

# AGE AND GENDER CLASSIFICATION OF MERRIAM'S TURKEYS FROM FOOT MEASUREMENTS

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*Abstract:* Wild turkey sex and age information is needed to define population structure but is difficult to obtain. We classified age and gender of Merriam's turkeys (*Meleagris gallopavo merriami*) accurately based on measurements of two foot characteristics. Gender of birds was correctly classified 93% of the time from measurements of middle toe pads; correct classification of age and gender combined decreased to 78%. Measurements from the middle toenail to heel pad correctly classified gender 98% of the time; correct classification of age and gender of birds was 94%. An independent test of this technique on Merriam's turkeys from Colorado using measurements of the middle toe pads correctly classified the gender of Merriam's 99% of the time; gender and age combined were correctly classified only 50% of the time.

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*Key words:* age, foot morphology, gender, Merriam's turkeys, sex.



Wild turkey sex and age data are needed to define population structure but are difficult to obtain from wild birds. (R. Hoffman)

With increasing demands on natural resources, wildlife managers need better methods to estimate population parameters and monitor populations. Since reproductive performance of subadult hens varies among populations of Merriam's turkeys (Hengel 1990; Wakeling 1991; Rumble and Hodorff 1993; Thompson 1993), it would be useful for managers to know the proportion of subadult to adult hens in the population. Presently, there is no reliable method of classifying the gender and age of wild turkeys in the field without capturing the birds.

Gender and age of turkeys can be ascertained from feather characteristics (Petrides 1942; Keiser and Kozicky 1943; Leopold 1943; Knoder 1959; Larson and Taber 1980). Primary feathers X and IX on subadults are pointed, have smooth edges, and lack barring toward the feather tips. In comparison, primaries X and IX on adults are rounded and frayed, with the white bars extending to the feather tips. Males have black-tipped breast feathers, in contrast to the buffy-tipped breast feathers of females (Keiser and Kozicky 1943). Breast feather characteristics are usually visible after 16 weeks of age

(Larson and Taber 1980), but assigning gender to juvenile turkeys based on breast feather characteristics is difficult for birds <8 months of age (M. A. Rumble and B. F. Wakeling, pers. observ.). Other morphological features that have been used to ascertain the age and gender of free-ranging turkeys include overall size, thickness of the tarsus, shape of secondary wing coverts, spur length, beard length, and size and shape of fecal droppings (Keiser and Kozicky 1943; Mosby and Handley 1943; Bailey 1956; Williams 1961; Mosby 1967; Pelham and Dickson 1992).

The techniques discussed above require birds in the hand or have other limitations. Trapping is expensive and labor-intensive, and the resulting information may be biased because sampling is not random. Some methods require extensive training and experience or observation of turkeys in the field at close distances, which is difficult. Tracks, however, provide evidence of occurrence and can be used to index wildlife populations (Davis and Winstead 1980). Measurements from tracks were useful to estimate the gender and age of eastern turkeys (*M. g. silvestris*) during late winter to early spring (Keiser and Kozicky 1943) or to differentiate the gender of adult eastern turkeys in late summer to early fall (Williams 1959). The accuracy of determining the age and gender of turkeys from tracks is unknown. The objective of our study was to assess the utility of foot measurements for classifying the age and gender of Merriam's turkeys.

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## METHODS

We trapped and measured foot characteristics on 202 Merriam's turkeys in Arizona ( $n = 112$ ) and South Dakota



Foot characteristics have been used to distinguish eastern wild turkey gobblers from hens. (A. Cornell)

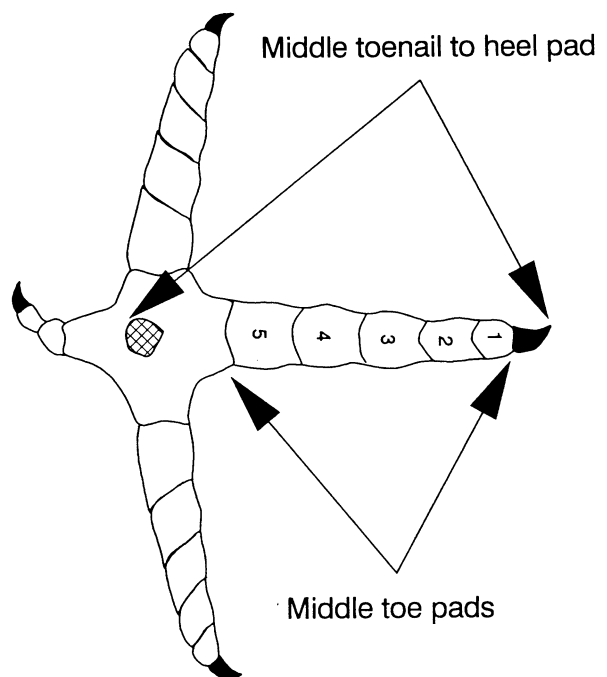


Figure 1. Measurements of middle toe pads, and middle toenail to heel pad of Merriam's turkey feet.

