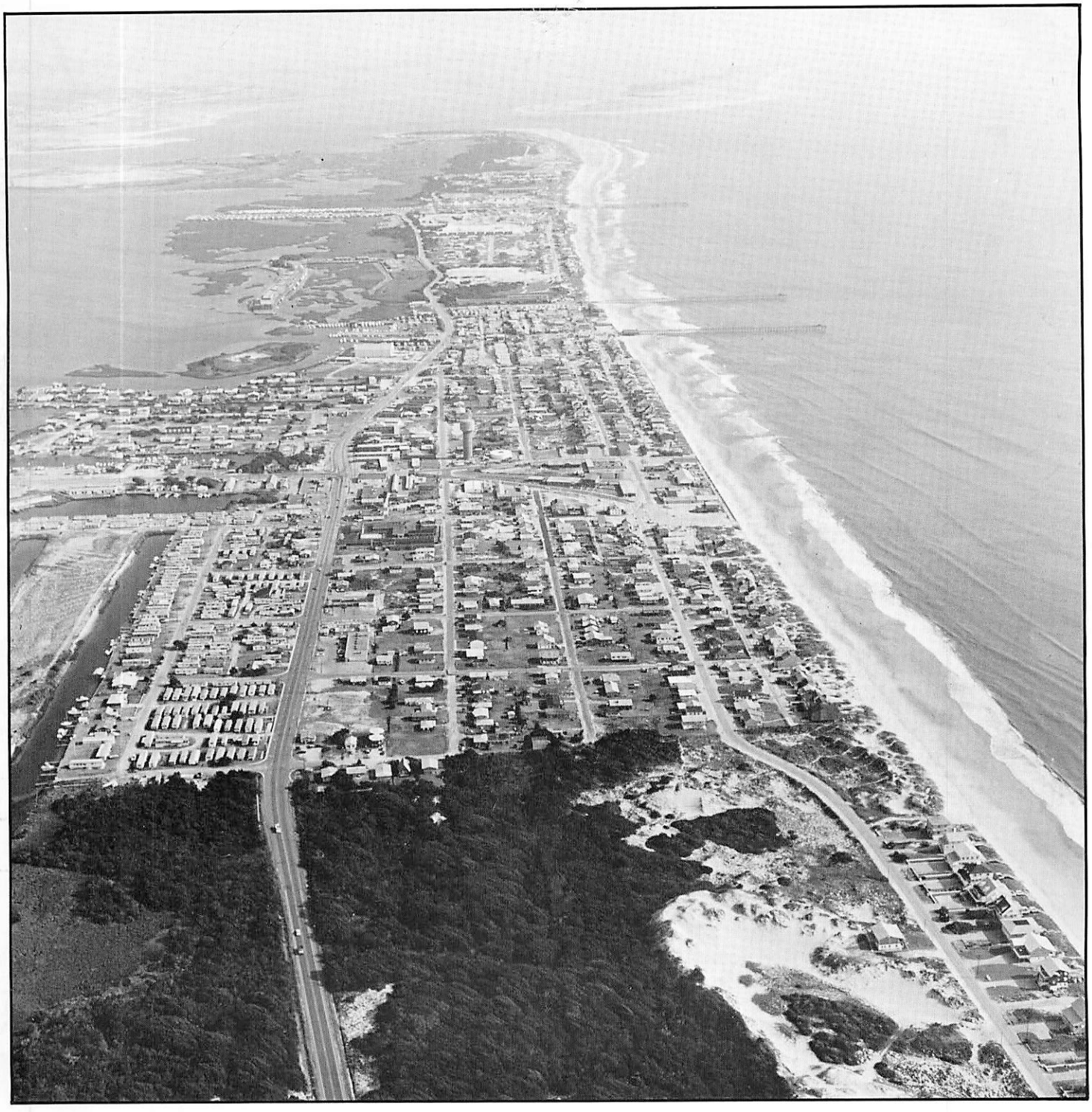

A Land Use and Land Cover Classification of the North Carolina Barrier Islands: Level III

Simon Baker

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A LAND USE AND LAND COVER CLASSIFICATION OF THE NORTH CAROLINA BARRIER ISLANDS: LEVEL III

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PART 1

ORIGIN AND USE OF THE LEVEL III LAND USE AND LAND COVER CLASSIFICATION SYSTEM

North Carolina's ocean shoreline consists entirely of a chain of sandy barrier islands. In the north, these islands lie well offshore, separated from the mainland by the sounds. In the south, they are divided from the mainland by marshes and the Intracoastal Waterway. The islands were focal points of the early settlement and history of the state. More recently, they have become a recreational resource attracting greater numbers of people. As a consequence of larger summer and year-round populations, land use on the inhabited barrier islands has changed rapidly.

To understand and manage this fragile natural resource, it is necessary to evaluate the impact of people on the islands. This can be done by classifying, mapping and measuring the different ways the land is being used. A detailed survey of land use and land cover can give us an appreciation of the existing situation. It serves as a kind of "barometer," indicating human pressure on the land. A similar survey made after a period of years, using the same classification system, can show the nature and locations of changing land use patterns. Thus, we have an accurate means for determining trends in the degree and quality of change.

This type of information is needed to plan future growth. It will help preserve the beauty of the islands and their ecologically valuable areas. Such surveys are also useful in planning for the safety of temporary and permanent residents, and the maintenance of the quality of life on the islands.

The value of land use and land cover surveys is widely recognized. Their use is not new. The practice in this country and around the world has been to design classification systems of land use and land cover to meet the needs of specific projects. Little comparability is usually possible between various classification systems, even though they may have some categories in common. This situation has made it impossible to assemble uniform data at the state, regional or national levels from various surveys.

In 1971, the Federal Interagency Steering Committee on Land Use Information and Classification was formed and given the task of bringing order to the chaotic land use data situation in this country. The committee, under the leadership of the United States Geological Survey, had two non-governmental groups as members:

the Association of American Geographers and the International Geographical Union. As Geological Survey Professional Paper 964 explains: "The objective of the committee was the development of a national classification system that would be receptive to inputs of data from both conventional sources and remote sensors on high-altitude aircraft and satellite platforms, and that would at the same time form the framework into which the categories of more detailed land use studies by regional, state and local agencies could be fitted and aggregated upward from Level IV toward Level I for more generalized smaller scale use at the national level."

After five years of consultation, testing and evaluation, the committee devised a two-level classification system for state and federal agencies. Geological Survey Professional Paper 964 contains a description of the system that has become the basis for mapping land use and land cover throughout the United States in recent years. It was recognized that no single classification system could meet all needs. The two-level classification would provide sufficient data for the federal government, but would be inadequate for use by municipalities, counties or even some states. To make possible more detailed surveys, it was proposed that two additional levels of increasing complexity should be created to meet the needs of smaller units of government. Each organization is free to create its own classification at either Levels III or IV as long as it pertains to the structure of the federal classification at Levels I and II. This flexibility allows for the creation of tailor-made classification systems that meet local needs and systematically aggregate to fit in with national data at Level II.

The two-level classification system devised for national mapping is described in Table 1. The nine categories under Level I are the basis for the system and include the major land use and land cover types found in the 50 states. Broad categories were selected to account for all use and cover types, leaving no blank areas on maps made at Level I. They were also selected because they can be seen on images made by LANDSAT satellites. Thus, it should be possible to produce maps at Level I by carefully analyzing satellite data alone.

The 37 categories listed under Level II are subheadings of the nine major Level I categories. These are the units depicted on the land use map series of the United States published by the USGS. A portion of the Beaufort, N. C., sheet (Map L-67) is typical of maps available for the entire state and much of the country (Figure 1). The Level II categories were selected because they provide information various federal agencies need and can be identified fairly easily on high-altitude aerial photographs at scales of about 1:80,000 (1 in. = 6667 ft.). Not all Level II categories can be interpreted on the photographs with equal reliability. Other types of supplemental information may be required in some complex urban areas.

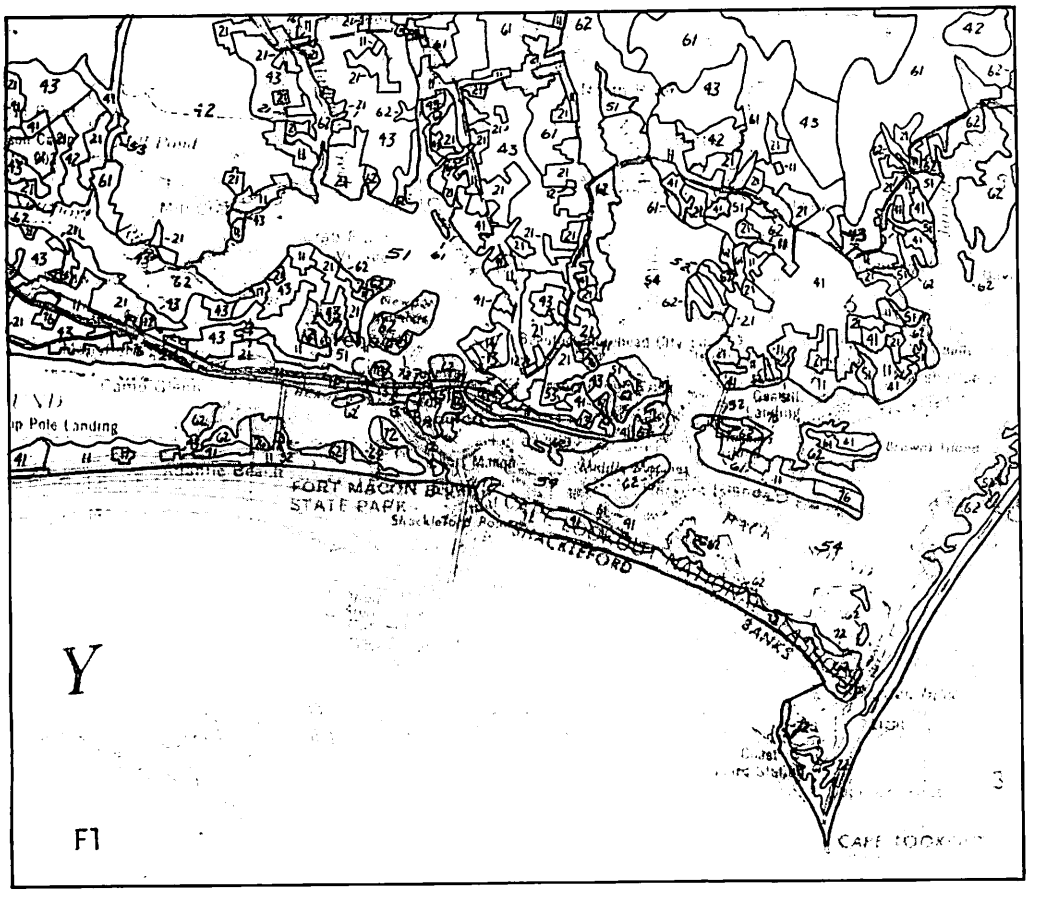

Figure 1. The area around Cape Lookout, N. C., as it appears on a typical map of the Land Use and Land Cover Series of the U. S. published at the scale of 1:250,000 (1 in. = 3.95 miles).

A classification system of greater detail than Level II is required for closer examination of the land use and land cover of the North Carolina barrier islands. The system described in Geological Survey Professional Paper 964 makes allowances for creating two more levels (III and IV) of land use and land cover classification.

Classification at Levels III and IV may be devised in any fashion as long as the categories logically form subheadings and follow the numbering system of the categories of Level II. Table 2 is a Level III classification of land use and land cover created for use on the North Carolina barrier islands by the author.

To illustrate this, item number 11 under Level II (Table 1) has been expanded into eight types of residential situations that can be found along the coast (Table 2). Each of the Level III residential categories is identified by a three-digit number, with the first two being 11. This classifies it as a residence at Level II. In this manner, all Level II categories that apply to the barrier islands were expanded to create the Level III classification

system described in this publication. Conversely, measurements of areas of these Level III categories can be aggregated so that they fit the national system of statistics on land use and land cover at Level II.

The Level III classification could, in turn, be expanded to Level IV in order to identify and map information in still greater detail. For example, the category 111, Single-Family Cottage (Table 2), could be divided further to identify the buildings by type of construction, by seasonal use, or economic characteristics of the owners. Each new category would then be described by using four digit numbers as 1111, 1112, 1113 and so on. The same could be done for the other categories of the Level III classification, and result in a greatly expanded system created to show the kinds of information required by the organization designing and using it. At the same time, local needs are met by a detailed Level IV classification. The data being mapped or collected will fit the state and national systems.

Just as the individual categories in Levels I and II can be seen on satellite images or aerial photographs, it is expected that larger-scaled, more detailed aerial photographs can and should be used in working at Levels III and IV. Geological Survey Professional Paper 964 suggests that aerial photographs at scales of 1:20,000 (1 in.=1667 ft.) to 1:80,000 (1 in.=6667 ft.) be used in identifying categories at Level III, while scales larger than 1:20,000 be used for Level IV. Even at these two levels of detailed observation there are many things that cannot be seen on aerial photographs, and it is essential that supplemental sources of information are consulted when mapping at Levels III and IV. Supplemental information may consist of: maps from any source, studies and reports, questionnaires, building permits, property plats, soil surveys, ground level photographs, field observations by the mapper and pertinent data from any other source.

The objective in creating Level III was to provide a detailed and uniform classification system for all of the barrier islands. The mapping of all parts of the coast at Level III will provide bench mark data against which future changes can be measured. Thus, at the state level, we will be able to have complete maps and area measurements of land use and land cover, and therefore be able to plan and act on the basis of current and accurate information. The classification system is sufficiently detailed to be used for planning purposes at the local level. Maps of land use at Level III should also be useful, in a variety of ways, to business interests involved with the coast. Two other advantages of this classification system are that it was designed to be used with aerial photographs to speed up the mapping process, and it is compatible with the national classification and mapping system of land use and land cover.

Table 1. - Land use and land cover classification system for use with remote sensor data

Level I	Level II
1 Urban or Built-up Land	11 Residential
	12 Commercial and Services
	13 Industrial
	14 Transportation, Communications and Utilities
	15 Industrial and Commercial Complexes
	16 Mixed Urban or Built-up Land
	17 Other Urban or Built-Up Land
2 Agricultural Land	21 Cropland and Pasture
	22 Orchards, Groves, Vineyards, Nurseries and Ornamental Horticultural Areas
	23 Confined Feeding Operations
	24 Other Agricultural Land
3 Rangeland	31 Herbaceous Rangeland
	32 Shrub and Brush Rangeland
	33 Mixed Rangeland
4 Forest Land	41 Deciduous Forest Land
	42 Evergreen Forest Land
	43 Mixed Forest Land
5 Water	51 Streams and Canals
	52 Lakes
	53 Reservoirs
	54 Bays and Estuaries
6 Wetland	61 Forested Wetland

Table 1. (continued)

Level I	Level II
	62 Nonforested Wetland
7 Barren Land	71 Dry Salt Flats
	72 Beaches
	73 Sandy Areas other than Beaches
	74 Bare Exposed Rock
	75 Strip Mines, Quarries and Gravel Pits
	76 Transitional Areas
	77 Mixed Barren Land
8 Tundra	81 Shrub and Brush Tundra
	82 Herbaceous Tundra
	83 Bare Ground Tundra
	84 Wet Tundra
	85 Mixed Tundra
9 Perennial Snow or Ice	91 Perennial Snowfields
	92 Glaciers

Table 2. - Level III land use and land cover classification of the North Carolina Barrier Island System

1 Urban or Built-up Land

11 Residential

111 Single-family cottage

112 Multi-family cottage

113 Mixed single-and multi-family cottages

114 Apartment or condominium (low rise)

115 Apartment or condominium (high rise)

116 Mobile homes (low density)

117 Mobile homes (high density)

118 Residential area partially developed

12 Commercial and services

121 Motels and hotels

122 Commercial and recreation

123 Marinas, docks and boat storage facilities

124 Military installations

125 Campgrounds and travel trailer parks

126 Country clubs

127 Parking lots for public beach access

128 Other institutional uses

129 Commercial or service areas partially developed

13 Industrial

131 Construction industry locations

14 Transportation, communications and utilities

141 Ferry boat landings

142 Airports

143 Commercial docks

144 Well fields for water supply

145 Water purification facilities

146 Sewage treatment facilities

147 Electrical facilities

148 Major roads

149 Lighthouses and electronic communications

15 Industrial and commercial complexes

It is anticipated that this Level II category will not be required at the large scales used for Level III mapping. Commercial elements could be mapped under category 12 and industrial sites under category 13.

16 Mixed urban or built-up land

As in category 15 above, the various elements comprising the mixture could be identified at Level III scales and mapped under the appropriate urban categories.

17 Other urban or built-up land

171 Golf courses

172 Cemeteries

173 Urban Parks

2 Agricultural Land

21 Cropland and pasture

210 Included for possible use

3 Rangeland

31 Herbaceous rangeland

311 Dune grass areas

Table 2. (continued)

312 Flat grass areas

313 Spoil bank areas covered with grass

32 Shrub and brush rangeland

321 Dune shrub areas

322 Flat shrub areas

323 Spoil bank areas covered with shrubs

33 Mixed rangeland

331 Mixed grass and shrub on dune areas

332 Mixed grass and shrub on flat areas

333 Spoil bank areas covered with grass and shrub

4 Forest Land

43 Mixed forest land

431 Maritime forest on barrier islands

432 Maritime forest on spoil banks

5 Water

51 Streams and canals

511 Intracoastal Waterway

512 Canals associated with residential development

513 Canals associated utilities, industry or commerce

52 Lakes

521 Freshwater ponds

54 Bays and estuaries

541 Tidal creeks

542 Open water

Table 2. (continued)

6 Wetland

- 61 Forested wetland
  - 611 Mixed deciduous and coniferous wetlands
- 62 Nonforested wetland
  - 621 Regularly flooded salt marsh
  - 622 Irregularly flooded salt or brackish marsh
  - 623 Irregularly flooded freshwater or brackish marsh
  - 624 Inland freshwater marsh
  - 625 Sparsely vegetated sand flats

7 Barren Land

- 72 Beaches
  - 721 Ocean Beaches
  - 722 Inlet beaches
- 73 Sandy areas other than beaches
  - 731 Dunelands
  - 732 Unvegetated spoil bank areas
- 76 Transitional areas
  - 761 Land in transition to housing uses
  - 762 Land in transition to uses other than housing

PART 2

DESCRIPTION AND ILLUSTRATION OF THE LEVEL III CATEGORIES

The Level III classification (Table 2) presented by itself does not provide enough information to answer questions that may arise during the mapping of land use and land cover. To aid in classification, more detailed descriptions of each category follow. Ground and aerial photographs have been used to illustrate typical examples of use or cover in each category. These pictures and the corresponding descriptions should help the user make quick and positive classification decisions. The illustrations are to be used as a guide and are not intended to comprise a complete aerial photographic key. Such devices are designed to provide detailed information to photo interpreters, so that they can make most of their classification decisions without going into the field. However, it will be necessary to conduct considerable field work for some categories, and to rely heavily on supplemental sources of data for others when using this Level III classification.

The ground photographs included in this publication were made during the summer of 1984 in a series of field trips. The trips covered the inhabited barrier islands from Currituck County in the north to Brunswick County in the south. The aerial photographs were taken from a uniform series of the coast made in December 1976 and January 1977 by the N. C. Department of Transportation and designated as M-1276. The original scale of these photographs was 1:24,000 (1 in.=2000 ft.). Portions of these photographs were enlarged and appear in this publication at an approximate scale of 1:6,000 (1 in.=500 ft.). The number in parentheses on each enlargement refers to the frame from which it was taken. The M-1276 series of photographs is held by the photogrammetry laboratory of the N. C. Department of Transportation. Contact prints or enlargements may be purchased from that organization.

The aerial photographs used were carefully selected to show various features which appear the same now as when the photographs were originally taken. Thus, their age does not present a problem. Wherever possible, ground photographs were taken of the features shown on the aerial photographs. Only ground views illustrate various categories in a number of cases, because the features or changes depicted are more recent than shown on the M-1276 photography.

111 SINGLE-FAMILY COTTAGE

Dwellings of this type accommodate one family, usually during the warm season. Also included in this category are more substantial structures built for year-round occupancy.

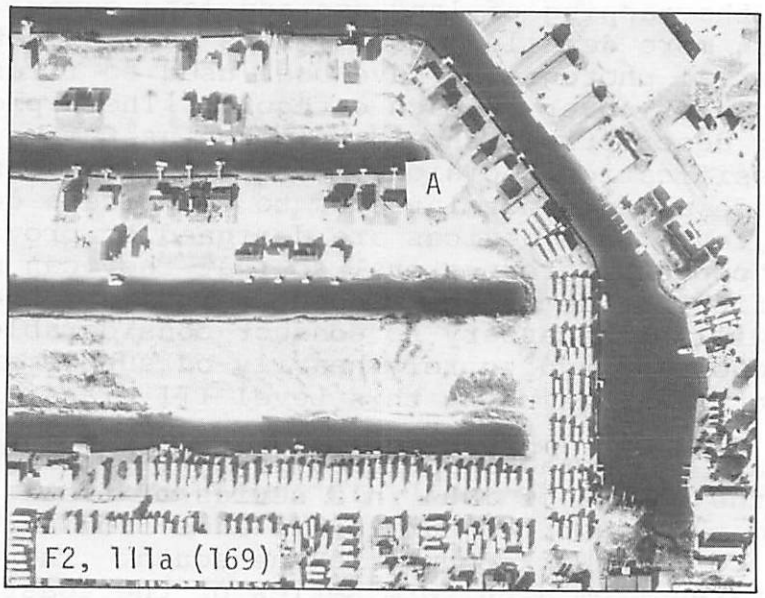

Figure 2. Single-family cottages at point A, Atlantic Beach. They are mostly one story with small roof areas.

Figure 3. Ground view of single-family cottages at point A in Figure 2.

112 MULTI-FAMILY COTTAGE

This is a large cottage designed to accommodate more than one family usually during the warm season. More substantial structures built for year-round occupancy are also included in this category. Such cottages are free-standing and smaller than apartments or condominiums.

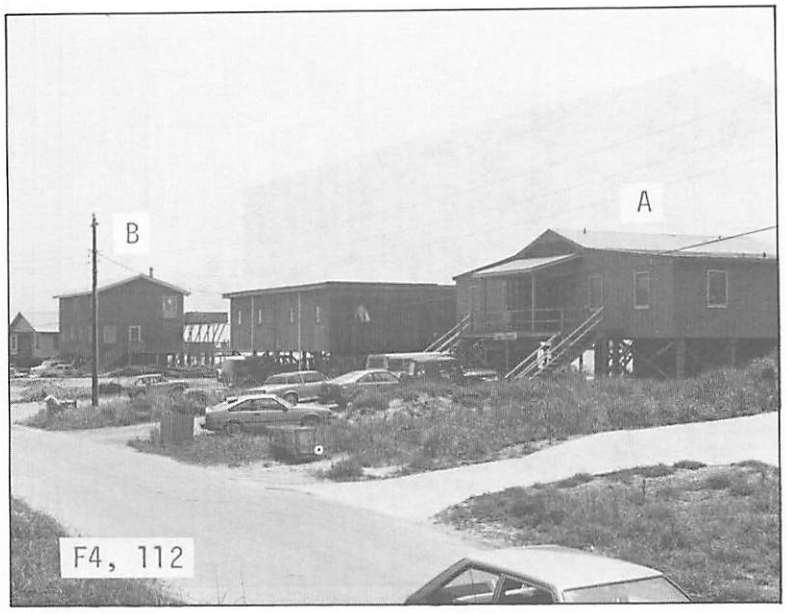

Figure 4. Multi-family cottages at Emerald Isle. The cottage in the foreground at point A is a duplex with a large roof area and several cars parked in front. The cottage at point B has a smaller roof area that might confuse the photo interpreter. Cottage B also has several cars parked outside.

113 MIXED SINGLE- AND MULTI-FAMILY COTTAGES

This classification includes dwellings such as those described under 111 and 112 that are mixed and in close proximity. This category is used when the scale of mapping does not allow for the separation of the two types of housing.

Figure 5. A larger multi-family cottage with single-family cottages around it at Atlantic Beach. In this case, the larger roof area and two stories should distinguish it from the smaller single-family cottages.

114 APARTMENT OR CONDOMINIUM (LOW RISE)

These are large structures of up to two stories that contain multiple dwelling units. The building may be under one roof or several large roofs, or may consist of a group of single family units joined together to make one large structure. If the building is on pilings, the ground level is not counted as a story.

Figure 6. This structure on Bogue Banks, and others like it, might be interpreted on an aerial photograph as a motel (121). Originally it was a motel, but was converted to a condominium.

115 APARTMENT OR CONDOMINIUM (HIGH RISE)

These are large structures of three or more stories. The buildings may be under one roof or several large roofs, but other configurations are also used. If the building is on pilings, the ground level is not counted as a story.

