



**guidelines for the protection
and management of
COLONIALY NESTING
WATERBIRDS**

PREPARED BY

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United States Department of the Interior

NATIONAL PARK SERVICE
WASHINGTON, D.C. 20240

IN REPLY REFER TO:

MAY 25 1976

Memorandum

To: All Regional Directors and Director, National Capital Parks

From: ^{Acting} Associate Director, Park System Management

Subject: Guidelines for the Protection and Management of Colonially Nesting Waterbirds
Reply Due: November 1, 1976

Enclosed are two copies of the subject guidelines. The guidelines have been prepared through the principal efforts of Dr. Paul Buckley of the North Atlantic Regional Office and provide information and techniques that can assist in the management and protection of several waterbird populations.

Request was made for such guidelines upon learning that numerous populations of waterbirds, primarily those along the eastern seaboard, were experiencing declining population success rates due to various reasons. The lack of success was not limited to areas of the System, but also other public and private lands.

The guidelines document reflects comments received from 20 persons who are authorities in the biology, management and protection of waterbirds in the eastern part of the country. Moreover, the document represents guidelines and not policy requirements. The document will not only be used by the National Park Service, but the U.S. Fish and Wildlife Service, state agencies and numerous other organizations as well.

The document has been intentionally laid out single-spaced with a blank opposite page, so that it can be used extensively--and heavily annotated throughout the field season.

We request that after use of the guidelines by your areas during the 1976 summer season, they forward their comments concerning the guidelines to Dr. Paul Buckley, North Atlantic Regional Office, National Park Service, 150 Causeway Street, Boston, Massachusetts 02114, by November 1, 1976, so revised guidelines for the 1977 breeding season can benefit from this year's use. Any specific questions or comments regarding the guidelines may also be addressed to Dr. Buckley at telephone number (617) 223-3778.



A copy of this memorandum and two copies of the guidelines have been forwarded to the park areas in your region on the enclosed list.

A handwritten signature in cursive script that reads "Philip C. Stewart". The signature is written in black ink and is positioned to the right of the "Enclosures" text.

Enclosures

APRIL 1976

GUIDELINES FOR PROTECTION AND MANAGEMENT OF

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PRELIMINARY GUIDELINES FOR THE PROTECTION AND MANAGEMENT
OF COLONIALY NESTING WATERBIRDS

BY

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I. *INTRODUCTION*

A. PREFACE

1. Background

Following the 1880's and 1890's, when terns, herons and other colonialy nesting waterbirds were almost exterminated species by species, the U. S. slowly but finally developed an awareness of the need for protecting these splendid animals as part of our national heritage. Thanks largely to the good offices of the National Audubon Society, the birds' protection was such that by the 1930's and 1940's they were reclaiming their former ranges along the Atlantic and Gulf coasts of the U. S. With the expansion of the National Wildlife Refuge and National Park systems --- especially of National Seashores and Lakeshores --- and passage of the Migratory Bird Treaty Act and similar laws, a kind of complacency set in. After all, weren't these species now all protected?

The first glimmerings of possible trouble came from Massachusetts, where it was noticed that Common Terns seemed to be declining despite increased protection. Pesticides were thought to be the culprit, but were soon largely ruled out. Then workers in other areas along the Atlantic Coast became aware that despite a thriving appearance, many colonies were in fact producing few flying young each year, and that traditional colony sites were being abandoned one after another. Other, more subtle, tendencies were soon uncovered: birds were concentrating in fewer and fewer, larger (and hence more vulnerable) colonies; colonies were shifting from beachfronts and other natural sites to man-made areas such as dredge spoil deposition islands, roof tops, and man-made and -maintained impoundments; and sometimes startling changes in habitat preferences for colony siting were taking place (e.g. using salt marshes instead of sandy beaches). In at least one species astounding changes in social structure and population increases were detected; similar changes are suspected in several others but remain to be documented.

In the early 1970's, these impacts of human activity on colonially nesting waterbirds were noticed by a number of workers on different species and by certain observant refuge managers and park superintendents. Consequently, we were asked by Secretary Reed to prepare guidelines for use by refuges and parks under his jurisdiction in protecting and managing these valuable and threatened resources.

In the initial stages of the preparation of the present document, we drew heavily on a report dealing with the same problem at Cape Cod National Seashore, prepared by its Chief Naturalist Richard Cunningham, whose contribution we enthusiastically acknowledge. However, most of the ideas expressed herein crystallized following a meeting we called in December 1975 at facilities graciously extended to us by Deborah Howard and the Massachusetts Audubon Society. We had drafted an outline for this document, and used it to elicit additional ideas, criticisms, and material on diverse species, areas and approaches. Represented at that meeting were Atlantic and Gulf Coasts and inland areas; Herring Gulls, Ring-billed Gulls, Laughing Gulls, Sooty, Common, Royal, and Least Terns, herons and ibises all had their proponents and experts.

Taking the comments on our original outline offered at that all-day and evening meeting, we have fashioned this document. It must be regarded as it is titled: preliminary. We hope that field personnel as well as additional students of the animals discussed will read it critically and make suggestions for deletions, additions, changes especially of illustrative material, terms for definition in a glossary, and additional appendices. There are many sections that need expansion, and we hope succeeding versions will have, for example, chapters dealing with the species-specific management problems and biological properties of the birds considered; and that an extensive selection of black and white photographs will augment our meager and yet prolix text.

2. Acknowledgements

A first draft of this document was read by a number of people. We especially acknowledge the extensive comments and extraordinarily helpful suggestions for improving the ideas and their expression received from Brian Harrington (Manomet Bird Observatory), Joanna Burger (Rutgers University), Michael Gochfeld (Rockefeller University), Bradford Blodget (University of Massachusetts), Michael Bartlett, Gaylord Inman, Alan Zellig, Ralph Andrews (US Fish and Wildlife Service), Kathleen C. Anderson (Manomet Bird Observatory), James Baird, Richard Forster, Deborah Howard, Ian Nisbet (Massachusetts Audubon Society), Jonnie Fisk (National Audubon Society), William Drury (College of the Atlantic), Richard Cunningham and William Robertson (US National Park Service).

While we must take the blame for errors of omission, commission, interpretation or just bad judgement, we must share any credits with all who have contributed ideas to the solution of these vital problems. In any event, what we have presented here must be regarded as highly tentative probings to be tested in the crucible of the field situation, and to be used. If ultimately it is not useful, we will all have wasted our time. Only our combined knowledge can obviate that unhappy eventuality.

B. SCOPE

1. Geographic: We treat colonially nesting waterbirds of the Atlantic and Gulf Coasts of the United States, and of those inland areas east of the Rocky Mountains.
2. Taxonomic: For a number of reasons we will not go into here, we have decided to exclude from specific consideration several species of "waterbirds" that occur, sometimes (loosely) colonially, in these geographic areas. These animals are adequately considered elsewhere (endangered species programs, waterfowl management plans, etc.), or are local and/or have species-specific problems, or are not colonial, or are in other ways simply beyond the original intent of this document.

EXCLUDED SPECIES

Leach's Petrel
 all other tubenoses
 all grebes
 all waterfowl
 Osprey
 cranes
 rails
 gallinules & coot
 Wilson's Plover
 Piping Plover
 Snowy Plover
 American Oystercatcher

Upland Sandpiper
 Willet
 American Avocet
 Black-necked Stilt
 Wilson's Phalarope
 all alcids
 all kingfishers
 Bank Swallow
 Sharp-tailed sparrow
 Seaside Sparrow
 Boat-tailed Grackle
 Great-tailed Grackle

INCLUDED SPECIES

Brown Pelican	Roseate Spoonbill
White Pelican	Great Black-backed Gull
Great Cormorant	Herring Gull
Double-crested Cormorant	California Gull
Olivaceous Cormorant	Ring-billed Gull
American Anhinga	Laughing Gull
Magnificent Frigatebird	Franklin's Gull
Great Blue (incl. "Great White") Heron	Little Gull
Green Heron	Gull-billed Tern
Louisiana Heron	Forster's Tern
Little Blue Heron	Common Tern
Black-crowned Night Heron	Roseate Tern
Yellow-crowned Night Heron	Arctic Tern
Cattle Egret	Least Tern
Reddish Egret	Sooty Tern
Great Egret	Royal Tern
Snowy Egret	Sandwich Tern
Glossy Ibis	Caspian Tern
White-faced Ibis	Black Tern
White Ibis	Brown Noddy
Scarlet Ibis	Black Noddy
Wood Stork	Black Skimmer

We do not have space to go into details of identification, ranges, the habits and habitat preferences of these birds. Many users of these guidelines will already be familiar with these species from personal experience, but for additional information please refer to Appendix 1. The standard field guides --- Peterson; Robbins et al. --- are essential starting points for identification and the *Bent Life Histories of North American Birds* (Dover Reprints) supply life history data.

C. NEED AND JUSTIFICATION FOR PROTECTION AND MANAGEMENT

Frequently, informed persons are hard put to answer the basic question "*Why should we be protecting these animals?*" Many of us consider that a rhetorical question. Unfortunately to many others it is not rhetorical, and unless answered convincingly, they will not support protection plans.

There are many reasons for protecting our colonial waterbirds. Some might seem more, others less, obvious, but all are important --- in different degrees to different people. The following enumeration is not intended to be all-inclusive or a ranking of importance.

1. Living Creatures. They are living, vulnerable creatures needing man's protection. The initial question might better be "Why *shouldn't* we be protecting them?"
2. Mandated by Law. Their protection is mandated by numerous Federal and state laws and treaties.
3. Protected on Public Lands. Where these animals live on public lands, a premium should be placed on the preservation of all life. Moreover, it is the stated mission of the Fish and Wildlife Service to protect and manage our natural resources; and of the National Park Service to protect and interpret our natural resources. Wildlife on public lands belong to all the people.
4. Esthetic Value. There is esthetic value in diversity of life, and the visibility and diversity of bird life in waterbird breeding colonies is high and impressive. Imagine a "silent summer" without gulls, terns or herons in our estuaries.
5. Rectify human disruption. Man has intruded into and disturbed so much of the native habitat of these birds that it is no longer available. We have an obligation to repair that damage insofar as we are able.
6. Restricted Populations. Many of these animals are either presently rare, endangered or threatened, or are showing the declines in productivity and recruitment usually preceding population crashes and extirpations.
7. Educational Value. They offer tremendous potential for natural history education, with ecology and biology themes readily accessible to millions of people; and they have inestimable value in ecological research, especially of their role in estuaries, only beginning to be understood.
8. Ecosystem Significance. They are an integral part of all the ecosystems in which they occur, and we have only the faintest glimmerings of what changes would be wrought in those ecosystems should these animals disappear. As one example, we can speculate on the condition of our beaches should there be no gulls to clean them.
9. Energy Interchange. Colonial waterbirds are probably responsible for some of the greatest interchanges of energy between the land and water biotas. The impact of serious disruption in this energy flow to the dynamics of estuarine biomass production has never been adequately investigated, but must be immense.

