

Long-term Hummingbird Monitoring at Bandelier National Monument

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Abstract

Four species of hummingbirds are commonly seen in Bandelier National Monument from April to October: Broad-tailed, Black-chinned, Rufous and Calliope. This report details the results of the Long-term Hummingbird Monitoring Program hosted by Bandelier National Monument from 2015 to 2021. Bandelier National Monument appears to be an important habitat resource for breeding hummingbird populations and migrating hummingbird populations. We discuss hummingbird banding results such as age-sex distributions, recapture rates, ages of recaptured birds and breeding dates. Ultimately, we learned about hummingbird life cycles and habitat use in Bandelier National Monument. This information may be used to understand how hummingbirds are affected by land management decisions and to direct conservation efforts.

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1 Introduction

Four species of hummingbirds are commonly seen in Bandelier National Monument from April to October: Broad-tailed, Black-chinned, Rufous and Calliope. All hummingbird species seen in the United States spend the winter in Mexico, Central America and northern South America. Annually, these small birds carry out an epic north-south circuit to find suitable breeding grounds and sufficient food for their journeys. Hummingbirds feed about every fifteen minutes to maintain the energy required for normal activities. They must store up reserves of fat to survive non-feeding intervals, such as flights between migration stops. Bandelier National Monument is an important habitat resource for at least these four hummingbird species, during breeding and migration.

Some Broad-tailed and Black-chinned hummingbirds come to Bandelier each year to feed, breed, nest, incubate and hatch eggs, fledge and fatten up. These two species of hummingbirds return year after year to the same breeding sites. Other Broad-tailed and Black-chinned hummingbirds stop to feed in Bandelier during northward migration in April and May, and again during southward migration from August to October. Without reliable breeding and feeding grounds, these populations of Broad-tailed and Black-chinned hummingbirds could not survive.

Rufous and Calliope hummingbirds move northward in the spring by a more westerly route, ultimately breeding in the northwestern United States and western Canada. However, some return south by way of Bandelier National Monument from July through October. Both adult and juvenile birds pass through Bandelier, indicating that Bandelier is a reliable feeding stop for these two species.

Hummingbird banding is a method used to study the annual and seasonal trends in hummingbird populations. Bird banding provides the opportunity to study, measure and examine birds in a safe and systematic manner. The application of bands also allows us to monitor individual birds that are recaptured over time. Same-site recaptures between seasons and between years inform us about populations that revisit a location, either as a nesting site or as a migration stop. Recaptures between banding sites provide information about migration timing and migration routes.

This report details the results of the Long-term Hummingbird Monitoring Program hosted by Bandelier National Monument from 2015 to 2021. We discuss hummingbird banding results such as age-sex distributions, recapture rates, ages of recaptured birds and breeding dates. Ultimately, we learned about hummingbird life cycles and habitat use in Bandelier National Monument. This information may be used to understand how hummingbirds are affected by land management decisions and to direct conservation efforts.

1.1 *Outcomes of Hummingbird Monitoring in Bandelier National Monument*

From 2015 to 2021, Bandelier National Monument hosted a long-term, hummingbird-monitoring program. Hummingbird banding sessions were held in Bandelier from mid-May to early-September for six years, from 2016 to 2021. In 2015, banding sessions were held in August and September only. The hummingbird monitoring program in Bandelier National Monument has provided the following outcomes which will help guide management within the park:

- We documented the common species of hummingbirds that visit Bandelier National Monument, and their relative abundance.
- We compiled the age-sex distributions of each species over time. These distributions contribute to our knowledge of species' life-cycles, which can be used to guide conservation efforts.
- We calculated the recapture rate of birds returning to Bandelier. The multi-year recapture rate provides a simple measure of hummingbird site-specific returns.
- We made partial age calculations for returning birds. Minimum ages were calculated because the monitoring program was active for only six and a half years.
- We documented the extent of the hummingbird breeding season in Bandelier National Monument by observation of gravid hummingbirds. This information may be used to guide land management, such as scheduling controlled burns before or after the hummingbird breeding season.
- We documented the existence of a Rufous hummingbird migration route between British Columbia and Bandelier National Monument, because of the recapture of a banded bird.
- We documented the occurrence of an adventitious mating encounter of a Calliope hummingbird, during southward migration.

This report details these outcomes over the life of the Long-term Hummingbird Monitoring project in Bandelier National Monument.

1.2 *Outcomes of Hummingbird Monitoring within the Hummingbird Monitoring Network*

A network of hummingbird banding sites that are located at key locations within hummingbird migration zones can provide information about the changing geographic distribution of hummingbird populations over time. *The Hummingbird*

*Monitoring Network*¹ (HMN) has coordinated a network of hummingbird banding sites in the western United States, Mexico, and Canada since 2002, with an objective of monitoring hummingbird population trends. The network adds new banding stations intermittently. At each HMN site, the duration of the monitoring program varies. Monitoring continues at the discretion of local personnel and is dependent upon local resources.

Long-term Hummingbird Monitoring at Bandelier National Monument was an all-volunteer, citizen science effort. In 2015, the Bandelier station was established, permits were obtained, and four exploratory banding sessions were held in August and September. Data were collected from May to September in the 2016, 2017, 2018, 2019, 2020 and 2021 field seasons. We provided six years of continuous, high-quality monitoring data conforming to HMN's standard protocols.

All of the data collected at Bandelier National Monument have been shared with HMN for analysis in coordination with other HMN sites. This report focuses on single-site analysis at Bandelier National Monument, and does not attempt to compare results with other HMN sites.

¹www.savehummingbirds.org. The Hummingbird Monitoring Network official website, 2021.

2 Location

The Bandelier monitoring site was located directly east of Ponderosa Campground on Escobas Mesa. The criteria for site selection included access for feeder maintenance, a history of hummingbird activity nearby, and a shady location with access for loading and unloading banding equipment. The site was near the edge of the ponderosa pine forest as it transitions to pinyon-juniper woodland. E-bird² sightings recorded for Escobas Mesa include Broad-tailed (*Selasphorus platycercus*), Black-chinned (*Archilocus alexandri*), Rufous (*Selasphorus rufus*), and Calliope (*Selasphorus calliope*) hummingbirds. Within HMN, the Bandelier hummingbird monitoring site was given the name “Ponderosa Campground-Bandelier National Monument” or PCBNM. Henceforth in this report, the site will be referenced as PCBNM.

3 Methods

Monitoring was accomplished by capturing, banding, and releasing hummingbirds according to established protocols. The protocols used by the Bandelier hummingbird banding team adhered to the standards set by the North American Banding Council³ and HMN. Each year from 2016 to 2021, five hummingbird feeders were installed on Escobas Mesa near Ponderosa Campground in April. The feeders were serviced a minimum of twice weekly (more often during the height of migration) through mid-October. Banding sessions for the Ponderosa Campground site occurred every two weeks between May and September, on a schedule that was coordinated between all of the HMN sites. Two Hall’s traps were used to capture birds during banding sessions. On banding days, banding effort began within fifteen minutes of sunrise and continued for five hours.

HMN coordinates monitoring dates between stations according to a schedule of monitoring sessions. Table 1 equates the numbered HMN monitoring sessions to the PCBNM monitoring dates from 2015 to 2021. The exact dates of each monitoring session changed from year to year, but always occurred within the same calendar week. The span of sessions when monitoring occurs varies between HMN monitoring stations, and is determined based on latitude, elevation, temperature and migration dates. In 2015, when the station was starting up, we monitored at PCBNM from session 15 to session 18. In subsequent years, monitoring ended after session 17 because morning temperatures were too cold for hummingbird banding during session 18 (late September). In 2016, monitoring started at session 8, but we found that morning temperatures were usually too cold for hummingbird banding during session 8 (early May). Therefore, from 2017 until 2021, monitoring started with session 9 (mid-May) and continued through session 17 (early September).

²*ebird.org*. A real-time, online checklist program, 2016.

³Russell, Stephen M., Russell, Ruth O., Pollock, Jessica and Hill, Anthony *The North American Banders’ Manual for Banding Hummingbirds*, North American Banding Council, Point Reyes Station, California 94956-1346 U.S.A., 2019. 93 pp. <http://www.nabanding.net>

Table 1: Schedule of HMN Monitoring Sessions and PCBNM Monitoring Dates

HMN Session Number	PCBNM 2015	PCBNM 2016	PCBNM 2017	PCBNM 2018	PCBNM 2019	PCBNM 2020	PCBNM 2021
8	*	5/7/16	***	***	***	***	***
9	*	5/21/16	5/21/17	5/19/18	5/18/19	5/17/20	5/15/21
10	*	6/4/16	6/3/17	6/2/18	6/1/19	5/30/20	5/29/21
11	*	6/18/16	6/17/17	****	6/15/19	6/13/20	6/12/21
12	*	7/3/16	7/1/17	6/30/18	6/29/19	6/27/20	6/26/21
13	*	7/16/16	7/15/17	7/14/18	7/13/19	7/11/20	7/10/21
14	*	7/30/16	7/29/17	7/28/18	7/27/19	*****	7/24/21
15	8/13/15	8/13/16	8/12/17	8/11/18	8/11/19	8/8/20	8/7/21
16	8/29/15	8/27/16	8/26/17	8/25/18	8/24/19	8/22/20	8/21/21
17	9/12/15	9/10/16	9/9/17	9/8/18	9/7/19	9/5/20	9/4/21
18	9/26/15	**	**	**	**	**	**

* In 2015, we didn't monitor during sessions 8 to 14 because permits were not yet active.

** After 2015, we didn't monitor during session 18 because of cold temperatures.

*** After 2016, we didn't monitor during session 8 because of cold temperatures.

**** Banding was cancelled on 6/16/18 because of rain.

***** Banding was cancelled on 7/25/20 because of pandemic quarantine.

4 Results: Birds Banded

A total of 2874 hummingbirds were captured during the life of the monitoring program at PCBNM, encompassing four species: Broad-tailed, Black-chinned, Rufous, and Calliope hummingbirds. Of the 2874 hummingbirds captured, 1881 were newly banded, and 993 were recaptures from previous sessions at PCBNM. The 993 recapture events represent 454 unique individuals, because some birds were recaptured multiple times. When a bird was recaptured from a previous session or a foreign recapture, the bird was measured and weighed in the same manner as a newly banded bird. Same-day recaptures were not counted as recapture events, because these birds were not re-measured.

The total numbers of birds captured at every banding session are given in Table 2. Broad-tailed hummingbirds were the most common bird captured, with Black-chinned hummingbirds being the second most common. Broad-tailed hummingbirds were captured during every banding session. Black-chinned hummingbirds were captured at almost every banding session, except for a few September dates. Both Broad-tailed and Black-chinned were observed to breed in Bandelier National Monument. Rufous hummingbirds arrived in late June or early July, indicating that this species migrates through Bandelier after breeding farther north. Migrating Calliope hummingbirds arrived in late July.

Table 2: Total number of birds captured at PCBNM from 2015 to 2021. Includes new bands and recapture events.

Date	Broad-tailed	Black-chinned	Rufous	Calliope	Totals
2015	63	18	14	0	95
2016	235	140	24	4	403
2017	272	115	59	16	462
2018	261	111	30	12	414
2019	219	133	44	6	402
2020	322	133	41	11	507
2021	326	202	49	14	591
Totals	1698	852	261	63	2874

The total number of birds captured of each species from 2015 to 2021 is illustrated in Figure 1. The number of birds captured and processed varied according to abundance, but also according to the number of banders and volunteers available. From 2015 to 2018, one bander handled all of the banding. In 2019, we added a bander-trainee working closely with the bander. In 2020 and 2021, the trainee was able to band independently at a second banding table which allowed more birds to be processed. Therefore, the number of birds captured and processed increased in 2020 and 2021.

