

INJURY DUE TO LEG BANDS IN WILLOW FLYCATCHERS

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Abstract.—We report an apparently unusually high incidence of leg injury in Willow Flycatchers (*Empidonax traillii*) as a result of banding and color banding. Color bands and U.S. Fish and Wildlife Service (USFWS) bands applied to Willow Flycatchers from 1988–1995 resulted in an overall leg injury rate of 9.6% to birds returning to our study areas in subsequent years. Most injuries occurred on legs with only color band(s) (58.3%) or on legs with both a USFWS band and a color band (35%); only 6.7% of injuries (4/60) were due to USFWS bands alone, yielding an overall USFWS band injury rate of only 0.6%. Injuries ranged from severe (swollen, bleeding legs; a missing foot) to relatively minor (irritations on the tarsus). Amputation of the foot occurred in 33.9% of the cases. Return rates of adult injured birds in the year(s) following injury were significantly lower than for the population at large.

HERIDAS PRODUCIDAS EN LAS PATAS POR ANILLAS EN INDIVIDUOS DE *EMPIDONAX TRAILLI*

Síntesis.—Se informa una alta incidencia de heridas en las patas en individuos de *Empidonax traillii* producidas por anillas, particularmente de colores. Anillas de color y las regulares de provistas por el Servicio de Pesca y Vida Silvestre Federal colocadas en individuos de papamoscas entre 1988–1995 dieron origen a un 9.6% de heridas entre las aves que retornaron a los lugares en donde fueron anilladas. La mayoría de las heridas ocurrieron en las patas en donde tan solo había anillas de color (58.3%) y en el 35% de los casos en patas con anillas de color y anillas del Servicio. El 6.7% de las heridas ocurrieron en donde tan solo había una anilla del Servicio, lo que da un 0.6% del total de heridas producidas por anillamiento. Las heridas variaron desde irritación del tarso a casos más severos como inflamación, patas sangrientas a pérdidas de los dedos. La amputación de los dedos ocurrió en el 33.9% de los casos con heridas. La tasa de regreso de aves con heridas, en los años subsiguientes a las heridas fué significativamente menor que para el resto de la población.

It is generally assumed that there is little or no harmful effect of bands on birds. Although most marking techniques are known to cause some injury under particular conditions (Marion and Shamis 1977), reported injury rates are usually very low. This is especially true of standard U.S. Fish and Wildlife Service (USFWS) bands. Butt-end color bands are also generally assumed to be safe, especially for passerines, for which there are no published accounts of injury caused by color bands. Some instances of butt-end color-band injury have been reported for other groups of birds (Nisbet 1991). Other types of bands (e.g., spiral coil and wrap-around color bands) have been known to cause injury because of band shrinkage (USFWS 1989). Less conventional markers such as leg flags (Arnold and Coon 1971), wing tags (Howe 1980), neck collars (Ankney 1975), and nasal discs and saddles (Sugden and Poston 1968) are somewhat better known for causing infrequent injury (Marion and Shamis 1977).

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As part of a long-term study of population dynamics in Willow Flycatchers (*Empidonax traillii*) we were able to encounter the same banded birds multiple times and detect injuries, possibly to a greater extent than in other studies. Based on these long-term studies, we report an apparently unusually high incidence of leg injury in Willow Flycatchers caused by color and USFWS leg bands.

STUDY AREA AND METHODS

Our study was conducted on Malheur National Wildlife Refuge, which lies at the northern extremity of the Great Basin in southeastern Oregon (42°52'N, 118°53'W). It is one of the largest wildlife refuges in the lower 48 states (73,250 ha) and one of the largest wetland complexes in North America. Dominant features of the refuge include rimrocks, freshwater marshes, lakes, meadows, alkali flats, shrub uplands, and shrub-willow riparian areas. It is in these riparian areas at the southern end of the refuge along the Blitzen River that we established three study areas spanning 5 km.

