Management of North Carolina's Colonial Waterbirds

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Introduction

Planned management of colonial waterbirds apparently began in this country in the late 1800s and the early 1900s through the efforts of private individuals, Audubon Societies and the U. S. Fish and Wildlife Service (McIlhenny 1934, Graham 1978, Parnell et al. 1988). Early efforts were aimed primarily at stopping the killing of birds for their feathers and most often involved the passing of protective laws. This led to efforts to protect breeding sites—and the Audubon Sanctuary and National Wildlife Refuge systems were born. Most efforts since have involved protection of birds and nesting sites. The manipulation of nesting habitat as a management tool, however, began at least as early as 1892 when E. A. McIlhenny dammed a small stream, built a large wire enclosure over the resulting pond and introduced eight young Snowy Egrets (Egretta thula). From this, he developed a heronry at Avery Island in southern Louisiana that at one time contained more than 22,000 nests (McIlhenny 1934). Habitat manipulation has also occurred in North Carolina, but here it has been primarily the unplanned byproduct of dredging in coastal waterways (Soots and Parnell 1975, Parnell and Soots 1975a).

Although Audubon Societies, the U. S. Fish and Wildlife Service, state agencies and private individuals have all been involved in the management of colonial waterbirds, efforts other than those involving protective laws have usually involved a single site, i. e. a refuge or sanctuary. However the availability of repeated state or region-wide censuses (Osborn and Custer 1978, Parnell and Soots 1979, Parnell and McCrimmon 1984) provides the regional perspective that allows us to begin to think about the management of populations over a larger area.

This report presents a management plan for the coastal zone of North Carolina. It builds on protective laws and refuges and recommends an active management plan, under the leadership of the nongame species program of the North Carolina Wildlife Resources Commission, involving state, federal and private agencies with conservation and management interests and responsibilities in the North Carolina coastal zone. It is a unique approach, not yet tried elsewhere, but workable in North Carolina given the leadership of the N. C. Wildlife Resources Commission, a good body of information about the resource, and the already proven cooperative spirit among conservation and management agencies operating in North Carolina.

The Nesting Species

Twenty-five species of colonial waterbirds nest in the coastal zone of North Carolina (Table 1). Eleven of these are wading birds—herons, egrets and ibises (order Ciconiiformes). Eleven are gulls, terns and skimmers (order Charadriiformes) and three are members of the pelican order (Pelicaniformes). The gulls, terns, Black Skimmer and Brown Pelican nest on the ground, while the wading birds, Anhinga and Double-crested Cormorant typically nest above the ground in trees or shrubs. Twenty of these species nest primarily in estuaries or along the barrier islands. Anhingas and Double-crested Cormorants nest in coastal swamps. The Great Blue Heron nests almost exclusively in coastal swamps, and the Yellow-Crowned Night-Heron and Green-backed Heron nest primarily in the swamps, but a few individuals are sometimes present in estuarine colonies. Great egrets regularly nest in both swamp and estuarine colonies. Ospreys (*Pandion haliaetus*)which sometimes nest in a near-colonial situation, are not included.

Table 1. Species of colonial waterbirds that breed in coastal North Carolina.

Common Name	Scientific Name
Anhinga	*Anhinga anhinga*
Double-crested Cormorant	*Phalacrocorax auritus*
Brown Pelican	*Pelecanus occidentalis*
Great Blue Heron	*Ardea herodias*
Great Egret	*Casmerodius albus*
Snowy Egret	*Egretta thula*
Little Blue Heron	*Egretta caerulea*
Tricolored Heron	*Egretta tricolor*
Cattle Egret	*Bubulcus ibis*
Green-backed Heron	*Butorides virescens*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Yellow-crowned Night-Heron	*Nyctanassa violaceus*
White Ibis	*Eudocimus albus*
Glossy Ibis	*Plegadis falcinellus*
Laughing Gull	*Larus atricilla*
Herring Gull	*Larus argentatus*
Great Black-backed Gull	*Larus marinus*
Gull-billed Tern	*Sterna nilotica*
Caspian Tern	*Sterna caspia*
Royal Tern	*Sterna maxima*
Sandwich Tern	*Sterna sandvicensis*
Common Tern	*Sterna hirundo*
Forster's Tern	*Sterna forsteri*
Least Tern	*Sterna antillarum*
Black Skimmer	*Rynchops niger*

Breeding Site Requirements

A key to successful management of breeding populations of colonial waterbirds is providing the basic requirements for reproduction. Two of the most important requirements are isolated, disturbance-free colony sites and appropriate nesting habitat at such sites.

Isolated colony sites. Isolation of colony sites on small islands reduces the chances of predation and human disturbance and increases the chances of successful nesting. Because of their colonial breeding habit, nesting waterbirds are often conspicuous. For example, large colonies of white-plumed birds (which include most colonial waterbirds in North Carolina) may be visible from several miles away. Such flocks of birds may act as beacons directing predators to the colony as they regularly fly between the colony and foraging areas.

If a predator gains access to a colony, predation on eggs, chicks, and adult birds may be severe (Burger 1981a, Wittenberger and Hunt 1985, Rodgers 1987). Mammals, such as the gray fox (*Urocyon cineroargenteus*), raccoon (*Procyon lotor*), Norway rat (*Rattus norvegicus*), and feral cat (*Felis domesticus*), are the most destructive predators in North Carolina colonies. For this reason, colonial waterbirds generally seek sites that are inaccessible to terrestrial mammals (Lack 1968, Shields 1989). Avian predators, such as gulls, Fish Crows (Corvus ossifragus), and Bald Eagles (*Haliaeetus leucocephalus*) can easily reach even the most remote colony. They appear to have less of an adverse impact on colony productivity than do mammalian predators. This is probably a result of differences in the timing of attacks by these two groups of predators. Gulls, crows, and eagles forage during the day when colonial waterbirds can see their approach and respond by group mobbing (Kruuk 1964) or increasing nest attentiveness (Burger and Hahn 1977). These defensive tactics often deter avian predators. Mammalian predators are most active at night, and colonial waterbirds seem to have evolved few defensive mechanisms against nocturnal attacks (Southern et al. 1982). Such attacks may send panic throughout the colony, which can result in loss of eggs and chicks or complete colony abandonment (Emlen et al. 1966, Southern et al. 1985).

Disturbance of colonies by humans can have equally devastating effects (see Burger 1981b and references therein). When adult birds are disturbed by the presence of humans, they leave their nests unattended, and embryos and young nestlings may die of chilling or overheating. Larger chicks may wander from their nests and become lost or tangled in vegetation, or they may even be killed by other colony members whose territories they have entered. In addition, predators such as crows and gulls often take advantage of human-induced disturbances to rob unattended nests. Colony sites subjected to frequent or intensive human disturbance are likely to be abandoned.

Because nests are often densely packed together, even a single visit by a predator or human can have a significant, detrimental impact on the reproductive output of the colony. Several species of colonial waterbirds nest in large numbers at only a few sites along our coast. Predation or disturbance at just one of these sites could adversely affect the regional population of a species. Prevention, or at least reduction, of disturbance is therefore a critical component of any management effort.

Nesting habitat. The 25 species of colonial waterbirds breeding in coastal North Carolina occupy diverse habitats, ranging from bare, wind-swept beaches to the canopies of dense maritime or swamp forests. Although all colonial waterbird species prefer isolated, predator-free breeding sites, each has its own preference for a particular nesting substrate and vegetation community.

Ground-nesting colonial waterbirds prefer sandy substrates, but the amount of shell mixed with the sand may be important for some species. For example, Least Terns and Gull-billed Terns prefer sites with much shell mixed with sand (Jernigan et al. 1978, Everhart et al. 1980). Shell at the surface reduces wind erosion and stabilizes a site. Ground nesters generally avoid silty substrates, which are more prone to nest-destroying erosion. Substrate particle size is of little direct importance to wading birds, Anhingas and cormorants because they usually nest in vegetation above the ground.

Most coastal islands in North Carolina are composed primarily of sand mixed with varying amounts of shell. Only where rivers carry considerable amounts of silt into the estuaries and where dredged-material islands are diked do substrates contain enough silt to jeopardize their use by ground nesters.

Vegetation structure is a major determinant of colony site selection by colonial waterbirds. Each species will occupy only a narrow range of plant cover and height configurations (Soots and Parnell 1975). Species with similar or overlapping habitat preferences often nest together in mixed-species colonies.

Because vegetation succession typically leads to taller and denser stands of plants at a site (Soots and Parnell 1975), the habitats preferred by many colonial waterbird species are temporary. For example, a newly created dredged-material surface may succeed from bare sand to dense shrub thicket in 20 years or less (Soots and Parnell 1975). The shrub thicket may endure for decades, but the earlier successional stages last only a few years each. Waterbird species preferring these early stages must therefore move frequently, as succession leads to less suitable conditions. But suitable nearby sites may not always be available to relocating birds. Manipulation of vegetation succession patterns at selected breeding sites will be required to ensure the continued availability of appropriate nesting habitat for these species as alternative sites become fewer.

Management Groups

To simplify management of colonial waterbirds, we have divided the 25 breeding species into eight management groups (Table 2). The species comprising a group traditionally nest in close association and prefer similar habitats. Although each species has its own requirements, independent of other species, this approach will simplify the task of habitat management by allowing managers to deal with fewer species groups rather than 25 separate and independent species. A description of the habitat preferences of each management group follows. Management of breeding habitat for each group will be discussed in a later section.

When new islands are built, new surfaces created, or when overwash occurs along beach fronts, bare sandy substrates usually result, often with shell fragments in the matrix. This new surface undergoes wind sorting and finer particles are removed, leaving surfaces dominated by coarse sands and shell fragments. These surfaces provide nesting habitat for Royal and Sandwich terns, pioneer species that may occupy sites within a year. These two species usually nest together, and management practices for one will benefit the other (Soots and Parnell 1975).

Least Terns also nest readily on bare sites but generally do not nest with the larger Royal and Sandwich terns. Most often Least Terns nest in monospecific colonies, but they will nest adjacent to colonies of Common and Gull-billed terns and Black Skimmers (Jernigan et al. 1978). Management designed to benefit these medium-sized terns also will benefit Least Terns, but it will often be necessary to manage them independently.

Common and Gull-billed terns and Black Skimmers often nest together. They may nest on bare sites but appear to prefer a sparse cover of low vegetation (Everhart et al. 1980), which apparently provides some protection but allows the birds a good view of the area surrounding the nests. Gull-billed Terns appear to prefer substrate with clumps of low vegetation or debris. Habitat for these three species can be managed together.

As cover of grasses and forbs increases beyond about 25 percent cover and 20 cm in height, sites are usually abandoned by terns and skimmers (Everhart et al. 1980). However, they are now suitable nesting habitat for Laughing Gulls, which prefer a relatively dense cover of grasses and forbs. Laughing Gulls may nest on islands occupied by other gulls and terns, but their habitat requirements are sufficiently different that they seldom nest among other species. Exceptions are the placement of an occasional Herring Gull nest among Laughing Gulls or the occurrence of Forster's Terns among Laughing Gulls when the latter nest in areas frequently flooded. Brown Pelicans also prefer habitat similar to that of Laughing Gulls, most often nesting in areas of moderate to dense grasses. It is likely that management for either of these species would benefit the other (Soots and Parnell 1975).

Forster's Terns usually nest on natural marsh islands in Pamlico and Core sounds. They typically place their nests on mats of dead plant material that wash into the marshes on especially high tides and that are deposited over living marsh grasses. The presence of these

mats (wrack) is dependent on the vagaries of wind and tide, and they may not occur in the same places in successive years. Therefore Forster's Terns and sometimes Common Terns nesting in such situations often move between years. This makes habitat management more difficult.

Herring and Great Black-backed Gulls appear to prefer habitat dominated by scattered bunches of tall grasses such as panic grass (scientific names of plants are listed in Appendix A). In such habitats, nests are usually placed next to a clump of grass. Herring Gulls appear quite flexible, however, and nests may be found on bare substrate in completely open situations or beneath the heavy cover of wax myrtle thickets (Soots and Parnell 1975).

Herons, egrets and ibises that nest along the coastal zone may usually be managed as one unit. Most will readily nest in the dense maritime shrub thickets common on the back side of barrier islands or on small natural or man-made estuarine islands (Parnell and Soots 1979, Parnell and McCrimmon 1984). When such thickets are not available at preferred locations, some species will nest in low stands of sea ox-eye and saltmeadow cordgrass or in tall grasses such as giant reed or giant cordgrass. Such sites appear less than optimal, and management efforts should emphasize the thickets typically used by all species.

Although Green-backed Herons and Yellow-crowned Night-Herons regularly nest in estuarine colonies, numbers are always low. These species apparently nest most often as isolated pairs or small groups in coastal swamps. In North Carolina, the Great Blue Heron nests almost entirely in coastal swamps (Soots and Parnell 1979), and the Anhinga and Double-crested Cormorant nest solely in swamps. Management of estuarine sites will not greatly benefit the statewide populations of these species. Great Egrets nest primarily in estuarine colonies, but they also nest with Great Blue Herons in some swamp colonies.

Once a species has become established at a site, it remains until conditions deteriorate to the point that the site becomes unsuitable. In fact, tradition (site tenacity) often keeps birds at a site after nesting conditions have become sub-optimal. Royal Terns, for example, will persist at a site after it has become vegetated to such a degree that they probably would not choose to establish a new colony on the site. Table 2 provides an indication of the life expectancy of a site after occupancy by a species. This was based on several years of observation of North Carolina colonies but should be considered only as a guide as local conditions may reduce or extend the usable life of a given site for a species. With management, many of these usable periods may be extended.

Table 2. Colonial waterbird management groups.

Management Group	Primary Species	Secondary Species*	Typical nesting Habitat	Estimated use of a given site in years**
1	Royal Tern Sandwich Tern	Caspian Tern Least Tern Black Skimmer	Bare sand to sparse forbs	4
2	Least Tern	Common Tern Gull-billed T. Black Skimmer	Bare sand and shell to sparse forbs	4
3	Common Tern Gull-billed T. Black Skimmer	Least Tern Forster's T.	Bare sand and shell to moderate forbs	4-7
4	Brown Pelican Laughing Gull	Common Tern Gull-billed T. Herring Gull Great Black-backed Gull	Moderate to dense grasses and forbs	10
5	Forster's Tern	Common Tern	Drift material on moderate to dense grasses and forbs	Unpre-dictable
6	Herring Gull Great Black-backed Gull	Laughing Gull	Sparse to dense grasses and forbs	5
7	Great Egret Snowy Egret Little Blue Heron Tricolored Heron Cattle Egret Green-b. Heron Black-c. Night-H. Yellow-c. Night-H. White Ibis Glossy Ibis		Shrub thickets to maritime forests (occasionally in dense grasses and forbs)	30+
8	Great Blue Heron Great Egret Anhinga Double-c. Cormorant	Green-b. Heron Yellow-c. N.-H.	Swamp forests	30+

* Management for the primary species may also produce conditions suitable for the secondary species.

** Length of time from first appearance of the appropriate habitat until vegetation succession makes a site unsuitable for the species.

Management

Goals

We perceive five goals for this program. The first is to maintain reproductive populations of most species at or near current levels. Two sets of data are available for most species against which to measure trends. These are from 1977 (Parnell and Soots 1979) and 1983 (Parnell and McCrimmon 1984). A third incomplete data set from 1988 is also available. Data from 1976 (Soots and Parnell 1979) provide the only recent information on numbers of Great Blue Herons and Great Egrets nesting in the coastal swamps of North Carolina.

A second goal is to encourage those native species that are presently at low numbers or are currently declining. Censuses indicate that Glossy Ibis, Common Tern, Gull-billed Tern, Black Skimmer, Least Tern and Forster's Tern numbers have declined in recent years.

A third management goal is to discourage problem species when one species is having a strong negative effect on another species. For example, if it is shown that Herring Gulls and/or Great Black-backed Gulls are having a strong negative impact on nesting terns, management efforts to discourage Herring and Great Black-backed Gulls should be considered.

The fourth goal is to encourage a dispersed nesting population over that portion of the coastal zone traditionally occupied by each species. This is very important in that it helps to prevent catastrophic events or disease at a single site from destroying a large portion of the nesting effort of a given species (Buckley and Buckley 1976).

The fifth goal is to provide special attention for species endangered, threatened or of special concern. None of the 25 species under consideration is threatened or endangered now. The Brown Pelican, recently considered endangered, has been delisted along the Atlantic Coast as a result of a recent dramatic increase in its numbers.

Achievement of these five management goals will depend on many factors. Actual management practices will be determined by present status relative to stated goals and on the best biological evidence concerning needs of the species or species group in question.

Although management needs may vary considerably from species to species and from year to year, certain management practices are critical now. We know that current needs for maintaining present populations of most species include maintaining adequate nesting habitat spaced over appropriate portions of the coastal zone. We also know that, since most species are very dependent on dredged-material sites (Parnell and Soots 1979, Parnell and McCrimmon 1984), the continued availability of suitable nesting habitat depends greatly on human activities in the coastal zone. A clear need is to minimize disturbances at colony sites. Special concern must be given to disturbance by humans and predatory mammals. Some species may require other kinds of management. For example, we are not sure why some species are declining. It will require further study to determine what is needed to reverse these trends.

Even here, however, the availability of suitable, undisturbed nesting habitat is a clear positive step.

We will recommend steps in a coming section designed primarily to assure adequate, undisturbed habitat in appropriate places along the coast. When other needs are identified, we will include appropriate recommendations. We recognize that much additional research is needed before the steps needed to reach stated goals can be taken. We also recognize that this process assumes a continued program of population monitoring and censusing to allow trends to be determined and to evaluate the progress of the management program. There will be a continued necessity for much active involvement by professional biologists as the needs of these species change with the changing coastal environment foreseen for North Carolina.

Population Monitoring

It is necessary to have good information on colony locations and populations if management goals are to be set, management practices evaluated, and disturbances to colony sites minimized (Parnell et al. 1988).

Aerial surveys should be accomplished each year in mid-May. By this time all sites should be occupied. This will provide information on the locations of colonies and the kinds of sites occupied. Royal Terns and Brown Pelicans can be counted by photographing colonies from the air, but most species cannot be censused from the air with sufficient accuracy. Aerial surveys have been accomplished in the past using a Cessna 170 or Piper Cub with pilot and one or two trained observers. Air time required is about 16 hours.

Site visits are needed to follow up the aerial surveys and to provide information on breeding populations. Two levels of censuses should be utilized. At three-year intervals each colony should be visited at the peak of incubation and all nests counted where possible, or estimated from samples where total counts are not possible. Actual nests counts are usually possible, but in large colonies of Laughing Gulls, strip censuses may be needed, and in large mixed-species heronries it may be necessary to apportion nests among those species with similar eggs and chicks. See Parnell and Soots (1979) and Parnell and McCrimmon (1984) for details of techniques used in North Carolina in the past. The peak census technique is a relatively inexpensive way to obtain data on general population trends. Completion of the census will require a crew of at least 4 people to be in the field for about six weeks.

More detailed ground surveys should be completed every nine years. These involve repeating censuses at three to four week intervals—the approximate incubation period for most species. This will allow late nesters to be included in counts (Parnell and Soots 1979) and will detect shifts in the timing of nesting—a factor not accounted for in the peak census technique. These censuses will require a crew of at least four people to be in the field for three to four months. Ground surveys also can provide detailed information on nest site characteristics, species associations, and other aspects of the biology of the species involved. They also provide an opportunity to evaluate nesting sites in terms of habitat suitability, erosion, disturbances and other factors that require close observation of colony sites.

Special attention should be given at all levels to species that may become endangered or threatened or that are declining in numbers within the state or region.

Habitat Management by Species Group

We indicated earlier that much of the management effort could be applied to groups of species with similar nesting requirements. Table 2 provides a listing of groups to be considered. As a method of organizing the habitat management section, we will discuss management of pioneer species first and then progress to those that prefer older sites dominated by woody plants.

Group 1: Royal and Sandwich terns nest throughout the North Carolina coastal zone, with most colonies located on dredged- material islands. Preferred sites are isolated islands with bare sandy substrates near inlets (Buckley and Buckley 1972). Primary habitat management should consist of periodic return of island substrates to a bare condition. This can be accomplished in most cases by the deposition of dredged material on sites that are becoming too densely vegetated.

We estimate that such sites should receive new dredged material at approximately five year intervals (Soots and Parnell 1975). If dredging schedules require, dumping could be done on cycles as short as three years or perhaps as long as six or seven years. When dredged-material deposition is feasible as a management tool, sites should not be diked. Dikes result in dramatic changes in vegetative succession and produce conditions usually much less suitable for Royal and Sandwich terns (Parnell et al. 1978). A technique of directing the flow of the dredged-material slurry back toward the channel and thus protecting the shallow bottom communities adjacent to the disposal site is preferred.

The need for vegetation removal will not always coincide with dredging needs, and other methods are needed. Tilling a site in late fall or winter or the application of carefully selected chemicals may provide alternate methods of vegetation removal. Both techniques need further study, however, before they can be properly evaluated as management tools.

Management for Royal and Sandwich terns will likely benefit other species as well. These terns most often nest on the highest portions of islands where plants are the slowest to take hold and grow (Soots and Parnell 1975). Caspian Terns, Least Terns and Black Skimmers often share such sites, with the latter two species usually nesting farther down the slopes than Royal Terns.

Royal and Sandwich terns have traditionally nested at Oregon, Hatteras, Ocracoke, New Drum and Barden inlets, and in the lower Cape Fear River. Primary and alternate sites should be maintained in or near each of these areas.

At Oregon Inlet, islands along Old-House Channel are the most appropriate sites. Royal and Sandwich terns have nested here regularly in recent years. The channel adjacent to these sites is dredged frequently, and management should involve the planned deposition of

dredged material through coordination with the Corps of Engineers and other agencies. At Hatteras Inlet, islands DR-009-03 and DR-006-10 should be considered alternative sites. Again, planned deposition of DR-006-10 should be considered alternative sites. Again, planned deposition of dredged material can be a basic tool. This channel, from Hatteras Village to Ocracoke, is maintained by the State of North Carolina, and appropriate coordination is necessary.

The sites traditionally occupied in Ocracoke Inlet are islands HY-011-06 and HY-011-07. These are not adjacent to maintained channels, and methods other than the deposition of dredged material will be necessary to maintain bare substrates. Royal and Sandwich terns have not nested at either of these sites in the last few years (due apparently to vegetation encroachment). A small colony was present for a few years on island CR-012-24, a low, bare island. Small size and low elevation make use of this site precarious, and efforts are needed to create appropriate conditions on island HY-011-07. These terns have apparently moved southwest to Wainwright Island (CR-014-02), which provides a suitable alternative, although it is rather far from an inlet.

Wainwright Channel, connecting Pamlico and Core sounds, requires frequent dredging and dredged material is usually placed on adjacent Wainwright Island (CR-014-02). Careful planning can result in a very attractive nesting site. It has been used by Royal Terns and other species for many years.

Island CR-014-04 near Drum Inlet has been a very important colony site. This large island is becoming heavily vegetated, and a portion should be returned to bare conditions. There is no alternate site close by, but these birds have nested at island CR-016-01 (now heavily vegetated) to the north and also could shift south to sites in Barden Inlet. Island CR-017-07 and CR-017-01 in the channel to Barden Inlet should be maintained as primary sites for pioneer species. This channel is dredged frequently, and planned deposition of dredged material can maintain these sites.

The next traditional nesting site for Royal and Sandwich terns is BW-039-37 in the lower Cape Fear River. Islands NH-039-32 and BW-039-37 are now in use. These are the only suitable sites on the river, and both should be maintained in bare or nearly bare condition. Island BW-039-37 received dredged material in 1982 in a first North Carolina effort to place dredged material on a site directly to benefit a nesting colonial waterbird species - the Brown Pelican. The new substrate was occupied during the first season after deposition by Black Skimmers, Royal, Sandwich, Gull-billed and Common terns.

A plan of placing dredged material on alternate sites at each important location at two to three year intervals would assure that there would always be one bare or nearly bare site at each traditional nesting location. As a minimum, one bare site should be maintained in each major nesting region.

Group 2: Least Terns have been placed in a management group by themselves. They usually do not associate closely with other nesting species, although they will sometimes nest in close association with Common and Gull-billed terns. Least Terns are pioneers that nest on bare or

nearly bare sites and move on as vegetation begins to cover the site. In North Carolina they nest along most of the coast at a variety of sites ranging from barrier beaches to dredged-material islands and even occasionally on the mainland. They tend to choose new overwash sites or sand spits adjacent to inlets on barrier beaches. Preferred island sites are similar to those chosen by Royal and Sandwich terns. Least Terns, however, show a marked preference for an abundance of broken shell in the substrate (Jernigan et al. 1978). Least Terns, which often nest in colonies of less than 100 pairs, also will accept smaller units of appropriate habitat than will the larger terns.

On the undeveloped barrier islands there appears to be sufficient suitable sites for Least Terns as a natural consequence of overwash and inlet migration, and habitat maintenance in terms of vegetation and substrate may not be as important as regulating disturbances. Dredged-material island sites may require vegetation management similar to that recommended for Royal and Sandwich terns.

There are usually no large Least Tern nesting colonies north of Oregon Inlet or on the west side of the sounds. There is usually a colony in Oregon Inlet and island DR-005-03 is presently in use. Two or more bare sites in this inlet should be maintained.

Least Terns have nested at several beach sites between Oregon Inlet and Morehead City. Sites change frequently, and, since most of this beach is in public ownership, natural conditions should prevail. Nesting sites will usually be on fresh overwash or on sand spits adjacent to inlets. Especially important sites developed in 1983 and 1984 at Cape Point (DR-008-02) and on the flats just north of Hatteras Inlet (DR-009-01). These sites should be monitored closely as vegetative management may be needed.

Most beaches south of Morehead City are at least partly developed, and Least Terns tend to nest only in the unstable and usually undeveloped areas adjacent to inlets or on dredged- material islands along the AIWW. Islands CR-020-03 and CR-020-06 along the Morehead City ship channel are particularly important nesting sites for Least Terns. Dredged material deposition, especially on island CR-020-06, is frequent, and adequate habitat has been maintained by this method. A problem at this site has been the deposition of dredged material during the nesting season (April-August). This should not happen. Least Terns also traditionally nest along the AIWW from Morehead City to the South Carolina state line. They move frequently, choosing nesting sites where recent dredged-material deposition has created appropriate habitat. Suitable sites should be maintained near Swansboro in Bogue Sound, at New River Inlet, adjacent to Topsail Island, Figure Eight Island, Masonboro Island and in the vicinity of Shallotte Inlet. Dredging will normally result in adequate suitable sites if present schedules and practices are maintained.

The beach at Ft. Fisher south of Kure Beach has become an important site for nesting Least Terns. New Inlet is moving southward providing an expanding sand spit on the north side of the inlet. This has created suitable Least Tern nesting habitat when other nearby sites have been less suitable. A major problem here is human disturbance.

Group 3: Common Terns, Gull-billed Terns and Black Skimmers will nest on bare substrate but they seem to prefer a sparse cover of low vegetation (Everhart et al. 1980). They may follow Royal and Sandwich terns or Least Terns at a site where vegetation is beginning to encroach. Appropriate habitats are generally present on overwash fans, inlet spits or estuarine islands as plant cover begins to develop. It is likely that use of a site by these species could be extended by mowing or tilling, but this has not been attempted in North Carolina. Vegetation removal has been used to extend the period of site use and to create additional area for use by nesting Common Terns at Great Gull Island, New York (Harwood 1976) and on Gull Island, Ontario (Morris et al. 1980). Sites also may be made more attractive by the addition of driftwood or other debris (Richards and Morris 1984).

All three species nest from Oregon Inlet southward to the Cape Fear River, and suitable habitat should be maintained throughout this area. Nesting is primarily on dredged-material islands associated with inlet channels or on sand spits adjacent to inlets.

This group has nested at Oregon Inlet in recent years, but numbers are now much reduced from those of the mid-1970s. The recent use of islands DR-007-05 and DR-007-06 within the diked impoundments at the Pea Island National Wildlife Refuge may indicate that habitat on dredged-material islands in this vicinity is either becoming unsuitable or that disturbances are increasing. Management of islands along Old-House Channel for pioneer species should assure that adequate nesting habitat will be suitable for these species at Oregon Inlet.

This group also nests to some extent on the mainland side of Pamlico Sound. Only island DR-006-09 in Stumpy Point Bay requires habitat management. This island should continue to receive dredged material regularly to maintain preferred habitat conditions. Dredging appears, however, to be infrequent at this site, and other forms of vegetation manipulation may be required.

Sizeable colonies of Common and Gull-billed terns and Black Skimmers have traditionally nested in Hatteras and Ocracoke inlets and at the confluence of Pamlico and Core sounds. Islands DR-006-10 and DR-009-03 are important sites in Hatteras Inlet and islands HY-011-05, HY-011-06 and HY-011-07 have been most important in Ocracoke Inlet. Current dredging practices in Hatteras Inlet will continue to provide suitable habitat on island DR-009-03, but island DR-006-10 needs to receive dredged material to provide an alternate site. Appropriate habitat for this group is no longer present at traditional sites in Ocracoke Inlet, and since 1985 nesting has been on a low natural shoal (HY-011-03) in the mouth of the inlet. Vegetation removal on island HY-011-07 recommended for Royal and Sandwich tern management also will benefit this group.

Along the Outer Banks, this group appears to be shifting to greater use of barrier beach nesting sites. New and large colonies at Cape Point (DR-008-02), on the flats north of Hatteras Inlet (DR-009-01), and on a recently formed island in Ocracoke Inlet (HY-011-03) have replaced the once large colony nesting on Ocracoke Flats (HY-011-01). This has likely resulted from decreased availability of habitat on dredged-material sites in the region and from growth of

vegetation on Ocracoke Flats that resulted when off-road vehicular (ORV) traffic was limited by the construction of a road to the inlet. Appropriate beach habitat will likely be maintained by natural factors, if human disturbance is managed. The planned deposition of dredged material may provide elevated beach sites less subject to overwash than natural sites.

Habitat for this group is declining in Core and Back sounds. Islands CR-017-01, CR-017-03 and CR-017-07 in Back Sound were important nesting sites for this group in the mid-1970s. Appropriate habitat on at least one of these sites should be maintained. At Morehead City, islands CR-020-03 and CR-020-06 have been very important sites for this group. Coordination of dredged-material deposition can assist in habitat maintenance for this group as well as for Least Terns that use these sites.

South of Morehead City, Common Terns, Gull-billed Terns and Black Skimmers nest primarily on barrier beaches, usually adjacent to inlets. Habitat management for this group, as with Least Terns using these areas, will primarily involve protection from human disturbance and perhaps from pets and feral cats.

There is little use of dredged-material islands by this group between Morehead City and the Cape Fear River. In the Cape Fear, islands NH-039-32 and BW-039-37 are most suitable for the ground nesting pioneer species. Terns have nested on other sites there but generally have not been successful, apparently due to disturbance by mammalian predators. It is critical that the two suitable islands be carefully managed to provide habitat for as many pioneer species as possible.

Populations of the three species in this group declined during the period between 1977 and 1983 (Parnell and McCrimmon 1984). It is therefore important that we pay particular attention to their needs.

Group 4: Laughing Gulls and Brown Pelicans appear to prefer nesting cover of dense grasses and forbs. Pelicans also may nest above ground in dense shrub thickets.

Both species nest in North Carolina from Oregon Inlet to the Cape Fear River. Neither species nests on beaches, and both nest most often on dredged-material islands. Preferred habitat becomes available six to ten years after the deposition of dredged material, and sites may remain suitable for 10 or more years (Soots and Parnell 1975). On natural islands, they may nest in stands of saltmeadow cordgrass and salt grass where occasional flooding prevents succession to shrub thickets. Such sites may remain usable indefinitely—although flooding during the nesting season may be a problem.

Habitat maintenance will involve the prevention of destruction of vegetation by the untimely deposition of dredged material and the removal of invading shrubs. Shrub removal has not been practiced in North Carolina, and research is needed to evaluate the effects of this management tool.

Laughing Gulls have traditionally had large colonies in the Oregon Inlet vicinity, and

appropriate habitat should be maintained there. Islands DR-003-05 and DR-003-09 appear presently suitable, although most birds have moved to island DR-006-02. Brown Pelicans have established a new colony site (in 1983) on the western tip of island DR-006-08, and this has rapidly become the largest colony in the state.

Laughing Gulls have traditionally nested in the natural saltmeadow cordgrass flats on island DR-006-12 near Salvo, and Laughing Gulls and Brown Pelicans nest on island HY-011-04 in Ocracoke Inlet. Both of these important sites are on natural islands and appropriate vegetation is maintained by periodic flooding. No vegetation management should be necessary.

Large Laughing Gull colonies are currently present on islands DR-009-03 in Hatteras Inlet, CR-016-04 in Core Sound, CR-017-07 in Back Sound and BW-039-37 and NH-039-32 in the Cape Fear River. Management should continue to ensure appropriate habitat on sites in Oregon, Hatteras and Ocracoke inlets, Core and Back sounds, and on the Cape Fear River.

Group 5: Forster's Terns usually nest on the windrows of dead eel-grass or cordgrass stems that pile up on marshy islands in Pamlico and Core sounds. The availability of this nesting substrate varies with wind and tide, and it is not generally possible to predict which islands will be used from year to year. There is, however, almost always a colony in the vicinity of Judith Marsh on the northwest side of Pamlico Sound, and Gull (DR-006-12) and Beacon (HY-011-04) islands also are usually occupied. Habitat manipulation is probably unnecessary for this species.

Group 6: Herring and Great Black-backed gulls are relatively new nesting species in North Carolina (Parnell and Soots 1975b). Both nest primarily in Pamlico Sound, but Herring Gulls have been recorded nesting as far south as the Cape Fear River (Parnell and Soots 1975b). Both species have undergone dramatic increases in numbers along the New England coast (Kadlec and Drury 1968) and are likely to continue to increase in numbers in North Carolina. Both are predators on other colonial waterbirds, and farther north they have been implicated in declines in populations of smaller native gulls and terns (Kadlec and Drury 1968). We do not anticipate encouraging either species in North Carolina but may discourage them from breeding. Further work on the relationships between these large gulls and the other nesting species is needed prior to any decisions.

Group 7: Long-legged waders nest from Currituck Sound to the Cape Fear River in a series of mixed-species colonies. They generally occupy coastal shrub thickets on estuarine or barrier islands. Although some colonies occupy stands of sea ox-eye or giant reed, wax myrtle-yaupon-red cedar thickets are preferred. The span of use of colony sites may be long. Battery Island (BW-039-51), for example, has been in use since 1928 (Pearson et al. 1942). The basic tool of habitat maintenance is the prevention of destruction of shrub thickets. Dredged-material deposition must not occur, for example, during the life of the site as a heronry. Wading birds may themselves damage a site by heavy fertilization of colony vegetation by defecation. Studies are in progress to evaluate methods of extending the life of colony sites. Where such

methods are not feasible, alternate colony sites should be provided. A habitat suitability model for identifying alternate wading bird colony sites in the North Carolina estuaries recently has been developed (Shields 1989).

The major nesting sites of wading birds are Monkey Island (CK-001-01) in Currituck Sound, island DR-003-09 in Roanoke Sound, site HY-010-16 on Ocracoke, Middle Marshes (CR-018-15 and CR-018-07) in Back Sound, Phillips Island (CR-021-04) in the Newport River, island CR-022-41 in Bogue Sound and Battery Island (BW-039-46 and BW-039-51) in the lower Cape Fear River. Several other smaller colonies are also present during most years.

Group 8: Great Blue Herons nest almost entirely in coastal swamps in North Carolina. Nests are usually clustered in the tops of cypresses or gums. Colonies may be monospecific or may consist of Great Blue Herons and Great Egrets. The only extensive survey of swamp colonies done in North Carolina was accomplished in 1976 (Soots and Parnell 1979). At least one site located during that survey has since been logged, and this appears to be the primary threat. Along the coast Double-Crested Cormorants have nested only at Lake Ellis Simon and Great Lake in Craven County (Doig et al. 1988). Recently nesting was discovered at Jordan Lake in the Piedmont. Anhingas nest as isolated pairs or small colonies in coastal swamp forests (Doig et al. 1988). Habitat maintenance for this management group should consist of efforts to locate current colony sites and to prevent destruction of the swamp forests in which they occur.

Summary: Beach habitats will tend to be maintained by natural environmental factors for long periods as plant succession on overwash fans and inlet spits is slow compared to island sites, and succession may be arrested by subsequent storms. In coastal swamps, appropriate habitats are also mature forests and no maintenance is required if sites are not logged. The primary need for habitat maintenance programs will be on natural and man-made estuarine islands. Here, succession is rapid and sites suited for pioneer species are limited. Site maintenance can usually involve the management of selected dredged-material islands by regulating the frequency, timing, placement, amount and method of the deposition of dredged material. Soots and Landin (1978) have provided an excellent review of management needs and possibilities on dredged-material island sites. This should be a basic reference for managers working in North Carolina. Such management will usually require only planning and coordination because dredging is ongoing in coastal waters.

