FINAL REPORT

DEVELOPING AN AGING CRITERIA FOR HATCH-YEAR WHITE-WINGED DOVES

submitted to
Texas Parks and Wildlife Department
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submitted by
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OVERVIEW

The white-winged dove (*Zenaida asiatica*) is expanding throughout much of the southern United States (Schwertner et al., 2002). Consequently, research is being directed toward understanding the ecology of this species, particularly in view of its status as a migratory game bird (George et al., 2000). To aid researchers and biologists in determining population characteristics, it is often necessary to assign individuals into age classes. Unfortunately, there is little information regarding how to accurately determine the specific age of hatch-year (HY) white-winged doves as they transition into adults. This study will characterize feather development, persistence of immature secondary coverts, and primary feather replacement in captive HY white-winged doves.

INTRODUCTION

The white-winged dove is a large, semitropical game bird that is native to southwestern United States, Mexico, Central America, and certain localities in South America and the Caribbean islands (George et al., 1994; Schwertner et al., 2002). Historically, the primary breeding area for the eastern population of white-winged doves was the Lower Rio Grande Valley of Texas (LRGVT) and adjoining Mexican state of Tamaulipas (Cottam and Trefethen, 1968; George et al., 1994). During the last 40 years, a significant northward range expansion has occurred into central, north, and east Texas (George et al., 1994). The extent of this range expansion became evident in 1990, when more white-winged doves were estimated to breed north of the LRGVT than in the LRGVT (West et al., 1993). Because of range expansion and increased breeding productivity, the white-winged dove has established itself as the second-most numerous migratory game bird species in North America (George et al., 1994).

Due to expanding populations of white-winged doves in Texas and other regions of North America and classification of the white-winged dove as a game bird, it is important for agencies charged with managing this species to be able to obtain accurate estimates of productivity and develop appropriate profiles of population structure. To obtain these kinds of data, classification of individuals into their respective age categories is necessary.

Although HY aging keys have been developed and presented for mourning doves (*Zenaida macroura*) from hatching up to adult (Swank, 1955; Larson and Taber, 1980; Mirarchi, 1993; Dimmick and Pelton, 1996), we know of only a few rudimentary aging keys for HY white-winged doves. One unpublished thesis documented daily development from 1–12 days (Alamia, 1970). In appendix 11 of Cottam and Trefethen (1968), data are presented from an unpublished administrative report by G. B. Saunders, in which HY white-winged doves were aged by weeks using the number of juvenile primaries present. This information is based on 10 captive juveniles and several banded (known age) wild juveniles shot by hunters. Because of this, Cottam and Trefethen (1968) suggested that additional studies are needed to improve the accuracy of the primary feather replacement technique. It is unclear if these aging keys accounted for hatching sequence and number of nest-mates, particularly since nestlings can grow at different rates based on hatch sequence and presence or absence of brood mates (Cottam and Trefethen, 1968). It is apparent that additional research is needed to advance our understanding of feathering chronology, persistence of immature secondary coverts, and replacement of primary feathers. This information can then be used to aid researchers and biologists charged with the task of elucidating white-winged dove ecology, which is needed for the development of more effective management strategies.

OBJECTIVES

1. Determine feather development, persistence of immature secondary coverts, and primary feather replacement of HY white-winged doves.
2. From the data obtained, we will develop a HY aging key for white-winged doves.

2007 ACTIVITIES

Undergraduate Students Hired

Two undergraduate technician positions were advertised for work related to trapping doves, modifying the Texas A&M University-Kingsville (TAMUK) aviary for white-winged dove nesting activities, and maintaining the captive doves at the aviary. The positions were filled by TAMUK undergraduate students Robert Carmichael and William Colson. Robert was employed from March to September. William began in May and is currently employed for this project.

Permit Revisions

In accordance with the appropriate state and federal regulations regarding migratory game birds, requests for permit amendments to the PI's existing permits began in early 2007. An amendment request was submitted to TPWD in January, and the amended permit arrived in mid-February. An amendment request was submitted to USFWS in February. Unfortunately, delays in the federal permit amendment process beyond our control resulted in the amended federal permit arriving on May 1st.

Aviary Modifications

The TAMUK aviary pens were modified to allow for white-winged dove nesting activities, which included adding perches, nesting boxes, and visual barriers between adjoining pens. Additionally, feeding and watering containers were added.

Trapping Activities

Once both the state and federal permits were authorized (May), trapping of white-winged doves commenced in the Kingsville area. On June 15, Dr. Kenneth Pruitt sexed the adult white-winged doves that were caught and housed at the TAMUK aviary by that time, which we then paired and placed in individual breeding pens.

Dove Breeding Activities

Because of the delays experienced in getting the amended federal permit, which delayed the actual start date for trapping and possessing migratory game birds, we missed the optimal breeding period for year 1 of the study. Consequently, none of the paired doves bred. Because of this, we plan to request a no cost extension to the TPWD contract extending it through the breeding season of 2008 followed by data analysis and report preparation completed by August 2009.

Information Transfer

A published abstract of the study was included in the Caesar Kleberg Wildlife Research Institute's (CKWRI) 2006–2007 Current Research report, which was distributed to stakeholders and individuals requesting copies. Additionally, Current Research reports are posted on the world-wide web as a downloadable pdf files on CKWRI's web site: http://www.ckwri.tamuk.edu/.

2008 ACTIVITIES

Project Extension and Support

Texas Parks and Wildlife Department granted an extension of the project with a new end date of August 31, 2009 and included an additional $3,500 for support. Additionally, we applied for a grant to the Harvey Weil Sportsman Conservationist Award Trust and were awarded $5,000 in support of the project.

Dove Breeding Activities

At the beginning of the 2008 breeding season, we had 23 paired white-winged doves in the aviary. As the breeding season progressed, we trapped 7 additional doves to achieve our goal of 30 pairs. Dr. Mike Small, Texas State University, verified sex on the pairs; re-pairing was made on several individuals, based on his observations.

The first egg was laid on March 29, 2008. Twelve pairs successfully constructed nests with 7 pairs having hatched and fledged offspring. These 7 pairs also renested 1–3 times, most of which produced fledged offspring.

Of the 46 eggs laid, 20 hatched. As of August 18, 2008, we monitored and photographed (see *Monitoring Feather Development* section below) 19 nestling to 14 days, of which 15 were older than 14 days; the oldest was 128 days old. As of August 18, 2008, all nestlings survived with the exception of one which died when 3 days old.

