

THE GULF OF MAINE TERN MANAGEMENT PLAN

1989

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Increase the Abundance and Expand the Distribution of Terns	
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1) Restore populations of terns to the levels of the 1930s	
Arctic Terns: 8,000 pairs, including 2,300 pairs on Machias Seal Is.	
Common Terns: 8,000 pairs, including 1,700 pairs on Isles of Shoals	
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PREFACE

In the early years of European settlements, seabirds were freely exploited in New England and Atlantic Canada, and by the mid-nineteenth century this pressure had resulted in the extirpation of several species from the coast and the drastic reduction in numbers of many more. At the end of the nineteenth century plume hunting for the millinery trade nearly delivered the coup de grace. Terns were almost completely eliminated from much of the eastern seaboard, including remote parts of the Maine coast.

Growing public concern led to a number of local initiatives to preserve the small populations that remained. In 1916, the U.S. signed the Migratory Birds Convention with Mexico and Great Britain, on behalf of Canada, with the purpose "of saving from indiscriminate slaughter and of insuring the preservation of such migratory birds as are either useful to man or are harmless." The Migratory Bird Treaty Act of 1918, implemented the Conventions, establishing Federal responsibility for protection of migratory birds. Since then, many species of seabirds which had previously been over-exploited, have increased in numbers. During the last several decades, however, tern numbers have decreased, and several private organizations and public agencies have taken steps to halt the decline.

Gulls and terns, like seaducks on the bays and the songbirds in the spruce trees, are important symbols of the natural environment of the Gulf of Maine. Visiting tourists see landscapes and seascapes in terms of movement, as gulls fly after a lobsterboat or terns hover over a riptide. Many of the tourists have a highly sophisticated appreciation for the state's flying wildlife, and any diminution of these elements would degrade their experience. Tourism contributes importantly to the economic survival of island communities, making it possible for many families to stay on the coast who would otherwise have to move inland or to cities to find work.

Because many readers of this management plan will not be familiar with terns and "tern problems," we include a description of the species and a brief history of major features of the population changes in the Gulf of Maine.

This plan was prepared by members of the Gulf of Maine Tern Working Group, including representatives of Audubon Society of New Hampshire, Canadian Wildlife Service, College of the Atlantic, Island Institute, Maine Audubon Society, Maine Department of Inland Fisheries & Wildlife, National Audubon Society, U.S. Fish & Wildlife Service.

The plan includes contributions by the following biologists: John Anderson, Ralph Andrews, Jane Arbuckle, Tom Goettel, Anthony Lock, Stephen Kress.

The report was prepared and edited by
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NATURAL HISTORY OF TERN SPECIES BREEDING IN THE GULF OF MAINE

Gulls and terns, together, form the family Laridae within the order Charadriiformes. Terns are slender, short-legged birds with long pointed wings. The sexes are alike and the adults are white with grey wings and back. The beak and legs are usually red, orange or yellow. They feed by diving from the air to catch small fish or crustaceans near the surface. Terns lay one to three eggs, characteristically in rudimentary nests on shingle, sand or matted vegetation. The incubation period of the Maine species is between three and four weeks and chicks fledge at about one month. They typically reach breeding age at two or three years but do not reach peak breeding success until they are more than five years old (I.C.T. Nisbet, pers comm.). Adult mortality is low and they have a long reproductive life, up to 15 to 25 years.

Five species of terns breed in Maine. The Black Tern (Chlidonias niger) breeds only on fresh water, and its status is not known. The Least Tern (Sterna albifrons) breeds on sandy beaches in southwestern Maine, where it is especially vulnerable to disturbance by bathers, picnickers and their pets. The Maine Audubon Society has undertaken a program to protect all the nesting sites of this species in Maine. The species is widespread and numerous on the sandy shores of Massachusetts and further south.

The three species of marine terns include Arctic Tern (Sterna paradisaea) and Common Tern (Sterna hirundo), which are widespread, and Roseate Tern (Sterna dougalli) which breeds in small numbers at a few sites.

ARCTIC TERNS breed as far north as 80 degrees North Latitude and as far south as Massachusetts. They are the most pelagic of our nesting terns, migrating far out to sea, crossing the Atlantic in the autumn, towards the Azores and Cape Verde Islands, and wintering along the edge of the ice pack in the Antarctic. In the northern parts of their range Arctic Terns nest in small numbers, often only a few pairs together, or solitarily at inland lakes, ponds and on the shingle on deltas of arctic rivers. In the subarctic part of their nesting range, they breed, often in large numbers, in mixed colonies with other terns. They place their nests among rocky outcrops where fescue grass is short enough to allow this bird with very short legs to move about, or on shingle or sand beaches. Their clutch size is one or two eggs, seldom three, laid in late May or early June. The chicks are flying by late July and migrate directly offshore in early to mid August.

Arctic Terns nest in large numbers on outer islands in eastern Maine as far west as Matinicus Rock, where the cold water flowing out of the Bay of Fundy turns offshore. They nest in much smaller numbers on islands further west, like Eastern Egg Rock in Muscongus Bay and Stratton Island in Saco Bay.

During the last 75 years the major colonies of nesting terns have been on islands with lighthouses manned by keepers and their families: Machias Seal, South Libby, Petit Manan, and Matinicus Rock. The lighthouse keepers kept marauding gulls away from the nesting terns. Where there were no lighthouses or keepers, as on islands like Metinic Green in the Approaches to Penobscot Bay, gulls drove terns off

by the 1920s. Herring Gulls moved in and terns soon abandoned the island after the lighthouses on South Libby and Petit Manan were abandoned.

Arctic Terns have more slender and relatively longer wings than Common or Roseate Terns. Their head protrudes only a short way in front of their wings and their long tail streams behind. When hovering over an intruder they "face you, head on," as if using binocular vision, unlike the other species. Their light flight is suitable for skimming and dipping small items of food, such as yearling herring (Brit), white hake and crustacea, from the surface or close under the surface.

COMMON TERNS breed from North Carolina north to Hamilton Inlet, Labrador. They are less tied to the sea than are Arctic Terns, breeding on many fresh water lakes, including the Great Lakes and as far northwest as Great Slave Lake. Common Terns may breed in small colonies or solitarily on inland lakes, while their marine colonies may be very large. In Maine Common Terns nest in large numbers on Petit Manan, (and have done so periodically on Metinic, Large Green and Eastern Egg Rock), but mostly in small numbers on islands near the mainland shore: Stratton Island, North Sugar Loaf, Killick Stone, The Brothers at Port Clyde, Tommy Island in Muscle Ridge, Thrumcap in Brooksville, and Smuttynose between Blue Hill and Jericho Bay. Their wings are broader than those of Arctic Terns. Their protruding head and longer bill seem to suit them for diving after larger fish than those sought by Arctic Terns.

Their relatively long legs allow them to move around in taller grasses found on the middle and inner islands in mid-coast Maine. They prefer to nest in bare patches in relatively thick stands of grass. They lay a clutch of two or three eggs, which is consistent with their commuting relatively short distances for food and having access to relatively large prey. They lay in late May and early June and the southward migration begins in early September. Common Terns migrate southward close to shore toward their wintering range from Florida and the Caribbean Sea south to Brazil.

The populations of Arctic Terns and Common Terns in Maine are not in danger of extirpation at present; they are classified as Species of Special Concern in Maine by the MDIF&W, but that of Roseate Terns is.

ROSEATE TERNS have a wide breeding distribution across temperate and tropical regions, including northwest Europe and southeast Australia. Everywhere they occur it is in small numbers. Maine is near the northern limit of their breeding range. Most Maine birds nest at Petit Manan, though they have nested in the past in numbers at North Sugarloaf in the mouth of the Kennebec River, and at Stratton Island in Saco Bay. They nest in colonies of other terns, primarily Common Terns.

Their relatively short wings, long tail and fast, steady flight allow them to commute long distances (up to 15 or 20 miles) to feed. Their wings make it difficult for them to hover over their prey as long as Common and Arctic Terns. They dive especially deep from higher in the air than do the other species. They feed over tide rips or places where fast currents flow over shallow bars, making small fish vul-

nerable. They appear to be limited to places that have bars like those between Petit Manan and Petit Manan Point, between Bar-Trumpet-Ship islands and between Great Gott and Mount Desert islands in lower Blue Hill Bay. The lack of suitable, shallow bars elsewhere in Maine may be a reason that Roseate Terns are rare.

Their relatively long legs facilitate their moving around in coarse vegetation, under which they prefer to nest, e.g. Seaside Goldenrod (*Solidago sempervirens*), coarse Umbellifers (Seaside Angelica (*Coelopleurum lucidum*), Scotch Lovage (*Ligusticum scoticum*), and Beach Pea (*Lathyrus maritimus*). They lay two eggs and seldom raise more than one chick, which is consistent with their commuting rather long distances to forage.

Roseate Terns practice piracy. Such birds "hang on," like a hunting Peregrine, flying back and forth at about 30 feet above the milling terns flying to and from a ternery. The pirates dive on a tern flying in with a fish or on a parent just feeding a chick, surprising the victim, and fly off with the fish to their own young.

They winter on the Atlantic coasts of the Caribbean Sea south to Brazil. They are nowhere numerous, and the recent decline has resulted in their being officially listed as an Endangered Species by both the U.S. Fish & Wildlife Service and the Maine Department of Inland Fisheries and Wildlife.

JUSTIFICATION FOR A TERN MANAGEMENT PLAN

In contrast to many other seabirds, terns were apparently not seriously reduced until the last quarter of the nineteenth century, when gunners found a market for the wings and whole skins of gulls and terns in the millinery trade. This led to a campaign of shooting adults on nesting islands between Saco Bay and Isle au Haut.

Once terns breeding in North America were protected under the Migratory Bird Treaty Act, they responded quickly to protection. The terns nesting in Maine, for example, are estimated to have increased by 2.5 times, from about 6,500 pairs at the end of the nineteenth century (Dutcher, 1905) to nearly 16,000 pairs in the 1940's (Palmer, 1948). For the entire New England Coast, the increase was from about 22,000 of all three species about 1900 to about 58,000 in the 1940s (Nisbet, 1973). In the same period, gulls in New England increased by 10 times, from 10,000 to 100,000 breeding pairs (Drury, 1973-74).

The population explosion of Herring and Great Black-backed Gulls seems to have been caused by human activities, primarily large-scale disposal of garbage at urban dumps and gurry thrown over the side from fishing vessels. The increase in gull numbers triggered a second important decline in tern numbers starting in the 1940s.

