

## **Body Mass of Female Cooper's Hawks is Unrelated to Longevity and Breeding Dispersal: Implications for the Study of Breeding Dispersal**

Author(s): Robert N. Rosenfield John Bielefeldt Taylor G. Haynes , Madeline G. Hardin , and Frederick J. Glassen Travis L. Booms

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## SHORT COMMUNICATIONS

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### BODY MASS OF FEMALE COOPER'S HAWKS IS UNRELATED TO LONGEVITY AND BREEDING DISPERSAL: IMPLICATIONS FOR THE STUDY OF BREEDING DISPERSAL

ROBERT N. ROSENFELD<sup>1</sup>

*Department of Biology, University of Wisconsin–Stevens Point, Stevens Point, WI 54481 U.S.A.*

JOHN BIELEFELDT<sup>2</sup>

*S65 West 38010, County Road ZZ, Eagle, WI 53119 U.S.A.*

TAYLOR G. HAYNES, MADELINE G. HARDIN, AND FREDERICK J. GLASSEN

*Department of Biology, University of Wisconsin–Stevens Point, Stevens Point, WI 54481 U.S.A.*

TRAVIS L. BOOMS<sup>3</sup>

*Department of Biology, University of Wisconsin–Stevens Point, Stevens Point, WI 54481 U.S.A.*

**KEY WORDS:** *Cooper's Hawk*; *Accipiter cooperii*; *breeding dispersal*; *body mass*; *longevity*.

In our long-term study of Cooper's Hawks (*Accipiter cooperii*) in Wisconsin, we have found no evidence that habitat (i.e., urban vs. rural, conifer plantation vs. non-plantation nests, presumptive site quality as indexed by consistency of nesting area use and high breeding density) was related to indices of reproductive success, phenology, annual adult survival, production of recruits, or fitness (Rosenfield and Bielefeldt 1999, Rosenfield et al. 1995, 2000, 2009, 2013, 2015a). Rather, reproductive success of Wisconsin Cooper's Hawks was apparently related to intrinsic qualities of individuals. For example, body mass (i.e., size) of Cooper's Hawks  $\geq 2$  yr old of both sexes, which was also unrelated to nesting area habitat, was positively correlated to brood size and number of detected recruits; larger birds also tended to breed earlier in the year than smaller ones (Rosenfield and Bielefeldt 1999, Rosenfield et al. 2013). However, longevity was more important than body mass in determining lifetime reproduction of male Cooper's Hawks in our Wisconsin study areas (Rosenfield et al. 2009). Similarly, longevity was strongly correlated with lifetime production for several other raptor species (Newton 1986, Gehlbach 1989, Postupalsky 1989, Marti 1997).

Annual survivorship in Cooper's Hawks is similar between the sexes (81% males, 75% females) for breeding

adults  $\geq 2$  yr old on our Wisconsin study areas (Rosenfield et al. 1995, 2009, 2013, R. Rosenfield unpubl. data), although the sexes of this highly dimorphic raptor (females on average 1.7 times heavier than males) exhibit different roles in parenting and other aspects of reproductive biology (Rosenfield and Bielefeldt 1993a). Male Cooper's Hawks establish breeding territories, invest more in reproductive effort via nest building and anti-predator behavior before fertilization, and are principally responsible for procuring prey for themselves, their mates, and their young (Rosenfield and Bielefeldt 1993a, Rosenfield et al. 2013). Females leave the brood in the fledgling stage, while males continue to defend and deliver prey to young for up to 6 wk after fledging (Rosenfield and Bielefeldt 1993a, R. Rosenfield unpubl. data).