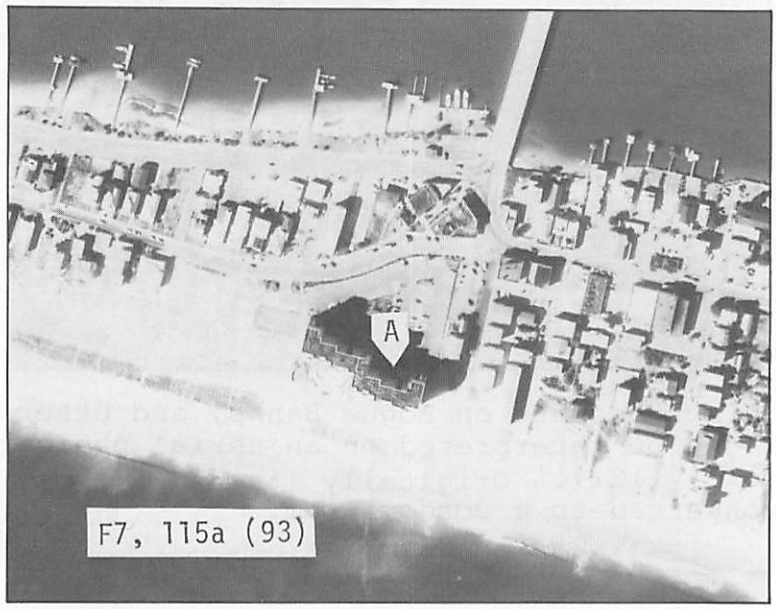

Figure 7. This large condominium (point A) at Wrightsville Beach is a structure many stories high judging by the length of the shadow it casts. It could be confused with a large motel (121).

Figure 8. A ground view of the high rise condominium in Figure 7.

Figure 9. This example from Bogue Banks of a high rise condominium is typical of such structures built on pilings. The ground level is not counted in this three-story structure.

116 MOBILE HOMES (LOW DENSITY)

A gross density of about six units or less per acre comprises this category. Mobile homes mixed in with other types of structures are mapped under this category if the scale will allow.

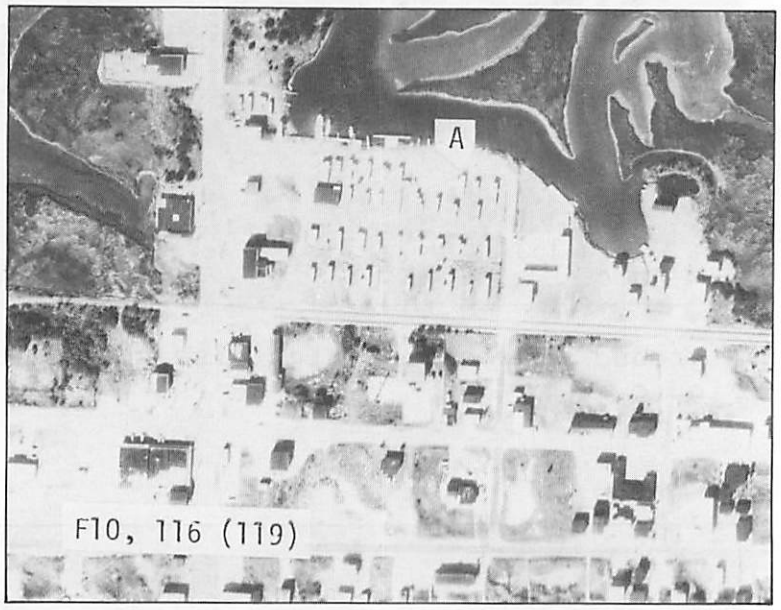

Figure 10. This group of mobile homes at Surf City (point A) is widely spaced and uncrowded. Such spacing is not common on the barrier islands.

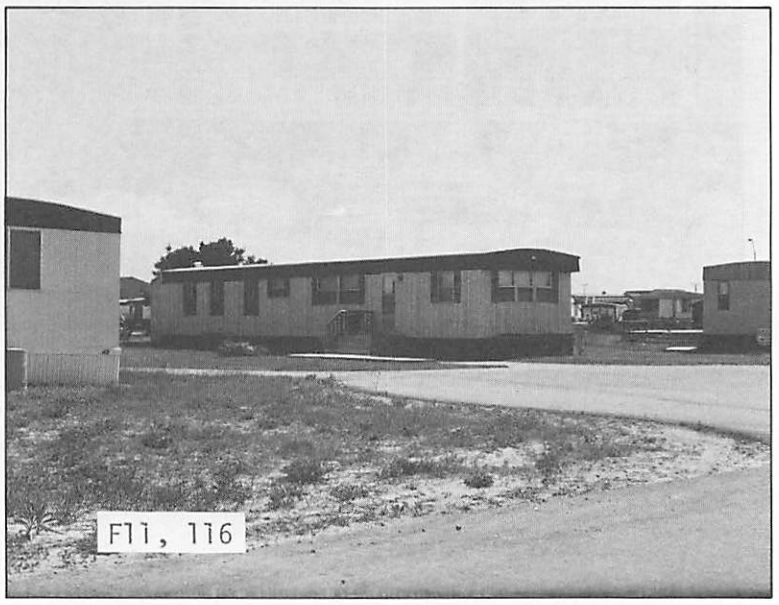

Figure 11. A new, low density mobile home development on Bogue Banks.

117 MOBILE HOMES (HIGH DENSITY)

A gross density of more than six units per acre comprises this category.

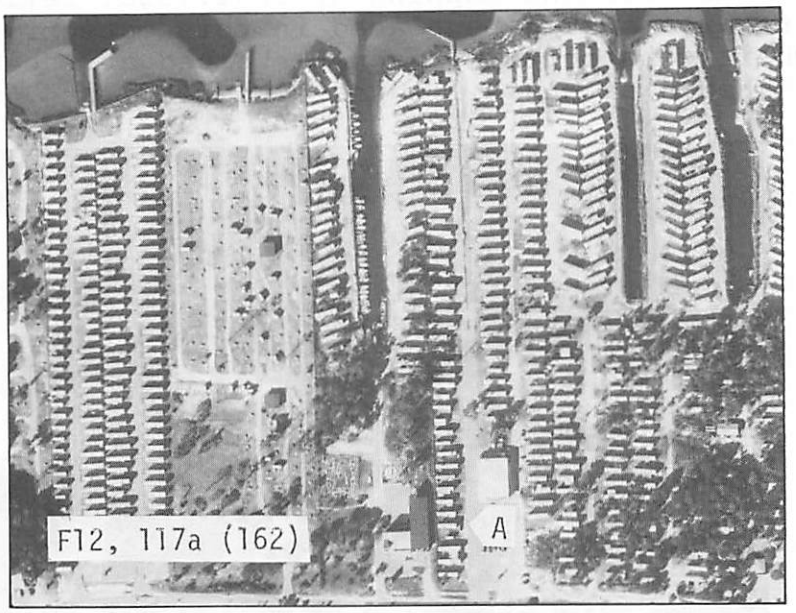

Figure 12. Very high density of mobile homes on Bogue Banks. Such spacing is more typical on many parts of the barrier islands than the low density spacing shown in Figure 10. Point A is shown on Figure 13.

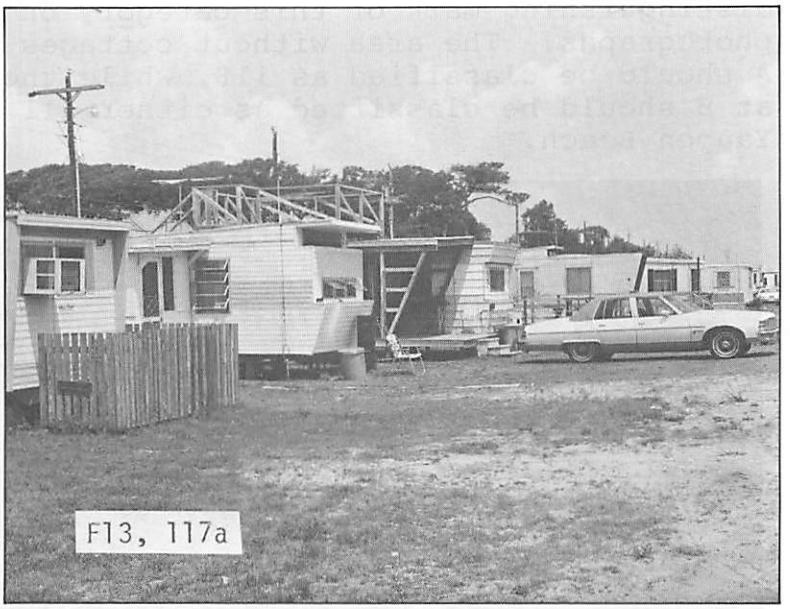

Figure 13. A typical mobile home high density situation on Bogue Banks at Salter Path. This is a view of point A in Figure 12.

118 RESIDENTIAL AREA PARTIALLY DEVELOPED

The existence of streets and some cottages or year-round dwellings is a clear indication of intended future land use. After the existing housing has been classified by type, the remainder of the area is placed in this category regardless of the vegetative cover. If the mapping scale does not allow for the mapping of individual residences, the entire area should be placed in this category. Cleared areas, where construction has not started at the time of mapping, should be classified as either 761 or 762.

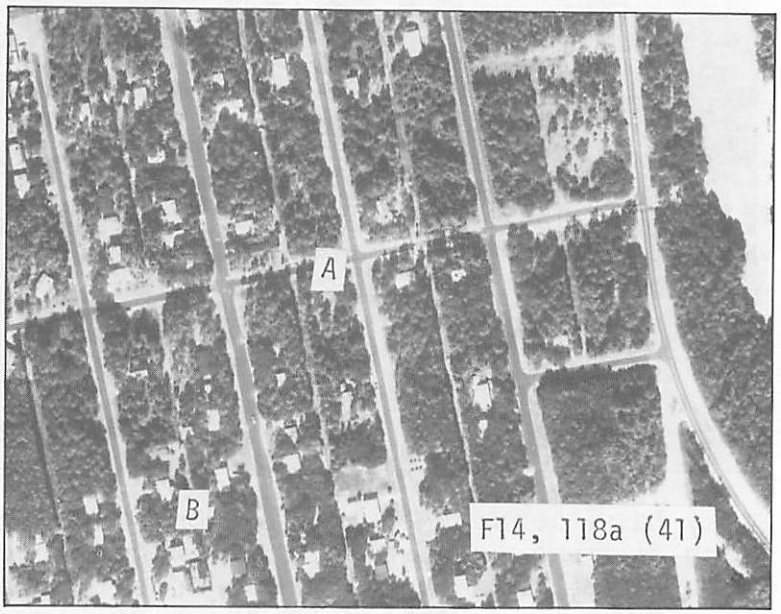

Figure 14. The presence of streets, but few houses, is the distinguishing mark of this category on aerial photographs. The area without cottages at point A should be classified as 118, while the cottages at B should be classified as either 111 or 112. Yaupon Beach.

Figure 15. A ground view of Figure 14. Note the presence of a fire hydrant on the empty lot. The intent to develop this area is very clear.

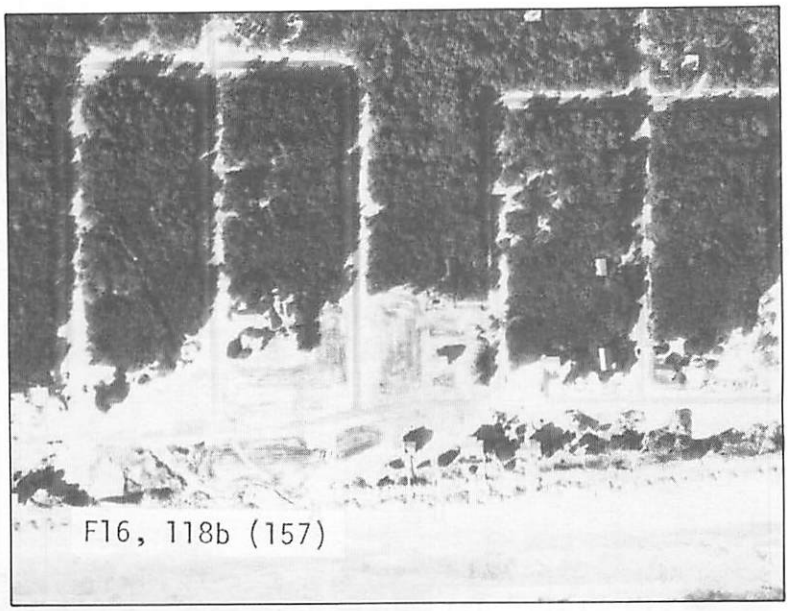

Figure 16. A smaller, partially developed residential area at Emerald Isle. This is more typical than the large development in Figure 14. Almost the entire area would be classified as 118.

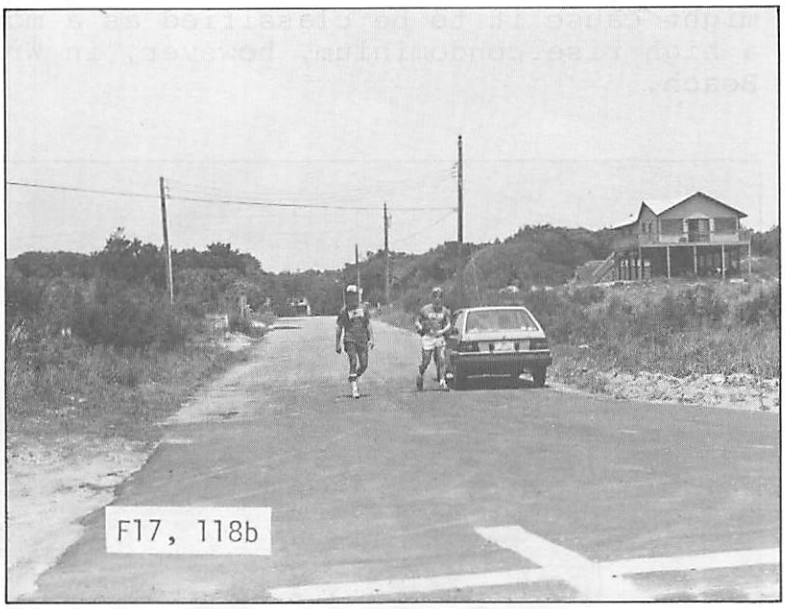

Figure 17. A ground view of Figure 16 showing the largely uninhabited nature of the place at the time the photograph was made. Cottages should be mapped appropriately as the scale will allow.

121 MOTELS AND HOTELS

This category includes not only the buildings, but also the parking lots, landscaped areas and other associated outdoor areas.

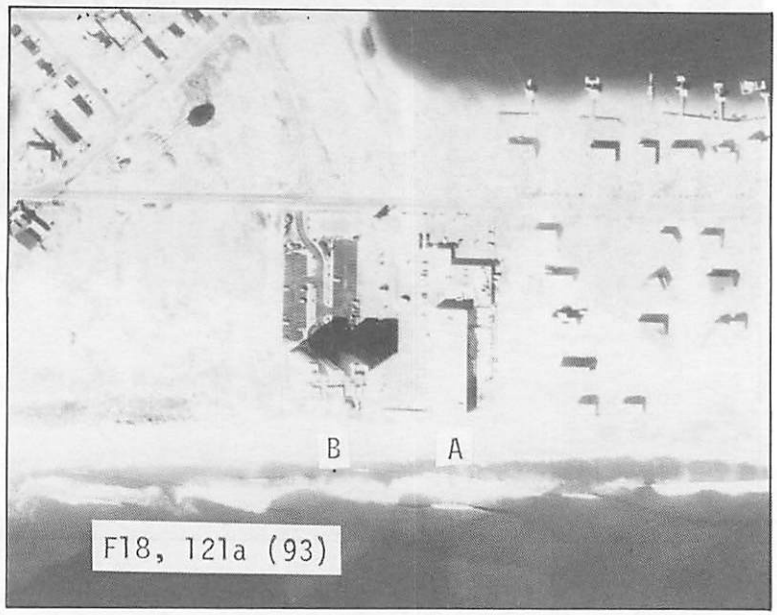

Figure 18. Building A is a motel. All the grounds around the motel, including the building, would be mapped in this category. The taller building at point B has many features about it and its grounds that might cause it to be classified as a motel. It is a high rise condominium, however, in Wrightsville Beach.

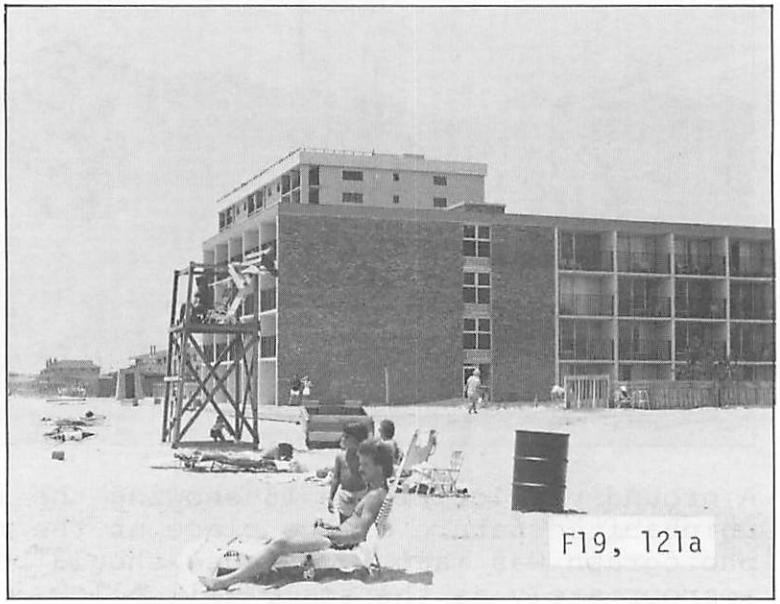

Figure 19. A ground view of Figure 18. The top of the high rise condominium is seen beyond the motel.

122 COMMERCIAL AND RECREATION

This category includes areas or structures devoted to the sale of products and services of all types, including public amusement. The category includes such structures as shops, restaurants, miniature golf courses, fishing piers and public bath houses.

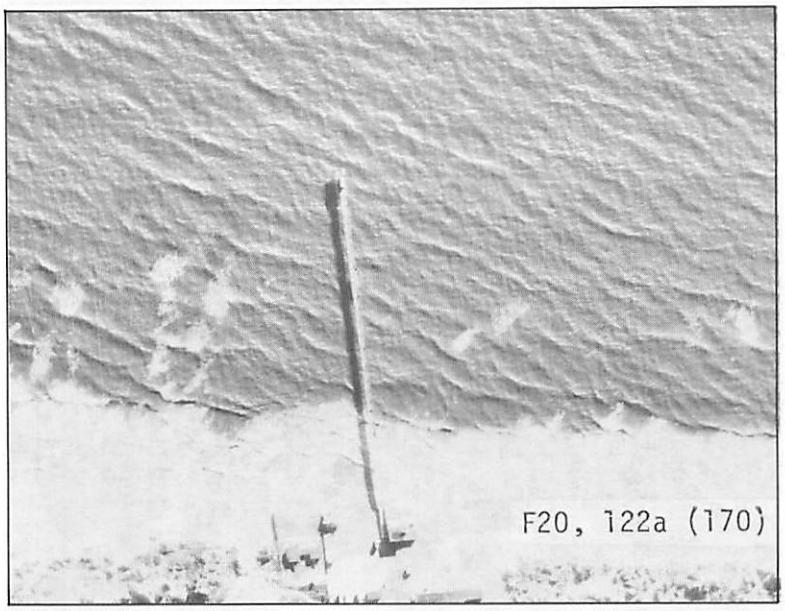

Figure 20. Fishing pier on Bogue Banks. The pier and building at its entrance, as well as the parking lot associated with it, would be included in this category.

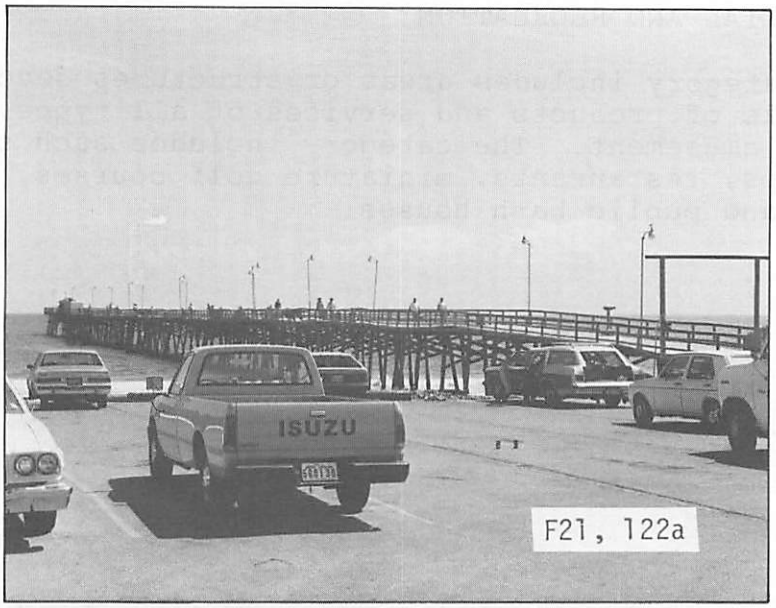

Figure 21. A ground view of the pier and its parking lot shown in Figure 20.

Figure 22. An amusement park on Bogue Banks providing a variety of activities, including small boats and a miniature golf course.

123 MARINAS, DOCKS AND BOAT STORAGE FACILITIES

A marina is included in this category if it handles private boats or a mixture of private and commercial charter boats. A dock area devoted entirely to charter boats falls under 143. The area to be mapped includes all the structures associated with the marina, whether on land or in the water. Small private docks are mapped in this category if the scale will allow. The entire area of a dry boat storage facility, including associated open space, falls under this category.

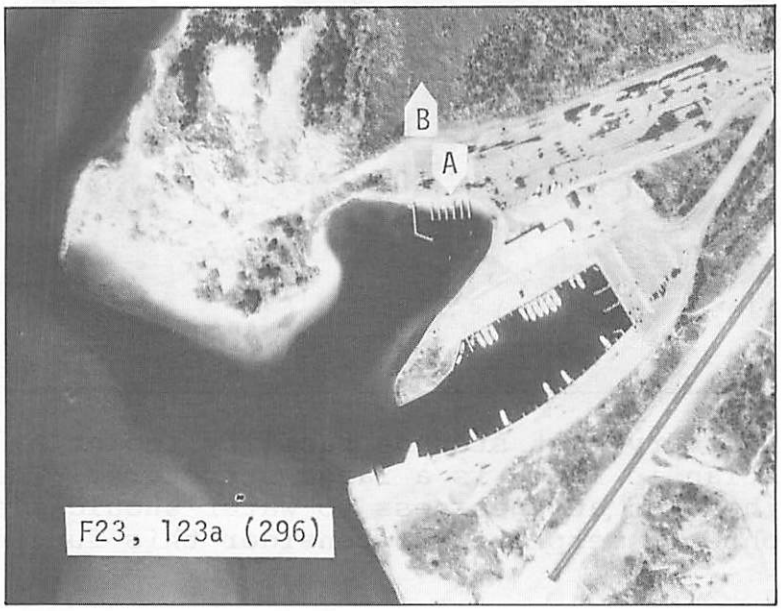

Figure 23. Marina at Oregon Inlet that handles a mixture of private and commercial charter boats. The public launching ramps at point A would also be included in this cateogry. For an explanation of point B, see category 622.

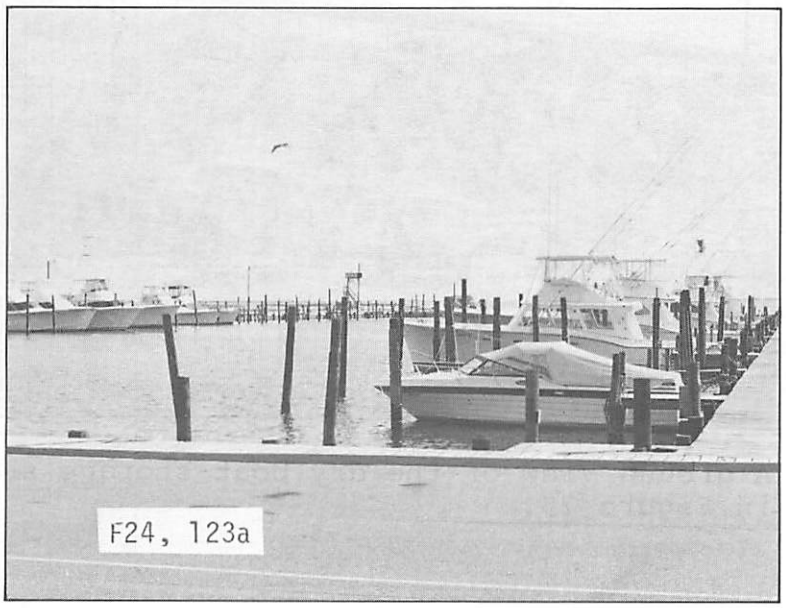

Figure 24. A ground view of the marina in Figure 23.

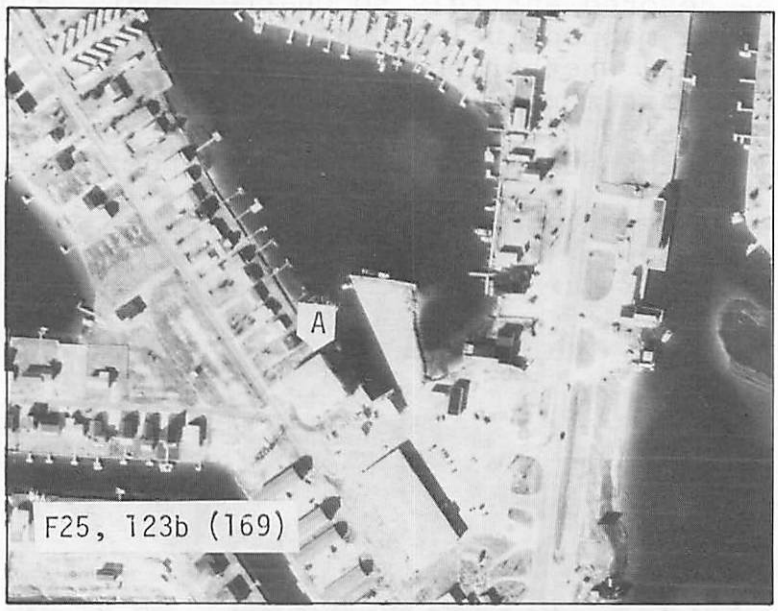

Figure 25. This dry boat storage facility (point A) at Atlantic Beach is a large structure. The size of the roof and nearness to water should alert the photo interpreter to consider this function.

