

POPULATION STATUS OF ARCTIC, COMMON, AND ROSEATE TERNS IN
THE GULF OF MAINE WITH OBSERVATIONS OF FIVE DOWNEAST COLONIES.

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INTRODUCTION:

Declines in numbers of Arctic Terns *Sterna paradisaea*, Common Terns *S. hirundo*, and Roseate Terns *S. dougallii*, throughout the northeast have been noted since 1940 (Drury 1973, Korshgen 1978, Nisbet 1973). Recent observations of Arctic and Common Terns in the Gulf of Maine have indicated a continuation and potential heightening of trends noted over the past forty years. Comparisons between counts of Arctic Terns by Drury in 1972-73 (Drury, 1973) and by Drury and Folger in 1983 (unpublished data), have indicated a population decline of as much as 40% over the last decade. Furthermore, the most recent complete survey of Common Terns in the state, done in 1977, indicated a parallel decline of 30%. Reductions in breeding habitat and in number of Roseate Terns has prompted federal consideration for "threatened" status (Nisbet, 1980). Because of a concern for terns in general and warnings indicated by previous surveys our work was initiated to further clarify the tern situation in the Gulf of Maine and to investigate the reasons for the decline in numbers.

In the summer of 1984 we censused the outer islands of the Maine coast for terns from Metinic Island, at the western edge of Penobscot Bay, to Old Man Island, east of Cutler. ~~We made~~ Detailed observations ^{we made} on five of the islands in order to examine the various factors that influence tern production.

Important events in 1984 included: a) the recolonization by terns of Petit Manan Island following a gull removal program carried out by the United States Fish and Wildlife Service in the spring of 1984. b) the abandonment of three of the five closely monitored downeast islands. c) a statewide census of tern colonies involving cooperators from the Maine Audubon Society, the National Audubon Camp at Hog Island, the Maine State Department of Inland Fisheries and Wildlife, and College of the Atlantic. d) the reintroduction of Peregrine Falcons *Falco peregrinus* in Acadia National Park.

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Part I STATUS OF NORTHEASTERN TERN POPULATIONS

Historical Background (1890-1970)

At the turn of the century northeastern United States and Canadian populations of Arctic, Common, and Roseate Terns were at their lowest in recorded history. The earliest censuses in the late 1890's were prompted by the obvious influence upon tern populations of the millinery trade, egg collecting, and human use of nesting islands. These early counts were sporadic and often did not distinguish between Arctic and Common Terns. Not until Dutcher's census in 1901 was there a comprehensive survey of northeastern terns. Since this time counts have been done roughly at twenty-year intervals; Dutcher in 1901, was followed by Norton's work in 1910-1925, Allen and Norton's census in 1931, and Palmer's synthesis of reports published in 1949. At the turn of the century the population from Grand Manan to New Jersey was estimated to be 2,500 pairs of Arctic Terns, 16,000 pairs of Common Terns, (Drury, 1973), and 1,500 pairs of Roseate Terns (count in 1890) (Nisbet, 1980). In the years following these early counts laws protecting nesting seabirds were enacted and human use of nesting islands changed. Tern numbers skyrocketed in the early part of the century and reached their peak in New England around 1940 (Drury, 1973). Counts at this time showed about 6,500 pairs of Arctic Terns, 45,750 pairs of Common Terns, and 7,500 pairs of Roseate Terns (Drury, 1973). From 1940 to 1970 numbers of terns in the northeast have apparently been declining. For more complete reviews of past population trends see Drury (1973) and Nisbet (1973).

Recent Changes (1970-present)

Southern New England and Long Island

Since the early 1970's annual surveys of terns have been completed in Massachusetts, and compiled by The Massachusetts Audubon Society and the state. Numbers of Common Terns recorded over this period have shown moderate fluctuations but in general appear to be holding relatively stable. Roseate Terns on the other hand have experienced a sudden decline. This is primarily a result of the breakup of the Monomoy Island colony, once the third largest Roseate Tern colony in the northeast. Arctic Terns in Massachusetts have declined most dramatically of all three species, from 105 pairs in 1972 (Nisbet, 1973), to 18 pairs in 1983 (Blodgett, pers. comm.).

From 1974 to 1978 in Long Island Sound, Buckley and Buckley (1980) reported Common Tern numbers and colony sites had increased while Roseate Tern colonies and number of pairs had decreased.

In both Massachusetts and Long Island the reversal of the population decline in Commons can be largely attributed to the work of conservationists, especially those researching terns. In tern colonies on Cape Cod the Massachusetts Audubon Society and the National Park Service have initiated programs to carry out predator control and promote public awareness of the terns' plight. On Great Gull Island in New York researchers from the American Museum of Natural History and the Linnaean Society of New York have greatly increased nesting habitat and have provided a secure island for nesting terns since the early 1960's.

Gulf of Maine

Four censuses of nesting terns in the Gulf of Maine have been conducted over the past 15 years. In 1972-73 Drury censused the coast for Arctic, Common, and Roseate Terns. (In 1972 the census covered west of Swan's Island, in 1973 colonies east of Swan's.) In 1977 Korschgen conducted a similar census, in 1983 Drury and Folger censused for Arctic Terns, and in 1984 a cooperative census of all terns along the coast was undertaken. (see next section)

The censuses in 1972-73, 1983, and 1984 involved estimates of breeding birds and species composition made from a boat and by landing on islands wherever necessary and practical. In 1977, Korschgen performed nest counts on islands he visited and supplemented these with estimates of species composition.

