THE CURRENT STATUS OF THE HERRING GULL POPULATION IN THE NORTHEASTERN UNITED STATES[1]

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Kadlec and Drury (1968a) suggested that the Herring Gull (*Larus argentatus*) population breeding in the northeastern United States increased at an average rate of 4.5% - 5% per year between about 1900 and 1965, except during the period of 1940-1955 when a combination of factors caused it to level off. Aerial censuses of breeding birds conducted by us, using the same methods in 1965 and 1972, suggest an increase of only 0.75% - 1.5% per year during these seven years (Table 1). The accuracy of the census method (± 20%, Kadlec and Drury, 1968b) is insufficient to distinguish between two alternative hypotheses: (a) little increase in breeding birds occurred in the census area between 1965 and 1972; or (b) the increase continued through the period, but the estimate in 1965 was too high, or the estimate in 1972 was too low, or both.

Table 1.
Number of pairs of breeding Herring Gulls.[1]

	1951	1962	1963	1964	1965	1972
Long Island	225	950	(2,000)	(1,700)	4,200	5,500
Block Is. Sound	5,250	9,600	(5,350)	(5,350)	(9,175)	11,800
Cape & Islands	17,700	18,300	(12,200)	19,400	19,300	19,600
Massachusetts Bay	7,100	15,200	(13,300)	18,950	17,300	16,650
Isle of Shoals	4,900	(3,800)	3,350	4,400	5,850	7,100
Portland Area	7,375	5,500	5,250	6,800	9,600	14,375
Seguin to Monhegan	4,600	2,500	3,000	1,900	4,825	3,600
Penobscot Bay	2,000	3,000	3,500	3,100	2,800	3,000
Jericho-Blue Hill Bay	(500)	(450)	450	1,500	2,000	1,100
Outer Islands	5,900	1,900	1,700	2,600	3,500	2,175
Eastern Maine	3,950	2,900	2,950	4,250	4,100	4,750
Grand Manan		12,300	11,150		11,900	14,100
Total		76,000	64,000		95,000	104,000

[1]Data for 1945 and 1951 are from A. O. Gross's mimeographed reports on the gull and cormorant control program. Data from 1962-1972 are from aerial censuses. Figures in parentheses are extrapolated from incomplete data.

A halt in the growth of the New England Herring Gull population has several theoretical and practical implications. Accordingly, we have sought evidence from other sources to permit choice between these alternatives.

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We tested two other sampling techniques to confirm the results of the air censuses. Then we reviewed measurements of reproductive success and age structure to see whether they were consistent with the suggested population trend. Finally we re-examined the data on population trends over the last 20 years to see whether the trend is recent or long term.

Estimates of breeding population size. We examined two sources of data: surface estimates and counts of the numbers of breeding pairs, and nest counts on sample islands.

(1) Surface estimates of gulls at breeding colonies were made in May and early June 1965 and surface counts in early July 1972. Estimates or counts were available in both years for 56 islands, and for 45 of these, air estimates were also available (Table 2).

The comparisons have some serious shortcomings. The 1965 estimates were made in late May at about the peak of colony occupation. The 1972 counts were made in early July after the peak of nest occupation, and some birds may have already left the islands. The 1965 estimates were of "all gulls" over the islands. These estimates were divided by 1.5 to convert to the number of nests of pairs (Drury, 1973). The 1972 figures are of counts of occupied territories.

TABLE 2.
Surface counts of breeding Herring Gull pairs and corresponding air estimates, for regions of the Maine coast.

	No. islands	Surface 1965[1]	Surface 1972	Air 1965	Air 1972
Saco Bay	4	1,300	1,200	975	1,075
Casco Bay	10	4,250	3,580	3,965	5,550
Booth Bay	10	2,050	2,485	2,560	1,475
Muscongus Bay	13	800	425	720	930
Fox Islands	4	650	520	985	585
Upper Penobscot Bay	9	1,100	560	1,400	525
Matinicus Islands	6	2,250	1,245	500	800
		12,400	10,015	11,050	10,940
		56 Islands		45 Islands	

[1]Surface estimates in 1965 have been divided by 1.5 because they were estimates of all birds over the island (Drury, 1973).

