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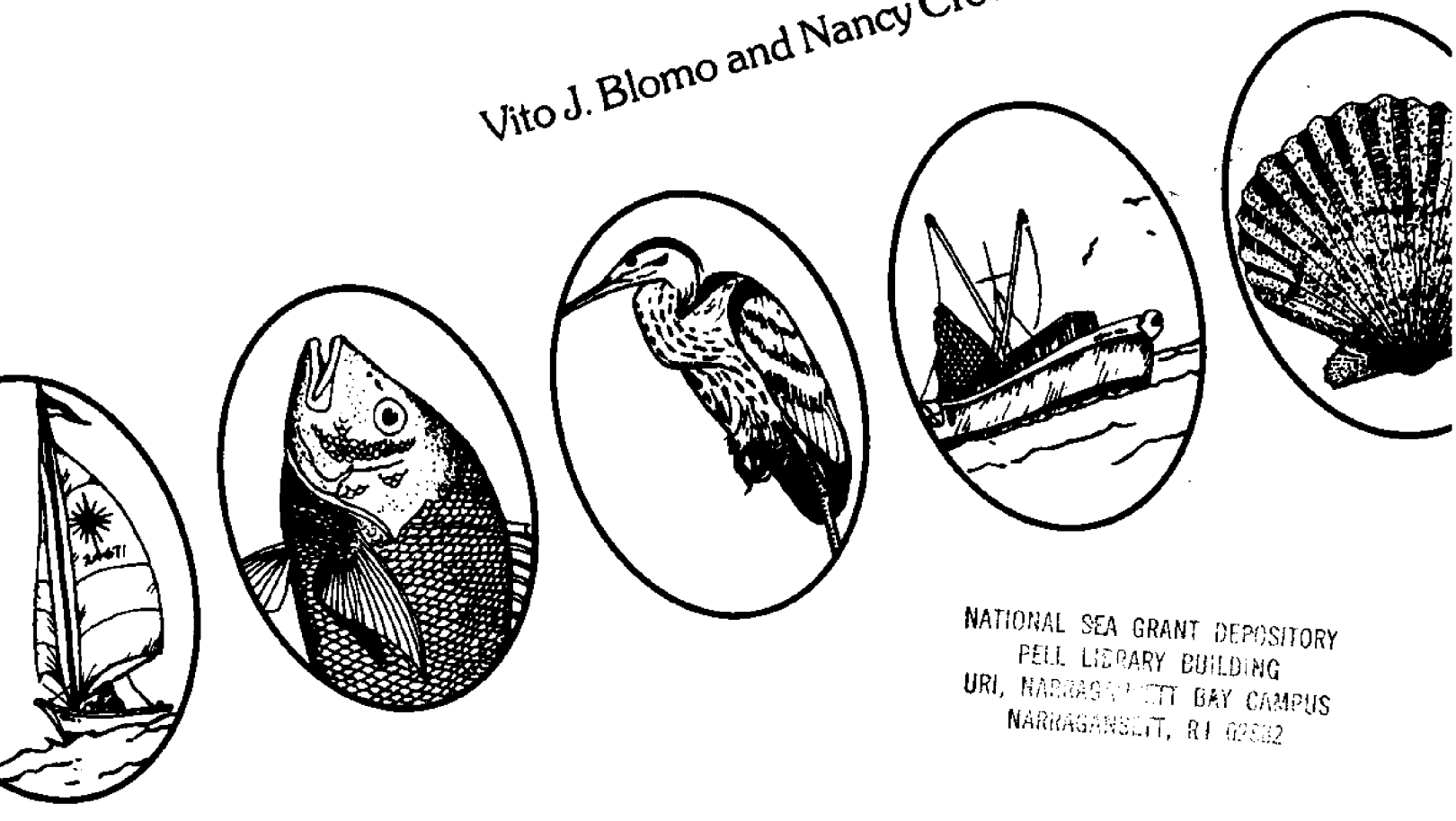

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ECONOMIC IMPACT OF A CLOSED FISHING CORRIDOR ON THE NORTH CAROLINA MENHADEN FISHERY

by
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ABSTRACT

The present research analyzes the economic impact of a closed fishing corridor on the North Carolina menhaden industry and related sectors. At issue is the industry's ability and willingness to withstand large short-term losses in order to operate at a reduced level from present in the long run. Another important issue is the ability of the industry's labor force, with a generally low level of education and training, to find alternative employment. A closed fishing corridor may permanently reduce industry fish meal revenue by 4 to 13 percent and wages accruing to the harvesting sector by 4 to 13 percent. The decline in fish meal revenues would result in as many as 34 to 155 fewer jobs region-wide.

INTRODUCTION

North Carolina's largest commercial marine resource, in terms of weight, is menhaden. This fish is the subject of resource conservation concerns all along the Atlantic coast. The Atlantic States Marine Fisheries Commission (ASMFC), is charged to recommend fishery management measures to deal with problems common to the states.

The rationale for a larger purse seine mesh size and a closed fishing corridor proposal involves resource conservation. Particular emphasis is placed on reducing the heavy fishing pressure on the menhaden "peanuts," i.e., menhaden less than one year old and which have not spawned. It was felt that continued intense fishing pressure on the resource could reduce the stock to uneconomical levels and possibly cause recruitment failure in future populations of menhaden.

As background, in 1976 representatives of the Atlantic Coast menhaden industry, state marine fisheries management agencies and the National Marine Fisheries Service (NMFS) met in Washington, DC, to discuss the status of the industry. Landings had declined precipitously from the peaks of the late 1950s and early 1960s. A cooperative interstate Atlantic Menhaden Program was initiated, involving industry, state marine fisheries agencies and NMFS. A board, comprised of state agency directors, industry executives and a NMFS representative, was formed to provide guidance for the program. The Atlantic Menhaden Scientific and Statistical Committee (S&S Committee), with technical members from industry, states and NMFS was appointed and given the task of preparing a management plan for the fishery. The menhaden program has since become a constituent part of the ASMFC's Interstate Fisheries Management Program. The ASMFC administers the program which is funded by NMFS and includes cooperative management planning for several other Atlantic Coast fisheries.

The menhaden management plan was formally adopted by the ASMFC in October, 1981. At its meeting in May, 1982, the Atlantic Menhaden Management Board considered several management options (developed by the Atlantic Menhaden Advisory Committee (AMAC), successor to the S&S Committee) aimed at guarding against recruitment failure and improving yield per-recruit. The options in the plan included (1) a one-mile corridor extending southward from Cape Henry to Cape Fear which would be closed to menhaden purse seining during the fall, (2) a series of minimum mesh sizes designed to promote escapement of the smaller fish in each area, and (3) reducing the fishing season in various areas by various amounts of time.

The ASMFC recommended a management measure to the North Carolina Marine Fisheries Commission as well as to other Atlantic states marine fisheries agencies, to shorten the fall fishing season. The recommendation lacked a detailed evaluation of its economic and social impact on North Carolina's menhaden industry and economy. Blomo, Orbach, and Maiolo (1983) analyzed these impacts from the shortened fishing season. Their findings indicated revenue losses for the industry (compared to the status quo) at 20.2 percent and 17.9 percent in the first two (respectively) of the five years for the resource to adjust biologically. Such large losses raised the question of the industry's adaptability, as well as the impact on industry employment and regional economic activity.

There are two other management options considered by the ASMFC which could be the basis for possible regulations in the North Carolina menhaden fishery (provided the shortened season is adopted first by all states and then evaluated). The two options are 1) a larger mesh size than the present (unregulated) one in use for purse seine nets, and 2) a corridor closed to fishing extending one mile from the shoreline between November and the end of January. The latter option is analyzed and evaluated with respect to the North Carolina menhaden industry and related industrial sectors in this paper. With respect to the minimum mesh size, experiments have just been initiated (Institute of Coastal and Marine Resources, East Carolina University) to generate data on size of fish escaping from various sized meshed nets in the North Carolina fishery. Only a methodology for examining the impacts of a minimum mesh size will be presented herein.

OBJECTIVES

This report examines the economic impact of the proposed closed fishing corridor by accomplishing the following objectives:

(1) quantify in monetary terms the impact on the North Carolina menhaden industry from each proposal;
(2) quantify employment impacts on the North Carolina menhaden industry from each proposal; and,
(3) quantify in monetary terms and employment numbers the impact on the North Carolina economy from each proposal.