Gulls compete with terns for desirable breeding habitat and they prey on tern eggs and chicks. The effects of gull predation caused comment by Arthur Norton as early as 1924 (Maine Naturalist, 1925). From an estimated 8,000 Common Terns (including 1700 pairs at Isles of Shoals) and 8,000 Arctic Terns (including 2,300 pairs at Machias Seal Island) in the mid 1940s in Maine and nearby waters, numbers fell to

2,100 Common Terns (none at Isles of Shoals) and 3,250 Arctic Terns (1,600 at Machias Seal Island) in 1977. Private groups undertook to stop the decline in 1984. Yet the 1989 estimate of 2,700 Common Terns (Kress and Borzik, 1989) (within the probable sampling error of previous censuses) indicates that there has been little if any recovery in the past 12 years, despite a large increase south of Cape Cod. Moreover, 85% of the surviving terns nested on four islands (Machias Seal, Petit Manan, Matinicus Rock and Eastern Egg Rock) and nearly all successful reproduction took place on these four islands. While Arctic Terns occurred in large numbers on all four islands, Common Terns occurred in large numbers on only two. The small numbers of Roseate Terns were similarly restricted to two islands. This situation makes them especially vulnerable to disturbance.

Recently, convenient and powerful outboard motors have given people summer access to islets where terns formerly bred. The disturbance by visitors may displace terns to less desirable breeding sites, or facilitate predation by gulls. The loss of any of these remaining breeding sites to predators and incompatible coastal development could seriously reduce the promise of their long-term survival. We believe there is an immediate need to supply additional island breeding sites, because several hundred pairs of terns have been moving among nesting islands during the last five years, chivied off by predatory gulls. Meanwhile their breeding attempts have failed.

Preservation of Viable Populations of Terns will Require

- 1) regular monitoring of tern and other seabird numbers;
- 2) long-term active management to ensure the availability of predator-free islands having suitable nesting habitat. Ecological requirements for successful reproduction indicate that these must be distributed near to or on the islands that were major centers of tern nesting when terns were free to nest where they preferred (see Table 1 & Map 1);
- 3) research assessing the efficacy of monitoring and management techniques, and evaluating the suitability of nesting sites and habitats available on islands that might possibly be occupied by terns.

Tern Populations and Population Changes

Census Methods

The numbers of colonial nesting seabirds are usually easily estimated when they are concentrated at nesting sites. Terns persistently nest at some islands over many years so that the birds at some substantial colonies can be readily counted, which makes the task easier. But the task may be made harder by the behavior of birds that nest at many small colonies or as isolated pairs. The unpredictable movements of some of these birds from one colony to another may cause large annual variations in the size of small colonies, independent of overall population changes.

Because terns exhibit both extremes, strong colony site fidelity and readiness to move, censuses of sample colonies may not reflect the true changes in numbers. If numbers are increasing and colonies proliferate rather than individual colonies in-

creasing in size, or if numbers are decreasing because sub-optimal colonies disappear, spot censuses will miss important data on general population trends. This is likely to happen because larger colonies appear to be tolerant of disturbance, and persist despite it. Small colonies, particularly, may persist for only a few years and if they are disturbed early in the breeding season the birds may abandon the site and move to another island. Tern populations can be monitored with confidence only by visiting all potential nesting sites in the area.

Causes of Population Declines

a. Problems on the Breeding Range

The two most important negative effects on terns during the breeding season are gull competition & predation, and human disturbance.

As gull populations increase, nesting birds displace terns from some breeding sites because the gulls settle on the breeding sites earlier than do terns, and preempt desirable habitat. During range expansion gulls often settle first on outer islands and then abandon those (see Appendix B, Drury in press) to move onto islands close to the mainland coast, where they suffer from predation by Raccoons, Foxes, Minks, Crows, Great Horned Owls and Black-crowned Night Herons. The predators not only kill adults and chicks but also cause incubating adults to abandon their nests at night, leading to reproductive failure as the tern eggs and chicks die of exposure. Meanwhile the movements of gulls away from outer islands leaves a small number of gulls excluding terns from nesting on what were important tern-nesting islands.

The effects of gulls are not confined to displacement from desirable nesting sites. Gulls also prey on tern eggs and chicks, and occasionally on adult terns.

Human disturbance of nesting islands exposes the eggs and young to intolerable heat on hot days or to chilling on cold, rainy days. The most damaging effects of human disturbance of tern colonies may be making them subject to increased gull predation because some gulls are attracted to the disturbance and will take advantage of the absence of the parents.

b. Problems on the winter range

Common Terns and Roseate Terns breeding in New England and Atlantic Canada migrate along the coast to wintering grounds in the Caribbean Sea and coasts of Central and South America. In these regions they are exposed to market hunting and chemical contamination (Nisbet 1981, 1984 and pers. comm., Andrews, et al. 1989). Human predation has been identified as an important factor in the decline of Roseate Terns and it is probably important for Common Terns also (Nisbet 1981, 1984). There are some indications that terns wintering in the tropics occasionally find that food is in short supply.

Arctic Terns, in contrast, migrate off shore, to the upwellings off the West African Coast (R.G.B. Brown, pers. comm.) where they may occasionally be snared by fishermen (S. Kress, pers. comm.). Thence they migrate southward over the productive Benguela Current to winter along the edge of the Antarctic icepack,

where, according to D. Parmelee's and D. Ainley's studies on the Antarctic Ice-front, they have access to abundant food.

The populations of Common Terns and Arctic Terns are not in imminent danger of extirpation in Maine at present, but four problems are immediately pressing:

- i. eighty-five percent of the terns nest in 4 colonies;
- ii. two-thirds of the Maine population of the nationally endangered Roseate Tern nest on one island;
- iii. 600-900 pairs of Common Terns in the mid-coast region have repeatedly suffered breeding failure due to lack of a suitable nesting island.
- iv. no significant reproductive success has been reported from any tern colony between Muscongus Bay and Cape Ann, Massachusetts.

The following management plan provides an outline of the tasks proposed to restore tern numbers to levels approximating those reached during the last period of population growth. We know that recovery will not happen by itself. During a short period of hands-off protection in the late 1970s, gulls overran the terns nesting at Petit Manan. The terns promptly responded to our intervention by returning to the island. We also know that the mere presence of terns nesting on an island is not enough; our measurements show that the terns nesting on almost all islands that are not being managed suffer almost total breeding failure.

These objectives include Machias Seal Island in the Grand Manan Archipelago, through the cooperation of the Canadian Wildlife Service.

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GULF OF MAINE TERN MANAGEMENT PLAN for the Gulf of Maine Tern Working Group

GOALS: Increase the Abundance and Expand the Distribution of Terns

MANAGEMENT OUTLINE

I. MONITOR ABUNDANCE, DISTRIBUTION AND PRODUCTIVITY.

1. Monitor numbers of terns at known nesting islands;
2. Estimate breeding success at major colonies (200 or more pairs).

II. PLAN AND IMPLEMENT MANAGEMENT ACTIONS:

OBJECTIVE 1) Restore populations of terns to the levels of the 1930s

Arctic Terns: 8,000 pairs, including 2,300 pairs on Machias Seal Is.

Common Terns: 8,000 pairs, including 1,700 pairs on Isles of Shoals

Roseate Terns; 275 pairs.

1. Continue current intensive management to maintain and increase numbers at existing successful colonies;
2. Manage vegetation and mineral soil to create suitable nesting sites.
3. Mitigate factors negatively affecting tern numbers, distribution or reproduction.
4. Discontinue management if criteria indicate.

OBJECTIVE 2) Expand the number of islands available for terns to nest using historical records of former geographic distribution:

Arctic Terns: 10 colonies;

Common Terns: 25 colonies;

Roseate Terns: 3 colonies.

(Appendix A: Table 1, Appendix C., & Map 1)

Identify additional islands to be intensively managed.

1. Insure adequate regional distribution.
2. Use criteria in choosing specific islands.

III. CONDUCT STUDIES TO GUIDE MANAGEMENT PROGRAMS:

1. Investigate the effects of predators and competitors at the major tern nesting sites;
2. Investigate factors affecting the numbers and distribution of small colonies, and the causes of failure where breeding fails chronically;
3. Refine survey techniques;
4. Investigate techniques for manipulating vegetation;
5. Make general studies of breeding biology;
6. Survey the distribution and abundance of Gulls.

Purposes of the Management Plan:

Our intention is to reverse population declines that occurred between 1950 and 1980. This decline was primarily the result of human-induced environmental effects resulting in the increase of Herring and Great Black-backed Gulls. Our recent experience indicates that the decline reflected breeding failures caused by gull predation on adults, eggs and chicks. Many terns in this period moved about among several islands in groups of 50-300 birds, occasionally having some temporary breeding success, but mostly failing annually (See Appendix A: Table 3).

Palmer (using Norton and Allen, 1931, and additional information from 1936) reported: Common Terns - 8,899 birds in 25 colonies;

Arctic Terns - 11,940 birds in 10 colonies;

Roseate Terns - 553 birds in 3 colonies.

In 1972, Drury, using additional information provided by Ralph Palmer, estimated that the total in the early 1940s was about:

Common Terns - 8,000 pairs, (including 1,700 at Isles of Shoals),

Arctic Terns - 8,000 pairs (including 2,300 at Machias Seal Is.),

Roseate Terns - 275 pairs. (Appendix A: Table 2.)

We believe that to ensure healthy populations for the future it is important to restore a more dispersed geographic distribution of terns as well as increasing the population levels. Currently 85% of successful tern nesting occurs on just four islands. A dispersed geographic distribution and redundancy of suitable nesting sites will minimize the possibility of either continuing attrition, or a single catastrophe eliminating a major population from the coast. We believe that we have suitable sources of information for this part of the management program in the islands listed by Arthur Norton as occupied between 1880 and 1916, together with the list reported by Robert Allen and Arthur Norton (1931).

The proposed task under Objective 2., to establish a dispersed distribution of nesting islands implies maintaining one or more colonies in the following regions (Appendix A. & C. and Table 1.), listed by Norton and Allen.

a. southern Maine (Isles of Shoals, to Saco Bay and Cape Elizabeth);

b. Casco Bay;

c. Small's Point to Damariscove Is., including the Kennebec River mouth;

d. Muscongus Bay;

e. The Approaches to Penobscot Bay (including islands in the Muscle Ridge Channel, Matinicus Rock, Wooden Ball and Seal Island);

f. northeastern Penobscot Bay;

g. islands in the approaches to Jericho Bay and Swans Island;

h. upper Jericho Bay and lower Blue Hill Bay;

i. Petit Manan

j. Machias Bay.

The species and population sizes in these regions will vary according to the area of foraging grounds, and quantity and quality of food resources. The food resources will vary from year to year.

MANAGEMENT PLAN

I. MONITOR ABUNDANCE, DISTRIBUTION AND PRODUCTIVITY

Identify and Enhance Positive Factors Affecting the Species Numbers;

1. Monitor numbers of terns at known nesting islands;

Estimate numbers present between 12-22 June.

- a. use mark-recapture method to get an index of nests at major colonies (those with more than 200 pairs or those occupied by field party).
- b. estimate numbers of birds in the air or count nests at small colonies.
- c. estimate the percentage of Arctic to Common Terns by taking repeated samples of the identity of birds in the air in several parts of the nesting area.