The bias (a) will tend to make the 1965 estimates high relative to the air estimates and the 1972 surface estimates. A slight error in the factor 1.5 (bias b) could make the 1965 ground estimate either too high or too low relative to the air estimates. Two of the three possibilities would tend to reinforce the closeness of the air and surface estimates and therefore the similarity between 1965 and 1972.

We have discussed the reliability of techniques elsewhere (Kadlec and Drury, 1968b; Drury, 1973). The central problem lies not so much in the accuracy of estimates or counts of birds as in the relation of the numbers of birds on the island to the number of nests on that island. Our experience shows that the relation is complex and variations are not systematic. Therefore we have made estimates of many colonies over large areas so as to average out non-systematic variations.

Even so, variations in some regions such as Casco Bay, Booth Bay, and the Matinicus Islands (Table 2) are unusually large. In these areas commercial fishermen are active within sight of the colonies. As a consequence, during any one census a majority of gulls may be away from the island and flying around the boats. Alternatively a majority of the nonbreeding adult gull population that follows the fleet may be loafing on unoccupied parts of the gull colonies during other censuses.

The data in Table 2 are most consistent with the conclusion that the populations involved have changed little. They are not consistent with the conclusion that the populations are increasing at 4-5% per year.

(2) Nest counts on 19 islands visited in both 1965 and 1969 indicated a 15-20% decrease in nesting gulls, both in Maine and Massachusetts (Table 3). The sample is small (in comparison with the total of about 300 island colonies) and our previous studies (1964-1969) may have disturbed the gulls. Nevertheless, these data also suggest stability or decline of the breeding population.

If the population growth rate has decreased there has presumably been either a decrease in recruitment of young or an increase in adult mortality (including emigration). These changes should be expressed in an altered age structure.

Measurements of recruitment of young. (1) Age ratio. In our earlier work (Kadlec and Drury, 1968a), we found that sample counts of age ratios around Massachusetts Bay between mid-September and mid-November 1962-1963 were similar to those of the entire population wintering on the Atlantic and Gulf coasts in 1965.

Counts of gulls by plumage classes around Massachusetts Bay in September-November 1972 indicated a decrease in the proportions of chicks (4 months old) and intermediates (16 and 28 months old) to adults when compared to similar counts in 1962-1963 (Table 4). These counts suggest that the number of chicks produced in 1970 and/or 1971 was less (in proportion to the adult population) than usual for 1962-1963, and that the number of chicks produced in 1972 was proportionately still smaller.

It might be suggested that the age structure observed in autumn 1972 as compared to 1965 simply reflects early southward migration of young birds. The trend to winter farther north (Drury and Nisbet, 1972) may have been reversed between 1965 and 1972 because of less food available in New England. It seems unlikely, however, that young would have moved unusually far south as early as September and October. This is especially true for 1972

TABLE 3.
Nest counts on selected islands in 1965 and 1969.

	1965			1969		
	With eggs	Empty	Total	With eggs	Empty	Total
Massachusetts Bay						
Little Calf	243	2	245	239	22	261
Marblehead Rock	262	1	263	200	10	210
Is. south of Cat	236	0	236	226	14	240
North Gooseberry	178	5	183	93	16	109
Great Egg Rock	381	1	382	277	6	283
Norman's Woe	526	9	535	462	27	489
Total	1,826		1,844	1,497		1,592
Difference 1965-1969				−329(18%)		−252(13%)
Saco Bay						
Gooseberry	225	8	233	194	26	220
Casco Bay						
North Upper Green	193	21	214	190	64	254
Two Bush	251	26	277	157	27	184
East Brown Cow	244	18	262	226	24	250
Booth Bay						
Middle Heron	162	58	220	104	5	109
South Fox	190	21	211	131	17	148
North Hypocrite	118	16	134	105	7	112
Matinicus						
East Duck	188	9	197	151	11	162
Hog	103	34	137	70	19	89
Little Green (shore)	116	34	150	67	13	80
Fox Islands						
Green Is. Ledge	166	29	195	213	28	241
Little Brimstone	256	34	290	225	22	247
Upper Penobscot						
Sloop	112	21	133	85	28	113
Total	2,324		2,653	1,918		2,209
Difference 1965-1969				−406(17%)		−444(17%)

because the young left their colonies on the central coast of Maine about a week later than usual.

