# The Continued Development of a Purple Martin Population at Beaverhill Lake

**Maia Visscher**

**Beaverhill Bird Observatory Internship**

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## Abstract

This study seeks to contribute to the historical data collected by the Beaverhill Bird Observatory and its ongoing monitoring of purple martins (*Progne subis*) with the goal of sustaining a resilient and returning population. This summer's results show a continued increase in occupancy rates for the newer houses installed in the summer of 2024. The results also show that the older houses have on average higher levels of occupancy than the newer one, 95.8% and 87.5% respectively. Like the trends collected from previous summers, the average clutch sizes, number of hatchings, and number of fledglings tend to be higher for adult martins compared to the subadults. These results align with other published studies and the expectations for this summer.

## Introduction

Purple martins are synanthropic species, reliant on humans to provide them with housing, a relationship that started when Indigenous people would hang hollowed out gourds on trees acting as cavities for the birds to build nests (Stokes et al. 1997). Since then, the materials humans have used to house purple martins has changed dramatically. Today, purple martin landlords provide nesting structures made of aluminum, wood, or plastic. A variety of winch designs are often used to access nests for monitoring or maintenance. Hosing designs often feature designs that protect the nests from predators including owl guards or pole baffles (Stokes et al. 1997).

Figure 1: (A) a busy house (PA), (B) view of house from below, and (C) view of house with multiple purple martin pairs through Vortex HD Viper 8x32 Binoculars

Once the homes have been set up and purple martins have taken up residence, like in figure 1C, biologists can identify individual's sex and age, maturation of chicks in the colony, and nest development. Purple martins, like most birds, exhibit sexual dimorphism allowing the differentiation of males from females. Adult male martins are a dark, slightly iridescent purple over the entirety of the body with black wings. Adult females have a gray breast, undertail coverts that have a gray center and dark purple/black wings and back. Similarly, adults (after second year/third calendar year) can be differentiated from the subadults (second year). Subadult females are like the adults but with a lighter overall appearance with fully white undertail coverts. Subadult males look like subadult females but with patches of dark feathers scattered in the breast/belly (Stokes et al. 1997).

Once martins have formed mated pairs and are ready to breed, they enter the stage of nest development. Nest development can be used to monitor the progress of a mated pair of purple martins in their preparation for egg laying, hatching, and chick development. Martins use grass, twigs, and mud to build up a sturdy base for the nest with a cavity that later gets lined with green leaves as egg laying begins (Stokes et al. 1997). Once eggs have been laid, usually one a day, incubation time is around 16 days. Clutch sizes range from 2-7 eggs, often dependent on the age of parents and the environmental conditions. Upon hatching, the nestling period extends between 26 to 32 days, culminating in fledgling being ready to leave the nest (Robyn 2024 Apr 18).

As purple martin hatchlings mature, their plumage develops from fluffy feathers to pin feathers to give them a brown/gray coat. The males do not develop shiny purple coats until they are full adults (PMCA Home - Purple Martin Conservation Association 2024). This pattern makes it difficult to determine the sex of chicks, but the feather development and size are key indicators of age and are vital pieces of information when gauging hatch date and consequently fledge date.

Figure 2: complete next fully lined with fresh green leaves containing 6 eggs

Figure 3: (A) just hatched chick (on hatching day), (B) hatchings 5-6 days old, and (C) hatchings around 13 days old

Monitoring purple martin colonies is important because it can provide regular updates about nesting success and providing some protection from predators, parasites, and invasive species, potentially contributing to the overall health of the local population. Recording data on purple martins can be an important citizen science initiative to aid in the conservation efforts and programs devoted to protecting martins (like Project Martinwatch which is organized by the Purple Martin Conservation Association). The efficacy of monitoring martins has become increasingly researched and suggests that more stewardship and frequent checks of nest boxes increase the success of the nest along with improving the viability of returning martins (Kelly and Hvenegaard 2022).