This paper will accomplish the objectives above by establishing a baseline condition within the fishery and, as a result of any new proposed measures, compare catches, product yield, and dollar values of the changed fishery with the baseline. The comparison will be done over the period of time it takes the menhaden resource to adapt to such changes biologically.

DATA

Information and data for this report have come from several sources. Data of a secondary nature, from published and unpublished reports, are attributable to the North Carolina Division of Marine Fisheries (DMF, 1982) and NMFS (1978-83); the unpublished data of particular importance are the Captain's Daily Fishing Reports and the Bio-stat survey. In addition, economic and biological data have come from the ASMFC menhaden management plan.

Current industry information was made available by the North Carolina menhaden industry. This information, which included revenues, costs, employment and markets, was obtained through personal and telephone interviews with each of the firms currently based, or operating in, North Carolina. Because of confidentiality regulations, information specific to any one firm is not made available in this report; only industry totals are cited.

The labor force profile information was obtained from a survey conducted by East Carolina University under subcontract to NMFS in 1978.

HISTORICAL REVIEW[2]

The menhaden industry is one of North Carolina's oldest fisheries. Record-keeping began in 1870, from which time the industry has operated continuously. By weight, menhaden is North Carolina's largest fishery, as it is along the Atlantic and Gulf of Mexico coasts and for the United States as a

whole. In 1981 North Carolina landings accounted for 15 percent of all U.S. menhaden landings, which in turn accounted for 40 percent of all U.S. landings. North Carolina menhaden landings in 1981 accounted for 36 percent of all Atlantic coast menhaden landings; landings from New Jersey and Virginia accounted for most of the rest.

Historical trends indicate decreases in the number of firms and processing plants operating in North Carolina. As many as twelve plants operated during the early 1900s; presently, there are four plants owned by three firms. Once firms and/or plants cease operation, it appears to be financially very difficult for any new firm to enter the industry with a new plant and equipment. Blomo (1974) has estimated investment costs for a complete plant at $2 million to $10 million, depending on processing volume, with the basic equipment costing over $870,000 (both estimates in 1973 dollars).

Firms in the North Carolina menhaden industry are vertically integrated, that is, the harvesting, processing, and marketing operations are all done by the same company. Menhaden are caught for processing into fish meal, fish oil, and fish solubles--which are no longer in the form of whole fish. Therefore, the most relevant market level at which to calculate industry revenues is the processor level; the exvessel level has no real meaning in the context of this industry.

Recent menhaden catches in North Carolina show no clear trend (Figure 1). During the last thirty years, the largest catch on record occurred during 1981 and the second largest in 1959. Between 1965 and 1973, landings had a downward trend, bottomed out in 1973 and then had an upward trend. Industry sources cite extremely poor weather during 1972-73 as the reason for a low level of fishing effort resulting in poor catches. Poor recruitment, poor spawning success and a low stock of menhaden (from heavy fishing pressure in the 1960s) are other reasons for this pattern.

The fishing season for menhaden in North Carolina is divided into two time periods. There is the longer summer fishing season which has accounted for most of the landings since 1970; and there is a fall fishery which begins in November and extends into January and accounted for most of the landings prior to 1970. In terms of average monthly landings between the two periods, the fall fishery is the most productive for North Carolina firms. December and January catches account for a substantial portion of annual catches (Figures 2 and 3). Industry sources suggest that in some years, menhaden do not become available in commercial quantities in the fall off North Carolina until after mid-December. In fact, preliminary data from industry sources indicate that catches in the December-January period for 1981, 1982, and 1983 were 22 percent, 34 percent, and 66 percent of the total annual catch.

The number of vessels and of fishermen on vessels has been decreasing over time (Figure 4). Reasons for this trend are replacement of older, smaller vessels with fewer, larger vessels; the introduction of hydraulic power blocks which replace labor and manual equipment on the smaller vessels; and widespread use of aircraft to spot schools of menhaden, thus making each vessel more efficient. The result is that the value of the catch is shared among a declining number of fishermen; therefore, each fisherman's share should theoretically be increasing. It is not clear empirically whether or not this has been the case.

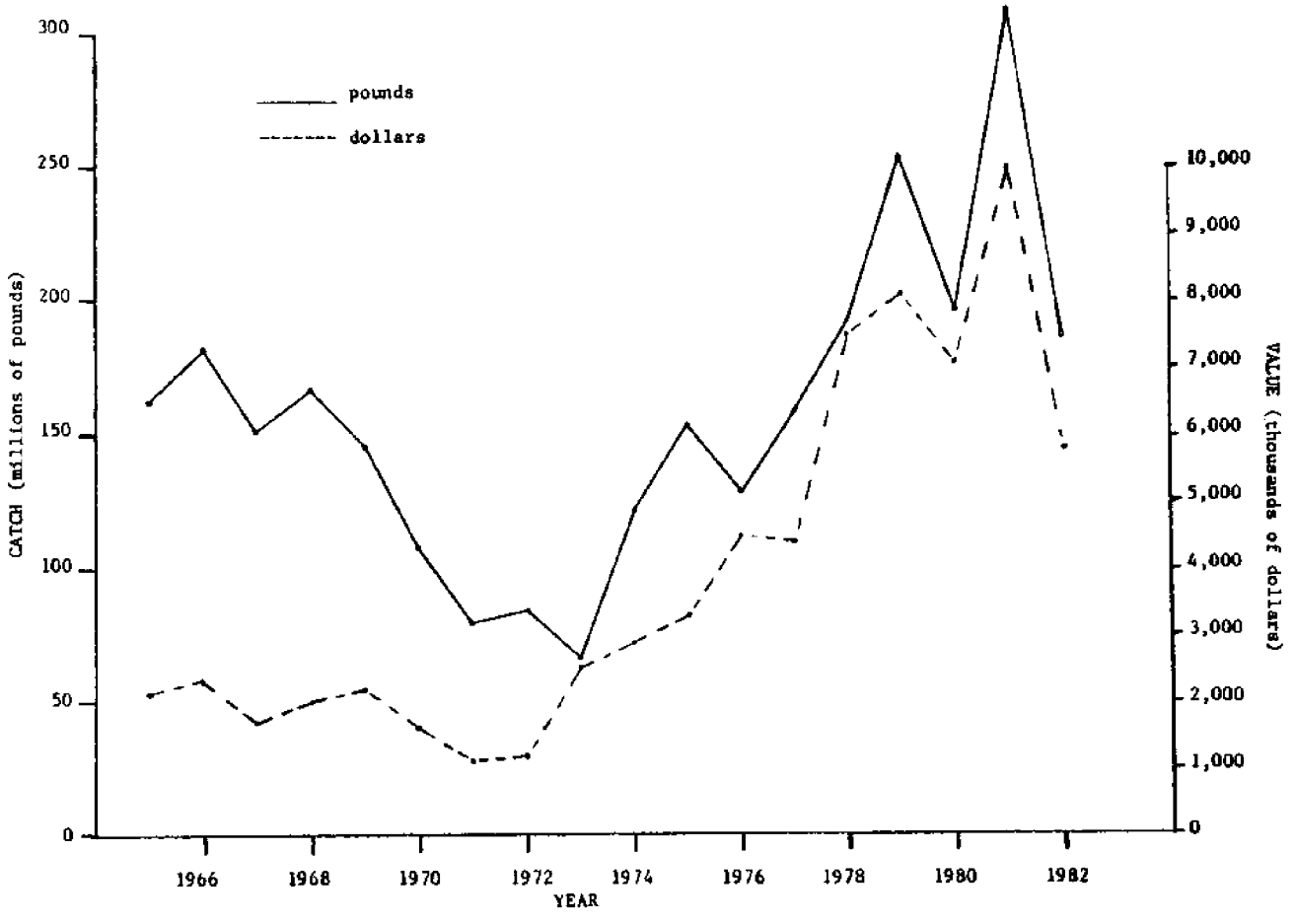

FIGURE 1.- North Carolina annual menhaden catch and dockside value, 1965-82.
(North Carolina Division of Marine Fisheries, 1982)