Males exhibit lifetime fidelity to their nesting areas in Wisconsin, but we estimate that 23% of experienced breeding females move to different nesting sites annually (range of detected distance of such breeding dispersal: 1.0–14.6 km; Rosenfield and Bielefeldt 1996, Rosenfield et al. 2009, R. Rosenfield unpubl. data). Thus, body size of breeding male Cooper's Hawks is necessarily unrelated to the rate of nesting area reoccupancy in our study sites in Wisconsin. We also have demonstrated that mass is not related to longevity in breeding males (Rosenfield et al. 2009). We have not, however, explored the relationship of body size in females to several of the aforementioned ecological correlates documented for male Cooper's Hawks.

Some researchers suggest or have found that size of females is related to survival and breeding dispersal in other *Accipiter* species (e.g., Newton 1986, Sunde 2002, Kenward 2006). Larger body size allows for a greater

<sup>1</sup> Email address: rosenfi@uwsp.edu

<sup>2</sup> Deceased

<sup>3</sup> Present address: Alaska Department of Fish and Game, Wildlife Diversity, 1300 College Avenue, Fairbanks, AK 99701 U.S.A.

accumulation of body reserves, which in turn enhances survival, in part due to the increased ability to withstand periods of food deprivation (Newton 1986, Sunde 2002). Starvation is a predominant source of mortality in raptors (Newton 1979, Sunde 2002). Similarly, Newton (1986) indicated that female longevity in the Eurasian Sparrowhawk (*A. nisus*) was greater than that of males because of the females' larger size.

Female Cooper's Hawks, as in some other *Accipiter* species (e.g., Newton 1986), compete via physical fights for mates and/or nesting sites (Newton 1986, Millsap et al. 2013, B. Millsap unpubl. data). It is possible that larger body size confers an advantage in contests for occupancy of nesting areas (Newton 1986, Perez-Camacho et al. 2015). Indeed, victory in animal fights typically goes to the larger or heavier contestant because size is generally correlated with strength and the ability to inflict injury (Arnott and Elwood 2009). Therefore, larger females may hold nesting sites longer than smaller females do, and smaller females may be more likely to exhibit breeding dispersal.

Here we use a 28-yr data set to investigate whether size of breeding females  $\geq 2$  yr of age (which make up about 96% of breeding females in our Wisconsin study populations; R. Rosenfield unpubl. data) is related to longevity and breeding dispersal in Cooper's Hawks. We hypothesize that body size may be a key variable determining life-history variation among Cooper's Hawks (Bennett and Owens 2002). Our results underscore the importance of long-term, individual-based studies of animals to help document and attempt to reveal possible age- and sex-related disparities in life histories. Knowledge of such variation improves our understanding of different strategies for energy allocation, reproductive performance, and evolutionary adaptation both within and between sexes of animals (Clutton-Brock and Sheldon 2010).

## METHODS

**Study Areas.** We studied breeding Cooper's Hawks during 1980–2007 at two principal areas in the central and southeastern parts of Wisconsin as described by Rosenfield et al. (1995) and Rosenfield and Bielefeldt (1996). Our central Wisconsin study area included primarily rural areas in Portage County and the adjacent municipalities of Stevens Point, Whiting, and Plover, with a predominately urban human population approximately 38,000, and a human density approximately 600/km<sup>2</sup> (U.S. Census Bureau 2000). Our southeastern Wisconsin study area included mostly rural regions of the Kettle Moraine State Forest, South Unit. These study sites were chosen without preconceptions about their suitability for nesting Cooper's Hawks (Bielefeldt et al. 1998).

We defined a nesting area as a nest-centered plot of 800 m in diameter that was occupied by a breeding adult female in 1 or more years; an individual female exhibited fidelity to a nesting area when we found her in a subsequent year at a new nest within 400 m of her original

nest. (We found that a Cooper's Hawk nest was rarely reused in another year by Cooper's Hawks and a reoccupied nesting area never had in one breeding season more than one female nesting within 400 m of the original nest; Rosenfield and Bielefeldt 1996, R. Rosenfield unpubl. data). We found most occupied nesting areas (>90%) before egg-laying by listening for dawn vocalizations or by searching for partially constructed nests during the pre-incubation stage, ca. mid-March through late April in Wisconsin (Bielefeldt et al. 1998, Rosenfield and Bielefeldt 1991). For further descriptions of our study areas and nest-searching techniques, see Rosenfield and Bielefeldt (1991, 1996).