Coordinate plans for these surveys at pre-season meetings (February/March); compile results and review findings of the effectiveness of management with field workers at post-season meeting (August). Consult suggested census techniques in Appendix D.

2. Estimate breeding success at major colonies (> 200 pairs).

- a. Where possible, determine fledging success (to the age of 15 days) of marked nests, (identified to species) in sample plots each including 10-15 nests so that 5-10% of the total in the colony are sampled.

Plots should be dispersed over the nesting area and monitored annually.

*(Pens/exclosures that control the movements of chicks may be appropriate at some colonies but not at others. See III page 9)

Studies are needed to determine the effectiveness of enclosures in measuring breeding success.

- b. Alternatively,

- i. estimate the numbers of pairs present in June.
- ii. estimate the proportion of Common and Arctic terns and count the Roseate Terns present.
- iii. visit the island in mid- to late July to count the chicks that gather on the beaches either from a boat or from the beach.

In some cases a telescope will be needed to collect this information.

Absence of either adults or young on a July visit is evidence of breeding failure.

See suggested methods of measuring breeding success in Appendix D.

II. PLAN AND IMPLEMENT MANAGEMENT ACTIONS

OBJECTIVE 1. Restore Populations of Terns to the Levels of the 1930s:

Arctic Terns: 8,000 pairs, including 2,300 pairs on Machias Seal Is.

Common Terns: 8,000 pairs, including 1,700 pairs on Isles of Shoals

Roseate Tern; 275 pairs.

1. **Continue current intensive management to maintain and increase the numbers of birds nesting at existing successful colonies:**
at Petit Manan, Matinicus Rock, Eastern Egg Rock;
2. **Manage vegetation and mineral soil to create suitable nesting sites.**
 - a. to provide habitat that encourages successful reproduction;
 - b. to increase the number of birds nesting;
3. **Mitigate Factors (predators and competitors) Negatively Affecting Tern Numbers, Distribution or Reproduction.**
4. **Discontinue management if the following criteria indicate that management is ineffective, not cost-effective or undesirable.**
 - a. productivity is low every year for more than 5 years;
 - b. the numbers of nesting pairs shows serious and continuing decline;
 - c. management actions have negative effects on desirable species.

OBJECTIVE 2. Expand the number of islands available for terns to nest in the former geographic distribution, based on historical records:

Arctic Terns: 10 colonies;

Common Terns: 25 colonies;

Roseate Terns: 3 colonies.

(Appendix A: Table 1, Appendix C: Map 1.)

Identify Additional Islands to be Managed Intensively.

1. Insure adequate regional distribution.

Recognize that the distributions of the three species differ. Most Common Terns prefer to nest on inner islands, some quite close to the mainland shore, and historically their numbers were scattered along the entire coast. Arctic Terns were most numerous on outer islands in eastern Maine and their numbers drop off sharply west of Matinicus Rock, where the westward flow of cold water out of the Bay of Fundy turns offshore. Roseate Terns nest among Common Terns and forage where strong currents carry small fish over shallow sand or gravel bars.

The three species will be differentially involved in rebuilding historical colonies according to geography.

- a. Islands near the mainland will attract primarily Common and Roseate Terns, vis. Trumpet/Ship Island in lower Blue Hill Bay; islands in inner Jericho Bay, in upper Penobscot Bay and the Muscle Ridge.
- b. Some islands will attract all three species, vis. Petit Manan, Two Bush, Eastern Egg Rock and North Sugar Loaf.
- c. Outer islands will attract primarily Arctic Terns, vis. Seal Island, Matinicus.

2. Use the following criteria to identify specific islands to be intensively managed within the regional guidelines (above):

- a. birds are nesting currently;
- b. evidence that predation by mammals or raptors is not a concern, or that it can be controlled;
- c. location is consistent with needs for geographic dispersion;
- d. the existence of a populous colony in the region in the past indicates that adequate food resources are available, though fish prey are notorious for fluctuating in numbers;
- e. suitable nesting substrate is present;
- f. the island's location and topography make it practical to camp and to maintain a field party from mid-May to the first of August;
- g. owners are interested and will allow a field party;
- h. the present or potential levels of pollution are not considered prohibitive;
- i. special measures may be necessary where Roseate Terns nest.

III. CONDUCT STUDIES TO GUIDE MANAGEMENT PROGRAMS.

- 1. Investigate the effects of predators and competitors at the major tern nesting sites;**
- 2. Investigate when, where and why tern populations may be vulnerable or are decreasing;**
When and where possible, identify factors affecting the numbers and distribution of small colonies, and find the causes of failure where breeding fails chronically.
- 3. Refine survey techniques for censusing tern populations.**
Several survey methods should be tested at the colonies with resident field parties in order to refine techniques continuously:
 - a. estimation of numbers of birds in the air over nesting area;
 - b. mark-recapture index of nests.

We need to develop techniques that provide extensive as well as intensive census coverage, because in some years major numbers of failed breeders transfer between islands in late June and early July. We need to test repeatedly the relation between the numbers of birds in the air and the numbers of nests to provide an index for quick assessment on the many small colonies. We need to know how the reliability of these techniques varies with individuals and with the calendar. We need to know the importance of taking replicate samples on the same or successive days; we need to know what techniques provide accuracy at the level of significant figures, and yet do not take so much time and group effort that they are impractical at small, dispersed colonies.

We need to establish the average reliability of the several methods of measuring productivity. Some workers, for example, find that the use of exclosures is not suitable on their nesting habitats, some mistrust the use of estimates of the birds in the air as an index of nests present, and some mistrust the use of nest counts, because capture/recapture studies show that they are usually low. We need to identify methods to be used under different circumstances, even though they may provide different levels of significance.

We should test the mark-recapture method regularly for its reliability as an index of nests.

4. Investigate techniques of manipulating vegetation so as:

- a. to attract terns to nest at the site;
- b. to measure effects of different habitats on breeding success.

Habitat characteristics influence where birds settle, but it is not clear whether habitat quality *per se* influences breeding success. Some doubt that habitat alteration is a practical method of achieving our objectives.

Techniques for manipulating vegetation should be tested, for example: mowing, burning, use of herbicides or rock salt, and soaking with sea water. The management tests should be designed so that results can be used to improve quality and quantity of nesting habitat on existing and potential nesting islands.

In nearly all colonies of mixed species composition, differences in habitat affect where the species settle. It may be prudent to increase the area of habitats on some islands to encourage one species or another, e.g. large areas of Beach Pea, Angelica and Scotch Lovage may expand the numbers of Roseate Terns.

5. Make General studies of breeding biology

These studies do not contribute directly to the management program as no amount of information garnered will allow us to affect the age and experience of breeding birds, or the food supply available.

- a. Estimate survival rates, establish age at first breeding and changes in breeding performance with age; estimate the effects of inter-island movements on calculating survivorship.

It may be practical to color-band terns at some sites to measure lifetime breeding performance, but this is a very labor-intensive study that must be continued over at

least a decade to achieve results. If such studies are proposed the group should get advice on the validity of the premises, the practicality of the plans, the sample sizes, and the methods of sampling needed to avoid being superficial.

Some have expressed doubt that the current color-banding to estimate site-fidelity and inter-island movements should be continued, unless a coordinated plan including the taking of larger and consistent samples in Maine is agreed upon. All banding must be under permit from the Banding Office of the U.S. Fish & Wildlife Service and the Maine Department of Inland Fisheries and Wildlife.

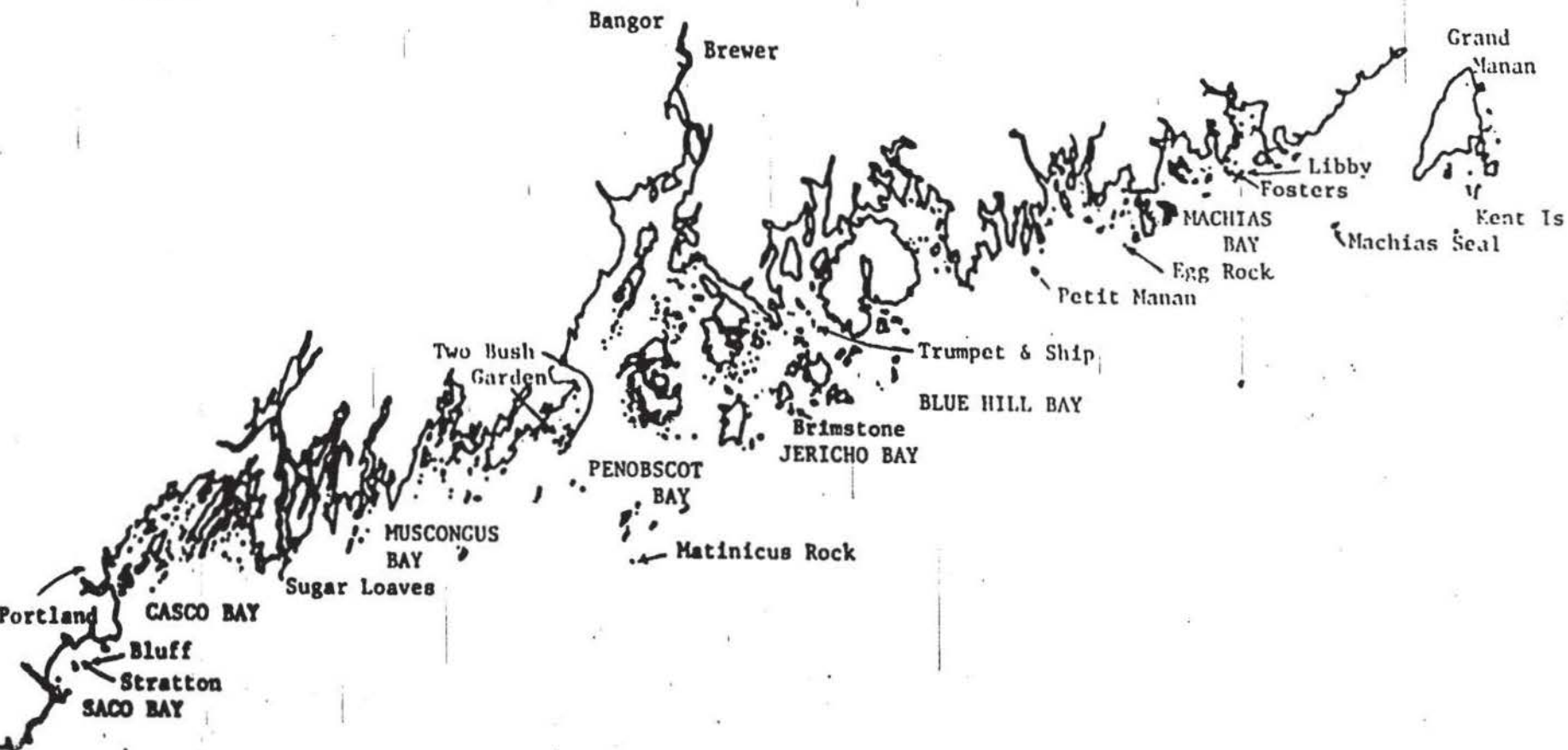
b. Study feeding ecology and annual differences in feeding rates and weight-gain in tern chicks.