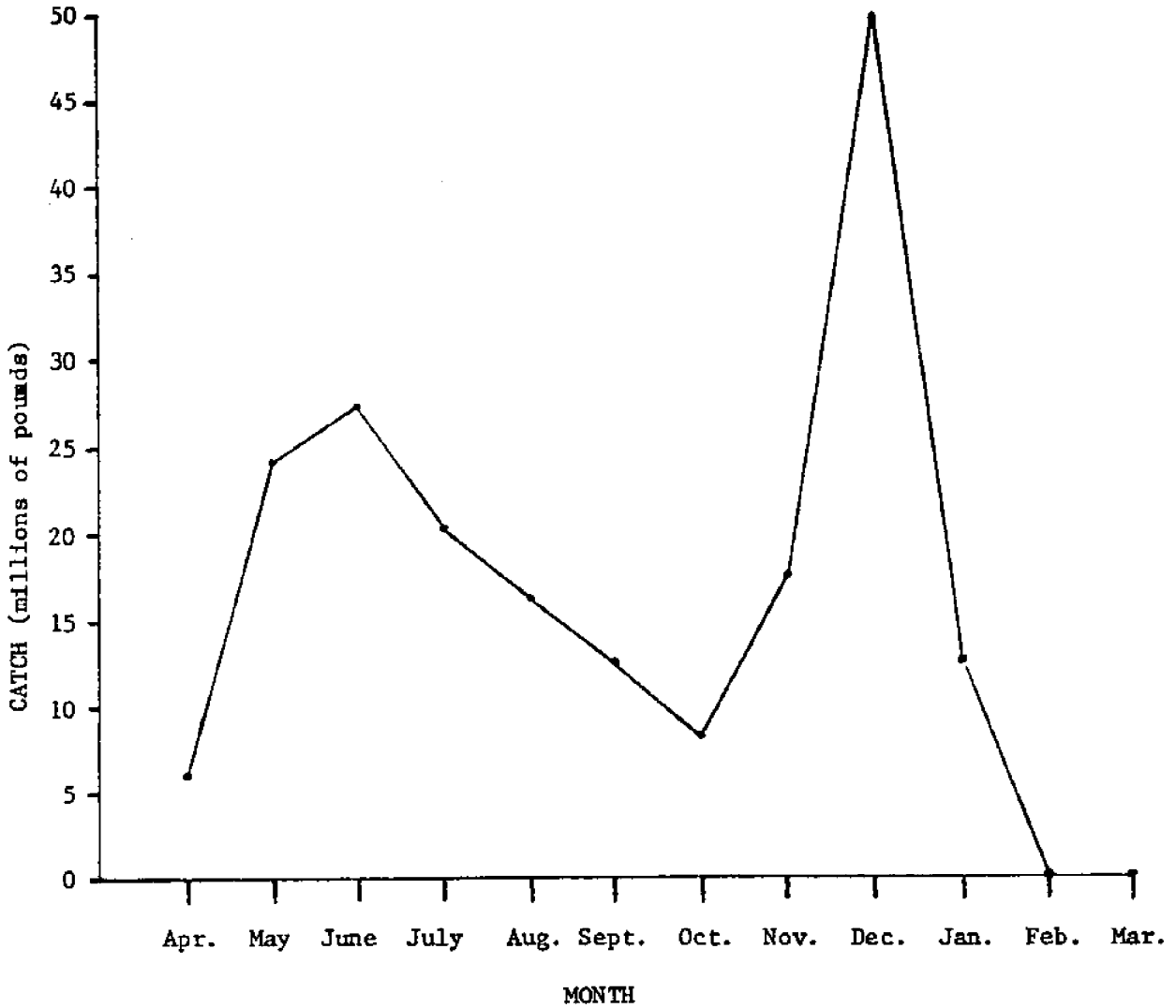

FIGURE 2.- Average monthly catch in pounds for menhaden in North Carolina, 1975-82. (North Carolina Division of Marine Fisheries, 1982)

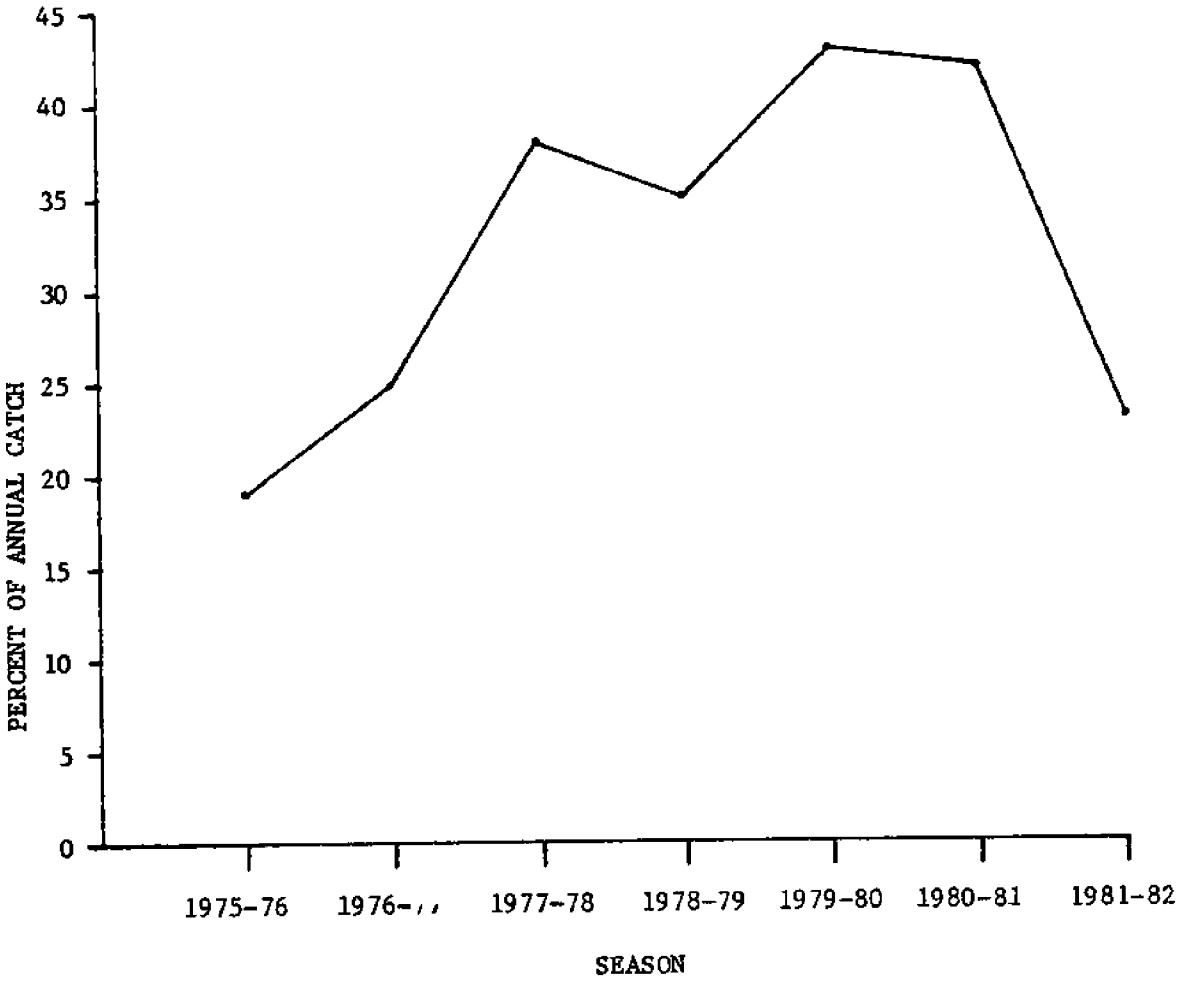

FIGURE 3.- Portion of total season catch accounted for by December and January catches, 1975-76 through 1981-82 seasons. (North Carolina Division of Marine Fisheries, 1982)