Monitoring Feather Development

Nestlings were photographed daily from 1–14 days old from 3 positions (left-side, right-side, top), which was necessary to develop a photographic record of feather development similar to that presented in Dimmick and Pelton (1996) for mourning doves. We recorded hatch date, hatch sequence, and brood size for each HY individual. To chronicle replacement of immature secondary coverts and primaries, HY individuals were photographed every 3 days from 17 days post hatch date up to 160 days, with additional pictures taken of the underside of the left wing showing primary replacement. This should encompass all HYs through replacement of the 9th primary (based on findings of mourning doves which averaged 117–123 days with maximum of 157 days: Swank, 1955; Larson and Taber, 1980; Mirarchi, 1993) and at least some early hatched (April–May) birds replacing the 10th primary (mourning doves averaged 142–158 days: Larson and Taber, 1980; Mirarchi, 1993). From the above information, we have a database documenting feather development, persistence of immature secondary coverts, and primary feather replacement.

Information Transfer

An abstract was submitted for publication in CKWRI's 2007–2008 Current Research report; the Current Research report was subsequently distributed to stakeholders and individuals requesting copies. The report was posted as a downloadable pdf file on CKWRI's web site: http://www.ckwri.tamuk.edu/.

2009 ACTIVITIES

Monitoring Feather Development

We elected to extend the feather monitoring end date of each bird from 160 days (as indicated in the proposal and 2008 progress report) to 170 days because some of the birds still had retained the 9th and 10th primary at 160 days. This extension resulted in photographing 5 fledged white-winged doves into January 2009 (classified as second year [SY]; by definition, a bird hatched in the proceeding calendar year, Larson and Taber, 1980). Of these 5 birds, 2 (#4102 and #5408) were killed by rats at 149 and 161 days old, respectively.

Data Collected from Photographs and Data Analysis

Review of the photographs and dataset development were initiated in 2009. It was evident that 2 distinct sets of data were obtainable: (1) characterization of nestling development based on eye opening and feather development and (2) characterization of fledged bird development based mainly on primary feather replacement.

Data were collected on the following variables to characterize nestling development, measured in days: eyes slightly open, eyes fully open, emergence of primary feathers, emergence of secondary feathers, emergence of tail feathers, start of primary feather unfurling, emergence of back feathers, beginning appearance of white on wing, full white on wing, and fully feathered. The following calculations were made for each of these categories: median, mean, 1 standard deviation, and range. T-tests compared the means of each of these variables between first-hatched and singleton nestlings to second-hatched nestlings to determine whether hatching sequence resulted in different rates of feather development.

Primary feather replacement data were collected on fledged birds (>14 days old) for each of the 10 primaries, which included the following criteria in days: primary missing, stub, primary < halfway developed, primary half way developed, primary > half way developed, and old primary fully replaced. For each of the primaries, median, mean, 1 standard deviation, and range were calculated for 3 variables: (1) day primary was missing and/or stub, (2) day primary was more than stub and ≤ halfway developed, and (3) day the old primary was fully replaced with the new primary. T-tests compared the means of each of these 3 variables between first-hatched and singleton nestlings to second-hatched nestlings to determine whether hatching sequence resulted in different rates of primary feather development.

Additionally, we focused our monitoring efforts on primary coverts instead of secondary coverts of fledged white-winged doves because presence or absence of juvenile primary coverts has been used to age mourning doves (Mirarchi, 1993) and white-winged doves (Cottam and Trefethen, 1968; page 324), but the methodology was not adequately described by Cottam and Trefethen (1968). Based on mourning doves, juveniles have light-colored (buffy) edging on the primary coverts that are replaced as the bird transitions into an adult (Mirarchi, 1993).

Although not part of the original proposal, photographs were examined to assess the development of eye ring color and the black neck bar of fledged white-winged doves to determine if these features could be used to determine juvenile status. Eye ring color was categorized as gray, dull gray-blue, gray-blue, off-blue, and bright blue. Neck bar development was categorized as broken (incomplete colored) black bar and solid (complete colored) black bar. Additionally, we monitored the change in leg color because it has been reported that white-winged doves can be separated into juveniles and adults by leg color (Cottam and Trefethen, 1968; page 324). Leg color was categorized as dull pink, pink, pink-red, and bright red. Data were collected on these 3 variables beginning on day 32 and approximately every 30 days thereafter up to day 170 because differentiation of slight color changes at 3-day sampling intervals in which the pictures were taken was not practical.

During the course of this study, we realized the arbitrariness of the assignments of HY, SY, and AHY (after hatching year) as per USDI Bird Banding Laboratory guidelines. For purposes of this report, we define juvenile white-winged doves as those individuals from hatching until all juvenile characteristics monitored were absent (i.e., absence of buffy-tipped primary coverts, presence of blue eye ring, complete black neck bar, and red legs); subadults are those individuals that have all adult features, but have not entered their first breeding season; and adults are those individuals that have entered at least their first breeding season.

Results and Discussion

T-tests were nonsignificant ($P > 0.05$) for each of the nestling variables between first-hatched and singleton nestlings (n = 11) and second-hatched nestlings (n = 8); therefore, the 2 nestling groups were pooled. It is likely that the small sample sizes resulted in low power and, therefore, it was not possible to differentiate small or moderate differences between the 2 groups. Representative photos of the side view of a nestling at day 1, 3, 6, 9, 12, and 14 are presented in Figure 1. Summary statistics of the nestling data are presented in Table 1 and serves as an aging key for nestlings. Graphical representation of the nestling data is found in Figure 2.

Photos of a fledged white-winged dove showing replacement sequence of primary feather number 4 are presented in Figure 3. Primary wing feather summary statistics are presented in

Table 2 and displayed graphically in Figure 4.

T-tests compared the means of 3 variables (day primary was missing or stub, day the replacement primary was more than stub and ≤ half, and day the old primary was fully replaced with new primary) between first-hatched and singleton individuals and second-hatched individuals. Statistical differences ($P \leq 0.05$) were found between the 2 groups for the following 2 categories: primary 7 fully replaced and primary 8 fully replaced, in which first hatched and singletons took longer to re-grow to completion each of these primaries than did second-hatched individuals (Table 3).

Overall, it is evident based on standard deviations of the measured variables that primary feather replacement is variable among individuals, particularly beyond 35 days old beginning with primary 3 (Table 2). A similar observation was found in juvenile mourning doves. When mourning doves began replacing primaries 5 through 10, standard deviations increased dramatically (Swank, 1955; Mirarchi, 1993) and in most instances standard deviations exceeded 10 days and reached 36.6 days for primary 10 (n = 6, mean 157.8, range 128–222 days; Mirarchi, 1993). Morrow et al. (1985, citing Morrow, 1983) indicated that the variability observed in mourning doves molting primaries 9 and 10 was so great that it negated the usefulness of using those 2 primaries to predict age.