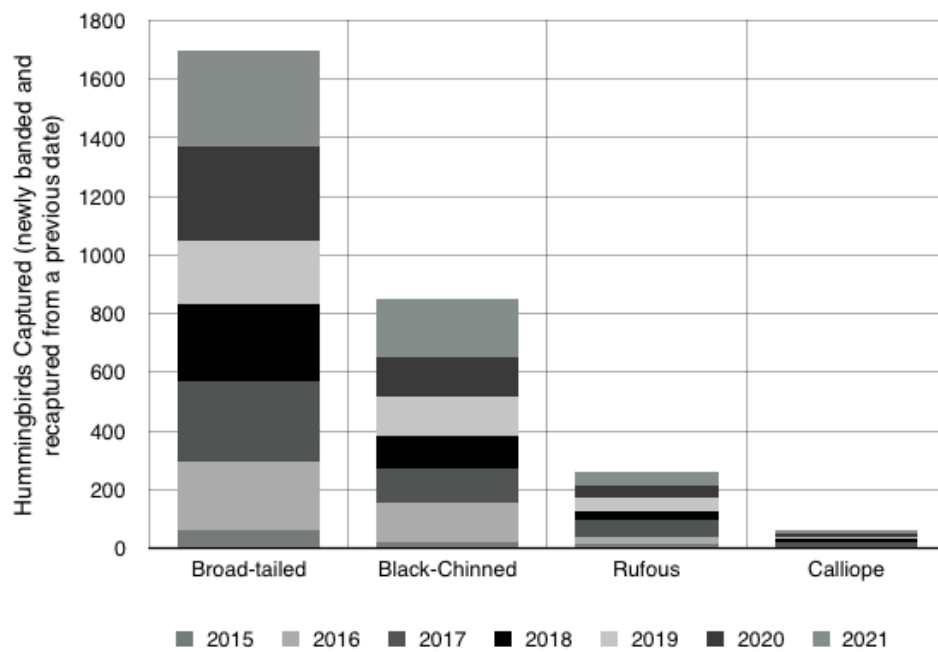


Figure 1: Hummingbirds captured at PCBNM from 2015 to 2021 (newly banded and recaptured from a previous date).

The following results sections will refer to the age-sex distributions of each species. Four age-sex classes have been identified for the purposes of this report: adult-male, adult-female, juvenile-male, and juvenile-female. Adults are after-hatch-year birds, and juveniles are hatch-year birds. In some charts, the species may be referred to by the USGS four-letter species code: Broad-tailed = BTLH; Black-chinned = BCHU; Rufous = RUHU; Calliope = CAHU.

5 Results: Broad-tailed Hummingbirds

5.1 *Age-Sex Distributions of Broad-tailed Hummingbirds*

The distributions of adult Broad-tailed hummingbirds captured at PCBNM from 2015 to 2021 are displayed in Figure 2. Adult males were most abundant in May and June and early July, and relatively few were captured in late July, August and September. Adult females were present throughout the monitoring season. The distributions of juvenile Broad-tailed hummingbirds captured at PCBNM from 2015 to 2021 are given in Figure 3.⁴ Juvenile birds were captured in late June through September, with the highest numbers observed in August and September.

These data suggest that adult male Broad-tailed hummingbirds arrive early at Bandelier and stay through the breeding season, but leave when the juveniles start to fledge. Adult females are resident through the breeding season and stay for a few weeks after the juveniles have fledged. After fledging, the juvenile Broad-tailed hummingbirds remain on site to put on weight and practice flying, then migrate south in late August and September. Some Broad-tailed hummingbirds that were captured in late August and September may have been migrants that bred farther north, stopping in Bandelier on their way to southern wintering grounds. By the same reasoning, some Broad-tailed hummingbirds captured in May and early June may have been migrants moving north.

⁴The tabular age-sex distribution data for Broad-tailed hummingbirds at PCBNM from 2015 to 2021 are presented in Appendix A.

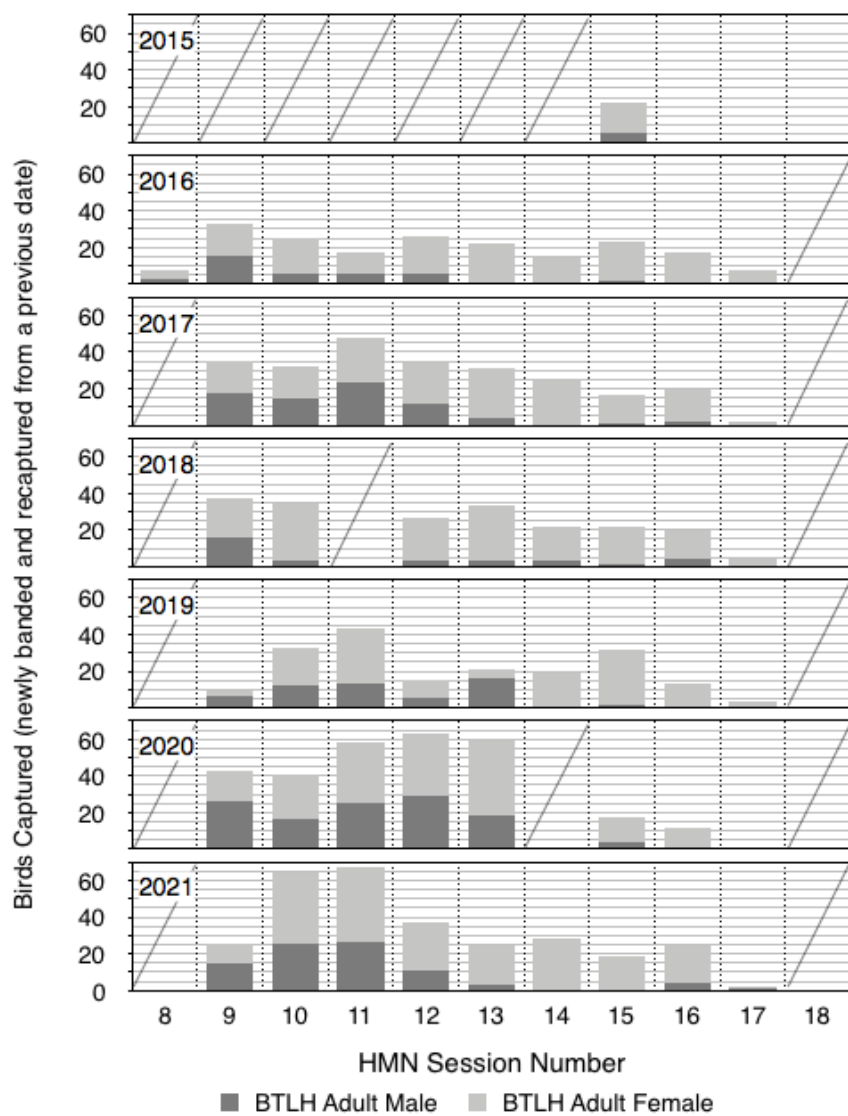


Figure 2: Number of adult Broad-tailed hummingbirds captured at PCBNM from 2015 to 2021.

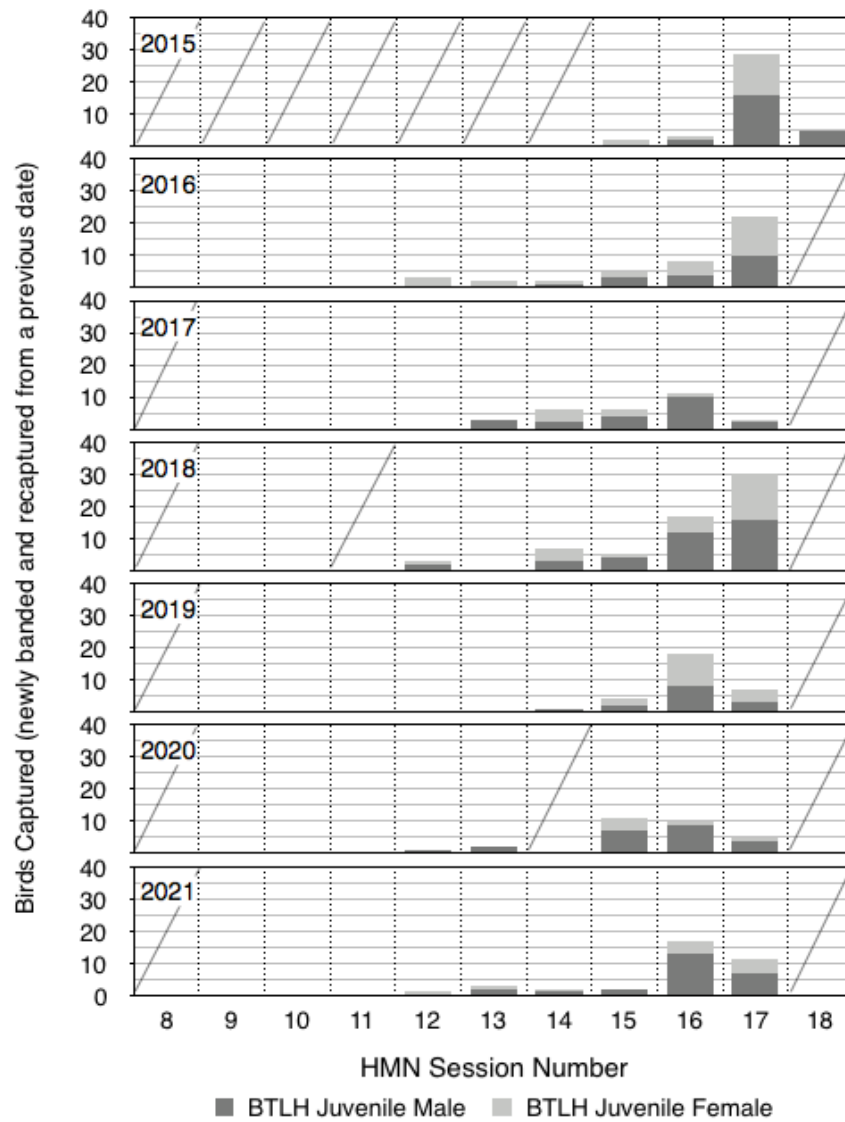


Figure 3: Number of Juvenile Broad-tailed hummingbirds captured at PCBNM from 2015 to 2021.

5.2 *Broad-tailed Hummingbird Recapture Rate*

Over the life of the monitoring program, we recaptured Broad-tailed hummingbirds 676 times, out of 1698 Broad-tailed captures. Thus, the overall Broad-tailed recapture rate is 40% of all Broad-tailed captures from 2015 to 2021. Multiple recaptures of adult birds in the same year indicate that Broad-tailed individuals remain on-site from May to September to feed, breed, nest, incubate and hatch eggs, and fledge their young. Multiple recaptures of juvenile birds indicate that Broad-tailed individuals stay on site after fledging to put on weight and practice flying, before migrating south in late August and September.

Some recaptured individuals were observed multiple times during the same year that they were banded, but were not recaptured in any subsequent year. Other individuals were recaptured in one or more subsequent year. If we consider only unique individuals that were captured in multiple years, we can compute a multi-year recapture rate. The multi-year recapture rate is a simple measure of Broad-tailed site-specific returns. From 2015 to 2021, 1022 unique Broad-tailed individuals were banded. In the same period, 205 individuals were recaptured at least once in a year different from the year in which they were banded. Thus, the multi-year recapture rate for Broad-tailed hummingbirds at Bandelier over the life of the monitoring program is 20%.