**Field Procedures.** We captured breeding adult female Cooper's Hawks near their nests during the pre-incubation, incubation, or nestling stages using a variety of techniques (Rosenfield and Bielefeldt 1993b, 1999), and banded them with U.S. Geological Service (U.S.G.S.) lock-on aluminum leg bands as well as colored, alphanumeric coded leg bands (Rosenfield and Bielefeldt 1996). We later recaptured the birds using similar techniques or sighted them using binoculars or spotting scope and identified them via their color bands.

We classified the age of adult female Cooper's Hawks at initial capture following Rosenfield and Bielefeldt (1997). Most unbanded breeding females we captured were ASY (after-second-year) birds  $\geq 2$  yr old; breeding SY (1 yr old, in their second calendar year) females were uncommon on our study areas (Stout et al. 2007). Thus, for this study, we included only ASY females. We designated eye (iris) color of captured hawks as yellow, light orange, orange, dark orange, or red following Rosenfield and Bielefeldt (1997). We measured body mass of adult females to the nearest 1 g with a balance-beam scale. Age-related inter-year variation in body mass during the nestling stage was negligible (and statistically nonsignificant for individually marked birds (Rosenfield and Bielefeldt 1999, R. Rosenfield unpubl. data), and we demonstrated in Rosenfield and Bielefeldt (1999), Rosenfield et al. 2010, and in Sonsthagen et al. (2012) that body mass during the nestling stage was a reliable index to body size for birds captured throughout all study years. We therefore use body mass at initial capture of an individual female during the nestling stage as an index to size.

**Analyses.** To analyze the relationship of female longevity to size, we examined body mass of recaptured or sighted breeding adults by relative age category during the last year of detection: A3Y (after-third-year individual, at least 3 yr old), A4Y, A5Y, and to obtain adequate sample sizes per category, A6Y–A7Y and A8Y–A10Y following Rosenfield et al. (2009) for adult males in the same study areas and years (Table 1). We termed these categories "relative-age" categories because they represent a minimum age, as all birds except four (two 3-yr-olds, one 4-yr-old, and one 5-yr-old) were of unknown age when initially captured and thus classified as ASY then. The four birds of known age were included in appropriate categories (e.g.,

Table 1. Numbers (and percentages) of maximum relative-age per individual male and relative-age at last year of detection per individual female breeding Cooper’s Hawks in Wisconsin, 1980–2007. These tallies of recaptured birds index age-specific longevity in both sexes.

AGE <sup>a</sup>	NUMBER OF MALES		NUMBER OF FEMALES	
	<i>n</i>	(%)	<i>n</i>	(%)
A3Y	43	(40)	30	(43)
A4Y	26	(24)	12	(17)
A5Y	14	(13)	8	(11)
A6Y–A7Y	16	(15)	15	(21)
A8Y–A10Y	8	(7)	5	(7)
Total	107		70	

<sup>a</sup> Relative ages are A3Y (after-third-year bird; ≥3 yr old), A4Y, A5Y, etc.