Another important finding regarding primary replacement was that some white-winged dove juveniles dropped the 9th and 10th primaries before day 170, whereas others did not. Of those juveniles surviving to 170 days, 4 birds did not drop the 9th or 10th primary and another 8 birds did not drop the 10th primary. A study on mourning doves reported that the 9th primary dropped between 109–157 days and the 10th between 128–222 days (Mirarchi, 1993 citing Morrow, 1983). It appears that as juvenile white-winged doves get older, there is a substantial increase in variability in when primaries are shed and replaced. Based on the above information, the ability of researchers and biologists to accurately age a juvenile dove by primary feather replacement appears to be diminished as the bird progresses toward adulthood. We should also note that our captive white-winged doves had free access to food and water and they were not exposed to harsh and/or highly variable environmental conditions found in the wild. Consequently, it is likely that wild juvenile white-winged doves would demonstrate even greater variability in primary feather replacement.

Replacement of buffy-tipped primary coverts is shown in Figure 5. The first day the last primary covert was dropped averaged 129.8 days (SD = 18.4) and ranged from 104–161 days, however, 2 birds retained at least 1 juvenile primary covert to day 170, indicating high variability

(Figure 5). Based on these findings, a white-winged dove with buffy-tipped primary coverts is a juvenile, but a white-winged dove without buffy-tipped primary coverts may or may not be a juvenile.

The color of the eye ring developed as the birds aged, first appearing as gray and progressing to bright blue (Figure 6). Marked variability in color was observed at day 92, 122, and 152, in which birds could be placed into 1 of 3 eye ring color groups of the 5 color groups possible. Clearly, birds with gray and dull gray-blue eye rings can be classified as young juveniles, and eye ring colors less than bright blue could be used to determine older juveniles. However, white-winged doves with bright blue eye rings could be older-aged juveniles, thereby reducing its usefulness as an exclusive characteristic in separating birds into age categories.

Fledged white-winged doves developed the black neck bar as early as day 122 (Figure 7). Young juveniles had an incomplete (mixture of gray and black feathers) neck bar up to 92 days, which then progressed to an unbroken appearance (completely black feathers). However, several birds still retained the incomplete bar pattern at 170 days old, reducing its usefulness as an exclusive characteristic in grouping birds into age categories.

Leg color progressed from gray to bright red (Figure 8). By day 155, all birds had red-colored legs (Figure 8). It appears that juvenile status can be assigned using leg color provided that the leg color ranges from gray to pink. Cottam and Trefethen (1968) reported 700 birds were aged (juvenile or adult) using leg color with 97–100% accuracy by 3 observers examining hunter-shot white-winged doves. However, they did not specify the leg color criteria. Based on our findings, birds with red legs could still be older-aged juveniles or subadults. Consequently, misclassification could represent an underestimation of annual production surveys.

Eleven birds (65%; excludes 2 birds [#4102 and #5408] that died before the end of the study) developed all 4 adult features (absence of buffy-tipped primary coverts, blue eye ring color, complete black neck bar, and red leg color), indicating that these birds are subadults. Two (10%; n = 19) had these characteristics at day 122, 6 (32%; n = 19) more were added by 149–154 days, and 3 (18%; n = 17) more were added by day 170.

Based on our findings, young juveniles can be distinguished using primary coverts, eye ring color, neck bar development, and leg color. Fortunately, these features predominate in the juvenile white-winged dove population in September, when the special white-winged dove season occurs on Wildlife Management Areas (WMA) in the LRGVT. However, these variables cannot be individually relied upon and need to be considered together to minimize misclassification. An aging key based on the findings of this study is presented in Table 4.

Information Transfer

A presentation entitled "*Onset of Initial Eye Opening in Captive White-winged Doves*" was made at the Texas Chapter of the Wildlife Society in February 2009, in which the student William Colson was lead author. Additionally, 2 research abstracts of the study were submitted for publication in CKWRI's 2008–2009 Current Research report, which will be published in December 2009 and distributed to stakeholders and individuals requesting copies. Current Research reports are posted as downloadable pdf files on CKWRI's web site: http://www.ckwri.tamuk.edu/. Additionally, we anticipate a manuscript will be developed for the nestling aging criteria and the aging key for fledged white-winged doves. The manuscript focusing on nestling development characteristics may be combined with the results of the TPWD-funded study "Field Assessment of the White-winged Dove Aging Technique."

Additional Research Needs

Data presented in Table 1 serves as an aging key for nestlings, which needs to be fully tested on wild nestlings. Through a TPWD-funded study, this aging key will be field-tested during 2010 to determine if it can successfully age wild white-winged dove nestlings. Graduate student William Colson conducted nestling monitoring during summer 2009 to provide preliminary data for the full-scale project beginning in spring 2010. Photographic and video monitoring is being used to verify the accuracy of the captive aging key. If necessary, the aging key will be adjusted to increase accuracy or an entirely new key will be developed using wild white-winged dove nestlings. The verified or adjusted aging key will allow those conducting nesting and productivity studies to assign age estimates to wild white-winged dove nestlings.

Based on our findings, it appears that young juvenile white-winged doves can be easily determined based on primary coverts, eye ring color, neck bar pattern, and leg color. However, older juveniles take on one or more features of adults, thereby diminishing and/or precluding the usefulness of these features. For example, at day 152 all the fledged white-winged doves had red legs typical of adults, however, eye ring color and neck bar varied among individuals at day 152. Additionally, 65% of the birds hatched in 2008 had all 4 of the external adult characteristics by 170 days post-hatching. Thus, future studies should explore ways to determine differences between subadults (HY and SY) and adults. Examination for a bursa would be useful to differentiate between juveniles and adults, but this method is thought to be too time-consuming for aging mourning doves in the field (Mirarchi, 1993).

Lastly, field-testing the primary feather aging key is needed to determine if it can be used by field biologists. As a first test, William Colson used the key to age 56 juvenile white-winged doves shot by hunters at the Las Palomas WMA, Anacua Unit during September 12–13, 2009. However, more rigorous testing is required using field biologists to determine its effectiveness. Additionally, variability among observers should be tested, including comparisons between observers with different levels of experience in aging birds. These tests will help determine where improvements to the key are needed. However, it should be noted that based on our findings of variability in primary feather replacement for white-winged doves and those found for mourning doves (Swank, 1955; Morrow et al., 1985), this method of aging older juveniles has limitations that may not be resolved with additional primary feather molting studies.