Figure 4 and Table 3 display the number of unique Broad-tailed individuals captured from 2015 to 2021, and the number of years recaptured individuals were observed. One female Broad-tailed hummingbird was captured every year from 2016 to 2021. Four female and two male Broad-tailed hummingbirds were observed in five different years between 2016 and 2021. These observations suggest that breeding Broad-tailed hummingbirds of both sexes have high site fidelity.

Table 3: Unique Broad-tailed Individuals Captured at PCBNM from 2015 to 2021

Number of Years Observed	Never Recaptured	Recaptured at Least Once	Total
1	730	87	817
2		140	140
3		42	42
4		16	16
5		6	6
6		1	1
7		0	0
Total	730	292	1022

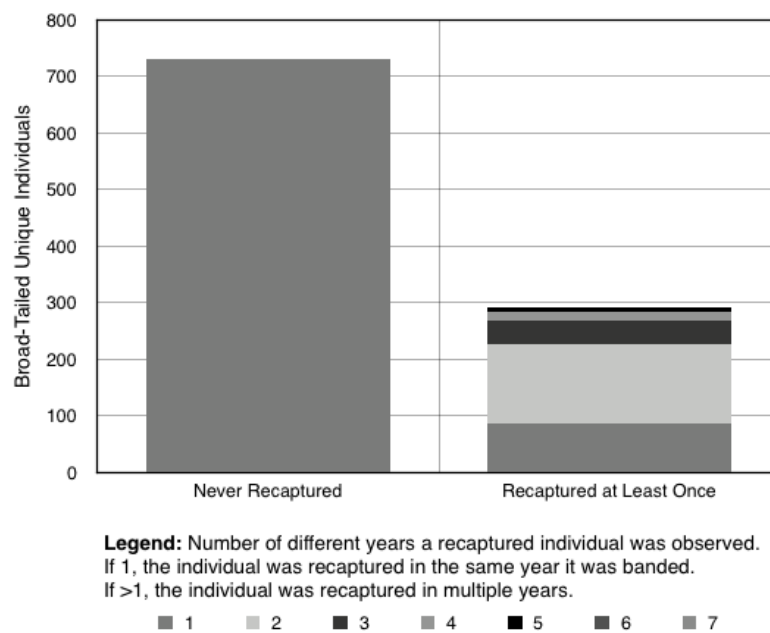


Figure 4: Unique Broad-tailed individuals captured, and the number of years recaptured individuals were observed.

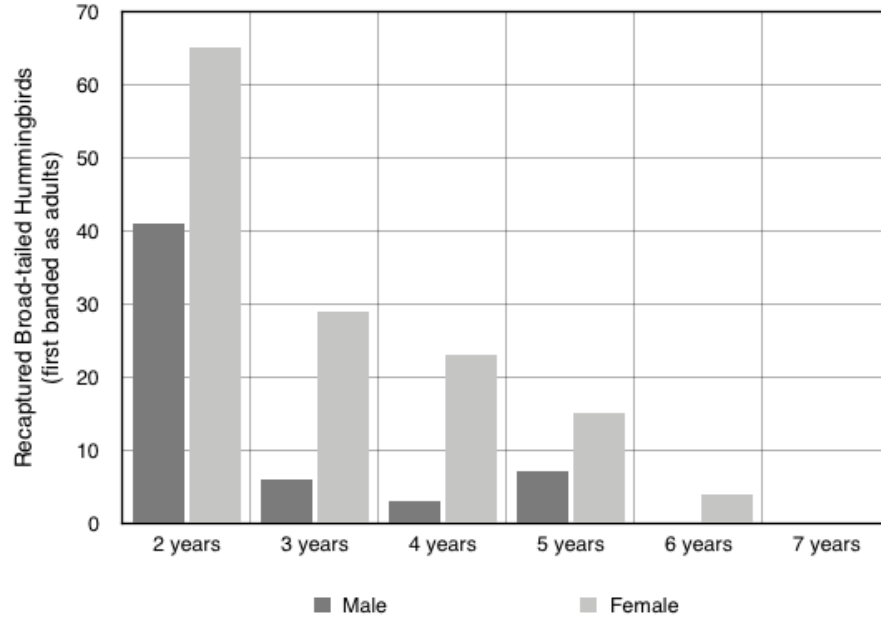


Figure 5: Minimum ages of multi-year recaptured Broad-tailed individuals that were first banded as adults.

5.3 *Broad-tailed Hummingbird Age Calculations from Recaptured Birds*

We can calculate the minimum age of a bird that has been recaptured in two or more years. For example, consider a bird that was banded in 2018 and recaptured in 2019. If the bird was first banded as an adult, then the bird is at least two years old. If the bird was first banded as a juvenile, then the bird is exactly one year old. When a recaptured individual, first banded as an adult, is recaptured in the same year it was banded, it is at least one year old. When a recaptured individual, first banded as a juvenile, is recaptured in the same year it was banded, it is exactly zero years old. Figure 5 summarizes the minimum ages of recaptured Broad-tailed hummingbirds at PCBNM that were first banded as adults. The oldest Broad-tailed hummingbirds encountered were four females, at least six years old. Figure 6 summarizes the exact ages of recaptured Broad-tailed hummingbirds at PCBNM that were first banded as juveniles. The oldest Broad-tailed hummingbird hatched in Banderliet that returned to be recaptured was a male exactly five years old.

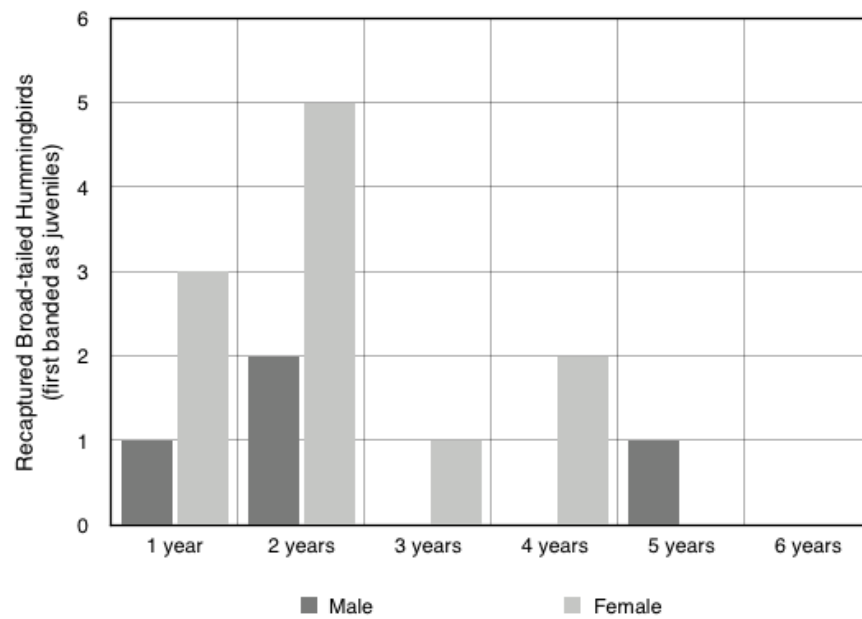


Figure 6: Exact ages of multi-year recaptured Broad-tailed individuals that were first banded as juveniles.

5.4 *Broad-tailed Hummingbird Breeding Season*

Figure 7 shows the number of gravid Broad-tailed captures, for each monitoring session. In most years, the Broad-tailed breeding season at PCBNM has extended from session 9 (mid-May) to session 12 (late June/early July). In 2016, the only year when we banded during session 8 (early May), a gravid female was captured in session 8. In 2021, a gravid female was captured in session 14 (late July). This late-breeding female may have had a failed nest earlier in the season. Calendar year 2021 was unusual because of late snowfalls in May and early June, and heavy rain events in June and July. Some early nests may have failed because of the adverse weather, leading to late breeding events. Because of this unusually late gravid capture, we have evidence that the Broad-tailed breeding season in Bandelier extends from early May to late July.

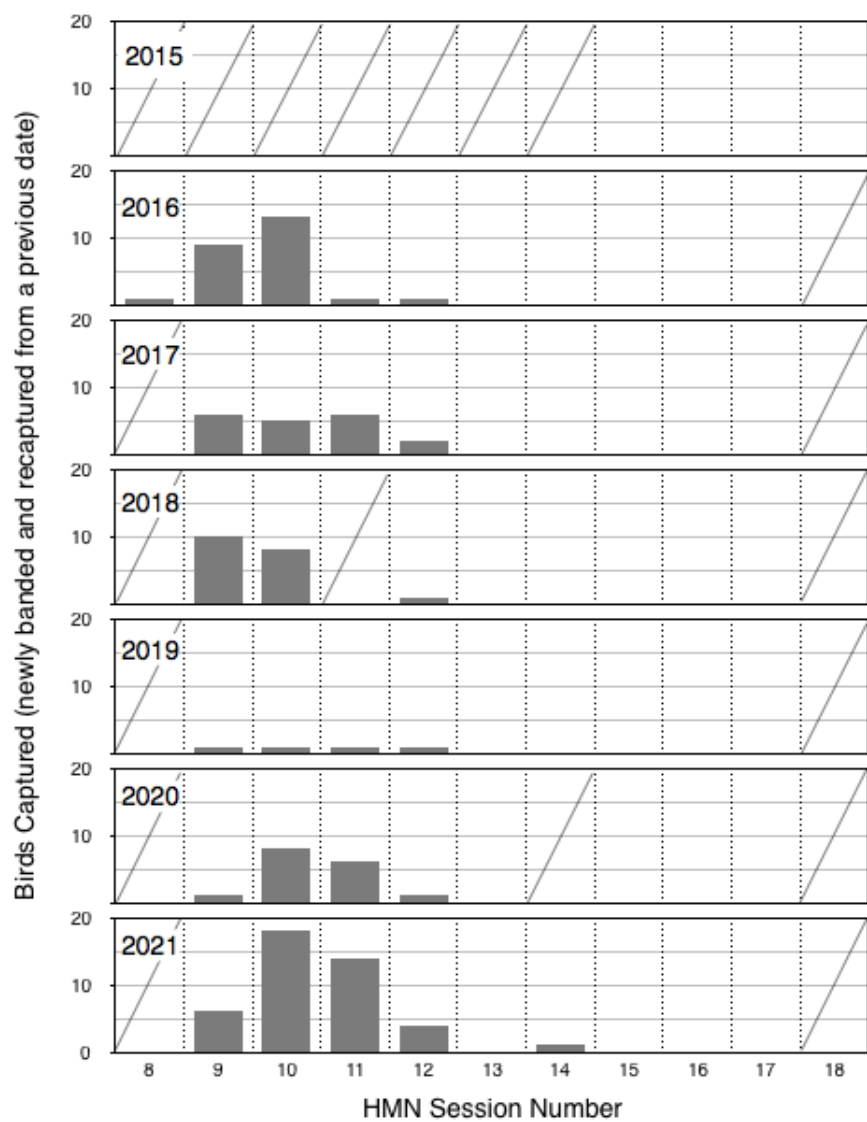


Figure 7: Total number of Broad-tailed hummingbirds observed to be gravid.

6 Results: Black-chinned Hummingbirds

6.1 *Age-Sex Distributions of Black-chinned Hummingbirds*

The distributions of adult Black-chinned hummingbirds captured at PCBNM from 2015 to 2021 are displayed in Figure 8. Adult males were most abundant in May and June and early July, and relatively few were captured in late July, August and September. Adult females were present throughout the monitoring season. The distributions of juvenile Black-chinned hummingbirds captured at PCBNM from 2015 to 2021 are given in Figure 9.⁵ Juvenile birds were captured in July through September, with the highest numbers observed in August and September.