Drury (1973) divided the Maine coast into several sections for the purpose of presenting his data. Each section corresponds to a bay or cluster of islands. Such a system is useful in making comparisons between years because it tends to diminish the dramatic fluctuations that appear when populations are examined island by island. We have presented our own numbers in accordance with Drury's divisions (see Table 1).

In 1972-73 Drury found 2,900 pairs of Arctic Terns from Matinicus Island east to Machias Bay (Drury, 1973). He reported an additional 5,000 pairs of Arctic Terns on Machias Seal Island (Grand Manan), although this number was based on faulty information and is probably closer to 2,000 (Drury, pers. comm.). In this census 80% of the Arctic Terns found were on three islands: Machias Seal, Petit Manan, and Matinicus Rock. In the same census 2,970 pairs of Common Terns were found on eighteen islands from Saco Bay to Machias Bay, with an additional 100 pairs in the Grand Manan area. Finally, this census indicated 85 pairs of Roseate Terns in Maine, primarily on North Sugarloaf Island at the mouth of the Kennebec river and on Petit Manan Island.

In 1977 Korschgen found 1,640 pairs of Arctic Terns on nine islands (Korschgen, 1978). Although no published numbers are available for Machias Seal Island, clearly there was a

significant decline in the Arctic Tern population in Maine between 1972-73 and 1977. In both counts Matinicus Rock and Petit Manan were major colonies, and numbers on these islands dropped sharply. Matinicus Rock went from 750 pairs in 1972-73 to 400 pairs in 1977, while Petit Manan went from 1,100 pairs in 1972-73 to 700 pairs in 1977 (Korschgen, 1978). Korschgen also found a total of 2,095 pairs of Common Terns on 24 islands, indicating a 30% decline since Drury's census. Eighty pairs of Roseate Terns were found on 3 islands, indicating virtually no change in the overall population of Roseates, although the numbers on Petit Manan increased, North Sugarloaf decreased, and Beech Island off Biddeford was noted as a new colony.

In 1983 Drury and Folger censused the offshore islands for Arctic Terns from North Sugarloaf to Machias Bay, taking note of Commons and Roseates when seen. This census showed 1,855 pairs of Arctic Terns on 10 islands. An additional 1,250 pairs of Arctics were recorded on Machias Seal Island (Daniels, pers.comm.). The most significant factor influencing the Arctic Tern population between 1977 and 1983 was the breakup and total abandonment of Petit Manan Island. The population seemed to remain relatively stable during this period. After Petit Manan broke up, however, marked increases were noted on Matinicus Rock, Metinic, Egg Rock (Frenchman's Bay), and the Nash Islands. Corresponding movements were noted in Common and Roseate Terns after the breakup of Petit Manan. Dramatic increases in numbers of Common Terns were noted at Eastern Egg Rock, Egg Rock (Frenchman's Bay), and the 3 islands near Petit Manan: Big Nash, Nash, and Flat. All known Roseate Tern colonies, except those in the Casco Bay region, were visited during this census and 92 pairs were found.

Comparisons of these censuses indicate declines in Maine populations of Arctic Terns between 1972-73 and 1983. This decline from 1972-73 to 1977 may have been as high as 43%, and from 1972-73 to 1983 it was approximately 35%. Over this same ten year period the population on Machias Seal Island followed this trend, with a decline of about 48% for Arctic Terns. Roseate Tern numbers in the region have remained steady. A decline of 30% in Common Terns is indicated between 1972-73 and 1977; except for this year's census, numbers are not available after 1977.

Part II

THE 1984 CENSUS

Methods

In the summer of 1984 we censused the 'outer' coast from Metinic Island, at the western edge of Penobscot Bay, to Machias Bay. This census was part of a statewide survey of nesting terns. Other participants included: in the Casco Bay region, Jane Arbuckle of the Maine Audubon Society; in Muscongus and Penobscot Bays, Evie Weinstein of the Hog Island Audubon Camp; in upper Penobscot and Jericho Bays, Al Hutchinson of the Maine State Department of Inland Fisheries and Wildlife.

Prior to our census Al Hutchinson of the Department of Inland Fisheries and Wildlife flew the coast in order to identify islands with tern colonies. Cooperators in the statewide survey then visited those islands.

Islands were visited in the sloop *Guillemot*, and estimates of all breeding adults present (roosting birds excluded), were made either from the deck of the boat or from the island. Three to four experienced observers conducted these counts. Ratios of Arctic and Common Terns were determined by estimating relative numbers of birds in the air over each colony. Because Roseate Terns are easily distinguished, and because they are present in such small numbers, pair estimates were based on direct counts. On 3 of the 14 islands visited, Egg Rock (Frenchman's Bay), Petit Manan, and Flat Island, nest counts were also conducted. A capture-recapture method (Lincoln-Peterson Index) was employed. Nests were marked with a toothpick in the first search. A second search was made counting marked to unmarked nests, which in turn gave an estimate of the percent missed in the first count. By comparing our estimates with nest counts at the three aforementioned islands, we were able to determine our error in estimating nesting pairs. Our findings showed on average of 1.2 adults per nest present during midday. The numbers in Table 2 reflect the use of this coefficient.

