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DISCRIMINATING THE SEX OF LAUGHING GULLS BY LINEAR MEASUREMENTS

DANIEL R. EVANS, EDWIN M. HOOPES, AND CURTICE R. GRIFFIN
Department of Forestry and Wildlife Management
324 Holdsworth Hall
University of Massachusetts
Amherst, Massachusetts 01003-0130 USA

Abstract.—Discriminant function analysis (DFA) has been used to sex many gull species. DFA has been used to determine the sex of Laughing Gulls (*Larus atricilla*) from Florida using three measurements. The function derived from the Florida population misidentified 40% of Laughing Gulls from a New York population. Laughing Gulls from New York were significantly smaller than those from Florida ($P \leq 0.004$). A new discriminant function, based on bill, total body and wing lengths, that correctly classified the sex of 92% of gulls collected in New York was derived. These findings support past studies that suggest a discriminant function derived for one population cannot be applied with confidence to a different population of the same species.

IDENTIFICACIÓN DEL SEXO EN INDIVIDUOS DE *LARUS ATRICILLA* UTILIZANDO MEDIDAS LINEARES

Sinopsis.—Los análisis de función discriminativa (AFD) han sido utilizados para determinar el sexo de muchas especies de gaviotas. Con estos análisis se ha podido determinar el sexo de individuos de *Larus atricilla* en la Florida utilizando tres parámetros morfometricos. No obstante, el AFD utilizado para la población de Florida falló en identificar el sexo del 40% de las gaviotas de una población de New York. Las gaviotas de New York resultaron ser significativamente de menor tamaño que las de Florida ($P \leq 0.004$). Se derivó un nuevo AFD utilizando el tamaño del pico, largo total del ala y del cuerpo, para clasificar correctamente el sexo del 92% de la población de New York. Este estudio demuestra que el AFD derivado de una población no necesariamente puede ser aplicado para evaluar a otras.

Discriminant function analysis (DFA) has been used to sex a variety of gull species, including Herring (*Larus argentatus*; Fox et al. 1981, Threlfall and Jewer 1978), Laughing (*L. atricilla*; Hanners and Patton 1985), Ring-billed (*L. delawarensis*; Ryder 1978), Lesser Black-backed (*L. fuscus*; Harris and Jones 1969), and Great Black-backed (*L. marinus*; Harris 1964) Gulls. It may be inappropriate, however, to apply a discriminant analysis function for one population to populations of the same species in different geographic locations (e.g., Coulson et al. 1981, Threlfall and Jewer 1978).

We applied the discriminant function developed by Hanners and Patton (1985) for Laughing Gulls in Florida to Laughing Gulls from New York. Their function misidentified 40% of the New York males as females. Thus, the purposes of our study were to (1) determine if there were morphological differences between Laughing Gulls in New York and Florida and (2) derive a discriminant analysis formula that can more accurately classify the sex of Laughing Gulls in New York than that developed by Hanners and Patton (1985).

METHODS

We measured adult Laughing Gulls collected on John F. Kennedy International Airport (JFKIA), Queens County, New York, between May and August 1990 and 1991. Most birds ($n = 65$) were shot as part of a U.S. Department of Agriculture Animal Damage Control gull control project at JFKIA. The remainder ($n = 38$) were found dead along runways of JFKIA. We assume that gulls collected were associated with the large gull colony immediately adjacent to JFKIA in Jamaica Bay.

Linear measurements were taken on all birds, including flattened wing length (wing length), total body length (total length), mandible length (bill length), tarsometatarsus length (tarsus length) and middle toe length for all birds. Additionally, total head length (head length) and gonys depth measurements were taken for 76 of the birds. Total length and wing length were measured with a ruler to the nearest 1 mm; measurements of bill, tarsus, middle toe and head lengths, and gonys depths were measured with calipers to the nearest 0.5 mm. Due to the poor condition of most birds when collected (e.g., missing appendages), mass was not taken. All Laughing Gulls were dissected to determine sex of the bird. To examine whether there were significant differences ($P < 0.05$) in size between Florida and New York Laughing Gulls, we performed a two sample t-test using SYSTAT (Wilkinson 1991).

Following the guidelines of Frank et al. (1965) as described by Fox et al. (1981) for the V1 validation method, the measured birds were divided into two samples, analysis and validation samples. A base discriminant function was derived from all measurements ($n = 7$) using the MGLH program in SYSTAT (Wilkinson 1991). The combination of measurements that best discriminated between the sexes was selected from the base function. Our first discriminant function was derived using the analysis sample ($n = 76$, 74%), and was tested for its accuracy with the validation sample ($n = 27$, 26%). Once minimal bias in our sample was established, a second, more accurate function was then derived by combining both sample groups ($n = 103$).

RESULTS

Males were significantly larger than female gulls for all measurements ($P \leq 0.004$) (Table 1). Head, wing and total lengths were generally the least variable measurements within sexes (CV = 2.5–4.1%), whereas gonys depth, bill, tarsus and middle toe lengths were slightly more variable within sexes (CV = 4.1–7.8%). When compared to mean measurements of Laughing Gulls from Florida (Hanners and Patton 1985), measurements for both sexes of New York gulls were smaller than those from Florida for gonys depth, head length and tarsus length ($P \leq 0.03$) (Table 2). Wing length, however, was not significantly different between the two areas for either sex.