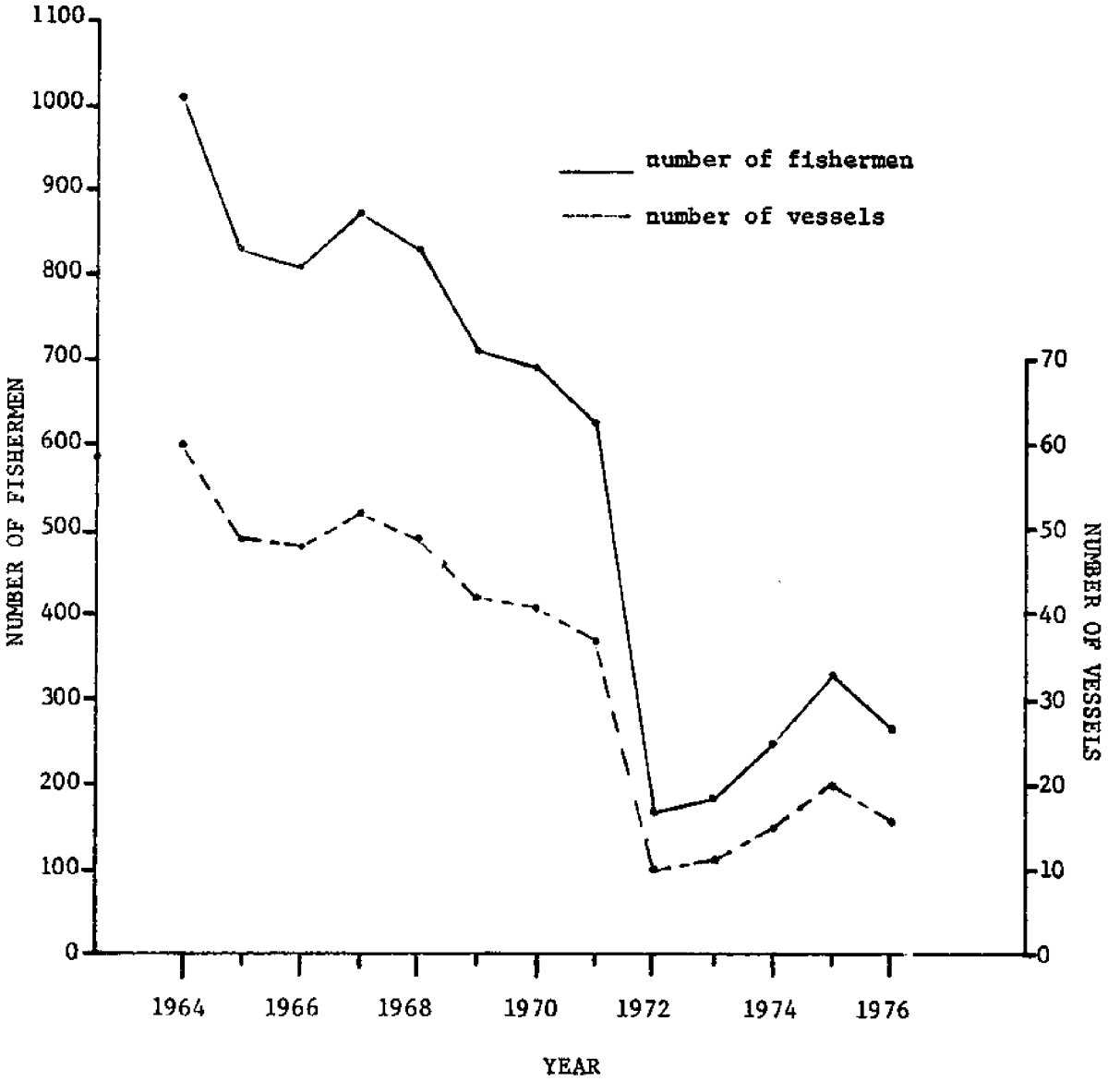

FIGURE 4.- Number of vessels and fishermen on vessels in North Carolina menhaden fishery, 1964-76.
(North Carolina Division of Marine Fisheries, 1982)

THE SOCIOECONOMIC REGION

The North Carolina menhaden industry affects an area larger than simply those two towns where vessels unload and the four processing plants are located (Beaufort and Southport). Menhaden firms buy supplies, provisions and items from other industries throughout North Carolina, and in turn they provide an input to the state's growing poultry industry. In addition, employees of the firms come from surrounding counties as well as the counties in which the plants are located. Even out-of-state employees either reside in North Carolina while employed and/or spend their income locally while employed in North Carolina. Therefore, for purposes of this report the area affected by changes in the menhaden industry is the region of counties bounded on the south by Brunswick, on the west by Columbus and Duplin, and on the north by Craven and Carteret (Figure 5).

The areas of the most direct impact would be Carteret, Brunswick, and Craven counties. It is within Carteret and Brunswick counties that the four processing plants are located (three in Carteret county), and virtually all the North Carolina employees in the three firms come from these three counties. Demographic and economic statistics for these three counties are provided in Table 1 (see Blomo, Orbach, and Maiolo, 1983, for a fuller discussion).

Labor Force Profile

The labor force for the North Carolina menhaden industry resides predominately in the counties of Carteret, Craven and Onslow. There are approximately 270 crew positions on the 17 vessels which have operated in the North Carolina waters in recent years, although because of crew replacement, turnover and other factors, the total number of individuals who work on the boats in any given season may be somewhat higher. In addition, there are between 78 and 145 people employed each year in North Carolina in the processing sector of the industry, depending on the season of the year.

The general profile of the labor force, then, is of a moderately low income group, the majority of whom are in their most productive years but who have little education and few occupational alternatives. They appear to be relatively stable in their community residence (73% preferred to change jobs rather than their residence) and in their association with fishing units. Although the major portion of respondents' income is earned in North Carolina, many of them follow a regular migratory labor pattern primarily involving locations in Mississippi and Louisiana. In conclusion, it should be emphasized that industry jobs are very much seasonal in nature. In fact, they are of a recurring seasonal nature with very few full-time jobs in either the harvesting or processing phases.

EXISTING INDUSTRY STATUS

For purposes of this analysis, it is necessary to establish a baseline situation with which any changes in the industry as a result of a larger purse seine mesh size and a closed fishing corridor may be compared. The analysis will compare the existing situation with all the changes that may be projected with some degree of confidence. The analysis examines the time period theorized by biological scientists for the menhaden population to adjust to a new equilibrium population as a result of a closed fishing corridor.

FIGURE 5.- Map of coastal North Carolina counties indicating the area affected by the menhaden industry.

Table 1. Demographic Characteristics of Craven, Brunswick, and Carteret Counties, 1975-80.

A

Characteristic	Craven County	Brunswick County	Carteret County
Year			
Total population			
1975	67,662	32,720	35,632
1980	71,043	35,767	41,090
Total labor force			
1975	24,370	14,120	13,550
1979	26,850	15,790	14,920
Per capita income			
1975	$4,714	$3,486	$4,323
1979	$6,893	$5,598	$6,545

B. New industry, increased employees in existing and new businesses

Years	Craven County		Brunswick County		Carteret County	
	New	Expanded	New	Expanded	New	Expanded
1960-64	1,245	225	115	0	149	215
1965-69	713	501	550	675	387	377
1970-74	685	100	353	10	243	270
1975-79	194	539	280	557	252	370

Source (A and B): Office of State Budget and Management, Research and Planning Services.

C. Monthly unemployment rates in the civilian labor force in Carteret and Craven Counties, 1982.

	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
County												
Carteret	11.4	10.8	9.9	8.0	7.3	7.2	5.7	6.4	6.9	7.3	9.6	10.0
Craven	7.9	8.3	7.8	7.5	8.0	7.9	7.4	9.7	8.7	9.3	9.6	9.0

Source: County Labor Statistics, Employment Security Commission, 1983.

Total North Carolina Catch

Starting with the resource itself, the present (equilibrium) yield per recruit in Area 4 is 9.7 grams and in Area 5 is 5.34 grams, which is broken down into 1.26 grams for inshore areas, 3.62 grams for the Corridor, and 0.46 grams for offshore areas. For the number of recruits of menhaden to the fishery, two estimates are cited from the AMAC (1982) report on menhaden:

5.3×10^9 recruits, the 1973-76 average yearly population size of 0.5-year olds, and
7.2×10^9 recruits, the 1976-78 average yearly population size of 0.5-year olds.