( $n = 90$ ). The populations sampled represent extremes in adult and yearling nesting rates (Rumble and Hodorff 1993) and in latitude of Merriam's turkey range. We recorded the length of the middle toe pads (Fig. 1), length from the middle toenail to heel pad, age (subadult or adult), and gender of each turkey. *T*-tests were used to evaluate hypotheses that these measurements did not differ between birds from South Dakota and those from Arizona. We used box-and-whisker plots to display the median and interquartile ranges of the measurements collected for gender and age categories. Discriminant function analysis was used to estimate classification coefficients based on middle toe pads and toenail-to-heel-pad measurements. We used the jackknife method (Lachenbruch and Mickey 1968) to develop an independent estimate of the accuracy of gender and age classification from these variables. We then applied the classification to measurements taken from 82 Merriam's turkeys trapped near Grand Junction, Colorado.

## RESULTS

Merriam's turkeys from Arizona and South Dakota had similar middle toe pad measurements ( $P > 0.27$ ). Measurements from the toenail to heel pad also were similar between Arizona and South Dakota females ( $P = 0.19$ ), but males from Arizona had longer ( $P = 0.04$ ) toenail-to-heel-pad measurements than males from South Dakota. Separate classifications for birds in each state were not consistently improved over the results presented below.

## Classification of Gender

The quartile including the smallest toe pad and toenail-to-heel-pad measurements of males was not distinct from the quartile including the largest measurements from males (Fig. 2). Despite this overlap, both measurements accurately predicted gender. Classification of gender using the length of toe pads was 92% accurate; classification of gender using the toenail-to-heel-pad measurement was 98% accurate (Table 1). Birds with toe pads >5.8 cm (Table 2) and toenail-to-heel-pad measurements >10.4 cm (Table 3) were probably males. Probabilities for classifying gender are displayed for 0.1-cm increments of each measurement in the tables.

Table 1. Unstandardized discriminant coefficients for length of middle toe pads and middle toenail to heel pad, and reclassification rates for predicting gender and age of Merriam's turkeys.

Foot measurement	Gender	Gender-age
Middle toe pad	3.68	4.78
Constant	-20.22	-26.20
Reclassified, %	92.8	77.8
Middle toenail to heel pad	2.22	3.17
Constant	-21.92	-31.31
Reclassified, %	98.3	93.5

Table 2. Incremental lengths of middle toe pads and probabilities<sup>a</sup> for classifying gender and gender-age categories using this measurement for Merriam's turkeys.

Toe pad length (cm)	Probability		Predicted gender	Probability				Predicted gender-age
				Subadult		Adult		
	Female	Male		Female	Male	Female	Male	
4.30	1.00	0.00	Female	1.00	0.00	0.00	0.00	Subadult female
4.40	1.00	0.00	Female	0.99	0.00	0.01	0.00	Subadult female
4.50	1.00	0.00	Female	0.99	0.00	0.01	0.00	Subadult female
4.60	1.00	0.00	Female	0.98	0.00	0.02	0.00	Subadult female
4.70	1.00	0.00	Female	0.96	0.00	0.04	0.00	Subadult female
4.80	1.00	0.00	Female	0.92	0.00	0.08	0.00	Subadult female
4.90	1.00	0.00	Female	0.86	0.00	0.14	0.00	Subadult female
5.00	1.00	0.00	Female	0.76	0.00	0.24	0.00	Subadult female
5.10	1.00	0.00	Female	0.62	0.00	0.38	0.00	Subadult female
5.20	1.00	0.00	Female	0.46	0.00	0.54	0.00	Adult female
5.30	1.00	0.00	Female	0.31	0.00	0.69	0.00	Adult female
5.40	1.00	0.00	Female	0.19	0.00	0.81	0.00	Adult female
5.50	0.99	0.01	Female	0.11	0.02	0.87	0.00	Adult female
5.60	0.95	0.05	Female	0.05	0.13	0.82	0.00	Adult female
5.70	0.81	0.19	Female	0.02	0.47	0.51	0.00	Adult female
5.80	0.49	0.51	Male	0.00	0.84	0.16	0.00	Subadult male
5.90	0.18	0.82	Male	0.00	0.97	0.03	0.00	Subadult male
6.00	0.05	0.95	Male	0.00	0.99	0.01	0.00	Subadult male
6.10	0.01	0.99	Male	0.00	0.97	0.00	0.03	Subadult male
6.20	0.00	1.00	Male	0.00	0.90	0.00	0.10	Subadult male
6.30	0.00	1.00	Male	0.00	0.72	0.00	0.28	Subadult male
6.40	0.00	1.00	Male	0.00	0.41	0.00	0.59	Adult male
6.50	0.00	1.00	Male	0.00	0.16	0.00	0.84	Adult male
6.60	0.00	1.00	Male	0.00	0.05	0.00	0.95	Adult male
6.70	0.00	1.00	Male	0.00	0.02	0.00	0.99	Adult male
6.80	0.00	1.00	Male	0.00	0.00	0.00	1.00	Adult male
6.90	0.00	1.00	Male	0.00	0.00	0.00	1.00	Adult male
7.00	0.00	1.00	Male	0.00	0.00	0.00	1.00	Adult male
7.10	0.00	1.00	Male	0.00	0.00	0.00	1.00	Adult male
7.20	0.00	1.00	Male	0.00	0.00	0.00	1.00	Adult male

