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Leg Injuries Observed in Banded Female Anna's Hummingbirds *(Calypte anna)* in Central California

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ABSTRACT

Three sites in central California reported leg injuries in 7% to 16% of recaptured female Anna's Hummingbirds (Calypte anna). *Proposed causes of the injuries are accumulated nesting material debris under the bands, combined with normal enlargement of legs during the breeding season. We tested the prediction that altering the bands' diameter might decrease leg injuries; however, leg damage continued to occur with the larger-diameter bands. Also, during the project, avian pox-like lesions were observed on bills, feet, legs, and around eyes in a number of captured hummingbirds. This diseased state may result in permanent injuries in afflicted hummingbirds.*

INTRODUCTION

Although most marking techniques are selected to avoid adverse physical or behavioral effects on the birds, injuries have been reported from some marking techniques under specific conditions (Marion and Shamis 1977). Bird studies using leg bands made of steel, aluminum, or plastic have reported many incidents of leg or foot injuries with certain species. Plastic color bands also have caused problems when used singly, doubly, or in conjunction with metal bands, specifically in flycatchers and terns (Nisbet 1991, Sedgwick and Klus 1997, Splittgerber and Clarke 2006, Pierce et al. 2007). Serious leg injury increased in Piping Plovers (*Charadrius melodus*) with the use of tall anodized aluminum bands (Amirault et al. 2006). Significant leg injuries have been reported in doves and Snowy Plovers (*Charadrius alexandrinus*) banded only with metal bands (Amat 1999, Grosselet and Michael 2005).

Swelling of banded legs in hummingbirds was first observed anecdotally more than 15 years ago. Speculated causes included the use of band sizes that were too small for the individual or a physiological response to the band material (Russell 1994). No further study was carried out. Recently, as part of a population dynamics study of hummingbirds in central California, observers recorded a considerable number of retrapped female Anna's Hummingbirds (*Calypte anna*) with injuries to their banded legs. They had been banded with standard USGS aluminum hummingbird bands and retrapped at each of three sites in central California over a period from one to four years.

METHODS

From 2004-2008, over 4,000 Anna's Hummingbirds were banded at Indian Peak Ranch (IP) in Mariposa County, CA (37.373° N 119.834° W), situated at 619 m elevation. Banding was part of a constant-effort hummingbird banding project organized by the Hummingbird Monitoring Network (HMN). Banding was performed one day during a five-day window every two weeks from Mar through Oct. Two Hall hummingbird traps (Russell and Russell 2001), baited with hummingbird feeders, were used for each session, which started within one-half hour of local sunrise and continued for five hours. In 2004, hummingbirds of both sexes were banded with 6.0 mm length bands as recommended by the USGS Bird Banding Laboratory (BBL).

Hummingbird bands are printed on sheets of aluminum alloy with each sheet producing 300 bands. Band numbers, printed in rows of ten, are cut by the bander and edges smoothed. Each numbered band is cut to the desired length, shaped, and stored for use. Bands used at IP during the years 2004 to 2006 were cut into strips using scissors, as recommended by the North American Banding Council (Russell and Russell 2001). Upper and lower black lines of the band row were completely removed yielding a band height of approximately 1.45 mm. The designated band length was cut using a MacDonald's cutter, and then formed into a circular shape with the MacDonald's band former.

Banded-leg injuries in female Anna's Hummingbirds were observed during the second year at IP while using this size band. As a result, band length for females was increased. Because no similar injuries were noted, male band size was not changed.

In view of these results, the MacDonald band cutter template was retooled to cut the bands 0.2 mm longer. The accuracy of cut length was double-checked before the bands were used. Despite the increased band length, leg injuries continued to be found, and the band length was again increased in 2007 to 6.4 mm for females. A new device, the Roger's band-length cutting tool, was used; it is a metal plate with laser-cut slots from 5.2 mm to 8.0 mm in 0.2 mm increments. Also, starting in 2007, band strips were cut with a bench shear rather than with scissors. This tool cut strips reliably narrower than scissors, approximately 1.27 mm wide, yielding a shorter band height.