Results

See Table 2

Discussion

Table 2 shows estimated numbers of birds on each island and the dates they were censused. In assessing these numbers it is important to realize that they represent a single point in time, which is not an accurate reflection of the dynamic changes in number of terns observed over the season. If counts

are made too early in the nesting season, observers may miss late arriving birds. If counts are made too late, birds that have given up may be missed, or, in the case of nest counts, renesters will be counted twice. Ideally, as pointed out by Drury and Nisbet (1972), nest counts should be conducted just prior to first hatching, before chicks are mobile and can no longer be associated with nests. We conducted nest counts using this timetable, however we found that late nesting and local disturbances greatly influenced the number of breeding pairs that could be associated with a colony at any one time. For example, on June 9 Big Nash Island was estimated to have 280 terns in the early stages of egg laying, but sometime between June 16 and 22 the island was abandoned. Based on a count of empty nests performed on June 23, our final estimate was of 210 breeding pairs associated with Big Nash Island. Had we strictly adhered to the ideal timetable the birds from Big Nash would not have been included in the regional total. In this case our options were either to accept the early count or to wait until the Big Nash birds had resettled. The problems with waiting are that there is no guarantee that birds will resettle, and that late nest counts will encounter chicks. The goal of the census was to establish the number of breeding pairs in the Gulf of Maine. Consequently, our numbers do not necessarily reflect a precise number of pairs associated with each colony, but instead represent an accurate regional assessment.

Experience has shown that greater accuracy is possible when counting and estimating species composition in colonies of less than 100 pairs, as opposed to larger colonies, although the degree of precision may be the same in both cases. An error of 20% is hardly significant in a colony of 50 pairs, while the same error in a colony of 500 has much greater meaning. Thus we believe that nest counts are vital in colonies of more than 100 pair. However, in some cases it may actually not be advisable to enter small colonies because of the disturbance generated by a nest count. A significant difference in species composition only exists when ratio differences of Arctic to Common Terns are greater than 20%. Our experience shows that around the 50% level observers' estimates will often vary by 15%, whereas in colonies of increasing disproportion, ratio error decreases.

In comparing the results of the 1984 census with those of 1977, we find that the total number of breeding pairs of all three species in the Gulf of Maine has not changed significantly. However, a comparison with Drury's 1972-73 counts shows a marked decline in Arctic and Common Tern populations in Maine. In considering Korschgen's 1977 census, Drury and Folger's 1983 census, and this year's census, it seems reasonable to conclude that the Maine population of Arctic Terns stands at 1,700 pairs, plus or minus 100. The confidence in numbers of Common Terns is less, but presently the population is approximately 2,100 pairs. The number of

Roseate Terns in Maine appears to have held steady at 80 pairs over the past 15 years. Despite the consistency of these numbers there is still considerable doubt regarding recent trends in the population. Major questions remain concerning mortality, recruitment and other factors influencing the population size.

Part III

OBSERVATIONS

At the beginning of the 1984 field season we set out to examine production, feeding behavior, and sources of mortality in four downeast terns colonies. These were Egg Rock in Frenchman's Bay, and Nash Island, Big Nash Island, and Flat Island, all in Pleasant Bay. These islands were chosen primarily because of their proximity to Petit Manan Island. Drury and Folger's census of 1983 indicated increases in these colonies after the breakup of the Petit Manan colony, which was apparently due to gull predation. It was reasoned that since gulls were being removed from Petit Manan by the USF&WS, terns from these "satellite" colonies might return in the near future. By focusing on the satellite colonies we hoped to gain insights into what makes a "good" tern colony. To our astonishment, terns returned to Petit Manan immediately after the gull removal program. Consequently we immediately began monitoring this colony as well.

Nash Island

Nash Island is approximately 7 hectares and is located 2 miles off South Addison at the western edge of Pleasant Bay. In 1983 50 pairs of Arctic Terns, 20 pairs of Common Terns, and 4 pairs of Roseate Terns were estimated on this island. On June 9, 1984 20 pairs of Arctic and 5 pairs of Commons were observed in the early stages of egg laying. On June 24, observers returned, intending to perform a nest count. They found the island abandoned. A walk through the area where the birds had been revealed 7 one-egg clutches, 8 two-egg clutches, 1 three-egg clutch, and 3 empty nests. Additionally, there was evidence of 7 broken eggs which appeared to have been eaten. A man who shears sheep on the Nash Islands reported that terns were present on June 16. The broken eggs that were found had no fresh albumen, indicating that they had been broken several days earlier. On the basis of this information we set the date of abandonment at between the 16 and 22 of June.

We counted 260 Herring Gulls and estimated 150 nesting pairs on the island. Forty Greater Black-backed Gulls were counted, of which 18 pairs were thought to be nesting. On June 9 a Black-backed Gull was seen setting up a territory adjacent to the terns' nesting area and was being intensely harrassed by the terns. Most of the broken eggs found on the 24th were near the rock that this gull roosted on. We believe that the broken eggs can be attributed to this Black-backed Gull.