10. Promote Vegetation Growth. Waterbird colonies in many locations supply an enormous amount of fertilizer to beaches and coastal uplands, and the resulting vegetation often serves to stabilize sand dunes and other coastal soils against erosion and blowouts. Likewise, heronries nourish plant successional stages and in many places no doubt accelerate succession.
11. Early Indicators of Pollution. Being at the top of the food chain, these birds are especially vulnerable to pollution and to prey declines. They can be used as indicators or early warning detectors of both conditions, but in any event as top predators need special protection if they are to survive successfully in their man-changed environment.
12. Used by Fishermen. Terns and gulls especially are used by fishermen to locate schools of bait fish being preyed upon by larger sport and commercially valuable fishes.
13. Recreational Value. A significant number of people derive intense recreational value from observing, photographing, painting, and writing about colonial waterbirds, and a far larger portion of the populace enjoys experiencing the fruits of their photography, painting and writing.
14. Economic Value. Colonial waterbirds have distinct economic value when one examines visitor statistics (not presented here) for those National Wildlife Refuges and units of the National Park Service with significant numbers of colonial waterbirds, including the following:

NATIONAL WILDLIFE REFUGES

Anahuac
 Aransas
 Back Bay
 Bear River
 Bombay Hook
 Bosque del Apache
 Brigantine
 Cape Romain
 Chincoteague
 Crab Orchard
 Darling
 Havasu

NATIONAL PARK SERVICE UNITS

Acadia
 Apostle Islands
 Assateague Island
 Canaveral
 Cape Hatteras
 Cape Lookout
 Cape Cod
 Channel Islands
 Cumberland Island
 Everglades
 Fire Island
 Fort Jefferson (Dry Tortugas)

Horicon
 The Klamaths
 Laguna Atascosa
 Loxahatchee
 Malheur
 Merritt Island
 Monomoy
 Okefenokee
 Parker River
 Pea Island
 Sabine River
 St. Marks
 Salton Sea
 Tule Lake

Glacier Bay
 Jamaica Bay (Gateway)
 Golden Gate
 Gulf Islands
 Haleakala
 Hawaii Volcanoes
 Katmai
 Olympic
 Padre Island
 Point Reyes
 Sleeping Bear Dunes
 Virgin Islands
 Voyageurs
 Yellowstone

An estimation of the economic impact had by just one small portion of the nature-enjoying public --- birders --- may be gauged by the number of participants in the 1975 Christmas Bird Counts (28,000) and by the number of copies of Robbins et al.'s *Guide to Field Identification: Birds of North America* sold since its publication in 1966 (1.5 million), to pick just two indices at random.

D. NEED FOR BETTER INTERPRETATION OF COLONIAL WATERBIRD RESOURCES

It is widely felt that both the National Park Service and the Fish and Wildlife Service have a need to make better interpretive and educational use of their colonial waterbird resources than at present. While there are conspicuous exceptions, the visitor to most parks and refuges has been left on his own. This might suffice for those already interested in seeing or understanding animals, but these are not the people who need to be reached and educated.

Many of our problems of protection and management could be easily solved by the simple expedient of a carefully designed educational program, whether keyed to naturalist-led walks or to self-guided walk/drive tours. The former is more frequently encountered in the National Park Service, the latter more frequently in the Fish and Wildlife Service. Each agency has much to learn from the other, and both from outside groups. We suggest that in those units with an interpretive division, public education or interpretation be made an integral part of any management program for colonial waterbirds.

Other interpretive devices or techniques include: (1) signs, kiosks, dioramas and outdoor exhibits, especially explaining the animals' biology and need for protection, as well as any research projects underway; (2) lectures, both recorded and live, before visitors enter or approach areas with colonial waterbirds; (3) ex-

planatory leaflets and pamphlets (but the danger of littering is of great concern); (4) seasonal wardens, rangers, monitors --- especially effective when there are local inhabitants knowledgeable about, and protective of, the local area and its bird colonies; and (5) guided tours with signs, such as are in use at Brigantine National Wildlife Refuge.

E. CRITICAL BIOLOGICAL FEATURES OF COLONIALY NESTING WATERBIRDS: MANAGEMENT AND PROTECTION IMPLICATIONS

Appreciation of a number of critical features of the biology of these animals is essential if management and protection plans are to be adequate. It is our intention only to briefly outline some of the more important features here; for additional information see Bent's *Life Histories*.

1. Most colonialy nesting waterbirds are densely packed into only a few small areas while breeding, and thus whole populations are vulnerable to single disturbances.

This is quite unlike the condition we are more used to, where songbirds, being non-colonial, are widely dispersed in the breeding season, with concentrations occurring only during migration or winter.

Despite range maps showing widespread distributions for most of the species we are concerned with, actual breeding distributions are far more clustered. As an example, "Long Island N.Y." is always listed in the breeding range of Common Tern, and indeed the species is readily found along the oceanfront there. While we tallied in excess of 11,000 pairs nesting in June 1975, the critical management data were that (a) there were only four colonies with more than 1000 pairs; (b) the next largest had only 500 pairs; (c) of the four largest colonies, one was non-productive (on a salt marsh), another is threatened by sewer pipe construction, and the third sits between traffic lanes at Jones Beach State Park. It would thus not take much bad luck to eliminate Common Tern as a breeder on L.I. Other colonial nesters are even more localized, and thereby more vulnerable.

2. When they are clustered in colonies waterbirds must be censused over wide geographic areas, so that populations on individual Federally-administered areas can be placed in a regional perspective.

It is quite one thing to know that park a has one 2000-pair colony of species x out of an area population of 50,000 pairs in 25 colonies; it is quite another to know that park a 's 2000 pair colony is the *only* colony within, say, a 100-mile radius. And it is dif-

ferent again not to have any idea of how park *a* relates to its geographic region. In the first and second cases, different degrees of protection and kinds of management would be indicated; in the third, it would be difficult to arrive at a sensible plan for management. Thus extensive region-wide censusing is indicated in virtually all cases.

3. To offset large-colony vulnerability, every effort should be made to provide sufficient habitat for dispersal to as many additional small colonies as can be productive.

As we are largely unaware of the fine cues used by these birds in choosing one site over others, seemingly identical, we can only provide as much "suitable" habitat as we can (see Chapter IV, *HABITAT MANAGEMENT* Section, p 40). Each new satellite colony should be carefully protected until it is securely established. Today's satellite is tomorrow's seed colony.

4. Habitat suitability must be judged only by bird use

One must assume that if other locations were suitable, and the population not declining, those additional sites would be occupied by colonies. It should be noted here that many traditional colony sites are occupied year after year, even though the birds in them may be severely disturbed by people. While these colony sites might appear to be "marginal" or "less than adequate" or "suboptimal," the birds regard them the best they can find in those areas, so we must respond accordingly.

5. Changes in species' breeding habits and habitat preferences as a result of human disturbance might be occurring.

We have indications that habitat preference changes are taking place now in such species as Least Terns (resorting increasingly to flat rooftops), Herring Gulls and Common and Roseate Terns (nesting in open, unprotected marshes). Oystercatchers are nesting more and more in salt marshes instead of their usual sandy beaches where human disturbance is more severe. For most of these birds, we have reason to fear severely reduced productivity in their new colony habitats, although this condition might change with time as the species adapt. We do know that ditching of salt marshes on Long Island, N.Y. has resulted in astounding changes in the breeding biology of Seaside Sparrows, from colonial and non-territorial to solitary and territorial. Should similar behavioral changes occur in any colonial waterbirds, management practices would have to be reassessed. Habitat preference changes may in fact reveal failures of existing management techniques.

6. Habitat Requirements even for very closely related species may differ so much that no one habitat will provide optimum conditions for all species.

While details of habitat selection in mixed-species colonies have only just recently been examined, it seems clear that minor and sometimes exceeding subtle differences in vegetation, topography, etc., determine the presence or absence of individual species. Careful examination of each situation must be done before management is attempted.

7. Despite widely held contrary beliefs, many species will not renest if disturbed or if the colony is forced to move.

This can be disastrous, and locally fatal, particularly for species already stressed by other factors such as pollution, habitat or food reduction, or for species having small clutches, or short lifespans, or heavy winter or migration mortality. Many of the birds we are discussing fall into several of these categories, and a few into all. Once established, colonies should be given absolute protection until all adults and young have departed.

8. Colonies are most likely to desert during the courtship and nest-site selection stages, and least likely to desert when young are present.

This is a generality, and there are individual bird, species and even colony, differences. Likewise, there is an intermediate likelihood of desertion during the egg-incubation state. But degree of protection from disturbance can be tied to this general schedule with reasonable safety/accuracy.

9. The mere movement of a colony from one site to another following disturbance is no indication the move will be successful.

It is not uncommon for a disturbed colony to move and then experience total failure to produce any eggs or young after initial re-establishment. Failure can be from many causes, frequently different in each case, but one underlying explanation is the tremendous loss of energy involved in fruitless courtship, egg laying, incubation, etc. Most colonial waterbirds do not have two broods, probably because of a combination of energetic and time limitations.

10. Animals at the edges of their geographic ranges are under appreciably greater stresses than those towards the centers.

Exposed to different climatic extremes, novel food, strange habitats and sometimes different competitors, animals that are pioneering range expansions frequently have lowered breeding success than

normal for their species. Colonies appear and disappear with more than usual frequency. They thus need extra measures of protection until the new population is well-established. Usually, an expanding population is a healthy population, while a declining population is a sick population.

11. Regional seed colonies need greater protection than less important colonies.

In many areas some colonies always seem to be more important than others as the source of individuals establishing new colonies. These "seed" colonies need special protection and management, since regional productivity, expansion and recruitment are tied directly to them. They can be identified only after analysis of banding data from area colonies; fortunately colonial birds of the Atlantic and Gulf coasts have been banded so heavily that additional banding is not needed, but adequate analysis of existing data is. (While there are exceptions, new banding projects should be initiated only with the greatest of caution. Bird banding "expeditions" may be among the greatest causes of regular colony failure, especially among herons, ibises and terns.) As the relative importance of several seed colonies in an area probably shifts over the years, regular evaluation of their composition, productivity, dispersal patterns and health is clearly indicated.