Figure 26. A ground view of the dry boat storage shed down in Figure 25.

124 MILITARY INSTALLATIONS

This classification includes the active bases of all military services, as well as their reserve components and the National Guard.

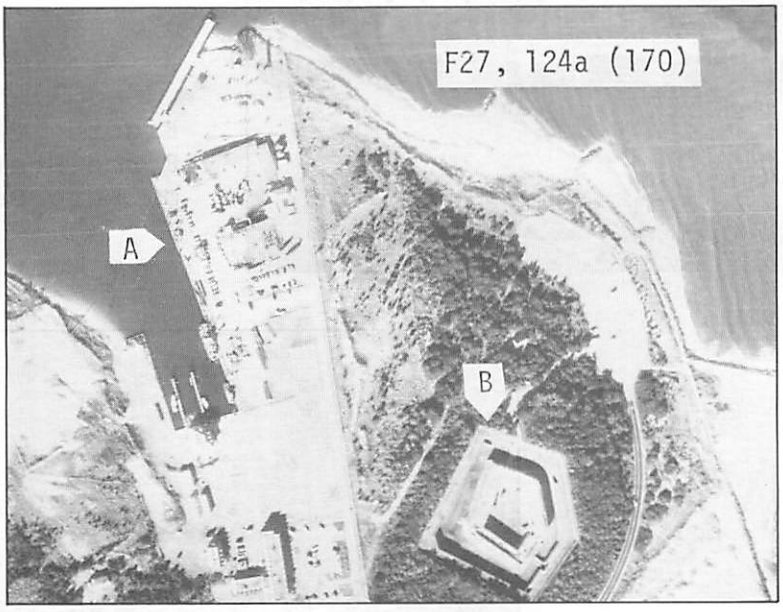

Figure 27. A Coast Guard Station (A) with docks for large vessels at Beaufort Inlet. Historic Fort Macon is located at point B. This Civil War fortification is an example of category 128.

Figure 28. A ground view of the dock in Figure 27.

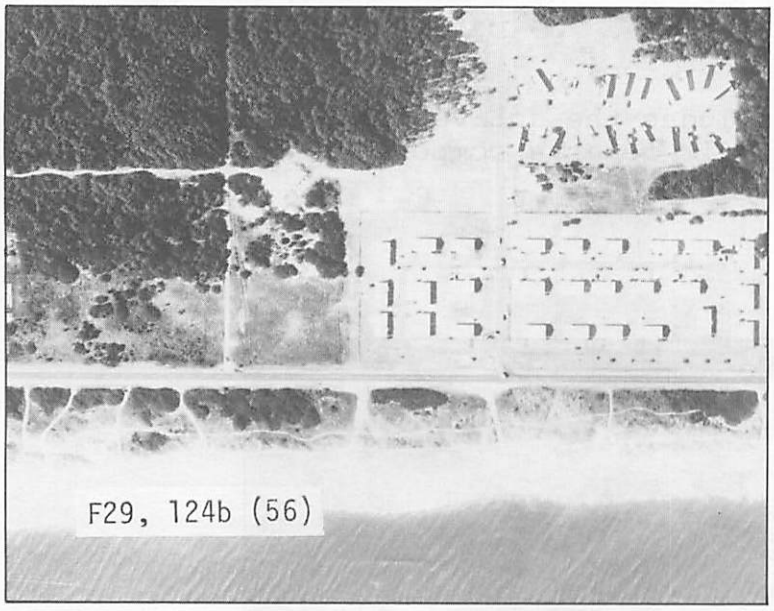

Figure 29. A small Air Force Station located south of Kure Beach.

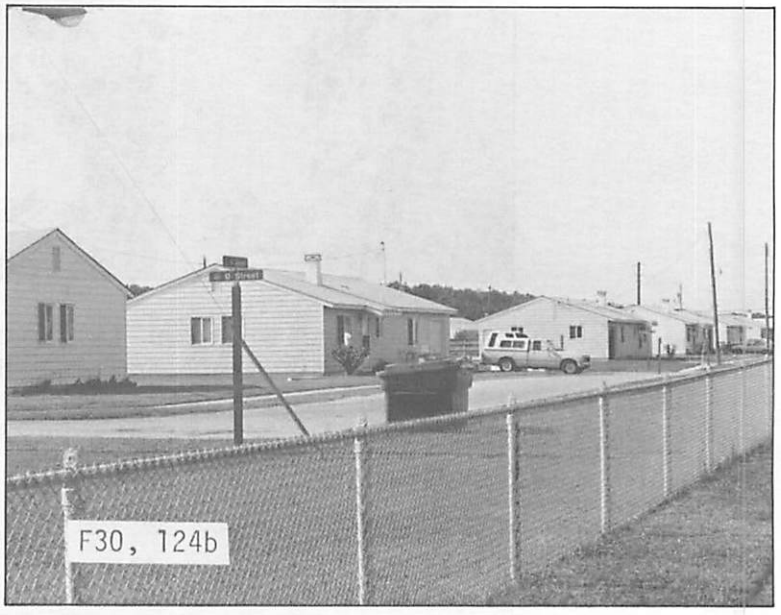

Figure 30. Housing in the Air Force station shown in Figure 29.

Figure 31. The Coast Guard Station at Ocracoke. The wooden buildings are typical of many of the other Coast Guard installations found on the barrier islands.

125 CAMPGROUNDS AND TRAVEL TRAILER PARKS

Areas designated for the use of tents and/or travel trailers and recreational vehicles are included in this group.

Figure 32. A campground operated by the National Park Service at Cape Hatteras. The street pattern allowing access to the individual campsites is typical of other National Park campsites on the barrier islands.

Figure 33. A ground view of the campground in Figure 32.

Figure 34. A private campground at Emerald Isle. Heavy tree growth tends to obscure aerial detection of this and similar campgrounds.

126 COUNTRY CLUBS

Only the structures and nearby pools and tennis courts fall under this classification. The open area portions of golf courses are classified as 171.

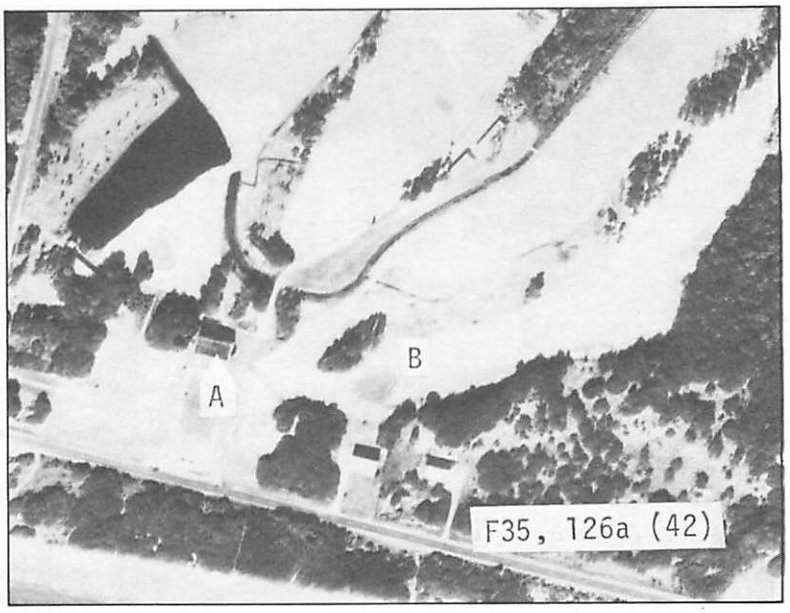

Figure 35. Only the clubhouse at point A and the nearby facilities fall in this category. The fairway and green at point B are an example of 171.

Figure 36. A ground view of the clubhouse shown at point A in Figure 35.

127 PARKING LOTS FOR PUBLIC BEACH ACCESS

This use of land is distinguished separately even when it is a component of another category such as a historical site.

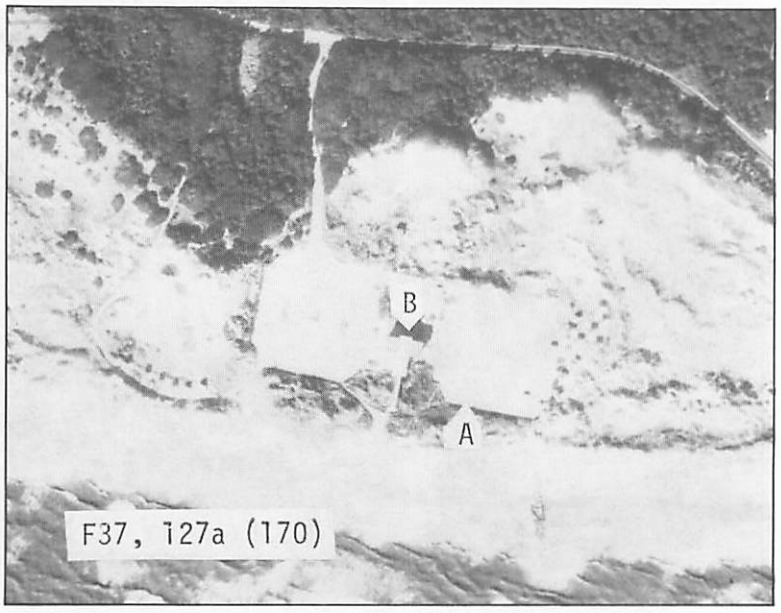

Figure 37. The public parking lot (A) and bath house (B) are located on Bogue Banks near Fort Macon. Few facilities such as these are on the barrier islands.

Figure 38. A ground view of the bath house and parking lot shown in Figure 37.

128 OTHER INSTITUTIONAL USES

This category consists of structures and open areas associated with all local governmental functions. Historic sites, schools, churches and other public buildings are included in the category when the scale of mapping will allow.

Figure 39. The town government complex at Nags Head. It is relatively easy to find on an aerial photograph because the area around it is not as developed as other parts of town. In this case, the shadow of the water tower helps the photo interpreter locate the complex.

Figure 40. A ground view of the Nags Head town government buildings. This is the area shown in Figure 39.

Figure 41. Town government buildings at Atlantic Beach. These would be difficult to distinguish from some commercial structures of category 122.

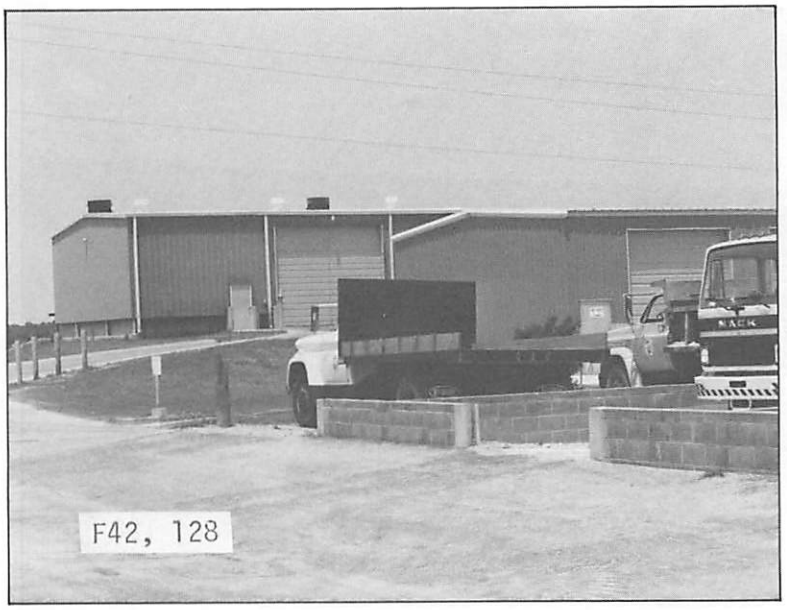

Figure 42. The public works yard of Wrightsville Beach. Trash collection and other functions are carried out here. The presence of vehicles and large structures in combination is different from the general appearance of this cottage community.

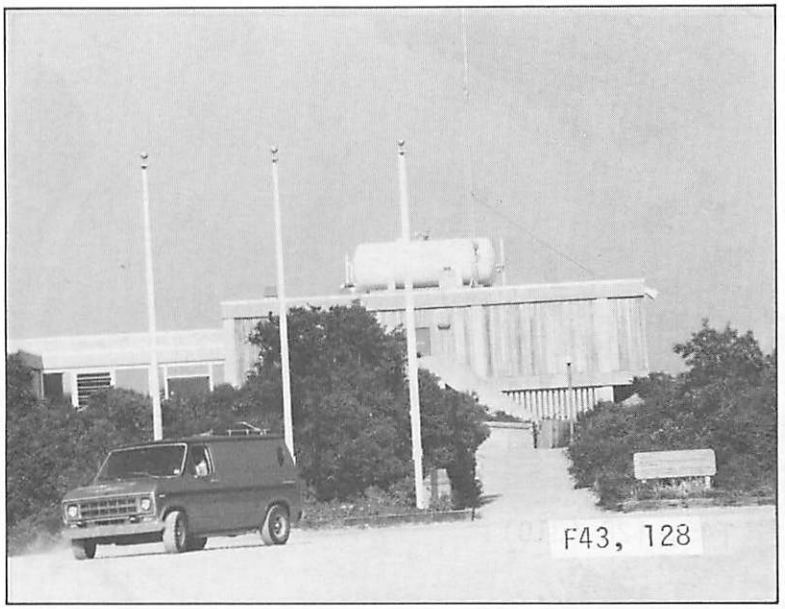

Figure 43. The Marine Resources Center at Fort Fisher. This is an institutional structure standing alone with its own parking lot.

Figure 44. The exhibition hall at Fort Fisher, the site of a Civil War battle on the coast. The surrounding open spaces would be included in this category.

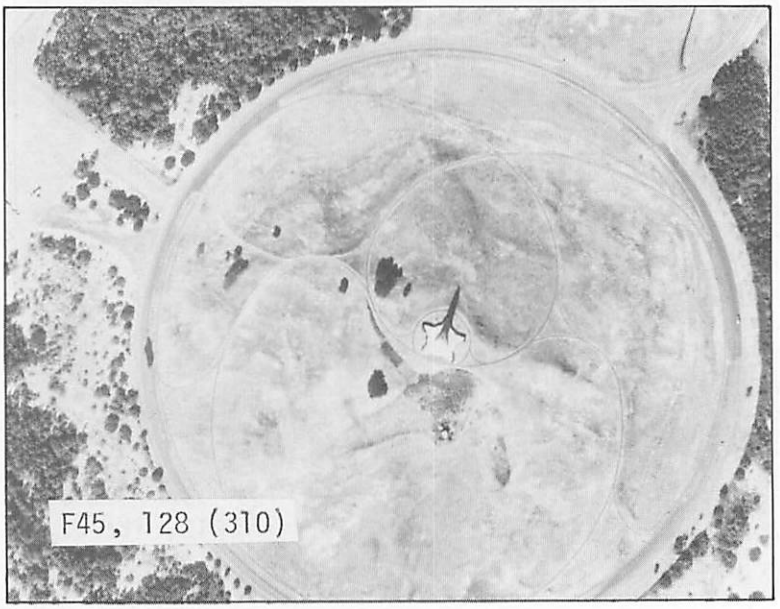

Figure 45. The monument at the Wright Brothers National Memorial at Kill Devil Hills. All the open areas and the exhibition hall outside of this view would be included in this category.

129 COMMERCIAL OR SERVICE AREAS PARTIALLY DEVELOPED

Areas to be included are those where construction is under way at the time of the survey, and it is known that the ultimate use will be devoted to commercial or service purposes.

Figure 46. New stores under construction at Nags Head.

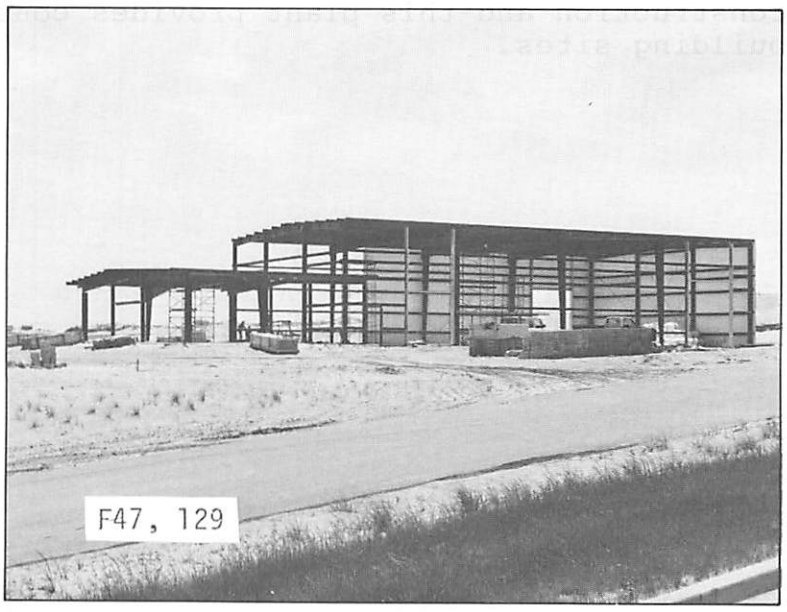

Figure 47. A large commercial structure under construction at Nags Head. It is clear this building and those in Figure 46 will be devoted to commercial or service uses because of their forms and the locations they occupy.

131 CONSTRUCTION INDUSTRY LOCATIONS

Areas and structures devoted to the fabrication or preparation of materials to be transported to actual building sites are included in this category.

Figure 48. A site for the preparation of ready-mixed concrete at Nags Head. The vicinity is undergoing much construction and this plant provides concrete for building sites.

141 FERRY BOAT LANDINGS

Docks, buildings, roads, parking lots and other open areas associated with the operation of a ferry boat service make up this classification.

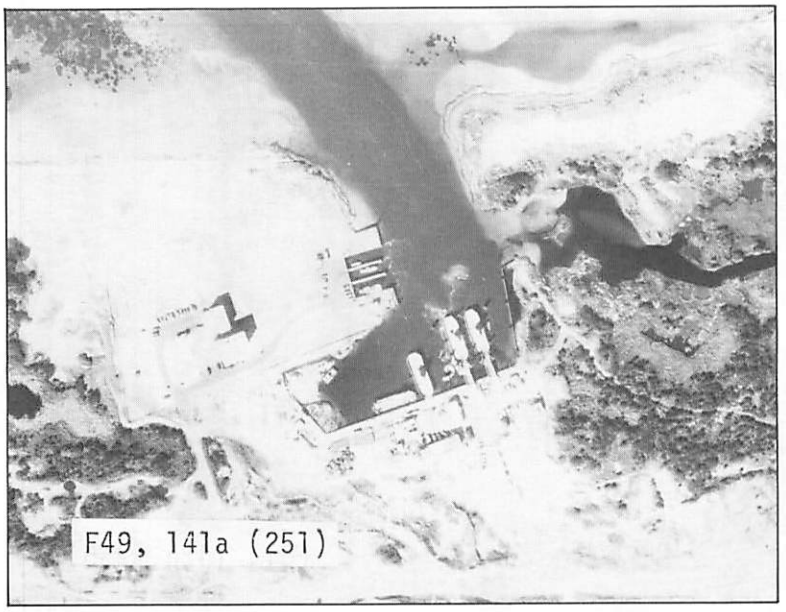

Figure 49. The Hatteras free ferry to Ocracoke Island. The parking area and vessels are visible in this picture.

Figure 50. A ground view of the Hatteras ferry offloading vehicles after a run from the terminal at the north end of Ocracoke Island.

142 AIRPORTS

Airports and their associated structures and open spaces are included in this category. All airports are included regardless of runway surface types.

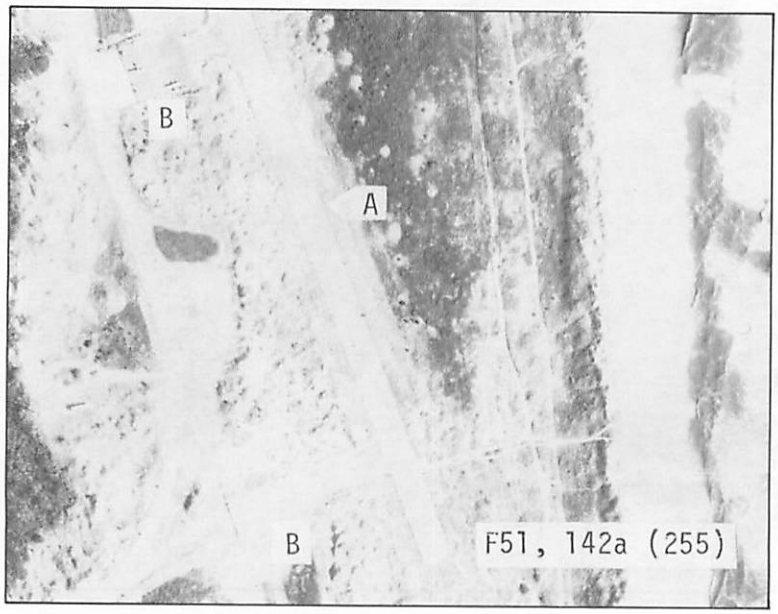

Figure 51. The Billy Mitchell airfield at Hatteras. The hard-surface runway at point A is set among dunes and is very close to the beach. Airplanes are usually parked at point B.

Figure 52. Airplanes parked at Billy Mitchell airfield.

143 COMMERCIAL DOCKS

The docks and structures exclusively associated with the activities of working boats, including those for charter to recreational fishermen, are classified as commercial docks. Private recreational boating facilities are classified under 123.

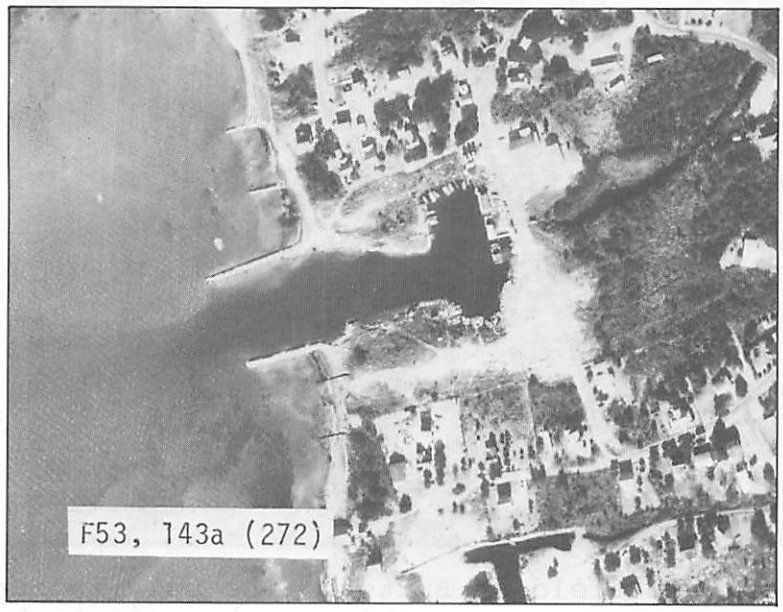

Figure 53. A small harbor devoted to commercial fishing at Avon.

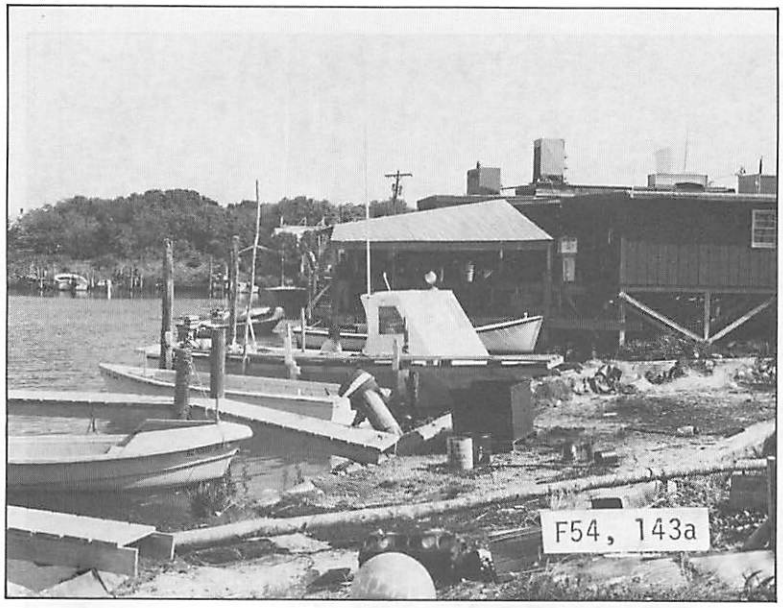

Figure 54. A ground view of the docks and buildings used for the handling of fish at Avon.

144 WELL FIELDS FOR WATER SUPPLY

An area set aside for the location of wells to tap ground water for human consumption is included in this category, regardless of its vegetative cover.