Big Nash Island

Big Nash is located about 200 meters northeast of Nash Island and is approximately 32 hectares. In 1983 Drury and

Folger estimated 235 pairs of Arctic Terns, 175 pairs of Common Terns, and 6 pairs of Roseate Terns on this island. On June 9, 1984 observers estimated 280 terns on the island. Approximately 50% were Arctic, 50% were Common, and at least 3 Roseates were noted. On June 24th the *Guillemot* returned in order to conduct a nest count, however, terns had abandoned this island as well. Upon landing we discovered that a complete nest count would be impossible. Terns had been spread out across the island in several small groups and the resident sheep had trampled some of the areas. In addition, many eggs had been eaten, presumably by gulls, and these factors combined to make identification of nests very difficult. Part of the island was surveyed and 123 nests with shell fragments were found, as well as 55 empty nests. The remains of 3 adult Common Terns and 1 Arctic Tern were also found. All these were decapitated, the bills were split, and in two cases the wings had been clipped. This was reminiscent of owl predation as described by Austin (1948), Nisbet (1975), and as observed by Folger at Monomoy National Wildlife Refuge in Chatham, Massachusetts. However, other predators cannot be ruled out, i.e. mink, weasel, or a falcon. The following day a more thorough search revealed the remains of 12 more Arctic Terns. These birds had been eaten in the same manner.

It is difficult to say exactly what caused the abandonment of this colony. Several factors probably contributed to it's demise. The fact that the annual roundup of the island's 100+ sheep occurred on June 16 undoubtedly disturbed the terns. With the killing of adults by the unknown predator(s), the chances of desertion increased. Lastly, the presence of about 500 large gulls on the island (estimated 300-320 pairs of Herring Gulls and 6-10 pairs of Black-backed Gulls) cannot be ignored.

Given the count of June 9, combined with the partial nest count of June 24, we estimate that the breeding population of the island would have been approximately 75 pairs of Arctics, 130 pairs of Commons, and 2-3 pairs of Roseates.

Flat Island

Flat Island is approximately 6 hectares, and lies one mile east of Big Nash Island, 2.8 miles offshore. In 1983 Drury and Folger estimated 30 pairs of Arctic Terns and 25 pairs of Common Terns. On June 9, 1984 observers estimated 16-20 individual Arctic Terns in the early stages of nesting. On June 24 a nest count was done and a ground estimate was made in order to establish a Common to Arctic species ratio. Forty-five nests were found with a species breakdown of 30 pairs of Arctic Terns and 15 pairs of Common Terns. An additional 30-50 individual Common Terns were seen roosting on the shore and courting. We suspect these birds were probably from the Nash Islands, and were attempting to re-nest.

On July 2 the *Guillemot* returned to Flat Island and observers estimated 65-70 pairs of terns nesting. Over a two hour period observers watched three unsuccessful attempts by gulls to feed in the tern colony. The gull population on the island was estimated to be 140 Black-backed Gulls and 40 Herring Gulls. On July 4 the island was visited again. Some Arctic Tern chicks had hatched, but all the Commons seemed to still be incubating. During six hours of observation from a blind, one Herring Gull took three tern chicks, and a Black-backed Gull took another chick. On July 5 the *Guillemot* arrived at Flat Island around 11:00am. All adult terns had abandoned the colony although many were still in the vicinity. Two to four gulls were observed scouring the colony area, eating tern eggs. It appeared as if we had arrived just as the gulls were completing a major foraging period in the tern colony. After watching the gulls for two hours we made a nest count. Only one intact 1-egg clutch was found; 75 empty nests, many containing egg shell fragments and yolk, were also found. Contrary to the situation on Big Nash, the presence of 50-odd sheep did not seem to have affected the terns.

All evidence points to the cause of this desertion being a prolonged period of predation by gulls, the culmination of which was witnessed by the *Guillemot* crew on July 5. At no time were tern chicks more than 3-4 days old seen, although by July 4 there should have been chicks 7-10 days old. It is interesting to note circumstances surrounding the final period of gull predation. Local fishermen were inactive on July 4 because of the holiday and again on July 5 because of thick fog and sloppy seas. Inclement weather had a similar effect on gulls, forcing them to remain ashore and reducing their foraging opportunities. We believe that bad weather, resulting in a decline of food availability for gulls, significantly accelerated the rate of predation on the tern colony.

Egg Rock

Egg Rock is an island of about 1.5 hectares, located in the mouth of Frenchman's Bay, approximately 2.2 miles east of Mount Desert Island. Terns and Laughing Gulls were first seen nesting on this island in 1977, following the automation of the lighthouse on the island and during the breakup of the Petit Manan colony. In 1983 Drury and Folger estimated 120 pairs of Arctic Terns, 140 pairs of Common Terns, 5 pairs of Roseate Terns, and 175 pairs of Laughing Gulls.

OM: In 1984 observers were based on Egg Rock for most of June and July. Principal tasks included observing the impact of human activity, measuring reproductive success, observing gull/tern interactions, and maintaining a presence in order to observe the effects of potential visits by newly "hacked out" Peregrine Falcons from Acadia National Park. A nest count, conducted on June 21, with a capture/recapture, produced 388 nests. The estimated species breakdown was 60 pairs of Arctic

Terns, 325 pairs of Common Terns, and 3 pairs of Roseate Terns. Laughing Gull nests were not counted, but estimated at 75-100 pairs. Forty Herring Gull nests were found on June 5 and destroyed. An additional 350-400 gulls (95% Herring Gulls), regularly roosted on the island.