12. Despite the advantages of dispersal into numerous small colonies, in many species there appears to be minimum number of colony individuals below which reproductive success of the colonies declines rapidly.

Several explanations for this phenomenon have been advanced, the three most important being that (a) colony members use each other as cues in locating patchy food sources such as fish schools; (b) the presence of a certain number of conspecifics is needed to provide the social stimulation required for successful courtship, pair formation and reproduction; (c) in larger colonies, the proportion of individuals exposed to predation on the colony's edge is less than in smaller colonies, so that average colony productivity is higher in larger colonies. These three are not mutually exclusive processes, but they serve to emphasize that colonial species generally do not survive except colonially, and that they need man's help to do that once he has disturbed natural processes.

13. Many colonial species also need extensive and reasonably near-by protected areas for feeding, resting, bathing and other non-breeding activities.

While these are obvious after having been pointed out, all too often the best of management plans fail to provide for them. An-

other critical space requirement is for areas where non-breeders, especially so-called "bachelors," can live and learn near the colony during the breeding season. These groups also frequently supply mates when one member of an established pair disappears.

F. OTHER SPECIES BENEFIT FROM COLONIAL WATERBIRDS' PROTECTION

Although most workers do not consider as colonial waterbirds many of the species listed as "Excluded" from this discussion (page 3) nonetheless many of them do breed in colonies with our subjects. Thus any protective measures undertaken for the latter will usually benefit the former. Initiation of protective measures for these associated birds might well follow successful protection of colonial nesters, or at least an increased awareness of their presence and habitat needs.

Valuable data on many of these excluded species can be taken at the same time surveys or censuses are made of colonial nesters, especially of the more conspicuous species. For example, during our survey-census of Long Island, N.Y. we were able to locate and count virtually all Piping Plovers, Willets and American Oystercatchers. The former species is seriously declining on L.I., and the latter two have only recently invaded the area as breeders, so these data are exceptionally useful. They were taken with little added effort during our work; other workers are encouraged to record similar information.

One other group of animals benefits from protection afforded breeding waterbirds: migrating shorebirds. Especially on heavily travelled beaches, resting habitat for these animals at high tide is extremely scarce and disturbance of sleeping flocks by passing beach vehicles is commonplace. On Cape Cod, when the birds sought out the tern nesting area enclosures, disturbance ceased. Now several of these areas are posted with "SHOREBIRD RESTING AREA" signs after the tern season and the protection is permanent --- a serendipitous spinoff from the original management intent.

II. ASSESSMENT OF COLONIAL WATERBIRD RESOURCES

A. INTRODUCTION AND CONCEPTS

The ultimate purpose of our activities in regard to colonial waterbirds is to protect their colonies and manage their habitat so they can exist safely with minimal human disturbance. In order to protect and manage for them (the subjects of succeeding sections), we first must locate all colonies, and then determine their composition -- the subjects of this section.

We have identified four different kinds of activities customarily resulting in data which meet the above goals.

Surveying is the process of locating active colonies;

Censusing records the species and numbers of colony inhabitants;

Monitoring oversees the colonies during the period of their occupancy;

Evaluating details the productivity and health of the colony.

Occasionally all these activities are done by the same persons in the same area in the course of a single season. But this would be an unusual situation, in that the different techniques and procedures mandate different kinds of skills and resources; frequently only one or two of these four processes occur in a given area each year. Thus we will treat them separately below.

If monetary or manpower resources are limited, we suggest the following order of priority: 1st, colony surveying followed by posting; 2nd, monitoring throughout the breeding season; 3rd, censusing; 4th, evaluation of colony health and productivity. At the very minimum, surveying and monitoring of each colony should be done in every area each year, but without some sort of protection and enforcement, mere monitoring often results only in careful recording of the demise of colonies.

B. GENERAL CONSIDERATIONS

1. Disturbance. All of these practices result in some disturbance to the nesting birds. If the animals are to be protected, some disturbance is inevitable. But it can be justified only on the grounds that thereby we are preventing even greater disturbance and are enhancing their reproductive success. We will stress methods we have found only minimally disturbing, but must caution that a method that does not disturb the animals at all in one area might cause colony abandonment in another area, or in another species or at

some critical stage in the nesting cycle. We have not yet prepared species-by-species enumerations of the effectiveness and dangers to each species of the various methods; that must await a later version of this document. Be ever alert to the damage done by protective measures. If in doubt, err on the side of caution.

2. Personnel. Much damage has been done in waterbird colonies by inexperienced and/or unsupervised personnel. Always attempt to obtain experienced or trained personnel for work with colonial birds, and place the strongest possible emphasis on their tight supervision and close control over all working with them. This does not necessarily mean that only professional biologists should supervise this work. Quite the contrary: very many amateur ornithologists or birders are extremely competent, experienced and careful. They form a pool of eager and often indefatigable, workers who will perform exhaustible tasks merely for the price of logistic support and the satisfaction of knowing they helped to preserve the birds they love. Contact local experts such as the *American Birds* regional editors (Appendix 2) for names and groups. Always try to use the same personnel year after year. Besides instilling additional personal loyalty and identification with the animals, efficiency of activities increases each succeeding year.

3. Scheduling. Monitoring should be done throughout the season in all areas, and evaluation only in selected colonies sporadically. But how often should surveying and censusing be done, and when during the year?

All areas should begin immediately to establish baseline survey data. There is still no agreement among experts on how infrequently an area can be surveyed without missing major colonies or detecting major population shifts; it probably varies with species and locations. If funds permit, annual surveying should be the goal, initiated perhaps by an all-out effort the first year, and with more selective follow-ups in subsequent years. Biennial surveying might be almost as good for many species, and triennial or quadrennial surveys would just span the normally shortest generation times for many species we are considering,* so they might represent maximum intervals for detecting generation differences.

When and how often to survey in a given year are less easy to answer. Important variables to consider are:

- a) latitudinal differences in breeding time in the same species;
- b) early and late breeding species at the same latitudes;
- c) differences in arrival time at the same colony within one species: experienced breeders generally arrive first, neophytes generally arrive last;

* Most gulls and terns do not usually breed until at least 3 years old.

- d) relative numbers of adults present at a colony vary with species, time of day, stage in the breeding cycle, etc.;
- e) avoid surveying during courtship or egg-laying when birds are most susceptible to desertion.

Ideally (after consultation with local experts and regional references) several surveys and censuses should be made to allow for all the above variables. That is rarely feasible, however, so one or perhaps two short periods when most species will be occupying their colonies should be chosen. *Once the proper time is chosen, all surveying or censusing in succeeding years should be done in that same time period allowing for annual weather variation.* If additional resources allow more work, add earlier or later surveys or censuses, but DO NOT ABANDON the original one. Consistency is essential for year-to-year comparisons.

4. Data Recording. While research biologists often use more sophisticated methods of recording data, surveyors and censusers are urged to stick with three proven methods: written notes (unqualifiedly the best); photo-augmentation whenever possible; and tape recordings. Tape recordings should never be used as a primary recording method, only for backup to written notes.

Censusing data should be recorded in the field only in one or two forms: number of nests with eggs or young, or number of adults present in the colony. (The second is normally twice the first.) Field notes must always clearly record at each colony whether data are for nests or adults. Stick to one system once chosen. While it is customary to present findings of censuses as number of pairs present or nesting, these data are always derived from nest or adult counts, and attempts at conversion to number of pairs should never be attempted in the field. If confusion between numbers of pairs or nests, and numbers of adults occurs, data could then be in error by 100%. This has occurred in some published reports.

5. Total Colony Population Size. *There is no one figure for the total number of breeding pairs in any colony.* Pairs, or members of pairs, are emigrating or immigrating (coming and going), dying, failing to lay, failing to hatch or fledge any young, etc. Birds might be paired early in the season but not later, or the reverse, etc. One can only strive to arrive at some approximation of the number of breeding pairs at some particular time -- hopefully at maximal colony occupancy --- and if at all possible, attach a plus and minus figure (error estimate) to it. But even that latter figure is itself often little more than a guess.

6. Value of carefully taken data. Aside from the immediate management use of carefully taken data, there are other important values.
- a) They allow quantified evaluation of various management techniques.
 - b) They provide new area managers with a handy guide to the resources to be managed.
 - c) They provide details for the zoogeographer and evolutionist concerned about the fine points of animal distribution.
 - d) They allow us to monitor our environment in yet another way and to detect contamination and degradation early.
 - e) They facilitate species-wide population estimates, lacking for most animals.
 - f) They allow calculation and analysis of historical population trends.
 - g) They are a necessary basis for decision making in land use, planning and resource management.

All data collected from surveys and censuses should be reported internally through each agency's normal reporting channels, as well as recorded in the field unit's records. They should also be reported to the appropriate Regional Editor of *American Birds*, the archival journal of distribution of North American species. Appendix 2 gives names and addresses of Regional Editors; the journal is published by the National Audubon Society, 950 Third Avenue, N.Y., N.Y. 10022. Copies of intra-agency reports are sufficient material for Regional Editors.

7. Staff Responsibility. Each field area should designate one person responsible for coordinating all matters dealing with colonial waterbirds, whether resource assessment, protection, enforcement, habitat management, interpretation, or reporting --- even though actual duties might be the responsibility of several field area divisions. Extra-agency personnel would then report to only one agency staffer. Designation of the "colonial waterbird officer" should be made known to personnel in sub-regional or regional offices, and to key outside persons for promulgation.

C. SURVEYING TECHNIQUES

1. Aerial surveying types. Where conditions and species permit, is fastest, most efficient, and allows widest

coverage in the shortest possible time, essential for one-shot, replicable work. Small (2-or-4 seat) helicopters are better than fixed-wing craft in most cases, because they are more maneuverable, have no stalling speed problems, and can come in close and slow (no FAA ceiling limitations). They cost far more to rent than fixed-wing craft, however, and generally (although not always) disturb birds much more. However, the disturbance is controlled and short-lived, and in that time very much useful data can be gotten if the birds tolerate the disturbance. Funds, species, and experience must dictate choice of method.