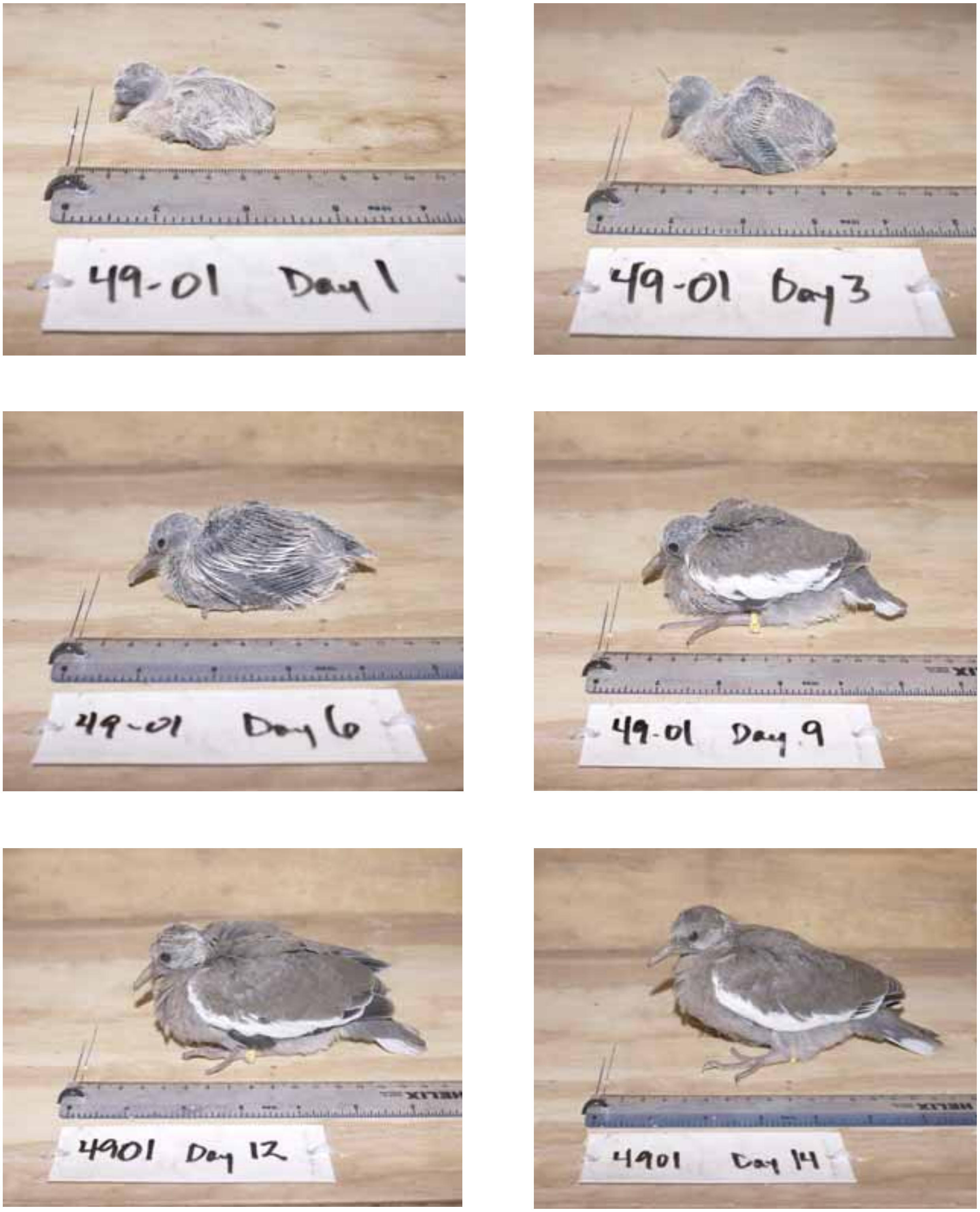


Figure 1. Left side view of white-winged dove nestling number 4901 at 1, 3, 6, 9, 12, and 14 days old, which shows progression of feather development from hatching to fledging.