These data suggest that adult male Black-chinned hummingbirds arrive early at Bandelier and stay through the breeding season, but leave when the juveniles start to fledge. Adult females are resident through the breeding season and stay for a few weeks after the juveniles have fledged. After fledging, the juvenile Black-chinned hummingbirds remain on site to put on weight and practice flying, then migrate south in late August and September. Adult males are rarely seen in Bandelier in August and September, which may indicate that PCBNM is mostly a breeding site for Black-chinned hummingbirds and is not part of a Fall migration route.

⁵The tabular age-sex distribution data for Black-chinned hummingbirds at PCBNM from 2015 to 2021 are presented in Appendix B.

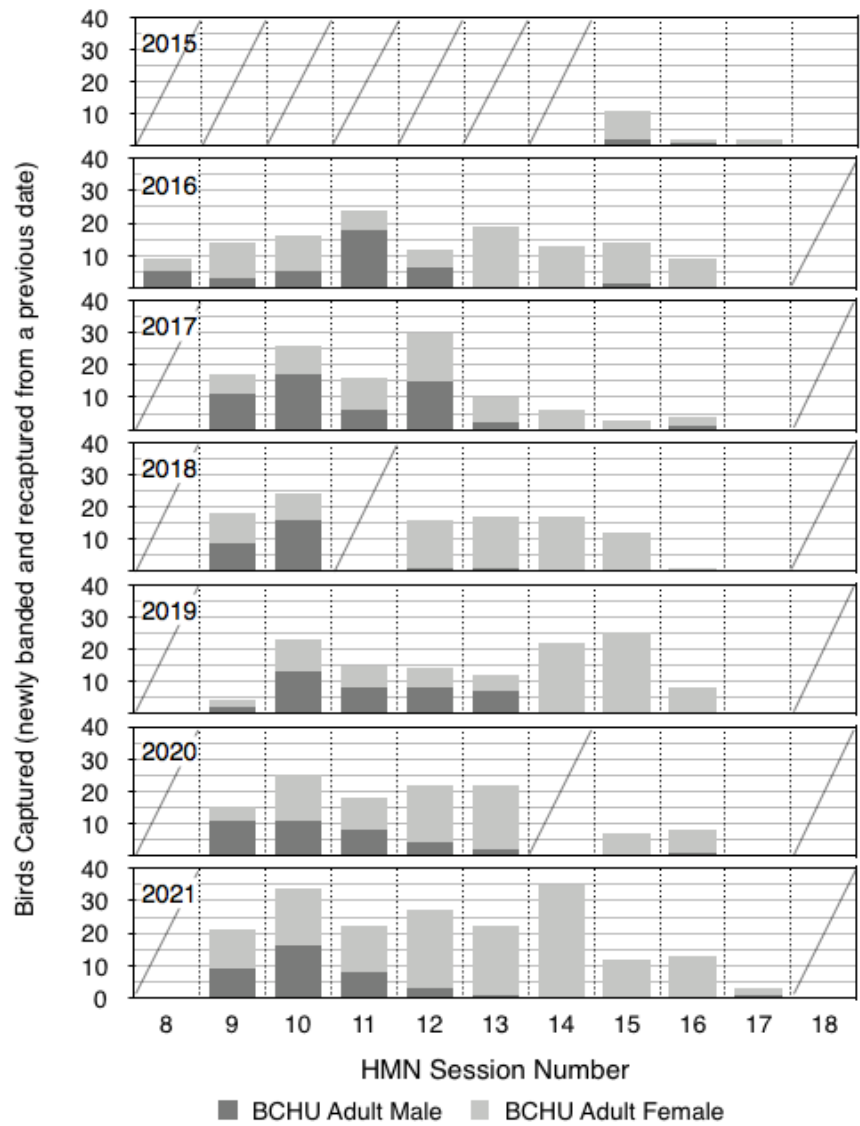


Figure 8: Number of adult Black-chinned hummingbirds captured at PCBNM from 2015 to 2021.

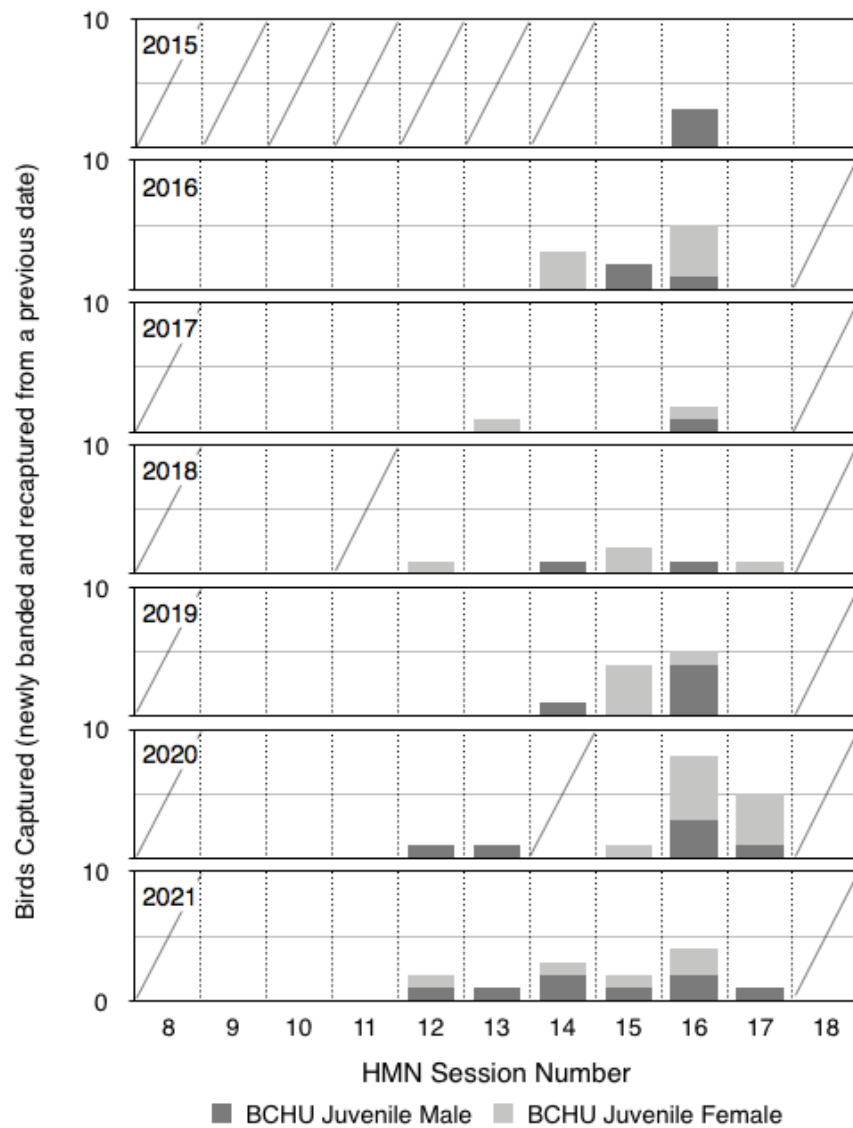


Figure 9: Number of Juvenile Black-chinned hummingbirds captured at PCBNM from 2015 to 2021.

6.2 *Black-chinned Hummingbird Recapture Rate*

Over the life of the monitoring program, we have recaptured Black-chinned hummingbirds 318 times, out of 852 Black-chinned captures. Thus, the overall Black-chinned recapture rate is 37% of all Black-chinned captures from 2015 to 2021. Multiple recaptures of adult birds in the same year indicate that Black-chinned individuals remain on-site from May to September to feed, breed, nest, incubate and hatch eggs, and fledge their young. Multiple recaptures of juvenile birds indicate that Black-chinned individuals stay on site after fledging to put on weight and practice flying, before migrating south in late August and September.

We can calculate the multi-year recapture rate in the same manner as was described for Broad-tailed hummingbirds. This multi-year recapture rate provides a measure of Black-chinned site-specific returns. From 2015 to 2021, 534 unique Black-chinned individuals were banded. In the same period, 112 individuals were recaptured at least once in a year different from the year in which they were banded. Thus, the multi-year recapture rate for Black-chinned hummingbirds at Bandelier over the life of the monitoring program is 21%.

Figure 10 and Table 4 display the number of unique Black-chinned individuals captured from 2015 to 2021, and the number of years recaptured individuals were observed. One female Black-chinned hummingbird was captured every year from 2016 to 2021. Five female Black-chinned hummingbirds were observed in five different years between 2016 and 2021. These observations suggest that breeding female Black-chinned hummingbirds have high site fidelity.

Table 4: Unique Black-chinned Individuals Captured at PCBNM from 2015 to 2021

Number of Years Observed	Never Recaptured	Recaptured at Least Once	Total
1	373	49	422
2		85	85
3		16	16
4		5	5
5		5	5
6		1	1
7		0	0
Total	373	161	534

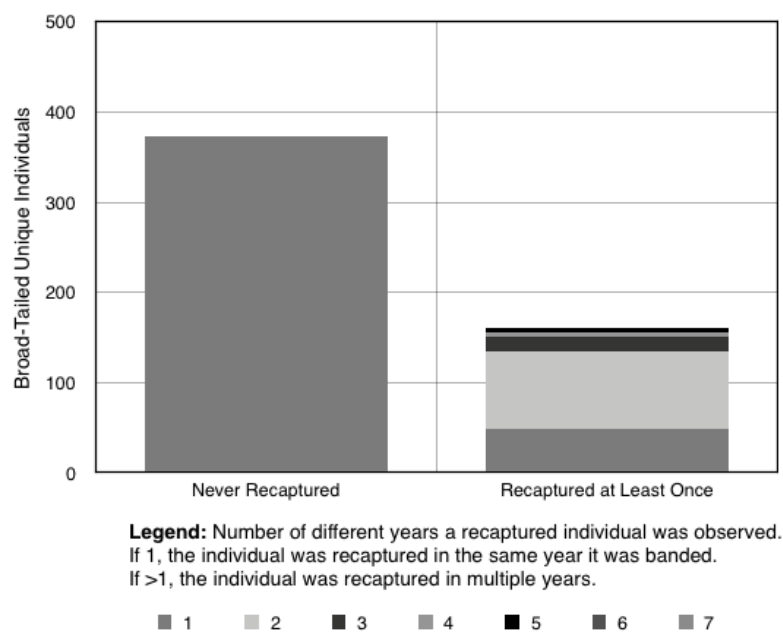


Figure 10: Unique Black-chinned individuals captured, and the number of years recaptured individuals were observed.

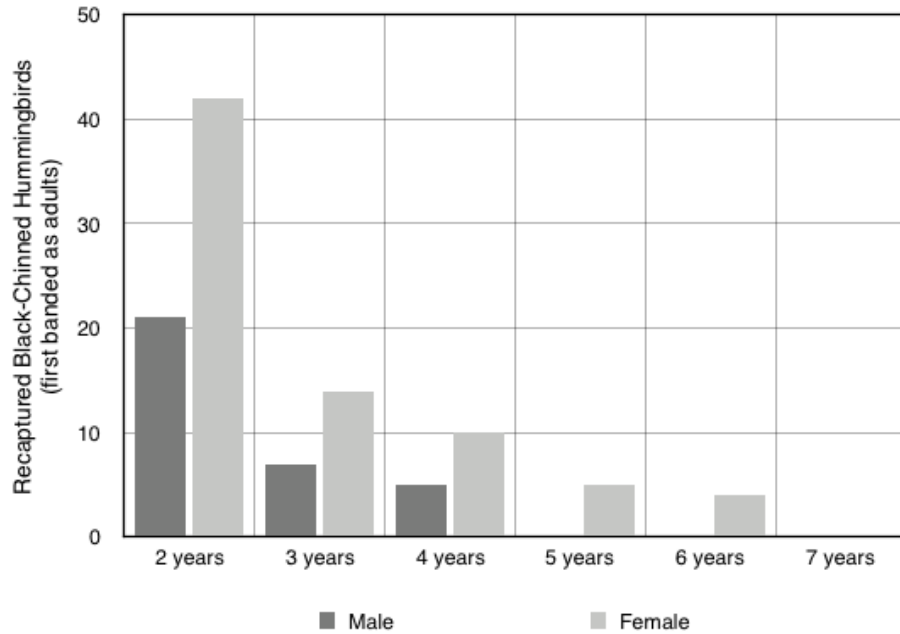


Figure 11: Minimum ages of multi-year recaptured Black-chinned individuals that were first banded as adults.

