycatchers maintain territories and build nests in dense shrub habitat (Sedgwick 2000). Most documentation of nesting habitat requirements is based on observations of singing males and on locating active nest sites (Sedgwick and Knopf 1992). However, male singing and female nesting activities represent only a portion of the birds' individual time budgets during the breeding season. Males generally only vocalize while within the boundaries of their territories and during the early stages of breeding, often quietly sulking and foraging while outside their territory or preferred habitat (Hanski and Haila 1988). Detections are biased in favor of males, as females are typically quieter, often remaining within dense stands of willow near their nests and vocalizing infrequently. Because activity away from breeding habitats is largely undetectable by observers relying upon sight and sound, data collected on habitat usage can be strongly biased by traditional survey techniques.

Management plans for the Willow Flycatcher tend to focus primarily on the riparian habitat where breeding occurs; however, flycatchers may depend upon a more diverse landscape to provide resources related to nesting, foraging, and predator avoidance. For example, Willow Flycatchers may be moving outside their territories for the acquisition of resources (e.g. food, water), for thermoregulation, or to obtain copulation with birds other than their mates (extra-pair copulations or EPCs). Furthermore, although considered a riparian obligate species, incidental observations of Willow Flycatchers outside of riparian habitats suggest that other habitat types within and around riparian breeding sites may be an important component of flycatcher habitat (Paxton et al. 2002). The value of these non-breeding habitat types to Willow Flycatchers is largely unknown, yet their use could have substantial management and conservation implications.

To overcome the difficulties of detecting Willow Flycatchers using traditional survey methods, this study utilized innovations in radio telemetry technology to investigate habitat use by Willow Flycatchers on spatial, temporal and behavioral scales. Telemetry has been used in wildlife research for at least 40 years, mainly on mammals and large birds. Recent advances in radio telemetry technology have decreased the size and weight of telemetry radios such that transmitters can now be placed on small passerines. Using radio telemetry, we investigated differences in home range size and habitat use between male, female, breeding and non-breeding flycatchers during the nesting season. Over the 2003 breeding season, 16 radios were attached to Willow Flycatchers at Fish Creek, and 13 of these 16 birds were successfully radio-tracked; this report presents initial analysis of that research.

METHODS

Study Area

This study was conducted along a five-mile extent of the Fish Creek drainage in Manti-La Sal National Forest, Carbon County, Utah. Fish Creek is a perennial high elevation (~2560 m) creek that drains the Wasatch Plateau from west to east into Scofield reservoir. Within the floodplain, Fish Creek is composed primarily of young and mature riparian vegetation (Fig. 1) that is dominated by willow shrubs (*Salix spp*.), growing in a continuous series of patches along the stream corridor. Herbaceous vegetation, open water (creek and beaver ponds) and upland habitat types border the riparian patches. Upland habitats consist of Englemann's spruce, White fir and Douglas Fir (*Picea engelmanni, Abies concolor* and *Pseudotsuga menziesii*, respectively) forest, and Quaking aspen (*Populus tremuloides*) forest on the south slopes of the creek, or a mixture of mountain shrub and desert shrub-steppe on the north slopes.

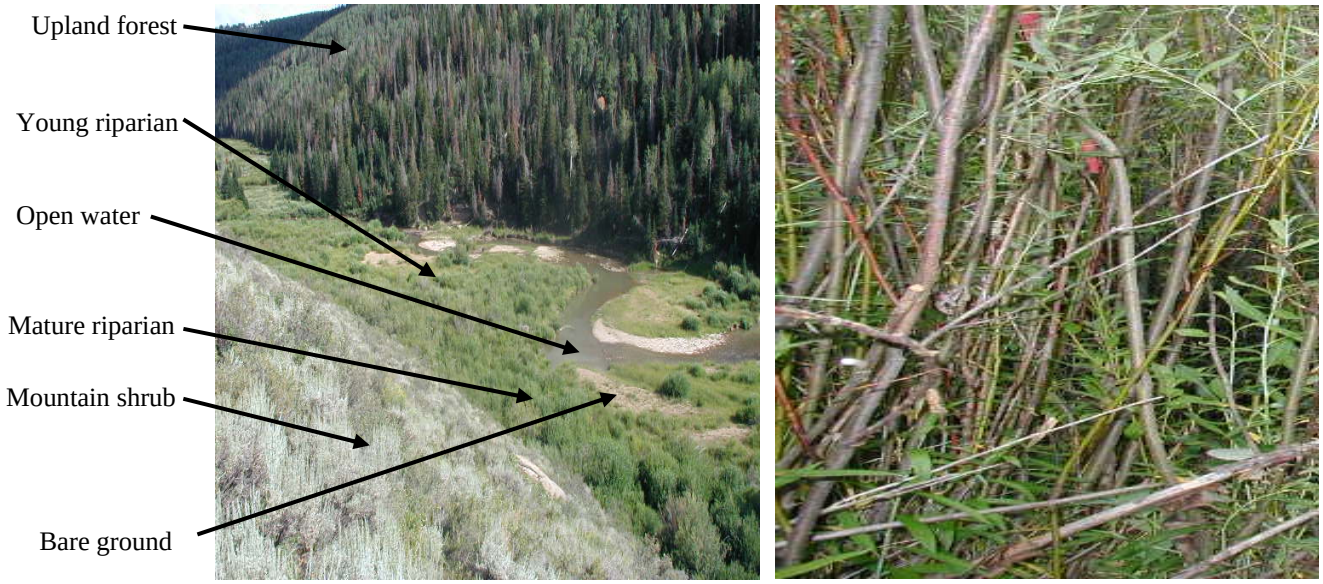


Figure 1. A typical stretch of Fish Creek showing all six habitat types (left) and an interior view of mature riparian habitat (right).

Line-transect surveys were conducted daily, using CD audio playback of conspecific songs and calls, to determine flycatcher presence along Fish Creek. Locations of territorial flycatchers were mapped onto aerial photographs of the Fish Creek drainage. Active territories were determined through observation of territorial behaviors such as defending against conspecifics, singing by males, and vocal or physical interactions between male and female Willow Flycatchers. Flycatchers maintained territories in seven patches of riparian habitat distributed linearly along Fish Creek within the study area (Table 1). Nest searching was conducted in territories where pairing was confirmed. All efforts to capture, band, and apply transmitters were focused on birds with confirmed active breeding status. Flycatchers in breeding condition (enlarged cloacal protuberance or brood patch) and/or captured adjacent to known nests were assumed to be breeding at the time of capture.

Table 1. Listing of habitat patches used by Willow Flycatchers at Fish Creek from June to August 2003, including patch number, patch name, approximate distance of each patch from the campground, area of patches, and Willow Flycatchers that utilized the patch.

Patch number	Patch name	Approximate distance from campground (m)	Area (ha)	Willow Flycatchers that used the patch
1	Campsite	158	2.747	8,9
2	Cougar	383	1.581	1,2
3	French Creek	1192	0.429	6,11
4	Trailside	1408	1.139	3,4,5 and 7
5	Lone fir	1623	2.566	10,12,and 13
7	Twin	2886	2.621	14,16
10	Gooseberry	4356	3.049	15

Capture and Banding

Willow Flycatchers were captured using mist-nets, which provide the most effective technique for live-capture of adult songbirds (Bibby et al. 1992, Ralph et al. 1993). Birds were captured using both passive netting and target netting techniques. Typically, target netting was attempted first (per Sogge et al. 2001), with speakers were placed on both sides of a mist net and various songs and calls of conspecifics broadcast to lure the territorial flycatchers into the mist net. When target netting was unsuccessful, birds were passively netted by placing numerous mist nets within a flycatcher territory, strategically positioned to intercept birds on observed flight patterns between song perches and nest sites

Once captured, Willow Flycatchers were banded with a red anodized Federal numbered band on one leg, and a unique colored metal band on the opposite leg. Age was determined by examining plumage and molt patterns. Sex was determined based on the presence of a cloacal protuberance in males or brood patch in females, and in some cases based on wing chord and tail length (Pyle 1997). The weight of flycatchers was recorded and morphometric data was taken for wing length, tail length, bill length (nare to tip), and bill width (at distal edge of nares).