Multiplying each area's yield per recruit estimate by the population size will result in a potential harvest for each area depending on the size of the menhaden stock. Converting grams to pounds will result in pounds harvested. The period 1973-76 was a low-abundance period while 1976-78 was a relatively higher abundance period; thus these two periods represent extreme conditions for recruitment during the period analyzed in the ASMFC (1981) report. The results are indicated below:

	Low Abundance	High Abundance
	(Pounds)	
Area 4 catch	113,357,360	153,997,200
Area 5 catch	62,405,885	84,777,744
Total catch	174,763,245	238,774,944

Industry Gross Revenues

The yield and value of fish meal, the primary product from menhaden, is the most important determinant of industry revenue. The other significant menhaden product is fish oil. The industry processes menhaden into regular fish meal through traditional techniques. An alternative is to combine processed fish meal and fish solubles into a "full meal" product which results in a higher yield per million standard fish. Both processes are used in the North Carolina industry.

Based on each company's present percentage of total catch, each company's fish meal yield, and a June 1984 price of $350 per ton, industry fish meal revenue for low and high abundance years are:

	Low Abundance	High Abundance
Fish meal revenues	$7,671,685	$10,481,625
Fish meal yield	21,919.1 tons	29,947.5 tons

Fish oil is the other main source of industry revenue. Oil yield depends primarily on the size of the individual fish, the larger specimens containing more oil per ounce of weight. Yield can vary between one and nine gallons per thousand standard fish, or between 8 and 69 pounds per thousand standard fish. Since North Carolina specimens are smaller than menhaden to the north, fish oil yield is less, and increases in fish size should still result in a relatively small increase in oil yield. Furthermore, since data is extremely limited on fish oil yield from menhaden landed in North Carolina (J. Nelson, manuscript 1982), an estimate is derived. Given the yield range in pounds, the average percentage of zero age fish caught of total individual fish caught (40% over 1955-80, from National Marine Fisheries Service data), an industry average of

4.7% of fish oil per pound of landed menhaden is used. With a June 1984 price of $0.12 per pound, industry fish oil revenue for low and high abundance years are:

	Low Abundance	High Abundance
Fish oil revenues	$1,001,589	$1,360,164
Fish oil yield	8,346,577 lbs.	11,334,702 lbs.

Summing fish meal and fish oil revenues results in total industry revenue. For low and high abundance years total industry revenue is:

	Low Abundance	High Abundance
Total industry revenue	$8,673,274	$11,841,789

Harvesting Sector Wages

Harvesting sector wages are the next baseline variable of concern. Crew pay is based almost exclusively on number of fish caught. The average pay scale paid by the three firms is $5.52 per thousand standard fish units (667 pounds). Based on the percentage of total catch each company accounts for and each company's pay scale, harvesting sector wages for low and high abundance years are:

	Low Abundance	High Abundance
Harvest sector wages[4]	$1,492,667	$2,027,675

Interviews with the three firms revealed a total of 255 crew positions on 16 vessels during the 1984-85 fishing season.

Processing Employment and Wages

The number of employees in the processing plants varies imprecisely with the volume of menhaden processed. There is always a skeleton crew throughout the year in every plant, and employees are added as the fishing season reaches a peak, usually in December of the fall season. The number of workers during the summer seems to be adequate since there is such a large amount of plant capacity unused and available for any large increases in catch (see Figures 2-3). The most appropriate estimate for processing sector wages, based on interview data for the most recent complete fall season with data (1982-83), is approximately $700,000.

Since one or more of the menhaden firms varies workers' tasks between harvesting and processing duties, an accurate number of processing employees cannot be easily calculated. According to the NMFS(Ken Harris, pers. comm., 1982), permanent year-round employment and peak seasonal employment figures for 1981 (latest year available) are 78 and 145, respectively. Like the harvest workers, not all processing workers are North Carolina residents; some workers maintain permanent residence in Virginia. From interviews with industry sources, perhaps half or more of all employees are North Carolinians.

THE INDUSTRY'S REGIONAL ECONOMIC CONTRIBUTION

The North Carolina menhaden industry contributes to the surrounding region's economic activity (See The Socioeconomic Region above). This contribution is a multiple of the industry's value since the industry's products are used in higher-valued products which in turn generate more economic activity. The economic multiplier in the region for prepared feeds for animals and fowls is 1.984 (U.S. Water Resources Council 1977); that is, a dollar increase in value of feed produced will generate $1.98 of gross output (value) in the immediate region. Since fish meal falls into the prepared feed category, it is assumed that the industry has a multiplier of this magnitude. The economic multiplier for animal and marine fats and oils is 2.10, a category into which fish oil falls.

Utilizing the value of the menhaden fish meal and fish oil as it is sold by the North Carolina industry at the processing level, and the appropriate economic multipliers for meal and oil, the industry's economic contribution to the region is indicated below for low and high abundances of the resource.

North Carolina Menhaden Industry Regional Economic Contribution

Menhaden Stock

	Low Abundance	High Abundance
Fish Oil Value	$ 1,001,589	$ 1,360,164
Multiplier	2.1	2.1
Gross Value	2,103,337	2,856,344
Fish Meal Value	7,671,685	10,481,625
Multiplier	1.98	1.98
Gross Value	$ 15,189,936	$ 20,753,618
Total Gross Value	$ 17,293,273	$ 23,609,962

The contribution of the menhaden industry to employment is also in excess of its own employees. There are two employment multipliers available, neither of which is specific to the menhaden industry nor to North Carolina. One multiplier (Centaur Management Consultants, 1975) is an average across the United States for all fishery products. The multiplier (0.49 man years per $1,000 landed value) can be broken down into the (1) fishing and fishing inputs sector (0.13 multiplier), (2) processing sector (0.21), (3) transportation sector (0.01), and (4) wholesaling and retailing sector (0.14).[5] Only the first three sectors appear appropriate for this industry, and fish meal revenues are adjusted by 0.6 to put them in terms of landed value.[6] (Fish oil revenues are not used because there is no adequate method to compute their exvessel value.) Based on the fish meal revenues above for low and high abundance, the regional employment impacts are:

Sector	Low Abundance	High Abundance
	(man-years)	
Fishing & Fishing Inputs	598	817
Processing	966	1,320
Transportation	46	63
Total	1,610	2,200

The second employment multiplier (Loehman and Hsiao, 1979) is an average across Florida (a South Atlantic state like North Carolina) for all fishery products. The multiplier (0.156 jobs per $1,000 value) can be divided into the harvesting sector (0.101 jobs per $1,000 exvessel value) and the processing sector (0.055 jobs per $1,000 processing value).

The employment impact based on this multiplier for low and high abundance of menhaden is:

Sector	Low Abundance	High Abundance
	(jobs)	
Harvesting	465	635
Processing	422	576
Total	887	1,211

The main difference between the two employment impacts is in the processing sector. The second multiplier may be more accurate due to the menhaden industry's low ratio of labor per unit output. The first multiplier may be thought of as the upper limit on employment impacts; in this study employment impacts will be presented using the second multiplier.

METHODOLOGY

The basic methodology is one of comparative analysis using the MAREA simulation program for menhaden developed by NMFS. The biological analyses have been performed by NMFS (Beaufort, NC, laboratory) and will appear in a forthcoming report to AMAC. The methodology would apply to both the minimum mesh size and closed corridor proposals; in this paper, however, it is only applied to the latter because of the absence of experimental data on mesh size selectivity (see OBJECTIVES above).

With the Captain's Daily Fishing Reports (CDFR) matched up against the NMFS biostat sampling program, population dynamics characteristics were calculated for menhaden (weight, length, proportion of individuals and of catch, F) in the closed corridor and outside of it from PFU 37 till the end of January. These characteristics were inserted into the MAREA simulation to calculate new catch statistics for Areas 1 through 5, with subdivisions in area 5.

The first set of calculations were accomplished assuming no changes in fishing strategy by North Carolina firms. It was assumed that there were no changes in the menhaden stock in other fishing areas (to the north, Areas 1-3). Nevertheless, MAREA results do permit a review of the effect on these other areas' catches as a consequence of North Carolina changes only. The second set of calculations was accomplished by assuming greater fishing effort taking

place farther offshore to compensate for the closed corridor (0-1 mile from the coastline); of course, it must also be assumed that menhaden are available to be caught farther offshore. A third and final set of calculations was accomplished by redeploying the fishing effort proportionally according to historical effort into the inshore and offshore areas.