6.3 *Black-chinned Hummingbird Age Calculations from Recaptured Birds*

We can calculate the ages of recaptured Black-chinned hummingbirds in the same manner as was described for Broad-tailed hummingbirds. Figure 11 summarizes the minimum ages of recaptured Black-chinned hummingbirds at PCBNM that were first banded as adults. The oldest Black-chinned hummingbirds encountered were four females at least 6 years old. Figure 12 summarizes the exact ages of recaptured Black-chinned hummingbirds at PCBNM that were first banded as juveniles. The oldest Black-chinned hummingbird hatched in Bandelier that returned to be recaptured was a female exactly 4 years old.

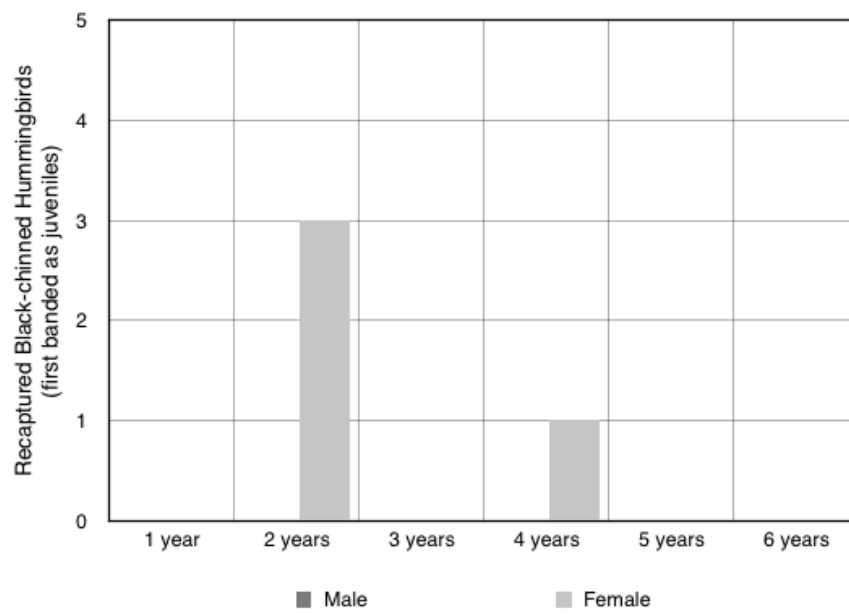


Figure 12: Exact ages of multi-year recaptured Black-chinned individuals that were first banded as juveniles.

6.4 *Black-chinned Hummingbird Breeding Season*

Figure 13 shows the number of Black-chinned captures observed to be gravid, for each monitoring session. The Black-chinned breeding season at PCBNM extends from session 9 (mid-May) to session 13 (mid-July).

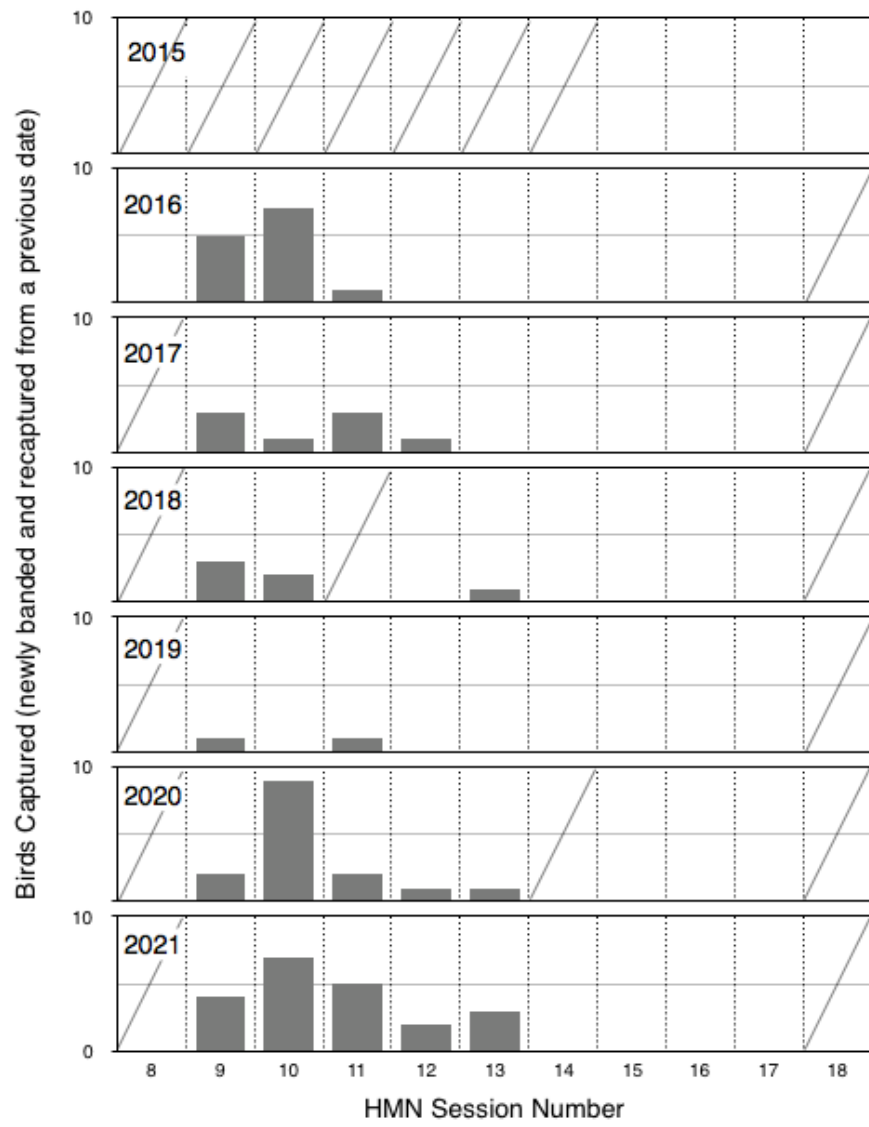


Figure 13: Total number of Black-chinned hummingbirds observed to be gravid.

7 Results: Rufous Hummingbirds

7.1 *Age-Sex Distributions of Rufous Hummingbirds*

The distributions of adult Rufous hummingbirds captured at PCBNM from 2015 to 2021 are displayed in Figure 14. Adult males and females began to arrive in Bandelier in session 12 (late June/early July) and were seen through September, with the highest numbers occurring in sessions 13, 14 and 15 (mid-July to mid-August). The distributions of juvenile Rufous hummingbirds captured at PCBNM from 2015 to 2021 are given in Figure 15.⁶ Juvenile birds were captured in mid-July through September, with the highest numbers observed in August and September.

These data suggest that Rufous hummingbirds breed, incubate and fledge in the northwest United States and Canada, stopping in Bandelier during Fall migration. Since Rufous hummingbirds are not seen in May and June, we conclude that Bandelier is not on the Spring migration route for Rufous hummingbirds.

⁶The tabular age-sex distribution data for Rufous hummingbirds at PCBNM from 2015 to 2021 are presented in Appendix C.

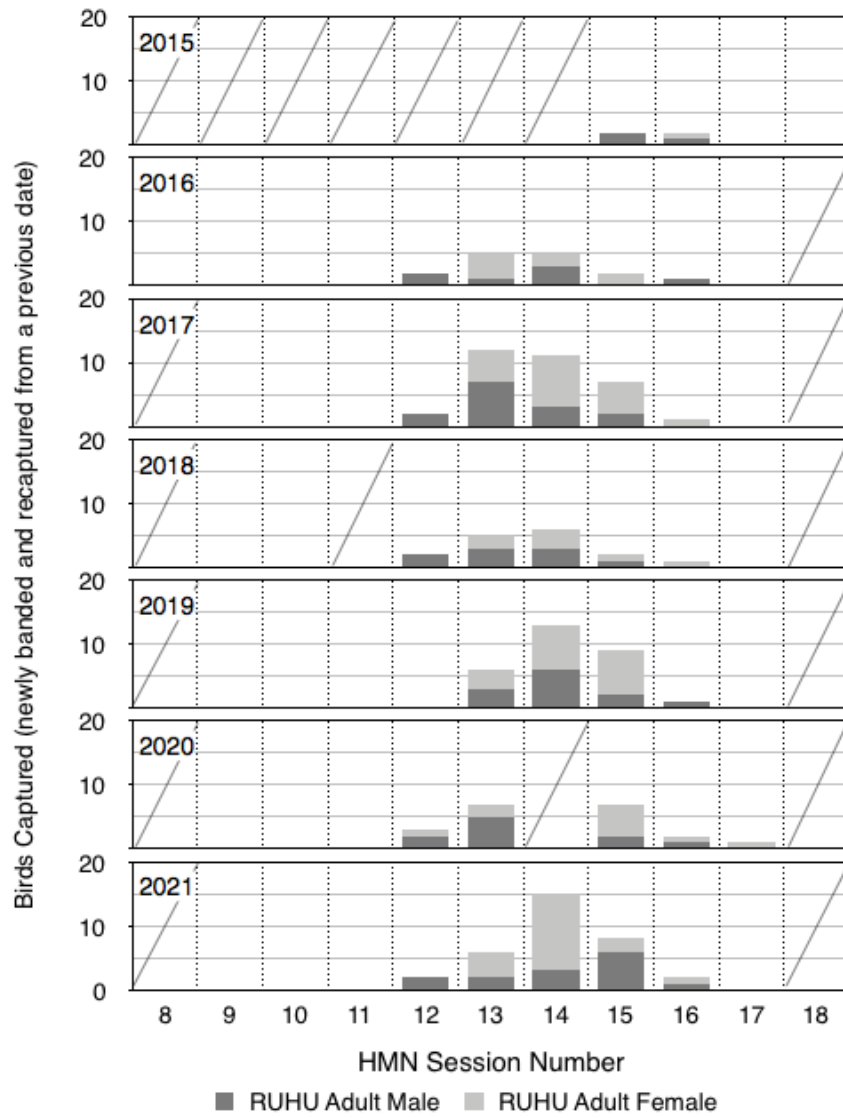


Figure 14: Number of adult Rufous hummingbirds captured at PCBNM from 2015 to 2021.