Other means of vegetation management are needed to provide alternate methods of maintaining sites when dredged-material deposition is not a practical management tool. Some work has been done in other states on vegetation management, and initial studies have begun in North Carolina. Methods used to date are very labor intensive and appear feasible only where specific sites are critical and when considerable manpower is available. Use of service groups that can supply a large number of people at a specific site at a specific time may be possible, but it is unlikely to be a viable method of maintaining a series of sites scattered throughout the coastal zone over a long period.

Site Protection

Although habitat must be managed on a group-specific basis, site protection is an

important tool for all species. Colonies face two dangers—frequent disturbances and total site destruction.

Site disturbance varies with the ease of access by people and with the presence of mammalian predators. Although mammalian predators will be a problem only occasionally, people are a frequent problem.

Many beach colonies are within the jurisdiction of the U.S. National Park Service or the U. S. Fish and Wildlife Service. An excellent manual for management of colonial waterbird colonies in national parks was published in 1976 (Buckley and Buckley 1976). It recommended a series of practical actions including colony posting. This has been done in most cases in North Carolina and it works well. Colonies at Hatteras and Ocracoke have been successful in spite of heavy ORV traffic immediately next to colony sites (Golder 1984). It is recommended that posting of colony sites and education of local communities be extended to all beach colonies.

Swamp colonies are protected from human disturbance by their remoteness and by the habit of birds placing nests high in the tree tops. No steps are needed to prevent casual disturbances so long as sites are not destroyed.

Disturbances on estuarine islands vary with the amount of recreational boat traffic in the vicinity of sites. Although fishermen occasionally go ashore on bird islands, boaters or sunbathers are the primary problem, especially when pets are along. It is recommended that sites where problems are likely to occur be posted. The system used by the National Park Service works well. They use two kinds of signs. The colony is enclosed by a ring of small signs often connected by rope. Larger signs giving a series of reasons for not disturbing the birds are placed at key entrance points. Ideally, such signs should be erected in March prior to the onset of nesting activities and removed in September once nesting is complete. It may, however, be necessary to post colonies after initiation of nesting at new sites or sites where exact colony location cannot be predicted. It is also advisable to string flagged line between signs to make it impossible to enter a colony site without seeing the barrier.

A second level of protection should be provided by frequent site visits by uniformed conservation officers as part of regular patrols. Where there are concentrations of birds in areas of intense human summer activity, use of seasonal employees or interns could contribute significantly to the success of colonies and to education of the public. This has been done at the Cape Hatteras National Seashore in recent years.

Mammalian predators may cause great damage if they discover colonies of ground nesting colonial waterbirds. This is probably a major reason that most colonies are located on isolated sites that lack appropriate habitat to support such predators through the year. When such predation is discovered it may be necessary to remove individual predators. Feral cats appear to be important predators on some beaches, and research on their impact on beach nesting birds is needed.

Research at Battery Island has shown that Fish Crows take large numbers of eggs of colonial waterbirds during the nesting season but that renesting appears to compensate for

much of this loss (Shields and Parnell 1986). This study did not recommend control of crows in nesting colonies. Avian predators such as crows do not appear to disturb the entire colony as do mammals.

Protection from site destruction is also an important management consideration. Beach sites on public land are not likely to be destroyed, and some sites on private beaches may be protected by being next to inlets on sites protected by the Coastal Management Act as areas of environmental concern. Dredged-material sites are protected to some degree through public ownership and easements. Some important sites are in private ownership, however, and could be destroyed. Most mainland swamp sites are in private ownership and are not protected.

The State of North Carolina and the National Audubon Society are presently determining ownership of key estuarine sites. It is recommended that as many of these sites as possible be given protection by private or public conservation groups. When this is not possible, other alternatives for protection should be sought.

Finally, we need in North Carolina an active program of public education about the needs of nesting colonial waterbirds. Their needs could be made known in a variety of ways including films, slide programs and leaflets that could be placed in the hands of coastal residents and visitors.

Planning and Cooperation

Careful planning and coordination among several agencies are necessary to assure that this plan of management reaches the goals set. The coastal zone of North Carolina is a complex natural set of ecosystems with many functions and many human uses. Several agencies manage the region's resources and regulate human activities. Agreement on the need for management of colonial waterbirds and cooperation toward achieving the goals of management will be very important. The goals of this plan cannot be reached by the efforts of a single agency, but with a continuation of the spirit of cooperation between agencies that is present in North Carolina, the goals of this plan are achievable.

Several steps have been initiated to implement this plan. First, the N. C. Wildlife Resources Commission approved the plan. This identified the Wildlife Resources Commission as a lead agency for management of colonial waterbirds in North Carolina. Second, responsibility for planning was assigned to the nongame program within the commission staff. Third, the cooperation of other coastal management agencies has been assured through a series of memoranda of agreement between the Wildlife Resources Commission and other agencies.

An interagency coordinating committee has been established to assist with the cooperation so necessary to a successful management program. Since colonies occur on land controlled by many agencies, several different administrative units including the U.S. Fish and Wildlife Service, the National Park Service, the N. C. Division of Parks and Recreation, N. C. Department of Administration, The Nature Conservancy and the National Audubon Society may be involved in management at different sites. Several agencies also impact on management

through such activities as the deposition of dredged materials in the coastal zone, and it is thus important that agencies such as the U. S. Army Corps of Engineers and the National Marine Fisheries Service be involved. Careful cooperation among all coastal management and conservation agencies in the planning and carrying out of this plan is most important and will minimize conflicts and maximize efficiency. The coordinating committee will consist of representatives of agencies signing memoranda of agreement relative to the management of colonial waterbirds.

The primary function of this group will be to facilitate communications among agencies and to assure that each agency is aware of the program and maintains a ready avenue for the exchange of information as problems and opportunities arise. It also will simplify action by a participating agency when management goals require action.

The committee should meet at least annually to review management needs for the year. Other meetings can be called as needed.

The Region

Introduction

The coastal zone of North Carolina contains a diverse series of ecological units. Currituck Sound in the northeastern corner of the state is shallow and fresh to slightly brackish. There are no inlets from the ocean and no major boat channels with adjacent dredged-material islands. The barrier island beaches are not generally subject to overwash. They are comprised primarily of very coarse loose sands and are heavily affected by development. Pamlico Sound is a large brackish sound with three inlets, each with a series of dredged-material islands next to channels between the ocean and sound. The eastern perimeter is a series of narrow barrier islands much subject to overwash. To the west, the sound is bounded by extensive brackish marshes. The barrier islands begin to approach more closely to the mainland south of Ocracoke Island; and Core Sound, while still being primarily open water, is much narrower than Pamlico. Two inlets drain the area between Cedar Island and the Newport River, and dredged-material islands are present adjacent to each of these channels. South of Morehead City barrier islands approach the mainland even more closely. The shallow sounds are generally dominated by regularly flooded saltmarshes. The Atlantic Intracoastal Waterway enters the estuary at Morehead City and bisects the estuary to the South Carolina state line. A series of small inlets separate barrier islands into discrete units southward until the Cape Fear River creates a large river estuary disrupting the barrier island chain and associated estuaries. The barrier island chain and estuaries west of the Cape Fear in Brunswick County are similar to those to the north of the Cape Fear but contain increased amounts of fine river-transported sediments.

Management Regions

We have divided this coastal zone (Figure 1) into five regions for management purposes. The regions were established to allow the management of colonial waterbirds within somewhat similar ecological units. A primary goal of management will be to maintain adequate appropriate habitat within each region for those species that have traditionally nested there. This will help to assure that species that traditionally nest throughout the coastal zone are not forced to nest in unusually large concentrations at one or two sites where catastrophic or epidemic events could do great damage. It also will assure that we manage species within areas that have provided all necessary factors to assure successful breeding. If species do move into new areas, the management plan can be modified to provide for appropriate consideration.

Region 1 consists of Currituck Sound and the beaches of Currituck County and northern Dare County. This region has a single heronry, and few colonial waterbirds nesting on the beaches. Management efforts here should emphasize the continued availability of suitable primary and alternate nesting sites for waders. Emphasis on the ground nesting gulls, terns and skimmers is not necessary.

Region 2, the largest and most complex region, is comprised of Pamlico Sound and the adjacent barrier islands and includes the Cape Hatteras National Seashore. Within this region we should maintain appropriate habitat for essentially all the colonial waterbirds that nest in the state. While this region is large, it appears to be a natural ecological unit, and birds are known to move among colony sites within this region.

Region 3 consists of the barrier islands and sounds from the north end of Portsmouth Island to the south end of Shackleford Banks, including the Cape Lookout National Seashore. It represents a zone of transition from the wide, open sounds farther north to the nearly closed, marsh-dominated estuaries farther south. Colonial waterbird use is heavy in this region and most species are present. A complete range of nesting conditions is required.

Region 4 consists of the barrier islands and narrow, marsh- dominated sounds from Atlantic Beach to Carolina Beach. There are presently two heronries and small scattered colonies of terns and skimmers on the barrier beaches and dredged-material islands. Management should emphasize appropriate habitat for nesting wading birds and for Least, Common and Gull-billed terns and Black Skimmers at sites adjacent to the series of inlets that occurs in this region.

Region 5 consists of the barrier beaches from Carolina Beach to the South Carolina state line, the Cape Fear River estuary and the estuaries of Brunswick County. While the Cape Fear River estuary and the estuaries behind the barrier islands of Brunswick County are rather different, there appears to be considerable movement of Least Terns between nesting sites in the two areas, and we consider this a single region. The Cape Fear River estuary is an area of heavy colonial waterbird use, and appropriate habitat for all species nesting in North Carolina should be maintained there. The beaches at Fort Fisher and in Brunswick County are utilized primarily by Least Terns and Black Skimmers and management should emphasize the needs of these species.

The following sections discuss colonial waterbird use in each of these regions in more detail and locate all sites that have been used in recent years (Appendix B). Key sites are those that have been regularly used in past years and/or which we expect to be important in the future (Appendix C). Original site descriptions were taken from Parnell and Soots (1979). Descriptions have been updated when possible, but size and topography may have been modified by erosion or deposition of dredged material. New measurements were not taken in all cases.

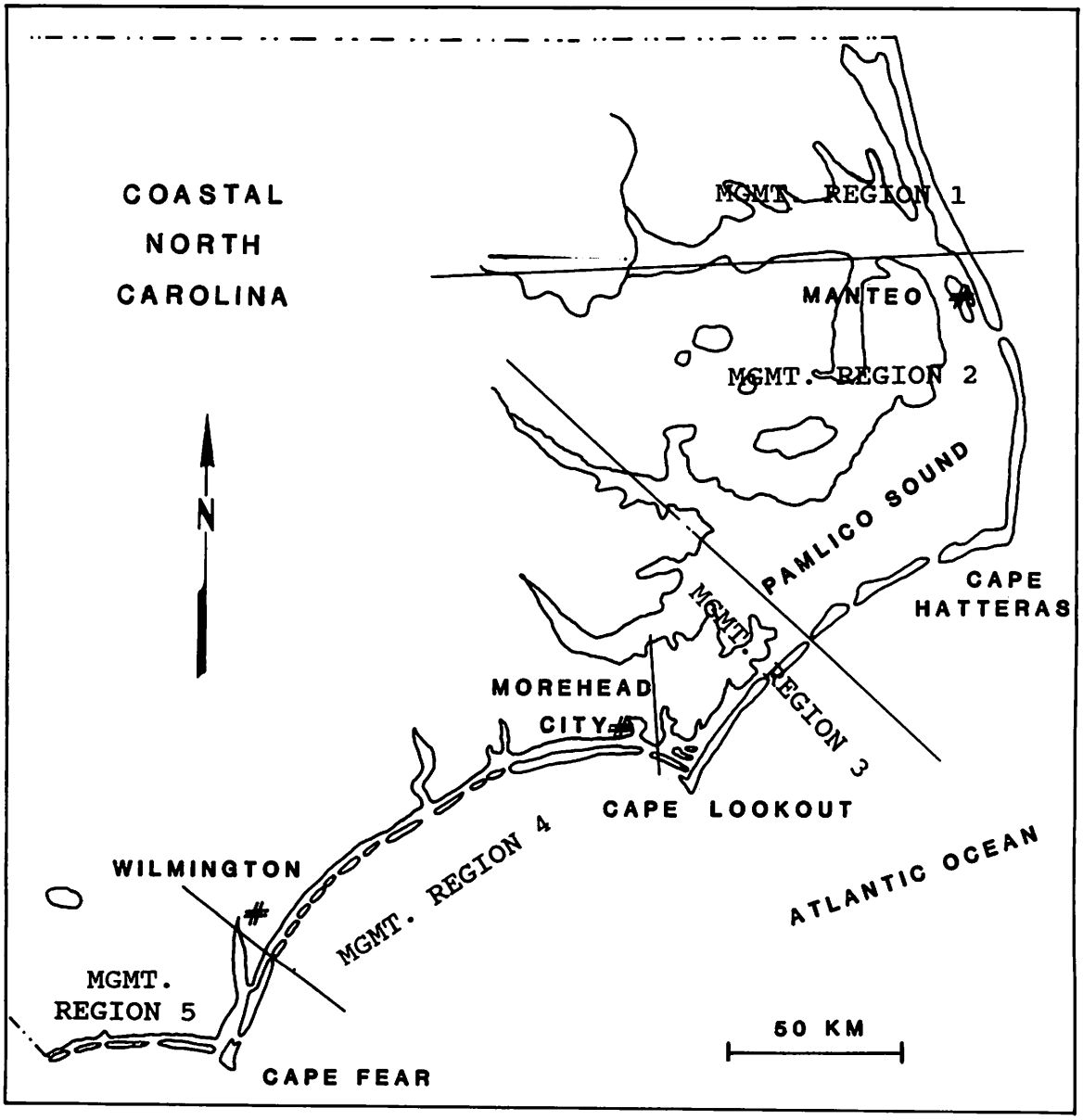

Figure 1. Management Regions

Region 1.Currituck Sound and the beaches from Virginia to Whalebone Junction.

The only known regularly used nesting site for colonial waterbirds in this region is Monkey Island (CK-001-01) in northern Currituck Sound. This natural island has been the site of a mixed-species heronry for several years. There are no colonies of birds on the barrier island beaches in this region other than an occasional small Least Tern colony. Apparently, the combination of very heavy human disturbance during the summer and lack of washover environments in the region have made this area unattractive to beach nesting terns and skimmers. There are few dredged channels and no dredged-material islands in this region.

Key Sites: CK-001-01

Key sites are located on Map A.

Monkey Island (CK-001-01)

Monkey Island (36°24'N,75°52'W) is located in Currituck County in the northern part of Currituck Sound (Map A).

Site type: Natural estuarine island.

Size: About 2 ha.

Topography: Low flat island with some associated marsh.

Vegetation: The island is dominated by a well developed forest of loblolly pine, hackberry, live oak, red cedar, and yaupon. Shrub thickets of wax myrtle, willow, and silverling occur along the forest edge, and a freshwater marsh occupies a cove across the middle of the island.

Surroundings: Monkey Island is surrounded by the shallow waters of Currituck Sound.

Ownership: Currituck County.

History of use by colonial waterbirds: A heronry has been present on this site for several years. In 1977, there were 403 nests of 6 species. In 1983, the number of nesting birds had risen to 690, and in 1988, 550 nests of 4 species were estimated.

Site potential: This is the only known mixed-species heron nesting site in Region 1. Vegetation appears healthy, so the potential for continued use is good. A wooden groin surrounds the island and provides protection from erosion. There is no potential for use by ground nesting gulls and terns at this site.

Region 2: Pamlico Sound and adjacent beaches: Whalebone Junction to Ocracoke Inlet.

This is the largest and most complex region in the state. It encompasses barrier island beaches, three inlets with associated dredged-material islands, and many miles of mainland brackish marshes and associated marsh islands. It appears to represent an ecological unit with considerable movement of birds among sites within the region. The primary areas of concentration of nesting colonial waterbirds are on dredged-material islands adjacent to channels associated with Oregon, Hatteras and Ocracoke inlets; on the beaches at Cape Point and Hatteras Inlet, and on scattered islands in Pamlico Sound.

Dredged-material islands along the channels from Oregon Inlet to Wanchese and westward to the open water of Pamlico Sound represent the most northern concentration of colonial waterbird nesting sites in the state. A large heronry has developed adjacent to the Roanoke Sound channel. A large colony of Royal and Sandwich terns has nested on an island adjacent to Old House Channel for several years. Island DR-006-08 is the site of the most northern Brown Pelican colony in North Carolina. In 1988, it was the largest pelican colony in the state. Colonies of Common and Gull-billed terns and Black Skimmers have been present during some years in Oregon Inlet and absent in others. Their presence likely depends on the availability of suitable habitat and may be influenced by the abundance of Herring and Great Black-backed gulls. Laughing Gulls usually establish a large colony in this vicinity. Oregon Inlet is also the location of the largest colonies of the invading Herring and Great Black-backed gulls in the state. They have nested on several islands along the Roanoke Sound channel and along Old House Channel. They move from island to island depending on vegetative conditions and perhaps other factors. These two chains of dredged-material islands are among the most important in the state, and suitable habitat for most species should be maintained there.

The next major nesting concentration in Pamlico Sound is at Hatteras Inlet. In past years there has been a concentration of birds on the dredged-material islands along the channel from Hatteras Village to the inlet. Most of these sites have been lost to erosion. The primary site for nesting gulls, terns and skimmers is now on the large dredged-material island (DR-009-03) in the center of the inlet between Hatteras and Ocracoke. The Atlas (Parnell and Soots 1979) and the Supplement (Parnell and McCrimmon 1984) show two islands here, but island DR-009-04 no longer exists as a separate entity. Herons and egrets and some ground nesting terns continue to nest along the channel to Hatteras Inlet on island DR-006-10. This site should continue to provide suitable habitat for herons and egrets but likely will be abandoned soon by the terns. The site is undergoing severe erosion, and deposition of dredged material is badly needed.

Ocracoke Inlet is the site for the most southern of the large concentrations of nesting birds in Pamlico Sound. This is the location of the oldest known Brown Pelican colony in North Carolina, active at least since 1929 according to Pearson et al. (1942). Brown Pelicans, Royal, Sandwich, Common, Forster's and Gull-billed terns and Laughing and Herring gulls are usually present, but often shift nesting sites among islands HY-011-04, HY-011-06, and HY-011-07. Beacon Island (HY-011-04) usually has nesting Forster's Terns and Laughing Gulls and

is most frequently the site chosen by Brown Pelicans. A new natural island in the mouth of Ocracoke Inlet (HY-011-03) has become an important nesting site for Common and Gull-billed Terns and Black Skimmers.

Several other islands scattered over the sound are used at times by nesting colonial birds. Island CR-012-24 just west of the north end of Portsmouth, Outer Green Island (HY-010-02) just west of the northern tip of Ocracoke, and Gull Island (DR-006-12) just west of the banks southwest of Salvo have colonies of gulls and terns or small heronries most years.

Clam Shoal (DR-006-22), well out in Pamlico Sound, north of Hatteras Village, is emerging after being mostly submerged in recent years. This site is attractive to Royal Terns when it is emergent. It will likely become an important colony site for the pioneer species if it continues to build.

On the mainland side of Pamlico Sound there have been colonies of Common Terns, Forster's Terns and occasionally Black Skimmers on dredged-material island DR-006-09 in Stumpy Point Bay, Hog Island (HY-006-30), and islands off Judith Marsh southwest of Swanquarter. Island use varies from year to year with colonies moving frequently among sites. The choice for a particular year appears to depend on the availability of mats of dead marsh grasses or eel-grass deposited on marshy islands. Forster's and Common terns use this wrack as nesting substrate.

The Pamlico Sound region also has the most significant concentrations of terns and skimmers nesting on barrier beach sites in North Carolina. There are colonies of Least Terns at several locations between Pea Island and Ocracoke. Colonies are usually small and located on areas of recent overwash. They move frequently. In 1984 a large, mixed colony of Least, Common and Gull-billed terns and Black Skimmers was established on the beach at Cape Point (DR-008-02) near Buxton. A large colony of these same species was established on the beach at Hatteras Point (DR-009-01) just north of Hatteras Inlet in 1983. These two colonies, coupled with the large colony that was present for many years on the flats just north of Ocracoke Inlet (HY-011-03) and the recently established (1987) colony on the emerging shoal in the mouth of Ocracoke Inlet (HY-011-01), represent a large proportion of the nesting population in this region. Since 1983 most of the Least Terns, Common Terns, Gull-billed Terns and Black Skimmers in this region nested in these beach colonies. All except HY-011-03 are within the Cape Hatteras National Seashore and all are protected by the National Park Service. There was an active heronry within the shallow impoundments on the Pea Island National Wildlife Refuge for many years, but it was abandoned in the mid-1980s. A new heronry was recently established on a marsh island (HY-010-01) just south of Ocracoke Village.

Key Sites: DR-003-05, DR-003-09, DR-005-03, DR-006-02, DR-006-08, DR-006-10, DR-006-12, HY-006-13, HY-006-14, HY-006-15, DR-006-22, HY-006-30, DR-008-01, DR-008-03, DR-009-01, DR-009-03, HY-010-01, HY-011-01, HY-011-03, HY-011-04, HY-011-05, HY-011-07.

Key sites in this region are located on Maps B-J.

Roanoke Sound, Island H (DR-003-04)

Island DR-003-04 (35°51'N,75°37'W) is part of the chain of dredged-material islands that lie along the channel from Oregon Inlet through Roanoke Sound in Dare County (Map B).

Site type: Diked dredged-material island.

Size: About 1 ha.

Topography: This island has been diked since 1977. The dike is 2 to 3 m in height, and has been filled to within 0.5 m of the top. The surface of the deposit is nearly flat with little indication of a dome.

Vegetation: The surface was nearly bare of vegetation in 1983, but the outer slope of the dike was being covered with plants.

Surroundings: This island is bounded to the west by a navigation channel and on all other sides by shallow estuarine waters.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: This site was covered by dense stands of saltmeadow cordgrass and wax myrtle thickets in 1977, but was not used by colonial waterbirds. It was diked and received at least one deposit of dredged material between 1977 and the early 1980s. By 1982 it was occupied by terns. It was the site of the only colonies of Least, Common, and Gull-billed terns in Oregon Inlet in 1983 and was also occupied by nesting Herring Gulls. It was not used by colonial waterbirds in 1988.

Site potential: Potential for use at this site is dependent upon the frequency of dredged material placed at this site. With frequent depostion the site may be used by the pioneer species. Without deposition grasses and shrub thickets may allow use by Laughing Gulls or wading birds.

Roanoke Sound Island, Island F (DR-003-05)

This island (35°48'N, 75°35'W) is located along the channel between Oregon Inlet and Wanchese in Dare County (Map B).

Site type: Dredged-material island.

Size: 20 to 30 ha.

Topography: This large, long island is characterized by a series of alternating domes and swales. Maximum elevation is 3.5 m.

Vegetation: Dense stands of saltmeadow cordgrass occupy the swales and slopes. Several scattered thickets comprised primarily of bayberry and wax myrtle occur in the swales along the east side of the island.

Surroundings: A navigation channel and open water flats.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: In the early 1970s this island was occupied by Black Skimmers, Gull-billed and Common terns, Laughing and Herring gulls, and a mixed-species heronry. By 1975 the skimmers and terns had abandoned the site and by 1983 the heronry had moved to nearby DR-03-09. In 1988, only Herring Gulls nested here.

Site potential: The shrub thicket habitat is expanding, and nesting habitat for herons, egrets, and ibises is increasing. Vegetation has become too dense for the ground nesters.

Roanoke Sound, Island E (DR-003-06)

This island (35°50'N, 75°36'W) is located along the channel from Oregon Inlet through Roanoke Sound in Dare County (Map B).

Site type: Undiked dredged-material island.

Size: 2.0 ha.

Topography: This site consists of several domes separated by low swales. Maximum elevation is 2.3 m.

Vegetation: This island is covered by moderate to dense stands of grasses and forbs. Saltmeadow cordgrass dominates the site.

Surroundings: A navigation channel and open water flats.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: This site was used by Herring and Laughing Gulls in 1977. Since that time only small Herring Gull colonies have been present.

Site potential: This site is developing dense stands of grasses and forbs and is not likely to be used again by pioneer species unless there are new deposits of dredged material.

Roanoke Sound, Island G (DR-003-09)

This island is located about midway (35°49'N,75°35'W) along the channel from Oregon Inlet through Roanoke Sound in Dare County (Map B).

Site type: Undiked dredged-material island.

Size: 20-30 ha.

Topography: This island consists of several low domes separated by swales. Maximum elevation in 1976 was 1.3 m.

Vegetation: Most of the island is covered by dense stands of grasses and forbs dominated by saltmeadow cordgrass and seaside goldenrod. Dense wax myrtle and silverling thickets are also present. A deposit of dredged material, placed on the north end of the island in 1982 or 1983, began to develop a cover of grasses and forbs by 1988.

Ownership: As a dredged-material island built on a subtidal flat, this island is most likely owned by the State of North Carolina.

Surroundings: The island is bounded on the west by a maintained channel and on all other sides by shallow estuarine waters.

History of use by colonial waterbirds: This site has been used by nesting Laughing and Herring gulls since at least the early 1970s. In 1976, there was a mixed colony of the smaller terns on a new dredged-material deposit. By 1977, only Laughing, Herring and Great Black-backed gulls remained. By 1983, the heronry, which had been developing on nearby DR-03-05, had moved to this site, as had additional gulls. By 1988, the Laughing Gulls had abandoned the island. Herring and Great Black-backed gulls continued to nest in 1988, and the heronry was still active. It became the most northern nesting site for White Ibis in North Carolina in 1983 when one nest was found (Shields and Parnell 1983), and in 1988 several adults were present and apparently nesting.

Site potential: This site should be protected for use by nesting herons, egrets and ibises. The shrub thickets are expanding and the heronry is growing. Deposits of dredged material in 1982 or 1983 destroyed a portion of the thicket in which the herons were nesting.

Sand Shoal Island (DR-005-03)

This new island (35°46'N,75°34'W) was built during the dredging of Oregon Inlet in 1987 (Map B).

Site type: Undiked dredged-material island.

Size: Less than 1 ha.

Topography: A sandy island with a single elevated dome about 3 m tall.

Vegetation: The site was without vegetation in 1988.

Surroundings: Open water of Oregon Inlet.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: This island was created in 1987. In 1988, the first year of use, more than 600 nests of 6 species (Common, Least, Gull-billed, Royal and Sandwich terns and Black Skimmers) were present.

Site potential: This site is eroding severely and without further deposition of dredged material will likely vanish in a few years.

Oregon Inlet, Island B (DR-005-05)

This is the most eastern (35°47'N, 75°33'W) of the island chain extending westward from the Oregon Inlet bridge and north of the inlet channel (Map B).

Site type: Undiked dredged-material island.

Size: Not measured.

Topography: A sandy elongate island elevated about 2 m above high tide.

Vegetation: Most of the uplands were covered by a dense shrub thicket in 1989.

Surroundings: Marshes and shallow flats to the north and the Oregon Inlet channel to the south.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the state of North Carolina.

History of use by colonial waterbirds: A small heronry was located on this island in 1988. By 1989 there were at least 374 nests of 9 species present.

Site potential: Erosion along the Oregon Inlet channel is moderate. The site will likely remain suitable as a heronry site for several years.

Oregon Inlet, Island C (DR-005-06)

This island is west of the Oregon Inlet Bridge at the junction of channels to Pamlico Sound and Wanchese (35°46'N, 75°34'W) in Dare County (Map B).

Site type: Undiked dredged-material island.

Size: Not measured.

Topography: This large island contains domes elevated as much as 4.1 m. Low swales exist along the northern edge.

Vegetation: This site contains bare or nearly bare sandy domes, sparse to dense stands of grasses and forbs dominated by saltmeadow cordgrass and low shrub thickets dominated by wax myrtle.

Surroundings: This island is bounded to the south by a deep channel and to the north by shallow flats.

Ownership: This island may be in private ownership. A cabin is present.

History of use by colonial waterbirds: This site has been used occasionally by small colonies of terns and skimmers. In 1985, two Great Black-backed Gull nests were present.

Site potential: The large size and presence of a cabin make this site less suitable than other nearby sites. It is unlikely to become an important nesting site.

Old House Channel, Island L and Old House Channel, Island MN
DR-006-02 and DR-006-08

These two islands comprise the chain of dredged-material islands extending from Oregon Inlet west into Pamlico Sound in Dare County (Map B). When initially numbered they represented three distinct islands, but DR-006-08 (35°46'N,75°36'W) and DR-006-23 (35°42'N,75°46'W) have now coalesced into a single island, and DR-006-02 (35°46'N,75°35'W) has joined with other unnumbered islands to form one large multi-domed island.

Site type: Undiked dredged-material island.

Size: DR-006-02 is 10-20 ha; DR-006-08 is 10-20 ha.

Topography: These islands consist of several elevated domes separated by low swales. Maximum elevations in 1977 were about 2 m.

Vegetation: In 1988 the easternmost dome of island DR-006-02 was bare. All other domes were sparsely or moderately vegetated with grasses and herbs such as seaside goldenrod and panic grass. The lower slopes and swales were covered with saltmeadow cordgrass and other forbs. Shrub thickets dominated by wax myrtle were developing in some swales, especially on the western end of the island chain.

Surroundings: These islands are bounded to the north by shallow flats and to the south by Old House Channel.

Ownership: As dredged-material islands established on subtidal flats, these islands are most likely owned by the State of North Carolina.

History of use by colonial waterbirds: These islands have been important nesting sites for the pioneer ground nesting gulls and terns since at least the early 1970s. In 1977, gulls and terns nested on islands DR-006-02, DR-006-08 and DR-006-23. However, Royal and Sandwich terns did not move to this site until 1978. In 1983, the Royal and Sandwich terns remained on DR-006-02 and Laughing Gulls had also increased in numbers. Most of the smaller terns had abandoned these islands. Brown Pelicans established a colony on the far western end of DR-006-08 in 1983, and this island is also becoming an important nesting site for Herring Gulls. By 1984 the pelican colony had grown to more than 50 nests and appeared to be firmly established. In 1988, more than 1000 Brown Pelican nests made this the largest nesting colony in North Carolina. A small heronry was present in 1988.

Site potential: This is the most important nesting site for the ground nesting gulls, terns and pelicans in the northern portion of Pamlico Sound. While nearby islands adjacent to the channel through Roanoke Sound are also important, they are less isolated and more susceptible to disturbance. Regular dredging of the heavily used Old House Channel is likely to continue, and maintenance of early successional stages is possible if these islands remain undiked.

UNI, Stumpy Point Bay (DR-006-09)

Island DR-006-09 is located in Dare County in Stumpy Point Bay (35°42'N, 46°46'W) just south of the boat harbor next to US 64 (Map C).

Site type: Undiked dredged-material island.

Size: 1 to 2 ha.

Topography: This island had a single low dome about 2.5 m in elevation in 1976.

Vegetation: Dense stands of mixed grasses and forbs cover the lower slopes and swales. Shrub thickets cover the remainder of the site.

Surroundings: Open water.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: This island was occupied by nesting Common and Gull-billed terns and Black Skimmers during 1976, 1977 and 1983 (Soots and Parnell 1979, Parnell and McCrimmon 1984). No nests were present in 1988.

Site potential: This is the only site on the west side of Pamlico Sound that is sufficiently elevated and that has the proper substrate to attract Black Skimmers and Gull-billed Terns. A return of the surface of this island to bare conditions would likely lead to recolonization.

UNI, Hatteras Ferry Channel #1 (DR-006-10)

Island DR-006-10 (35°12'N,75°36'W) is in Pamlico Sound about 2 km west-southwest of Hatteras Village in Dare County (Map I).

Site type: Undiked dredged-material island.

Size: 3-5 ha.

Topography: The single dome of this island had a maximum elevation of about 2 m in 1983. By 1988 erosion had removed much of this dome.

Vegetation: In 1988, the dome was sparsely vegetated, and the slopes were densely covered by saltmeadow cordgrass, seaside goldenrod, pennywort, and giant reed. The lower slopes and swales contained a thicket of silverling and giant reed.

Surroundings: Boat channel and shallow water flats.

Ownership: As a dredged-material island established on subtidal flats, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: This island was the site of a large Royal and Sandwich tern colony from the mid-1970s to the mid 1980s. Common and Forster's terns also nested. Laughing Gulls were numerous in 1977, but this species was absent in 1983. A single Herring Gull nest was present in 1977; nine were found in 1983, and 70 in 1988. This island has supported a small heronry since 1977. Small tern colonies persist.

Site potential: This island lies next to a heavily used boat channel, and moderate erosion of the site is occurring. Beach erosion and encroachment of vegetation on the dome probably account for abandonment by Royal Terns. Although the numbers of Common and Forster's terns doubled since 1977, continued use of the site by these species is difficult to predict. They use the upper beach and drift ridges, often nesting on wrack lines. The availability of wrack and the succession of plants on the upper beach and drift ridges are dependent upon the vagaries of storm tides. The shrub thicket has spread since 1977 and the number of wading bird nests increased slightly in 1988. Suitable habitat for wading birds should continue to exist for several years.

Gull Island (DR-006-12)

Gull Island (35°28'N,75°31'W) is in Dare County just southwest of Salvo (Map D).

Site type: Natural estuarine island.

Size: 35 ha.

Topography: A flat marsh island. Maximum elevation in 1976 was 0.8 m. Most of the island is irregularly flooded marsh, with a slightly elevated sand rim along the western shore. A duck club is adjacent to an old boat basin and channel.

Vegetation: Most of the island is covered by dense stands of saltmeadow cordgrass, black needlerush and smooth cordgrass. The sand rim is dominated by saltmeadow cordgrass and low thickets of marsh elder and sea ox-eye.

Surroundings: Shallow estuarine waters.

Ownership: Private.

History of use by colonial waterbirds: This island has supported colonial waterbirds since at least the early 1970s. The size of the heronry is diminishing, but the marsh nesting Laughing Gulls and Forster's Terns continue to use the site. The Laughing Gull population grew considerably between 1977 and 1983 and appeared to remain stable in 1988. This island has had a nesting colony of Royal Terns in the past in addition to the species currently present.

Site potential: This site should continue to be suitable for nesting Laughing Gulls and Forster's Terns. If the thickets on the sand rim continue to develop, habitat for a heronry may improve at the expense of Laughing Gull habitat. Forster's Tern habitat should continue to be suitable as long as wrack is deposited in the marsh.

Swanquarter Island, Judith Island-Point, Judith Island, Judith Narrows (HY-006-13, HY-006-14, HY-006-15)

These islands are within the Swanquarter National Wildlife Refuge just southwest of Swanquarter in Hyde County (35°20-21'N,76°22'W) (Map F).

Site type: Natural estuarine islands.

Size: 1-2 ha each.

Topography: Low flat marsh islands 0.1 to 0.3 m in elevation.

Vegetation: These islands are covered primarily by dense stands of saltmeadow cordgrass and salt grass.

Surroundings: Open shallow water.

Ownership: Department of the Interior, U. S. Fish and Wildlife Service.

History of use by colonial waterbirds: Forster's and Common terns nest on one or more of these islands most years. Sites chosen depend on the presence of mats of dead marsh grasses deposited during high tide.

Site potential: These islands should continue to be used by Common and Forster's terns as long as wrack deposits are available.

Swan Island (CR-006-19)

Swan Island (35°05'N, 76°25'W) is off the western tip of Cedar Island in Carteret County (Map H).

Site type: Natural estuarine island.

Size: Not measured.

Topography: A low, marsh island. Maximum elevation is 0.5 m.

Vegetation: Elevated portions of this island are covered by somewhat dense stands of grasses and forbs, primarily saltmeadow cordgrass and seaside goldenrod. Much of the island is brackish marsh dominated by smooth cordgrass.

Surroundings: Open shallow water.

Ownership: Unknown.

History of use by colonial waterbirds: In 1976 and 1977, a small heronry was present. In 1985 Least Terns and Herring Gulls were present in addition to a heronry. In 1988 Brown Pelicans nested on the site for the first time.

Site potential: This island is very isolated and apparently attractive to nesting birds. The low elevation indicates that flooding is likely. Continued use of the site appears likely.

Clam Shoal (DR-006-22)

Clam Shoal (35°22'N, 75°40'W) is located along the eastern edge of Pamlico Sound west of Buxton (Map G).

Site type: Natural estuarine island.

Size: Not measured.

Topography: A long, narrow, shoal rising a few cm above high tide.

Vegetation: None.

Surroundings: Open shallow water

Ownership: The State of North Carolina.

History of use by colonial waterbirds: In 1988 this low shoal was occupied by small colonies of Least, Common, Forster's and Royal terns and Black Skimmers.

Site potential: This site is very isolated and free from mammalian predators and human disturbance. The low elevation and exposed placement suggest a strong likelihood of nest destruction by flooding.