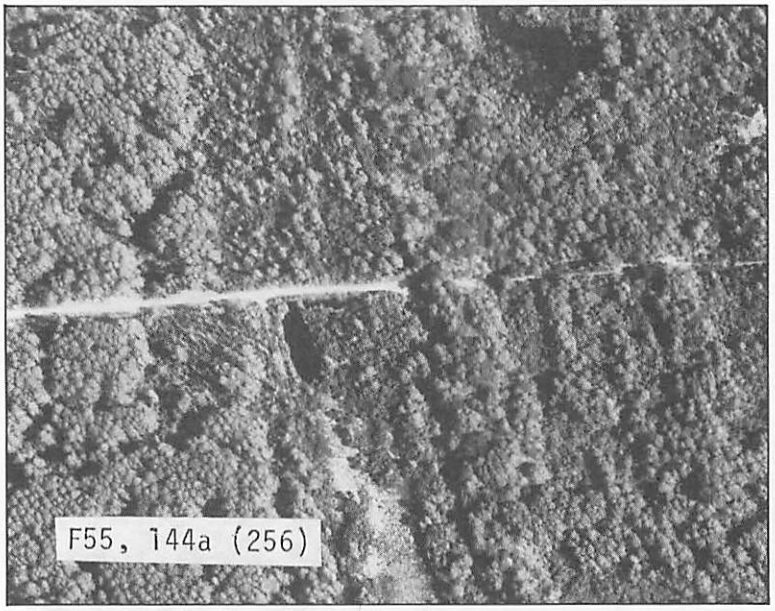

Figure 55. The well field at Buxton. The only indication of this activity visible on the aerial photo is the presence of a dirt road and trail apparently leading nowhere. Individual wells cannot be located under the dense growth of trees.

Figure 56. One of the wells in the Buxton field with its protective cover removed. Each installation is small and easily hidden from view by the trees.

145 WATER PURIFICATION FACILITIES

All structures and open spaces associated with a water purification plant are designated to this category.

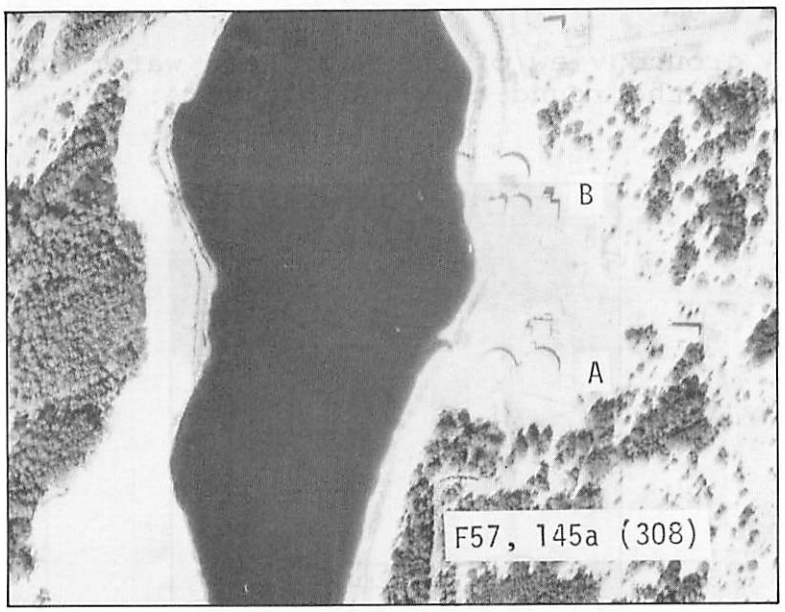

Figure 57. This freshwater pond (521) water serves as part of the supply for Nags Head and Kill Devil Hills. The Nags Head water works is located at point A and the Kill Devil Hills works at point B. The large, round, covered tanks are an indication of this activity.

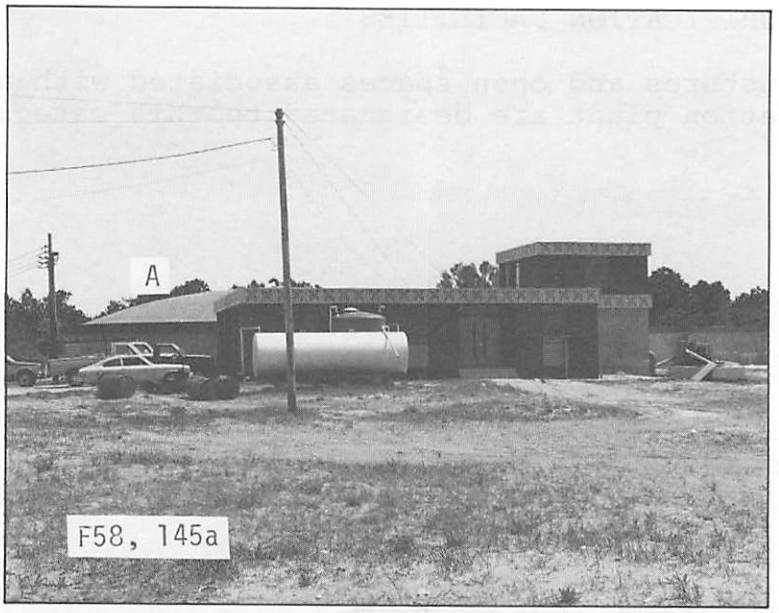

Figure 58. A ground view of the Nags Head water works. Note the round tank visible at A.

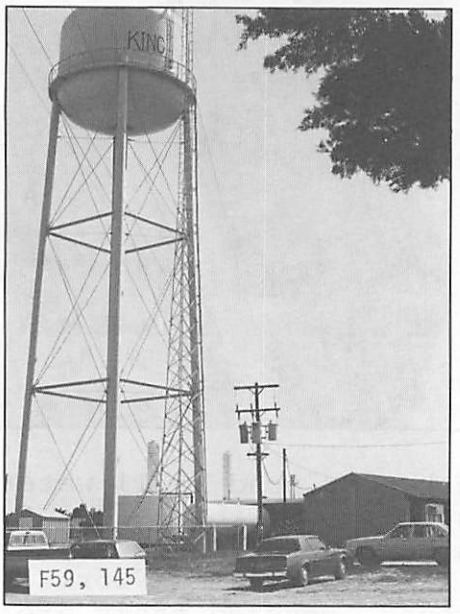

Figure 59. The water works at Ocracoke. Raised water tanks are often associated with this activity. This plant uses brackish water pumped from a depth of 625 feet and a process of reverse osmosis to remove the salts. A variety of sources are used to provide fresh water on the barrier islands, and in some places, the water is piped from the mainland.

146 SEWAGE TREATMENT FACILITIES

All structures and open spaces associated with a sewage treatment plant of any size are included in this category.

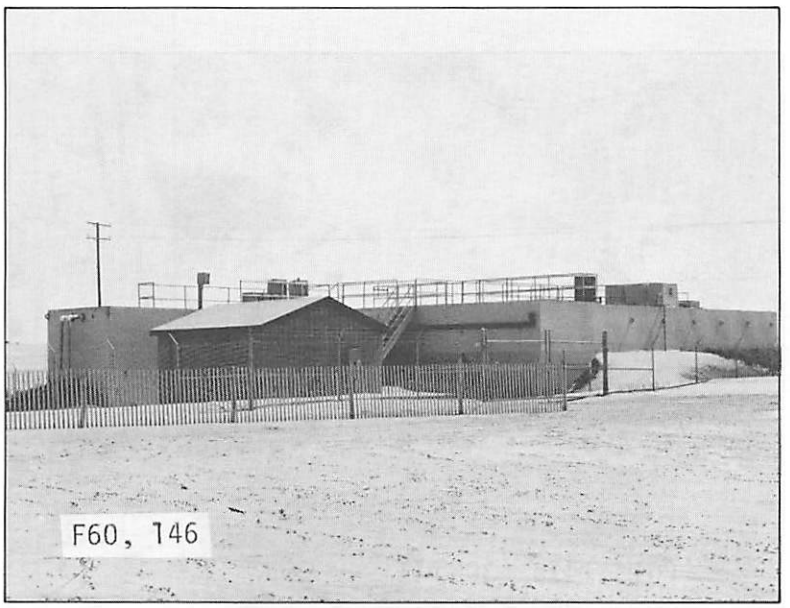

Figure 60. A small sewage treatment plant at Nags Head.

147 ELECTRIC POWER FACILITIES

This classification includes all structures and open spaces associated with an electrical facility devoted to the production or distribution of electricity.

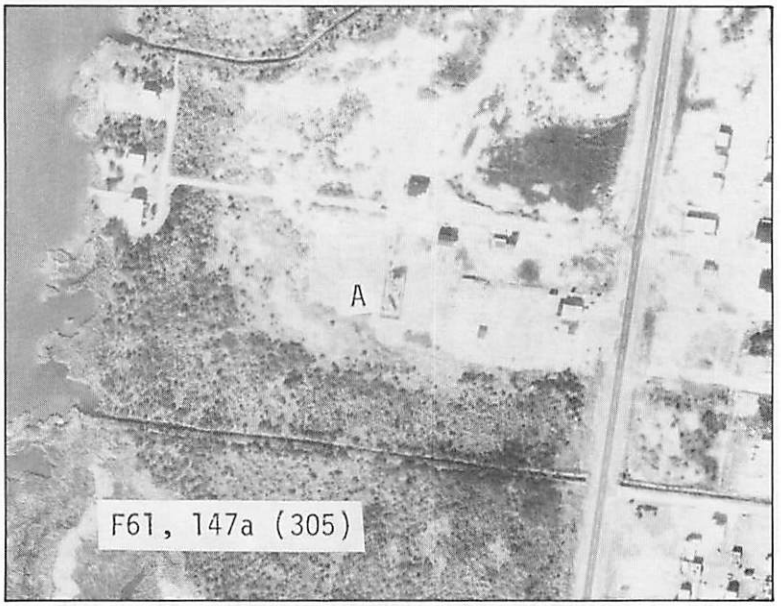

Figure 61. A power substation at Nags Head at point A. These skeletal structures are often difficult to detect on air photos because of their open nature. Sometimes the shadows of power line pylons and poles around the structure help identify it.

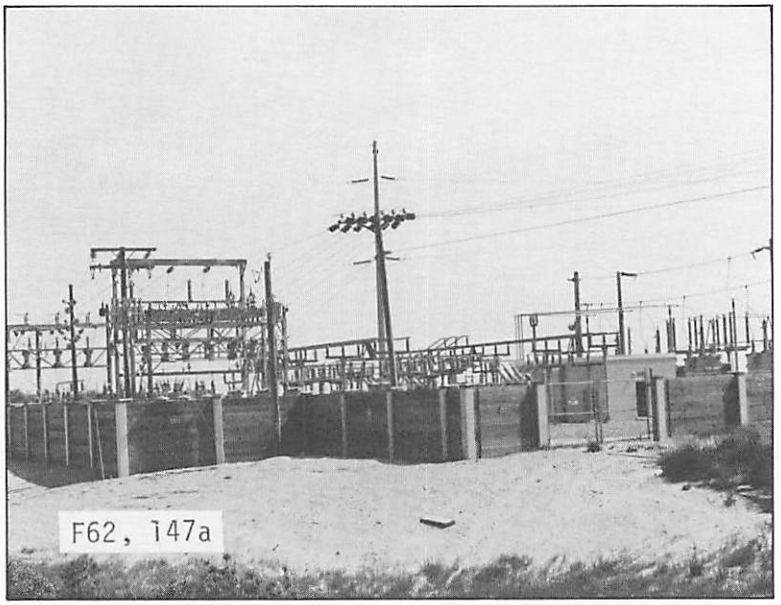

Figure 62. A ground view of the substation in Figure 61.

The major road on a barrier island is a main artery for the flow of traffic and the location of commercial activities. It usually runs parallel to the ocean and extends the length of or over part of the island. In larger coastal communities, more than one road may bear this designation. The relative size of the governmental unit responsible for the maintenance of the road has no bearing on its functional importance.

Figure 63. The main road running through Kure Beach is marked at A. This is not only the main artery for through traffic, but it is also commercially important. In a community of this size and configuration, one or more other streets may fall into this category. In smaller barrier island communities, there is usually only one main road.

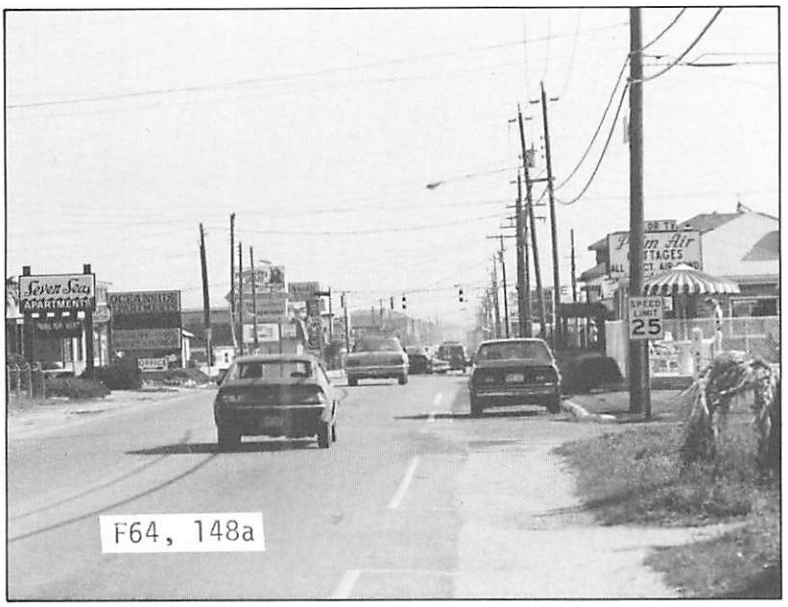

Figure 64. A ground view of Figure 63. Note the many commercial establishments on both sides of the road. These would be classified under 122; only the road would be designated as 148.

149 LIGHTHOUSES AND ELECTRONIC COMMUNICATIONS

All structures and open spaces associated with these functions are included in this category as the mapping scale will allow.

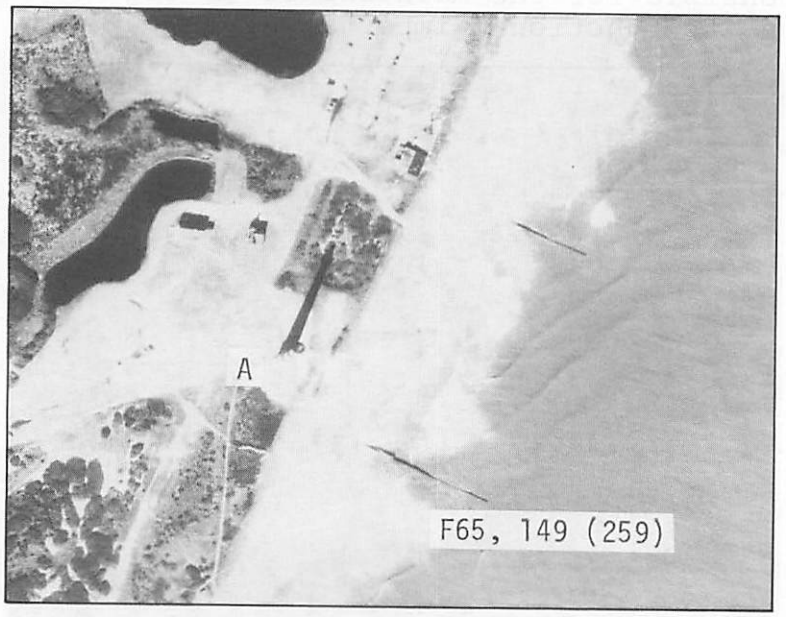

Figure 65. The Hatteras lighthouse at point A is hardly visible because of its relatively small diameter. Its shadow, however, is perfectly clear and tells us about the height and shape of the structure.

171 GOLF COURSES

The open playing areas and their natural surroundings are included in this category, while associated structures fall under 126.

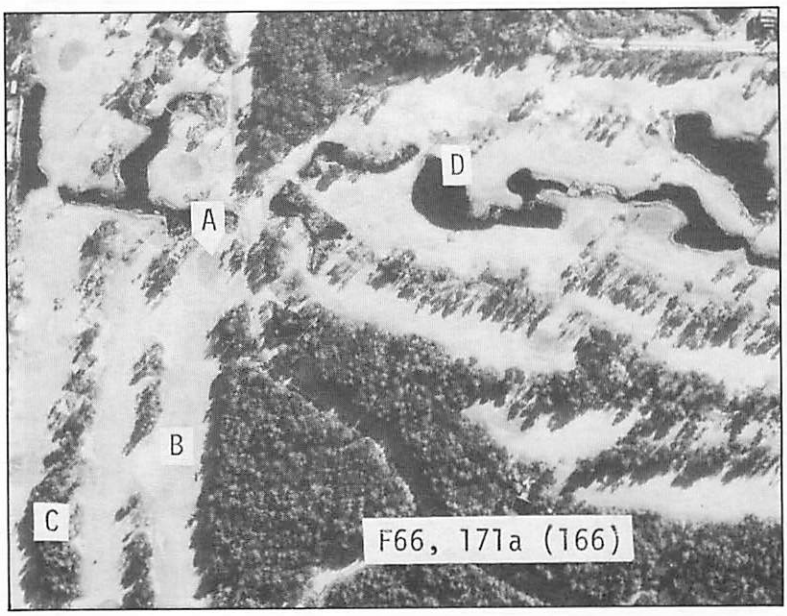

Figure 66. This golf course at Pine Knoll Shores serves to illustrate the open playing areas. The greens (A), the fairways (B), vegetation separating the fairways (C), water hazards and (D) sand traps all fall within this category.

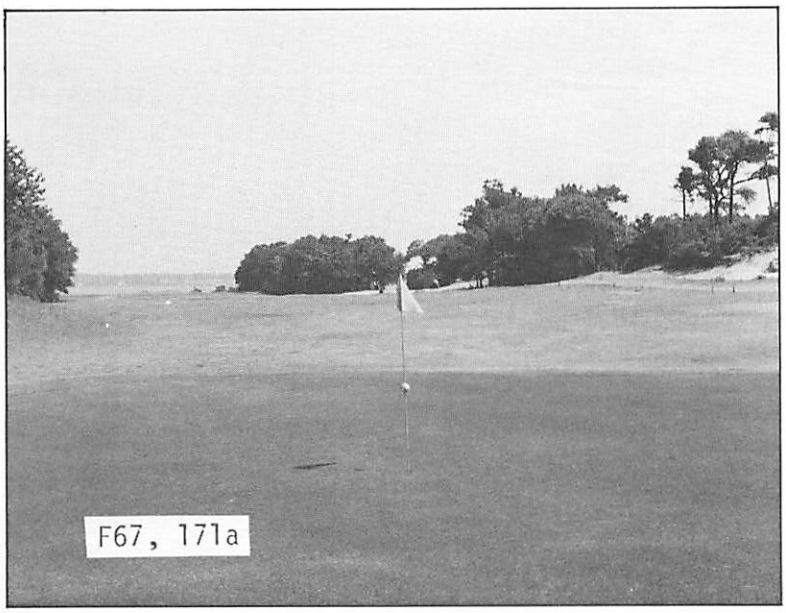

Figure 67. A ground view taken at point A on Figure 66.

172 CEMETERIES

Any cluster of grave sites large enough to show up at the mapping scale is included in this category.

Figure 68. This cemetery at Collington is fairly large and could easily be mapped. Many similar plots exist in various parts of the barrier islands. Some would be too small to map at any but the largest scales.

All structures, playing fields or courts, landscaped grounds and parking lots associated with the park facility are included in this category.

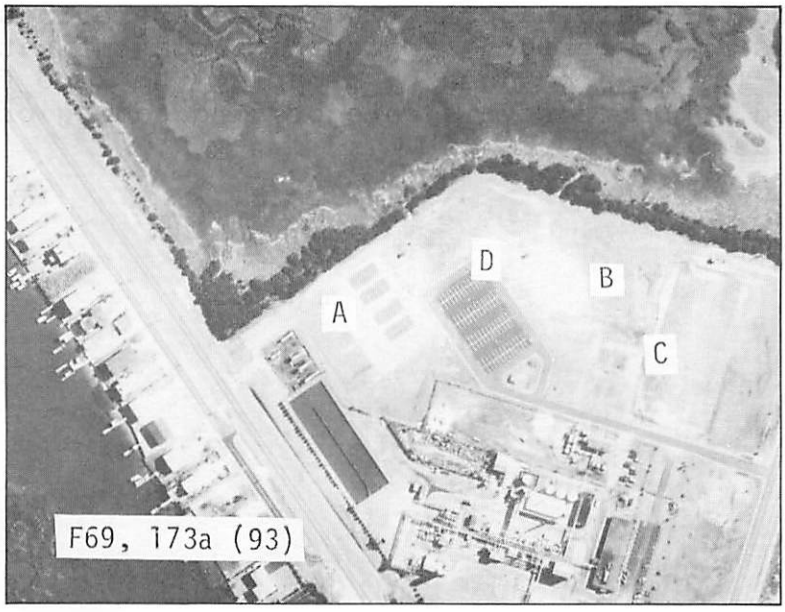

Figure 69. Play and game areas like tennis courts (A) baseball diamonds and (B) basketball courts (C) are an indication of a park like this one at Harbor Island in Wrightsville Beach. Parking facilities (D), in association with the fields, are a typical feature of such a park.

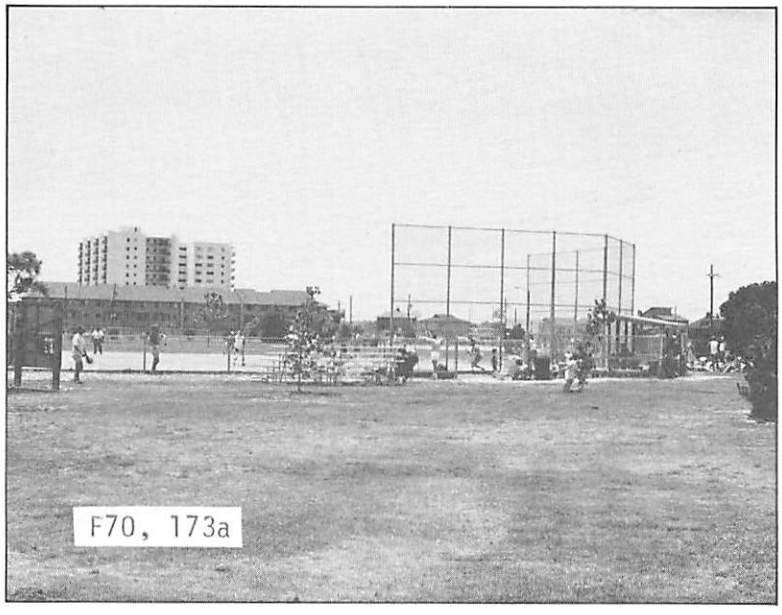

Figure 70. A ground view of the park in Figure 69.

210 CROPLAND AND PASTURE

This is not an established category, but it is included for possible use in the future.

Years ago, small farms existed on the barrier islands, and certain animals grazed the pastures. But today, such activities are not likely to be conducted as a means of livelihood. Should mappers find areas where these activities are practiced, appropriate classifications can be made. This can be done by dropping the zero from the designated number for this category and adding other numerals as required.

311 DUNE GRASS AREAS

Higher areas of sloping and irregular topography where grass is the predominant vegetation are included in this category.

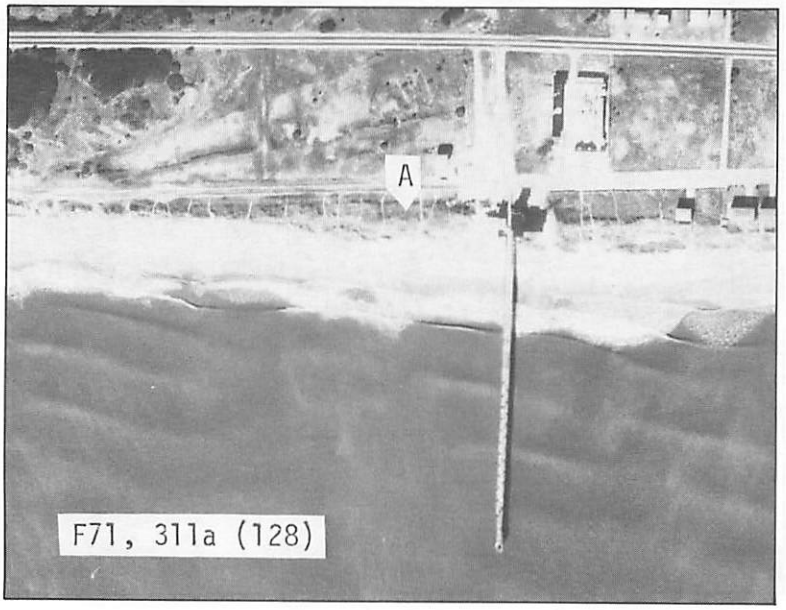

Figure 71. Dunes covered with grass at West Onslow Beach (A).

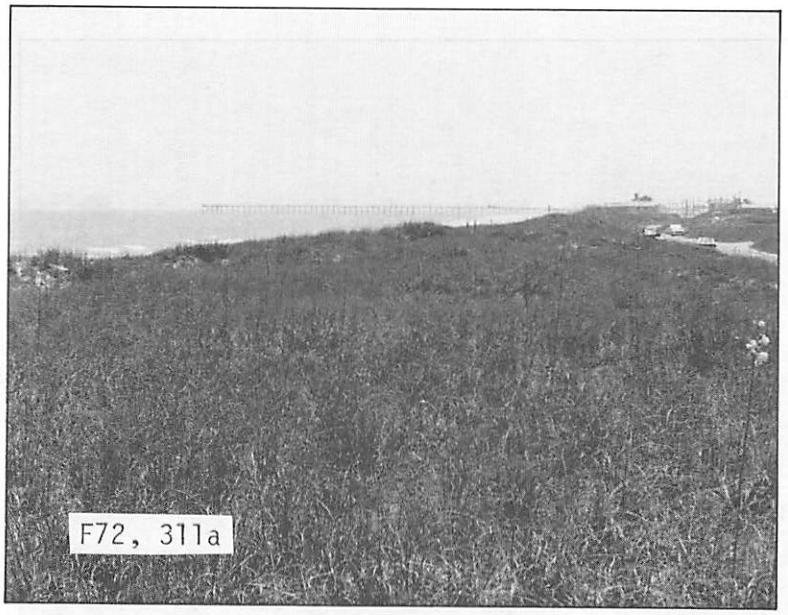

Figure 72. A ground view of point A in Figure 71.