Two additional banding sites were established in 2007 as part of the HMN project, one at McLaughlin Reserve (MC), a University of California Biological Reserve at Clear Lake, Lake County, CA (38.874°N 122.883°W) at an elevation of 720 m. The other was a private residence near Scotts Valley (SV), Santa Cruz County, CA (37.073°N 121.950°W) at an elevation of 315 m. Both sites followed the same banding protocol as at the Indian Peak site. At the SV site, female Anna's Hummingbirds were banded with 6.2 mm bands; both the bench shear and the Roger's band-length cutting tool were used. At the MC site, female birds were banded with the 6.0 mm bands. The strips were cut with scissors, while the band lengths were cut with the Rogers' band-length cutting tool.

During the breeding seasons at all three sites in California, many unbanded female Anna's Hummingbirds were observed with both tarsi slightly enlarged. Over the years, hummingbird banders have observed this breeding season enlargement in several species (B. Hilton, L. Rogers, D. Mankey, A. Moran, S. Weidensaul, pers. comm.). Tarsi that appear thicker than normal and seem to have an accumulation of fluid have been noticed in

females in breeding ranges during the breeding months. This condition is assumed normal, but has not been published.

Because I suspected that this enlargement might be involved in the injuries, I attempted to document the enlargement by measuring the tarsus width with calipers. Due to the short, unusual shape of the hummingbird's tarsus, consistent, reproducible measurements were difficult. The hummingbird tarsal gauge, developed in 2007 by Lee Rogers, allows a tarsal width to be taken which yields an appropriate band size for the bird. The gauge is a small plate with multiple laser-cut slots graduated in 0.065 mm increments (+/-0.01 mm) along the edges. The hummingbird leg is inserted into successively smaller slots until the sides of the tarsus just touch the edges of a slot. To learn if there was a difference in band size values, i.e. tarsal width, between seasons, we used the tarsal gauge to measure the legs of all adult male and female Anna's Hummingbirds banded and recaptured during the breeding months of Mar through Jun and non-breeding months of Jul through Oct 2009 at the SV site. Measurements were taken by two banders to verify the resulting leg gauge values.

RESULTS

By early September of the second year at IP (2005), five females banded in 2004 were captured with swelling of the banded leg. These injured legs had aggravated inflammation that, in severe cases, partially or totally encased the bands. The skin of the legs was inflamed, but smooth with no lesions or warts or other indications of disease (Fig. 1).

Because this leg problem was apparently exclusive in females, we first assumed that the 6.0 mm band was too small for certain individuals. Therefore, in Sep 2005 we increased the band size for all females by 0.2 mm. By mid-Jun 2007 two adult females, banded with the 6.2 mm size, were recaptured and exhibited the same leg injuries as those with the 6.0 mm size. Therefore, the band size was increased to 6.4 mm beginning in Oct 2007. Band sizes were increased for females at the SV and MC sites as well, since injuries were also noted at these sites.

We recaptured a total of 364 adult female Anna's Hummingbirds from previous years at the three sites; 41 of these females had injuries to their banded legs (Table 1). In comparing captures of females with

Fig. 1. Banded-leg injury showing inflamed, swollen leg.

injuries against females without injuries at the three sites, there was no significant difference among the sites (Fisher-Freeman-Halton exact test, p=0.450). These leg injuries occurred in returning females originally banded with healthy, unaffected legs in previous years. The longer-term data from IP showed that injuries took place one to four years after banding, with some females being retrapped over multiple years before the injuries arose. Because many of the banded females with leg problems had been recaptured without apparent leg problems before the injuries occurred, and because multiple banders were banding at the three sites, the possibility that the injuries were caused by one particular bander can be discounted.

Table 1. Total number of female Anna's Hummingbirds recaptured with and without leg injurirs at the three banding sites in central California over all years (IP, Indian Peak Ranch, 2004 to 2008; SV, Scotts Valley, 2007 to 2008; MC, McLaughlin Reserve, 2007 to 2008). No significant difference (p=0.450), Fisher-Freeman-Halton exact test.