Hog Island (HY-006-30)

Hog Island (35°22'N,76°04'W) is along the western shore of Pamlico Sound, about 5 km south of Gull Rock, Hyde County (Map E).

Site type: Natural estuarine island.

Size: Unmeasured.

Topography: This is a low, flat marsh island with a maximum elevation of about 0.2 m in 1983.

Vegetation: Hog Island is covered by dense growths of saltmeadow cordgrass, saltgrass, and giant cordgrass.

Surroundings: Shallow open water.

Ownership: State-owned, part of Gull Rock Wildlife Management Area.

History of use by colonial waterbirds: This site was unoccupied in 1976 and 1977, but contained 308 Forster's Tern nests in 1983. It was not surveyed in 1988.

Site potential: The frequent flooding of this island by storm tides should prevent the habitat from progressing past its present stage. Use of Hog Island by Forster's Terns is apparently dependent upon the presence of wrack lines. Continued use of the site may be expected as long as wrack lines are available.

Great Island (HY-006-31)

Great Island (35°19'N,76°17'W) is in Hyde County within the Swanquarter National Wildlife Refuge (Map F).

Site type: Natural estuarine island.

Size: Not measured.

Topography: This is a low marsh island.

Vegetation: This site is dominated by smooth cordgrass, saltmeadow cordgrass, black needlerush and marsh elder.

Surroundings: Open water of Pamlico Sound.

Ownership: Department of the Interior, U. S. Fish and Wildlife Service.

History of use by colonial waterbirds: This site has been used sporadically by Common and Forster's terns when appropriate substrate is present.

Site potential: This site will likely be used when wrack deposits are present.

UNI, West Tip Judith Island (HY-006-32)

This small island (35°22'N,75°26'W) is just off the west end of Judith Island in the Swanquarter Wildlife Refuge (Map F).

Site type: Natural estuarine island.

Size: Less than 1 ha.

Topography: A small, low marsh island.

Vegetation: Site is covered by smooth cordgrass, saltmeadow cordgrass and black needlerush.

Surroundings: Larger marsh islands and the open water of Pamlico Sound.

Ownership: Department of the Interior, U. S. Fish and Wildlife Service.

History of use by colonial waterbirds: This site has been used sporadically by Common and Forster's terns when appropriate substrate is present.

Site potential: This site will likely be used when wrack deposits are present.

UNI, Pea Island Marsh #2 (DR-007-06)

This site consists of several small islands within the impoundments at the Pea Island National Wildlife Refuge in Dare County (35°42'N,75°30'W) (Map B).

Site type: Man-made islands within diked impoundment.

Size: Narrow linear islands probably less than 0.1 ha each.

Topography: These islands were constructed as windbreaks to provide protection from wave action for the dikes. They are narrow elongate islands elevated 0.5-1.0 m.

Vegetation: Covered with sparse stands of grasses.

Surroundings: Shallow open water.

Ownership: Department of the Interior, U. S. Fish and Wildlife Service.

History of use by colonial waterbirds: These small islands were used as nesting sites for only a year or two. They were first surveyed in 1983. The colonies were not visited, but incubating adults could be counted from nearby dikes. A total of 62 Common Tern and 23 Black Skimmer adults was counted in 1983. No birds were nesting in 1988.

Site potential: Potential for successful nesting is poor at this site. The refuge is home for raccoons and other predators. Access to these sites is easy.

Beach Sites On Hatteras Island (DR-008-01)

Hatteras Beach Sites (35°14-40'N, 75°27-30'W) located in Dare County (Map D & G).

Site type: Barrier beach.

Size: Not applicable.

Topography: Sites located on berm of beach between the high tide line and the foot of the dune.

Vegetation: Generally bare, with scattered clumps of sea rocket, sea oats and saltmeadow cordgrass.

Surroundings: Ocean and barrier dunes.

Ownership: National Park Service, Cape Hatteras National Seashore.

History of use by colonial waterbirds: Small colonies of Least Terns are usually present between Oregon Inlet and Buxton each year. Colony location varies depending on overwash and other factors.

Site potential: As long as overwash occurs and inlets continue to migrate, Least Tern habitat will be present on the outer beaches. Inlet and dune stabilization will tend to reduce habitat. Human disturbance increasingly disrupts colonies as the number of people using the beaches increases.

Cape Point (DR-008-02)

This colony site is at Cape Point near Buxton in Dare County (35°13'N,75°41'W) (Map G).

Site type: Barrier island beach.

Size: Not applicable.

Topography: Cape Point is a sand spit at the point where the shoreline of Hatteras Island turns abruptly westward. The colony site is well above the high tide line between the south facing beach and the large borrow pit that lies between the ocean and the foredunes.

Vegetation: The site was mostly bare with scattered clumps of sea oats, sea rocket and saltmeadow cordgrass in 1983. By 1988, succession had led to a moderate cover of grasses and forbs on the site.

Surroundings: Open sand flats.

Ownership: National Park Service, Cape Hatteras National Seashore.

History of use by colonial waterbirds: A mixed-species colony of terns and skimmers was established in 1984, although a few Least Terns nested nearby in earlier years. It was studied carefully in 1984 as a part of a cooperative study between the National Seashore and the University of North Carolina at Wilmington (Golder 1984). Nest numbers in 1984 were as follows: Gull-billed Tern, 32; Common Tern, 1,082; Least Tern, 616; and Black Skimmer, 87 (Golder 1984). In 1988 the same species were present, but total numbers had declined to 707.

Site potential: Habitat at this site is likely to be maintained by a combination of natural environmental factors and human activities. The area is heavily used by people and ORV traffic is often intense. The site may be sufficiently distant from heavy cover to discourage visits by mammalian predators. With protection from human interference and maintenance of a bare or sparsely vegetated surface, this site may remain usable for several years.

Cape Point-South Beach (DR-008-03)

Cape Point-South Beach (35°14'N, 75°33'W) is southwest of Cape Point near Buxton in Dare County (Map G).

Site type: Barrier island beach.

Size: Not applicable.

Topography: This site is on the upper beach berm just seaward of the base of the foredune.

Vegetation: This site is mostly bare.

Surroundings: Open beach and dunes.

Ownership: National Park Service, Cape Hatteras National Seashore.

History of use by colonial waterbirds: This site has been used since 1986 by small to moderate colonies of terns and skimmers.

Site potential: Use of this site is likely to continue so long as the National Park Service provides protection from human disturbance, unless beach erosion renders the site unsuitable.

Beach Northside Hatteras Inlet (DR-009-01)

This colony was located on the beach spit just north of Hatteras Inlet in Dare County (35°11'N,75°45'W) (Map I).

Site type: Barrier island beach.

Size: Not applicable.

Topography: Low sand flats with scattered haycock dunes just above high tide; floods on moderate storm tides.

Vegetation: Generally bare except for scattered clumps of sea rocket and sea oats.

Surroundings: Open sand flats.

Ownership: National Park Service, Cape Hatteras National Seashore.

History of use by colonial waterbirds: This site became occupied in 1984 when it contained nests of 16 Gull-billed Terns, 428 Common Terns, 217 Least Terns and 318 Black Skimmers (Golder 1984). In 1988, a total of 174 nests was counted.

Site potential: This site is lower in elevation than the Cape Point site and was partially flooded during the nesting season in 1984 (Golder 1984) and 1988. Vehicular traffic is not as heavy as at Cape Point. Periodic flooding should prevent rapid plant succession and the site should remain suitable for management groups 2 and 3 for several years. Flooding of nests may continue to be a problem.

Outer Green Island (HY-010-02)

Outer Green Island (35°11'N,75°48'W) is located in Pamlico Sound near the northern tip of Ocracoke Island in Hyde County (Map I).

Site type: Natural estuarine island.

Size: 3-6 ha.

Topography: This is a low, flat marsh island. Maximum elevation in 1983 was 0.5 m.

Vegetation: Outer Green Island was covered by a dense growth of sea ox-eye, saltgrass, saltmeadow cordgrass, smooth cordgrass, and black needlerush in 1983.

Surroundings: Shallow open water.

Ownership: Unknown.

History of use by colonial waterbirds: Outer Green Island was the site of a heronry and a Laughing Gull colony from 1974 through 1983. In 1977, 111 nests of six wading bird species and 99 Laughing Gull nests were present. A single Herring Gull nest was also found in 1977. In 1983, the number of Laughing Gulls had decreased substantially, and only a single wading bird, the Glossy Ibis, nested. A small colony of Forster's Terns was present in 1983. No birds nested at this site in 1988.

Site potential: The habitat on Outer Green Island changed little between 1977 and 1988, and regular flooding during storm tides will likely prevent plant succession from progressing beyond the current stage. The reason for the decline in wading bird and Laughing Gull numbers is unclear. The potential for future use of this site by wading birds, Laughing Gulls, and Forster's Terns appears good.

DOT Island (DR-009-03)

Island DR-009-03 (35°13'N,75°45'W) lies just inside Hatteras Inlet on the border of Dare and Hyde counties (Map I).

Site type: Partially-diked dredged-material island.

Size: 5-10 ha.

Topography: This large island frequently receives deposits of dredged material. In 1983, the eastern end of the island was composed of two high domes with a maximum elevation of 15 m. The domes dropped abruptly to the sound on the east and south sides of the island, but sloped gradually to the north and west. The northern edge and western end of the island were somewhat low and flat.

Vegetation: The high domes and much of the upper slopes were vegetated only by scattered clumps of sea oats in 1988. The lower slopes and swales were covered by saltmeadow cordgrass, pennywort, horseweed, and marsh elder. A wax myrtle thicket is developing.

Surroundings: Shallow open water and boat channel.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: Island DR-009-03 has been heavily used by ground-nesting species since the early 1970s. In 1977, this island supported a large breeding assemblage of Common, Forster's and Gull-billed terns, Black Skimmers and one of the largest Least Tern colonies in the state. No Least Terns nested here in 1983, but large numbers of Royal and Sandwich terns and smaller numbers of Common, Forster's, and Gull-billed terns and Black Skimmers were present. The Laughing Gull population grew from five nests in 1977 to 2,685 nests in 1983. By 1988, the Laughing Gull colony had grown to more than 3,500 nests, but all terns, except Forster's, had abandoned the site.

Site potential: The lower vegetated portion should continue to provide suitable habitat for Laughing Gulls and Forster's Terns for several years, provided no dredged material is deposited on this area.

Ocracoke Beach and Ocracoke Beach Airport (HY-010-01)

Ocracoke Island beaches (35°05-11'N,75°45-59'W) (Map J).

Site type: Barrier island beach.

Size: Not applicable.

Topography: This site consists of two beach sites that are generally on the berm between the high tide line and the base of the foredune.

Vegetation: Vegetative cover is generally sparse or absent. Scattered clumps of sea rocket, sea oats, or saltmeadow cordgrass may be present.

Surroundings: Beach and dune fields.

Ownership: National Park Service, Cape Hatteras National Seashore.

History of use by colonial waterbirds: Small colonies of Least Terns have become established at several sites on Ocracoke Island. Location varies from year to year.

Site potential: As long as overwash occurs and protection from human disturbance is provided, Ocracoke Island beaches are likely to be used by Least Terns.

UNI, Ocracoke Marsh #5 and #6 (HY-010-10)

UNI, Ocracoke Marsh Islands (35°09'-11'N, 75°49'-55'W) are located in Hyde County on the west side of Ocracoke Island (Map J).

Site type: Natural estuarine islands.

Size: Less than 1 ha.

Topography: Low marsh islands a few cm above high tide. Maximum elevation is 0.1-0.2 m.

Vegetation: These islands are dominated by dense stands of saltmeadow cordgrass, sea ox-eye, smooth cordgrass, and an occasional marsh elder.

Surroundings: Extensive salt marshes and shallow open water.

Ownership: Unknown.

History of use by colonial waterbirds: Each year several colonies of Forster's Terns are established on those islands that have the appropriate accumulation of drift material (primarily dead marsh grasses or sea grasses). Nesting sites may be expected to shift from year to year.

Site potential: These sites are seldom visited by people during the summer, and colonies are not likely to be disturbed. Sites are accessible to predators. Vegetation is maintained by storm tide flooding and is unlikely to progress beyond the present stage. Potential for continued use appears good.

Ocracoke Village (HY-010-16)

This site (35°06'N, 75°59'W) is located south of Ocracoke Village on Ocracoke Island in Hyde County (Map J).

Site type: Barrier island.

Size: Not applicable.

Topography: This site is an elevated island within an extensive saltmarsh. Maximum elevation is 1.0 m.

Vegetation: The island is covered by a dense thicket of wax myrtle, red cedar, loblolly pine and live oak.

Surroundings: Extensive salt marshes.

Ownership: National Park Service, Cape Hatteras National Seashore.

History of use by colonial waterbirds: This site has been used as a heronry only since 1987.

Site potential: This site should remain suitable for many years.

Pony Pen South (HY-010-17)

Pony Pen South (35°05'N, 75°58'W) is located on the sound side of Ocracoke Island just south of the pony pens (Map I).

Site type: Barrier beach.

Size: Not applicable.

Topography: This site is along the westward edge of the barrier island near the upland marsh junction.

Vegetation: This site has an upland thicket of wax myrtle, loblolly pine, red cedar and yaupon, interlaced with greenbriar.

Surroundings: This site is bounded to the west by the marsh fringe of Ocracoke Island and to the east by low sea oats covered dunes.

Ownership: National Park Service, Cape Hatteras National Seashore.

History of use by colonial waterbirds: This has been the site of a small heronry for several years.

Site potential: This site should remain suitable as a heronry site for many years.

Pony Pen North (HY-010-18)

Pony Pen North (35°06'N, 75°59'W) is located on the south side of Ocracoke Island just north of the pony pens (Map I).

Site type: Barrier beach.

Size: Not applicable.

Topography: This site is along the westward edge of the barrier island near the upland marsh junction.

Vegetation: This site is dominated by a dense tangle of live oak, yaupon and greenbriar.

Ownership: National Park Service, Cape Hatteras National Seashore.

History of use by colonial waterbirds: This site is either the site of a small heronry or is a breeding season roost.

Site potential: This site should remain suitable as a heronry site for many years.

Ocracoke Inlet Beach-N (HY-011-01)

Ocracoke Inlet Beach N (35°04'N,76°00'W) is located on Ocracoke Flats at the southern terminus of Ocracoke Island in Hyde County (Map J).

Site type: Barrier beach.

Size: Not measured.

Topography: This site has low flats that are often overwashed by storms, and small scattered haycock dunes.

Vegetation: For many years Ocracoke Flats was an area of low, bare sand flats. Vegetation consisted of a sparse cover of sea oats on scattered low dunes and a fringe of saltmarsh along the western edge of the island. Flooding and intense and unrestricted ORV traffic apparently maintained the barren conditions. In the early 1980s a road was constructed across the flats and traffic was restricted. The flats quickly converted to salt marsh. Most of the once bare region was a rapidly developing brackish marsh by 1988.

Ownership: National Park Service, Cape Hatteras National Seashore.

History of use by colonial waterbirds: Ocracoke Flats was one of the most important beach nesting areas in North Carolina from the mid-1970s to early 1980s. Gull-billed, Common and Least terns and Black Skimmers nested on the beach and Forster's Terns nested on drift material in the fringing saltmarsh along the sound in 1977. All species except the Gull-billed Tern were present in 1983, and Gull-bills returned in 1984; a single Caspian Tern nest was also present in 1984. By 1988 all nesting colonial waterbirds had abandoned the site.

Site potential: Unless the substrate at this site is returned to bare or nearly bare conditions, potential for future nesting by colonial waterbirds is not good.

Natural Shoal Ocracoke Inlet (HY-011-03)

Natural Shoal (35°04'N,76°02'W) in the mouth of Ocracoke Inlet (Map J).

Site type: Natural estuarine island.

Size: Not measured.

Topography: Generally low and flat. A small central region has risen about 1 m above high tide.

Vegetation: Most of this site is bare. The slightly elevated area was covered by a sparse to moderately dense cover of saltmeadow cordgrass in 1988.

Surroundings: Open waters of Ocracoke Inlet.

Ownership: Unknown, but likely the State of North Carolina.

History of use by colonial waterbirds: This site was colonized in 1987 by many of the terns and skimmers that were forced to abandon Ocracoke Flats (HY-011-01) by the developing vegetation. In 1988, it became an important site with more than 880 Common Tern and Black Skimmer nests. It was also the site of two Sooty Tern (Sterna fuscata) nests.

Site potential: This windswept island is emerging and may provide suitable nesting habitat for the pioneer species for several years. It is in a very dynamic system and could easily become sub-tidal again.

Beacon Island (HY-011-04)

Beacon Island (35°06'N,76°03'W) lies just inside Ocracoke Inlet about 6 km west of the village of Ocracoke in Hyde County (Map J).

Site type: Natural estuarine island.

Size: About 5 ha.

Topography: Beacon Island is low (maximum elevation 0.3 m) and flat.

Vegetation: In 1988, this island was covered by dense stands of salt grass, smooth cordgrass, and sea ox-eye. A narrow thicket of marsh elder fringed the southern perimeter of the island.

Surroundings: Shallow open water.

Ownership: National Audubon Society.

History of use by colonial waterbirds: A small colony of Great Egrets, Snowy Egrets, Little Blue Herons, Tricolored Herons, and Glossy Ibises nested in the thicket from at least the early 1970s through 1977. No wading birds were present in 1988. Brown Pelicans moved to this site from nearby North Rock and Shell Castle islands in 1978 and have nested here each year since (Parnell and Soots 1982, Parnell and McCrimmon 1984). More than half the state's breeding population of Brown Pelicans (800+ pairs) nested on Beacon Island in 1983 (Parnell and McCrimmon 1984), but by 1988 numbers had declined to only 181 nests. This island is an important breeding site for Laughing Gulls and Forster's Terns. The Herring Gull population increased from a single pair in 1977 to 68 nests in 1983, but numbers were reduced in 1988.

Site potential: Beacon Island has been an important nesting site for colonial waterbirds since the early 1970s and should continue to provide suitable nesting habitat for Brown Pelicans, Forster's Terns, and Laughing and Herring gulls. This island is isolated from the mainland and appears predator-free, except for the Herring Gulls. A stack of crab pots and a duck blind were present in 1988, but local watermen seem quite protective of the birds. Human disturbance during the breeding season appears limited to the activities of these local fishermen in the surrounding waters. Beacon Island is low and flooding appears to be the major threat to nesting birds. Moderate shoreline erosion was noted in 1988.

Shell Castle Island, East (HY-011-05)

Shell Castle Island, east (35°06'N, 76°03'W) is adjacent to Wallace Channel in Hyde County (Map J).

Site type: Site obviously altered heavily, origin uncertain.

Size: About 0.25 ha.

Topography: A long, narrow shell bank. Maximum elevation is 0.5 m.

Vegetation: This site was mostly unvegetated. There were a few isolated clumps of sea rocket and saltmeadow cordgrass.

Surroundings: A deep water channel and extensive shallow open water flats.

Ownership: National Audubon Society.

History of use by colonial waterbirds: In 1977, a small colony of Royal and Sandwich terns moved to this site. There was a colony of Common Terns and four Forster's Tern nests. Eighteen Herring Gull nests were present. By 1978, the Royal Terns had abandoned the site. In 1983 and 1988 the site was used only by nesting Herring Gulls.

Site potential: This site has maintained its present character since the early 1970s. Its low elevation and shell substrate will likely prevent rapid growth of vegetation. It probably will remain a suitable nesting site for small numbers of the pioneer species for several years.

Shell Castle Island West and North Rock Island (HY-011-06 and HY-011-07)

These islands lie inside Ocracoke Inlet about 8 km west of Ocracoke in Hyde County (35°07'N,76°04'W) (Map J).

Site type: Origins uncertain, but both islands have been greatly altered by human activity.

Size: Shell Castle: 0.5-1.0 ha; North Rock: 2-5 ha.

Topography: Shell Castle is a long narrow island with a maximum elevation of about 1 m. North Rock is composed of two islands separated by intertidal flats. Maximum elevation of these islands is 0.5 m.

Vegetation: Shell Castle had a moderate cover of sea ox-eye, paspalum grass, and marsh elder in 1983. The easternmost island in the North Rock complex was moderately covered by seaside goldenrod, saltmeadow cordgrass, paspalum grass, and marsh elder. The other island was moderately to heavily vegetated by sea ox-eye and a thicket of marsh elder.

Surroundings: Extensive shallow open water flats. A deep channel lies next to Shell Castle Island.

Ownership: National Audubon Society.

History of use by colonial waterbirds: Brown Pelicans have nested on Shell Castle, North Rock or neighboring islands most years since 1947 (Parnell and Soots 1979). In recent years pelicans have nested only on nearby Beacon Island (Parnell and Soots 1982, Parnell and McCrimmon 1984). Forster's Terns and Herring Gulls have nested on Shell Castle since the late 1970s. The North Rock complex has supported a heronry and colonies of Common and Forster's terns since the early 1970s. A colony of Royal and Sandwich terns used this site in 1978, but neither species was present in 1983. A single Herring Gull nest was present on North Rock in 1977; two nests were found in 1983 (Parnell and McCrimmon 1984); and 25 nests were counted in 1988.

Site potential: The number of terns nesting on these islands has declined since 1977 as vegetative cover increased. Vegetation probably will become too dense for nesting by Common Terns in the near future. Herring Gulls, however, have increased in numbers since 1977, and Forster's Terns have used the site most years. The shrub thicket on North Rock still supports a small heronry and should continue to do so in future years. A small fishing shack and boat dock were present on North Rock in 1983.

UNI, Wallace Channel #1 (HY-011-08)

This site (35°05'N, 76°04'W) is located just west of the northern tip of Portsmouth Island in Wallace Channel in Hyde County (Map J).

Site type: Natural estuarine island.

Size: Not measured.

Topography: A low marsh island.

Vegetation: This small island is covered by stands of smooth cordgrass and saltmeadow cordgrass.

Surroundings: Open shallow water.

Ownership: Unknown.

History of use by colonial waterbirds: This site was occupied by a small colony of Least and Common terns and Black Skimmers in 1985.

Site potential: This site should continue to be suitable when appropriate substrate is present.

Avers Rock (CR-012-02)

Avers Rock (35°05'N, 76°04'W) is in Ocracoke Inlet just North of Portsmouth Village in Carteret County (Map J).

Site type: Natural estuarine island.

Size: 1 to 2 ha.

Topography: A low marsh island. Maximum elevation 0.1 m.

Vegetation: This small island is covered by stands of smooth cordgrass, glasswort, and sea ox-eye.

Surroundings: Open water.

Ownership: Unknown.

History of use by colonial waterbirds: This site has been used by Forster's Terns during most years since 1977.

Site potential: This site should continue to be suitable when appropriate substrate is present.

UNI, Ocracoke Inlet #1 (CR-012-03)

Unnamed island (35°04'N,76°03'W) in Ocracoke Inlet in Carteret County (Map J).

Site type: Natural estuarine island.

Size: Less than 1 ha.

Topography: A low marsh island.

Vegetation: This island is dominated by smooth cordgrass and saltmeadow cordgrass.

Surroundings: Open water of Pamlico Sound.

Ownership: Unknown.

History of use by colonial waterbirds: This small marsh island is sometimes chosen by nesting Forster's Terns when appropriate wrack lines provide nesting substrate. In 1988, 25 nests were present.

Site potential: This site should continue to be suitable when appropriate substrate is present.

Casey Island (CR-012-23)

Casey Island (35°05'N, 76°04'W) is just northwest of the northern tip of Portsmouth Island (Map J).

Site type: Natural estuarine island.

Size: 4.0 ha.

Topography: A low marsh island. Maximum elevation is 0.1 m.

Vegetation: Site covered by dense stand of smooth and saltmeadow cordgrasses.

Surroundings: Shallow open water.

Ownership: Unknown.

History of use by colonial waterbirds: This island has occasionally been occupied by small colonies of Forster's Terns.

Site potential: This site will likely continue to be used by Forster's Terns during years when deposits of wrack are present.

UNI, West Portsmouth Village (CR-012-24)

Unnamed island west of Portsmouth Village (35°04'N, 75°06'W) (Map J).

Site type: Natural estuarine island.

Size: Less than 1 ha.

Topography: A low sand and shell island a few cm above high tide.

Vegetation: None.

Surroundings: Shallow open water of Pamlico Sound.

Ownership: Unknown.

History of use by colonial waterbirds: This low sandy shoal has been used in the past by nesting Royal and Sandwich terns, but in 1988, only 25 Herring Gull nests were present.

Site potential: This low island is unlikely to vegetate rapidly due to periodic flooding. It may continue to be used sporadically, but low elevation and location near the south end of Pamlico Sound make it especially vulnerable to flooding.

Region 3: Core and Back sounds and adjacent beaches including Portsmouth Island and Core and Shackleford banks.

There have been traditional concentrations of nesting colonial waterbirds within this region at the confluence of Pamlico and Core sounds, at Old and New Drum inlets, at Barden Inlet and in the mouth of the Newport River. There are usually small colonies of Least, Common and Gull-billed terns and Black Skimmers on overwash fans on Portsmouth and Core Banks, and sometimes at the point on the southwest end of Shackleford Banks. Forster's Terns nest at scattered sites on marsh islands located behind the barrier beaches.

Several small islands extend from the easternmost point of Cedar Island toward Portsmouth Island. Most are natural, but one, Wainwright Island, is either a dredged-material island or has had dredged material deposited on a natural surface. In the recent past, colonial waterbirds have nested on Chainshot Island (CR-015-11), Harbor Island (CR-014-03), Wainwright Island (CR-014-02) and Shell Island (CR-014-01). Vegetation on Chainshot is too thick for most ground nesters. Dredged material has recently been placed on a portion of Wainwright. This degraded the site in terms of use by herons, and the heronry that has been there for several years was reduced in 1988. Royal Terns and Laughing Gulls nested at this site in the late 1970s, but abandoned it as vegetative cover became too heavy. They recolonized the island in 1985 after the creation of an area with a bare substrate. Brown Pelicans also nested in 1988. Shell Island is a very low, narrow shell island. It has been used in the past, but nesting birds usually had difficulties during high water, as maximum elevation was about 0.5 m when measured in 1988.

Opposite Old Drum Inlet in Core Sound there are several islands that were associated with the channel to this inlet that is now closed. One of these islands, CR-016-01, has been an important nesting site since the early 1970s. In recent years, use of this island by pioneer species declined as the habitat became too dense for most terns. In 1988 it had the largest colony of Laughing Gulls in North Carolina, and was the site of a small heronry.

At Barden Inlet a series of islands provide nesting sites for another concentration of birds. Morgan Island (CR-017-01), island CR-017-03, and island CR-017-07 are important. Historically Morgan Island has been most important, often providing nesting substrate for both ground nesters and thickets for herons and egrets. Recently, the heronry has declined and the ground nesters have moved to island CR-017-07, a newer island with less vegetation. The colony on CR-017-03 was disrupted by Norway Rats in the late 1970s and this apparently led to the abandonment of the site.

Several sites along the lower Newport River channel are also important. For many years herons, egrets and ibises nested on Phillips Island (CR-021-04), just north of the Morehead City-to-Beaufort causeway. In the mid-1970s the colony split and many birds moved across the channel to dredged-material island CR-021-03. Both sites were occupied until 1985 when island CR-021-03 was abandoned. Islands CR-018-15 and CR-018-17 in Middle Marsh just behind the west end of Shackleford Banks have been used by herons and egrets for several years. Use of these sites has been erratic with sizable colonies present during some years and few or no nesting birds in others. Dredged-material islands adjacent to the Morehead City

shipping channel are important to ground nesting gulls, terns and skimmers. Island CR-020-03 on the west end of Bird Shoal, and Brant Island (CR-020-06) are most important. They often provide nesting substrate for large colonies of Least, Common and Gull-billed terns and Black Skimmers.

In addition to these large concentrations of nesting birds, several small, low natural islands in Core and Back sounds provide nesting sites for Common and Forster's terns and Black Skimmers. Colonies usually are small and move frequently from one island to another.

Forster's Terns nest on the small marshy islands behind Portsmouth Island and Core Banks. They depend primarily on windrows of dead plant material piled in the marshes. They move nesting sites frequently.

Least, Common and Gull-billed terns and Black Skimmers also nest in small to moderate colonies on overwash fans along the beaches of Portsmouth Island and Core and Shackleford banks. Colonies move frequently, and numbers of nests and species composition vary considerably from year to year. Nesting success is often low due to nest destruction by overwash. Feral cats have also been a problem.

Key sites: CR-011-02, CR-014-01, CR-014-02, CR-014-04, CR-014-05, CR-014-17, CR-014-24, CR-014-25, CR-016-01, CR-017-01, CR-017-02, CR-017-07, CR-018-08, CR-018-15, CR-020-03, CR-020-06, CR-021-03, CR-021-04.

Key sites in region 3 are located on Maps J-P.

Tump Island (CR-006-20)

Tump Island (34°59'N, 76°23'W) is off the western tip of Cedar Island in Carteret County (Map L).

Site Type: Natural estuarine island.

Size: 1 ha.

Topography: A low marsh island. Maximum elevation is 0.6 m.

Vegetation: This site is dominated by dense stands of saltmeadow cordgrass and smooth cordgrass.

Surroundings: Open shallow waters.

Ownership: The U.S. Fish and Wildlife Service, Cedar Island National Wildlife Refuge.

History of Use by Colonial Waterbirds: Since the mid-1970s, this site has regularly been used by small colonies of terns, skimmers and Laughing Gulls.

Site Potential: Potential for continued use of this site is good. Isolation and protection as a part of a National Wildlife Refuge are favorable. The low elevation makes occasional flooding likely.

Raccoon Island (CR-006-34)

Raccoon Island (35°04'N, 75°26'W) is located west of Cedar Island just off Point of Marsh in Carteret County (Map H).

Site type: Natural estuarine island.

Size: Not measured.

Topography: This is a large, low marsh island separated from the Piney Island marshes only by a narrow channel. Maximum elevation is 0.3 m.

Vegetation: This island is dominated by dense stands of smooth cordgrass and saltmeadow cordgrass.

Surroundings: Shallow open water.

Ownership: U.S. Government, within the Piney Island bombing range.

History of use by colonial waterbirds: This site was used by a small Forster's Tern colony in 1989.

Site potential: This site will likely be used by Forster's Terns during years when appropriate deposits of wrack are present.

Ocracoke Inlet Beach-S (CR-011-02)

This site is at the north end of Portsmouth Island (35°04'N, 76°03'W) (Map J).

Site type: Barrier island.

Size: Not measured.

Topography: An incurving sand spit on the south side of Ocracoke Inlet.

Vegetation: Most of this site is bare, with only scattered clumps of grasses and forbs.

Surroundings: Open waters of Ocracoke Inlet and sand flats of Portsmouth Island.

Ownership: National Park Service, Cape Lookout National Seashore.

History of use by colonial waterbirds: This site is occasionally used by small colonies of Least Terns.

Site potential: This site is accreting and should remain usable for several years.

Swash Inlet, Beach (CR-012-01)

Swash Inlet, Beach (35°01'N, 76°06'W) is at the north end of Portsmouth Island in Carteret County (Map J).

Site type: Barrier beach site.

Size: Not measured.

Topography: This beach site is in an area of heavy overwash with scattered haycock dunes.

Vegetation: Most of the site is bare dunes are sparsely vegetated by sea oats and saltmeadow cordgrass.

Surroundings: Open sand flats.

Ownership: National Park Service, Cape Lookout National Seashore.

History of use by colonial waterbirds: This site has occasionally been used by small colonies of terns and skimmers.

Site potential: Overwash and frequent flooding will likely maintain this area in bare or nearly bare conditions. Flooding will be a problem for nesting birds.

Shell Island (CR-014-01)

Shell Island (34°59'N, 76°12'W) is in Carteret County at the confluence of Pamlico and Core sounds (Map L).

Site type: Natural estuarine island.

Size: 0.5 to 1 ha.

Topography: A long, narrow shell bank. Maximum elevation is 0.5 m.

Vegetation: Parts of the beaches were bare, but most of the area was covered with a moderate to dense stand of saltmeadow cordgrass and sea ox-eye. Elongate narrow thickets of marsh elder were developing along the central ridge of the island.

Surroundings: Open shallow water.

Ownership: Unknown.

History of use by colonial waterbirds: This has been an important nesting site for gulls and terns for many years. Laughing Gulls have nested each year at least since 1972. Royal and Sandwich terns also nested in the early 1970s in what appeared to be very marginal habitat. In the 1980s the site has been used by Forster's and Common terns and by Laughing and Herring gulls.

Site potential: Flooding should maintain this site in low, dense vegetation suitable for Laughing Gulls. The presence of Common and Forster's terns depends on the presence of wrack lines. Human disturbance and mammalian predation do not appear to be problems.

Wainwright Island (CR-014-02)

Wainwright Island (34°59'N,76°12'W) is at the junction of Core and Pamlico sounds in Carteret County, about 5 km east of Cedar Island (Map L).

Site type: Origin uncertain, but island has received deposits of dredged material.

Size: 4-6 ha.

Topography: This site received a deposit of dredged material in the early 1980s. In 1983 a single 1.3 m-high dome covered about 20% of the island. The rest of the site was generally low and flat.

Vegetation: The dome was bare in 1983; but partly vegetated by panic grass in 1988. The rest of the island was moderately to densely covered by saltmeadow cordgrass, giant cordgrass, pennywort, and seaside goldenrod. A small thicket of silverling was present.

Surroundings: Boat channel and shallow open water.

Ownership: Unknown.

History of use by colonial waterbirds: Wainwright Island has supported a heronry since at least the early 1970s. Laughing Gulls and Royal Terns nested at this site for several years in the 1970s. In 1977 the island housed more than 350 wading bird nests, 160 Laughing Gull nests, 4 Herring Gull nests, and 1 Common Tern nest. Only 46 nests of five wading bird species were present in 1983. By 1988 Royal and Sandwich terns had recolonized the site and Brown Pelicans had begun nesting for the first time.

Site potential: Wainwright Island once contained one of the best shrub thickets in the lower Pamlico Sound/upper Core Sound area and was an important breeding site for wading birds. Recent deposition of dredged material destroyed much of the thicket, causing a decline in wading bird nest numbers in 1983. Vegetation on the rest of the island apparently became too tall and dense for Laughing and Herring gulls by 1983. Redeposition between 1983 and 1988 again created appropriate conditions for the pioneer species and the site was recolonized. It remains one of the most important nesting sites in the region.

Harbor Island (CR-014-03)

Harbor Island (34°59'N, 76°13'W) is west of Wainwright Island in Carteret County (Map L).

Site Type: Natural estuarine island; modified by man.

Size: 0.5 to 1 ha.

Topography: A shell bank with a small adjacent marsh.

Vegetation: This island was the site of an oyster-rock-cement building in the past. The ruins remain. Natural habitats present are small bare areas, dense low stands of grasses and forbs dominated by saltmeadow cordgrass, seaside goldenrod, orach, and sea ox-eye. Small shrub thickets are dominated by marsh elder and Hercules'-club.

Surroundings: Shallow open water.

Ownership: Unknown.

History of use by colonial waterbirds: In 1976 a small colony of Laughing Gulls nested at this site. They were not present in 1977. Small numbers of Herring Gulls nested both years. Small colonies of Common Terns nested among the rubble of the building ruins both years. In 1988 a small colony of Common and Gull-billed terns was present.

Site potential: Human activity associated with this site may have been a factor in its reduced use. Habitat remains appropriate.

New Dump Island (CR-014-04)

New Dump Island (34°52'N,76°20'W) is in Core Sound beside the boat channel leading to Drum Inlet. It lies about 2 km south of Atlantic, Carteret County (Map L).

Site type: Diked dredged-material island.

Size: 5-10 ha.

Topography: This island is bounded by a dike. The most recent deposit of dredged material formed a high (6.0 m in 1983) dome on the northern end of the island. The dome covered about 50% of the site: the remainder of the area was about 2 m below the top of the dike and was somewhat flat. Erosion is severe.

Vegetation: The dome was bare in 1983 but by 1988 erosion and rapid plant growth had eliminated all bare substrates. The dikes and lower portions contained by the dikes were moderately to densely vegetated by saltmeadow cordgrass, Mexican tea, and nightshade.

Surroundings: Shallow open water and boat channel.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: From the early 1970s through 1977 this island was occupied by Common Terns, Gull-billed Terns, and Black Skimmers. Least Terns have also nested at this site. Large colonies of Royal and Sandwich terns and Laughing Gulls occupied the site in 1983, when a small heronry and several Brown Pelican nests were also present. By 1988, only Laughing Gulls (900 + nests), Herring Gulls (3 nests) and Black-crowned Night-Herons (3 nests) remained.

Site potential: Dense herbaceous vegetation and developing shrub thickets are rendering this site unsuitable for ground nesting species. Potential for developing a heronry is improving. History suggests that this site is in a very good location, and creation of bare substrate through dredged material deposition should attract the pioneer species.

UNI, Core Sound #1 (CR-014-09)

Unnamed Island (34°42'N, 76°29'W) opposite the east end of Harker's Island and next to the Core Banks marshes (Map N).

