The Condor 89:150–157

BODY MORPHOMETRICS AND MOLT OF BONAPARTE'S GULLS IN THE QUODDY REGION, NEW BRUNSWICK, CANADA[1]

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Abstract. In the Quoddy region of New Brunswick, Canada, the postnuptial molt and feather renewal of Bonaparte's Gulls lasted about 14 weeks with the primary feather molt of the second-year birds being more advanced than that of the adults by 20 to 30 days or 2 to 3 primary feathers. Males were larger than females by body weight, and body, culmen, and tarsal lengths. There was a general trend for migrants passing through the Quoddy region during July and August to be larger in size than during October and November. Based on culmen and tarsal lengths measured on museum specimens collected from different geographical regions of the breeding range, there was a general trend for decrease in body size from east to west, which suggests that the first migrants through the Quoddy region represented populations from the east followed later by western populations.

Key words: *Gull;* Larus; *migration; molt; morphometrics.*

INTRODUCTION

The Bonaparte's Gull, *Larus philadelphia* Ord., is a widely-distributed North American species. The Quoddy region of the Bay of Fundy off New Brunswick, Canada, serves as a major autumn staging ground for migrating Bonaparte's Gulls, resulting in the largest known concentration of this species in eastern Canada (Canadian Wildlife Service 1979). This localized concentration, in combination with the ease of access to the area, creates a favorable situation for intensive study of these birds.

The objective of the present study was to evaluate data on population composition, molt, and body morphometrics for the gulls passing through the Quoddy region during autumn migration, and to determine how the characteristics of this population compare with those in other areas of North America.

MATERIALS AND METHODS

COLLECTION OF BIRDS

Bonaparte's Gulls (n = 222) were collected by shotgun (under Scientific Kill Permits issued by Canadian Wildlife Service) from the Quoddy region off southeastern New Brunswick (Fig. 1). The birds were pooled into 15 10-day time periods spanning 22 July through 18 December 1978 to 1984. The contents of the proventriculus and gizzard were removed. The gulls were aged by plumage coloration (juvenile, second-summer/second-winter, adult) following Grant (1982), and the sex determined by examination of gonads. Body length (bill tip to tip of central rectrix) was measured to the nearest 0.1 cm using a tape measure, and culmen and right tarsal lengths were measured to the nearest 0.05 cm with calipers. Fresh body weight minus stomach contents was measured to the nearest 0.1 g using a triple beam balance.

Stage of autumn molt of collected birds was recorded for 19 birds during 1980 and 1981 and for 96 birds during 1982 to 1984. In gulls, the molt of primary wing feathers is sequential starting from the first (innermost) to the tenth (outermost) primary feather. The advancement of molt was recorded by categorizing the stage of new feather growth of the right wing as follows: 0—premolt; 1—missing feather; 2—quill without vane; 3—appearance of vane; 4—vane comprises 30 to 50% of feather length; 5—new feather growth almost or totally complete. The molt score for each bird was calculated as the sum for the ten primary feathers ranging from 0 (all premolt feathers) to 50 (all new feathers). Molt of head feathers was categorized according to the color of the hood as follows: premolt—black, molting—grey, postmolt—white with dark 'eye' spots. Supplemental data on molting adults was collected during 1981 to 1984 by noting the color of the hood of birds in flocks at sea.

[1] Received 27 April 1986. Final acceptance 13 August 1986.

POPULATION STRUCTURE OF QUODDY REGION BIRDS

Estimates of proportions of juvenile, second-year, and adult Bonaparte's Gulls in the population staging in the Quoddy region were made by opportunistically counting the number of different-aged gulls in flocks at sea during eight successive field seasons collectively spanning May to December, 1977 to 1984. Total monthly population estimates were calculated annually for the 8 years using the method of Braune and Gaskin (1982). The overall monthly minimum and maximum estimates used were the single highest minimum and maximum values over the 8 years.

ANALYSIS OF BODY MORPHOMETRICS

Quoddy region. Mean body weights for each of the 10-day time periods were tested for differences between sexes for each age group using single-factor analysis of variance (ANOVA) (SAS Institute 1982). Differences in body weights over the time periods for each age group separated into sexes were tested using ANOVA followed by GT2 tests for unequal sample sizes between pairs of time periods (Sokal and Rohlf 1969, SAS Institute 1982). A time period with a high mean body weight (fat birds) followed by a time period with a low mean body weight (lean birds) was presumed to indicate a transition between waves of migrants passing through the Quoddy region. It was assumed that the fat birds which had been feeding in the region had departed to continue their southward migration, while a different group of lean birds had arrived to start their feeding stop-over in the area.