Establish standardized techniques for examining the occurrence and frequency of prey species in chick diets, feeding rates and weight gain in chicks. Accompany these studies, where possible, with surveys of the distribution of foraging adult terns and stocks of important fish prey (White Hake, Herring, Sand Launce). This information provides indices of current food availability and can be used to track reasons for annual differences in nesting success and numbers settling on the colonies.

6. Survey the distribution and abundance of Herring and Great Black-backed Gulls.

We need to understand changes in distribution and numbers in the populations of the large gulls to understand the effects of gulls on the number of islands available for terns and on tern breeding success.

MAP 1



This map shows the major bays on the coast of Maine and important tern nesting islands referred to in the text and tables.



This map shows islands repeatedly occupied by terns in mid-coast and eastern Maine. Terns have repeatedly colonized and then abandoned them after suffering heavy predation from Herring and Great Black-backed Gulls.

The distance from Eastern Egg Rock to Petit Manan is about 140 kilometers.

APPENDIX A: CENSUSES OF TERNS NESTING ON THE MAINE COAST (bold 12)

TABLE 1. TERNS NESTING IN MAINE IN 1931

(Numbers are of pairs, Robert P. Allen and Arthur H. Norton,
unpublished report to the National Association of Audubon Societies)

Stratton Is., (Saco Bay)	-	800	Common Terns, a few Roseates.
The Sugar Loaves, (Kennebec River)	-	550	Common, 150 Roseate Terns
Garden Is., (Penobscot Bay)	-	500	Common Terns (many young)
Two Bush Is., (Penobscot Bay)	-	100	Common Terns (150 young dead)
Metinic Is., (Penobscot Bay)	-	150	Arctic and Common Terns
Little Green Is., (Penobscot Bay)	-	300	Common Terns
Matinicus Rock, (Penobscot Bay)	-	500	Arctic Terns
Brimstone Is., (Jericho Bay)	-	150	Common Terns
Trumpet Is., (Blue Hill Bay)	-	500	Common Terns
Ship Is., (Blue Hill Bay)	-	300	Common Terns
Petit Manan	-	400	Common and Arctic Terns
Egg Rock, (off Jonesport)	-	300	Common Terns
Foster's Is., (Machias Bay)	-	600	Common, some Arctic Terns
Machias Seal Island, (Grand Manan)	-	2,000	Arctic and some Common Terns

TABLE 2. CHANGES IN NUMBERS OF TERNS NESTING ON THE GULF OF MAINE COAST

	Common Terns	Roseate Terns	Arctic Terns	Arctic Terns at Machias Seal
1900-1905	4,000		2,500	100
1930-1935	5,000 /19 is. 6,000 /25 is.	75 /3	5,250 /6	3,500
1940	8,000 /25 is.		5,500	2,300
1972	2,600 /18 is.	85 /2	3,000	2,100
1977	2,100 /24 is.	80 /3	1,650 /9	1,600
1984	2,550 /28 is.	76 /8	1,720 /18	1,350
1988	3,100 /14 is.	75 /9	2,050 /7	1,900

The numbers before 1940 are based on estimates from several sources. Counts were made on different sections of the coast, and often in different years. The authors did not make clear whether the numbers are of birds or pairs. The numbers after 1940 are of pairs; those for 1972 and after are based on surveys of known, potential nesting islands.

TABLE 3. INTER-ISLAND MOVEMENTS OF COMMON TERNS OF MID-COAST MAINE (PAIRS)

ISLAND	1972	1977	1984	1985	1986	1987	1988	1989
Petit Manan	300	700	410	750	750	700	650	925
<u>No. Penobscot Bay</u>								
Thrumcap	125	300	--	60+	--	--	--	--
Barred	250	--	--	--	--	--	--	--
Spectacle	--	--	--	--	--	--	--	80
<u>Blue Hill Bay</u>								
John's	50	3	--	--	--	--	--	--
Rummel Cove	25	--	--	--	--	--	--	--
Indian Point	--	--	?	120+	120+	130	150	130
<u>Upper Jericho Bay</u>								
Flye/Sand	10	25	--	--	--	--	--	--
Smuttynose	250	25	--	--	--	--	--	--
Southern Mark	20	20	--	--	--	--	--	--
Canary Nubble	--	--	75	--	--	--	--	--
<u>Lower Jericho Bay</u>								
Green Island	50	20	20	--	--	--	--	--
Mason Ledge	--	--	20	--	--	--	--	--
Gooseberry	70	--	--	20	--	--	--	35
Great Spoon	--	--	--	30	200	30	--	--
Little Spoon	--	--	--	--	--	--	--	12
Compen	15	--	60	--	--	10	60	--
Threebush	--	--	--	--	--	--	--	50
<u>Lower Penobscot Bay</u>								
*Metinic Rock	5	--	50	--	10	20	40	50
Large Green	125	--	10	--	10	90	400	100
Metinic	5	50	180	480	630	70**	--	--
Two Bush	75	--	--	--	--	--	--	--
Brothers	30	80	--	--	--	--	--	--
<u>Muscongus Bay</u>								
Eastern Egg Rk	--	--	330	110	***	270	600	900
Killickstone	--	--	50	--	--	--	--	50
Totals:	1280	1220	1150	1570	1720	1320	1450	2330

* All nests of 3 eggs were assumed to be Common Tern on Matinicus Rock.

** In 1987, several hundred Common Terns came into Metinic Island in late May and moved onto Large Green in late June, after the census was taken.

*** In 1986, few terns nested at Eastern Egg Rock. No nest count.

This table shows how groups of terns have moved around, settled temporarily and moved on in the mid-coast region.

APPENDIX B. TABLES OF BIOLOGICAL INFORMATION ON HERRING GULLS

This information can be used in making decisions about to tern management, as is the reprint of "Man and Medric," (Island Journal, 1989. Volume six:13-15). The reprint offers a brief historical review of the increase of the gull population and how gulls displaced terns from traditional nesting island.

Gulls have moved about among the islands along the coasts of the Gulf of Maine, even while they were expanding their range to the south. After the decline of market hunting and eggging, gull numbers decreased on the outer islands where they nested during the first decades of this century. They moved to nest on inner islands nearer to human sources of food.

MOVEMENTS OF HERRING GULLS AMONG BREEDING ISLANDS IN MID-COAST MAINE
(Birds, not pairs, unpublished data from A.H. Norton and A.O. Gross)

	1920	1930	1940
Outer Islands:			
Great Duck, Little Duck	5,000	4,300	3,300
No Man's Land, Matinicus	5,000	1,000	900
Metinic Green	5,000	1,200	800
Big Spoon	1,000	1,000	550
Inner Islands:			
Fisherman's	300	500	1,500
Western Egg	50	500	2,250
Colt Head, Barred ..	0	50	1,350
Schoodic	0	25	2,140

This table shows how the numbers of Herring Gulls increased for several decades on major offshore nesting islands. Then, about mid-century, their numbers began to decrease steadily.

TABLE OF CHANGES IN NUMBERS OF GULLS & TERNS NESTING ON OUTER ISLANDS
 From Drury, W.H. Gull Increase, Terns, and Gull Control in New England, USA,
 (in press) submitted to Biological Conservation.

	KENT ISLAND		ISLES OF SHOALS		MUSKEGET ISLAND		
	HERRING GULL		HERRING	GR'T BLK-BK	TERNs	LAUGHING G.	HERRING GULL
1880s	...	*	...	...	*	4,000	0
1890s		*			*		
1900s	...	*	...	...	*	8,000	45
1910s	...	*	...	...	*	13,000	650
1921	...	*	500	0	*		0
1920s	...	*	...	...	*	...	2,000
1931	...	*	2,700	3	*		150
1930s	...	*	...	...	*	20,000	1,500
1937	20,000	(1) *			*		200
1940	16,000	(2) *	...	...	*	850	400
1941	...	*	3,750	16	*	20,000	...
1945	25,000	(3) *	...	50	*	...	13,000
1947	30,000	(4) *			*		
1949	17,000	(5) *	...	...	*	...	20,000
1951	...	*	4,900	120	*	0	5,000
1954	...	*			*		16,000
1961	...	*	...	...	*	0	13,000
1963	10,000	(6) *			*	700	10,000
1965	7,500	(6) *	5,900	725	*	0	8,500
1967	8,350	(7) *			*	400	
1972	8,000	(6) *	7,000	1,150	*	0	200
1973	4,000	(8) *			*		3,500
1975	...	*	4,650	1,300	*	...	...
1979	4,560	(9) *	...	...	*	0	0
1980	5,000	(10) *	4,000	2,050	*	0	0
1989	?	*	2,500	2,500	*	0	0

Data for Kent Island show the decline at an island of major importance early in the 20th century. (1) Pettingill 1939; (2) Crystal 1941; (3) Cameron 1945; (4) Gross 1947; (5) Pimlott 1952; (6) Drury, air est.; (7) Ainley 1967; (8) Drury, surface est.; (9) Lock 1983; (10) Cannell and Maddox 1983.

Data for Isles of Shoals show the increase of Herring Gulls and their decline after "Earth Day," while Great Black-backed Gulls have been steadily increasing. Palmer (1949), Drury (1973/74) and Borror (1980, pers. comm.).

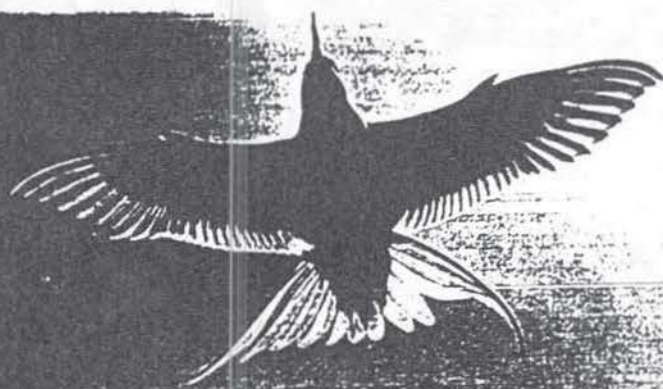
Data for Muskeget Island (see Drury 1973/1974) show the replacement of terns by Laughing Gulls, then Laughing Gulls by the larger Herring Gulls. In the late 1980s the island was sparsely occupied, primarily by Great Black-backed Gulls, as the Herring Gulls had moved to Monomoy Island near the mainland.

An important feature of the population biology of Herring Gulls is that they do not reproduce equally well on all nesting islands. In fact, the birds nesting on most of the outer islands, where gulls are harassing terns, produce very few young, and their numbers appear to be maintained by immigration of young gulls excluded from breeding at the larger nesting islands. Thus, these islands play little part in maintaining the coast's gull population, which is such an important part of the Gulf of Maine.