There is evidence in the historical data of the BBO that the success of a colony is dependent on a history of establishment by returning adults. It is likely that adult martins remember successful nest sites and return to sites they are familiar with (Airola and Kopp 2024). Older birds who have returned earlier have an advantage to picking existing houses that have had successful nests before (Komarnisky 2024). Further increase in the use of a colony will also occur when subadults from the previous summer returning now as adults to the same houses they occupied before (Chalifoux 2025). These data support the need to maintain the infrastructure purple martins use can contribute to the success of the population; having colonies that have been up long enough to be established is vital for a returning purple martin population.

This research project seeks to collect data to inform of the behaviour and productivity trends of the purple martins in the Beaverhill Natural Area (BNA). That leads to questions about how parental age is distributed over the houses and contributes to the overall breeding productivity. Linking to how age of housing affects nest productivity. We hypothesize that activity and the numbers of individuals, as seen in a greater percent of holes with nesting pairs that produce eggs, using the new housing structures installed in May 2024 (houses PC and PD), will have increased this summer compared to past years. This expectation is because of previous subadult nesters who are returning as adults to this now established nesting location as well as subadults who may attempt nesting for the first time later in the season. We can hypothesize that we will observe reduced clutch sizes and a delay in hatch dates (Brown 1978) in PC and PD relative to longer established colonies (houses PA and PB) in place since 2014 and 2020, respectively because of more subadult purple martins utilizing those colonies. It is also expected that PA and PB will continue to have high success rates following the trends from previous years.

**Study Site Description**

The Beaverhill Bird Observatory (BBO) is located in the Beaverhill Natural Area (BNA) just east of the Cooking Lake Moraine roughly 12 km east of Tofield Alberta. The BNA is in the Aspen Parkland and is home to hundreds of species birds and animals. The purple martins inhabited the BNA since 2014 where the first house was put up at site PA. However, the martins only started taking up residence at PA in 2020, due to this the purple martin nests expanded in 2020 with replacement of the original box at PA and addition of PB. Later, in 2024, new houses, PC and PD, were added. The houses each hold 12 nest boxes which slide out to facilitate nest checks. The colonies are made of wood and utilize a hand winch system to raise and lower the house. Colonies were located away from tall bushes and trees to maximize the success of the purple martin population by minimizing interspecific competition with sparrows and starlings (Wild Species Status Search), predators, and parasites (Kostka et al. 1999). As martins are aerial insectivores (Chalifoux 2025), having wide open spaces for them to hunt is very important and colonies were located close to a waterbody to provide a steady food source for the martins.


Figure 4: Map of Beaverhill Natural Area with location of purple martin houses.

In addition to the general landscape around purple martin colonies, weather contributes to the behaviour and survival of the martins. The summer of 2026 was exceedingly wet and food sources for purple martins were plentiful. In particular, there was a spike in the mosquito population and while mosquitos do not directly make up most of the martin's diet, other insects (like dragonflies) that feed on mosquitos do (Stokes et al. 1997). Conversely the persistent storms, rain, and windy conditions that are not favourable to insect prey flying may have limited the food supply for young martins. Additionally, the tremendous amounts of flooding conditions also impacted foot access, which left regular monitoring and nest checks difficult to conduct.

## Methods

### *Observations*

I conducted weekly nest checks and observations, typically on Sunday morning/midday, to monitor purple martin individuals, nest development, and colony conditions. Firstly, observations were made about the age and sex of individuals in and around the nest sites based on physical characteristics and behaviour, often while in flight. Second, the area around the colony was checked, any nest material, eggs or even birds were looked for on the ground.

