

*The Wilson Journal of Ornithology* 132(3):791–797, 2020

## Multiple broods, simultaneous nests, and autumn nesting by Costa's Hummingbirds (*Calypte costae*)

Dave Boyarski,<sup>1</sup> Ned Batchelder,<sup>2</sup> Gigi Batchelder,<sup>2</sup> Mary Jane DeRoss,<sup>1</sup> Dennis DeRoss,<sup>1</sup> Lynne Thomason,<sup>1</sup> Gary Thomason,<sup>1</sup> Paul Hendricks,<sup>3\*</sup> and Jeffrey S. Marks<sup>3</sup>

**ABSTRACT**—We report 14 cases of banded female Costa's Hummingbirds (*Calypte costae*) fledging young from 2 or 3 broods in single breeding seasons during late February to mid-June in southern Nevada, USA. Successfully raising 2 broods in a single breeding season has been reported only rarely for this species, and raising 3 broods is previously unreported in the literature. We also report 8 cases of banded females simultaneously tending young and eggs from 2 nesting attempts. Females constructed a new nest and began incubating while (1) feeding large nestlings in the earlier nest (5 cases), or (2) feeding recently fledged young from the earlier nest (3 cases). One banded female accounted for 5 of these 8 cases. We also report 5 cases of autumn nesting, not previously documented for Costa's Hummingbird, including 5 young fledged from 3 nests in late November and early December. Our results suggest that multiple broods, simultaneous nests, and autumn nesting are viable breeding strategies for female Costa's Hummingbirds, some of which may be year-round residents at our study site in the Mojave Desert. We also suggest that multiple brooding and autumn breeding are facilitated by the availability of hummingbird feeders and cultivated exotic flowering plants in an urban setting. Received 29 September 2020. Accepted 20 November 2020.

Key words: breeding biology, Mojave Desert, nesting behavior, nest sites, Nevada, urban habitat.

### Múltiples nidadas, nidos simultáneos y anidación otoñal en el colibrí *Calypte costae*

**RESUMEN** (Spanish)—Reportamos 14 casos de hembras anilladas del colibrí *Calypte costae* emancipando polluelos de 2 o 3 nidadas en la misma temporada reproductiva desde febrero hasta mediados de junio en el sur de Nevada, EUA. La crianza exitosa de 2 nidadas en la misma temporada ha sido raramente reportada en la literatura para esta especie; la crianza de 3 nidadas, nunca. También reportamos 8 casos de hembras anilladas simultáneamente atendiendo polluelos y huevos de 2 intentos de anidación. Las hembras construyeron nuevos nidos y comenzaron a incubar mientras (1) alimentaban polluelos grandes en un nido anterior (5 casos) o (2) alimentaron polluelos recientemente emancipados de un nido anterior (3 casos). Una misma hembra anillada fue responsable de 5 de estos 8 casos. También reportamos 5 casos de anidación otoñal, que no ha sido reportado previamente para este colibrí, incluyendo 5 polluelos emancipados de 3 nidos a finales de

noviembre e inicios de diciembre. Nuestros resultados sugieren que las nidadas múltiples, nidos simultáneos y la anidación otoñal son estrategias viables para las hembras de *C. costae*, algunas de las cuales podrían ser residentes durante todo el año en nuestro sitio de estudio en el desierto de Mojave. También sugerimos que múltiples nidadas y reproducción otoñal son facilitadas por la disponibilidad de bebederos para colibríes y plantas exóticas cultivadas en ambientes urbanos.

Palabras clave: biología reproductiva, comportamiento de anidación, desierto de Mojave, hábitat urbano, Nevada, sitios-nido.

Costa's Hummingbirds (*Calypte costae*) breed primarily in desert shrublands and chaparral from central California, southern Nevada, and southwestern Utah south through western Arizona, Baja California, and much of Sonora, Mexico (Baltosser 1989a, Baltosser and Scott 2020). Nesting typically occurs during late winter and spring when nectar resources are most available. Based on the range of clutch-initiation dates, females are suspected to attempt 2 broods in a single breeding season in some regions, but direct evidence of this is limited to 1 case each in the Anza-Borrego Desert, California, and the Maricopa Mountains, Arizona, where females fed fledglings, presumably from a prior nesting, while incubating eggs (Baltosser and Scott 2020). Cases of unmarked females producing 3 and 4 successful broods during single seasons in the Mojave Desert of southern California have been reported on the internet (R. Hallowell, 2004, unpubl. data) but not in the refereed literature, and it is unclear if all broods in each of these cases can be attributed to the same females. Nesting at the northern and eastern periphery of the breeding range appears to be delayed relative to elsewhere, which led Baltosser (1989a) and Baltosser and Scott (2020) to suggest that most nests initiated after mid-April in peripheral locations (including in the Mojave Desert, where most reported nests have been initiated in April and May), were second attempts

