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A comparison of age, size, and health of House Finches captured with two trapping methods

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ABSTRACT. House Finches are being increasingly studied because of their variation in male plumage, evolving migration, and susceptibility to mycoplasmal conjunctivitis. Researchers traditionally use two methods for capturing House Finches: a walk-in hardware mesh cage around a bird feeder and mist nets placed next to lure feeders. However, because one method relies on birds' willingness to enter a foreign structure to obtain food, while the other captures them while flying, these methods may not sample the same subset of the House Finch population. This possibility could have serious consequences for studies of plumage coloration, where sex and age ratios are important; for studies of migration, where measures of wing lengths reflect migratory ability; and for studies of mycoplasmal infections, where disease state and measures of health are important. I used data from a long-term monitoring project of House Finches that employs both capture techniques to test if any attributes of House Finches differed between mist-netted and cage-trapped birds. Of 1173 House Finch captures over 3 yr, I found no trap-related difference in the proportion of birds with conjunctivitis, nor in the proportions of males or in the ratios of molting versus non-molting birds. There was also no difference in House Finch tarsus lengths or weights between capture methods. However, a larger proportion of young birds were captured in cage traps, and wing lengths were greater in birds captured with mist nets. I conclude that in general, cage traps and mist nets sample similar subsets of House Finches, but that researchers should view their trapping data with these inherent age and size biases in mind.

SINOPSIS. **Comparación de edad, tamaño y estado de salud de individuos de *Carpodacus mexicanus* capturados con métodos diferentes**

Los gorriones caseros (*Carpodacus mexicanus*) se han estudiando con mayor frecuencia debido a las variaciones en el plumaje de los machos, patrones migratorios y su susceptibilidad a conjuntivitis micoplásmica. Se han utilizado dos métodos tradicionales para capturar a estas aves: el de una jaula colocada en los alrededores de comederos y el uso de redes de niebla colocadas cerca de los comederos. Sin embargo, como uno de los métodos depende de la voluntad de las aves de entrar dentro de una estructura extraña para comer, mientras que el otro método los captura mientras vuelan, estos métodos no necesariamente muestrean el mismo tipo de grupo dentro de la población de aves. Esta posibilidad pudiera tener serias consecuencias para estudios sobre la coloración del plumaje, tasa de edad y sexo y patrones migratorios en donde el largo del ala est relacionado a la capacidad del ave para moverse. De igual manera de estudios de susceptibildad a micoplasmosis, en donde el estado de salud es importante. Utilicé los datos de un estudio a largo alcance que empleo ambos métodos de captura, para analizar, retrospectivamente, si alguno de los resultados de los aspectos a estudiarse variaban con el método de captura. En 1173 individuos capturados a lo largo de tres años, no encontré diferencias en la proporción de aves con conjuntivitis, tampoco en la proporción de machos o en la tasa de muda entre aves que estaban mudando y las que no habían comenzado. Tampoco se encontró diferencia entre las medidas del tarso y el peso de los individuos. Sin embargo, encontramos una mayor proporción de juveniles atrapados con la jaula y el largo del ala resultó mayor en las aves capturadas con las redes. En conclusión se puede decir que con ambos métodos de captura se obtienen resultados similares, pero que los investigadores deben tener cuidado con el tipo de captura a ser utilizado dado el caso de que puede haber sesgo en la edad y tamaña de los animales.

Key words: *Carpodacus mexicanus*, conjunctivitis, House Finch, mist net, trap

House Finches (*Carpodacus mexicanus*) in North America have been the subject of considerable interest by researchers. In particular, because of the natural variation in male plumage color in most populations, they have often been considered a model subject for studies of sexual selection in birds (e.g., Hill 1990, 2002; Hill et al. 1999). Further, the evolving migration of the introduced eastern population of House Finches has also been studied (e.g., Hamilton 1991; Able and Belthoff 1998; Egbert and Belthoff 2003). More recently, House Finches have been found to be susceptible to a new strain of the bacterium, *Mycoplasma gallisepticum*, which causes (mycoplasmal) conjunctivitis (Ley et al. 1996). As such, they have now become a model species for the study of avian

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disease dynamics (e.g., Dhondt et al. 1998; Davis et al. 2004; Faustino et al. 2004). The fact that House Finches are used in each of these diverse but growing research areas makes them one of the most widely studied passerine species in North America.