Next the colonies were lowered using a hand winch and the state of the nests were recorded including whether the nest was empty, partially built or fully complete, lined, incomplete/left. The number of eggs and the estimated age of any chicks based on feather development was recorded. The presence of dead young and any parasites (blowfly larvae) was also noted. The nests were then raised again and repeated for all nest sites. Nest checks were completed once hatchlings reached around 20 days old or when the projected fledge date was approaching to prevent premature fledging. Any nests that had blowfly larvae present were replaced with dry grass if the nests were infested. If any larvae were found on a chick, they were carefully removed. Further, any damaged boxes were fixed before any nesting activity took place and periodically during the summer the grass was trimmed around the houses (2-meter radius) to maintain the site for checks and to protect from predators. At the end of the season (once all the martins have left for migration) the boxes were cleaned out and closed for the winter. The houses were then lowered to 1/3 of the height so wildlife and livestock in the area would not cause any damage.

*Data processing*

Once all nest checks had been completed for the 2026 summer breeding season, in mid to late August, the data processing began. To have statistically relevant data, any nests without purple martin activity, that is without eggs, were removed from the data. Any missing values in the data remained blank. Dates were recorded as both universal standard and Julian types. The ages of the houses were recorded as either 6 or 2, this is in accordance with the duration of time the martins have inhabited them, even if the nest sites themselves have existed longer. Percent hatched was calculated from the number of hatchings divided by the number of eggs multiplied by one hundred. Percent fledged was recorded as number fledged divided by number or fledglings or number of eggs multiplied by one hundred. Success was determined if there was at least one fledgling per box and then at least one fledgling per house.

## Results

The data collected comes from the 4 purple martin houses (PA, PB, PC, and PD), each with 12 nest boxes, and 3 nests per side of house facing all 4 cardinal directions. The presence of eggs in a nest was used to determine the occupancy of each house. PA had an occupancy rate of 92% with 11/12 boxes having eggs. PB and PC both had an occupancy rate of 100%, and PD had an occupancy rate of 75% with 9/12 boxes having eggs. In addition to occupancy rates for the houses based on nests there were trends that the purple martins followed based on age within these nests. Adult martin pairs laid eggs roughly 5 days before any subadult pairs did (166.1 in Julian or June 15$^{th}$ for ASY/ASY pairs vs 170.6 in Julian or June 20$^{th}$ for SY/SY pairs).

Activity at the houses started occurring in early May (droppings visible starting May 10$^{th}$) and occupancy started in late May (around May 24$^{th}$). Most of the martins had left by late August except for around 10 individuals who persisted into September. These individuals, at house site PA consisted of fledglings, those of which are likely a second brood or reattempt.

Table 1: Breeding productivity variables. Overview of average values for nest data across all houses. Valid is the number of nests where the statistics are available, missing is the number of nests that cannot have that statistical analysis. Mean is the average of the values being measured. Dates are recorded in Julian.

*Descriptive Statistics*

| | Valid | Missing | Mean (arithmetic) | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|---|
| No. of Eggs in Box | 44 | 0 | 4.932 | 1.208 | 3.000 | 8.000 |
| No. of Nestlings in Box | 44 | 0 | 3.364 | 2.253 | 0.000 | 7.000 |
| No. of Fledglings from box | 44 | 0 | 2.614 | 2.345 | 0.000 | 6.000 |
| Actual Hatch Date (Julian) 2 | 28 | 16 | 186.7 | 4.243 | 180.0 | 198.0 |
| Earliest Fledge Date (julian) | 27 | 17 | 214.5 | 4.191 | 208.0 | 226.0 |

Table 2: Overall occupancy per age of house. ANOVA test between number of eggs and the age of the house.

*ANOVA – Total No. of Eggs in House*

| Cases | Sum of Squares | df | Mean Square | F | p |
|---|---|---|---|---|---|
| Age of house | 238.2 | 1 | 238.2 | 10.41 | .002 |
| Residuals | 961.0 | 42 | 22.88 | | |

*Note.* Type III Sum of Squares

Table 2: Post Hoc comparison to see mean difference of age of house and number of eggs. 2 and 6 are ages of the houses, the test compares the two.