The MAREA simulation uses the population dynamics characteristics in its algorithm to project yield per recruit (YPR) into the future until there are no more significant changes in YPR, i.e., the menhaden population has stabilized. This time period is usually five years to correspond to the menhaden life cycle. Each year the MAREA program tracks juvenile growth through age 5 using AMAC's estimates of growth and natural mortality. Fishing mortality was derived from the CDFR's and biostat sampling for each fishing vicinity: 1) bays, estuaries, and rivers, 2) the corridor, and 3) offshore (greater than 1 mile). Each year-class is followed through each year of the five years, with catches being calculated all along each year.

Using the estimates of resulting YPR, calculations are then made of catches, and fish meal and oil yield. Furthermore, the value of fish meal and oil are also calculated, assuming constant product prices and no inflation. Harvest and processing sector wages are also estimated, as well as secondary (region-wide) economic impacts, e.g., monetary and employment.

Comparisons can then be made between the baseline and the situation after imposition of the closed corridor. Reduced harvesting and processing costs, if any, by not fishing should also be indicated in the comparisons with the baseline. A criterion for the economic success (failure) of the closed corridor measure is a positive (negative) difference after subtracting five years worth of product value (baseline situation) from five years worth of product value of the new situation.

CORRIDOR CHARACTERISTICS

The corridor that is proposed to be closed to fishing is an important source of catches to the North Carolina industry during the Fall season. Of the reported catches between the 1978 and 1982 fishing seasons, approximately 80 percent of the catch (in standard fish) took place in the corridor on average; the percentage varied between 68 percent in 1982 and 87 percent in 1981. It appears that during these five years the corridor accounts for relatively more of the catch when the total catch is high (1979 and 1981), and when the catch is lower (1978, 1979, and 1982) the corridor accounts for a smaller proportion of the catch (Table 2). Second in importance is the area further offshore than the corridor, which on average has a catch almost twice as much as the inside waters.

The effort expended in fishing, measured by number of sets, also indicates the relative importance of the corridor (Table 3). On average, between 1978-82, approximately 70 percent of all sets occurred in the corridor. Dividing catch by sets would yield a crude measure of catch per unit effort (Table 4). This indicates again the productivity of the corridor relative to the two other fishing choices. In addition, even though the corridor accounts for most of the catch and sets, its catch per set is significantly higher than the average over all three areas for all years. The offshore area is close to the average in 3 out of 5 years.

Other advantages of the corridor area include a deep enough draft for vessels, short steaming time relative to offshore areas, shorter distances for

Table 2. Reported catches from Captain's Daily Fishing Reports in the area between Cape Fear, NC, and Cape Henry, VA after PFU 36, 1978-82 fishing seasons.

AREA	Year 1978	1979	1980	1981	1982	Five-Year Average
			(Thou. Std. Fish)			
Inside	18,115	9,207	7,897	1,055	720	7,399
0-1 mile	57,642	109,084	56,496	142,915	44,628	82,153
1 mile	5,815	12,048	10,460	18,900	19,905	13,426
Total	81,572	130,339	74,853	162,870	65,253	102,978

Source: National Marine fisheries Service, Beaufort Laboratory, N.C., unpublished data, 1983.

Table 3. Reported number of sets from Captain's Daily Fishing Reports in the area between Cape Fear, NC, and Cape Henry, VA after PFU 36, 1978-82 fishing seasons.

AREA	Year 1978	1979	1980	1981	1982	Five-Year Average
			(No. of Sets)			
Inside	158	117	90	12	11	78
0-1 mile	290	611	287	691	300	436
1 mile	32	121	62	132	173	104
Total	490	849	439	835	484	618

Source: National Marine Fisheries Service, Beaufort Laboratory, N.C. unpublished data, 1983.

Table 4. Ratio of reported catches to reported number of sets from captain's Daily Fishing Reports in the area between cape Fear, NC, and Cape Henry, VA, after PFU 36, 1978-82 fishing seasons.

AREA	Year 1978	1979	1980	1981	1982	Five-Year Average
			(Thou. Std. Fish per set)			
Inside	114.6	78.7	87.7	87.9	65.5	94.9
0-1 mile	119.8	178.5	196.9	206.8	148.8	188.4
1 mile	181.7	99.6	168.7	143.2	115.1	129.1
Average	166.5	153.5	170.5	195.1	134.8	166.6

Source: Tables 2-3.

spotter pilots, and relatively calmer seas than areas farther offshore.

CLOSED CORRIDOR IMPACTS

Analysis of the closed corridor impacts through the MAREA simulation reveal permanent declines in the yield per recruit for the North Carolina fishery between 4 percent and 12.8 percent. The impacts in YPR are subdivided into Area 4, in which there is an increase in YPR and into Area 5, in which there is a decrease (Table 5). The large YPR decreases in Area 5 more than counteract the YPR increases in Area 4 under any of the three alternative scenarios. These scenarios include: 1) no redeployment of fishing effort from the corridor; 2) redeployment of all the effort from the corridor to outside waters, proportionately based on CPUE; and 3) redeployment of all the effort from the corridor to outside and inside waters, proportionately based on the average CPUE pattern (Table 4). At the same time, there are increases in YPR for the whole fishery of 6 percent, 4 percent, and 1 percent, respectively, in association with each of the three scenarios above.

In translating these equilibrium YPR estimates into the catch, product, and value estimates, the analysis will assume constant 1984 prices and wages, inflation at zero rate of growth, market conditions for fish meal and fish oil will remain the same, and company market shares and product yield will remain the same.

Modifications to MAREA indicate YPR changes in the intervening years between the baseline and various equilibria. Evaluating the effects of these temporary changes is also important because: 1) the intervening years are five in number for the menhaden to adjust, and 2) industry members and employees may react differently to temporary changes if they are quite different in magnitude or direction from the permanent changes. In the study of the impacts of a shortened season on the North Carolina menhaden fishery (Blomo, Orbach, and Maiolo, 1983). it was found that temporary changes were almost three times as great as the permanent changes in YPR. catch, product yield, and dollar losses. As a result of the closed corridor, during intra-adjustment period YPR declines would be two to four times as great as equilibrium declines, and these are indicated in the Appendix. The following discussion deals with long-run impacts.

Industry Gross Revenues

Projecting the percentage decreases in equilibrium YPR in the North Carolina menhaden fishery and adjusting the baseline conditions, estimates can be derived for changes in industry revenues. Catch, fish meal yield, fish oil yield, and dollar values are all reduced from baseline conditions (Tables 6-8). At equilibrium these decreases range from 3.9 percent to 12.8 percent as indicated in Table 5, or industry revenues would be 87 percent to 96 percent of baseline. By not adjusting fishing effort at all- the no redeployment of effort scenario- fish meal and fish oil revenue declines are greatest between the three scenarios. The least dollar loss appears to be effort redeployed to areas both inshore farther offshore. Thus, industry revenues decline more when the idustry does not adapt its fishing strategies to the closed corridor.

Table 5. Equilibrium yield per recruit in the North Carolina menhaden fishery, Areas 4 and 5, under the closed corridor management option under selected fishing effort scenarios.

Scenario	Area 4 (grams)	Percentage Change[a]	Area 5 (grams)	Percentage Change[a]	Total (grams)	Percentage Change[a]
Baseline	9.70	--	5.34	--	15.04	--
No redeployment of effort	11.13	+14.7	1.98	-62.9	13.11	-12.8
Effort redeployment offshore	10.75	+10.8	2.93	-45.1	13.68	-9.0
Effort redeployed off- and inshore	9.96	+2.7	4.49	-15.9	14.45	-3.9

[a]Compared to baseline.

Source: NMFS MAREA menhaden simulation, Beaufort Laboratory, N.C.

Table 6. Projected permanent decreases in North Carolina menhaden industry fish meal revenues under the closed corridor management option under selected fishing effort scenarios, with low and high abundance of recruits[a].

Alternative	Low Abundance	High Abundance
	(dollars)	
No redeployment of effort	981,976	1,341,648
Effort redeployed to offshore	690,452	943,346
Effort redeployed to in- and offshore	299,195	408,783

[a]Based on present company shares of catch and respective fish meal yields; $350 per ton for fish meal and no change in future price.

Table 7. Projected permanent decreases in North Carolina menhaden industry fish oil revenues under the closed corridor management option under selected fishing effort scenarios, with low and high abundance of recruits[a].