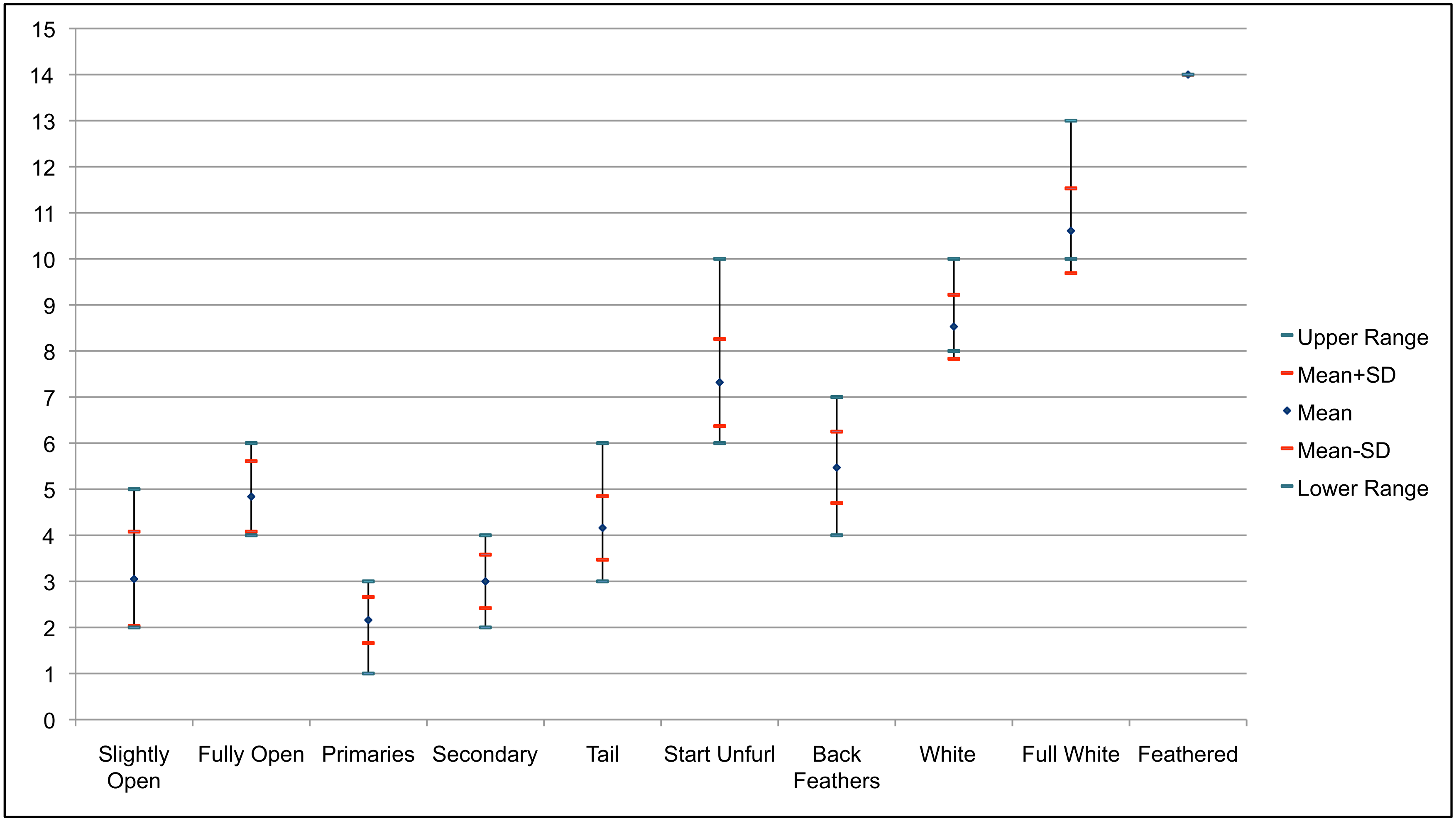


Figure 2. Graphical representation of the data collected from 19 captive-raised nestling white-winged doves from day 1–14 for the variables eyes slightly open, eyes fully open, emergence of primary feathers, emergence of secondary feathers, emergence of tail feathers, start of primary feather unfurling, emergence of back feathers, appearance of white on wing, full white on wing, and fully feathered.

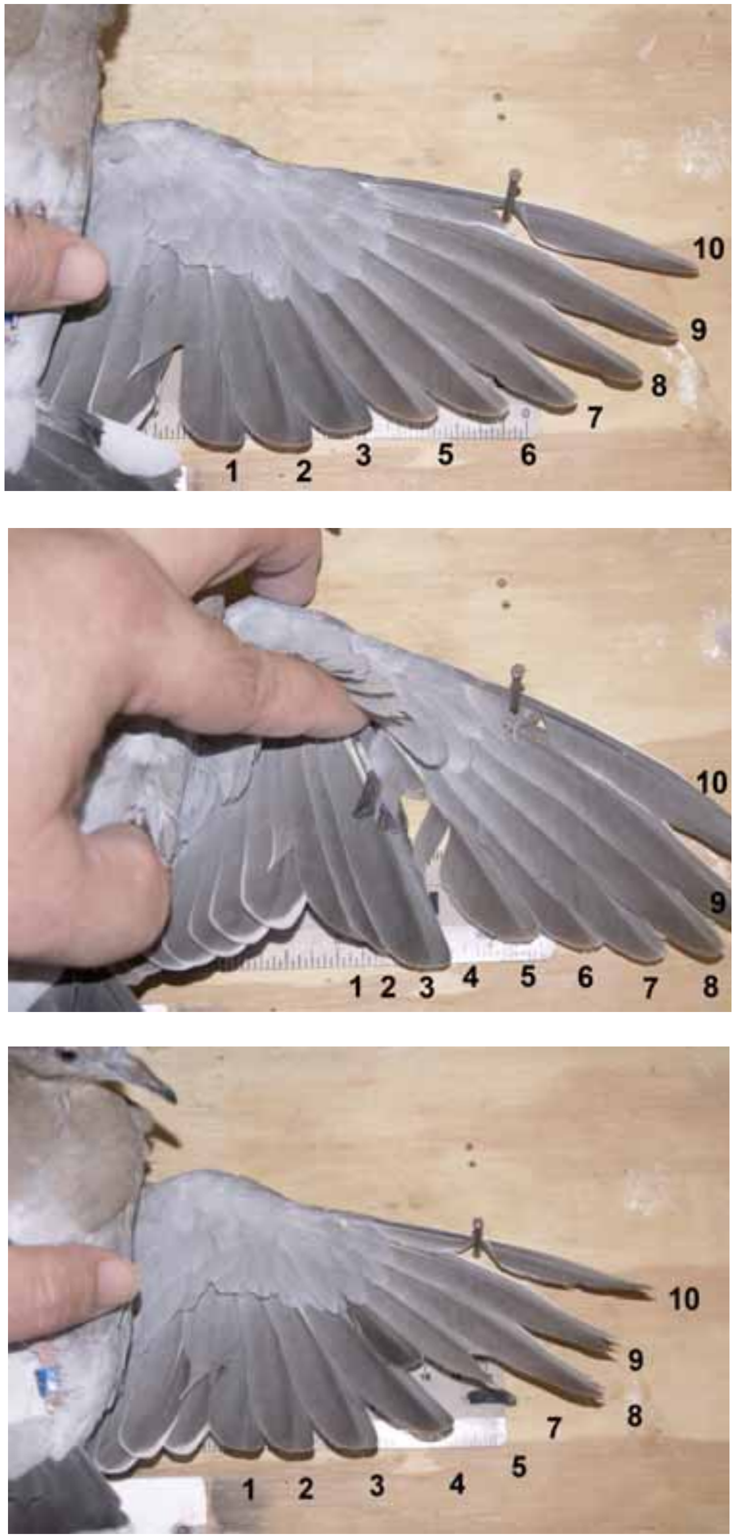


Figure 3. Photos showing the developmental sequence of primary 4: feather drop (top photo), new primary feather half way developed (middle photo), and old primary feather fully replaced with the new primary feather (bottom photo); note primary 5 half way developed with primary 6 missing in bottom photo.

