UNIVERSITY OF NORTH CAROLINA

SEA GRANT PROGRAM

THE MENHADEN FISHING INDUSTRY IN NORTH CAROLINA

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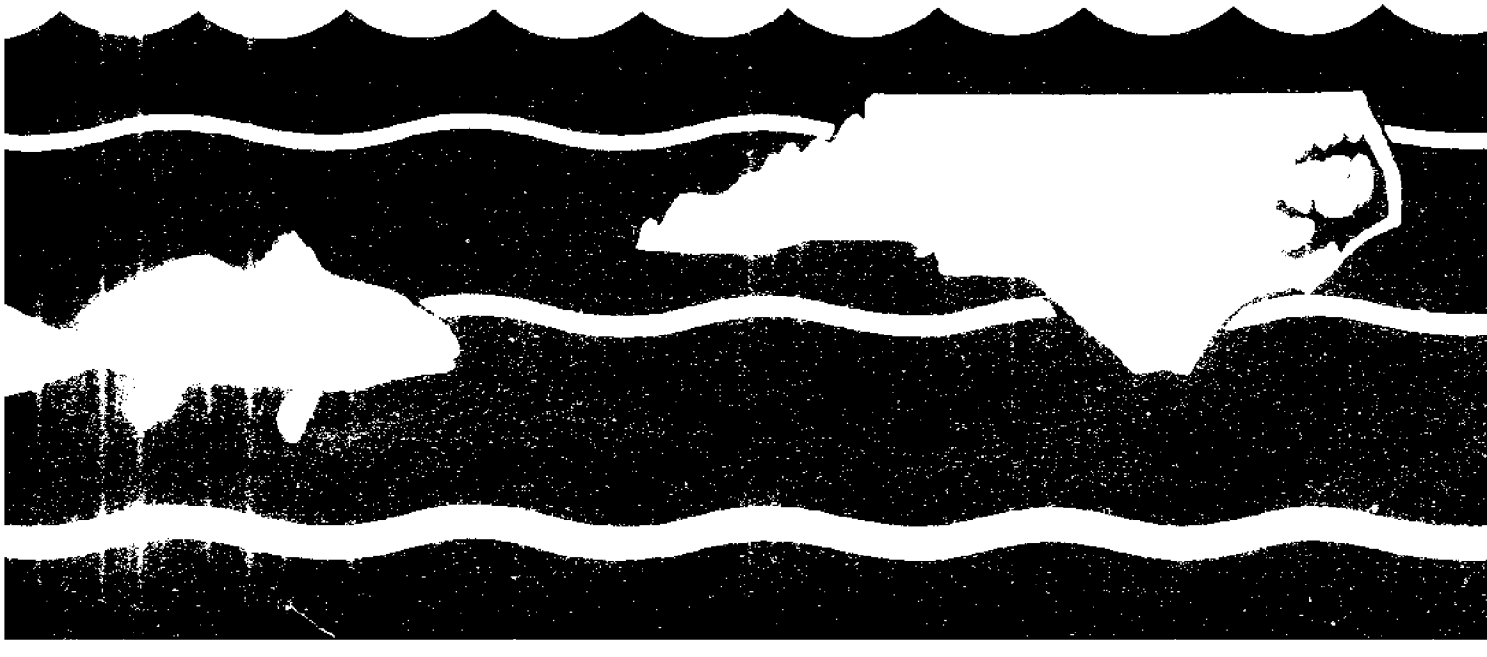
SEA GRANT PUBLICATION
UNC-SG-72-12

JANUARY, 1973



THE MENHADEN FISHING INDUSTRY IN NORTH CAROLINA

by

Jonathan H. Whitehurst

This study was originally presented to the faculty of the Department of Geography, East Carolina University, in partial fulfillment of the requirements for the degree Master of Arts, February 1970.

Partial support for this Sea Grant publication was provided by the North Carolina Division of Commercial and Sports Fisheries, Department of Natural and Economic Resources.

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INTRODUCTION

In the United States several different types of fish are captured regularly by various commercial fishing enterprises. Based on value of catch, shrimp constitute our most important fish, followed by salmon, tuna, oysters, and menhaden, in that order. Although ranking fifth in value, menhaden lead all species in terms of catch tonnage, making the fishery for this species the largest in the nation (Riley, 1970). Not only is the menhaden fishery the largest, it is also one of the oldest marine industries in the States.

The utilization of menhaden in North America predates settlement of the continent by Europeans. Along the northeast Atlantic coast of that region now called the United States indigenous Indian tribes placed raw, whole fish in their corn fields in an attempt to increase soil fertility. The first Massachusetts settlers adapted the method of fertilization established by the Indians, and within the first quarter of the seventeenth century colonist were actively fertilizing their own crops with menhaden (Corbett, 1951). Thus, from an early, rather crude beginning, exploitation of the vast menhaden resource was expanded into an enterprise that eventually became the largest commercial fishery, by volume of catch, in the United States.

Since the early nineteenth century menhaden have been processed, for the most part, as industrial fish. Although for many years the fish were caught as a raw material in the manufacture of fertilizers, throughout the last four decades only a negligible amount of the annual catch has been used in this manner. Almost all menhaden are now processed into three industrial products: 1) fish meal; 2) oil; and 3) condensed solubles. Whole meal and condensed solubles constitute important ingredients in food supplements for certain animals, particularly poultry and swine. Menhaden oil is used in various commercial products including margarine, paints, and detergents (Sanford and Lee, 1960).

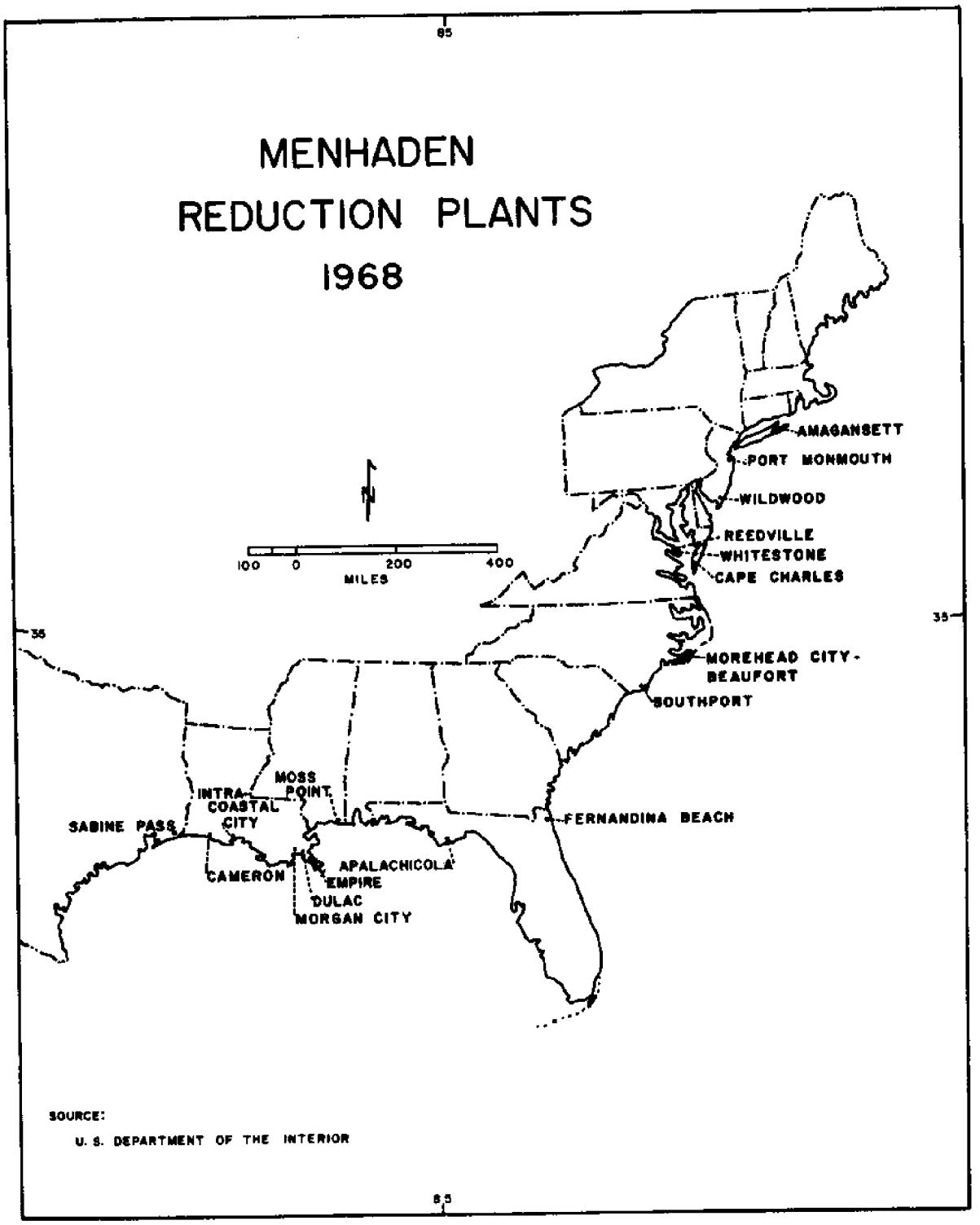
Exploitation of the menhaden resource has been confined to the United States, even though the fish are found in Latin American waters. In recent years the menhaden industry has been in operation along both the Atlantic and Gulf coasts. In 1968, thirty-three reduction plants (See Map 1) were located in eight states from New York to Florida (east and west coasts), and from Mississippi to Texas (U. S. Department of Interior, 1968). The fishery for menhaden has been conducted over approximately 45,000 square miles of sea surface, extending along the Atlantic coast from central Maine to central Florida (east coast), and along the Gulf coast from Pascagoula, Mississippi, to Port Arthur, Texas (June, 1961).

North Carolina constitutes the major production area of the South Atlantic fisheries region (Lyles, 1967). In 1968 eight firms were engaged in the manufacture of menhaden products on the North Carolina coast (U. S. Department of the Interior, 1968). In Tar Heel waters the menhaden present a unique fishing situation. Menhaden are caught during two distinct periods of the year. A "spring" fishery is in operation from May until August, and a "fall" fishery is conducted from the middle of October through December. During the latter season menhaden are caught only along the North Carolina coast (June, 1961).

The Problem

Statement of the purpose

The main objective of this study is to present a geographical description and analysis of the menhaden fishing industry in North Carolina. Specifically, the study is concerned with an analysis of the spatial distribution and interaction of various selected aspects of the fishery.


MENHADEN
REDUCTION PLANTS
1968
85
35
100 0 200 400
MILES
AMAGANSETT
PORT MONMOUTH
WILDWOOD
REEDVILLE
WHITESTONE
CAPE CHARLES
MOREHEAD CITY-
BEAUFORT
SOUTHPORT
FERNANDINA BEACH
MOSS
POINT
INTRA-
COASTAL
CITY
SABINE PASS
CAMERON
APALACHICOLA
EMPIRE
DULAC
MORGAN CITY
SOURCE:
U. S. DEPARTMENT OF THE INTERIOR

Map 1

Importance of the study

The selection of the menhaden fishing industry as the object of this study seems particularly appropriate at this time. The industry supported by menhaden constitutes "the largest and one of the oldest fisheries in North America" (June, 1963). Concerning this important fishery, Sanford and Lee (1961) have stated that "despite the importance of menhaden to our fishing economy, this species is relatively unknown even to many users of menhaden products, and the large industry that it supports has not received due recognition."

The present report deals with the various aspects of the menhaden fishing industry as they have developed along the Atlantic and Gulf coasts, but is focused on the North Carolina fishery in greater detail. Thus, the main emphasis of the paper is concerned with the geographical description and analysis of the menhaden enterprise of North Carolina in terms of: 1) the historical aspects of the fishery; 2) the development of the modern industry; and 3) the significance of the modern functions of the fishing operation. The location of the industry and the importance of this factor are treated in great detail. The particular approach used in this report is systematic in that the various component sectors of the industry are analyzed separately, proceeding from the general (over-all development of the industry) to the specific (regional phase of North Carolina). Some of the questions asked in this paper are:

1. What has been the early pattern of development of the industry from its inception in New England through the shift down the Atlantic coast? What part did the North Carolina fishery play in the distribution of the industry?

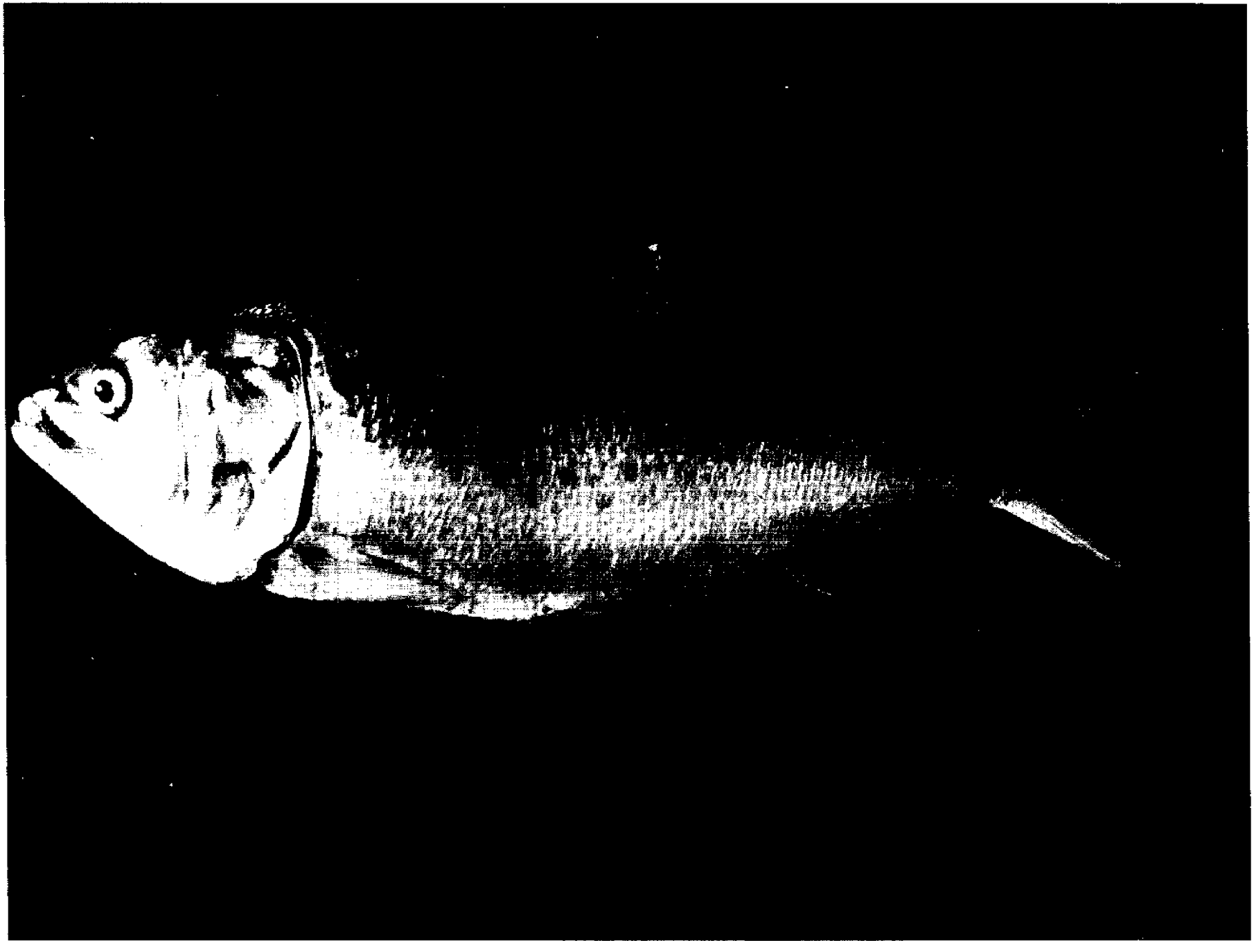
2. What are the contemporary areal patterns of the various menhaden species? What are some of the major factors behind the spatial arrangement and seasonal migrations of the fish?

3. What are the various geographical aspects of the fishery in respect to fishing areas and seasons, fishing methods, and catch distribution?

4. What are the current problems and trends associated with the menhaden industry? What measures are being taken to help solve the problems, and what future developments may be anticipated? How does North Carolina reflect the over-all menhaden situation?

The Menhaden

Menhaden belong to the Clupeidae herring family. These fish are considered relatively small in size, generally running less than twelve inches in length and under a pound in weight. However, some adult fish reach up to eighteen inches in length and more than three pounds in weight. Similar in appearance to other herring-like fish, such as the alewife and shad, menhaden are differentiated by their particular scale arrangement. Menhaden range in color from dark blue to blue brown along their upper portions, while the sides are usually silver colored. A single, dorsal fin projects from the center of the back, and along the midline of the belly a number of bony plates are arranged in row fashion (June, 1963). See Figure 1.