No matter the specific goal, for most ornithological field studies, researchers are required to capture subsets of a particular population to obtain measurements and/or samples from multiple individuals. In studies of House Finches, two of the most commonly employed capture methods both involve luring individuals to trapping sites with bird feeders. In one method, the lure feeder is replaced with a hanging "basket" or cage trap (hereafter called cage trap; Hill 2002) on the day of trapping. This device consists of a cylindrical, hardware cloth cage that surrounds the lure feeder. Two finch-sized, slightly-funneled openings in the cage walls, each equipped with stick perches leading into the opening, allow birds to enter the cage. Birds are usually unable to find these openings once inside. The birds then remain inside until a researcher checks the trap. This method can be very effective in capturing many individuals at once, as trapped individuals can often lure other individuals into the cage (A. K. Davis, pers. obs.). The second method is more traditional and involves placing one or more standard mist nets next to the lure feeder and capturing finches as they fly toward the feeder.

Each of these trapping methods operates in a different way to capture House Finches. One relies on birds walking into an apparatus to obtain food, while the other captures birds while flying (albeit towards the lure feeder). Previous research with Brown-headed Cowbirds (*Molothrus ater*) has shown that trapping methods that rely on birds' hunger to lure them inside cages can yield samples that are biased toward lean individuals (Dufour and Weatherhead 1991). Also, the initial individuals to enter a trap may act as decoys to lure additional birds into the trap, but this does not occur with mist nets. Further, in House Finches, those birds with mycoplasmal conjunctivitis may be more likely to be captured with mist nets than non-infected individuals because of their impaired vision. These possibilities raise the question of whether both trapping methods capture similar subsets of the House Finch population.

This issue has important consequences for studies involving House Finches, since many studies utilize one (e.g., Duckworth et al. 2001; Hartup et al. 2001; Roberts et al. 2001; Nolan et al. 2004) or both (e.g., Luttrell et al. 2001; Hill et al. 2002; Egbert and Belthoff 2003) methods of capture. For studies of sexual selection where male House Finches are captured and their plumage measured (e.g., Hill et al. 2002), an important question is do both trapping methods capture similar ages of House Finches. Immature House Finch males have duller plumage than adults (reviewed in Hill 2002), so problems arise if one method is biased toward young males. Other relevant questions include whether both methods capture males with equal frequency, and whether molting birds are more likely to be captured with either method. Molt is an important period for male House Finches, since that is the time when red plumage feathers are grown (Hill 2000). For studies of the evolving migration behavior of the introduced eastern population, measurements of wing lengths are important because eastern House Finches have been shown to have longer, more pointed wings than western populations (Egbert and Belthoff 2003). Do both methods capture similarly sized individuals (with respect to wing length or tarsus)? Finally, it is crucial for many studies of mycoplasmal conjunctivitis in House Finches that objective assessments of conjunctivitis prevalence in a population be made (e.g., Altizer et al. 2004), and thus we need to know whether both trapping methods capture similar proportions of infected individuals. Moreover, for studies focusing on the effect of conjunctivitis on the health of individuals, some measure of physiological condition (such as body weight) is usually required, which could also differ with respect to trapping regime.

I addressed these questions using 3 yr of existing trapping data from a long-term monitoring project that used both trapping methods to catch House Finches (Altizer et al. 2004; Davis et al. 2004; Hotchkiss et al., in press). I specifically asked whether adults and young birds were captured similarly with cage traps or mist nets; whether males and females were captured with equal probability using both methods; whether cage traps and nets captured similarly sized birds (with respect to wing and tarsus length) or birds with similar weights; and whether mycoplasmal infected and non-infected birds were captured similarly with cage traps or mist nets.