Body, culmen, and tarsal lengths were pooled for each wave of birds defined by the changes in body weight. Differences between sexes for each age group, and differences between waves for each age group separated into sexes, were tested in these data using ANOVA as described for body weight. All statistical comparisons with probability values greater than 0.05 were considered to be insignificant.

Museum specimens. To investigate the possibility of polymorphism in Bonaparte's Gulls, data were gathered from 72 museum specimens from three geographical regions: Ontario (hereafter Eastern); Manitoba, Saskatchewan, Alberta, Northwest Territories (hereafter Central); British Columbia, Yukon, Alaska (hereafter Western). Culmen and tarsal lengths were measured to the nearest 0.01 cm using calipers. Measurements were restricted to adults collected during the breeding season (1 May to 31 July). Differences in culmen and tarsal lengths across the three geographical regions were tested, with and without separation by sex, using ANOVA as described for body weight. ANOVA was also used to test for sexual dimorphism in birds within each of the three geographical regions.

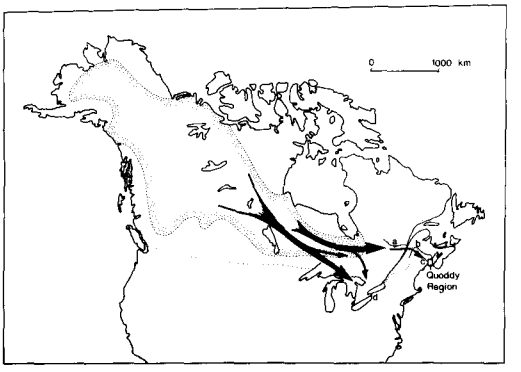

FIGURE 1. Breeding range (stippled area) and northeastern autumn migration routes. a: Saguenay River; b: Saint John River; c: St. Croix River; d: Niagara River–eastern Lake Erie region.

RESULTS

POPULATION STRUCTURE OF QUODDY REGION BIRDS

The earliest and latest records of Bonaparte's Gulls in the Quoddy region were 14 June and 31 December for adults, 24 May and 11 December for second-year birds, and 23 July and 16 November for juveniles. A survey conducted in the Quoddy region on 31 December 1982 recorded one adult Bonaparte's Gull, and a survey conducted on 19 March 1982 recorded no Bonaparte's Gulls in the area.

Second-year birds were the first to arrive in May and June (Table 1). The first large influx of adult birds began in late July and continued throughout August diluting population proportions of second-year birds from 97 to 100% during May and June to 7 to 8% during July and August. The arrival of the juveniles began in late July and continued throughout August and September (Table 1). Most juveniles had departed by October, none being sighted in late October, whereas substantial numbers of adults lingered into December (Table 1). A new influx of juveniles was observed in mid-November, but none were seen in the area during December.

TABLE 1. Monthly population estimates and composition for Bonaparte's Gulls observed and/or collected in the Quoddy region pooled over years for March, May to December 1977 to 1984.

Month	No. gulls present	Percentage of population				Adult sex ratio	
	Range	*n*	Juvenile	2nd Year	Adult	*n*[a]	Female: Male
March	0	0	0	0	0	0	ND
May	70	70	0	100	0	0	ND
June	114–177	368	0	97	3	0	ND
July	5,000–6,397	771	<1	8	92	17	2.4
Aug	6,000–13,055	2,092	13	7	80	41	1.6
Sept	8,000–9,258	1,696	2	ND	98	0	ND
		30[a]	ND[b]	27	73	38	1.4
Oct	2,000–4,405	35[a]	ND[c]	11	89	31	1.4
Nov	2,500–4,400	10[a]	ND[c]	20	80	8	1.0
Dec	1,500–2,000	12[a]	ND	17	83	10	0.7

[a] Collected birds.
[b] ND: No Data.
[c] Juveniles present but proportionate numbers not recorded.

There is some indication that adult females arrived in the Quoddy region in slightly greater numbers than males during July and August, but the proportion of males gradually increased in the population throughout September to December (Table 1).