312 FLAT GRASS AREAS

Generally low-lying level areas, either among dunes or away from them, where grass is the predominant vegetation are included in this category.

Figure 73. A flat area of grass around point A. Area B is an example of 331—Mixed grass and shrub on dune areas.

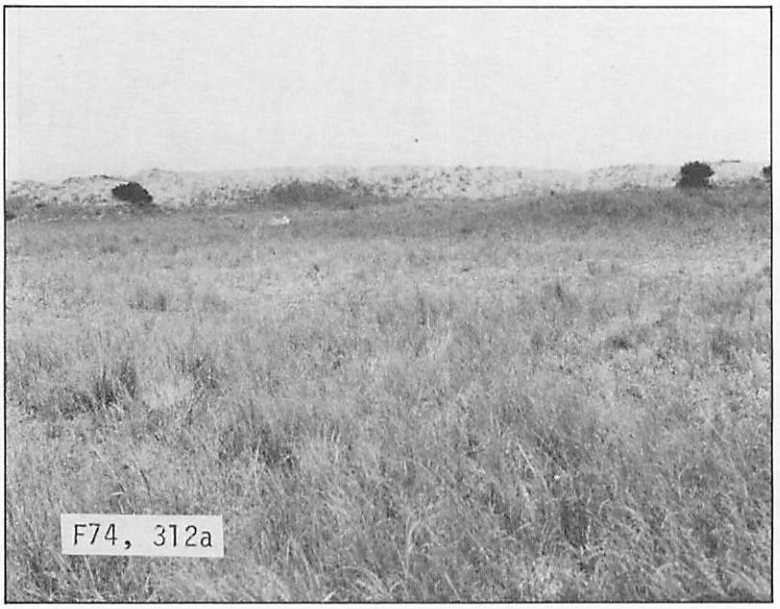

Figure 74. A ground view of the flat grass area in Figure 73.

313 SPOIL BANK AREAS COVERED WITH GRASS

A spoil bank is a pile of excavated earth usually from dredging operations in channels. If grass covers all or part of the spoil bank, the affected portion is included in this category.

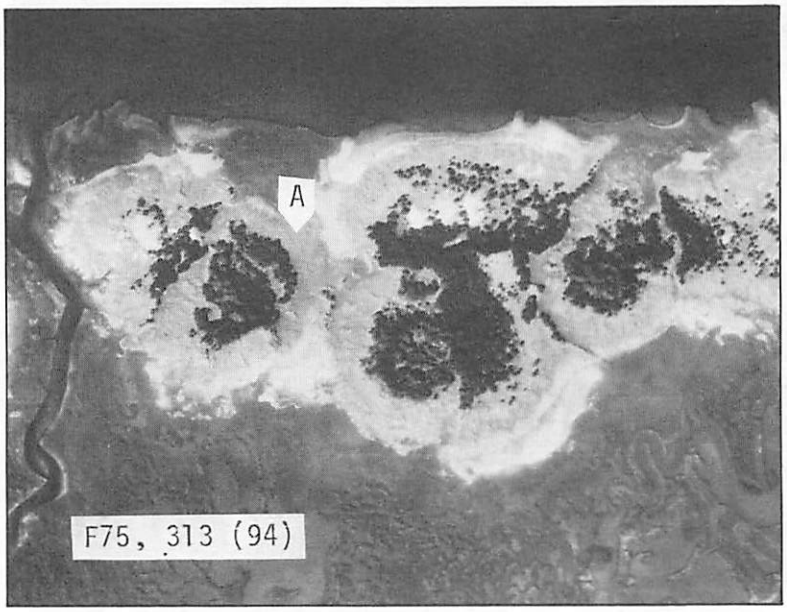

Figure 75. Spoil banks next to the Intracostal Waterway near Wrightsville Beach. The spoil was dumped onto adjoining marshland and gradually became covered with vegetation. Grass (A) has established itself on the lower margins of the spoil banks.

321 DUNE SHRUB AREAS

Higher areas of sloping and irregular topography where shrubs are the predominant vegetation are included in this category.

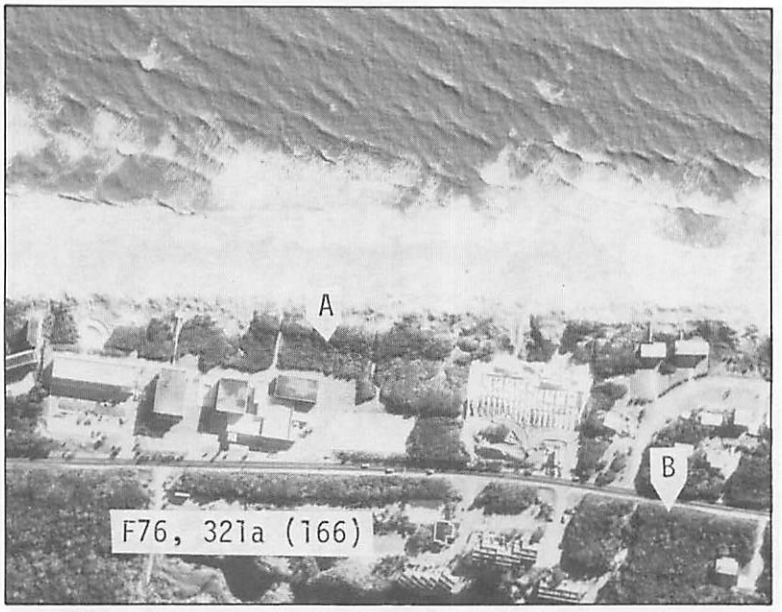

Figure 76. Shrub growth on the dunes at Pine Knoll Shores at point A. Point B illustrates 431—Maritime forest.

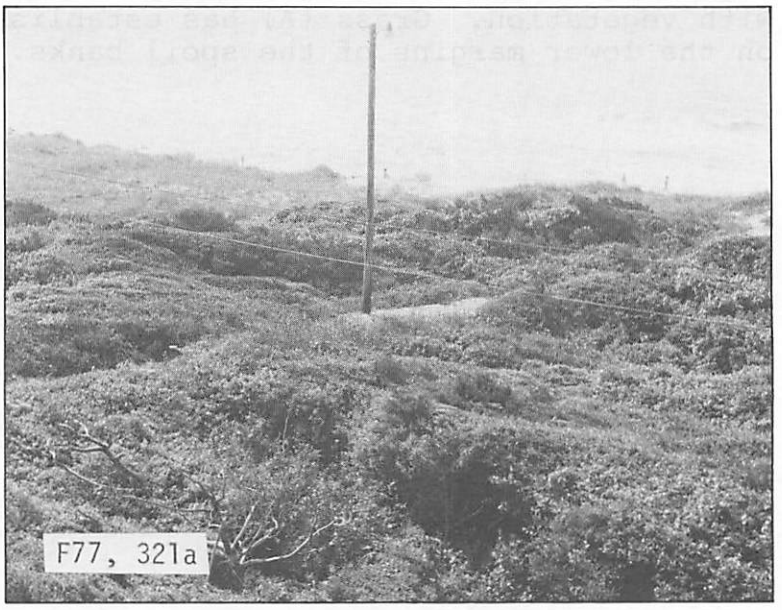

Figure 77. A ground view of the shrub area at point A in Figure 76. The irregular dune terrain is almost obscured by the thick growth of shrubs. The surface of the shrub growth has a smooth appearance due to the effects of salt spray pruning.

322 FLAT SHRUB AREAS

Generally low-lying level areas, either among dunes or away from them, where shrubs are the predominant vegetation are included in this category.

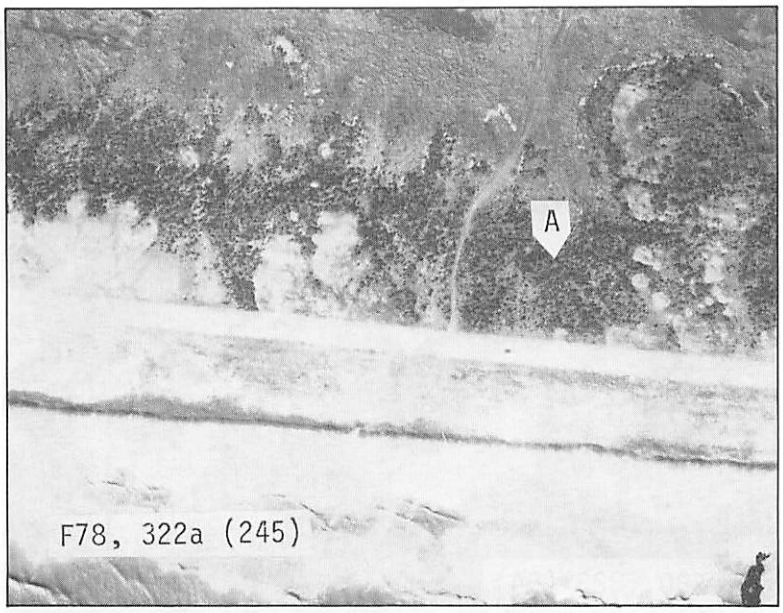

Figure 78. A flat shrub area (A) behind the dunes on Ocracoke Island.

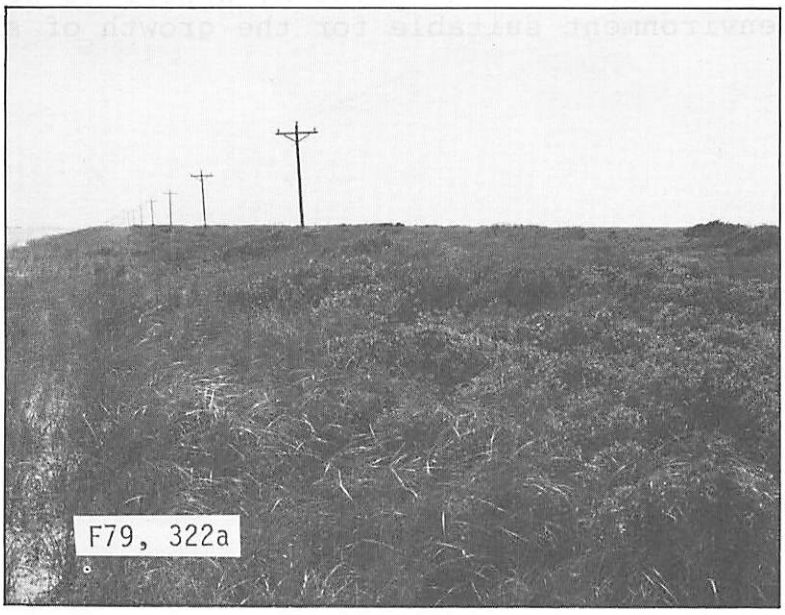

Figure 79. A ground view at point A in Figure 78.

323 SPOIL BANK AREAS COVERED WITH SHRUBS

Portions of a spoil bank covered by shrubs are included in this category. For the definition of a spoil bank see 313.

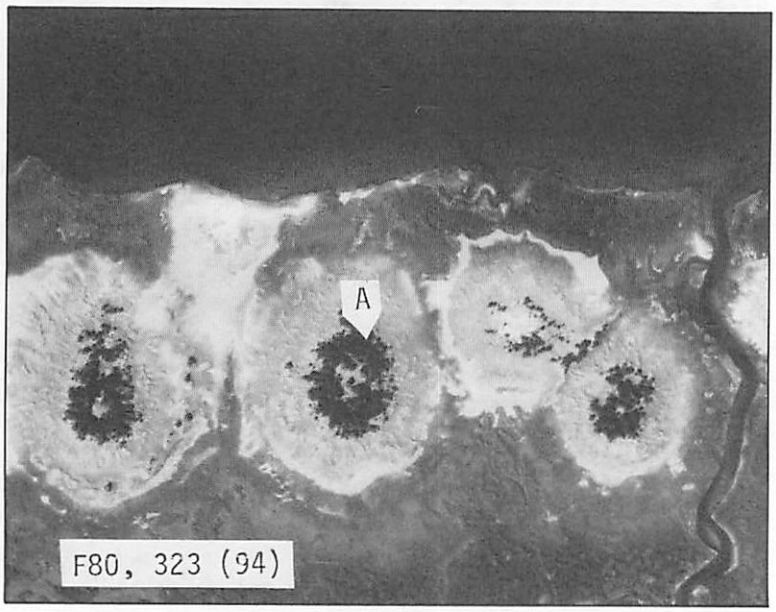

Figure 80. Spoil banks next to the Intracoastal Waterway near Wrightsville Beach. The higher locations on the spoil banks, as at point A, appear to provide an environment suitable for the growth of shrubs.

331 MIXED GRASS AND SHRUB ON DUNE AREAS

Higher areas of sloping and irregular topography, where the growth of shrubs and grasses is so mixed that the plant types cannot be separated at the scale of mapping, are in this category.

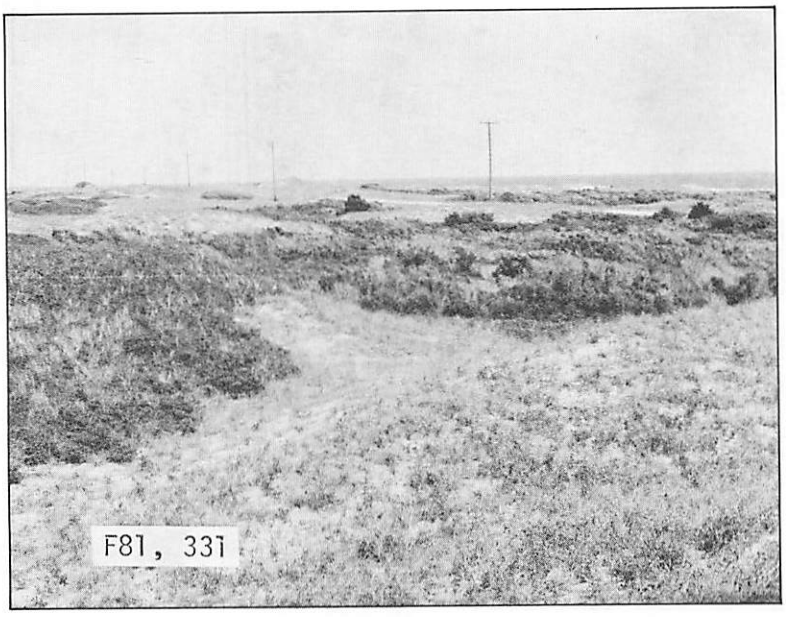

Figure 81. This a ground view of area B in Figure 73. Except at a very large scale, it would be difficult and impractical to map the grass and shrubs separately.

332 MIXED GRASS AND SHRUB ON FLAT AREAS

This classification pertains to generally low-lying level areas, either among dunes or away from them, where the growth of shrubs and grasses is so mixed that the plant types cannot be separated at the scale of mapping.

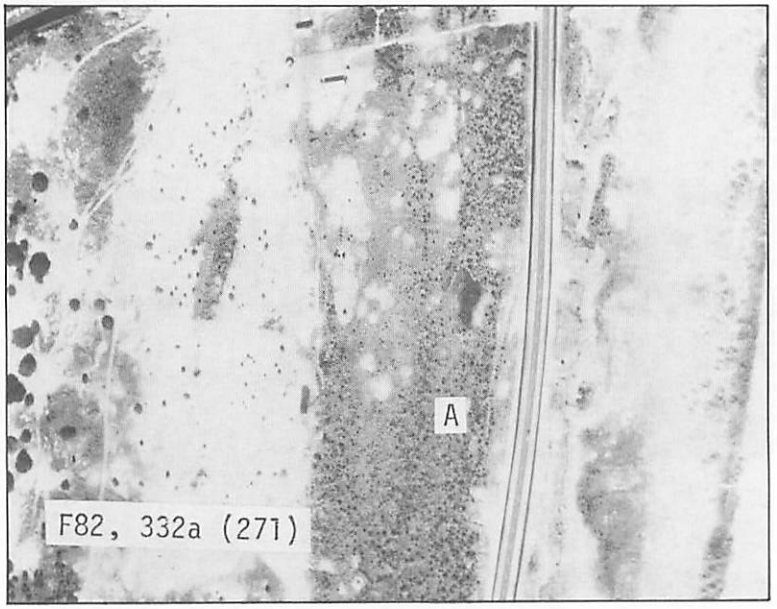

Figure 82. The vegetation surrounding point A is mixed grass and shrub on a flat area behind the dune on Ocracoke Island.

Figure 83. A ground view of A on Figure 82.

333 SPOIL BANK AREAS COVERED WITH GRASS AND SHRUB

The portions of a spoil bank, where the growth of shrubs and grasses is so mixed that the plant types cannot be separated at the scale of mapping, are included in this category. For the definition of spoil bank see 313.

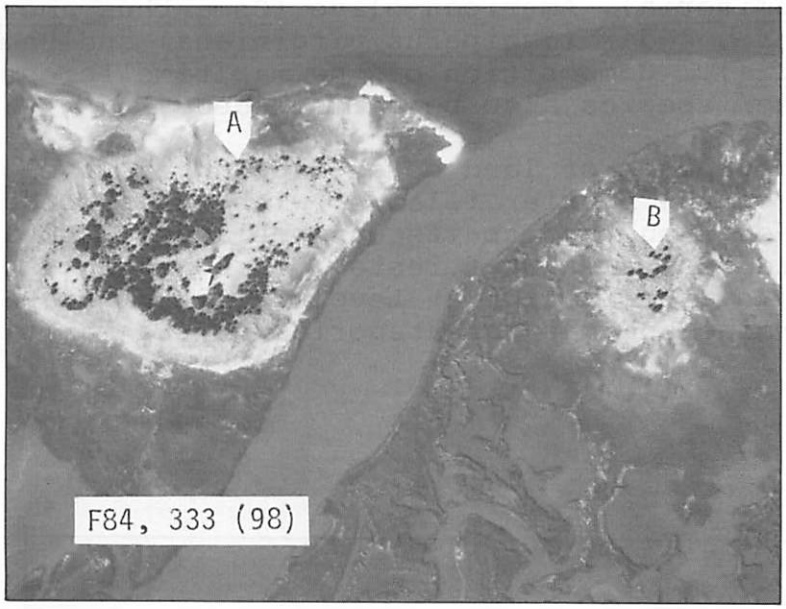

Figure 84. Spoil banks near Rich Inlet in Pender County. Points A and B are examples of sparse shrub growth mixed with grass.

431 MARITIME FOREST ON BARRIER ISLANDS

The species comprising the maritime forest show adaptations to conditions of strong winds, salt mist, limited freshwater supply and low nutrient levels in the soil. On the barrier islands, the important species making up this plant community are: Southern live oak (Quercus virginiana), laurel oak (Quercus laurifolia), red bay (Persea borbonia), wax myrtle (Myrica cerifera), American holly (Ilex opaca), yaupon (Ilex vomitoria), American olive (Osmanthus americana), eastern red cedar (Juniperus virginiana) and bamboo (Smilax laurifolia). Composition of the maritime forest is varied, with other species also being included.

For the purposes of land cover mapping at Level III, all forests on the barrier islands, with exception of 611 (Mixed deciduous and coniferous wetlands), should be classified as maritime forests. In constructing a more detailed classification at Level IV, it might be desirable to determine and map subcategories of the maritime forest.

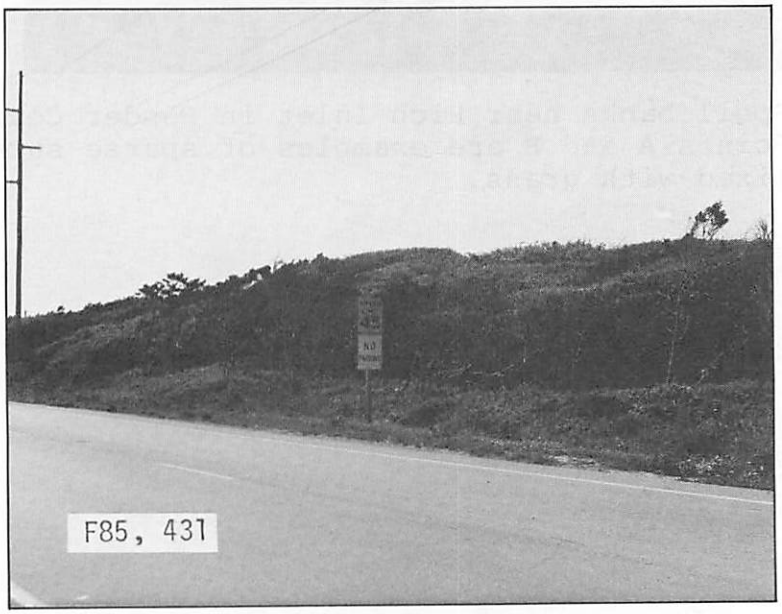

Figure 85. A ground view of point B in Figure 76. The forest here at Pine Knoll Shores is subject to the effects of salt spray pruning, giving it the appearance of a wind-swept thicket.

Figure 86. Forest near Fort Fisher with a heavy representation of oaks in the mix of species.

432 MARITIME FOREST AREAS ON SPOIL BANKS

The species listed under 431 are also found growing under similar environmental conditions on old spoil banks that have not been disturbed for a long time. For the definition of a spoil bank see 313.

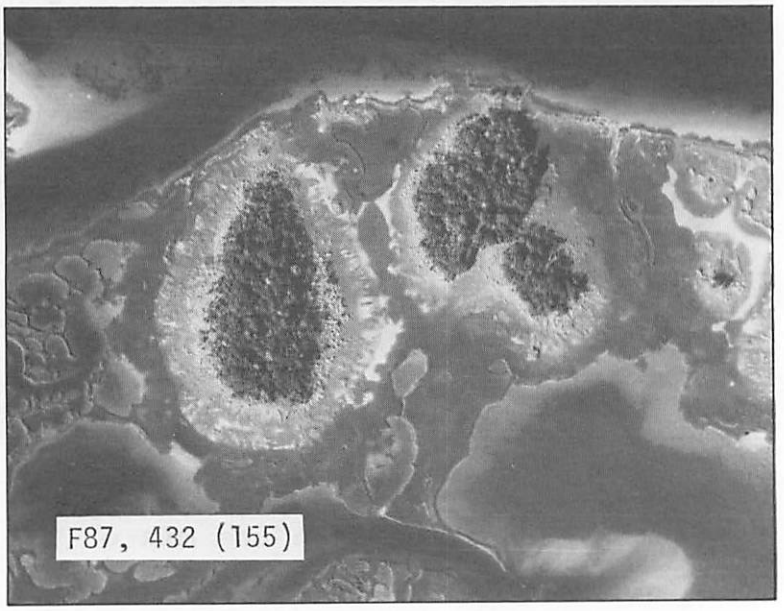

Figure 87. The tops of the spoil banks are covered with dense forest growth, indicating that they have been undisturbed for many years since the dredging that created them was done.

511 INTRACOASTAL WATERWAY

From Bogue Banks southward to the state line, the Intracoastal Waterway is located close to the barrier islands on their landward sides. For the purpose of this classification system, the waterway is considered to be the interior boundary of the barrier islands and is to be mapped only under these circumstances.

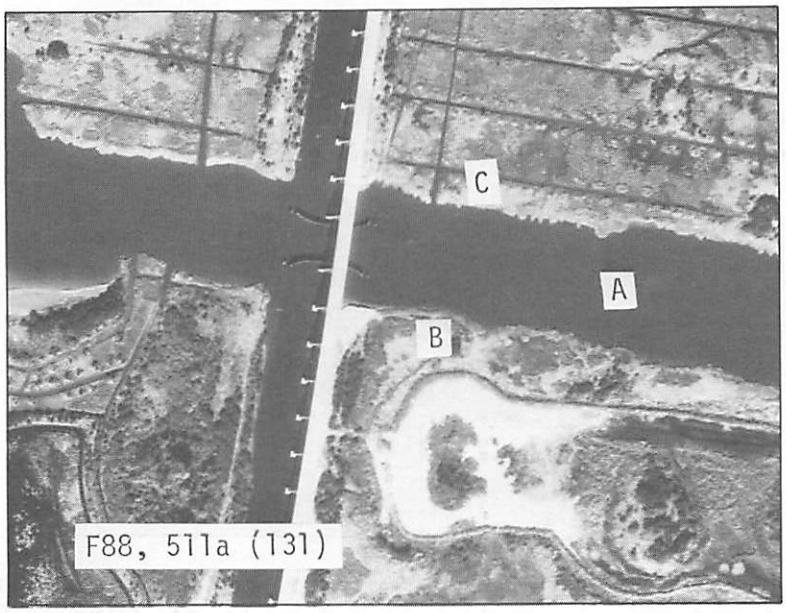

Figure 88. The Intracoastal Waterway (A) passes under the bridge to West Onslow Beach from the mainland. The shore marked by point B is the boundary of the barrier island, while point C marks the beginning of the mainland.

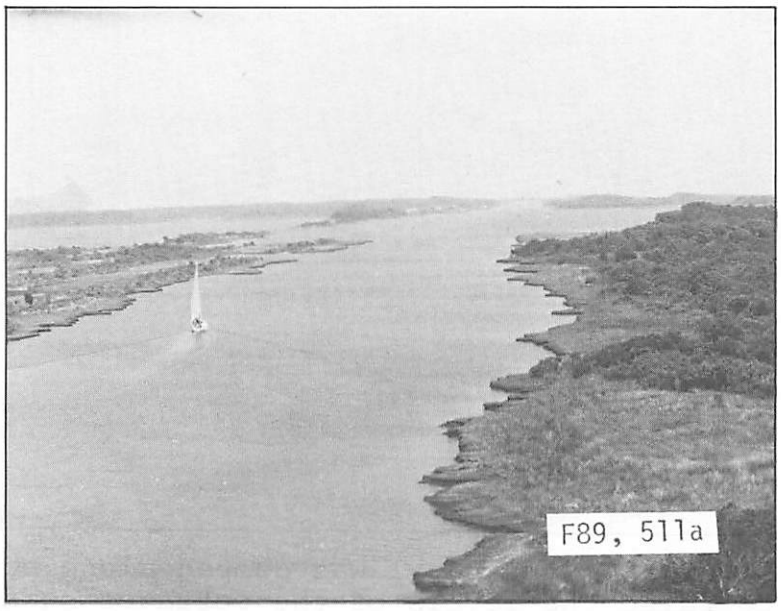

Figure 89. A view to the northeast from the bridge in Figure 88 toward point A. The barrier island is to the right. Note the vegetated spoil banks standing above the level of the marsh on which they were dumped.