Courtesy of the National Fisheries Service

Fig. 1.--Atlantic Menhaden, Brevoortia tyrannus

All menhaden belong to the Genus Brevoortia, four species of which occur along the Atlantic and Gulf coasts of the United States. Atlantic waters are inhabited by Brevoortia tyrannus, commonly called the Atlantic menhaden, and Brevoortia smithi, the yellowfin menhaden. In the Gulf of Mexico the two dominant species are Brevoortia patronus, the Gulf menhaden, and Brevoortia gunteri, the fine-scaled Gulf menhaden.

The two most common and distinct species, Brevoortia tyrannus, the Atlantic menhaden, and Brevoortia patronus, the Gulf menhaden, virtually support the commercial fisheries in their respective areas. The other two species, yellowfin and fine-scaled menhaden, are caught in such small quantities that the total landings of these species are insignificant when compared with the landings of the Atlantic and Gulf menhaden (June, 1961).

Popular names

Long before any scientific names were assigned to menhaden people in different parts of the country referred to the fish by a variety of vernacular appellations. The persistent use of many different common names to identify the various species of the Genus Brevoortia has undoutably contributed to the general lack of recognition acquired by the menhaden industry. Still today, throughout different geographical areas Brevoortia fish are known by numerous popular names, among which are "pogy," "fatback," "mossbunker," "old wife," "bonyfish," "white-fish," "bugfish," "alewife," and "yellowtail shad" (Lee, 1953). Simmons and Breuer (1964) have described the general, geographical distribution of common names in recent years:

> In Maryland and Virginia fishermen call them bugheads, bugfish, oldwives, alewives, greentails, and chebugs. Delaware fishermen add the name mossbunker to this list; Connecticut fishermen call them whitefish, bonyfish, and bunkers; and in North Carolina they are fatbacks, shad, and pogies. This last name is the one commonly used among fishermen of the Texas coast. All of the names apply to a bony, mealy fleshed, oily, shadlike fish which normally travels in large schools in nearshore salt water.

However, the employment of a number of local names is not restricted to contemporary times, for most of the common names now used in connection with menhaden have long histories, some dating back to Indian words. In 1884 Coode discussed the various names and their origins:

> North of Cape Cod the name "Pogy" is almost universally in use while in Southern New England the fish is known as the "Menhaden." The two names are derived from two Indian words of the same meaning; the first being the Abnaki name "pookagan," or "Poghaden," which means "fertilizer," while the latter is the modification of a word which in the Narragansett dialect meant "that which enriches the earth." About Cape Ann, "Pogy" is partially replaced by "Hardhead," or "Hard-head Shad," and in Eastern Connecticut by "Bony Fish." In Western Connecticut the species is usually known as the "White-fish," while in New York the usage of two centuries is in favor of "mossbunker." This name is a relic of the Dutch colony of New Amsterdam, having evidently been transferred from the "Shad," or "Horse Mackerel," Trachurus lacerta, a fish which visits the shores of Northern Europe in immense schools, swimming at the surface in much the same manner as our Menhaden, and known to the Hollanders as the "Marshbanker." In Delaware

> Bay, the Potomac, and the Chesapeake, we meet with the "Alewife," "Bay Alewife," "Pilcher" (Pilchard), and "Greentail." Virginia gives us "Bugfish," "Bug-head," and "Bug-shad," referring to the parasitic crustacean found in the mouths of all Southern Menhaden. In North Carolina occurs the name "Fat-back," which prevails as far south as Florida, and refers to the oiliness of the flesh. In this vicinity, too, the names "Yellow-tail" and "Yellow-tailed Shad" are occasionally heard, while in Southern Florida the fish is called "Shiner" and "Herring."

Goode (1884) also commented on the popular names associated with the menhaden of the Gulf coast:

> The Gulf Menhaden has several vernacular names. At Key West it is called 'Sardine,' in common with other fish of the same general appearance. At Apalachicola, Pensacola, and Mobile it is called 'Alewife'; at New Orleans the names 'Sardine' and 'Alewife' are both in use, the latter perhaps more generally. On the Texan coast it is known as 'Herring,' 'Alewife,' 'Sardine,' and 'Shad,' each locality having its peculiar name.

Zoological names

In the 1802 Transactions of the American Philosophical Society Benjamin Latrobe, an engineer-architect with a penchant for natural history, first named menhaden as Clupea tyrannus. By 1861 Theodore Gill, an ichthyologist writing in the Proceedings of the Academy of Sciences, Philadelphia, had established the species as genus Brevoortia. Eighteen years later Goode wrote that the terms "tyrannus" as given by Latrobe and "Brevoortia" as established by Gill referred undoubtably to menhaden, and that "the laws of priority demand that the species shall henceforth be known as Brevoortia tyrannus (Goode and Associates, 1879).

Thus, by the latter half of the nineteenth century, the Atlantic menhaden was identified by a single scientific name and at least thirty common appellations. There is little doubt that consistent use over the years of many different names in reference to menhaden has definitely contributed to the general lack of familiarity associated with the menhaden industry.

HISTORICAL GEOGRAPHY

Introduction

Exploitation of menhaden actually predates settlement of the North American continent by Europeans. The fish were initially captured for use as soil enriching material by the native Indians and early colonists of that region which later became known as Massachusetts. Widespread employment of menhaden remained rather limited until just after the turn of the nineteenth century when news spread of experiments that seemed to indicate the fish as a powerful plant-growth agent. During the early 1800's the capturing of menhaden was restricted almost exclusively to the off-season activities of farmers turned fishermen in the coastal areas of Long Island, New York, and Connecticut (Lee, 1953). The dominant use of this abundant marine resource continued to be as side dressing for crops up to the middle of the century at which several events combined to shift the emphasis from fertilizer production to oil extraction. Used primarily as a substitute for the scarce vegetable and whale oils, menhaden oil became very popular as an ingredient in numerous products ranging from lamp fuels to machine lubricants. By the

late 1870's an organized fishing enterprise had been developed with professional fishermen working out of factories located in the New England states of Rhode Island, Connecticut, Massachusetts, and Maine; the Middle Atlantic states of New York and New Jersey; and the Chesapeake Bay region of Virginia (Harrison, 1931). At that time several attempts had been made to establish menhaden fisheries in North Carolina, but all efforts had proven unsuccessful. It was not until late in the nineteenth century that menhaden operations were finally prosperous in the Tar Heel state. In recent years the fish have supported the largest fishing industry, by volume of catch, in North Carolina and the entire South Atlantic region.

Northern States

According to the 1621 colonial writings of Governor Bradford, the value of fish fertilizer was known to the coastal Indians of that region which later became Massachusetts (Bradford, 1621). The aborigines caught menhaden, or "Mannawhatteaug," which were abundant in the coastal waters during the summer, and used the whole fish as fertilizing material in their fields. When the first Europeans arrived, Squanto of the Massachusetts Tribe taught them the method of capturing the fish and pointed out how to place the raw fish under each hill of corn. During colonization the first settlers followed the technique established by the Indians. Although there is no way of knowing how long the colonists used menhaden for fertilizer, local use no doubt did occur for some time. There was, however, no great exploitation of the multitude of fish that came into coastal waters during the colonial period (Harrison, 1931).

The exploitation of the vast resource for commercial purposes did not begin until the early nineteenth century. Around the turn of the century, Ezra L'Hommedieu, a Long Island landowner of considerable wealth, conducted a series of experiments in which he was attempting to increase the fertility of his soils by using menhaden as a side dressing. The result was quite successful, and in 1801 L'Hommedieu published the findings of his experiments. On hearing the news, coastal farmers interpreted the claims as a foolproof way of increasing crop yields. Consequently, a number of small "companies" were organized for the purpose of providing menhaden for fertilizer. Most of the companies were operated by farmers who would fish only the inshore waters as a sideline to their regular farming practices (Gabriel, 1920).

Up to about 1850 menhaden activities were limited to the states of New York (Long Island) and Connecticut. That half century period may be described as the "agricultural-fertilizer-inshore fishery" phase of the menhaden industry. During that time operations were very small and widely scattered along the beaches. The major use of the menhaden resource was as a fertilizing material, although small portions of the catches were: 1) used as bait; 2) consumed as human food; and 3) converted into oil. Fishing was restricted to the shallow inshore waters where menhaden came in seemingly endless numbers. Professional farmers, using haul seines and gill nets, made up almost the entire lot of "fishermen (Lee, 1953).

Toward the end of the first half of the nineteenth century a number of companies were established to operate full-time in the capturing of menhaden, and as the demand for the fish increased, many fishing associations, known by such names as "Fish Hawks," "Eagles," and "Water Witches," began to engage in what turned out to be very profitable ventures.

By the middle of the nineteenth century several events had taken place which

changed the menhaden industry into what may be called the "factory-oil-ocean fishery" phase. Previous to the half century mark small amounts of oil had been extracted from menhaden by use of extremely crude methods. The fish were first allowed to rot in barrels, and then the entire contents were pressed in hogsheads in order that the oil could rise to the top. Steam cooking eventually replaced the rotting process and by the late 1850's the mechanical screw press had also been introduced. In conjunction with those developments the Civil War brought into being a great demand for menhaden oil which came into "general use for painting and tanning and for the adulteration of other, more expensive oils" (Gabriel, 1920).

Prior to those developments what few oil operations that existed had consisted of crude kettles, tubs, and presses, which were seldom housed in anything more substantial than a lean-to shed, and most often were left open on the beach. As the demand for menhaden oil increased many companies were formed and small factories were constructed for the specific purpose of reducing menhaden to oil. The factory organizations had no fishing fleets of their own and were, thus, wholly dependent on the small fishing associations which were first created to provide menhaden to farmers.

After a half century of fishing the inshore waters, fishermen had to venture out into the open seas in order to capture enough menhaden to fill the new and larger demand for the fish. About 1850 the purse seine was developed and replaced the older, less efficient methods of fishing. With that turn of events, the whole fishing operation was switched from the beaches to large sailing vessels which were able to engage in a deep-sea fishery (Lee, 1953).

Soon the factory owners grew tired of buying menhaden from the fishing associations, and a number of "floating factories" were put into operation. These sea-going plants, old vessels outfitted with the necessary equipment, were only temporary solutions to the problem of obtaining the needed raw resources, and by the late 1860's most of the oil factories had their own fleets. By the late 1870's the "factory-oil-ocean fishery" phase of the industry was fully developed with operations located in Rhode Island, Connecticut, Massachusetts, Maine, New York, New Jersey and Virginia (Gabriel, 1920).

New England

The first successful attempt at reducing menhaden to oil was carried out in Rhode Island. In 1811 John Tallman and Christopher Barker set up a very crude operation on the shore near Portsmouth. The fish were boiled in open kettles, and the oil was barreled and sent to market in New York (Deblois, 1882). By the late 1870's the menhaden industry had reached the factory stage, and thirteen menhaden plants were in operation along Narragansett Bay (Goode and Associates, 1879).

The Connecticut industry had its beginnings sometime before 1850 when oil was extracted from bony fish (menhaden) at Poquannock Bridge. By the middle of the century there was a small factory for the manufacture of whitefish (menhaden) oil near New Haven Harbor. In 1852 or 1853 the process of extracting oil by steam cooking was patented by William Hall of Wallingford (Goode and Clark, 1887), and by the year 1877 there were nine factories along the coast of Connecticut.

In Massachusetts during the late 1870's a number of factories were engaged in the production of menhaden oil as a side line to their regular business. Two factories, one located at Provincetown and the other at Wellfleet, produced a small quantity of menhaden oil annually, although their chief activity was concerned with the reduction of blackfish and porpoises to oil. Some of the

Cape Cod fishermen would produce a small amount of oil from menhaden, although the main use of the fish was as bait (Goode and Associates, 1879).

In Maine the first crude attempts at oil extraction were carried out at Blue Hill about 1850. That year John Bartlett and his sons had set up their equipment, which consisted of the typical kettles and a crude press used to compress the boiled fish, and produced thirteen barrels of oil (Goode and Clark, 1887). A decade and a half later the first menhaden factory in Maine was built by a company from Rhode Island. By the spring of 1877 there were fourteen factories in the state (Goode and Associates, 1879).

Middle Atlantic

The first factory in New York state was built in the vicinity of Greenport, Long Island, by D. D. Wells and his son. Constructed in 1850, the factory was equipped with steam cookers for oil extraction (Goode and Clark, 1887). By 1873 the number of oil works had increased to eight and all were clustered at the eastern end of Long Island. Also at that time two floating factories were employed in oil reduction.

By 1873 there were two oil factories in New Jersey, at Somers Point and Great Egg Harbor. By 1877 the number of factories had increased to five. One oil works was at Port Monmouth, while Somers Point and Tuckerton had two factories each. During the season of 1878 a floating menhaden factory, the Alabama, was operated in New Jersey waters (Goode and Associates, 1879).

Chesapeake Bay

In 1865 David Floyd, of Greenport, Long Island, started the menhaden fishing industry in the Chesapeake Bay area. Floyd, operating from a sailing vessel equipped with oil works, lacked experience and was unsuccessful in his pioneering venture (Goode and Clark, 1887). Three years later the first factories were constructed in Virginia: one located on Tanners Creek and the other on Back Creek. The following year another oil works was set up at Reedville (Greer, 1915). By 1880 the menhaden oil industry in Virginia had increased to nearly sixty large and small factories, employing over seven hundred fishermen and factory workers (Goode and Clark, 1887).

North Carolina

Introduction

Menhaden, or "fat-backs" as the fish were known locally, have been recorded in Tar Heel waters since the colonial period. As early as 1709 John Lawson listed menhaden as one of the salt water fish of North Carolina. In his general description of the species, Lawson wrote that "Fat-Backs are small fish, like Mullets, but the fattest ever known. They put nothing into the Pan, to fry these. They are excellent sweet food" (Lawson, 1709).

Even though menhaden were known to inhabit local waters since the early eighteenth century, impetus for establishment of a fishery did not come until the middle of the nineteenth century. During the Civil War years many soldiers of the Union army, while stationed along the coast of North Carolina, noticed the apparently plentiful supply of menhaden which periodically frequented the inshore waters. Later these northern soldiers gave exuberant accounts of the availability of the fish in Tar Heel sounds. On hearing those encouraging reports, capitalists traveled south, substantiated the stories, and eventually invested in fisheries for menhaden. However, in spite of the fish supply,

the expertise of northern fishermen, and the capital of the promoters the early period of commercial exploitation was plagued with a number of failures and severe losses. Several different locations were tried, but due to a variety of natural and human factors all attempts proved futile. See Map 2.

