POPULATION CHANGES IN NEW ENGLAND SEABIRDS

By William H. Drury

This paper reviews the historical changes in seabird populations between New York City and the Grand Manan Archipelago, New Brunswick, after 1900. Special attention has been given to species that nest on treeless outer islands of the coast of Maine. In a companion paper Nisbet (1973) treats the history of the tern populations, concentrating on the area between Cape Cod and Long Island. The purpose of this paper is to compare the results of a pilot survey made in the last few years to the population changes of the last 75 years.

INTRODUCTION

The recent history of the seabirds in New England is unusual in two ways. First, many seabirds along the Northeast Coast have enjoyed a period of extraordinary population growth and range expansion during the last 75 years. Second, censuses have been taken at about 20-year intervals thus making it possible to follow these changes.

Seabirds were almost completely "eaten off" the outer islands during the 18th and 19th centuries (Bent, 1919, 1921, 1922, 1925; Dutcher, 1901, 1902, 1903, 1904, 1905; Forbush, 1925; Norton, 1907, 1923, 1924a, b, 1925a, b). Double-crested Cormorants (*Phalacrocorax auritus*) and Great Black-backed Gulls (*Larus marinus*) had disappeared from the coast as breeding birds early in the 19th century. By the 1870s Common Eiders (*Somateria molissima*), Common Puffins (*Fratercula arctica*) and Black Guillemots (*Cepphus grylle*) were essentially eliminated and the remnant populations of Herring Gulls (*Larus argentatus*) were driven to small outer islands. Only small birds of relatively little food value, such as Leach's Petrels (*Oceanodroma leucorhoa*) and terns (*Sterna* sp.), survived in large numbers. Two great campaigns of shooting seabirds for the millinery trade, about 1876 and 1896, nearly eliminated all seabirds except petrels (Norton, 1923, 1924a, b, 1925a, b). The low ebb of seabird populations in New England seems to have been between 1890 and 1906.

Evidence of the lack of gulls at the turn of the century in southern New England is provided in 50 photographs taken by Gleason in 1903 of the shores of Cape Cod and the fishing fleet at Provincetown; these show no gulls. Wheelwright (1971), in editing Thoreau's writings on Cape Cod (with which Gleason's photographs are included), commented on this lack and showed her own surprise at it: "It would actually be difficult to catch a scene on the Bay side without gulls being part of it. . . . We can only guess at the explanation for this lack. . . ."

As a result of public outcry the legislatures of Maine and Massachusetts passed "model" bird protection laws. Public subscription raised the "Thayer Fund" of $1,400, and the American Ornithologists' Union, together with the Audubon Societies, hired wardens to

[1]Contribution No. 105 from the Scientific Staff, Massachusetts Audubon Society.

protect 13 island seabird colonies in New England from Penikese in Buzzards Bay to Old Man in Machias Bay (Dutcher, 1901).

It is apparent from reading the official reports by Dutcher, Norton, and others that the elected members of the several legislatures and the owners of the millinery companies were responsive, sympathetic, and cooperative. Their reaction contrasts sharply with the antagonism shown by many agricultural and chemical industries and governmental agencies during the 1950s and 1960s. Perhaps the economic problems were simpler then, and probably those who were directly affected had less power. Perhaps the problems were more wisely handled. The administrators of the Thayer Fund made a practice of hiring the owner of an island to be the warden. The owner was not required to explain bird protection; he merely had to enforce laws of trespass.

The response of gulls and terns to protection was immediate and spectacular. The course of events during the following three-quarters of a century is described in the following pages.

Justification and significance

Because seabird populations are sensitive to habitat changes in the shallow sea and coastal zone, they should continue to prove useful in the next decades as bioassays of the health of this area where chemical pollution and heavy human exploitation have become important ecological forces. At present chemical pollution seems to be the most serious because it is so pervasive. Many wildlife populations have been shown to be contaminated with chemicals and some population changes in wildlife species have been associated with specific pollutants. Scattered measurements show that some New England seabirds carry a body burden of contaminants—heavy metals, pesticides, PCBs, and other industrial chemicals—whereas others are relatively free of them.

Populations considered here (eiders, gulls, terns, and alcids nesting on the outer islands) have apparently been largely spared contamination with persistent pesticides. Hickey and Anderson (1968) found eggs of Herring Gulls on the outer islands off the coast of Maine to be almost free of chlorinated hydrocarbons and their eggshells showed very little thinning. Thus the Maine coast population was a useful control for studies of the heavily contaminated gulls of the Great Lakes. Body burdens of gulls on the inner islands is unknown. In contrast, several tree-nesting species of the inner islands —Great Blue Heron (*Ardea herodias*) Black-crowned Night Heron (*Nycticorax nycticorax*), Osprey (*Pandion haliaetus*), and Bald Eagle (*Haliaeetus leucocephalus*)—have decreased. All these species have been shown to be contaminated with chlorinated hydrocarbons and their eggshells thinned to critical levels in some areas (Ames and Mersereau, 1964; Ames, 1966; Sprunt, pers. comm.; Hickey, 1969; Vermeer and Reynolds, 1970; Vermeer and Risebrough, 1972). The terns of Buzzards Bay, Block Island Sound, and Long Island Sound carry a variety of toxic industrial chemicals (chlorinated hydrocarbons including PCBs, and mercury) (Gochfeld, 1971; Hays and Risebrough, 1972; Nisbet (pers. comm.). Those in the Great

Lakes contain a slightly different mix, and perhaps by making comparisons, causative agents can be isolated.

Perhaps the most serious environmental hazards to pelagic seabirds are many small oil spills (Tuck, 1957, 1960). Several large spills and a steady incidence of small spills of crude oil have occurred along the new England coast, but their impact on the seabirds has not yet been measured because the censuses available have not been precise enough. Previous counts of key species were made 20-30 years ago and populations have in some cases doubled more than once since those counts were made. Unfortunately for seabirds, there are grand designs for several deep-water oil terminals and oil wells off New England's islands.

Published sources

Breeding censuses were taken in the first decades of the century (Dutcher, 1901, 1902, 1903; Norton, 1907, 1923, 1924a, b, 1925a, b) because seabirds were endangered nesting species in New England. In the later decades censuses have been made in the course of research and management activities generated by "the gull problem" (Gross, 1951b; Drury, 1963; Kadlec and Drury, 1968a)[2]. In addition, many scattered reports of the numbers of birds seen over or around the colonies have been made by "birders." Comments occasionally included the number of pairs thought to have nests.

Secondary sources have been used extensively in the historical review. Dutcher and Norton summarized the many published articles on the distribution and numbers of seabirds during the last two decades of the 19th century and the first two decades of the 20th. Data gathered during the 1930s and 1940s have been reviewed by Allen (1931, 1937), Norton and Allen (1931, 1932), Gross (1944b, 1944c, 1945b) and by Palmer (1949).

The following additional sources have been valuable: (a) parts of a manuscript report to the National Audubon Society on their 1931 census by R. P. Allen and A. H. Norton (1931), (b) mimeographed annual reports on the Herring Gull and cormorant control program by Gross (1944a-1952a), (c) Gross's field notebooks, and (d) material extracted from many sources by Palmer (pers. comm.) These reports were made available by the librarian of Bowdoin College. Copies of nearly all materials, including additional data supplied by Palmer are on file at the library of the Scientific Staff, Mass. Audubon Soc. A number of counts were found in *Records of New England Birds* and in *Audubon Field Notes* (later *American Birds*). These are abbreviated RNEB, AFN, and AB in the text.

Many of the numbers included in this review were compiled from scattered visits to seabird islands. Many of these visits occurred at

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[2]Beginning in 1934 the U. S. Fish and Wildlife Service and the Maine Department of Sea and Shore Fisheries embarked on a program to control the gull population of New England. Between 1934 and 1938 eggs were needled to inhibit breeding, but the results were not satisfactory. Between 1939 and 1941 (Spear 1942) Gross experimented with several techniques for killing the embryos without having the eggs rot and burst. By 1940 large-scale field experiments included collecting eggs for food for fish hatcheries or spraying eggs with a mixture of oil, formaldehyde, water, and a dye. In 1944 the control program was extended to include Double-crested Cormorants. Both control programs were stopped in 1953.

inappropriate times of year, and in many cases the counts were made by observers of diverse interests and experience. Seldom was an attempt made to make a systematic census of a geographic unit or to count nests on any one island. It is often not clear whether numbers represent pairs or individuals. Hence scattered individual reports are useful only within the context of the systematic coverage by Dutcher, Norton, Allen, and Gross.

Citations are not given for each entry in the tables that follow because they would add confusion to the already great complexity. All publications used are cited at the end of the text. A number of judgments and interpolations have been made, but when these are important the numbers are put in parentheses. Published estimates of gulls and terns that are believed to represent individuals have been divided by 1.5 as an approximation of the number of breeding pairs (for discussion see Nisbet, 1973).

Recent censuses by the author

Censuses made after 1962 have included estimates made from low flying aircraft and counts made from boats. In some cases landings were made to count nests not visible from the boat or to make incubating terns fly up.

Aerial censuses were made of Double-crested Cormorants, Herring Gulls, and Great Black-backed Gulls. Some tern colonies were found from the air. Nearly all the censuses reported were made from low-flying, fixed-wing aircraft, primarily the U. S. Coast Guard "Albatross." The 1972 census was made from a U. S. Bureau of Sport Fisheries and Wildlife "Beaver."

Aerial census of gulls (not separating Herring and Black-backed) were made in 1962 and 1963 by me with J. A. Keith and P. R. Mott. In 1964 and 1965 similar censuses were made with J. A. Kadlec. These censuses extended from Sandy Hook, N. J., to Eastport, Me. In 1972, Double-crested Cormorants, Herring Gulls, and Great Black-backed Gulls were censused with Kadlec between Cape May, N. J., and the Grand Manan Archipelago, N. B.

Surface counts of gulls were made in 1965 with J. Kadlec, M. Libby, and D. Weaver in Boston Harbor, the Isles of Shoals, and along the coast of Maine between Saco Bay and Swan's Island. Occasional counts of Double-crested Cormorants, Common Eiders, or Black Guillemots were made but there was no systematic coverage. In May and June 1969 and 1970, surface estimates and counts of gulls, Common Eiders, and in some places Black Guillemots were made with I. C. T. Nisbet and D. V. Howard between Machias Bay and Penobscot Bay. In 1971, a systematic count of gulls, terns, and Common Eiders was made between Saco Bay and Jonesport. In 1972, systematic counts of all species were made between Cape Porpoise and Swan's Island. In early May 1973, systematic counts of adult male Common Eiders and of Black Guillemots were made between Great Duck Island, Me., and Maces Bay, N. B., including the Grand Manan area. In June 1973, a pilot survey was made of "the outer islands" (Fig. 1) to assess the breeding population of Leach's Petrels.

The Massachusetts coast has been censused from the surface for terns each year between 1968 and 1972, and additional censuses of terns for 1972 are available for the coasts of Connecticut and Long Island through cooperators (Gochfeld, Duffy, and others). Air and surface census data from 1971 are available from the coast of Nova Scotia (Lock, 1971) and several areas in the Gulf of St. Lawrence (Nettleship and Pearce, pers. comm.)

The counts listed for 1972 in the following tables are air estimates of Herring and Great Black-backed gulls and surface estimates of Laughing Gulls (*Larus atricilla*) and terns. They represent surface counts of Double-crested Cormorant nests, all female Common Eiders seen around each island, and the total count of Black Guillemots divided by 1.5. These counts are totaled by geographic regions.

Precision and error

The techniques for estimating seabirds (The Seabird Group, 1969; Nettleship, 1972a; Kadlec and Drury, 1968b)—that is, by estimating or counting the birds seen around or recorded on photographs of a colony—appear to be so approximate as to be of little comparative value. But counts of nests (apparently the most adequate technique for usual standards of rigor) are impossibly time-consuming to be applied over any large area. Moreover, the precision indicated by nest-by-nest counts is more apparent than real. A count of nests made at any one time, especially in the case of gulls and terns, misses early clutches that have been lost, late clutches not yet laid, and omits territorial birds that fail to lay eggs (Kadlec and Drury, 1968, Nisbet and Drury, 1972a). Furthermore, counts of nests made on one island over a 7-9 year period have varied by 9-33%, usually 12-15%. Moreover, it is difficult to know whether or not nonbreeding birds or ineffective breeders should be included in the population estimates. They may amount to 10-25% of the regional population and are of importance in forming new colonies.

Counts of territorial pairs tend to compensate for the limitations of nest counts. Such counts can be made from the surface or from enlarged prints of photographs taken from low-flying aircraft. But the day-to-day, tide-to-tide and hour-to-hour variations in the number of birds on any island are high (Kadlec and Drury, 1968b). This is because at one extreme all territorial birds may be present and be joined on the island by a large number of nonbreeding birds. At the other extreme, when the birds are off fishing, when a "dragger" is cleaning fish, or when a shoal of fish appears, so many birds leave that some territories may be left unoccupied. Our experience indicates that no unique number is characteristic of a colony. Air estimates varied somewhat more than nest counts (20-30%, Kadlec and Drury, 1968b). This variation includes fluctuations in the number of birds on the island and errors in estimation. Inconsistencies are minimized when estimates are totaled within subregions (Kadlec and Drury, 1968b; Table 5).

A few published estimates differ markedly from the rest. Norton (1924a, census cards) estimated 10,000 Herring Gulls on Metinic Green in 1921; Russell estimated 12,000 *pairs* of Arctic Terns

(*Sterna paradisaea*) at Machias Seal in 1972 (AB) whereas Hatch, Nisbet, and Drury estimated 4,500 pairs in 1970. Merrill and Meservy estimated 10,000 individuals (6,500 pairs) in 1971 (Baldwin, 1971 and in litt.). Borror (AB, 1972) made "careful June estimates" of gulls at the Isles of Shoals and reported 2,755 pairs of Great Black-backed Gulls (compared to 1,150 in this census) and 9,150 pairs of Herring Gulls (compared to 6,250).

When estimates differed markedly from the trend of estimates in the middle years of this period, they were discarded. Recent or contemporary estimates will be checked. Such comparisons are a critical part of assessing the precision and reliability of the census. They also emphasize that it is necessary to decide what information and conclusions are to be derived from the data and what limits of error are tolerable. Conspicuous changes in populations during each 10-year period of this century appear in the available data, even in the presence of 20-30% error in estimates.