BREEDING SUCCESS ON GULLERIES OF DIFFERENT SIZES
BETWEEN LONG ISLAND AND GRAND MANAN

	Islands with over 400 pairs		Islands with 40-400 pairs		Islands with less than 40 pairs	
	number	%	number	%	number	%
Study Colonies	11	25%	34	75%	.....
Chicks fledged	26,871	84%	5,285	16%	.....
Total colonies	76	32%	311	55%	31	13%
Total Nests	104,700	81%	23,600	18%	840	0.6%
Ave. Production - (chicks per nest extrapolated from study islands)	1.15	...	0.95	...	0.70	.....
Total Chicks fledged - (number of nests x average production.)	120,000	84%	22,000	15%	600	0.4%

(From Drury, W.H., and I.C.T. Nisbet, 1972. The importance of Movements in the biology of Herring Gulls in New England. in Population Ecology of Migratory Birds: a Symposium. U.S. Dept. of Interior Wildlife Research Report 2. 278p.)



MAN & MEDRIC

Historical Biology of Gulls & Terns

WILLIAM H. DRURY

THE POPULATIONS of all seabirds on the coasts of the North Atlantic have changed remarkably over the last 300 years. There is no evidence that this instability is new or that changes are inherently "bad," but nevertheless we humans have considered some changes to have been so.

During the late 18th and all of the 19th century, the New England-Maritimes region was as much a center of economic development as Salem, Boston, Nantucket, Philadelphia, or Charleston. Ships built and sailed by crews from Maine and the Maritimes plied the sea lanes of world commerce. Northeast centers of international trade were cosmopolitan, while much of the rest of Canada and the U.S. had only recently been settled by peasant immigrants. Evidence of this can be seen in the fact that it took until 1987 for the State of Maine to regain the population level it had in the 1880's.

In the 19th century, the coast and islands of the New England-Maritimes were occupied by people crowded into the centers of commerce, while fishermen and their families eked out a subsistence living on many of the more remote islands and outer coasts. They moved their families to the islands in the spring to be near the fishing grounds, because the sailing sloops from which they did their day-fishing were of conservative design and slow.

Families in the camps and small settlements used whatever food was available. They ate seabird eggs, and salted chicks for bait in the cod fishery. The small birds, like Leach's petrels and those that nested in rock crevices, like puffins and black guillemots, were

Seashore and sea birds go together in our psyche. When we see the one we expect the other, most particularly gulls and terns, the designated gatekeepers and resident entertainers of island experience. These are the people's birds; the others are in the care of birdwatchers. At that, it is chilling to think that herring gulls were nearly wiped out early in this century, and that terns are endangered in our own time. Ornithologist to the islands, Prof. William Drury writes of everybody's white birds on the coast of Maine.

killed by pet dogs and cats, or trapped in herring nets set over jumbled boulders at night. By the middle of the 19th century, eight species of seabirds, including great auks and Labrador ducks, had been killed off along the New England coast, and the numbers of the remainder were seriously reduced.

Then a new threat emerged — fashion demanded that ladies should wear feathers on their hats. This demand produced two great campaigns of shooting gulls, terns, and egrets for their feathers in 1876 and 1896. Arthur H. Norton, writing in the early 1930's from his own experience, told of the "feather campaigns" and listed 15 islands in Maine's Muscongus and Penobscot bays from which terns were exterminated in the late 1880's, and from Casco Bay islands in 1889 to 1890.

NO GULLS OR SHAGS

Edward Sturtevant, co-author of *Birds of Rhode Island* and a one-time market gunner, told me that there were three years during the late 1870's when he did not see a single sea gull. At the turn of the century, Norton and Dutcher reported that their survey of the coast of Maine showed no nesting great black-backed gulls or double-crested cormorants, and the presence of only five female eiders, and two pairs of Atlantic puffins (on Matinicus Rock).

At the same time, Wendell Townsend reported about 50 female eiders and 30 puffins around Grand Manan. Herring gulls nested on a few of the outer islands in eastern Maine, and the National Association of Audubon Societies hired wardens to protect them from the depredations of the plumage hunters.

Terns were confined to nesting on Bluff Island south of Portland, two islands in inner Muscongus Bay, three remote islands in the approaches to Penobscot and Jericho bays, small islands in upper Penobscot Bay, and on the outer islands in easternmost Maine.

The exceptions were the islands on which lighthouses were maintained. For several critical decades, lighthouse operators and their families from Machias Seal, Libby Island, Petit Manan, Great Duck, Great Spoon, and Matinicus Rock kept off both the predatory feather-hunters and the predatory gulls. Unfortunately their family pets, dogs, and cats devastated the nesting populations of some small seabirds, like Leach's storm petrel and black guillemots.

All seabirds have increased since then, and five of the species that had been extir-

...these birds recognized... double-crested cormorants, great cormorants, great black-backed gulls, razorbills, and common murre. Most species have increased steadily, and so rapidly as to suggest colonization from refuges in the Maritime Provinces. So, it seems probable that redundancy of geographically remote sanctuaries played an important part in these species' escape from extinction. This movement of seabirds among several geographic areas has, presumably, allowed them to persist in habitats that have repeatedly changed in space and time in the past.

GULLS INCREASE AND EXPAND

Norton reported that by 1911 herring gulls had occupied small islands east of North Haven in inner Penobscot Bay and the Spoon Islands in Jericho Bay, forcing the terns to seek other places to nest. By 1921 herring gulls had colonized islands 60 miles to the west of their previous limit and Townsend reported about 20,000 gulls nesting in the Grand Manan archipelago.

Meanwhile, the numbers of gulls nesting on the outer islands in Maine decreased as scavenging birds moved closer to the mainland and to islands near fish plants. Many summer fish camps were abandoned to the gulls and flocks of marooned sheep.

RAPID RECOVERY OF TERNS

Norton reported that terns had reoccupied many islands by 1903, with 6,500 common and Arctic terns nesting on 18 islands. Terns increased rapidly and reached peak numbers in the late 1930's. This increase may have been a recovery of previous numbers, or it may have been a phenomenon of a special period with special advantages for terns by gaining sudden access to a large number of islands traditionally occupied by gulls.

By the early 1930's the terns in Maine were doing well, and fortunately their numbers were censused. The distributions of the three species differ. Most common terns were found on inner islands, some quite close to the main shore, and their numbers were evenly spread along the coast. Arctic terns were most numerous on outer islands in eastern Maine and their numbers drop off sharply west of Matinicus Rock, where the westward flow of cold water out of the Bay of Fundy turns offshore.

CAPE COD SHIFTS

The shift of groups of terns away from traditional "populous" islands has been evident many times in the last decades as gulls have occupied, one after another, the major traditional nesting islands along the coast of New England. Most recently, the terns nesting at Petit Manan, east of Mount Desert Island, showed "malaise" about 1978, as gulls began to prospect the island and to increase predation pressure on the terns.

In 1982 approximately 1,400 pairs of terns had nested on Petit Manan, while about 150 pairs of gulls nested on neighboring Green Island, according to Jeremy Hatch. After the lighthouse on Petit Manan was automated in

1972, a local resident lived there for several years, and then the island became vacant. Gull numbers increased to about 350 pairs on Green Island and 10 pairs had settled on Petit Manan in 1977, according to Carl Korschgen. By 1978 terns and laughing gulls began to decrease, and by 1983 the terns had abandoned the island.

In 1984 some of my students looked into what was happening to the displaced terns, some of which settled on Flat Island and Nash Island about 10 miles to the east of Petit Manan and others on Egg Rock in Frenchman Bay, about 12 miles to the west. Those camped on Flat and Nash islands reported that gulls, after six days of fog which denied them access to their usual food acquired following lobster boats, began to hunt in the tern nesting area and to clean out all the young chicks. The students at Egg Rock reported gulls pouncing on incubating adult laughing gulls and terns from the air, and eating them alive.

At this same time, Steve Kress of the National Audubon Society began to use decoys and tape recordings of tern calls to attract terns to return to Eastern Egg Rock in Muscongus Bay, about 85 miles to the west. Herring gulls had displaced terns from that island by 1920, according to Arthur Norton. In early July in 1980, well after the usual time to settle to breed, some 80 pairs of common terns settled in. Steve reasoned that these first colonists were failed breeders from other terneries. In 1981 another 80 pairs arrived in late June and early July, and by late August 1982, 424 pairs were nesting: 400 pairs of common terns and 20 pairs of Arctic terns. As Steve said:

"Since Maine tern colonies have been declining for approximately 40 years, and there has been considerable inter-colony movement during this period, there is no way to be certain of the specific source(s) for the

Egg Rock tern population. However, the 1980 breakup of the large tern colony at Petit Manan Island, located approximately 145 KM east of Egg Rock, is a likely source.

The temporary increase in numbers of terns nesting on many islands made it difficult to convince the people on those islands that the tern population was in trouble. From their narrow view, the terns were in good shape. This point emphasizes the need to keep track of terns over a long stretch of coast, and to realize that subpopulations are strongly influenced by immigration and emigration."

HOW GULLS COLONIZE NEW ISLANDS

The increase in the East Coast herring gull population reflected rapid and continuing island colonizing. This meant that many young birds settled on an island at some distance "from home." Usually among seabirds, young birds are strongly attracted to established cities and are hesitant to nest alone. So young birds, newly recruited to the breeding population, are attracted to fully occupied islands, even though many other islands may be empty. This effect usually inhibits the growth of seabird numbers.

The growth of the herring gull population and southward extension of their breeding range continued during the 1950's, to Connecticut, New Jersey, and Maryland. The first herring gull colonists reached North Carolina about 1960, and the colonies south of New York continued to grow in the 1970's and 1980's.

Although the number of herring gulls nesting in Maine did not increase again after the control program of the 1940's, gulls continued to shift around among the islands.

Once an area is colonized only a relatively small number of gulleries is needed to

Gulf of Maine Tern Working Group

The poet Kathleen Raine refers to terns as "the signature of the sea." Few would disagree that the sight of a pair of terns locked in a courtship flight over an outer island is one of the rare treasures on the Maine coast. But what will it take to guarantee the long-term preservation of these fragile populations? This question is at the core of the three-year-old Gulf of Maine Tern Working Group.

The working group has approximately 20 members with representatives from the U.S. Fish and Wildlife Service, the Canadian Wildlife Service, the National Audubon Society, The Maine Audubon Society, the Maine Department of Inland Fish and Wildlife, and the Island Institute. Members gather in late summer to share census data collected at all the terneries in the Gulf of Maine. The 1988 meeting was held in late August at the National Audubon Society Camp on Hog Island in Bremen, Maine.