METHODS

Trapping sites. House Finches were trapped each month of the year (with a minimum of 10 trapping days per month) at three sites on and near Emory University, Atlanta, Georgia, using both mist nets and cage traps. One site was on the Emory campus, and the other two were in the backyard of houses in residential neighborhoods 2 and 5 km from the campus, respectively. At all sites, standard tube-style bird feeders were maintained on non-trapping days to lure House Finches to the site.

Cage and mist net usage. On the day of trapping, I determined whether mist nets or cage traps would be appropriate, based largely on the weather that morning, but to a lesser extent, on the availability of helpers. On windy days, mist nets were useless, as birds could either see the nets billowing, or the wind kept the nets taught enough so that birds bounced off. Cage traps were more appropriate to use during light rain. As a result, there tended to be fewer days where mist nets were more appropriate than cage traps. Because the cage trap effectively captures House Finches while other species are able to find their way back out of the cage, it was used more frequently than the mist net method. Thus, more House Finches were captured with cage traps than mist nets (902 cage trappings vs. 271 in mist nets) over the 3 yr of this project. However, I did not preferentially use one method over the other at any one site, so that the relative proportion of cage trapped birds (77% overall) versus mist netted birds (23% overall) was similar between each trapping site (78 vs. 22%, 80 vs. 20%, and 65 vs. 35% for the three sites). Also, even though more individual birds were captured overall with the cage traps than mist nets, the analyses of trap effects tests relative proportions only within each trap sample, so that differences in sample sizes between the two trapping methods do not matter.

Trapping methods and data collection. In almost all cases, I maintained the cage or nets for 3 h in the morning of trapping days, beginning within 1–2 h after sunrise. If cage traps were utilized, I replaced the lure feeder with the cage trap (i.e., I hung the cage where the lure feeder was normally hung) and checked the trap every 20 min thereafter for captured birds. If mist nets were utilized, I placed 1–2 standard 9 m, (30 mm mesh) mist nets within 1 m of the lure feeder, usually on either side of it, and checked the nets every 20 min thereafter. Upon being captured using either method, House Finches were placed in cloth bags for transport to the processing area. Each bird was banded with a unique color band combination, aged and sexed based on Pyle (1997) and Hill (1993), weighed to the nearest 0.1 g using a portable electronic balance, and the presence or absence of mycoplasmal conjunctivitis (i.e., visible signs of swelling around eyes), and flight feather molt noted. Furthermore, the right tarsus and wing chord was measured on each bird with calipers and a standard wing rule.

Data analyses. Using three years of data (August 2001–August 2004) representing 1173 individual House Finches (recaptures were not included), I organized the data into two overall groups according to the type of trap used to capture each House Finch. I used chi-square tests of homogeneity to test if the proportion of adult versus young birds differed within each trap sample; if the proportion of each sex differed; if proportions of molting birds versus non-molting birds differed; and if the proportion of birds with and without conjunctivitis differed between the trapping methods. For the analysis of age frequencies, I only used data from May to October, the months when both adult and young birds are present and can be reliably aged. Birds that were an unknown age were excluded. For analyses of sex frequencies, all months were included but birds of unknown sex were excluded. For the analysis of molting birds, I only used data from August to December of each year, as this period overlaps the time of the House Finch prebasic molt in Atlanta (Altizer et al. 2004). For the analysis of conjunctivitis frequencies, I used data from July to February, the period when mycoplasmal conjunctivitis is present in the Atlanta area (Altizer et al. 2004).

I used analysis-of-variance and model simplification techniques to determine if the overall sample of birds captured with either method differed with respect to tarsus measurements, weight, or wing chords. Three separate univariate ANOVAs were performed, and in each test I included trap method, age, sex, and conjunc-

Table 1. Summary of data and results of chi-square tests. Values represent proportions of the total number of birds (*N*) captured with each trapping method.