The original data from which the tables were prepared are on file (a) on cards prepared by Norton at the library of the University of Maine, (b) Gross's field data sheets at the Bowdoin College Library, and (c) colony estimates of the present census series at the Massachusetts Audubon Society.

Geographic location of islands

Use of names of individual islands has been kept to a minimum, but in many cases specific references will be valuable to those with local interests. In order to refer to as few names as possible in the text, the coast of the Gulf of Maine has been divided into sections on the accompanying map (Fig. 1). When an island or group of islands is referred to in the text, it will be followed by the name of the appropriate geographical region in parentheses.

SPECIES ACCOUNTS

Oceanodroma leucorhoa. Leach's Petrel.

Materials and census techniques. The little information available is imprecise. Estimates have been made at long intervals and have usually been based on single visits without systematic search. Nesting burrows are hard to count.

Events of the last 75 years. In contrast to the other seabirds, Leach's Petrels seem to have decreased steadily since 1900 or before. A summary statement of reports is included as follows:

> In the Grand Manan Archipelago W. Gross (1935) reported: Outer Wood (Little Wood) 12,000 burrows; East Green 2,000; West Green 30; Whitehead 500; Kent Island 10,000. Wilbur (1969) noted 15,000 burrows on Kent Is. Previously Townsend (1923) had reported petrels "present" on these islands and on Whitehorse in addition. Machias Seal was reportedly the largest colony on the coast in 1900 (about 2,000 burrows); it was reported to be large in 1931, to contain 1,000-3,000 in 1935, 2,000 in 1950 and 200 in 1970.
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> On the Maine coast in 1900 (Dutcher, 1904; Norton, 1925b) large colonies were reported in eastern and western Maine on the Brothers (Machias Bay) and on Shark, East-

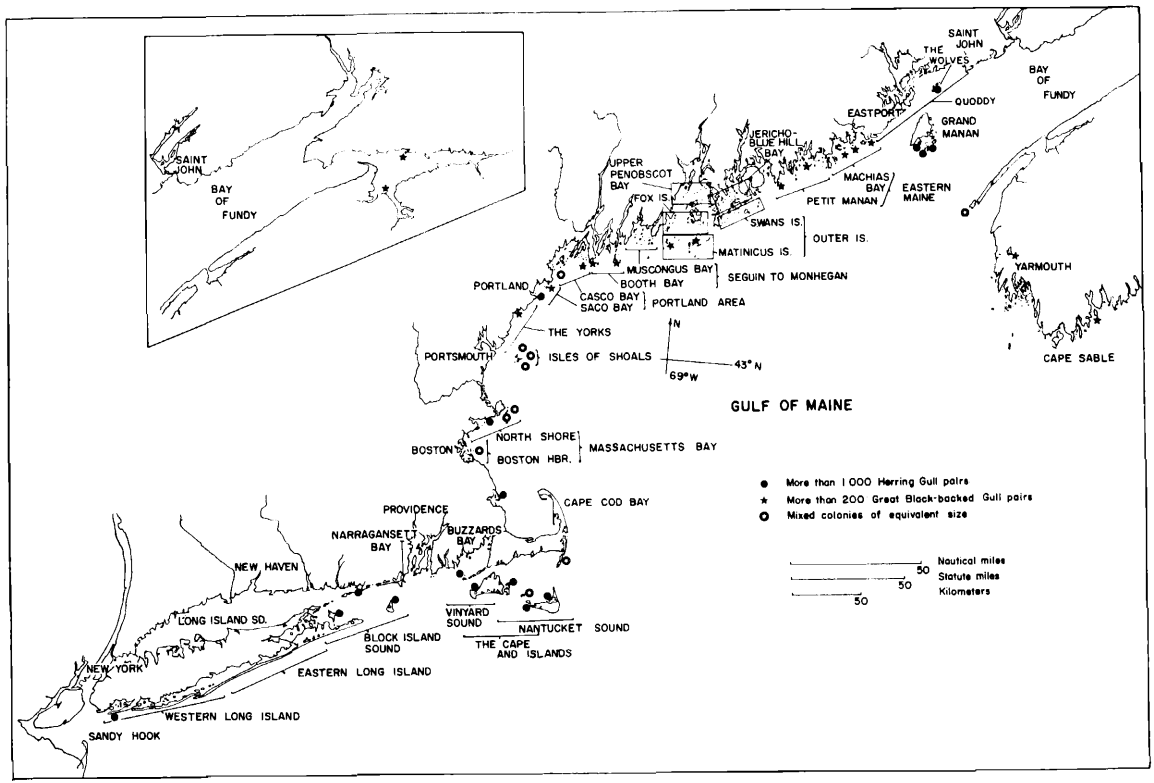

FIGURE 1. The area reviewed. Islands mentioned in the text are located by reference to geographical subregions. The subregions used are identified on this map.

ern Egg and Western Egg (Muscongus Bay) but no petrels nested on the Outer Islands: small colonies on John's, Little Spoon (Swan's Is.), Matinicus Rock, No Mans Land, Metinic and Metinic Green (Matinicus Is.). Considerable or enormous colonies were reported on Large Duck (2,000±), Little Duck, Great Spoon (Swan's Is.), Matinicus Seal, Wooden Ball, Large Green, Little Green (Matinicus Is.)

In 1931 Allen and Norton (1931 Ms.) reported small colonies at John's (Swan's Is.), Matinicus Rock, Large Green and Little Green (Matinicus Is.). They reported large colonies at Machias Seal, Large Duck, Little Duck, Matinicus Seal, No Mans Land (Matinicus Is.).

More recently the reports are very scattered. At Matinicus Rock Courson (1957) reported 65 burrows in about half the colony, and Buchheisters (1968) reported 300-400 burrows. Staff of the National Audubon Camp of Maine have recorded 12-20 burrows on Eastern Egg Rock in 1940 and 17-24 in 1963 (Morse, 1963).

Our 1973 survey suggested that fewer than 25 burrows existed on Metinic, fewer than 5 burrows on Metinic Green, fewer than 5 burrows on Large Green, 25-45 burrows on No Mans Land, 50-75 burrows on Wooden Ball, 2,000-2,500 on Matinicus Seal Island (Matinicus Is.). In the Swan's Islands area we recorded fewer than 5 burrows on Great Spoon, fewer than 5 burrows on Johns, 800-900 burrows on Great Duck Island, and 400-500 pairs on Little Duck. About 10 burrows were found on Brimstone Island (Fox Is.). No traces of petrels were found on Roberts or Otter Island (Fox Is.), on Ten Pound Island (Matinicus Is.), or on Little Spoon, Heron and Green Island (Swan's Is.).

The survey was made by transects of typical vegetation and soil types. The areas searched were 10-15% of the island and were chosen so as to cause as little disturbance of breeding Common Eiders as possible.

The major colonies in 1900 included Wooden Ball, Matinicus Seal (Matinicus Is.), Large Duck and Little Duck (Sean's Is.) on the Maine coast, and Machias Seal in New Brunswick, the largest at that time (Dutcher, 1904).

During the early decades predation by dogs and cats brought in by people was a serious danger. The lighthouse keeper's dog, which killed many petrels every day at Machias Seal, was a cause for concern for Pearson (1911). By 1910 the colony at No Mans Land (Matinicus Is.) had declined because many birds were killed by cats and dogs brought in with fish camps (Smith in Pearson, 1910). The same story was reported for Great Spoon (Swan's Is.), and Large and Little Green (Matinicus Is.). The population on Wooden Ball was reportedly reduced to a trace by 1905; the population on Matinicus Seal Island was much reduced by 1907, and that on Metinic Green (Matinicus Is.) had nearly disappeared by 1940 (Norton, 1925b).

Allen and Norton (1931) did not census petrels but reported occupied burrows on 12 of the islands they visited. They presumed that 7 others were "probably tenanted" but did not land because of surf. At that time the colony at Great Duck was second only to that at Machias Seal. They believed that petrels had decreased

even more alarmingly than terns. Allen (1937) reported that when he visited 5 of the 10 islands where petrels were found in 1931, he found petrels still on three.

A. Gross (notebooks) reported many fewer on East Green and Outer Wood (Grand Manan) in 1938 than reported in 1935 (W. Gross, 1935). In 1946, only the comment that petrels were present was made for Little Wood. Huntington (pers. comm.) reported only a few on Green Island in 1959 and none in recent years. He reported further that during the period that he has been at Kent Island, Grand Manan Archipelago, there has been no significant decline in the numbers nesting at that important colony. Some burrows have been abandoned as a result of human disturbance and probably none nest in the gull colony on the south end of the island.

In 1936-1940 Gross (1945c) and Cruickshank (1952) reported 100 pairs of petrels on Little Green (Matinicus Is.), but Palmer (1938) reported not over 20. Cruickshank (1952) reported not over 25. In 1965 we found about 15 burrows and in 1973 fewer than five.

Townsend and Allen (1933) discovered an isolated colony on Penikese Island in Buzzards Bay in the early 1930's. Hagar (pers. comm.) collected a juvenile on 23 August 1940 which he deposited in the collection of the Boston Society of Natural History. He mapped the location of 90 burrows on 21-22 May 1941. When Hagar went back in 1952, the colony was already much reduced. In the last two decades Penikese has become a large gull colony and only 2-6 burrows have been found in the last four years. A superficial search of No Mans Land southwest of Martha's Vineyard on a moonlight night in 1971 gave no sign of petrels.

Neighboring populations

Knowledge of petrels breeding in Nova Scotia is apparently as vague and limited as it is in Maine. Lock (1971) in his pilot census listed 13 islands where petrels have been recently reported, but suggests that many more islands are probably occupied.

Comments

The presence of sheep has a seriously detrimental effect on nesting Leach's Petrels. Matinicus Seal and Wooden Ball Islands (Matinicus Is.) are similar in size and lie next to each other in the approaches to Penobscot Bay. Both had large petrel colonies 75 years ago. Wooden Ball has about 30 sheep on it, is covered with a dense, grassy turf, and now has only a remnant breeding population of petrels. In contrast, Matinicus Seal Island has had no sheep for about 30 years while it was used as a bombing and strafing target. It has a varied heathy plant cover, peaty soil and a large petrel colony. Little Green and Large Green, like Wooden Ball, have been transformed by sheep and their petrels have all but vanished. Matinicus Rock, lacking sheep, has a varied vegetation and a large petrel colony.

Metinic Island, No Mans Land, Ten Pound (Matinicus Is.), Roberts, Otter, Brimstone (Fox Is.), Large Spoon, Little Spoon, Heron, John (Swan's Is.), Nash, Flat, Fisherman's (Petit Manan), Halifax, the Brothers and the Libby Islands (Machias Bay) have

sheep on them or show conspicuous effects of their presence. Petrel colonies are very small or lacking on them.

Phalacrocorax auritus. Double-crested Cormorant.

Materials and census techniques. Double-crested Cormorant nests are convenient to count and nearly all reports have included counts of nests. Allen and Norton's census in 1931 occurred soon after the first Double-crested Cormorant colonies were re-established. Gross (1944c) reviewed the status of the species on the coast of Maine until that date. His notebooks include island-by-island records until 1953. Detailed records for Muscongus Bay 1931-1944 appear in Kury (1969) and are extended to the present in Table 1. These show the marked year-to-year differences in numbers of nests at any one colony.

Double-crested Cormorant colonies were located during air censuses for gulls in 1962-1965. In 1972, the numbers of nests were estimated during the census flight. These estimates were tested against counts of nests made from a boat during the first week of July 1972. The comparison of air estimates with surface counts on 65 islands between Saco Bay and Swan's Island indicated that our air estimates are 15-20% low (Table 2).

Double-crested Cormorant colonies, like those of terns and Black-crowned Night Herons (but unlike gulls), may abruptly move to another site in response to disturbance. Double-crested Cormorants nesting in the approaches to Swan's Island moved from Brimstone to Spirit Ledge in 1972. In 1962 the birds nesting on Milk Island moved to South Gooseberry Island, and in 1971 from there to the small island south of Cat Island (north shore Massachusetts Bay). For this reason all counts used in estimating the total population of an area should be taken in a single year.

Events of the last 75 years. The history of this species in Maine in the 17th-19th centuries is reviewed by Mendall (1936). Baird, Brewer and Ridgway (1884) and Townsend (1905) stated that they formerly nested in Essex County, Mass. They were killed off the New England coast in the early 19th century (Audubon, 1835 in Mendall, 1936; Dutcher, 1901).

Seven nests were reported in 1893 on Black Horse Ledge (Swan's Is.) (Knight, 1900) and those were quickly eliminated by egg collectors. There were two nests in 1896. Then the species was not recorded nesting in Maine again until 1925 (Norton and Allen, 1931; Gross, 1944c). However, during these years many young and adult Double-crested Cormorants loafed on several rocky outer islands in Penobscot Bay, Jericho Bay, Pleasant Bay (Petit Manan area), and Machias Bay.

Table 3 shows numbers of nests totaled by geographic regions. In 1931, Allen and Norton (1931) found Double-crested Cormorants nesting in 5 places: Old Man, Pulpit Rock (Machias Bay), Spoon Ledge (Swan's Is.), Marblehead Rock (Fox Is.), Old Hump Ledge (Muscongus Bay). They found them loafing on 16 additional islands. In the next few years new colonies were established and grew rapidly. Mendall (1934) found 1,200 pairs nesting.

TABLE 1. Nest counts of Double-crested Cormorants at Muscongus Bay

Location	1945	1946	1947	1948	1949	1950	1953	1965	1966	1967	1972
Old Hump	434	415	203		290			0	49	41	0
Mosquito Rock	209						147	75	172	219	140
Shark Rock	696	657	388		579			350	300	272	158
Western Egg Rock	796	952	135					605	870	1,031	515
Hay Ledge	248		322	299	257	141	120	125	337	362	200
Shag Ledge E							300	150	104	133	60
Shag Ledge W							86	—	57	82	
Long Ledge							143	150	230	334	12
Franklin Island									12	—	
Coombs Ledge											85
Jones' Garden											15
Eastern Egg			26					20	25	—	75
Total	2,383	2,024	1,074		1,126		796	1,475	1,819	2,112	1,260

[1]Figures for 1953, 1966 and 1967 are published by Kury (1969); figures for 1945 through 1950 are from Gross's notebooks; figures for 1965 and 1972 are from my censuses. Mosquito Rock (its local name) is listed on most charts as Little Egg Rock.