When the dust settled members reported terns nesting on only 19 of the 3,000-plus islands in the Gulf of Maine. Some 6,853 pairs of terns were found nesting on these islands. The breakdown by species was as follows, 2,955 pairs of common terns, 3,824 pairs of Arctic terns, and 74 pairs of the recently endangered roseate tern. On several islands the productivity of the terns was measured and averaged approximately one fledgling per nesting pair. The fate of the Gulf of Maine terns is intimately tied to the fate of the 19 islands that support them. In 1977, 25 islands supported 5,321 pairs of terns. So in the last decade we have actually gained 1,500 pairs but lost six nesting islands. At one time or another over the last 400 years 37 different Gulf of Maine Islands are known to have supported a maximum of 11,000 pairs of terns. The big picture is that it appears the region is losing both terns and tern nesting islands. What actions should

produce the young birds that keep the population going. Reproduction on other islands is not important.

This means two things: first, that eliminating gulls from a number of outer islands where terns might nest will have no effect on "reducing the gull population." Second, that our concern for terns must be focused on those islands where parents produce enough young to export. These colonies will be able to maintain the population, but keeping terns nesting on islands where parents fail, provides a population sink. To manage a tern population we need to make sure when we attract birds to a nesting island that they breed successfully.

FICKERING TERN WINGS ATTRACT GULLS. Several biologists in Scandinavia have pointed out the importance of groups of gulls already in residence as a "signal" to birds prospecting for nesting territories. The events of the 1960's suggest that nesting herring gulls serve this "ethological signal function," not only for other herring gulls, but also for colonizing double-crested cormorants, eiders, and great black-backed gulls.

Unfortunately, nesting terns provide "signal value" for this ethological function and attract herring gulls. We saw gulls attracted to terns at Large Green Island, Wooden Ball, and Petit Manan, and at Tern Island and Monomoy Island on Cape Cod.

GULLS AS AN 'OFFICIAL' PROBLEM

During the Great Depression in "downeast" Maine, farmers used sea herring and alewives to fertilize their fields. The ready supply of fish, spread out as if for them, attracted gulls to the uplands and to the annoyance of farmers. The good times had suddenly come for the gulls. But beginning in 1934 the Biological Survey of the U.S. Department of Agriculture (now the Fish &

Wildlife Service) and the Maine Department of Sea and Shore Fisheries began a program to reduce the growing gull population.

By 1940 the Maine nesting islands were under heavy pressure by egg-spraying crews bent on halting gull breeding. Close to 350,000 eggs were sprayed in 1940-1944. In 1945 it was clear that the numbers of birds nesting in Maine were decreasing, but the numbers nesting in Massachusetts were increasing rapidly.

The population of gulls nesting in Maine grew only slowly during the 1950's, and some can argue that the program was working. The population in Maine has stayed "conservative" since the program was ended, and it seems likely that the effect is the same as that of the gulls moving from outer islands to the inner islands in the 1930's and 1940's.

LETHAL CONTROL

Between 1967 and 1973, we worked with Biological Services agents John Peterson and Frank Gramlich of the Fish and Wildlife Service to conduct control experiments at islands where gulls were encroaching on terns.

We tried Alpha-Chloralose at Tern Island in Chatham on Cape Cod, where we were attempting to restore a formerly important tern nesting site that had been taken over by gulls in the early 1960's. The poison worked when used massively for a short period, as it had in Europe.

This exercise taught us that as we removed the nesting birds a number of gulls, especially immatures, replaced them. Killing gulls on Tern Island was not being successful because we had to "bleed down" the surplus of young gulls interested in, but excluded from, breeding.

SUCCESSFUL INTERVENTION IN MAINE

Our experience at Matinicus Rock in the late 1960's illustrated how it could come together, even though many doctrinaire protectionists were still opposed. Carl and Francis Buchheister (former President of the National Audubon Society) spent vacations in a camp on Matinicus Rock in the 1960's. With a long-term agenda in mind, I suggested to Carl that he watch for indications that the herring gulls newly settled on the Rock were disturbing tern nests.

I think they were already aware, because at the end of the first summer, Carl and Francis both commented that they had seen gulls taking tern chicks and had found several of the bands they had put on terns in gull nests on the north end of the Rock. Carl endorsed a program to remove the new gull colonists, and Frank Gramlich of the Division of Biological Services tolled them to bread, poisoned with 1339, thrown out behind a boat circling the island. The terns enjoyed another ten years of successful reproduction.

Steve Kress embarked on a similar program in 1974 at Eastern Egg Rock, and reported the events:

"... Well-established gull populations are not likely to decline unless there is repeated and complete breeding failure, increased mortality and emigration for at

least three summers. Even after this period of control, continued destruction of clutches late in incubation will be necessary to keep gull populations from quickly rebounding."

PHILOSOPHICAL QUESTIONS

Some people have recommended that the entire gull population or a regional segment be reduced. The reality of the reproductive potential of gulls and the fluidity of the populations suggest that this is a much larger undertaking than its proponents realize. It is a project that would require the cooperation of operators all over most of the east coast herring gull range, and it is unlikely that such cooperation would be given. If the numbers of gulls were seriously reduced, they would probably first become scarce in remote places, because most gulls are attracted to food around towns and cities. It is more reasonable and effective to remove the attractions where gulls gather and become pests.

The problem of gulls is important in places where forces strongly attract a relatively small number of gulls. That is what we are dealing with at vulnerable tern colonies. But reducing the problems to a small number of areas and a minimum number of gulls is not good enough for some committed idealists.

Many people with whom I must debate killing gulls prefer to deny that any need exists. Some argue against killing on humanitarian grounds. I agree; killing is not a pretty or enjoyable activity. But gulls eating living tern chicks is not a pretty sight, nor is the sight of a herring gull pecking at the bleeding head of a living laughing gull that was just recently incubating its eggs.

I think that the philosophical question of killing one species to favor another was made and accepted by those early agriculturalists who pulled up plants that inhibited the growth of their crops — they weeded the garden. A biologist can argue that it is precious and self-serving to make a philosophical separation of plants from animals, or "lower animals" from vertebrates, or us. Why should fish be placed "beyond the pale?" When we find vulnerable species that we think are important, and want to encourage them, we may have to seed the garden.

As to the philosophical issue of nature's order and "playing God," we now know that laissez-faire ecology, like laissez-faire economics, doesn't lead to balanced systems, it leads to monopolies. Some species will take over and assert an order favorable to them, whether white spruce or starfish or herring gulls. Unless we believe that there is a natural order established at the creation, we should acknowledge that when we won't play God, someone else will.

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be taken to insure the long-term viability of terns? At the very least the islands that currently support the majority of terns should be guaranteed protection. And the best way to do this is to post tern wardens. Of the 19 currently active tern islands, 10 of them support 90% of the terns found in the region. From east to west these islands are; Machias Seal, Petit Manan, Indian Point, Eastern Cowpens, Matinicus Rock, Large Green, Eastern Egg Rock, Stratton Island, Pond Island, and West Goose Rocks. The ownership pattern of these islands is varied, ranging from Canadian owned, U.S. owned, state owned, and privately owned. Clearly we need to look long and hard to see if these islands afford long-term protection. One solution would be to incorporate these islands into a designated Tern Sanctuary System where protection and monitoring by resident tern wardens could be a continuing and coordinated effort.

APPENDIX C. MAINE ISLANDS HISTORICALLY RECORDED AS TERN NESTING SITES

The following list includes those islands which Arthur Norton identified as supporting numbers of nesting terns between 1880 and 1920. It is the best information available on where terns should do well. The list also includes those islands to which terns moved when they were driven off the preferred nesting sites. We should probably not attract terns to the secondary islands, as they may not have access to food or they may be vulnerable to predation. Terns nesting at such places may act as a population sink.

Probably the earliest and most important list of traditional nesting sites is Arthur Norton's hand-written manuscript in the archives of the University of Maine at Orono, discovered by Ralph Palmer.

"In 1885 terns occupied numerous, long-established, often populous colonies on many, the following islands. From west to east, Bluff Island, Casco Bay. The Outer, Inner Green Islands and Junk of Pork, Western Brown Cow, Western Mark Islands, White Bull, and Eastern Brown Cow in Casco Bay. In this bay even the Upper Green Islands, were occupied for a number of years.

East of Small Point, the Heron Islands, and Egg Rock, off Popham Beach, Black Rock in Sheepscot Bay, Damariscove Island, the adjacent Pumpkin Knob, Thrucape, were regular breeding places.

In Muscongus Bay Shark Rock, Eastern and Western Egg Rocks, and among the Georges Islands, Shag Ledges and the Sisters, afforded breeding places for colonies of from one to several hundred of pairs.

Penobscot Bay was the home of numerous colonies, many of them very populous. These included Metinic Green Island, Big and Little Green Island, Wooden Ball and Matinicus Seal Island, Matinicus Rock. Big Two Bush, the Clam Ledges, Little Hurricane, Garden Island, Marble Head and Fisherman's Islands, Robinson's Rock and Mouse Island several small rocks or islets north and northeast of the Fox Islands, Roberts Island and Little Brimstone southeast of there. In Blue Hill Bay Tinkers, Trumpet, Ship and the two small Barge Islands.

In Jericho Bay, the two Spoon Islands, Southern Mark Islands, supported populous colonies, with Halibut Rocks, and Saddleback Ledges with several smaller ones were large enough to attract the shooters when the larger ones were broken up.

Further east, Petit Manan Islands, the _____ Egg Rock, Pot Rock, Crumple Island Egg Rock, Mason's Ledge, North Libby Island, Halifax _____ and Machias Seal Island."

(The spaces were left in Norton's list. Mason's Ledge is probably that southwest of Swan's Island.)

Norton was occasionally inconsistent in his use of names for islands. For instance there is a Lower Mark Island in eastern Sheepscot Bay, and that may have been the one Norton meant when he referred to terns reoccupying Outer Green, Lower Mark and Eastern Brown Cow by 1911. All of these are in Casco Bay. In another place he refers to a Lower

Mark in association with the "two Spoon Islands," Halibut Rocks and Saddleback Ledges, which are all in Jericho Bay. The island referred to in Jericho Bay must be Southern Mark, which he referred to in the list for 1885. Again, Norton did not make it clear whether the "Brimstone Island" referred to is in Isle au Haut Bay off Vinal Haven (where he reported terns nesting on the three Little Brimstones) or near Swan's Island in Jericho Bay (where terns have nested repeatedly in recent years). It seems clear that the Big Two Bush Norton referred to several times is in Muscle Ridge Channel, not in the Matinicus group or in east Casco Bay, because in the above list, he listed Garden Island and Fishermans with it, and in another place he noted Common Terns. The presence of Common Terns suggests inner islands, not the Matinicus group.

Norton's list of nesting islands for COMMON TERNS, grouped by bays, as Norton did, and arranged geographically from southwest to northeast.