Transmitter Specifications and Attachment Method

After a flycatcher was banded and measured, a radio transmitter was attached to its lower back. The transmitter used on Willow Flycatchers at Fish Creek was the Holohil LB-2N (Table 2). The LB-2N weighs 0.4 grams while the average Willow Flycatcher weighs ~ 12.0 g. Of the 16 birds to which the transmitter was applied, the combined weight of the transmitter, grid cloth, skin bond, and bands, ranged between 3.6% to 4.3% of total body weight.

Table 2. Specifications of the LB-2N transmitters, including life span, and total weights of the transmitter and bands.

Transmitter model	Battery life (days)	Initial transmitter weight	Grid-cloth(g)	Skin-bond(g)	Total transmitter Weight (g)	Service band (g)	Total weight (g)
Holohil LB-2N	21	0.40 g	0.01	0.02	~0.44	0.07	0.44 - 0.45

Of the multiple methods available for transmitter attachment (Kenward 2001), we used the glue-on technique, determined to be safe on Willow Flycatchers (Paxton et al. 2002). The transmitters were prepared in advance for attachment by gluing lightweight grid-cloth to the sandpaper scoured bottom of the transmitter. Following capture and banding, each flycatcher was held in a grip that limited the bird's wing and leg movements but exposed their lower back. A small group of back feathers were removed, an even layer of Skin-bond was applied to both the back of the bird and the transmitter, and the transmitter was attached. After allowing 5 minutes of drying time, the back tract feathers were rearranged to cover the transmitter and the bird was released. The entire banding and transmitter application process took less than 20 minutes, and each bird was constantly monitored for signs of stress.

Tracking Methods

Tracking was conducted at least four times daily for each Willow Flycatcher, within four established time periods; AM early (0600-0915), AM late (0916-1230), PM early (1231-1545) and PM late (1546-1900). All tracking of individuals was randomly assigned within each time interval; for the most part, the tracking efforts for each bird were evenly distributed across all four intervals, with a goal of collecting at least 30 locations per bird. Equipment used in tracking included R-1000 Telemetry receivers manufactured by Communications Specialists, Inc. and standard hand-held 3-element yagi antennas.

Several methods were used to pin point the location of the telemetered birds; all were slight variations of the homing-in method described by Paxton et al. (2002). Frequently, the location of an individual was determined by homing-in and visual confirming from a distance of up to 50 m. If the telemetry signal was irregular and/or the flycatcher was foraging or moving through vegetation (preventing observation), the tracker moved slowly and quietly towards the bird, following the bearing that produced the strongest signal, and acquired a location while trying to avoid disturbance to the bird. In all cases, attempts were made to resight and observe the flycatcher in order to collect behavioral data associated with its location. After the bird was observed, the technician waited for the bird to move from its location and then acquired GPS coordinates at that location.

Occasionally, the tracker disturbed the flycatcher prior to observation, causing it to fly away. In such cases, we recorded an estimate of the location of the bird before it was disturbed. On some occasions a flycatcher was heard nearby but a visual confirmation was not possible due to thick vegetation. In this case, both the homing-in method and the vocalizations were used to determine the position of the bird. For all location points, information such as perch

substrate, position in the substrate, habitat type, and vocalization types were recorded. Additionally, detailed behavioral data was collected.

Tracking was continued daily until the transmitter failed due to battery failure, or the flycatcher became undetectable. Although extensive efforts were made to try to relocate a flycatcher when a signal was lost, we were not always successful due to the limited range of the transmitters.

Nest Searching and Monitoring

Active Willow Flycatcher nests were located within each territory of the five flycatcher pairs used in this study. Once a nest was located, the location was recorded via GPS. Nests were visited every four to five days in order to monitor their progress, with monitoring continued until fledging, abandonment, or depredation.

Home Range and Total Use Area Analysis

Home range is defined as an area that an organism normally uses to forage, breed and care for young (Burt 1943). We feel it is appropriate, based upon the flycatcher's natural history and behavior, to distinguish between two distinct types of home ranges based on scale (see Tyron and MacLean 1980, Hanski and Haila 1988). The core area is the region surrounding the arithmetic mean of a territory that is actively defended against conspecifics, and contains the nest; we chose to represent this with a 50% kernel. The extended home range contains the core area and a larger region used for foraging; we chose to represent this with a 95% kernel.

We used ArcView 3.3 to project flycatchers' telemetry locations (in UTMs) onto aerial photographs of the Fish Creek drainage. The core area and extended home ranges were computed using the kernel home range function provided by the Animal Movement Extension (Hooge and Eichenlaub 1997). The total area used by each bird was computed using the minimum convex polygon function available through the Animal Movement, which creates a polygon containing all telemetry locations of a bird. We also examined the average and furthest distance traveled between all telemetry locations for each Willow Flycatcher.

Assessing Habitat Availability

Rectified aerial photographs of the Fish Creek drainage were used to classify habitat types of the drainage. Six habitat types were identified at Fish Creek: mature riparian habitat, young riparian habitat, bare ground, upland forest, upland mountain shrub steppe, and open water (Table 3). In our analysis of habitat use versus availability we precluded open water from our consideration, using the remaining five categories to classify habitat used and available.

Table 3. The six land-cover types identified at the Fish Creek study area.

Habitat type	**Definition**
Mature riparian	Stands of mature *Salix spp*. (> 2 m tall) dominated vegetation found adjacent to standing water. An understory of mixed grasses and forbes should be present. Breeding habitat for flycatchers.
Young riparian	Stands of shrubby, mixed vegetation found adjacent to standing water. Typically, comprised of *Salix spp*. (< 2 m tall) that may grow as isolated shrubs, or may be found in stands. Willows may be interspersed with other shrub species including black twin-berry (*Lonicera involucrate*), choke cherry (*Prunus virginiana*), serviceberry (*Amelanchier alnifolia*), and various forbes and grasses. Vegetation may also be interspersed with areas of bare ground.
Bare ground	Ground void of vegetation and comprised of bare soil or rock.
Upland forest	Thick stands of various tree species including White Fir, Douglas Fir, Englemann's Spruce, and Quaking Aspen.
Mountain shrub steppe	Various shrubs including but not limited to big sagebrush (*Artemisia tridentate*), choke cherry, gooseberry (*Ribes spp*.), black twin-berry, service berry, and rabbitbrush (*Chrysothamnus spp*.). Shrubs are interspersed with various forbes and grasses.
Open water	Areas of flowing or standing water of measurable depth.

All habitat used and available was determined from GIS layers derived from the rectified aerial photographs of Fish Creek. Used habitat was determined by overlaying the GPS locations of each flycatcher with the vegetation layers. In assessing habitat availability, difficulty occurs in determining the point at which habitat becomes unavailable (Johnson 1980). Initially, we chose to base habitat availability on the behavior of the birds by using the furthest distance traveled by Willow Flycatchers from the arithmetic means of their telemetry locations; this measure varied considerably from one bird to another. Therefore, we decided to find the mean furthest distance traveled by all Willow Flycatchers based on the arithmetic means of their telemetry locations (100 m), and used it to quantify available habitat.

The mean furthest distance traveled by all birds was used to identify a 200 x 200 m box around the arithmetic mean of a bird's telemetry locations. Each 4 ha box was broken down into the six habitat types identified at Fish Creek (Table 3). These boxes represent the habitat immediately available in the area within and surrounding the home ranges of each bird. Habitat was considered "used" when a radio location occurred in that particular habitat type.

Results

Tracking

Willow Flycatchers were selected for radio attachment after the first nests were located on the 5 June. Birds were numbered sequentially from WIFL 1 to WIFL 16 in the order that they were captured (Table 4), and tracked over 62 days in seven habitat patches from 6 June through 7 August 7 (Figs. 2 and 3). The mean duration of time spent radio tracking flycatchers was 12 days (range = 1 - 23; Fig. 4). The tracking of females was more consistent than males, as no female was radio tracked for fewer than five days while five different males were radio tracked for less than five days each. Over this two month period, 693 locations were collected with an average of 43 telemetry locations per bird (range = 4 – 86; Table 4).