Alternative	Low Abundance	High Abundance
	(dollars)	
No redeployment of effort	128,203	174,101
Effort redeployed to offshore	90,143	122,415
Effort redeployed to in- and offshore	39,062	53,046

[a]Based on industry's average fish oil yield; $0.12 per pound and no change in future price.

Table 8. Projected permanent decreases in North Carolina menhanden industry revenues under the closed corridor management option under selected fishing effort scenarios, with low and high abundance of recruits.

Alternative	Low Abundance	High Abundance
	(dollars)	
No redeployment of effort	1,110,179	1,515,749
Effort redeployed to offshore	780,595	1,065,761
Effort redeployed to in- and offshore	338,257	461,830

Source: Tables 6 and 7.

Cost and Net Revenues

Although industry revenues decline, part of the industry's costs will also decline from not having to incur some of the expenses of harvesting and processing from PFU 37 to 42. Therefore, net revenue losses to the industry will be less than gross revenue losses.

The most recent study of overall industry costs is the ASMFC menhaden management plan (1981), wherein total costs were apportioned several ways. Total costs were made up of catching costs (57 percent of the total), plant costs (35 percent) and administration (8 percent). Plant and catching costs were broken down into variable, fixed, seasonal and off-season costs. Further, the various cost components -- labor, energy, maintenance, and employee benefits-- were apportioned among the catching, plant and administrative costs.

As there were varying interpretations of reductions in cost upon interviewing the three North Carolina menhaden firms, the management plan is used as the basis for estimates of reductions in costs resulting from the closed corridor. In the absence of more standardized cost information, it is assumed that the intra-firm percentage breakdown of costs cited above (for the three firms interviewed for the management plan) is representative of cost breakdowns for the three North Carolina firms.

The reduction in catch should only reduce some costs, such as labor and employee benefits, but not others, such as depreciation. The most likely cost reductions with catch reductions would be variable (seasonal) labor costs in catching and in plants, related employee benefits, and variable (seasonal) plant energy cost. These costs account for 28.2 percent of total costs. Repair and maintenance, and catching energy costs may or may not decline at all, depending on the firms' fishing strategies in an attempt to maintain annual catches. These costs, on a total seasonal basis, account for an additional 7.6 percent of total costs. It is assumed that these costs will decline for the scenario of no redeployment of effort, but will not decline for the other two scenarios.

Reducing the 35.8 percent (and the 28.2 percent for the other two scenarios) by the fraction of the reductions in catch and calculating the reduction in total costs, net revenue reductions can be approximated (Table 9). They range from a permanent decline of 8.2 percent for the no-redeployment-of-effort scenario to a low of 2.8 percent for the scenario where effort is redeployed to offshore and inshore waters. Net revenue reductions for both fish meal and fish oil, in absolute dollar amounts, are indicated in Table 10.

Harvesting and Processing Wages

Wages in the harvesting sector are affected by the volume of fish caught. Since these wages are tied directly to the product of crew shares and catch, a decline in total wages between 4 percent and 12.8 percent would be expected as per the equilibrium YPR declines. Absolute dollar declines are indicated in Table 11 for low- and high- abundance years under the three effort-redeployment alternatives.

Wages in the processing sector would be expected to decline because of two factors. First, even though YPR and catch are expected to increase in Area 4, processing needs may not increase at all during the summer months because of the industry's overcapacity in its harvesting and processing operations in a physical or engineering sense. Area 4's projected increase in YPR and catch varies between 3 percent and 15 percent (Table 5). However, examining these

Table 9. Projected permanent annual reductions in total costs, and industry net revenue, under the closed corridor with selected fishing effort scenarios.

Seasonal cost items	Percent of total cost[a]
Varible costs	
Labor Costs	
Catching and Processing	16.3
Employee Benefits	3.1
Plant Energy	8.8
Subtotal	28.2
Total (Fixed and Variable) Costs	
Catching energy	1.7
Repair and Maintenance materials	5.9
Total	35.8

Reduction in total cost per year =

35.8% times 12.8% decline in catch (no effort redeployed)
28.2% times 9.0% decline in catch (effort redeployed offshore)
28.2% times 3.9% decline in catch (effort redeployed in- and offshore)

Item	No effort redeployed	Effort redeployed offshore	Effort in and offshore
Gross revenue decline	12.8	9.0	3.9
Total cost decline	4.6	2.5	1.1
Net revenue decline	8.2	6.5	2.8

[a]Source: Atlantic States Marine Fisheries Commission (1981).

Table 10. Projected permanent annual reductions in industry net revenue under the closed corridor with selected fishing effort scenarios and high and low abundance of recruits.

Scenario	Decline in Net Revenue[a]	
	Low Abundance	High Abundance
	(dollars)	
No redeployment of effort	711,208	971,027
Effort redeployed to offshore	563,763	769,716
Effort redeployment to in- and offshore	241,613	329,878

[a]Decline from Baseline; percent decline taken from Table 9.

increases in light of the industry's ability to process catches (Figure 2) reveals a large over-capacity during the summer. The second reason for declining processing wages is of course the large declines expected in YPR and catches in Area 5 (the fall fishery)-- from 32 percent to 63 percent. Under this reasoning, it is expected that processing wages occurring during the fall fishery decline in direct proportion to the percentage decreased in YPR and catch (processing through-put). These declines are indicated in Table 11.

Impacts on the Menhaden Labor Force

Projected impacts on the labor force would depend on the strategies employed by the menhaden firms to deal with the reduced fishing under the closed corridor. Should the firms presently engaged in the industry in North Carolina remain in business, the impact may be limited to a reduction in wage income commensurate with the general reductions in business activity referred to above, on the order of 3.9 percent to 12.8 percent at the projected equilibrium level of catch. Should the firms decide to ameliorate this impact by reducing the number of employees and thus possibly preserving the income levels of those remaining, the burden of the reductions would possibly fall on the less senior or less experienced portions of the labor force. If the firms were not able to remain economically viable with the reduced catches, the entire labor force could be affected dramatically.

In any of these cases, one must keep in mind that the labor force is characterized by low levels of education and limited occupational alternatives, a high proportion of whom would probably remain in the eastern North Carolina area (gauged by 73 percent of the interview sample who preferred to change jobs rather than residence). The unemployment rate in November 1982 for the affected counties averages 9.6 percent, and we assume that those employees put out of work by the closed corridor would either compete in an already tight labor market or enter the state unemployment roles (as many do regularly when fishing is slack). In addition, the monthly unemployment rates for the months affected by the closed corridor November through January--are already the highest throughout the year (see Table 1.C). Since the residence patterns of the harvesting and processing sector labor force tend to center on a relatively few communities in the affected counties, we would expect the impacts to be concentrated in these communities.

Regional Economic and Employment Impacts

Changes in the gross economic value (revenue) of the menhaden industry should have an impact on the regional economy of eastern North Carolina. Since the net impacts indicated above for YPR, catch, product yield, and product values have all been negative, the impact on the regional economy from the changes in the menhaden industry can be expected to be negative as well.

In the low abundance (of recruits) situation, gross output in the region would reach a maximum of $2.2 million decline and 113 less jobs directly as a result of declines in the menhaden industry (Table 12). With effort redeployed to the inshore and offshore areas, the decline in regional gross output is projected to be $674,000 and 34 jobs.

In the high abundance (of recruits) situation, gross output in the region would reach a maximum of $3 million decline and 155 less jobs directly as a result of declines in the menhaden industry (Table 12). With effort redeployed to the inshore and offshore areas, the decline in regional gross output is $920,000 and 47 jobs.

Table 11. Projected permanent decreases in harvesting sector wages under the closed corridor management option under selected fishing effort scenarios, with low and high abundance of recruits[a].

Alternative	Low Abundance	High Abundance
	(dollars)	
No redeployment of effort	191,061	259,542
Effort redeployed to offshore	134,340	182,491
Effort redeployed to in- and offshore	58,214	79,079

[a]Assumes no change in future crew shares paid by industry member firms.

Projected Decline in Processing Wages[b]

Scenario	Decline
No redeployment of effort	$440,300
Effort redeployed to offshore	$315,700
Effort redeployed to in- and offshore	$ 96,600

[b]As a percentage of annual processing wages, these declines are of course smaller since the fall fishery is a part of the annual one.