The following prefixes to supply additional information:

- # means that Arthur Norton listed the island as having been used as a tern nesting island several times between 1880 and 1921.
- + means that the island was listed as occupied in 1931 by Robert Allen and Arthur Norton in their report to the National Association of Audubon Societies.
- * means that the island has been occupied recently.

BIDDEFORD TO KITTELY

Bumpkin Is. Kittery formerly important

* Beach Is. Biddeford

* West Goose Rocks

SACO BAY

Bluff Island

+* Stratton Is. - Saco Bay (+ 1,600 Common, a few Roseates)
owned by National Audubon Society.

WEST CASCO BAY

Outer Green

Inner Green

Junk o' Pork

Western Mark

* Clapboard Is. Ledge Falmouth Foreside

* Nubbins - Yarmouth

EAST CASCO BAY

Lower Mark

White Bull

Eastern Brown Cow

Turnip - Harpswell

* Pond

SHEEPSHOTT BAY TO SMALL'S POINT

Heron

Egg Rock off Popham Beach

Black Rocks
 + Sugar Loaves - Phippsburg (+ 1,100 Common)
 (+ 150 Roseate)

BOOTH BAY/JOHN'S BAY
 Damariscove
 # Pumpkin Knob
 Thrumcap
 Cuckholds - Southport

MUSCONGUS BAY
 Shark Rock
 # Western Egg Rock
 ** Eastern Egg Rock owned by Nat. Audubon Soc.
 * Killick Stone
 Crotch in Broad Sound, Bremen
 Nubbins in Friendship

GEORGE'S ISLANDS
 Shag Ledges
 Sisters
 Brothers

MUSCLE RIDGE - PENOBSCOT BAY
 # Clam Ledges
 #+ Garden (+ 1,000 Common)
 # Marblehead
 # Fishermans
 #+ Big Two Bush (+ 200 Common)

APPROACHES TO PENOBSCOT BAY
 # Metinic Green
 ++ Metinic (+ 300 Arctic and Common)
 ++ Little Green (+ 600 Common)
 (* Large Green - temporary)
 # Wooden Ball
 # Matinicus Seal owned by Fish & Wildlife Service
 ++ Matinicus Rock (+ 1,000 Arctic) owned by USF&W Service.

WEST PENOBSCOT BAY
 # Goose Rock
 # Robinson Rock
 # Mouse Island
 Hardhead

EAST PENOBSCOT BAY
 # North Haven Egg Rock
 # Sloop Island Ledges
 Compass Island
 Grass Ledge
 Spoon Ledge
 Barred in Deer Isle
 Thrumcap in Brooksville

ISLE AU HAUT BAY
 Medrick Rock
 Green Ledges
 Green Island
 Little Hurricane

Hay Island
 # Robert's Island
 # Little Brimstones (3)
 JERICHO BAY
 # Southern Mark (populous)
 # Little Spoon (populous)
 ## Big Spoon (populous)
 Popplestone
 Green Islands
 Green Ledge
 # Halibut Rocks
 # Saddleback Ledges
 ## Brimstone (+ 300 Common) (unlikely to be off Vinalhaven)
 Mason's Ledge
 * The Cow Pen
 BLUE HILL BAY
 Tinkers
 #+ Trumpet (+ 1,000 Common)
 #+ Ship (+ 600 Common)
 # two small Barge Is
 Smuttynose/Flye Brooklin
 * Hub Is - Mount Desert
 Runnell Cove - Tremont
 FRENCHMAN'S BAY
 Egg Rock
 ## PETIT MANAN (+ 800 Common and Arctic - owned by USF&WLS)
 Green Island (owned by MDIFish & Wildlife)
 WESTERN BAY
 #+ Egg Rock by Crumple Is. (+ 600 Common)
 # Freeman's Rock
 Ladle=Nash - Addison
 Flat
 JONESPORT REGION
 Pot Rock
 # Egg Rock
 MACHIAS BAY/ENGLISHMAN BAY
 # North Libby Is.
 #+ Foster - Roque Bluffs (+ 1200 Common and Arctic)
 # Halifax

Norton's hand-written list of nesting islands for ARCTIC TERNS, arranged in his usual geographical order, as follows:

Junk of Pork	1873-1889-1916, 1917-1918. 1928
Heron Id.	1897, leave
Black Rocks	1897 = 16 (Means they left in 1919?)
Inner Sugar Loaf	1924 -
Egg Rock Popham	1895 - 1897, leave
Damariscove Id.	- 1884
Pumpkin Knob	1888 - 1890 -
Near Bristol	- ", 1895
Muscongus Bay	1884 - 1897
E. W. Lit Egg	1898
(May mean Eastern, Western and Little Egg/Mosquito)	
Shark	
Little Green Id.	- 1885-1886 - 19
Metinic Green	1883 -
Matinicus Rock	1865 -
Ship	1898
Barge	"
Trumpet	"
Jonesport Egg	1902
Freeman's Rock	
Foster's Id.	1905 - 1931
Libby Island	
Machias Seal Id.	1879 - 1939

The lists should not be taken as indicating discrete populations of terns nesting at these many places. They suggest, instead, that good tern habitat exists in these places, as terns have bred successfully there over several years. Studies of gulls and terns suggest strongly that birds steadily exchange across regional "borders," and once they leave an island they may move a long distance.

Probably the most promising places for intervention on behalf of Roseate Terns are at the Sugar Loaves in the mouth of the Kennebec River (where all three species of terns nested until recently), and at Ship and Trumpet Islands in lower Blue Hill Bay which were successful terneries until the 1940s.

There is less promise of quick returns of Common and Arctic Terns to the following places, but at least as much need:

- a. eastern Casco Bay;
- b. the Junk o' Pork, Outer Green Islands area in southwest Casco Bay;
- c. the region between Biddeford and Kittery
- d. the Isles of Shoals (The Audubon Society of New Hampshire has undertaken a project there.)
- e. Machias Bay at Halifax, Foster, or Libby Islands.

THE FOLLOWING PAGES ARE ARTHUR NORTON'S NOTES
from the Archives of the University of Maine at Orono

MAINE TERN COLONIES IN 1885.

Saco Bay.

Bluff island.

Casco Bay.

Upper Green Islands, (2).

West Brown Cow

Lower Mark Island

Inner Green Island

Outer Green Island

Junk-of-pork

White Bull .

Eastern Brown Cow.

Phippsburgh.

Heron Islands

Egg Rock.

Sheepscot Bay and John's Bay.

Black Rock

(Damascove Island)

Dr. T.M. Brewer reported a colony on this island
(1884, Watre Birds N. Am II, 302).

Pumpkin Knob

Hypocrites.

Thrumcap

Muscongus Bay.

Shark Rock

Eastern Egg Rock

Western Egg Rock

Little Egg Rock

Georges Islands.

Shag Ledges

East Penobscot Bay

Metinic Green Island

Little Green Island

Big Green Island

Big Two Bush (Ceased about 1884)

Clam Ledges

Garden Island

Marblehead Island

Fisherman's Island

Little Hurricane.

Fox Islands;

Medrick Rock

Green Ledges

Green Island

Egg Rock

Compass Island

Grass Ledge

Sloop Island Ledges

Spoon Ledge

Robinson's Rock

Goose Island

Mouse Island

Hardhead

Hay Island

Robert's Island

Little Brimstones, (3)

Matinicus Islands

Matinicus Rock

Wooden Ball

Seal Island

Jericho Bay.

Little Spoon Island
 Big Spoon Island
 Green Ledge
 North Popplestone
 Southern Mark Island
 Halibut Rocks
 Saddleback Ledge

Bluehill Bay

Tinker's Island
 Trumpet Island
 Ship Island
 The Barges (2).

Petit Manan Region

Green Islands.

Egg Rock

Jonesport Region

Pot Rock

Ladle

Egg Rock

~~Mason's / 1900s~~ Freeman's Rock

Englishman's Bay, (or "Machias Bay")

North Libby Island

Cutler.

Machias Seal Island.

Gull Rock

During the years of 1886 and 1887 a wholesale slaughter of terns was carried on in Muscongus Bay, Penobscot Bay, Matinicus Seal Island and the Wooden Ball, Blue Hill and Jericho Bays. Several of the most populous colonies were annihilated.

A change in "fashion" in millinery, and the passage of a law for the protection of terns in Maine passed by the legislature of 1889 caused a pause in the destruction of these birds.

Survivors from the persecuted colonies joined other established colonies and some of these became populous again. In 1890 colonies were known at the following places.

Maine Tern Colonies in 1890.

Saco Bay

Bluff Island

Casco Bay

Junk-of-pork
Outer Green Island

Lower Mark Island

White Bull.

Phippsburg.

Heron Islands

Egg Rock

Sheepscot and John's Bays.

Black Rock

Pumpkin Knob

Thumb Cap (?)

Muscongus Bay

Eastern Egg Rock

Westwrn Egg Rock

Penobscot Bay

Metinic Green Island

Matinicus Rock

Marblehead Island

Fisherman's Island

Fox Islands,

Egg Rock

Slop Island Ledges.

Jericho Bay.

Big Spoon Island

Saddleback Ledge
Green Ledge

Halibut Rocks

Green Island

1890

Blue Hill Bay

Trumpet Island

Ship Island

The Barges

Petit Manan to Cutler.

Green ¹islands

Egg Rock, (Crumple Island)

Msos's Lodge Freeman's Rock

North Libby Island

Machias Seal Island.

Gull Rock

presented to collection

The demand for plumage was revived, and the summer of 1899 saw the colonies at Outer Green Island, the Phippsburg colonies and Pumpkin Knob swept out of existence for a number of years. Pumpkin Knob, and the Phippsburg colonies were permanently destroyed; Outer Green Island was after a few years slowly repopulated, but through several causes led a fluctuating existence until a few years subsequent to 1918, when the Island was taken full possession of by the herring gulls.

The summer of 1900 showed the following colonies of terns on the coast of Maine.

Maine Tern Colonies in 1900.

Saco Bay

Bluff Island

Casco Bay

Lower Mark Island

White Bull

Muscongus Bay

Eastern Egg Rock

Western Egg Rock

Penobscot Bay

Metinic Green Island

Matinicus Rock

Marblehead Island (?)

Fisherman's Island (?)

Fox Islands ,

Egg Rock

Sloop Island Ledges

Jericho Bay

Green Ledge

Popplestone

Saddleback Ledge

Halibut, Rocks

Blue Hill Bay

Ship Island

The Barges

PetitManan to Cutler.

Green Islands

Egg Rock, (Crumple Island)

~~Kisson's Ledge~~ Freeman's Rock

North Libby Island

Machias Seal Island.

Gall Rock

From the year of 1900 terns were little molested by man, having been protected through the Thayer Fund, which shortly gave rise to the National Association of Audubon Societies. This organization through the employment of local guardians attended to the enforcement of the "model Bird Law" enacted by the Maine legislature of 1901.

Gulls shared the benefits of this care, and by 1911 had increased to the extent where beginning of their extension of range was noticed.