Table 4. Willow Flycatcher banded and radio-tracked during 2003 at Fish Creek. Data includes sex (M = male, F = female, U = unknown), age (AHY = after hatch year, SY = second year), location of capture, Federal band number, color band combination, tracking start and end date, pair number, and nest number.

WIFL #	Sex	Age	Location of capture	Federal Band	Color band	Tracking start date	Tracking end date	Pair #	Nest #
1	F	AHY	Cougar	2280-96765	GW:RR	6/6/2003	6/29/2003	2A	2A & 2B
2	M	AHY	Cougar	2280-96766	RR:RK	6/7/2003	6/8/2003	2A	2A & 2B
3	F	AHY	Trailside	2280-96776	RR:YD	6/9/2003	6/30/2003	4A/4B	4A
4	U	AHY	Trailside	2280-96767	WW:RR	6/9/2003	6/10/2003	Unknown	Unknown
*5	M	AHY	Trailside	2280-96798	VG:RR	6/9/2003	6/13/2003	4A	4A
6	M	AHY	French Creek	2280-96769	KZ:RR	6/14/2003	7/7/2003	3A	3A
7	M	AHY	Trailside	2280-96770	GZ:RR	6/18/2003	7/7/2003	4B	4A
8	M	SY	Campsite	2280-96762	ZW:RR	6/19/2003	7/4/2003	Non-breeding	None
*9	U	SY	Campsite	2280-96763	KD:RR	6/23/2003	6/26/2003	Unknown	Unknown
10	F	AHY	French Creek	2280-96764	DW:RR	7/2/2003	7/12/2003	Non-breeding	None
11	F	AHY	French Creek	2280-96771	RR:OW	7/7/2003	7/12/2003	3A	3A
12	F	AHY	Lone Fir	2280-96772	YZ:RR	7/12/2003	8/2/2003	5A	5A
13	M	AHY	Lone Fir	2280-96773	KV:RR	7/12/2003	7/31/2003	5A	5A
14	M	AHY	Twin Patch	2280-96777	YG:RR	7/20/2003	8/4/2003	7A	7A
15	U	SY	Twin Patch	2280-96775	RR:OO	7/20/2003	7/22/2003	Floater	None
16	F	AHY	Twin Patch	2280-96780	RR:RW	7/24/2003	8/7/2003	7A	7A

* denotes bird of known mortality

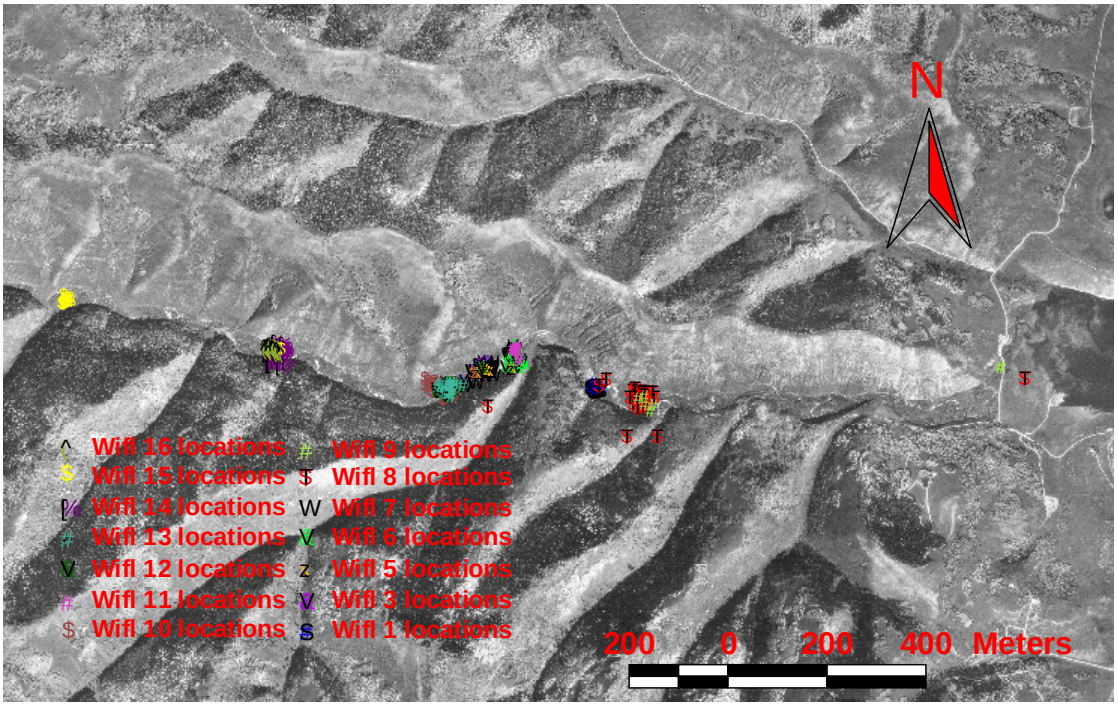


Figure 2. Distribution of the locations of 14 Willow Flycatchers tracked along Fish Creek, UT.

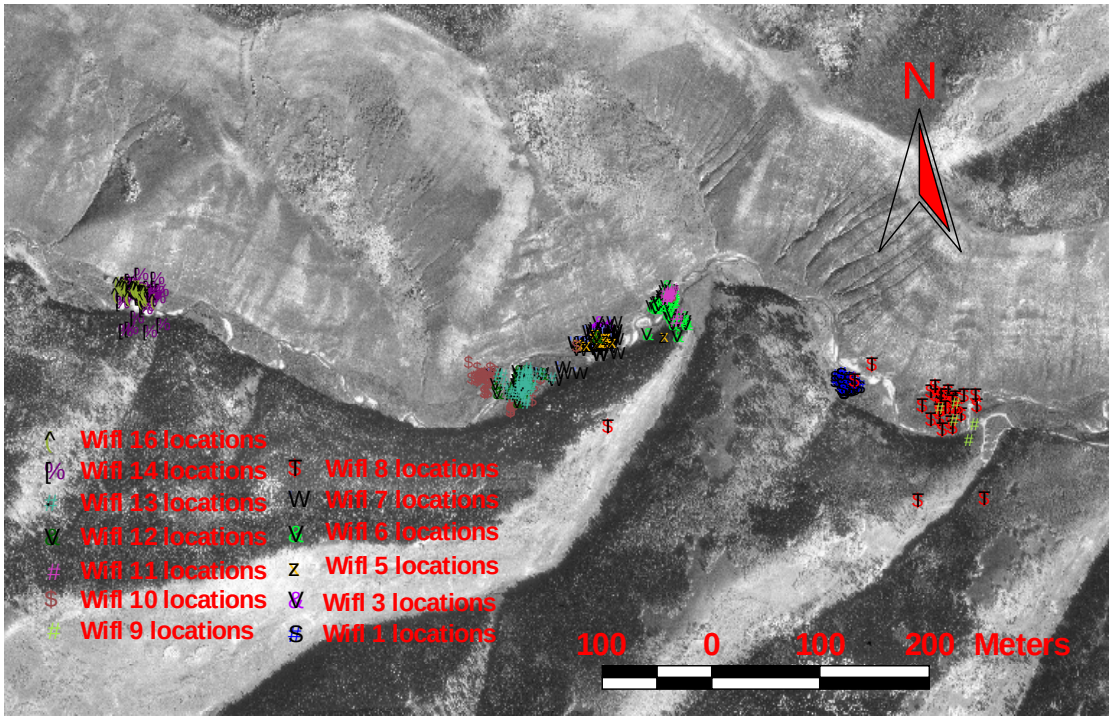


Figure 3. Enlarged view of a 5 km stretch of Fish Creek containing radio locations of 13 Willow Flycatchers.