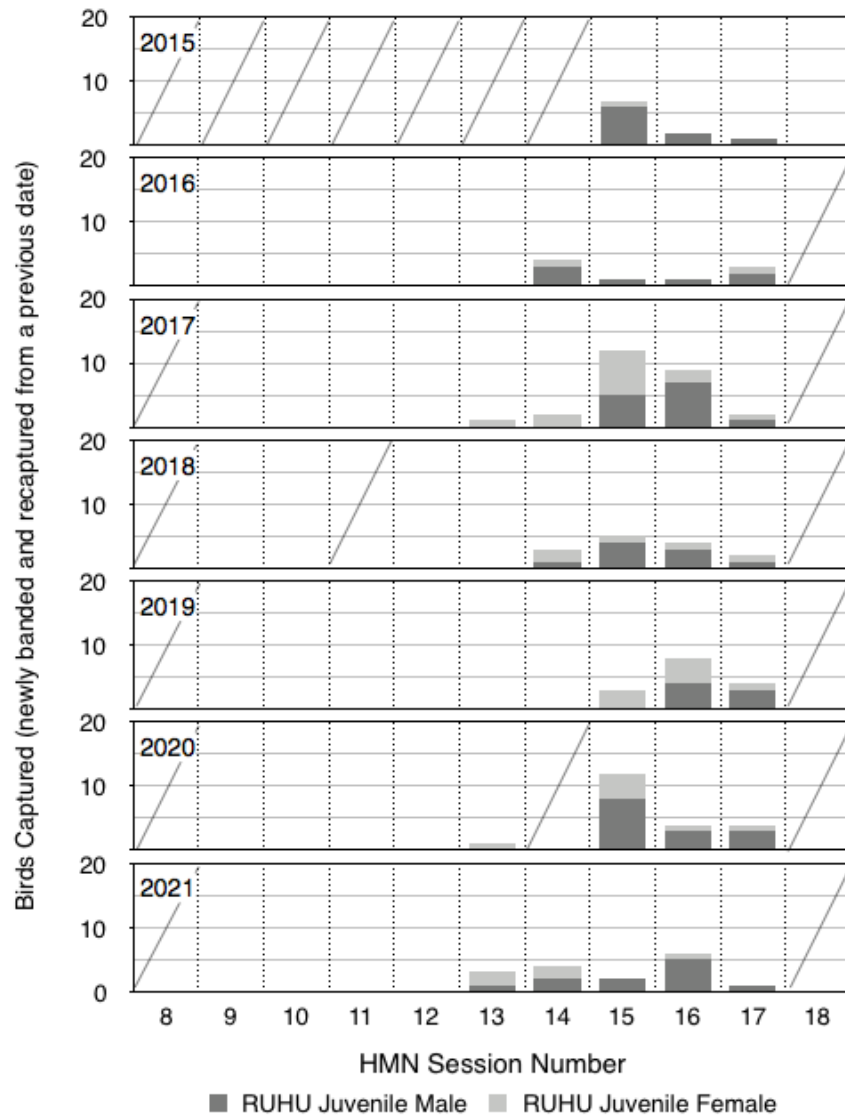


Figure 15: Number of Juvenile Rufous hummingbirds captured at PCBNM from 2015 to 2021.

7.2 Rufous Hummingbird Recaptures

Only one Rufous hummingbird was recaptured at PCBNM. The recaptured bird was an adult female hatched in 2016 or earlier, band number J95661, captured at PCBNM on 8/12/2017. This bird was originally banded on 5/3/2017 near Oliver, British Columbia. This recapture event is strong evidence of a Fall migration route for Rufous hummingbirds that extends from British Columbia through New Mexico.

There were no multiple year recaptures of Rufous hummingbirds at PCBNM.

No Rufous hummingbirds were ever recaptured in the same year that they were banded. This indicates that migrating Rufous hummingbirds stayed on-site for less than two weeks, because the monitoring sessions occurred at two week intervals. We conclude that Rufous hummingbirds stay on-site only long enough to put on the fat needed to see them through to the next migration stop.

7.3 Rufous Hummingbird Breeding Season

No gravid Rufous hummingbirds were captured at PCBNM from 2015 to 2021.

8 Results: Calliope Hummingbirds

8.1 *Age-Sex Distributions of Calliope Hummingbirds*

The distributions of adult Calliope hummingbirds captured at PCBNM from 2015 to 2021 are displayed in Figure 16. Adult males and females began to arrive in Bandelier in session 13 (mid-July) and were seen through September, with the highest numbers occurring in sessions 14 and 15 (late-July to mid-August). The distributions of juvenile Calliope hummingbirds captured at PCBNM from 2015 to 2021 are given in Figure 17.⁷ Juvenile birds were captured in late July through September, with the highest numbers observed in late August and September.

These data suggest that Calliope hummingbirds breed, incubate and fledge in the northwest United States and Canada, stopping in Bandelier during Fall migration. Since Calliope hummingbirds are not seen in May and June, we conclude that Bandelier is not on the Spring migration route for Calliope hummingbirds.

⁷The tabular age-sex distribution data for Calliope hummingbirds at PCBNM from 2015 to 2021 are presented in Appendix D.

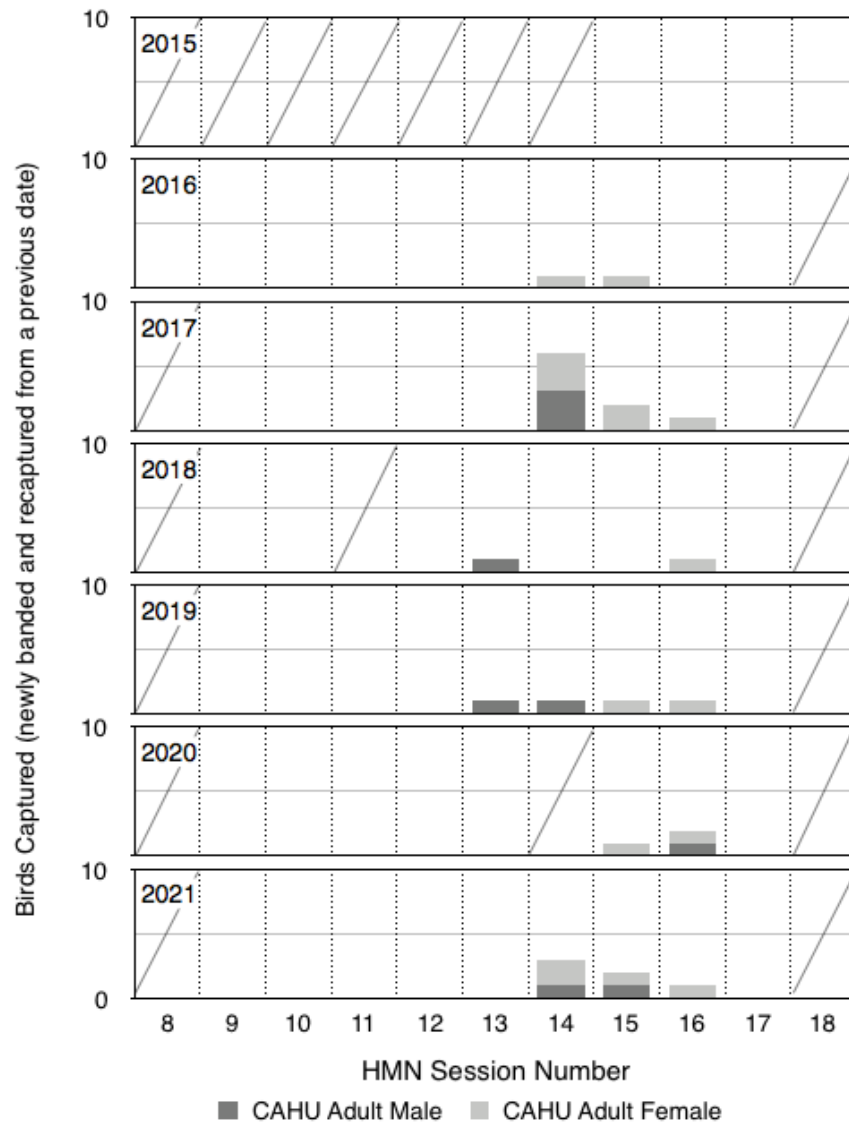


Figure 16: Number of adult Calliope hummingbirds captured at PCBNM from 2015 to 2021.

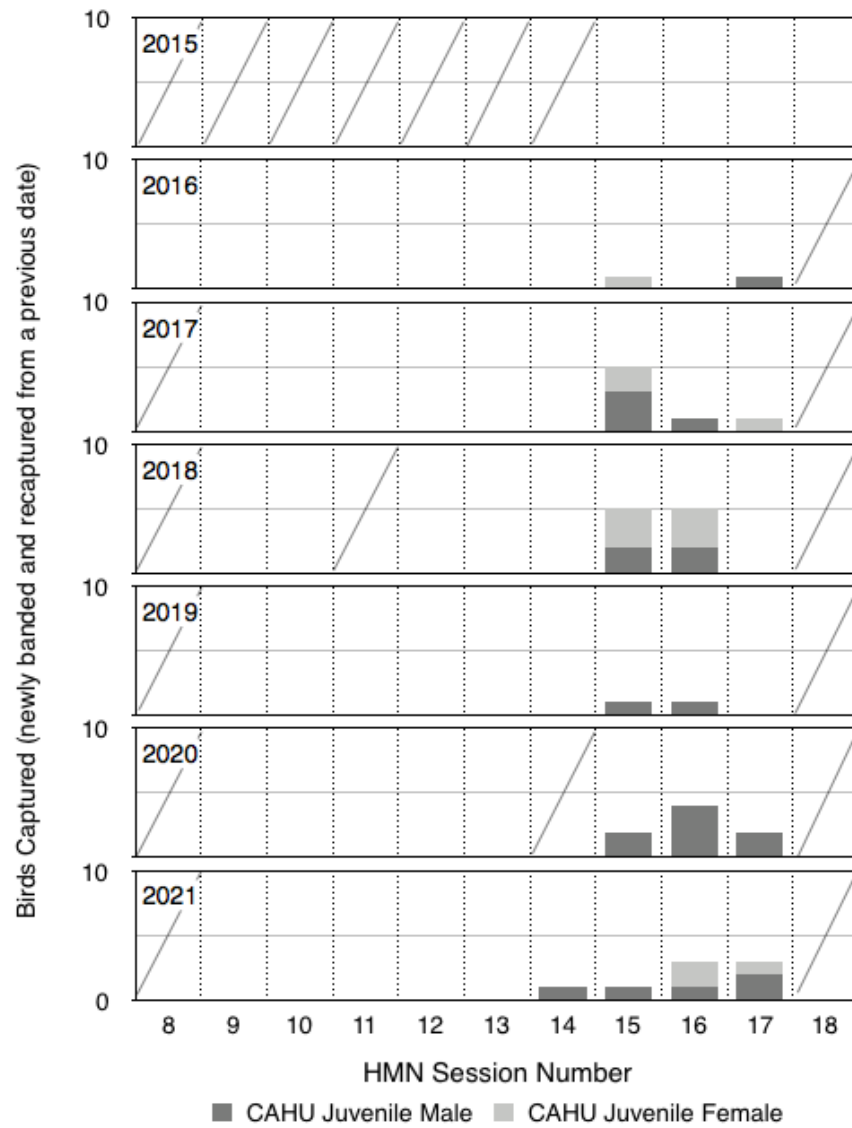


Figure 17: Number of Calliope Rufous hummingbirds captured at PCBNM from 2015 to 2021.

8.2 *Calliope Hummingbird Recaptures*

There were no multiple year recaptures of Calliope hummingbirds at PCBNM.

No Calliope hummingbirds were ever recaptured in the same year that they were banded. This indicates that migrating Calliope hummingbirds stay on-site for less than two weeks, because the monitoring sessions occurred at two week intervals. We conclude that Calliope hummingbirds stay on-site only long enough to put on the fat needed to see them through to the next migration stop.