MOLT

Adult Bonaparte's Gulls arriving in the Quoddy region in late July had the black hood of summer plumage, but by late August to early September, only 1 to 2% of the adults still retained it (Table 2). Second-year gulls were distinguishable in the field by their faded wing bars and presence of tail markings until mid-August, when their body and tail feather molt made them indistinguishable from adults in winter plumage. Close examination, however, revealed that some second-year birds retained small dark flecks near the tips of the new outer rectrices.

Molt of primary wing feathers and growth of new feathers had already started by late July (Fig. 2). New feather growth averaged about 10 days (one time period) per primary wing feather for both second-year and adult birds. Primary feather molt of second-year birds was earlier than that of the adults by 20 to 30 days or 2 to 3 feathers. All new primary feathers were completely grown by late October.

TABLE 2. Progression of molt of head feathers from summer plumage (premolt to black hood) to winter plumage (postmolt to white with dark 'eye' spots) in adult Bonaparte's Gulls observed and/or collected from the Quoddy region, New Brunswick, during 1981 to 1984.

Time period	Date	*n*	% Premolt
1	22 July–31 July	37	100
2	1 Aug–10 Aug	101	99
3	11 Aug–20 Aug	10	30
4	21 Aug–30 Aug	413	2
5	31 Aug–9 Sept	1,784	<1

MORPHOMETRICS

Body weight. In the Quoddy region, juveniles showed no significant differences in body weight between sexes in the two time periods (TP) (TP 5—early September, TP 8—early October) for which data for both sexes was available. Therefore, body weight data for this age group were pooled. Second-year birds showed a significant ($P = 0.040$) difference in body weight between sexes in one time period (TP 1—late July) of the three tested (TP 1—late July, TP 2—early August, TP 10—late October), and adults in seven ($P_1 = 0.041$, $P_3 = 0.0036$, $P_4 = 0.0044$, $P_5 = 0.0001$, $P_6 = 0.0035$, $P_8 = 0.032$, $P_{10} = 0.010$) of the ten time periods tested (TP 1 to 6—late July to mid-September, TP 8—early October, TP 10—late October, TP 12—mid-November, TP 14—early December). Therefore, body weight data for second-year and adult birds were separated by sex. The mean body weights of males were greater than those for females in all groups tested except second-year and adult birds in mid-November (TP 12).

Based on change in mean body weight over time periods, juvenile birds appeared to pass through the Quoddy region in two waves (Fig. 3). The first wave arrived around mid-August and left by early October (wave 1—TP 3 to 8).

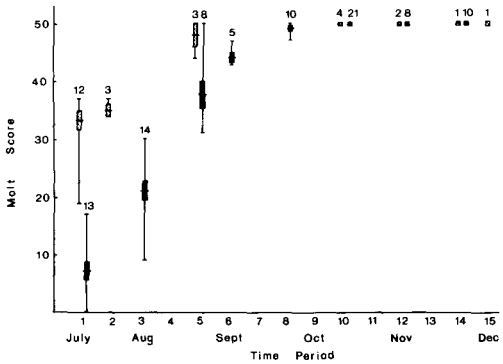

FIGURE 2. Mean molt scores ± standard errors for primary feathers of second-year (stippled bars) and adult (solid bars) Bonaparte's Gulls collected during 1980 to 1984 from the Quoddy region, New Brunswick. Sample size for each time period is given above the molt score range bar.

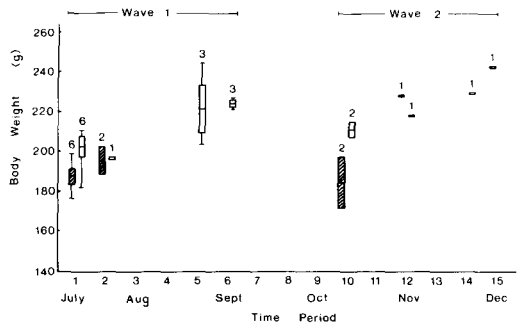

FIGURE 4. Mean body weights ± standard errors of female (hatched bars) and male (open bars) second-year Bonaparte's Gulls collected during 1981 to 1984 from the Quoddy region, New Brunswick. Sample size for each sex for each time period is given above the body weight range bar.