TABLE 2. Double-crested Cormorant nests estimated from the air and counted from the sea[1]

Location	Air	Sea
Saco Bay	125	130
Casco Bay	1,525	1,840
Booth Bay	685	985
Muscongus Bay	1,100	1,160
Matinicus Is.	285	385
Fox Is.	685	735
Penobscot Bay	940	1,380
Jericho Bay	1,910	1,985
Swan's Is.	520	525
Total	7,775	9,125

[1]Only directly comparable islands are included. Data from 1972.

The growth of the population was spectacular between 1925 and 1945 (Fig. 2), reaching about 13,000 pairs on 38 colonies along the Maine coast (Gross, 1944c). In the same years young Double-crested Cormorants regularly loafed in flocks on another 35 islands. The species expanded its range southward past the Isles of Shoals to Shag Rocks, Boston Harbor (Hagar, 1941) and to the Weepecket

TABLE 3. Pairs of Double-crested cormorants nesting in New England[1]

Location	1931	1936	1940	1943	1945	1950	1965	1972
Long Island Sound								30
Block Island Sound								35
Cape and Islands					125	—		175
Massachusetts Bay			54	(45)	370	715	125	325
Isles of Shoals				18	100	—	400	325
Portland area				754	2,080	935	1,250	2,075
Seguin to Monhegan	4	720		3,984	3,941	3,075	2,925	2,340
Penobscot Bay	300	390		2,906	3,669	2,800	2,350	3,255
Outer Islands	20	140		1,007	1,375	945	(960)	1,323
Jericho-Blue Hill Bay					280	600	—	2,060
Eastern Maine	550	—		441	943	900		2,295
Grand Manan					15	—		36
Quoddy								335
Total	875	1,600		9,100	13,000	9,700		15,000

[1]The census of 1931 is after Allen and Norton; that of 1936 is after Mendall; those between 1943 and 1950 are after Gross; those in 1965 and 1972 are my censuses.

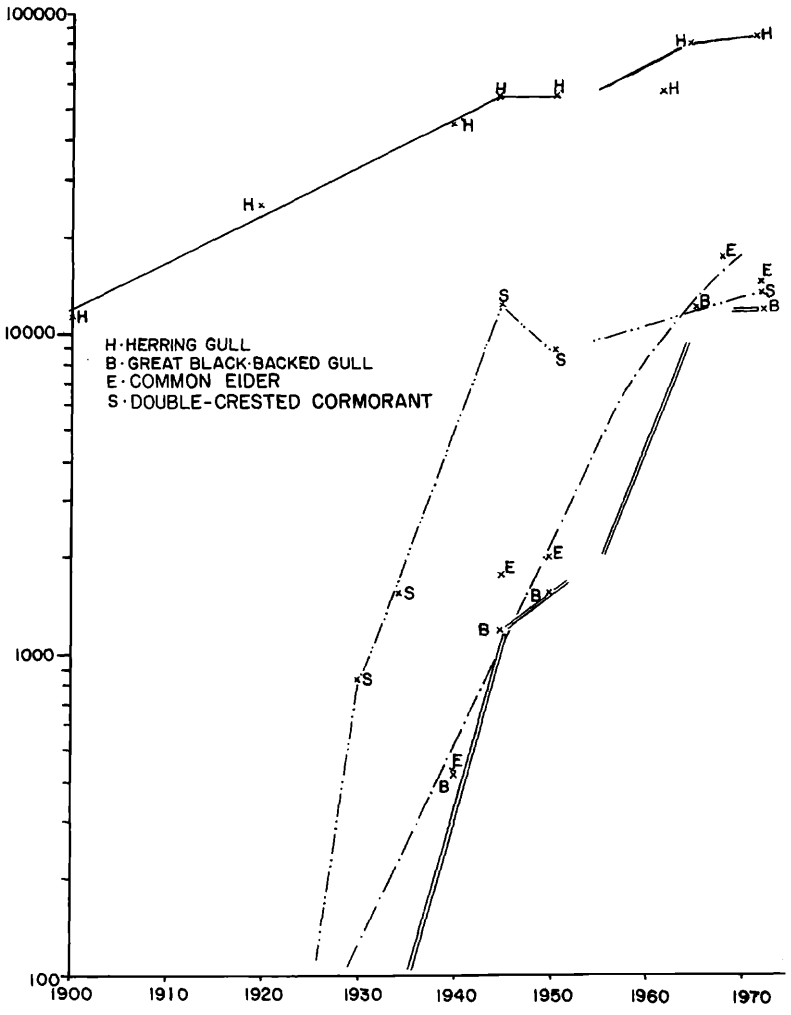

FIGURE 2. Changes in breeding populations of seabirds—large gulls, Common Eider and Double-crested Cormorant. Semilog plot of estimated numbers of four species of seabirds plotted at approximately 10-year intervals. This plot does not include population estimates of these species nesting south of New York City or in New Brunswick and Nova Scotia. In this and the following figures it would be more appropriate to use the biological unit of generation time on the horizontal scale instead of years, but not enough is known of the species involved to do so.

Islands in Buzzards Bay (Vineyard Sound) in 1946 (Griscom and Snyder, 1955).

However, weir fishermen (those using fixed "maze" traps for herring) on the coast of Maine have had a traditional vendetta against this species because Double-crested Cormorants learn to fish in "the bag" where herring are held until they have digested their "feed" and are ready to be processed for "sardines." Apparently the birds drive many fish into the net and the owners spend hours laboriously plucking the gilled fish out of the mesh. Double-crested Cormorants are also accused of consuming a large number of small fish (herring, flounder, or salmon) and some people believe that the adult population of these commercially valuable fish suffers. The evidence is conflicting. Double-crested Cormorants primarily eat trash fish which compete with game fish. Lewis (1957) has shown that they do almost no economic harm, but a number of "tags" from marked smolt were found on the colonies at the mouth of the Narragaugus River (Petit Manan area).

In the early 1940s complaints of fishermen to the Maine authorities led to Gross's being assigned to a state and federal program of spraying eggs of this species in 1944. This program continued through 1953 (Gross, 1951b; Dow, 1953).

In response to the official program and harassment by fishermen, several colonies shifted islands abruptly during the 1940s. The records kept by the spray parties suggest that the colonies did not move far. For example, those in upper Penobscot Bay did not leave that area nor did those in the Muscle Ridge Channel (Fox Is.). Some colonies moved from Muscongus Bay past Pemaquid to Pumpkin Island (Booth Bay), but that seems to be the farthest a group was displaced.

The cormorant control program coincided with a halt in population growth. Moreover, in the 20 years since the program was stopped, the Double-crested Cormorants have barely regained the numbers of 1945 (Fig. 2). Although about 40 islands are occupied by loafing birds each summer, few "new" colonies have been established, nor has the range been expanded south of the colonization that took place about 1940. The air census in June 1972 showed some colonies on the coast of Rhode Island and Connecticut but no important number of birds nesting south of Boston Harbor. Moreover, colonies on the north shore of Massachusetts Bay have not increased in the last 10 years.

Double-crested Cormorants are again being controlled in eastern Maine as part of a cooperative program of the State of Maine and the U. S. Bureau of Sport Fisheries and Wildlife, which is part of attempts to re-establish the Atlantic salmon run to rivers in this area. The slowness of the species population growth between 1950 and 1970 contrasts sharply with the remarkable expansion of range and increase in numbers from the mid-1920s to the mid-1940s. The implications of contamination by pesticides are considered in the Discussion.

Neighboring populations. In the Quoddy area between 1945 and 1973, the number of Double-crested Cormorants nesting on White Horse Island increased from 15 to 160 pairs. Lewis (1929) reported

a colony of about 200 pairs at Saltkill Islands, Lepreau, west of St. John, N. B. This area was not visited in recent censuses. The increase on the coast of Nova Scotia has in general paralleled that of the increase on the coast of Maine, although available figures are probably not directly comparable. Lewis (1929) in what may have been an incomplete survey reported 67 pairs nesting in 1929, whereas the survey by Lock (1971) showed 4,200 pairs in 21 colonies.

Lock and Ross (1972) pointed out that Double-crested Cormorants prefer to nest in spruce trees. In New England colonies they nest in trees at only one location (Mahoney Is., Blue Hill-Jericho Bay). At three others they now nest amid the stumps of trees which may have been killed by their excrement.

It is possible that *Phalacrocorax carbo* (Great Cormorant) will again breed in the United States in the next few years. Baird, Brewer and Ridgway (1884) said: "A few of these birds still breed on rocky cliffs in Frenchman's Bay and in the Bay of Fundy" (east of Mount Desert Island). Lock (1971) reported about 2,100 pairs of Great Cormorants in 23 colonies in Nova Scotia. Lewis (1941) reported 100 pairs in 1940. The nearest colonies reported were two in Queen's County, just east of Cape Sable. Erskine's (1972) review shows an increase in numbers and expansion of range of these cormorants all through the Maritimes. Cruickshank (1938) reported an adult summering in Muscongus Bay in 1927. One or two adults have been seen in May and June among Double-crested Cormorants at the Brothers (Maces Bay, N. B.), at Jordan's Delight (Petit Manan) and Metinic Green (Matinicus Is.) in the recent survey, and at Milk Island (north shore of Massachusetts Bay).

Somateria molissima. Common Eider.

Materials and census techniques. When Common Eiders are courting in late April-early May, pairs associate closely with each other and with the island where the duck builds her nest. At this period the pairs can best be counted at high tide early in the morning (Mendall, 1968). Soon after the female starts incubating, the male moves away from the island to join flocks feeding on the outer ledges. Then, searching for nests disturbs the incubating ducks and invites predation from gulls.

Censuses taken from 1930-1950 were made during the incubation period in late May-early June, so the counts reflect the numbers of females seen off their nests or leading young. The best data come from Gross's own work (Gross's journal and the field sheets 1940-1944). The field data sheets prepared after Gross stopped participating in the field work (1945-1951) appear to be undependable. During many years, blocks of islands were not visited and in many cases the entries for eiders were left blank.

My counts were made from a boat "by twos" of flocks of females, including those loafing on or swimming near the nesting island, in the middle weeks of May 1969 and 1971. In 1972, the counts were made in the first week of July when nearly all females have their broods off the islands. Late in the breeding season the separation of breeding from nonbreeding birds is not obvious, but there is a clear subjective separation of flocks of adult females (closely attached to

an island) from flocks of mixed plumages on the ledges and in the channels between islands. In 1973, counts were made of adult males around each island 5-11 May.

The large rafts, primarily of males and young, present from late May until October on the sunken ledges at the mouth of Muscongus Bay, Penobscot Bay, and in the approaches to Swan's Island were counted separately. These counts were made "by tens" in the early morning when the sea was flat calm, and are shown separately in parentheses (Table 4). It is not known what percentage of these birds are nonbreeding immatures. It is not clear whether mature females join these flocks if their nests are destroyed.

The first reports of mixed flocks on the sunken ledges were in 1943 in Muscongus Bay (Gross's notes). A flock of "good numbers" was reported near Western Egg Rock; another of 1,200 birds was recorded in 1949 between Shark Rock and Eastern Egg Rock. These flocks are apparently present in the same places from year to year, but it is probably not valid to combine numbers from different years or different seasons. Flocks totaling 13,900 were counted between Matinicus Seal and No Mans Land in May 1970, and 8,700 in the same area in July. In August 1968, 25,500 eiders were counted between Shark Rock in Muscongus Bay and Large Green Island in Penobscot Bay.

Our counts were not taken at the most desirable time of year nor do they give exhaustive coverage of all islands and ledges. The numbers are available by islands and geographic regions. Mendall(1968) allowed for 8-10% nonbreeding birds in his air censuses. This correction has not been applied here.

Events of the last 75 years. "In early years this species nested at various points along the Maine coast west to the Egg Rocks in Muscongus Bay. In 1900 none of the birds were found or reported" (Allen and Norton, 1931).

In 1902, Job reported a Common Eider's nest on the Green Islands off Swan's Island; in 1903, Dutcher reported a female on Southern Mark, 1 on White Ledges, 2 on Saddleback and 3 on Spirit Ledges, all in Jericho Bay. In 1905, Dutcher reported a female on Old Man, one on Pulpit Rock (Machias Bay) and a flock of 30 at Jordan's Delight (Petit Manan). In 1907, 7 females nested on Old Man in the eastern shore of Machias Bay.

Between 1911 and 1915 the number of Common Eiders breeding in Machias Bay and Jericho Bay built up rapidly. But in 1923 Townsend still saw only 3 or 4 in the Grand Manan Archipelago. Table 4 and Figure 2 show the spectacular increase in this species which began to become obvious about 1930. Allen and Norton (1931) listed 17 islands, 165 adults, 25 broods. They found 27 nests on 6 islands extending as far west as Metinic Island (Matinicus Is.).

In 1943, Gross (1944b) found the westernmost Common Eiders nesting among gulls on Mark Island in eastern Casco Bay, and estimated Maine's breeding population to be probably more than 2,000 pairs. In 1951, Gross found them nesting on Little Brown Cow in western Casco Bay (1951d) and Buchheister (1951) found the first nest in Muscongus Bay on Wreck Island 1950 and 1951. In

TABLE 4. Pairs of Common Eiders summering in New England.[1]

Location	1907	1931	1941	1945	1944-50	Flocks	1965	1972-73	Flocks
Portland area to Booth Bay			60	43			(290)	725	
Muscongus Bay			5	140	800 —	(1,700)	730	610 —	(2,650)
Penobscot Bay		84	210	1,175	(200)		(1,225)	4,500 —	(3,300)
Outer Islands		8	54	330	(120)		3,650	5,300 —	(11,000)
Jericho-Blue Hill Bay		20	—	15				1,200 —	(1,000)
Eastern Maine	2	8	100	140	150			3,200	
Grand Manan-Quoddy								4,700	
Total	2	120	430	1,845	2,100			15,155	
No. of islands	1	5	17	37				119	

[1]Estimates made in 1931 are from Allen and Norton; those between 1940 and 1950 are primarily after Gross's notebooks and Gross 1944; the figures for 1965 and 1972 are from my censuses.

1952, Gross (1952b) found a nest on Outer Green off Portland Harbor and a pair together off Bluff Island in Saco Bay.

