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AGE CLASSIFICATION OF LAUGHING GULLS BASED ON SUMMER PLUMAGE

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Abstract.—We described quantitatively 19 summer plumage characteristics and bill and foot pigmentation of 247 known-age Laughing Gulls (*Larus atricilla*) collected in New York during 1992–1994. There were no differences in characteristics measured for male and female Laughing Gulls. Ninety percent of 2-yr-old Laughing Gulls and 96% of ≥3-yr-old birds had full hoods. Fifty-seven percent of 2-yr-old Laughing Gulls possessed at least partial tail bands in contrast to 4% of 3-yr-old and 0% of ≥4-yr-old gulls. Thus 2- and ≥3-yr-old Laughing Gulls cannot be separated reliably by the presence or absence of a tail band. Pink pigmentation on the breast or abdomen occurred in 12% of individuals and was unrelated to age. Using the presence or absence of a distinct black-and-gray interface on the distal portion of the fifth primary, we correctly classified 96% of 245 2- and ≥3-yr-old Laughing Gulls. Using this characteristic in combination with the length of distinct black pigmentation present on the proximal vane of the sixth primary, we correctly aged 98% of 244 gulls. This technique and previously published plumage characteristics provide rapid and accurate classification of Laughing Gulls in summer plumage as <1, 1, 2, or ≥3 yr of age.

CLASIFICACIÓN POR EDAD DE *LARUS ATRICILLA* BASADA EN EL PLUMAJE VERANIEGO

Sinopsis.—Describimos cuantitativamente 19 características del plumaje de verano y de la pigmentación del pico y de las patas de 247 *Larus atricilla* de edad conocida obtenidas en New York entre 1992 y 1994. No hubo diferencias entre machos y hembras en las características medidas. Noventa porciento de aves de dos años y 96% de aves de ≥3 años tenían capuchas completas. Cincuenta y siete porciento de las aves de dos años poseian bandas de cola al menos parciales en contraste con 4% en aves de 3 años y 0% en aves mayores de ≥4 años. Por lo tanto, no se puede discriminar confiablemente entre aves de 2 y ≥3 años por la presencia o falta de una banda de cola. Pigmentación rosada en el pecho o el abdomen ocurrió en 12% de los individuos y no se relacionó con la edad. Pudimos clasificar correctamente el 96% de 245 aves de dos y ≥3 años utilizando la presencia o ausencia de una entrecara nergra y gris distintiva en la porción distal de la quinta primaria. Utilizando esta característica en combinación con el largo de la pigmentación negra distintiva presente en la barba de la sexta primaria pudimos determinar la edad correcta de 98% de 244 aves. Esta técnica y otras caracteristicas del plumaje previamente publicadas proveen una clasificación rápida y certera de *Larus atricilla* en plumaje veraniego como de <1, 1, 2, o ≥3 años de edad.

Several studies of plumage and other external characteristics have been conducted to differentiate age classes of gulls (*Larus* spp.) (Allaine and Lebreton 1990, Harris 1962, Monoghan and Duncan 1979, Smith et al. 1992). With few exceptions (e.g., Blokpoel et al. 1985), these studies have been qualitative, based on small samples, and have not used known-aged birds.

Although 1-yr-old gulls can generally be discerned from adult conspecifics using subjective plumage characteristics (see Grant 1982), few quantitative techniques are available for differentiating age classes of gulls

≥2-yr old. Blokpoel et al. (1985) developed a technique to distinguish between 2- and 3-yr-old Ring-billed Gulls (*L. delawarensis*). Although Grant (1982) qualitatively described plumage variation between 2- and 3-yr-old Laughing Gulls (*L. atricilla*), no quantitative technique exists currently to differentiate these age classes. Our objectives were to: (1) quantitatively describe summer plumage characteristics and bill and foot pigmentation of known-age Laughing Gulls and (2) develop a field technique to differentiate objectively 2-yr-old from ≥3-yr-old gulls.