Site type: Natural estuarine island.

Size: Not measured.

Topography: A low marsh island.

Vegetation: This island is covered by stands of smooth cordgrass and saltmeadow cordgrass.

Surroundings: Open shallow water.

Ownership: Unknown.

History of use by colonial waterbirds: This island was occupied by small colonies of Forster's Terns and Laughing Gulls in 1989.

Site Potential: This island is likely to be used during those years when deposits of wrack are present.

Drum Inlet, North and Core Banks Beach, Drum Inlet-S (CR-014-05 and CR-014-17)

New Drum Inlet (34°51'N,76°19'W) is a man-made inlet southeast of Atlantic in Carteret County (Maps L & M).

Site type: Barrier island beach.

Size: Not applicable.

Topography: Low sand spits on both sides of New Drum Inlet.

Vegetation: Nearly bare, but with scattered clumps of sea rocket and saltmeadow cordgrass.

Surroundings: Beach and inlet waters.

Ownership: National Park Service, Cape Lookout National Seashore.

History of use by colonial waterbirds: Large colonies of Least, Common and Gull-billed terns and Black Skimmers nested on the north side of this inlet in 1976 and 1977. The site had become inactive by 1983, with a smaller colony present on the south side of the inlet. In 1988, most birds had shifted to the south site of the inlet, and a total of 320 nests was present.

Site potential: Inlet spits are generally attractive nest sites for those species in management groups 2 and 3 if appropriate habitat is present and if disturbances are minimal. Plant succession usually proceeds slowly and may be frequently returned to earlier stages by flooding. If this site can be protected from disturbance it should continue to provide suitable habitat.

Core Beach, Cape Lookout (CR-014-22)

This site (34°41'N, 76°29'W) is on Core Banks in Carteret County (Map N).

Site type: Barrier beach.

Size: Not applicable.

Topography: A sand spit between the high tide line and the base of the foredunes.

Vegetation: This site was nearly bare in 1983 with only scattered clumps of sea oats, sea rocket and saltmeadow cordgrass.

Surroundings: Ocean and dune field.

Ownership: National Park Service, Cape Lookout National Seashore.

History of use by colonial waterbirds: This site was used by a small colony of Least Terns in 1983.

Site potential: This site is likely to remain suitable for Least Terns for several years.

Core Banks, Power Squad Spit (CR-014-24)

Core Banks, Power Squad Spit (34°37'N, 76°34'W) (Map N).

Site type: Barrier island.

Size: Not applicable.

Topography: A beach berm site between the intertidal zone and developing dunes.

Vegetation: This site, like most beach colony sites, was essentially bare. Small clumps of saltmeadow cordgrass and sea rocket were present.

Surroundings: Beach and dune fields.

Ownership: National Park Service, Cape Lookout National Seashore.

History of use by colonial waterbirds: This site was occupied in 1988 by a large mixed colony of Least Terns, Common Terns and Black Skimmers.

Site potential: As long as overwash occurs and protection from human disturbance is provided, Core Banks is likely to continue to be used by Least Terns.

Core Banks, Cape Point (CR-014-25)

Core Banks, Cape Point Beach (34°39'N, 76°31'W) (Map N).

Site type: Barrier island.

Size: Not applicable.

Topography: A beach berm site between the intertidal zone and developing dunes.

Vegetation: This site, like most beach colony sites, was essentially bare. Small clumps of saltmeadow cordgrass and sea rocket were present.

Surroundings: Beach and dune fields.

Ownership: National Park Service, Cape Lookout National Seashore.

History of use by colonial waterbirds: This site was occupied in 1988 by a small colony of Least Terns.

Site potential: As long as overwash occurs and protection from human disturbance is provided, Core Banks is likely to continue to be used by Least Terns.

Rush Island (CR-014-26)

Rush Island (34°41'N, 76°30'W) is a small marsh island opposite the east end of Harker's Island and next to the Core Banks marshes (Map N).

Site type: Natural estuarine island.

Size: Not measured.

Topography: A low marsh island.

Vegetation: This island is covered by a stand of smooth cordgrass.

Surroundings: Open shallow water and extensive marshes.

Ownership: Unknown.

History of use by colonial waterbirds: This island had a single Laughing Gull nest in 1989.

Site potential: This site is likely to be used when deposits of wrack are present.

Little Deep Marsh Island (CR-014-27)

This marsh island (34°41'N, 76°30'W) is opposite the east end of Harker's Island and adjacent to the Core Banks marshes (Map N).

Site type: Natural estuarine island.

Size: Not measured.

Topography: A low marsh island.

Vegetation: This island is covered by a stand of smooth cordgrass.

Surroundings: Open shallow water and extensive marshes.

Ownership: Unknown.

History of use by colonial waterbirds: This island had a small Laughing Gull colony in 1989.

Site potential: This site is likely to be used when deposits of wrack are present.

Cockle Marsh Island (CR-014-28)

Cockle Marsh Island (34°40'N, 76°30'W) is a small marsh island opposite the east end of Harker's Island and adjacent to the Core Banks marshes (Map N).

Site type: Natural estuarine island.

Size: Not measured.

Topography: A low marsh island.

Vegetation: This island is covered by a stand of smooth cordgrass.

Surroundings: Open shallow water and extensive marshes.

Ownership: Unknown.

History of use by colonial waterbirds: This island had a small Laughing Gull colony in 1989.

Site potential: This site is likely to be used when deposits of wrack are present.

Big Deep Marsh Island (CR-014-29)

This marsh island (34°42'N, 76°30'W) is opposite the east end of Harker's Island and adjacent to the Core Banks marshes (Map N).

Site type: Natural estuarine island.

Size: Not measured.

Topography: A low marsh island.

Vegetation: This island is covered by a stand of smooth cordgrass.

Surroundings: Open shallow water and extensive marshes.

Ownership: Unknown.

History of use by colonial waterbirds: This island had a small Laughing Gull colony in 1989.

Site potential: This site is likely to be used when deposits of wrack are present.

Old Dump Island (CR-016-01)

Old Dump Island (34°54'N, 76°17'W) is in Core Sound east of Atlantic, Carteret County (Map L).

Site type: Dredged-material island.

Size: 4 to 6 ha.

Topography: A central dome is elevated 3-4 m. A sand spit is developing along the southwest corner.

Vegetation: This island has a complex pattern of vegetation. The dome, slopes, and swales are moderately to densely covered with grasses and forbs. The dominant species were saltmeadow cordgrass, fescue, pennywort, melic grass, and seaside goldenrod. A thicket of silver poplar, 3-7 meters high, was present as were small, low thickets of marsh elder, silverling, and wax myrtle.

Surroundings: Shallow open water flats.

Ownership: Private.

History of use by colonial waterbirds: This island has been used by most species of colonial waterbirds at some time since the early 1970s. Thickets at this site have been occupied by waders at least since the early 1970s. In 1977 nearly 200 Cattle Egret nests and several Black-crowned Night Heron nests were located in the poplar thicket, while a mixed colony of about 175 nests of 6 species of wading birds was located in low scattered shrub thickets. In 1988 the heronry was not censused but appeared to have grown in both size and species composition. In the early 1970s, most of the tern species nested on this island. By about 1975, plant succession eliminated most of the bare or nearly bare sites required by the pioneers. In 1976 and 1977, however, this island was occupied by the largest Laughing Gull colony in North Carolina (3,511 nests in 1977). The Laughing Gull colony remained the largest in the state in 1988, and a colony of Common and Gull-billed terns was present on a newly developing sand spit.

Site potential: This site should remain as suitable Laughing Gull nesting habitat for several years. As the shrub thickets spread, the site should accommodate increasing numbers of waders. The island is in private ownership, and a weekend cabin is present. The owners are very protective of the nesting birds.

Morgan Island (CR-017-01)

Morgan Island (34°40'N,76°32'W) is in Back Sound about 3 km south of Harker's Island, Carteret County (Map N).

Site type: Diked dredged-material island.

Size: 4-6 ha.

Topography: About two-thirds of this large, irregularly-shaped island is diked. The area enclosed by the dikes is primarily a dredged-material dome with a maximum elevation of about 5 m in 1983. The area outside the dikes is low in elevation and adjoined a saltmarsh.

Vegetation: The dome was sparsely covered with saltmeadow cordgrass, seaside goldenrod, and horseweed in 1988. Dikes were densely covered by saltmeadow cordgrass as was a drift ridge on the undiked portion of the island. A shrub thicket of silverling occupied the outer base of the dikes on the southern end of the island.

Surroundings: Shallow water flats and saltmarsh.

Ownership: Unknown.

History of use by colonial waterbirds: Morgan Island was occupied intermittently by a large colony of Royal and Sandwich terns from the early 1970s through 1977. These two species apparently moved to nearby Sandbag Island (CR-017-07) in 1983. Laughing Gulls occupied the low grassy areas outside the dikes in the early 1970s, but were present in reduced numbers in 1983 and had abandoned the site by 1988. Common Terns, Gull-billed Terns, and Black Skimmers nested in the mid-1970s, but were absent in 1977. All three species were present in small numbers in 1983, but were gone by 1988. A small wading bird colony has occupied the shrub thicket since the mid-1970s.

Site potential: Morgan Island was heavily used by colonial waterbirds through the 1970s. The construction of nearby Sandbag Island (CR-017-07), vegetative succession on Morgan, and perhaps the presence of nutria (Myocastor coypus) on Morgan have all apparently contributed to a decline in use of this site. With redeposition this site would again be suitable for pioneer species.

Whitehurst Island (CR-017-02)

Whitehurst Island (34°39'N, 76°31'W) lies along the east side of the channel to Lookout Bight (Map N).

Site type: Natural estuarine island.

Size: 2.5 ha.

Topography: A low marsh island.

Vegetation: This island is dominated by smooth cordgrass.

Surroundings: Shallow water and boat channel.

Ownership: Unknown.

History of use by colonial waterbirds: This site is occasionally used by small colonies of Forster's Terns and Laughing Gulls when suitable wrack deposits are present. In 1988, nearly 300 Laughing Gull and small numbers of Common and Forster's tern nest were present.

Site potential: This island is likely to remain suitable during those years when wrack deposits are present.

Sand Bag Island (CR-017-07)

Sand Bag Island (34°40'N,76°31'W) lies midway between Harker's Island and Morgan Island in Back Sound, Carteret County (Map N).

Site type: Undiked dredged-material island enclosed by a ring of sandbags.

Size: About 1 ha.

Topography: This island consists of a high (3.0 m in 1983) central dome sloping to a series of drift ridges and swales. A sandy beach was present along the island's entire perimeter.

Vegetation: The dome was unvegetated in 1983. The lower slopes had a sparse cover of saltmeadow cordgrass, and the upper swales and drift ridges were densely vegetated by this species. The lower drift ridges and swales were sparsely covered by sea rocket and saltmeadow cordgrass. Experimental plantings of natural vegetation have occurred along the southern perimeter
of the island.

Surroundings: Shallow open water and boat channel.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: This island was constructed in 1976, and in 1977 it was colonized by small numbers of Common Terns, Least Terns, and Black Skimmers. In 1983, increased numbers of Common Terns and Black Skimmers were present, but Least Terns no longer nested here. A colony of Royal and Sandwich terns occupied the dome in 1983 and 1988. A colony of Laughing Gulls nesting in the vegetated portions of the island has grown from about 200 nests in 1983 to over 300 nests in 1988.

Site potential: This site should continue to provide suitable bare nesting sites for Royal and Sandwich terns for several years. Gull-billed Terns, Common Terns, and Black Skimmers also should find nesting sites available on the lower drift ridges for the next few years. In addition, these three species will benefit as vegetation encroaches upon the slopes and dome. The grassy areas preferred by Laughing Gulls should remain available for 5-10 years. With periodic deposition of dredged material the site may remain heavily used for many years.

UNI, Barden Inlet Channel (CR-017-09)

Unnamed island between Whitehurst Island (CR-17-02) and Cape Lookout (34°39'N, 76°31'W) (Map N).

Site type: Natural estuarine island.

Size: Not measured.

Topography: A low marsh island.

Vegetation: This island was dominated by smooth cordgrass and saltmeadow cordgrass.

Surroundings: Marsh islands and open water of Core Sound.

Ownership: Unknown.

History of use by colonial waterbirds: This site has occasionally been used by Forster's Terns and Laughing Gulls depending on the presence of appropriate deposits of wrack. In 1988, a small Laughing Gull colony was present.

Site potential: This island is likely to remain suitable during those years when wrack deposits are present.

Middle Marsh (CR-018-07)

This marsh island (34°44'N, 76°37'W) is adjacent to the North River between the west end of Harker's Island and Shackleford Banks (Map O).

Site type: Natural estuarine island.

Size: 1 ha.

Topography: A long, narrow island consisting of a single linear ridge adjacent to the open shallow sound to the south, and bordered by extensive salt marshes to the north. Maximum elevation is 1.0 m.

Vegetation: The elevated portion of this site contains a low thicket dominated by yaupon. The adjacent marsh is dominated by smooth cordgrass.

Surroundings: Shallow open water and extensive marshes.

Ownership: Unknown.

History of use by colonial waterbirds: This site is used during some years by nesting wading birds (during some years these birds nest on nearby CR-018-15). Small Forster's Tern colonies occasionally are present in the marshes next to this island.

Site potential: The shrub thicket on this site appears to be suffering salt damage, and continued use of the site by nesting herons and egrets is not promising. Small Forster's Tern colonies may be expected in the adjacent marshes when wrack deposits are present.

Bottle Run Point (CR-018-08)

Bottle Run Point (34°41'N, 76°35'W) is in Back Sound in Carteret County (Map O).

Site type: Natural estuarine island.

Size: Not measured.

Topography: A low marsh island.

Vegetation: A portion of this small island was bare, but most was covered by a low stand of saltmeadow cordgrass, smooth cordgrass, sea ox-eye, salt grass, and scattered clumps of marsh elder.

Surroundings: Shallow open water and marsh islands.

Ownership: Unknown.

History of use by colonial waterbirds: This site is used by small colonies of Common and Gull-billed Terns and Black Skimmers during most years.

Site potential: This low island is visited regularly by wild horses from Shackleford Banks. Human disturbance is apparently infrequent. Nesting sites appear to flood frequently and nesting success is likely poor. While the habitat probably will remain unchanged, the potential for successful nesting does not appear good.

UNI, Back Sound #3 (CR-018-15)

This island (34°42'N, 76°37'W) is in Middle Marshes in Back Sound, Carteret County (Map O).

Site type: Natural estuarine island.

Size: Less than 1 ha.

Topography: A long, low marsh island with a slightly elevated central ridge.

Vegetation: Most of this long narrow island was covered with a dense maritime shrub thicket dominated by live oak, yaupon, silverling, and marsh elder. The fringes consisted of dense stands of grasses, primarily saltmeadow cordgrass.

Surroundings: Extensive marshes.

Ownership: Unknown.

History of use by colonial waterbirds: In the early 1970s this island and nearby CR-018-07 were the sites of active nesting colonies of wading birds. In 1976 the numbers of nests diminished significantly and in 1977 the site was abandoned. In 1988 the island was again the site of a thriving multi-species heronry.

Site potential: Vegetation at this site appears suitable for nesting wading birds. The island is easily accessible to boats and is within a large marsh which may harbor mammalian predators. The cause of colony abandonment in 1977 is unknown.

Shackleford Point (CR-020-05)

Shackleford Point (34°41'N, 76°39'W) is at the southwestern end of Shackleford Banks in Carteret County (Map O).

Site type: Barrier Beach.

Size: Not applicable.

Topography: A flat berm between the intertidal zone and the foredune.

Vegetation: The region just to the north of the Beaufort Ship Channel consisted of sand flats and scattered clusters of dunes. The flats were generally without vegetation, while the dunes were sparsely to moderately vegetated with sea oats, saltmeadow cordgrass, and sea rocket.

Surroundings: Ocean, inlet, and grass-covered flats.

Ownership: National Park Service, Cape Lookout National Seashore.

History of use by colonial waterbirds: In 1976 Common and Gull-billed Terns and Black Skimmers were present. In 1977 the site was not used, but in 1988 a few Least Terns were present and one nest was found.

Site potential: The habitat appears suitable for pioneer species. Shackleford is, however, occupied by feral horses and sheep as well as mammalian predators. Human disturbance also may be a factor.

Brant Island (CR-020-06)

Brant Island (34°42'N,76°42'W) lies adjacent to the Morehead Channel about 1 km south of Morehead City, Carteret County (Map P).

Site type: Diked dredged-material island.

Size: 80-100 ha.

Topography: Brant Island is probably the highest dredged- material island in North Carolina; maximum elevation in 1983 was about 15 m. This site frequently receives deposits of dredged material and has a series of irregular domes separated by shallow swales. A lagoon was recently created when a large volume of deposited material was transferred to Atlantic Beach as a part of a beach renourishment program.

Vegetation: Most of the site was bare in 1983, with only small scattered clumps of sea rocket, saltmeadow cordgrass, and evening primrose present. The high elevation results in much wind erosion and establishment of vegetation on the higher portions is slow.

Surroundings: Shallow open water, saltmarsh, and boat channel.

Ownership: As a dredged- material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: Brant Island has been an important nesting site for Gull-billed Terns, Common Terns, Least Terns, and Black Skimmers since at least the early 1970s. A total of 770 nests of these four species was present in 1977; in 1983, 855 nests were counted. By 1988, activity had declined, and only a small colony of skimmers and terns was present.

Site potential: Much of this island has been maintained in a bare or nearly bare condition by frequent deposition of dredged material and wind erosion. Thus, Brant Island was very attractive to the pioneer ground-nesters that prefer bare or sparsely vegetated sites. Yet, nesting success at this site appears to be low. The primary reason for this poor reproduction appears to be an unstable substrate; loose blowing sand frequently buries nests. Nevertheless, terns and skimmers have nested here for many years. Recent removal of dredged material means that several subsequent deposits may be necessary to re-elevate the site.

Annex, Newport River (CR-021-03)

Annex Island (34°34'N,76°42'W) is in the Newport River about 1.5 km north of Morehead City, Carteret County (Map P).

Site type: Partially diked dredged-material island.

Size: About 4 ha.

Topography: This island consisted of a single high (6 m) dome partially enclosed by a dike. The undiked northern end slopes gradually to saltmarsh.

Vegetation: The dome was sparsely covered with saltmeadow cordgrass and camphorweed in 1983. Uplands outside the dike consisted of a dense shrub thicket dominated by red cedar, loblolly pine, red mulberry, wax myrtle, and silverling.

Surroundings: Extensive saltmarshes and the Intracoastal Waterway.

Ownership: As a dredged-material island established on a subtidal flat, Annex Island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: Annex Island was created in the 1950s and was occupied by wading birds in the 1960s (McCrimmon 1978). In 1977, a total of 71 nests of seven wading bird species was found; the colony grew to 1,145 nests of eight species in 1983, but the site had been totally abandoned by 1988.

Site potential: Many individuals apparently move between Annex and nearby Phillips Island (CR-021-04), and in some years most birds nest on Phillips. However, in 1983 the majority nested on Annex. Both islands have been important nesting sites for wading birds since the 1960s and should continue to be used for many more years.

Phillips Island (CR-021-04)

Phillips Island (34°43'N,76°57'W) is in the Newport River about 2 km north of Morehead City, Carteret County (Map P).

Site type: Origin uncertain, but island has received deposits of dredged material.

Size: 1.5 ha.

Topography: This island is low and flat. Maximum elevation in 1983 was about 1 m. Erosion is severe.

Vegetation: Phillips Island contains a dense maritime shrub thicket composed of wax myrtle, silverling, red cedar, and white mulberry. The thicket was bordered by a band of saltmeadow cordgrass, sea ox-eye, and glasswort.

Surroundings: Saltmarsh and the Intracoastal Waterway.

Ownership: Private.

History of use by colonial waterbirds: A colony of wading birds has occupied Phillips and nearby Annex Islands since the 1960s (McCrimmon 1978). In 1977, 263 nests of six species were present; a total of 194 nests representing six wading bird species was counted in 1983, and in 1988 the colony had grown to 1024 nests of 7 species.

Site potential: Phillips Island is eroding rapidly along the north end. Erosion is presently removing portions of the thickets occupied by the nesting birds. Deposition of dredged material on the north end of the site would slow the destruction of this important colony site.

Region 4. Atlantic Beach and Bogue Sound to Carolina Beach.

This region is characterized by a series of heavily populated beach communities such as Atlantic Beach, Topsail Island and Wrightsville Beach alternating with partly developed beaches, such as Figure Eight Island, and undeveloped barrier islands such as Hammocks Beach and Masonboro Island. The sounds are much narrower than further north and are often dominated by regularly flooded salt marshes. An important feature is the Atlantic Intracoastal Waterway that bisects the estuary. Adjacent to the waterway, usually on the eastern side, is an almost continuous series of dredged-material islands. Most are dominated by dense shrub thickets, but sites dumped on more frequently remain bare or nearly bare.

This region is not heavily used for nesting by colonial waterbirds. The more developed stretches of beach are not utilized at all, but small to moderate sized colonies of Least, Common and Gull-billed terns and Black Skimmers nest near inlets on less heavily disturbed islands. Thus, there are often colonies at Camp Lejeune on the beach on the north side of New River Inlet (ON-026-01), at the south end of Topsail Island (PD-030-01), on the north side of Rich Inlet (PD-032-01) and on the north end of Masonboro Island (NH-035-02).

There is also some use of dredged-material island sites in this region. Islands CR-022-40 and CR-022-41 in western Bogue Sound were the site of a very large mixed-species heronry in the late 1970s. This colony has diminished in size recently but still occupies the dense thickets of these two islands. A small heronry occupied only by Green-backed Herons has also become established on island ON-026-07 in the mouth of New River.

Least Terns regularly nest in small colonies on dredged-material islands at several sites in this region. These sites shift from island to island as the birds seek the preferred bare or nearly bare substrate. There is usually a colony on one of the islands near Bogue Inlet and often a colony on either island ON-026-06 or ON-026-07 in the mouth of New River. Often a colony also will be present on one of the small islands to the west of Masonboro Island.

A problem with the use of these dredged-material islands is that they are surrounded by extensive marshes that provide suitable habitat for mammalian predators. Raccoons are abundant and Gray Foxes, Opossums (Didelphis virginiana) and feral Domestic Cats are often present.

Key Sites: CR-022-39, CR-022-41, CR-022-42, ON-022-44, ON-023-14, ON-026-07, ON-026-08, PD-030-01, PD-030-02, PD-032-01, PD-032-02, PD-034-01, NH-035-02.

Key sites in region 4 are located on Maps Q-V.

Cat Island (CR-022-28)

Cat Island (34°41'N, 76°57'W) is in Bogue Sound southwest of Salterpath (Map Q).

Site type: Natural estuarine island.

Size: Not measured.

Topography: This long narrow island was used as a bombing range in the past, and craters remain. Maximum elevation is 2.0 m.

Vegetation: Uplands are dominated by a low, wind-sheared live oak forest.

Surroundings: Shallow open water.

Ownership: Unknown.

History of use by colonial waterbirds: This island was first used by herons in 1988.

Site potential: This site is likely to remain suitable for use by nesting wading birds.

UNI, Bogue Sound #6 (CR-022-39)

Island CR-022-39 (34°41'N,77°02'W) is in Bogue Sound about 5 km west-northwest of Emerald Isle, Carteret County (Map Q).

Site type: Diked dredged-material island.

Size: Not measured.

Topography: In 1983 this island consisted of a 3 m high dome completely enclosed by a dike.

Vegetation: The dome was sparsely vegetated by forbs and grasses, primarily saltmeadow cordgrass in 1983. A small thicket of wax myrtle was developing in the swales.

Surroundings: Shallow open water and Intracoastal Waterway.

Ownership: As a dredged-material island built on a subtidal flat, island CR-022-39 is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: Least Terns usually nest on one or more dredged-material islands in western Bogue Sound and often shift locations as they seek their preferred bare or nearly bare nesting substrates. Island CR-022-39 was unoccupied in 1977, but several nearby islands contained over 60 Least Tern nests that year. In 1983, 37 Least Tern nests and 1 Common Tern nest were present on CR-22-39; the other nearby islands were not occupied. The site was not used in 1988.

Site potential: Deposition of dredged material is needed to return this site to a bare nesting substrate. With periodic dredged-material deposition, the site will likely be usable by Least Terns for several years after each deposit.

Emerald Island Heronry #1-#2
(CR-022-41 and CR-022-42)

These two islands are located in Bogue Sound about 2 km southeast of Cape Carteret, Carteret County (34°41'N,77°02'W) (Map R).

Site type: Undiked dredged-material islands.

Size: Large islands, not measured.

Topography: These long, narrow islands consisted of a series of low domes (maximum elevation was 1.5 m in 1983) separated by shallow swales.

Vegetation: Most of these islands are covered by dense shrub thickets of wax myrtle, red cedar, black cherry, and silverling. Saltmeadow cordgrass borders the thickets.

Surroundings: Shallow open water and Intracoastal Waterway.

Ownership: Private.

History of use by colonial waterbirds: Islands CR-022-41 and CR-022-42 have shared a large heronry since at least the early 1970s. In 1976 and 1977 this was the second largest heronry in North Carolina. Over 1300 nests were present in 1977, but numbers declined to 881 nests of seven species in 1983. In 1988, 1181 nests of 6 species were counted.

Site potential: These islands have been important nesting sites for waders in past years and appear suitable for continued use for many years.

UNI, Entrance Bogue Inlet #1 (ON-022-44)

Island (34°40'N, 77°06'W) at junction of AIWW and Bogue Inlet (Map R).

Site type: Diked dredged-material island.

Size: Not measured.

Topography: A diked island with an elevated flat dome.

Vegetation: A sparse cover of saltmeadow cordgrass and other grasses and forbs covered much of this site in 1988.

Surroundings: AIWW and extensive salt marshes.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: The dome of this elevated island is occasionally used by nesting Least Terns. In 1988, 59 nests were located.

Site potential: This site should remain suitable for Least Terns for several years. It is well elevated, and plant succession is proceeding slowly. The site also appears to receive dredged material frequently. Mammalian predators are likely present as this site is next to extensive marshes and other vegetated islands.

UNI, Entrance Bogue Inlet #2 (ON-022-45)

This island (34°40'N, 77°06'W) is at Swansboro adjacent to the channel to Bogue Inlet in Onslow county (Map R).

Site type: Diked dredged-material island.

Size: Not measured.

Topography: A large elevated dredged-material deposit consisting of elevated domes, swales and perimeter salt marshes. Maximum elevation is 5.2 m.

Vegetation: The most elevated portions of this island are bare or nearly bare. Slopes are vegetated by sparse to moderate stands of grasses and forbs. Swales are covered by dense stands of grasses and forbs or developing shrub thickets.

Surroundings: A deep water channel and extensive salt marshes.

Ownership: Unknown.

History of use by colonial waterbirds: This site is occasionally used by small to moderate colonies of Least Terns.

Site potential: This site will likely continue to be used by Least Terns during periods when bare substrates are present.

UNI, Swansboro #6 (ON-023-14)

Unnamed island (34°40'N, 77°06'W) is in Bogue Inlet on the Carteret-Onslow County line (Map R).

Site type: Natural estuarine island.

Size: Less than 1 ha.

Topography: A low, sandy shoal along the perimeter of a saltmarsh.

Vegetation: This small shoal was vegetated by scattered clumps of smooth cordgrass, sea rocket, and orach.

Surroundings: Open water and marshes.

Ownership: Unknown.

History of use by colonial waterbirds: This site was occupied in 1976, 1977 and 1988 by small colonies of Common Terns and Black Skimmers.

Site potential: This shoal was formed next to the Bogue Inlet channel. It may persist or be washed away. If it persists it will likely be vegetated by smooth cordgrass and soon become unavailable to ground nesting colonial birds. Potential for long term use is not good.

UNI, Bogue Inlet (ON-023-15)

Unnamed Island (34°41'N, 77°05'W) next to the channel to Bogue Inlet in Onslow County (Map R).

Site type: Natural estuarine island.

Size: 0.1 ha.

Topography: A small low sandy island adjacent to a channel. Maximum elevation is 0.5 m.

Vegetation: The elevated portion of this small island is bare. The island perimeter grades into extensive saltmarshes.

Surroundings: A deepwater channel and extensive marshes.

Ownership: Unknown.

History of use by colonial waterbirds: This site was occupied in 1989 by a small colony of Common Terns.

Site potential: This small island may continue to be used if a bare substrate is maintained.

UNI, New River Channel #1 (ON-026-06)

Unnamed island (34°33'N, 77°21'W) at junction of AIWW and New River Inlet (Map S).

Site type: Diked dredged-material island.

Size: Not measured.

Topography: A large diked deposit along the perimeter of an extensive saltmarsh.

Vegetation: This large complex island had a bare dome in 1988. Slopes and swales were vegetated by sparse to dense stands of grasses and forbs. Well developed thickets dominated by wax myrtle were also present.

Surroundings: AIWW and extensive salt marshes.

Ownership: Unknown.

History of use by colonial waterbirds: This site had a small heronry in the past and is occasionally used by Least Terns. In 1988, 14 Least Tern nests were present.

Site potential: This site is frequently used for deposition of dredged material and a bare dome is usually present. It is, however, accessible to mammalian predators, and potential for use by colonial waterbirds is not good.

UNI, New River Channel #2 (ON-026-07)

Island ON-026-07 (34°34'N,77°21'W) is in the New River about 5 km east of Sneads Ferry, Onslow County (Map S).

Site type: Diked dredged-material island.

Size: Large island, not measured.

Topography: This diked island has several elevated domes and adjacent swales.

Vegetation: Domes are moderately vegetated and slopes and swales densely covered by grasses and forbs. Wax myrtle thickets are developing.

Surroundings: Shallow open water.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: This island was an important nesting site for Gull-billed Terns, Common Terns, Least Terns, and Black Skimmers in the early 1970s. However, in 1976 numbers were greatly decreased, and in 1977 only one Common Tern nest and two Least Tern nests were found. The number of Least Tern nests increased to 96 in 1983, but only two Common Tern nests were present. In addition, 15 Green-backed Heron nests were found in the shrub thicket. In 1988, small Least Tern and Green-backed Heron colonies were present.

Site potential: With appropriate management this island could once again be an important nesting site for the species comprising management groups 2 and 3. No other isolated islands with bare or nearly bare areas are available in the vicinity of New River Inlet. The shrub thicket should continue to support Green-backed Herons for many years. A heronry in nearby Alligator Bay was abandoned in the late 1970s, apparently the result of fox predation. The developing shrub thicket and presence of nesting Green-backed Herons on ON-026-07 may entice other wading birds to nest at this site in the future.

UNI, New River Channel #3 (ON-026-08)

Unnamed island in New River Inlet Channel (34°33'N, 77°21'W) (Map S).

Site type: Diked dredged-material island.

Size: Not measured.

Topography: A diked island with an elevated dome.

Vegetation: The dome is sparsely vegetated with grasses and forbs. Lower slopes are vegetated with dense stands of saltmeadow cordgrass, and developing wax myrtle thickets occur in the swales.

Surroundings: Open water.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: This site and adjacent ON-026-07 have been important nesting sites since the early 1970s. Birds have shifted between these two sites depending on availability of appropriate substrate. In 1988, small colonies of terns and skimmers shared the island with the state's largest known Green-backed Heron colony (41 nests).

Site potential: This site should continue to be used if appropriate nesting habitat remains available.

New Topsail Inlet, Northside and Southside (PD-030-01 and PD-030-02)

New Topsail Inlet (34°21'N,77°39'W) is at the south end of Topsail Island in Pender County (Map U).

Site type: Barrier island beach.

Size: Not applicable.

Topography: Sandy shell-covered spits next to the inlet.

Vegetation: These sites were nearly without vegetation in 1983. Small clumps of sea rocket and saltmeadow cordgrass were present.

Surroundings: Beach and dune fields.

Ownership: Private.

History of use by colonial waterbirds: Least Terns nested adjacent to New Topsail Inlet both in 1977 and in 1983. The location of colonies has varied, and the terns have used spits on both sides of the inlet. In 1977, a total of 151 Least Tern nests was present; 56 were counted in 1983. No birds nested at these sites in 1988.

Site potential: A large colony of Least Terns was present at this site in 1977, but numbers were much reduced in 1983. The habitat in 1983 appeared suitable, and it is likely that human disturbance was an important factor in the reduced use of this site. Access to the site is uncontrolled, and disturbance was likely regular as the nearby beaches are heavily used.

Rich Inlet, Northside and Southside (PD-032-01 and PD-032-02)

Site PD-032-01 is on the spit north of Rich Inlet, Pender County, while PD-032-02 is on the spit south of the inlet (34°17'N,77°44'W) (Map U).

Site type: Barrier island beach

Size: Not applicable.

Topography: Flats adjacent to the inlet between high tide and the foredunes.

Vegetation: Usually bare with scattered clumps of sea rocket or sea oats.

Surroundings: Open beach and sea oats-covered dunes.

Ownership: Private.

History of use by colonial waterbirds: A tern and skimmer colony has been present at one site or the other during most recent years. Site PD-032-02, south of the inlet, was active in 1977 while the colony was north of the inlet (PD-032-01) in 1983 and 1988.

Site potential: Habitat at these sites is maintained by occasional flooding and should remain suitable for management groups 2 and 3 for several years. Both sites are in private ownership. They are unlikely to be developed due to their proximity to inlets. They are subject to unrestricted disturbance.

UNI, Mason Inlet #2 (NH-033-16)

This dredged-material island (34°05'N, 77°46'W) is at the junction of the AIWW and the channel to Mason Inlet in New Hanover County (Map V).

Site type: Diked dredged-material island.

Size: Not measured.

Topography: A well-elevated diked island. Maximum elevation is 4.0 m.

Vegetation: The dome of this island is bare. Slopes and swales are covered by moderate to dense stands of grasses and forbs. Well-developed shrub thickets also occur.

Surroundings: Deep water channels and extensive salt marshes.

Ownership: Unknown.

History of use by colonial waterbirds: This site is occasionally used by small Least Tern colonies.

Site potential: Continued utilization depends upon frequent deposition of dredged material and the maintenance of bare substrate.

Harbor Island Park (NH-033-20)

Harbor Island (34°13'N, 77°49'W) is in New Hanover County between Wrightsville Beach and the mainland (Map V).

Site type: Developed natural estuarine island.

Size: Not applicable.

Topography: Slope from uplands into marsh.

Vegetation: Dense wax myrtle thicket.

Surroundings: Recreation area and saltmarsh.

Ownership: Town of Wrightsville Beach.

History of use by colonial waterbirds: This thicket has contained a small colony of Green-backed Herons for the past few years. The site is next to a heavily used public recreation area and some disturbance is likely.

Site potential: With protection from human disturbance this site should remain suitable for several years.

Mason Inlet, Northside (NH-034-01)

Beach of Figure Eight Island just north of Mason Inlet (34°14'N, 77°48'W) (Map V).

Site type: Barrier island.

Size: Not applicable.

Topography: Sand flats between the intertidal zone and the fore dune.

Vegetation: This inlet spit is mostly bare but has scattered clumps of sea oats, saltmeadow cordgrass and sea rocket.

Surroundings: Beach and dune fields.

Ownership: Private.

History of use by colonial waterbirds: This site has frequently been the site of mixed-species colonies of terns and skimmers. In 1988, small colonies of Least and Common terns and Black Skimmers were present.

Site potential: Plant succession on this site will likely be slow and conditions should remain appropriate for several years. Human disturbance is frequent.

Masonboro Inlet, Southside (NH-035-02)

This site is just south of the jetty on the south side of Masonboro Inlet (34°11'N, 77°49'W) in New Hanover County (Map V).

Site type: Barrier island beach.

Size: Not applicable.

Topography: Beach flats between the top of the beach berm and the base of the foredunes and in swales between dunes.

Vegetation: Either bare or with scattered forbs and grasses such as sea rocket, sea oats, and saltmeadow cordgrass.

Surroundings: Open beach to the east and dune field to the west.

Ownership: Private.

History of use by colonial waterbirds: The north end of Masonboro Island has been used by Least Terns and Black Skimmers since at least the early 1970s. The colony site has moved depending on the location of appropriate habitat. By 1977, Common Terns were also nesting, and all three species were present in 1983 although numbers of Least Terns were much reduced. Least and Common Terns were present in 1988.

Site potential: Portions of this site are subject to occasional flooding, and bare or nearly bare substrate is likely to be naturally maintained. Interior flats are slowly becoming vegetated and may become unsuitable in a few years. The site is a popular beach for sunbathing and fishing, and there is some traffic by three-wheel ORVs. Disturbances to nesting birds are frequent and completely uncontrolled.

Carolina Beach Inlet, South (NH-038-02)

Carolina Beach Inlet, South (34°04'N, 77°54'W) is in New Hanover County (Map V).

Site type: Barrier beach.

Size: Not applicable.

Topography: Area between beach berm and low dune field.

Vegetation: Either bare or vegetated by scattered clumps of sea oats, saltmeadow cordgrass or sea rocket.