3-yr-old birds were placed in the A3Y category). We believe the distributions of the males within these age categories (Table 1) accurately reflects maximum relative-age (at least to the last breeding period) because males exhibit lifetime nesting-area fidelity and when they disappear from the nesting area, we often find proof of death (Rosenfield et al. 2009). We are confident that the distribution of females in these relative-age categories also accurately indexes female longevity because: (1) the numbers of captures at the same pool of nesting areas were similar and thus unbiased between the sexes, with overall totals of 508 males and 469 females captured over 28 yr and means (and medians) of 18 (19) males and 17 (19) females captured per year (Rosenfield and Bielefeldt 1996, R. Rosenfield unpubl. data); (2), detection probability between dispersing and site-faithful females was similar (see below); and (3) the distributions of breeding male and female Cooper’s Hawks in these relative-age categories were similar ( $\chi^2 = 2.19$ ,  $df = 4$ ,  $P = 0.69$ ), suggesting that age-specific mortality (hence longevity) did not differ between the sexes (Table 1). Additionally, the oldest nesting female we detected was A10Y at the last year of detection and the oldest breeding male on our study area was also A10Y across the 28 yr of the study, an age that has not been exceeded for either sex by any reports to us from the general public, with whom we frequently interact, or by records from the Bird Banding Lab (BBL) for Wisconsin Cooper’s Hawks (R. Rosenfield unpubl. data). Annual survival rates were similar between the sexes (81% males, 75% females).

To further examine a possible link between longevity and size, we compared the masses of all females with either yellow or light orange eyes at initial capture to the masses of females with dark orange or red eyes at initial capture. Although individual birds of the same age show variation in eye color, especially orange, females’ eye color in our population is age-dependent and generally darkens from yellow in early ages to shades of orange (see above) or,

rarely, red in later years (Rosenfield and Bielefeldt 1997, R. Rosenfield unpubl. data). Rosenfield and Bielefeldt (1997) indicated that birds with lighter and darker extremes of eye color could be regarded as younger and older individuals, respectively. We therefore excluded ASY birds with orange eyes (middle eye-color category) at initial capture and compared the masses of the presumed older birds (dark orange or red eyes) with those of the presumed younger birds (yellow or light orange eye color), hypothesizing that older birds might be heavier than younger ones if longevity were positively related to body size. This analysis allowed us to examine a possible relationship between age and size using a larger sample of birds that mostly we did not recapture or sight (i.e., 84 [82%] of a total 102 females) and thus could not be used in the above analysis (Table 1).

We examined body size in relation to breeding dispersal by comparing masses of females detected moving among nesting areas across years to those of females who exhibited fidelity to nesting areas for 2, 3, or ≥4 consecutive years and for which we had no evidence of breeding dispersal. We acknowledge some ambiguity in classifying females as either dispersing females or those that exhibit fidelity to nesting area, given that we found three females that exhibited nest fidelity for 2 consecutive years and then later dispersed to other nesting areas. However, we did not detect fidelity to a nesting area by any dispersing female for more than 2 consecutive years; we classified all females that moved to different breeding sites in other years as dispersed birds. We typically locate about 25 nests each year by searching the same nesting areas found in earlier years, and we assume that our detection probability for dispersing females and site-faithful females was approximately the same (Rosenfield and Bielefeldt 1996, Rosenfield et al. 2013). We therefore believe that these two possible strategies, breeding dispersal and fidelity to nesting areas by females, were reasonably and objectively reflected in our categorizations of birds.

We used nonparametric procedures where appropriate (e.g., small sample sizes, skewed distribution [i.e., body mass of birds with either dark orange or red eye color, Table 2]); chi-square, Fisher, Kruskal–Wallis, and Mann–Whitney *U*-test analyses follow Rosenfield et al. (2009) and Whitlock and Schluter (2009). We calculated probability values using StatXact-Turbo (Mehta and Patel 1992). Significance was accepted at  $P \leq 0.05$ .

RESULTS

We captured, individually marked, and weighed 271 ASY breeding female Cooper’s Hawks during the nestling stage on two principal study areas in Wisconsin during 1980–2007 (Table 2). Despite a range of body masses from 455 to 701 g, most subsamples of the total 271 females exhibited similar median body masses (approximately 590 g) among categories of relative age, eye color at initial capture, and dispersal/fidelity strategy (Table 2). More-

Table 2. Descriptive statistics for samples of body mass (g) at initial capture during the nestling stage of an overall total of 271 breeding female Cooper's Hawks in Wisconsin, 1980–2007; and subsamples of these masses categorized by relative age attained per individual at last year of detection (A3Y, A4Y, etc.), eye color at initial capture, and breeding dispersal from or fidelity to nesting areas.

