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Record fledging count from a seven-egg clutch in the Cooper's Hawk (*Accipiter cooperii*)

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ABSTRACT—Cooper's Hawks (*Accipiter cooperii*) typically lay 3–5 eggs per clutch, rarely 6 eggs, and there are 2 accounts of 7-egg clutches and 1 record of a maximum 8-egg clutch for the species. Brood sizes of 3–5 young are common and the previous maximum brood count is 6 young. However, in 2019, we found an urban nest in Stevens Point, Wisconsin, with 7 eggs that resulted in a record high of 7 fledglings. We genetically confirmed that the attending male sired all the offspring and the attending female laid all 7 eggs. Larger body size of the tending adults may have been a factor in the exceptional reproduction reported here. *Received 1 November 2019. Accepted 12 May 2020.*

Key words: brood count, intraspecific brood parasitism, paternity and maternity analyses, urban nest.

Número record de polluelos emancipados de una puesta de siete huevos en el gavilán *Accipiter cooperii*

RESUMEN (Spanish)—El gavilán *Accipiter cooperii* típicamente pone 3–5 huevos por puesta, rara vez 6. Hay 2 reportes de puestas de 7 huevos y 1 registro máximo de una puesta de 8 huevos para esta especie. Los tamaños de nidada de 3–5 polluelos son comunes y la nidada máxima es de 6 polluelos. Sin embargo, en 2019 encontramos un nido urbano en Stevens Point, Wisconsin, con 7 huevos que resultó en un récord máximo de 7 polluelos emancipados. Confirmamos genéticamente que el macho que los cuidaba era el padre de todos los polluelos y que la hembra que los cuidaba puso los 7 huevos. El tamaño corporal de los adultos a cargo podría ser un factor en el evento de reproducción extraordinario que reportamos aquí. *Recibido 1 noviembre 2019. Aceptado 12 mayo 2020.*

Palabras clave: análisis de paternidad y maternidad, parasitismo de puesta intraespecífico, nido urbano, tamaño de nidada.

Cooper's Hawks (*Accipiter cooperii*) normally lay 3–5 eggs per nest and rarely 6 eggs. In the largest samples of clutch sizes for the species, 7 (3%) of 266 clutches at the Western Foundation of Vertebrate Zoology in California contained 6 eggs (Ellis and Depner 1979), and in Wisconsin 23 (3%) of 686 clutches contained 6 eggs, 1980–2019 (Rosenfield et al. 2016; RNR, 2019, unpubl. data). There are only 2 accounts of clutches containing 7 eggs, one in Arizona (Ellis and Depner 1979) and another in Ontario (Peck and James 1983). Stout (2009) reported the maximum clutch size of 8 eggs for the species at an urban nest in Milwaukee, Wisconsin. No data were provided on the fate of the nest with 7 eggs in Ontario, but the Arizona nest likely failed as it was eventually found "broken up" with no adults present. The nest with 8 eggs was found deserted at the incubation stage, but investigation of the 8 eggs showed that at least 6 of them had embryos (Stout 2009). Rosenfield et al. (2019) reported that the largest brood size for the species is 6 nestlings; in a 40 year study (1980–2019) of breeding Cooper's Hawks in Wisconsin, 8 (1%) of 794 broods had 6 young (RNR, 2019, unpubl. data). We are unaware of any record of 6 fledglings for a Cooper's Hawk nest.

This report documents select breeding events and fledging success at a nest with an exceptionally large clutch count of 7 eggs that led to 7 nestlings in Wisconsin. Researchers suggested that more than one female may have laid eggs in the 7-egg nest in Arizona (Ellis and Depner 1979), and we have reported a higher probability of detecting extra-pair paternity in larger brood sizes in Wisconsin Cooper's Hawks (Rosenfield et al. 2015). We thus also aim to identify the genetic relationship between tending parents and the 7 young using microsatellite genotype data from all offspring with respect to putative maternal and paternal genotypes.

Methods

We studied breeding Cooper's Hawks during 1980–2019 primarily at 2 areas in central and southeastern Wisconsin as described in Rosenfield and Bielefeldt (1996) and Rosenfield et al. (2019). Our central Wisconsin study areas mostly included rural areas in Portage County and the adjacent

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municipalities of Stevens Point, Whiting, and Plover, with a predominately urban human population of approximately 38,000 and a human density of approximately 973/km^2 (U.S. Census Bureau 2020). Our southeastern Wisconsin study area included mostly rural regions in and around the Kettle Moraine State Forest, South Unit, in Waukesha and Jefferson counties.

Each year we find most nests (>90%) before egg-laying by listening for dawn vocalizations of courting pairs or by searching for partially constructed nests during the pre-incubation stage, about mid-March through late April (Rosenfield 2018). We make at least 2 visits to each nest to assess reproduction events. Nests are climbed to during the mid-incubation period around mid-May to obtain completed clutch counts and again about mid-June when young are 16–19 d of age, or about 70% of fledgling age, to ascertain brood size, age, and to sex and band young with U.S. Geological Survey (USGS) lock-on aluminum bands at successful nests. Cooper's Hawks are highly dimorphic and at ≥12 d of age males are noticeably smaller and can be reliably sexed (Rosenfield 2018). A successful nest is one where ≥1 young reached 16–19 d of age, and brood counts herein are from successful nests. Nesting phenology was estimated using Julian hatching dates, which were determined by backdating from estimated nestling ages of the oldest chick based on plumage development of known-age birds (Meng and Rosenfield 1988, Rosenfield 2018).