<sup>a</sup>Probabilities that do not sum to 1.00 result from rounding.

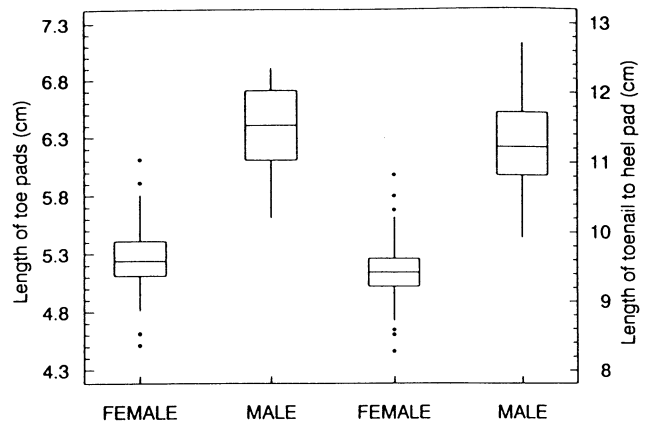


Figure 2. Box-and-whisker plots showing median and interquartile ranges for length of middle toe pads and middle toenail to heel pad by gender of Merriam's turkeys. The box contains 50% of observations ( $\pm 25\%$  above and below the median) and each whisker contains 25% of observations. Observations >1.5 times the interquartile range are displayed by solid circles.

## Classification of Gender and Age

Distinct separation of subadult and adult females using measurements of the middle toe pads was difficult (Fig. 3). Twenty-four percent of large subadult females were classi-

Table 3. Incremental lengths of middle toenail to heel pad and probabilities<sup>a</sup> for classifying gender and gender-age categories using this measurement for Merriam's turkeys.