The U.S. Coast Guard began working on the buildings and seawall on the southeast side of the island during the first week of June. This work involved from 2-15 men and lasted about two weeks, during which time the terns persisted in their attempts to nest. During our initial visit to the island on June 5, construction work was already in progress. Our observers counted 25 nests in the construction area, all of which had been abandoned. Several of these had been stepped on or otherwise destroyed. Because the maintenance work was sporadic after the first few days, terns continued to set up territories around the lighthouse, but the area was not permanently settled until the work stopped. While work was in progress most of the birds concentrated on the north shingle beach, as far away from the house as nesting habitat would allow. On June 21 the beach contained approximately 250 nests, construction activity had been finished for about one week, approximately 90 pairs of terns established nests east of the house, and some 40 pair were nesting just west of the house.

Egg Rock's terns were undoubtedly affected by the activities related to the construction, such as the use of a loud air compressor and a chainsaw, as well as workers' presence on ladders and the roof of the house. Although the work did not seem to cause irreparable harm, many females did not start laying until the second half of the month. Interestingly, two helicopter visits to the island seemed to have little effect on the birds. The first visit was at the end of May before observations began, but the second visit, to retrieve machinery, occurred on June 25 while we were present. The helicopter arrived at 6:55pm and stayed for 11 minutes. As it approached all adults on the island flew out over the water and remained offshore until the helicopter left. At one point it hovered less than 10 feet over nests west of the house for about 90 seconds. However, within one minute after it left adults began returning to the colony and their nests. Although jittery, they settled after 10 minutes. A subsequent search revealed all nests intact in the area directly underneath where the helicopter had been hovering. Our conclusion was that the helicopter visit, while traumatic, caused no permanent damage. It is worth noting, however, that chicks may be much more susceptible to being blown around by a helicopter's downwash than eggs are. Had this visit occurred later in the season, when many chicks were present, the result might have been devastating.

The only other human activity on the island was due to the presence of researchers. Although we were unable to measure our own impact on nesting success, we believe it was

negligible. We visited the nesting areas on an average of once every 2-3 days for approximately 20-25 minutes. Most observations were made from inside the house. An average of two trips per day between the house and a blind in the colony were also made. Such trips rarely kept birds off their nests for more than 3 minutes. This leads us to believe that our presence did not hinder the activities of the terns.

Over the course of the summer we assessed reproductive success and found it to be low. Several surveys of the nesting areas revealed that between 30 and 55 chicks fledged out of a colony of some 380 pairs. Thus production approximates 0.11 ± 0.03 chicks per pair.

Our estimates are based on measurements made in each of the three sections of the colony. Repeated searches for chicks on the north shingle beach in mid-July produced no more than 9 chicks older than 15 days. Capture/recapture figures indicate that our success rate in finding chicks was approximately 75%. Therefore we feel confident that no more than 20 chicks fledged from this area of 251 nests.

We believe the principal source of mortality was predation by Herring and Great Black-backed Gulls. Observers witnessed over 245 gull incursions into this area throughout the season. Observations of behavior and methods of predatory gulls leads us to believe that less than 10 individual gulls were responsible. The combination of periods of thick fog and periods during which observers were not present prevent us from giving precise figures on gull predation, but the trend is clear. Of the 245 attacks, we know that 29 resulted in an egg or chick being taken. We know that 98 were unsuccessful, and we don't know the outcome of the remaining 118. *is unknown*

Observations from the house were hindered by a ridge which partially obscured the colony and the gulls' principal route in and out of the tern area. Observers knew when gulls entered the area because of the terns reactions, but they were often unable to see what a gull was doing once it landed in the colony. Gulls flew into the center or walked along the edges of the colony as terns hovered and dove at them. Despite the terns' aggressive efforts they were unable to drive gulls away. Sometimes gulls spent as much as five minutes in the colony, out of sight from the house. Observers were only able to be sure of the outcome when a gull was seen flying away with a chick in it's beak.

Especially intense gull activity was noted during periods of fog. From July 4-8, just after the peak of hatching, Egg Rock was shrouded in thick fog. The shingle beach area, containing 251 of the island's nesting pair, was entirely obscured from view during most of this time, but observers could hear gulls in the tern colony. On July 9 when it was again dry enough to enter the colony, a marked decrease in the

number of tern chicks was noted. Of 95 banded chicks known in this area prior to the period of fog, only 11 were recovered. Of these, 3 had died from weather-related causes. The other 84 disappeared without a trace. Over the course of the season only 12 chicks out of a banded sample of 100, were known to have died from "natural causes", such as exposure. We presume the 87 banded chicks that disappeared did so as a result of gull predation.

In contrast to the north shingle beach, terns nesting just east of the house fared better. Our observations indicate that 10-20 chicks fledged from this area containing approximately 90 nests. The fledging rate in the north colony was $6\% \pm 2\%$, while east of the house it was $16\% \pm 5\%$. This difference can be primarily attributed to the fact that gull predation was not as severe in the east area. We ascribe this to our presence in the house which, because of our harassment efforts, discouraged gulls from approaching the area around the house.

We made a similar observation in the group west of the house. Counts revealed approximately 10-15 chicks fledged from this area of 42 nests, indicating that $29\% \pm 6\%$ of the nesting pairs fledged young. This higher rate is largely due to the group's location, situated on a steep slope that was difficult for gulls to enter. Furthermore, it was less than 20 meters from the front steps of the house where researchers often sat. Thus, gulls were especially disinclined to approach the area.

It should also be noted that the impact of large gulls was not restricted to terns. The 75-100 nesting pairs of Laughing Gulls present on Egg Rock early in the season also experienced heavy gull predation. Ultimately fewer than 10 pairs produced fledged young. Observers witnessed many cases of Herring Gulls' eating Laughing Gull eggs. At least 5 adult Laughing Gulls were killed and eaten by Herring Gulls.