Nearly a quarter of a century passed before the menhaden business was successfully managed in the Tar Heel state. During the late 1880's some factories were in operation at Beaufort and the Cape Fear area where landings have been made for most years to the present. Geographical distribution of the major fishing endeavors is as follows:

Harper's Island

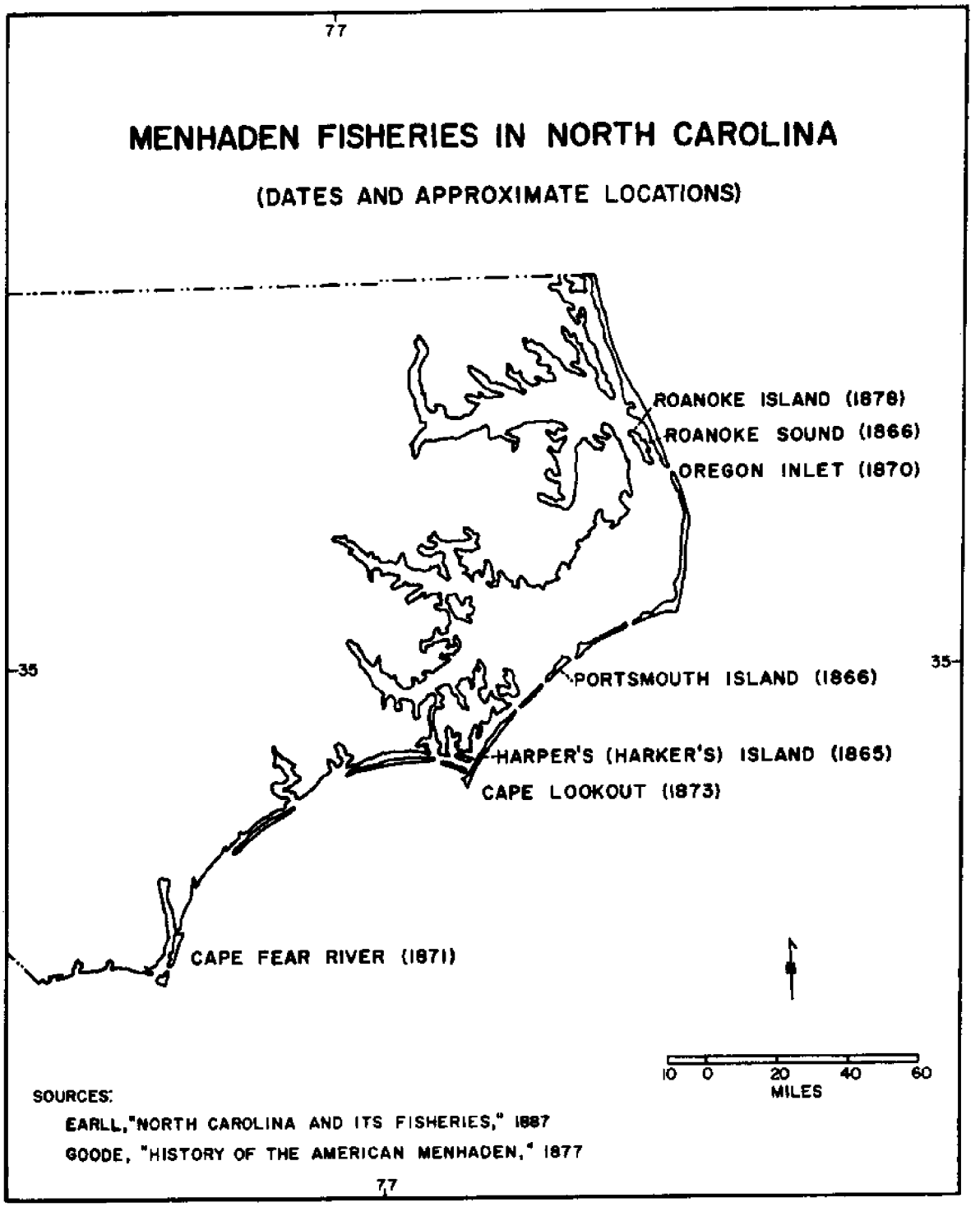
According to R. Edward Earll's account, Harper's (Harker's) Island, situated just off the mainland in Core Sound, was the scene of the first menhaden processing plant in North Carolina (See Map 2). Built in 1865 this oil and guano factory utilized menhaden which were captured in a gill net fishery. Although kettles and handpress constituted the factory equipment initially, a steam operated boiler was subsequently added to the operation, and some time later, the fishery was expanded with the introduction of purse and haul seining techniques. The factory remained in operation until 1873 when the equipment was dismantled and transferred to what was considered a more favorable location - Cape Lookout. However, the equipment was never reassembled at the Cape, and the business venture came to a halt with losses totaling approximately $3,000 (Earll, 1887).

Roanoke Sound Vicinity

Another attempt at menhaden fishing was started the year after the Harper's Island fishery began operation. A prospecting party of the Quinnipiac Fertilizer Company of New Haven, Connecticut, spent the winter of 1866 in the Roanoke Sound area, and "established weirs for the capture of menhaden, which were very abundant" (See Map 2). However, this enterprise did not last long due to the fact that the local people were envious of the northern fishermen. The native inhabitants destroyed the weirs and drove the strangers away from the area. Menhaden were extremenly plentiful at Cape Charles, Virginia, and the prospecting party relocated there (Goode and Associates, 1879).

Portsmouth Island

In 1866 a Rhode Island stock company, called the Excelsior Oil and Guano Company, invested $50,000 in a venture to set up a menhaden fishery in North Carolina waters. Having investigated the claims of northern soldiers, the promoters established a factory on Portsmouth Island (See Map 2). Northern fishermen, experienced in the use of purse seines, were imported to run the fishery, and "modern" factory equipment was installed to cook and press the fish. After the third season, the venture had proved futile and the operation was closed with a combined loss of $75,000. According to the business manager of the company, a number of factors were responsible for the failure. First, the menhaden had not been as abundant as expected. Less than twenty-five barrels of fish made up the average school of menhaden. Second, since the captured fish would begin to decompose in a few hours under the summer heat, the range of fishing could not exceed twenty-five miles from the factory. Third, ocean fishing was not engaged in due to the shoalness of the inlets at low tide and the prevalence of sudden storms. Fourth, the fishery had depended on fish caught in the sounds, but these menhaden were very poor with only two quarts of oil


77
MENHADEN FISHERIES IN NORTH CAROLINA
(DATES AND APPROXIMATE LOCATIONS)
ROANOKE ISLAND (1878)
ROANOKE SOUND (1866)
OREGON INLET (1870)
35
35
PORTSMOUTH ISLAND (1866)
HARPER'S (HARKER'S) ISLAND (1865)
CAPE LOOKOUT (1873)
CAPE FEAR RIVER (1871)
10 0 20 40 60
MILES
SOURCES:
EARLL, "NORTH CAROLINA AND ITS FISHERIES," 1887
GOODE, "HISTORY OF THE AMERICAN MENHADEN," 1877
77

Map 2

from a barrel of fish on the average. The company's business manager expressed the opinion that "it would be impossible to make the menhaden fisheries profitable along this coast" (Earll, 1887).

Oregon Inlet

About 1870 another menhaden factory was constructed, this time, at Oregon Inlet (See Map 2). Financed by the Church Brothers of Rhode Island the interprise lasted two seasons. During the first year of operation a steamer, the Seven Brothers, was employed in the fishery, but in the final year small sailing vessels were used in place of the larger steam-powered boat. According to a business partner of the Church Brothers, strong currents often prevented the fishing boats from having free passage into and out of the sound, and it was a situation that led to the factory's closing (Earll, 1887).

Cape Fear

In 1871 a tract of land near the mouth of the Cape Fear River became the site of a menhaden factory (See Map 2). The Nevassa Guano Company of Wilmington, which used fish scrap as an ingredient in its fertilizers, established the factory in an attempt to supply the needed raw material for their business. Two vessels were employed in the purse seine fishery. After only two seasons the enterprise was abandoned with a total investment loss estimated between $8,000 and $10,000. According to the president of the company, the fish were too scarce and the oil yields too limited to allow profitable business (Earll, 1887).

Roanoke Island

During the late 1870's Captain I. Cain, of Roanoke Island, investigated the possibility of establishing a menhaden fishery at that sound location (see Map 2). Following a number of experiments, which "satisfied him that the menhaden fishery could be carried on with profit", Cain set up a factory for processing the fish. His equipment consisted of the essential kettles and presses, and a small boat outfitted for use in the fishery. However, due to the lack of sufficient amounts of fish in the sound waters, work never began during the season of 1879. In spite of that initial failure, Captain Cain planned to add a steam boiler and some hydraulic presses to this plant (Earll, 1887). Although it is not certain, the Captain probably carried out his plan with a total investment of approximately $2,000. According to Goode and Clark's section entitled "The Census Statistics of the Menhaden Industry for 1880," North Carolina was given credit for $2,000 under "Value of factories and fixtures" and $2,000 under "Total capital invested". However, within the same source it was recorded that no menhaden fishing was conducted in Tar Heel waters during the season of 1880 (Goode and Clark, 1887).

Writing in 1887 Goode and Clark reported the status of the menhaden fishery up to that time, and commented on the possibility of a profitable menhaden fishery in North Carolina waters:

> Several efforts have been made to locate factories on the North Carolina coast, and some parties have prosecuted the business with varying success for several years. Thus far, however, no one has succeeded in making it profitable. It is therefore, an open question whether this fishery can be prosecuted in the State. The currents are so strong at the inlets that sail vessels are often unable to enter them when the tide is unfavorable, and they are thus frequently delayed so long

> that the fish spoil before they reach the factory. Menhaden are quite abundant in the inner sounds, but the water is usually so shoal as to interfere seriously with the use of purse-seines, and the fish are so scattered that only a few barrels can be taken at a haul.

Beaufort

In spite of the early failures experienced in the attempts to establish a menhaden fishery at various locations in the State, the industry was finally set up and operated successfully in the Beaufort area. Although it is not certain, the fishery was probably established in this area as early as 1887, since North Carolina was given credit in the catch records for 14,756,000 pounds of menhaden during that year (Lyles, 1967). By 1889 a menhaden fishery was definitely concentrated at Beaufort and the immediate vicinity, with seven factories in operation during that year. In the following year, the total number of factories had been reduced to six, and the total capital invested in buildings, vessels, and apparatus amounted to nearly $100,000 (Smith, 1893). Shortly after the turn of the century menhaden operations were centered in two separate and distinct localities: 1) Beaufort and vicinity; and 2) the Cape Fear area. During the 1902 season, more than eighteen million pounds of menhaden, valued at over thirty thousand dollars, were captured in the Tar Heel fishery (Smith, 1907).

Thus, from an unpromising beginning, the menhaden industry became an important activity along the State's seaboard. In 1907, just two decades after Goode and Clark had expressed doubts concerning a successful menhaden fishery in North Carolina, Hugh M. Smith described the status of the (then) well established fishery:

> The menhaden is one of the most valuable of the North Carolina fishes. Here as elsewhere it is caught chiefly for conversion into oil and guano, at factories located in the vicinity of Beaufort and Cape Fear. Fishing is done with purse seines and haul seines in the ocean and sounds, and the industry give employment to many people. In recent years there have been about 10 such establishments, with upwards of 500 fishermen and shore hands connected therewith.

Slightly over a decade later Samuel Hildebrand (1919) recognized and scientifically described what up to that time had been the much misunderstood natural resource which was the basis of that most important North Carolina fishery. According to Hildebrand, the Atlantic menhaden, known locally as fatback, was the "most abundant fish in the vicinity of Beaufort," and was captured in large amounts to be converted into oil and scrap. This species, Brevoortia tyrannus, was described as migratory, and it was determined that the fish congregated in schools. Inside the harbor small schools were noted to be common, with large schools occuring only infrequently. In the Beaufort area fatback appeared throughout the "warmer part of the year." During this early investigation, Hildebrand described the migrations of Brevoortia tyrannus:

> There is usually a period late in the spring, one in midsummer, and another late in the fall when large schools pass by. It is during these "runs," generally known as the spring, summer, and fall runs, that the fish are taken in large quantities. The fall run is, however, by far the most important one, as at this time the fish are not only much more abundant than during the other runs, but they are also usually bigger and fatter, therefore yielding more oil.

The yellowfin menhaden was described as "much less abundant than the fatback," and was "not known to school." In the summer months yellowfin menhaden were captured inside the harbor, but not in any great amount at a particular time. This species usually occupied the deeper waters.

Summary

Although menhaden, Genus Brevoortia, have been known to inhabit North Carolina waters since the colonial period, impetus for commercial exploitation of the vast resource did not come until after the Civil War. When accounts telling of immense schools of fish reached northern capitalists via Union soldiers, several companies sent experienced fishermen south with plans to work the apparently teeming Tar Heel waters. For almost a quarter of a century different locales were tried, including the sound locations of Roanoke and Harper's Island; the Outer Banks' areas near Roanoke Sound, Oregon Inlet, and Portsmouth Island; and a mainland site near the mouth of the Cape Fear River. Due to a combination of several natural and human factors all attempts were unsuccessful. It was not until the late 1880's that the menhaden industry was finally carried out on a profitable basis in North Carolina. Although the industry was probably in operation as early as 1887, full scale business was definitely in progress at Beaufort during the season of 1889. By the turn of the century the fishery had been expanded to an area near Cape Fear. Since that early period both areas have recorded menhaden landings for most years to the present.

THE RESOURCE

Introduction

Menhaden, Genus Brevoortia, and other clupeid fishes similar to menhaden, namely of the genera Ethmalosa and Ethmidium, occur in three geographically separate areas of the world. Six species of menhaden are distributed in certain parts of the western Atlantic Ocean, including the Gulf of Mexico, from Nova Scotia to Argentina. Two species of Ethmidium are found in the eastern Pacific Ocean from Mexico to Peru. Ethmalosa occurs in the coastal waters of the eastern Atlantic Ocean from Senegal to Angola. A general world survey of the distribution of menhaden and menhaden-like fishes is provided in Table 1. It is important to note the two non-menhaden fishes because: 1) a large industrial fishery is conducted for Ethmalosa, and there is potential for an industrial fishery in connection with Ethmidium (Reintjes, 1964); and 2) the misconception that menhaden occur in Peruvian and west African waters needs to be corrected.

Atlantic and Gulf Coasts

Geographical distribution and migrations

Four species of menhaden are recognized in North American waters. Along the Atlantic coast Brevoortia tyrannus, the Atlantic menhaden, ranges the more temperate waters from Nova Scotia to the east central coast of Florida (Reintjes, 1959). Brevoortia smithi, the yellowfin menhaden, occurs in the warmer waters from North Carolina to Louisiana, although they are common only in the coastal waters of Florida (Dahlberg, 1966). In the Gulf of Mexico, the large-scaled Gulf menhaden, Brevoortia patronus, occurs in the more temperate waters from Tampa Bay, Florida, to Brazos Santiago, Texas (Christmas and Gunter, 1960). In

TABLE 1

MENHADEN AND MENHADENLIKE FISHES
BY GEOGRAPHICAL AREAS

Scientific name	Common name	Area
Brevoortia tyrannus	Atlantic menhaden	Atlantic Coast of North America from Nova Scotia to Florida
Brevoortia smithi	Yellowfin menhaden	Atlantic Coast of the United States and Gulf of Mexico from North Carolina to Louisiana.
Brevoortia patronus	Gulf menhaden	Gulf of Mexico from Florida to Mexico.
Brevoortia gunteri	Finescale menhaden	Gulf of Mexico from Alabama to Mexico.
Brevoortia pectinata	Lacha or savelha	Atlantic Coast of South America from Brazil to Argentina.
Brevoortia aurea	Lacha or salvelha	Atlantic Coast of South America from Brazil to Argentina.
Ethmidium chilcae	Machete, machuela, or trite.	Pacific Coast of South America from Peru and Chile.
Ethmidium maculatum	Machete, machuela, or trite.	Pacific Coast of Central and South America from Mexico to Peru.
Ethmalosa fimbriata	West African shad or bonga.	Atlantic Coast of West Africa from Senegal to Angola.

Source: Reintjes, 1964

the warmer waters the fine-scaled menhaden, Brevoortia gunteri, "ranges from Mississippi to the Gulf of Campeche, Mexico" (Dahlberg, 1966). Thus, there is an overlapping of the distribution of the three species occurring in the Gulf of Mexico, with all three menhaden present in the waters around Chandeleur Sound, Louisiana (Christmas and Gunter, 1960).

Atlantic menhaden, Brevoortia tyrannus, constitute the great resource of the menhaden fishery of the Atlantic coast. These fish followed a most interesting migration pattern, which has been described by June and Reintjes (1962):

> Atlantic menhaden undertake extensive migrations. There is northward movement in spring, following which the smaller and younger fish are found in the southern part of the range and progressively larger and older fish occur in each more northerly latitude. Furthermore, there is a tendency for fish of similar size and age to occur together in a given locality, but remain separated from those of overlapping sizes and ages in adjacent localities. Thus, a north-south gradient in size and age becomes established, with the larger and older fish found farther northward.
>
> A southward movement of the fish takes place in the autumn. Prior to their withdrawal from the summer grounds, the fish congregate in large schools comprised of many millions of individuals. Such large schools appear along the coast of North Carolina in November. These schools disappear in the vicinity of Cape Fear, N. C. in December.