Flycatchers were captured during the breeding season from June–August 1988–1995. Adults were captured in mist nets placed near known nest sites, and additionally at locations adjacent to study areas in an attempt to recapture birds that had established territories in subsequent years outside the study areas. Locals (nestlings) were banded at the nest at 8–10 d after hatching. Adult flycatchers were banded with both a USFWS band and either one or two color bands; thus each adult carried up to three bands (two on one leg and one on the other). Locals were banded with a USFWS band, and in the first two years of the study (1988 and 1989) were color-banded as well. With the return of a number of injured birds, locals were banded only with USFWS bands beginning in 1990. Birds returning to the study areas as adults but originally banded as locals (USFWS band only) were then banded with color bands, as well. Adults were sexed by cloacal protuberance (males) and brood patch (females), and in a few instances by a combination of wing length, tail length (longer in males), and the above characters (Pyle et al. 1987). Locals and hatching-year birds could not be sexed. We weighed birds with 30-g Pesola scales to the nearest 0.1 g.

Butt-end, plastic color bands of ten different colors were applied (red, orange, black, white, yellow, pink, light green, dark green, light blue, and dark blue). Color bands (“celluloid split rings”) were obtained from A. C. Hughs Ltd., 1 High St., Hampton Hill, Middlesex, United Kingdom TW12 1NA. (Use of trade names does not necessarily reflect an endorsement of these products.) Size XF color bands were applied with a tapered aluminum opening tool supplied by Hughes; size “O” USFWS bands were applied with standard size 0–1–1A banding pliers. Color bands were not sealed (with acetone), as is done in some studies, but were squeezed together to correct for any stretching that occurred during opening.

Because two primary objectives of the study were to examine the population dynamics and site tenacity of Willow Flycatchers, we netted in the

same territories annually and attempted to recapture all individuals returning to the study areas. Thus, most band injuries were detected by direct, physical examination of individual flycatchers. In some instances we were unable to recapture specific, previously banded individuals, and their band combinations were read through binoculars or spotting scopes. Amputations were relatively easy to discern in this manner and severe injuries (loss of use of a foot) could be recognized when the bird frequently held up the injured foot or was unable to grasp the branch on which it was perched. We were unable to detect other, less serious types of injury except by direct examination.

RESULTS

Rates of injury.—Of 2523 Willow Flycatchers captured and banded on our study areas 1988–1995, 617 returned in subsequent years. Of this 617, 59 returned with injured legs (9.6%). Injuries included relatively minor irritations on the tarsometatarsus, severe injuries (leg swollen above, below, or under the band; leg bleeding around the band; band adhered to the leg; loss of use of a foot), and amputation of the foot. Amputation occurred in 33.9% of cases (20/60); an additional 59.3% of cases were considered to be severe injuries (35/59).

We captured an additional four unbanded birds with amputated feet. It is unknown whether these birds were once banded and subsequently lost a foot and their leg band(s). Two of these four birds were suspected to have been previously banded (on only one leg) because they were captured, as amputees, in the same territory as birds originally captured there and banded on only one leg.

Although numerous birds were recaptured after banding in the same year, no injuries were observed in the year of banding. Most injuries were detected either in the first (44.1%) or second (42.4%) year following banding. Eight injuries were not detected until 3–5 yr following banding (13.6%). In some cases, injuries may have occurred earlier than 2 ($n = 12$ cases) or 3 ($n = 1$ case) yr following banding, as not all individuals were recaptured or observed in every year following the year of banding.

A slightly higher percentage of birds banded as adults (10.4%) returned with injuries than birds banded as locals (7.9%). Of the 59 injured birds, 42 were originally banded as adults (out of 403 adult returns) and 17 were banded as locals (out of 214 local returns); this difference in injury rate across age classes was not significant ($\chi^2 = 0.825$, $P = 0.364$) (Table 1). Injuries to adult females occurred at a higher rate than to adult males (32 females, 10 males, $\chi^2 = 8.72$, $P = 0.003$). The difference was marginally significant for birds originally banded as locals (11 females, 6 males; $\chi^2 = 2.04$, $P = 0.153$) (Table 1). Most of the severe injuries (females = 25, males = 10; $\chi^2 = 5.86$, $P = 0.015$) and amputations (females = 14, males = 6; $\chi^2 = 2.98$, $P = 0.084$) were to females, as well.

Injury and band type.—The majority of leg injuries were to legs with color bands. Only 6.7% of injuries ($\frac{4}{60}$) were to legs with only a USFWS band. By comparison, there were 17 injuries to legs with only one color

TABLE 1. Frequency of captures, returns, and injuries to Willow Flycatchers by age banded and sex.