Surroundings: Open beach and low dune field.

Ownership: Private.

History of use by colonial waterbirds: This site is occasionally used by small colonies of Least Terns.

Site potential: This site is overwashed frequently and is unlikely to succeed to dense vegetation. It is heavily traveled by ORV's and potential colony success is poor.

Region 5: Carolina Beach to the South Carolina state line

This region includes the beaches of New Hanover County south of Carolina Beach, the Brunswick County beaches, the Cape Fear River estuary and the estuaries adjacent to the beaches of Brunswick County.

Most colonial waterbird nesting activity is within the Cape Fear River estuary south of Snow's Cut. There are also sites on the Ft. Fisher beach just north of New Inlet (NH-039-49) and on the beaches and dredged-material islands in Brunswick County west of Southport.

The Ft. Fisher beach (NH-039-49) is used primarily by Least Terns, Common Terns, and Black Skimmers, and management should be designed to benefit those species. The Ft. Fisher beach is used regularly and most Least Terns in the region now nest there. Use of sites along the Brunswick County section of the Atlantic Intracoastal Waterway is erratic and depends primarily on the location of bare substrate created by recent dredged-material deposition. Small colonies also occasionally become established next to the inlets in this region.

The lower Cape Fear River estuary is one of the most important colonial waterbird nesting areas in North Carolina. Most species nesting in the state are present and several sites are important. Battery Island (BW-039-46 and BW-039-51) is the largest heronry in North Carolina and has been active at least since 1928 (Pearson et al. 1942). Upriver, islands BW-039-37, NH-039-32, and NH-039-30 are very important nesting sites for Brown Pelicans; Royal, Sandwich and Gull-billed terns; Laughing Gulls, and Black Skimmers. Dredged-material islands NH-039-25 and NH-039-23 have also been occupied by small colonies of Common and Gull-billed terns and Black Skimmers in recent years. Large fringing marshes, however, make these latter two islands more likely to house mammalian predators, and they are only marginally suitable for use by colonial waterbirds.

Battery Island (BW-039-46 and BW-039-51) should continue to be managed for use as a nesting site for wading birds. It has a long history of use by these birds and is now a National Audubon Society Sanctuary. Islands NH-039-32 and BW-039-37 should be managed for use by ground nesting gulls, terns and pelicans. A bare dome should be maintained on one site at all times to provide nesting habitat for Royal and Sandwich terns. As one site becomes too heavily vegetated for the terns, it should become usable for Laughing Gulls and Brown Pelicans. Deposition on alternate islands at three to five-year intervals should maintain appropriate habitat for most species on one or the other site. There are really no alternate sites in this region for those species requiring bare or nearly bare substrate. These are the only two isolated islands suitable for the birds but unsuitable for mammalian predators. A third site is needed in the lower Cape Fear River as erosion and heavy demands for space by nesting birds make the two islands presently available only marginally adequate.

Key Sites: NH-039-30, NH-039-32, NH-039-49, BW-039-37, BW-039-51, BW-039-46, BW-043-09. Key sites in region 5 are located on Maps W-Z.

Eagle Island (BW-030-01)

Eagle Island (33°54'N, 77°14'W) is just west of the city of Wilmington across the Cape Fear River in Brunswick County. This site is up river from Map W.

Site type: Diked dredged-material island.

Size: Not measured.

Topography: This is a large diked dredged-material deposit. Most of the site is low marsh, but occasional elevated domes of sand are present.

Vegetation: The sandy elevated domes are bare to sparsely vegetated by mixed grasses and forbs. Marshes within this diked site are dominated by giant reed.

Surroundings: Extensive brackish marshes.

Ownership: U.S. Government, U.S. Army Corps of Engineers.

History of use by colonial waterbirds: This site was occupied by a small colony of Least Terns in 1989.

Site potential: Potential for continued nesting at this site is poor.

North Pelican Island #2 (NH-039-30)

North Pelican Island (33°59'N,77°56'W) in the lower Cape Fear River has two domes separated by intertidal marsh (Map W).

Site type: Undiked dredged-material island.

Size: Not measured.

Topography: Low elevated domes surrounded by extensive brackish marshes.

Vegetation: The domes are vegetated by saltmeadow cordgrass, panic grass, and other grasses and forbs. Shrub thickets of wax myrtle are developing.

Surroundings: Marsh and open water of Cape Fear River.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: This island has been occupied by small colonies of Laughing Gulls for several years. Between 1983 and 1986 a small heronry was established and Brown Pelicans moved to the site. In 1988 it was the site of an important pelican colony and the heronry was growing.

Site potential: Vegetation on this site is becoming very dense. Potential as a heronry site appears good, but it is likely that the ground nesters will relocate soon. The surrounding marshes offer adequate habitat for mammalian predators.

Ferry Slip Island (NH-039-32)

This island is situated on the east side of the Cape Fear River channel approximately 5 km southwest of Kure Beach, New Hanover County (39°59'N, 77°57'W) (Map W).

Site type: Undiked dredged-material island.

Size: Approximately 1 ha.

Topography: Ferry Slip Island has a central dome (maximum elevation 3 m in 1983) and a series of swales and drift ridges along the island perimeter. A sandy beach encircls the island.

Vegetation: The dome and slopes were covered by a sparse to moderately dense growth of wild geranium in 1983. The swales and ridges were densely vegetated with saltmeadow cordgrass, sea rocket, and sea ox-eye.

Surroundings: Shallow open water.

Ownership: As a dredged-material island established on a subtidal flat, Ferry Slip Island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: This island has supported a nesting colony of Royal Terns since 1975, with colonies in 1976 and 1977 being the largest in the state. Small numbers of Sandwich Terns nest among the Royal Terns. A colony of Brown Pelicans first occupied this site in 1979, and in recent years Ferry Slip and nearby South Pelican Island (BW-039-37) have supported about half the North Carolina breeding population of this species. Other species nesting on this island in the past include Black Skimmers and Common and Gull-billed terns. Laughing Gulls are now common breeders here.

Site potential: This island, with nearby South Pelican Island, comprise the most important nesting sites for ground-nesting colonial waterbirds on the Cape Fear River. These islands are well-isolated from land, are uninhabited by mammalian predators, and provide the range of nesting habitats required by several species of terns, Laughing Gulls, and Brown Pelicans. No other islands in the Cape Fear River possess these important characteristics. However, severe erosion and vegetation succession threaten the ability of Ferry Slip Island to continue to support this diversity of bird life.

South Pelican Island (BW-039-37)

South Pelican Island, actually composed of two connected islands (BW-039-36 and BW-039-37), is on the east side of the Cape Fear River channel about 3 km northeast of Southport, Brunswick County (33°56'N, 77o°51'W) (Map W).

Site type: Undiked dredged-material island.

Size: About 1 ha.

Topography: This island is generally low (< 0.5 m) and flat. The portion created by deposition of dredged material in 1983 is slightly higher (about 1 m) and has the typical dome-shape of an undiked dredged-material island.

Vegetation: In 1988 the island was vegetated with saltmeadow cordgrass, seaside goldenrod, sea ox-eye, and beach elder.

Surroundings: Shallow open water. The Cape Fear River channel lies about 200 m to the west.

Ownership: As a dredged-material island established on a subtidal flat, this island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: South Pelican Island and nearby island NH-039-32 have been important breeding sites for ground-nesting colonial waterbirds on the Cape Fear River since at least the early 1970s. The entire Cape Fear River population of Royal Terns nested here from 1971 to 1974, then moved to Ferry Slip Island in 1975 after vegetation encroachment and erosion made South Pelican Island unsuitable for this species. Royal Terns returned to this island in 1978 and have nested each year since. In 1978 a small colony of Brown Pelicans occupied this island, providing the first record of this species nesting in southeastern North Carolina. South Pelican Island and nearby Ferry Slip Island now support nearly one-half of the state's Brown Pelican breeding population. Laughing Gulls first nested on this island in 1978 and their population has grown.

Site potential: South Pelican Island is one of the two most important islands for ground-nesting colonial waterbirds on the Cape Fear River (see Ferry Slip Island account). Continued use of this site, however, is threatened; the generally low elevation makes it subject to flooding by storm tides. In 1983, several hundred Royal Tern nests were washed out by high tides. Many Brown Pelican nests were also threatened by this flooding.

Battery Island
(BW-039-46 and BW-039-51)

Battery Island (33°54'N,78°01'W) is located near the mouth of the Cape Fear River about 1 km southeast of Southport, Brunswick County (Map W).

Site type: Natural estuarine island subsequently receiving deposits of dredged-material.

Size: Total area about 40 ha. North Colony (BW-039-51) is about 1 ha; South Colony (BW-039-46) is 7 ha. Remainder of island is intertidal saltmarsh.

Topography: The South Colony site was created by deposition of dredged material (Funderburg 1960) and has the flattened inverted cone shape typical of undiked dredged-material islands. Maximum elevation is about 2 m. The North Colony is much older and has little topographic relief, except for a small depression in the center. Maximum elevation of the North Colony is about 0.3 m.

Vegetation: The dome of the South Colony is vegetated by a fairly dense cover of forbs and grasses, primarily saltmeadow cordgrass. The slopes and swales facing the Cape Fear River are similarly vegetated, whereas the slopes and swales bordering the saltmarsh are covered by a maritime shrub thicket. Thicket vegetation consists mainly of red cedar, yaupon, Hercules'-club, wax myrtle, red mulberry, hackberry, silverling, and marsh elder. Clumps of shrubs and trees were also scattered over the dome and slopes. The North Colony has a dense maritime shrub thicket composed of yaupon, live oak, red cedar, silverling, and marsh elder.

Surroundings: The South Colony is bordered on the north and east by saltmarsh, and on the south and west by the Cape Fear River. The North Colony is surrounded by saltmarsh.

Ownership: Battery Island is owned by the State of North Carolina. The National Audubon Society has a long-term lease on this site and maintains it as a sanctuary.

History of use by colonial waterbirds: The North Colony has supported a mixed-species heronry since at least 1928 (Pearson et al. 1942) and was the first North Carolina nesting site for the Glossy Ibis (Brimley 1941) and Cattle Egret (Quay and Adams 1956). The once bare dome of the South Colony provided nesting habitat for Gull-billed Terns, Least Terns, and Black Skimmers (Davis 1960, Funderburg 1960, Adams 1963). However, vegetation encroachment caused these ground-nesters to abandon the site in the 1960s. In 1961 the developing shrub thicket began to be used by nesting wading birds (Adams 1963). The South thicket continued to increase in size as did the wading bird population. The South Colony now supports the largest White Ibis colony in North Carolina (Allen-Grimes 1982, Shields and Parnell 1983). The North and South colonies combined form the largest wading bird colony in North Carolina (Parnell and Soots 1979, Parnell and McCrimmon 1984), and total nest numbers have continued to increase in recent years. In 1988, the total nesting population exceeded 6,800 nests.

Site potential: In September 1984, the eye of Hurricane Diana passed within a few km of Battery Island, and high winds caused considerable damage to thicket vegetation. The southern portion of the South Colony was hardest hit as many trees were uprooted or their limbs snapped. Most tall cedars throughout the South Colony suffered damage. The North Colony was less severely affected. In addition to storm damage, vegetation in the older portions of the thickets has apparently been degraded by over-fertilization by wading bird excrement in recent years (Parnell and Soots 1979). This has been particularly evident in the North Colony. Decreased numbers of several heron and egret species in recent years suggests that suitable nesting habitat for these species may be declining. Thus, habitat management probably will be required in the future to maintain wading bird populations at current levels.

Fort Fisher Beach (NH-039-49)

This site is on the rapidly developing sand spit north of New Inlet in southern New Hanover County (33°56'N,77°56'W). (Map W).

Site type: Barrier island beach.

Size: Not applicable.

Topography: Flat sandy beach between the high tide line and a series of low developing haycock dunes.

Vegetation: Generally bare with scattered clumps of sea rocket.

Surroundings: Open sand flats.

Ownership: The State of North Carolina.

History of use by colonial waterbirds: This site was used by Least Terns and Black Skimmers in 1977; in 1983, only Least Terns nested, and in 1988, over 300 nests of four species (Least, Common, and Gull-billed terns and Black Skimmers) were present.

Site potential: Habitat at this site appears suitable for groups 2 and 3. ORV traffic, however, is heavy and the nesting site should be posted. The habitat should remain appropriate for many years.

UNI, Monks Island, Bowen Point
(BW-043-09)

Monks Island (33°55'N,78°23'W) is inside Shallote Inlet about 7 km south of Shallote, Brunswick County (Map Y).

Site type: Diked dredged-material island.

Size: Large island, not measured.

Topography: In 1983, Monks Island was a large diked dredged-material island consisting of two domes approximately 5 m high. Shallow swales separated the domes.

Vegetation: This island received deposits of dredged material in 1982 or 1983, and in May 1983 the area inside the dike was completely bare. A shrub thicket was developing outside the dike.

Surroundings: Shallow open water and marsh.

Ownership: As a dredged-material island established on a subtidal flat, Monks Island is most likely owned by the State of North Carolina.

History of use by colonial waterbirds: Monks Island has been the primary nesting site for Least Terns in the area bounded by the Cape Fear River and the South Carolina border. Over 400 Least Tern nests and smaller numbers of Gull-billed Tern, Common Tern, and Black Skimmer nests were present in 1977. Only 42 Least Tern nests were counted in 1983, and the site was not used in 1988.

Site potential: This island has been a favorite nesting site of Least Terns. With somewhat frequent deposition of dredged material, Monks Island should continue to provide suitable bare nesting sites for Least Terns and other pioneer species.

UNI, Ocean Isle #1 (BW-045-02)

This unnamed island (33°54'N, 77°25'W) is next to the AIWW just north of Ocean Isle beach in Brunswick County (Map Z).

Site type: Diked dredged-material island.

Size: Not measured.

Topography: This diked dredged-material island has an elevated bare dome. Maximum elevation is 4.0 m.

Vegetation: The most elevated portion of this island is bare. Slopes and swales are vegetated by moderate to dense stands of grasses and forbs.

Surroundings: A deepwater channel and extensive marshes.

Ownership: Unknown.

History of use by colonial waterbirds: This island was occupied in 1989 by a small Least Tern colony.

Site potential: This site may occasionally be used by Least Terns when bare substrates are present.

Mad Inlet, Northside (BW-047-04)

Sunset Beach just north of Mad Inlet (33°52'N, 78°31'W) (Map Z).

Site type: Barrier island.

Size: Not applicable.

Topography: Sand beach between high tide line and dunes.

Vegetation: This inlet spit is generally bare of vegetation.

Surroundings: Beach and dune fields.

Ownership: Unknown.

History of use by colonial waterbirds: This site is occasionally used by small Least Tern and Black Skimmer colonies. In 1988, about 48 nests were located.

Site potential: This is a heavily used public beach. While the site is likely to remain bare or nearly bare, disturbance will be an important factor discouraging use by nesting birds.

Summary

Planned management of colonial waterbirds began in this country in the late 1800s, primarily as laws prohibiting the killing of the birds and protecting key nesting sites as refuges and sanctuaries. Incidental management of habitat by the creation of dredged-material islands at coastal sites has also been going on at least since the late 1800s. North Carolina has been typical of most coastal states with colonial waterbirds benefiting from the presence of refuges and other public lands along the coast and from many dredged-material islands associated with channels through the estuaries.

The value of dredged-material islands in North Carolina became evident in the early 1970s, and by the mid-1970s the first coastwide censuses provided a database on populations of colonially nesting waterbirds. This census, correlated with similar ones in adjacent states, allowed us, for the first time, to relate current populations to historical accounts. We found that many species of colonial waterbirds had increased significantly since the days of plume hunting in the late 1800s. These data also allowed us to view North Carolina populations in light of those of adjacent states and to realize two primary facts about numbers here. First, populations of most species in North Carolina were high relative to numbers in adjacent states; and second, birds in this state were more dependent on dredged-material islands than those in most other Atlantic coast states.

A second set of population and habitat data gathered in 1983 allowed the first between year comparisons in this state. Trends could be viewed for a 6 year period. This comparison showed that populations of several species were increasing sharply, while numbers of some species were about stable, and a few were declining.

An apparent slight trend toward fewer and larger colonies of the pioneer species indicated that appropriate nesting habitat may be becoming harder for these birds to locate. This is alarming in that larger colonies, while sometimes more successful than smaller colonies, create a situation where disturbance or disease at a single site affects a larger portion of the total population.

While data are not conclusive, this apparent decline in numbers of suitable sites is consistent with observed changes in the methods of deposition of dredged material, the primary habitat used in North Carolina. More islands are being diked, and this generally results in a speeding up of community succession and a shortening of the period of use for the pioneer species, in addition to creating conditions less suitable for many species. There is also an increased emphasis on mainland or beach deposition of dredged material, and less material is being deposited on estuarine islands. This is resulting in fewer bare or nearly bare surfaces available to pioneer species and will ultimately result in fewer grassy islands being available for those species preferring dense herbaceous cover for nesting.

The combined factors of relatively healthy populations of most species and a reasonably good database on populations and nesting sites has coincided with the emergence of a new

nongame emphasis by the North Carolina Wildlife Resources Commission. This, plus an increased interest in colonial waterbirds by other conservation and resource management agencies operating in the North Carolina coastal zone, makes this an appropriate time to consider additional management efforts to assure the continued health of colonial waterbird populations in North Carolina.

This plan will expand the efforts of those agencies already managing colonial waterbirds by extending management beyond the confines of specific refuges and sanctuaries. It also will provide for an active management program extending beyond the traditional site protection, and will recommend the coordinated input of agencies involved in the management and regulation of North Carolina's coastal natural resources.

The plan recommends that the North Carolina Wildlife Resources Commission establish the active management of the state's colonial waterbirds as a function of the nongame species program and that staff be identified to lead the efforts. It also recommends that an advisory committee be established that will include representatives of private, state, and federal agencies that have responsibilities for the management or regulation of coastal resources. This group will meet at least annually to review an annual plan of work and to assist with the coordination needed to assure that the needs of these birds are considered with the needs of other coastal resources.

The plan sets five goals for the management program. They are: 1) to maintain the reproductive populations of most species at or near current levels, 2) to design management tools to encourage those native species that are presently at low numbers or that are currently declining, 3) to discourage problem species when it is determined that they are having a strong negative impact on other species, 4) to encourage a dispersed nesting population of each species over that portion of the coastal zone traditionally occupied, and 5) to provide special attention for species Endangered, Threatened or of Special Concern.

Several management strategies are recommended to accomplish these goals. First, regular surveys should be conducted to allow colonies to be located and nesting populations monitored. Second, coastal nesting sites should be actively managed to maintain adequate numbers of habitat units within each management regions. Third, active protection from disturbances by people and mammalian predators should be provided in those colonies where disturbances prove to be a problem. Fourth, active cooperation is requested of all coastal management or regulatory agencies to assure that the goals are met.

There are 25 species of herons, egrets, ibises, pelicans, anhingas, cormorants, terns, skimmers and gulls nesting in the North Carolina coastal zone. They have been divided into 8 groups for management purposes. Each group contains those species with nesting requirements similar enough to allow them to be managed as a unit. The North Carolina coastal zone has been divided into 5 management regions, each a more or less distinct ecological unit with similar environmental conditions. Management will emphasize maintaining dispersed nesting sites for appropriate species within each management units.

The key features of the biology of the species nesting in North Carolina have been outlined and specific recommendations have been made relative to nesting habitat needs. All nesting sites that were used in 1977, 1983, and 1988, the years of coastal surveys, have been evaluated as to importance to colonial waterbird species. Specific recommendations have been made relative to each key site to assure that adequate sites will be available for each species within their traditional nesting range in North Carolina.

