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Table 1. All prey types delivered to 9 Rock Wren nests in northern Colorado monitored with cameras.

Prey type	% of prey	Number

prey were identified to type (Table 1). Cameras were set to continuously photograph when motion was detected, thus prey delivery or nest attendance events were considered independent if it was clear that the parent had left and returned. We further noted if there was a prey pass-off between adults. Prey passed from one parent to another and subsequently to chicks was only counted once as a prey delivery event and was attributed to the original parent. All nest predation events were examined and predators noted. We also noted interesting behavior by the wrens not related to prey deliveries, including carrying nesting material or stones for the species' characteristic rock patio and nest cavity paving. Tagged photos were verified by a second observer for quality control and to confirm prey types.

All experimental procedures were conducted in accordance with the University of Northern Colorado Institutional Animal Care & Use Committee (Protocol No. 1506C-LB-Birds-18). All banding was performed under Federal Bird Banding Permit number 23741 and Colorado State Permit TRb2041.

## Nesting ecology and parental care

We calculated means for (1) clutch size from nests where eggs could be seen using the inspection camera, (2) number of hatched chicks in the nests where chicks were observed with the inspection camera, and (3) number of fledglings for pairs that fledged at least 1 chick. As a summary measure, we assessed overall nest success by dividing the number of nests where at least 1 fledgling was observed by the total number of pairs confirmed to have started a nest (=12) to get a percentage of successful nests. To calculate the minimum possible nest success for the population studied, we assumed that mated pairs for which we never found a nest had indeed at least attempted to breed but had failed if fledglings were never seen on the territory.

To examine feeding behavior at the nest, we calculated the proportion of each type of prey delivered (e.g., grasshopper, beetle, unknown prey) for all nests monitored using motion detection cameras (= 8; one camera malfunctioned). We counted the number of prey items delivered in the first 5 d post-hatching and calculated the proportion of prey contributed in that time frame by each parent. We evaluated the amount of prey delivered by males in the first 5 d post-hatching in relation to the number of female prey deliveries. All statistics were run in JMP 9.0 (JMP, SAS Institute Inc., Cary, North Carolina, USA).

## Results

## Behavioral observations and nest monitoring

Of 27 males found singing as if actively defending territories, 21 were mated and all pairs were suspected to have nests, although not all nests were found or were accessible. We located nests with eggs present for 12 pairs (6 in 2016 and 6 in 2017). Of the 12 discovered nests, 9 (5 in 2016 and 4 in 2017) had at least 1 fledgling survive at least 2 weeks after emergence from the nesting cavity, meaning that 75% of discovered nests fledged at least 1 young (Table S1). One nest was abandoned after 5 eggs were laid, and 2 were depredated, one right after the first egg was laid and the other during the nestling phase.

For the remaining 9 out of 21 pairs, nests could not be found, and nest success is unknown. However, no fledglings were ever detected within the vicinity of the defended territory or in the presence of banded males in that area. It is possible that these pairs attempted to breed but failed, in which case a minimum overall estimated nest success for the population is that 42.9% of monitored pairs fledged at least 1 chick. Some of these pairs may have fledged chicks that we failed to detect, and therefore it is possible the nest success rate for this population is slightly higher than that reported here.

Complete clutch sizes in our population (in all cases we report mean  $\pm$ 

No estimates of nestling or fledgling numbers per nest have been reported previously for Rock Wrens. We documented nests with 3 or 4 nestlings and with 2 or 3 fledglings. There are also no direct estimates of fledging success in the literature per se, though 8 of 50 nests in western Kansas suffered predation, making for a possible fledging success of 84%, which is higher than our minimum fledging success of 42.86% for the population as a whole, but similar to the success rate of 75% for our located nests (Matiasek 1998). These estimates are, by default, skewed by imperfect knowledge of nesting locations and affected by the stochastic nature of predation events, but suggest that breeding success rates are similar across the range of this species.

Camera traps provide an excellent tool to estimate parental investment at the nest and for watching natural behaviors (Swann et al. 2011). They also provide an easy way to quantify prey deliveries to nestlings, to estimate nestling diets, and to quantify parental division of labor. Previous work in northern Colorado found that food items delivered to Rock Wren nestlings included moths, crickets, grasshoppers, leafhoppers, cicadas, mantids, and robber flies (Warning et al. 2014). We found prey type delivery rates similar to Matiasek (1998) and also noted that grasshoppers were the most often-delivered identified prey items, suggesting that they make up a substantial portion of chick diets in multiple locations. The prey delivery metrics reported here do not account for quality or size of prey types delivered. Follow-up studies with more thorough investigation of prey availability on different territories in relation to nesting ecology and fledgling success would be immensely valuable (Bailey 1904; Merola 1995; Oppenheimer and Morton 2000; Warning and Benedict 2015b, 2016).

Previous work has not assessed the relative feeding contributions of male and female Rock Wren parents to the young (Wolf et al. 1985, Merola 1995, Matiasek 1998). In our study, provisioning rates were variable from nest to nest, but males consistently provisioned much more than females did when they had small chicks, providing over 86% of prey items. As chicks age and females no longer need to help them thermoregulate, it is possible that provisioning behavior becomes more evenly distributed between the parents. There is evidence, however, that males typically continue to take the lead in feeding young fledglings for approximately 2 weeks postfledging (Benedict et al. 2021). During this time a biology of Rock Wrens. Results include breeding metrics and natural history data and provide a baseline from which to investigate Rock Wren breeding success in the more northern, migratory part of their range. Rock Wren population numbers are thought to be relatively stable, but negative population trends have been detected in breeding bird surveys from the past 30 years and knowing more about the species' patterns of reproductive success should help to reveal drivers of these trends (Salamacha Breeding Bird Census 1992– 1996, Sauer et al. 1997, Brewer 2010, Benedict et al. 2021).

High nest predation has been proposed as a factor limiting population size and our results lend support to this possibility, as snakes depredated 3 of the 9 nests watched by trail cameras (Benedict et al. 2021). Analyzing additional behavioral, ecological, and mate choice pressures that affect reproductive success would be valuable in understanding the population fluctuations of Rock Wrens and their differential fledging success across the species' range.

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