TABLE 4.
Percentages of gulls in three age categories in Greater Boston, Mass. area, September to November.

Counts—Gloucester to Boston	Adults	Intermediates	Chicks
300 counts 1962-1963	.68	.18	.14
163 counts 1972	.83	.095	.069

(2) Breeding success. The lower proportion of chicks relative to older categories suggested in the fall counts in 1972 might reflect increased mortality of chicks either before fledging, i.e., on the colony, or after fledging.

Pre-fledging reproductive success, measured as the number of chicks reaching 15 days (Kadlec et al., 1969), were made on six islands in Penobscot and Jericho Bays, Maine, two islands in Salem Harbor, Massachusetts, and on Block Island, Rhode Island, between 1964 and 1973 (Table 5). The data suggest lowered reproductive success on these islands in 1969, 1970, and 1971. On Block Island, hatching success was high through 1971, perhaps indicating that the problem has been in the post-hatching period. However, there has been some indication of a recent reduction in numbers of breeding gulls and an increased proportion of unhatched eggs on the study area at Block Island (Merrill and Virginia Slate, pers. comm.).

A test for increased early post-fledging mortality was made by comparing recovery rates by three-month periods of 198 recoveries of chicks banded in 1969 with 3,844 recoveries from chicks banded before 1965 (Kadlec and Drury, 1968a; Nisbet and Drury, 1972). Although the mortality patterns were not identical, there was no evidence that significantly greater mortality in the first three months following fledging occurred in the 1969 sample as compared to the pre-1965 sample. The data will be made available on request.

The most reasonable conclusion seems to be that there has been an increase in pre-fledging and immediately post-fledging mortality of young in recent years. The winter age ratio is the most sensitive measure of this trend. A census of the Atlantic Coast such as that conducted in 1965 would establish this age ratio accurately.

In sum, all these data from field measurements tend to agree that the growth of the Herring Gull population has been slower between 1965 and 1972 than between 1900 and 1965 (Kadlec and Drury, 1968a). Therefore, we have re-examined other data to see whether the trends are recent or our previous conclusions were incorrect.

When did the rate of increase change? We have examined two sources of information, the early winter population size as indicated by Christmas Counts and the population growth rate indicated by periodic breeding censuses taken between 1900 and 1965.

(1) Christmas Counts. In our previous paper we used a sample of Christmas Counts chosen for consistency of coverage (Treat-

TABLE 5.
Measurements of reproductive success: young produced per nest—islands in Penobscot Bay, Maine, Salem Harbor, Mass., and Block Island Sound, R. I.

	1964	1965	1966	1967	1968	1969	1970	1971	1973
Penobscot Bay									
Little Green Is.		.4		.6	.6(.7)[1]	.6(.3)	(.2)		.6
Little Brimstone E.	1.3	1.6		.85	1.0	.75			.8
Popplestone				.5	.8	.8			.6
Sloop Is.		1.0		.3	.4	(.2)	(.2)		
Flat Is.					.9(.6)	.5(.3)	(.2)		
Goose Rock					(1.1)	(.7)	(.6)		
Salem Harbor									
Is. South of Cat	1.2	1.1	1.3	.5	.5	1.4			1.24
Marblehead Rock	1.0	.93	.8	.4	.3	1.1			.8
Block Is. Sound									
Block Is. (Fledge)	1.9	1.0	1.5	1.4	1.5	1.0	1.0	.9	.7
(Hatch)		2.0	2.3	2.4	2.0	2.3	2.1	2.0	

[1]Measurements in parentheses are from Hunt (1972). Differences between our measurements and those of Hunt are explained in part by the choice of different study plots on the same island, and probably also by the greater degree of disturbance involved in Hunt's study.

ment B, Kadlec and Drury, 1968a) to describe the growth of the New England Herring Gull population. Extending the earlier data through 1971 did not indicate any change in growth rate. The Christmas Count data may be insensitive to minor changes in the New England population because (a) Canadian gulls are mixed with the New England birds in winter, (b) we have data only through 1971, and (c) the technique uses a three-point moving average that delays the appearance of changes. Nevertheless, these data suggest that the increase of the gull winter population has been continuous from about 1950 through 1970. If the New England breeding population has not increased for several years, a very large increase in the relatively small Canadian population would be necessary to produce the continued increase in the wintering population of New England. Yet, the 1970 breeding population of Nova Scotia was only about 14,000 pairs (Lock, 1971).