Variable	Cage	Mist net	*P*
Age (May–October)			
Adult	0.23	0.32	0.028
Young	0.77	0.68	
N	501	165	
Molt (August–December)			
No molt	0.72	0.77	0.274
Molt	0.28	0.23	
N	437	150	
Infection (July–February)			
No conjunctivitis	0.86	0.81	0.096
Conjunctivitis	0.14	0.19	
N	648	211	
Sex			
Males	0.57	0.58	0.816
Females	0.43	0.42	
N	612	199	

tivitis status as binomial independent variables as well as all two-way interaction effects (11 total fixed effects and interaction terms). For the tests of wing and weight, I included tarsus length as a continuous covariate. I initially ran each test with all independent variables, then used model simplification techniques (comparison of model fit parameters based on AIC_c values) to systematically remove non-important factors, until the smallest possible model (i.e., minimum adequate model) was obtained. For each of these three tests, all data were included.

Results were considered significant when $P < 0.05$. All tests were performed using SPSS software (SPSS 2004).

RESULTS

Age, sex, molt, and conjunctivitis. There was a significant difference in the age ratios of House Finches captured with the different trapping methods ($N = 666$, $\chi^2_1 = 4.8$, $P = 0.028$; Table 1). The proportion of young House Finches captured with the cage trap was 0.77, while the proportion of young captured with mist nets was 0.69. There was no significant difference in the frequency of sexes captured with either trap method as approximately 58% of all captures with either method were of male House Finches ($N = 811$, $\chi^2_1 = 0.054$, $P = 0.82$; Table 1). There was no difference in the proportion of birds captured in molt (0.72, 0.77) between trap methods ($N = 587$, $\chi^2_1 = 1.2$, $P = 0.27$; Table 1). There was also no trap-related difference in the proportion of birds captured with conjunctivitis ($N = 859$, $\chi^2_1 = 2.8$, $P = 0.10$; Table 1).

Table 2. Analysis of variance of House Finch wing length.

Independent variable	df	Mean square	*F*	*P*
Tarsus	1	98.56	38.02	0.000
Sex	1	910.29	351.12	0.000
Trap method	1	10.15	3.91	0.048
Sex*trap method	1	10.01	3.86	0.050
Error	794	2.59		

Tarsus, wing, and weight. I found no significant variation in tarsus lengths between trap methods, nor in any other independent variable, as model simplification procedures resulted in a minimum adequate model where only the intercept was significant. For the ANOVA focused on wing lengths, comparison of AIC_c among models with different interaction terms and main effects supported the following simplified model: wing length = tarsus + sex + trap method + sex*trap method. Wing lengths of House Finches were significantly related to tarsus lengths ($F_{1,794} = 38.02$, $P < 0.001$) and differed significantly with respect to sex ($F_{1,794} = 351.12$, $P < 0.001$; Table 2). House Finches captured in the cage traps had significantly shorter wings (mean, 75.3 mm) than those captured with mist nets (mean, 75.5 mm; $F_{1,794} = 3.91$, $P = 0.048$; Table 2). Moreover, the significant sex*trap method interaction term ($F_{1,794} = 3.86$, $P = 0.050$) indicated that this effect differed between males and females. Males captured in mist nets had greater average wing lengths than those captured in cage traps, but there was little difference between female wing lengths (Fig. 1).

Although I found several significant fixed factors and interaction terms affecting House Finch body mass, including tarsus, sex, sex*age, and sex*conjunctivitis (Table 3), after model simplification procedures, the final minimum adequate model did not include trap method or any two-way interaction terms involving trap method (final model: body weight = tarsus +

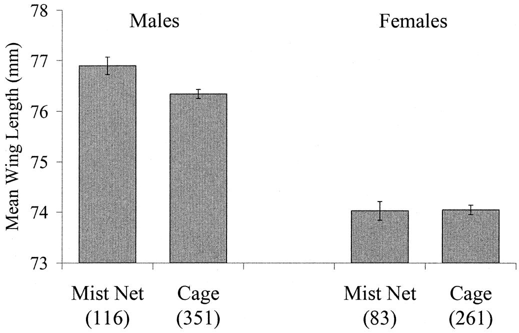

Fig. 1. Comparison of wing length of male and female House Finches captured with mist nets and cage traps. Only birds of known sex were included. Sample size for each group is indicated in parentheses. Error bars represent standard errors.

sex + sex*age + sex*conjunctivitis). Thus, there was no difference in weights of House Finches captured with either trapping method.