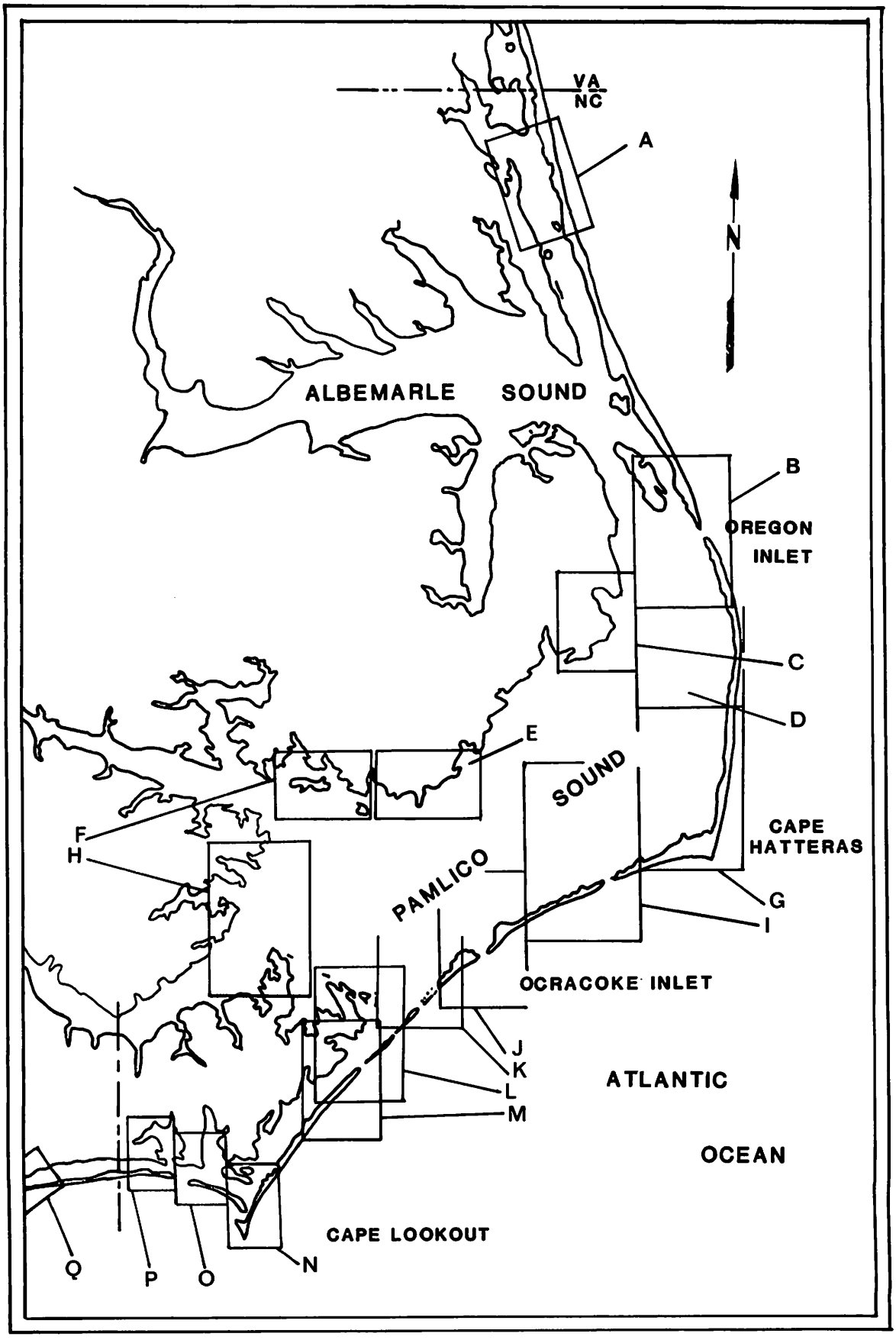

Figure 2. Index Map 1

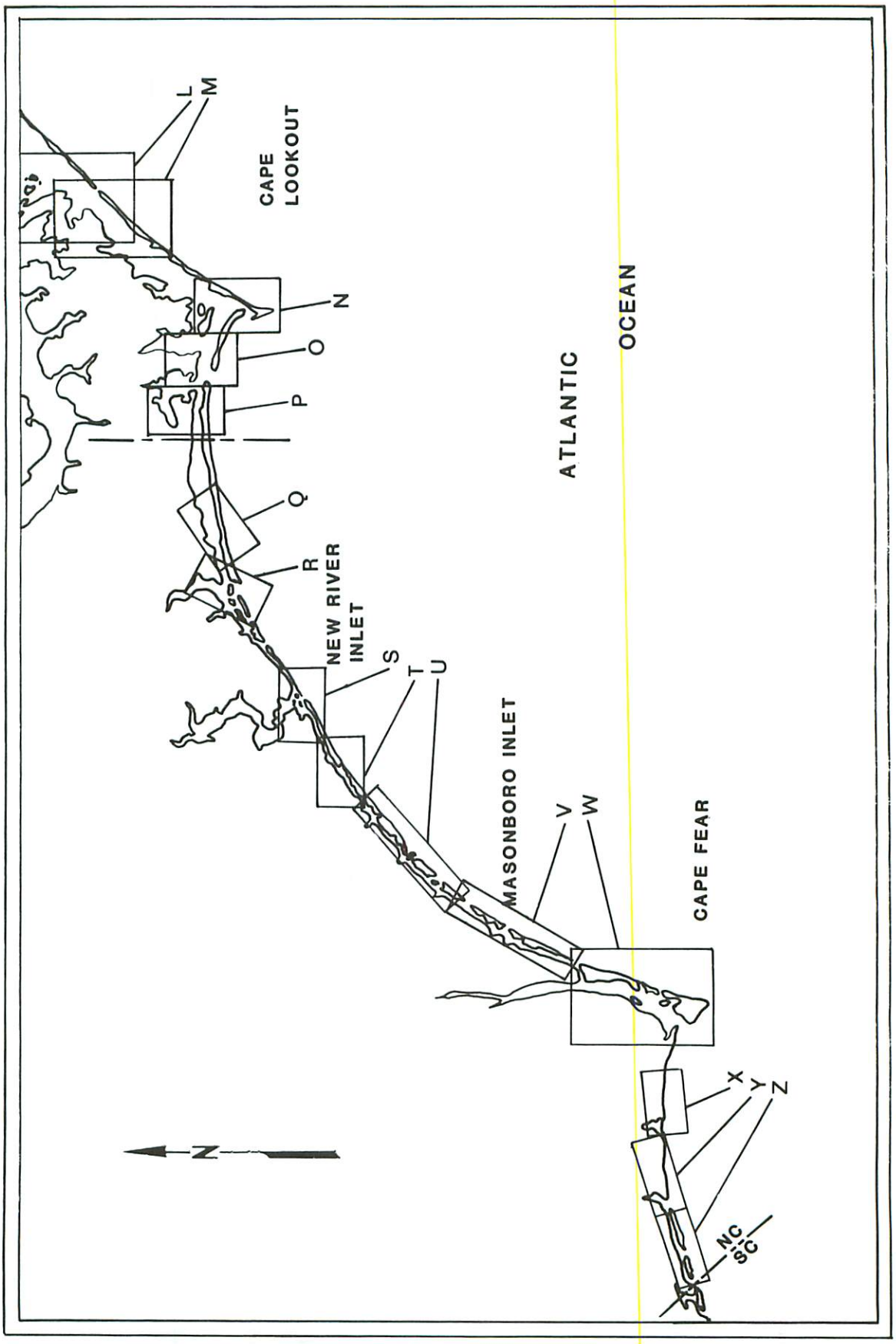

Figure 3. Index Map 2

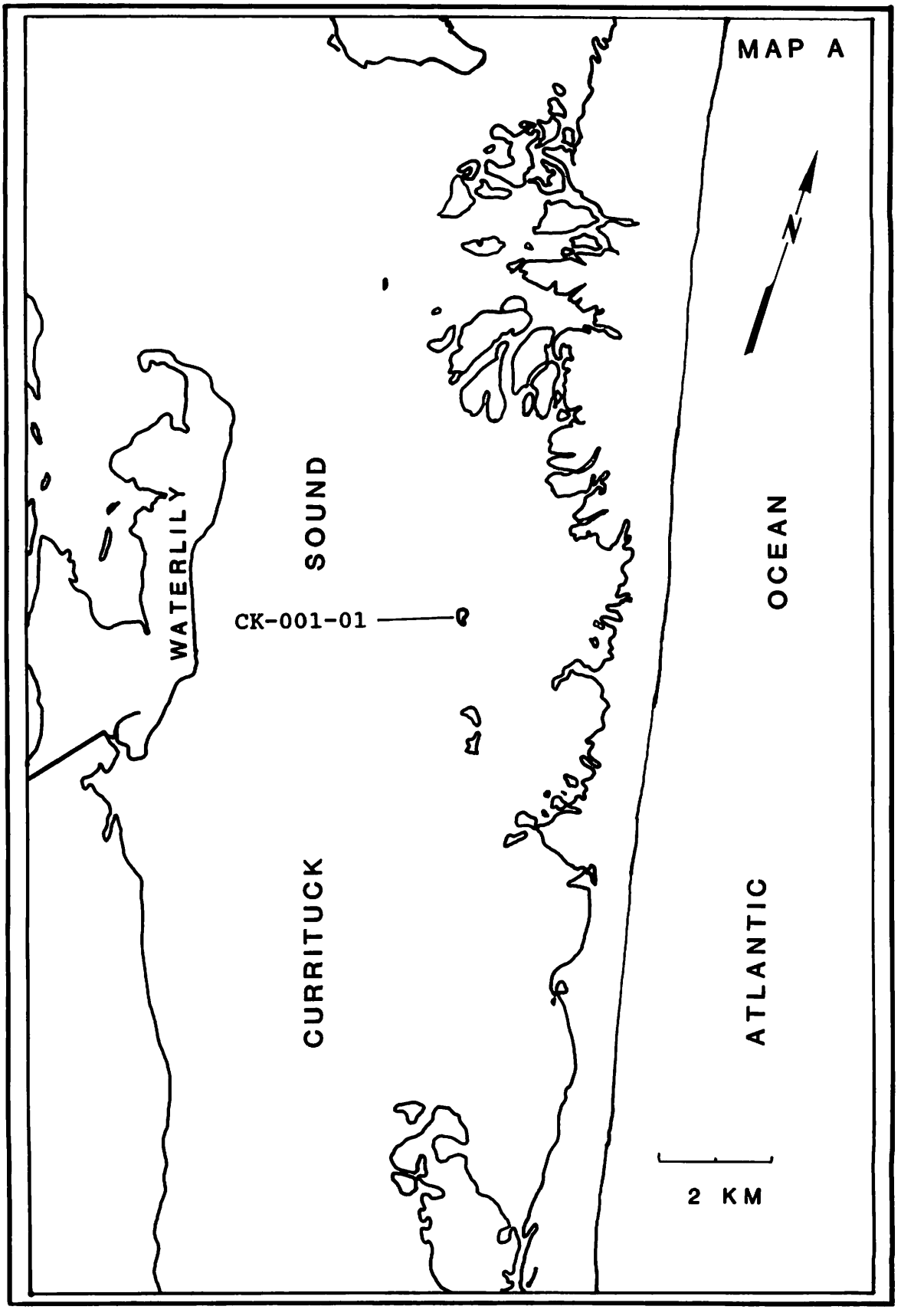

Figure 4. Map A. Currituck Sound and vicinity

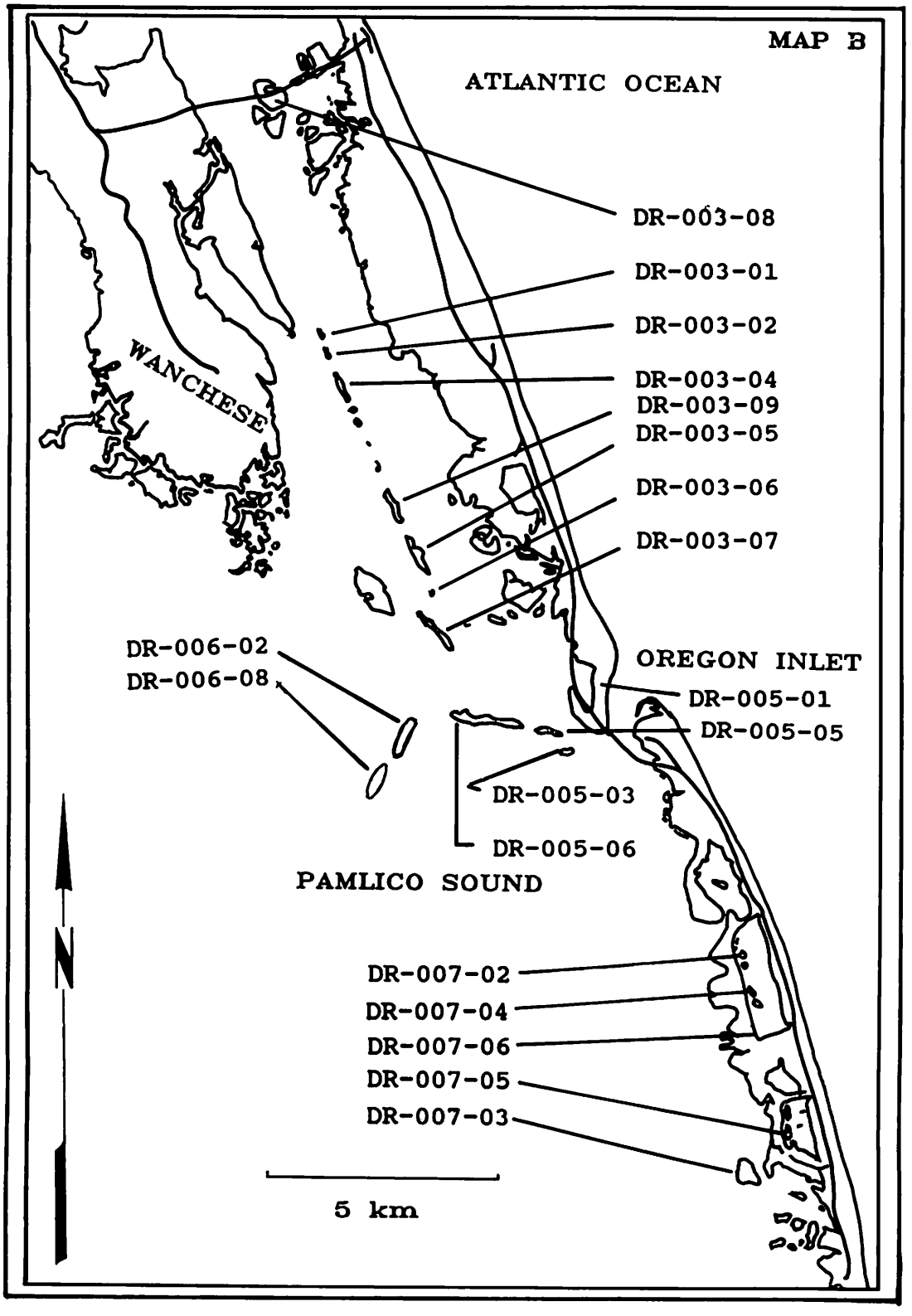

Figure 5. Map B. Oregon Inlet and vicinity

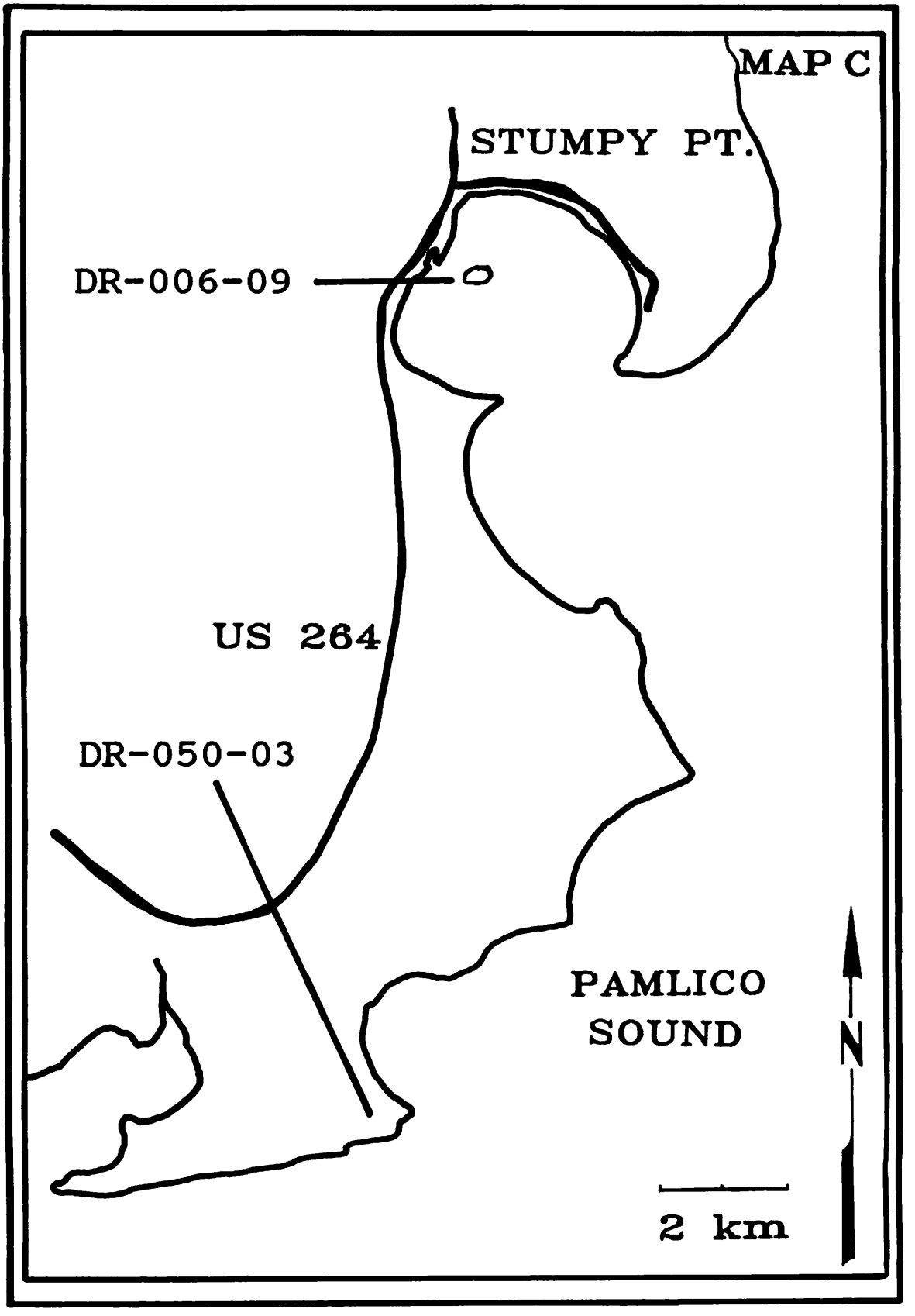

Figure 6. Map C. Stumpy Point region

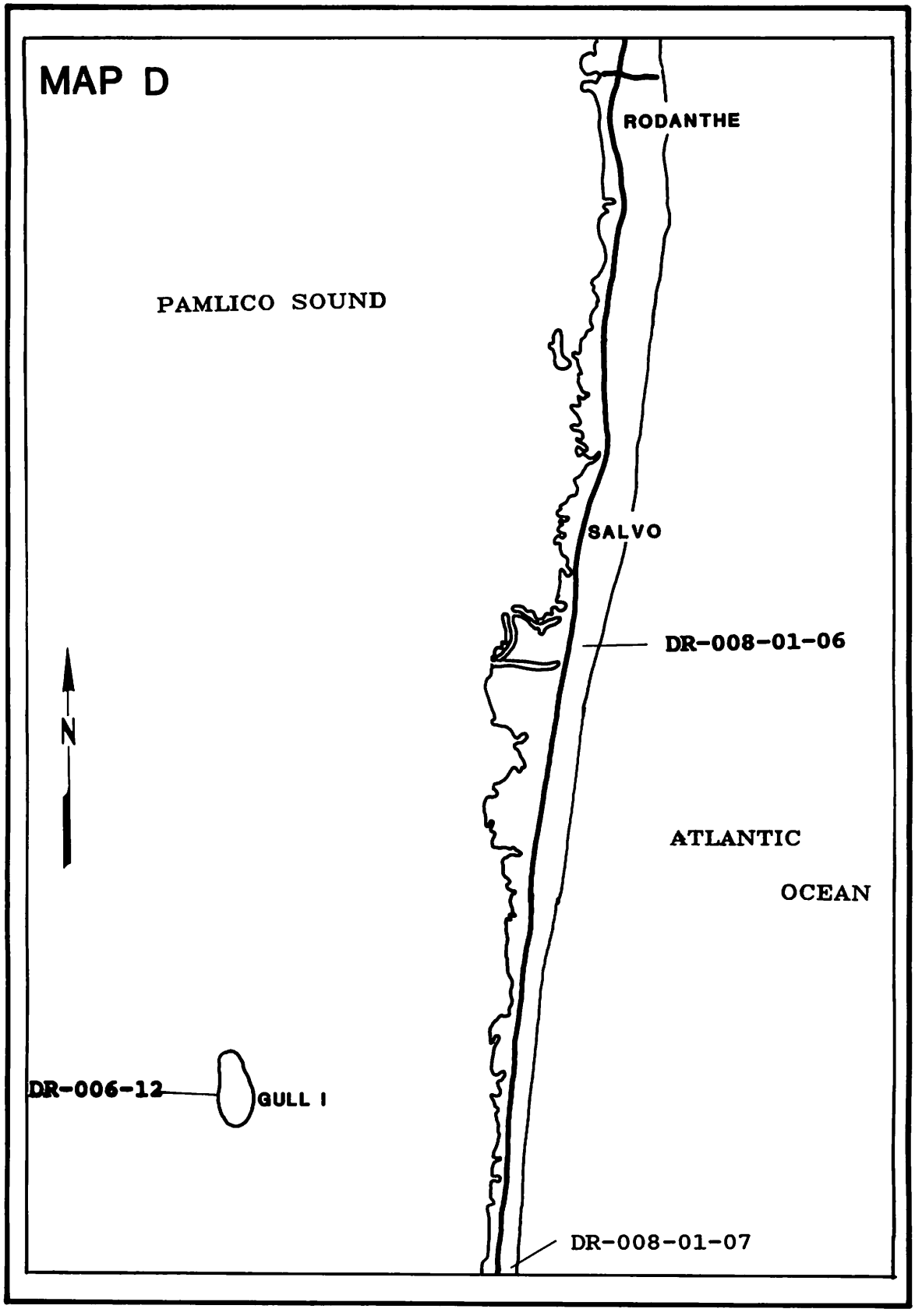

Figure 7. Map D. Pamlico Sound, Rodanthe/ Salvo region

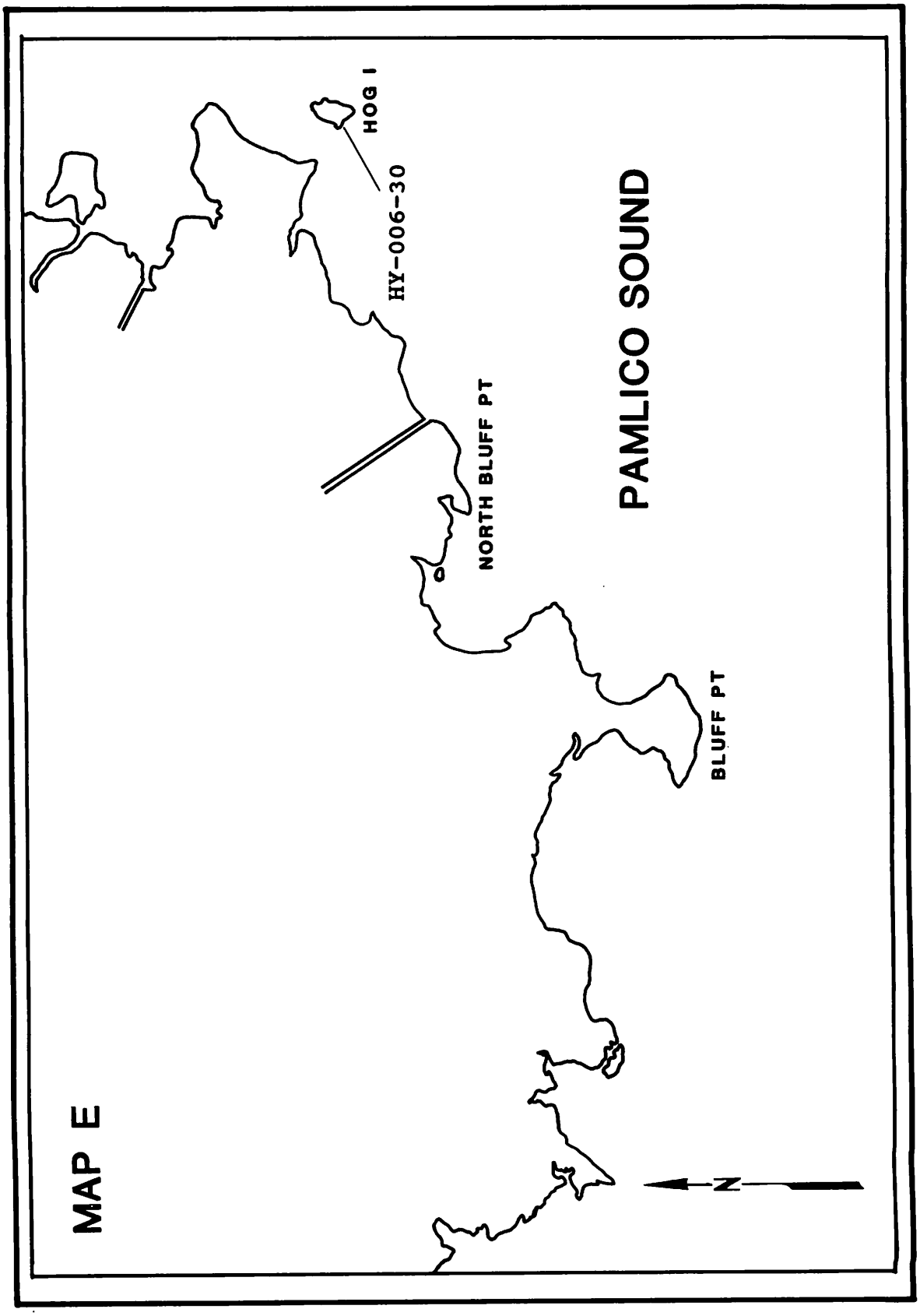

Figure 8. Map E. Pamlico Sound, Hyde County

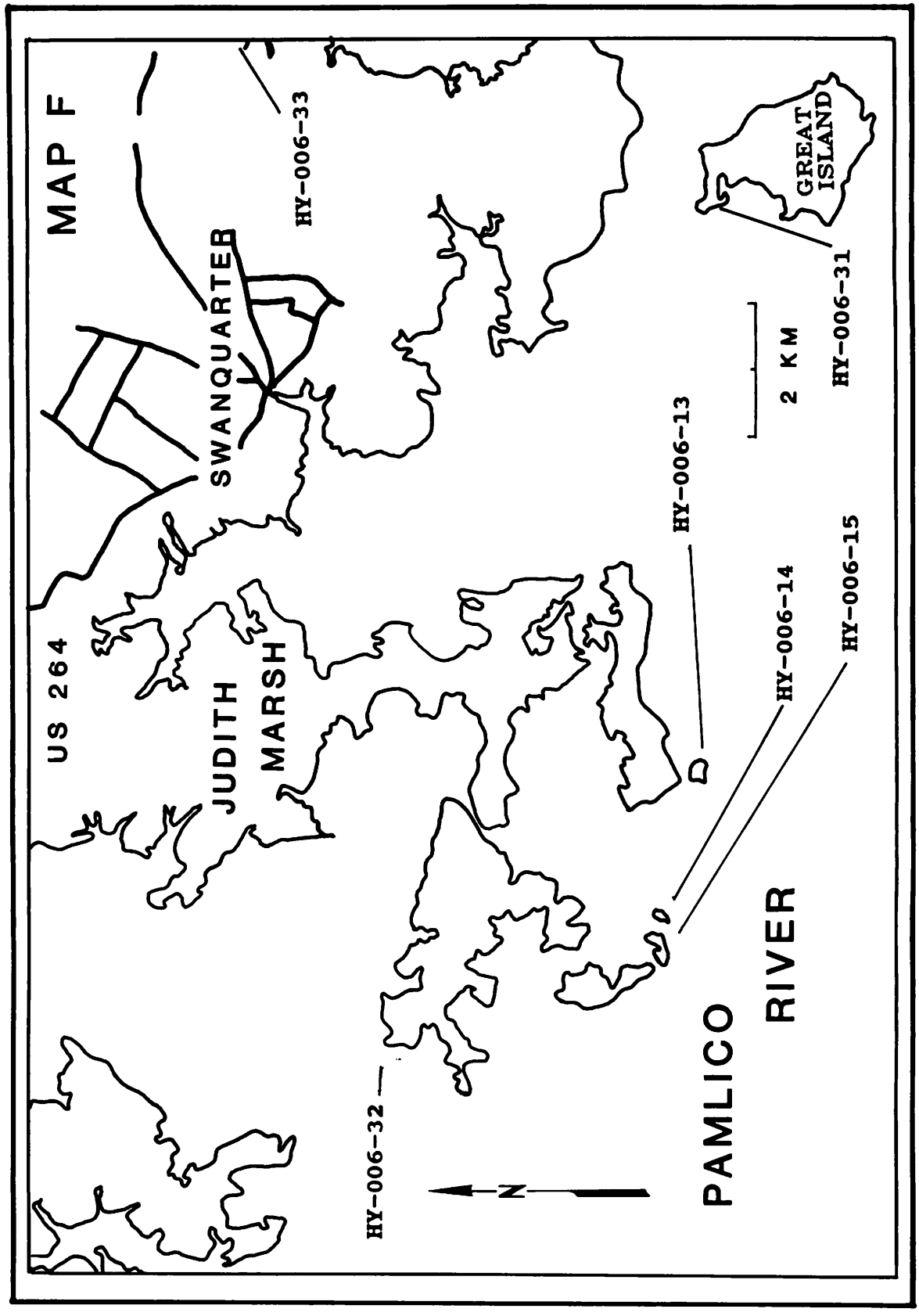

Figure 9. Map F. Swanquarter and vicinity

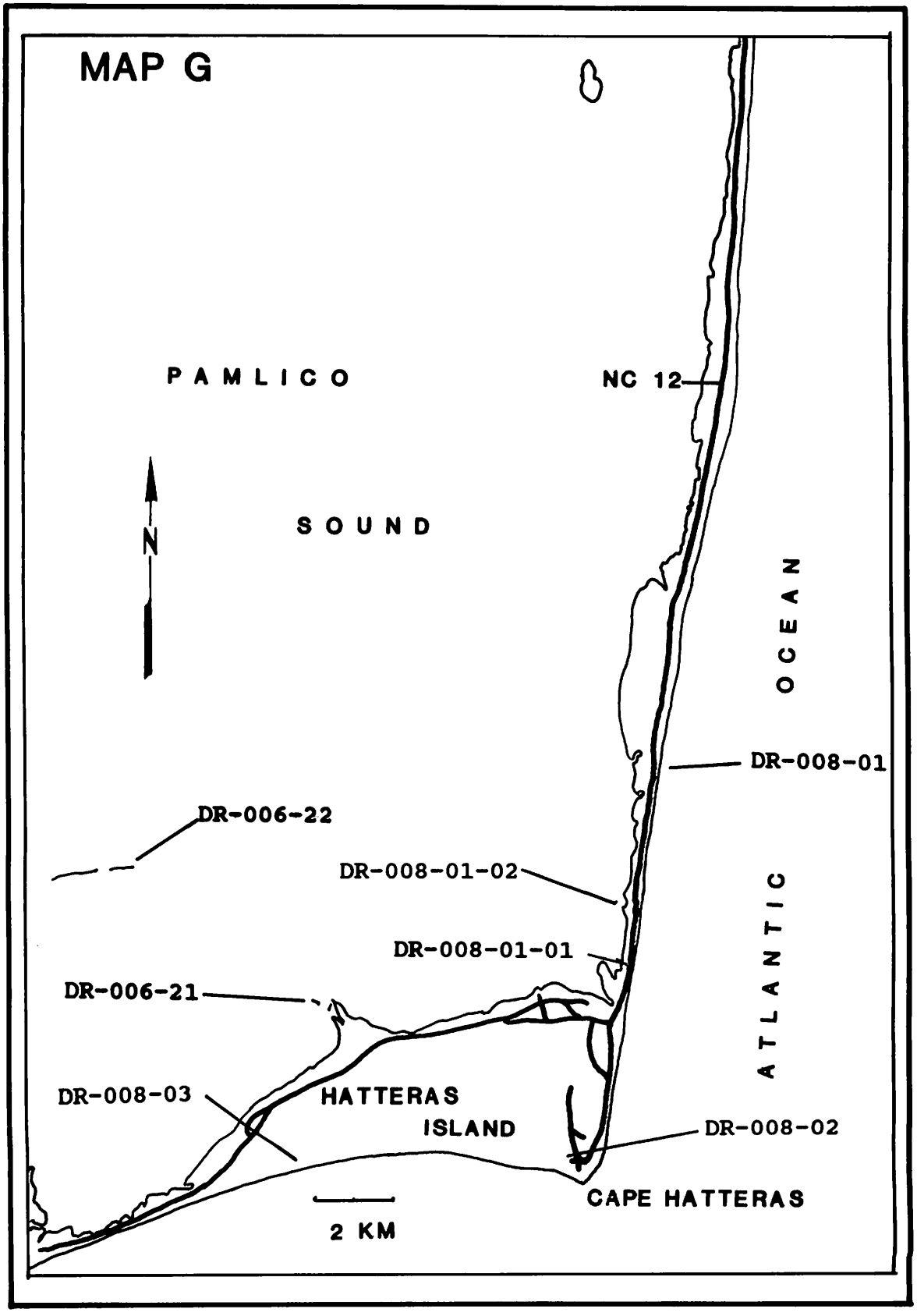

Figure 10. Map G. Hatteras Island and vicinity

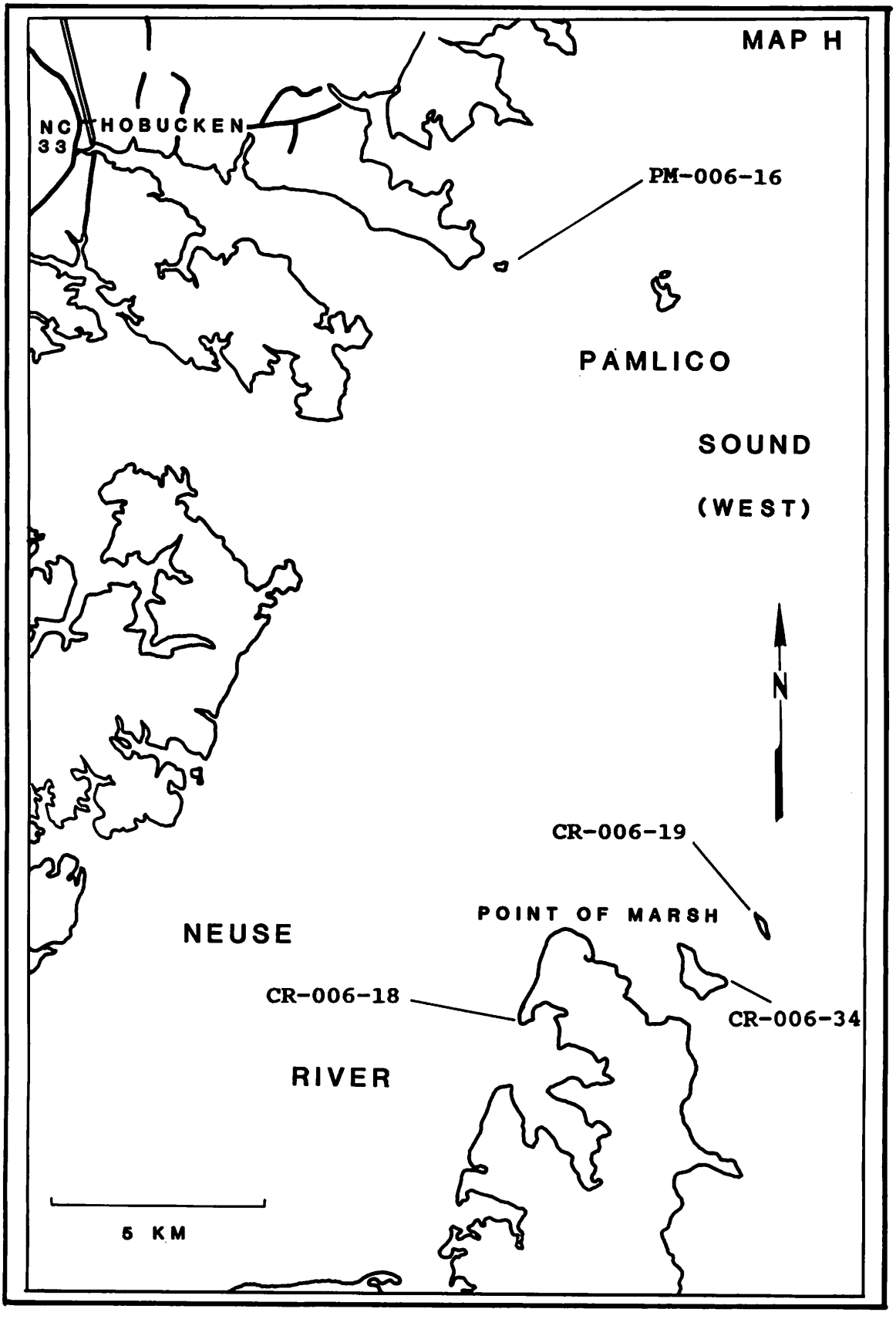

Figure 11. Map H. Pamlico Sound in vicinity of Neuse River mouth

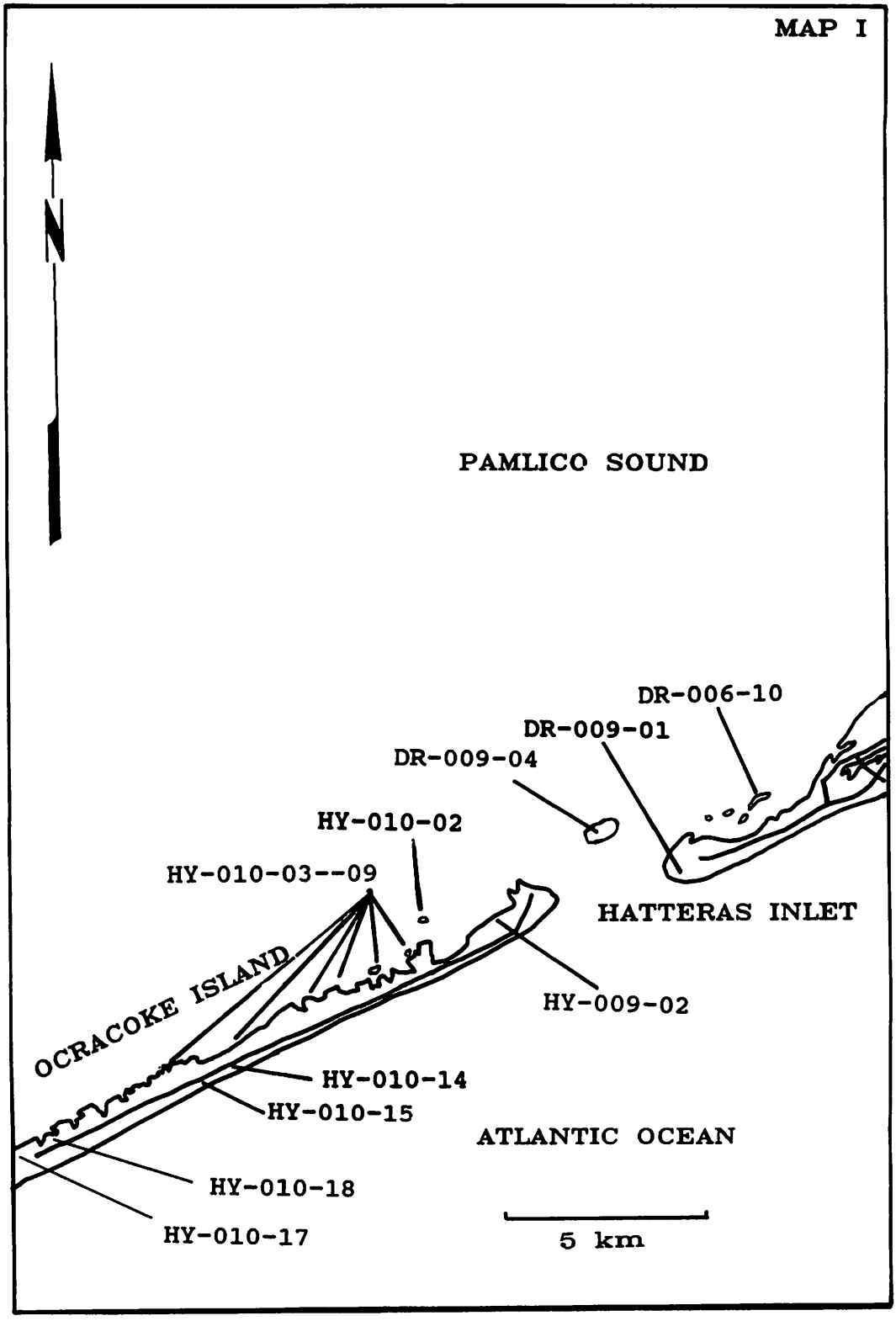

Figure 12. Map I. Hatteras Inlet and vicinity

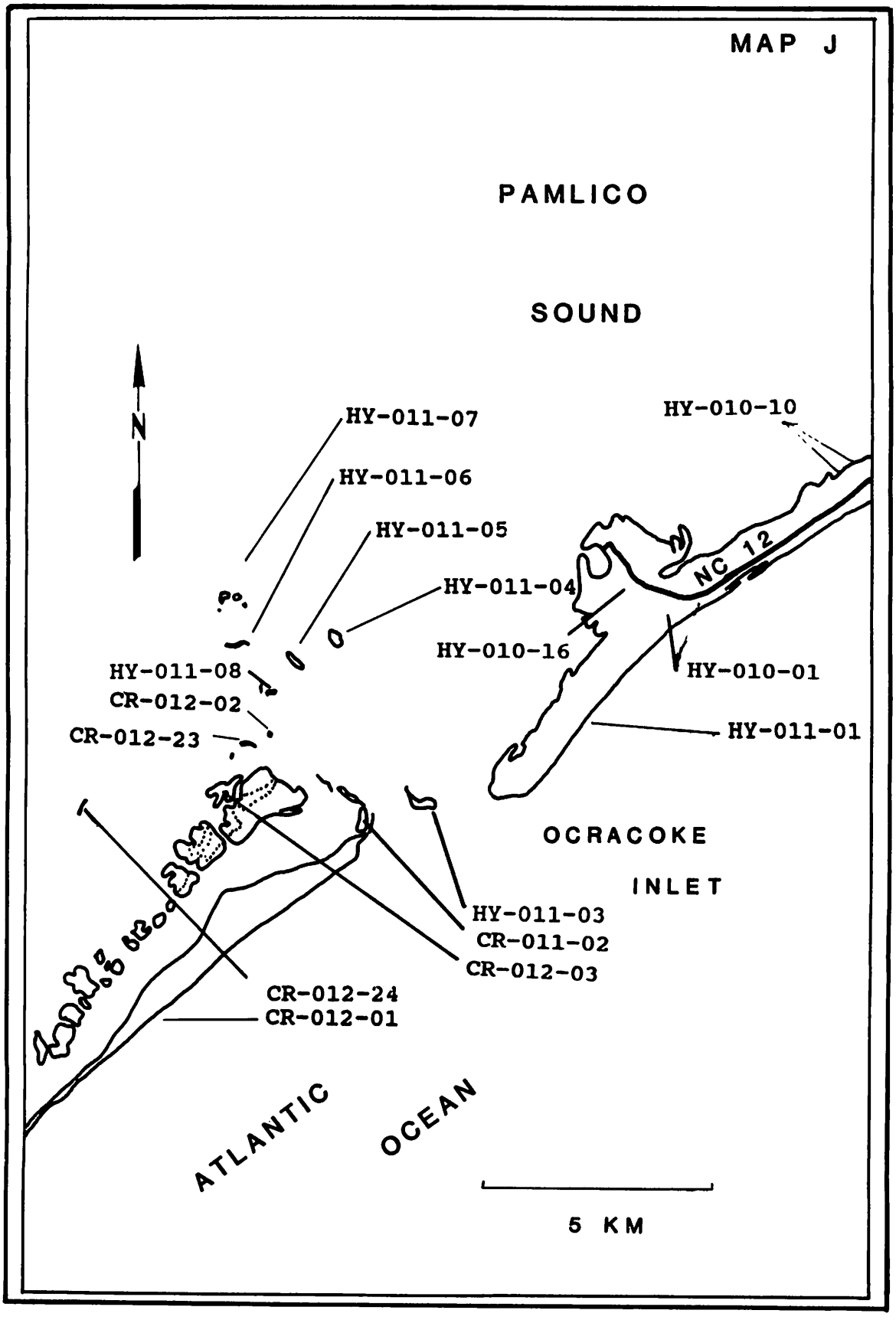

Figure 13. Map J. Ocracoke Inlet and vicinity

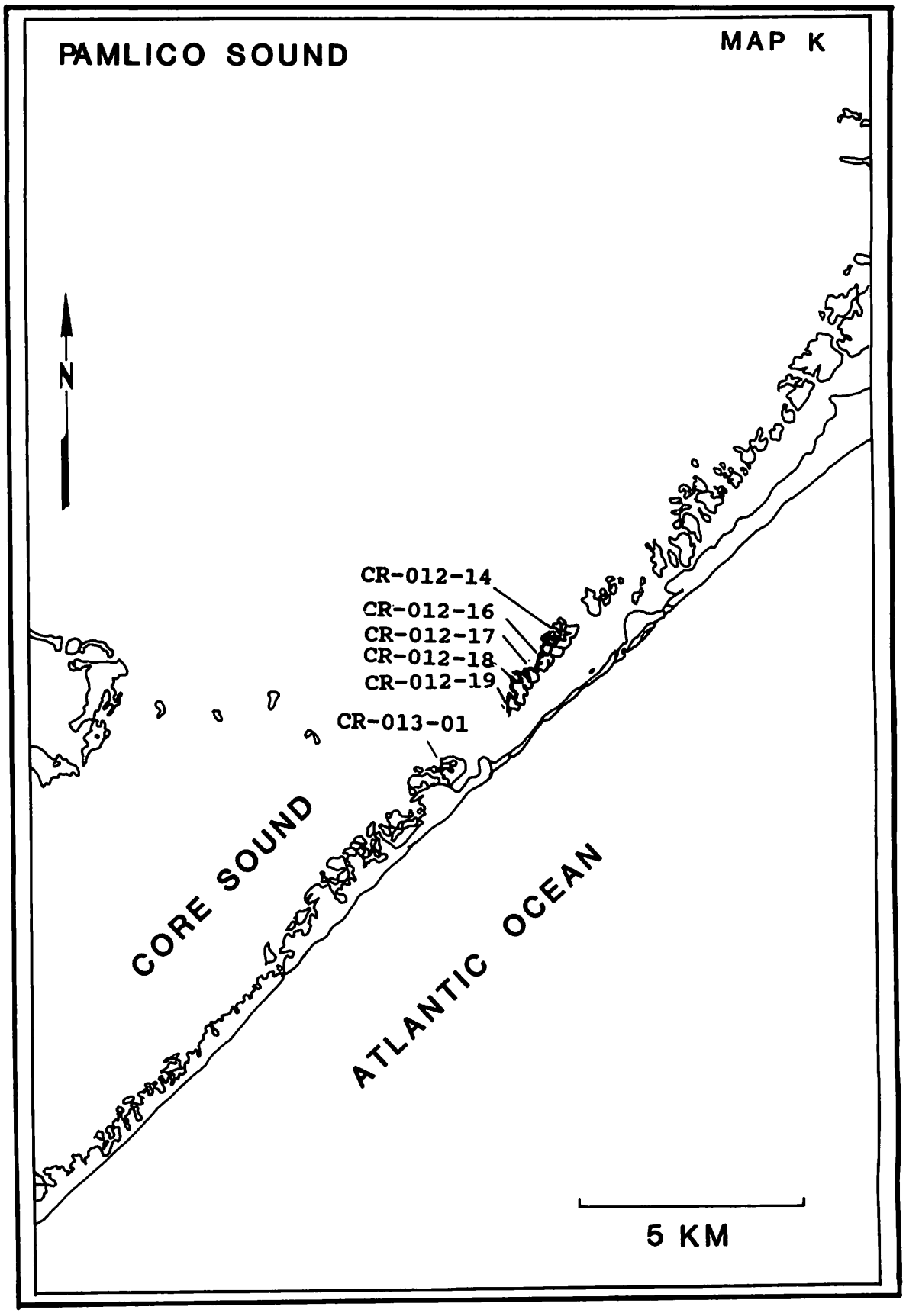

Figure 14. Map K. Upper Core Sound, vicinity of Swash Inlet

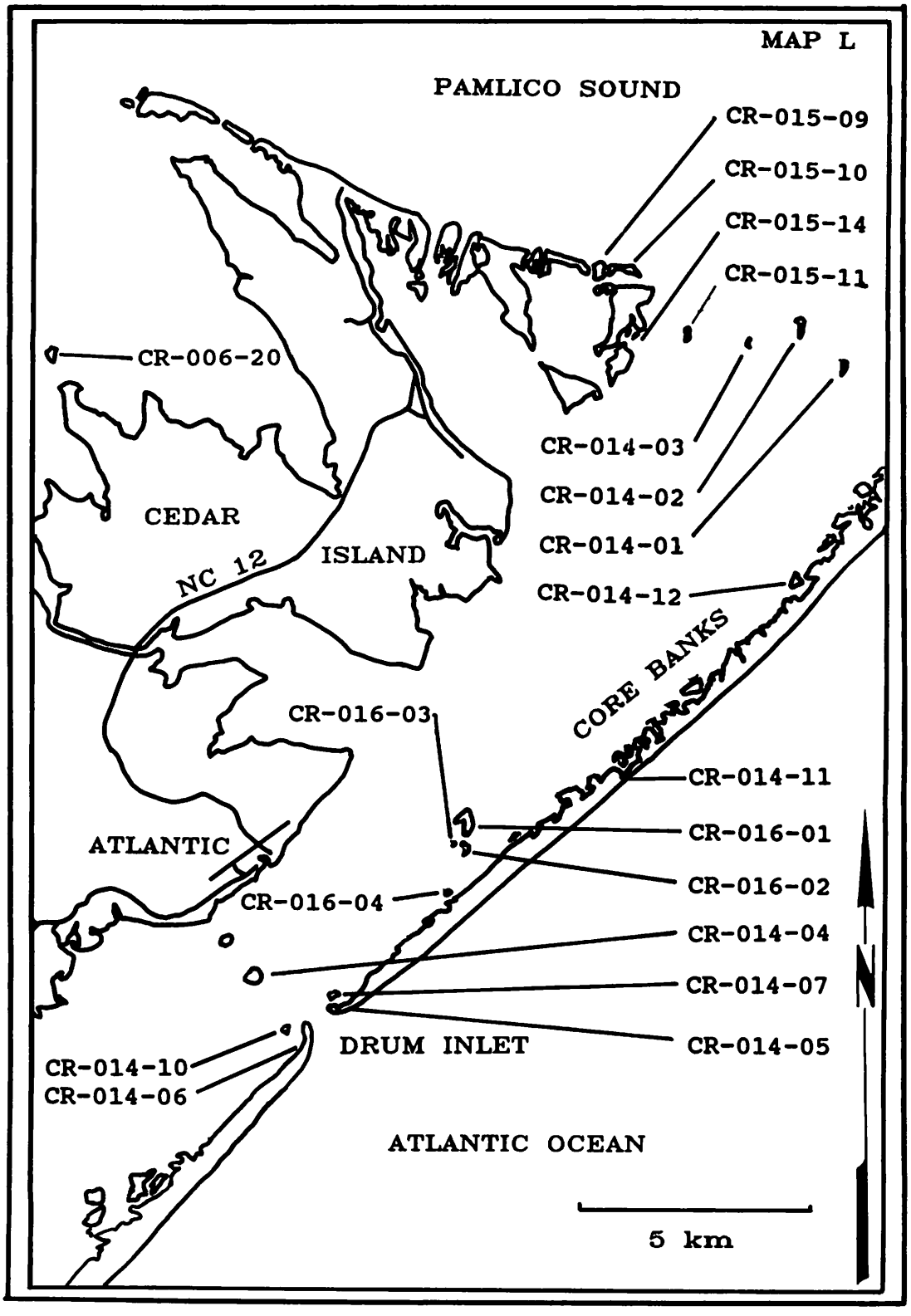

Figure 15. Map L. Core Sound, Drum Inlet to Pamlico Sound

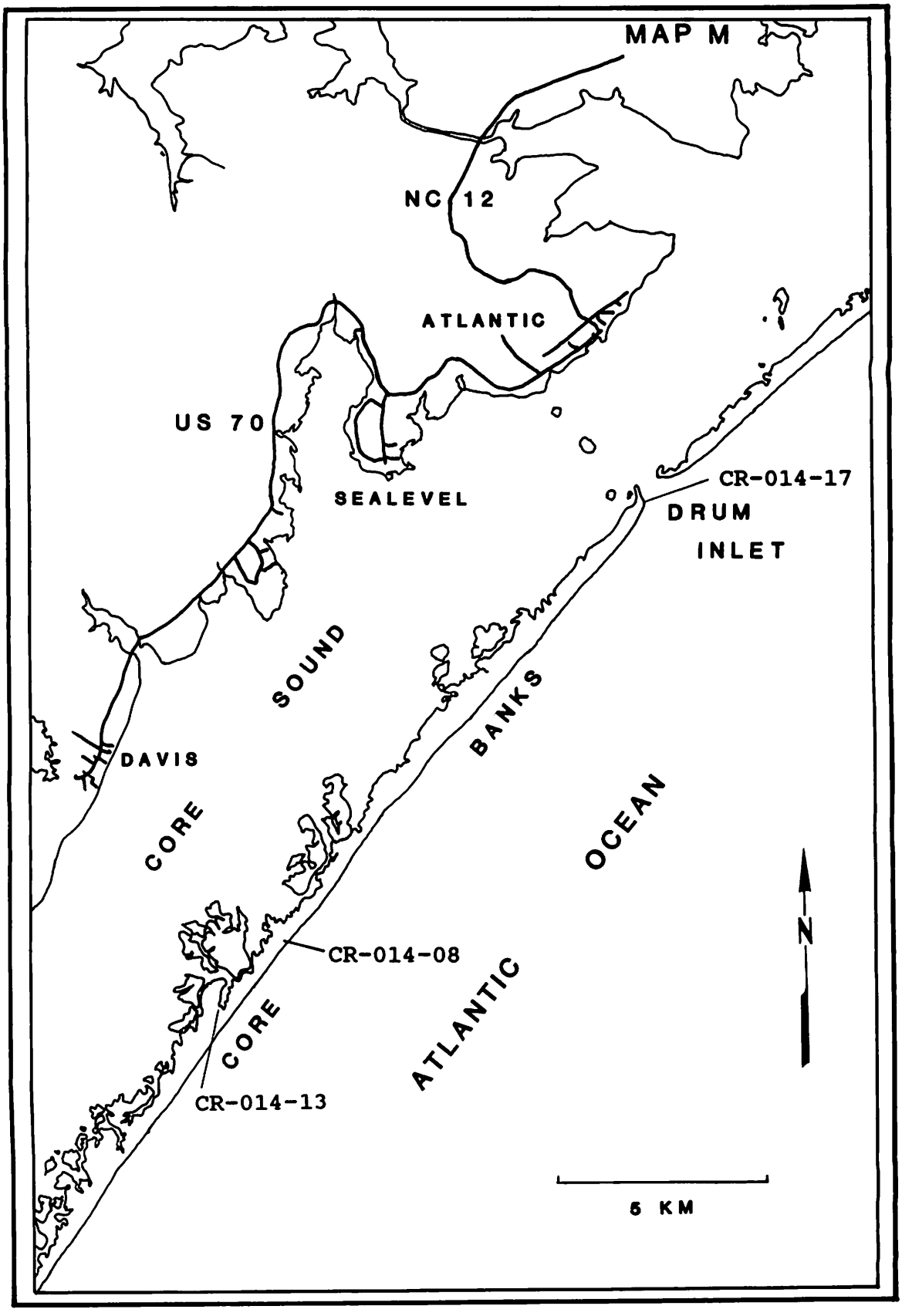

Figure 16. Map M. Core Sound, Davis to Atlantic

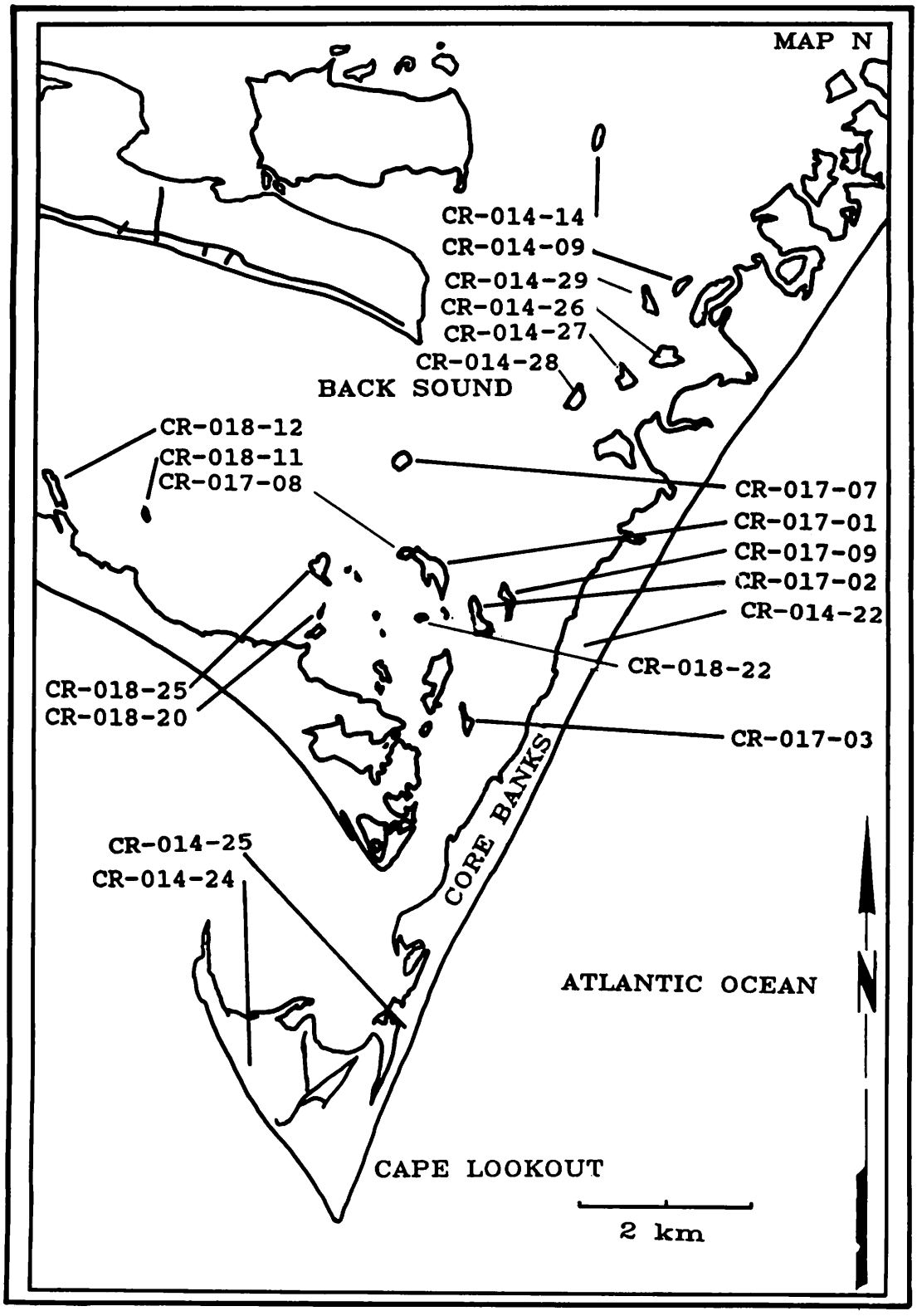

Figure 17. Map N. Cape Lookout and vicinity

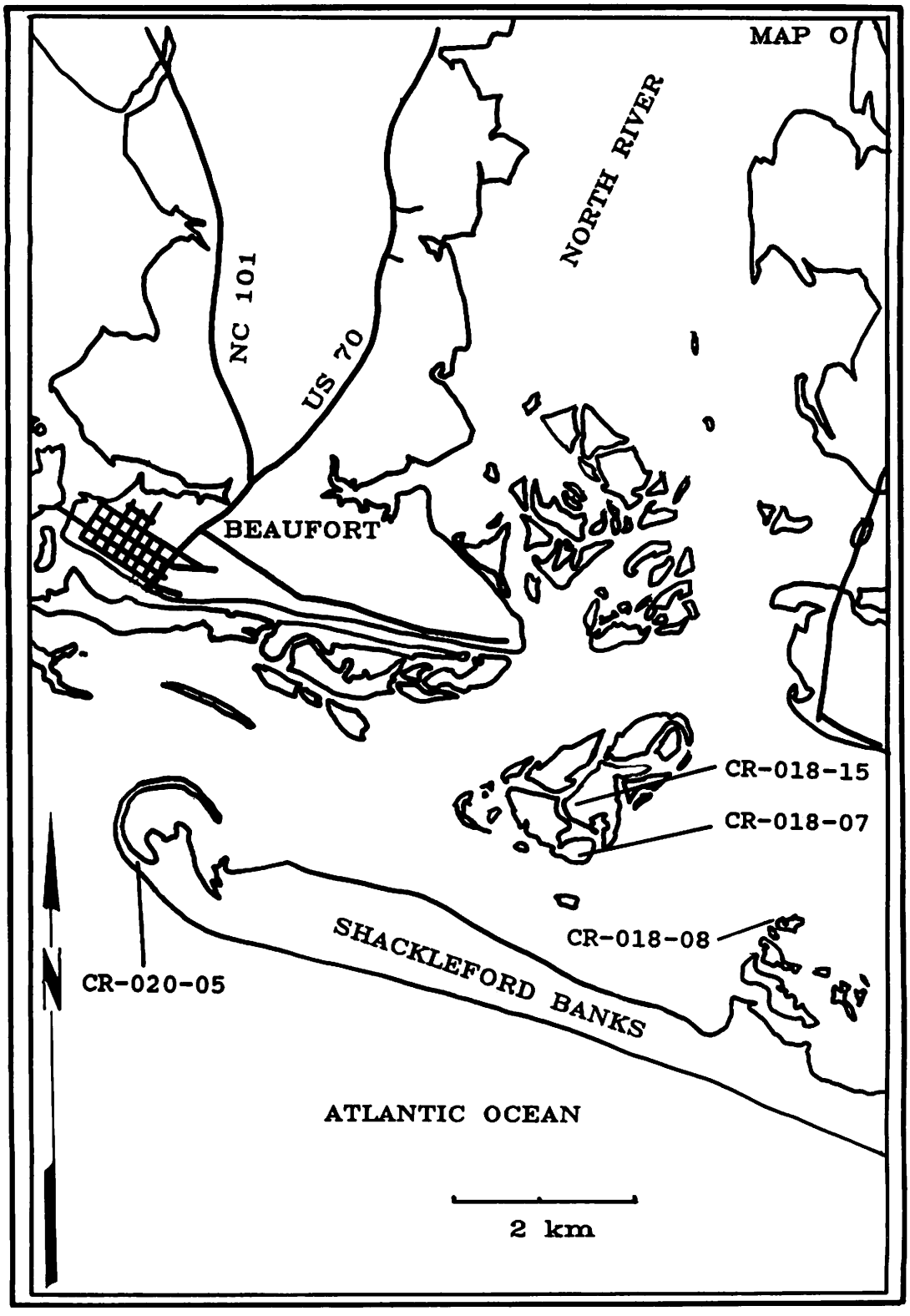

Figure 18. Map O. North River to Shackleford Banks vicinity

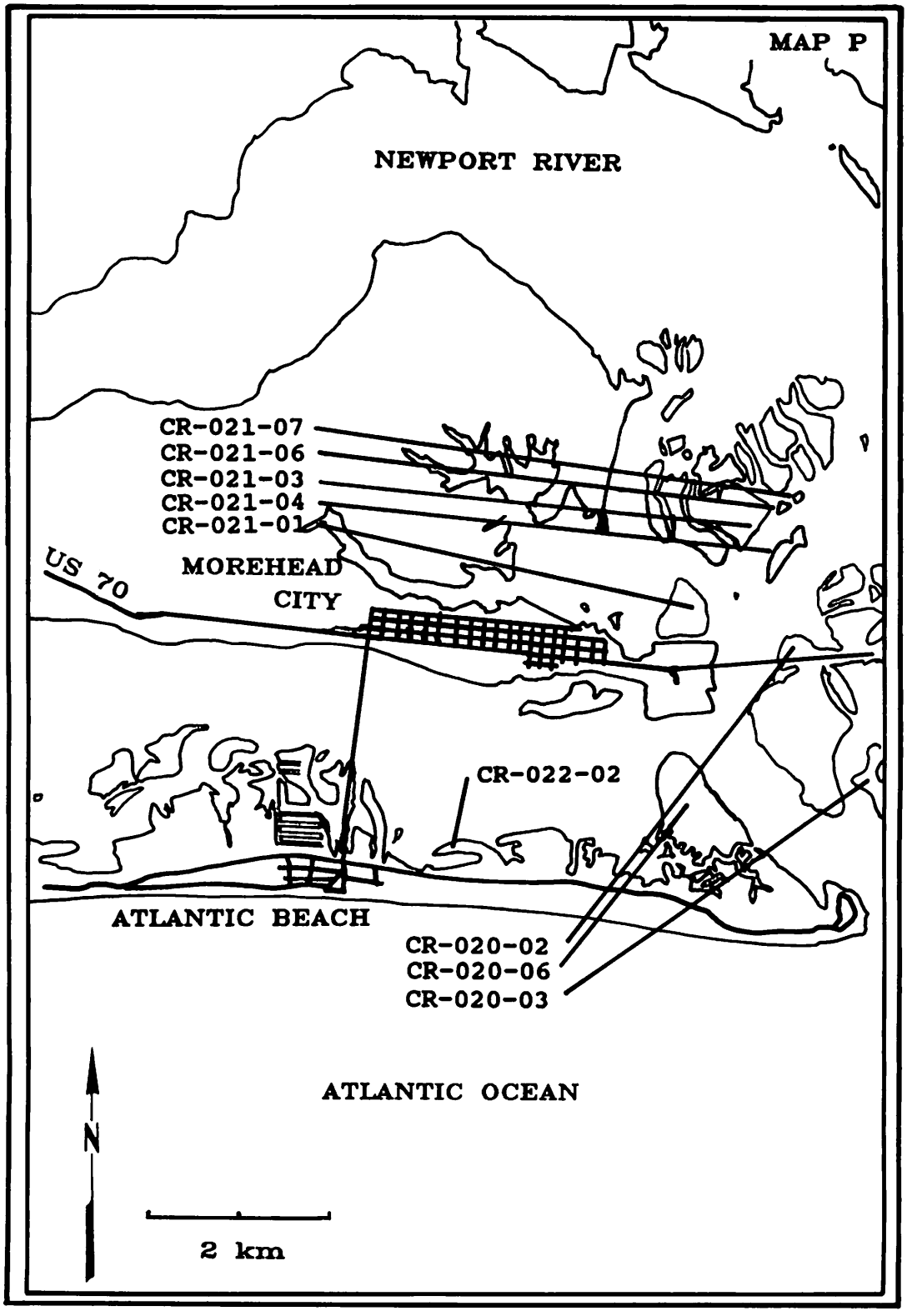

Figure 19. Map P. Morehead City and vicinity

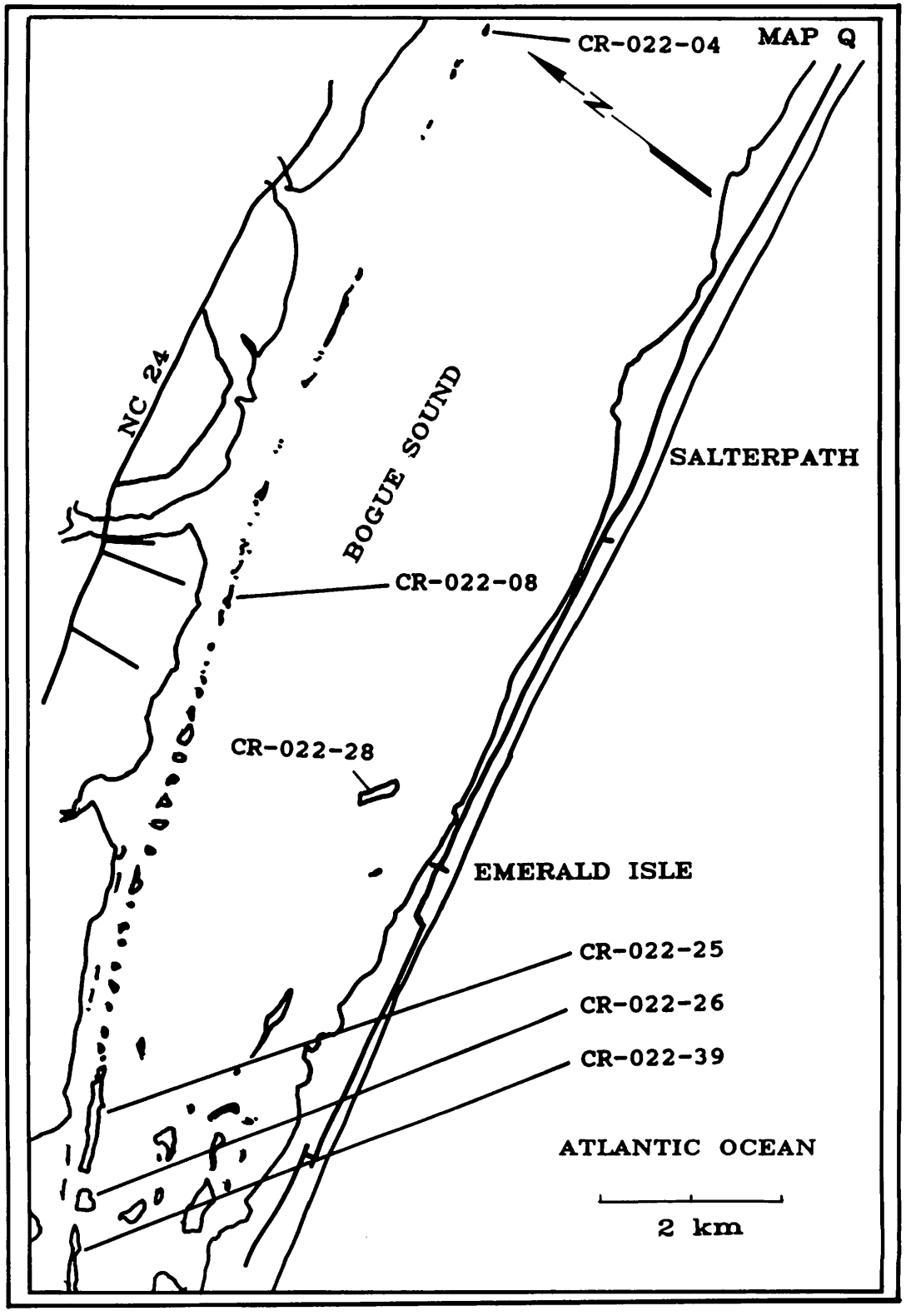

Figure 20. Map Q. Bogue Sound

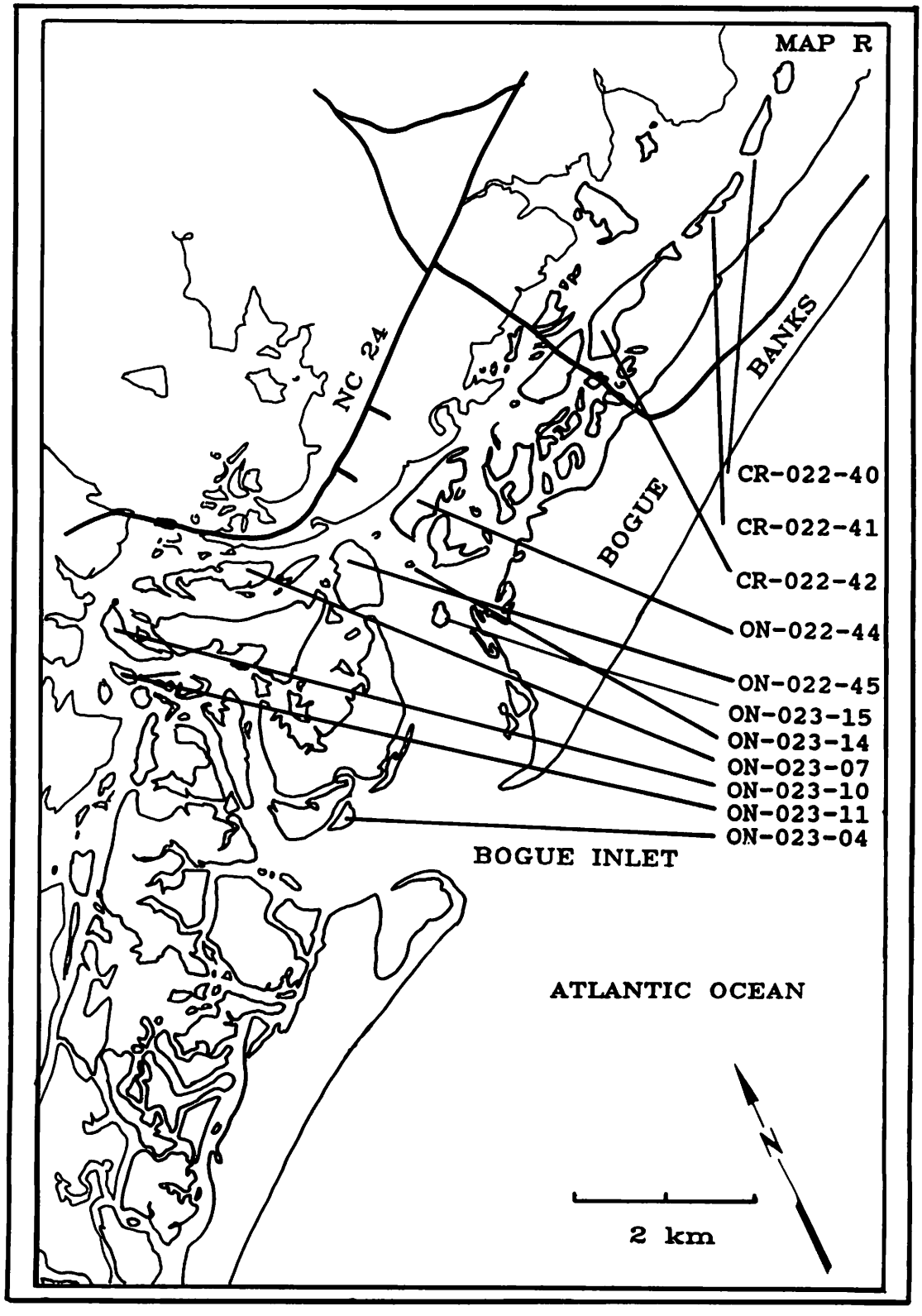

Figure 21. Map R. Bogue Inlet and vicinity

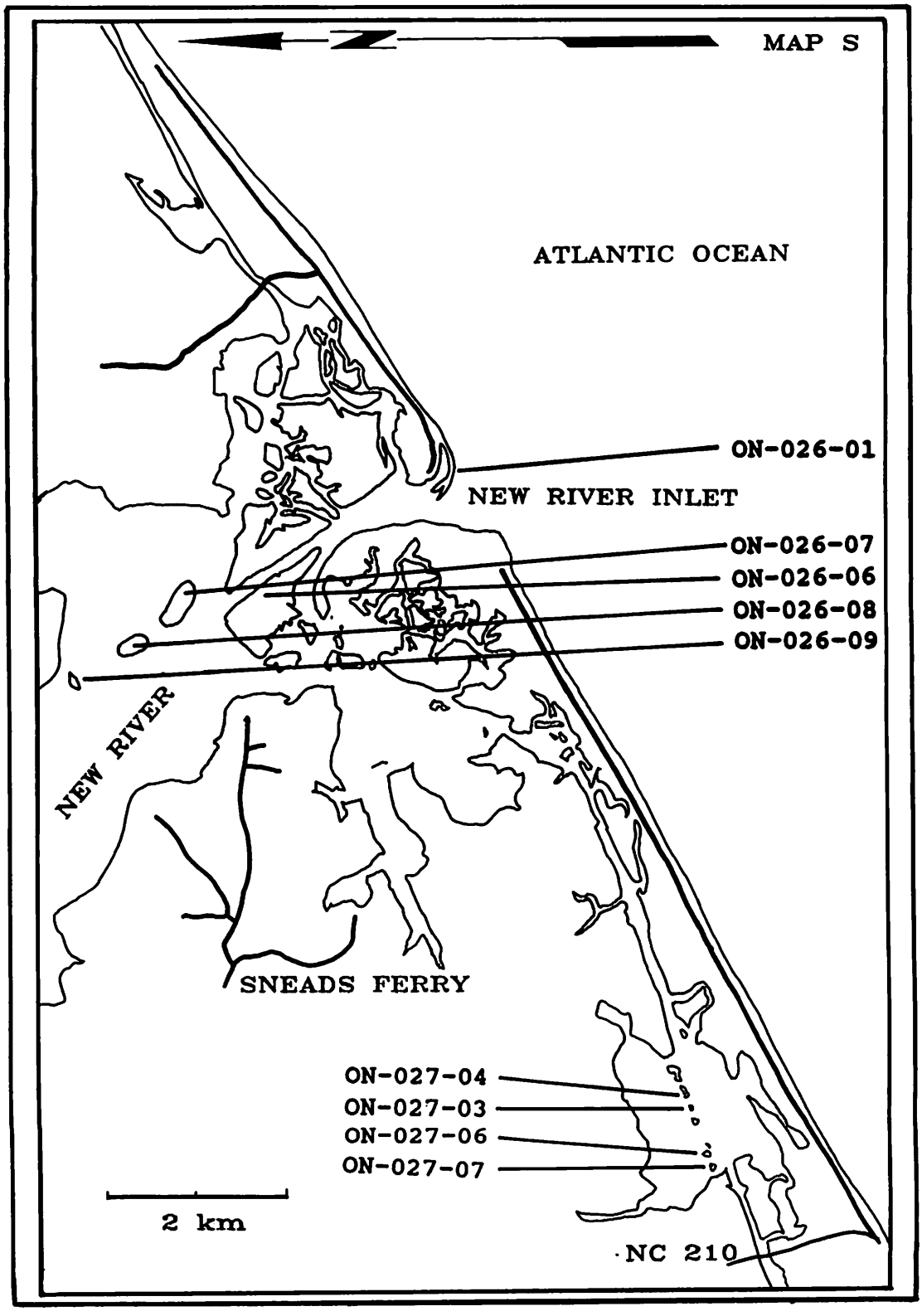

Figure 22. Map S. New River Inlet and vicinity

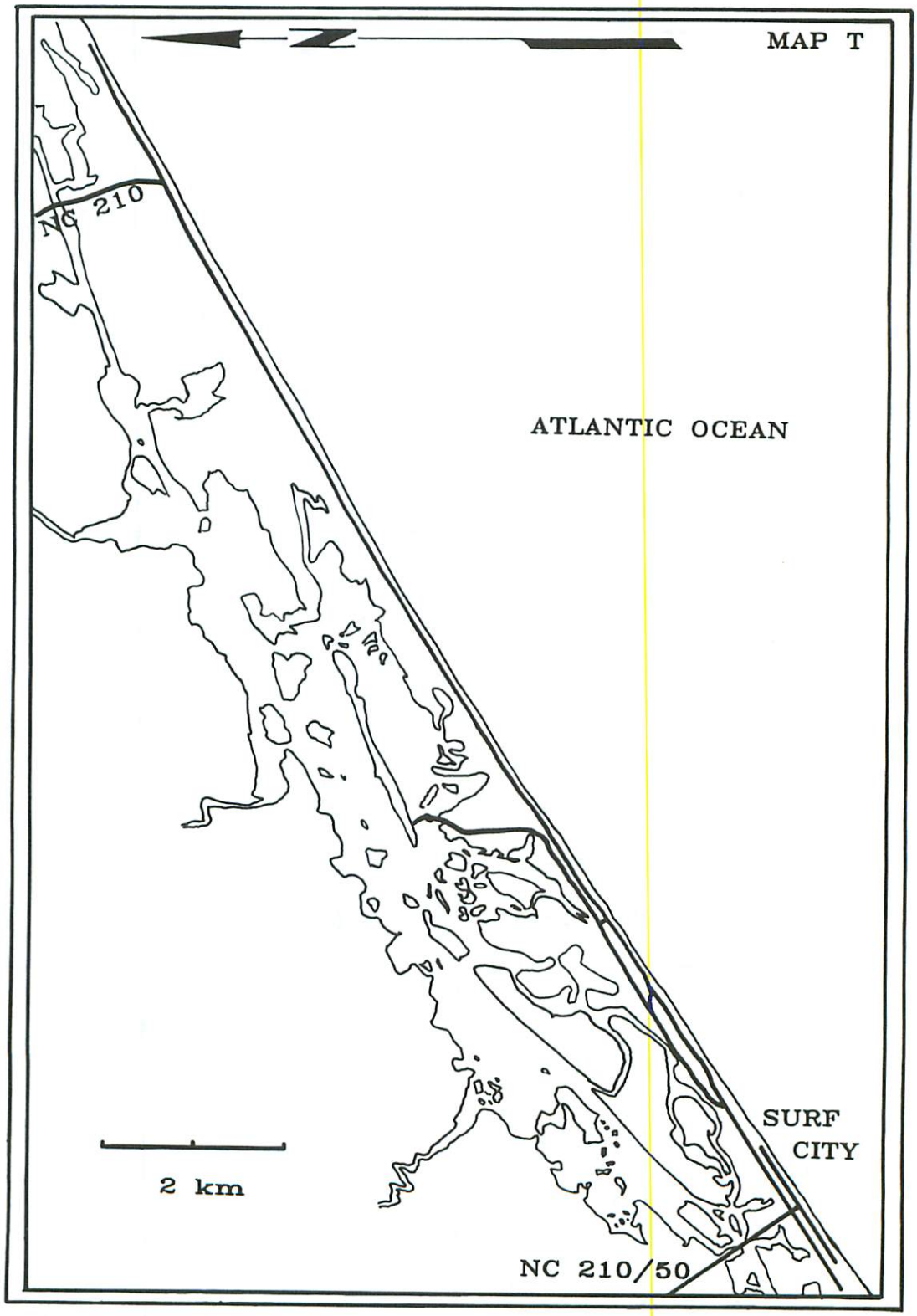

Figure 23. Map T. Topsail Island and vicinity

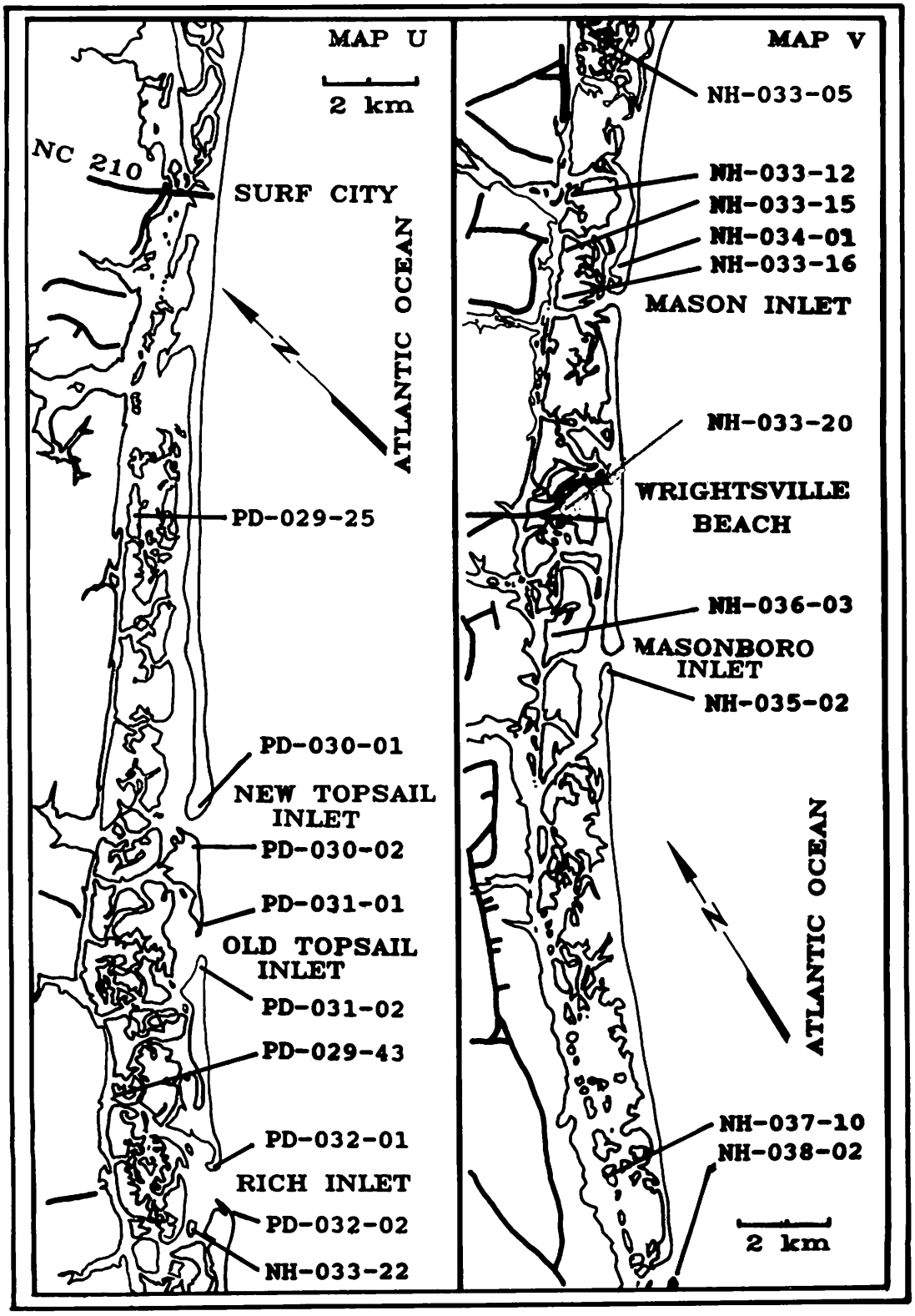

Figure 24. Maps U and V. Surf City to Masonboro Inlet

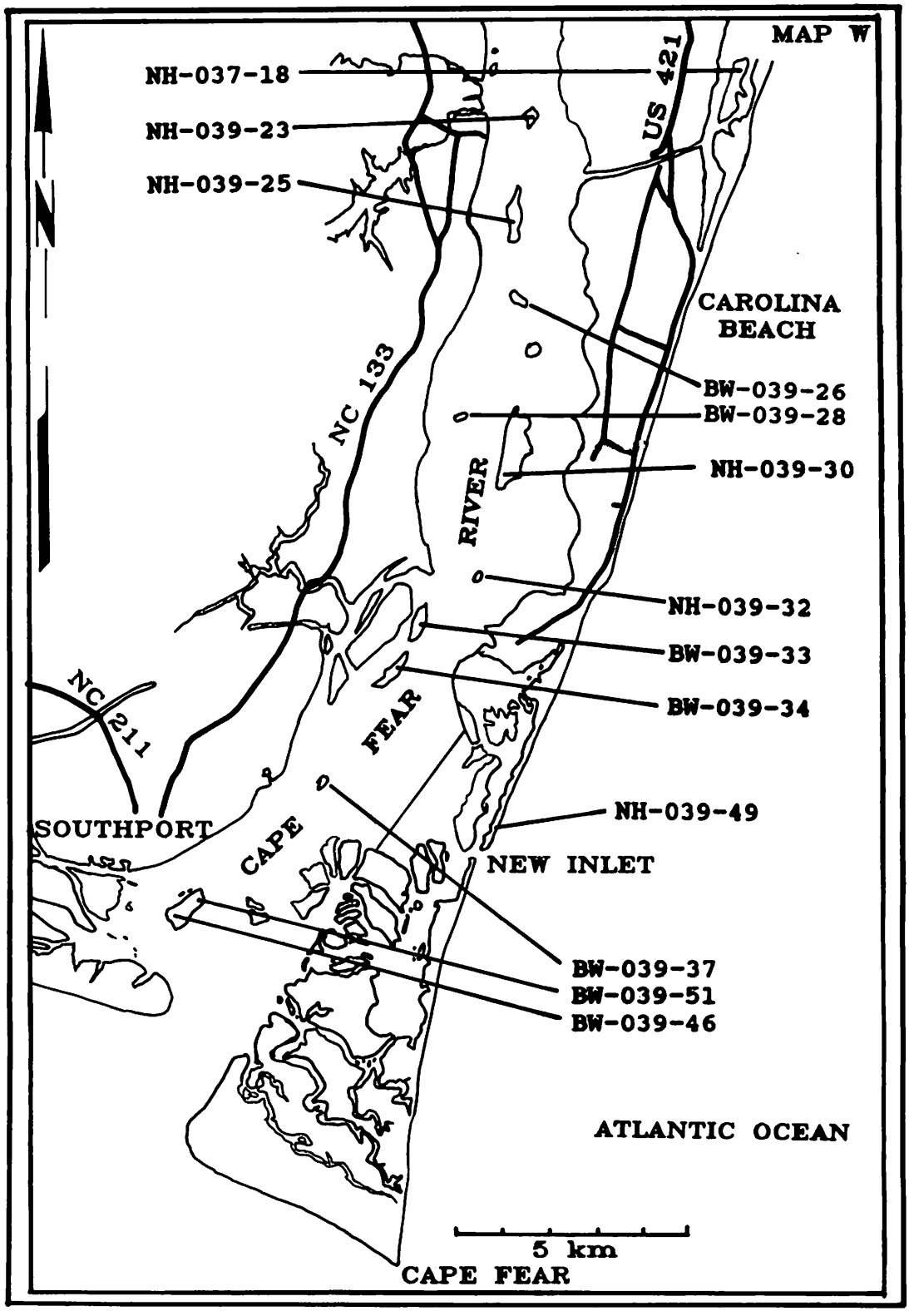

Figure 25. Map W. Cape Fear River region

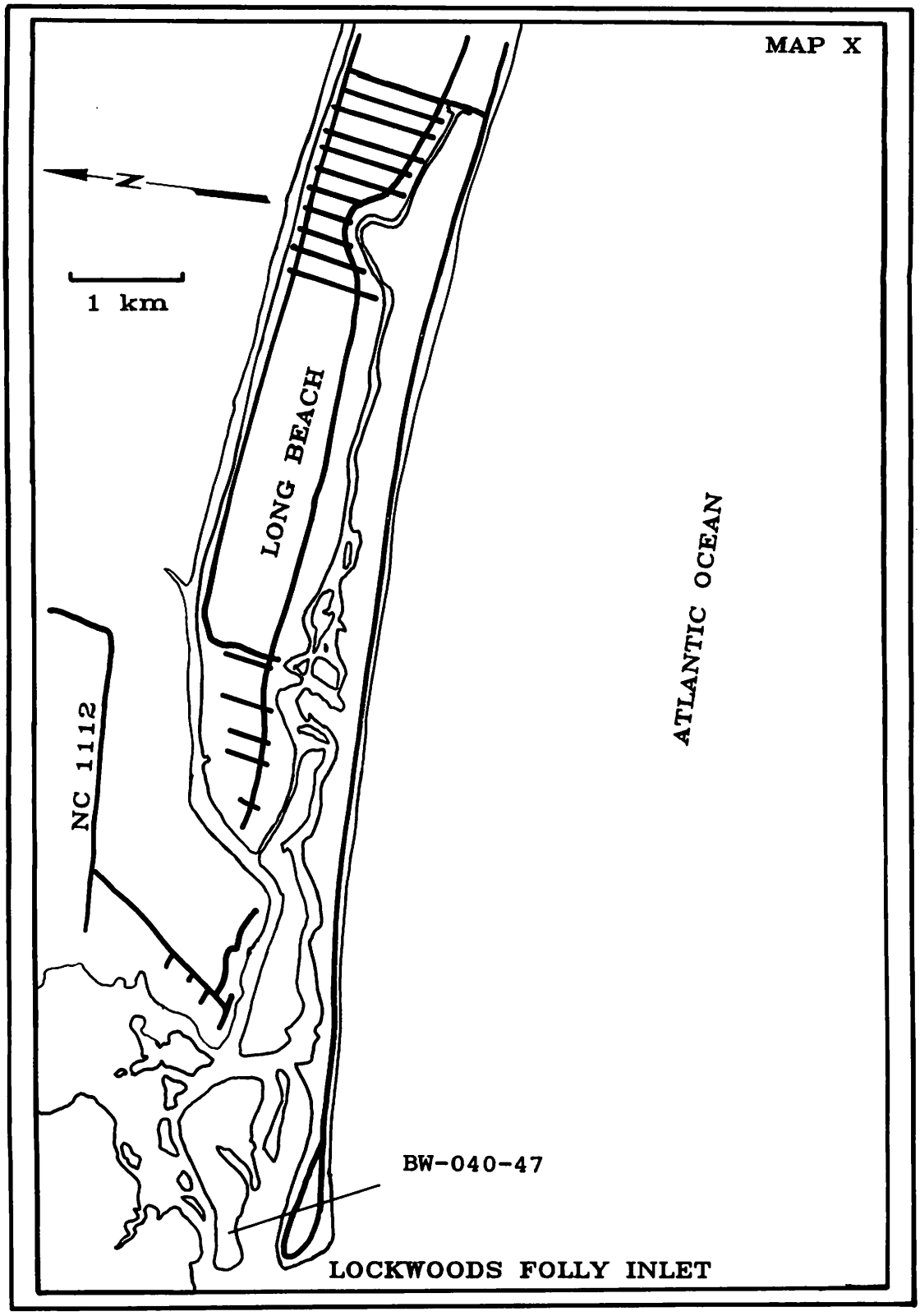

Figure 26. Map X. Long Beach vicinity

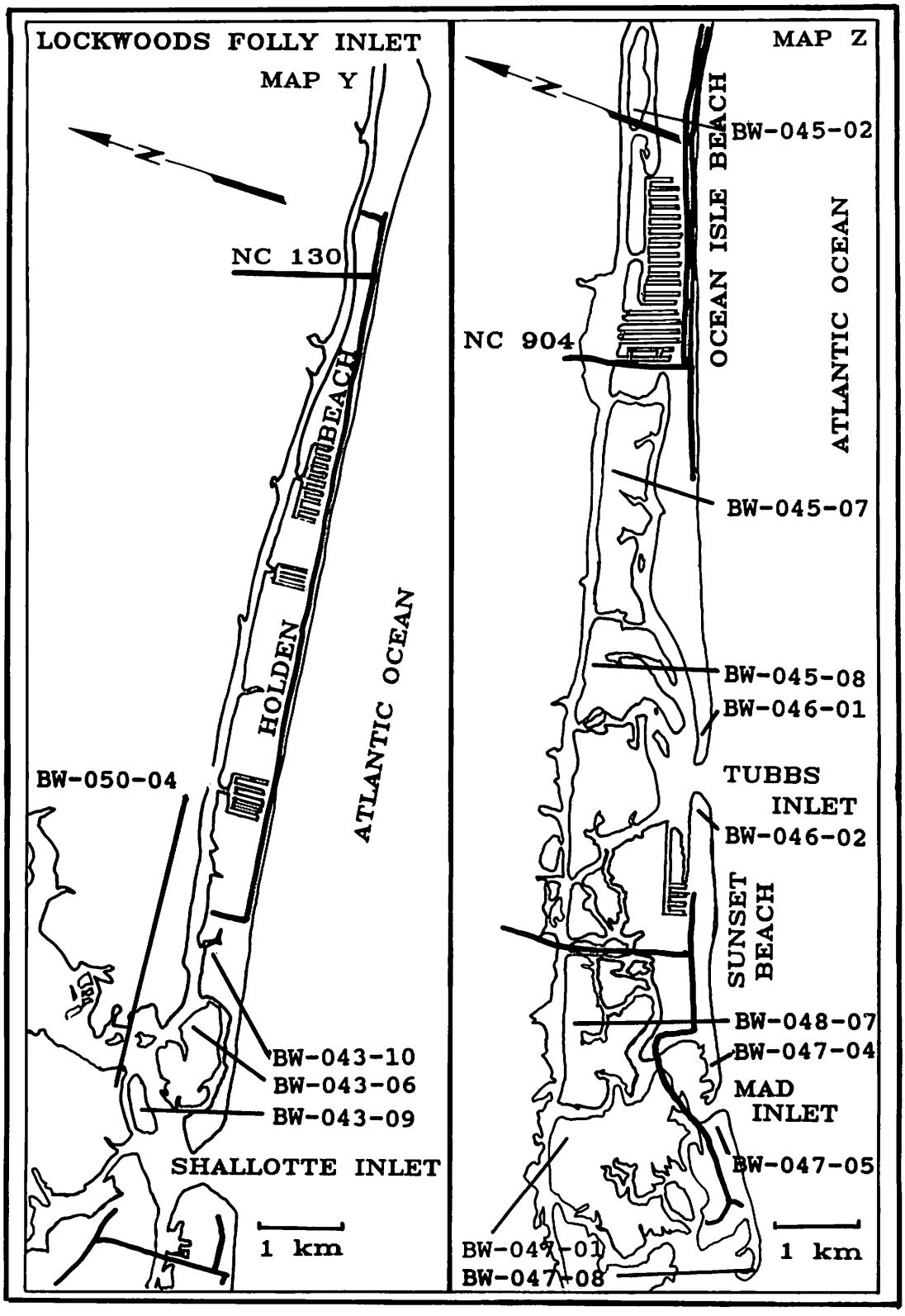

Figure 27. Maps Y & Z. Lockwoods Folley Inlet to Mad Inlet

Literature Cited

Adams, D. 1963. Battery Island 1963. Chat 27: 65-68.

Allen-Grimes, A. W. 1982. Breeding biology of the White Ibis (Eudocimus albus) at Battery Island, North Carolina. Unpublished M.S. thesis, Wilmington, North Carolina, Univ. North Carolina.

Brimley, C. S. 1941. Glossy Ibis nests near Southport. Chat 5: 47.

Buckley, F. G., and P. A. Buckley. 1972. The breeding ecology of Royal Terns Sterna (Thalasseus) maxima maxima. Ibis 114:334- 359.

Buckley, P. A., and F. G. Buckley. 1976. Guidelines for the protection and management of colonially nesting waterbirds. North Atl. Natl. Park Serv. Boston, Mass.

Burger, J. 1981a. A model for the evolution of mixed-species colonies of Ciconiiformes. Quart. Rev. Biol. 56: 143-167.

Burger, J. 1981b. Effect of human disturbance on colonial species, particularly gulls. Colonial Waterbirds 4: 28-36.

Burger, J., and D. C. Hahn. 1977. Crow predation on Black-crowned Night Heron eggs. Wilson Bull. 89: 350-351.

Davis, H. T. 1960. Banding young birds in N.C. nesting colonies. Chat 24: 79-83.

Doig, V., J. M. Hagan, and J. R. Walters. 1988. Double-crested Cormorant and Anhinga nesting in the Croatan National Forest. Chat 53:1-4.

Emlen, J. T., D. Miller, R. Evans, and D. Thompson. 1966. Predator-induced parental neglect in a Ring-billed Gull colony. Auk 83: 677-679.

Everhart, S. H., J. F. Parnell, R. F. Soots, Jr., and P. D. Doerr. 1980. Natural and dredged material nesting habitats of Gull-billed Terns, Common Terns and Black Skimmers in North Carolina. UNC Sea Grant Publ. UNC-SG-79-05.

Funderburg, J. B. 1960. The breeding birds of Battery Island, North Carolina. Chat 24: 19-20; 36.

Golder, W. W. 1984. Colonial waterbird studies at the Cape Hatteras National Seashore. Unpublished final project report.

Graham, F., Jr. 1978. The Audubon ark. Audubon 80(1): 2- 172.

Harwood, M. 1976. The view from Great Gull. New York, E. P. Dutton & Co, Inc.

Jernigan, L. S., Jr., R. F. Soots, J. F. Parnell, and T. L. Quay. 1978. Nesting habitats and breeding population of the Least Tern (Sterna albifrons antillarum) in North Carolina. UNC Sea Grant Publ. UNC-SG-78-07.

Kruuk, H. 1964. Predators and anti-predator behaviour of the Black-headed Gull (Larus ridibundus L.). Behaviour Suppl. 11: 1-129.

Lack, D. 1968. Ecological adaptations for breeding in birds. London, Methuen Press.

Kadlec, J. A., and W. H. Drury. 1968. Structure of the New England Herring Gull population. Ecology 49: 644-676.

McCrimmon, D. A., Jr. 1978. Nest site characteristics among five species of herons on the North Carolina coast. Auk 95: 267-280.

McIlhenny, E. A. 1934. Bird city. Boston, Christopher Publ. House.

Morris, R. D., I. R. Kirkham, and J. W. Chardine. 1980. Management of a declining Common Tern colony. J. Wildl. Manage. 44: 241-245.

Osborn, R. G., and T. W. Custer. 1978. Herons and their allies: atlas of Atlantic coast colonies, 1975 and 1976. Biological Services Program, U. S. Fish and Wildlife Service. FWS/OBS-77/08.

Parnell, J. F., D. M. DuMond, and R. N. Needham. 1978. A comparison of plant succession and bird utilization of diked and undiked dredged material islands in North Carolina estuaries. U. S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi, Tech. Rept. D-78-9.

Parnell, J. F., and D. A. McCrimmon, Jr. 1984. 1983 supplement to atlas of colonial waterbirds of North Carolina estuaries. UNC Sea Grant Publ. UNC-SG-84-07.

Parnell, J. F., and R. F. Soots. Eds. 1975a. Proceedings of a conference on management of dredge islands in North Carolina estuaries. UNC Sea Grant Publ. UNC-SG-75-01.

Parnell, J. F., and R. F. Soots. 1975b. Herring and Great Black-backed gulls nesting in North Carolina. Auk 92: 154-157.

Parnell, J. F., and R. F. Soots, Jr. 1979. Atlas of colonial waterbirds of North Carolina estuaries. UNC Sea Grant Publ. UNC-SG-78-10.

Parnell, J. F., and R. F. Soots, Jr. 1982. Populations and breeding biology of the eastern Brown Pelican (Pelecanus occidentalis carolinensis) in North Carolina. Final project report to

N.C. Wildlife Resources Commission.

Parnell, J. F., D. G. Ainley, H. Blokpoel, B. Cain, T. W. Custer, J. L. Dusi, S. Kress, J. A. Kushlan, W. E. Southern, and B. C. Thompson. 1988. Colonial waterbird management in North America. Colonial Waterbirds 11: 129-169.

Pearson, T. G., C. S. Brimley, and H. H. Brimley. 1942. Birds of North Carolina. Raleigh, N.C. Dept. Agric.

Quay, T. L., and D. A. Adams. 1956. Nesting of Cattle Egrets and Glossy Ibises in the Battery Island rookery at Southport, North Carolina. Chat 20: 56-57.

Richards, M. H., and R. D. Morris. 1984. An experimental study of nest site selection in Common Terns. J. Field Ornithol. 55: 457-466.

Rodgers, J. A., Jr. 1987. On the antipredator advantages of coloniality: a word of caution. Wilson Bull. 99: 269-271.