(2) Historical and geographical changes in the rate of increase. In Table 6, data on the mean annual rates of increase of the New England population are divided into the Maine and southern New England sub-areas.

This analysis indicates a decline in growth rate dating back to the 1940s for Maine, perhaps reflecting control measures, but the decreased rate continues up to 1965. Southern New England showed very high growth rates from 1938 to 1948, much higher than reasonable without immigration (Drury and Nisbet, 1972). The differential increase in southern New England has continued since 1950 but at a decreasing rate.

TABLE 6.

Mean annual rates of increase $\left(\frac{100}{p}\lambda\right)$ of the breeding population (% per year).

Period[1]	Maine	Southern New England	All New England
1905-1920	+5.9		+5.9
1920-1931	+2.5		+2.5
1931-1938	+3.1		+3.1
1938-1942	+3.0	+15.0	+9.8
1942-1945	−3.2	+15.0	−0.5
1945-1948	−2.8	+44.2	+9.1
1948-1953	−3.5	+ 3.9	−0.5
1953-1965	−0.7	+ 1.7	+0.6
1965-1972	+0.8	+ 1.1	+1.0

[1]Periods were determined by availability of population estimates in 1905, 1920, 1931, 1938, 1942, 1945, 1948, 1953, 1965 and 1972. Rates are mean exponential rates over intervening years, given by:

$$e^{\lambda \Delta t} \quad \frac{N_{t+\Delta t}}{N_t}$$

where λ = mean annual rate of increase as a decimal
N_t = breeding population in year t
Δt = number of years between population estimates.

This re-analysis suggests that the conclusion in our earlier paper (drawn from the overall growth rate between 1905 and 1945, and local rapid increases in southern New England between 1962 and 1965) was evidently too high for the regional population as a whole in the period 1955-1973. Between 1905 and 1945 the population doubled approximately every 15 years (10,000-63,000 pairs). Between 1951 and 1973 the growth rate of the population was equivalent to doubling approximately every 40 years (59,600-89,600 pairs).

What is happening in the New England Herring Gull population? In this section we speculate about the implications of our data by comparing the age ratio found in 1965 with that found in the counts made in early autumn 1972. These are assumed to be the best indicators of what is happening in the population as a whole.

Table 7 illustrates the changes in age ratio which result from changing several population parameters. Year 1 in Table 7 is the stable age distribution appropriate to the rate of population increase we believed was in progress in 1965. In projection A and B, survival of chicks to September was drastically reduced in year 2 and the population began to decrease. Projection A differs from B only in the adult mortality rate; this has almost no effect on the age distribution, even though it did affect the rate of population decrease. Projection C allowed better chick survival to September and this had a marked effect on the age distribution. Projection D allows the population to increase slowly with an associated increase in the fraction of nonbreeding adults.

TABLE 7.
Changes in age ratio from hypothetical changes in fledging rates or survival rates.[1]