8.3 *Calliope Hummingbird Breeding Season*

Surprisingly, we captured one gravid Calliope on 7/24/2021. This was the only gravid Calliope captured at PCBNM. In general, Calliope hummingbirds breed further north and complete their breeding season in early July. It is likely that this individual had an adventitious mating encounter during migration. Since the gravid bird was never recaptured, it is not known if eggs were successfully laid or hatched. Anecdotaly, it is known among the local birding community that a nestling Calliope was found in August 2015 in nearby Los Alamos. The nestling had fledged, but was clearly unable to fly well or find food on its own. The nestling was taken to a hummingbird rehabilitator. This anecdote corroborates the theory that migrating Calliopes sometimes have adventitious mating encounters and incubate eggs during migration in the vicinity of Bandelier National Monument.

9 Conclusions

A population of Broad-tailed hummingbirds and a population of Black-chinned hummingbirds return to Bandelier yearly to breed and feed. Gravid females of both species have been captured every year since 2016. The percentage of recapture events relative to total capture events was 40% for Broad-tailed hummingbirds and 37% for Black-chinned hummingbirds. Adult hummingbird recapture events inform us that Broad-tailed and Black-chinned individuals remain on-site at Bandelier from May to September to feed, breed, nest, incubate eggs, and fledge their young. Juvenile hummingbird recapture events suggest that individuals remain on-site after fledging to put on weight and practice flying, before migrating south in August and September. Multi-year recapture events prove that many individuals return to the site every year. The multi-year recapture rate, considering only individuals who returned a year or more after their first-banding-date, was 20% for Broad-tailed hummingbirds, and 21% for Black-chinned hummingbirds. Some Broad-tailed individuals are documented to be at least six years old, and some Black-chinned individuals are documented to be at least six years old. We have shown that breeding season for Broad-tailed hummingbirds in Bandelier National Monument is early May to late July. Black-chinned breeding season in Bandelier is mid-May to mid-July. Bandelier National Monument is therefore documented to be both a consistent breeding ground and a reliable migration stop for Broad-tailed and Black-chinned hummingbirds.

Rufous and Calliope hummingbirds migrate through Bandelier from July to September. Adult Rufous and Calliope hummingbirds arrive in July and continue to be seen through August. Juvenile Rufous and Calliope hummingbirds migrate through from August to October. A single Rufous recapture event provides evidence that Bandelier is on a Fall migration route from Rufous breeding grounds in British Columbia. A single Calliope gravid capture event suggests that Calliope hummingbirds occasionally have late adventitious mating encounters during Fall migration, in the vicinity of Bandelier National Monument. Because there were never any same-year recaptures of Rufous and Calliope hummingbirds, we conclude that Rufous and Calliope individuals stay on-site for less than two weeks during fall migration. Reliable migration stops are necessary for the survival of these two species, because they must acquire reserves of fat for the next leg of migration.

The results of Long-term Hummingbird Monitoring in Bandelier National Monument may have consequences for park management. By documenting the extent of hummingbird activity on-site, events such as controlled burns and tree trimming can be timed to avoid interruption of the hummingbird breeding season. Hummingbird migration routes to and from Bandelier National Monument should continue to be studied, and conservation efforts can focus on providing habitat pathways for hummingbird populations. When resources are available, additional monitoring of hummingbird populations in Bandelier National Monument may detect trends when compared with the 2015 to 2021 hummingbird monitoring data.

10 Acknowledgements

The long-term hummingbird monitoring effort at Bandelier was a volunteer-based, citizen-science project. The author wishes to thank many individuals for their service to this project. Ms. Sarah Milligan, National Park Service Biologist, provided oversight of the project for Bandelier National Monument from 2016 to 2021. Dr. Susan Wethington and Mr. Lee Rogers of HMN provided the training and mentoring necessary to get the project underway, and they provided coordination of the project with other HMN banding sites. The author is extremely grateful for the team of volunteers that serviced the feeders, worked the traps, recorded the data, and hauled the equipment. There was a core team of volunteers that attended nearly every session: Ms. Beth Cortright, Mr. James Loy, Mr. Joseph Schmidt and Mr. Wilhelm Schmidt. There were several volunteers who provided continuing assistance over several years: Mr. Keegan Tranquillo, Ms. Linda Boncella, Dr. Robert Walker, Ms. Katie Sayre, Ms. Melanie Boncella. Other helpful volunteers included (in alphabetical order): Ms. Marissa Ardovino, Mr. Dirk Adema, Ms. Adelle Anderson, Mr. Zach Boyd, Ms. Kathryn Brooks, Mr. Jack Burell, Mr. Wesley Burnham, Ms. Miranda Butler-Valverde, Mr. Daniel Dorantes, Mr. Kevin Doxstater, Ms. Dulce Flores, Ms. Lisa Ford, Mr. Ryan Gaul, Ms. Kim Geissler, Mr. Cliff Hoyt, Mr. Sammy Kutly, Ms. Allie Lalor, Mr. Jason Lott, Ms. Carolina May, Ms. Grace McCartha, Mr. Dennis Milligan, Ms. Zoe Moffet, Ms. Chloe Moore, Mr. Jesus Ordaz, Mr. Patrick Payne, Ms. Emily Phillips, Ms. Emily Reich, Ms. Julie Shieldcastle, Ms. Carrie Tallus, Ms. Caroline Urban, Mr. Travis Voorhees, and Ms. Sare Zaniewski. The author thanks Mr. Stephen Fettig, formerly a National Park Service Biologist at Bandelier National Monument and currently a Wildlife Biologist for the US Fish and Wildlife Service. Mr. Fettig conceived of this project, contacted Dr. Susan Wethington of HMN, and recruited the author to head the project.

11 Appendix A: Age-Sex Distributions of Broad-tailed Hummingbirds 2015 to 2021

Table 5: Number of Broad-tailed hummingbirds captured at PCBNM in 2015 according to age and sex.

Date	Broad-tailed adult male	Broad-tailed adult female	Broad-tailed juvenile male	Broad-tailed juvenile female	Total Banded for date
8/13/15	6	16	0	2	24
8/29/15	0	1	2	1	4
9/12/15	0	1	16	13	30
9/26/15	0	0	5	0	5
Total Broad-tailed	6	18	23	16	63

Table 6: Number of Broad-tailed hummingbirds captured at PCBNM in 2016 according to age and sex.

Date	Broad-tailed adult male	Broad-tailed adult female	Broad-tailed juvenile male	Broad-tailed juvenile female	Total Banded for date
5/7/16	3	5	0	0	8
5/21/16	15	18	0	0	33
6/4/16	6	19	0	0	25
6/18/16	6	11	0	0	17
7/3/16	6	20	0	3	29
7/16/16	1	21	0	2	24
7/30/16	0	14	1	1	16
8/13/16	2	21	3	2	28
8/27/16	1	16	4	4	25
9/10/16	1	7	10	12	30
Total Broad-tailed	41	152	18	24	235

Table 7: Number of Broad-tailed hummingbirds captured at PCBNM in 2017 according to age and sex.

Date	Broad-tailed adult male	Broad-tailed adult female	Broad-tailed juvenile male	Broad-tailed juvenile female	Total Banded for date
5/21/17	18	17	0	0	35
6/3/17	15	17	0	0	32
6/17/17	22	25	0	0	47
7/1/17	12	22	0	0	34
7/15/17	4	27	3	0	34
7/29/17	0	24	2	4	30
8/12/17	1	16	4	2	23
8/26/17	2	18	10	1	31
9/9/17	0	2	2	1	5
Total Broad-tailed	74	168	21	8	271

Table 8: Number of Broad-tailed hummingbirds captured at PCBNM in 2018 according to age and sex.

Date	Broad-tailed adult male	Broad-tailed adult female	Broad-tailed juvenile male	Broad-tailed juvenile female	Total Banded for date
5/19/18	16	21	0	0	37
6/2/18	3	31	0	0	34
6/16/18	*	*	*	*	*
6/30/18	3	24	2	1	30
7/14/18	3	30	0	0	33
7/28/18	3	19	3	4	29
8/11/18	1	21	4	1	27
8/25/18	4	16	12	5	37
9/8/18	0	4	16	14	34
Total Broad-tailed	33	166	37	25	261

*Banding cancelled on 6/16/18 because of rain.

Table 9: Number of Broad-tailed hummingbirds captured at PCBNM in 2019 according to age and sex.

Date	Broad-tailed adult male	Broad-tailed adult female	Broad-tailed juvenile male	Broad-tailed juvenile female	Total Banded for date
5/18/19	6	3	0	0	9
6/1/19	12	21	0	0	33
6/15/19	13	30	0	0	43
6/29/19	5	10	0	0	15
7/13/19	16	5	0	0	21
7/27/19	1	18	1	0	20
8/11/19	2	30	2	2	36
8/24/19	1	12	8	10	31
9/7/19	0	4	3	4	11
Total Broad-tailed	56	133	14	16	219

Table 10: Number of Broad-tailed hummingbirds captured at PCBNM in 2020 according to age and sex.

Date	Broad-tailed adult male	Broad-tailed adult female	Broad-tailed juvenile male	Broad-tailed juvenile female	Total Banded for date
5/17/20	26	17	0	0	43
5/30/20	16	25	0	0	41
6/13/20	25	33	0	0	58
6/27/20	29	34	1	0	64
7/11/20	18	41	2	0	61
7/25/20	*	*	*	*	*
8/8/20	4	13	7	4	28
8/22/20	1	11	9	1	22
9/5/20	0	0	4	1	5
Total Broad-tailed	119	174	23	6	322

*Banding cancelled on 7/25/20 because of pandemic restrictions.

Table 11: Number of Broad-tailed hummingbirds captured at PCBNM in 2021 according to age and sex.

Date	Broad-tailed adult male	Broad-tailed adult female	Broad-tailed juvenile male	Broad-tailed juvenile female	Total Banded for date
5/15/21	15	10	0	0	25
5/29/21	25	39	0	0	64
6/12/21	26	41	0	0	67
6/26/21	11	26	0	1	38
7/10/21	3	21	2	1	27
7/24/21	0	28	1	1	30
8/7/21	0	19	2	0	21
8/21/21	4	20	13	4	41
9/4/21	1	1	7	4	13
Total Broad-tailed	85	205	25	11	326

12 Appendix B: Age-Sex Distributions of Black-chinned Hummingbirds 2015 to 2021

Table 12: Number of Black-chinned hummingbirds captured at PCBNM in 2015 according to age and sex.

Date	Black-chinned adult male	Black-chinned adult female	Black-chinned juvenile male	Black-chinned juvenile female	Total Banded for date
8/13/15	2	9	0	0	11
8/29/15	1	1	3	0	5
9/12/15	0	2	0	0	2
9/26/15	0	0	0	0	0
Total Black-chinned	3	12	3	0	18

Table 13: Number of Black-chinned hummingbirds captured at PCBNM in 2016 according to age and sex.

Date	Black-chinned adult male	Black-chinned adult female	Black-chinned juvenile male	Black-chinned juvenile female	Total Banded for date
5/7/16	5	4	0	0	9
5/21/16	3	11	0	0	14
6/4/16	5	11	0	0	16
6/18/16	18	6	0	0	24
7/3/16	6	6	0	0	12
7/16/16	0	19	0	0	19
7/30/16	0	13	0	3	16
8/13/16	1	13	2	0	16
8/27/16	0	9	1	4	14
9/10/16	0	0	0	0	0
Total Black-chinned	38	92	3	7	140

Table 14: Number of Black-chinned hummingbirds captured at PCBNM in 2017 according to age and sex.