No juveniles were sighted in late October, but a second wave was present in the area during mid-November (wave 2—TP 12). The change in mean body weight of birds across all time periods was significant ($P = 0.0026$). The gain of 17% of initial mean weight between arrival and departure of the first wave (TP 3 vs. 8) was significant (GT2 test, $P < 0.05$).

Second-year birds also appeared to pass through the area in two waves: July to September (wave 1—TP 1 to 6), and October to December (wave 2—TP 10 to 15) (Fig. 4). Change in mean body weight across all time periods was significant for females ($P = 0.0081$) but not for males ($P = 0.19$). During the two waves, the birds (sexes pooled) gained 15% and 23%, respectively, of their initial mean body weights.

There were three waves of adults: July to August (wave 1—TP 1 to 4), September to early October (wave 2—TP 5 to 8), and late October to December (wave 3—TP 10 to 14) (Fig. 5). Adults of wave 3 coincided with juveniles and second-year birds of wave 2. Change in mean body weight across all time periods was significant for both adult females ($P = 0.0001$) and males ($P = 0.0001$). For mean body weights of females, GT2 values were significant for departing wave 1 fat birds vs. arriving wave 2 lean birds (TP 3 vs. 5), and for wave 3 lean vs. fat birds (TP 10 vs. 14). For mean body weights of males, GT2 values were significant for wave 1 lean vs.

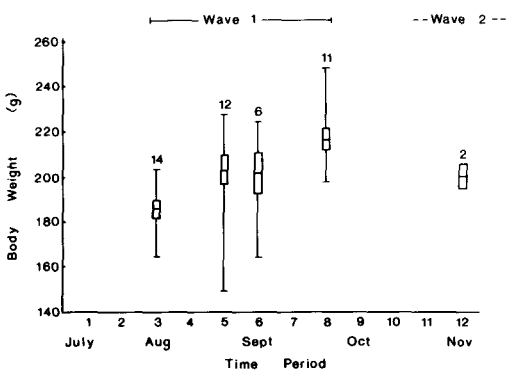

FIGURE 3. Mean body weights ± standard errors of juvenile Bonaparte's Gulls collected during 1978 to 1984 from the Quoddy region, New Brunswick. Sample size for each time period is given above the body weight range bar.

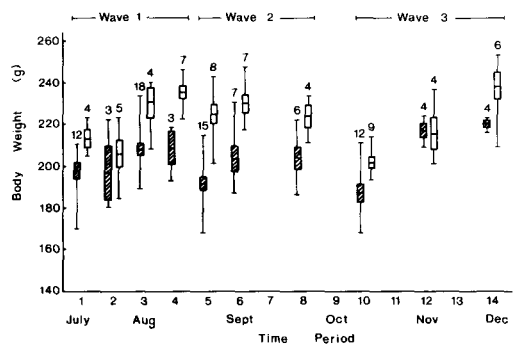

FIGURE 5. Mean body weights ± standard errors of female (hatched bars) and male (open bars) adult Bonaparte's Gulls collected during 1978 to 1984 from the Quoddy region, New Brunswick. Sample size for each sex for each time period is given above the body weight range bar.

TABLE 3. Mean body, culmen, and tarsal lengths (cm) for different ages and waves of Bonaparte's Gulls collected from the Quoddy region. Probability values (*P*) are given for analyses of variance testing for sexual dimorphism.