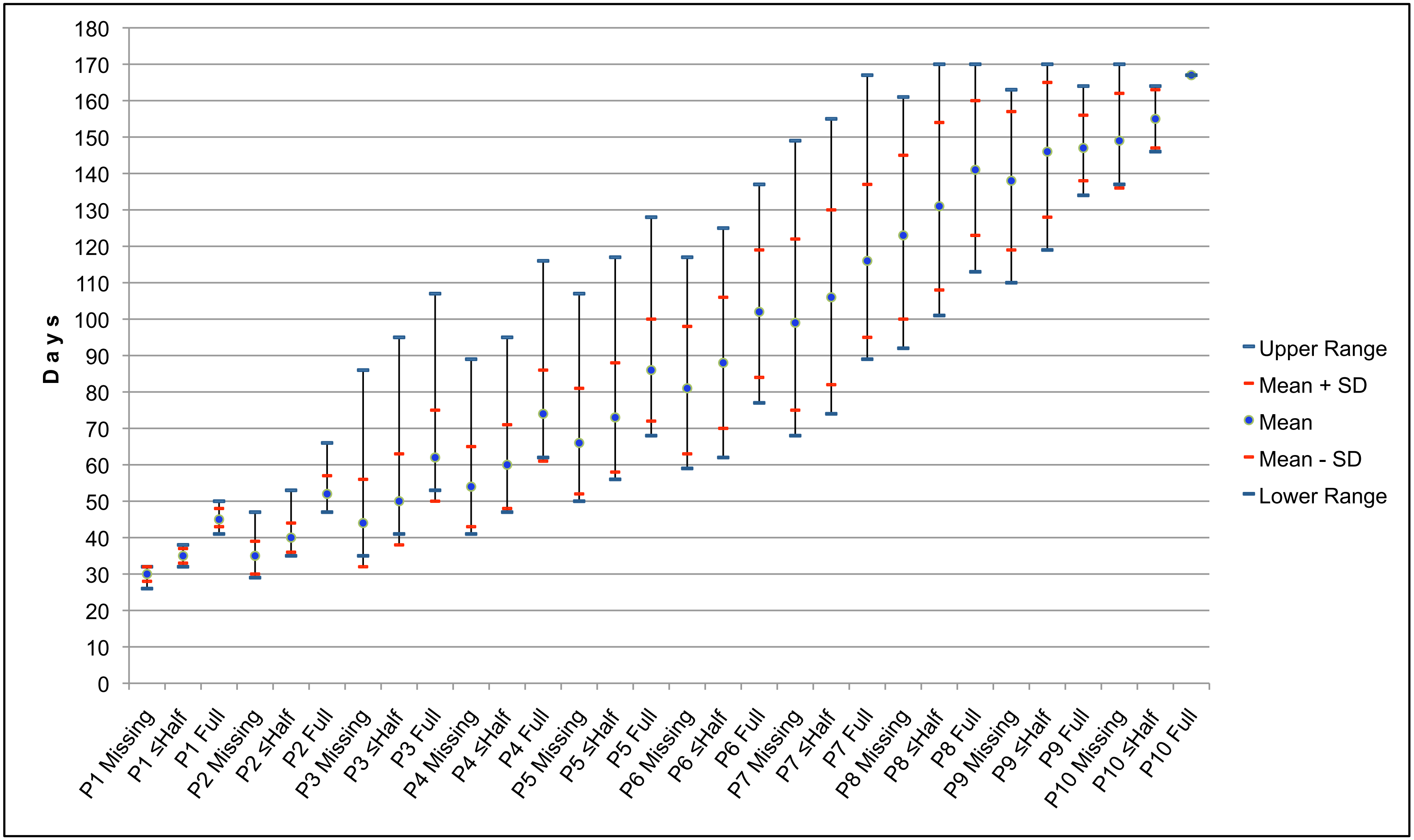
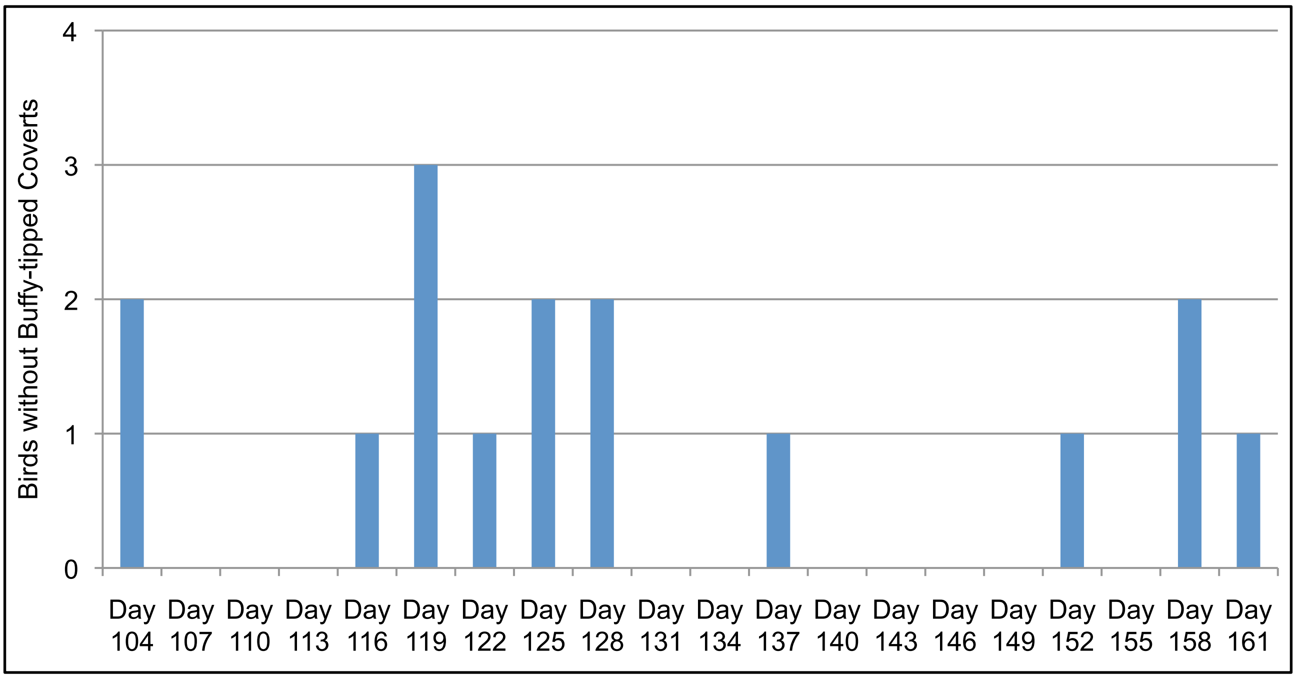


Figure 4. Graphical representation of primary wing feather (P1–P10) descriptive statistics of fledged captive-raised white-winged doves.