Site	Total Recaptured Females	Without Leg Injury	With Leg Injury	% Injured
IP	278	247	31	11
SV	42	29	3	7
MC	44	37	7	16
Total	**364**	**323**	**41**	

Originally, I thought that injuries occurred only in returning birds (i.e., between banding years), but three adult females at IP and two at MC developed injuries two weeks to six months after being banded. All of these females, however, were banded early in the breeding season. To summarize, all 41 females with banded-leg injuries were originally banded with normal healthy legs, and a breeding season was occurring or had transpired between the time of banding and the detection of injury. No leg injuries were observed in those females first caught and banded after a breeding season, and then recaptured before the next breeding season. During five years of banding at all sites, only two male Anna's Hummingbirds were observed with banded-leg injuries.

During the initial years of banding, no cause for the leg injuries was apparent. In 2007 at IP, we noted a deposit of a whitish substance compacted under the band of a female's swollen injured leg. Subsequently, we found females with leg injuries at all three sites that also had matted substances and/or white fibrous material wrapped around their legs under the band. Two of the small matted samples, analyzed at Antech Diagnositcs, Irvine, CA, by a veterinary pathologist, were degenerated skin cells interspersed with blood, bacteria, and plant debris. A third sample of a white thread-like fiber deposit was spider webbing. On several occasions there was no visible leg injury or swelling with the band in its normal position on the leg, but after the band was pushed aside, deposited material was apparent around the leg, but the leg itself was unaffected. At other times when the band was pushed aside, material was found, as well as some degree of leg injury. Damage ranged from slight constriction caused by a few filaments of fiber to slight swelling and constriction of the leg. More severe conditions were, of course, visible with the band in place on the leg.

Table 2. The presence or absence of detritus and foreign material under the bands of recaptured male and female Anna's Hummingbirds within age classes of young and adult individuals during the 2009 banding at the Scotts Valley, Santa Cruz County, CA, banding station. (*p<0.0001, Fisher-Freeman-Halton exact test, significantly greater than expected.)

Sex/Age Class	Detrius Absent	Detritus Present	Total
Male/adult	30	2	32
Male/young	43	0	43
Female/adult	30	20*	50
Female/young	19	7	26
Total	**122**	**29**	**151**

As a result of these observations, examination for substances under the bands was initiated late in 2007 and was made routine on all recaptured birds in 2009. In that year, we examined the legs under the bands on all recaptured male and female Anna's

Hummingbirds at the SV site and compared detritus found under the bands for both sexes and age classes (Table 2). The number of adult females with material under their bands was significant.

Results of the tarsal gauge measurement taken at SV in 2009 to corroborate a variation in band size in females show a shift to larger values for females that were measured during the breeding season than smaller band sizes measured during the non-breeding season (Fig. 2). Male Anna's Hummingbirds do not show this pattern (Fig. 3). There is no statistically significant difference (Student's t-test, p= 0.250) between the means of male and female leg thickness in the non-breeding season. For a non-breeding male, mean band size = 6.16 mm (s=0.187, n=119) while for a non-breeding female, mean band size = 6.18 mm (s=0.238; n= 24).

Fig 2. Band size values in female Anna's Hummingbirds at Scotts Valley site in 2009 taken during the breeding season, Mar - Jun, and the non-breeding season, Jul - Oct. The difference is statistically significant (Student t-test, p< 0.001). The mean non-breeding female = 6.18 mm (s= 0.238, n= 24), the mean breeding female = 6.54 mm (s= 0.434, n = 42).