		Sexes pooled			Female			Male			
	Wave	*n*	$\bar{x}$	SD	*n*	$\bar{x}$	SD	*n*	$\bar{x}$	SD	*P*
Body length											
Juvenile	1	45	23.5	1.08	6	23.4	0.68	19	24.2	0.99	0.070
	2	2	22.8	1.63	1	21.6	—		ND[a]		ND
2nd year	1	22	23.9	1.42	8	23.6	1.17	13	24.1	1.62	0.46
	2	8	23.6	1.45	4	23.5	2.03	4	23.7	0.89	0.88
Adult	1	58	23.4	1.27	37	23.1	1.20	20	24.1	1.17	0.007
	2	48	23.3	1.46	28	22.9	1.32	20	23.8	1.50	0.032
	3	39	23.4	1.01	20	22.9	0.74	19	23.9	0.98	0.0004
Culmen length											
Juvenile	1	14	2.87	0.142	5	2.83	0.156	3	2.97	0.115	0.24
	2	2	2.76	0.007	1	2.75	—		ND		ND
2nd year	1		ND			ND			ND		ND
	2	7	2.92	0.198	4	2.83	0.176	3	3.04	0.180	0.18
Adult	1	7	2.97	0.208	3	2.82	0.161	4	3.09	0.165	0.082
	2	25	3.00	0.152	18	2.97	0.153	7	3.10	0.104	0.046
	3	30	2.89	0.141	16	2.85	0.144	14	2.94	0.124	0.076
Tarsal length											
Juvenile	1	14	3.68	0.193	5	3.59	0.096	3	3.58	0.076	0.92
	2	2	3.55	0.000	1	3.55	—		ND		ND
2nd year	1		ND			ND			ND		ND
	2	7	3.52	0.087	4	3.49	0.087	3	3.55	0.090	0.41
Adult	1	7	3.71	0.093	3	3.67	0.058	4	3.74	0.111	0.37
	2	25	3.62	0.157	18	3.58	0.143	7	3.72	0.155	0.046
	3	30	3.54	0.113	16	3.51	0.103	14	3.57	0.117	0.11

[a] ND: No Data.

fat birds (TP 2 vs. 4), and for wave 3 lean vs. fat birds (TP 10 vs. 14). Female and male adults of wave 1 gained 6% and 15% of their initial mean body weights, respectively. Females and males of wave 3 both gained 18% of their initial mean body weights.

Body, culmen and tarsal lengths of Quoddy birds. There was no significant sexual dimorphism in body, culmen, and tarsal lengths among juvenile or second-year birds of the two independently tested waves (Table 3). Wave 2 adults showed significant sexual dimorphism in mean culmen length and mean tarsal length, and adults of all three waves showed significant sexual dimorphism in mean body length (Table 3). Males were larger in size than females in all age groups (Table 3).

There were no significant differences in means of body, culmen, and tarsal lengths when the sexes were pooled or treated separately between waves of juveniles, and between waves of second-year birds (Table 4). There was no significant difference in body length between the three waves of adults when the sexes were pooled or treated separately (Table 4). There was, however, a significant difference in mean culmen lengths between adults of the three waves both among pooled sexes and sexes treated separately (Table 4). GT2 values were significantly different between adults (sexes pooled) of waves 2 and 3, and between males of waves 2 and 3. Mean tarsal lengths of adults were significantly different between the three waves with sexes pooled and for males, but not for females (Table 4). GT2 values were significantly different only between adults (sexes pooled) of waves 1 and 3. There was a general trend for birds of all age groups in wave 1 to be larger in size than birds of the later waves (Table 3).

Culmen and tarsal lengths of museum specimens. There was significant sexual dimorphism in mean culmen and tarsal lengths of adults breeding in the Central region, and in mean culmen lengths of adults in the Eastern region (Table

TABLE 4. Probability values (*P*) for analyses of variance for differences in body, culmen and tarsal lengths (cm) between waves of juveniles (J), second-year (S) and adult (A) Bonaparte's Gulls collected from the Quoddy region, and between geographical regions of the breeding grounds from which the museum specimens of adult Bonaparte's Gulls were collected.

Age	No. waves		Body length *n*	Body length *P*	Culmen length *n*	Culmen length *P*	Tarsal length *n*	Tarsal length *P*
Quoddy Region								
J	2	N_f[a]	7	0.062	6	0.67	6	0.72
		N_m	19	—	ND[b]		ND	
		N_T	47	0.33	16	0.29	16	0.38
S	2	N_f	12	0.91	ND		ND	
		N_m	17	0.63	ND		ND	
		N_T	30	0.60	7	—	7	—
A	3	N_f	85	0.62	37	0.050[c]	37	0.067
		N_m	59	0.85	25	0.017[c]	25	0.023
		N_T	145	0.88	62	0.024[c]	62	0.0046[d]
Breeding grounds								
Age	No. regions							
A	3	N_f	—	—	33	0.46	34	0.027[e]
		N_m	—	—	37	0.30	36	0.090
		N_T	—	—	70	0.45	70	0.028[f]

[a] f—females, m—males, T—females + males.
[b] ND: No Data.
[c] Significant GT2 value ($P < 0.05$) for waves 2 vs. 3.
[d] Significant GT2 value ($P < 0.05$) for waves 1 vs. 3.
[e] Significant GT2 value ($P < 0.05$) for Eastern vs. Central region.
[f] Significant GT2 value ($P < 0.05$) for Eastern vs. Western region.