Historically, Egg Rock has only recently been colonized by terns. Its future as a viable tern colony is questionable. The island's proximity to Bar Harbor and Winter Harbor, with their active fishing industries, as well as Mt. Desert Island's ample refuse created by summer tourism, makes it a prime location for roosting gulls. This situation is not likely to change. Egg Rock's location and accessibility for tour boats makes it ideal for educational purposes, but there is little hope for a successful program without active management.

Finally, observers did witness one visit to the island by a young Peregrine Falcon, almost undoubtedly one of the birds from Acadia National Park's reintroduction program. On July 12 a Peregrine made two passes over the island. All adult terns took to the air. The Peregrine was unable to make a kill and was severely harassed by about 300 adult terns. These birds chased the falcon west across the bay back to MDI. For the next 45-50 minutes terns rarely settled on their nests for more

than two minutes before taking to the air again. While the incident raised interesting implications for the future, its impact this year was insignificant.

Petit Manan

Petit Manan is a 7 hectare island approximately two miles offshore at the western edge of Pigeon Hill Bay. Available figures indicate that at least from 1968-1977 it was the largest tern colony in Maine. In 1968 Hatch estimated 400-500 pairs of Common Terns, 800-1000 pairs of Arctic Terns, and 4-5 pairs of Roseate Terns. In 1971 Nisbet and Drury estimated 400 pairs of Commons, 1100 pairs of Arctics, and 2 pairs of Roseates. In 1977, Korschgen estimated 700 pairs of Commons, 700 pairs of Arctics, and 20 pairs of Roseates (Korschgen, 1979).

In 1968 Hatch observed gulls preying upon tern chicks. At that time he estimated predation pressures to be so great as to reduce tern production by 0.48-1.2 chicks per pair (Hatch, 1970). At the time of the automation of the light in 1972 the gull population was drastically loward by a control program carried out by the U.S. Fish and Wildlife Service. At the same time a control program was carried out at Matinicus Rock and the effects seem to have given the nesting terns on the two islands temporary relief. Following the end of human summer occupation in 1974 the gull pressure again increased and by 1978-1979 had become serious again. In 1977 Korschgen estimated 5 pairs of Herring Gulls and 5 pairs of Great Black-backed Gulls on Petit Manan, and 50 pairs of Black-backed Gulls and 300 pairs of Herring Gulls on neighboring Green Island. By 1980 Petit Manan had been entirely abandoned by nesting terns.

In May, 1984 USF&WS carried out a program to eliminate nesting gulls from the two islands with the hope of attracting terns back to Petit Manan sometime in the future. This was done using the toxicant DRC 1339.

On May 11, the USF&WS with Drury, Drennan and Folger landed on the refuge to count gulls and pre-bait nests. Estimates for Green Islands were 250-300 gulls, 85% Black-backed. We estimated the number of nests at 125-135, and expected this to increase as the season progressed. On Petit Manan approximately 100 gulls were counted roosting on the shore. We saw 20-30 gulls rise from the center of the island. A not very thorough nest count revealed only 5 nests with eggs. We estimated the island to have 25-35 nests. Of all nests found on both islands 15% had 1 egg, 65% had 2 eggs, and 20% had 3 eggs, indicating the peak of laying had not yet been reached.

On May 17, the USF&WS began the poisoning program. Approximately 250 active gull nests were treated on Green

Island, while roughly 150 were treated on Petit Manan. The number of gulls culled from both islands was 651 Herring Gulls and 117 Black-backed Gulls. On May 28, three-quarters of the way through the poison program, a half dozen terns were seen over Petit Manan going through courtship flights.

WRONG
THIS IS
TOTAL
FOR
ALL THREE
TXs

Although no one expected terns to recolonize the island immediately, on June 9, observers visited briefly, and were pleased to find 500-600 terns nesting on the northwest side of the island and another 40 terns nesting on the southwest side. Approximately 60 Laughing Gulls were also counted.

On June 12, observers returned to the island. Ground estimates at this time were: 400-450 terns on the northwest side (60-65% Arctic), 100-120 terns on the southwest side (70-75% Common), and 17 Arctic Terns counted in an area south of the generator building. The number of Roseate Terns was estimated to be 8-10 pairs.

On June 22, the Guillemot crew returned to the island to make a nest count. Six people were present and we used a capture/recapture method to estimate counting error. Nest counts showed 544 nests in the northwest group, 120 nests in the southwest group, 18 nests south of the generator building, and 24 nests east of the boardwalk. Our sampling error approximated 20%; thus our estimate for the number of nests at this time was 655, 150, 20 and 30, respectively. The species composition was estimated to be 50-55% Arctic and 45-50% Common. Thus our overall estimate is 445-450 Arctic nests, 405-410 Common nests and 10+ Roseate nests.

The Laughing Gull nest count revealed 164 nests counted in only 75% of the nesting area. We estimated another 25 nests would probably have been found. Thus with a sample error of approximately 15%, we estimate the total number of nests to be 200-225. Counting Laughing Gulls nests was very difficult because the nests were built in a stand of tall grass, *Calamagrostis canadensis*, and were widely spaced over a large area.