Gross's gull control program on the islands where Common Eiders nested started in 1940. At that time counts covering the majority of islands became available. Unfortunately, disturbance by spray crews also increased at this time and this might have led to greater predation by gulls. Mendall (1968) emphasized that human disturbance of incubating females results in lowered nesting success as a result of increased gull predation.

Growth of the Common Eider population apparently continued to be rapid through 1945 (Table 4, Fig. 2) but might have slowed between 1945 and 1950: in 1941, 400 pairs, in 1945, 1,800 pairs, in 1949, 2,100 pairs. This might reflect a movement of these ducks off the treated islands. Unfortunately, the 1945-1949 period is the one of less careful record-keeping. Why should there be a steady increase while Gross kept the records 1940-45, then a much slower increase when he was no longer in the field?

Estimates of the breeding population in Muscongus Bay (AFN, 1965) show an increase from 800 birds in 1949 to over 6,000 in 1959, but an increase of only another 1,000 from 1959-1965. At present not enough data are available from other bays to determine similar periods of rapid increase followed by plateaus. Such data might become available as Mendall continues his air censuses of the coast of Maine (Mendall, 1968).

Neighboring populations

Flocks including 200-300 females and mature males spent the summer at the Isles of Shoals in 1969-1972. Flocks of 10-15 or more females with a few adult males have summered off Cape Ann (Massachusetts Bay) off Monomoy Island (Nantucket Sound) and around Penikese Island (Buzzards Bay) in recent years, but nests have not been reported south of Saco Bay.

Published information on the numbers of Common Eiders nesting in Nova Scotia is apparently not available.

Comments

The rapid increase of Common Eiders during this century suggests that if there is a depressing effect of gull predation on the growth of the population (Mendall, 1968) it has been confused by the inaccuracy of the censuses or offset by other favorable circumstances (see Discussion). Although our censuses (1970-1972) were at unsuitable times of year, they agree satisfactorily with Mendall's (1968) estimate of 18,000 pairs nesting on 75 islands. The points on the curve of population growth are too few to conclude whether the exponential increase is continuing into the 1970s.

Larus argentatus. Herring Gull.

Materials and census techniques

(1) *Breeding censuses.* (a) Dutcher (1901, etc.), Allen and Norton (1931) estimated the number of gulls (not pairs) on islands on the coast of Maine between 1900 and 1931. (b) Gross and others associ-

ated with the gull control program counted the number of eggs on gull colonies between Machias Bay and Block Island Sound (Gross, 1944a-1952a; Dow, 1953). (c) Drury, Kadlec, Keith and Mott made estimates of gull pairs between New Jersey and the Grand Manan Archipelago in the period 1962-1972. Kadlec and Drury (1968b) discussed the errors inherent in aerial censuses and concluded that estimates of territorial pairs made from the air are useful as estimates of the number of nests and that regional totals are accurate within 20-30%. In 1972, the numbers of gulls estimated from the air was tested again by comparing the air estimates with counts of territorial birds made from a boat (Table 5). This table indicates that totaling counts by regions smooths out local variation.

TABLE 5. Air and surface estimates of breeding pairs of gulls.[1]

Location	Herring Gulls		Great Black-backed Gulls	
	Air	Sea	Air	Sea
Saco Bay	3,050	2,930	350	205
Casco Bay	3,485	2,458	575	330
Booth Bay	1,775	2,585	1,095	945
Muscongus Bay	1,200	695	480	425
Matinicus Is.	1,295	1,880	420	660
Fox Is.	1,345	1,595	285	400
Penobscot Bay	790	750	175	290
Jericho Bay	1,065	910	450	315
Swan's Is.	730	1,320	430	675
Total	14,735	15,125	4,200	4,245

[1]The islands included are only those for which both an air estimate and a surface count were made in 1972. The table shows that the two techniques average out, although they may differ markedly for individual islands.

In Figure 3 the plot of breeding census data gives two possible extreme interpretations. Conservative interpretations of the data are represented by (□); liberal interpretation by (×). The two interpretations are possible because two sets of data can each be interpreted two ways.

(a) In previous papers (Drury, 1963; Kadlec and Drury, 1968a) the estimates given by Dutcher or Norton were divided by 2 to get the number of breeding pairs. This assumes that groups of non-breeding resident gulls are attached to the island. (Gross assumed that this group was 20% of the total.) In recent surface censuses only the gulls spaced out on the nesting area have been included. Dividing this figure by 1.5 gives a good indication of the number of nests. In the treatment in Figure 3 the Dutcher and Norton (1900-1931) data divided by 1.5 are represented by (×); divided by 2 are represented by (□).

(b) In previous papers (Drury, 1963; Kadlec and Drury, 1968a) the egg count data reported by Gross (1944a) were converted to pairs according to Gross's formula. In one place in his early reports

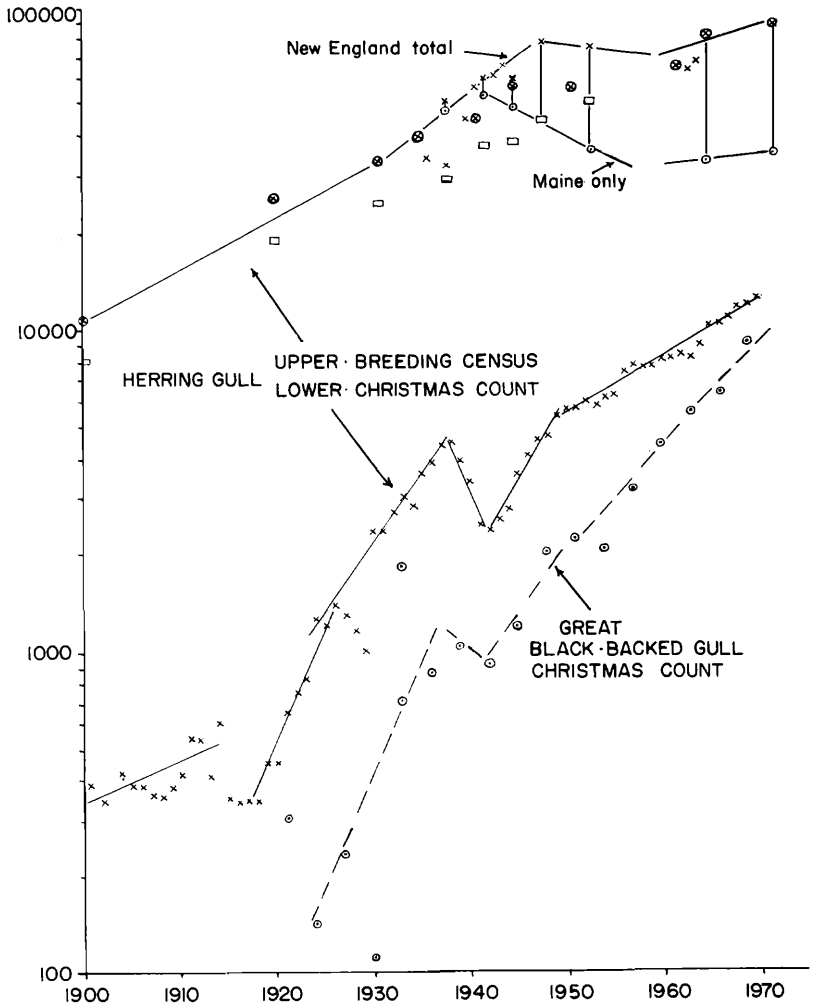

FIGURE 3. Changes in the New England population of Herring Gulls.
Semilog plot of censuses of breeding colonies (top plot) and of Christmas Counts (middle plot) of Herring Gulls between New York City and Eastport, Maine. The bottom plot is of Christmas Counts of Great Black-backed Gulls.

In the plot of breeding censuses of Herring Gulls the symbol ⊕ are figures shown in Table 7. The symbol □ represents the most conservative and × the more liberal interpretation of Norton's and Gross's data (see text). The vertical lines connect the estimate of the total breeding population x to the estimate of the breeding population in Maine alone ⊙ in the years when both data are available.

Christmas Count data are three-year running average. The characteristics of the data as plotted are discussed in the text. Note that the Christmas Count data of both Herring and Great Black-backed gulls suggest declines in numbers followed by rapid recovery about 1930, in the early 1940s and a plateau in the early 1950s. These are discussed in the text.

Gross recommended adding 10% to the egg count for missed nests; in another later report, 20%. In this paper 10% was added to egg counts on the islands where Gross supervised the work and 20% was added to egg counts on the islands where the spray crews worked without his supervision. The total of the egg count was divided by 2.5 (average clutch size) and then 20% added for territory-holding but nonbreeding gulls. In Figure 3 the points established by this calculation are shown (□).

Subsequent review of the field sheets on file in the Bowdoin College Library showed that many islands were not reported because they were untreated, and that the visits to the islands were very early (May 20-June 10). In our own work (1963-1969) we found that the maximum number of occupied nests is to be found 5-20 June in Maine. Two steps were taken to correct these omissions: first, the egg count from the next year was used if the count was omitted in any year or if the egg count was conspicuously low; second, instead of applying Gross's formula correcting egg counts to nest counts, a correcting factor was used which had been developed in reviewing the field sheets. The operators who filled out field data sheets for 90 islands between 1946 and 1952 listed both egg counts and the number of adults seen on the island. On these islands (Table 6) the total of adults was on average 85% of the total of eggs. This total of adults was divided by 1.5 (as above) to give the number of pairs. In Figure 3 the points established by this calculation between 1934 and 1953 are shown (×).

TABLE 6. Herring Gull eggs and adults on the same islands.[1]

	1946	1947	1948	1949	1950	1951
Number of eggs	20,006	41,510	9,986	10,815	14,906	32,325
Number of adults	23,160	56,720	17,015	11,660	20,100	37,230
Number of pairs	15,450	37,800	11,350	7,775	13,400	24,825
Eggs per pair	1.3	1.1	.9	1.4	1.1	1.3
Number of islands	11	26	9	17	10	16

[1]Data from field sheets of Gross's gull control program.

Apparently no precise and consistent relationship exists between the number of gulls on an island and the number of nests. Annual repetition of censuses indicates a significant degree of variability (Table 9 in Kadlec and Drury, 1968a). Even taking this variability into account, censuses of a given geographic area may be obviously low in a given year. For example, a significant percentage of the gulls nesting in the Booth Bay and Muscongus areas apparently were missing during the 1964 census. It is probable that commercial fishermen who regularly fish for Whiting or Gray Sole off this shore had attracted large numbers of gulls during the short period of the census flight.

Nevertheless the air censuses taken in 1962 to 1964 appear to be systematically low (Fig. 3). Examination of the island-by-island

TABLE 7. Pairs of Herring Gulls nesting in New England.[1]

Location	1901	1921	1931	1935	1941	1945	1951	1962	1965	1972
Long Island			3		350		225	950	4,200	5,500
Block Is. Sound			20		125	2,250	5,250	9,600	9,175	11,800
Cape and Islands			300	1,300	4,700	1,440	17,700	18,300	19,300	19,600
Massachusetts Bay				200	1,200	7,600	7,100	15,200	17,300	16,650
Isles of Shoals		500	2,700	2,350	3,750	5,000	4,900	(3,800)	5,850	7,100
Portland Area		125	1,700	3,725	10,400	11,500	7,375	5,500	9,600	14,375
Seguin to Monhegan		300	2,400	6,000	9,000	5,100	4,600	2,500	4,825	3,600
Penobscot Bay		1,400	8,800	3,400	4,000	3,100	2,000	3,000	2,800	3,000
Jericho-Blue Hill Bay		75	1,300	(150)	(250)	350	(500)	(450)	2,000	1,100
Outer Islands	8,200	25,700	13,600	3,900	5,500	6,850	5,900	1,900	3,500	2,175
Eastern Maine	3,000	13,000	11,500	4,000	6,500	6,850	3,950	2,900	4,100	4,750
Grand Manan		20,000						12,300	11,900	14,100
Quoddy										6,550
Total (excluding Grand Manan and Quoddy)	11,000	26,000	34,000	40,500	45,500	56,500	56,000	65,000	83,000	89,500
Number of islands	17	24	77	61	83	93	100	174	226	305

[1]The table shows the increase in numbers and expansion of range during the last 75 years.

estimates suggests consistent underestimation and later experience showed that a number of colonies had been missed. In Table 7 adjustments based on judgments have been made where estimates are contradictory or missing. The figures from Table 7 are shown on Figure 3 as ⊗. Someone else repeating the calculations will probably arrive at numbers that differ in minor ways.

(2) *Christmas Counts*

The purposes, design, and usefulness of Christmas Counts coordinated by the National Audubon Society since 1900 have been criticized (Stewart, 1954) and explained (Hickey, 1955). The limitations of the Christmas Counts include failures in consistency of counting, in consistency of coverage, and in relevance of the samples to the regional population. A bias toward increase is possible as a result of increase in the number, mobility and competence of observers. But in order to avoid this in the comparison made here, a sample of counts was selected for consistency and continuity of coverage between 1900 and 1971. The counts were averaged by regions and are shown as a three-year running average (Method B of Kadlec and Drury, 1968a).

Summary of events of the last 75 years

The growth of the breeding population in New England is shown in Figures 2 and 4 in Kadlec and Drury (1968a). Figures 8 and 9 (ibid.) show the expansion in breeding range which has accompanied the approximately 9-fold increase in the last 75 years.

The graph of increase in breeding population parallels that of the Christmas Counts (semilog plot, Fig. 3). The two thus tend to confirm each other. The steeper slope in the graph of the Christmas Counts probably reflects the fact that gulls from a large area of both New England and the Maritimes collect on the relatively small wintering area.

The breeding population

In the 19th century gulls nested on the Eastern and Western Egg Rocks (Muscongus Bay) and on Wooden Ball, Ragged and No Mans Land (Matinicus Is.) (Norton, 1924a). In the late 19th century gulls also bred on small islands southeast of the Fox Islands and on the islands south of Swan's Island (Norton, 1924a).