5). Adults (sexes pooled) and females showed significant differences in mean tarsal length between the three geographical regions (Table 4). There was a general trend for a decrease in body size from east to west (Table 5).

DISCUSSION

AUTUMN MIGRATION

The main wave of Bonaparte's Gulls migrates through Quebec during August to October with peak numbers passing through central and southern Quebec during late August and early September (David 1980). In the Bay of Fundy, Bonaparte's Gulls are abundant in the Quoddy region off southeastern New Brunswick, and uncommon on the middle and upper Bay of Fundy and lower Saint John River valley (D. S. Christie, pers. comm.). This would suggest that the birds follow the inland river-lake systems from the mouth of the Saguenay River and the Gulf of St. Lawrence to the upper Saint John River and then to the St. Croix River leading into the Quoddy region (Fig. 1). There are few birds left in the

TABLE 5. Mean culmen and tarsal lengths (cm) for museum specimens of adult Bonaparte's Gulls from the Eastern, Central, and Western regions of the breeding grounds. Probability values (*P*) are given for analyses of variance testing for sexual dimorphism.

	Sexes pooled			Female			Male			
	n	$\bar{x}$	SD	*n*	$\bar{x}$	SD	*n*	$\bar{x}$	SD	*P*
Culmen length										
Eastern	16	2.84	0.140	9	2.77	0.122	7	2.93	0.107	0.014
Central	37	2.79	0.132	18	2.72	0.099	19	2.86	0.122	0.0004
Western	17	2.80	0.139	6	2.71	0.116	11	2.84	0.132	0.060
Tarsal length										
Eastern	18	3.44	0.102	10	3.42	0.098	8	3.47	0.105	0.29
Central	37	3.38	0.112	18	3.32	0.100	19	3.44	0.090	0.0005
Western	15	3.34	0.102	6	3.30	0.086	9	3.37	0.107	0.060

Quoddy region by late December to early January.

In the Niagara River–eastern Lake Erie region, there is an early wave during August and September which thins out in October, followed by a very large wave in November and December (Beardslee 1944). The size of the waves is the reverse for the Quebec–Quoddy region birds. The birds usually depart the Great Lakes region sometime in January (Beardslee 1944).

DISTRIBUTION OF AGE GROUPS OF BIRDS DURING MIGRATION

In the Quoddy region, the first wave was the major one and brought with it up to 13% juveniles in August (Table 1). Many of these birds left as others arrived during September (Fig. 5). During October, numbers of birds generally declined so that few juveniles were observed in early October and none were sighted during late October (Table 1).

The passage of adult and immature Bonaparte's Gulls during autumn migration was documented by Beardslee (1944) for the Niagara River–eastern Lake Erie region. During early August, the flocks consisted only of adults, but by mid-August, 5% were juveniles and 15% were second-year birds. Considerable numbers of gulls of this first minor wave left in late September, and those that remained throughout October were mainly adults.

During the main wave of November and December in the Niagara River–eastern Lake Erie region, the juveniles did not tarry long and were gone by the end of November leaving only adults during December (Beardslee 1944). Second-year birds probably comprised a large portion of the great November to December flocks, but because they had completed their molt, they were indistinguishable from the adults. The minor late October to December wave in the Quoddy region also contained juveniles during November but not during December (Table 1). Black flecks on the outer rectrices identified second-year birds with retarded molt which comprised 17 to 20% of the November to December population. The true population proportion of second-year birds must have been considerably higher.

Of the thousands of Bonaparte's Gulls that migrate through the Niagara–Erie area, less than 3% were juveniles, suggesting that the latter migrate southward over a different route (Beardslee 1944). On the Atlantic coast, records for August to October, 1979 to 1981 showed a high proportion of juvenile birds off Newfoundland (J. Wells, unpubl. data). Of all the birds surveyed by age during late July to November (Table 1), about 6% were juveniles compared with less than 3% in the Niagara–Erie region.

AUTUMN MOLT

Winter plumage is acquired by a complete postnuptial molt during July to October (Grant 1982). On the Niagara River, the complete postnuptial molt of the adults takes place in August (Beardslee 1944). By the end of August, only 2 to 3% still show a trace of the black hood. This agrees well with the timing of the head molt in the Quoddy region (Table 2).