<sup>1</sup> Mesquite, NV, USA

<sup>2</sup> Sheridan, WY, USA

<sup>3</sup> Montana Bird Advocacy, Missoula, MT, USA

\* Corresponding author: pipitpaul@gmail.com

following dispersal from elsewhere. Migratory patterns of Costa's Hummingbirds remain poorly known (Baltosser and Scott 2020), and evidence that some females attempt additional nests after dispersal from previous nesting areas is lacking.

Here, we describe results from a study of banded female Costa's Hummingbirds during 2014–2020 near the northeastern edge of the breeding range in the Mojave Desert of southern Nevada. We document cases where individual females successfully fledged young from multiple broods in a single nesting season, including a female that did so 5 years in succession. We also report cases where females tended eggs and nestlings or fledglings from 2 nesting attempts simultaneously, and describe nesting in late autumn in which young fledged in late November and early December. We are not aware of published reports of wild Costa's Hummingbirds regularly fledging young from multiple nests at the same locality in a single nesting season, nor are we aware of published reports of autumn nesting by this species.

## Methods

Our observations occurred in Mesquite, Clark County, Nevada, USA, near the northeastern extent of the Mojave Desert. Mesquite (36°49'N, 114°05'W, elevation 488 m, population ~19,000) is situated in the Virgin River Valley 130 km northeast of Las Vegas. Summers are hot and dry; high and low temperatures for the year average 29.1 °C and 9.3 °C, respectively, and annual precipitation averages 15 cm. The average high temperature in July is 42.1 °C, by which time Costa's Hummingbirds have stopped new nesting attempts or abandoned active nests; the average high temperature in January is 16.7 °C, by which time a new nesting season commences (Baltosser and Scott 2020; NB and GB, unpubl. data).

NB and GB captured birds from 2013 to 2016 at feeders placed within a wire-cage trap. Captured females were banded on the right leg with a standard alpha-numeric hummingbird band, and reproductive status (e.g., incubation patch, presence of oviducal egg) was recorded. Beginning in 2014, and extending through 2020, we monitored all known active nests as time permitted. We centered nest searches around regular banding

locations. Banded females were identified at nests through use of a 20–60× spotting scope as well as from photos and videos taken by DB. Females stood on the nest rim when they fed nestlings, and only then was the band on their leg visible for identification. Some females were recaptured and tracked to nests upon release. We also located nests from reports provided by a network of homeowners and volunteers. In particular, MD and DD kept track of yearly nesting activities for female J54568, whereas LT and GT did the same for female P67468. We measured nest heights with a tape measure and flight distances between simultaneous nests (to account for nests separated by houses) by pacing. The majority of nests were low enough ( $\bar{x} = 1.8 \pm 1.0$  m; range = 0.5–5.2 m,  $n = 108$ ) that we could examine their contents directly to determine nesting stage. We examined nests that were higher above ground with a mirror attached to a pole, or else nesting stage was determined by female behavior and/or nestlings that were visible above the nest rim. A successful nest fledged at least 1 nestling, and fledging success was the proportion of nests, including those abandoned before eggs were laid, in which at least 1 nestling fledged (Baltosser 1986).

We considered nests as simultaneous if a banded female was incubating at 1 nest while caring for nestlings or recent fledglings from the previous nesting attempt. Thus, simultaneous nests included cases where a female incubating at least 1 egg continued to feed fledglings, as well as cases where she continued to feed at least 1 large nestling (Batchelder et al. 2012). We determined some cases of simultaneous nests by backdating 39 d from the day of fledging, based on an average 16 d incubation period and 23 d nestling period (Woods 1927, Baltosser and Scott 2020; NB and GB, unpubl. data).

## Results

### Multiple broods

During 2014–2020, we found 61 nests tended by 20 banded females whose identities we confirmed. Of these nests, 32 (52%) were found during nest building or egg laying, 18 (30%) during incubation, and 11 (18%) after eggs had hatched. Forty-five (74%) of the nesting attempts by banded females were successful and produced 81 fledglings (1.3 fledglings/attempt). Twelve of

**Table 1.** Single breeding-season multiple broods successfully raised by banded female Costa's Hummingbirds, Mesquite, Clark County, Nevada, 2014–2020. At least 1 nestling fledged from each successful nest.