DISCUSSION

Whether the focus of the study is on plumage, migration, or mycoplasmal conjunctivitis, researchers are often required to capture large numbers of House Finches. They traditionally have done so using either a combination of cage traps and mist nets and pooled the combined trap data (e.g., Luttrell et al. 2001; Hill et al. 2002; Egbert and Belthoff 2003), or they have used one method only (e.g., Duckworth et al. 2001; Hartup et al. 2001; Roberts et al. 2001; Nolan et al. 2004). The results obtained here indicate that in general, these practices are valid for most studies, since cage traps and mist nets in my study captured similar subsets of the House Finch population with respect to most of the variables I measured. I found that sex ratios and molt frequencies were similar between trap types, each of which are important in studies of House Finch plumage coloration (e.g., Hill et al. 1999; Hill et al. 2002). I also found that each trapping method captured similar subsets of individuals with mycoplasmal conjunctivitis, which is a critical assumption in most studies of this disease where prevalence from multiple sites and/or trapping methods are pooled (e.g., Altizer et al. 2004; Faustino et al. 2004).

I found two trap-related differences. I found that cage traps tended to capture more young individuals than mist nets. This finding was consistent with work on other species. Dufour and Weatherhead (1991) found evidence that young cowbirds were particularly susceptible to baited traps. They suggested that young birds were more likely to have reduced foraging skills, be in the poorest condition, and thus should be most likely to overcome their inhibition and enter cage traps. Alternatively, it may be that young birds are more easily lured into the trap by following already trapped birds. Dufour and Weatherhead (1991) suggested that trapped individuals in a cage can create an artificial signal of local food abundance, which could act to lure naïve (in this case young) birds into the trap. However, regardless of the reason for the age bias between trapping methods, the fact that it exists could have implications for studies of House Finch plumage coloration since young males are known to have duller plumage coloration than adults (Hill 2002). Thus, my data suggest that comparisons of House Finch plumage between samples obtained with mist nets and cage traps would only be valid if ages were accounted for.

I also found that larger birds (with respect to wing size but not tarsus), and especially with respect to males, were captured with mist nets. This was surprising, since this effect was not due to more adult birds or more males in the

Table 3. Analysis of variance of House Finch body weight.

Independent variable	df	Mean square	*F*	*P*
Tarsus	1	59.04	44.897	0.000
Age	1	0.19	0.147	0.701
Sex	1	17.73	13.483	0.000
Conjunctivitis	1	2.36	1.793	0.181
Sex*age	1	12.11	9.211	0.003
Sex*conjunctivitis	1	8.71	6.622	0.010
Error	618	1.31		

mist-net samples. If smaller birds are socially subordinate, they may be more likely to enter the cage traps than the larger, dominant individuals. However, the lack of a significant difference in tarsus measurements and the relatively minor differences in wing lengths between mist-netted and cage-trapped birds (less than 1 mm) makes further speculation on the causative factors unwarranted. However, this bias does have implications for studies of House Finch migration, where measurement of wing length is important (Egbert and Belthoff 2003). My data indicate that comparisons of wing morphology between locations or populations should only be made if the trapping method is either accounted for, or is similar between locations that are compared.

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LITERATURE CITED

ABLE, K. P., AND J. R. BELTHOFF. 1998. Rapid 'evolution' of migratory behaviour in the introduced House Finch of eastern North America. Proceedings of the Royal Society of London B 265: 2063–2071.

ALTIZER, S., A. K. DAVIS, K. C. COOK, AND J. J. CHERRY. 2004. Age, sex, and season affect the risk of mycoplasmal conjunctivitis in a southeastern House Finch population. Canadian Journal of Zoology 82: 755–763.

DAVIS, A. K., K. C. COOK, AND S. ALTIZER. 2004. Leukocyte profiles of House Finches with and without mycoplasmal conjunctivitis, a recently emerged bacterial disease. EcoHealth 1: 362–373.

DHONDT, A. A., D. L. TESSAGLIA, AND R. L. SLOTHOWER. 1998. Epidemic mycoplasmal conjunctivitis in House Finches from eastern North America. Journal of Wildlife Diseases 34: 265–280.