512 CANALS ASSOCIATED WITH RESIDENTIAL DEVELOPMENT

On the mainland sides of the barrier islands, some canal cutting associated with housing development has taken place. The canals should be mapped under this category as the scale will allow.

Figure 90. These canals have been cut to enhance this residential development on the sound side of Avon. The view of the canal at point A from the road at the bottom is shown in Figure 91.

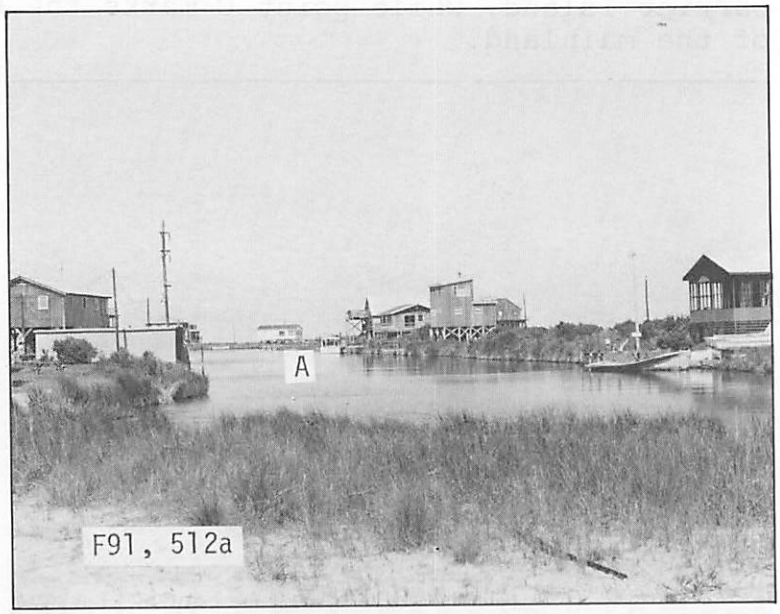

Figure 91. Spoil from the canal was dumped along both sides to raise the levels of the cottages being built there.

513 CANALS ASSOCIATED WITH UTILITIES, INDUSTRY OR COMMERCE

Canals functionally associated with a utility, industry or commercial activity are mapped under this category as the scale will allow.

Figure 92. Coolant water from the atomic energy electrical generating facility near Southport is carried in this canal. It crosses the Intracoastal Waterway and reaches the sea in the vicinity of Yaupon Beach.

521 FRESHWATER PONDS

Some rain-fed freshwater ponds exist on the islands. They have served - and still may be serving - as part of the water supply of nearby communities.

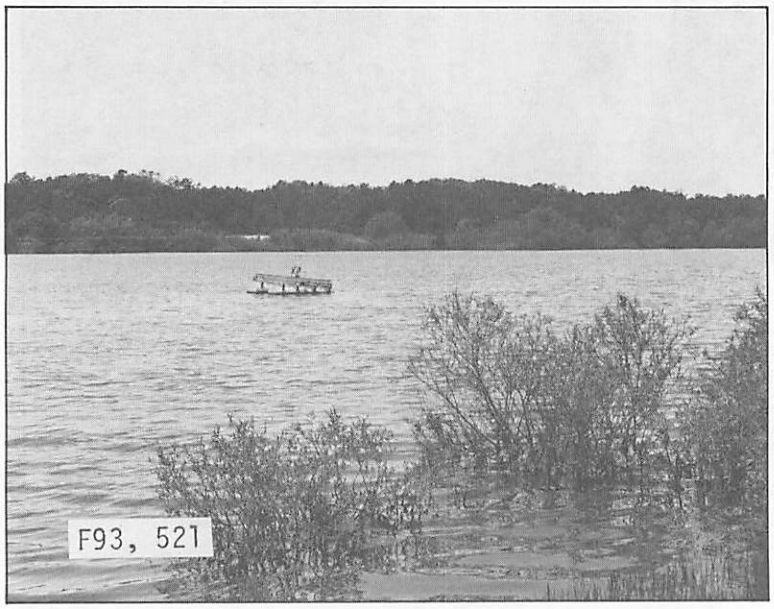

Figure 93. This is a ground view of the large freshwater pond at Nags Head and Kill Devil Hills. See Figure 57 for an aerial view.

541 TIDAL CREEKS

Tidal creeks penetrate the barrier islands generally from their mainland sides. The boundary between a tidal creek and open water is the point at which a single creek channel extending inland can be identified. Thus, an islet or group of islets at the mouth of a creek are considered to be surrounded by open water (see 542). The interior portion of a tidal creek system beyond the single channel demarcation point may branch out into numerous smaller channels. These are mapped as the scale will allow.

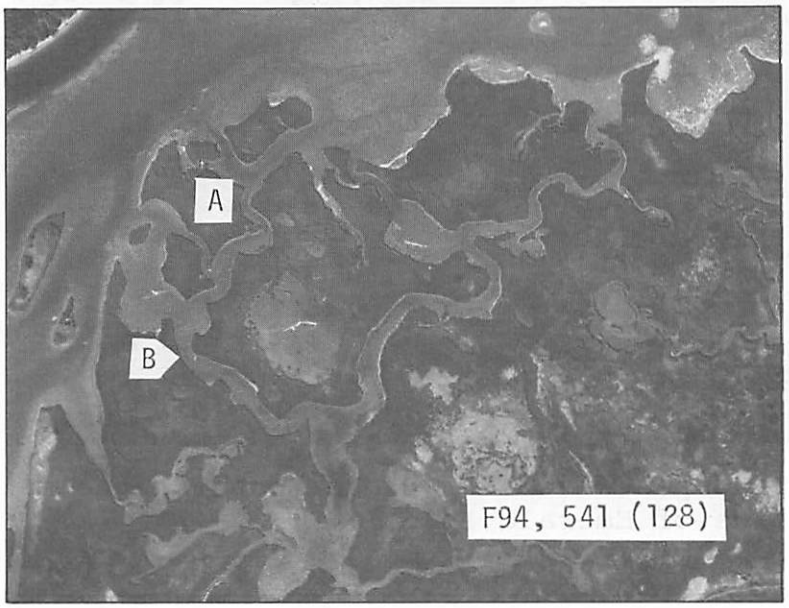

Figure 94. The small islands at point A are considered to be surrounded by open water 542. The tidal creek should be mapped from point B and extend from there into the interior of the barrier island. Near Del Mar Beach.

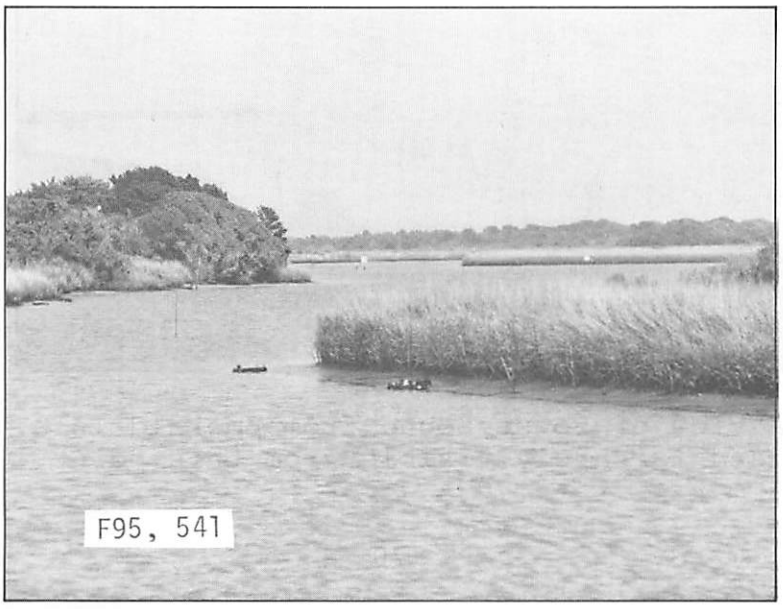

Figure 95. A portion of the same marsh shown in Figure 94.

542 OPEN WATERS

The sounds and large rivers lying on the mainland sides of the barrier islands are part of the inland waters of the United States. All areas of open water in these locations are included in this category.

Figure 96. The open waters of Bogue Sound on the mainland side of Emerald Isle.

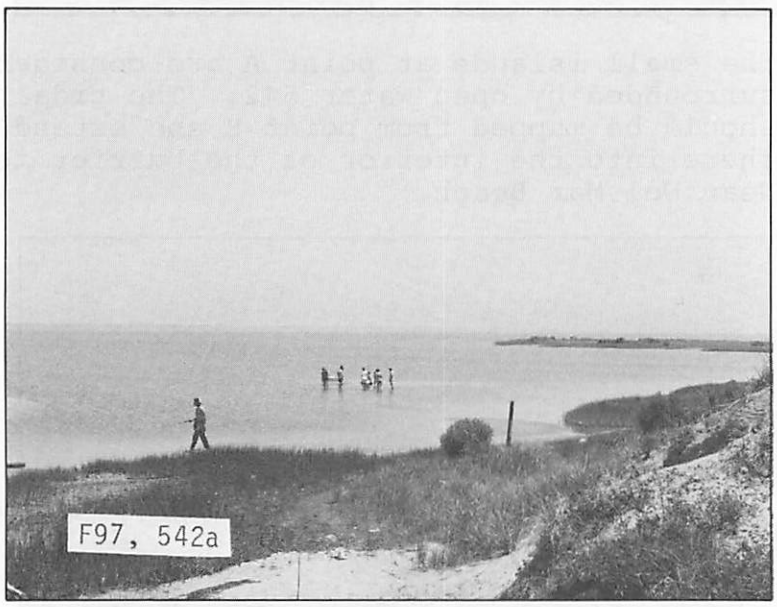

Figure 97. A view of Bogue Sound from Emerald Isle. The mainland is barely visible from this point.

611 MIXED DECIDUOUS AND CONIFEROUS WETLAND

Small areas of wooded freshwater swamplands fall into this category. They are generally found on Conaby soils in low-lying locations among the forested relict dunes in the Buxton and Nags Head Woods. These soils have a high water table that is at or near the surface most of the year.

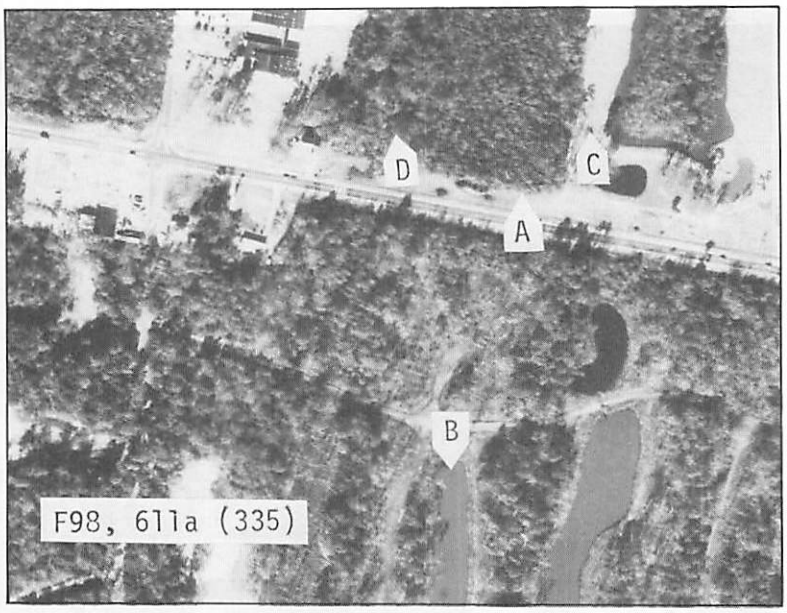

Figure 98. Point A indicates a low, wet place between the dunes at C and D. The appearance of the mixed deciduous and coniferous vegetation indicated by A is different in texture from the maritime forest vegetation on both sides of the road from D. The trough in which A is located continues across the road to point B where it is very low and filled with fresh water and should be classified as 521.

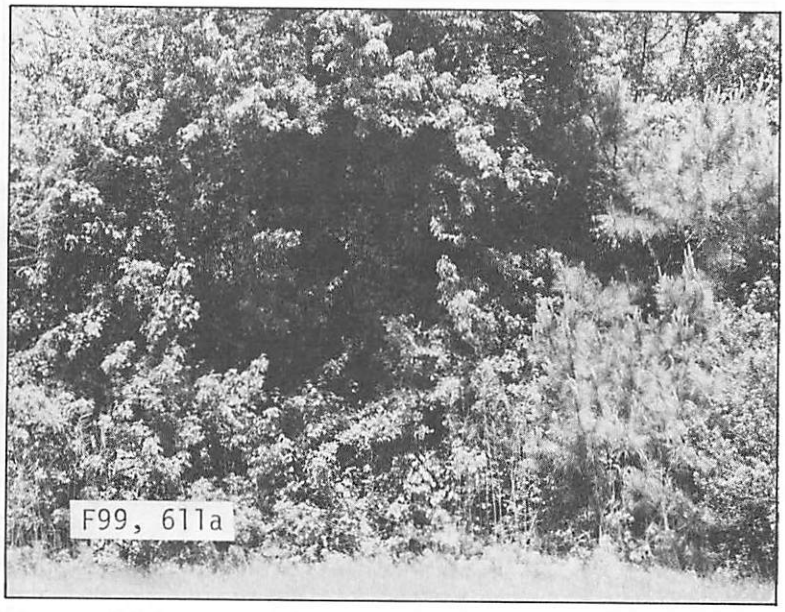

Figure 99. A view from the road looking in the same direction as pointer A in Figure 98.

621 REGULARLY FLOODED SALT MARSH

This type of marsh occurs on the sound sides or mainland sides of the islands from the vicinity of Roanoke Sound in the north to the South Carolina line. The typically low-lying areas are flooded daily by ocean tides. Nearly pure stands of smooth cordgrass (Spartina alterniflora) cover these areas of Bohicket soils, low; and Carteret soils, low.

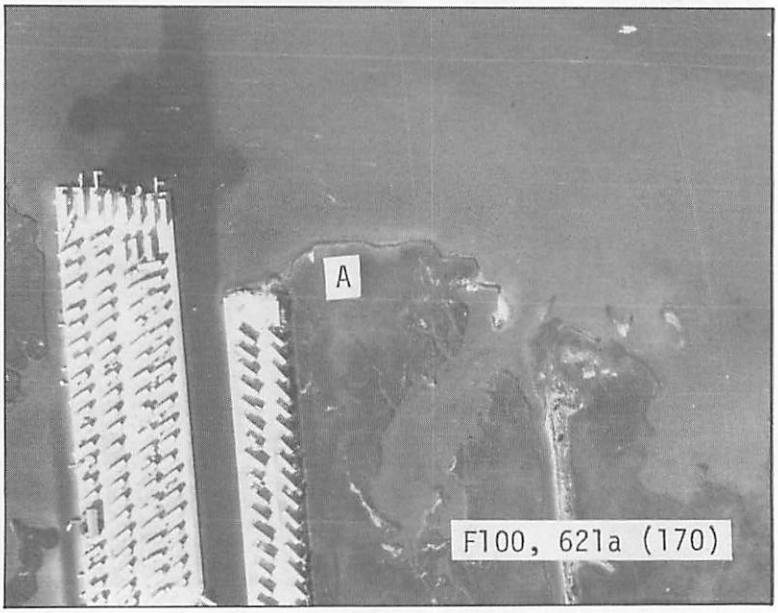

Figure 100. This marsh is on Bogue Banks and close to Beaufort Inlet. It is flooded daily by the ocean tides. The marsh grasses are dead in this winter scene, but their stems are numerous and of uniform height, creating a smooth texture and fairly even tone of dark gray in the photograph.

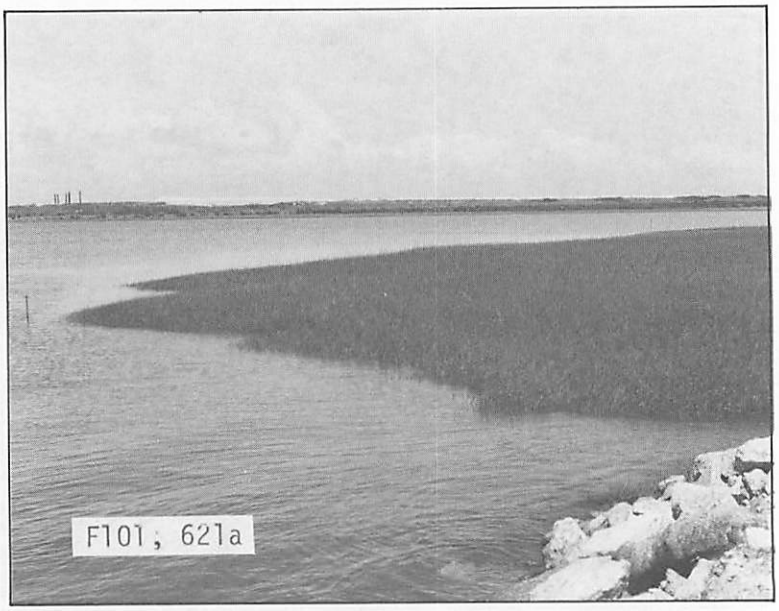

Figure 101. The marsh at point A in Figure 100 is shown here. It was taken from the point of dry land at the end of the mobile home park.

622 IRREGULARLY FLOODED SALT OR BRACKISH MARSH

This type of marsh occurs on the mainland or sound sides of the barrier islands. These marsh areas are not subject to daily tidal flooding as those in category 621. They are either higher than the salt marshes they adjoin, or are bounded by the northern sounds and are far removed from inlets and the daily tidal fluctuations of the ocean. They are irregularly flooded by salt or brackish waters, usually as a result of wind-driven tides governed by changing weather conditions. The soils and their dominant vegetation species included in this category are: Hobonny soil with black needlerush (Juncus roemerianus); Carteret soils, high with black needlerush; Carteret soils with salt-meadow cordgrass (Spartina patens); and Bohicket soils, high with black needlerush alone or smooth cordgrass (Spartina alterniflora) mixed with black needlerush.

Figure 102. Just beyond the shrubs in the foreground is an area of marsh that is irregularly flooded. It is shown at point A. Beyond this at the water's edge is a zone of regularly flooded marsh at point B. The direction of this view and the area depicted is indicated by the B pointer in Figure 23.

623 IRREGULARLY FLOODED FRESHWATER OR BRACKISH MARSH

As in 621 and 622 this type of marsh occurs on the mainland sides of the barrier islands. This marsh is found bordering the northernmost sounds whose waters are brackish to fresh and are far removed from inlets and the influence of ocean tides. They are irregularly flooded—mainly as a result of wind-driven tides governed by changing weather conditions. The soils and dominant vegetation species in this category are: Levy soils with mixed species consisting of salt-meadow cordgrass (Spartina patens): black needlerush (Juncus roemerianus); and saltgrass (Distichlis spicate); Currituck soils with black needlerush and giant cordgrass (Spartina cynosuriodes); and Currituck soils, high with salt-meadow cordgrass (Spartina patens) and saltgrass.

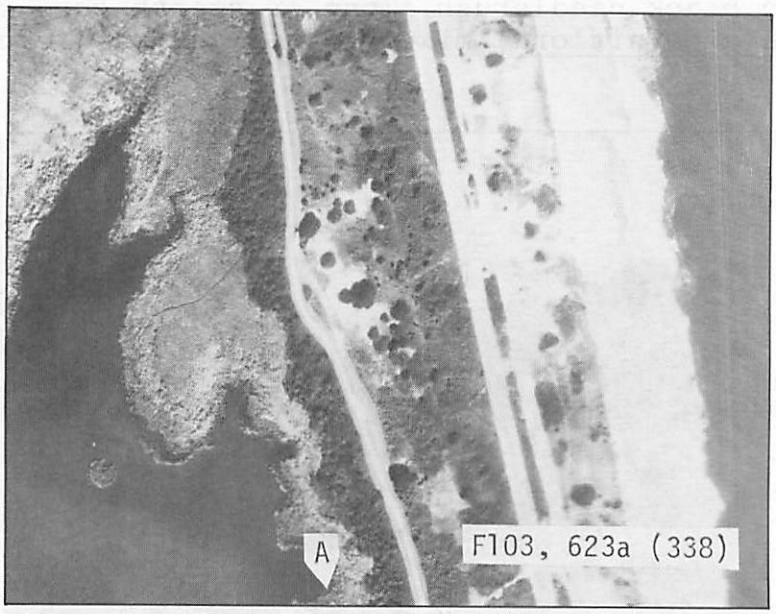

Figure 103. This photo was taken near the Currituck-Dare County boundary and overlooking the sound. The portion of marsh shown here falls into this category. Note the textural appearance of this marsh and compare it with the marshes shown in Figures 23 and 100.

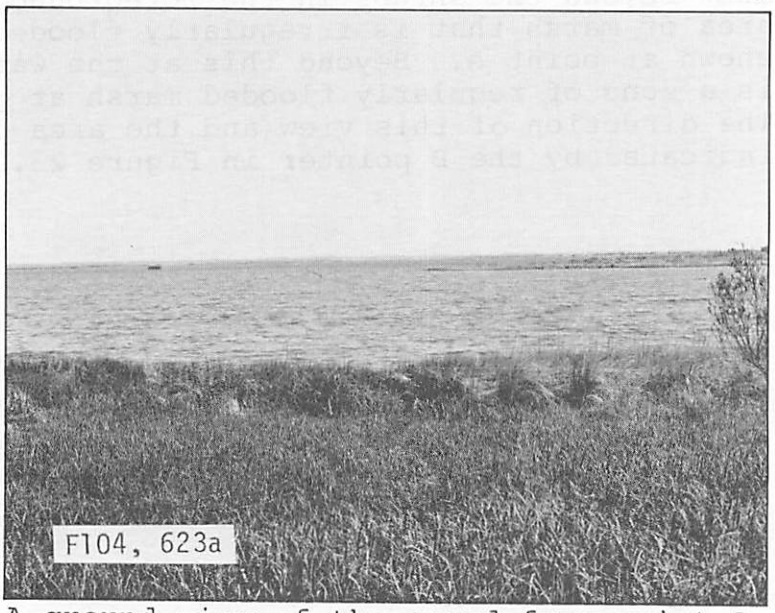

Figure 104. A ground view of the sound from point A on Figure 103.

624 INLAND FRESHWATER MARSH

Small areas of inland freshwater marsh occur in depressions among the forested relict dunes in the Buxton Woods. The dominant species of cattail (Typha Spp.) and sawgrass (Cladium jamaicensis) are found growing on Currituck soils in these interior locations.

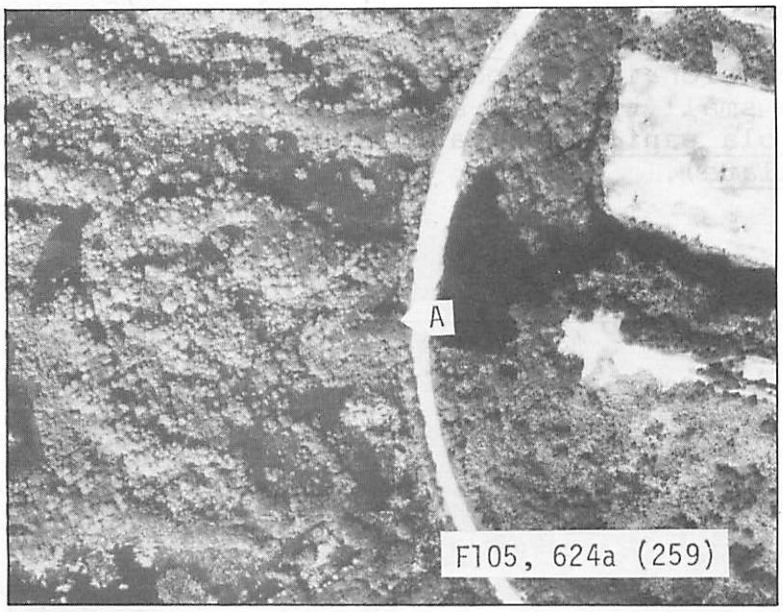

Figure 105. Point A indicates an area of freshwater marsh near Buxton. The marsh vegetation, seen here as a relatively smooth texture, surrounds a small freshwater pond. A larger pond lies across the road.