2. Limitations on aerial surveying. Aerial surveying is not simple, though. Some species are more easily seen from the air than others, some refuse to flush from cover, different cruising heights are better for different species. But on balance, aerial, and especially helicopter, surveying is clearly best.
3. Photo augmentation of aerial surveys. Aerial surveying should be supplemented by photos, but this is not always a satisfactory procedure. Motion, vibrations, distortion through windows, some species showing up better (Black Skimmers) than others (Glossy and White-faced Ibises), and difficulty in identifying some species are problems frequently encountered in aerial surveying backup photography.
4. Value of small helicopters. Small helicopters allow simultaneous surveying and censusing --- judiciously flushing the birds for counting and allowing landing near the colony for determinations unable to be made from the air. If done properly, no additional visits are necessary to groundtruth (=confirm) the aerial data, that all being done at once.
5. Use of personnel in aerial surveys. Helicopter and fixed wing surveys are best done by 3-4 persons, although they can be effectively done by one observer-pilot if experienced. One pilot, one right-side and one left-side observer, with possibly a fourth person as recorder (and one photographing), have proven to miss the least information, and have the added advantage of several different simultaneous assessments of numbers and species composition in difficult cases. One agreed-upon set of figures can then be obtained.
6. Cost-benefit ratios of various methods. If one excludes personnel and time costs, ground surveying --- whether by vehicle, boat, horseback or on foot --- is undoubtedly cheapest. But it frequently

misses whole colonies, does not usually investigate "unsuitable areas," takes terribly long, does not allow uniform coverage of large areas in short periods of time, and can cause severe disturbance. Nonetheless, ground surveying should be done if aerial is impossible. When non-aerial surveying methods are used, colonies can exist for a whole breeding season without being discovered.

7. Earth satellites. While their data are not yet available for general examination, earth-satellites are clearly the wave of the future. They provide non-disturbing, constant and periodic coverage at several wavelengths. Once public technology has reached the point where classified military technology is now, we should be able to routinely survey merely by accessing passing satellites.

D. CENSUSING TECHNIQUES

1. Helicopter vs. fixed-wing. Much the same as was said about fixed-wing and helicopter use for surveying applies to censusing, in this case tilting the balance even more strongly in favor of small helicopters, in those locations where they do not unduly disturb the birds. Advice and experience of local field personnel are essential before making a disturbance-level determination. As an example, we have routinely censused over 1000 linear miles of Long Island, N.Y. coastline in about 24 air-hours this way. (Helicopters, like fixed-wing, generally give one hour of free ground time for each hour of paid air-time. This is valuable, usable time.) Accurate censusing of mixed-species tern or white heron colonies, is, in our opinion, difficult at best in a fixed-wing craft, but much easier in small helicopters.

2. Photography. Photo backup is useful in colony surveying and sometimes essential in censusing. Again, one can obtain better photos at lower altitudes from a helicopter than from fixed-wing craft, and, after landing near the colony, one can photograph birds in the air against sky for later counting.

3. Ground-based methods. Ground- or water based censusing, like surveying, is feasible, cheap, and unlike surveying, covers all the colonies once located. But it is time consuming and generally disturbs the animals more over a lengthy period, so that short-term, comparable stage-in-cycle data are harder to get over the years. It also usually involves many more observers at different times in different areas than helicopter censusing, and each additional, isolated observer is another source of data error.

4. Identifying species and estimating numbers. Regardless of how they reach the colonies, observers censusing should have experience or training in arriving at reasonably precise and hopefully accurate figures, a skill that not all are equally capable of acquiring or perfecting. Even species identification can sometimes be a problem. Greatest attention should be paid to resolving these two problems, or much effort will be wasted.
5. Ground-truthing aerial data. Whenever incomplete aerial censusing is not accompanied, for whatever reason, by on-the-scene verification while on the ground, later trips will have to be made into the colonies for this "ground-truthing." Each such trip is not only additional disturbance, but almost inevitably occurs some time after the initial data are taken. Frequently, the ground data will then differ from the aerial data, even if taken by the same observers, since actual colony size fluctuates over the breeding season.
6. Recommended behavior while in colonies. Whenever observers must enter a colony on the ground, they should plan their activities before entering so as to be inside the shortest possible time. Groups should be small, and stick close together. Entry should be avoided, if at all possible, during the heat of the day, and when it is cold, windy or rainy (especially if all three). Wear subdued clothing, and move deliberately. Do not procrastinate. The longer you remain in a colony, the better are the chances that avian predators will be eating eggs or young while their owners are off their nests. Do not make frequent incursions into a colony. The more often you enter a colony, the more likely it is that mammalian predators will follow your trail into the colony that night.
7. Prohibited behavior. Do not touch or otherwise disturb eggs, nests, or young. Do not attempt to replace any eggs that have been rolled or been kicked out of nests,* or to return any young that seem to have strayed. Never chase young to count them. Just count from a distance, and leave.

E. MONITORING TECHNIQUES

1. Definition. Monitoring should consist mainly of keeping an eye on all colonies on a constant but possibly irregular basis to see that they have not moved or been disturbed and that all protective measures such as signs, fencing and the like are repaired and effective. Pathological predation (see pp. to) is also often detected first by monitors.
2. Personnel. It can and should be done by co-opted amateurs as

*Many such eggs will already be addled and will interfere with subsequent incubation.

well as by professionals such as rangers on routine air, boat, horse, beach vehicle patrol, etc. Many opportunities present themselves for taking advantage of available talent for monitoring purposes.

3. Use of maps. Potential monitors should all be given easy-to-read but inexpensive maps locating all colonies.
4. Repair of signs and fences. Some groups of monitors could see that signs and fences are kept in repair as part of their normal duties.
5. Use of volunteers. Monitoring lends itself exceptionally well to making use of the Volunteers in Parks and similar programs, whereby laymen are federalized, with no salary, and perform a valuable public service.

F. EVALUATING TECHNIQUES

1. Use of professional biologists. While providing the most important data of the whole assessment program, colony evaluation is the most difficult, extensive, and disturbing part of the process. It should only be attempted by professional biologists using a program carefully worked out in advance so impact is minimal. The plan should be approved by the area manager and appropriate technical staff in the agency.
2. Suitable locations. It must be done only under the most carefully controlled circumstances, preferably far removed from the general republic, and should be done in very few colonies at a time.
3. Use of non-biologists. Amateurs should be involved in evaluation *only* when under the closest professional supervision.
4. Use of bird banding. Such programs should *never routinely* include mass banding of adults or young. Special use permits, granted only under exceptional circumstances following professional evaluation of carefully drawn up research proposals, should be required for *any* banding activities in *any* waterbird colonies.
5. Field and research stations. Most evaluation studies require the support of a nearby field station or laboratory.
6. Research institution cooperation essential. When needed,

evaluation studies can frequently be best accomplished by establishing a cooperative working **arrangement** with an adjacent college, university, museum or similar institution. Frequently, all they require is logistic support or modest amounts of space in return for much useful data.

7. Assessment of damage by investigators. Evaluation studies should all have built into them some means for assessing the damage done to the colonies by the investigating team. This possibly major source of disturbance is only just beginning to be appreciated, and we need information so that damage can be minimized or eliminated.

8. Technical details of evaluation procedures. Details of techniques for evaluation of colony success and health are beyond the scope of this paper. If more information is required, contact the writers of this document.

G. CLUES TO COLONY EXISTENCE AND LOCATION

Locating colonies is not always easy, for they are not always obvious. Densely packed Royal Terns on a small spoil island and White Ibis nests clustered in mangroves are not likely to be missed if one is in the area, but scattered, sitting Least Terns, isolated Great Blue Heronries in the tallest treetops in densely wooded swamps, or Glossy Ibis colonies on the ground in thick *Phragmites* patches are all too easily passed by, unnoticed.

Obviously, finding suitable habitat is the first requisite, although what is "suitable" for many species is rapidly changing with human encroachment on traditional habitats. Do not become stereotyped in your thinking about what is likely habitat, or you will miss new colonies in new habitats. See Chapter IV, *HABITAT MANAGEMENT*, page 40). Several clues can be helpful in approximating colony locations, but the presence of nests and eggs is always the only verification of a breeding colony.

Previous colony sites, determined from the literature, local experts or oral tradition (not to be discounted), should always be investigated first. Even if unoccupied early in the season, they should be rechecked periodically. All surveys should begin by checking old colony sites.

Indicators of active colony sites include the following, with much variation depending on species.

1. Adults in breeding plumage persistently flying over, into, or

around one location in suitable habitat.

2. Persistent clustering of adults in one place above the high tide/high water mark, especially true of gulls, terns and skimmers.
3. Breeding-plumaged adults carrying food or nest material (twigs, sticks, shells, grass, etc.,) to one location.
4. Courtship behavior and displays, or copulations, in/on/over small areas.
5. Roosting at night in one particular area, especially by herons and ibises.
6. Adults dive-bombing persons or animals when they intrude on specific areas in suitable habitat.
7. Clusters of adults regularly spaced out from one another on the ground (terns, gulls, skimmers) or in trees and bushes (herons and ibises), especially other than at dusk.
8. Whitewashed and/or smelly areas with suggestions of nests, or with nest 'scoops' and many birds' footprints.
9. Clustered adults sitting on the ground or in trees and bushes, and allowing unusually close approach before flushing and then returning to the same spots.

III. PROTECTION AND MANAGEMENT OF COLONIAL WATERBIRDS

A. DISTURBANCES OF COLONIAL NESTERS

1. Kinds of disturbance

There are many different kinds of disturbance with differing impacts; therefore, different corrective measures are needed. We shall briefly enumerate the more serious ones. The list is not exhaustive, nor is any ranking of significance implied.

a) *aircraft*. Our experiences on Long Island, N.Y. indicate that colonial waterbirds there habituate rather readily to most aircraft, including helicopters of all sizes. Many other areas, such as Everglades National Park, have had quite the opposite experience with helicopters, but most observers would agree that fixed-wing craft operating normally do not appreciably bother most colonial nesters. This is not the case where civilian or military pilots buzz or harass colonies, or where seaplanes (= floatplanes, amphibious planes) approach island colonies too closely.

b) *sonic boom*. This has not been thoroughly investigated as a hazard to colonial birds, but we will describe one incident suggesting the enormity of its effect. In 1969, repeated sonic booms over the Dry Tortugas caused total breeding failure of the 80,000+ pair Sooty Tern colony's nesting attempt, apparently because embryonic membranes were vibrated loose. Sooty Terns are ground nesters. However, interspersed among the Sooties were 2000-3000 Brown Noddies nesting in low trees. That species exhibited virtually no deleterious effects of the shock waves.

c) *off-road vehicles*. Including various beach buggies, all-terrain vehicles, swamp buggies, snowmobiles, etc., they are greater problems in some areas than others. They impact birds in several ways: by running them over; by crushing nests, eggs and young; by bringing people and pets into remote colonies; by destroying habitat; by bringing litter injurious to birds (six-pack holders, etc.); by keeping birds off their nests, etc.

d) *pedestrians*. Included here are strollers, the curious, picnickers, fishermen, boaters, hunters, etc. They cause upset far more than just vehicles or boats; they often bring pets which may do incalculable harm; and, in general, present the most common disturbance problem encountered. Astonishingly, pedestrians will often be standing in the middle of a tern colony, with irate adults screaming, diving and defecating on them, blissfully unaware that they are disturbing nesting birds.