DUCKWORTH, R. A., M. T. MENDONCA, AND G. E. HILL. 2001. A condition dependent link between testosterone and disease resistance in the House Finch. Proceedings of the Royal Society of London B 268: 2467–2472.

DUFOUR, K. W., AND P. J. WEATHERHEAD. 1991. A test of the condition-bias hypothesis using Brown-headed Cowbirds trapped during the breeding season. Canadian Journal of Zoology 69: 2686–2692.

EGBERT, J. R., AND J. R. BELTHOFF. 2003. Wing shape in House Finches differs relative to migratory habit in eastern and western North America. Condor 105: 825–829.

FAUSTINO, C., C. S. JENNELLE, V. CONNOLLY, A. K. DAVIS, E. C. SWARTHOUT, A. DHONDT, AND E. G. COOCH. 2004. *Mycoplasma gallisepticum* infection dynamics in a House Finch population: analysis of seasonal variation in survival and transmission rate. Journal of Animal Ecology 73: 651–669.

HAMILTON, T. R. 1991. Seasonal movements of House Finches in the midwest. North American Bird Bander 16: 119–122.

HARTUP, B. K., J. M. BICKAL, A. A. DHONDT, D. H. LEY, AND G. V. KOLLIAS. 2001. Dynamics of conjunctivitis and *Mycoplasma gallisepticum* infections in House Finches. Auk 118: 327–333.

HILL, G. E. 1990. Female House Finches prefer colourful males: sexual selection for a condition-dependent trait. Animal Behaviour 40: 563–572.

———. 1993. House Finch (*Carpodacus mexicanus*). In: The birds of North America, no. 46 (A. Poole, and F. Gill, eds.), Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington, D.C.

———. 2000. Energetic constraints on expression of carotenoid-based plumage coloration. Journal of Avian Biology 31: 559–566.

———. 2002. A red bird in a brown bag: the function and evolution of colorful plumage in the House Finch. Oxford University Press, New York, NY.

———, C. Y. INOUYE, AND R. MONTGOMERIE. 2002. Dietary carotenoids predict plumage coloration in wild House Finches. Proceedings of the Royal Society of London B 269: 1119–1124.

———, P. M. NOLAN, AND A. M. STOEHR. 1999. Pairing success relative to male plumage redness and pigment symmetry in the House Finch: temporal and geographic constancy. Behavioral Ecology 10: 48–53.

HOTCHKISS, E. R., A. K. DAVIS, J. J. CHERRY, AND S. ALTIZER. *In press.* Mycoplasmal conjunctivitis and the behavior of wild House Finches (*Carpodacus mexicanus*) at bird feeders. Bird Behavior.

LEY, D. H., J. E. BERKHOFF, AND J. M. MCLAREN. 1996. *Mycoplasma gallisepticum* isolated from House Finches (*Carpodacus mexicanus*) with conjunctivitis. Avian Diseases 40: 480–483.

LUTTRELL, M. P., D. E. STALLKNECHT, S. H. KLEVEN, D. M. KAVANAUGH, J. L. CORN, AND J. R. FISCHER. 2001. *Mycoplasma gallisepticum* in House Finches (*Carpodacus mexicanus*) and other wild birds associated with poultry production facilities. Avian Diseases 45: 321–329.

NOLAN, P. M., S. R. ROBERTS, AND G. E. HILL. 2004. Effects of *Mycoplasma gallisepticum* on reproductive success in House Finches. Avian Diseases 48: 879–885.

PYLE, P. 1997. Identification guide to North American Birds. Part 1. Slate Creek Press, Bolinas, CA.

ROBERTS, S. R., P. M. NOLAN, L. H. LAUERMAN, L.-Q. LI, AND G. E. HILL. 2001. Characterization of the mycoplasmal conjunctivitis epizootic in a House Finch population in the southeastern USA. Journal of Wildlife Diseases 37: 82–88.

SPSS. 2004. Version 12.0. SPSS, Inc., Chicago, IL.