Toenail to heel pad <sup>b</sup> (cm)	Probability		Predicted gender	Probability				Predicted gender-age
	Probability			Subadult		Adult		
	Female	Male		Female	Male	Female	Male	
8.3	1.00	0.00	Female	1.00	0.00	0.00	0.00	Subadult female
8.4	1.00	0.00	Female	0.99	0.00	0.01	0.00	Subadult female
8.5	1.00	0.00	Female	0.99	0.00	0.01	0.00	Subadult female
8.6	1.00	0.00	Female	0.98	0.00	0.02	0.00	Subadult female
8.7	1.00	0.00	Female	0.97	0.00	0.03	0.00	Subadult female
8.8	1.00	0.00	Female	0.95	0.00	0.06	0.00	Subadult female
8.9	1.00	0.00	Female	0.91	0.00	0.09	0.00	Subadult female
9.0	1.00	0.00	Female	0.84	0.00	0.16	0.00	subadult female
9.1	1.00	0.00	Female	0.75	0.00	0.25	0.00	Subadult female
9.2	1.00	0.00	Female	0.63	0.00	0.37	0.00	Subadult female
9.3	1.00	0.00	Female	0.49	0.00	0.51	0.00	Adult female
9.4	1.00	0.00	Female	0.35	0.00	0.65	0.00	Adult female
9.5	1.00	0.00	Female	0.24	0.00	0.76	0.00	Adult female
9.6	1.00	0.00	Female	0.15	0.00	0.85	0.00	Adult female
9.7	1.00	0.00	Female	0.09	0.00	0.91	0.00	Adult female
9.8	1.00	0.00	Female	0.05	0.00	0.94	0.00	Adult female
9.9	0.99	0.01	Female	0.03	0.01	0.96	0.00	Adult female
10.0	0.97	0.03	Female	0.02	0.05	0.94	0.00	Adult female
10.1	0.94	0.07	Female	0.01	0.15	0.84	0.00	Adult female
10.2	0.85	0.15	Female	0.00	0.40	0.60	0.00	Adult female
10.3	0.69	0.31	Female	0.00	0.71	0.29	0.00	Subadult male
10.4	0.46	0.54	Male	0.00	0.90	0.10	0.00	Subadult male
10.5	0.25	0.75	Male	0.00	0.97	0.03	0.00	Subadult male
10.6	0.12	0.89	Male	0.00	0.99	0.01	0.00	Subadult male
10.7	0.05	0.95	Male	0.00	1.00	0.00	0.00	Subadult male
10.8	0.02	0.98	Male	0.00	1.00	0.00	0.00	Subadult male
10.9	0.01	0.99	Male	0.00	0.99	0.00	0.01	Subadult male
11.0	0.00	1.00	Male	0.00	0.97	0.00	0.03	Subadult male
11.1	0.00	1.00	Male	0.00	0.93	0.00	0.07	Subadult male
11.2	0.00	1.00	Male	0.00	0.84	0.00	0.16	Subadult male
11.3	0.00	1.00	Male	0.00	0.66	0.00	0.34	subadult male
11.4	0.00	1.00	Male	0.00	0.43	0.00	0.58	Adult male
11.5	0.00	1.00	Male	0.00	0.22	0.00	0.78	Adult male
11.6	0.00	1.00	Male	0.00	0.09	0.00	0.91	Adult male
11.7	0.00	1.00	Male	0.00	0.04	0.00	0.96	Adult male
11.8	0.00	1.00	Male	0.00	0.01	0.00	0.99	Adult male
11.9	0.00	1.00	Male	0.00	0.01	0.00	1.00	Adult male
12.0	0.00	1.00	Male	0.00	0.00	0.00	1.00	Adult male
12.1	0.00	1.00	Male	0.00	0.00	0.00	1.00	Adult male
12.2	0.00	1.00	Male	0.00	0.00	0.00	1.00	Adult male
12.3	0.00	1.00	Male	0.00	0.00	0.00	1.00	Adult male

<sup>a</sup>Probabilities that do not sum to 1.00 result from rounding.  
<sup>b</sup>Tracks 43.3 cm are subadult females; tracks > 12.3 cm are adult males.

fied as adults. Conversely, 18% of small adult females were classified as subadults. Five percent of large adult females were classified as subadult males. Conversely, 20% of small subadult males were classified as adult females. No females were classified as adult males. Sixteen percent of subadult males were classified as adult males, but only 5% of adult males were classified as subadults. Across gender and age categories, the average classification error rate using the length of middle toe pads was 22%.

The toenail-to-heel-pad length more accurately classified gender and age of Merriam's turkeys (Fig. 4). Seven percent of the larger subadult females were misclassified as adult females, whereas 8% of the smaller adult females were misclassified as subadults using the toenail-to-heel-pad



Both age and gender of Merriam's turkeys were classified 95% correctly from measurement of the middle toenail to heel pad distance, and 78% correctly from measurement of the middle toe pads. (C. Braun)

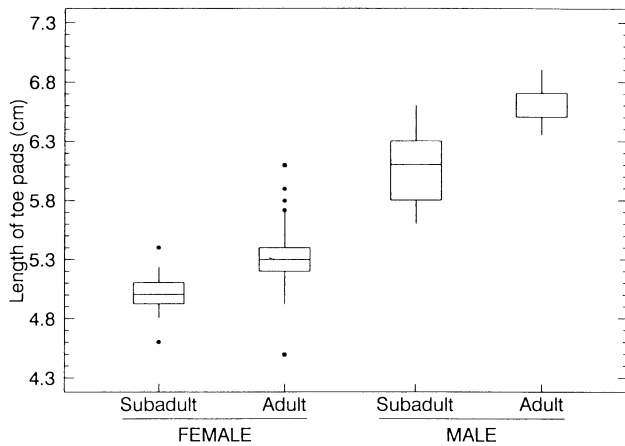


Figure 3. Box-and-whisker plots showing median and interquartile ranges for length of middle toe pads by gender and age of Merriam's turkeys. The box contains 50% of observations ( $\pm 25\%$  above and below the median) and each whisker contains 25% of observations. Observations  $>1.5$  times the interquartile range are displayed by solid circles; observations  $>3$  times the interquartile range are displayed as solid squares.