On July 3 and 4, following the breakup of the Nash Islands, tern nests south of the generator building and east of the boardwalk were recounted. In the former area, 22 nests were found and in the latter, 85. This constitutes a dramatic increase of roughly 60 nests for the area east of the boardwalk and a slight increase south of the generator building. South of the generator building only Arctics nested, whereas east of the boardwalk 85-90% of the birds were Common.

On July 22, following the breakup of Flat Island, further nest counts of the areas east of the boardwalk and south of the generator building, made from the tower, revealed 96 and 39 nests with species ratio remaining the same.

On August 1, a similar count was done, revealing 116 and 41 nests.

Thus, from the time of the initial nest count on June 22 and after the abandonment of the Nash and Flat Islands in mid-June and early July, there was an increase of 80-90 tern nests east of the boardwalk and 20 nests south of the generator building. We believe increases also occurred in the other nesting groups, but were masked because of the large number of birds already established in those areas. It is possible that these late arrivals could have come from the Flat and the Nash Islands. Numbers of immigrants are suggestive of those that were counted there. However, these were not the only colonies in the region that abandoned, and there are a variety of possible sources for the influx onto Petit Manan.

Three distinct study plots were set up in three of the four nesting groups in order to assess production. The first plot was located in the main group of 650 tern pairs and included 22 nests, the second was located in an area of 120 pairs where many late arrivals settled and included 44 nests, and the third was in an entirely Arctic group of 45 pairs and included 39 nests. Plots 'two' and 'three' were mapped and observed from the top of the 123 ft. lighttower while plot 'one' was mapped and observed from the second floor of a building. Nest status in plot 'one' was checked daily while plots 'two' and 'three' were checked at 2-5 day intervals. Because observers were able to see into nests from above, they did not need to enter nesting areas. Our analysis of the results of these observations leads us to estimate overall production at approximately 0.7 chicks fledged per nest ($n=105$). Arctic Tern production is estimated at 0.7 chicks per nest ($n=53$), and Common Tern production at 0.85 chicks per nest ($n=28$). No Roseate Terns were present in our study plots, however, approximately 10 fledglings were on the shore in mid-July.

Although sample sizes are small and do not accommodate all the nesting schedules on the island, we believe these numbers are representative of tern production over the season. Predation by gulls and weather were the two chief sources of egg and chick mortality noted. Several individual gulls were observed taking a total of 20 chicks, with many more undoubtedly going unrecorded. Given the size of the Petit Manan colony, however, gull predation was relatively insignificant whereas in smaller colonies it would have been more severe.

We were unable to measure Laughing Gull production. However, 56 fledged chicks were once counted on the shore, and we believe production was good.

PART IV

LATE SUMMER SURVEY OF MID-COAST COLONIES

Failures at three of the downeast colonies prompted us to revisit terneries in the mid-coast region. On August 8 we rechecked Green Island, Mason Ledge, The Cowpen, and Great Spoon Island southwest of Swans Island. All the islands were abandoned except for Mason Ledge where 60 individuals were counted, showing a marked increase from the June census. Our feeling is that this increase is a result of displaced birds from neighboring islands arriving on Mason Ledge and renesting. We do not know the fate of the colonies on Metinic or Large Green Island. On Wooden Ball, Evie Weinstein reported the colony abandoned sometime before July 20.

We do not have data to provide a thorough assessment of regional production, although of the ten colonies we have known histories for, only Petit Manan produced an appreciable number of young. This translates to approximately 675 chicks fledged by 1,665 pairs of terns. Figures from Machais Seal Island, Matinicus Rock, Metinic and other major colonies are needed to make a proper assessment.

Results from this summer's observations of nesting success provide suggestive evidence towards the causes of tern declines in Maine over the last forty years. It appears that poor production, allowing only minimal recruitment into the population, is the limiting factor. Adult mortality in the summer quarters seems to be relatively insignificant. However, mortality in the winter quarters may be quite influential (Blokpoel et.al, 1982). The factors surrounding the abandonment and poor production of the islands we closely monitored this year do not appear unique. Periods of extended fog as well as hungry gulls are regular features each nesting season. The fact that terns are long lived (recovery of a 34 year old banded Arctic Tern was reported by Hatch on Petit Manan in 1970, Hatch, 1974) probably has dampened the declines noted in the population since the 1940's. Meanwhile, over the last three quarters of a century the increase of gulls on Maine islands must be considered, especially as terns have shown a reciprocal decline.

Part V

PETIT MANAN AND SEABIRD CONSERVATION

Less than half a dozen islands on the Maine coast can be considered to be of primary importance to nesting seabirds such as terns, puffins, and razorbills. Because Petit Manan is the largest tern colony in the state, and second largest in the Gulf of Maine, developing a management plan for the island seems prudent. Ideally, all seabird colonies should be protected and monitored, but practicality dictates that human efforts are most effective when concentrated on a few large, important, colonies such as Petit Manan. What follows is a discussion of some considerations for the future.

Petit Manan Island National Wildlife Refuge is twelve miles east of Mount Desert Island, approximately two miles off Petit Manan Point. It is flat and treeless, roughly circular with a diameter of 250-350 meters. The island has a granite bedrock base and is ringed by steep cobbly beaches. The soil is primarily peat with small accumulations of mineral soil. Vegetation consists of a wide assemblage of grasses and Carex species, as well as a lush component of herbaceous flowering plants. A smaller portion is composed of low woody shrubs such as: Blueberry, Dewberry, Chokeberry, and Raspberry.