- a) *pets*. Dogs are the most frequent problems. Owners use wide open beaches for exercising dogs, which then run amuck through colonies. They upset a colony of terns more than any other cause, presumably owing to their fox-like shape. Feral dogs are an even worse problem in those areas unfortunate enough to have packs. A small but critical minority of visitors to parks and refuges sees them as convenient dumping grounds for all sorts of unwanted pets, dogs and cats doing the most harm. Feral animals should be eliminated in all cases.
- f) *bird banders*. We have alluded to damaging effects of "ring-and-throw" bird banders who descend on colonies of waterbirds each year for recreational purposes. We have seen the damage they do, often not evident until several hours, days or years after they leave, and often the banders themselves are unaware of it, however good their intentions.
- g) *nature photographers*. Always well-meaning, photographers can do as much damage as banders, and for the same reasons. They especially like to work in colonies when the sun is best for taking pictures --- during the heat of the day when young birds and eggs are most susceptible. We know of cases where vegetation and adjacent nests were removed for a better "scene."
- h) *scientists*. In the very attempt to study the birds in order to obtain information necessary for their survival and management, scientists can impact their subjects severely. Of late, there has been a small but growing awareness of the problem in the scientific community. The most dangerous practice is turning loose inexperienced or unsupervised, and usually well-meaning, students on colonies for a summer's work.
- i) *vandals*. There exists a high enough level of vandalism to make it a problem, but one dealt with only by the strictest law enforcement methods. We have seen vandals having egg fights with tern eggs, and know of a case where some boys set fire to the grass harboring a 1500-pair Common Ternery to "see what the birds would do." Sensibly, the terns left, and never returned.
- j) *egging*. In some of the more isolated coastal areas, and paradoxically in some of the densest metropolitan areas, egging is still practiced. To the isolated inhabitants, it is a source of food, a harvesting of nature's bounty; to the city dweller of several ethnic backgrounds, it is an 'old country' custom. Both groups need to be reeducated rather than policed.
- k) *poaching*. Like egging, poaching of adults and young is generally restricted to more isolated areas, and is less a

problem than with waterfowl. Nonetheless, it is a problem.

l) *mosquito control*. Spraying of various pesticides, and environmental modification practices such as digging of drainage ditches in salt marshes, impounding freshwater, etc., to control mosquitoes and other nuisance insects, doubtless result in occasional disruption or obliteration of waterbird colonies.

m) *dredging activities*. Disturbance from dredging activities takes several forms, ranging from destruction of habitat, to noise impact, to actual deposition of spoil atop a breeding colony. Impossible as this might seem, we have on several occasions seen dredging contractors pumping spoil slurry onto an active ternery, washing incubating adults off their nests. In another case, a hastily constructed slurry retaining dike next to a skimmer and tern colony collapsed, flooding out the entire colony. More subtle but just as devastating can be changing the appearance of a colony area by spoil deposition enough so that returning adults have difficulty recognizing the site, and thus move on to other, frequently suboptimal locations.

2. Effects of disturbance

Aside from the specific effects of the various kinds of disturbances just enumerated, there are many other, more general damaging results. Any of the foregoing activities can cause any or all of the following effects, and other impacts have already been discussed on pages

- a) Reduced fertility, fecundity or viability.
- b) Nest material is stolen by those individuals or species settling first following disturbance.
- c) "Agressive neglect" of egg and young leading to hatching failure or death.
- d) Eggs falling or being kicked out of the nest, eggs being broken or chicks becoming lost.
- e) Chick or egg mortality.
- f) Nest desertion.
- g) Colony abandonment.
- h) Some species or individuals may fail to relay or may move abruptly to new colonies.

- i) Severe changes in individual or social behavior.
- j) Species undergo extreme changes in habitat use and colony siting.
- k) Pathological predation appears, or normal predation increases abnormally.
- l) Populations **decline**.
- m) Species' ranges contract.

B. PROTECTIVE MEASURES AGAINST DISTURBANCE

The particular goal of this section, and the general goal of the document, is to enumerate the various devices and procedures that can be used effectively under various conditions to keep colonial waterbirds under Interior Dept. jurisdiction as free of human disruption as possible. These measures fall broadly into two categories, 1. interpretive or education, and 2. admonitory (or warning, threatening and restricting.) We cannot emphasize enough that while the bulk of the text that follows concerns the second category, much of the enforcement called for now could be discarded if the human users of these areas were educated to the needs and sensitivities of the animals. It would seem, though, that we are a long way from that happy day.

1. Interpretive/Educational

- a) *Lectures and tours.* Using the birds as subjects, these can be given effectively in several locations: (1) at entrances to areas with colonies; (2) in sight of, but not too near, colonies; (3) in remote locations where off-road vehicle users cluster; (4) on boardwalks or towers overlooking colonies.
- b) *Leaflets.* Depicting and explaining colonial birds, these have been successful in some locations. They can have maps in them locating colonies, but the dangers in that are obvious. The potential for litter must also be weighed before issuing literature.
- c) *Exhibits.* Various educational exhibits, dioramas, kiosks can be set up in numerous locations: (1) visitor centers; (2) at colony area entry points; (3) on boardwalks and towers; (4) in sight of, but not too near, colonies, especially along carefully marked-out vehicle tracks. Exhibits should be refurbished annually, and temporarily emplaced near carefully selected colonies. They can be both educational and admonitory, and pictures of the habitat and animals should be included. They

should be removed as soon as the colony is deserted for the year.

- d) *signs.* These can likewise be simultaneously educational and admonitory, and can be emplaced in the same sorts of places as exhibits. Frequently, a two-tiered signing system is effective: (1) informative signs placed at some distance from, and if appropriate, within sight of, the colony, and then (2) warning signs when one gets closer, which may be interspersed with fencing. (For details of sign construction and emplacement, see following section Restrictions on movement.)
- e) *off-road vehicle stickers.* Permits and paste-on stickers issued to ORV users could have information about colonial birds on them, as well as restrictions placed on ORV users relative to bird colonies. Acceptance and use of the permit and sticker would constitute acknowledgement of the rules. Under some conditions, vehicle AM radios could be tuned to park/refuge stations or rented tape cassettes could be used, giving an educational message about colonies.
- f) *press releases.* Several parks have issued press releases to publicize colonies for both educational and warning purposes. This procedure is somewhat risky in advertising colonies' locations, but on balance more is probably gained than lost by so doing (particularly where colonies are conspicuous and accessible anyway).
2. Restrictions on movement. (These are ideal conditions not always attainable.)
- a) *seasonal or areal closure to off-road vehicles.*
- (1) After determination of dates by local experts, close off entire areas to all ORVs, but soften impact by use of education exhibits. To maintain good faith, remove closure as soon as colony has been vacated.
 - (2) Attempt to reduce to the bare minimum all official ORV traffic.
 - (3) Restrict essential ORVs to carefully marked tracks during critical periods.
 - (4) Do not allow ORVs to stop or discharge passengers (except in emergencies) within 1000 feet of active, posted colonies if at all possible.
 - (5) Forbid foot traffic within 1000 feet of active, posted colonies.

- (6) Pets must remain under the physical control of ORV occupants or owners at all times, and must not be allowed out of the ORV within 1000 feet of colonies. This condition should be printed on all ORV permits. Violation subjects permittee to automatic permit revocation.
- (7) Trail bikes, snowmobiles, all-terrain vehicles and other self-propelled devices not easily restricted to clearly defined tracks should be totally banned from areas with active colonies in season. The temptation to stray from tracks is too great and effective enforcement is generally impossible.
- (8) To avoid ecological damage, forbid ORV driving on dunes, in marshes or along the beach above the high water line; exceptions to the latter should be made where no other course is possible, but vehicles must be then confined to clearly marked tracks.
- (9) Prohibit night use by visitors anywhere near the colony.

b) seasonal or areal closure to pedestrians.

- (1) Restrict foot travel within 1000 feet of active colonies.
- (2) Be certain all colonies are clearly marked off and posted.
- (3) Require written permission from area manager before a closed area can be visited on foot.
- (4) Enforce same strict pet regulations as for ORVs near colonies.
- (5) If foot travel must be allowed near colonies (e.g. on narrow beaches), keep all persons as far away as possible, and on one narrow path. Discourage group use.
- (6) De-post colonies as soon as birds depart them.
- (7) Prohibit night use of area by visitors.

c) signs and posting.

- (1) All colonies should be at least posted with some sort of admonitory signs. Better still are combined educational/admonitory signs.
- (2) Effective signs at Cape Cod National Seashore had stencilled silhouettes of birds (terns) feeding young; similar signs at Gulf Islands National Seashore were equally effective (see Appendix 3).

- (3) Sample wordings include:

THESE DECLINING BIRDS ARE HARMED BY ANY DISTURBANCE

PLEASE KEEP AWAY

and

TERN NESTING AREA

KEEP AWAY

- (4) Whenever possible, they were jointly signed by the National Park Service, the Massachusetts Audubon Society and the local town Board of Selectmen. Such multi-agency backing is enthusiastically recommended.
- (5) Wooden signs are too easily torn down for firewood or otherwise destroyed. Tempered Masonite with signs glued on works reasonably well, and is inexpensive, but we recommend investing in heavy plastic, or best of all, enamelled metal signs.
- (6) 12-inch by 8- or 10-inch signs proved a useful size.
- (7) 5- or 6-foot tall metal post or poles of whatever cheap, non-bendable kind available should be used.
- (8) If the area indicated, bilingual signs should be used.
- (9) If no fencing is used (see later section), place a perimeter of warning signs no closer than 50 meters or 150 feet from the colony's edge. They should be spaced about 50 feet apart.
- (10) Traditional colony sites, especially of species that are susceptible to disturbance during courtship and nest site-selection

(such as skimmers and many terns), should be posted with signs well before their arrival. Consult local experts for dates. Heronries can usually be left posted all year long, as they are generally in/on places where off-season multiple use is rare.