Date	Black-chinned adult male	Black-chinned adult female	Black-chinned juvenile male	Black-chinned juvenile female	Total Banded for date
5/21/17	11	6	0	0	17
6/3/17	17	9	0	0	26
6/17/17	6	10	0	0	16
7/1/17	15	15	0	0	30
7/15/17	2	8	0	1	11
7/29/17	0	6	0	0	6
8/12/17	0	3	0	0	3
8/26/17	1	3	1	1	6
9/9/17	0	0	0	0	0
Total Black-chinned	52	60	1	2	115

Table 15: Number of Black-chinned hummingbirds captured at PCBNM in 2018 according to age and sex.

Date	Black-chinned adult male	Black-chinned adult female	Black-chinned juvenile male	Black-chinned juvenile female	Total Banded for date
5/19/18	9	9	0	0	18
6/2/18	16	8	0	0	24
6/16/18	*	*	*	*	*
6/30/18	1	15	0	1	17
7/14/18	1	16	0	0	17
7/28/18	0	17	1	0	18
8/11/18	0	12	0	2	14
8/25/18	0	1	1	0	2
9/8/18	0	0	0	1	1
Total Black-chinned	27	78	2	4	111

*Banding cancelled on 6/16/18 because of rain.

Table 16: Number of Black-chinned hummingbirds captured at PCBNM in 2019 according to age and sex.

Date	Black-chinned adult male	Black-chinned adult female	Black-chinned juvenile male	Black-chinned juvenile female	Total Banded for date
5/18/19	2	2	0	0	4
6/1/19	13	10	0	0	23
6/15/19	8	7	0	0	15
6/29/19	8	6	0	0	14
7/13/19	7	5	0	0	12
7/27/19	0	22	1	0	23
8/11/19	0	25	0	4	29
8/24/19	0	8	4	1	13
9/7/19	0	0	0	0	0
Total Black-chinned	38	85	5	5	133

Table 17: Number of Black-chinned hummingbirds captured at PCBNM in 2020 according to age and sex.

Date	Black-chinned adult male	Black-chinned adult female	Black-chinned juvenile male	Black-chinned juvenile female	Total Banded for date
5/17/20	11	4	0	0	15
5/30/20	11	14	0	0	25
6/13/20	8	10	0	0	18
6/27/20	4	18	1	0	23
7/11/20	2	20	1	0	23
7/25/20	*	*	*	*	*
8/8/20	0	7	0	1	8
8/22/20	1	7	3	5	16
9/5/20	0	0	1	4	5
Total Black-chinned	37	80	6	10	133

*Banding cancelled on 7/25/20 because of pandemic restrictions.

Table 18: Number of Black-chinned hummingbirds captured at PCBNM in 2021 according to age and sex.

Date	Black-chinned adult male	Black-chinned adult female	Black-chinned juvenile male	Black-chinned juvenile female	Total Banded for date
5/15/21	9	12	0	0	21
5/29/21	16	18	0	0	34
6/12/21	8	14	0	0	22
6/26/21	3	24	1	1	29
7/10/21	1	21	1	0	23
7/24/21	0	35	2	1	38
8/7/21	0	12	1	1	14
8/21/21	0	13	2	2	17
9/4/21	1	2	1	0	4
Total Black-chinned	38	151	8	5	202

13 Appendix C: Age-Sex Distributions of Rufous Hummingbirds 2015 to 2021

Table 19: Number of Rufous hummingbirds captured at PCBNM in 2015 according to age and sex.

Date	Rufous adult male	Rufous adult female	Rufous juvenile male	Rufous juvenile female	Total Banded for date
8/13/15	2	0	6	1	9
8/29/15	1	1	2	0	4
9/12/15	0	0	1	0	1
9/26/15	0	0	0	0	0
Total Rufous	3	1	9	1	14

Table 20: Number of Rufous hummingbirds captured at PCBNM in 2016 according to age and sex.

Date	Rufous adult male	Rufous adult female	Rufous juvenile male	Rufous juvenile female	Total Banded for date
5/7/16	0	0	0	0	0
5/21/16	0	0	0	0	0
6/4/16	0	0	0	0	0
6/18/16	0	0	0	0	0
7/3/16	2	0	0	0	2
7/16/16	1	4	0	0	5
7/30/16	3	2	3	1	9
8/13/16	0	2	1	0	3
8/27/16	1	0	1	0	2
9/10/16	0	0	2	1	3
Total Rufous	7	8	7	2	24

Table 21: Number of Rufous hummingbirds captured at PCBNM in 2017 according to age and sex.

Date	Rufous adult male	Rufous adult female	Rufous juvenile male	Rufous juvenile female	Total Banded for date
5/21/17	0	0	0	0	0
6/3/17	0	0	0	0	0
6/17/17	0	0	0	0	0
7/1/17	2	0	0	0	2
7/15/17	7	5	0	1	13
7/29/17	3	8	0	2	13
8/12/17	2	5	5	7	19
8/26/17	0	1	7	2	10
9/9/17	0	0	1	1	2
Total Rufous	14	19	13	13	59

Table 22: Number of Rufous hummingbirds captured at PCBNM in 2018 according to age and sex.

Date	Rufous adult male	Rufous adult female	Rufous juvenile male	Rufous juvenile female	Total Banded for date
5/19/18	0	0	0	0	0
6/2/18	0	0	0	0	0
6/16/18	*	*	*	*	*
6/30/18	2	0	0	0	2
7/14/18	3	2	0	0	5
7/28/18	3	3	1	2	9
8/11/18	1	1	4	1	7
8/25/18	0	1	3	1	5
9/8/18	0	0	1	1	2
Total Rufous	9	7	9	5	30

*Banding cancelled on 6/16/18 because of rain.

Table 23: Number of Rufous hummingbirds captured at PCBNM in 2019 according to age and sex.

Date	Rufous adult male	Rufous adult female	Rufous juvenile male	Rufous juvenile female	Total Banded for date
5/18/19	0	0	0	0	0
6/1/19	0	0	0	0	0
6/15/19	0	0	0	0	0
6/29/19	0	0	0	0	0
7/13/19	3	3	0	0	6
7/27/19	6	7	0	0	13
8/11/19	2	7	0	3	12
8/24/19	1	0	4	4	9
9/7/19	0	0	3	1	4
Total Rufous	12	17	7	8	44

Table 24: Number of Rufous hummingbirds captured at PCBNM in 2020 according to age and sex.

Date	Rufous adult male	Rufous adult female	Rufous juvenile male	Rufous juvenile female	Total Banded for date
5/17/20	0	0	0	0	0
5/30/20	0	0	0	0	0
6/13/20	0	0	0	0	0
6/27/20	2	1	0	0	3
7/11/20	5	2	0	1	8
7/25/20	*	*	*	*	*
8/8/20	2	5	8	4	19
8/22/20	1	1	3	1	6
9/5/20	0	1	3	1	5
Total Rufous	10	10	14	7	41

*Banding cancelled on 7/25/20 because of pandemic restrictions.

Table 25: Number of Rufous hummingbirds captured at PCBNM in 2021 according to age and sex.

Date	Rufous adult male	Rufous adult female	Rufous juvenile male	Rufous juvenile female	Total Banded for date
5/15/21	0	0	0	0	0
5/29/21	0	0	0	0	0
6/12/21	0	0	0	0	0
6/26/21	2	0	0	0	2
7/10/21	2	4	1	2	9
7/24/21	3	12	2	2	19
8/7/21	6	2	2	0	10
8/21/21	1	1	5	1	8
9/4/21	0	0	1	0	1
Total Rufous	14	19	11	5	49

**14 Appendix D: Age-Sex Distributions of Cal-
liope Hummingbirds 2015 to 2021**

Table 26: Number of Calliope hummingbirds captured at PCBNM in 2015 according to age and sex.

Date	Calliope adult male	Calliope adult female	Calliope juvenile male	Calliope juvenile female	Total Banded for date
8/13/15	0	0	0	0	0
8/29/15	0	0	0	0	0
9/12/15	0	0	0	0	0
9/26/15	0	0	0	0	0
Total Calliope	0	0	0	0	0

Table 27: Number of Calliope hummingbirds captured at PCBNM in 2016 according to age and sex.

Date	Calliope adult male	Calliope adult female	Calliope juvenile male	Calliope juvenile female	Total Banded for date
5/7/16	0	0	0	0	0
5/21/16	0	0	0	0	0
6/4/16	0	0	0	0	0
6/18/16	0	0	0	0	0
7/3/16	0	0	0	0	0
7/16/16	0	0	0	0	0
7/30/16	0	1	0	0	1
8/13/16	0	1	0	1	2
8/27/16	0	0	0	0	0
9/10/16	0	0	1	0	1
Total Calliope	0	2	1	1	4

Table 28: Number of Calliope hummingbirds captured at PCBNM in 2017 according to age and sex.

Date	Calliope adult male	Calliope adult female	Calliope juvenile male	Calliope juvenile female	Total Banded for date
5/21/17	0	0	0	0	0
6/3/17	0	0	0	0	0
6/17/17	0	0	0	0	0
7/1/17	0	0	0	0	0
7/15/17	0	0	0	0	0
7/29/17	3	3	0	0	6
8/12/17	0	2	3	2	7
8/26/17	0	1	1	0	2
9/9/17	0	0	0	1	1
Total Calliope	3	6	4	3	16

Table 29: Number of Calliope hummingbirds captured at PCBNM in 2018 according to age and sex.

Date	Calliope adult male	Calliope adult female	Calliope juvenile male	Calliope juvenile female	Total Banded for date
5/19/18	0	0	0	0	0
6/2/18	0	0	0	0	0
6/16/18	*	*	*	*	*
6/30/18	0	0	0	0	0
7/14/18	1	0	0	0	1
7/28/18	0	0	0	0	0
8/11/18	0	0	2	3	5
8/25/18	0	1	2	3	6
9/8/18	0	0	0	0	0
Total Calliope	1	1	4	6	12

*Banding cancelled 6/16/18 because of rain.

Table 30: Number of Calliope hummingbirds captured at PCBNM in 2019 according to age and sex.

Date	Calliope adult male	Calliope adult female	Calliope juvenile male	Calliope juvenile female	Total Banded for date
5/18/19	0	0	0	0	0
6/1/19	0	0	0	0	0
6/15/19	0	0	0	0	0
6/29/19	0	0	0	0	0
7/13/19	1	0	0	0	1
7/27/19	1	0	0	0	1
8/11/19	0	1	1	0	2
8/24/19	0	1	1	0	2
9/7/19	0	0	0	0	0
Total Calliope	2	2	2	0	6

Table 31: Number of Calliope hummingbirds captured at PCBNM in 2020 according to age and sex.

Date	Calliope adult male	Calliope adult female	Calliope juvenile male	Calliope juvenile female	Total Banded for date
5/17/20	0	0	0	0	0
5/30/20	0	0	0	0	0
6/13/20	0	0	0	0	0
6/27/20	0	0	0	0	0
7/11/20	0	0	0	0	0
7/25/20	*	*	*	*	*
8/8/20	0	1	2	0	3
8/22/20	1	1	4	0	6
9/5/20	0	0	2	0	2
Total Calliope	1	2	8	0	11

*Banding cancelled on 7/25/20 because of pandemic restrictions.

Table 32: Number of Calliope hummingbirds captured at PCBNM in 2021 according to age and sex.

Date	Calliope adult male	Calliope adult female	Calliope juvenile male	Calliope juvenile female	Total Banded for date
5/15/21	0	0	0	0	0
5/29/21	0	0	0	0	0
6/12/21	0	0	0	0	0
6/26/21	0	0	0	0	0
7/10/21	0	0	0	0	0
7/24/21	1	2	1	0	4
8/7/21	1	1	1	0	3
8/21/21	0	1	1	2	4
9/4/21	0	0	2	1	3
Total Calliope	2	4	5	3	14