Sex	Captures	Returns	Injuries			Total
			Minor	Severe	Amputation	
Birds Banded as Adults						
M	443	192	0	6	4	10
F	450	211	3	17	12	32
	893	403	3	23	16	42
Birds Banded as Locals						
M	1618 ^a	114	0	4	2	6
F		100	1	8	2	11
	1618	214	1	12	4	17

^a Locals cannot be sexed until their return to the study area in subsequent years as After-Hatching-Year birds.

band, 18 injuries to legs with two color bands, and an additional 21 instances of injury to legs with a color band and a USFWS band. Relative to the distribution of color band combinations of recaptured birds, injuries occurred disproportionately more to legs with two color bands and occurred disproportionately less to legs with just a USFWS band ($\chi^2 = 18.03$, $P = 0.001$; Table 2). Injuries to legs with only one color band and to legs with a USFWS band and a color band occurred in proportion to the distribution of band combinations of returning birds.

Survival.—Survival of injured adult flycatchers following the detection of band injury was significantly lower than that of the population at large. Adult, uninjured flycatchers ($n = 859$) in the population at large (including birds that did not return at least one year) survived an average of 0.80 yr after initial capture, whereas injured, adult flycatchers ($n = 46$; includes four birds returning with injuries, but no bands) survived only 0.24 yr after the detection of band injury (t -test, $t = 3.01$, $P = 0.003$). Most ($38/46$) adult, injured flycatchers were not recaptured in the years

TABLE 2. Band combinations on injured and uninjured legs of Willow Flycatchers returning to the study areas, Malheur NWR, 1988–1995. Percentages are of the total number of a given band combination returning.

Status	Band combination									
	1 Color	(%)	2 Color	(%)	Color over USFWS	(%)	USFWS over Color	(%)	USFWS	(%)
Injured	17 ^a	(5.6)	18	(11.3)	10 ^a	(5.8)	11	(7.1)	4	(1.4)
Uninjured	286		142		162		143		286	
Total	303		160		172		154		290	

^a One bird (of 59 injured birds) was injured on both legs.

TABLE 3. Number of years injured and uninjured Willow Flycatchers survived following the year of injury and capture, respectively.

Years survived	0	1	2	3	4	5	6	7	8
Birds Banded as Adults									
Injured	38	5	3	0	0	0	0	0	0
Uninjured	499	193	83	42	23	12	4	2	1
Birds Banded as Locals									
Injured	13	4	0	0	0	0	0	0	0
Uninjured	1404	98	58	17	12	5	5	2	0

following discovery of injury whereas 41.9% of uninjured adults were recaptured in a subsequent year (Table 3). However, overall survival after initial capture (0.84 yr, $n = 43$) of injured adults did not differ from that of uninjured adults (0.96 yr, $n = 326$) that had been recaptured after time intervals similar to that in injured birds ($t = 0.57$, $P = 0.57$). Whereas survival after the detection of injury was low, survival of injured birds after initial capture did not significantly differ from that of uninjured flycatchers because such birds had already survived at least one year; their injuries could not be detected or did not occur until at least one year (and up to 5 yr) after banding.

Injured and uninjured flycatchers captured as locals or hatching-year birds did not differ in survival rates following injury and initial capture, respectively (injured = 0.24 yr; uninjured = 0.24 yr; $t = 0.03$, $P = 0.98$). The survival rate of birds with amputated feet (survival = 0.22 yr) did not differ from that of all other injured birds (survival = 0.25 yr; $t = 0.23$, $P = 0.81$).

Effects on mass.—Mass of injured and uninjured flycatchers did not differ. Mass of injured vs. uninjured juvenile males, juvenile females, and adult males were similar (Table 4). Uninjured adult females were somewhat heavier (12.47 g, $n = 369$) than injured adult females (12.18 g, $n = 33$), but this difference was not significant ($t = 1.41$, $P = 0.16$).

TABLE 4. Mass of injured and uninjured Willow Flycatchers, Malheur National Wildlife Refuge, 1988–1995.