CATEGORY	n	BODY MASS		MEDIAN	INTERQUARTILE
		MEAN (SE)	RANGE		RANGE
Age <sup>a</sup>					
ASY (all)	271	581 (2.61)	455–701	585	551–607
Relative age					
A3Y	30	584 (8.2)	473–677	588	548–607
A4Y	12	576 (14.46)	487–677	581	542–610
A5Y	8	595 (15.96)	514–656	592	571–632
A6Y–A7Y	15	601 (5.75)	530–638	601	587–622
A8Y–A10Y	5	595 (4.27)	585–608	598	586–598
Eye color					
Yellow or light orange	59	587 (5.27)	491–701	587	563–617
Dark orange or red	43	571 (7.27)	461–649	585	542–606
Nesting area occupancy history					
Breeding dispersal	15	586 (10.29)	514–677	587	578–607
Site fidelity 2 yr	28	586 (8.57)	473–677	591	553–617
Site fidelity 3 yr	8	553 (13.8)	487–656	550	533–581
Site fidelity ≥4 yr	19	606 (9.06)	564–656	598	586–628

<sup>a</sup> Relative ages are ASY (after-second-year bird; ≥2 yr old), A3Y, A4Y, etc.

over, body mass of breeding females did not vary significantly among birds in five categories of relative age, A3Y to A10Y (Kruskal–Wallis statistic = 2.85,  $df=4$ ,  $P=0.58$ ), our index to longevity; nor did body mass vary significantly between females of lighter vs. darker eye color (i.e., presumed younger and older females, respectively; Mann–Whitney  $U$ -test statistic = 1099.5,  $df=1$ ,  $P=0.25$ ; Table 2). Further, there were no significant differences in body mass between dispersing females vs. birds exhibiting fidelity to nesting areas of 2, 3, or ≥4 consecutive years (Mann–Whitney  $U$ -test:  $U=204.0$ ,  $df=1$ ,  $P=0.88$ ;  $U=85.0$ ,  $df=1$ ,  $P=0.16$ ;  $U=92.5$ ,  $df=1$ ,  $P=0.08$ , respectively; Table 2). We concluded that size of breeding females was unrelated to longevity and breeding dispersal/fidelity strategy.

We detected breeding dispersal in 15 females. The mean and median number of years of detection of these 15 dispersing birds was 4.0 and 3.5 yr, respectively (range: 2–8 yr), or an average relative age of A5Y (range: A3Y–A9Y) for this cohort. The corresponding means and medians for the pool of nondispersing birds were 3.3 and 2.0 yr (range: 2–9 yr), or an average relative age of A4Y (range: A3Y–A10Y). Dispersing females, as with site-faithful females, occurred in all five categories of relative age, and the proportions of these five categories varied significantly between dispersing females and females exhibiting fidelity to nesting areas (Fisher statistic = 9.77,  $P=0.04$ ; Table 3); thus, it is possible that dispersing females live longer than nondispersing females.

## DISCUSSION

Our study represents the first analysis of the possible relationships between body mass, or size, and longevity and breeding dispersal in nesting female Cooper's Hawks. In contrast to some other studies of *Accipiter*, we found that body mass (or size) was unrelated to longevity (as evidenced by two different analyses), breeding dispersal, and fidelity to nesting areas of Cooper's Hawks in Wisconsin during 1980–2007. Although we previously demonstrated body mass in both males and females to be linked significantly and positively to annual reproductive rate, number of recruits (or fitness), but inversely related to timing of breeding (i.e., larger birds seasonally breed earlier), it appears that, as for males, body size in female Cooper's Hawks is subordinate to other, non-habitat factors that influence longevity and reoccupancy of nesting areas in Wisconsin (Rosenfield and Bielefeldt 1999, Rosenfield et al. 2009). We do not know how birds select nesting areas and, like other researchers, we lack documentation of behaviors of individuals while they were vying for breeding sites and mates. We encourage raptor researchers to gather and incorporate behavioral data during the pre-laying period in their analyses of breeding dispersal.

