SEX DETERMINATION OF GREAT BLACK-BACKED GULLS USING MORPHOMETRIC CHARACTERS

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Abstract.—We evaluated sexual size dimorphism of Great Black-backed Gulls (Larus marinus) from a breeding colony in the Bay of Fundy and provide a reliable method for predicting the sex of measured individuals. Males were significantly larger than females in all body measurements. A predictive function using only three linear measurements (head length, bill depth and wing length) was more accurate than any single linear measure and correctly sexed 99–100% of the individuals.

In ecological and behavioral studies, it is often important to know the sex of individuals. In sexually monomorphic species such as Larids, researchers have developed predictive models based on the relationship between body size and sex for samples of known individuals (Fox et al. 1981, Hanners and Patton 1985, Bosch 1996). Discriminant functions derived from morphometric data are commonly used. However, these functions can be applied only to the populations from which they were derived because geographic variation within a species (Threlfall and Jewer 1978, Coulson et al. 1983, Evans et al. 1993) may limit a function’s generality.

Great Black-backed Gulls (Larus marinus) have expanded their range and numbers along the eastern coast of North America since the early 1920s (Drury 1973, 1974) and have become quite common. However, little is known about their ecology in this region, and no studies have investigated sexual size dimorphism and geographic variation. Gull control programs on a breeding colony in the Bay of Fundy provided a large sample of Great Black-backed Gulls (Mawhinney and Diamond, unpubl. data) and we used the opportunity to gather morphological data on the specimens. The objectives of this paper were to (1) quantify sexual size dimorphism in Great Black-backed Gulls and (2) offer a reliable method for determining the sex of Great Black-backed Gulls.
STUDY AREA

Spruce and Flatpot Island are two islands within the Wolves Archipelago (44°56'N, 66°44'W), 12 km offshore from Beaver Harbour, New Brunswick, Canada. The dominant vegetation on the islands is balsam fir (Abies balsamea) and spruce (Picea spp.). Breeding seabirds on the two islands include Great Black-backed Gulls, Herring Gulls (Larus argentatus), Common Eiders (Somateria mollissima) and Black Guillemots (Cepphus grylle).

METHODS

In mid-April to early May Great Black-backed Gulls were removed from Spruce and Flatpot Island in New Brunswick in 1996 (Canadian Wildlife Service Scientific Kill Permit No. SK196) through a combination of shooting and nest trapping. Gulls captured on the nest (sea bird traps, Mills and Ryder 1979) were killed by cervical dislocation. Each bird was weighed to the nearest 25 g with a spring balance and six measures of structural size were recorded: (1) head and bill (HL), the maximum distance from the bill tip to the posterior extremity of the occipital process; (2) bill length (BL), from the bill tip to the posterior extremity of the lateral side of the bill; (3) culmen (C), from the bill tip to the posterior extremity of the culmen; (4) bill depth (BD), vertical height of the bill with the mandibles closed, from the gonys; (5) wing length (WL), distance from the wrist to the tip of the wing with the wing flattened and flexed at the wrist; (6) tarsus length (TL), from the pit at the posterior junction of the tibiotarsus and the tarsometatarsus to the anterior distal end of the tibiotarsus. All measurements were taken to the nearest 1 mm with callipers except wing length, which was measured to the nearest mm with a flat ruler. All birds were sexed by dissection.

Morphometric analyses were performed using log_{10} transformed data. Multivariate analyses of variance (MANOVA) were used to determine whether overall external morphology varied with sex (SAS Institute 1990) and discriminant function analyses (DFA) were used to explore the nature of this variation. Gulls were analysed with a stepwise DFA of transformed morphometric measurements, entering at each step the measurement that added the most separation between the two sexes (Bosch 1996). Results were considered to be significant at \( \alpha = 0.05 \). The data of the discriminant functions were validated using a jackknife statistical procedure (also called Leave-one-out; Lachenbruch and Mickey 1968) in which each individual was classified using a function derived from the total sample less the individual being classified (e.g., Chardine and Morris 1989, Amat et al. 1993). This method produces an unbiased estimate of the success rate of the discriminant functions (Seber 1984).