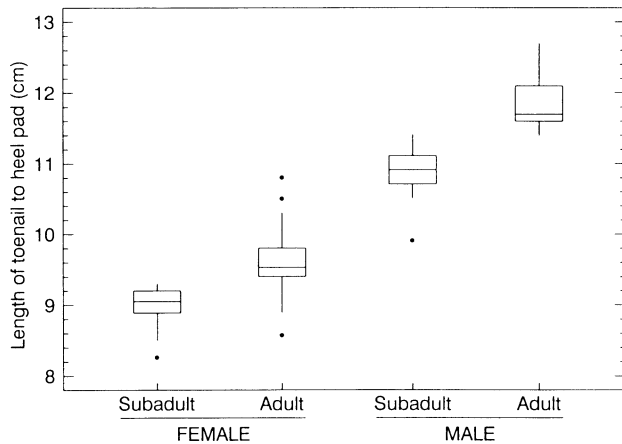


Figure 4. Box-and-whisker plots showing the median and interquartile ranges for length of middle toenail to heel pad by gender and age of Merriam's turkeys. The box contains 50% of observations ( $\pm 25\%$  above and below the median) and each whisker contains 25% of observations. Observations  $>1.5$  times the interquartile range are displayed by solid circles.

ment. Three percent of the larger adult females were classified as subadult males, and 4% of small subadult males were misclassified as adult females. All adult males were correctly classified. Across all gender and age categories, 94% of birds were correctly classified using the measurement from the toenail to heel pad.

We applied the classification to data obtained from 82 Merriam's turkeys from Colorado. Using the middle toe pad length, 99% of these birds were correctly classified as to gender. Estimates of gender and age were less precise. Fifty-six percent of subadult females were classified as adult females, and 55% of adult females were classified as subadult females. Com-

parable classification errors for males were 27 and 33%. We could not evaluate the utility of the toenail-to-heel-pad length on these birds because these measurements were not consistent with those used to develop the classification.

## DISCUSSION

Foot measurements of turkeys from Colorado were longer and more variable than from Arizona or South Dakota. Merriam's turkeys from Arizona and South Dakota were from mostly natural habitats and had more similar foot measurements. Some Colorado birds fed on waste grain in barnyards year-round, which may have enhanced their growth and development, including foot size.

Measurements from the web between toes to the middle toe pads from 108 (58 subadult females, 20 adult females, and 30 subadult males) game-farm eastern turkeys (Keiser and Kozicky 1943) showed similar variability but less overlap than ours. It is difficult to identify web-to-middle-toe-pad markings of turkey tracks without snow (Williams 1959). Length of middle toe pads accurately characterized gender of adult eastern turkeys during late summer or early fall; measurements  $<5.5$  cm were adult hens (Williams 1959). The largest adult females in our study had middle toe pads  $<6.1$  cm; the smallest adult male had middle toe pads  $>6.3$  cm. Length from the middle toenail to heel pad on adult hens was  $<10.8$  cm for both eastern and Merriam's turkeys (Williams 1959, this study). No classification errors occurred in determining the gender of adult birds in our study using either measurement.

There was a high degree of accuracy for gender classification of Merriam's turkeys from measurements of the middle toe pad or middle toenail to heel pad during late winter or early spring; classification of gender for adult birds would be nearly 100%. We anticipate that measurements from turkey tracks can be used to predict both gender and age of Merriam's turkeys. Preliminary comparisons of track measurements from eastern turkeys suggest that the age and gender of other subspecies could be classified using measurements from tracks. Measurements from the toenail to heel pad increased the accuracy of classifying population structure. Field application of the toenail-to-heel-pad measurement may be difficult, because marks from toenails are not always visible in tracks of turkeys. Including an adjustment from the toe pad to toenail would be difficult, because toenails vary in length and shape and are molted annually (Welty 1962:29). A better measure may be from the middle toe pads to heel pad. Additional research is needed to validate the technique on tracks from marked wild birds of known age and gender. Field measurements to classify gender and age of turkey populations should be conducted between winter and early spring, when growth by turkeys is negligible (Bailey and Rinell 1967).

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