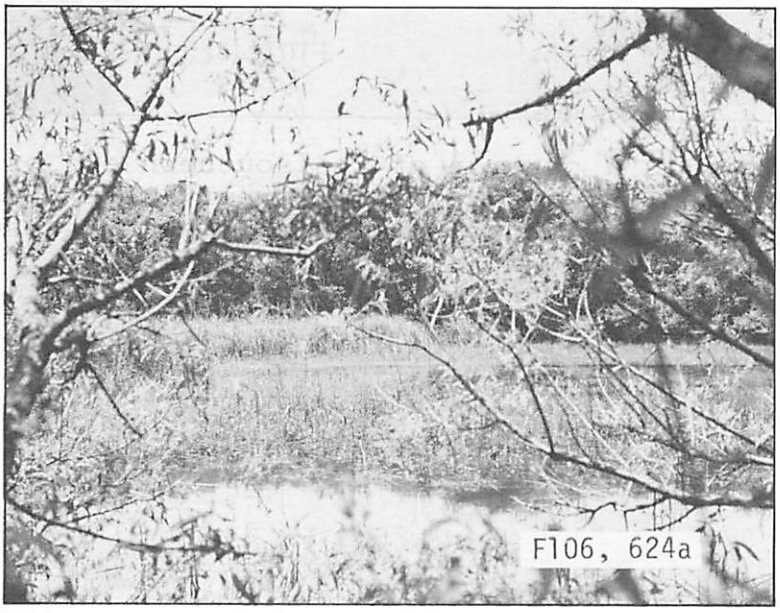

Figure 106. A ground view of the marsh in Figure 105. The view is from the road at point A. The foreground of this view shows the freshwater pond.

625 SPARSELY VEGETATED SAND FLATS

These mostly barren, sandy expanses are higher than the areas covered by normal daily tides. Occasional above-normal tides and storm flooding may result in ocean overwash. The water table is within a few feet of the surface and soil salinity is very high. Two units described in the Soil Survey of the Outer Banks mainly comprise this category. The first is "Tidal Flats," which may have sparse vegetation consisting of smooth cordgrass (Spartina alterniflora) and saltwort (Sulicornia Spp.). The second is "Beach Occasionally Flooded," where limited vegetation occurs on small hummocks and may consist of saltwort, sea oats (Uniola paniculata) and American beachgrass (Ammophila breuiligulata).

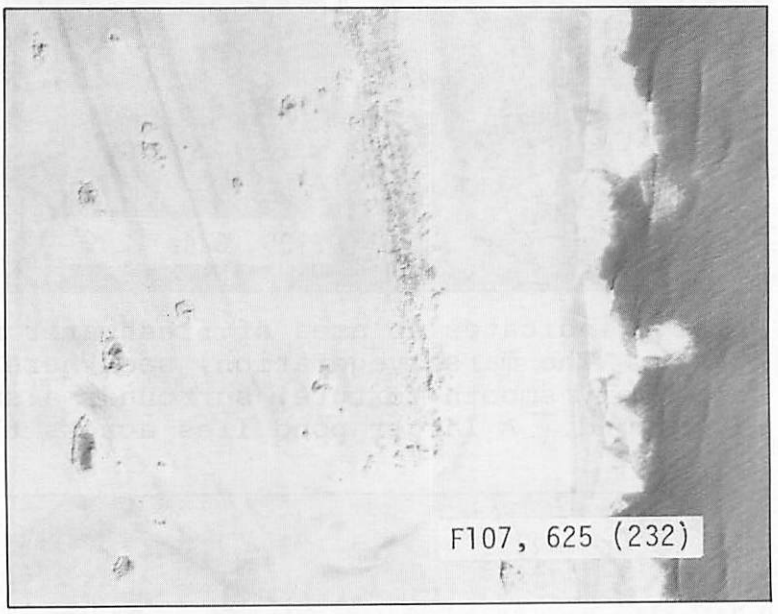

Figure 107. This is a portion of the southern end of Ocracoke Island and is typical of other areas throughout the barrier islands, particularly among those well offshore.

721 OCEAN BEACHES

The strip of sand facing the ocean that the tides flood daily, and the slightly higher berm behind it, comprise this category. It consists of the low-lying unvegetated portion of the "Beach-Foredune Association" as shown on the maps of the Soil Survey of the Outer Banks.

Figure 108. This ocean beach is located directly in front of the large condominium at point A in Figure 7.

722 INLET BEACHES

These beaches are similar in form and tidal regime to those described in 721 except that they occur at the ends of islands and do not face the ocean directly. The processes of erosion and deposition are especially active here, and changes in the shoreline are constant and sometimes dramatic after periods of rough seas or storms.

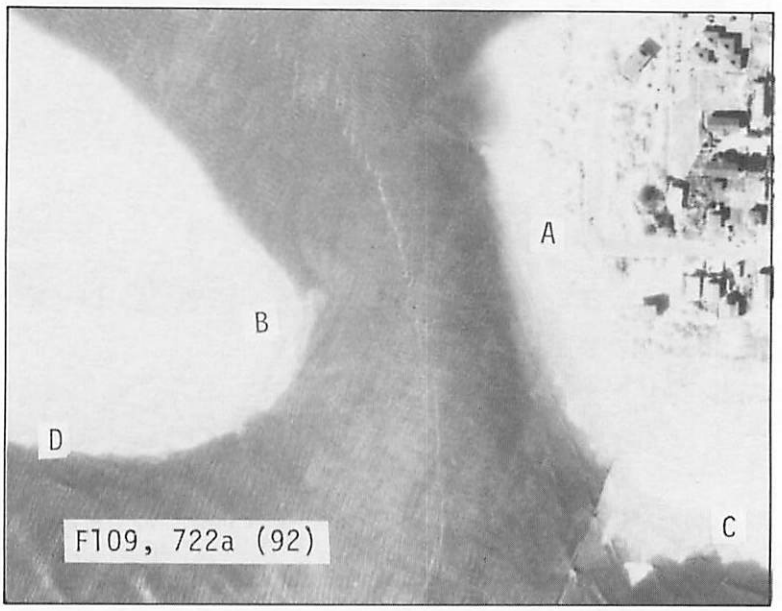

Figure 109. Masonboro Inlet with Wrightsville Beach on the right at A. The beaches on the sides of the inlet fall in this category. Ocean beaches are at points C and D.

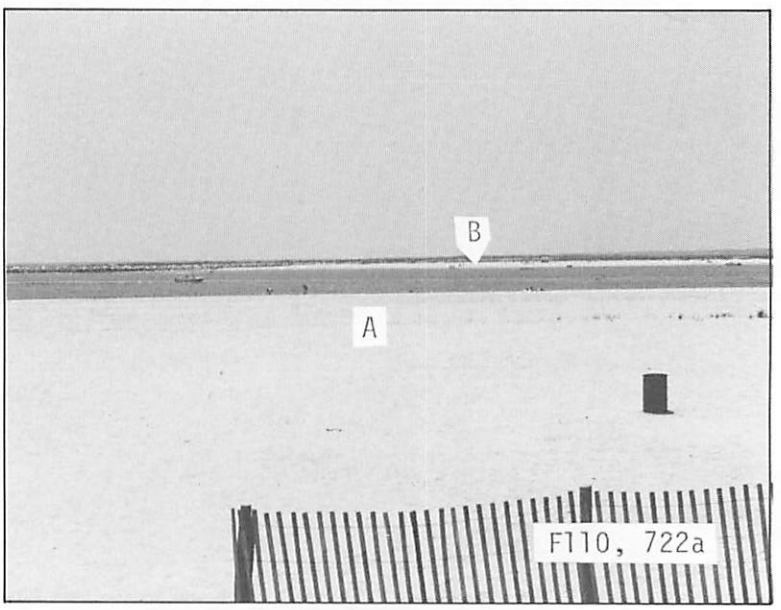

Figure 110. A ground view of the area shown in Figure 109. The letters A and B in this photo correspond to locations A and B in Figure 109.

731 DUNELANDS

These are areas of very dry sand dunes that vary in heights of a few feet to more than 100 feet, and differ in slope from 2 to 30 percent or more. Only the barren or very sparsely vegetated portions of the following soils are included in this category: Duneland, Newhan fine sand and the Duneland-Newhan Complex. Mapable areas of more dense vegetation in these surroundings are classified under 311, 321 or 331.

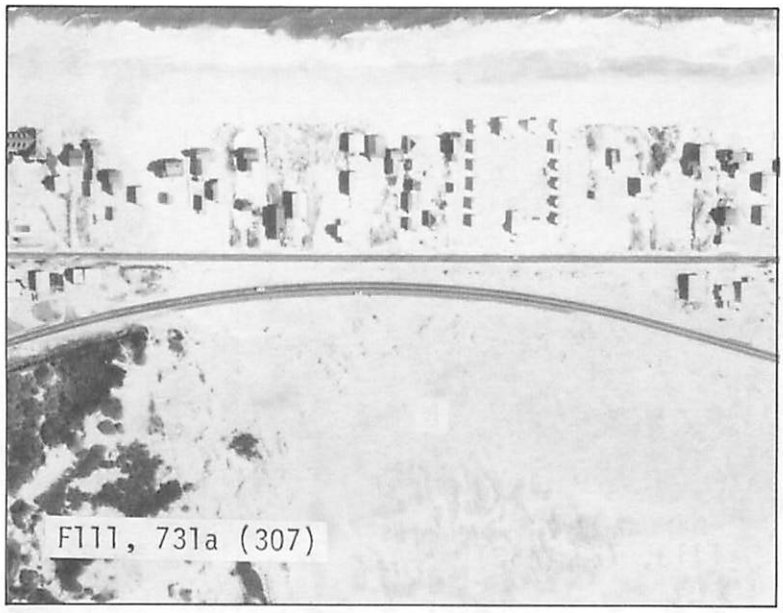

Figure 111. A portion of the Jockey's Ridge State Park is shown here. The largely unvegetated sandy area is highly reflective. This is typical of similar smaller areas falling in the category.

Figure 112. A view from the ground of Jockey's Ridge, the highest active sand dune on the barrier islands.

732 UNVEGETATED SPOIL BANK AREAS

This category consists of deposits of recently dredged materials on which no vegetation has become established. The barren portions of large, partially-vegetated spoil banks are included in this category. Soils identified in the Soil Survey of the Outer Banks as dredge spoil may be mapped in this or other spoil bank categories. For the definition of a spoil bank see 313.

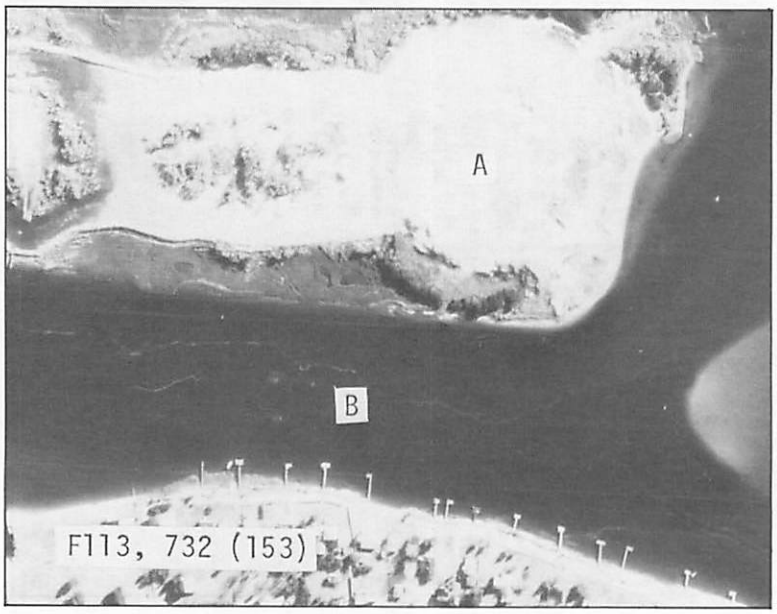

Figure 113. Freshly deposited dredge spoil at point A. There is no vegetation evident, and the bright reflectance indicates dry sand. The material came from the Intracoastal Waterway at point B. The location of this view is just behind Bogue Inlet.

761 LAND IN TRANSITION TO HOUSING USES

At the time of the mapping survey, any cleared areas on which little or no construction has occurred are placed in this category if it is known that they will be devoted to some form of housing.

Figure 114. This cleared lot is in an area of cottages. It is reasonable to assume that a cottage will be built on the site.

762 LAND IN TRANSITION TO USES OTHER THAN HOUSING

At the time of the mapping survey, any cleared areas with little or no construction are placed in this category if it is known that they will be devoted to some use other than housing.

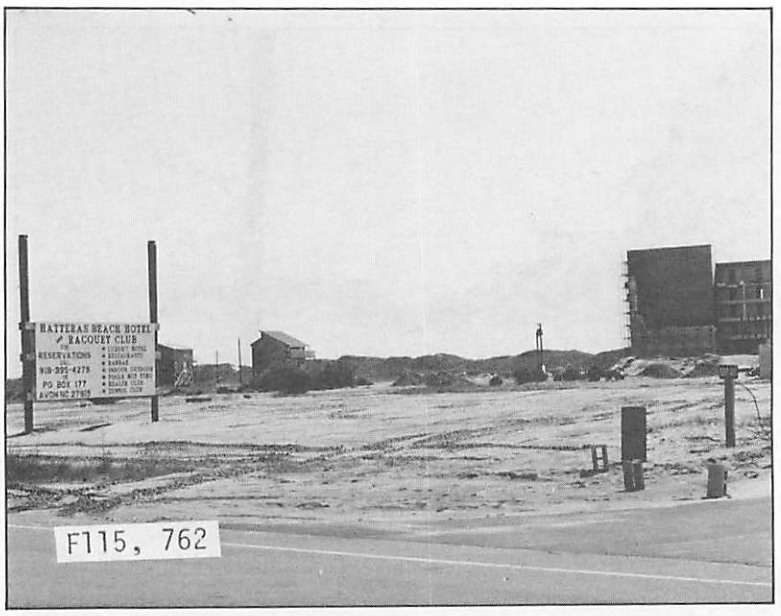

Figure 115. The sign in front indicates that several commercial ventures will be centered on the hotel to be built here. In this classification, a hotel is considered a commercial structure, not residential.

PART 3

MAPPING LAND USE AND LAND COVER

Selection of an appropriate scale presents a problem in many mapping activities. Level III land use and land cover mapping is no exception. The amount of detail that can be mapped using this classification system requires the use of maps of large scale. But how large is large enough? One could say "the larger the better," but there are practical limits to the availability and ease of handling such maps. For example, it would be easy to map small areas like individual single-family cottages at a scale of 1 in. = 100 ft. There would be sufficient space to easily record the three digit number of that category within the spaces delineated. Such a large scale map for a town the size of Nags Head would be unmanageable if it were printed on one sheet. It would be necessary to cut the map into smaller segments in order to use it efficiently. A second problem is that maps of this scale are not commonly made and are not readily available.

At the other extreme, maps of the scale 1 in. = 1000 ft. represent a limit beyond which Level III mapping should not be undertaken. Mapping at this scale was tested using the Level III categories. Results were good, in general, with the exception of some generalization occurring among the types of cottages. It was often difficult to distinguish between single- and multi-family cottages on aerial photographs at 1 in. = 1000 ft. scale. Even when a building was known to be one or the other type of cottage, it was not possible to draw a line around it and have enough room within the enclosed polygon to record the identifying three digit number. The result of these limitations was that large areas of cottages were classified as 113, mixed single-and multi-family cottages.

Other categories occupying small areas, like 147 - electrical facilities, or 149 - lighthouses and electronic communications are also likely to be grouped with other nearby land uses. This problem is not unique to mapping with this Level III classification. It occurs in most mapping situations, for some degree of generalization is inevitable. The map users must consider whether or not the more precise identification of certain categories is worth the extra costs involved in conducting more field work and obtaining aerial photographs and base maps of larger scales.

In spite of these limitations, the scale of 1 in. = 1000 ft. would probably be a good one for mapping the entire barrier

island system. It would be useful to state and federal agencies concerned with the coast. The author is not aware of the existence of a uniform line map of this scale covering all of the barrier islands, however, mapping at this scale has been done in the Soil Survey of the Outer Banks, North Carolina. In that publication, the various soil units have been mapped directly on a base of aerial photographs of the entire barrier island system at 1 in. = 1000 ft. These photographs could be utilized as a base for mapping land use and land cover at Level III if all of the barrier islands are to be mapped at a uniform and useful scale. Such mapping could be done on overlays of transparent plastic drafting film placed over the individual soil maps. The lines delineating the soil units are not obtrusive. They can easily be ignored by the land use and land cover mapper who would be using the photographic detail. The aerial photographs contain considerable detail that is pertinent to present day conditions. More recent photography by the National High Altitude Photography Program could be used to update the information obtained from those in the Soil Survey of the Outer Banks. NHAP is discussed in detail in Part 4 of this publication.

Local governmental units using Level III maps for planning purposes will require finished products at scales larger than 1 in. = 1000 ft. Some communities may already have base maps at scales like 1 in. = 400 ft., and these would serve the purpose.

If a community does not have maps of sufficiently large scale, the M-1276 aerial photography of the barrier islands taken by the N. C. Department of Transportation may be helpful. This photography was discussed in Part 2 and has been used to illustrate the various Level III categories. The original scale of these photographs was 1 in. = 2000 ft., but they can be enlarged four times to a scale of 1 in. = 500 ft.

The overall size of the enlarged paper prints is 36 in. x 36 in. The cost for several enlargements, which may be sufficient to cover a small community, is not prohibitive. A very adequate base map can be traced off these enlargements, and considerable land use and land cover information is also there to be mapped. The M-1276 aerial photography is held by Division of Highways of the N. C. Department of Transportation, P.O. Box 25201, Raleigh, N. C. 27611. Inquiries about prices and availability of various services should be addressed to the Photogrammetric Laboratory.

PART 4

AERIAL PHOTOGRAPHY AS A SOURCE OF MAPPING INFORMATION

The use of aerial photography in the mapping of land use and land cover provides accurate information, precise locations and a means for speeding the production of the finished product. Aerial photographs are not only a valuable tool in the present mapping process, but also significant to the future revision of maps. In addition, they are an important means of communication with the public about problem areas and planning.

Several governmental sources of aerial photography make their products available at low costs. In the state, aerial photographs are available from the Department of Transportation. At the federal level, the Agricultural Stabilization and Conservation Service of the U. S. Department of Agriculture has aerial photographs of all parts of the country, dating back to the 1930s. ASCS acquires photography by county units. If the county has a coastline, it is also included in the coverage. A second agency, the National Ocean Survey, specializes in coastal aerial photography and has made coverage of North Carolina's coast since the 1940s. Both agencies obtain aerial photographs on a repetitive basis so their collections represent historical, as well as current, records of the coast.

ASCS and NOS provide aerial photographs in a variety of scales and film emulsions. Until the late 1970s, ASCS photography was usually taken at the scale of 1:20,000 (1 in. = 1667 ft.). But since then, this agency has produced its photography at the scale of 1:40,000 (1 in. = 3333 ft.). The standard film emulsion used by ASCS is black-and-white panchromatic. NOS has coverage of the North Carolina coast available at scales from 1:4,000 (1 in. = 333 ft.) to 1:60,000 (1 in. = 5000 ft.). For its various purposes, NOS uses a number of different film emulsions: black-and-white panchromatic, black-and-white infrared, natural color and color infrared. Contact prints and enlargements are available from both agencies.

When pictures of a particular location are desired, it is best to query ASCS or NOS about available coverage and to send a portion of a standard road map with the area of interest marked out. This procedure has been described in Aerial Photography for Planning and Development in Eastern North Carolina: A Handbook and Directory. The request for information should also indicate the time of coverage desired. If current photography is needed, ask for the dates of the most recent coverage available. The letter should also contain a general description of the location such as the

state, county and nearby cities. Request the current price list. Letters to ASCS should be addressed as follows:

Aerial Photography Field Office
ASCS-USDA
2222 West 2300 South
P.O. Box 30010
Salt Lake City, Utah 84130

Letters to NOS should be addressed as follows:

NOAA National Ocean Survey
Nautical Data, CG222
WSCL, Room 818
Rockville, Md. 20852

Once the information has been received from the agency, the necessary aerial photographic coverage may be ordered. Orders are usually filled and shipped within 30 days after their receipt.

Since 1978, a new and important development in aerial photographic coverage of the United States has occurred. The National High Altitude Photography Program was created to provide coverage of the 48 states at uniform scales, and to save money by avoiding duplication of effort among federal agencies. About 15 federal agencies provide funds for its operation. NHAP is operated on a day-to-day basis and coordinated by the United States Geological Survey. It is expected that the first completed uniform coverage of the United States mainland will be finished before the end of 1986. Photography of the entire barrier island system of North Carolina, taken during 1982 and 1983, is now available to the public.

NHAP produces two standard types of aerial photography. Two cameras are mounted in the same aircraft and operate at 40,000 feet above mean terrain. One camera is used to produce black-and-white panchromatic photography at a scale of 1:80,000 (1 in. = 6667 ft.), with each resulting 9 in. X 9 in. contact print covering nearly 130 square miles of terrain. A second camera takes color infrared photographs at a scale of 1:58,000 (1 in. = 4833 ft.), with each resulting 9 in. X 9 in. contact print covering nearly 68 square miles of terrain. Enlargements are available in several sizes. An example of the 1:80,000 black-and-white photography is shown in Figure 116. This is a portion of NHAP81, 220-56 (See Figure 119) showing the eastern end of Bogue Banks from the vicinity of Pine Knoll Shores to Beaufort Inlet. This is almost the same area that is depicted on the cover of this publication. Although the resolution of the photograph is excellent, the scale is too small to derive data in the detail required at Level III. This is the case if we confine ourselves to the use of paper prints examined through a stereoscope, as is the usual procedure in photo interpretation.

In spite of what seems to be a limitation to using NHAP black-and-white panchromatic photography, it can serve the purpose of Level III mapping when used in the form of positive film transparencies rather than paper prints. Such transparencies are made like paper prints except that the photograph is printed on film, not paper, so light can be transmitted through it. This makes the optical enlargement of any portion of a 9 in. X 9 in. transparency possible without going through the process of making enlargements on paper. This can be done by using a common microfiche viewer of the type found in libraries and business establishments. These machines normally have optical systems capable of enlarging microfiche transparencies 20 times. When a 1:80,000 NHAP aerial photographic transparency is put into a microfiche reader, the portion visible on the screen will be enlarged at a scale of 1:4,000 (1 in. = 333 ft.). At this scale, it is possible to see detail that can be interpreted for use in Level III mapping. An approximate example of such magnification is shown in Figure 117. It is a photo enlarged 17 times of the area enclosed by the frame of parallel lines on the 1:80,000 view of Bogue Banks (Figure 116). The detail in the enlargement is at a scale of 1:4,706 (1 in. = 392 ft.). It was presented at this scale rather than 1:4000 because our photo laboratory did not have the facilities for making a photo 20 times larger.

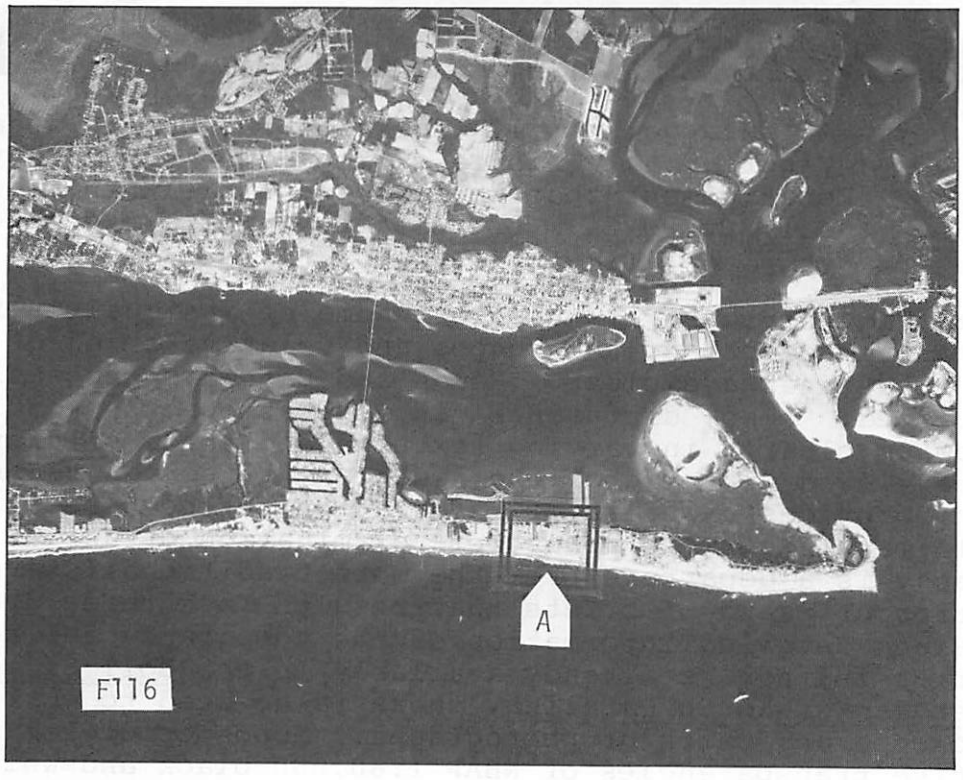

Figure 116. The eastern end of Bogue Banks and Morehead City are shown on this segment from a 1:80,000 scale black and white NHAP photograph. The framed area at point A appears as an enlargement in Figure 117.

Figure 117. An enlargement (17 times) of the framed area in Figure 116. This is a simulation of the optical enlargement that would be possible when viewing a 1:80,000 film transparency in a microfiche reader.

Even though Figure 117 has lost some of its quality in the process of reproduction, the shapes and relative sizes of various structures are clear. Roads and pathways can easily be distinguished. Also, differences in vegetation types and bare sand show up clearly in varying textures and tones of gray. The same area viewed on a microfiche reader white screen is bright and clear and provides a wealth of information to the person doing Level III mapping. This monoscopic examination of aerial photography is a departure from the more traditional stereoscopic examination of pairs of prints that results in a three-dimensional view. Since detailed information of the topography and relief of the barrier islands is already available in the Soil Survey of the Outer Banks, North Carolina, there is no need to work with a stereoscope and pairs of photographs. Monoscopic examination of positive transparencies of NHAP 1:80,000 black-and-white or 1:58,000 color infrared can provide the bulk of the information needed.