In contrast to our results, longevity and body size were positively correlated in the congeneric Eurasian Sparrowhawk (Newton 1986). Newton (1989) emphasized, however, that individual lifespan in female Sparrowhawks was greatly influenced by territory quality and he suggested that good territories were successfully acquired by females of



larger size. Female sparrowhawks exhibited persistent use of high quality sites and/or dispersed from poorer to better territories (Newton 1989). Habitat quality has a similar influence on breeding dispersal in other raptors (e.g., California Spotted Owl [*Strix occidentalis*], Blakesley et al. 2006; Black Kite [*Milvus nigrans*], Forero et al. 1999). Millsap et al. (2013) reported a high rate (68% [vs. 23% in our Wisconsin study areas]) of annual breeding dispersal by female Cooper’s Hawks in rural northern Florida and suggested that competition for (apparently higher quality) nesting sites was “widespread” each year; he did not investigate any possible relationship between body size and competitive ability in his study areas, which were characterized as being unusually limited in prey resources (and see below). Mannan et al. (2006) reported a 9.4% apparent annual rate of breeding dispersal by female Cooper’s Hawks among high-quality urban breeding sites in Arizona but they did not relate these movements to body traits of birds. We reiterate that we have been unable to link breeding habitat quality (including urban and rural) to variation in body size, reproductive success, survival, or fitness of Cooper’s Hawks in Wisconsin (e.g., Rosenfield and Bielefeldt 1999, Rosenfield et al. 1995, 2000, 2009, 2015a, R. Rosenfield unpubl. data). It is possible that factors, especially those unrelated to territory quality, influencing breeding dispersal in Wisconsin Cooper’s Hawks are not similar to those of other raptors.

Dispersing female Cooper’s Hawks may exhibit greater longevity than did nondispersing birds (Table 3). This finding seems to contrast with that of Millsap et al. (2013) who suggested that older breeding females (based on eye color) tended to become more sedentary with age in Florida. They suggested that this tendency reflected a greater competitive success by older females in displacing younger females from higher-quality nesting areas, but they did not have behavioral data. We do not know why the relationship between age and breeding dispersal seems to differ between the two study sites. We emphasize that we have been unable to identify nesting areas with varying levels of habitat quality on our Wisconsin study areas (Rosenfield and Bielefeldt 1999, Rosenfield et al. 2009). Additionally, we have recently documented two smaller and younger ASY females physically attack and displace older and larger ASY females from nesting areas during the pre-incubation period in Wisconsin (L. Sobolik and R. Rosenfield unpubl. data). In one of these instances, only the displaced female had been observed during each day (0500–1800 H) for about 2 wk, approximately half of the pre-incubation period (Rosenfield and Bielefeldt 1991), before a brief (<10 sec) in-flight battle with an intruding female apparently displaced the former occupant permanently from that site that year. Moreover, and at least on our study sites, we have incomplete documentation and understanding of the factors, including the pre-incubation social dynamics within and between the sexes, that seemingly would influence breeding dispersal and nesting area fidelity in female Cooper’s Hawks. Such social factors

Table 3. Numbers (and percentages in parentheses) of nesting female Cooper’s Hawks that exhibited fidelity to or breeding dispersal among nesting areas by categories of relative-age per individual at last year of detection (A3Y, A4Y, etc.) in Wisconsin, 1980–2007.