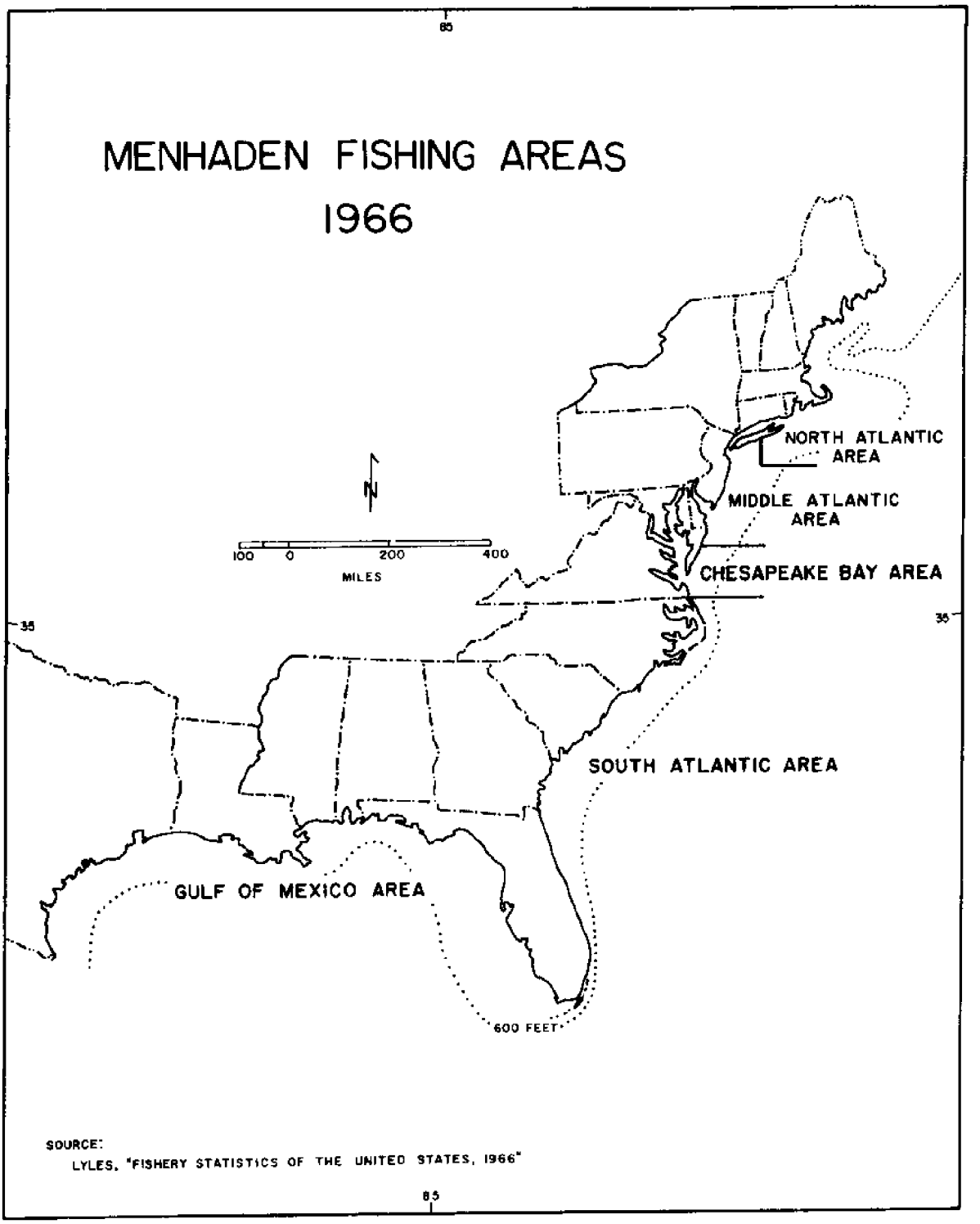
Gulf menhaden, Brevoortia patronus, do not have a migration pattern similar to the Atlantic menhaden. In the warm summer months these fish, which make up by far the greatest amount of the Gulf menhaden fishery's catch, appear congregated in immense schools along the shallow Gulf coast. The greatest concentration is usually located in the waters about the Mississippi River delta. In the autumn the fish leave the coastal waters. Knowledge of where the menhaden go during the winter is lacking (June, 1961).

Fishing areas and seasons

The fishing areas and seasons for menhaden are highly correlated with the seasonal migrations and availability of the fish (Reintjes, 1959). Along the Atlantic coast the earliest fishing begins in the South Atlantic area during the late March and continues until December or January. The fishing region of the South Atlantic fisheries ranges over the waters of the continental shelf from Cape Kennedy to the North Carolina-Virginia line (see Map 3). Two distinct seasons are apparent in the South Atlantic. The summer fishery is conducted from late March or early April to the middle of October (June and Nicholson, 1964). The fall fishery is conducted only along the coast of North Carolina, and lasts from the middle of October through December.

The Chesapeake Bay fishing region consists of "Chesapeake Bay proper and coastal waters outside the Bay lying between False Cape and Great Machipongo, Va." (Roithmayr, 1963). See Map 3. Beginning in April menhaden are captured by the pound net technique in the Chesapeake Bay. Although the pound nets are set up primarily to entrap other fish, menhaden often constitute the greatest percentage of the catch (McHugh, 1960). From late May until the end of October menhaden are taken in immense quantities by the purse seine fishery (Nicholson and Higham, 1964).

The coastal waters lying between Great Machiponga Inlet, Virginia, and


MENHADEN FISHING AREAS
1966
85
N
100 0 200 400
MILES
NORTH ATLANTIC AREA
MIDDLE ATLANTIC AREA
CHESAPEAKE BAY AREA
SOUTH ATLANTIC AREA
GULF OF MEXICO AREA
600 FEET
35
35
SOURCE:
LYLES, "FISHERY STATISTICS OF THE UNITED STATES, 1966"
85

Map 3

Moriches Inlet, Long Island, are designated as the Middle Atlantic region (Roithmayr, 1963). In this area menhaden are taken by a pound net fishery beginning in April. A purse seine fishery is conducted for Atlantic menhaden from May until the middle of October (Nicholson and Higham, 1965).

The North Atlantic areas consists of "waters along the southern coast of Long Island, east of a line due south of Moriches Inlet, Long Island Sound, and waters northward" (Roithmayr, 1963). A purse seine fishery is conducted in the coastal waters of this northern area from the end of May through October (Nicholson and Higham, 1966).

In the Gulf of Mexico, menhaden are captured by a purse seine fishery from May until October, with July and August being the period of concentrated fishing. The fishing grounds consist of the inshore waters ranging "along a relatively short stretch of the northern Gulf Coast from Sabine Pass on the Texas and Louisiana border eastward to Alabama" (June, 1967).

Factors affecting distribution

Concerning the factors affecting the distribution of menhaden, June (1967) has stated:

> Although the effect of oceanographic factors on the availability of menhaden has not yet been clearly demonstrated, fishery scientists believe that the varying seasonal and geographical distribution of the schools depends upon prevailing hydrographic conditions.

Although there is no complete answer for the distribution of menhaden, several explanations have been presented in recent years. Dahlberg (1966) has stated that the Atlantic and Gulf menhaden (Brevoortia tyrannus and Brevoortia patronus) "were probably a single continuous population before they were isolated by the emergence (probably more than once) of the Florida peninsula."

The continental shelf appears to be an important factor in the areal pattern assumed by menhaden, particularly during the summer months. Roithmayr (1963) has stated that "during the warmer months, the fish congregate in schools which are found in greater concentrations in water of less than 20 fathoms overlying the inner third of the Continental Shelf."

Presently it is believed that estuaries are a major factor in the distribution of menhaden. After hatching in the Atlantic Ocean or the Gulf of Mexico the menhaden larvae go into estuaries and remain there for over half of their first year (Reintjes and Pacheco, 1966). Larvae generally enter the estuaries during the late winter and spring months. "Between Cape Canaveral and Cape Cod there are approximately thirty-eight estuarine systems which are known to provide an environmental link in the life history and biology of the Atlantic menhaden (Brevoortia tyrannus)" (June and Chamberlin, 1958). According to Pacheco and Grant (1965), menhaden "larvae and juveniles have been reported in nearly every river system along the Atlantic coast of the United States from Maine to Florida". In connection with estuaries, another factor important in the distribution of menhaden is the availability of food. "During the warm months, the fish are caught in greater numbers in the vicinity of major estuarine systems where the microscopic plants and animals upon which they feed are in rich supply" (June and Reintjes, 1962).

Surface temperature of coastal waters seems to be a major factor in the migration pattern of menhaden. Concerning this factor, Gunter and Christmas (1960) have stated:

> It has been generally agreed that temperature governs the north and south migrations of menhaden and that menhaden do not enter waters of temperatures less than 50° F . . . . Goode (1879) collected temperature records along the coast and compared them with the time of appearance of the menhaden. This information led him to state that menhaden appeared after the water temperatures rose to 50° and 51° F. and preferred temperatures between 60° and 70°.

Undoubtably many other factors, such as water salinity, have an affect on menhaden. However, there is a general lack of information concerning the factors behind the distribution and migrations of menhaden. June and Reintjes (1962) have stated:

> Relatively little is known of the relation between environmental factors and the distribution, behavior, and survival of the fish. Seasonal differences in the schooling of the fish occur, but causes of year to year variations in the distribution and movements of the schools remain obscure.

North Carolina

Menhaden have been known to frequent the waters of North Carolina since early colonial times and have been shown to have supported a fishery since the late 1880's. By the early part of this century the menhaden was considered to be "one of the most valuable of the North Carolina fishes" (Pratt, 1917), and in recent years has been considered "by far the most important species of finfish produced in North Carolina both in quantity and value" (Woodward, 1956). In 1966 menhaden maintained the highest position in both quantity and value (Lyles, 1968), with over 180 million pounds (approximately 72 per cent of all fish caught in North Carolina) valued at over two and a half million dollars (approximately 26 per cent of the total value of all Tar Heel fish). This vast menhaden resource consists of two different species: the Atlantic menhaden, Brevoortia tyrannus, and the yellowfin menhaden, Brevoortia smithi (Reintjes, 1964). However, of the two species of menhaden which are found in North Carolina waters, it is the Atlantic menhaden which makes up almost entirely the large annual catches of the Tar Heel fishery. In fact, yellowfin menhaden are seldom encountered in Tar Heel waters. While it is a scientific truism that the yellowfin species inhabits the coastal waters from North Carolina to Florida, only a few scattered specimens have been taken in the State in recent years (Reintjes, personal communication, 1969).

Distribution

In recent years William Ellison (1951) has described the distribution and migrations of Atlantic menhaden, Brevoortia tyrannus, in the coastal waters of North Carolina. Menhaden are abundant in Tar Heel waters for ten months, April through January, and there is some evidence that menhaden are abundant in February and March, although the data are not conclusive.

Atlantic menhaden migrate along the North Carolina coast in a pattern similar to and in conjunction with the north-south movement of menhaden along the Atlantic coast. Early in spring a run of menhaden generally strikes the coast of South Carolina near Georgetown, and proceeds northward paralleling the coast. These "Georgetown-flats fish," as they are known in North Carolina, consist of

specimens ranging from six to eight inches in length. Beginning in May, or sometimes as early as April, the first wave of menhaden strikes the coast of North Carolina. These fish, believed to have originated off the Florida coast, move into Tar Heel waters from the south, and remain there until August.

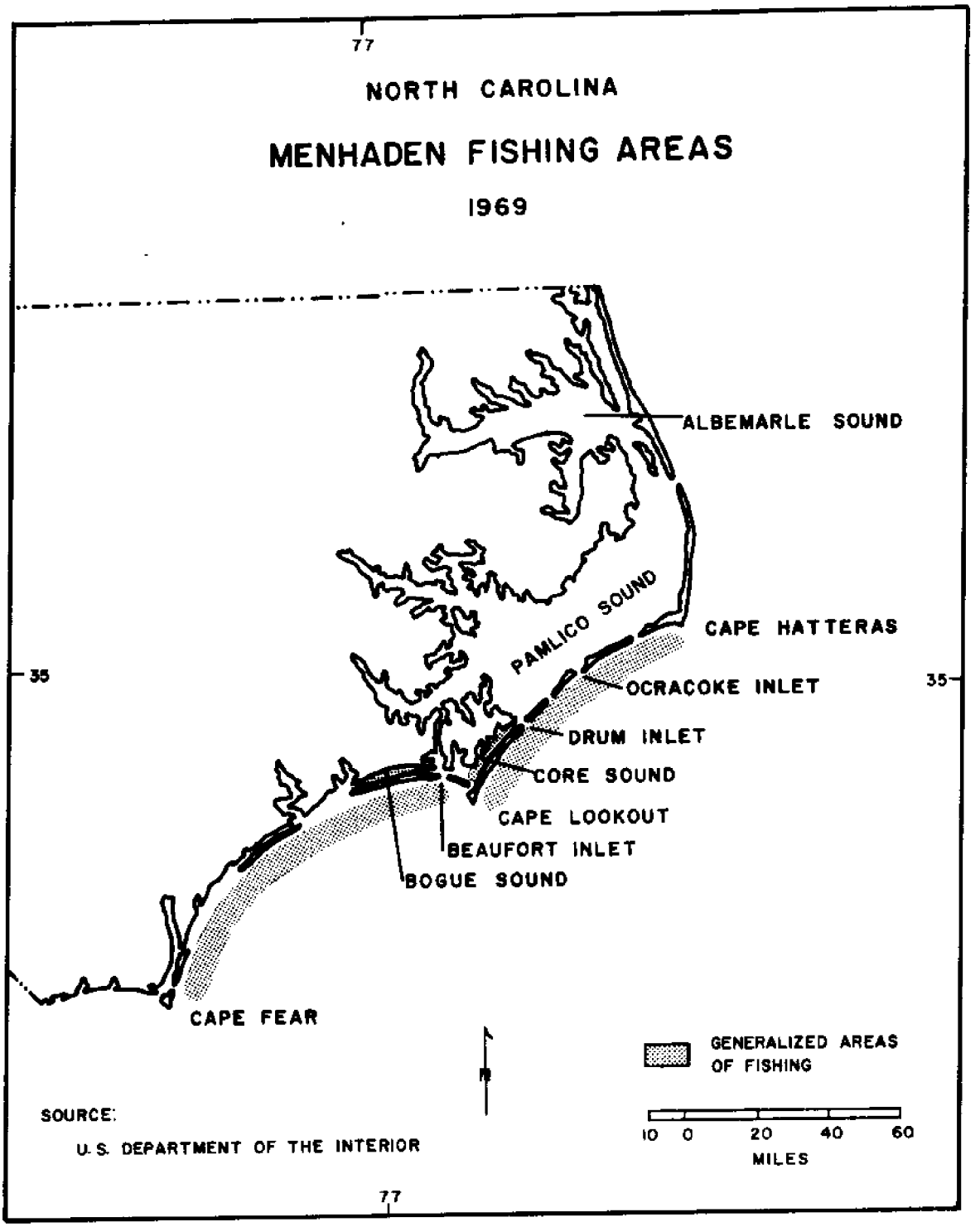
A "fall run" of menhaden made up of two different groups strikes the coast of North Carolina about the middle of October. One group of fish moves in from the north, and a second group moves out from the near-by sounds and estuaries. These fish, known in North Carolina as "Chesapeake Bay" fish, "holy jumpers," or "forerunners," range ten to twelve inches in length. This first wave lasts about a month. About the middle of November a second wave of menhaden known as the "Delaware" fish, comes into local waters. These fish, ranging from thirteen to sixteen inches in length, remain in local waters for two or three weeks. About Thanksgiving or the end of November, a third wave of menhaden known as the "Boston Bay" or "Amagansett" fish, strikes the coast. These fish are the largest of the fall run, ranging from sixteen to twenty inches. However, after this run of large fish, a fourth wave of menhaden comes into Tar Heel waters. Appearing in December, this final group is made up of the smallest size fish, with individuals ranging from two to ten inches. No information is available on the source or destination of these fish.

A Beaufort fish meal and oil manufacturer has described the seasonal migration pattern of menhaden as is currently observed in North Carolina waters (Potter, personal communication, 1967): A spring advance of fish usually begins in May or sometimes in April, and consists of two main groups, one menhaden and the second thread herring. The first group, made up of menhaden, migrates northward from Florida into Bogue, Core and Pamlico Sounds (see Map 4). These "Florida run" fish remain in the sounds until early September. With the coming of the first days of autumn weather, known locally as a "mullet shift," the Florida run fish leave the sounds and migrate south. At this time, a second group of fish, composed of thread herring or "hairy backs" as they are known locally, comes into North Carolina waters from the north. Remaining in the coastal waters until October, these fish are exploited by the local menhaden fishery.

The fall advance of menhaden begins about the middle of October when the surface water north of Cape Hatteras and in the Chesapeake Bay drop below 50° F. The first fish of the season, called "forerunners," come in from the north. In November the second group of fish, made up of individuals called "Mammy shad" by the native people, comes in from the north and ranges throughout the coastal waters from the North Carolina-Virginia state line to the North Carolina-South Carolina line. The fall migration lasts until the end of December. A final short migration lasts for about two weeks in January. During this time the small fish which are late leaving the coastal waters begin disappearing and are usually gone by the middle of January.

Fishing seasons and areas

The fishing seasons for menhaden are highly correlated with the migrations and availability of the fish. The exact times of the year when the menhaden migrate into and emigrate out of North Carolina waters vary each season. Sometimes the fish come as early as April and leave as late as the middle of January. As has been shown the reasons behind the fluctuations are not completely understood. In the North Carolina fishery there are actually two separate and distinct fishing seasons, dependent on the two main migrations of menhaden, known locally as the "spring" and "fall" runs (Ellison, 1951).


77
NORTH CAROLINA
MENHADEN FISHING AREAS
1969
ALBEMARLE SOUND
PAMLICO SOUND
CAPE HATTERAS
OCRACOKE INLET
DRUM INLET
CORE SOUND
CAPE LOOKOUT
BEAUFORT INLET
BOGUE SOUND
CAPE FEAR
35
35
GENERALIZED AREAS OF FISHING
10 0 20 40 60
MILES
SOURCE:
U.S. DEPARTMENT OF THE INTERIOR
77

Map 4

The spring fishery begins in May, or sometimes in April and lasts until August. This fishing period corresponds to the arrival and departure of the "Georgetown-flats" fish, which are the principal types captured during this period (Nicholson and Higham, 1965). Although the fishing areas vary from season to season, the spring fishery is carried on in both inshore and outside waters along the Tar Heel coast. Core Sound is the most frequented inshore area, with landings recorded from May through the middle of August (see Map 4). Bogue Sound is also a popular inshore fishing area. Outside fishing is conducted in the ocean between Cape Hatteras and Ocracoke. In addition to this important area, outside fishing is also conducted in the vicinity of Cape Lookout and the Cape Fear River (Nicholson and Higham, 1964).