Having reached this state of abundance, their extension of colonies was rapid, and their encroachment and replacement of the colonies of terns continual. The expelled terns began to occupy smaller islands and ledges, which were frequently unsuited to their need, for various reasons.

The following islands and ledges were known to be occupied by terns in 1911.

Colonies Occupied in 1911

Saco Bay.

Bluff Island

Casco Bay

Outer Green Island

Maddock Ledge

(No record in 1911; occupied 1914, unsuccessfully)

Lower Mark Island.

Muscongus Bay.

Eastern Egg Rock

Western Egg Rock

Penobscot Bay and Matinicus.

Metinic Green Island

Matinicus Rock

Marblehead Island

(No record)

Fisherman's Island

(No record)

Robinson's Rock

(No record 1911; occupied 1914).

Goose Island

(No record 1911; occupied 1914).

Mouse Island

(No record 1911; occupied 1914).

Slopp Island Ledges

Channel Rock

Jericho Bay

Southern Mark Island

Saddleback Ledge

Halibut Rock

Blue Hill Bay

Ship Island

The Barges

Petit Manan to Cutler.

1911

Petit Manan to Cutler.

Egg Rock, Crumple Island

Freeman's Rock

North Libby Island

Machias Seal Island

Gull Rock

Tern Colonies in 1931.Saco Bay.

Stratton Island

Casco Bay.

Prince's Point Ledge

Stepping Stones

(Fishermen reported a colony on Flag Id.).

Haddock Ledge

Lower Mark Island

Pond Island

Phippsburg.

Upper Sugarloaf

Lower Sugarloaf

Penobscot Bay

Metinic Island

Matinicus Rock

Garden Island

Little Green Island

Jericho Bay Region

Halibut Rock

Two Bush

Brimstone

Blue Hill Bay

Trumpet Island

Ship Island

Western Barge

Petit Manan to Cutler

Green Island

Egg Rock, (Crumple Id.) S.E. of Hunt was est. in Wash Co.

1931

(Petit Menan-Cutler, Continued)

Freeman's Rock

Foster's Island - *made*

Machias Seal Island

Gull Rock.

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APPENDIX D. SUGGESTIONS FOR FIELD PARTIES

STANDARDIZED TECHNIQUES FOR CENSUSING AND MEASURING BREEDING SUCCESS

Our management plans have two objectives within the goal of maintaining and increasing the populations of terns nesting in Maine:

- a. to keep track of the health of the populations and the success of our efforts at protection, by measuring reproductive success at islands where we have resident work parties;
- b. to keep track of changes in the population as a whole from year to year, by censusing numbers at all tern nesting islands.

Detailed Studies to be made at Islands with Resident Work Parties.

Unless observers intend to make repeated visits to individually marked nests, they should make only one, careful complete count. Subsequent counts may confuse the issue as during the course of the season, some pairs abandon when their nests fail. In addition:

- a. new nests will appear belonging to inexperienced birds breeding for the first time, and
- b. if the ternery has been disturbed, repeat nestings may appear through most of June and into July. If the new nests are counted as they appear, they will tally up to a very impressive, but not very helpful total.

Suggested Procedures for Counting Nests.

1. Estimate the numbers of birds flying over the nesting area (see techniques proposed below) and conduct a complete nest count.
2. Nest counts are best made by at least two people walking abreast at arms length systematically making swaths through the nesting area. Plan routes ahead of time so that you avoid duplication and gaps. The census team should make as many passes as necessary to cover all nesting habitat completely. One person should record data while the others count. Avoid making counts on rainy or cold days, which would have negative effects on nesting success.
3. Make counts just before eggs hatch, during an annually agreed upon ten-day period between June 10 and 25. Counts conducted after this period are likely to be inflated. If birds start at one island, but are disturbed, they may move to another in late June (as they apparently did at Metinic in 1987 and Large Green in 1988).
4. For colonies over 50 nests, conduct a "mark and recapture" sample of the nests. The technique adds only a little extra work, and can provide a check on the accuracy of both the nest counts and the estimates of birds in the air.

Mark each nest as it is counted (to avoid counting a nest more than once). Use substantial markers, like tongue depressors or flower pot markers. Don't worry about possible subtle effects of having your eye drawn to marked nests, and do worry about putting small objects in the nests as markers. Terns will remove some "foreign objects," such as your inconspicuous markers, and you will get an inflated count.

After you have completed a count-and-mark survey, search a swath or transect running diagonally across the nesting area, recording the

number of nests found marked and the number found unmarked (missed in the first search). Use these numbers to calculate an index for the total number of nests, called a Peterson or Lincoln index, as follows:

Say you found 86 nests on the main search, and 18 marked nests and 4 unmarked on the transect. Divide 22 (the total) by 18 (the number marked); this gives you 1.2. Multiply 86 by 1.2 giving the index total of 103. Remember that because you missed some, the correction is upwards and the correct multiplier will be more than 1.

Estimating Reproductive Success.

Ian Nisbet and I (1972. "Measuring Breeding Success in Common and Roseate Terns." Bird Banding 43(2):97-106) found that we could establish the number of chicks per nest by either:

- a. putting up a blind and counting the chicks visible at each of several samples of nests.
- b. setting up fences around several samples of about twenty nests each, marking and counting the nests within the fences and later banding chicks, or

a. USING BLINDS - Good data on reproductive success can be obtained with relatively little disturbance, by setting up a blind at each of several places from which 10 - 20 nests can be seen clearly. Nests can be marked with tall stakes during the incubation stage and then each nest site repeatedly checked from the blind for the number of chicks loitering at it. Twenty to forty well-monitored nests will give good data on chicks produced per nest.

b. USING FENCED PLOTS - Fence selected areas; count and mark the nests. When the eggs have hatched search the area very carefully, banding chicks (record the band-numbers). A couple of days later repeat the search, recording band-numbers of all banded chicks and band and record any chicks found unbanded. Again a "Peterson/Lincoln Index" gives a total of the chicks surviving to the time of the first banding trip.

Comments.

You should wait until nests are being incubated before putting up the fences. Otherwise the birds recognize the difference between "inside" and "outside" and lay their eggs in scrapes outside the fence. Make sure that the wire mesh will not allow a chick to get part way through and not be able to get back. Be sure that the bottom of the fence is free of places for tiny chicks to slip through and not be able to get back. The parents may not have sense enough to feed them outside the fence. Avoid having the fences run through dense vegetation, because chicks press themselves under the "thatch." These chicks are very hard to find and it is distressing to step on one that you haven't seen.

Another more detailed body of information can be got by marking chicks as they hatch (banding or putting a small, biodegradable tag on one wing and banding them later). Then at regular intervals (twice weekly is adequate) weigh and measure the chicks - the length of the "hand-plus-primary-feathers." These measurements give a growth-rate,

which provides a high-grade measure of the quality of the local feeding grounds - or the parents' competence.

We need to have banded, known-aged adults for this study.

Censusing the Many Islands not Subject to Detailed Studies.

In any year in which we run a coastwise census, we must estimate numbers on all occupied islands to follow trends in the tern population, because the birds move around so much. As shown by models tested by biometrician William Bossert of Harvard, we can use data with as much as 30% "error" to identify population trends over several decades. We can gather data comparable in accuracy to nest counts by making careful estimates of the numbers of birds flying up over a nesting area.

Estimating the numbers of birds in the air over a nesting area is the most practical way of keeping track of numbers over a large portion of the coast. Observers should record the details of their methods.

Estimating the Number of Birds over a Ternery.

In mid June, (when most of the birds are incubating), observers should go into the nesting area as soon as they land, and put the birds up; almost all will fly up. Once they are up, set about estimating the numbers of birds flying carefully and quickly, counting by groups of "tens" or "fifties." It is important to avoid dallying, because those that go up soon begin to settle and drift away. Don't let someone distract you by calling your attention to some rare species.

You should estimate the numbers of birds loafing in flocks on the shore separately. These are non-breeders and failed breeders.

Observers should test themselves to establish whether their estimates of birds in the air are equal to the number of nests, higher or lower - and by how much. Observers can calibrate their estimates by comparing the percentage of the air estimates with the estimates of nests on the island. It is also helpful to spread differing numbers of grains of rice on a black piece of paper and "fix" the number (gestalt) in your mind's eye. Many people can learn this trade easily while others can't.

Experience, which is primarily paying attention, and practice will help to refine accuracy and consistency. Most important, consider what it is that you are trying to learn and what level of precision is necessary to learn that. The difference between 15 and 25 is important, but that between 75 and 95 is much less important, as is the difference between 650 and 675. That is one meaning of logarithmic function.

A quick way to measure breeding success requires two visits, one in mid-June to estimate birds over the nesting area (approximate number of nests), and one in late July to see whether the terns are still present and to count fledging chicks. Chicks gather at the shore soon after fledging. The number of terns over the island on the second visit reflect the number of pairs that have chicks, as failed birds leave.

These data allow you to estimate whether the breeding season was a disaster (no chicks), poor (maybe 10-20% success), or good. This is useful, because breeding attempts at most unsupervised islands in Maine have run from 0 to 20% success.

APPENDIX E. MANAGEMENT PROCEDURES

The following management activities are intended to improve conditions for successful breeding at the colonies chosen for intensive management.

1. Breaking eggs and shooting will not be effective in driving gulls from a nesting island once they have bred there for several years. Managers must poison adults and if gulls are to be poisoned, they should not be disturbed beforehand.

Remove nesting Herring and Great Black-backed Gulls from the island by poisoning. Success may require 2 poisonings per year for two years.

Support the poisoning program by shooting adults and breaking eggs in nests found after the poisoning to prevent resettling.

As many as 3 excursions per week may be needed during nesting season to shoot gulls and break eggs.

2. Remove any mammalian predators such as rats and feral cats. If mink repeatedly gain access to the island, the island may not be suitable for management.

3. Maintain a field party camping on the island wherever possible and post the nesting area to limit visitor access. No access for visitors with dogs even on a leash can be allowed during the nesting season, May 15 to August 15. Other visitors must be supervised and stay on marked access routes.

4. If the island has been overgrown by bushes (Bayberry, Cherries and Raspberry) or grass, it may be necessary to mow, burn repeatedly and apply herbicides to create openings. Chicks need some cover for shelter from sun and rain, but no shelter will provide protection from predation.

5. Use of decoys and recordings of calls has been successful in attracting terns to empty islands, but these are probably superfluous where a few terns have settled.

6. For the long term, it will be helpful to take political action to keep "second-home" housing development off existing or potential tern nesting islands. This involves seeing that all tern-nesting islands receive special consideration during the environmental reviews by state agencies such as the Department of Environmental Protection (DEP) and the Department of Inland Fisheries and Wildlife (DIFW). Citizens can insure that local municipal governments and planning boards are aware of the nesting sites of seabirds and waterfowl within their jurisdiction.

7. The most effective protection is provided by owning or obtaining conservation easements or management agreements for nesting islands.