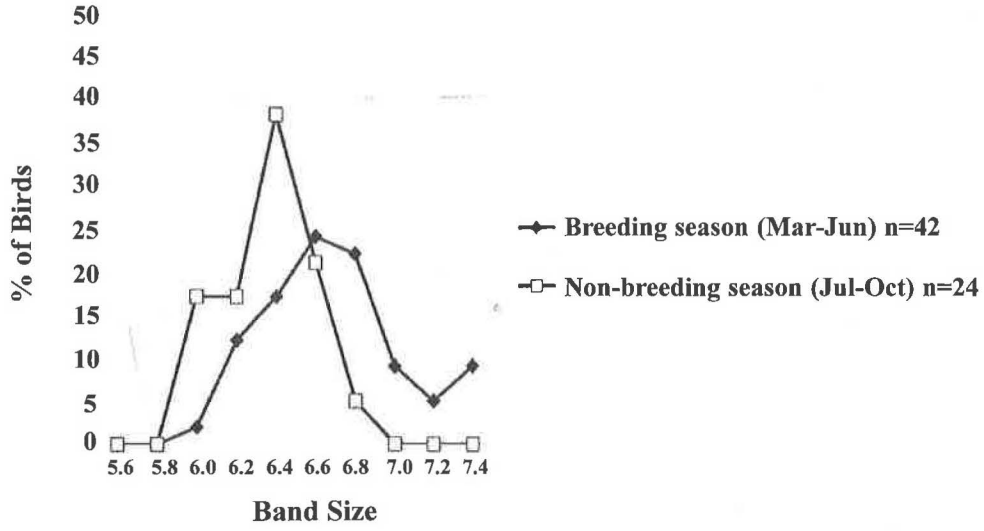
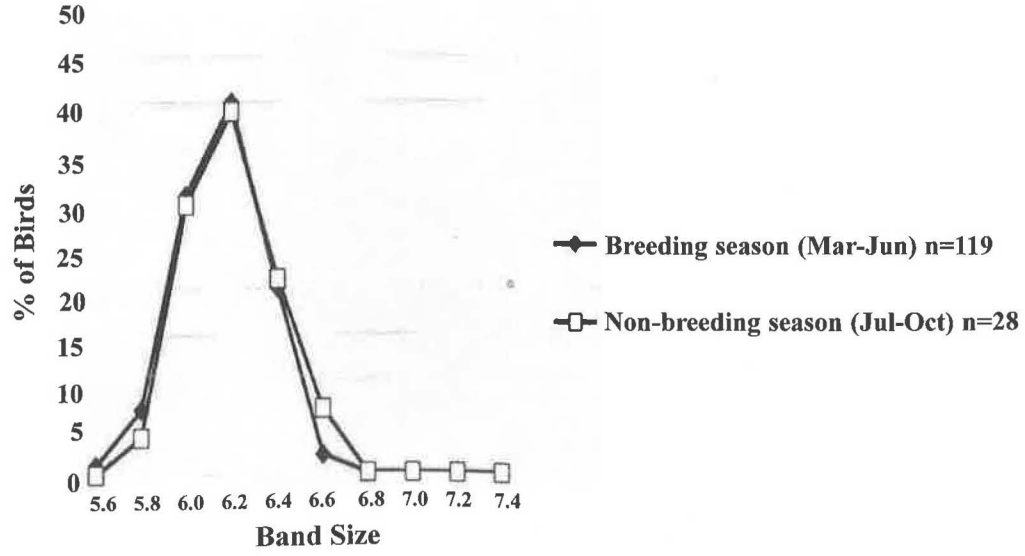


Fig. 3. Band size values in male Anna's Hummingbirds at Scotts Valley site in 2009 taken during the breeding season, Mar - Jun, and the non-breeding season, Jul - Oct. The difference is not statistically significant (Student t-test, p= 0.250). The mean non-breeding male = 6.16 mm (s= 0.187, n= 119), the mean breeding male = 6.20 mm (s= 0.196, n= 28).