During the last half of the 19th century individual pairs nested for one or a few years at scattered places in Buzzards Bay and Nantucket Sound, but no colonies persisted (Forbush, 1925; Mackay, 1925). Floyd (1930) said that Herring Gulls had formerly nested on Tern Island (Chatham, Cape Cod), "their numbers far outweighing those of the terns." After two great milliners' campaigns about 1876 and 1896, gulls were reduced to about 10,000 pairs, mostly nesting on islands off Swan's Island or in the Matinicus Islands. They had been killed off east of Swan's Island. Photographs taken by Gleason (in Wheelwright, 1903) show that gulls were essentially absent even from the fishing ports on Cape Cod in autumn in this period (see above).

The growth and expansion of the breeding Herring Gull population are shown in Table 7.

In 1911, Norton (1924a) estimated 20,000 adult birds on No Mans Land (Matinicus Is.) and by 1914 several colonies of over 100 adults occurred in the upper part of Penobscot Bay. In 1916, No Mans Land was sold and the new owner built camps on the island, kept pets, and released foxes. The gulls began to move away to Ten Pound Island and to Metinic Green Island (Matinicus Is.)

By 1921, Norton reported that Herring Gulls had colonized islands 60 miles to the west of their previous limit, and he estimated over 60,000 pairs nesting in Maine and sounded the alarm that continued expansion of the gull population threatened the survival of terns. It is hard to believe Norton's estimate of 60,000 pairs nesting on the coast of Maine, because by later estimates gull numbers did not reach this figure until about 1940-1950. For example, it is improbable that 6,500 pairs of gulls could set up territories on Metinic Green, as his estimate of 10,000 gulls suggests. The island is too small and does not have enough broken topography to support a really dense gull colony. Moreover, he presumably included the gulls of Grand Manan in his estimates. Townsend (1923) reported 17,000 pairs of gulls on Outer Wood, 2,000 on Inner Wood and "a considerable number of each on the Three Islands" (which include Kent Island). It is hard to know just how many gulls bred between Muscongus Bay and Grand Manan at that period, but undoubtedly the population had recovered rapidly.

In the early 1920s the majority of Herring Gulls nested on Maine's outer islands but increasing numbers of adults spent the summer in southern New England and a few pairs bred in 1919 on Skiff's Island among the shoals between Martha's Vineyard and Muskeget (Forbush, 1925).

During the next decades the numbers of gulls nesting on the outer islands decreased while colonies were formed and grew closer to the mainland (Table 7; see also Drury and Nisbet, 1973b). At the same time gulls expanded their range southwestward (Table 7; Figs. 21 and 23, Drury 1963; Figs. 8 and 9, Kadlec and Drury, 1968a).

In 1926, Lawson (1926) reported what was apparently the first nesting of Herring Gulls on the north shore of Massachusetts Bay "for nearly a century" on North Gooseberry Island. Late in the decade they settled on the Isles of Shoals, at Muskeget in Nantucket Sound, and in two places in Block Island Sound, that is, at Wicopesset Island (Fisher's Is., Allen, 1933) and at Orient (northeast tip of Long Island, Latham in Bull, 1964).

Between 1930 and 1940 gulls did not expand their range but the population growth during this period seems to have been especially rapid (Fig. 3). They colonized places like Narragansett Bay (Clement and Woodruff, 1962) that had been by-passed in the rapid expansion of the early 1930s. The total number of islands occupied increased only from 77 to 83. Cruickshank (1942) reported that gulls had increased to 1,000 pairs breeding on Long Island by 1942, including 750 pairs on Wicopesset Island (Poor in Bull, 1964). The population of gulls nesting on Muskeget (Nantucket Sound) and Penikese Islands (Vineyard Sound area) rose from about 100 pairs to 4,500-5,000 pairs.

Yet gulls were still not evident at Cape Ann, Mass. Chamberlain's (1953) pictorial impression of Cape Ann, including 66 photographs of the waterfronts and fishing centers such as Pigeon Cove, Sandy Bay and Gloucester Harbor, taken 1935-1938, showed harbors crowded with fishing boats, but only two photographs contain gulls (one shows two gulls and the other may show three). On an average summer day in Gloucester in 1965 usually 4,000-5,000 gulls were visible and any picture would probably include two dozen gulls. By 1940, 750 pairs nested on the north shore of Massachusetts Bay but no published estimates of the gulls breeding in Boston Harbor have been found.

Between 1945 and some time after 1950 a plateau appears in the graph of the breeding population (Figs. 2 and 3). This is presumed to be related to the program of gull control in effect on almost all gull colonies between Maine and New York (Gross, 1951b; Kadlec and Drury, 1968a; Dow, 1953).

One important effect of the gull control program was probably to accelerate the shift of gulls from the coast of Maine southward to Massachusetts and from the outer islands on the coast of Maine (Tables 7 and 8) to ones closer to the coast (see also Drury and Nisbet, 1973b).

In Figure 3, vertical lines connect the estimates of the total New England population (×) with estimates of the Maine population ⊙ for the years 1938, '42, '45, '48, '53, '65, and '72. As Figure 3 shows, while the Maine population started to decrease about 1945, the gull population of Massachusetts was increasing rapidly. The spray program was expanded to include islands off the north shore of Massachusetts Bay, Nantucket Sound and Vineyard Sound; then in 1947 Cartwright Island (Block Island Sound) was added.

Southward extension of the breeding range continued during the 1950s. About 1950, Herring Gulls colonized the shore of Connecticut (MacKenzie, 1961), New Jersey (AFN), and Maryland (Stewart and Robbins, 1958). They reached North Carolina about 1960 (Hailman, 1963; Ames, 1963), and nested at many places along the Middle Atlantic States in this period (AFN). The increase in the size of gull colonies south of New York has been slow, even though gull colonies in Block Island Sound and behind the beaches on the south shore of Long Island have grown to large sizes.

The shift from outer islands towards centers of human population has continued during the last 20 years. Gull populations have doubled during this period in the following regions: western Long Island Sound, Block Island Sound, Massachusetts Bay and the Portland area, but have remained nearly constant elsewhere. Figure 3 suggests that the population in Maine as a whole has been constant for the last 20 years.

Neighboring populations

The gull population apparently has remained constant throughout the last 50 years in the Grand Manan Archipelago. It was a major center in 1920 (20,000 pairs, Townsend, 1923) and still supports 17,000 pairs in 1972. Furthermore, in this spot the eastward

TABLE 8. Herring Gull breeding pairs on outer islands in Maine and Massachusetts.[1]

Location	1900	1910	1920	1930	1940	1950	1961	1972
Eastern Maine								
Old Man	250	750	500	2,000	900	500	100	200
Brothers	200	750	500	1,000	1,500	575	75	100
Cone (Nash)	900	2,000	2,500	2,500	2,000	750	500	150
Outer Islands								
Great Duck	2,000		5,000	300	600	600	100	75
Little Duck	300		750	4,000	1,800	2,500	550	100
Metinic Green	0		5,000	1,200	775	600	400	20
No Mans Land	2,500	10,000	0	1,000	650	300	100	100

	1925	1929	1935	1940	1945	1948	1952	1954	1961	1965	1972
Muskeget, Nantucket Sd.	150	200	400	4,000	13,000	20,000	16,000	13,000	10,000 (8,000-9,000)	12,000 (8,000)	(3,500)
Ground estimates											

[1]The consecutive censuses show the increase, then decrease, of gull pairs reflecting growth of the population, then its transfer to colonies nearer sources of human food. The estimates for the Maine islands for 1961 and 1972 are air estimates. The estimates for Muskeget which are in parentheses are air estimates.

trend toward predominance of Great Black-backed Gulls is markedly reversed (see that species). The large colonies in the Grand Manan Archipelago were not included in the gull control program, and possibly emigration of surplus young from these islands contributed to the continued growth of the gull population in southern New England during the 1940s (Drury and Nisbet, 1973b).

The Herring Gull population is sparser for long distances of shoreline both east and west of Grand Manan. Lock (1971) reported only 12,700 pairs of Herring Gulls in about 100 colonies on all the mainland of Nova Scotia (plus 2,000 pairs estimated on Sable Island). Southwest of Grand Manan the next gull colony of 1,000 pairs is near Portland Harbor.

The overall increase and present state of the breeding population

Figure 3 summarizes the growth of the New England Herring Gull breeding population since 1900. The conservative estimates (□) could be interpreted to trace a slow, steady growth without interruption since 1900, doubling each 20-25 years. The liberal estimates suggest that the gull population grew steadily between 1900 and 1930, then grew more rapidly between 1930 and 1948, doubling about each 15 years. According to these data, growth was reversed about 1948 but records are unavailable between 1953 and 1962. The average numbers (Table 7, Figs. 2 and 3) suggest a plateau beginning in 1945.

Data from aerial censuses since 1962 suggest a rapid growth between 1960 and 1965. Records of the rapid growth of a number of colonies in Massachusetts between 1960 and 1965 (Kadlec and Drury, 1968a; Drury and Nisbet, 1973b) suggest that the gull population in southern New England did grow rapidly during the 1960s. However, if the data for 1962-1964 are considered to be underestimates, a steady increase is indicated beginning about 1957 (when the breeding population should have shown the effects of release from the control project). The population trends shown by the graph of the Christmas Count data suggest that the population has been growing at a constant rate since about 1950. Details of contemporary events in the New England gull population are the subject of another study (Drury and Kadlec, Ms.).

The Christmas Counts

The Christmas Count data suggest several periods of different growth rate. First is a period of slow increase, confused by highly variable count data. Second is a period of sudden decline in counts during World War I, followed by rapid recovery between 1919 and 1929. Third is a period of steady increase 1930-1938. Fourth is a period of sharp decline in counts during World War II, followed by a rapid recovery between 1944 and 1952. Fifth is a period of steady growth between 1952 and 1970.

The most evident events in this 75-year period are the difference in slope (1924-1938) as compared to that (1947-1970), and the sharp declines followed by rapid recoveries related to the two World Wars. The difference in slope of the plot for the period 1947-1970 as compared to 1924-1938 will be referred to in the Discussion.

The sharp declines followed by rapid recoveries

No data are available on changes in the breeding population of gulls in 1910-1920 and unusually detailed data are available for the period 1935-1950, covering the second period of decline and recovery. The following discussion applies to the second period. How is the sharp population decline 1938-1942 related to the plateau in breeding population (1945-1948 and subsequently)? Does this reflect effectiveness of Gross's gull control program or the effects of World War II (1939-1945) or some combination of influences?

Inhibiting reproduction should have maximal effect on the number of young birds and thus might be first reflected in the winter counts although first year birds contribute only 10-15% of the winter population. Its impact on the breeding population should be delayed about 4 years, the time taken for these gulls to reach breeding age. A decline in the apparent winter gull population between 1939 and 1942 preceded the plateau in the breeding population by 4-6 years. This is consistent with the interpretation that the spray program was effective, but Gross's spray program was not operational until 1940, after the drop in the winter population had started. Furthermore, the rapid recovery that began in 1943 occurred while the control program was still in progress. Thus if the drop in Christmas Counts of 1939-1942 reflects the gull control program, the early work, including experimental work, must have been more effective than the later operational work.

Perhaps this was the case if the results of egg spraying reflected primarily the effects of disturbance in the colony. In the course of experiments with spraying gull eggs in Massachusetts 1963-1965 (Drury, 1967), productivity was lowered by about 90% whether 20% or 90% of the nests on an island were sprayed. The disturbance caused by spraying seemed to spread through the whole colony. Furthermore, it has since been found that late hatching young (the products of replacement clutches) are subject to disproportionately high mortality (Nisbet and Drury, 1972b) after they have left the colony.

Possibly, breeding gulls became accustomed to the disturbance caused by spray crews after several years (Robert and Ralph, Ms); moreover, it is apparent from the field sheets that in later years (after 1945) the spray crews visited most islands in mid-May before the peak of Herring Gull nest occupancy (see above). The sheets also indicate that blocks of islands were omitted when the work was interrupted by bad weather. But if disturbance was the key factor, why did the needling program begun in 1934 have so little effect? Moreover, elimination of reproduction over a period of 4 years should have lowered the gull population about 20-30%, not the 50% suggested by the Christmas Counts.

The large change in winter gull populations indicated by the Christmas Counts might have other or additional explanations: for example, changes in availability of garbage and in public access to the seashore during the national emergency. When Americans first experienced rationing of food during the early war years, they might have been unusually parsimonious with their garbage. Kluyver

(pers. comm.) reported that during World War II, in spite of the cessation of an (ineffective) gull control program, the gull population of the Netherlands decreased. This was presumably a response to the fact that the Dutch people were being starved.

If less garbage had been available in coastal urban areas, gull mortality should have increased and many gulls would have withdrawn to outer beaches away from the areas censused. This occurred rapidly in response to closing of dumps or closing down of fish factories in recent years (Drury, 1963, 1967). The apparent decrease in gulls would have been exaggerated by wartime restrictions of access to the sea beaches and the absence of young and enthusiastic bird watchers.

Increase in the Christmas Counts of gulls in 1919-1929 and 1944-1954 might reflect relief from a combination of forces: for the gulls (a) return to profligate disposal of garbage at the end of the wars, (b) relaxation of the spray program (for the period 1944-54) after Gross stopped personally supervising the operation, and (c) for the observers, renewed access to the seashore.

It appears to stretch the evidence too much to conclude that Gross's program should have dramatically lowered the wintering gull population for three years in its experimental years and that, when operational, it had no effect on the wintering population. It seems reasonable to assume some mortality by starvation and some regional shifts in wintering gulls during both wartime periods. However, the data do not allow a clear choice among the several alternatives.

Following the rapid increase in counts (1944-1952) the winter gull population has increased steadily but slowly until the present. The Christmas Counts do not suggest a recent plateau as seems to have occurred in the gulls breeding population of New England.

Summary

The New England gull population increased exponentially between 1900 and 1945; then its growth rate was slowed. Part of this effect may be attributable to environmental effects (see Discussion) and part to the gull control program. It is not clear whether in recent years the gull population had a period of rapid growth between 1958 and 1965, followed by a plateau, or whether it has increased slowly throughout the 1960s. It does seem clear that growth rate is now much slower than indicated in the period 1930-1945 and suggested by Kadlec and Drury (1968a). The present status of the Herring Gull population is discussed in a separate paper (Drury and Kadlec, Ms).

Larus marinus. Great Black-backed Gull.

Materials and census techniques are the same as those used for Herring Gulls.