AGE <sup>a</sup>	NESTING AREA OCCUPANCY HISTORY	
	NO. OF FEMALES WITH SITE FIDELITY <i>n</i> (%)	NO. OF FEMALES WITH BREEDING DISPERSAL <i>n</i> (%)
A3Y	28 (51)	2 (13)
A4Y	7 (13)	5 (33)
A5Y	5 (9)	3 (20)
A6Y–A7Y	12 (22)	3 (20)
A8Y–A10Y	3 (5)	2 (13)
Total	55	15

<sup>a</sup> Relative ages are A3Y (after-third-year bird; ≥3 yr old), A4Y, A5Y, etc.

may potentially influence longevity and breeding duration (see Newton 1986, Rosenfield et al. 2013, Chainé et al. 2015). For example, we have documented nonrandom mating by size on our study areas with males and females exhibiting choice of social partners (Rosenfield and Bielefeldt 1999, R. Rosenfield unpubl. data), but we do not know the behavioral dynamics of these phenomena. We also cannot completely describe the locations, breeding status, and behavior of 11 (73%) of the 15 dispersing females in the years before we redetected them as breeders, thereby precluding our ability to validly document (and analyze) more completely the phenomenon of breeding dispersal in female Cooper’s Hawks in Wisconsin. Indeed, the average duration of the time we did not know the locations of these dispersing females was 2.8 yr. Further, breeding dispersal by females seems obligatory when a male is not replaced on our study sites (R. Rosenfield unpubl. data) and we do not know the behavioral dynamics associated with this phenomenon. Further complicating our understanding of the social system during the pre-incubation period is a lack of details about behaviors involved in the movement across neighboring territories of female Cooper’s Hawks in an apparent effort to seek food in trade for extra-pair copulations (Millsap et al. 2013, Rosenfield et al. 2015b, B. Millsap unpubl. data). The rate of extra-pair paternity per nest we recently documented in Wisconsin Cooper’s Hawks is about four times higher than any other yet reported for raptors, and may involve both territorial and floater males. Because copulations are associated with food-provisioning in Cooper’s Hawks to a greater extent than in other raptor species (Rosenfield et al. 2015b), we suggest that food resources from extra-pair males likely contribute to the potential reproductive success of a female (Rosenfield et al. 2015b). This phenomenon could

conceivably confound a conventional investigation to determine territory quality if that study assumes that food resources requisite for reproduction, particularly early in the breeding season, were derived exclusively from where a female nests when in fact some resources could have come from elsewhere. Extra-pair dynamics involve at least three individuals, but we have documented behavioral interactions of at least five individuals (including at least three different females) at one nesting area across 3 wk before egg-laying (Rosenfield et al. 2015b, R. Rosenfield and L. Sobolik unpubl. data). The social system of the Cooper's Hawk prior to incubation is complex and we thus recommend long-term studies that track adequate samples of dispersing and non-dispersing females, their body sizes and breeding histories, and investigations that document complementary behavioral dynamics of all interacting individuals (male and female), especially during the pre-laying stage, to better understand the ecology of nest-site fidelity and breeding dispersal of female Cooper's Hawks.

Researchers often investigate potential factors related to or influencing breeding dispersal in raptors by constructing a hierarchy of the relative strength of covariates via modeling of competing hypotheses (Burnham et al. 2011). These covariates conventionally include history of nesting success, age, sex, and especially territory quality (e.g., Blakesley et al. 2006, Forero et al. 1999, Ganey et al. 2014, Gutiérrez et al. 2011). It appears common for researchers to conclude that birds tend to disperse from sites of poorer quality to sites of higher quality habitat and in doing so improve reproductive success (e.g., Newton 1986, Gutiérrez et al. 2011; we note that dispersing females in our study did not increase their reproductive output at the sites to which they moved compared to their previous nest sites [Rosenfield et al. 2016]). Such modeling is requisitely dependent upon the inclusion of the pertinent variables or potential covariates to generate valid competing hypotheses (Burnham et al. 2011). We highlight that breeding dispersal is a behavior and to our knowledge researchers generally lack descriptions and enumeration of behaviors associated with individual birds when they are vying for and selecting breeding sites (e.g., Marti 1999, Blakesley et al. 2006, Forero et al. 1999, Steenhof et al. 2005, Ganey et al. 2014). Ganey et al. (2014) seemed to recognize these limitations in their study of breeding dispersal when they indicated that it was unknown how Mexican Spotted Owls (*S. o. lucida*) select new territories. Using the aforementioned conventional covariates in their models, and despite documentation each year of the reproductive output of >95% of individual owls in their study area, Gutiérrez et al. (2011) indicated that their best model explained only 9% of the variation in breeding dispersal of the California Spotted Owl; they concluded that more factors were probably involved in dispersal than the ones they examined. We note their study presented no behavioral data of birds while they were competing for breeding sites. We suggest that researchers may potentially compromise