METHODS

Laughing Gulls flying over John F. Kennedy International Airport, New York (40°38′N, 73°47′W), were shot from 15 May–5 Aug. 1992–1994 as part of a management program related to air traffic safety (Dolbeer et al. 1993, Dolbeer and Bucknall 1994). All Laughing Gulls with U.S. Fish and Wildlife Service bands were collected for plumage evaluation as were random, almost daily samples of 10–40 unbanded Laughing Gulls. Seventy-six percent of banded Laughing Gulls were collected during May and June.

The sex of each bird was determined by necropsy. The age of each banded bird was provided by the U.S. Fish and Wildlife Service, Office of Migratory Bird Management (OMBM), Patuxent, Maryland.

For each Laughing Gull, we measured 19 plumage characteristics and recorded foot and bill pigmentation. The hood was classified as full (black plumage with no more that 1–2 white feathers), partial (>50% black plumage but not full), or absent (<50% black plumage). The subterminal black tail band was categorized as: (1) complete; black tail band present on ≥66% of rectrices, (2) prominent; black tail band present on ≥33% but <66% of rectrices, (3) partial; black tail band present on >0% but <33% of rectrices, or (4) absent. We recorded the presence of gray pigmentation on the tail as well as subtle but apparent pink pigmentation (Grant 1982:20) on the breast and abdomen. Bill and foot (left foot was used unless damaged) pigmentation each were described as red (≥66% of area red), black (≥66% of area black), or intermediate (<66% of area black or red).

We recorded five characteristics each for the fourth, fifth, and sixth primaries (outermost primary = 1; see Grant 1982) (Fig. 1). Unless damaged, we used the left wing for all measurements. The dorsal surfaces of feathers were used for all measurements. We first determined the presence of black pigmentation on the distal portion of each primary. If present, we noted whether the black pigmentation was continuous (complete) across the vanes or incomplete (e.g., a spot). We also noted if the black-and-gray pigmented interface was distinct or indistinct. If this interface was indistinct for either vane, the primary was classified as indistinct. For each primary vane with a distinct interface, we measured the length (mm) of black pigmentation from the minimum point at the proximal end to the maximum point at the distal end. These measurements were made parallel to the rachis using the point of measure at the proximal end.