The fall fishery corresponds with the arrival and departure of the "fall run" fish. Fishing usually begins about the middle of October and lasts until the end of December, sometimes finishing in January. This is the only fall fishery for menhaden (Ellison, 1951). The primary fishing area ranges between Cape Hatteras and Cape Lookout, with the waters around Drum and Ocracoke Inlets being areas of specific importance (see Map 4). Fishing is also concentrated between Beaufort and Cape Fear Inlets, with the waters off Beaufort and Cape Fear being areas of intense activity (Nicholson and Higham, 1965).

Factors influencing distribution and migrations

It is generally believed by fishery scientists that menhaden appear in coastal areas when the water temperature reaches 50°F. on the surface. An average monthly temperature of 50°F. or more is experienced in North Carolina coastal waters throughout the year. According to Ellison (1951), "menhaden are year-round inhabitants" off the North Carolina coast.

Another factor that might influence the distribution of menhaden along the Tar Heel coast is the presence of a large number of estuaries. Certainly, the vast estuaries of the Pamlico, Neuse, and Cape Fear rivers provide excellent nursing areas for the young menhaden. In addition to these large estuaries, the Tar Heel coast has numerous smaller estuaries, such as those associated with the Roanoke, Chowan, Newport and New Rivers. Not only do these areas provide nurseries for the young menhaden, the estuaries provide food, another major factor, for the migratory fish.

Certainly, other factors are involved in the distribution and migration of menhaden along the coast of North Carolina. However, more research needs to be completed before any definite conclusions can be made.

Summary

Six species of menhaden, Genus Brevoortia, range from Nova Scotia to Argentina in the western Atlantic Ocean. Of the four North American varieties, the two most abundant species, Brevoortia tyrannus in the more temperate Atlantic waters and Brevoortia patronus in the cooler Gulf of Mexico waters, constitute the major resource of the vast United States menhaden industry. These two most important migratory species appear in the shallow waters over the Continental Shelf as the surface water warms with the coming of summer weather. Along the Atlantic coast the earliest fishing begins in the South Atlantic area, with each more northerly area starting a little later in the year. This progression corresponds to the arrival of the menhaden in their northward migration each spring. In the fall the progression is reversed, correlating with the withdrawal of the fish from the cooler northern area. The fishing seasons end first in the higher

latitudes, with each more southerly area having a later closing date. The Atlantic coast fishery ends each year with the exploitation of the North Carolina fall run of Brevoortia tyrannus.

Menhaden have been known to enter North Carolina waters since colonial times. Although two species are listed as inhabitants of Tar Heel waters, only Brevoortia tyrannus is common to the area. This migratory fish comes in immense schools into the area during two separate and distinct periods. Each spring the first run lasts from May until September, and each fall the second run lasts from about the middle of October to January. Brevoortia tyrannus constitutes virtually the entire catch of menhaden in North Carolina. Corresponding to the migration pattern of that species, the State's menhaden industry is composed of two separate fisheries, one utilizing the southern fish during spring and other exploiting the northern fish in the fall. While the spring fishery is principally an inshore operation, the fall fishery is predominantly an ocean activity. Thus, North Carolina is the only area that experiences two different menhaden seasons, one in the spring and another in the fall, with the latter being the only fall menhaden operation anywhere.

THE FISHERY

Introduction

The capturing of menhaden (Brevoortia tyrannus) for commercial purposes has been described as "the greatest pelagic fishery of the Americas" (Morgan, 1965). Although a number of different fishing methods are employed in this fishery, two basic factors must be met in virtually every method used. Concerning these factors, Morgan has stated:

> the habits of most pelagic species are such that at certain times they are normally near the surface. Catching them therefore involves, firstly, finding the area in which they are in sufficient quantity, and secondly, using a device operating on or near the surface to catch them.

Complying with these conditions, the two main fishing methods used in commercial fishing are: 1) the purse seine method, and 2) the pound net method. Of the two methods, the purse seine is by far the most important method. Several minor techniques are also used in this fishery.

Atlantic and Gulf Coasts

The purse seine method

"Since the inception of the large-scaled menhaden reduction industry in about 1850, purse seines have been the principal means of supplying the high quantities of fish required by the plants" (June, 1967). Morgan (1956) described the purse seine as:

> another "curtain" type net, hung between surface floats and weights along its foot. It possesses a purse line, which is a stout rope threaded through eyes along the foot of the net. When the school is surrounded, this purse line is hauled on by a winch, thus closing or "pursing" the bottom of the net at the same time as it draws it in to a small area beside the vessel. The fish are thus trapped completely.

(See Diagram 1 for a schematic representation of a purse seine.) These purse seines are made of 1 3/4-inch webbing, with nylon being used in place of cotton or linen in recent years. Although there are several sizes, seines on the average run about 1,200 feet in length and 60 feet in depth. Over 98 per cent of the annual catch is landed with purse seines (June, 1967). A detailed description of purse seine fishing will be given in the North Carolina section of this report.

In 1966 approximately 1.3 billion pounds of menhaden were captured with purse seines. Fishing by this method was conducted in waters along the Atlantic and Gulf coasts, namely in the states of New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, Florida, Mississippi, Louisiana, and Texas.

The pound net method

Although the number of menhaden taken in pound nets is extremely small in relation to the numbers taken in purse seines, pound nets account for fairly large numbers of menhaden, particularly in the Chesapeake Bay (Lyles, 1968). During early spring menhaden are also taken in a pound net fishery along the coast of Long Island. Reduction plants receive most of the pound net catches, but "large quantities are sold for bait" (June and Reintjes, 1962). Concerning the pound net, Reid (1955) has stated:

> The fundamental principle is that of a large bag of netting for impounding, and a series of nets hung from poles to divert the fish into the pound . . . bowl, or "head," which is the actual impounding structure, heart-shaped "bays" which concentrate and direct the fish toward the head, and finally, a leader, or "hedging," which turns the fish toward the bays and head.

(See Diagram 2 for a schematic representation of a pound net.)

In the Chesapeake Bay pound nets are used to capture menhaden, although many other species are caught in conjunction with the menhaden. Nevertheless, the catches are dominated by young menhaden, and are "used principally as bait for crab pots" (June, 1961).

In 1966 pound nets were used to capture over 23 million pounds of menhaden. This technique was used in the Atlantic Coast states of Massachusetts, New York, New Jersey, Maryland, Virginia, and North Carolina. Virginia accounted for by far the greatest poundage with over seventeen million.

Minor techniques

Menhaden are taken in relatively very small quantities by a number of methods. Including the menhaden caught in pound nets, several minor techniques, namely those associated with haul seines, fyke and hoop nets, gill and trammel nets, floating traps, and otter trawls, accounted for only two per cent of the total catch of menhaden in 1966. One or more of these methods was used in each of the following states: Rhode Island, Connecticut, New York, New Jersey, Maryland, Virginia, North Carolina, South Carolina, and Florida (Lyles, 1968).

Geographical distribution of reduction plants

"The fishing grounds and the location of plants for processing the catch are determined by the seasonal occurrence and abundance of the fish" (Reintjes, 1959). According to the Fishery Statistics of the United States, 1963, for example, the geographical distribution of menhaden landed along the Atlantic and Gulf coasts was as follows:

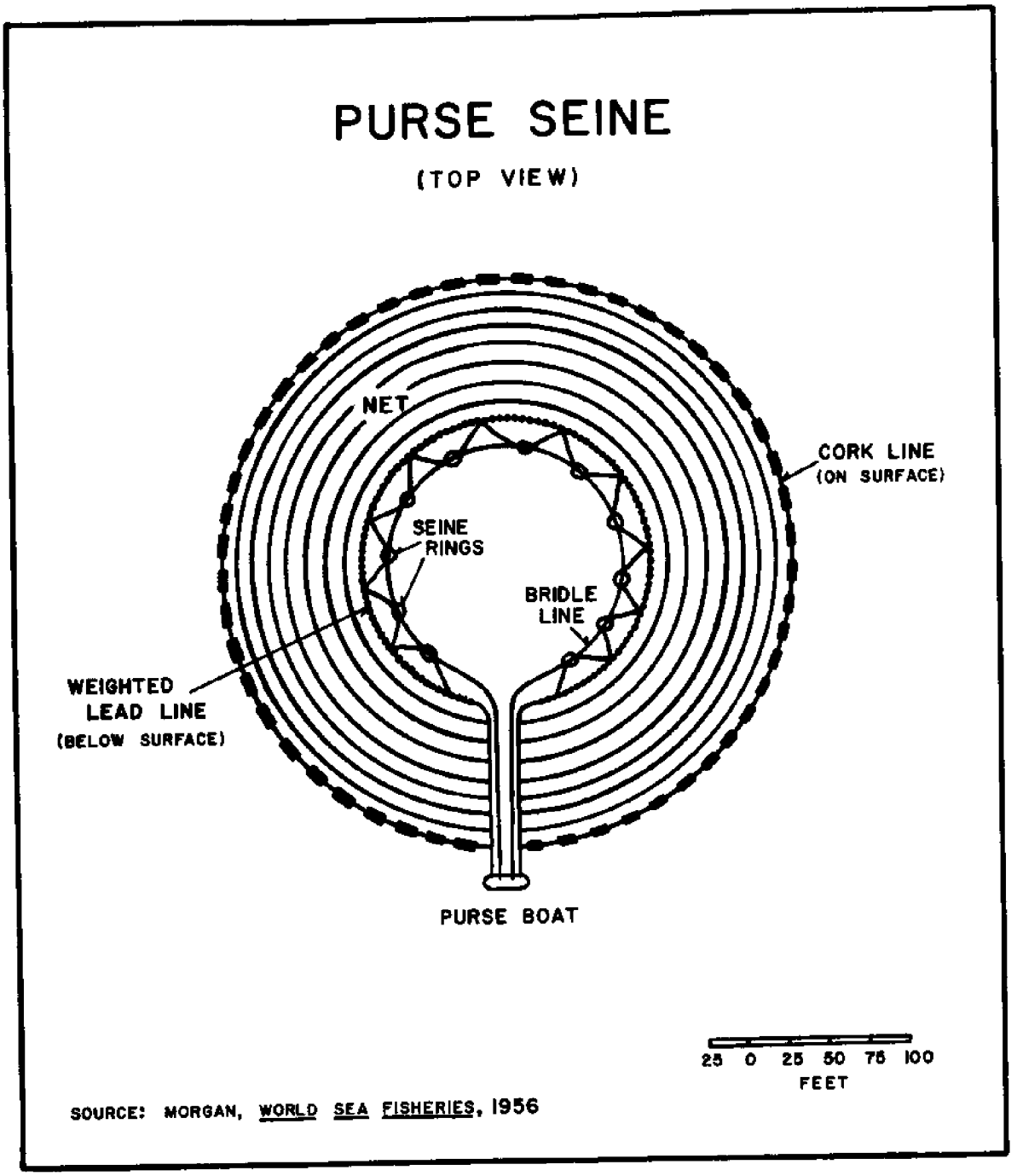

PURSE SEINE
(TOP VIEW)
NET
CORK LINE
(ON SURFACE)
SEINE
RINGS
BRIDLE
LINE
WEIGHTED
LEAD LINE
(BELOW SURFACE)
PURSE BOAT
25 0 25 50 75 100
FEET
SOURCE: MORGAN, WORLD SEA FISHERIES, 1956

Diagram 1

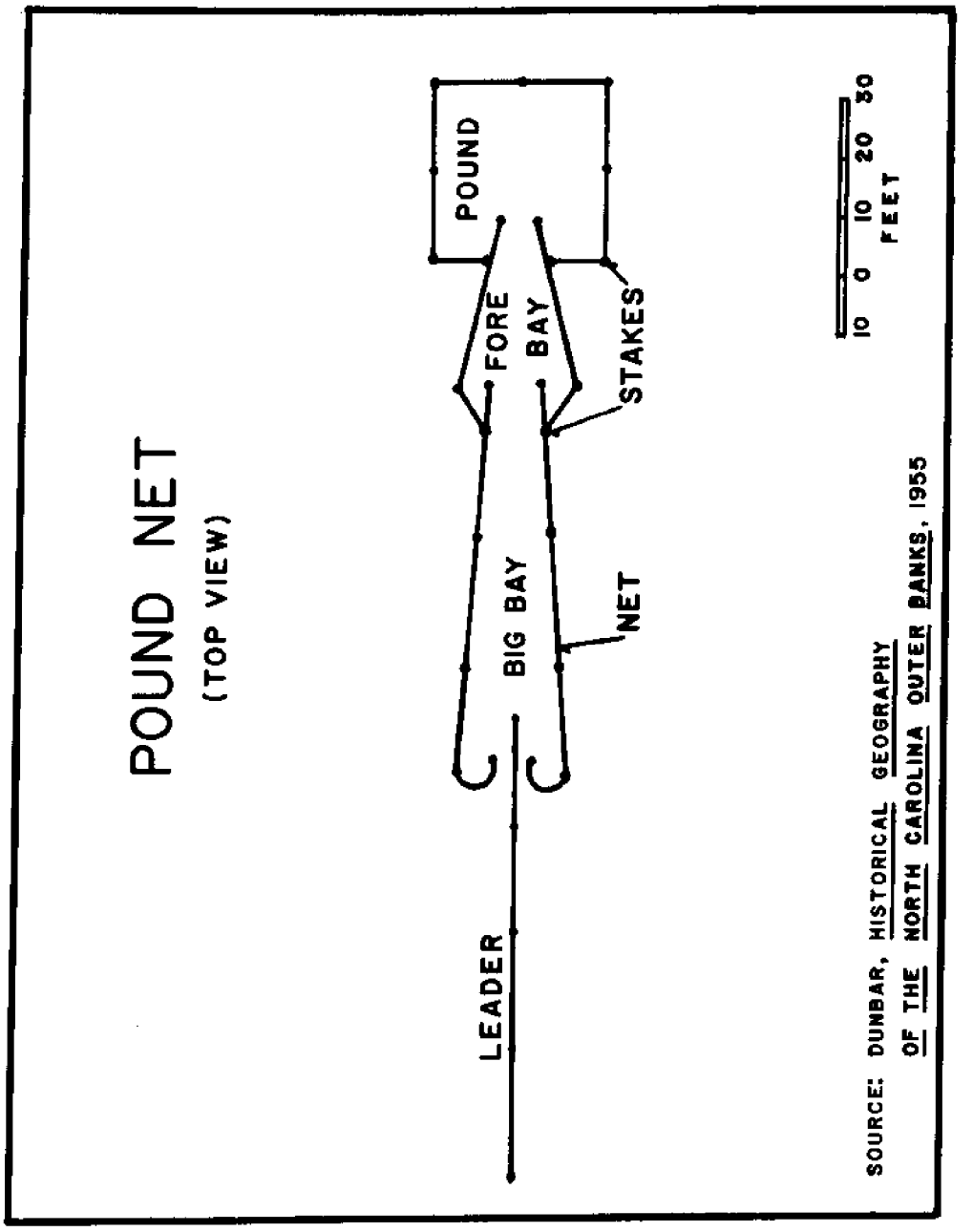

POUND NET
(TOP VIEW)
POUND
FORE BAY
STAKES
BIG BAY
NET
LEADER
10 0 10 20 30
FEET
SOURCE: DUNBAR, HISTORICAL GEOGRAPHY OF THE NORTH CAROLINA OUTER BANKS, 1955

Diagram 2

> Of the total, 53 per cent was landed in the Gulf of Mexico; 21, in the Middle Atlantic States; 14, in the Chesapeake States; and 12 per cent in the South Atlantic States. Less than ½ of one per cent was taken in the New Englnad States.

The reduction plant, where the raw fish are converted to meal and oil, constitutes the primary market for landed menhaden. The raw fish are taken directly to the reduction plants or factories for processing, usually within several hours of capture (Sanford and Lee, 1960). In 1963 the total menhaden catch was processed at thirty plants located in nine states. The distribution of menhaden plants, by city and state, was as follows: Amagansett, Long Island, New York; Port Monmouth, Tuckerton, and Wildwood, New Jersey; Lewes, Delaware (2); Reedville (4) and Whitestone, Virginia; Beaufort (4), Morehead City (2), and Southport (2), North Carolina; Fernandina Beach, Florida; Moss Point, Mississippi (3); Empire (2), Morgan City, Dulac, and Cameron (2), Louisiana; and Sabine Pass, Texas (U.S. Department of the Interior, 1965).