*Post Hoc Comparisons – Age of house*

| | | Mean Difference | SE | df | t | $p_{Tukey}$ |
|---|---|---|---|---|---|---|
| 2 | 6 | −4.658 | 1.444 | 42 | −3.227 | .002 |

The Post Hoc comparison in Table 3 indicates that there is a mean difference between house ages.

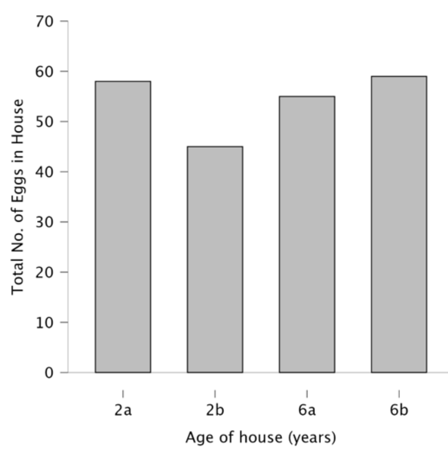


Figure 5: graphical representation of number of eggs per house depending on the house age.

In figure 5 house age 6a is PA, house age 6b is PB, house age 2a is PC and 2b is PD. The number of eggs in each house were distributed in the occupied nests. PA had 11 nests occupied, PB and PC both had all 12, and PD had 9 of the 12 nests occupied. Looking at previous summer's reports at the BBO there is a steady increase in these values, going from an occupancy of 92% in PA (10 years old in 2024) and PB (4 years old in 2024), 33% in PC, and 50% in PD in 2024 (both PC and PD new that season) (Komarnisky 2024).

The occupancy can be analysed when the nests together and then compared based on the parental age, specific to the female or male. The mean number of fledglings per box was higher for ASY female parents (3.9) than for SY female parents (1.4; $t = 3.061$, $df = 24$, $p = .005$). This trend of adult martins having higher breeding productivity is seen in the mean number of eggs per box for ASY female parents (5.1) compared to SY females (4.6; $t = 0.89$, $df = 24$, $p = 0.382$). for the mean number of nestlings ASY females had more (4.2) than SY females (2.1; $t = 2.293$, $df = 24$, $p = 0.031$). Similarly, the male mean number of fledglings is higher in ASY (3.4) compared to SY (1.7; $t = 2.035$, $df = 25$, $p = 0.053$). For ASY males the mean number of eggs per box (5.3) is greater than SY males (4.8; $t = 1.031$, $df = 25$, $p = 0.312$). And the number of nestlings per box for ASY males (3.7) was higher than SY males (2.3; $t = 1.411$, $df = 25$, $p = 0.171$).

The direction that the entrance hole of the nest faces saw slight differences in the productivity (number of fledglings per nest). North averaged 3.25, east averaged 2.75, south averaged 1.67, and west averaged 2.55 (results from ANOVA test). After running a post hoc test the north and south facing holes have the largest mean difference in number of fledglings per nest (1.583; $SE = 1.042$, $df = 40$, $t = 1.520$, $p_{Tukey} = 0.435$).

Another observable result is that from a correlation test. The analysis shows that as the date of first egg laid progressed further into the summer the number of eggs decreased ($r = -0.4839$). This correlation is statistically significant ($r = 0.002$) and a similar trend follows when looking at number of hatchings and fledglings.

There were also strong results that showed thar the adult birds had more successful nests, success being defined by a least one fledgling making it out of the nest. In total the ASY pairs had 2 unsuccessful nests (out of the 7 unsuccessful nests across all 4 houses) this was significantly lower than expected (4.375). In comparison the SY pairs had an increased number of unsuccessful houses (5) compared to the expected number (2.3; $X^2 = 6.534$, df = 2, p = 0.038).