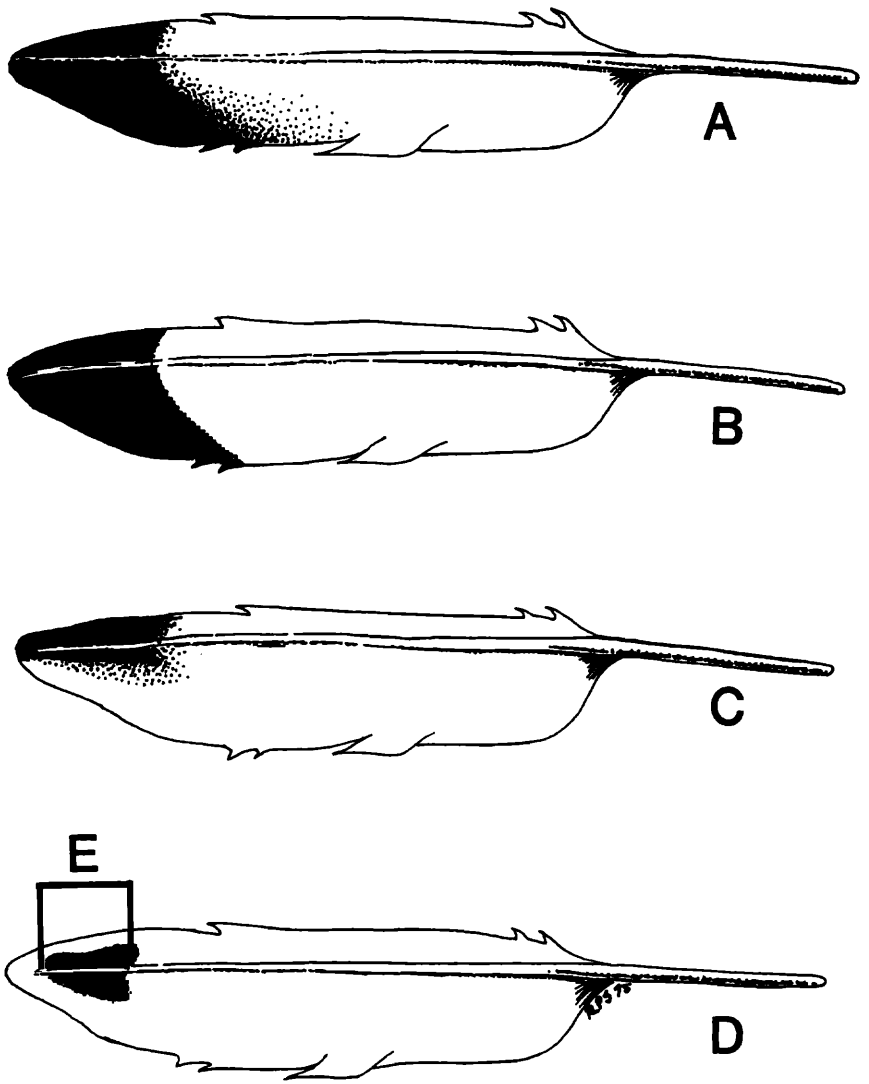

FIGURE 1. Examples of Laughing Gull primaries illustrating categories of black pigmentation and measurements used. A: complete, indistinct black pigmentation, B: complete, distinct C: incomplete, indistinct, and D: incomplete, distinct. When present, the length (mm) of distinct black pigmentation on the distal and proximal vanes of each primary was measured from the minimum point at the proximal end to the maximum point at the distal end and parallel to the rachis (E; example of measurement taken from distal vane).

TABLE 1. Occurrence (%) of black subterminal tail band and gray pigmentation on tail for known-age Laughing Gulls, New York, 1992–1994.

Age (yr)	*n*	Tail band (% of retrices possessing band)				% with gray pigmentation on tail
		Complete (≥66%)	Prominent (≥33% and <66%)	Partial (>0% and <33%)	Absent (0%)	
2	21	33	14	10	43	10
3	57	0	0	4	96	7
≥4	159	0	0	0	100	11

We used analysis of variance for unequal sample sizes to compare mean length of black coloration present on the distal and proximal vanes of primaries 4–6 with distinct black-and-gray interfaces (General Linear Models Procedure, SAS Institute, Inc. 1988). Chi-square tests of independence were used to analyze bill and foot pigmentation; chi-square statistics for proportional data (Fleiss 1973) were used for all other analyses. Sample sizes varied for measurements because of missing feathers (in part due to molt) in some birds.

RESULTS

There were no differences ($P > 0.05$) in any characteristic measured for male and female Laughing Gulls; data were combined for the following analyses.

Plumage characteristics.—Of the 21 2-yr-old Laughing Gulls, 19 (90%) had full hoods, and of the 226 ≥3-yr-old Laughing Gulls, 217 (96%) had full hoods. One 2-yr-old gull did not have a hood (<50% black plumage); all ≥3-yr-old birds had at least partial hoods. The proportion of 2-yr-old Laughing Gulls with partial tail bands was greater ($\chi^2 = 120.78$, df = 6, $P < 0.01$) than were the proportions of 3- and ≥4-yr-old gulls with partial tail bands (Table 1). Pink pigmentation on the breast or abdomen occurred in 12% of individuals. Although this sample was too small for analysis, proportions of pink pigmentation among age classes appeared similar. Percent of Laughing Gulls with gray pigmentation on their tails did not vary with age ($\chi^2 = 1.08$, df = 2, $P = 0.39$) (Table 1).