Note: Figure does not include 1 bird that died at day 149 and 2 birds that had buffy-tipped primary coverts at the end of 170 days. For convenience in graphical presentation, day 125 includes 1 bird recorded on day 126; day 128 includes 1 dove recorded on day 129.

Figure 5. First day in which buffy-tipped primary coverts were absent for fledged captive-raised white-winged doves.

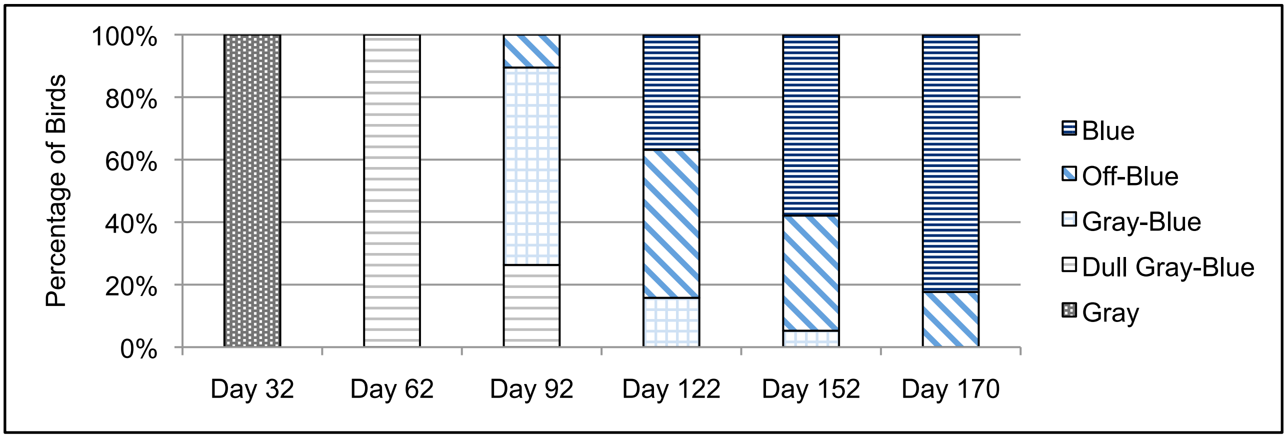


Figure 6. Percentage of fledged captive-raised white-winged doves by eye ring color.

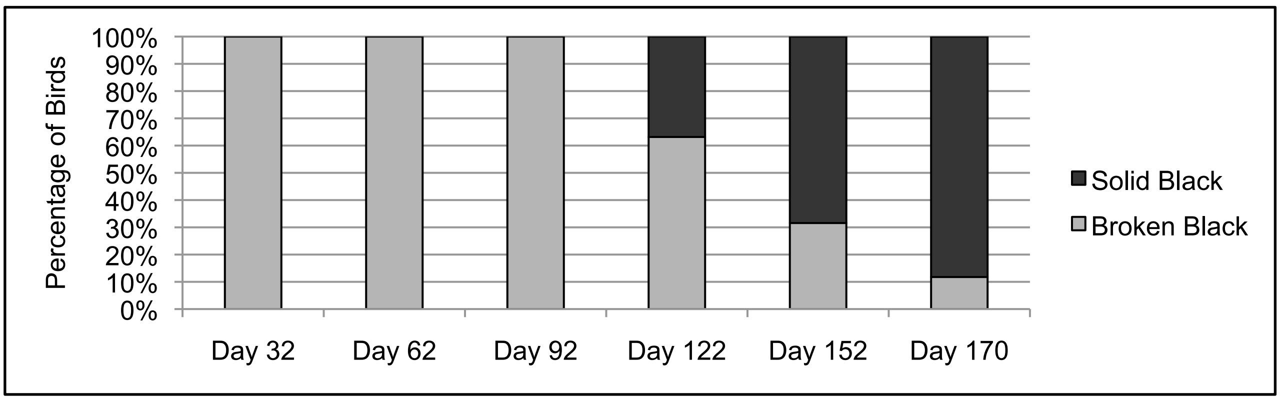


Figure 7. Percentage of fledged captive-raised white-winged doves by neck bar color.

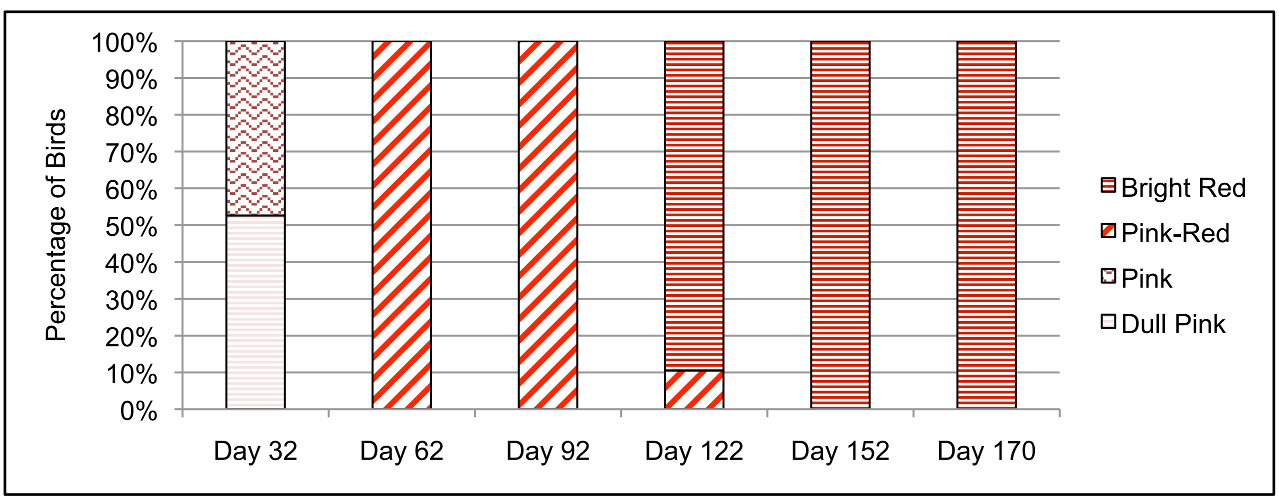


Figure 8. Percentage of fledged captive-raised white-winged doves by leg color.

Note: All days have a sample size of 19 white-winged doves except day 170, which has 17 white-winged doves (excludes the 2 birds that died before the end of the study; last observation day 149 and 158, respectively). Day 152 contains data from 16 birds plus an additional 3 recorded on days 149, 153 and 154.