We placed each flycatcher into one of four breeding status categories (Table 4). Territorial flycatchers exhibiting pair-like vocal interactions and maintaining an active nest were considered "breeding". Birds that demonstrated territorial behavior but did not have an active nest were classified as "territorial non-breeding". Flycatchers that were acting non-territorial were considered "floaters." Flycatchers that were not tracked long enough to determine breeding status were classified as "unknown". Although we intended to track only breeding pairs, five of the 16 telemetered flycatchers did not exhibit breeding behavior during the period of time that we tracked them. One left the study site within a day of being captured and may have been a migrant, another was hit by a car before its status could be determined, and the other three exhibited non-territorial (floater) behavior.

Four of the five nests monitored over the course of the study successfully fledged young (Table 5). Radio telemetry was conducted during all stages of the breeding season including nest building, egg incubation, feeding of nestlings and fledging of young. Telemetry coincided most frequently with feeding of nestlings and least frequently with fledging of young (Fig. 5).

We attempted to re-sight all Willow Flycatchers involved in this study after their transmitter batteries failed. Pairs 1A, 3A, 5A and 7A were observed completing their breeding efforts and feeding fledglings. When we were no longer able to locate territorial birds in August, we assumed they dispersed along with their fledglings from the nest area. Pair 2A was not observed after the nest predation event that occurred on 13 July. We recorded the death of two individuals:

Table 5. Nesting information concerning the six Willow Flycatcher nests that were monitored at Fish Creek from June-August, 2003, including pair number, male and female members of the pair, nest number, date found, initial nesting stage status, outcome of nesting attempt, and number of fledglings produced per nest.

Pair #	Male	Female	Nest #	Date found	Initial Status	Date Completed	Outcome	# fledglings
2A	WIFL 2	WIFL 1	2A	6/5/2003	building	6/7/2003	abandoned	0
			2B	6/9/2003	building	7/26/2003	fledged	2
3A	WIFL 6	WIFL 11	3A	6/26/2003	incubating	7/12/2003	depredated	0
4A	WIFL 5 & 7	WIFL 3	4A	6/5/2003	building	7/20/2003	fledged	3
5A	WIFL 13	WIFL 12	5A	7/10/2003	incubating	8/1/2003	fledged	4
7A	WIFL 14	WIFL 16	7A	7/22/2003	feeding	8/1/2003	fledged	2

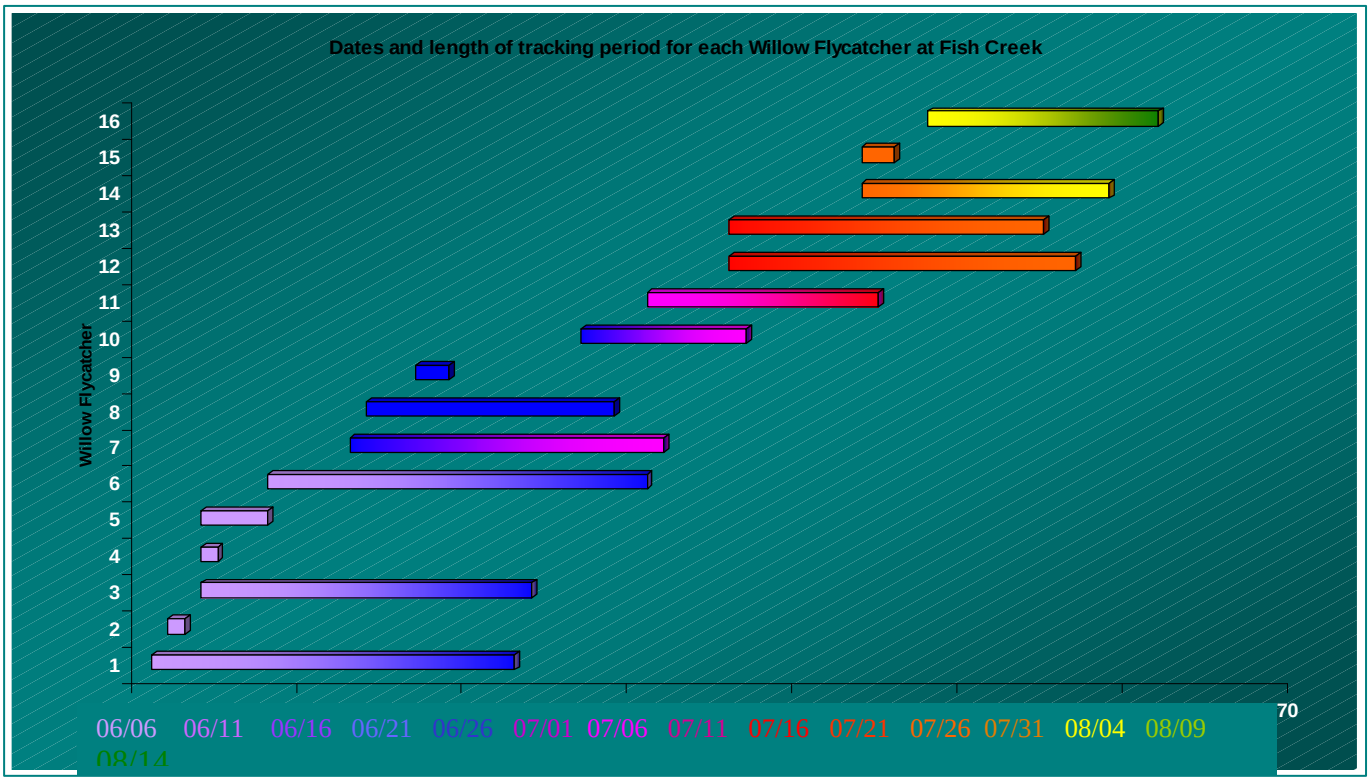


Figure 4. Tracking start and end dates for all 16 Willow Flycatchers tracked at Fish Creek, 2003, showing length of tracking period.