The mortality rate of fledglings was 22%, calculated by the difference of fledglings from hatchings divided by number of hatchlings multiplied by 100. A similar measurement comes from the number of unhatched eggs per nest comes from the number of hatchlings subtracted from the number of total eggs in said nest. For females the adults had lower mean value of unhatched eggs (0.9) compared to the subadults (2.5; t = -1.946, df = 24, p = 0.063). For the males the trend was similar; there were more unhatched eggs (1.7) in the ASY males but still more in the SY males (2.4; t = -0.8547, df = 25, p = 0.401). It is interesting how the number of unhatched eggs between the adult females and males is so different. Overall, 31% of the eggs laid were unhatched, calculated by totaling unhatched per box divided by total number of eggs multiplied by 100.

**Discussion**

The goal of this study was to collect data which can inform us of the behaviour and trends of the purple martins in the BNA. When looking at all the data there are clear patterns in the distributions of martins over the houses available and in their behaviour in terms of eggs laid, when, and how those translate into fledgling numbers and overall success.

Generally, purple martin pairs, with both male and female parents as adults, have higher reproductive success, consequently having higher fledging success as compared to both being subadults or even mixed-age breeding pairs (Eads 2001). The clutch size for both adult male and female purple martins averaged higher than that of both parents being subadults, 5.1 compared to 4.6, respectively. Adult martins, being the more experienced breeders, also arrived at the houses earlier than any subadults, occupying the older houses (PA and PB) and the best nesting holes first. Then they laid eggs roughly 5 days before any subadult pairs did (166.1 in Julian or June 15$^{th}$ for ASY/ASY pairs vs 170.6 in Julian or June 20$^{th}$ for SY/SY pairs). By nesting earlier, the adult purple martins were on average 5 days ahead of the subadult pairs in terms of first egg laid date, the hatch date, and the fledge date. Purple martin landlords can expect to observe this trend in the adult martin's early schedule, reported by the Purple Martin Conservation Association (PMCA Home - Purple Martin Conservation Association 2024). Martins that arrive early select the best nest and begin defending that territory early. Having longer at the nest also means chicks have plenty of time to fledge without being rushed back for the southern migration. A potential drawback for early arrival is that unfavourable weather (like rain) tends to take place early in the summer. If martins have just laid eggs or have newly hatched chicks at this time it can be increasingly more strenuous on the parents to provide for the chicks and keep them protected from the conditions.

In past summers there had been many unhatched eggs (40%), which is an area to explore (Chalifoux 2025). The large number of unhatched eggs, making up 31% (68 of the 217 eggs total) of all the eggs, is a point of interest for this summer. A reason for this could include the tremendous amount of rainfall earlier this season, potentially limiting the food supply for the martins. This could have caused the adults to abandon the eggs. The unhatched eggs are typically completely removed from the nest by the purple martins, pushed to the edge of the house, or the nest was abandoned. If the eggs are not viable, but it is early in the breeding season, the martins may try again for a successful clutch (Brown et al. 2021). We saw that this summer with the group of martins who stayed into early September with a fledgling of what I expect was from a second brood or reattempt. This summer there was a substantial difference between unhatched eggs for adult females compared to adult males. This could suggest that the age of the male within a mated pair may best determine the success of the nest. This, however, would be better tested with a larger sample size.

The results from this summer provide a scope of how the overall success of the nest does depend on the age of the parents, an idea which is supported by other published work. This summer I observed that the ASY pairs had fewer unsuccessful nests than expected. Oppositely, the SY pairs had an increase in the number of unsuccessful nests when compared to the expected. It was also apparent that early laying adult purple martins had an more eggs laid, thus improving the chances of them having more successful fledglings. A study on purple martins in Tennessee shows that adults martins have larger clutch sizes with a higher productivity in incubation, leading to fewer unhatched or infertile eggs compared to subadult martins. This does depend on the environment conditions at the time (weather, food, and parasites to name a few, Eads 2019). It is assumed that older martins (adults) have more experience in breeding and caring for a clutch compared to subadults who are new to the process. That experience is reflected through the early arrival and nest preparation, followed by the egg laying and hatching that happens earlier on in the breeding season.