Shields, M. A. 1989. Colony site selection by wading birds in the North Carolina estuaries. Final project report to N. C. Wildlife Resources Commission.

Shields, M. A., and J. F. Parnell. 1983. Expansion of White Ibis nesting in North Carolina. Chat 47: 101-103.

Shields, M. A., and J. F. Parnell. 1986. Fish crow predation on eggs of the White Ibis at Battery Island, North Carolina. Auk 103: 531-539.

Soots, R. F., Jr., and M. C. Landin. 1978. Development and management of avian habitat on dredged material islands. U.S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi, Rep. WES-DS-78-18.

Soots, R. F., Jr., and J. F. Parnell. 1975. Ecological succession of breeding birds in relation to plant succession on dredge islands in North Carolina. UNC Sea Grant Publ. UNC-SG-75-27.

Soots, R. F., Jr., and J. F. Parnell. 1979. Inland heronries of North Carolina. Chat 43: 10-16.

Southern, L. K., S. R. Patton, and W. E. Southern. 1982. Nocturnal predation on Larus gulls. Colonial Waterbirds 5: 169-172.

Southern, W. E., S. R. Patton, L. K. Southern, and L. A. Hanners. 1985. Effects of nine years of fox predation on two species of breeding gulls. Auk 102: 827-833.

Wittenberger, J. F., and G. L. Hunt, Jr. 1985. The adaptive significance of coloniality in birds. Pp. 1-78 in Avian biology, vol. VIII (D. S. Farner, J. R. King, and K. C. Parkes, Eds.). New York, Academic Press Inc.

Appendix A. Common and scientific names of plants used in the text.

Bayberry	*Myrica pensylvanica*
Beach elder	*Iva imbricata*
Black cherry	*Prunus spp.*
Black needlerush	*Juncus roemerianus*
Camphorweed	*Heterotheca subaxillaris*
Cypress	*Taxodium spp.*
Eel-grass	*Zostera marina*
Evening primrose	*Oenothera spp.*
Fescue	*Festuca spp.*
Giant cordgrass	*Spartina cynosuroides*
Giant reed	*Phragmites communis*
Glasswort	*Salicornia spp.*
Greenbriar	*Smilax spp.*
Gum	*Nyssa spp.*
Hackberry	*Celtis laevigata*
Hercules'-club	*Zanthoxylum clava-herculis*
Horseweed	*Erigeron canadensis*
Live oak	*Quercus virginiana*
Loblolly pine	*Pinus taeda*
Marsh elder	*Iva frutescens*
Melic grass	*Melica mutica*
Mexican tea	*Chenopdium ambrosioides*
Nightshade	*Solanum spp.*
Orach	*Atriplex spp.*
Panic grass	*Panicum virgatum*
Paspalum grass	*Paspalum spp.*
Pennywort	*Hydrocotyle spp.*
Red cedar	*Juniperus virginiana*
Red mulberry	*Morus rubra*
Salt grass	*Distichlis spicata*
Saltmeadow cordgrass	*Spartina patens*
Sea oats	*Uniola paniculata*
Sea ox-eye	*Borrichia frutescens*
Sea rocket	*Cakile harperi*
Seaside goldenrod	*Solidago sempervirens*
Silverling	*Baccharis halimifolia*
Silver poplar	*Populus alba*
Smooth cordgrass	*Spartina alterniflora*
Wax myrtle	*Myrica cerifera*
White mulberry	*Morus alba*
Wild geranium	*Geranium maculatum*
Willow	*Salix spp.*
Yaupon	*Ilex vomitoria*

Appendix B. Names and Numbers of Colonial Waterbird Nesting Sites in North Carolina

County	Site Number	Site Name
BRUNSWICK	NC-BW-039-01	EAGLE ISLAND
BRUNSWICK	NC-BW-039-26	UNI-OLD BRUNSWICK
BRUNSWICK	NC-BW-039-28	UNI, SUNNY POINT
BRUNSWICK	NC-BW-039-33	UNI, SNOWS MARSH #1
BRUNSWICK	NC-BW-039-35	UNI, CAPE FEAR RIVER #2
BRUNSWICK	NC-BW-039-36	UNI, CAPE FEAR RIVER
BRUNSWICK	NC-BW-039-37	SOUTH PELICAN ISLAND
BRUNSWICK	NC-BW-039-46	BATTERY ISLAND-SOUTH
BRUNSWICK	NC-BW-039-51	BATTERY ISLAND-NORTH
BRUNSWICK	NC-BW-043-06	UNI, LONG POINT #1
BRUNSWICK	NC-BW-043-09	UNI, MONKS ISLAND, BOWEN POINT
BRUNSWICK	NC-BW-043-10	UNI, LONG POINT #2
BRUNSWICK	NC-BW-045-02	UNI, OCEAN ISLE #1
BRUNSWICK	NC-BW-045-07	UNI, GAUSE LANDING
BRUNSWICK	NC-BW-045-08	UNI, NORTH SEASIDE
BRUNSWICK	NC-BW-046-01	TUBBS INLET, NORTHSIDE
BRUNSWICK	NC-BW-046-02	TUBBS INLET, SOUTHSIDE
BRUNSWICK	NC-BW-047-01	UNI, CORKINS NECK
BRUNSWICK	NC-BW-047-04	MAD INLET, NORTHSIDE
BRUNSWICK	NC-BW-047-05	MAD INLET, SOUTHSIDE
BRUNSWICK	NC-BW-047-08	UNI, SC LINE
BRUNSWICK	NC-BW-048-07	UNI, SUNSET BEACH #1
BRUNSWICK	NC-BW-050-04	BOWEN POINT
CARTERET	NC-CR-006-18	UNI, RATTAN BAY
CARTERET	NC-CR-006-19	SWAN ISLAND
CARTERET	NC-CR-006-20	TUMP ISLAND
CARTERET	NC-CR-006-34	RACCOON ISLAND
CARTERET	NC-CR-011-02	OCRACOKE INLET BEACH-S
CARTERET	NC-CR-012-01	SWASH INLET, BEACH
CARTERET	NC-CR-012-02	AVERS ROCK
CARTERET	NC-CR-012-03	UNI, OCRACOKE INLET #1
CARTERET	NC-CR-012-14	UNI, MERKLE HAMMOCK #1
CARTERET	NC-CR-012-16	UNI, PORTSMOUTH, MARSH ISL. #1
CARTERET	NC-CR-012-17	UNI, PORTSMOUTH, MARSH ISL. #2
CARTERET	NC-CR-012-18	UNI, PORTSMOUTH, MARSH ISL. #3
CARTERET	NC-CR-012-19	UNI, PORTSMOUTH, MARSH ISL. #4
CARTERET	NC-CR-012-23	CASEY ISLAND
CARTERET	NC-CR-012-24	UNI, WEST PORTSMOUTH VILLAGE
CARTERET	NC-CR-013-01	UNI, CORE BANKS, SWASH INLET
CARTERET	NC-CR-014-01	SHELL ISLAND
CARTERET	NC-CR-014-02	WAINWRIGHT ISLAND

County	Site Number	Site Name
CARTERET	NC-CR-014-03	HARBOR ISLAND
CARTERET	NC-CR-014-04	NEW DUMP ISLAND
CARTERET	NC-CR-014-05	DRUM INLET, NORTH
CARTERET	NC-CR-014-08	CORE BANKS BEACH, OP. DAVIS
CARTERET	NC-CR-014-09	UNI, CORE SOUND #1
CARTERET	NC-CR-014-10	UNI, BEHIND NEW DRUM INLET
CARTERET	NC-CR-014-11	CORE BANKS BEACH, DRUM INLET-N
CARTERET	NC-CR-014-12	UNI, CORE SOUND #2
CARTERET	NC-CR-014-13	CORE BANKS BEACH, OP. GREAT I.
CARTERET	NC-CR-014-14	UNI, CORE SOUND #1
CARTERET	NC-CR-014-17	CORE BANKS BEACH, DRUM INLET-S
CARTERET	NC-CR-014-22	CORE BEACH, CAPE LOOKOUT
CARTERET	NC-CR-014-24	CORE BANKS, POWER SQUAD SPIT
CARTERET	NC-CR-014-25	CORE BANKS, CAPE POINT
CARTERET	NC-CR-014-26	RUSH ISLAND
CARTERET	NC-CR-014-27	LITTLE DEEP MARSH ISLAND
CARTERET	NC-CR-014-28	COCKLE MARSH ISLAND
CARTERET	NC-CR-014-29	BIG DEEP MARSH ISLAND
CARTERET	NC-CR-015-09	HOG ISLAND SITE #1
CARTERET	NC-CR-015-10	HOG ISLAND SITE #2
CARTERET	NC-CR-015-11	CHAIN SHOT ISLAND
CARTERET	NC-CR-015-14	CAMP POINT
CARTERET	NC-CR-016-01	OLD DUMP ISLAND
CARTERET	NC-CR-016-02	UNI, OLD DUMP, SOUTH #1
CARTERET	NC-CR-016-03	UNI, OLD DUMP, SOUTH #2
CARTERET	NC-CR-016-04	UNI, OLD DUMP, SOUTH #3
CARTERET	NC-CR-017-01	MORGAN ISLAND
CARTERET	NC-CR-017-02	WHITEHURST ISLAND
CARTERET	NC-CR-017-03	UNI, ADJACENT LIGHTHOUSE BAY
CARTERET	NC-CR-017-07	SAND BAG ISLAND
CARTERET	NC-CR-017-08	UNI, SOUTH OF MORGAN ISLAND
CARTERET	NC-CR-017-09	UNI, BARDEN INLET CHANNEL
CARTERET	NC-CR-018-07	MIDDLE MARSH
CARTERET	NC-CR-018-08	BOTTLE RUN POINT
CARTERET	NC-CR-018-11	UNI, BACK SOUND #1
CARTERET	NC-CR-018-12	UNI, BACK SOUND #2
CARTERET	NC-CR-018-15	UNI, BACK SOUND #3
CARTERET	NC-CR-018-20	BAREGRASS ISLAND
CARTERET	NC-CR-018-22	UNI, CARROT ISLAND
CARTERET	NC-CR-018-25	UNI, BACK SOUND #4
CARTERET	NC-CR-020-02	BEAUFORT CAUSEWAY
CARTERET	NC-CR-020-03	WESTEND-BIRD SHOAL
CARTERET	NC-CR-020-05	SHACKLEFORD POINT

County	Site Number	Site Name
CARTERET	NC-CR-020-06	BRANT ISLAND
CARTERET	NC-CR-021-01	UNI, NEWPORT RIVER, #1
CARTERET	NC-CR-021-03	ANNEX, NEWPORT RIVER
CARTERET	NC-CR-021-04	PHILLIPS ISLAND
CARTERET	NC-CR-021-06	UNI, NORTH OF ANNEX #1
CARTERET	NC-CR-021-07	UNI, NORTH OF ANNEX #2
CARTERET	NC-CR-022-02	ATLANTIC BEACH AREA
CARTERET	NC-CR-022-04	UNI, BOGUE SOUND #1
CARTERET	NC-CR-022-08	UNI, BOGUE SOUND #3
CARTERET	NC-CR-022-25	UNI, BOGUE SOUND #4
CARTERET	NC-CR-022-26	UNI, BOGUE SOUND #5