Table 12. Projected permanent declines in regional gross output and employment as a result of changes in the North Carolina menhaden industry, under selected fishing effort scenarios with low and high abundance of recruits[a].

Scenario Impact	Low Abundance	High Abundance
No redeployment of effort		
Gross output	$2,213,538	$3,022,075
Jobs	113	155
Effort redeployed to offshore		
Gross output	$1,556,395	$2.124,897
Jobs	80	109
Effort redeployed to in- and offshore		
Gross output	$ 674,437	920,789
Jobs	34	47

[a]Declines from the Baseline situation; gross output calculated by multiplying declines in fish meal and fish oil revenues by respective multipliers (source of revenue declines: Tables 6 and 7) and summing the two products; the employment estimates calculated with declines in fish meal revenues (processing and exvessel levels) and the Loehman and Hsiao (1979) multiplier.

Net Regional Impact

The multiplier effect on regional gross output and employment from reduction in the North Carolina menhaden industry revenue under the closed corridor affect the coastal area of North Carolina the most. The overall impact on North Carolina may be as great as described previously if there were no compensating responses to reductions in fish meal availability within North Carolina. However, if the poultry industry makes up the loss in fish meal by substituting soybean meal produced within the state, then the overall impact may approach zero. North Carolina is also a large soybean producing state, and soybeans--a prepared feed for animals and fowl--have a regional multiplier the same as that for fish meal. Thus, a decision to implement the closed corridor could mean no change in total economic activity but a redistribution of income and employment from coastal to inland (soybean-producing) areas.

SUMMARY

A closed corridor regulation on the North Carolina menhaden industry has the potential to permanently reduce industry revenues by 4 percent to 13 percent and wages accruing to the harvesting sector by 4 percent to 13 percent. Within the five years necessary for the menhaden resource to reach a new equilibrium size as a result of the closed corridor, industry revenues and harvest sector wages are expected to decline by as much as two to four times the percentages above in the first year, and eventually to level off at the 4 percent to 13 percent range cited above (see Appendix).

Reduced catches and revenues of these magnitudes within the first five years of the proposed shortened season may put severe pressures on North Carolina menhaden firms trying to maintain operations, and may lead to at least temporary unemployment among harvesting and processing workers. At issue is the industry's ability and willingness to withstand large short-term losses in order to operate at a reduced level (compared to present) in the long run. Another important issue is the ability of the industry's labor force, with a generally low level of education and training, to find alternative employment.

Local and regional economies will experience at least temporary declines in economic activity as a result of reduced menhaden industry revenues and payrolls. Unemployment may also increase in local and regional economies in related industries. However, state-wide impacts may be zero if soybean meal is substituted for fish meal.

Using current fish meal and fish oil prices, and current pay scales of harvesting and processing workers, the range in monetary and employment effects on North Carolina menhaden firms and regional economy are projected to be:

Permanent annual decrease in total revenues - $338,257-$1,515,749
Permanent annual decreases in net revenues - $241,613-$971,027
Permanent annual decrease in industry payroll - $154,814-$699,842
Permanent annual decrease in regional economic activity - $674,437-$3 million
Permanent decrease in related employment - 34 to 155 jobs

These monetary estimates assume that North Carolina menhaden firms remain in operation during and after the five years it would take the stock to adjust completely to a closed corridor. However, if all the firms in the industry cease operations, the impacts may be up to eight times larger than indicated in the maximum annual amounts noted above.

In summary then, the closed corridor appears to be a failure in economic terms for North Carolina industry. The economic losses and employment declines may be compared with presumed increases in these two items for areas to the north which would benefit from a corridor closed to fishing off the North Carolina coast. Such a comparison would be useful since menhaden is a resource shared all along the Atlantic coast. These comparisons should also be expanded to include evaluation of other proposals, such as the shortened season.

FOOTNOTES

[1]AMAC recommends the Virginia mesh size phrase "When in use" as the target for implementation. The recommendation for the closed corridor is that the purse-seine fleet refrain from catching the migrating fish within 1 mile of the beach in the area from Cape Henry, Virginia, to Cape Fear, North Carolina; it would be in effect during the period of November (PFU 37) through January.

[2]Adapted in part from Michael Street (DMF), memorandum of May 24, 1982.

[3]Respectively, the menhaden plan designations for the South Atlantic summer and North Carolina fall fisheries. The vast majority of the South Atlantic summer fishery landings are made in North Carolina.

[4]Slightly different payment options--such as end-of-year bonuses and guaranteed wages--will result in actual payments to labor varying somewhat from these figures. These figures are, however, adequate for purposes of comparison of impacts in this analysis.

[5]The multiplier describes the employment impact not only in the various levels of fishing industry activity--harvesting, processing, marketing--but also related industries associated with those various levels of activity. For example, related to fishing and fishing inputs are boatyards, marine engine manufacturers, petroleum companies, net material suppliers, etc.

[6]The 0.6 factor to put fish meal value in exvessel terms is used by NMFS and DMF for statistical purposes, and is discussed in the management plan (ASMFC 1981). Fish oil's value is not included since its value at the processing level cannot be easily converted to an exvessel value.

[7]These impacts are directly attributable from declines in total revenue of the menhaden industry; the impacts do not reflect the net regional impact which may be zero if soybean meal produced within North Carolina is substituted entirely for all the foregone fish meal production.

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APPENDIX

The MAREA fishery simulation is capable of estimating not only the equilibrium YPR values for each subarea of the fishery, but also YPR values during the time in which the menhaden population adjusts to any new exogenous changes. The changes could affect natural mortality, fishing mortality, or their growth rate. The changes could be natural--climatic or environmental--or man-made, such as a change in fishing technology or change in fishing regulations. The closed corridor, the shortened season, and any change in purse seine net mesh size would be examples of changes in fishing regulations.

The menhaden stock is divided up in the simulation into 26 age intervals, beginning at 0.5 year, and continuing to 6.75 years in 0.25-year intervals. Thus there are 7 age-classes, 0's, 1's, 2's, etc. Since the base YPR values are known for each age class, as well as the equilibrium YPR values for each age class, these two sets of values can be combined to reveal how the change takes place over time. Basically, it is assumed that with each passing year after implementation of a regulatory change, an older age class assumes its equilibrium YPR value (from the base) and retains that value indefinitely. In other words, in the first year of the closed corridor implementation the 0 age-class assumes its equilibrium values, in the second year the 1- year age class also assumes its equilibrium values, etc. until this process of change ends. While there are 7 age-classes, in North Carolina waters the 5 and 6 year age classes are present so rarely that the stock adjusts almost completely with its 4-year olds, in the 5th year of implementation.

Changes in YPR values over the five-year implementation period are indicated in Appendix Table 1. The changes are an aggregate for both North Carolina's summer and fall fisheries (Area's 4 and 5 in AMAC nomenclature). The table indicates base YPR values, the YPR value in each year of implementation, equilibrium YPR value, the change in value and the percentage change in value compared to the base. These figures are presented for each of the three scenarios on redeployment of fishing effort.

The base and equilibrium YPR estimates in Appendix Table 1 are the same as can be found in Table 5. Close examination of Appendix Table 1 demonstrates that just as in equilibrium, the scenario of no redeployment of effort also has the most negative impact during the first year--almost twice as much, or a 24 percent decrease in catch, monetary values, and employment in the first year compared to baseline conditions. If the industry attempts to ameliorate its potential losses by redeploying its effort offshore, and also inshore, then percentage declines from the baseline are not as great as the first scenario (but they are larger than at equilibrium).

An important issue, but not developed here because of this paper's focus on North Carolina only, is the relationship between impacts on North Carolina from a closed fishing corridor and impacts on the whole Atlantic coast fishery. As stated in the first paragraph in the "Closed Corridor Impacts," equilibrium YPR declines of 13 percent, 9 percent, and 4 percent for North Carolina are associated with increases of 6 percent, 4.4 percent, and 1 percent, respectively, for the whole coast. In other words, the greater the sacrifice from North Carolina at equilibrium and during the adjustment period, the greater benefit will accrue to the whole fishery, i.e. states to the north.

There has been much controversy, but practically no research, on this issue. On the one hand there are questions relating to the mobility of firms and fishing effort to the north, the potential employment gains to the north,