There were no differences ($P > 0.90$) in the proportions of Laughing Gulls by age class with complete black pigmentation across the vanes on primaries 4 ($\chi^2 = 0.02$, df = 6) or 5 ($\chi^2 = 0.12$, df = 6) (Table 2). There was a difference ($\chi^2 = 83.48$, df = 6, $P < 0.01$) for primary 6, however, with 2-yr-old Laughing Gulls possessing proportionally more complete black pigmentation across the vanes than age classes ≥4. There were also differences ($P < 0.01$) in the proportions of gulls possessing a distinct black-and-gray interface by age class for primaries 4 ($\chi^2 = 29.65$, df = 6), 5 ($\chi^2 = 19.13$, df = 6), and 6 ($\chi^2 = 14.48$, df = 6). The proportions of 2- and 3-yr-old Laughing Gulls with distinct black pigmentation on primary 4 were less than the proportions for ≥4-yr-old gulls, for primary 5

TABLE 2. Occurrence (%) of black pigmentation on distal portion of primaries 4–6 for known-age Laughing Gulls, New York, 1992–1994.

	4th primary				5th primary				6th primary			
Age (yr)	*n*	Complete[a]	Distinct[b]	Absent	*n*	Complete[a]	Distinct[b]	Absent	*n*	Complete[a]	Distinct[b]	Absent
2	20	100	0	0	20	95	0	5	20	95	30	5
3	57	100	39	0	56	100	91	0	56	20	57	39
4	51	100	76	0	51	96	94	2	50	2	30	78
5	43	100	88	0	43	95	93	5	41	0	20	78
6	33	100	85	0	33	100	97	0	32	3	31	66
7	22	95	91	0	22	95	95	5	22	9	32	64
≥8	20	100	95	0	19	95	100	0	19	5	21	79

[a] Complete: black pigmentation extends across entire distal and proximal vanes of primary.
[b] Distinct: Interface between black and gray or brown pigmentation is well defined.

the proportion of 2-yr-old birds was less than the proportions for ≥3-yr-old birds, and for primary 6 the proportion of 3-yr-old birds was greater than the proportions for 2- and ≥4-yr-old gulls. For all age classes combined, the proportion of birds with black pigmentation on primary 6 (42%) was less ($\chi^2 = 66.21$, df = 2, $P < 0.01$) than the proportions for primaries 4 (100%) and 5 (98%).

The length of distinct black pigmentation decreased from primaries 4 to 6 ($F_{2,454} = 1480.47$, $P < 0.01$) (Fig. 2). There were no differences among age classes, however, in the length of this pigmentation on the distal or proximal vanes of the fourth ($F_{6,142} = 0.57$, $P = 0.76$ and $F_{6,141} = 1.15$, $P = 0.34$, respectively), fifth ($F_{6,154} = 1.52$, $P = 0.18$ and $F_{6,154} = 0.97$, $P = 0.45$, respectively), or sixth ($F_{4,48} = 2.53$, $P = 0.05$ and $F_{4,56} = 1.27$, $P = 0.29$) primaries.

Bill and foot pigmentation.—Bill pigmentation varied ($\chi^2 = 28.25$, df = 12, $P = 0.01$) among age classes (Table 3). Bill pigmentation was predominantly ($\chi^2 = 135.56$, df = 2, $P < 0.01$) red, with black-pigmented bills observed less than expected. In contrast, foot pigmentation did not vary ($\chi^2 = 12.08$, df = 12, $P = 0.44$) among age classes. Foot pigmentation was primarily ($\chi^2 = 8.68$, df = 2, $P = 0.01$) intermediate; black-pigmented feet also were observed less than expected.

Aging technique.—Nineteen (95%) of 20 2-yr-old Laughing Gulls possessed complete and indistinct black pigmentation on the fifth primary. In contrast, only 9 (4%) of 224 ≥3-yr-old Laughing gulls had complete and indistinct black pigmentation on the fifth primary and 211 (94%) had distinct pigmentation. Black pigmentation was absent on one 2-yr-old gull and 4 gulls ≥3-yr old. Thus, if the black pigmentation on the fifth primary was complete and indistinct, the Laughing Gull was considered 2 yr old. If the black pigmentation was distinct or absent, the Laughing Gull was considered ≥3 yr old. Using this method, we correctly classified 96% of 245 known-age Laughing Gulls ≥2 yr old. We incorrectly classified one 2-yr-old ($n = 20$) and 9 ≥3-yr-old gulls ($n = 225$).