- (11) Beachfront, multiple-use area colonies should be deposted immediately after the birds vacate the colony.
- (12) Nuisance signs such as **DANGER: POISON IVY** or **DANGER: TICK BREEDING AREA** or **DANGER: RATTLESNAKES (COTTONMOUTHS, ETC.)** are effective self-policing devices when placed in/on/near colonies where the described situation exists.
- (13) As a general rule, if a colony has been active in the last five years, post it annually for another five. But if in any year the birds fail to return within four weeks* of their normal time, depost the colony immediately.

d) *symbolic fencing.*

- (1) When protection beyond admonitory signing is needed, the next level we recommend is "symbolic" twine fencing. The psychological effect is virtually the same as genuine fencing, and this is cheap, easy to take down and convenient to store.
- (2) It is generally not needed in dense vegetation or on islands, where signing plus natural vegetation or the perimeter of the island may do as well.
- (3) We do not recommend using any kinds of wire for many reasons, notably safety; or using light weight cords such as kite string as they break or disintegrate too easily, and entangle birds readily.
- (4) Experience at Cape Cod strongly suggests using "Mason's Twine," readily available in hardware stores and costing only about \$40/mile. It can easily be rewound onto old chain reels for storage.
- (5) The string is tied about 4 feet high onto 2 inch square wooden, 5-6-foot long fence posts buried about two feet deep. Hard substrates would require different anchoring. Posts are about 50 feet apart.

*Variation in the length of this buffering period occurs in many areas and with many wading birds. Regard it as an average value only, and consult local experts for a more precise figure in each case.

- (6) To the string are attached strips of fluorescent or dayglow "surveyor's tape" every 10 feet for visibility, with about 12 inches left hanging downward. Pedestrians and vehicle operators can thus see the barrier at some distance.
- (7) The twine must be retightened every 7-10 days (especially in the first 2-3 weeks until all slack is taken out of it) or it sags to the ground, thereby rendered ineffective at preventing trespass, but frequently snagging flying birds.
- (8) The twine fence should, whenever possible, be placed about 50 meters or 150 feet from the actual edge of the colony as a buffer against disturbance.
- (9) Erection of the fence while birds are in the colony exacts a toll in disturbance. However, that one controlled disturbance is a price well paid for the prevention of many later, uncontrolled disturbances.
- (10) The buffer zone distance is not hard and fast, and common sense will occasionally indicate departure from it. The fence at Cape Cod sometimes had to be placed up to the very edge of the colony, with no buffer zone, so that at high tide permitted vehicles were able to traverse the beach safely.
- (11) As soon as the colony is vacated, remove the fence and signs for storage. Symbolic fencing especially would lose its effect if maintained longer than needed.

e) driftwood fencing.

- (1) Highly effective on beaches with concentration of driftwood.
- (2) Use to deflect or direct pedestrian or vehicular traffic.
- (3) Chaining together timbers for a more impervious barricade also works well.
- (4) Experiment with the use of other, on-hand natural materials.

f) snow fencing.

- (1) When a real physical barrier must be used, ordinary slatted-wood snow fencing is recommended for many reasons. It is most effective when it is free to wobble when pushed.
- (2) It ~~too~~ should have a buffer zone, especially so because wandering young birds need much room. With a symbolic fence they have it, but some birds cannot fit through snow fencing. If

there is no cover inside, they may die.

- (3) Wooden snow fencing is remarkably effective at collecting drifting sand, so be sure to remove it for winter storage at season's end.
- (4) New plastic forms of snow fencing are also good at collecting drifting sand, but do not keep out unwanted animals, including man, who hops it with ease.

g) *battery-operated electric fencing.*

- (1) Suggested only for extreme cases where pathological predation threatens a colony.
- (2) Is apparently only effective against certain quadrupeds (foxes, raccoons, weasels, opossums, dogs, cats, and perhaps goats and pigs).
- (3) Be certain to adequately warn people of electric shock hazard.
- (4) We have no experience with it yet, but details of its use are found in a paper by J.A. Forster in *Biological Conservation*, 7: 85 (1975).

h) *boat landings. (see also section on Dredge spoil islands pp. 41-42)*

- (1) If colonies are on islands accessible only by boat, post them closed to all persons for the proper period, except by special permit.
- (2) Whenever possible, place signs out in the water 50 meters or 150 feet from the shore of the island. Ideally, boats should be kept at least 500 feet from occupied islands.
- (3) As soon as the birds depart the island, deposit it.
- (4) During the breeding season, all pets are forbidden on islands with colonies.
- (5) Generally the same rules apply as for mainland colonies.

i) *aircraft.*

- (1) Rules for aircraft operation, including helicopters, should be established for all parks and refuges.
- (2) All colonies should be placed off-limits, with ceilings established for all aircraft.

- (3) If disturbance by aircraft is regular and unavoidable, such as near airports, do not be concerned. The birds will habituate to them quickly or leave.
- (4) Cooperative agreements with adjacent military bases may be imperative to prevent sonic booms, repeated low overflights, or buzzing of colonies.

j) pets.

- (1) Establish and use leash laws to keep all pets away from colonies.
- (2) Extra enforcement of leash laws within one-half mile of a colony, such as was done at Sleeping Bear Dunes National Lakeshore, will solve many pet problems.
- (3) Repeat offenders should be warned their animals will be removed and destroyed; the threat should not be a hollow one.
- (4) Pet owners dumping unwanted pets should be fined heavily.
- (5) Pets in ORVs and on boats are especially vexing and difficult to control. Additional attention should be paid to advising their operators of the laws.

k) bird banders and photographers.

- (1) Should be allowed in colonies only by special use permit, with the number, duration and other details of visits carefully controlled.
- (2) All banding projects should be supported by a full proposal and justification, and should be approved by area managers and region/subregional offices.
- (3) Recreational banding (not being done for specific scientific or management purposes) should be flatly forbidden in all cases.
- (4) Limits should probably be placed on the total daily time both banders and photographers can spend in a given colony, and enforced strictly. Consult experts on the species involved for details.

l) scientists.

- (1) All scientific study in colonies should be by special-use permit only, following approval of a technical proposal by area managers and regional/subregional office staff. This can be short, but must be precise.

- (2) All support personnel must be supervised carefully, especially if inexperienced.
- (3) Additional permits should be required if banding is to be done.
- (4) Students should be supervised by established, proven-to-be responsible scientists.

m) mosquito control activities.

- (1) All must be by special-use permit.
- (2) Guarantee must be obtained in writing that no work will be done near colonies, which will be marked on maps given control personnel.

n) dredging activities. Most of the adverse effects of dredging can be obviated by two procedures: (1) require all dredging activity proposals to indicate their awareness of the existence of known waterbird colonies; (2) forbid dredging or spoiling activities within appropriate dates in the vicinities of colonies; (3) inasmuch as dredging permits must be obtained from the U.S. Army Corps of Engineers, that agency should receive regular notification, probably at least twice a year -- at the beginning and end of local breeding seasons -- of the location, composition and health of all known waterbird colonies in the local Corps' administrative area; (4) monitoring of dredging contractors' work by the appropriate agency is also essential.

o) boardwalks and towers.

- (1) Can effectively control visitors while allowing them view of the colonies.
- (2) Should not be placed closer than 250 feet from active colonies.

p) use of vegetation and natural features.

- (1) Naturally occurring noxious or visitor-limiting plants such as poison ivy, catbriars, etc. can be encouraged to protect colonies.
- (2) Judicious plantings of prickly pear cactus, roses, etc. can be used the same way.
- (3) Ditches can be dug, or natural channels deepened, to prevent colony access.

q) *designation as special protection areas.*

Significant measures of protection of areas harboring active colonies of waterbirds can be achieved by various designations, where appropriate:

- (1) Research Natural Areas
- (2) National Natural Landmarks
- (3) National Environmental Study Areas
- (4) National Environmental Education Landmarks
- (5) Wilderness Areas, etc.

r) *enforcement.*

When all is said and the foregoing done, real last-ditch protection of colonies will be achieved only by regular patrols and apprehension of flagrant offenders. The public must be convinced that while we prefer to talk softly, we will if necessary fall back on law enforcement to emphasize our determination to protect these resources.

3. Techniques definitely NOT recommended

It is with some misgivings that we call attention to a few procedures sometimes used to protect colonial birds, but which we do not recommend. While well-intended, they usually are detrimental to the animals they are supposed to benefit. Avoid them under all conditions.

- a) Never move nests or eggs that appear to be "exposed" or "vulnerable." You are interfering with vital natural processes.
- b) Never attempt to mark eggs, especially in nests made on the edge of a colony. This only alerts visually-attentive predators to their location.
- c) Never **replace** "stray" eggs in any nests, or add eggs to nests. Many species recognize either their own eggs or nests, and will have nothing to do with strangers.
- d) Never handle young birds, especially to place them back in nests. In many species they must "wander" if they are to survive searing heat, predators, high tides, etc. Besides, parents will feed only their own young, which they recognize. And predators will follow you back to the nest and devour its contents.

- e) Never attempt to "keep a colony clean," or to alter, in any way, physical details of its setting. Adults locate their own nests using such cues as positions of trees, shrubs, branches, shells, bits of debris, etc.

C. PREDATION

Predation is a natural process and only in the following clearly defined circumstances should it be interfered with. Predation problems with colonial waterbirds are of two quite different kinds: those involving introduced or otherwise non-native predators, and those involving native predators.

Regardless of the class of predator involved, there are certain signs indicating their presence and impact. While it is generally not necessary to systematically look for signs of predation --- this in itself would adversely affect most colonies --- signs of excessive or pathological predation if noted mandate calling in a trained wildlife management biologist for verification.

1. Typical indications of pathological predation include, but are not limited to:
 - a) large numbers of punctured eggs;
 - b) large numbers of broken eggs with yolk inside (unhatched eggs);
 - c) overturned or destroyed nests;
 - d) large numbers of eggs on the ground (tree-nesting species);
 - e) partially eaten dismembered adults or young.
 - f) large numbers of dead chicks.
 - g) large numbers of displaced or missing eggs.
 - h) sudden appearance of empty nests previously containing eggs.
2. Non-native predators (rats, cats, dogs, starlings, mongooses, llamas, rocs, etc.)
 - a) All should be ruthlessly removed whenever conditions, local practices and legal restraints allow.
 - b) Every effort should be made to avoid using chemical control methods.

- c) Control of Norway and Black Rats is best done by contracting with a local, known-to-be responsible, licensed exterminator after the problem has been confirmed by a competent wildlife biologist.
- d) In areas where rats have been positively identified, control can be facilitated by seeking out burrows and using acceptable control methods (poisoning, trapping) just prior to the usual arrival time of nesting birds.
- e) Feral domestic mammals should be eradicated by whatever means seem reasonable. Keep in mind you might be dealing with someone's pet. One feral dog or cat can obliterate an entire island's ground nesting colonial birds in a short **time, especially** if the animal is having trouble obtaining food. They are also potential reservoirs for rabies and other dangerous diseases.