Because of the island's isolated yet conspicuous coastal location, a lighthouse was established in 1817. Subsequently several other buildings were built, and presently there are six structures standing, including the 123 ft. high lighttower.

Petit Manan plays host to large and important populations of nesting Arctic, Common and Roseate Terns and Laughing Gulls. Additionally the island provides a major feeding ground for as many as 6,000-7,000 eiders (85% immature males) in late summer. The island is in a typical location for a major seabird colony, and the presence of such large numbers of feeding eiders suggests it is situated in highly productive waters.

Several factors combine to make the Gulf of Maine ecologically unique. Its cold, productive waters support appreciable numbers of alcids found nowhere else in the eastern United States. Because of its seemingly unmarred coastline, the area has special aesthetic appeal. In recent years human use of the coast has increased, thereby encroaching on the resources available to wildlife. Considering the area's human appeal which is highlighted by its nesting seabirds, conservation of seabird avifauna is considered by many to be important.

The simplest course of action for Petit Manan would be to "let nature take its course". Experience shows that this led

to a takeover by large gulls. Such a takeover was at the expense of other nesting species. If Petit Manan is to be a viable and diverse seabird nesting island, humans must take an active role in developing the island's potential as a seabird nesting area.

A second option is to limit interspecies competition between large gulls and other nesting seabirds. This can be attempted in several ways with varying degrees of success. As we have seen, poisoning can be effective in removing large numbers of gulls from an island. However, public concerns prevent this from becoming a widespread and common practice. Destroying eggs does little to relocate territorial pairs; at best it postpones relaying by two weeks. Early season harrassment by humans and/or dogs, combined with loud noises, such as cracker shells, when used has generally had little effect. Some gulls will leave, but many will become accustomed to harrassment and the damage done to other nesting birds such as eiders may outweigh any benefits. Perhaps the most effective alternative is selective shooting of "problem" gulls. Observations have shown that usually only a handful of gulls on a given island are responsible for taking tern eggs or chicks. However, being present to identify such individuals requires long hours of observation. Thus, a warden's presence on the island may very well be necessary for protecting nesting terns and alcids from gulls. This alternative would require human presence beginning May 1.

If large gulls can be controlled the next logical step is to attempt to attract populations of desirable species to "safe" islands. This can probably be done with minimal effort by manipulating nesting habitat so as to attract such species. In the case of terns, experience indicates that they prefer to nest in areas of patchy vegetation. Typically nests are situated adjacent to areas of thick vegetation which serve as hiding places for chicks, as well as next to open sites where adults can alight, roost and look out for predators. Such edge areas can be created using several methods. Controlled burning is one, while mulching vegetation using black plastic, boards, or seaweed is another. In addition, areas can be mowed, tilled, or grazed. Mowing and tilling are rather labor intensive and short lived, becoming ineffective over the course of the nesting season. Grazing, by mice or sheep, may be harmful to nesting petrels and eiders as well as to stands of unique plants such as Beachhead Iris *Iris hookeri* or Oysterleaf *Mertensia maritima*, both found on the island. On several Maine islands terns nest next to boards and other trash. In light of this and because of the plentiful supply of material that washes up on beaches, using boards to mulch vegetation seems to be one of the most practical alternatives.

One of the more surprising events of this year on Petit Manan was the presence of 9-13 Atlantic Puffins *Fratercula arctica*, on and around the island and a landing by a Common

Murre *Uria aalge*. This is the first known record of these alcids landing on Petit Manan. Although the birds did not nest, Puffins were frequently seen "billing" and investigating potential nest sites. On one occasion a bird was seen carrying nesting material into a potential burrow. Observations of nesting Black Guillemots *Cephus grylle*, indicate that suitable nesting cavities are limited. Approximately 16 pairs of Guillemots nested on the island, but an additional 40 individuals were seen roosting, courting, and investigating rock crevices for nesting sites. Several "dumped" Guillemot eggs were found next to active burrows, which further reinforces our belief that there are few suitable nesting cavities. By rearranging rocks and introducing other materials such as pieces of scrap metal, darkened burrows can easily be created. In all likelihood construction of such burrows will increase the population of nesting alcids on Petit Manan. In the case of puffins, placing puffin decoys on the rocks may lure birds to potential nesting areas. However, the presence of live birds is more effective.

A consideration is that burrows constructed for Common Puffins will be equally suitable for use by Black Guillemots, and interspecies competition may exist. If such a situation arises it will have to be dealt with.

Because we have already taken steps along the lines outlined for both terns and puffins, it would be beneficial to establish a monitoring program in order to assess the effectiveness of the management activities we have instituted. Such a program would provide opportunity to add insights into the breeding ecology of Petit Manan's nesting seabirds. Similar to the human presence needed to manage gulls, the presence of a biologist/warden throughout the nesting season would help meet this need.

Clearly Petit Manan has tremendous potential as an important seabird refuge, and a place for visitors to the Maine coast to enjoy its more unusual seabirds. Because terns are declining in the northeast and because there are only 3 islands in the Gulf of Maine which support nesting puffins, the island holds great promise for conservation of these species. Additionally, it now maintains the largest nesting population of Laughing Gulls in the Gulf of Maine, as well as a small number of Leach's Petrels *Oceanodroma leucorhoa*. Not only is Petit Manan an ideal island for nesting seabirds, it holds great promise for activities centered around applied ecological research and public appreciation of coastal wildlife. In this way the island can serve both educational and aesthetic needs.

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