Female	Year	Attempts (successful)	Fledging dates
J19714	2014	2 (2)	9 Mar, 30 May
J56231	2015	2 (2)	15 Mar, 11 May
J54568	2016	2 (2)	21 Mar, 11 Jun
	2017	3 (2)	13 Apr, 28–29 May
P67468	2016	3 (2)	24 Mar, 28–30 Apr
	2017	3 (2)	19 Mar, 25 Apr
	2018	4 (3)	9–10 Mar, 28 Apr, 3–4 Jun
	2019	4 (3)	14 Mar, 23 Apr, 10–13 Jun
	2020	3 (3)	5–6 Mar, 19 Apr, 24 May
P67554	2016	2 (2)	23 Mar, 16 May
	2018	2 (2)	20 Feb, 30 Mar
J20338	2016	2 (2)	20 Apr, 31 May
J54645	2017	2 (2)	24 Mar, 29 May
J55299	2017	2 (2)	21 Mar, 2 May

the 20 females were found nesting just once in at least 1 year of the study, with 11 (65%) of 17 total nesting attempts successful, producing 19 fledglings. Ten of the 20 females nested multiple times during at least 1 year of the study ( $n = 18$  female nesting seasons), with 34 (77%) of 44 total nesting attempts in 14 female nesting seasons successful, producing 62 fledglings. Eighty-two percent of nests in both samples (14 of 17 nest attempts and 36 of 44 nest attempts, respectively) were found before eggs hatched.

Eight banded females successfully reared multiple broods in at least 1 year, and multiple broods were raised by at least 1 banded female in each year of the study (Table 1). Multiple nests were often built in the same or neighboring yards. A total of 36 nesting attempts was made by these females, 31 (86%) of which produced at least 1 fledgling. One female (P67468) raised multiple broods 5 years in succession and produced 25 fledglings from 17 attempts, including 3 years in which she successfully raised 3 broods each year. All but 1 of her nests (in 2020) were built in the same 2 bushes in the same yard (Fig. 1), all in ornamental bottle bushes (*Callistemon* sp.). Fledging dates for successful nests of multiple-brooded females ranged from 20 February to 13 June, indicating new nests were initiated from mid-January to early May.

**Table 2.** Simultaneous nests tended by banded female Costa's Hummingbirds, Mesquite, Clark County, Nevada, 2014–2020. Cases of approximate incubation initiation dates were backdated from fledging date. Nests that failed are marked with an asterisk (\*).

Female	Year	Fledge date <sup>a</sup>	Incubate date <sup>b</sup>	Distance (m) <sup>c</sup>	Stage <sup>d</sup>
J56262	2015	24 Mar	22 Mar*	~22.5	Nestling
P69286	2016	14 May	16 May*	~19.0	Fledgling
P67468	2016	24 Mar	23 Mar	8.0	Nestling
	2017	19 Mar	17 Mar	8.0	Nestling
	2018	28 Apr	~26 Apr	8.0	Nestling
	2019	25 Apr	25 Apr*	8.0	Nestling/ fledgling
	2020	19 Apr	16 Apr	7.0	Nestling
J54568	2017	13 Apr	~18 Apr	18.0	Fledgling

<sup>a</sup> Date last/only nestling fledged from earlier nest.

<sup>b</sup> Date incubation of first egg began at later nest.

<sup>c</sup> Flight distance between simultaneous nest sites.

<sup>d</sup> Nesting stage at earlier nest when incubation began at later nest.

### Simultaneous nests

We documented simultaneous nesting 8 times by 4 banded females (Table 2). These included 5 cases where nesting activity overlapped (female incubated in a new nest while feeding large nestlings in an earlier nest), 2 cases where the female was feeding fledglings while incubating at a new nest, and 1 case where the female began incubation the day the second nestling fledged and 2 d after the first had fledged. One female accounted for 5 of the cases, and these occurred each year her nesting activity was closely monitored. Simultaneous nests tended to be built near each other (flight distance between nests = 7.0–22.5 m), often in the same yard or an adjacent yard.