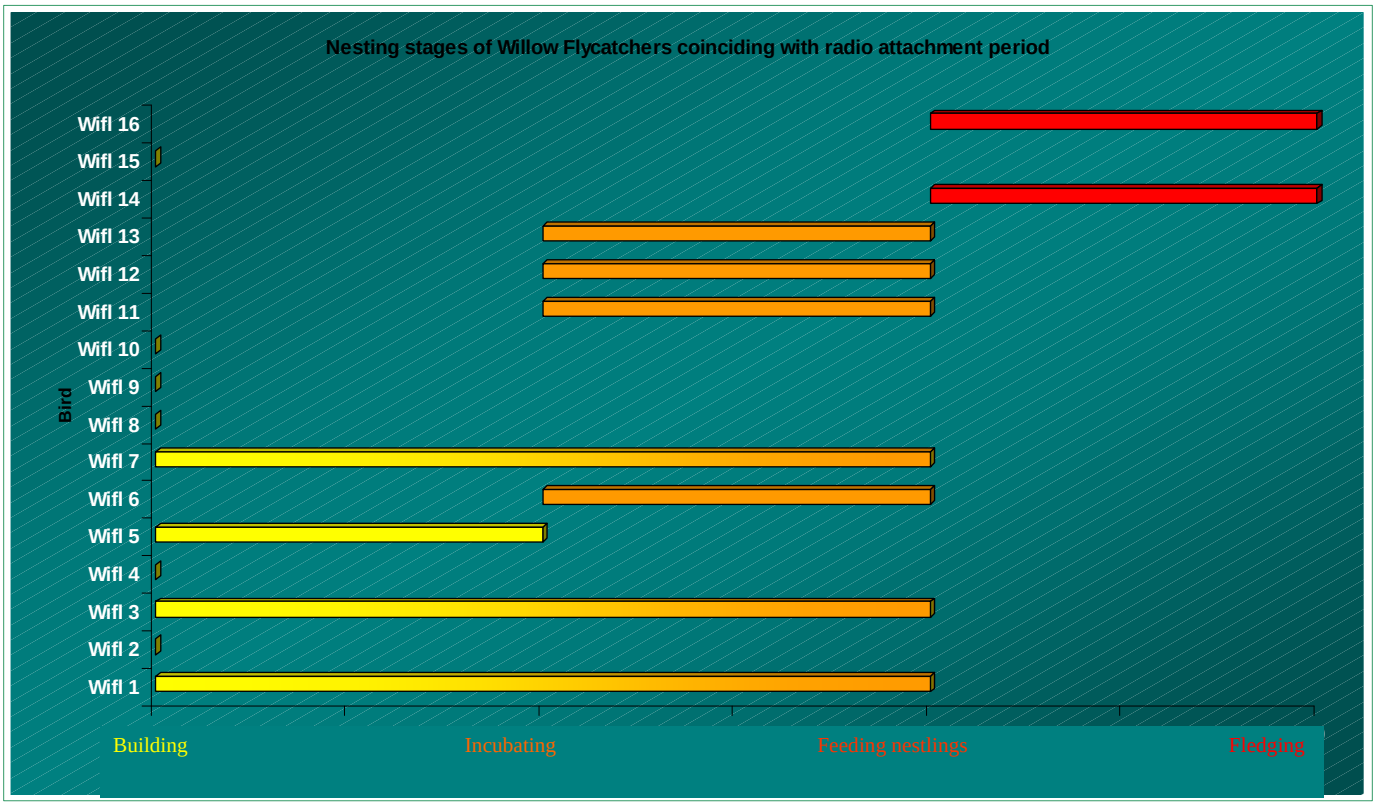


Figure 5. Nesting stages of telemetered Willow Flycatchers during the period they were tracked.

Home Range, Total Area Used and Movements

We collected a minimum of 30 radio telemetry points per individual for 10 of 16 birds. Core area, extended home range and total use area were computed for those 10 flycatchers (Figs. 7, 8 and 9), and for WIFLs 5 and 11, which had 19 and 28 detections, respectively. The core area measurements varied from 0.01 to 6.30 ha, extended home range estimates varied from 0.11 to 21.91 ha, and total use area ranged from 0.21 to 75.50 ha (Table 6).

Table 6. Total use area, core area, and extended home range for 12 radio tracked Willow Flycatchers at Fish Creek, UT. Information presented includes WIFL number, minimum number of days with attached radio, maximum number of days with attached radio, number of days tracked, use area size in hectares, maximum distance between locations, average distance between locations in meters, core area in hectares, and area of extended home range in hectares. NA (not available) is listed when value could not be computed due to lack of telemetry data.

								Fixed Kernels	
WIFL #	Minimum # of days attached	Maximum # of days attached	Days tracked	Number of Locations	Maximum distance b/t locations (m)	Average distance b/t locations (m)	Total use area (ha)	Area of core (ha)	Area of extended home range (ha)
1	23	N/A	23	71	53	22	0.22	0.02	0.22
2	23	N/A	1	5	20	14	NA	NA	NA
3	21	42	21	71	69	22	0.30	0.01	0.11
4	1	N/A	1	4	409	237	NA	NA	NA
5	4	4	4	19	212	51	0.47	0.15	0.95
6	19	N/A	19	86	244	42	2.08	0.11	0.55
7	20	33	20	71	327	63	2.75	0.30	1.20
8	15	N/A	15	36	2572	273	75.50	6.30	21.91
9	3	3	3	7	2377	823	NA	NA	NA
10	10	N/A	10	40	652	102	6.36	0.65	4.64
11	5	N/A	5	28	84	19	0.21	0.02	0.11
12	20	N/A	20	81	283	29	1.47	0.03	0.24
13	19	19	19	63	106	40	0.98	0.06	0.69
14	14	N/A	14	54	148	49	1.71	0.01	1.07
15	2	N/A	2	12	1474	425	NA	NA	NA
16	14	N/A	14	42	75	27	0.32	0.06	0.39

The sizes of the core area, extended home range and total use area differed as a function of both breeding status and sex (Tables 6 and 7; Fig. 6). The extended home range of WIFL 8, a second year non-breeding male, was 21.91 ha; >18 times greater than the largest extended home range maintained by a breeding male. The extended home range of WIFL 10, our only non-breeding female, was 4.64 ha; >12 times greater than the largest extended home range of a breeding female. The mean core area for breeding males (0.14 ha) was much greater than for breeding females (0.02 ha). Similarly, the mean extended home range was larger for breeding males (0.76 ha) than breeding females (0.21 ha), as was the mean total use area for breeding males (1.6 ha) and breeding females (0.50 ha).

Distances traveled between consecutive telemetry locations also varied greatly (Table 6; Fig. 6), ranging from 53 to 2,572 m. The mean distance traveled successively between points for all breeding male Willow Flycatchers (113 m) was greater than the mean for all breeding female Willow Flycatchers (37 m; Table 7).

We conducted 2-sample paired t-tests to compare differences in core home range, extended home range, total use area size and mean distance traveled successively between points among breeding pairs of flycatchers. Results indicate a significant difference between males and females in all categories (Table 7), with males having larger areas ranged and longer distances moved.

Table 7. Average sizes of core area, extended home range, total use area and mean distance between locations of breeding Willow Flycatcher pairs, separated by sex, with associated P-values for paired t-tests.

Sex	Mean core area (ha)	Mean extended home range (ha)	Mean total use area (ha)	Mean distance b/t locations (m)
Male	0.14	0.76	1.60	45
Female	0.02	0.21	0.50	24
P-Value	0.04	0.009	0.03	0.007

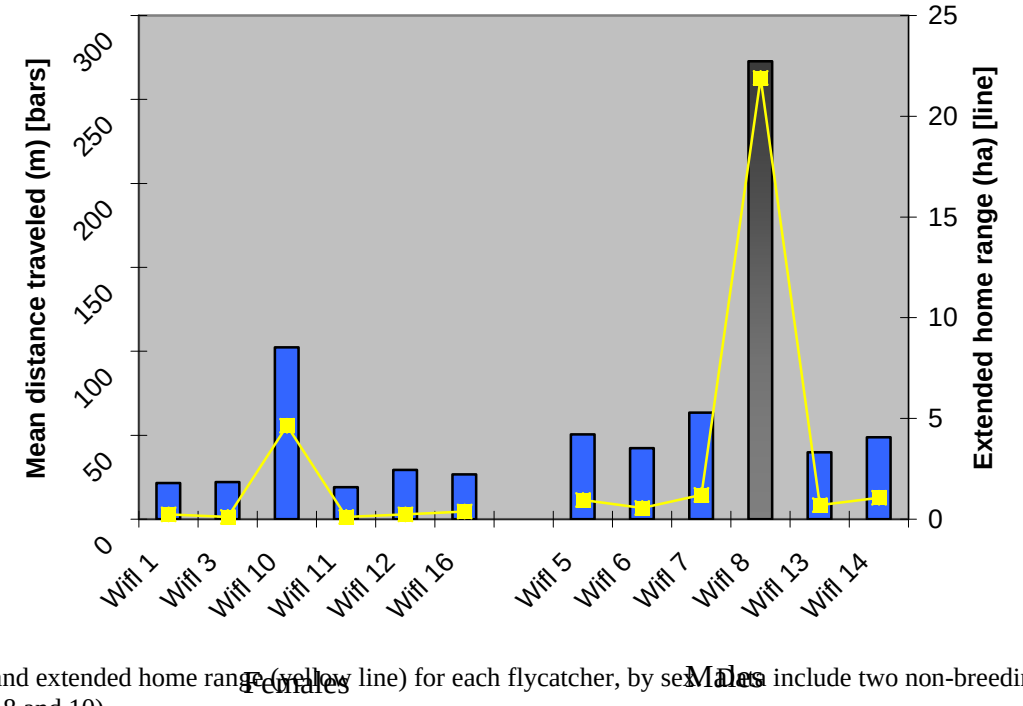


Figure 6. Mean distance traveled between successive locations (blue bars) and extended home range (yellow line) for each flycatcher, by sex. Males include two non-breeding birds (WIFLs 8 and 10).