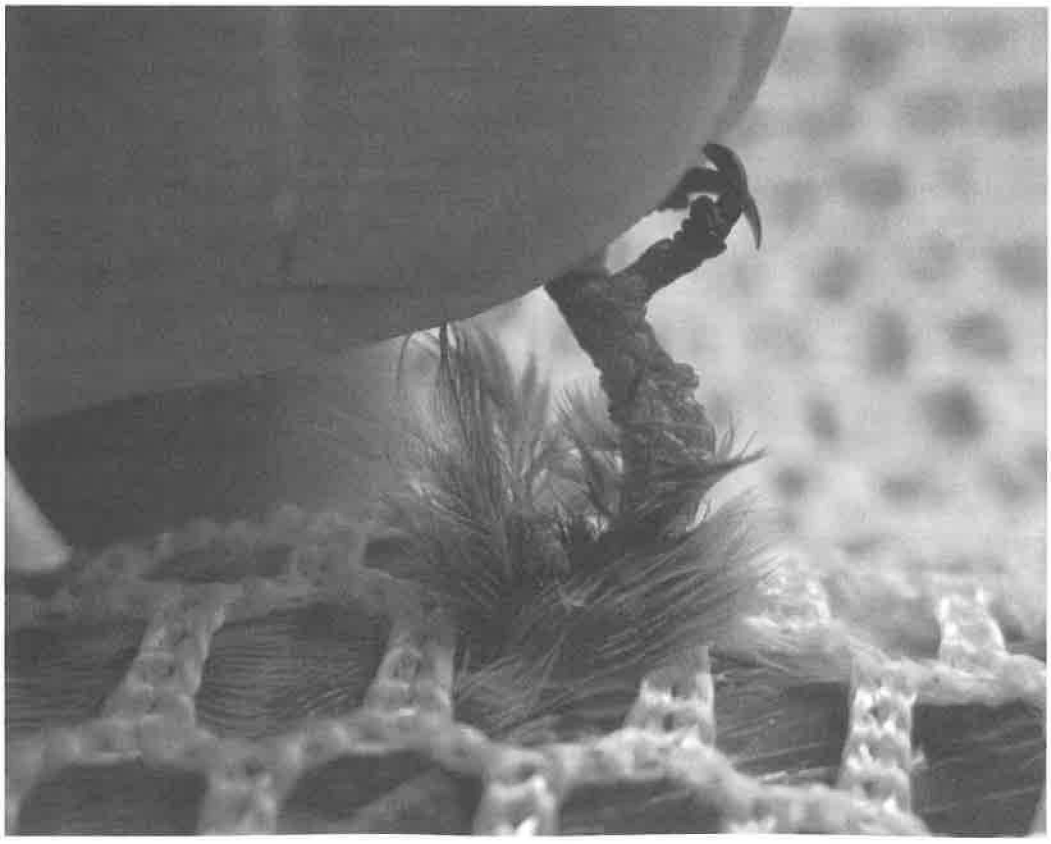


During the study, possible avian pox, or a similar disease condition, was noticed on bills, feet, legs, around eyes or a combination of areas on some Anna's Hummingbirds. Since diseased birds with infected legs were not banded, we do not know the extent of this disease in the population. The first year at IP we encountered 11 individuals that had pox or a pox-like disease on their feet or legs. In contrast to the banded-leg swellings, the diseased conditions we saw showed a distinctively rough surface to the skin often imbedded with scabs, warts, and/or acute bloody lesions in addition to the swelling (Fig. 4). Both age and sex groups were infected with this condition. However, no banded-leg injured female at any site had pox-like lesions elsewhere and no symptoms other than a swollen banded leg. Because of the difference in appearance of the two situations, we surmised that the banded-leg injuries of these females were likely not caused by avian pox.

DISCUSSION

Female hummingbirds of most species construct a nest over a period of several days. They use plant down and spider webs, pushing nest material with breast and vigorously tamping down material inside the nest with feet (Calder and Calder 1992, Baltosser and Scott 1996, Robinson et al. 1996, Russell 1996, Powers and Wethington 1999). In species that double brood, including Anna's Hummingbirds, the females perform this process a second time, usually constructing a new nest at a different site (Russell 1996). Because nesting material can be deposited between the band and the leg in some individuals, the space between the band and the leg is diminished. Amat (1999) and Splittgerber and Clarke (2006) found accumulation of foreign material under leg bands resulted in injuries to banded legs in Bell miners (*Manorina melanophrys*) and Snowy Plovers (*Charadrius alexandrinus*).