When comparing the averages from this summer to similar data collected on purple martins there are similarities. In Camrose, based on 150 occupied purple martin nests, the number of eggs in the box averaged 4.8 is like ours, the average number of hatchlings (4.5), and average number of fledglings (4.3) were significantly higher than our results (Wise and Hvenegaard, unpublished). This is most likely related to the small sample size at the BBO compared to Camrose, but other environmental conditions like moisture levels play a role in these results. In Camrose the fledge dates also averaged quite a bit earlier, evidence that they had a large proportion of adult purple martins occupying their nests.

Unique weather conditions played a role in the results for this summer. Not only did continuous rainfall and flooding at the BBO make observing purple martin activity around the nests near impossible but it also likely impacted the success of the nests. Rain is beneficial for thriving insect populations however, heavy rainfall, over 580 mm in June and July in parts of Alberta (Germano 2026 July 28), would severely limit the number of insects flying. Without flying insects the martin's food source dwindles, and they struggle to provide for themselves let alone young. This could be seen in our results with a high mortality rate (22%) and a high percentage of unhatched eggs (31%). The Purple Martin Conservation Association reports that continued rain for longer than 3 days results in starvation of nestlings due to the unavailability of food (PMCA Home - Purple Martin Conservation Association 2024). There is also the potential this is linked to the direction faced by the entrance holes of the nest. We saw an increased productivity in the north facing boxes and a decreased productivity in those facing south, potentially from rain and wind hitting the southwest side harder.

The inverse relationship between the date the first egg was laid and the number of eggs (as one increased the other decreased) could also be evidence in alignment of the effect of the weather on the purple martins. Adults returning earlier and laying eggs sooner, potentially avoiding the most adverse of the weather conditions this summer, had larger clutch sizes. Larger clutch sizes impact the potential for more hatchings to fledge from a greater number of eggs when compared to subadults, thus increasing the breeding potential and success of the adult purple martins.

*Limitations*

Due to most of the data being collected through visual observations there is room for error. Classification of the age and sex of the purple martins was done from a distance, and it is hard to ensure consistency between week to week with the observed pairs. This is also a relatively small sample size with only 44 nests of data collected. If the sample size was larger, we could better analyze consistencies and compare to other published work with a greater degree of accuracy.

*Future Research*

A large portion of the eggs this summer were left unhatched; the reason for this should be explored further, potentially a relationship involving the age of the purple martins. Continued monitoring to see how following summers weather impacts the purple martins would be beneficial. In the long term these studies could even be evidence for if purple martins begin to adapt to ongoing rainy conditions through migration arrival, preferences to housing direction, or even egg laying time. In future years as monitoring continues it would be interesting to see when the proportion of ASY/SY stabilizes in a house after a certain length of time since construction. Thus far the oldest house site (PA) still accommodates predominantly adult martins while the newest houses (PC and PD) have a greater ratio of subadults.

**Conclusion**

In conclusion, I hypothesized that older houses would have higher activity, occupation rates, and nest productivity. While this was true the oldest house did not have martins inhabiting every nest. The distribution of martins followed the expected results; adult martins arriving first to the older houses then subadults arriving weeks later and occupying primarily the newer homes. The breeding productivity (measure in number of eggs, hatchings, and fledglings) was greatest with adult martin pairs as adults due to their experience. Overall, each house saw success in terms of fledging, individuals which we hope will return during the next breeding season.

Having monitoring programs that are repeated yearly has been valuable in ensuring the continued prosperity of the purple martin population in the Beaverhill Natural Area. Monitoring also reveals any unexpected trends that could have many causational factors. This summer we collected data that contrasts literature of typical purple martin breeding season trends, which is likely due to the unseasonable weather patterns experienced during peak breading season.

*Recommendations for purple martin management*

If future summers include this type of abnormal weather patterns and heavy rain that eliminates food sources from the sky it could be beneficial to have food supplied by the BBO available nearby. Having a food source available to act as a backup could allow purple martin parents to continue to feed their vulnerable chicks while still meeting their own needs.

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