the validity of models regarding breeding dispersal by predominantly studying outcomes, or consequences of breeding dispersal. As with our study, we suspect this is because of the difficulty of documenting the pertinent behaviors and/or varying characteristics (e.g., possibly size, fighting ability, breeding experience, health) among individuals of both sexes involved during selection and acquisition of breeding sites. We suggest that our knowledge of breeding dispersal of raptors will be more complete when researchers are able to document and include in their analyses the behavior(s) and pertinent characteristics of the individuals interacting during acquisition of breeding sites.

Lastly, although body mass has been demonstrated to be a strong, non-habitat ecological correlate in the breeding ecology of both sexes of Wisconsin Cooper's Hawks (Rosenfield and Bielefeldt 1999, Rosenfield et al. 2009, 2013), we were unable to detect a relationship between body mass (or size) with either longevity (as with males [Rosenfield et al. 2009]) or breeding dispersal in female Cooper's Hawks.

#### LA MASA CORPORAL DE HEMBRAS DE *ACCIPITER COOPERII* NO ESTÁ RELACIONADA CON LA LONGEVIDAD Y LA DISPERSIÓN REPRODUCTIVA: IMPLICACIONES PARA EL ESTUDIO DE LA DISPERSIÓN REPRODUCTIVA

RESUMEN.—Capturamos, marcamos individualmente y pesamos 271 hembras reproductoras de segundo año de *Accipiter cooperii* durante la época de cría en dos áreas de estudio principales en Wisconsin durante el periodo comprendido entre 1980 y 2007. Luego recapturamos o volvimos a avistar a algunas de las aves utilizando prismáticos o telescopios y las identificamos a través del color de sus anillas. Para analizar la relación de la longevidad de la hembra con el tamaño, examinamos la masa corporal de adultos reproductores recapturados o avistados nuevamente por categoría de edad relativa durante el último año de detección. Encontramos que la masa corporal (o tamaño) en esta especie no estuvo relacionada con la longevidad ni con la dispersión reproductiva entre, o la fidelidad con, las áreas de nidificación en Wisconsin. Aunque previamente demostramos que la masa corporal tanto en machos como en hembras estuvo relacionada significativa y positivamente con la tasa reproductiva anual y con el número de reclutamientos (o la eficacia biológica), pero inversamente relacionada con el tiempo de la reproducción (i.e., las aves de mayor tamaño se reprodujeron antes en la temporada), parece que, para los machos, el tamaño corporal en *A. cooperii* está subordinado a otros factores no relacionados con el hábitat que influyen en la longevidad y la recuperación de las áreas de nidificación en Wisconsin. Los factores biológicos que influyen tanto sobre la dispersión interanual a un área de nidificación diferente por parte de una hembra experimentada, como sobre la fidelidad año tras año a un sitio se puede basar en comportamientos

sociales complejos previos a la incubación en *A. cooperii*. Sugerimos que nuestro conocimiento de la dispersión reproductiva de aves rapaces mejoraría si se documentaran detalladamente las interacciones sociales entre individuos durante la adquisición de lugares de cría.

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