Three of 8 later nesting attempts failed after the earlier nest was successful (Table 2). Female J56262 was not known to nest again in 2015 after the young nestlings disappeared by 11 April from her second nest in an ocotillo (*Fouquieria splendens*). Female P69286 was found dead on 19 May 2016 beneath her second nest in an oleander (*Nerium oleander*), which still contained 1 egg. Female P67468 abandoned her third nest in a bottle bush on 1 May 2019 when 1 egg was found on the ground beneath the empty nest following wind damage or a possible predation attempt by a larger bird. She began building her fourth nest in the same bush 2 d later (Fig. 1), from





**Figure 1.** Bottle bush (*Callistemon* sp.) in which female Costa's Hummingbird P67468 nested in 2016–2020. This female also nested all years except 2020 in a second bottle bush at the side of the house about 8 m distant. Nest sites 1, 3, and 4 from 2019 are shown, with nest 2 out of view in the second bottle bush. The female began incubation at nest 3, which failed, the day the second nestling fledged from nest 2 (25 Apr). Nestlings also fledged from nests 1 (14 Mar) and 4 (10–13 Jun). Photo by Dave Boyarski.

which her nestlings fledged on 10 and 13 June (Table 1).

#### Autumn nesting

We documented autumn nesting (Oct–early Dec) 4 times in 3 years of our study, and it was reported to us once. At least 3 of the 5 nesting attempts were successful. Female J54568 built a nest on a 1.5 m tall shepherd's hook hummingbird-

feeder pole that produced fledglings on 24 and 26 November 2014. Young fledged at a second nest 1.2 m above ground in a small African sumac tree (*Searsia lancea*) a few days before 26 November 2014, when the homeowners reported the event, and we noted fresh droppings on and in the nest on that date and observed the unbanded female nearby in the yard with her 2 fledglings. Female J54645 built a nest 1.3 m above ground in an African sumac in which both eggs hatched on 13

November 2015, but the large nestlings were found dead in the nest on 30 November, possibly because of freezing overnight and morning temperatures. A nest built ~2.7 m above ground in a mesquite tree (*Prosopis* sp.) by an unbanded female was found with 2 eggs on 30 October 2018 and fledged 1 young on 2 December; an unhatched egg was still present in the nest. Another nest that contained 2 nestlings was reported to us on 1 December 2018, but the exact location and fate of this nest were not known.

### Discussion

Female hummingbirds are unusual among birds with altricial young because they provide all of the care devoted to eggs and offspring (Cockburn 2006). We documented 3 features of the breeding biology of Costa's Hummingbirds that could enhance a female's annual reproductive success: fledging young from multiple broods in a single nesting season, simultaneous nesting (incubating eggs in 1 nest while feeding young from a prior brood), and nesting in autumn. We assume that the activities of banded females were representative of all females at our study site. Thus, we suspect that multiple brooding, simultaneous nesting, and autumn nesting are more widespread in this population than what we report.

Overall fledging success for banded females at our study site (74% for 61 nests) was high relative to reports of 9–41% from other studies (Woods 1927, Baltosser 1986, George 1987, Baltosser and Scott 2020). However, we did not find all nests at a similar stage of development, did not monitor all nests closely, and did not adjust estimates for nest-exposure days, so our value for fledging success is probably biased high relative to other studies. That said, comparison of fledging success for our samples of single-brooded and multiple-brooded females is less biased, with 82% of nests in both samples found before eggs hatched. In general, our study indicated that fledging success of females attempting multiple broods (77%) was similar to that of females attempting only a single brood (65%), but females attempting multiple broods produced more fledglings in a nesting season. The frequency of producing multiple broods by female Costa's Hummingbirds is not known, with only 2 prior cases reported in the literature (attributing 2

broods to individual females), but Baltosser and Scott (2020) thought clutches initiated in the Sonoran Desert after mid-April were most likely true second attempts and not replacement clutches. In our study, we documented 14 of 18 cases (involving 44 nests) where banded females successfully attempted multiple broods, with several of their second nests initiated after mid-April as determined from fledging dates (Table 1), thereby supporting Baltosser and Scott's (2020) conjecture. However, fledging dates also indicated that many other second clutches were initiated by late March and as early as late February. Our study also showed that producing multiple broods each nesting season may occur with some regularity among breeding females. Three of 8 banded females known to successfully raise multiple broods did so in more than 1 nesting season, and female P67468 accomplished this in 5 consecutive nesting seasons and produced 25 fledglings. She was also successful in fledging 3 broods in each of 3 years (Fig. 1, Table 1), which is unreported in the literature for this species (Baltosser and Scott 2020). Black-chinned Hummingbirds (*Archilocus alexandri*), which also nest in arid regions, have a nesting season that typically extends from late March to early July, and females often attempt 2 broods (Cogswell 1949, Baltosser 1986, Brown 1992, Baltosser and Russell 2020). However, nowhere in the literature is it indicated that attempting multiple broods is often successful, and only 2 published reports exist of females attempting 3 broods (Cogswell 1949, Baltosser and Russell 2020). Likewise, Anna's Hummingbirds (*Calypte anna*) breed in riparian corridors of arid regions, nest from mid-November to early June, and often raise 2 broods in a nesting season (Pitelka 1951, Legg and Pitelka 1956, Stiles 1973, Maender et al 1996, Scarfe and Finlay 2001, Clark and Russell 2020); cases of possible third or fourth broods (Pitelka 1951, Clark and Russell 2020), although sometimes reported (C.J. Clark, UC Riverside, 2020, pers. comm.), have not been published.