Using these same characteristics as well as measuring the length of distinct black pigmentation present on the proximal vane of the sixth primary (>16 mm = 2 yr old; <16 mm = ≥3 yr old), we correctly aged 98% of 244 gulls. We misclassified one 2-yr-old ($n = 20$) and 4 ≥3-yr-old Laughing Gulls ($n = 224$).

DISCUSSION

Pigmentation of bill and feet, presence of gray pigmentation on the tail, and prevalence of a subterminal tail band in Laughing Gulls from this study were in general agreement with previous qualitative descrip-

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FIGURE 2. Length (mm) of distinct black pigmentation present on distal and proximal vanes of primaries 4–6 from known-age Laughing Gulls, New York, May–August 1992. Error bars represent one standard deviation.

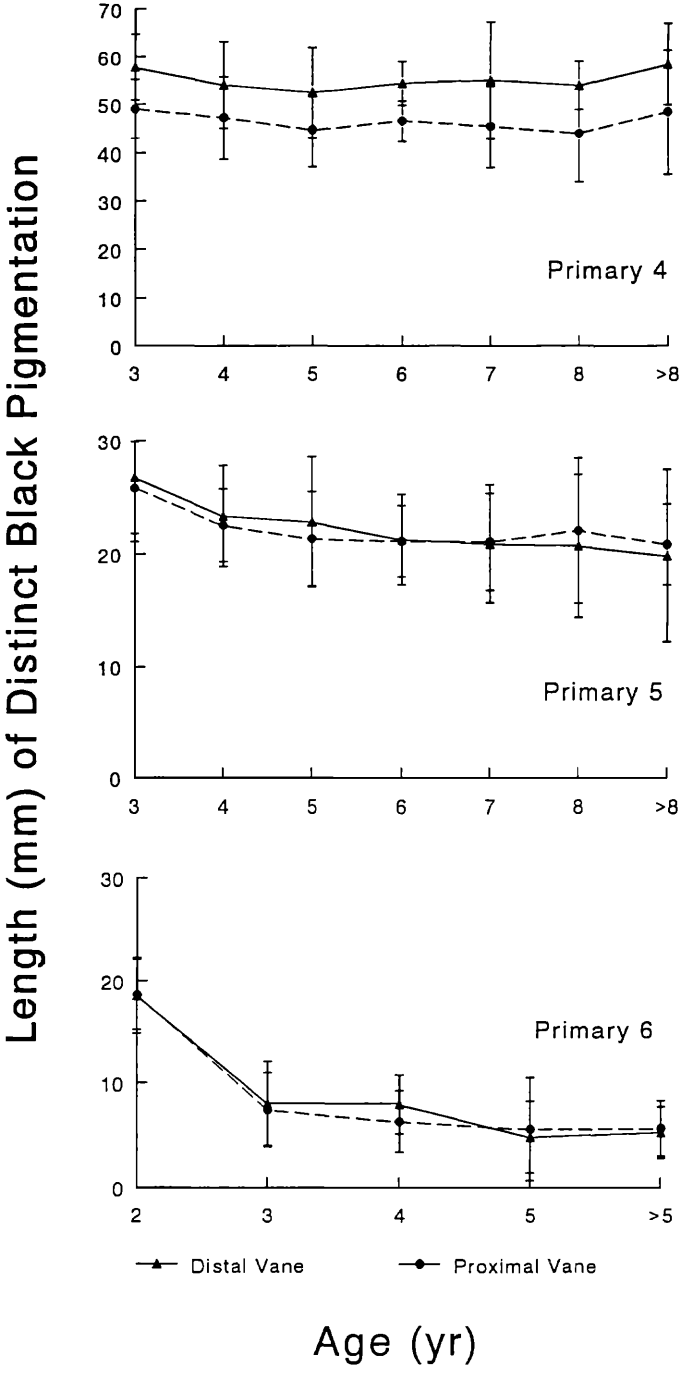
Length (mm) of Distinct Black Pigmentation
70
60
50
40
30
20
10
0
Primary 4
3
4
5
6
7
8
>8
30
20
10
0
Primary 5
3
4
5
6
7
8
>8
30
20
10
0
Primary 6
2
3
4
5
>5
Distal Vane
Proximal Vane
Age (yr)

TABLE 3. Occurrence (%) of bill and foot pigmentations for known-age Laughing Gulls, New York, 1992–1994. Colors were defined as red (≥66% of area red), black (≥66% of area black), or intermediate (<66% of area black or red).