North Carolina

In North Carolina the menhaden fishery is conducted almost exclusively with purse seine. For the five year period from 1962 through 1966 purse seines accounted for over 99 per cent of the menhaden catch each year (Power and Lyles, 1964, Lyles, 1965-68). Thus, since the purse seine fishery constitutes the most important part of the State's menhaden fishery, this report will be concerned primarily with that phase of the industry. Nevertheless, other phases of the State's menhaden fishery will not be neglected.

The vessels

The menhaden vessels provide a link between the fishing grounds and the reduction plants. June (1967) has given an accurate description of the modern vessel:

> The design of the carrier vessels has remained essentially unchanged since the early days of the industry. Basically, these vessels are laid out with a high bow, a low stern, a large fish hold amidships, and two houses, one forward and one aft of the fish hold. The forward housing includes a galley on the main deck and pilot house and officer's quarters above. Crew's quarters are below deck, beneath the forward house. The after housing encloses the main engine and auxiliary power equipment. A mast, with its conspicuous crow's nest and boom, is located just aft of the forward housing.

Alverson (1967) has stated that the menhaden vessel is "the only American fishing vessel with this particular superstructure arrangement" (See Figs. 2 and 3). Vessels operating in North Carolina waters range from about 50 to 600 gross tons in weight, and are highly specialized for this particular fishing activity (Lyles, 1968). During the fall fishing season, there is a migration of men and vessels into North Carolina. Most of these vessels and their crews come from the Chesapeake Bay area. However, vessels have been brought in for the fall season from as far north as New York and as far south as Mississippi (See Fig. 4).

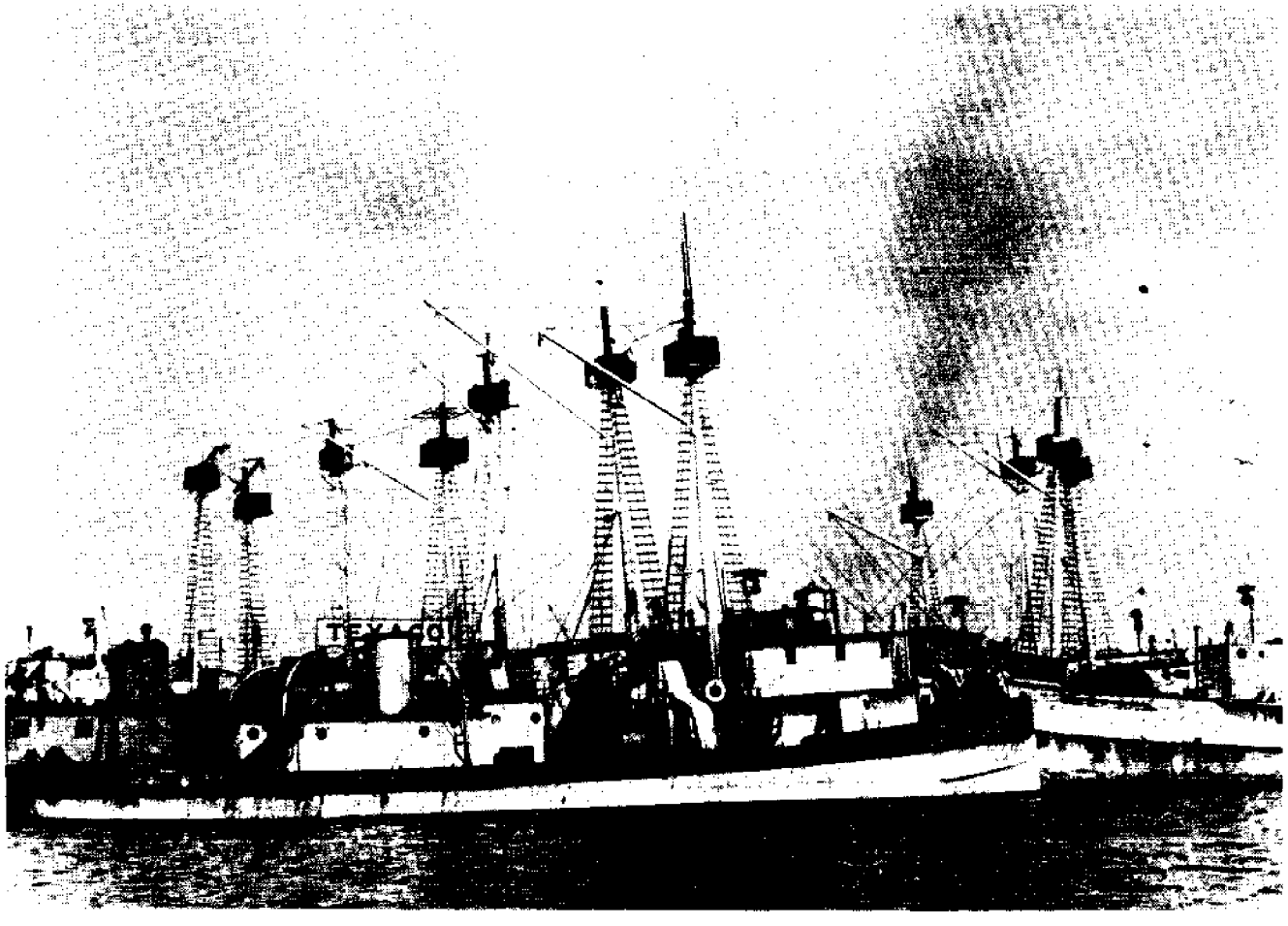
The labor

Courtesy of the National Marine Fisheries Service

Fig. 2.--Menhaden vessel (wood construction)

Courtesy of the National Marine Fishes Service

Fig. 3.--Menhaden vessel (steel construction)



Courtesy of the National Marine
Fisheries Service

Fig. 4.--Portion of fall menhaden fleet at Beaufort, North Carolina

Generally, a menhaden vessel will carry 17 fishermen made up of a captain, pilot, chief engineer, second engineer, cook, and 12 crew members. In the Beaufort-Morehead City fishery the locally owned vessels are crewed by fishermen from Carteret and Craven counties. However, during the fall fishery most of the labor force comes from around the Reedville and Kilmarnock areas of Virginia (Potter, 1967).

The fishing method

Purse seines are used to catch the menhaden schools as they swim along the near-surface waters. The seine, small boats, crew, and other essential elements of the fishing operation are carried to the grounds in the large menhaden vessel. The actual fishing operation, however, is not conducted from the mother vessel. The main purpose of the "steamer," as the mother vessel is known in the business, is three-fold: 1) transportation of the equipment and men to the grounds; 2) life support base for the crew; and 3) transportation of the men, equipment, and catch to the reduction plant. Two small aluminum boats, called purse boats, are used to carry the seine from the mother vessel to the menhaden school. It is from these purse boats that the actual fishing activity is accomplished.

On sighting a school of menhaden, the captain boards a purse boat and directs them to the fish. The purse seine is held and carried in two equal parts by the purse boats, which are secured together side by side (see Fig. 5). On reaching the school, the men begin laying the seine, while the purse boats move in a half circular direction opposite to each other until the school is entirely surrounded by the net (see Fig. 6). When the fish are encircled, a heavy lead weight called a "tom" is attached to the seine's purse line and dropped overboard. Connected to a power winch , the purse line is reeled in, causing the bottom of the seine to close like a "purse." The weight of the "tom" keeps the seine from being pulled up to the surface during winching. The seine is then attached to power-blocks, one to a purse boat, and is hauled in, compressing the school into an area which grows smaller and smaller until the entire body of fish is held in a very small space (see Fig. 7). The mother vessel then comes along side the net and the fish are pumped into the large central hold of the vessel by means of a large rubber hose (see Fig. 8). When the vessel is filled, or night falls, the day's fishing is completed, and the vessel returns to the reduction plant to unload the catch.

One of the most important innovations in the purse seine fishery has been the use of airplanes to "spot" fish. On this matter June (1961) wrote:

> Since about 1946, airplanes routinely have been used to locate the fish, and in recent years the practice of directing the laying of the seine around a school of menhaden from the air by radio communication between the airplane pilot and the fishing captain has been universally adopted.

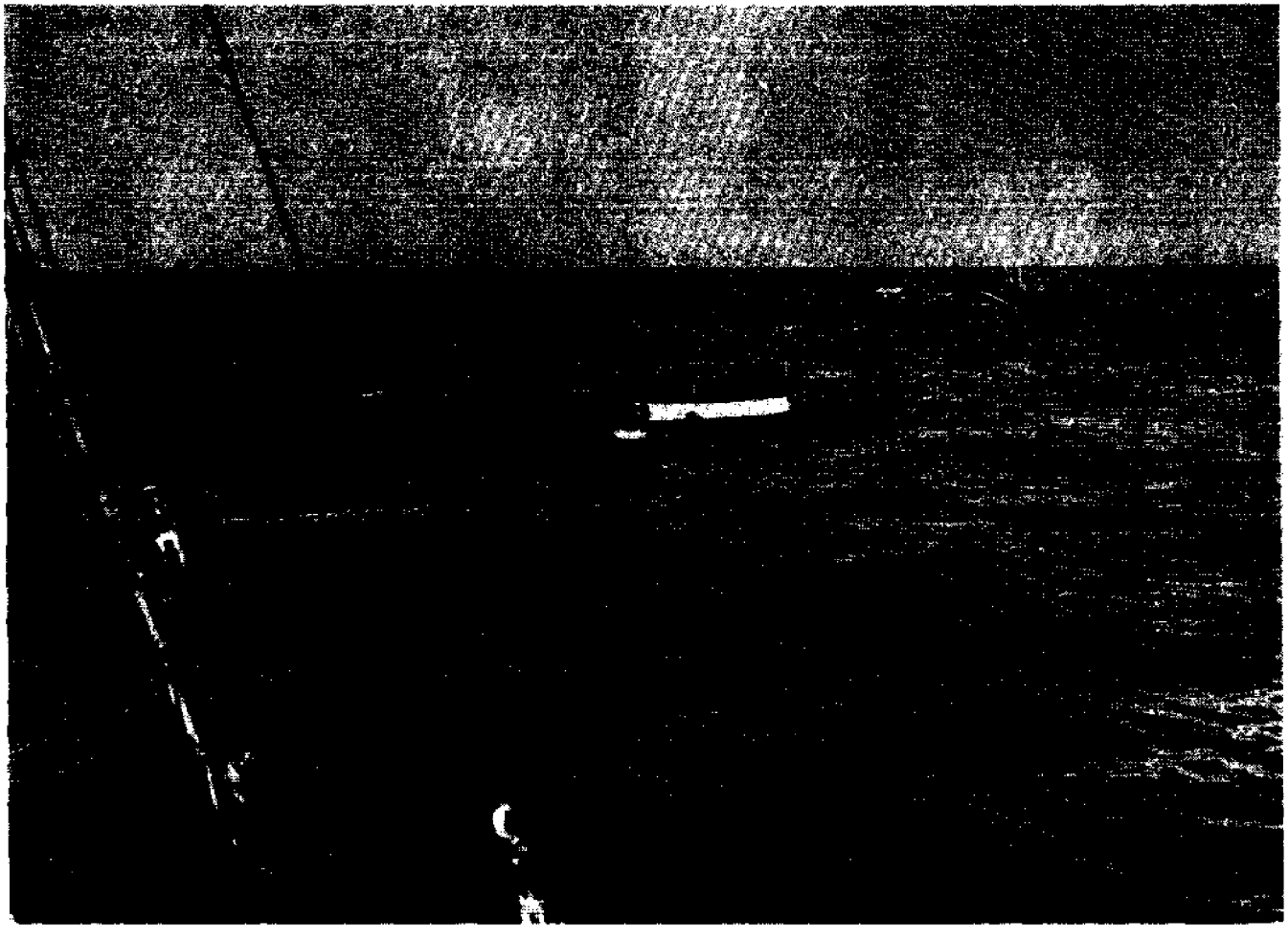
In North Carolina airplanes are used to spot the menhaden schools. During the 1967 season about twenty-five planes were used, one plane for every three vessels. Although no fishing is practiced on Sundays, airplanes are used to report the location of migrating schools (Potter, 1967).

Marketing

Reduction plants, or menhaden factories, constitute the primary markets for the daily catch of menhaden. June (1967) has explained the marketing of men-

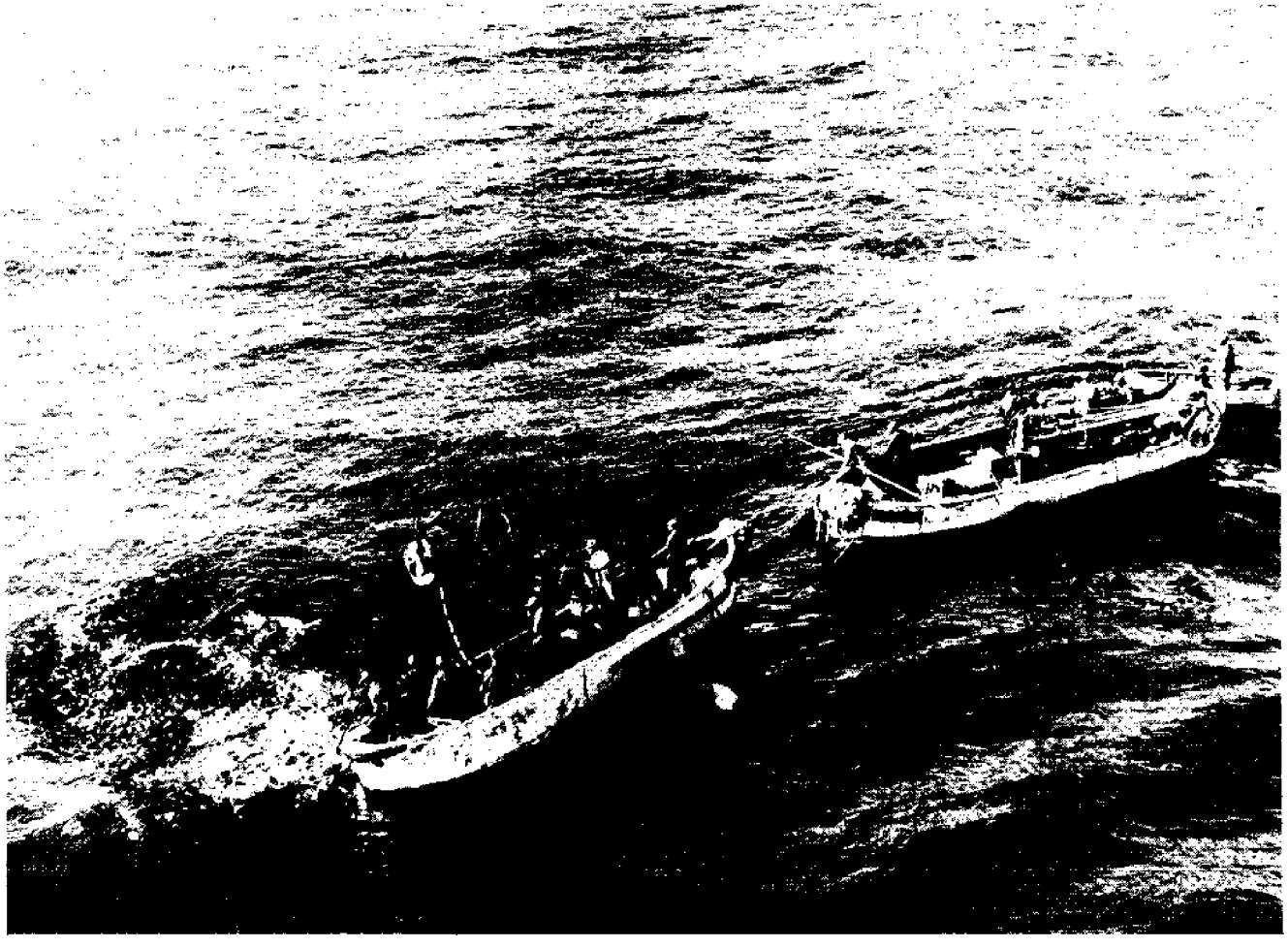
Courtesy of the National Marine Fisheries Service

Fig. 5.--Purse boats carry seine from the menhaden vessel to the school.