Simultaneous nests (overlapping care of eggs and young from successive nesting attempts) by female Costa's Hummingbirds can contribute to raising multiple broods during a nesting season in environments where the time available for breeding is compromised by weather and access to food. Simultaneous nesting reduces the number of days

required for nesting multiple times. Summers in the Mojave Desert (such as southern Nevada) are extremely hot and dry, and nectar resources are not renewed until autumn or early winter rains are followed by vegetative growth and consequent flower bloom (Beatley 1974), which restricts the typical nesting season for Costa's Hummingbird to January through mid-June (Baltosser and Scott 2020). Rapid renesting is a strategy employed by several hummingbird species with breeding ranges entirely or partly north of Mexico (Batchelder et al. 2012), including Black-chinned (Cogswell 1949), Anna's (Legg and Pitelka 1956, Maender et al. 1996, Scarfe and Finlay 2001), and Costa's (Baltosser and Scott 2020). The 8 cases of simultaneous nesting that we documented (Table 2) included females tending large nestlings or young fledglings at the onset of incubation, and occurred from mid-March to mid-May. Other cases of simultaneous nesting probably occurred in our study area, because several nests occupied by unbanded females, or females whose bands we could not read, were found near prior successful nests within the same residential yards or adjacent properties. Nevertheless, annual simultaneous nesting by female P69286 (Table 2) shows that it is a breeding strategy regularly employed by some females.

Lengthening the potential breeding season by nesting in autumn is another strategy that could contribute to the successful production of multiple broods. Autumn nesting by Costa's Hummingbirds apparently is a relatively new phenomenon that has not been previously documented (Woods 1927, Stiles 1973, Rea 1983, Baltosser 1989a, 1989b; Baltosser and Scott 2020). Autumn nesting has yet to be reported for Black-chinned Hummingbirds (Baltosser and Russell 2020), and we are aware of only 2 Arizona reports of nestling or fledgling Anna's Hummingbirds in mid- and late November, which indicates egg laying must have occurred in October (Clark and Russell 2020). The success of 3 of 4 autumn nests we observed in 3 different years, which produced 5 fledglings in late November and early December, suggests that autumn nesting is a viable breeding strategy for female Costa's Hummingbirds in some parts of their range. These autumn nests also indicate that some female Costa's Hummingbirds, and perhaps some males, may be resident year-round at our study site in southern Nevada. Female J54568

produced 2 fledglings during 24–26 November 2014 and then 1 fledgling on 29 February 2015, and she was seen or captured by us every month except August and September.

The urban environment in which we conducted our study probably helped buffer nesting females from the seasonal vagaries of weather and nectar availability that affect natural areas of the Mojave Desert (Beatley 1974). Exotic flowering trees and shrubs were abundant in town, as were hummingbird feeders, both of which increased the availability of nectar for nesting females throughout the year. Increased abundance of exotic flowering plants and use of hummingbird feeders in towns and cities have contributed to the increase in urban-dwelling hummingbirds in the southwestern United States (Stiles 1973, Baltosser 1989a). Stiles (1973) noted that no evidence existed linking increased abundance of exotic plantings to changes in the timing of hummingbird breeding activities at his study site in southern California, and Costa's Hummingbirds at our study site in southern Nevada still followed the typical phenological pattern for the species (Baltosser and Scott 2020) of ceasing nesting or abandoning active nests by early July, when it became excessively hot and dry. However, successful autumn nesting attempts, strong evidence that some females are now year-round residents in the region, and the regular production of multiple broods, including successful production of 3 broods, are evidence that breeding phenology and other nesting activities of Costa's Hummingbirds were affected by their urban setting, which included an abundance of exotic flowering plants. What remains to be determined is if regular production of multiple broods and recruitment of fledglings into the breeding population are positively related. If so, then urban habitats in the Mojave Desert might sometimes function as population sources (Dias 1996) for Costa's Hummingbirds nesting in adjacent native habitats.

#### Acknowledgments

We thank the many homeowners for sharing their observations and allowing NB, GB, and DB to access their properties while we banded and monitored the hummingbirds. We also thank C. Clark and an anonymous reviewer for suggestions that improved the presentation of this paper.

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