Table 1. Descriptive statistics measured in days for developmental characteristics of 19 white-winged dove nestlings: eyes slightly open, eyes fully open, emergence of primary feathers, emergence of secondary feathers, emergence of tail feathers, start of primary feather unfurling, emergence of back feathers, beginning appearance of white on wing, full white on wing, and fully feathered.

Statistic	Eyes Slightly Open	Eyes Fully Open	Primary Feather Emergence	Secondary Feather Emergence	Tail Feather Emergence	Primaries Start to Unfurl	Back Feather Emergence	White on Wing	Full White on Wing*	Fully Feathered
Range	2–5	4–6	1–3	2–4	3-6	6–10	4–7	8–10	10–13	14
Median	3	5	2	3	4	7	6	8	10	14
Mean	3.0	4.8	2.2	3.0	4.2	7.3	5.5	8.5	10.6	14.0
SD	1.0	0.8	0.5	0.6	0.7	0.9	0.8	0.7	0.9	0.0

* Sample size is 18 for this variable; data for this variable for bird #5404 could not be retrieved.

Table 2. Primary wing feather (P1–P10) descriptive statistics measured in days for fledged captive-raised white-winged doves.

Statistic	P1 Missing	P1 ≤ Half	P1 Replaced	P2 Missing	P2 ≤ Half	P2 Replaced	P3 Missing	P3 ≤ Half	P3 Replaced
Range	26–32	32–38	41–50	29–47	35–53	47–66	35–86	41–95	53–107
Median	29	35	47	35	38	50	41	47	59
Mean	29.8	35.3	45.3	34.7	40.2	52.1	44.2	50.3	62.5
SD	2.0	2.0	2.4	4.5	4.2	5.2	11.9	12.3	12.6
Sample	n=19	n=19	n=19	n=19	n=19	n=19	n=19	n=19	n=19

Statistic	P4 Missing	P4 ≤ Half	P4 Replaced	P5 Missing	P5 ≤ Half	P5 Replaced	P6 Missing	P6 ≤ Half	P6 Replaced
Range	41–89	47–95	62–116	50–107	56–117	68–128	59–117	62–125	77–137
Median	53	59	68	65	71	83	80	86	98
Mean	53.6	59.6	73.5	66.1	72.9	85.8	80.7	87.7	101.6
SD	11.0	11.4	12.7	14.5	14.9	13.9	17.3	17.9	17.8
Sample	n=19	n=19	n=19	n=19	n=19	n=19	n=19	n=19	n=19

Statistic	P7 Missing	P7 ≤ Half	P7 Replaced	P8 Missing	P8 ≤ Half	P8 Replaced	P9 Missing	P9 ≤ Half	P9 Replaced
Range	68–149	74–155	89–167	92–161	101–170	113–170	110–163	119–170	134–164
Median	92	101	116	111.5	119	137	137	146	146
Mean	98.5	106.1	116.4	122.5	131.0	141.1	137.8	146.2	147.3
SD	23.7	23.8	21.0	23.0	23.5	18.5	19.0	18.3	9.0
Sample	n=19	n=19	n=16	n=18	n=18	n=15	n=14	n=13	n=7

Statistic	P10 Missing	P10 ≤ Half	P10 Replaced
Range	137–170	146–164	167
Median	146	155	167
Mean	149.2	155.0	167.0
SD	13.1	7.7	0.0
Sample	n=5	n=4	n=2

Note: sample sizes vary because some individuals did not drop the 9th or 10th primary, replacement was not complete by day 170, 10th primary broke before being completely replaced, and 2 individuals died before the end of the study.

Table 3. Descriptive statistics of fully replaced primary 7 and 8 in days and separated by first hatched and singletons and second hatched fledged captive-raised white-winged doves.

	Primary 7 Replaced		Primary 8 Replaced	
Statistic	First Hatched & Singletons	Second Hatched	First Hatched & Singletons	Second Hatched
Range	101–167	89–116	122–170	113–150
Median	117.5	96.5	143	128
Mean	125.6	101.0*	148.7	129.7**
SD	20.4	10.9	18.3	12.9
Sample	10	6	6	6

* T-test of primary 7 means between First Hatched & Singletons and Second Hatched were significant at $P = 0.02$.

** T-test of primary 8 means between First Hatched & Singletons and Second Hatched were significant at $P = 0.05$.

Note: only birds that had primary 7 and/or primary 8 completely replaced were analyzed. First hatched and singleton sample sizes varied because in one bird, primary 7 and primary 8 were not replaced by day 170, and in one bird, primary 8 was not completely replaced by day 170. Second hatched sample sizes varied because one bird died before primary 7 was completely replaced and before primary 8 dropped, the primary 7 feather broke in one bird during the process of replacement preventing determination when it would be fully replaced, and one bird did not completely replace primary 8 by day 170.

Table 4. Aging key based on captive-raised juvenile white-winged doves.

1a.	Primary coverts with buffy-tipped edging	3
1b.	Primary coverts without buffy-tipped edging	2
2a.	Any of the following: eye ring gray to gray-blue, black neck bar incomplete, leg color gray to pink-red	3
2b.	All of the following: eye ring bright blue, black neck bar complete, leg color bright red	subadult or adult*
3.	juvenile; determine age by examination of primary missing, $\leq$ half, or fully replaced.	

Primary 1	**Missing**	**$\leq$ Half**	**Replaced**
Age in Days	29	35	47
Primary 2	**Missing**	**$\leq$ Half**	**Replaced**
Age in Days	35	38	50
Primary 3	**Missing**	**$\leq$ Half**	**Replaced**
Age in Days	41	47	59
Primary 4	**Missing**	**$\leq$ Half**	**Replaced**
Age in Days	53	59	68
Primary 5	**Missing**	**$<$ Half**	**Replaced**
Age in Days	65	71	83
Primary 6	**Missing**	**$\leq$ Half**	**Replaced**
Age in Days	80	86	98
Primary 7	**Missing**	**$\leq$ Half**	**Replaced**
Age in Days	92	101	116
Primary 8	**Missing**	**$\leq$ Half**	**Replaced**
Age in Days	111	119	137
Primary 9	**Missing**	**$\leq$ Half**	**Replaced****
Age in Days	137	146	146
Primary 10	**Missing****	**$\leq$ Half****	**Replaced****
Age in Days	146	155	167

Note: primary feather values for missing, $\leq$ half, and replaced are median values from Table 2.
* Adult white-winged doves were not examined in this study; characteristics are presumed to be representative of adults
**Based on a white-winged dove sample of $\leq$ 7.

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