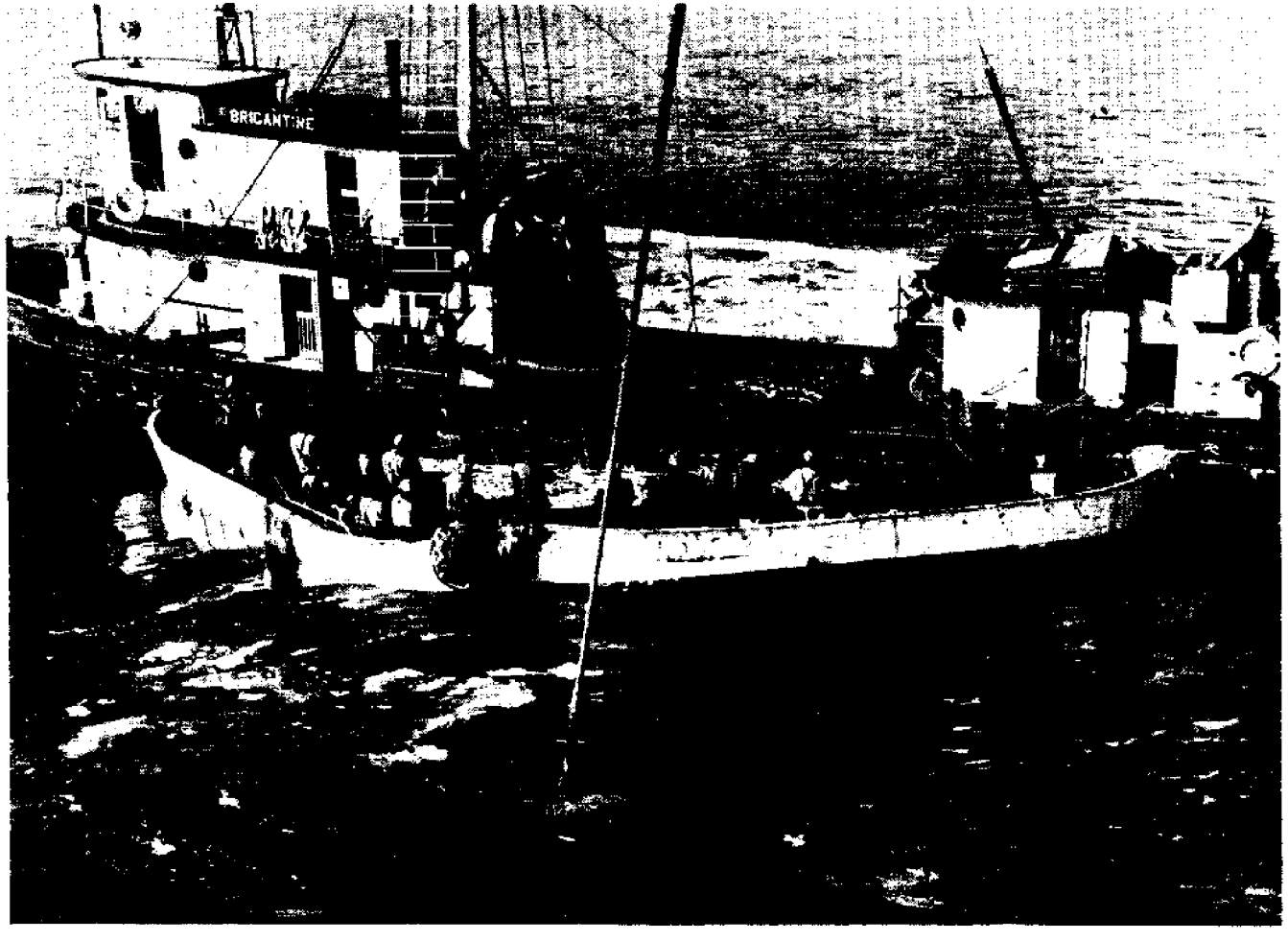
Courtesy of the National Marine Fisheries Service

Fig. 6.--Purse seine is set around the school of menhaden.



Courtesy of the National Marine Fisheries Service

Fig. 7.--Power blocks are used to haul in the purse seine.



Courtesy of the National Marine Fisheries Service

Fig. 8.--Menhaden are pumped into the central hold of the vessel through a large rubber hose.

haden:

> Because of the large quantities in which the fish are caught and the rapidity with which they decompose, vessels generally return with the catch to the processing plant at the end of the day. Accordingly, the fish are usually landed at the plant within 10 to 15 hours after being taken from the water. Vessels equipped with refrigerated holds may remain at sea for several days, particularly when catches are running light, and still deliver the fish in satisfactory condition.

Roger Harrison (1931) has commented on the location of menhaden factories:

> The factories are located as near the fishing grounds as practical. The buildings are generally built on banks of some creek, river, cove, or behind some natural windbreak, so that smooth water is assured the vessels at the unloading dock. It is essential that the unloading equipment be located on water deep enough to permit the vessels to come in at all times. As a result, parts of many factories and even entire factories have been put up on piling over the water; this also facilitates the dumping of waste water. Where the factory has not been so constructed, the unloading or elevator house has been placed on deep water and the fish are conveyed back to the reducing equipment.

(Note Fig. 9 for example of unloading facilities.)

In North Carolina five large menhaden factories are located in the Beaufort-Morehead City area, and one large factory is located at Southport. In the Morehead City area, two factories are located adjacent to each other along the shore of Bogue Sound. In Beaufort two factories are located on Taylor's Creek, and one factory is located on the Beaufort Channel of the Newport River (see Fig 10). A small, cat food manufacturing plant, which utilizes menhaden captured from one vessel, is also located on the Channel.

Minor fisheries

Menhaden have been recorded by several minor fisheries along the North Carolina coast. For example, during the 1966 season menhaden were taken in haul seines, pound nets and gill nets. The total catch of 166,000 pounds was valued at less than $2,500 (Lyles, 1968).

Geographical distribution of catch

Over a ten-year period from 1957 through 1966 menhaden landings were recorded in nine North Carolina counties. Landings were concentrated in the two counties of Carteret and Brunswick. For the ten-year period Carteret County accounted for the vast majority of the total catch, approximately 77 per cent. For the same period of time Brunswick recorded about 22 per cent. The remaining 1 per cent was recorded in seven counties: from north to south-Chowan, Washington, Tyrell, Dare, Pamlico, Onslow, and New Hanover (see Map 5). During this ten-year period Carteret County recorded an average yearly catch of over 150 million pounds. For the same period, Brunswick recorded a yearly average of nearly 44 million pounds.

Total menhaden landings for the State came to nearly 2 billion pounds over

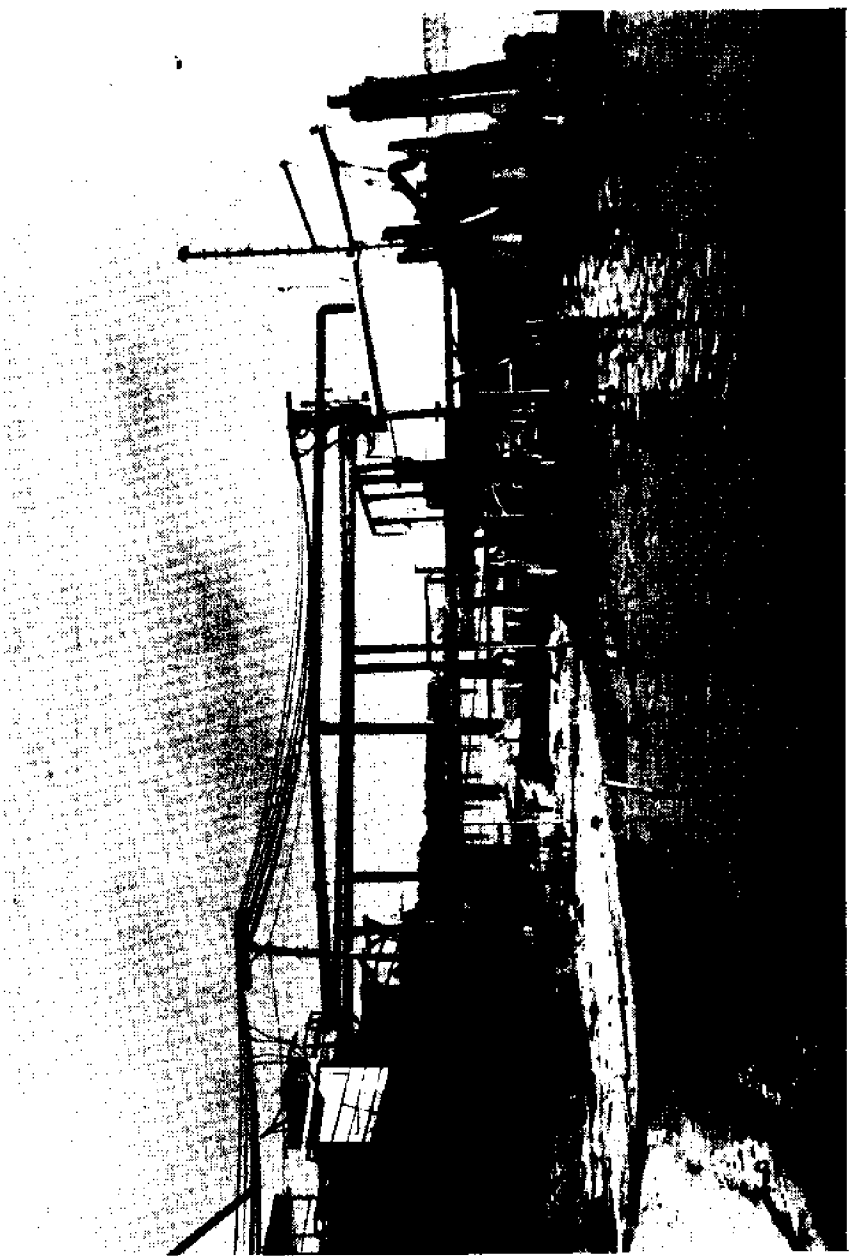
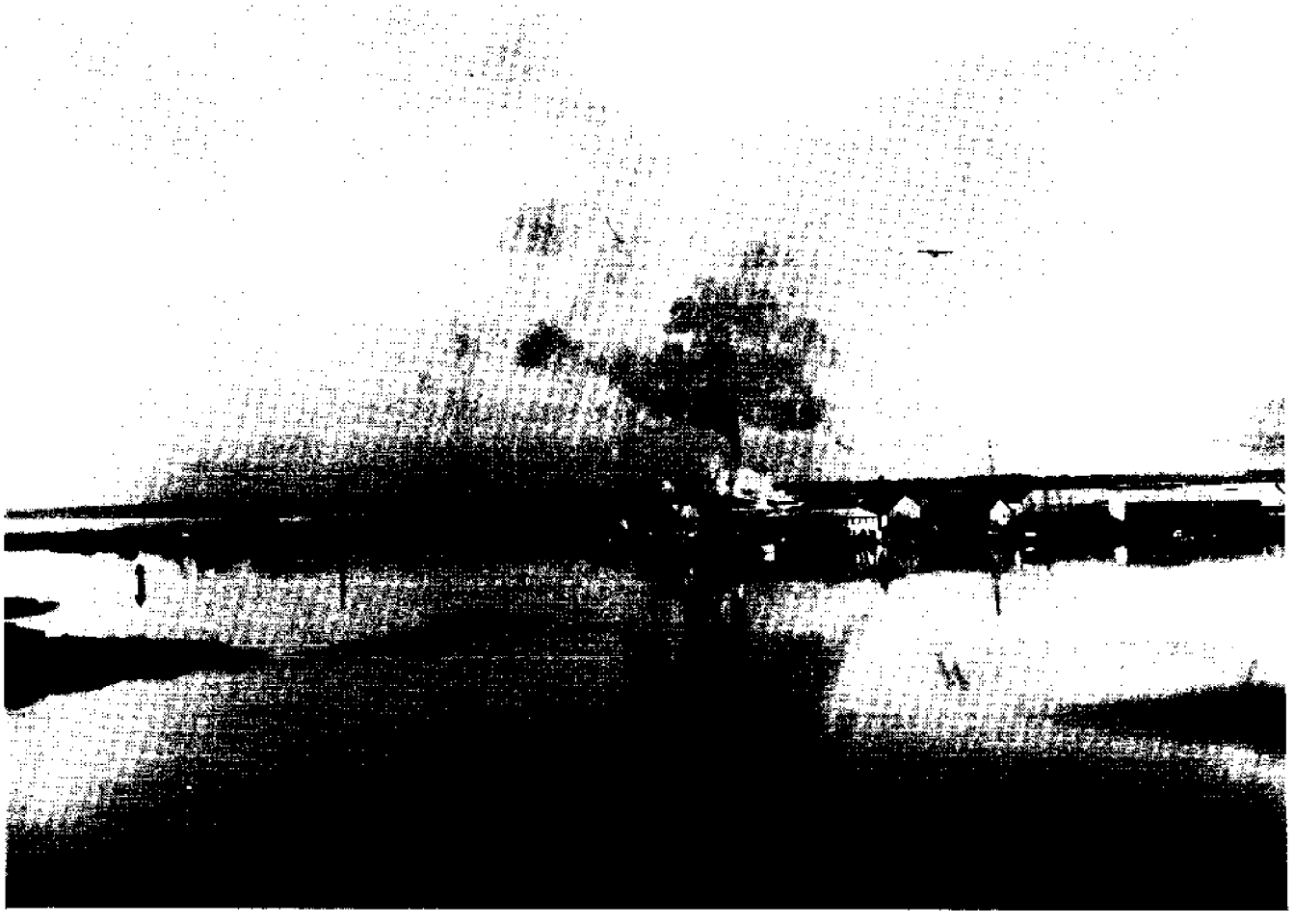
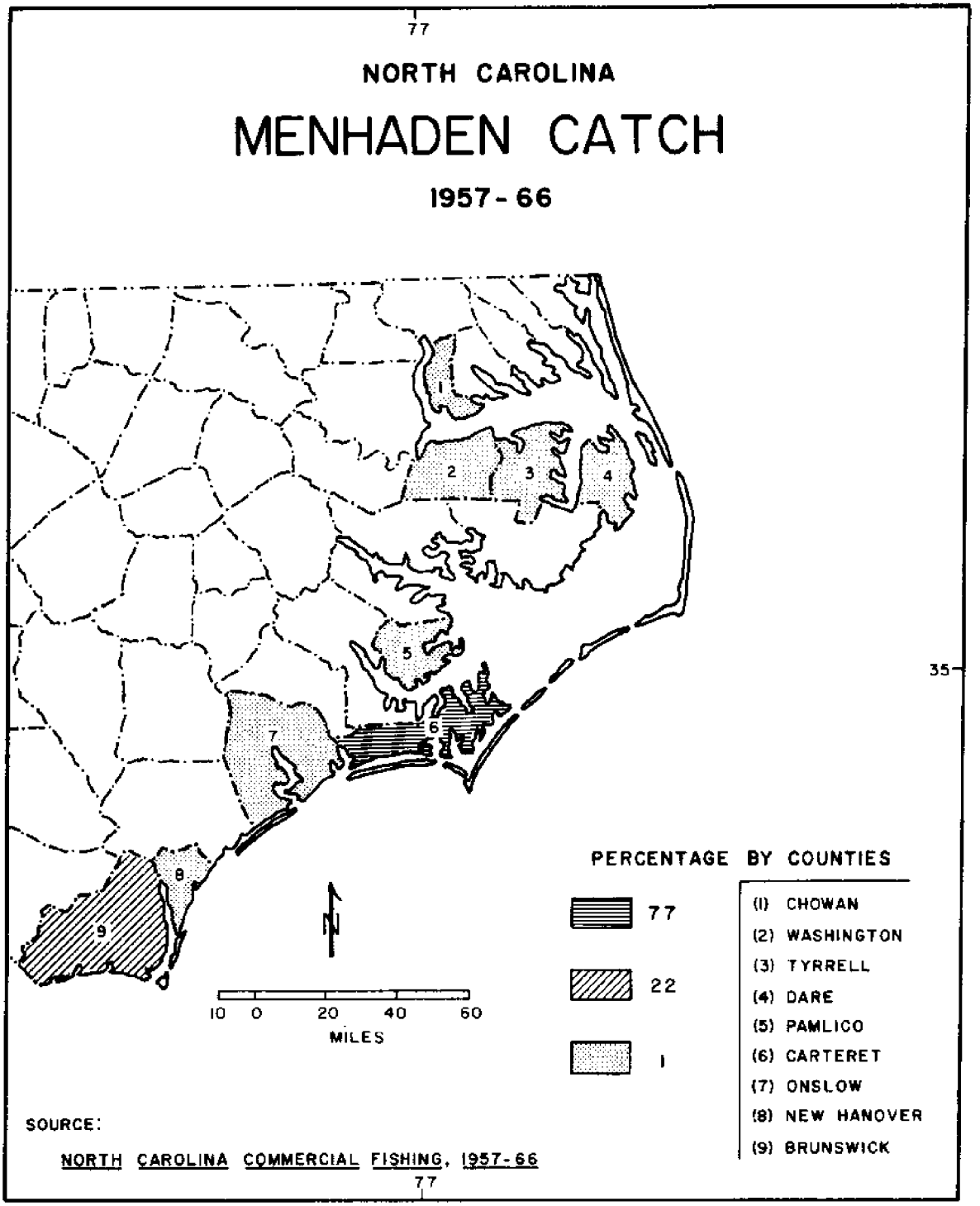


Fig. 9. -- Typical apparatus through which the fish are conveyed from the menhaden vessel to the reduction plant.