RESULTS

Male gulls were larger than females in all body measurements in both breeding populations (\( P_s < 0.001 \), Table 1). Head length was the most useful single measurement in discriminating between sexes, correctly
identifying 97% of females and 99% of males (Table 2). Stepwise DFA found that the combined function using head length, bill depth and wing length correctly identified the sex of 99% of all females and 100% of all males. The resulting function was:

$$D_1 = 73.46 \log_{10} HL + 18.64 \log_{10} BD + 32.97 \log_{10} WL - 3.31 \log_{10} BL - 233.51$$

$$P = 0.001, R^2 = 0.907;$$ (1)

where values of $D_1 < 0$ identified females and values of $D_1 > 0$ identified males. Because head length and bill depth are common measurements recorded for gulls we derived a function based on these measurements. The resulting function was:

$$D_2 = 82.69 \log_{10} HL + 18.03 \log_{10} BD - 203.06$$

$$P = 0.001, R^2 = 0.879.$$ (2)

This function had slightly less discriminatory power but was able to correctly classify 97% of the jackknifed classifications.

### Table 2. Accuracy of sexing Great Black-backed Gulls in New Brunswick by discriminant analysis using single measurements or combined functions.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Jackknifed classifications ($n = 186$)</th>
<th>$R^2$</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head length (HL)</td>
<td></td>
<td>0.877</td>
<td>97% (105/108)</td>
<td>99% (77/78)</td>
</tr>
<tr>
<td>Bill length (BL)</td>
<td></td>
<td>0.631</td>
<td>87% (94/108)</td>
<td>86% (67/78)</td>
</tr>
<tr>
<td>Culmen (C)</td>
<td></td>
<td>0.663</td>
<td>87% (94/108)</td>
<td>83% (65/78)</td>
</tr>
<tr>
<td>Bill depth (BD)</td>
<td></td>
<td>0.690</td>
<td>94% (101/108)</td>
<td>85% (66/78)</td>
</tr>
<tr>
<td>Wing length (WL)</td>
<td></td>
<td>0.711</td>
<td>82% (89/108)</td>
<td>90% (70/78)</td>
</tr>
<tr>
<td>Tarsus length (TL)</td>
<td></td>
<td>0.586</td>
<td>85% (90/108)</td>
<td>88% (68/78)</td>
</tr>
<tr>
<td>$D_1 = 70.26 \log_{10} HL + 18.53 \log_{10} BD + 31.91 \log_{10} WL - 230.66$</td>
<td></td>
<td>0.906</td>
<td>99% (107/108)</td>
<td>100% (78/78)</td>
</tr>
<tr>
<td>$D_2 = 82.69 \log_{10} HL + 18.03 \log_{10} BD - 203.06$</td>
<td></td>
<td>0.893</td>
<td>97% (105/108)</td>
<td>97% (76/78)</td>
</tr>
</tbody>
</table>
DISCUSSION

As in other gull species (Monaghan et al. 1983, Evans et al. 1993, Bosch 1996) male Great Black-backed Gulls were larger than females. The predictive function, using three linear measurements relatively easy to record in the field, was more accurate than any single linear measure. Despite the relative ability of some linear measurements (bill lengths and tarsus) to predict sex accurately, some were not selected in the stepwise DFA because their inclusion in the function did not improve its accuracy. The absence of some of the more accurate measurements (e.g., bill lengths) may be explained by the presence in the function of another measurement which was both more accurate and closely correlated with bill lengths (i.e., head length).

Wing length is the most difficult of the three measurements to take on adult Great Black-backed Gulls in the field. Therefore a function requiring only the two important head measurements was determined (Table 2). While this function had slightly less discriminatory power it was able to classify correctly 100% of the jackknifed classifications. The power of head length and bill depth to discriminate sex agrees with studies of other gull species (Fox et al. 1981, Hanners and Patton 1985, Bosch 1996). However, it should be used with caution as bill depth can vary with age (Coulson et al. 1981). To improve the degree of accuracy, the combined function using three measurements should be used.

ACKNOWLEDGMENTS

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LITERATURE CITED


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