	Injured			Uninjured		
	Mass (g)	SD	n	Mass (g)	SD	n
Adults						
Males	13.08	0.40	8	12.72	0.70	373
Females	12.18	1.06	33	12.47	1.12	369
Juveniles						
Males	12.82	0.50	5	12.68	0.52	95
Females	12.21	1.51	10	12.29	0.97	76

DISCUSSION

We believe the progression of band injury occurs as follows. Presumably because of the sharp edges on the rims of color bands, an irritation develops with continued movement and friction of the band against the tarsometatarsus. Bleeding above, below, or between bands may then occur, followed by infection and swelling of the leg under or between band(s). The band may then become adhered to the leg and no longer turn freely. At this point, the foot often becomes nonfunctional and the bird is no longer able to grasp with it. Subsequent recaptures suggest that because of continued infection and increased swelling of the leg under the band, amputation of the foot ensues. Some birds may die of infection, but birds returning at least one year with an amputated foot did not demonstrate any external signs of infection on the tarsometatarsus. We never observed any foreign material between the band and the leg and do not believe snagging of vegetation or other objects to be a factor. This does occur in some species (Marion and Shamis 1977), but is more common in gulls, terns, and shorebirds.

Injuries (amputations) observed in four unbanded birds suggest that foot loss in flycatchers is not due only to bands. It may be a result of lesions associated with avian pox (McClure 1989); natural leg injury has been noted for a number of other species, including Spotted Sandpipers (*Actitis macularia*), Sanderlings (*Calidris alba*), Semipalmated Sandpipers (*C. pusilla*), Ruddy Turnstones (*Arenaria interpres*), and Black-necked Stilts (*Himantopus mexicanus*) (Reed and Oring 1993).

Band injury and behavior.—We noted two differences in the behavior of injured flycatchers. Individuals of both sexes had more difficulty landing, perching, and remaining perched than uninjured birds. Birds with amputated or severely injured feet had difficulty balancing, frequently flapping their wings or teetering forward and backward to maintain balance. Secondly, some injured, nest-building females appeared to have more difficulty building nests than uninjured birds. We have no data on whether or not nests built by injured birds took longer to build than those built by uninjured females, but some injured females' nests were somewhat sloppier and looser in construction, especially at the bottom of the nest where an inordinate number of loose strands of nest material dangled from the bottom of the nest cup. No differences in the size of the nest cup or in quality of attachment to substrate stems or branches were noted.

Rates of injury.—We know of no biological reason to explain the higher incidence of band injury in females. In some shorebird species this may be due to the larger size of females, resulting in a tighter band fit and a greater tendency of the band to wedge against the joint (Reed and Oring 1993). Female and male Willow Flycatchers are approximately the same size. In Spotted Sandpipers, females are the more aggressive sex, and some injuries may be due to or exacerbated by intrasexual fighting (Maxson and Oring 1980, Reed and Oring 1993). Willow Flycatcher females

are the less aggressive sex. Major behavioral differences between the sexes in Willow Flycatchers pertain to parental care. Females build the nests, incubate and brood, and perform most of the feeding activities, but none of these differences suggest an obvious cause for differential rates of band injury.

Injury and band type.—Increased risk of injury to legs with two color bands may simply be due to the increased likelihood of irritation and friction from two bands as compared to one. We attribute the lower injury rates for USFWS bands to the smoother, more rounded edges on the upper and lower rims of these bands. USFWS bands, when properly applied, also have less of a gap at the butt ends than do unsealed color bands; sealing color bands may reduce the risk of injury. Nisbet (1991) found preliminary evidence that heat-sealed Darvic color bands on Common Terns (*Sterna hirundo*) did not cause injury and band loss compared to unsealed bands.

Survival and effects of lifetime reproductive success.—Survival of injured birds following the detection of injury was less than that of uninjured birds. Thus, lifetime reproductive success of individual males and females was diminished by band injury. However, reproductive success of injured birds in the year(s) immediately following injury did not appear to be affected based on behavioral observations of adult males and females during the nesting period. For example, several adult males with severe leg injuries observed over the course of the study did not have any difficulty establishing or maintaining territories or securing mates. And although some females with severe injuries appeared to have some difficulty building nests, others did not, and all laid normal clutches, and exhibited typical incubation, brooding, and feeding patterns. Band injury apparently did not affect survival by reducing foraging efficiency, as there were no significant weight differences between injured and noninjured birds.

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