Fig. 4. Leg showing warty appearance of pox-like syndrome.



An additional contribution to the injuries in female Anna's Hummingbirds could be the leg enlargement that develops during the breeding season that would further decrease the space between the leg and the band.

Not all the females we measured with the tarsal gauge during the breeding season months at the SV site in 2009 were in breeding condition. A shift to larger band size during breeding season might imply that females with larger leg sizes are on site during those months. However, 15 females were captured and measured during both seasons. Of these, 13 called for larger band sizes during the breeding season than during the non-breeding season. This suggests that the females' tarsi enlarge some time during the breeding season and regress afterward. The observed seasonal pattern of injuries strongly implies that leg damage is associated with breeding in females.

While increasing the band sizes to correlate with the measured tarsal gauge did result in reducing possible tightness of fit during the breeding season, it did not eliminate the leg injuries. Throughout the study, material continued to be found under the band, regardless of the band size. The reason why it takes some individuals less than a month to incur an injury, while others take several years can only be hypothesized. This variability may be caused by the type of nest substrate used, the amount of material collecting between the leg and band each time a nest is constructed, or perhaps the number of nests the female constructs per season.

During this study, we captured a number of females missing their right legs. We were unable to determine if these individuals had been banded previously. Because avian pox or a similar disease can be found on the legs, it may play a role in leg loss. This has yet to be established. Circumstantial evidence for the bands causing possible leg loss is based on the fact that, except for normal breeding season enlargement of both legs and pox-like infections on feet and legs, no unbanded female was captured with abnormal leg swelling of either leg, and no banded or unbanded female was found missing its left leg. At IP, by uniquely clipping rectrices, two one-legged females were recaptured some weeks after being initially encountered (B. Robinson, pers. comm.), indicating that these individuals can survive. However, having only one leg may negatively influence some normal tasks the female birds perform. Nest construction may be affected if the females cannot function optimally in order to tamp down nesting material. Their ability to tend and feed nestlings could be compromised. Nestling hummingbirds are fed by regurgitation when the perching females insert their bills into that of the young and pumps vigorously (Robinson et al. 1996), a task that may be difficult to achieve if the perching females have only one leg to support themselves. It is unknown if these speculations are warranted; but if the leg loss we encountered is due to the band, it is imperative that other adjustments to bands are made.

Our hypothesis of enlarging the diameter of the band to decrease leg injury was proven incorrect, and thus further investigation of this situation is essential. Research is urgently needed to discover if this problem in Anna's Hummingbirds is regional or widespread. Redesigning the shape of bands from circular to slightly oval to conform to the shape of a hummingbird's tarsus may alleviate the problem. The circular-shaped bands may rotate too freely around the leg during nest construction and allow tacky spider webbing to attach around the leg. In these cases, nest substrate could stick more readily to the spider webbing under the band.

Additional topics for further research include the cause of leg enlargement during the breeding season, as well as which other species are affected with this problem. Although this paper reports leg injuries on banded female Anna's Hummingbirds in central California, similar injuries have been found in banded females of other hummingbird species. At IP, returning female Black-chinned Hummingbirds (*Archilochus alexandri*) seem particularly prone to accumulation of spider webbing around their legs under bands (B. Robinson, pers. comm.). At the SV site where Allen's Hummingbirds (*Selasphorus sasin*) breed, several returning females demonstrated the initial stages of banded-leg injuries with material

being found under their bands and leg constriction (R. Colwell, pers. obs.). Returning breeding female Broad-tailed Hummingbirds *(Selasphorus platycercus)* at a long-term banding site in Colorado have been recaptured with banded-leg injuries apparently caused by spider webbing wrapped around the females' legs under their bands (F. Engleman, pers. comm.).

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