The molt of the primaries provides a rough gauge by which the progress of autumn molt may be measured, with the molt of the rest of the plumage taking place mainly within the period when the primaries are being renewed (Grant 1982). The growth rate of a single feather depends on its positioning in the molting sequence and its length (Lindberg and Odsjö 1983) suggesting that in the case of the Bonaparte's Gull, the growth rate may progressively decrease from the smallest primary feather no. 1 to the largest primary feather no. 10. Large larid species can take as long as four to seven months to complete their postnuptial molt (Ingolfsson 1970, Harris 1971, Barth 1975, Verbeek 1979, Grant 1982), whereas smaller species, such as the Bonaparte's Gull, generally take 4 to 6 weeks (Grant 1982). The complete postnuptial molt and feather renewal takes about 14 weeks for Bonaparte's Gulls in the Quoddy region (Fig. 2).

According to Beardslee (1944), the second-year birds had a later and slower molt than the adults. Data from the Quoddy region birds indicated the opposite (Fig. 2). Second-year birds had a primary feather molt that was more advanced than that of the adults by 20 to 30 days or 2 to 3 primary feathers. Ingolfsson (1970) and Grant (1982) also noted that the immature birds begin the molt earlier than the adults.

Other studies in temperate regions showed that medium to large larids overlap their breeding and molt schedules (Johnston 1961, Ingolfsson 1970, Harris 1971, Barth 1975, Verbeek 1979). It is probably the relatively extended time period required for completion of molt that necessitates this overlap. The shorter molt time required by

smaller larids, such as the Bonaparte's Gull, eliminates the need for such an overlap.

IMPLICATIONS OF BODY MORPHOMETRICS

Based on body weight, and body, culmen, and tarsal lengths, male Bonaparte's Gulls were, on the average, larger than the females (Tables 3, 5; Figs. 4, 5). This is generally true of gull species (Harris and Hope Jones 1969; Shugart 1977, Grant 1982), and earlier data for Bonaparte's Gulls supported this observation (Dwight 1925). In the Quoddy region, adult Bonaparte's Gulls of wave 1 were generally larger in size than those birds of waves 2 and/or 3 (Table 3). On the breeding grounds, adult birds were largest in the Eastern region (Ontario), and progressively decreased in size towards the west (Table 5). Therefore, it is likely that wave 1 gulls through the Quoddy region arrived from Ontario–Quebec with the later waves arriving from the Prairie Provinces and Northwest Territories. The second wave of adults was not as clearly defined by body weight as were waves 1 and 3 (Fig. 5). This was probably a result of the overlapping presence of fat birds of the first wave which had not yet departed and lean birds of the second wave which had recently arrived in the region. The adult birds arriving in late October were much leaner than the arriving birds of earlier waves (Fig. 5), probably because they had flown that much farther to reach the Quoddy region (Fig. 1).

Because the early August to September wave is the largest one in the Quoddy region but only a minor one in the Niagara River–eastern Lake Erie region, it is likely that most of the Bonaparte's Gulls of Ontario and Quebec migrate to the east coast (Fig. 1). Most of the birds from the Prairie Provinces and Northwest Territories probably pass through the Niagara region in the large November to December third wave while only a small fraction of these birds migrate via the Quoddy region.

ACKNOWLEDGMENTS

I wish to thank the members of the University of Guelph Cetacean and Seabird Research Group for assistance in the field, and especially D. B. Yurick who conducted the two winter surveys, and D. E. Gaskin who gave his time in support of the late autumn field sessions. I also appreciate the cooperation of the Royal Ontario Museum, Toronto, Ontario, and the National Museum of Natural Sciences, Ottawa, Ontario, who kindly allowed me access to their avian collections. G. Braune provided invaluable assistance with the measurement of museum specimens. D. E. Gaskin, V. G. Thomas, J. B. Sprague, R. Frank and M. Gochfeld kindly read and criticized an earlier draft of the manuscript. The work was supported by grants to Dr. D. E. Gaskin from the Natural Sciences and Engineering Research Council of Canada (operating grant no. A5863) and from the Canadian National Sportsmen's Fund and the Department of Fisheries and Oceans.

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