Events of the last 75 years. No Great Black-backed Gulls were known to nest in New England during the closing decades of the 19th century. Trotter (1904) reported "one of the most southerly breeding places of the Great Black-backed Gull" in 1897 at Cape

Split, N. S., in Minas Basin, off the Bay of Fundy. Norton (1907) reported that Great Black-backed Gulls were roosting in small numbers (a dozen or two birds) at No Mans Land, Wooden Ball, and Metinic Green Island (Matinicus Is.). Bent (1921) reported the southern limit of the species' breeding range as Nova Scotia. Townsend (1923) repeated a fisherman's report of one pair nesting at Green Island in the Grand Manan Archipelago, and thought that the species had probably nested at Grand Manan in former days. No Great Black-backed Gulls were reported nesting in the United States even in the mid-1920s.

Since the mid-1920s Black-backs have shown one of the most remarkable increases in numbers and spread of range of breeding pairs of any of the species considered (Fig. 2 and Table 9). The Christmas Count data (Fig. 3), however, suggest that the winter population growth has paralleled that of Herring Gulls.

TABLE 9. Pairs of Great Black-backed Gulls nesting in New England.[1]

Location	1930	1941	1943	1950	1965	1972
Long Island					21	80
Block Is. Sound			1	4	265	275
Cape and Islands		1	1	20	1,200	1,325
Massachusetts Bay	2	8	50	40	1,375	1,850
Isles of Shoals	3	16	60	120	725	1,150
Portland Area		46	86	196	2,000	1,625
Seguin-Monhegan	1	100	400	600	2,100	1,650
Penobscot Bay	7	76	188	153	725	575
Jericho-Blue Hill Bay		2	1	40	475	475
Outer Islands	1	118	197	258	1,100	1,050
Eastern Maine	13	100	240	205	1,900	2,125
Grand Manan	4	?	?	?	100	60
Quoddy						100
Total	30	450	1,250	1,600	12,400	12,400
No. of islands	12		61		180	177

[1]The population grew spectacularly between 1930 and 1965, and has apparently stopped growing.

Allen and Norton's notes (1931) indicate that in 1931 perhaps 25-35 pairs of Great Black-backed Gulls were nesting on probably 12 islands reaching as far west as the White Islands (Booth Bay). At the same period Shelley (1934) reported 3, perhaps 7, pairs at Duck Island at the Isles of Shoals, and Eaton (1931) reported one pair with young at North Gooseberry Island (north shore, Massachusetts Bay).

Within 10 years Black-backs nested on the Weepecket Islands (Vineyard Sound area) (Gibbs and Hagar, RNEB, 1941) and at

Cartwright Island (Block Island Sound) (Wilcox, 1944). In 1960 they nested at Jamaica Bay, western Long Island (Post and Restivo, 1961) and in 1965 they were nesting in Absecon Bay, N. J. (AFN); by 1970 on Fisherman Island in Virginia (AFN). In 40 years, the number of pairs nesting on the coast of New England has risen from 30-40 to about 12,500 (Table 9, Fig. 2), i.e., doubling about every five years. The increase is arithmetically possible but emigration from the colonies in Nova Scotia might have been involved. This conclusion is reinforced by the indication from the Christmas Count data that the winter population has doubled each 9 years (Fig. 3). Apparently the population growth has been sharply curtailed during the 1960s.

Observations suggest that nonbreeding Great Black-backed Gulls often space themselves out on the uplands of an island like Damariscove off Booth Bay, Heron (Swan's Is.) or Nash (Petit Manan area). Few nests have been found on any of these islands and the island might appear abandoned at the next visit or the next year, hence the conspicuous inconsistencies in air estimates and surface counts or between the two which have appeared in our recent censuses. Norton's observations of Black-backs loafing on many islands along the Maine coast several years before they were known to nest suggests the same behavior.

Great Black-backed Gulls appear to nest more widely dispersed among the islands than do Herring Gulls. Only 22 colonies have more than 200 pairs (Fig. 1). They also tend to be relatively more numerous on outer islands and along the coast east of Mount Desert Island. With the exception of the Grand Manan Archipelago where conspicuously few Great Black-backed Gulls occur, this trend toward proportionally more Great Black-backed Gulls than Herring Gulls continues eastward along the coast of Nova Scotia. Lock (1971) reported 14,000 pairs nesting in about 130 colonies (including Sable Island) and of these, 17 colonies contained 200 pairs or more. He reported over 530 pairs on Sable Island and listed 38 islands on which Black-backs nest but Herring Gulls do not.

Larus atricilla. Laughing Gull.

Materials and census techniques. Norton (1924a), Palmer (1949), and Nisbet (1971) reviewed the history of Laughing Gulls in New England in this century. Scattered additional references to the numbers on individual islands were found, principally in RNEB and AFN. Data presented by Nisbet (1971) are not repeated in this summary but are included in Table 10.

Laughing Gulls have not been seen in the course of the New England air censuses even on the islands where they were known to nest. Yet several large colonies were seen on the salt marsh islands of New Jersey. Surface censuses are reported here. The numbers reported include only the birds that fly up from the nesting area. Ten per cent has been subtracted from this figure to indicate the number of nests.

Events of the last 75 years. Laughing Gulls survived the millinery trade in two centers in New England, viz., western Maine and Nan-

TABLE 10. Pairs of Laughing Gulls nesting in New England.[1]

Location	1900	1910	1920	1930	1940	1951	1960	1965	1970	1972
Nantucket Sound	45	650	2,000±	(1,500)	20,000	5,000	400	700	200	135
Saco Bay						25	(100)	150±		
Seguin-Monhegan		35	175		30					20
Matinicus Islands	4			200	250	50	65	20	65	65
Petit Manan Area									40	75

[1]Population estimates for Muskeget are taken from many sources summarized in Wetherbee et al. (1972). Those for Maine islands are after Norton, Palmer and scattered reports in RNEB and AFN.

Pairs of Laughing Gulls nesting in Maine[2].

Location	1951	1952	1954	1959	1965	1967	1968	1969	1970	1971	1972
Stratten (Casco Bay)	160				150						
Cuckolds (Booth Bay)										2	20
Metinic (Matinicus Is.)										8	20
Little Green "	50	250									
Large Green "								6	45	100	0
Ten Pound				65							
Matinicus Rock			25		20	25	100	0	20	25	45
Petit Manan							30–40	50+	50–55	50	75

[2]Data for 1949 and 1951 from AFN; 1951 from Gross (1951c); 1952 from Hebard (1952); 1954 Cottrells in RNEB; 1959 Hebard, Maine Field Observer; 1965 et seq. from my census. Matinicus Rock after Buchheister (pers. comm.); Petit Manan after Hatch (pers. comm.).

tucket Sound. Three birds were on Muskeget (Nantucket Sound) in 1874, but with protection, birds began to increase in the 1890s. Nisbet (1971) and Wetherbee et al. (1972) reviewed the subsequent history of the species that built up to a peak of about 20,000 pairs on Muskeget in the early 1940s (Table 10, Fig. 4). The population has declined steadily and rapidly since then to 200 pairs in 1970 (Wetherbee et al., 1972). Andrews (AB, 1972) reported that the Muskeget colony was abandoned in 1972; however, 42 nests were found and 200 adults counted on the north end of the Monomoy Wilderness (Nantucket Sound) by Nisbet (AB, 1972).

Allen and Norton (1931) summarized the history in Maine during the late 19th century as follows: "During the period 1870-1880 a few small colonies . . . occupied a number of offshore islands in Casco Bay, Muscongus Bay and Penobscot Bay. In 1895 the population in Maine was reduced to 14 birds nesting on Western Egg Island only . . ." (Muscongus Bay). In 1896 a few nested on Metinic Green (Matinicus Is.). "In 1900 a single group numbering about four pairs of breeding birds with about 50 non-breeding associates remained" (Norton, 1924a).

Allen and Norton (1931) suggested that the birds moved back to Western Egg Rock between 1920 and 1923 in response to encroachment on Metinic Green by Herring Gulls. Norton, however, commented that they moved from Metinic Green to Western Egg Rock in 1904 after a shed was built to shelter the three sheep on the island (Dutcher, 1905). The gulls continued to breed on Eastern and Western Egg Rocks and had increased to 200-300 adults by 1918. Between 1920 and 1923 Herring Gulls drove the Laughing Gulls away from those islands. These Laughing Gulls may have moved to Little Green (Matinicus Is.) where they had nested in the 1860's and 1870's. Allen and Norton found about 300 adults there in 1931. In 1936, 300 adults were present, 250 pairs in 1937 and 1938 (Cruickshank, Hog Island Audubon Camp. mimeo report), and 300 pairs in 1940. In 1940, apparently 40 pairs driven from Marsh Island in Muscongus Bay had joined them. Sheep were introduced to Little Green in 1938. In 1944, 50 pairs were present but in 1944 the turf was closely grazed and the gulls were gone. Palmer (1949) reported that after 1944 this species did not nest in Maine. In 1951, 50 pairs returned to Little Green, then 250 pairs in 1952 (Hebard, 1952) when the sheep were temporarily removed, but the gulls left again when the sheep were returned.

In the Grand Manan Archipelago a pair of Laughing Gulls appeared on Machias Seal Island in 1948 (Hawksleys, 1949) and single birds occurred at Kent Island in 1958 and 1965 (Gobeil, 1968). Recent records are shown in Table 10. In 1968, Herring Gulls had overrun Stratten Island (Saco Bay) and the Laughing Gulls had left.

TERNS — GENERAL REMARKS

Materials and census techniques. Nisbet (1973) reviewed the history of tern colonies in Massachusetts and summarized published data for Rhode Island, Connecticut, Long Island, and New Jersey. The figures for colonies and pairs of terns nesting south of the Isles

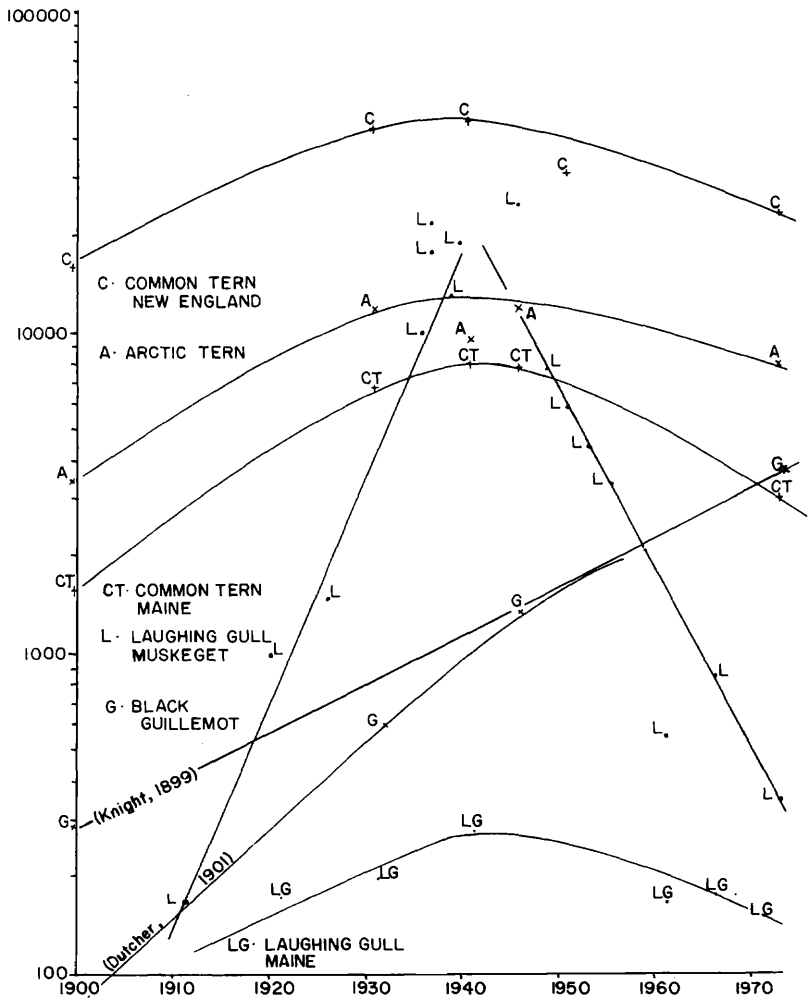

FIGURE 4. Changes in breeding populations of seabirds—Laughing Gull, terns and Black Guillemot.
Semilog plot of estimated numbers of four species of seabirds plotted at approximately 10-year intervals for New England. The following are excluded: populations of Laughing Gulls in New Jersey and south; populations of Common Terns south of New Jersey; populations of all species in New Brunswick and Nova Scotia.

of Shoals in Tables 11-13 are taken from his paper. The remainder of this section is concerned largely with New Hampshire and Maine.

Allen and Norton (1931) and Palmer (1938, 1949) reviewed the history of tern colonies in Maine. Valuable data for the 1940s were found in Gross's notebooks. Each of these authors made a comprehensive survey of the Maine coastline.

Many scattered references exist for numbers of terns on single islands, but it is difficult to synthesize a census at any one time by combining counts made in different years because tern colonies vary greatly in numbers and move around from year to year. In extreme cases several thousand terns have appeared on an island for only one season, viz., Douglas Island (Petit Manan area) 1903; Little Mark (Casco Bay) 1947 and again 1963; Little Spoon (Swan's Is.) 1946; Green Ledge (upper Penobscot Bay) 1946; Damariscove (Booth Bay) 1964; and Flat Island (Petit Manan area) 1964. Smaller colonies appear and disappear nearly every year. Nevertheless, all the published reviews have to some extent compiled notes taken from several years.

No complete nest counts have been published. Because authors of censuses have not commented on separating loafing birds from those inside the area of nests, it has been assumed that the numbers (published and unpublished) included all birds over the colony. Field tests suggest that the number of nests is approximated by dividing such estimates by 1.5 (Nisbet, 1973). The present censuses are estimates of birds (by 25s) that fly up over the nesting area, less 10%. Birds loafing near the colony are excluded.

Early censuses in Maine did not separate species; they did, however, list the occupied islands. For the purposes of this review, species have been assigned to these early estimates according to comments made at the time, and according to experience with the recent distribution of Arctic and Common terns. Roseate Terns have nearly always been given special notice. Common and Arctic terns have nested together on the islands in western and eastern Maine. On the central Maine coast, between Seguin (western edge of Booth Bay area) and the Duck Islands (Swan's Is.), Arctics nest on outer islands and Commons nest at the head of the bays.