3. Native predators. A moderate amount of predation is natural and usual in most colonies. Such culling is beneficial in maintaining vitality of prey species and natural ecosystem balances. Sometimes, **however**, predation **even** by natural predators becomes excessive or pathological. Under these conditions, some control of natural predators is indicated. But their control should be undertaken only when:

- a) A major colony is threatened, and
- b) **a competent** wildlife biologist has determined the predation to be excessive or otherwise pathological, and
- c) the predator has been clearly identified to species and preferably to individual(s). Predator species often have individual specialists who work over a given area or prey population to the exclusion of all others.
- d) Control methods are subject to the limitations and recommendations as in #1, above. Control program details should be worked out by the wildlife biologist in cooperation with the area manager, but generally approved by regional or subregional office staff.

D. ADDITIONAL SPECIAL CONSIDERATIONS

- 1. Rare and endangered species. Official Federal, state or other "Rare and Endangered" species lists, (including "threatened," "marginally rare", endemic, etc.) should be procured, and regularly updated, for all management areas, and any species on those lists occurring in the management unit should be espe-

cially protected. Perhaps even more importantly, as preventive medicine, managers should examine *American Birds'* "Blue List" of species that active field ornithologists feel merit particular attention or protection because of incipient declines. This list is now recognized as our best early warning device, and area managers can help keep it up to date by providing their respective Regional Editors (see Appendix 2) with data on all species listed.

2. Cooperative Agreements. All area managers are urged to identify lands adjacent to their own, or even within their boundaries but administered externally, where colonial waterbird colonies occur, especially where the birds feed in or otherwise rely on the Federal lands for sustenance. Cooperative agreements for the protection and management of these extra-Federal lands should then be worked out whenever possible. We can offer technical assistance, signing, etc. and all benefit by the animals' protection.
3. Use of volunteers. Cape Cod National Seashore has pioneered the use of summer seasonal positions and funds in support of Tern Wardens whose sole functions are to monitor and protect tern colonies. Other parks and refuges are urged to extend and use this concept. The Volunteers in Parks (VIPs) program of the National Park Service is a natural vehicle as are various environmental intern programs such as those of the Massachusetts Audubon Society, numerous colleges and universities, the New Jersey Audubon Society, etc. Public work-study programs can also be adapted for this use.
4. Timing disturbance of colonies. If for some pressing management reasons a colony must be disturbed, it is better to do so at the end of the breeding season than towards the beginning, as late nesters are almost invariably less successful than those breeding earlier with the majority of the colony.
5. Which colonies can be disturbed. Likewise, despite what was said earlier about the benefits of dispersed colonies, should a colony have to be disturbed and there is any choice possible, always pick the smallest and/or the newest colony. These are also generally least successful or productive.
6. Interpretive use of disturbed colonies. Make interpretive use of colonies that persist in vulnerable locations. These can, with caution and sound professional advice, frequently be used successfully for demonstration purposes. They can show how disturbance affects the birds,

what the animals' biology is, and the colony's inhabitants can become photographers' subjects under certain conditions. On rare occasions, birds in such colonies in proximity to man habituate to intrusion if all persons are kept at reasonable distances and on the same, confined paths or tracks. Sometimes these colonies are even more productive than others less exposed, but this is unusual and it cannot be counted on as an effective management tool.

7. Changes in an occupied colony. If for any reason a colony shows sudden declines in size, extent, numbers of adults present, amount of attacks on people, productivity, clutch size, or any other departure from normal, notify a competent agency biologist immediately. Problems in the early stages can be countered far more easily than when the colony is already collapsing or deserting.

IV. HABITAT MANAGEMENT

A. INTRODUCTION

Most of the preceding discussion was concerned with protection and preservation of colonial waterbirds as animals. But equally important are their habitat requirements. A healthy animal population will not long remain in any area if it cannot find adequate habitat. As human encroachment increases, especially in coastal areas, colonial waterbird habitat is disappearing. The birds are then increasingly forced to turn either to artificially created habitat, or are finding that the only suitable breeding areas are inside National Parks or Wildlife Refuges. These units are now more than ever facing the problem of having to manage expressly to maintain the particular stages in plant succession required by each of the species we are considering as the birds are rarely on areas still controlled by natural ecological processes.

Several questions are sometimes asked about the long-range implications of the kinds of habitat management we discuss here. Some of the more important ones include:

- Can or should we attempt to restore species formerly but no longer present in an area?
- Can or should we attempt to increase the numbers of those species present now?
- Can or should we attempt to preserve and manage areas formerly used as colony sites in the hope that they might be so used again in the future?

To each of these questions, we give a firm and unequivocal "yes" in reply.

But to the question, Should we attempt to introduce species not native to the area?, we give an equally resounding "no."

B. HABITAT TYPES

1. Beaches. Except for the extensive marshes now filled in or or dredged out, impact on beaches has perhaps been the most extensive of any of the habitats we are discussing. They have been obliterated for city development, modified almost beyond

recognition by erosion- or flood-control and navigation structures, and overused for recreation by man and vehicle.

Recommended management practices for placing beaches back into service as available habitat for colonially nesting birds include:

- a) Allow no new structures (houses, roads, jetties, groins, boardwalks, etc.) to be built, and raze existing ones;
- b) Build no dunes and allow existing ones to breach move or rebuild naturally;
- c) plant no vegetation whatever;
- d) encourage removal of detrimental exotic vegetation;
- e) eliminate all off-road vehicular traffic;
- f) prohibit uncontrolled pedestrian or vehicular traffic in, on, or across berms, dunes, mudflats, and marshes;
- g) attempt to restrict all essential vehicular traffic and pedestrian traffic to the beachfront intertidal zone;
- h) prevent all development.

2. Dredge spoil islands. As navigation channels through waterways and estuaries are constructed and maintained, we are faced with the problem of dredged material disposal. Practice has been to deposit this spoil, as it is called, in shallow waters adjacent to the dredging thereby forming naturally sloping islands or "lumps." Placed as they are along waterways or at inlets, they are usually relatively isolated from most quadruped and biped predators. If the islands are left free from additional dumping once created, the various natural plant successional stages form ideal habitat for a variety of colonially nesting waterbirds. In many areas, the only such habitat is now on spoil islands.

A growing literature in recent years has recognized the wildlife value of spoil islands, and detailed management recommendations are reserved to them. For our purposes, general management practices should include the following:

- a) Identify and map all area spoil islands to age, date of last spoil deposition, vegetational stage, and use-history by colonial waterbirds;

- b) keep all vehicles off them and boats away from them;
- e) generally encourage only natural vegetation to establish itself and at natural rates;
- d) never plant grasses on new spoil;
- e) manage for desired successional stages by burning, mechanical means, and dumping of fresh spoil following careful site-specific studies;
- f) keep all islands free of large mammals, especially feral carnivores;
- g) regulate off-season use to avoid vegetational damage;
- h) by means of cooperative agreements with the U. S. Army Corps of Engineers and other dredging agencies, clearly delimit dates within which all dumping of spoil is prohibited on islands with active colonies and make certain all agree on the identity of the islands;
- i) use necessary spoil deposition as an active management tool;
- j) make certain only clean spoil of the proper size sediments is used;
- k) carefully monitor all dredging contractors;
- l) vigorously resist the use of diked impoundments for creation of new spoil islands. While there are undeniable short-term detrimental impacts to bottom flora and fauna with natural-slope dumping, the long-term benefits to the bottom (e.g., creation of new substrate; burial of pollutant-covered bottom) and to birds using natural slope islands greatly outweigh the veritable deserts remaining uninhabitable for years that diked spoil islands become. A side benefit in coastal areas is the creation of highly productive *Spartina* marshes when the natural-slope method is used. This also is habitat needed by colonial waterbirds. To avoid low spoil islands' washing away and becoming shoals, they must be built to sufficient height;
- m) regard all spoil islands as potential colony sites and manage accordingly, dumping only as often as needed on the same island.

3. Impoundments, lakes, and swamps. While the latter are usually created and/or maintained naturally and the former artificially, they all provide important habitat for colonially nesting waterbirds. In most inland areas,

they provide the only such habitat. And while impoundment creation is no longer as fashionable as it once was, incoastal areas where saltwater is common but freshwater rare, and inland where large freshwater bodies or even any permanent freshwater at all is rare or absent, colonial species are utterly dependent on impoundments. In areas where naturally occurring freshwater lakes or swamps prevail, they too frequently require active management. Details are to be found in standard wildlife management guidebooks, especially the 3rd edition of *Wildlife Management Techniques*, so we will limit ourselves here to general recommendations.

- a) maintain water levels to provide proper depths for foraging and for preservation of important prey species of fishes and invertebrates;
- b) control growth of aquatics and emergents by water level manipulation;
- c) prevent runaway plant succession resulting in vast, impounded freshwater swamps barely useful to colonial species;
- d) create sandy, flat islands in strategic locations in the impoundments or lakes;
- e) keep water from getting so high that it kills important tree or other plant species or covers islands;
- f) do not plant vegetation on islands;
- g) eradicate aggressive monocultures of species such as *Phragmites communis* unless known to be used by colonial waterbirds;
- h) control pH, salinity, aquatic and emergent plants to maximize their value to colonial birds and their prey species;
- i) be certain all water-control devices (gates, valves, sluices, etc.) are in prime operating condition at all times;
- j) plan to maximize the use of these bodies of water by differential seasonal regulation of water levels for migrating shorebirds and waterfowl;
- k) prepare site-specific water resource management plans to establish the relationship between water levels and the abundance and distribution of colonial waterbirds as has already been done at Everglades National Park for Wood Stork and White Ibis;