	Year 1	2	3	4	5	6	7	8	9	10
A. Adult survival = .92, 0.3 young/breeding female, 20% nonbreeding.										
Adults	.68	.74	.79	.87	.86	.85	.85	.85	.85	.85
Intermediates	.17	.21	.16	.08	.08	.09	.09	.09	.09	.09
Chicks	.15	.05	.05	.05	.06	.06	.06	.06	.06	.06
Relative population size	100	94	91	88	85	82	79	77	74	72
B. Adult survival = .94, 0.3 young/breeding female, 20% nonbreeding.										
Adults	.68	.74	.80	.87	.86	.86	.85	.85	.85	.85
Intermediates	.17	.21	.15	.08	.08	.08	.09	.09	.09	.09
Chicks	.15	.05	.05	.05	.06	.06	.06	.06	.06	.06
Relative population size	100	96	94	93	92	90	89	88	87	86
C. Adult survival = 0.92, 0.5 young/breeding female, 20% nonbreeding.										
Adults	.68	.72	.75	.80	.79	.79	.78	.78	.78	.78
Intermediates	.17	.21	.17	.12	.12	.13	.13	.13	.13	.13
Chicks	.15	.07	.08	.08	.09	.08	.09	.09	.09	.09
Relative population size	100	97	96	95	95	94	93	93	92	92
D. Adult survival = 0.94, 0.5 young/breeding female, 30% nonbreeding.										
Adults	.68	.73	.77	.83	.82	.81	.81	.81	.81	.81
Intermediates	.17	.21	.16	.10	.10	.11	.12	.11	.11	.11
Chicks	.15	.06	.07	.07	.08	.08	.07	.08	.08	.08
Relative population size	100	98	98	98	99	99	100	100	101	101

[1]Age ratio in year one corresponds to 1965 winter observation.
Other survival values from Kadlec and Drury, 1968a.

None of the age ratios projected matches the observed ratios (Table 4) exactly. It would be possible to adjust various parameters until a match was made, but this would be only an academic exercise. Nevertheless, it appears that there has been a reduction in reproductive success and perhaps an increase in the percentage of nonbreeding birds.

Our previous studies indicated that the proportion of nonbreeding adults has been significant ever since the beginning of our study, about 20% between 1962 and 1965 (Kadlec and Drury, 1968a). We have no data on whether the proportion of nonbreeding birds is increasing at present, but the rapid replacement of territorial adults that were removed from breeding colonies in recent years suggests that competition for territories is intense (Drury and Nisbet, 1972; J. Peterson and F. Gramlich, pers. comm.).

DISCUSSION

We interpret these results as indicating that the New England Herring Gull population as a whole has been gradually stabilizing over the last two decades. The breeding population of Maine's islands appears to have been essentially stable since the end of the control program in 1953. At present, the gulls on colonies in southern New England and New York are acting as if the colonies were fully occupied, although land area is still available. This change in the breeding population is a major one because only a few years ago the gull populations of Nantucket Sound and Block Island Sound were thriving.

If the observed effect reflects decrease in reproductive success and increased mortality of immatures as a result of competition for limited resources, the whole regional population may be reaching its upper limits. Alternatively the effect may reflect continued reproductive success, yet increase in the number of nonbreeding birds (which is more consistent with the indications of the Christmas Counts) in which case the long term trend of a geographical shift to the southward may continue. After the Maine islands "filled up," gulls colonized the southern New England and New York coastal islands during the 1940s. In the last 20 years gulls have occupied the remaining islands suitable for colonization in southern New England (Tables 1 and 6).

In recent decades a number of reports of Herring Gulls nesting south of New York as far as the Outer Banks of North Carolina have been published (Stewart and Robbins, 1958; Ames, 1963; Hailman, 1963) but the numbers of gulls nesting on these colonies have not increased until recently. Perhaps environmental factors south of New York are not favorable for Herring Gull breeding success. Furthermore in recent years the majority of gulls winter in the metropolitan areas north of Chesapeake Bay (Kadlec and Drury, 1968a; Drury and Nisbet, 1972). Thus the experience of having become familiar with suitable breeding islands near the wintering grounds, which may have influenced the rapid growth of gull colonies in southern New England, may not be important in the south Atlantic States. Alternatively, as population pressures grow in the Northeast, we may expect an increase in the colony size along the middle and south Atlantic coastal states.

SUMMARY

The results of an aerial census taken in 1972 indicated that there had been little change since 1965 in the number of Herring

Gull pairs breeding between New Jersey and New Brunswick. Validity of the observation was tested against the results of two additional techniques of measuring gull populations. Measurements of reproductive success over the last decade suggest a recent decrease in productivity. Population data over the last two decades indicate that the population has been gradually stabilizing. We speculate on the implications.

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