Courtesy of the National Marine Fisheries Service

Fig. 10.--Modern reduction plant located on the Beaufort Channel, Beaufort, North Carolina.


77
NORTH CAROLINA
MENHADEN CATCH
1957-66
35
1
2
3
4
5
6
7
8
9
N
10 0 20 40 60
MILES
PERCENTAGE BY COUNTIES
77
22
1
(1) CHOWAN
(2) WASHINGTON
(3) TYRRELL
(4) DARE
(5) PAMLICO
(6) CARTERET
(7) ONSLOW
(8) NEW HANOVER
(9) BRUNSWICK
SOURCE:
NORTH CAROLINA COMMERCIAL FISHING, 1957-66
77

Map 5

the ten-year period. The largest single year catch amounted to over 235 million pounds, recorded in 1958; while the smallest annual catch was recorded at just over 122 million pounds during 1962. From 1957 through 1966 menhaden landings were recorded each year in both Carteret and Brunswick Counties. (N.C. Department of Conservation and Development, 1957-66).

Summary

Since menhaden are schooling fish which swim in the near-surface waters, the most efficient method of fishing employs a type of net, known as a purse seine, which because of its design allows the bottom to be "pursed," thus completely entrapping the fish. This purse seine method has been used since the middle of the nineteenth century, and presently accounts for over 98 per cent of the annual catch. Although the purse seine fishery is by far the largest operation, menhaden are caught in a pound net fishery in Virginia and by several minor methods. Most menhaden are marketed directly at plants where the raw fish are then reduced to meal, oil and condensed solubles. These reduction plants are located in eight states along both the Atlantic and Gulf coasts.

North Carolina constitutes the major area for purse seine activities along the south Atlantic coast. The State has six large reduction plants; three at Beaufort, two at Morehead City and one at Southport. Carteret and Brunswick Counties account for approximately 99 per cent of the total landings. During the summer season menhaden are captured by local fishermen, but in the fall a large influx of men and vessels primarily from Virginia constitutes the last major purse seine fishery for menhaden each year. A single purse seine operation involves basically a large carrier vessel specifically designed for menhaden fishing, two aluminum purse boats and small skiff from which the actual fishing activity takes place, and about seventeen fishermen. These elements are typical not only of the North Carolina fishery, but of all purse seine operations on the Atlantic and Gulf coasts.

PROBLEMS AND PROSPECTS

Introduction

Like any modern, complex industry the menhaden fishing industry has been experiencing a number of problems. These problems while interconnected may be classified into three main sections concerning: 1) the resource; 2) the fishery; and 3) foreign imports.

Atlantic and Gulf Coasts

The resource

When the California sardine or pilchard suddenly disappeared in the late 1940's and that fishery all but collapsed, the menhaden fishery was just beginning its long period of domination in the fish meal industry and was quick to take the lead in supplying the much-sought-after meal. "The result was that 8 out of 10 years in the flourishing fifties saw a new record set for the catch of menhaden" (Lee, 1961). During this period the menhaden resource was generally considered to be inexhaustible. One investigator (Roy, 1949), who "wondered if menhaden too would not decline in numbers as did the Pacific pilchard," received

this reply from a menhaden fisherman: "I've been fishing for menhaden for nearly 22 years, and instead of the fish decreasing in numbers they seem to be more abundant each season." In 1953 Lee commented on the menhaden resource:

> In spite of extreme local fluctuations in abundance, so far as is known, at no time in its existence has the menhaden fishery as a whole failed to the same extent that the pilchard fishery did just a few years back, or as has the herring and sardine fishery at intervals and in some areas throughout the world.
>
> From the vantage point of 75 years of generally successful fishing, the dire predictions made in the 1870's of ruin to the industry from overfishing or by predatory species may seem amusing.

However, the menhaden have declined in numbers. After the season of 1956, a weakening trend was observed in the Atlantic fishery, but a rise in Gulf of Mexico landings offset the drop in Atlantic catches. In 1966-67 the Gulf landings declined and the total U.S. catches were about half of the peak year, 1962. The Gulf landings set new records in 1969 and 1970 but have not wholly compensated for the Atlantic menhaden decline. According to Graham (1968) :

> The decline in the menhaden fishery, like that of the California sardines, has occurred in the face of a good demand for the fish. The market for menhaden in the United States is firm but the fish cannot be found.

According to Lyles (1968), fishery scientists "attribute the diminishing catch to overfishing along the Atlantic coast and recommend a curtailment of fishing to permit replenishment of the resource."

Still other factors may play an important role in reducing the menhaden resource. Lewis (1966) has commented on the destruction of the young menhaden's nursery grounds:

> Water-development projects and pollution are becoming more prevalent as the human population grows. For example, dams that will effect large masses of water in estuaries on the Atlantic and Gulf coasts of the United States are under consideration. These structures will probably reduce the nursery areas accessible to menhaden larvae and may reduce the numbers of menhaden.

Natural causes also effect the abundance of menhaden. Bigelow and Schroeder (1953) have commented on the great numbers of fish and marine animals which prey on menhaden:

> No wonder the fat oily menhaden, swimming in schools of closely ranked individuals, helpless to protect itself, is the prey of every predaceous animal. Whales and porpoises devour them in large numbers; sharks are often seen following the pogy schools; pollock, cod, silver hake, and swordfish all take their toll. . .Tuna also kill great numbers. But the worst enemy of all is the bluefish. . .Not only do these pirates devour millions of menhaden every summer, but they kill far more than they eat. Besides the toll taken by these natural enemies, menhaden

> often strand in myriads in shoal water, either in their attempt to escape their enemies or for other reasons, to perish and pollute the air for weeks with the stench of their decaying carcasses.

The fishery

Highly correlated with the diminishing resource is the decline in production of captured menhaden. Peeling (1968) has written:

> The catch by menhaden seiners along the Atlantic coast last year (1967) was 430 million pounds, the smallest since 1942. States bordering the Gulf of Mexico produced 697 million pounds, the Gulf fishery's worst year since 1958. Overall, production was down 11 per cent and value 30 per cent.

Aside from the overall decline in annual catches, tremendous fluctuations in the menhaden catches of a particular area have been and still are serious problems encountered in the fishery. Despite the availability of menhaden year-to-year fluctuations may be caused by: 1) bad weather conditions, which make fishing impractical if not impossible; 2) an oversupply at certain plants which prevents the vessels from unloading their catch; and 3) low wages which discourage the fishing effort (Potter, 1967).

Foreign imports

Accompanying the decline in menhaden catches, imports of foreign fish meal have begun to rise. In 1967 the herring fishery of Norway provided 17 per cent of the United States' imports of fish meal, while the anchovy fishery of Peru provided 68 per cent. Concerning this problem, Peeling (1968) has written:

> Since imports are available at prices lower than those paid United States producers, the U.S. producers are hit twice: they can't meet domestic needs and they have to drop price to compete. . . . . Fish meal imports in this country rose 45 per cent in 1967 over 1966. They have increased 82 per cent over the average for the period 1962-66.

Thus, in combination with other factors, the underselling of domestic fish meal by foreign imports constitutes a major economic problem for the fishing industry.

Research

The problems of the menhaden industry are undergoing intensive research. The National Marine Fisheries Service, which has conducted menhaden research since 1955, is currently involved in studies concerning the life history, ecology, physiology, and population dynamics of both the Atlantic and Gulf menhaden. Major emphasis is being placed on the "tagging" of menhaden in an attempt to obtain more accurate knowledge of the distribution and migrations of the fish. As of October 1969, over a million menhaden have been tagged, and 136,000 of the tags have been recovered from the processed fish (Reintjes, Personal Communication, 1969).

The menhaden fishing industry itself had conducted some small scale research in the areas of technology and fishing gear. Research has also been conducted by several state governments, and several universities have been planning some research activities concerned with menhaden.

Prospects for the future

While at the present time, "things look bleak" (Peeling, 1968) for the menhaden fishery, continued research may provide solutions to many of the problems associated with the industry. One possible solution to the declining resource might be in diversification of the fishing effort. Exploitation of the thread herring might replace dependence on menhaden. Reintjes and June (1960) have commented on this species:

> The thread herring, Opisthonema oglinum, occurs generally throughout the Carribean and along the Gulf coastal states southward to the Gulf of Campeche. This species was found to be available in large quantities throughout the year along the west coast of Florida and appeared to be present in large numbers in the shallow coastal waters of the remaining Gulf states during the summer.

Concerning the menhaden, June (1961) has stated that exploitation of the two warm water species, Brevoortia smithi and Brevoortia gunteri, would help augment the low catches of Atlantic and Gulf menhaden. June explained his thesis:

> Two North American species--the yellowfin and fine-scaled menhaden--exist as virgin stocks and apparently are not being utilized because the distribution and habits of the fish are not well known.

Continued research will surely bring forth methods by which the year-to-year supply of menhaden can be reasonably projected, thus making wiser harvesting practices possible. In this manner, the present stocks of menhaden might be allowed to replenish themselves for future utilization by the industry.

As far as foreign imports are concerned, some type of protective legislation on the national level might help control the importation of lower priced fish meal. A measure of this kind would certainly do much to help the menhaden industry.

North Carolina

The problems and prospects for future development of the menhaden fishing industry in North Carolina reflect the over-all situation in the United States' fishery.

Problems

Depletion of the raw resource constitutes the primary problem in North Carolina. Landings were "well below average" (Henry, 1968) in the Tar Heel fishery during 1967. The fall fishery, by far the larger of the two North Carolina seasons, accounted for approximately 113 million pounds of menhaden, a decline of about 45 million pounds from the previous year. Landings in the fall of 1970 were about 40 million pounds, the smallest catch since the 1930's.

In addition to the general decline in numbers of menhaden, great fluctuations in the annual catches have been characteristic of the fishery in North Carolina. The annual production of menhaden has been anything but steady over the ten-year period from 1957 through 1966. During this time menhaden landings ranged from a high of over 235 million pounds in 1958 to a low of over 122 million pounds in 1962. Throughout the ten-year period yearly variations ranged

from about 38 million to 157 million. The average yearly landings amounted to over 192 million pounds (N. C. Department of Conservation and Development, 1957 - 66).

Competition from lower priced, imported fish meal is felt directly in the Beaufort-Morehead City area. A newly established distributing plant at the Morehead City port receives foreign fish meal which is shipped throughout the State.

Prospects

The future of the menhaden industry in North Carolina appears to be dependent on the development of ways to arrest the decline in the menhaden resource. The National Marine Fisheries Service maintains a laboratory on Piver's Island, Beaufort, where the extensive research programs on both the Atlantic and Gulf menhaden are centered. It is through these programs that solutions to the menhaden problem may be found. One possible solution might be the taking for commercial purposes of other herring-like fish which are found in North Carolina waters. Already this practice is carried out on a limited scale. Some thread herring, known in the Beaufort-Morehead City area as "hairy backs", are now being captured and utilized by the local menhaden fishery during part of the summer season. In conjunction with this development, "research is underway to see if Atlantic herring can be used as a replacement for the declining menhaden stocks" (Hardee, 1969).

Conclusion

Menhaden were captured in North American waters before European settlement of the continent and were taken in large amounts for commercial purposes by the early 1800's. With its initial development in the New England states, the menhaden fishing industry gradually expanded southward. In North Carolina menhaden have been reported since early colonial times and, in spite of a number of futile attempts to establish a successful fishery in the state, have been captured on a continuous, commercial basis since about 1887.

Since 1946 menhaden have been captured along the Atlantic and Gulf coasts in the largest commercial fishery, by volume, in the United States. The vast majority of menhaden are captured in a highly efficient purse seine fishery, which is in operation from April through December. The North Carolina purse seine fishery constitutes the largest fishery in the South Atlantic region, and as such plays an important role in the over-all menhaden fishery in the United States. Menhaden are captured in Tar Heel waters during two distinct periods, namely the summer months from May through August, and the fall months from October through December. The latter season is the only fall fishery for menhaden.

Although the menhaden fishing industry still remains the largest fishery by volume in the United States, there has been a severe decline, since 1962, in the Atlantic fishery. A general decline in the menhaden catches reflects the diminishing raw resource. Several factors have been attributed to the declining menhaden stocks, chief among which are: 1) overfishing of the resources; and 2) pollution of estuaries, the nursing grounds of young menhaden. The general decline of menhaden catches are reflected in the North Carolina fall fishery which dropped from 158 million pounds in 1966 to 40 million pounds in 1970.

In the final analysis the menhaden fishing industry, while having a long and prosperous history as the largest fishery by volume of catch in the United States, appears at this time to be facing serious problems concerning both the natural resource base and uncontrolled foreign competition. The menhaden fishing industry in North Carolina exemplifies to a high degree the general situation in the United States' fishery.

APPENDIX A

MENHADEN CATCH STATISTICS
SOUTH ATLANTIC FISHERIES, 1880-1970

(Thousands of Pounds)

Year	North Carolina	South Carolina	Georgia	Florida (East Coast)	TOTAL
	Quantity	Quantity	Quantity	Quantity	Quantity
1880	(1)	(1)	(1)	(1)	(1)
1887	14,756	-	-	(1)	(1)
1888	13,844	-	-	-	13,844
1889	8,753	-	-	-	8,753
1890	12,410	-	-	-	12,410
1897	11,310	-	-	-	11,310
1902	18,862	-	-	-	18,862
1908	57,412	-	-	-	57,412
1918	179,911	-	29,485	48,363	257,759
1923	63,290	-	26,973	57,918	148,181
1927	98,987	-	34,102	24,876	157,965
1928	99,302	-	30,030	21,512	150,844
1929	173,490	-	29,213	31,717	234,420
1930	134,051	-	24,701	34,242	192,994
1931	67,877	-	869	3,710	72,456
1932	54,476	-	11,520	11,180	77,176
1934	106,651	-	18,752	29,404	154,807
1936	150,088	-	14,500	65,482	230,070
1937	61,706	-	9,864	133,538	205,108
1938	146,819	-	7,034	148,916	302,769
1939	181,968	-	2,957	102,318	287,243

1/ Not available.

Source: National Marine Fisheries Service

APPENDIX A-Continued

Year	North Carolina	South Carolina	Georgia	Florida (East Coast)	TOTAL
	Quantity	Quantity	Quantity	Quantity	Quantity
1940	129,592	-	234	95,056	224,882
1945	141,533	-	-	114,746	256,279
1950	124,905	961	-	21,259	147,125
1951	104,013	4,477	-	79,600	188,090
1952	191,341	3,218	-	120,282	314,841
1953	132,105	1,696	-	65,544	199,345
1954	160,301	3,952	-	42,009	206,262
1955	184,919	6,638	-	36,254	227,811
1956	246,648	-	-	67,998	314,646
1957	172,522	7,027	-	16,852	196,401
1958	235,385	861	-	7,871	244,117
1959	279,888	3,991	-	46,637	330,516
1960	190,431	-	-	24,592	215,023
1961	221,555	-	-	32,950	254,505
1962	122,898	-	-	34,271	157,169
1963	190,214	-	-	25,672	215,886
1964	172,992	-	-	17,154	190,146
1965	160,595	10	-	31,670	192,275
1966	182,289	235	-	32,590	215,114
1967	150,481	768	-	43,297	194,546
1968 2/	167,189	253	-	23,940	191,382
1969 2/	145,235	245	-	19,394	164,874
1970 2/	108,235	10	-	27,953	136,198

2/ Preliminary

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ACKNOWLEDGMENT

This paper was presented in 1970 to the Department of Geography, East Carolina University, as a thesis (Geography Research Paper No. 11) in partial fulfillment of the requirements for the degree Master of Arts. The author wishes to thank all those persons who in one way or another helped to make this final report possible.

Thanks are particularly due Professor Shea, my advisor, for his fine guidance and patience throughout the entire project, and Dr. Ennis Chestang, my second reader, for his many helpful suggestions both in the research and writing stages of the paper. Appreciation is expressed to Dr. Daniel Stillwell for his advice during the cartographical work phase of the report, and Dr. Robert Cramer, Chairman of the Department of Geography at East Carolina University, for his encouragement throughout my graduate studies.

I am very grateful to John W. Reintjes, research biologist at the National Marine Fisheries Service Biological Laboratory, Beaufort, North Carolina, who made available to me not only a vast amount of material but also his storehouse of knowledge acquired through years of menhaden research. Thanks also go to William R. Nicholson, fishery biologist, who aided in correcting some of my errors in the preliminary draft of this paper.

Lastly, the author is especially indebted to Doug Willis, of the Biological Laboratory, who helped in more ways than can be mentioned here.

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