- l) establish cooperative agreements with all water controlling and regulating agencies to assure adequate quantities and qualities;
- m) be aware of seasonal water level changes affecting success of colonial waterbirds, e.g., the seasonal droughts in Laguna Madre, rising waters in filling reservoirs, seiches in the Great Lakes and Carolina Sounds, coastal storm and spring high tides, agricultural drawdown, etc.; these can have such opposite effects as obliterating habitat at colony establishment or use time, or suddenly providing dry-land bridges from the mainland for predators, etc.
4. Streams and rivers. Streams and rivers, except at the latter's mouths in estuaries, are generally not thought of as providing critical habitat for colonial waterbirds. But when one includes the islands, bars, shoals, and embankments in streams and the swamps, bayous, "bays," and oxbows created during the formation of streams and rivers, they assume greater importance. Some species, such as the interior populations of Least Tern, have all but disappeared as their stream habitat has been manipulated. Recommended management practices are not many and overlap greatly those in No. 3 above. Additional practices include:
- a) Avoid all channelization, dredging, and damming whenever possible;
- b) protect floodplains and their native vegetation;
- c) monitor closely for pesticide and other chemical contamination;
- d) protect headwaters and all flow sources.
5. Tidal salt marshes. The biological and recently economic values of salt marshes are well recognized as is, unfortunately, the rate at which they are disappearing with development of coastal areas. Much has been written about their protection and management. What follow are from many sources including our own work in various locations:
- a) prohibit all marsh destruction or degradation;
- b) prohibit all maintenance of existing mosquito control ditches;
- c) do not close or fill in existing ditches but allow their natural closure. Closure activities are probably more disturbing than natural closure;
- d) prohibit new ditch construction in all cases;

- e) forbid use of all pesticides and herbicides;
- f) remove large pieces of debris to facilitate natural pool and panne development;
- g) avoid activities that will change subsurface fresh-/salt-water interface;
- h) especially protect "islands" and "hummocks" of vegetation wherein herons and ibises nest;
- i) consider burning or harvesting as tools to maintain desired successional stages if they were historically used;
- j) control the spread of *Phragmites* and other aggressive monocultures;
- k) remove all cattle grazing whenever possible;
- l) control pollution sources, especially of leachates, into high marshes;
- m) experiment with new marsh establishment by planting *Spartina*, *Juncus*, etc., but only in areas where marshes existed historically unless special circumstances dictate otherwise.

6. Treed areas. While it might seem that undue attention has been paid in this document to ground nesters at the expense of tree nesters, we do not feel this is the case. Except for some ground-specific recommendations, much of what we have advocated applies equally to tree-nesters. Nonetheless, there are some habitat management practices for that group deserving emphasis.

- a) Prohibit cutting of dead trees otherwise suitable for nesting use, especially dead trees in an existing colony;
- b) only under carefully controlled conditions, should one consider multiple land-use practices near/under existing colonies; e.g., at one inland location, a Great Blue Heronry is in forest that is being harvested;
- c) allow an exceptionally wide buffer zone around the base of tall-tree colonies, as the greater visibility from those heights renders them disturbable at greater distances;
- d) encourage preservation of the dense natural growth usually occurring under tree colonies, as it forms a good protective barrier;

- e) be especially alert to the detection and extinguishing of fires in tree colonies, whenever that is possible;
- f) by noting which tree species seem to be preferred by various birds, attempt to plant/manage for those trees;
- g) monitor tree health in colonies, obtaining horticultural help when indicated, as many tree nesters do not have sufficient habitat available to allow colony movement if trees become inadequate;
- h) some tree-nesting species are more sensitive to aircraft disturbances than others (cormorants kick eggs from nests when startled), so notify appropriate aviation authorities of danger zones.

C. HABITAT MANAGEMENT TECHNIQUES

1. Mechanical methods. Many mechanical techniques have already been recommended or decried. Additional ones such as mowing, disking, harrowing, trimming, grafting, fertilization (under carefully controlled conditions where it is not expressly contraindicated) are examples of useful and acceptable management devices. Three examples of drastic or extraordinary habitat manipulation by mechanical means follow; there are others.
 - a) Draining of impoundments or lakes where succession or eutrophication have gotten out of hand, then bulldozing the bottom free of unwanted vegetation or fecal accumulations;
 - b) razing barrier-beach shrublands, reducing them to their former natural condition--bare sand flats--and then allowing natural processes to start again;
 - c) disking and subsequent regular mowing to produce perpetual grasslands in areas now overgrown with shrubs or small trees.
2. Herbicides for vegetation management. There is general feeling that use of chemicals for vegetation management should be discouraged, if not altogether forbidden. There are many other methods that work just as well; are more species-specific or can be made so; do not present the twin hazards of unknown but likely detrimental effects on wildlife, and long term persistence; and can be counteracted more effectively if desired. Certainly the appropriateness of herbicide use of refuges and in parks is itself open to argument. Even with such stubborn plants as *Phragmites*, poison ivy and other nuisance plants, herbicides should be avoided if at all possible. Try instead putting the very presence of these plants to management use.

3. Fire. Fire has been so far infrequently used as a management toll for the creation, modification or maintenance of colonial waterbird habitat in our area of coverage, largely because its natural occurrence and significance have been investigated in very few eastern or midwestern locations. It should certainly not be dismissed out of hand as a management tool, but careful site-specific ecological and historical investigations should precede its use anywhere.
4. Cattle. Free-ranging cattle are known to have had profound ecological effects on the habitat used by colonial waterbirds, notable examples being at Padre Island National Seashore and at Cape Lookout National Seashore. Their continued presence in numbers in areas frequented by colonial nesters merits the closest of scrutiny, followed by carefully drawn management plans calling for either their elimination ~~or their use in controlling~~ vegetation and succession. Cattle should certainly be excluded from the vicinity of colonies of ground nesting waterbirds. Most of the foregoing applies equally to feral horse herds.
5. Pesticides. Pesticide use is virtually unanimously deplored in natural areas or wildlife areas. Besides direct toxic effects on colonial waterbirds--which, being at the top of food chains, are subject to the highest dosage--pesticides directly or indirectly produce reductions in numbers of fishes, insects and other invertebrates relying on spray-targets for food. These diminutions in turn reduce the numbers of the colonial waterbirds we are attempting to protect and manage for.

D. POLLUTION CONTROL

There is frequently little we can do about environmental pollution that might, or actually does, affect colonial waterbirds, as the sources are often beyond are boundaries, controlled by a variety of private, local or state groups. Activities ought to be directed, though, towards effecting changes resulting in diminished pollution from the following three sources affecting colonial waterbirds, and where protection and concern are likely to produce results.

1. Sewage treatment. Entities discharging raw sewage should be pressured to install at least secondary-treatment plants, and those having only primary treatment should be carefully examined, and if needed, monitoring should be undertaken. Heavy sewage output reduces drastically species diversity, abundance, health, and reproductive success of native fishes, in turn soon reflected by decreased reproductive activity of many colonial waterbirds, direct toxic effects aside.

2. Ocean outfalls. It is becoming increasingly frequent for newly sewered areas to dump their wastes out to sea. This customarily means the installation of a **pipe** to seaward, with the following generally adverse effects:

- a) destruction of bay bottom, salt marsh, beach and ocean floor habitat;
- b) lowering of ground water levels in the area served by the sewerage;
- c) salt water intrusion increased thereby;
- d) concentrated discharge of wastes in productive ocean feeding areas;
- e) disturbance of colonial birds during the construction phases;
- f) all the foregoing can act to reduce the numbers and reproductive success of colonial waterbirds in the affected area, so the development of ocean outfalls should be discouraged whenever possible.

3. Industrial plants. The major source of pollution by heavy metals, PCBs and related compounds, etc., is industrial plants. Careful monitoring of all colonies near estuaries, rivers or other areas populated by colonial waterbirds is essential, especially if any plumage, structural or behavioural abnormalities appear in their populations. A further measure of control can be exercised by urging that all industrial plants be sited as far from these colonies as feasible.

E. CONTROL OF PEOPLE

In their various ways, people --- on foot, in off-road vehicles, in boats --- can cause significant damage to the habitat supporting colonially breeding waterbirds. We have mentioned again and again throughout this document how people achieve their impacts, but how we can blunt or ameliorate them. In conclusion we can only reiterate: careful control of all persons in or near areas with colonies is a must. Any management and protection program, whether for animals, habitat or both, is only as good as its enforcement program. Failure to provide adequate patrols, failure to enforce strict regulations, or any other failure to indicate the seriousness of our intent to protect and manage these resources, will lead to failure of the best thought-through program. The commitment must be complete. For most of us, the sight of a thriving, active colony of any one of these birds is enough **reward** to keep us persevering.

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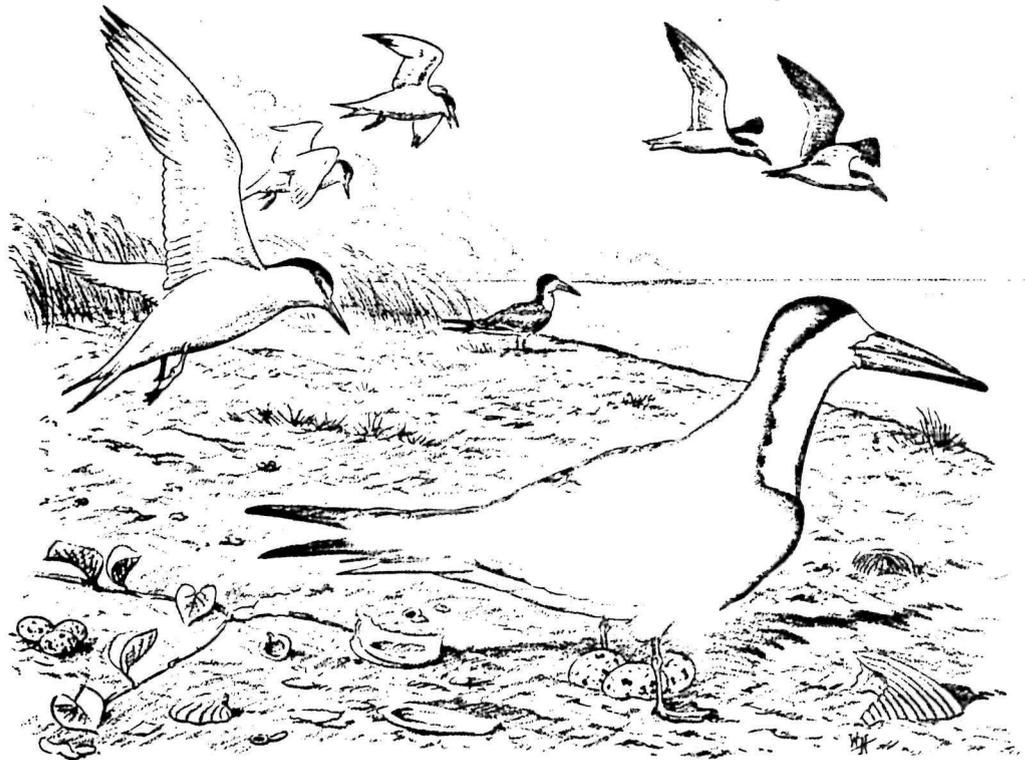
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