		Bill color (%)			Foot color (%)		
Age (yr)	*n*	Red	Inter-mediate	Black	Red	Inter-mediate	Black
2	21	48	48	5	33	52	14
3	57	70	26	4	46	37	18
4	51	75	24	2	39	27	33
5	42	69	26	5	33	45	21
6	32	69	31	0	34	50	16
7	22	59	36	5	36	32	32
≥8	20	40	50	10	45	40	15

tions (Bent 1921, Grant 1982). However, our study is the first to describe quantitatively the proportions of birds of various age classes displaying these characteristics. Prevalence of a black, full hood among age classes differed from previous descriptions. Ninety percent of 2-yr-old and 96% of ≥3-yr-old Laughing Gulls in our study possessed full hoods. In contrast, Grant (1982) stated that most Laughing Gulls do not acquire full hoods until 3 yr of age. With the exception of the greater prevalence of tail bands in 2-yr-old birds, Laughing Gulls attain adult plumage at 2 yr of age.

Overall, the frequency of occurrence and extent of black pigmentation on wings decreased as Laughing Gulls increased in age. The complete loss of pigmentation occurs first on the innermost primaries (e.g., primary 6). The prevalence of distinct black pigmentation also increased with age. On individual primaries, the loss of black appears to occur first proximally. Decreases in the frequency and extent of black pigmentation on wings also has been reported for Black-headed (*L. ridibundus*) and Ring-billed Gulls (Allaine and Lebreton 1990, Blokpoel et al. 1985).

We are unaware of previous documentation of pink pigmentation on the breast or abdomen of Laughing Gulls. We did not observe this pigmentation for Ring-billed, Herring (*L. argentatus*), or Great Black-backed (*L. marinus*) Gulls also obtained from New York during the same period. Ross's Gull (*Rhodostethia rosea*), however, has been reported as usually possessing intensely pink underparts during summer, with this pigmentation generally less visible during winter (Grant 1982). Slender-billed (*L. genei*) and Black-headed Gulls have also been reported to possess pink-flushed underparts (Grant 1982). Pink-pigmented plumage has been suggested to be caused by a colorant in the oil from the uropygial gland being coated on the feathers during preening (Grant 1982).

The presence or absence of a distinct black-and-gray interface on the distal portion of the fifth primary appears to be a reliable way to age Laughing Gulls. In our sample, 95% of 2-yr-old gulls had an indistinct black-and-gray interface and 94% of 3-yr-old gulls had a distinct black-

and-gray interface. Using this characteristic with the fifth primary in combination with the length of distinct black pigmentation present on the proximal vane of the sixth primary, we correctly aged 98% of 244 gulls. We recommend use of the former method as it is easier to conduct in the field and is only 2% less accurate. Using this technique and previously published plumage characteristics (e.g., Grant 1982) provides rapid and accurate classification of Laughing Gulls in summer plumage as <1, 1, 2, or ≥3 yr old.

The ability to differentiate 2- from ≥3-yr-old Laughing Gulls quickly and accurately has important demographic implications. For example, it would now be possible to determine age at first breeding. Laughing gulls have generally been considered to first breed at 3 yr. Fully developed brood patches in 2-yr-old Laughing Gulls, however, suggest that breeding may occur at an earlier age (Belant and Dolbeer, unpubl. data). This technique also provides for more accurate development of population age structures. Using previous plumage descriptions, Dolbeer et al. (1993) were not confident differentiating 2-yr-old from ≥3-yr-old Laughing Gulls. They reported that 95% of the population studied in 1992 was ≥2-yr old. Using our ageing technique on a subsample of 500 of these birds, we estimated that 20% of the Laughing Gulls were 2-yr old and 80% were ≥3-yr old. Use of this technique in future studies will provide an improved understanding of Laughing Gull population ecology.

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