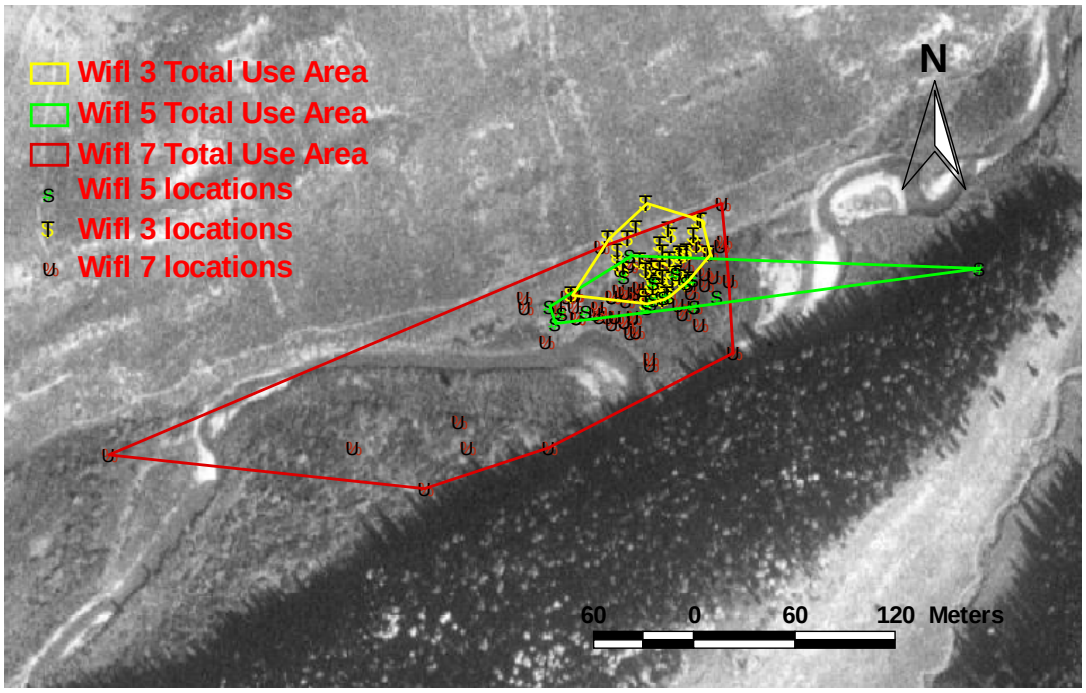


Figure 7. Telemetry locations and total use area of three Willow Flycatchers. WIFL 3 (female, in yellow) was paired with WIFL 5 (male, in green), who died, then paired with WIFL 7 (male, in red).

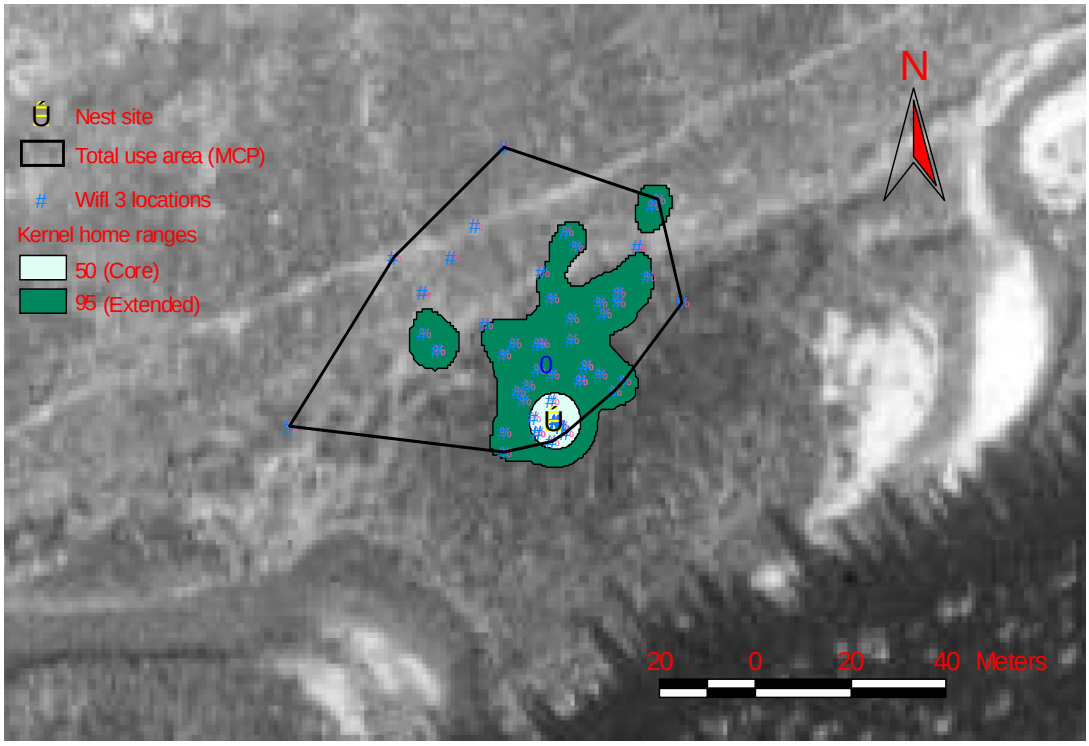


Figure 8. WIFL 3 (female) telemetry locations, core area, extended home range and total use area.

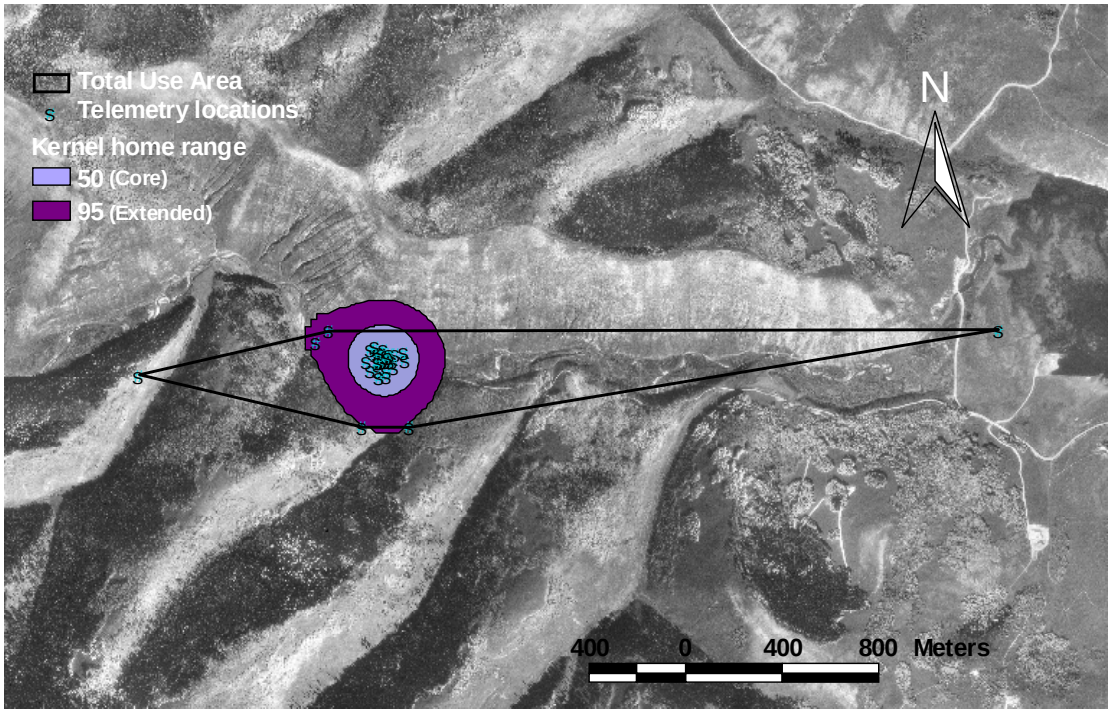
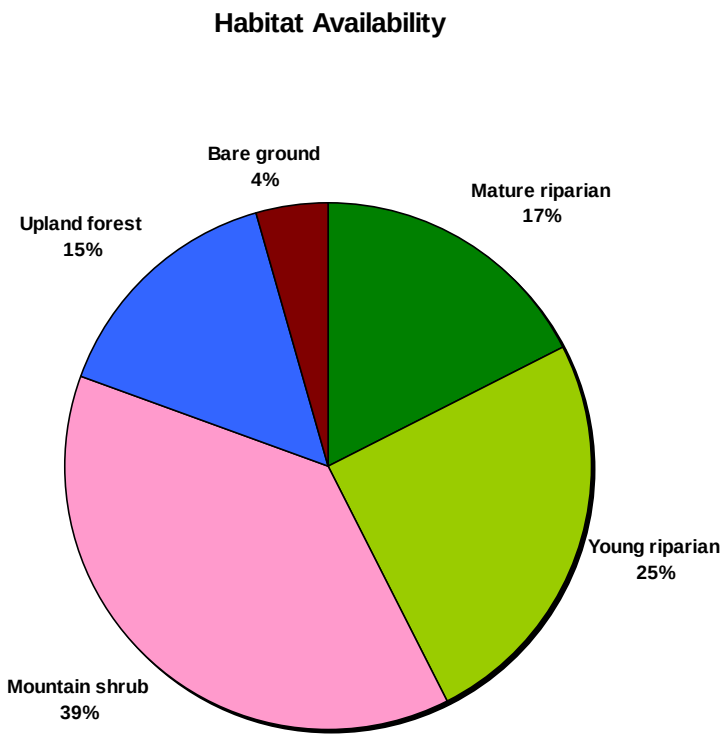