CARTERET	NC-CR-022-28	CAT ISLAND
CARTERET	NC-CR-022-39	UNI, BOGUE SOUND #6
CARTERET	NC-CR-022-40	UNI, EMERALD ISLE
CARTERET	NC-CR-022-41	EMERALD ISLAND HERONRY #1
CARTERET	NC-CR-022-42	EMERALD ISLAND HERONRY #2
CRAVEN	NC-CV-050-16	TWIN RIVERS MALL, NEW BERN
CURRITUCK	NC-CK-001-01	MONKEY ISLAND
DARE	NC-DR-003-01	ROANOKE SOUND, ISLAND J
DARE	NC-DR-003-02	ROANOKE SOUND, ISLAND I
DARE	NC-DR-003-04	ROANOKE SOUND, ISLAND H
DARE	NC-DR-003-05	ROANOKE SOUND, ISLAND F
DARE	NC-DR-003-06	ROANOKE SOUND, ISLAND E
DARE	NC-DR-003-07	ROANOKE SOUND, ISLAND D
DARE	NC-DR-003-08	ROANOKE SOUND, NC 64 BRIDGE
DARE	NC-DR-003-09	ROANOKE SOUND, ISLAND G
DARE	NC-DR-005-01	BEACH NORTHSIDE OREGON INLET
DARE	NC-DR-005-03	SAND SHOAL ISLAND
DARE	NC-DR-005-05	OREGON INLET, ISLAND B
DARE	NC-DR-005-06	OREGON INLET, ISLAND C
DARE	NC-DR-006-02	OLD-HOUSE CHANNEL, ISLAND L
DARE	NC-DR-006-07	OLD-HOUSE CHANNEL, ISLAND M
DARE	NC-DR-006-08	OLD-HOUSE CHANNEL, ISLAND MN
DARE	NC-DR-006-09	UNI, STUMPY POINT BAY
DARE	NC-DR-006-10	UNI, HATTERAS FERRY CHANNEL #1
DARE	NC-DR-006-11	UNI, HATTERAS FERRY CHANNEL #2
DARE	NC-DR-006-12	GULL ISLAND
DARE	NC-DR-006-21	KINGS ISLAND
DARE	NC-DR-006-22	CLAM SHOAL

County	Site Number	Site Name
DARE	NC-DR-006-22-01	CLAM SHOAL NE
DARE	NC-DR-006-22-02	CLAM SHOAL SW
DARE	NC-DR-006-23	UNI, OLD-HOUSE CHANNEL
DARE	NC-DR-007-02	UNI, PEA ISLAND, NORTH POND #1
DARE	NC-DR-007-03	JACK SHOAL
DARE	NC-DR-007-04	UNI, PEA ISLAND, NORTH POND #2
DARE	NC-DR-007-05	UNI, PEA ISLAND MARSH #1
DARE	NC-DR-007-06	UNI, PEA ISLAND MARSH #2
DARE	NC-DR-008-01	BEACH SITES ON HATTERAS ISLAND
DARE	NC-DR-008-01-01	HATTERAS BEACH SITE #1
DARE	NC-DR-008-01-02	HATTERAS BEACH SITE #2
DARE	NC-DR-008-01-06	HATTERAS BEACH SITE #6
DARE	NC-DR-008-01-07	HATTERAS BEACH SITE #7
DARE	NC-DR-008-02	CAPE POINT
DARE	NC-DR-008-03	CAPE POINT-SOUTH BEACH
DARE	NC-DR-009-01	BEACH NORTHSIDE HATTERAS INLET
DARE	NC-DR-009-03	DOT ISLAND
DARE	NC-DR-009-04	OLD DOT ISLAND
DARE	NC-DR-050-03	LONG SHOAL POINT
HYDE	NC-HY-006-13	SWANQUARTER ISLAND
HYDE	NC-HY-006-14	JUDITH ISLAND-POINT
HYDE	NC-HY-006-15	JUDITH ISLAND, JUDITH NARROWS
HYDE	NC-HY-006-30	HOG ISLAND
HYDE	NC-HY-006-31	GREAT ISLAND
HYDE	NC-HY-006-32	UNI, WEST TIP JUDITH ISLAND
HYDE	NC-HY-006-33	JUNIPER BAY
HYDE	NC-HY-009-02	BEACH SOUTHSIDE HATTERAS INLET
HYDE	NC-HY-010-01-01	OCRACOKE BEACH
HYDE	NC-HY-010-01-02	OCRACOKE BEACH AIRPORT
HYDE	NC-HY-010-02	OUTER GREEN ISLAND
HYDE	NC-HY-010-03	UNI, OCRACOKE MARSH #9
HYDE	NC-HY-010-04	GREEN ISLAND
HYDE	NC-HY-010-06	UNI, OCRACOKE MARSH #1
HYDE	NC-HY-010-07	UNI, OCRACOKE MARSH #2
HYDE	NC-HY-010-08	UNI, OCRACOKE MARSH #3
HYDE	NC-HY-010-09	UNI, OCRACOKE MARSH #4
HYDE	NC-HY-010-10-01	UNI, OCRACOKE MARSH #5
HYDE	NC-HY-010-10-02	UNI, OCRACOKE MARSH #6
HYDE	NC-HY-010-14	UNI, OCRACOKE MARSH #7
HYDE	NC-HY-010-15	UNI, OCRACOKE MARSH #8
HYDE	NC-HY-010-16	OCRACOKE VILLAGE

County	Site Number	Site Name
HYDE	NC-HY-010-17	PONY PEN SOUTH
HYDE	NC-HY-010-18	PONY PEN NORTH
HYDE	NC-HY-011-01	OCRACOKE INLET BEACH-N
HYDE	NC-HY-011-03	NATURAL SHOAL OCRACOKE INLET
HYDE	NC-HY-011-04	BEACON ISLAND
HYDE	NC-HY-011-05	SHELL CASTLE ISLAND, EAST
HYDE	NC-HY-011-06	SHELL CASTLE ISLAND, WEST
HYDE	NC-HY-011-07	NORTH ROCK ISLAND
HYDE	NC-HY-011-08	UNI, WALLACE CHANNEL #1
HYDE	NC-HY-012-20	UNI, OCRACOKE INLET #2
HYDE	NC-HY-050-15	NEBRASKA
NEW HANOVER	NC-NH-033-05	UNI, NIXON CHANNEL
NEW HANOVER	NC-NH-033-12	UNI, PAGES CREEK
NEW HANOVER	NC-NH-033-15	UNI, MASON INLET #1
NEW HANOVER	NC-NH-033-16	UNI, MASON INLET #2
NEW HANOVER	NC-NH-033-20	HARBOR ISLAND PARK
NEW HANOVER	NC-NH-033-22	UNI, MOUTH OF RICH INLET
NEW HANOVER	NC-NH-034-01	MASON INLET, NORTHSIDE
NEW HANOVER	NC-NH-035-02	MASONBORO INLET, SOUTHSIDE
NEW HANOVER	NC-NH-036-03	UNI, MONEY POINT
NEW HANOVER	NC-NH-037-10	PICKETT ROCK ISLAND
NEW HANOVER	NC-NH-037-18	UNI, CAROLINA BEACH INLET #1
NEW HANOVER	NC-NH-038-02	CAROLINA BEACH INLET, SOUTH
NEW HANOVER	NC-NH-039-23	UNI, CAPE FEAR, ORTON POINT
NEW HANOVER	NC-NH-039-25	UNI, ANDERSON LANDING
NEW HANOVER	NC-NH-039-29	NORTH PELICAN ISLAND #1
NEW HANOVER	NC-NH-039-30	NORTH PELICAN ISLAND #2
NEW HANOVER	NC-NH-039-32	FERRY SLIP ISLAND
NEW HANOVER	NC-NH-039-49	FORT FISHER BEACH
ONSLOW	NC-ON-022-44	UNI, ENTRANCE BOGUE INLET #1
ONSLOW	NC-ON-022-45	UNI, ENTRANCE BOGUE INLET #2
ONSLOW	NC-ON-023-04	UNI, SWANSBORO #2
ONSLOW	NC-ON-023-07	UNI, SWANSBORO #3
ONSLOW	NC-ON-023-10	UNI, SWANSBORO #4
ONSLOW	NC-ON-023-11	UNI, SWANSBORO #5
ONSLOW	NC-ON-023-14	UNI, SWANSBORO #6
ONSLOW	NC-ON-023-15	UNI, BOGUE INLET
ONSLOW	NC-ON-026-01	NEW RIVER INLET, NORTHSIDE
ONSLOW	NC-ON-026-06	UNI, NEW RIVER CHANNEL #1
ONSLOW	NC-ON-026-07	UNI, NEW RIVER CHANNEL #2

County	Site Number	Site Name
ONSLOW	NC-ON-026-08	UNI, NEW RIVER CHANNEL #3
ONSLOW	NC-ON-026-09	UNI, NEW RIVER CHANNEL #4
ONSLOW	NC-ON-027-03	UNI, ALLIGATOR BAY #1
ONSLOW	NC-ON-027-04	UNI, ALLIGATOR BAY #2
ONSLOW	NC-ON-027-06	UNI, ALLIGATOR BAY #3
ONSLOW	NC-ON-027-07	UNI, ALLIGATOR BAY #4
PAMLICO	NC-PM-006-16	SOW ISLAND
PENDER	NC-PD-029-25	UNI, SLOOP POINT
PENDER	NC-PD-029-43	UNI, GREEN CHANNEL
PENDER	NC-PD-030-01	NEW TOPSAIL INLET, NORTHSIDE
PENDER	NC-PD-030-02	NEW TOPSAIL INLET, SOUTHSIDE
PENDER	NC-PD-031-01	OLD TOPSAIL INLET, NORTH
PENDER	NC-PD-031-02	OLD TOPSAIL INLET, SOUTH
PENDER	NC-PD-032-01	RICH INLET, NORTHSIDE
PENDER	NC-PD-032-02	RICH INLET, SOUTHSIDE

APPENDIX C. Key Sites by Region and Group

Mgt. Group*	Management Regions**			
1	2	3	4	5
1	DR-006-02 DR-006-08 DR-006-10 DR-006-22 DR-009-03 HY-011-04	CR-011-02 CR-017-07		NH-039-32 NH-039-37
2	DR-005-03 DR-008-01 HY-008-03 DR-009-01 DR-009-03 DR-010-01-02 HY-011-01 HY-011-03	CR-014-05 CR-014-17 CR-014-24 CR-014-25 CR-017-07 CR-020-03 CR-020-06	CR-022-39 ON-022-44 ON-026-07 PD-030-01 PD-030-02 PD-032-01 PD-032-02 PD-034-01 NH-035-02	NH-039-49 BW-043-09
3	DR-005-03 DR-006-02 DR-006-08 DR-006-10 HY-006-14 DR-006-15 DR-006-22 HY-006-30 DR-008-03 DR-009-01 DR-009-03 HY-011-01 HY-011-03 HY-011-07	CR-014-01 CR-014-05 CR-014-17 CR-014-24 CR-016-01 CR-017-07 CR-018-08 CR-020-03 CR-020-06	ON-023-14 ON-026-08 PD-032-01 PD-032-02 PD-034-01 NH-035-02	NH-039-32 BW-039-37 NH-039-49
4	DR-006-02 DR-006-08 DR-006-10 DR-006-12 DR-009-03 HY-011-04 HY-011-07	CR-014-01 CR-014-02 CR-014-04 CR-016-01 CR-017-01 CR-017-02		NH-039-30 NH-039-32 NH-039-37

APPENDIX C (Continued)

Mgt. Group*	Management Regions**			
1	2	3	4	5
5	DR-006-10 DR-006-12 HY-006-13 HY-006-14 HY-006-15 HY-006-30 DR-009-03 HY-011-01 HY-011-04 HY-011-05 HY-011-07			
6	DR-003-05 DR-006-08 DR-006-10 HY-011-04 HY-011-05	CR-014-01 CR-014-02 CR-016-01		
7	CK-001-01 DR-003-09 DR-006-10 HY-011-04 HY-011-07	CR-014-02 CR-014-04 CR-016-01 CR-017-01 CR-018-15 CR-021-03 CR-021-04	CR-022-41 CR-022-42 ON-026-07	NH-039-30 BW-039-46 BW-039-51

* Management groups:

1. Royal Tern and Sandwich Tern
2. Least Tern
3. Common Tern, Gull-billed Tern and Black Skimmer
4. Laughing Gull and Brown Pelican
5. Forster's Tern
6. Herring Gull and Great Black-backed Gull
7. Long-legged waders

** Management regions:

1. Currituck Sound
2. Pamlico Sound and adjacent areas
3. Core and Back Sounds and adjacent beaches
4. Atlantic Beach to Carolina Beach
5. Carolina Beach to South Carolina