Lock (1971) lists tern colonies found on an air survey or reported in published and unpublished form on the coast of Nova Scotia. He comments that the census was not complete or systematic. Of the islands for which species are identified, 18 had nesting Common Terns alone, 5 had Arctic Terns nesting alone, 11 had both Arctic and Common terns nesting, and 6 had Arctic, Common and Roseate terns.

Events of the last 75 years—Arctic and Common terns combined. Norton (Allen and Norton, 1931) listed 67 islands on which terns nested in Maine in 1886. By 1890, the number was reduced to 32 islands and by 1900, to about 20. Since 1900, terns have nested on a total of more than 80 islands in Maine, but have occupied no more than 30 at any one time.

After the plumage trade was prohibited and hunting stopped, unexpectedly large numbers of terns reappeared on their breeding colonies. But at the turn of the century some tern colonies were sub-

TABLE 11. Pairs of Common Terns nesting in New England.[1]

Location	1886	1900-01	1903-04	1931-35	1940	1945-48	1952	1972
New Jersey	(10)	(50)		300			>3,000	>750
Western Long Island	0	0		(50)			n.d.	5,300
Eastern Long Island	0	0		(100)			n.d.	3,500
Long Island Sound	(10)	75		n.d.			900	900
Block Island Sound	3,000	2,500		7,000			(4,000?)	3,200
Narragansett Bay	10	100		(100)			(200)	250
Vineyard Sound	1,500	3,000		8,000			7,000	1,600
Nantucket Sound	4,000	(8,000)		(20,000)			3,000	2,600
Cape Cod Bay	(200)	(500)		2,000			5,500	3,000
Boston Harbor	0	0		0			0	300
North Shore	30	10		50			200	0
Cape Ann-Portsmouth	0	0		150			30	70
Isles of Shoals				650	1,700	650		0
York Shore						350		
Saco Bay		400	70	800	1,700	2,300		250
Casco Bay			20	400	650	75		300
Booth Bay		20	150	650	650	100		800
Muscongus Bay		35	20	20	0	100		275
Matinicus Is.		650	2,700	200	65	65		
Fox Is.		65	75	1,300	1,300			
Penobscot Bay		100	200	150		1,300		150
Jericho Bay		350	600	1,100	400			600
Swan's Is.		35		200	200	400		70
Petit Manan				750	1,300	2,300		450
Machias Bay		35	400	200	20	20		75
Grand Manan			65	150	30	n.d.		100
Total for Maine only		(1,700)	(4,800)	(6,500)	8,000	7,700		3,070
Total for northeast coast		16,000	19,000	44,000	45,750		31,500	24,000

[1]The data from the area south of Cape Ann are from Nisbet (1973). The colony estimates available between 1900 and 1930 do not separate Arctic and Common terns. For these years species have been assigned according to contemporary geographical distribution of the two species.

TABLE 12. Pairs of Arctic Terns nesting in New England.[1]

Location	1886	1901	1903-04	1931	1940	1945	1952	1965-68	1972
Vineyard Sound	(5)	(5)		0			5		35
Nantucket Sound	(20)	(30)		180			150	65	45
Cape Cod Bay	0	0		40			80	20	25
Boston Harbor	0	0		0			0		0
North Shore	(5)	0		10			5		0
Cape Ann-Portsmouth	0	0		0			0		0
Saco Bay								75	
Casco Bay						1,300		4,500	
Matinicus Is.		1,000	2,000	4,000	1,500	1,700	700	750	1,300
Swan's Is.						1,300			
Petit Manan				150	2,300	1,300			1,300
Machias Bay		1,000	1,100	1,100	35				300
Grand Manan		350	2,300	2,500	2,700	2,300			5,000
Total		2,500	5,500	8,000	6,500	8,000			8,000

[1]The data from Massachusetts are from Nisbet (1973). Comparison of this table with Table 13 suggests that Arctic and Roseate terns replace each other geographically on the northeast coast.

TABLE 13. Pairs of Roseate Terns nesting in New England.[1]

Location	1886	1900	1931	1952	1968	1972
New Jersey	0	0	5	(n.d.)		(n.d.)
Western Long Island	0	0	0	n.d.		10
Eastern Long Island	0	0	0	n.d.		500
Long Island Sound	0	0	(30)	100		65
Block Island Sound	5	(0)	500	n.d.		1,600
Narragansett Bay	0	0	5	0		(0)
Vineyard Sound	1,000	(1,500)	1,700	2,900	850	1,700
Nantucket Sound	1,200	(2,000)	3,000	800	230	260
Cape Cod Bay	0	0	100	100	400	380
Boston Harbor	0	0	0	0	0	0
North Shore	0	0	5	0	0	0
Isles of Shoals			10			0
Western Maine			400			75(150)
Eastern Maine						10
Total	2,200	3,500	5,700	3,900	Incomplete	4,700

[1]The data from the area south of Cape Ann are from Nisbet (1973). The Maine population of Roseate Terns has remained a minor element over the years but has stayed comparatively stable as has the main population in the area between Nantucket Sound and Block Island Sound.

jected to another harassment that has been eliminated from New England's coastline. In 1901 (Norton, 1925a), a Peregrine Falcon (*Falco peregrinus*) spent the summer on Eastern Egg Rock (Muscongus Bay) and destroyed not only the tern colony but also the Leach's Petrel colony. In 1907, a Peregrine spent the summer on the Brothers Islands and the large colony of terns on Libby Island (Machias Bay) was destroyed (Norton, 1907).

Norton (1925a) believed that terns had already reached peak numbers. Allen and Norton (1931) said: "Terns in Maine have no doubt reached and passed the climax of abundance and favorable breeding conditions." Nisbet (1973) concluded that Common Terns in Massachusetts reached peak abundance about 1920. It appears that terns in Maine, at least, continued to increase until about 1940 (Table 11).

In Maine, Common Tern colonies have moved more than those of Arctic Terns, and Common Terns seem to have suffered more from harassment by gulls and men. Arctic Terns have persisted on several traditional outer islands protected by lighthouse keepers and have fed in offshore waters. Nisbet (1973) comments that Roseate Terns in southern New England have similarly persisted in a few large colonies over the last 40 years.

"While there can be no doubt that the Common and Arctic Terns have from the remotest to the present time formed a large element in the bird population of the region, neither can there be much question that throughout this long reign, they have been subject to a ceaseless series of cycles, with an alternating ebb and flow of their numbers, a contraction and expansion of their breeding territory".—Norton (1924b)

Sterna hirundo. Common Tern.

Events of the last 75 years. In contrast to the seabirds discussed so far, the history of Common Terns in Maine has been one of three decades of success followed by three decades of failure (Fig. 4). Dutcher (1902-1905) did not separate Arctic from Common terns, but from his records apparently 1,100-1,700 pairs of Common Terns nested on 15 islands about 1900. In the next few years a combined total of 4,800 pairs were reported on 16 islands. In 1911, about 4,000 pairs of Common Terns apparently nested on 19 islands. Common Terns continued to increase (Table 11), even though they were driven from Jericho Bay and upper Penobscot Bay before 1920—whether by gulls or eggers—and from Metinic Green (Matinicus Is.) by gulls before 1920.

In 1931, 4,900 pairs of Common Terns were reported by Allen and Norton on 19 islands. The tern colonies in Muscongus Bay were overrun by gulls by 1935. Even so, in 1936 Palmer (1949) reported 6,000 pairs of Common Terns on 25 colonies. (The Isles of Shoals colonies are in New Hampshire.) A combination of sources indicates about 8,000 pairs on 25 islands about 1940, the population peak (Table 11).

Large colonies on Ship and Trumpet Islands (upper part of Jericho Bay-Blue Hill Bay) were broken up during the 1940s. The large colony on Garden Island (western part of Fox Is. area) was abanddoned between 1940 and 1945. The important colonies in Saco Bay which, as Dutcher said, survived the millinery onslaught, were overrun by gulls soon after 1945. Only a remnant was present on the southern tip of Stratten in 1965 and a few terns still breed somewhere in Saco Bay. The colonies on Bumpkin Island (Yorks) and on Lunging Island (Isles of Shoals) were displaced by gulls apparently in the 1950's.

From a peak of about 8,000 pairs of Common Terns about 1940, the population has been reduced to about 2,600 pairs on 18 islands in 1972. However, it is clear in Figure 4 and Table 11 that the population trends in Maine parallel those in Cape Cod. The factors involved are then presumably in effect all along the coast and some of them might act on the wintering grounds in northern South America where many terns are trapped for food.

Neighboring populations

Apparently the population of Common Terns becomes progressively less dense toward the northeast, from the large colonies in southern New England to Nova Scotia. Lock's data in 1971 suggest a very rough total of 2,000-2,500 pairs of Common Terns nesting on 35-40 islands on the mainland coast and about 500 pairs nesting on Sable Island. About the same number of Common Terns nest along

that shore as nest in Maine, but Nova Scotia has four times as many miles of coast.

Peters and Burleigh (1951) reported only 1,030 pairs of Common Terns nesting on 28 colonies in Newfoundland in 1943-1945. No more recent censuses were found. If the Newfoundland population has followed the trends shown in other parts of the Northeast, such as those of the sanctuaries on the north shore of the Gulf of St. Lawrence (Lewis, 1942; Hewitt, 1950; Tener, 1951; Lemieux, 1956; Moisan, 1962; Moisan and Fyfe, 1967), it is unlikely that those populations have changed by more than a factor of two.

In the southern Gulf of St. Lawrence, at least 5,000 pairs have been reported on the sandy shores of northeastern New Brunswick (S. Homer, P. A. Pearce, in litt.), more than 1,000 pairs on the Magdalen Islands (J. A. Hagar, in litt.) and probably over 2,000 pairs in the north shore sanctuaries (Moisan and Fyfe, 1967; Nettleship, 1972b; A. R. Lock, in litt.). Apparently about as many terns nest outside the north shore sanctuaries as nest inside. The censuses along this shore have not consistently separated Common from Arctic terns.

Sterna paradisaea. Arctic Tern.

Events of the last 75 years. The numbers of Arctic Terns have been more stable on the Maine coast than those of Common Terns (Fig. 4) Protection by lighthouse keepers has kept three of the major colonies free of gulls: Machias Seal (Grand Manan Archipelago), Petit Manan, and Matinicus Rock (Matinicus Is.). Metinic Green (Matinicus Is.) was the only major colony lost when gulls moved in between 1916-1920.

If species were present in the same proportions in 1902 (Dutcher, 1902) as they are today, 5,500 pairs of Arctic Terns must have nested in Maine and Machias Seal at that time (Table 12). The number was still about 5,500 pairs by 1911. The census in 1931 (Allen and Norton, 1931) covered all important Arctic Tern colonies and listed 5,000 pairs at 6 islands, excluding Machias Seal Island. Palmer (1949) listed 8,000 pairs at 10 islands in 1936. In 1972, 5,500 Arctic Terns were estimated nesting on 4 islands (Table 12).

It seems clear that the future of Arctic Terns on the New England coast depends on the integrity of their present major colonies. Possibly they will increase if smaller colonies on Foster (Machias Bay), Flat (Petit Manan area), Little Green, Wooden Ball, and Metinic (Matinicus Is.) can grow or they can return to Metinic Green and the Egg Rocks in Muscongus Bay.

Neighboring populations

Lock's data (1971) from Nova Scotia suggest about 1,000 pairs of Arctic Terns nesting on 25 colonies on the mainland coast and 600-1,000 pairs on Sable Island. These data indicate, surprisingly, that the population of Arctic Terns in Nova Scotia is at most one-half of that in Maine and Grand Manan.

Peters and Burleigh (1951) reported 2,700 pairs of Arctic Terns in 19 colonies on the coast of Newfoundland in 1944 and 1945. This

also seems to be a very small population. It is unlikely that the number has changed markedly since 1945 if the population in Newfoundland has followed the population trends of the rest of the Northeast.

Informal reports indicate that less then 10 % of the tern population in the southern Gulf of St. Lawrence is Arctic Terns. Censuses in the north shore sanctuaries have not consistently separated the two species.

The Arctic Terns breeding on two islands in Maine and one at Grand Manan appear to comprise well over one-half of the Arctic Tern population breeding south of Labrador.

Sterna dougallii. Roseate Tern.

Events of the last 75 years. Data in Nisbet (1973) show that the population in Maine is peripheral (Table 13). A small population of about 250 pairs of Roseate Terns has maintained its numbers in western Maine for the last 40 years (Table 13), in addition to which a few pairs have occurred widely scattered among colonies of Common Terns.

Allen (1903) noted that Roseate Terns once nested on the Isles of Shoals, and one was reported at Matinicus Rock in 1916 by Norton (1925a).

In 1931, Allen and Norton (1931) reported 400 Roseate Terns on Stratten Island (Saco Bay). In the same year Jackson and Allan (1931) reported 10 pairs on Londoners (Lunging) Island (Isles of Shoals). Palmer saw 2 at Matinicus Rock in 1936 (in litt.). Two were reported on Turnip Island (Casco Bay) in 1950 (RNEB), 6 were reported on Ten Pound Island (Matinicus Is.) (Buba, 1958, RNEB) in 1958. Hatch (in litt.) reported 2 on Machias Seal Island in 1968 and 2 at Petit Manan in 1972. In these censuses, 5 pairs were seen on Petit Manan in 1970, 2 on Metinic and 2 on Smuttynose (Jericho-Blue Hill Bay) in 1971, and 8-12 were seen fishing near Prout's Neck (Saco Bay) in 1969, 1971 and 1972. The most consistent colony appears to be at the Sugar Loaves in the mouth of the Kennebec River (Booth Bay). Allen and Norton (1931) reported 150 Roseate Terns there. Morse (1957) reported 5 pairs. In 1971, 150 pairs were seen and in 1972, 75 pairs. Lock's data in 1971 suggest about 100 pairs of Roseate Terns nesting on six islands along the coast of Nova Scotia and 150-175 pairs nesting on Sable Island.

Sterna albifrons. Least Tern.