To purchase 1:80,000 black-and-white transparencies, Figure 118, 119 and 120 have been prepared as a guide. These indexes were derived from more detailed indexes on microfiche

that covered large areas of eastern North Carolina. The barrier island indexes were constructed especially to facilitate ordering NHAP black-and-white photography by those concerned with the coastal area. The official North Carolina road map was used to provide the maximum amount of information necessary in finding specific locations.

At the time this was written, the cost of one 1:80,000 black-and-white film positive was $8. Each provides a great deal of current information at small cost. For example, all of Bogue Banks is covered by four film positives: NHAP81, 302-183; NHAP81, 310-88; NHAP81, 230-172; and NHAP81, 220-56 (Figure 119). The entire barrier island system of North Carolina is covered by 40 NHAP black-and-white film positives and is currently available for $320. This should be considered by any agency requiring uniform information about North Carolina's Atlantic shoreline. Dates of the coverage are as follows:

NHAP81, 232 - April 1982
NHAP81, 312 - April 1983
NHAP81, 310 - April 1983
NHAP81, 222 - March 1982
NHAP81, 220 - March 1982
NHAP81, 230 - March 1982
NHAP81, 302 - March 1983
NHAP82, 298 - March 1983
NHAP82, 284 - March 1983
NHAP82, 292 - March 1983

Black-and-white film positives may be ordered from the EROS Data Center, Sioux Falls, S. D. 57198. When placing an order, the following types of information are required: name of the project, roll number, frame number and product code. Using the photo of Cape Lookout as an example, NHAP81, 310-79 (Figure 119), the name of the project is NHAP81, the roll number is 310, and the frame number is 79. The product code, which describes film positives, is the number 13.

NHAP color infrared coverage of the barrier islands may also be beneficial to those doing land use and land cover mapping. This type of coverage has two advantages over the black-and-white panchromatic. The first is that the scale is larger - 1:58,000, as opposed to 1:80,000. When viewed under 20X magnification in a microfiche reader, the scale seen on the screen is 1:2,900 (1 in. = 242 ft.). The second advantage is that vegetational types may be easier to distinguish when viewed on color infrared. This can be useful in identifying land cover types. A possible limitation to this type of barrier island coverage is that the photographs were taken in March and April before some of the plant communities were in full leaf.

The cost of color infrared transparencies is higher than the black-and-white film positives, and more of them are needed to cover an area than with black-and-white 1:80,000 photography.

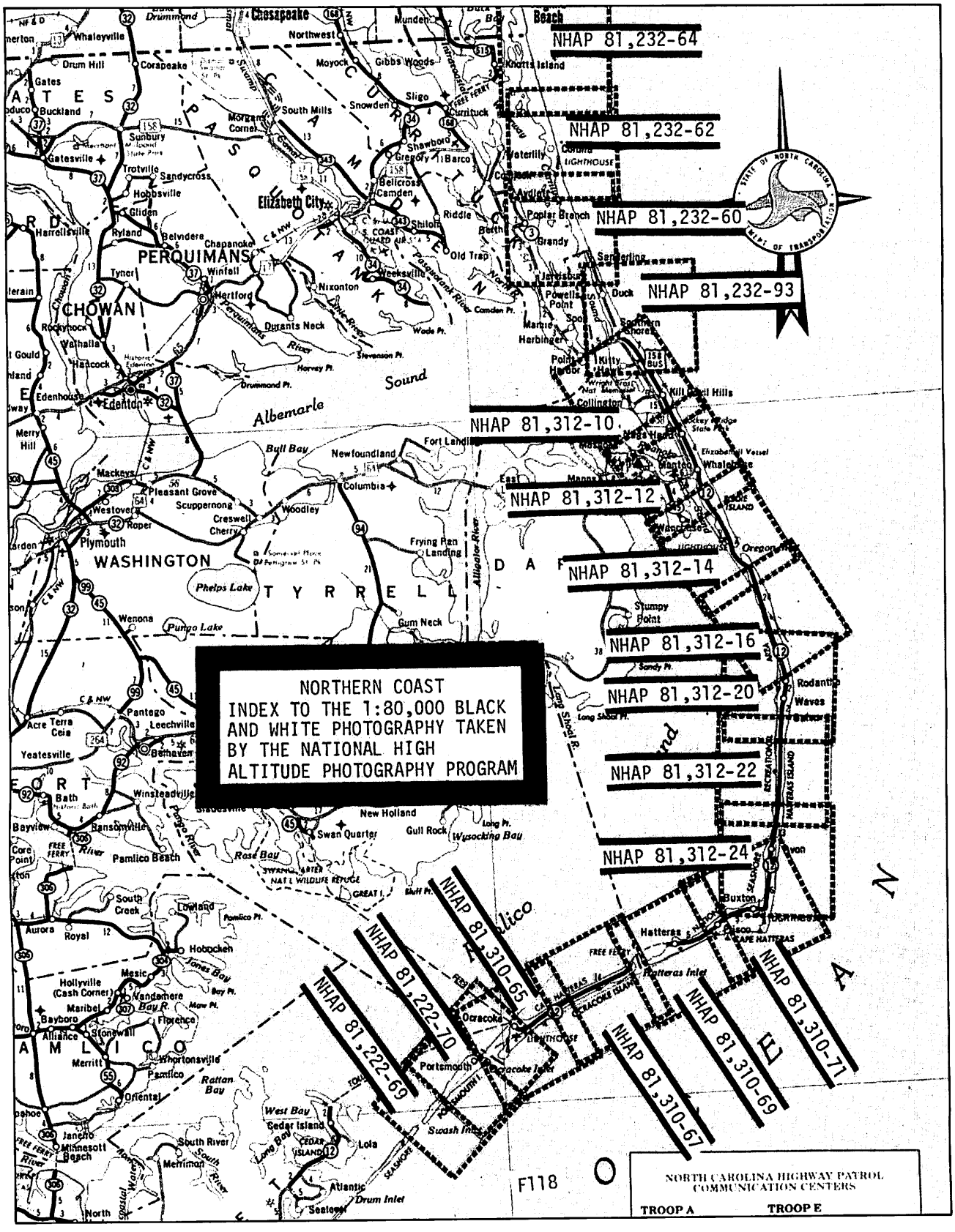

Figure 118. Each square represents the area of coverage on one 9 in. X 9 in. photograph. Information necessary to order the photograph appears between the black lines. This index covers the northern barrier islands.

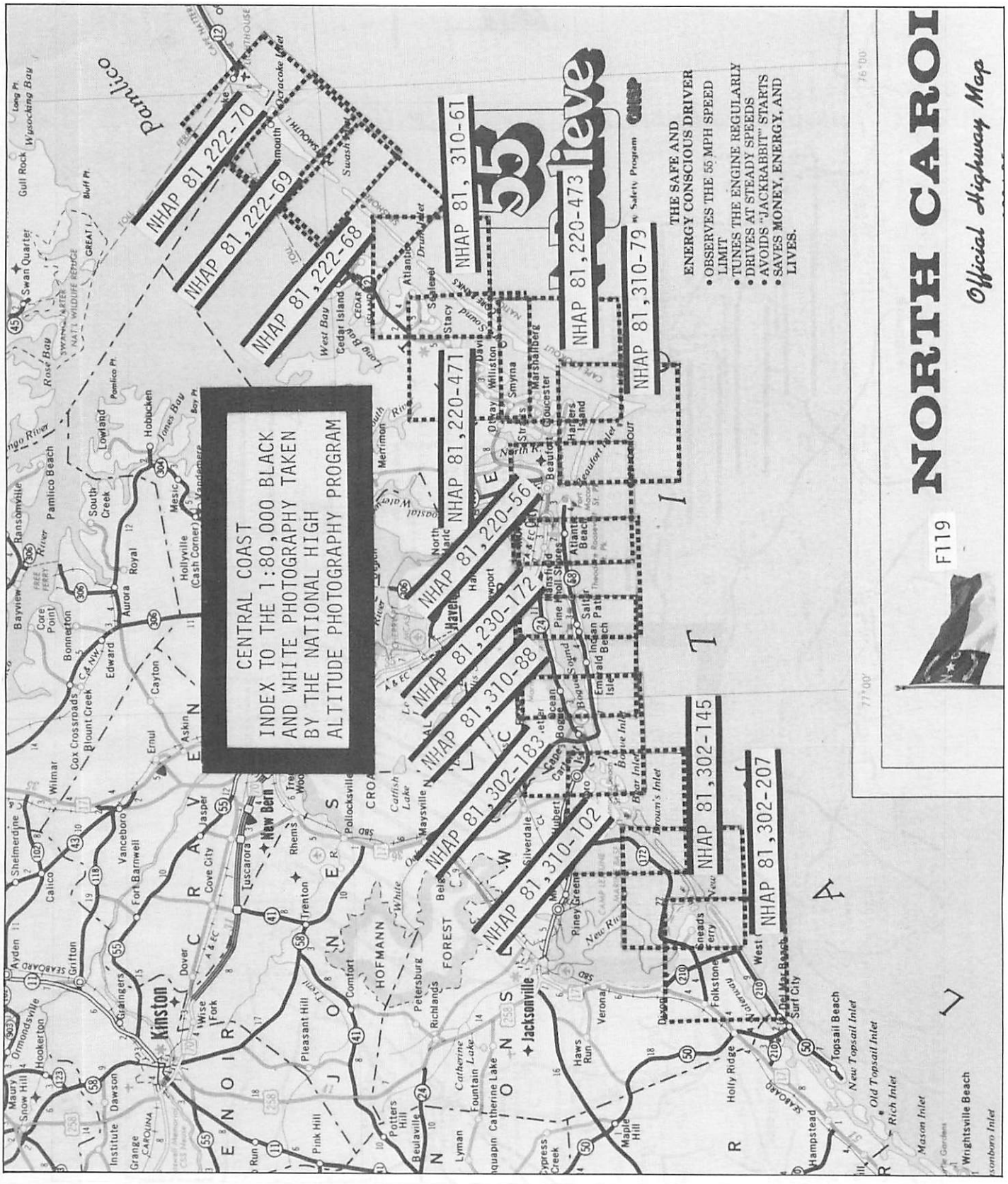

Figure 119. Each square represents the area of coverage of one 9 in. X 9 in. photograph. Information necessary to order the photograph appears between the black lines. This index covers the central barrier islands.

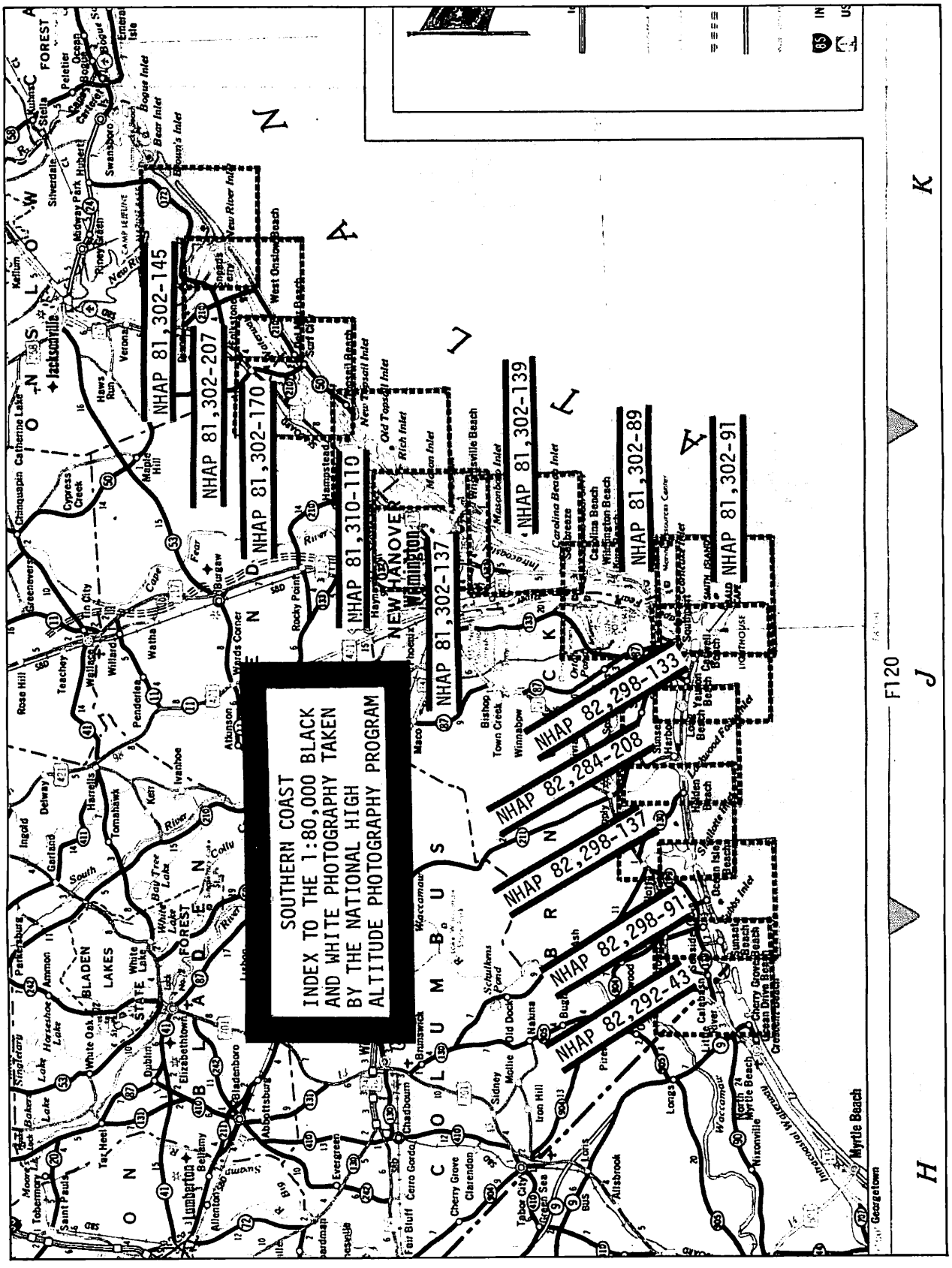

Figure 120. Each square represents the area of coverage of one 9 in. X 9 in. photograph. Information necessary to order the photograph appears between the black lines. This index covers the southern barrier islands.

Color infrared positive transparencies are available for $12 each (at the time of writing) from the Aerial Photography Field Office of ASCS, whose address appears at the beginning of this section. A complete index of coverage of color infrared photography for the barrier islands does not appear in this publication, but information can be obtained from the Aerial Photography Field Office. An ordinary road map with the area of interest marked on it is usually the best way to identify the coverage needed. Once the information is returned, an order can be placed. Color enlargements at various scales printed on paper are also available from ASCS. For example, 38 in. X 38 in. enlargements from 9 in. X 9 in. frames are available for $50 each. The scale of such an enlargement is 1 in. = 1,000 ft. This may be an adequate base for producing a line map, as well as providing information on current land use and land cover. See Part 3 for a discussion of mapping scales.

As mentioned, microfiche viewers are helpful in the monoscopic examination of aerial photography. However, because viewers are suited for 4 in. X 6 in. fiche, it is not possible to mount a standard 9 in. X 9 in. transparency in them without cutting it to fit. Smaller pieces of film can be lost, therefore leading to problems in identification. To avoid this, mark each piece with the project, roll and frame numbers, using drafting ink of the type used for drawing on film rather than paper. Also, it may be helpful to store the pieces of each film transparency in a separate envelope marked with the appropriate numbers.

It is often necessary to update maps of land use and land cover. This is particularly true in areas of rapid change such as the barrier islands. Current aerial photography from public sources may not be available at the time it is desired to review the situation and bring maps up to date. In small barrier island communities, the map revisions can be made from ground observations and supplemental sources of information such as building permits of locations of new construction. However, to speed up the process of map revision or to provide accurate information over a large area, it is better to work with the most current aerial photography available. If public agencies do not have photography of a suitable recent date, a private aerial survey firm could be contracted to provide coverage. However, it may not be practical for a small community to have the work done this way for a variety of reasons, including costs.

Those responsible for mapping should consider a do-it-yourself aerial photographic alternative of moderate cost that is both effective and feasible. The method involves the use of a standard 35mm camera and a rented airplane. The camera should be loaded with a standard color film, like Kodachrome or Ektachrome, used in making color slides. The camera may be any standard 35mm as long as it has shutter speeds of 1/250th, 1/500th or 1/1000th of a second. This is necessary to reduce the effects of the vibration of the airplane. Focus is not important because the camera will be set on infinity when shooting from aircraft altitudes. Since haze along the coast is sometimes a problem, the camera should have a filter to help reduce the effects. With color film and a filter,

such as the Kodak Skylight No 1A, good results can be obtained as long as the haze is not too thick. For the best view for oblique photography, the airplane should be high-winged. It should also have a window that can be opened during flight. It is not recommended that the photography be carried out through the glass window. Detailed instructions for this type of photography are described in Oblique Aerial Photography for Comprehensive Urban Planning.

Figure 121. A low oblique view of Pine Knoll Shores on Bogue Banks. The use of light aircraft and ordinary 35mm cameras makes it possible to take current photographs at low cost. Views like this one, taken from about 2000 feet, can be used to update maps of land use and land cover.

Figure 121 is an oblique view of part of Pine Knoll Shores on Bogue Banks obtained under the conditions described above. It was taken from an altitude of about 2000 feet above the surface being photographed. The Atlantic shoreline is at the bottom of the photograph, and a portion of Bogue Sound can be seen at the top. Figure 122 is a vertical aerial photograph included here to give the reader a basis for comparing the information on the oblique view. Less information about the sound side of the island in the

distance is available than on the ocean side of the oblique view. This can be remedied by making a parallel pass over the sound and shooting back toward the ocean. The resulting photograph would have the sound coastline in the foreground and would provide information on that side of the island, as well as the ocean side in Figure 121. On wider barrier islands, several parallel passes may be necessary. Each one would be further back toward the mainland side from the first pass made over the ocean side. Several passes could also be made over a community across the island from ocean to sound. The more photographs taken, the better the results are likely to be. The cost of film and processing is relatively small, but flying time is more expensive. Careful planning of the flight should be made before going aloft to minimize pilot and airplane costs.

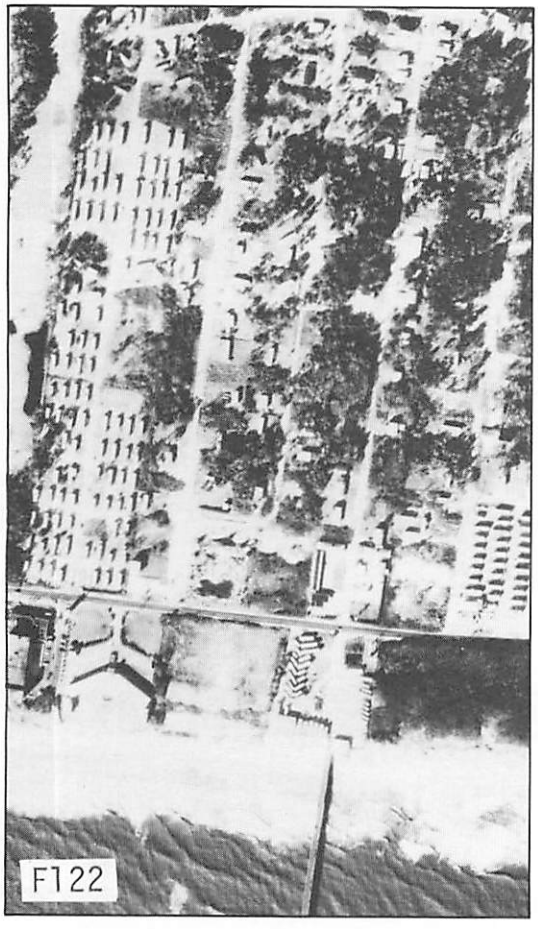

Figure 122. This vertical aerial photograph of Pine Knoll Shores is typical of those produced by governmental agencies. The area covered is approximately the same as in Figure 121. Note how easily the same locations can be found on both photographs.

Resulting color slides can be examined by either projecting them on a screen or placing them in a microfiche reader and studying them. The transfer of information from the oblique photography to the map represents no special problem if a photographic base was used in drawing the base map. Even though many years may have elapsed between the times the original vertical base photograph and the oblique photographs were made, there should be enough similar, recognizable features to locate and record areas of change. A careful comparison of Figures 121 and 122 shows how easy it is to find the same areas on both types of images.

Aerial photography of all types, is an excellent source of information about the earth's surface. Planners and others concerned with the mapping and analysis of data about land use and land cover have a powerful tool in the various types of aerial photography available to them. The costs incurred in obtaining suitable photography is more than offset by the accuracy of the finished map and by the savings in time and money in doing the job. Another important advantage in using aerial photography is in making presentations to citizen's groups concerned with their environment and the planning process. This is discussed at some length in Oblique Aerial Photography for Comprehensive Urban Planning. A good reference source for planners who have not worked much with aerial photography is an Introduction to Remote Sensing of the Environment.

PART 5

INTEGRATING AERIAL PHOTOGRAPHY, SUPPLEMENTAL INFORMATION AND FIELD WORK

Successful land use and land cover mapping of the barrier islands at Level III requires the combined use of aerial photography, supplemental information and field work. However, limitations exist if only photo interpretation is used in mapping. Questions are left unanswered, for those who do not work continuously and exclusively with aerial photography. Photo interpretation specialists may examine the various barrier island residential types seem on aerial photographs and come up with a very accurate categorization. But most others, will have difficulty distinguishing between single- and multi-family cottages, or between motels, large condominiums and apartment buildings. Or how can we tell, just by looking at an air photo, if the boats tied up at a marina are for commercial charter or are for private use only? The difference between some commercial structures and certain types of institutional buildings is also often unclear.

There are many other problems of this type, including those associated with the interpretation of types of marshes on aerial photographs. Even expert ecologists have problems with this one. The people responsible for the production of a land use and land cover map typically have other responsibilities in their organizations. They are not full-time aerial photographic interpretation specialists, so they must rely on other ways of obtaining information, in addition to what they get from the photos. They must also have some way to verify the accuracy of their interpretations. This is done by field observation.

The use of supplemental information is essential when mapping at Level III. Any form of reliable information can be defined as supplemental information. It can be found in local records or may be obtained from state and federal agencies. A recommended starting point in the search for supplemental information is the National Cartographic Information Center. This organization maintains an information data base that keeps track of the location and availability of cartographic data produced by various federal agencies. A request for information about federal maps available for a particular barrier island would result in a list that is returned to the inquirer. Then, the maps can be obtained after it is decided which ones will be most useful.

Requests to NCIC should contain a written description of the area of interest, and, if possible, a map showing the location. A portion of a road map marked with the location is helpful.

The procedure is the same as that described in Part 4 for ordering aerial photographs. Inquiries should be sent to:

National Cartographic Information Center
Eastern Mapping Center
U. S. Geological Survey
MS536 National Center
Reston, VA 22092

Telephone: 703/860-6336

The State of North Carolina works closely with NCIC and inquiries may also be directed to the following address:

Cartographer
North Carolina Geological Survey
P.O. Box 27687
Raleigh, NC 27611

The office of the cartographer is located in the Archdale Building in Raleigh. A visit to this office could save time and effort in locating many types of supplemental information.

In 1977, the Soil Survey of the Outer Banks, North Carolina was published. The work was carried out by the U. S. Department of Agriculture Soil Conservation Service, in cooperation with the N. C. Department of Natural and Economic Resources and the N. C. State University Soil Science Department. It consists of a volume describing the kinds of soils found on the barrier islands, as well as descriptions of vegetation associated with the various soils. For each county in which barrier islands are found, a separate volume of soil maps overprinted on aerial photographs exists for each portion. The author found this series invaluable in formulating the Level III classification system presented in this volume. The wealth of information contained in this soil survey is of such importance that it is strongly recommended that no mapping of land use and land cover be undertaken anywhere on the barrier islands without it.

Local records of all types such as building permits, property line maps, and previous reports or studies by local, county and state governments may also be used as supplemental information. It is useful to search records and files to determine the availability of pertinent local data prior to actual mapping.

In some instances, supplemental information sheds no light on the identification of a particular category and the interpretation of the aerial photograph will be uncertain. In such cases, conducting mapping in the field, or "field work," is necessary. Very often the appearance of a category may be new to the mapper and will not be understood. A solution to such

problems is to go into the field with aerial photographs of the area. Photo interpreters are trained in this way; they relate aerial photographic images with actual ground views. Both aerial and ground photographs have been used in Part 2 as sample illustrations of the various categories. This was done to aid in the training of the mapper and to show what belongs in each category. The ultimate answer in every case as to the meaning of a particular photo image or the assignment of a category designation is up to the mapper. The place where this is most accurately accomplished is in the field. The best and most efficient job of mapping is done by combining photo interpretation, the use of supplemental information and field work.

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Oblique Aerial Photography for Comprehensive Urban Planning, Planning Advisory Service, Report No. 361, American Planning Association, Chicago, 1981.

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Part I Text Material

Part II Soil Maps in separate volumes for the following counties:

- Brunswick
- Carteret
- Currituck
- Dare
- Hyde
- New Hanover
- Onslow
- Pender

Storms, People and Property in Coastal North Carolina, Simon Baker, UNC Sea Grant College Program, Raleigh, 1978.

The Citizen's Guide to North Carolina's Shifting Inlets, Simon Baker, UNC Sea Grant Program, Raleigh, 1977.

The National High-Altitude Photographic Data Base, Paul A. Antill, Proceedings of the American Congress on Surveying and Mapping/American Society of Photogrammetry Fall Convention, Washington, 1982.

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Ellen McGowan and Shirley Evans, both of the Department of Geography and Planning, typed the drafts and final manuscript.

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I alone am responsible for any errors or omissions that may be found in the classification system.