From our base function, the combined measurements of bill (BL), total (TL) and wing lengths (WL) were the most discriminating factors in

TABLE 1. Measurements (mm) of male and female Laughing Gulls from New York.

	Males			Females			
	n	Mean ± SD (range)	CV	*n*	Mean ± SD (range)	CV	*P*
Bill length	65	57.6 ± 5.2 (51–80)	5.2	38	53.7 ± 3.1 (46–58)	4.1	0.001
Gonys depth	47	11.2 ± 0.9 (8–12.5)	7.8	29	10.1 ± 0.7 (9–11.5)	7.0	0.001
Head length	47	88.9 ± 3.4 (79–96)	3.8	29	84.4 ± 2.7 (80–90)	3.2	0.001
Tarsus length	65	50.5 ± 3.0 (41–59.5)	6.0	38	47.3 ± 2.3 (42.5–53)	4.8	0.001
Mid toe length	65	43.2 ± 2.9 (35.3–49)	6.8	38	41.6 ± 2.0 (36–47)	4.8	0.004
Total length	65	410 ± 13.7 (386–440)	3.3	38	387 ± 15.8 (348–430)	4.1	0.001
Wing length	65	332 ± 11.2 (315–391)	3.4	38	318 ± 7.9 (300–338)	2.5	0.001

classifying the sex of Laughing Gulls from New York (Wilks' lambda = 0.453, $\chi^2 = 57.352$, df = 3, $P < 0.001$). The classification function:

$$(BL \times 0.649) + (TL \times 0.579) + (WL \times 0.762) = 507.392$$

correctly classified 89% of the Laughing Gulls from the analysis sample. If the function value was greater than 507.392, the gull was classified as a male; gulls with smaller function values were classified as females. This function correctly classified 25 of 27 females (93%) and 43 of 49 males (88%). Using the validation sample, the formula correctly classified eight of eight females (100%), and 17 of 19 males (89%), providing an overall accuracy of 93%.

The classification accuracies of our analysis sample ($n = 76$, 89%) were only slightly lower than the test sample ($n = 27$, 93%), suggesting minimal sampling bias. Combining all gulls from the analysis and validation samples, the second classification function classified 92% correctly:

$$(BL \times 0.704) + (TL \times 0.617) + (WL \times 0.813) = 545.562$$

(Wilks' lambda = 0.447, $\chi^2 = 59.611$, df = 3, $P < 0.001$). This combined classification function should be used when sexing Laughing Gulls from New York because of better accuracy from a larger sample size and minimal bias of the discriminant function.

DISCUSSION

Our study indicates that there are significant regional differences in size of adults between Florida and New York populations of Laughing Gulls during the breeding season. Thus, in applying discriminant functions to sex live Laughing Gulls, only those functions derived from adult

TABLE 2. Comparison of measurements (mm) of Laughing Gulls from New York and Florida.[1]

	New York mean ± SD	Florida mean ± SD	*t*-value	*P*
Gonys depth				
Male	11.2 ± 0.9	11.6 ± 0.5	1.93	0.03
Female	10.1 ± 0.7	10.8 ± 0.5	4.96	0.001
Head length				
Male	88.9 ± 3.4	92.5 ± 2.1	6.61	0.001
Female	84.4 ± 2.7	86.4 ± 2.0	3.64	0.001
Tarsus length				
Male	50.5 ± 3.0	52.8 ± 2.0	5.36	0.001
Female	47.3 ± 2.3	48.9 ± 1.6	3.86	0.001
Wing length				
Male	331.9 ± 11.2	328 ± 17.0	−1.64	0.1
Female	317.6 ± 7.9	317 ± 12.0	−0.309	0.1

[1] Measurements of Florida birds from Hanners and Patton (1985).

birds from the same population should be used. Further, whenever possible, sexing accuracy should be checked through field observations of classified individuals. Birds that fall in the middle range, close to the discriminant value, should be questioned and not necessarily used depending on the focus of the study.

Hanners and Patton (1985) identified gonys depth and head length as factors that would best discriminate between the sexes of Laughing Gulls from Florida. In contrast, we found bill, total body and wing lengths were the measurements that best discriminated between sexes of Laughing Gulls from New York. We did not use gonys depth in deriving our function because of the high variance within the sample, although several studies (Fox et al. 1981, Harris and Jones 1969, Ryder 1978) have suggested gonys depth to be useful for discriminating the sex of gulls. Coulson et al. (1981), however, reported that gonys depth of Herring Gulls continues to increase with age after sexual maturity and believed gonys depth could be a source of error in discriminant analysis. Further, they concluded that correction for age does not improve the discriminant function for Herring Gulls. It is unknown if gonys depth changes with age for other gull species; thus the error associated with its use in discriminant functions is unknown for Laughing Gulls as well as other gull species.

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