Figure 9. WIFL 8 telemetry locations, core area, extended area, and total use area.

Habitat Availability and Use

The habitat at Fish Creek was comprised of mountain shrub steppe (35%), young riparian (23%), mature riparian (16%), upland forest (14%), and bare ground (4%; Figs.10 and 12). The proportion of each habitat type within the 4-ha polygon surrounding the arithmetic center of telemetry locations of individual flycatchers varied (Fig. 11).

Willow Flycatchers did not use the habitats in proportion to their availability (Fig. 10). Although not the most commonly available habitat type, 80% of all detections occurred in mature riparian habitat (range = 53 -100%). Use of young riparian was less common, totaling 12% of all flycatcher locations (range = 0 – 33%). Mountain shrub steppe, the most common habitat type at Fish Creek, accounted for only 7% of the telemetry locations (range = 0 - 24%). Use of upland forest ranged from 0% to 9%. Birds were not observed using the bare ground habitat type.



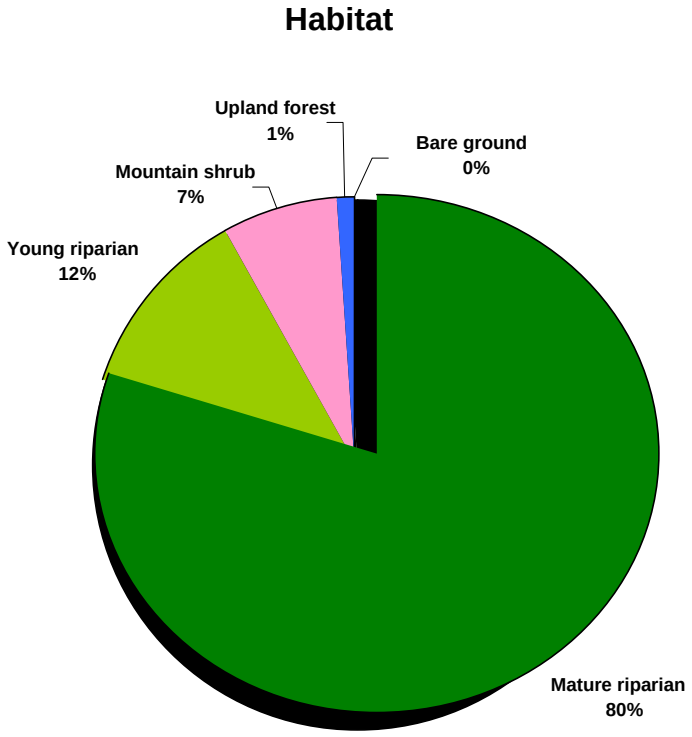


Figure 10. Habitat availability versus use at Fish Creek, UT, for all flycatchers combined.

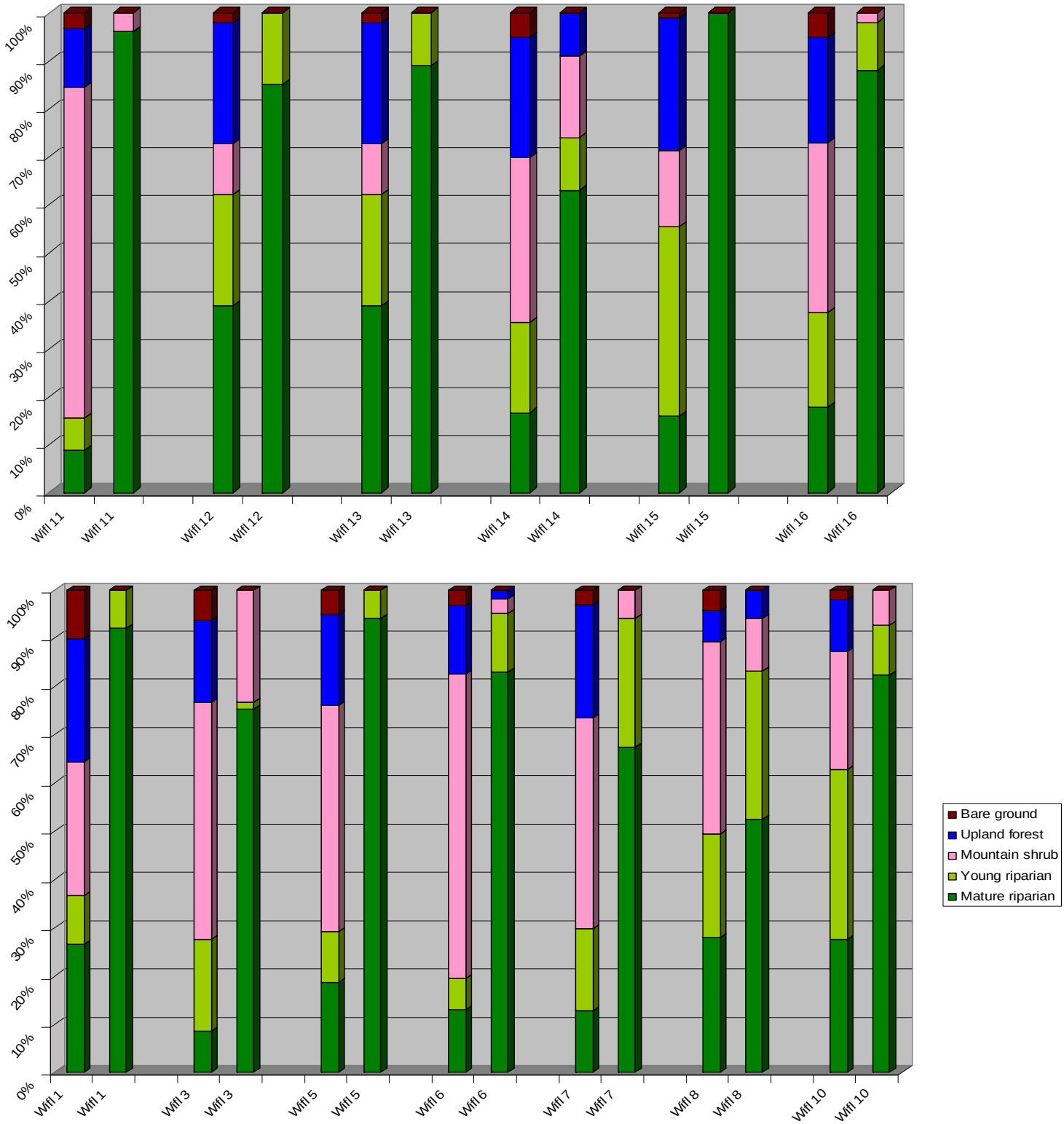


Figure 11. Individual habitat use versus availability at Fish Creek for 13 Willow Flycatchers. For each flycatcher, the left hand column shows the habitat available in the 4-ha plot surrounding arithmetic mean of radio telemetry locations. The right hand column corresponds to proportion of habitat type used. All flycatchers showed significant difference between available versus used habitat ($P < 0.05$).