We captured breeding adults in mist nets near their nests during the nestling stage using a live, decoy Great Horned Owl (*Bubo virginianus*) and banded them also with a USGS lock-on aluminum leg band on one leg and a unique colored, alphanumeric coded band on the other leg (Rosenfield 2018). Age of breeding adults was determined by plumage color and birds with gray plumage were ≥2 years of age, or after-second-year (ASY) birds following Rosenfield et al. (2019). Cooper's Hawks in their first year of life have brown plumage. We measured body mass of breeding birds to the nearest gram with a balance-beam scale. We note that body mass of breeding Cooper's Hawks at the nestling stage is a reliable index to body size for both male and female Cooper's Hawks (Rosenfield and Bielefeldt 1999, Sonsthagen et al. 2012).

Blood samples of young were taken when they were banded and from adults upon their capture. Blood samples (<100 μL) from adults and nestlings were collected from the brachial vein/artery, and stored at –80 °C at the Alaska Science Center, Anchorage, Alaska (Sonsthagen and Talbot 2020). Genomic DNA was extracted using a DNeasy Blood and Tissue extraction kit following the manufacturer's protocol (Qiagen, Valencia, California, USA). Genomic DNA concentrations were quantified using fluorometry and diluted to 50 ng mL^{-1} working solutions. PCR amplifications and data processing followed Rosenfield et al. (2015). Briefly, microsatellite genotype data were collected at 6 polymorphic loci (AgCA222, Takaki et al. 2009; Age7.1JT, Topinka and May 2004, Sonsthagen et al. 2012; BV13 and BV20, Gautschi et al. 2000; NVH206 and NVH195-2, Nesje and Røed 2000). Fluorescently labeled PCR products were electrophoresed following protocols described by Sonsthagen et al. (2004) using tailed primers. DNA from all of the samples was amplified and genotyped in duplicate for quality control. No inconsistencies in genotypes were observed between replicates. Microsatellite genotype data are available in Sonsthagen and Talbot (2020).

We visually compared genotype data collected from offspring with respect to putative maternal and paternal genotypes to identify maternal-offspring incompatibilities, suggestive of intraspecific brood parasitism, and paternal-offspring incompatibilities, suggestive of extra-pair paternity.

Results

On 14 May 2019 we counted 7 eggs at a residential, backyard Cooper's Hawk nest in a white pine (*Pinus strobus*) in the central part of Stevens Point, Wisconsin. On 1 July we banded 7 nestlings at this nest, 5 males and 2 females about 15 d old. On 29 July, when they were about 43 d old, we observed the 7 banded, fledged young (brown birds with no color bands) within 15–70 m of the nest. The masses of the tending adult male and female at the nestling stage were 335 g and 602 g, respectively.

Multilocus genotypes were generated for all sampled individuals ($n = 9$) and all individuals had

a unique multilocus genotype. No incompatibilities between genotypes generated for offspring and putative parents were identified, indicating that the attending male sired and the attending female laid eggs for offspring sampled.

Discussion

The 7 eggs and 7 fledglings at the urban nest in Stevens Point, Wisconsin, are the largest such metrics in our 40 year Wisconsin study (1980–2019), and to our knowledge the largest documented brood size and fledgling count for the species.

The masses of the tending adult male (335 g) and female (602 g) were above average as mean masses during the nestling stage for ASY male and female breeders in Wisconsin are 327 g ($n = 252$) and 580 g ($n = 310$), respectively, 1980–2019 (Rosenfield et al. 2019). The adult male was first banded as a nestling in Stevens Point in 2014 at another site ~1.5 km from the 2019 nest. Thus, he was 5 years old in 2019 and he bred successfully in this same backyard in 2017 and 2018, producing 4 young from a clutch of 4 eggs in 2017 and 3 young from 4 eggs in 2018. The adult female in 2019 was an ASY bird and previously unknown to our study. Typically, larger birds have larger clutch and brood sizes in our study population and larger birds tend to nest earlier than do smaller birds (Rosenfield and Bielefeldt 1999). However, the latest hatching date of 168 Julian d (17 Jun) for this and one other nest was the latest in our total of 15 successful nests investigated in 2019. The median hatch date for all nests was 156 Julian d (5 Jun); the earliest hatching date for a nest was 148 Julian d (28 May) in 2019.

Some researchers have demonstrated and/or suggested that reproductive output of raptors may be relatively higher for urban nests, including the avivorous Cooper's Hawk, due to the higher volume of avian prey found in cities (Boal and Mannan 1999, Boal and Dykstra 2018). Higher productivity might also result from global warming associated with recent climate change, which has prompted earlier spring arrival of migrant avian prey for some breeding raptors in the northern hemisphere, including Wisconsin (e.g., Lehikoinen et al. 2010, Rosenfield et al. 2016). However, we have been unable to link productivity of our Wisconsin study population of Cooper's Hawks to habitat, including urban versus rural environments (Rosenfield 2018, Rosenfield et al. 2019). And although our study population has advanced timing of egg-laying by 1.3 d/decade since 1980, our annual averages of clutch and brood counts (overall average of 4.3 eggs/nest and 3.7 nestlings/nest) have remained statistically stable across 40 years, 1980–2019; further, the incidence of rarely found large clutch sizes of 6 eggs—found in both urban and rural habitats—have shown no temporal trend during this time period (Rosenfield et al. 2016, 2019; RNR, 2019, unpubl. data). We believe that intrinsic individual traits, conceivably larger body size in both genetically confirmed parents, and which factor is known to be related to productivity in our population (Rosenfield and Bielefeldt 1999), provides in part a plausible explanation for the exceptional production reported here.

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