Nisbet (1973) reviewed the history of Least Terns in southern New England. Colonization of beaches north of Cape Ann, Mass., where Least Terns had been accidental stragglers since the 1860s, began with Plum Island in 1937 (RNEB), then Ipswich Beach in 1945 (Taber, 1947). The movement continued to Seabrook Beach, Hampton Harbor, N. H., in 1953 (RNEB), and on to Maine where they colonized Scarboro Beach in 1961 (AFN). The next suitable beaches to the northeast of Saco Bay are Small's Point and the mouth of the Kennebec River. These beaches should be searched. "Terns" have been reported there for a number of years (N. Chandler, pers. comm.) but I have not landed because of heavy surf. (After this

was written, a colony of Least Terns was reported in 1973 near the mouth of Kennebec River; M. L. Hunter, Jr., pers. comm.)

Rynchops nigra. Black Skimmer.

Champlain described Black Skimmers at Cape Cod in 1605 and when Brewster first visited Muskeget in 1870 he was told that they had nested there until only a few years before (Griscom and Folger, 1948). The species was extirpated from the Northeast by 1870, but in the last 75 years they have reoccupied most of their previous range.

The first nesting on Long Island in this century was recorded in 1934 on Great South Bay east of Jones Beach. Nesting occurred in 1935 near Fire Island Inlet and in 1936 near Moriches Inlet (Bull, 1964). By 1942, 40 pairs were reported nesting in 3 colonies. Between 1948 and 1954, 75 pairs were reported at Jamaica Bay, 100 pairs in the Jones Beach area, and 75 pairs at Moriches Inlet. In 1961, there were 100 pairs at Moriches, 80 pairs in the Jones Beach area (including Short Beach and Meadow Island), and 120 pairs at the Jamaica Bay Wildlife Refuge (Bull, 1964); other small colonies were reported. In 1971, the annual review of Long Island's breeding birds (*The Kingbird*) reported 50-60 pairs at the South of the Loop Causeway, 80-100 at Jones Beach, 75-100 pairs at Cedar Beach. However, no mention was made of colonies reported in the 1960s at Jamaica Bay (120 pr.), at Meadow Island north of Island Park (60-70 pr.), at Moriches Inlet (30 pr.), or Shinnecock Inlet (25 pr.).

In the late 1960s and early 1970s, one or two pairs were reported nesting for a few years at a time at Gardner's and Cartwright Islands in Block Island Sound (*The Kingbird*).

Black Skimmers were seen on the coast of Massachusetts every summer after 1939, and two pairs nested at Long Beach, Plymouth, in 1946 (Hagar, 1946). They bred at Cotuit on Cape Cod in 1956 and 1960; they bred again at Plymouth in 1960 and 1961 (RNEB). They have apparently nested annually on Monomoy at Chatham, Cape Cod, since 1967 (RNEB). I found nestlings there in 1971.

Alca torda. Razorbill.

Materials and census techniques. The most valuable counts of Razorbills in two major colonies, Machias Seal and Matinicus Rock, were made by those who have spent several days there. Highest counts have been made between mid-May and mid-June early in the morning or in the evening when these auks gather on the rocks or raft close offshore. Numbers of this species seem to fluctuate rapidly.

Events of the last 75 years. Norton (1923) reported that in the 1880s Razorbills summered in different years at Western Egg Rock (Muscongus Bay), Metinic Green, and Little Green Islands (Matinicus Is.), but that no history of a colony in Knox County was kept. Between 1894 and 1923, none was seen by Norton in Maine. In 1891, Bent and Durfee (*in* Townsend, 1923) found 10-15 at the Murre Ledges south of Grand Manan. Townsend (1923) quoted a report by Ernest Joy of Grand Manan that 300 (i.e., 200 pairs?) bred on the southernmost of the Murre Ledges. Gross (1935) reported 400 birds on the Murre Ledges.

Apparently one bird spent the summer of 1911 at Machias Seal Island (Pearson, 1911) and an egg, probably of this species, was laid there in 1922 (Pettingill, 1939). Pettingill reported Razorbills regularly at Machias Seal in 1937. The lighthouse keeper considered 75 pairs a normal number in 1940, but in 1947 believed 20 pairs were present (Hawksley, *in* Palmer, 1949) Gross (notebooks) reported only 8 Razorbills in 1946. Carter (*in* Baldwin, 1971) reported that Razorbills disappeared from Machias Seal Island in the late 1940s and early 1950s (which might explain the discrepancy between 1940 and 1947 above), but that a few had returned by 1955. Huntington (1959) reported an increase on Machias Seal since 1955. Russell and Thompson (AFN 1971) reported 50 pairs at Machias Seal island.

Forty Razorbills were counted at Old Man Island at the eastern entrance to Machias Bay in early May 1973. Hebard (1952) reported Razorbills at Matinicus Rock. By 1957, 8 birds were reported and 8 again in 1964 (AFN). The Buchheisters (1968) reported them nesting on the Rock in 1965. The highest count made from the sea on these censuses was 17 in May 1967; that same year the Buchheisters reported 21; in 1970 and 1971, the number was 10 in July. Lock (1971) reported about 50 pairs on Hertford and Ciboux islands off Sydney, Cape Breton Island, and 1 pair at Pearl Island south of Halifax. The population on the north shore of the Gulf of Maine is, then, a major part of the southern population of this species.

Cepphus grylle. Black Guillemot.

Materials and census techniques. Dutcher (1901, 1903), Norton (1923) Allen and Norton (1931) and Palmer (1949) are the major sources. The time at which censuses are taken and the weather conditions are especially important in counting these birds. Counts made early on calm mornings in the first two weeks of May and early July might be 10 times the counts made on windy afternoons. Counts made in July might be artificially high because nonbreeding birds are present (Winn, 1950; Drent, 1965). Because the species nests in small groups or single pairs scattered over many small coves and small islands, it is especially important to census the coast systematically. Entries in Table 14 are total individuals seen, divided by 1.5 (see above).

Events of the last 75 years. A. H. Norton (1923) remarked that populations of Black Guillemots changed little in the previous 70 years. Several writers have doubted this but the numbers available from two large islands—Little Duck (Knight, 300-400 in 1899[3]) (Swan's Is.) and Matinicus Rock (Dutcher, 150 in 1902) (Matinicus Is.)—indicate that the populations on these two islands have remained relatively constant (Table 15). The increase of guillemot populations (Fig. 4) has been associated primarily with founding new colonies (Table 14).

[3]Contemporary authors thought Knight's estimate was too high (Palmer, 1949).

TABLE 14. Pairs of Black Guillemots.

Location	1901	Est. 1900-03	1931	1945	1970-72
Isles of Shoals				2	2
York Shore					10
Saco Bay					4
Casco Bay				4	4
Booth Bay				6	6
Muscongus Bay			70	220	175
Matinicus Is.		200	250	350	1,000
Fox Is.			10	150	125
Penobscot Bay				50	100
Jericho Bay		20		—	300
Swan's Is.		250	250	450	1,230
Petit Manan			2	10	260
Machias Bay		25	20	100	210
Grand Manan				150	190
Quoddy					160
Est. Total	85		600	1,500	3,775
No. of islands	11		24	32	123

Dutcher (1903) reported the population in Maine as 150 birds breeding on 14 islands east of Metinic Green (Matinicus Is.). Allen and Norton (1931) reported 600 birds on 24 islands. The species was nesting in Saco Bay in the mid-1940s (Gross's field data). Taber (1955) reported Black Guillemots nesting on the Isles of Shoals, still their southern limit. One or two pairs nested on Smuttynose in the Isles of Shoals in the summer of 1969 and 1970. Birds have been seen several times in June at the Dry Salvages off Cape Ann, Mass.

Black Guillemots had large colonies in the Grand Manan area in the 1920s (Townsend, 1923). He reported that Outer Wood Island had many hundreds, if not thousands of birds, and that the western shore of Grand Manan sheltered many pairs along the rocky cliffs. In 1936, Pettingill (1939) gave a comprehensive report of the pairs breeding on the southern islands: Inner Wood 6, Outer Wood 300, North and South Green 80, White Horse 10, Sheep 20, West Green 2, and suggested that several hundred pairs were breeding on the main islands' west shore, and he reported 70 pairs for Kent's Island. In early May 1973, we counted 15 pairs at Outer Wood, 100 pairs at North and South Green, 15 pairs at White Horse, 30 pairs at three islands, and two pairs at Machias Seal Island. However, a fresh breeze blew throughout our survey of these islands.

Certain islands have large populations of Black Guillemots. These islands are apparently preferred even to neighboring islands with

TABLE 15. Pairs of Black Guillemots nesting on three islands.[1]

Location	1899	1901	1902	1931	1935	1936	1942	1945-46	1948-50	1952	1955	1956	1957	1958	1972-73
Matinicus Rock		120	220	150				100		75	150	175	200	350	250
Little Duck	300–400			57			185	485	200–300						300
Kent Island					70	100		75	75			45			30

[1]Numbers for Matinicus Rock are from Dutcher (1901 and 1902) Allen and Norton (1931), Burnett, (1946) Palmer, (1952, 1954), Courson (1957), Hundley (1958), Buchheister (1968). Estimates in my censuses between 1968 and 1972 have varied between 140 and 250 birds except for one May morning in 1971 when a flock of 600 birds was seen one-third of the way from Matinicus Rock to Ragged Island. Numbers for Little Duck are from Knight (1899), Allen and Norton (1931), Gross (1942-1949). Numbers for Kent Island are from Gross (1935, 1936, 1946), Winn (1950), Huntington (1956).

TABLE 16. Common Puffins at Machias Seal and Matinicus Rock.[1]

Location	1900	1902	1904	1907	1911	1922	1923	1931	1936	1937	1939	1946	1957	1958	1964	1968	1971
Machias Seal		300			300	over 200	350-450		600	750	1,000	650-1,000					1,500
Matinicus Rock	3		5	5				50-70		80		70	140	75-100	120-150	150	170

[1]Estimates at Machias Seal are from Norton (1902), Pearson (1911), Smith (1922), Townsend (1923), Pettingill (1936-1939), Peabody (1939) *in* Palmer, Gross (1946), Russell and Thompson (1971). Estimates at Matinicus Rock are from Dutcher (1901, 1904), Norton (1907), Allen and Norton (1931), Palmer (1937), Cruickshank (1946), Courson (1957), Hundley and Buchheister (1958), AFN (1964), Buchheister (1968), my census (1971).

apparently adequate boulder fields for nesting cavities. Colonies of 50 or more birds occur on Cross Island, Old Man (Machias Bay), Jordan's Delight, Schoodic (Petit Manan), Little Duck, Great Duck, Long, John, Great Spoon, Little Spoon (Swan's Is.), Green ledge, Saddleback, Southern Mark (Jericho Bay), Seal, Wooden Ball, Matinicus Rock, Green Ledge, Shag Ledge, Ten Pound, No Mans Land, Two Bush (Matinicus Is.), Marblehead, Fisherman's (Fox Is.), Mosquito, Eastern Egg Rock (Muscongus Bay). These are primarily in the outer islands; inner islands appear to have much smaller colonies.

Lock (1971) listed 32 islands in Nova Scotia where Black Guillemots are presumed to breed and his numbers indicate a minimum of 400 pairs. His survey was made largely from the air and was concerned primarily with gulls and cormorants.

Because this species is so widespread, occurring as a few birds around nearly every cove and small island, changes in its population can be measured on a local scale. Such changes should reflect changes in the quality of the local habitat.

Fratercula arctica. Common Puffin.

Materials and census techniques. All estimates of Common Puffins are based on counts of birds on the island or the adjacent waters. It is difficult to assign a proportion between the number of birds to the number of active nests, but as long as the estimates are of the same population elements, they should be comparable. The conclusions do not depend on precise counts.

Events of the last 75 years. Norton (1923) said that if Common Puffins nested on Matinicus Rock previous to 1865, all trace of that population was lost. Early histories report Common Puffins nesting on Matinicus Seal and on Large Green (Matinicus Is.) and on Eastern and Western Egg Rocks (Muscongus Bay). Reports of Common Puffins on Matinicus Rock exist for 1887, 1896, and 1897. At that time they were eliminated from Matinicus Seal by fishermen using herring nets. The changes in their population at the two colonies on the Gulf of Maine are shown in Table 16.

Common Puffins prospecting (that is, flying inland over the island) have been seen at the Egg Rocks (Muscongus Bay), at Metinic Green, Little Green, Ten Pound, Wooden Ball (Matinicus Is.), and at Petit Manan and Old Man (Machias Bay). Allen and Norton (1931) found feathers at the entrance of suitable burrows on Matinicus Seal, but no signs of the birds have been seen there recently in several searches.

Neighboring populations

Lock (1971) listed 50-70 pairs of Common Puffins nesting on Hertford and Ciboux Islands off Cape Breton Island and 2 pairs on Pearl Island south of Halifax, Nova Scotia. It is clear that the two colonies on the north shore of the Gulf of Maine are critical for the survival of the southern population of this species.

Comments

Doubtless, Common Puffins have increased steadily from the desperate straits of the early 1900s, but it is not clear whether the species had increased after the late 1950s.

During the summers of 1968-1970 many fewer Common Puffins were visible standing on the rocks in the sun on Matinicus Rock than had been usual in previous years. Between 1965 and 1970 about 200 gull pairs nested on the Rock. In 1970, the Buchheisters observed heavy predation by gulls on Arctic Tern chicks. Nettleship (1972c) has reported on the serious reduction in Common Puffin reproduction as a result of the presence of gulls in a colony in Witless Bay, Newfoundland.

In 1971, the nesting gulls were killed off the island through the cooperation of the State of Maine and the U. S. Fish and Wildlife Service. The results were spectacular. Not only did the Arctic Terns have a very successful year but the flocks of Common Puffins sunning themselves returned. Unfortunately the control program was discontinued in 1972 as a side-effect of the restriction on use of persistent poisons for predator control in the western United States. In 1972, the gulls were back, predation was high, the terns reproduced poorly, and few Common Puffins were evident on the Rock. It seems obvious that control of gulls on this island is necessary if the populations of other seabird species are to thrive there.

Uria aalge. Common Murre.

Murres are seen in summer plumage prospecting at Machias Seal and Yellow Murre Ledges almost every year (Ridgely, 1952; Baldwin, 1971). Cruickshank and Libby reported prospecting murres at Western Egg Rock (Muscongus Bay) in 1951 (RNEB). They were seen prospecting at Matinicus Rock in 1965, 1968, and 1973. This species reportedly bred at four places in Nova Scotia in the past but Lock (1971) reported no evidence of their breeding anywhere in the province. Norton (1923) reported that they formerly nested on the Green Islands (Matinicus Is.).

(To be continued)