Discussion

Radio telemetry provides an excellent tool to refine and expand what is known about Willow Flycatcher's use of different habitats, size of home ranges, and extent of long distance movements. It also allowed us to locate flycatchers continuously throughout the day, and to observe their movements and behaviors, even at times when birds were often silent and/or away from their core territories. Traditional census and survey techniques, such as line transects or point counts, would have been ineffective during such times. Thus, telemetry is an essential tool when there is a need to for locate flycatchers at all periods of the day and at the varying locations to which they may move.

An important consideration of this study, which involved the first application of radio transmitters to Willow Flycatchers, was the technique's safety with regard to the bird. Over the course of the 2003 field work, two of the 16 transmittered flycatchers died – one from predation and another from vehicle collision. On June 13th, a Sharp-shinned Hawk (*Accipiter striatus*) preyed upon a territorial male (WIFL 5). The hawk was later seen capturing other small birds within 300 m from where WIFL 5 was recovered, indicating that the hawk was actively predating passerines within this local area. On June 26th, a second flycatcher was found dead approximately 1 m west of the Scofield reservoir road, where it had been hit by a car. Because of these losses, we were initially concerned that the radio transmitters compromised the flycatchers' flight ability, thereby potentially increasing mortality. However, although birds with recently attached transmitters sometimes picked at them immediately after application, they appeared unencumbered throughout the duration of the study. Their foraging behavior and flight also appeared normal, and the nesting success of telemetered flycatchers at Fish Creek was high (4 of 5 nests fledged 2-4 young per nest). Thus, we do not believe that the radios compromised the ability of the birds to forage and nest successfully, and the observed mortalities were likely normal events that would have gone unobserved without telemetry.

Home ranges, total use area and movements between telemetry points

Breeding status and sex influenced the size of a bird's core and home ranges, and total use area. Breeding females used significantly smaller areas of the Fish Creek landscape than did non-breeding females, breeding males, and non-breeding males. The lone non-breeding, territorial male (WIFL 8), maintained the largest core area, home range, and total use area of all of the flycatchers. A similar trend was observed in the mean and longest distances traveled between consecutive telemetry locations; breeding females traveled smaller distances than did breeding males, and WIFL 8 (non-breeding male) traveled the longest distance.

Breeding birds

The habitat use behavior of a breeding bird may be strongly influenced by its need to maintain a nest and care for young. Male flycatchers have fewer nest tending responsibilities than females (Sedgwick 2000), which may allow them to travel longer distances and use non-mature riparian habitats more frequently. In contrast, female must provide extensive care to eggs and young, which may limit the distance they can travel away from the nest. This could explain why the extended home ranges of two breeding males (WIFLs 6 and 14) included more non-mature riparian habitat types than did the extended home ranges of their respective females (WIFLs 11 and 16). However, this pattern was not universal – the male and female

of pair 5A showed little difference in their use of various habitat types. Similarly, although WIFL3 used a smaller area than her male mates, she made use of the mountain shrub steppe more frequently than WIFLs 5 or 7. Despite individual differences, however, male flycatchers used non-breeding habitat types significantly more frequently than female flycatchers.

Non-breeding birds

Non-breeding males utilized a considerably larger combined total area (75.5 ha) of Fish Creek than breeding males (8.00 ha). The longer movements and larger total use area may indicate that they were in search of extra-pair copulations, territories or unpaired females. WIFL 8 made some particularly interesting movements: on July 1st he was tracked over 300 m south of the creek to the top of the south ridge (Fig. 7), where he foraged silently in the upland forest for more than an hour and covered a large area before returning to his territory.

The banding and tracking of a non-breeding female (WIFL 10) was unexpected but provided interesting information. Her core area and extended home range were considerably larger than those of her breeding female counterparts. She was observed foraging silently in various habitat types and made use of non-mature riparian habitats in 19% of our observations. She had a well-developed brood patch at the time of capture, so we assume that she had a failed nesting earlier on in the breeding season. Rather than making a second nesting attempt, it appears that she spent the remainder of her time at Fish Creek foraging silently before leaving the area.

Three of the four telemetered non-breeding males were aged as second year birds. Thus, younger males may make up a large proportion of the non-breeding and/or floater population. Given that differences in breeding status affect landscape use, additional studies of non-breeding males are needed to further verify the patterns we observed.

Factors that influence use of various habitats

Eighty percent of telemetry locations at Fish Creek occurred in mature riparian habitat, demonstrating that this habitat type is important to Willow Flycatchers for reasons beyond nest placement. However, 14 of 16 birds also used non-mature riparian habitats on at least one occasion, illustrating that flycatchers use a variety of habitats during the breeding season. An individual's selection of its nest site is often influenced by a particular "landscape neighborhood", where various land cover types surround a central core habitat thus creating a landscape mosaic (Pulliam 1988, Pulliam and Danielson 1991, Pearson 2002). We suspect that the broader landscape configuration, not just the mature riparian habitat patches, influences Willow Flycatcher's breeding site selection, as evidenced by the flycatcher's frequent use of non-nesting habitats.

There is also annual variation in the degree of non-riparian habitat use. Preliminary telemetry research conducted at Fish Creek (Paxton et al. 2002) over an eight day period in 2002 found a greater use of non-mature riparian habitat (52% of telemetry locations) than occurred in 2003. The reasons for such differences are unclear, but could be due to factors such as annual variation in rainfall, which may affect local insect prey abundance and distribution. Annual precipitation was variable at Fish Creek: 2002 was an extremely dry year, with below average winter snow pack levels; 2003 was dry but less extreme.

Additional research may yield insights as to whether rainfall variation affects the flycatcher's use of habitat types on a landscape.

Spatial and temporal aspects to habitat use

Individual flycatchers were more likely to use non-riparian habitat types if those habitats occurred in close proximity to the nest site. Flycatchers with nests located within 6 m of the edge of riparian and non-riparian habitats used non-riparian habitat types more frequently than did flycatchers with nests > 6 m from the edge. Of the seven flycatchers never detected outside of riparian habitats, four maintained nests placed at least 20 m from the riparian/non-riparian edge (the remaining three were tracked for too short a to draw significant conclusions). Although these four birds did not use upland habitats, three of them were observed foraging consistently in the young riparian habitat neighboring their nest sites. Thus, distance of the nest from non-riparian habitat types may discourage flycatchers from venturing into these habitat types.

Flycatcher use of non-riparian habitats may also be related to weather conditions. Birds were occasionally tracked into the aspen/fir forest and mountain shrub steppe during cold mornings or following periods of heavy rain, where they perched high facing east into the sun, perhaps for warmth.

Conclusions

Willow Flycatchers spent 80% of their time in mature riparian habitats but used secondary habitat types including young riparian, mountain shrub steppe, and upland forest habitat types. We speculate that the use of these alternative habitats is influenced by spatial and temporal factors such as nest site position, proximity of riparian patches to non- riparian habitat patches, and weather. Further, males traveled longer distances between points than did females, and male Willow Flycatchers maintained significantly larger core areas, extended home ranges and total use areas. There are two possible (non-exclusive) explanations for these gender differences: (1) male flycatchers may have different ecological requirements than females, and these needs may necessitate using a considerably larger area of the landscape; and (2) female nest attendance responsibilities nest may prevent them from venturing far from the nest site. Additional telemetry-based research would provide valuable further documentation of the general patterns and variation in flycatcher habitat use and movements.

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Appendix 1: