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A Productivity Analysis Of Major North Carolina Commercial Fisheries

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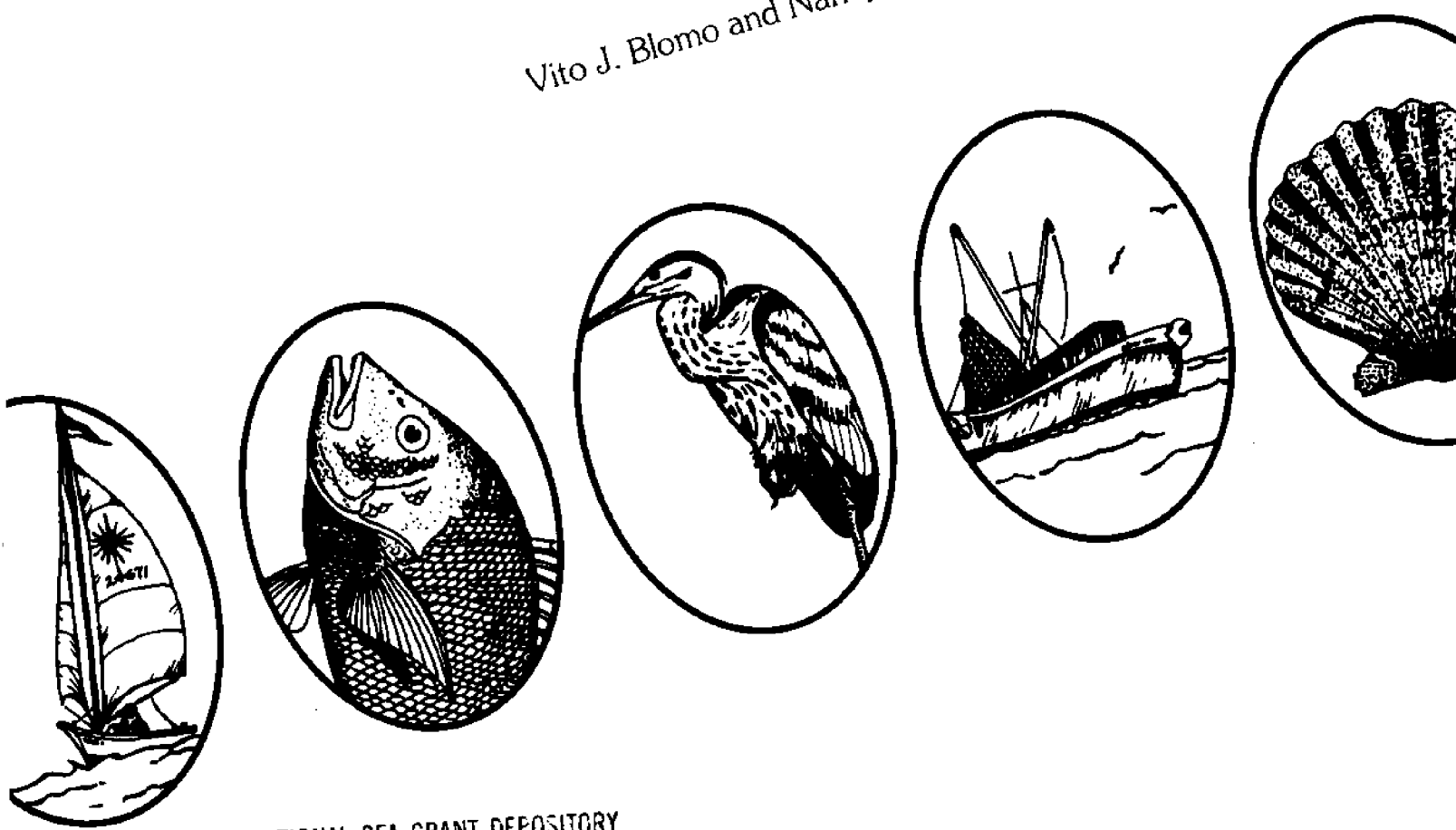

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INTRODUCTION

North Carolina has a rich history of human activities associated with its marine resources. Early settlements dotted the coastline and depended on fishing in part for their livelihood. This tradition continues today, whereby the coastal counties are among the fastest growing areas of the state, in part because of the available marine resources and related activities.

Fishing, of course, is one of these related activities and attracts commercial and recreational interests. North Carolina, like many other coastal states, takes an active interest and role in managing its marine fisheries resources. The structure of North Carolina institutions gives power to its Marine Fisheries Commission to authorize, license, and regulate marine resources with respect to time, place, gear, season, size limits and quantities. In addition, the Division of Marine Fisheries (a part of the Department of Natural Resources and Community Development) enforces such regulations and statutes and advises the state (via the Commission) of the status of its marine resources.

North Carolina is similar to other coastal states in that it has several species consistently providing most of the weight and value of its commercial catches. These include menhaden, shrimp, crabs, and flounder. At the same time, however, both the commercial fishing industry and marine resource agencies would like to increase the weight and value of catches by developing new species as well as improving existing ones.

To accomplish this, an understanding must be gained of the historical fishing patterns of the species above to form conclusions about the present status of species exploitation and future planning. Such an understanding would lead to consideration of changes in, or establishment of, fishermen and vessel licensing, permissible areas for fishing, seasons for fishing, size and quantity limits on catch, and permissible gear. The patterns would indicate if recent changes in the fishery are cyclical, and can be expected to change regularly, or are abnormal and exhibit either a significant upward or downward movement in key parameters. Thus, proper understanding of a fishery's condition should lead to a proper mix of state regulations of the resource and user groups.

OBJECTIVES

The overall objective of this study is to analyze the productivity of North Carolina's major commercial fisheries. This analysis will aid in evaluating the feasibility of intensifying existing fisheries and/or developing new species, which could supplement or replace existing ones. The analysis of productivity will be accomplished using both physical and economic measurements to approximate:

(1) biological availability, and
(2) economic feasibility for commercial operation.

Specific objectives of this study are to:

(a) establish physical and economic measures of productivity for the state's major commercial fisheries,
(b) establish criteria for identifying major commercial fisheries,
(c) analyze and evaluate productivity measures and trends for the state's major commercial fisheries, and
(d) identify any species that periodically can be classified as a major commercial one and that could be developed.

This study is economic in nature, in that it examines the status of the fisheries resources in monetary terms and their relationships to commercial fishermen and associated gear/vessel types. Thus, the study is concerned with the production aspects of the fisheries resources, and how the wealth from the production level is distributed among producers over time. Resource availability is stated only from inferences about the stock emanating only from catch statistics. Except where noted, this study does not purport to explain natural, or biological, changes in any species. While the analysis does not hold constant the stock of any species, changes in productivity measures will come about through changes in the stock and the level of fishing inputs, as discussed below in the Results sections.

METHODOLOGY

The methodology in this paper is one of comparative analysis of productivity measures among commercial species and over time. Statistics of a time series nature will be collected from which productivity measures will be derived. Following up on the criteria to identify major commercial species, comparisions can then be made between species statically (at any one point in time) and dynamically (over a period of time).

Analyzing productivity measures at a point in time and over time will enable evaluation of the fishery in terms of its physical and economic contributions to the state economy. For example, one productivity measure may be catch per fisherman, derived by dividing total catch (of a species) by number of fishermen (of a species). If this measure is declining over time, from perhaps increased numbers of fishermen, then resource managers may consider higher fees for fishing permits in order to reduce fishing pressure. Elementary statistics for the productivity measures, such as range, mean, and standard deviation, will be provided.

Productivity Measures

The basic set of variables with which productivity measures may be constructed includes the following:

1) total catch, in pounds, by species,
2) total exvessel value, in dollars, by species,
3) total number of fishermen, classified by full and part-time, participating in a fishery, and associated with a fishing craft and gear,
4) the number of vessels or boats participating in a fishery,
5) catch by gear type, by species
6) number of the major gear used, by species, and
7) the Producer Price Index to measure inflation (at the production marketing level).

The outputs are variables (1), (2), and (5), while the inputs used to produce the outputs are variables (3), (4), and (6). By dividing (1) and (2) each by (3) and (4), and by dividing (5) by (6), productivity measures are calculated over time to indicate patterns, if any, in the physical and monetary input-output relationships. Variable (2) can be divided by variable (7), as can average price per pound (variable (2) divided by variable (1)), to transform nominal or current dollars to inflation-adjusted (real) dollars relative to a base year. These "real" dollars used in the productivity measures would indicate if their values are keeping pace with inflation. (It is accepted practice to deflate a particular price series at the exvessel level, for example, by a price index based on the same marketing level; while almost all price indices move together over time, applying a particular one to a different marketing level is inappropriate since each index is based on a unique bundle of goods and services.)

Summarizing, the set of productivity measures include:

1) catch per fisherman, per vessel, and per gear,
2) current dollars per fisherman, per vessel, and per gear, and
3) real dollars per fisherman, per vessel, and per gear.

In addition, changes in the variables themselves may reveal patterns in the fishery and its markets, as in changes in total catch, in price per pound (the interaction of supply and demand), and in numbers of fishermen.

Criteria for Identifying Major Commercial Fisheries

The criteria for identifying major commercial fisheries in North Carolina are necessarily ones of convenience to suit the available data. There is a wide variety of economic tools and measures available to classify "major" industries, subsectors, or firms, in general and in actual practice. Economic studies of industries (the economy) in the U.S. attempt to measure control of the market held by the top four, eight, or ten firms (industries) in an industry (economy). Also in agriculture, to effect a marketing order, if at least 51 percent of all producers (of a commodity) who produce at least 67 percent of the commodity, or at least 67 percent of all producers who produce at least 51 percent of the commodity, vote affirmatively then one will be established. Thus, a combination of a limited number of species/fisheries which together make up a majority of the commercial catch and value in North Carolina would bring together elements of both popular approaches above.

The criteria that will be used to identify major commercial fisheries, therefore, are to identify those five species/fisheries that account for at least 51 percent of the total commercial catch and at least 51 percent of the total exvessel value. The criteria avoid characteristics of a fishery such as number of fishermen, vessels, gear, number of firms, or fishing areas because the emphasis is on pounds harvested, which contributes to civilian consumption, and dollars, which contributes to fishermen income and overall economic activity. Some of the characteristics of a fishery stated above will in fact be used to calculate productivity estimates.

DATA

All data used in this study are secondary in nature, that is, already collected and on file or available. Data are specifically from the National Marine Fisheries Service (NOAA, U.S. Department of Commerce) and the North Carolina Division of Marine Fisheries (Department of Natural Resources and Community Development). Variables (1) through (6) listed under the 'Productivity Measures' section above were obtained from the NMFS Statistical Digest series; the latest publication is for 1977 with later years' data available through computer access. Data are collected cooperatively by federal and state agencies. Beginning in 1978, the reader may perceive some sharp jumps in the values of some of the variables by species; this may be caused by the increased staffing of reporting agents in that year. Earlier data were not adjusted in any way to reflect the more extended coverage. The Producer Price Index (formerly Wholesale Price Index) is available from the "Survey of Current Business," published by the Bureau of Economic Analysis, U.S. Department of Commerce. Other general statistics such as consumer income, the Consumer Price Index, and meat consumption are also available from this source and are used in the results section.

RESULTS

North Carolina's commercial fisheries are made up of finfish and shellfish, which are used for direct and indirect human consumption and for industrial purposes. Over the period 1964-83 the total dollar value of all commercial species has increased steadily from $8 million in 1964 to $57 million in 1984 (Table 1). During this same time period the total catch exhibits a cyclical pattern of having a peak in 1966, a valley low in 1973, and another peak in 1981 (Table 1 and Figure 1). A variety of factors may explain this pattern, chief among them probably being environmental/climatic factors, and also variations in fishing effort. (Derivation of an annual average price per pound was done by excluding the catch and value of menhaden, which accounts for almost 100 percent of the catch used for indirect human consumption and industrial purposes; however, its proportion of total value is relatively low -- see Table 14.) The price has increased from 9 cents/pound in 1964 to 47 cents/pound in 1983 at a somewhat steady pace with few downward movements -- 1968 to 1969 and 1971 to 1972 -- and some sharp upward movements -- 1972 to 1973 and 1975 to 1979.

A second step in analyzing catch, value, and price for the total of the commercial catch is to analyze them in the context of some broader economic indicators. These indicators include the Consumer Price Index, for all items in a "market basket", and for meat, poultry, and fish, separately; The Producer Price Index (formerly the Wholesale Price Index); per capita disposable personal income; and per capita fish consumption (Table 2). The price indices not only provide bases for comparison to North Carolina statistics but are also used to deflate monetary value, i.e., factor out the effects of inflation (Table 1).

Examination of North Carolina exvessel value of commercial landings with these broad economic indicators reveal that fishermen revenue and average annual price have increased at an even greater rate in the 1964-84 period than inflation. Price and revenue (landings multiplied by price) are established from the interaction of supply and demand for fishery products. While landings

Table 1. Annual catch, exvessel value, and prices of total North Carolina commercial fishing industry, 1964-83.

Year	Total Catch	Exvessel Value	Average Nominal Price[a]	Average Real Price[ab]
	(Thou. lbs.)	(Thou. dllrs.)	(dllrs./lb.)	(dllrs./lb.)
1964	238,579	8,023	.09	.09
1965	233,961	9,241	.10	.10
1966	250,932	9,571	.10	.10
1967	225,088	8,328	.09	.09
1968	232,175	9,706	.12	.12
1969	219,034	12,525	.14	.13
1970	173,442	9,365	.12	.11
1971	143,475	11,227	.16	.14
1972	175,811	11,838	.12	.10
1973	137,869	16,066	.19	.14
1974	206,691	17,484	.17	.11
1975	238,301	20,000	.20	.11
1976	226,069	27,465	.25	.14
1977	251,260	28,648	.26	.13
1978	299,541	40,609	.31	.15
1979	390,472	58,454	.37	.15
1980	356,193	68,784	.39	.14
1981	432,006	57,520	.39	.13
1982	307,968	63,824	.48	.16
1983	287,733	57,425	.47	.15
1984	277,169	57,263	.44	.14

[a] Excludes the menhaden fishery catch and value for calculating average price.
[b] Calculated by dividing nominal price by the Producer Price Index (1967=100)

Sources: Fishery Statistics of the United States, 1964-83; and Survey of Current Business, 1964-83.

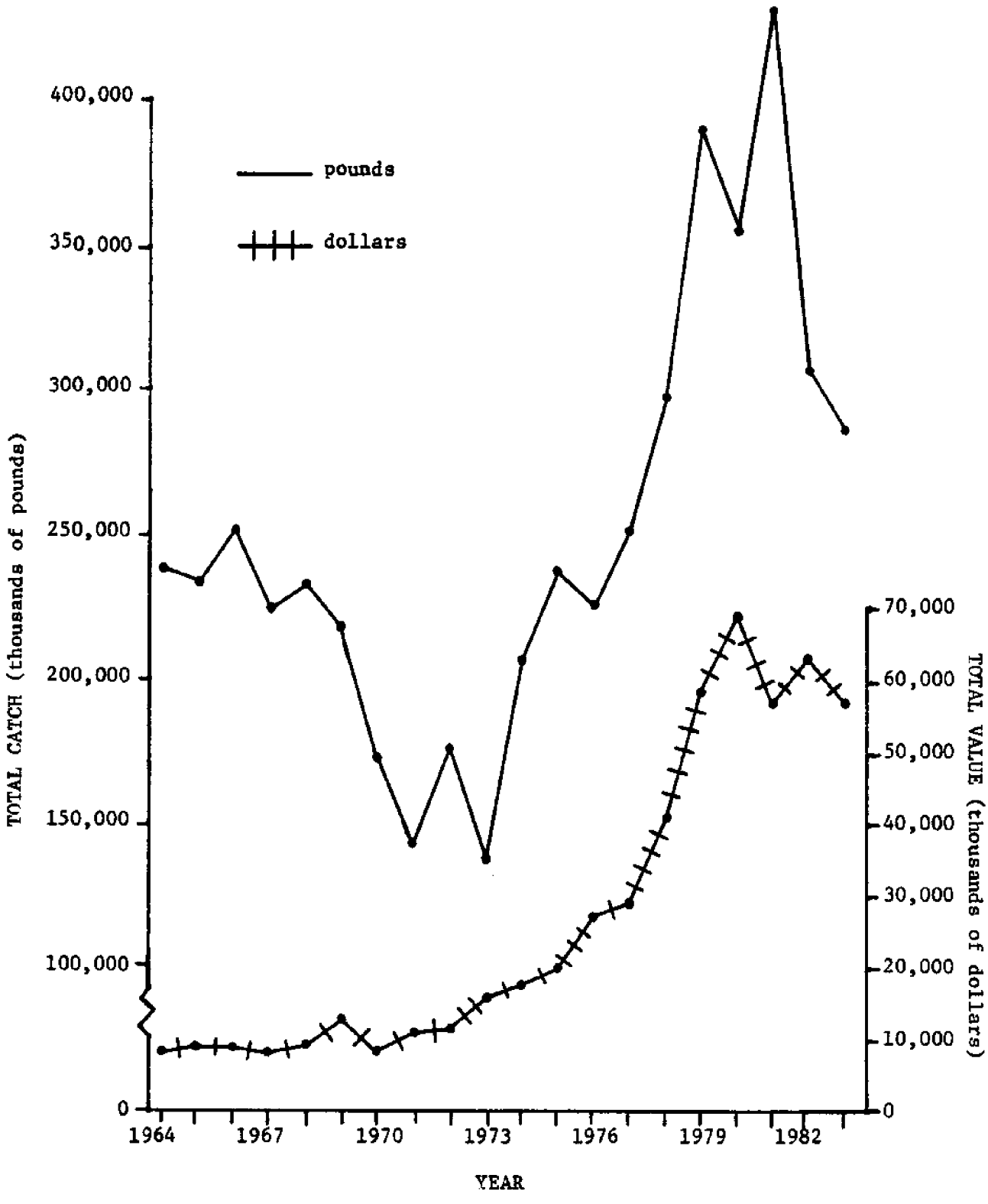

FIGURE 1.- Total annual catch and exvessel value of North Carolina commercial catches, 1964-1983. (Fisheries Statistics of the United States,U.S. Dept. of Commerce)

Table 2. National indicators of inflation, income, and fish consumption, 1964-82.

Year	Producer Price Index	Consumer Price Index (CPI)	CPI-Meat	CPI-Poultry	CPI-Fish	Nominal Per Capita Disposable Income	Real Per Capita Disposable Income[a]	Fish Consumption
	(1967=100)					(dllrs)		(lbs./capita)
1964	94.7	93.1	87.3	98.2	88.1	2,285	2,454	10.5
1965	96.6	94.5	94.0	101.3	90.8	2,437	2,579	10.8
1966	99.8	97.3	102.6	106.7	96.7	2,606	2,678	10.9
1967	100.0	100.0	100.0	100.0	100.0	2,751	2,751	10.6
1968	102.5	104.2	102.3	103.1	101.7	2,947	2,828	11.0
1969	106.5	109.8	111.4	108.9	107.2	3,119	2,841	11.2
1970	110.4	116.3	117.6	108.4	118.0	3,361	2,890	11.8
1971	113.9	121.3	116.7	109.0	130.2	3,599	2,967	11.5
1972	119.1	125.3	129.2	110.4	141.9	3,844	3,068	12.5
1973	134.7	133.1	161.1	154.8	162.8	4,296	3,228	12.8
1974	160.1	147.7	164.1	146.9	187.7	4,624	3,131	12.1
1975	174.9	161.2	177.9	162.4	203.3	5,042	3,128	12.2
1976	183.0	170.5	178.2	155.7	227.3	5,512	3,233	12.9
1977	194.2	181.5	174.2	156.7	251.6	6,038	3,327	12.7
1978	209.3	195.3	206.5	171.1	274.0	6,643	3,401	13.4
1979	235.6	217.7	241.4	179.5	298.4	7,443	3,419	13.0
1980	268.7	247.0	248.1	188.4	327.5	8,012	3,244	12.8
1981	293.4	272.3	257.4	196.7	353.9	8,830	3,243	13.0
1982	299.3	288.6	269.7	193.2	369.5	9,379	3,250	12.3
1983	303.1	297.4	266.7	195.5	373.3	9,934	3,340	13.1
1984	310.3	307.6	267.5	216.3	385.6	10,896	3,542	13.6

[a]Calculated by dividing the nominal per capita disposable income by the Consumer Price Index (1967=100).

Sources: Fisheries of the United States, 1984; Survey of Current Business, 1965-85; National Food Review, 1985.

exhibit a cyclical pattern (and which have an inverse relationship to price), most of the increased value of the catch appears to come from an ever-expanding demand. Thus, there is upward pressure on price. This pressure is evident when examining the undeflated North Carolina price in Table 1, which increases by over four times, with the Producer Price Index, with the consumer price indices for meat, poultry, and fish, and with consumer income. There appears a consistent pattern of increasing demand (indicated by rising prices) for fishery products in comparison with substitutes (red meat in particular) and with increases in income (inflation-adjusted or not - Table 2). Hence, even though U.S. per capita fish consumption is not increasing significantly (Table 2), North Carolina average price nevertheless is increasing after being inflation-adjusted (Table 1).

In identifying the five species that account for at least 51 percent of total exvessel value and at least 51 percent of total catch, four species have consistently remained in this group over the study period (1964-84). They are menhaden, shrimp, flounder, and blue crab. For most of this period, croaker rounds out the remaining position. However, it is this fifth position which may suggest potential major commercial fisheries, especially when croaker was displaced from it. Each of the five species is discussed below. In terms of total catch (measured in pounds) the top five species account for an average 85 percent, with a slight downward trend. Menhaden accounts for the bulk of total landings, with the second most numerous species having no more than a small fraction of menhaden landings. With respect to total exvessel value, these five species accounted for an average of 69 percent of revenue, with what appears to be a downward trend in this percentage in the last several years (Table 3). Identification of species which are accounting for a larger proportion of total dollar value may also help identify potential commercial fisheries.

Menhaden

Patterns in the menhaden fishery reflect somewhat the total North Carolina fishery since it comprises the overwhelming majority of the total catch. The menhaden catch exhibits a cyclical pattern, with a peak in 1966, a trough in 1973, and another peak in 1981 (Table 4). The nominal value of menhaden harvested appears to have a steady, upward trend to it (Table 4), thus indicating an upward trend in nominal price per metric ton. When this price is deflated, however, there is no apparent trend at all in menhaden price between 1964 and 1984, excepting 1973 as a reflection of a world-wide food shortfall. (Fish meal prices more than doubled from 1972 to 1973.) Because menhaden prices have just kept up with inflation, the menhaden fishery since 1964 has accounted for smaller proportions of the total North Carolina exvessel value. Between 1964 and 1971 there was a clear decline from almost -28 percent to -10 percent, while between 1972 and 1984 the proportion has varied between 8 percent and 18 percent with little evidence of a trend (Table 14 on page 25).

It should be noted in this discussion that the exvessel value of menhaden is somewhat contrived, that is, it is calculated (by NMFS personnel) by multiplying the value of its main processed product (fish meal) by 0.6. Thus, the exvessel value is derived from the interaction of supply and demand at a higher marketing level, as one would expect, but the use of the 0.6 adjustment factor is somewhat arbitrary in part because menhaden remain within the same firm from dockside to processing. The other processed product from menhaden is

Table 3. Annual catch and exvessel value of the top five commercial fish species each year in North Carolina, and percent of total commercial catch and value of all commercial species in North Carolina, 1964-83.

Year	Nominal Exvessel Value	Real Exvessel Value[a]	Catch	Percent of Total Value[b]	Percent of Total Catch
	.....(Thou. dllrs.)....		(Thou.lbs.)	....(Percent)...	
1964	5,743	6,064	218,298	71	92
1965	6,478	6,706	205,892	70	88
1966	7,114	7,128	223,436	74	89
1967	5,392	5,392	194,465	65	86
1968	7,197	7,021	209,223	74	90
1969	9,918	9,313	199,452	79	91
1970	6,580	5,960	150,851	70	87
1971	8,441	7,411	120,583	75	84
1972	7,994	6,712	138,205	68	79
1973	11,652	8,650	100,419	73	73
1974	12,340	7,708	160,824	70	78
1975	14,218	8,129	194,939	71	82
1976	20,742	11,334	184,131	76	81
1977	20,830	10,726	209,143	73	83
1978	26,471	12,647	258,988	65	86
1979	36,156	15,346	334,722	62	86
1980	43,803	16,302	289,657	64	81
1981	35,109	11,966	358,237	61	89
1982	39,083	13,058	257,536	61	84
1983	39,264	12,954	239,959	68	83
1984	35,029	11,289	223,281	61	81

[a]Calculated by dividing nominal exvessel value by the Producer Price Index (1967=100).
[b]Value in nominal terms.

Sources: Fisheries Statistics of the United States, 1964-82; Trends in North Carolina's Commercial Fisheries, 1965-81; Table 1.

Table 4. Catch, exvessel value, average price, and level of fishing inputs in the commercial menhaden fishery in North Carolina, 1964-83.

Year	Catch	Exvessel Value	Average Price	Number of Fishermen	Number of Vessels/Gear
	(thousand pounds)	(thousand dollars)	(dollars/ metric ton)		
1964	172,992	2,249	28.7	1,014	60
1965	160,595	2,072	28.5	825	49
1966	182,289	2,538	30.7	810	48
1967	150,481	1,694	24.8	878	52
1968	167,189	1,958	25.8	827	49
1969	145,235	2,228	33.8	409	42
1970	108,235	1,570	32.0	692	41
1971	79,488	1,116	31.0	623	37
1972	84,692	1,219	31.7	166	10
1973	66,943	2,540	83.7	183	11
1974	121,198	2,887	52.5	250	15
1975	153,805	3,259	46.7	334	20
1976	134,902	4,534	74.1	267	16
1977	158,119	4,369	60.9	409	20
1978	192,324	7,498	86.0	321	19
1979	254,330	8,060	69.9	321	19
1980	196,920	7,139	79.9	338	20
1981	309,415	10,039	71.5	NA	19
1982	187,015	5,773	68.1	NA	18
1983	177,973	6,168	76.4	NA	17
1984	157,667	4,746	66.4	NA	NA

NA - Not available

Sources: Fisheries Statistics of the United States, 1964-80; Trends in North Carolina's Commercial Fisheries, 1965-81.

fish oil. Menhaden in North Carolina waters do not have a high yield of oil compared to specimens caught to the north (Virginia and New Jersey) but the price of fish oil is high enough relative to fish meal to boost company revenues in some years.

Quite evident from the cyclical pattern of menhaden landings is the significant decline in numbers of fishermen, vessels, and gear. (Since there is normally one purse seine used per vessel, both inputs share the same columns in Tables 4-5). Part of the decline is due to the downward movement of the catch cycle between 1966 and 1973. However, significant structural changes in the fishery can also explain the decline, particularly since 1973 in the face of increased harvests. The structural changes were a result primarily of market forces. The changes include 1) the reduction/consolidation in the number of firms, 2) plant closings, 3) a reduction in the number of vessels, 4) inceased capacity of remaining vessels, 5) reduced crew sizes due to substitution of labor-saving hydraulic and power devices.

Because of the steady decline in physical inputs in the fishery, productivity is seen to be increasing over time (Table 5), despite the cyclical pattern of landings. In every measure of productivity the industry is seen to be steadily improving its catch and dollar value per fisherman and per vessel/gear. These results would imply that fisherman income has been increasing as well as the imputed value of a vessel (although this paper is not intended to verify this; crewmen are paid on the basis of catch multiplied by a dollar amount based on the value of menhaden products). Little can be inferred about the level of industry profit in the absence of complete cost information. It may be said that increased productivity was necessary to offset steady real prices throughout the period with higher real costs in the Producer Price Index.

In summary, the consolidation in the menhaden industry has enabled it to overcome the cyclical nature of the harvest and the stable nature of its market (as expressed in the inflation-adjusted dollars per metric ton; the long-term outlook for the fish meal market is somewhat negative because of expected large increases in soybean meal production, its main substitute). A likely recommendation to come out of this summary would be to continue management along an evolutionary path of allowing industry to operate internally without undue restriction and to insure the biological health of the stock.

Shrimp

The North Carolina shrimp fishery has exhibited sharp swings in catch and exvessel value over the 1964-84 period, resulting in a fluctuating share of the proportion of the total North Carolina fishing industry and of the top five species. Since shrimp are an annual crop, i.e., specimens survive no longer than a year, the dominant pattern discernible in the shrimp catch is the year-to year variation of a bad year followed by a good year (as in 1968 and 1969); or, because of a unqiue combination of environmental conditions and fishing effort (as in 1979-80) there may be two years of good landings, only to be followed by a poor year in 1981. Viewed in this context, the swings in catch range from 2.5 million pounds to 9.8 million pounds (Table 6), although the average catch over 1964-84 was 5.7 million pounds with 67 percent of the variation taking place within a 1.7 million pound range (above and below the average).

Table 5. Productivity measures for the commercial menhaden fishery in North Carolina, 1964-80.

Year	Catch per fisherman	Catch per vessel/gear	Nominal value per fisherman	Nominal value per vessel/gear	Real value per fisherman[a]	Real value per vessel/gear[a]
	(pounds)		(dollars)			
1964	170,551	2,882,460	2,217	37,472	2,341	39,570
1965	194,626	3,276,865	2,511	42,274	2,599	43,769
1966	224,843	3,794,223	3,131	52,835	3,139	52,963
1967	171,360	2,893,346	1,929	32,567	1,929	32,564
1968	201,962	3,408,618	2,365	39,923	2,308	38,946
1969	204,658	3,454,821	3,140	53,005	2,948	49,762
1970	156,409	2,639,883	2,269	38,304	2,056	34,707
1971	127,589	2,148,330	2,134	30,165	1,873	26,434
1972	510,193	8,469,210	7,345	121,933	6,169	102,400
1973	365,809	6,085,727	13,877	230,873	10,301	171,366
1974	484,791	8,079,847	11,546	192,438	7,214	120,223
1975	460,495	7,690,260	9,757	162,949	5,580	93,180
1976	505,252	8,431,400	16,983	283,397	9,280	154,862
1977	470,230	7,905,950	10,682	218,450	5,501	112,487
1978	599,141	10,122,315	23,358	394,632	11,160	188,548
1979	792,305	13,385,789	25,109	424,211	10,656	180,055
1980	582,604	9,846,000	21,121	356,950	7,861	132,843
Average	366,048	6,147,944	9,381	159,552	5,466	92,628
Standard Deviation	193,449	3,251,829	7,873	133,714	3,284	55,638

[a]Calculated by dividing nominal value per appropriate input by Producer Price Index (1967=100).

Source: Table 4.

Table 6. Catch, exvessel value, average price, and level of fishing inputs in the commercial shrimp fishery in North Carolina, 1964-83.

Year	Catch	Exvessel Value	Average Price	Number of		
				Fishermen	Vessels	Gear
	(Thou. lbs.)	(Thou. dllrs.)	(dllrs./lb).			
1964	4,279	1,503	.35	1,361	371	840
1965	5,416	1,719	.32	1,314	370	874
1966	5,697	2,566	.45	1,313	301	1,093
1967	4,919	1,809	.37	1,241	305	986
1968	4,615	2,357	.51	1,126	277	882
1969	7,854	4,476	.57	1,171	266	927
1970	5,054	2,493	.49	1,326	360	1,076
1971	7,615	4,765	.63	1,500	407	1,226
1972	5,563	3,549	.64	1,638	427	1,322
1973	5,003	4,738	.95	1,856	472	1,521
1974	8,440	4,606	.55	1,878	447	1,567
1975	5,164	5,054	.98	2,032	448	1,729
1976	6,643	8,171	1.23	2,011	451	1,714
1977	5,600	7,239	1.29	2,149	495	1,792
1978	2,961	3,884	1.31	1,977	541	1,616
1979	4,941	9,729	1.97	1,404	572	1,089
1980	9,823	17,185	1.75	2,574	611	2,253
1981	2,557	5,295	2.07	NA	NA	NA
1982	7,027	16,411	2.34	NA	NA	NA
1983	6,115	13,565	2.22	NA	NA	NA
1984	5,046	10,483	2.08	NA	NA	NA

NA - Not available

Sources: Fisheries Statistics of the United States, 1964-80; Trends in North Carolina's Commercial Fisheries, 1965-81.

Because of the upward movement of shrimp prices (Table 6), part of the fluctuation in catch is dampened if exvessel value is examined. The damping effect on exvessel value is most evident between 1964-72; after 1972 the changes in catch were either too strong or moved higher with higher prices (or vice versa) so that exvessel value was significantly affected. Over the 1964-84 period shrimp prices in North Carolina experienced phenomenal increases, on the order of five to six-fold, an increase higher than any of the economic indicators in Table 2. Thus, deflating shrimp prices reveals increases over and above the general inflation rate. Deflating the exvessel value of the catch results in a situation where there is no discernible trend in shrimpers' income, despite ever higher prices, because of the fluctuating catch.

In reviewing the inputs to shrimping -- number of fishermen, vessels, and gear -- it seems apparent that between exvessel value and price the latter is the signal influencing input levels during 1964-80. There appears a strong positive relationship between exvessel price over time and the number of fishermen, vessels, motor boats, otter trawl nets, and bag channel nets. In fact, using a graphical regression analysis relating number of otter trawls used this year to last year's exvessel price reveals that a 10 cent price increase in the previous year results in an increase this year of 200 otter trawls.

Utilizing the catch and value shrimp statistics with the input data yields annual productivity estimates. What emerges again can almost be described as a boom and bust cycle, although with increasing shrimp prices the low point in the down cycle appears to have increased over time for the monetary productivity estimates (Table 7). Fluctuations are the norm for the physical productivity measures, i.e., catch per fisherman, catch per etc., with little evidence of any trend during 1964-80 (especially excluding the 1969 calendar year).

In summary, on the basis of the 1964-84 period the shrimp fishery appears mature and fully exploited (given the fishery's regulatory aarrangements). However, the fishery can be characterized as either erratic with respect to annual catch or simply volatile from one year to the next within a range of 4.0 million to 7.4 million pounds. In addition, steadily increasing shrimp prices have drawn resources into the fishery, resulting in volatile returns to labor and capital.

Recommendations that could be made based on these findings would be two-fold, based on the shrimp stock and on the participants. First, while environmental/climatic factors do play the major role in the size of the shrimp stock available for harvest, the state can help greatly by insuring environmental quality in nursery areas for shrimp, in reducing industrial and agricultural point and non-point source pollution and run-off, and by optimal timing of the shrimp season opening. With respect to participants, the state may continue its present management of relatively low fees for shrimping and accept the volatility in fishermen income. Alternatively, it may consider much higher fees which may restrict entry into the fishery and, by so doing, improve the situation, even in bad years, for remaining participants. Higher fees may eliminate what appears to be excess physical capacity in the industry (see Blomo (1981) and Griffin, Lacewell, and Nichols (1976) for discussion on excess capacity) and allow the state to capture a higher value for its shrimp resource.

Table 7. Productivity measures for the commercial shrimp fishery in North Carolina, 1964-80.

Year	Catch per Fisherman	Catch per Vessel	Catch per Gear	Nominal Value per Fisherman	Nominal Value per Vessel	Nominal Value per Gear	Real Value per Fisherman[a]	Real Value per Vessel[a]	Real Value per Gear[a]
	(Pounds)			(dollars)					
1964	4,999	10,968	4,844	1,767	3,878	1,713	1,866	4,095	1,809
1965	6,308	13,895	5,882	2,025	4,461	1,888	2,097	4,619	1,955
1966	7,830	16,831	4,635	3,587	7,711	2,124	3,596	7,730	2,129
1967	6,864	15,100	4,671	2,530	5,567	1,722	2,530	5,567	1,722
1968	6,978	15,468	4,858	3,596	7,970	2,503	3,508	7,775	2,442
1969	12,478	28,004	8,036	7,171	16,095	4,618	6,732	15,110	4,336
1970	6,186	13,661	4,571	3,045	6,724	2,250	2,759	6,092	2,038
1971	8,205	18,204	6,043	5,156	11,439	3,797	4,525	10,039	3,333
1972	5,720	12,812	4,119	3,669	8,218	2,642	3,081	6,901	2,219
1973	4,546	10,307	3,198	4,327	9,810	3,044	3,212	7,282	2,260
1974	8,004	18,406	5,251	4,368	10,046	2,866	2,729	6,276	1,790
1975	4,454	10,168	2,870	4,387	10,014	2,826	2,509	5,727	1,616
1976	6,253	14,391	3,787	7,690	17,700	4,657	4,202	9,672	2,545
1977	4,805	11,270	3,113	6,211	14,568	4,024	3,198	8,090	2,072
1978	2,206	5,325	1,783	2,905	7,012	2,347	1,388	3,350	1,122
1979	4,729	8,070	4,239	9,324	15,910	8,357	3,958	6,753	3,547
1980	6,007	15,101	4,095	10,548	26,516	7,191	3,925	9,868	2,676
Average	6,269	13,999	4,470	4,841	10,802	3,445	3,283	7,350	2,330
Standard Deviation	2,140	4,868	1,376	2,462	5,616	1,825	1,191	2,692	765

[a]Calculated by dividing nominal value per appropriate input by Producer Price Index (1967=100).

Note: The productivity estimates are calculated for the specific pounds, and associated dollar value, caught by the main gear (shrimp otter trawls), vessels using that gear and fishermen on those vessels.

Source: Fisheries Statistics of the United States, 1964-80.

Blue Crabs

The North Carolina blue crab fishery displays a cyclical pattern to its harvests more like that of menhaden than that of shrimp, even though it is a shellfish. Between 1964 and 1982 there appears to be one full cycle of a peak-to-peak movement. After the 1964-1969 period (a peak period), landings decreased consistently through the 1970-1977 period and then experienced a low point during 1975-1976. Blue crab landings increased almost two-fold between 1977 and 1978 and have increased by more than 50 percent between 1978 and 1982. This most recent peak period is almost the same length as the earlier one and yet landings are significantly higher (Table 8).

The total exvessel value has increased dramatically during 1964-84, particularly since 1974. This movement in exvessel value reflects increased landings since 1977 and increased prices since 1976. The North Carolina blue crab market is a small part of a much larger national one with such dominant production states as Virginia, Maryland, and Louisiana. Thus the fishery may find itself whipsawed between a declining national market and the downside of its cyclical landings pattern, or vice versa. Such a situation is evident when considering the proportion of blue crab exvessel value to the value of the top five species (Table 14). Blue crab's percentage of dollar value experienced quite substantial fluctuations, from 19 percent in 1968 to 8 percent between 1975-77, up to 14 percent in 1981. While nominal prices appear to have experienced a somewhat steady increase, adjusting them for inflation reveals quite erratic real prices having a peak-to-peak movement of about three years. This may also amply illustrate the effect on the North Carolina blue crab fishery of national trends in the blue crab market and overall inflation.

Production inputs for the blue crab fishery -- fishermen, boats, and gear (pots and traps) -- have varying patterns during the 1964-80 period. The number of full and part-time fishermen appears to closely duplicate the pattern of landings. The number of gear, however, have a different pattern wherein there were increases when blue crab landings were declining. This may have been a response by the remaining fishermen to stabilize their catch and income by utilizing more traps per fishermen; as total catch climbed beginning in 1978 so did the number of traps, even more significantly (Table 8).

Productivity in the blue crab fishery (Table 9) indicates that the level of inputs has generally changed faster than changes in catch or value (nominal or real). This can be seen in the catch per (input) columns and the nominal/real value per (input) columns which should be used in conjunction with Table 8. For example, matching the declines in total blue crab catch with catch per gear, the decline in gear numbers accelerated until catch per gear in the early 1970's was comparable to catch per gear in the late 1960's; also matching the increased blue crab catch in the late 1970's with catch per gear indicates a much faster growth in gear numbers. This same pattern is exhibited in the catch per fisherman and real value per fisherman. While the nominal value per fisherman has increased during 1964-1980, this same pattern is still present although muted somewhat because of inflation; nevertheless, during 1978-80 this tendency for more inputs than the growth in dollar value is evident.

Table 8. Catch, exvessel value, average price, and level of fishing inputs in the commercial blue crab fishery in North Carolina, 1964-83.

Year	Catch	Exvessel Value	Average Price	Number of		
	(Thou. lbs.)	(Thou. dllrs.)	(dllrs./lb.)	Fishermen	Boats	Gear
1964	24,092	1,275	.05	513	438	28,500
1965	22,334	1,263	.06	422	397	26,945
1966	18,914	868	.05	426	407	30,795
1967	14,272	704	.05	305	278	20,735
1968	19,170	1,834	.10	361	339	24,380
1969	22,159	2,125	.10	371	359	24,740
1970	20,880	1,238	.06	346	315	26,655
1971	14,476	1,128	.08	352	318	27,440
1972	13,479	1,345	.10	364	331	31,560
1973	11,963	1,537	.13	427	368	38,060
1974	13,164	1,374	.10	409	339	36,640
1975	11,072	1,454	.13	404	337	36,350
1976	11,732	2,406	.21	480	480	65,775
1977	12,221	2,148	.18	451	398	63,137
1978	23,559	4,326	.18	736	608	91,696
1979	26,618	4,621	.17	934	877	134,675
1980	34,323	5,975	.17	1,317	1,226	188,446
1981	37,928	8,172	.22	NA	NA	NA
1982	38,206	7,185	.19	NA	NA	NA
1983	34,689	8,445	.24	NA	NA	NA
1984	32,491	6,665	.20	NA	NA	NA

NA - Not available

Sources: Fisheries Statistics of the United States, 1964-80; Trends in North Carolina's Commercial Fisheries, 1965-81.

Table 9. Productivity measures for the commercial blue crab fishery in North Carolina, 1964-80.

Year	Catch per Fisherman	Catch per Boat	Catch per Gear	Nominal Value per Fisherman	Nominal Value per Boat	Nominal Value per Gear	Real Value per[a] Fisherman	Real Value per[a] Boat	Real Value per[a] Gear
	(pounds)			(dollars)					
1964	30,850	30,357	466	1,756	1,728	27	1,854	1,825	28
1965	23,208	22,507	332	1,369	1,328	20	1,418	1,375	20
1966	29,725	19,573	259	1,361	896	12	1,364	898	12
1967	23,267	14,647	196	1,201	756	10	1,201	756	10
1968	39,100	23,068	321	3,641	2,148	30	3,552	2,095	29
1969	56,370	32,346	469	5,352	3,071	45	5,024	2,883	42
1970	85,382	41,742	493	5,170	2,528	30	4,684	2,290	27
1971	66,421	34,255	397	5,239	2,702	31	4,598	2,371	27
1972	64,644	33,005	346	6,474	3,306	35	5,437	2,776	29
1973	52,717	25,642	248	6,700	3,259	32	4,973	2,419	23
1974	63,127	32,960	305	6,487	3,387	31	4,053	2,116	20
1975	44,768	23,380	217	5,642	2,946	27	3,226	1,685	16
1976	30,554	16,677	122	6,244	3,408	25	3,412	1,862	14
1977	40,761	23,965	151	6,917	4,067	27	3,562	2,094	13
1978	26,009	29,773	197	4,783	5,476	36	2,285	2,616	17
1979	40,182	23,413	152	6,723	3,917	26	2,853	1,663	11
1980	27,428	23,245	151	4,639	3,931	26	1,726	1,463	10
Average	43,795	26,503	284	4,688	2,874	28	3,248	1,952	20
Standard Deviation	17,662	6,800	117	1,998	1,191	8.1	1,374	587	8.6

[a]Calculated by dividing nominal value per appropriate input by Producer Price Index (1967=100).

Note: The productivity estimates are calculated for the specific pounds, and associated dollar value, caught by the main gear (pots and traps), motor boats using that gear, and total number of fishermen on boats.

Source: Fisheries of the United States, 1964-80

Summarizing, blue crab landings have reached their highest levels recently, resulting from a combination of good environmental conditions and recruitment patterns and considerably more fishing inputs. Further study may indicate if more increases in catch could be expected from either natural conditions or from increased inputs. However, the cyclical nature of landings should be recognized, and the downside of the next cycle may be exacerbated by any increases in gear, as in the Maine lobster fishery or the Florida spiny lobster fishery.

Another aspect that should be considered in managing the fishery is the apparent volatility in the level of input usage in response to changes in total catch. While the historical fluctuations have been in a narrow range, e.g., catch per fisherman during 1964-80, if total catch were to return to the 15 million pound level it would halve catch per fisherman at the 1980 level of fishermen. Thus, the situation for the blue crab industry is a combination of menhaden's cyclical landings pattern and shrimp's increasing input level. Recommendations would include insuring biological viability and studying further increases in catch, and consideration of regulations to stabilize inputs into this fishery if stabilization were deemed appropriate.

Flounder

The North Carolina flounder fishery's position in the top five commercial fisheries has been one of steady growth in the level of landings (Table 10) and increased proportion of the top five's total dollar value. With increasing prices, the exvessel value of flounder has steadily increased, sometimes (1974-77) even in the face of declining landings — but not always as in 1980-81. The flounder fishery is divided into two segments: an inshore one taking place primarily in Core Sound and an offshore one (Division of Marine Fisheries, 1982). Much of the increase in catch has come from the offshore segment. As a whole, the fishery may be close to full exploitation since landings peaked in 1979 and have declined until 1984 (Table 10). The stock of flounder also appears to be an interstate one, with some tagged specimens from North Carolina being caught in South Carolina and Florida and as far northward as Massachusetts.

Flounder caught in North Carolina are part of a larger regional market wherein shipments of fresh-frozen whole flounder and fillets are trucked to larger metropolitan areas out of state. Thus, the North Carolina price is influenced by demand and supply conditions elsewhere, especially since North Carolina is a relatively small producer. Market forces outside North Carolina influence North Carolina flounder prices, as evidenced by the seven-fold increase in landings from 1964 to 1979 while nominal price increased over twice as much. In addition, the overall inflation is an outside uncontrollable influence on the fishery (Table 2). Adjusting nominal prices for inflation (by dividing average price in Table 10 by the Producer Price Index in Table 2) results in a real price in 1964 of 10 percent per pound, and in 1981 of 21 cents per pound, with an intervening range between 15 and 25 cents per pound. With virtually no trend in real prices, it is the increased landings of flounder which has resulted in higher values in the real exvessel value of landings.

Table 10. Catch, exvessel value, average price, and level of fishing inputs in the commercial flounder fishery in North Carolina, 1964-83.

Year	Catch	Exvessel Value	Average Price	Number of		
				Fisherman	Vessels	Gear
	(Thou.lbs.)	(Thou.dllrs.)	(dllrs./lb.)			
1964	2,450	481	.20	240	76	96
1965	4,721	951	.20	265	91	120
1966	4,017	744	.19	295	103	134
1967	4,391	867	.20	363	128	166
1968	2,602	626	.24	377	115	196
1969	2,766	706	.26	274	93	127
1970	3,163	780	.25	283	93	126
1971	4,011	1,118	.28	297	96	128
1972	4,655	1,388	.30	324	105	144
1973	7,365	2,161	.29	408	135	213
1974	11,812	2,842	.24	411	135	221
1975	11,510	3,547	.31	457	150	246
1976	11,452	4,054	.35	447	145	238
1977	11,137	4,998	.45	542	169	263
1978	12,311	6,306	.51	638	192	299
1979	18,457	8,848	.48	764	221	329
1980	16,923	7,950	.47	755	216	319
1981	9,795	6,206	.63	NA	NA	NA
1982	8,440	5,672	.67	NA	NA	NA
1983	9,813	5,684	.58	NA	NA	NA
1984	15,086	9,038	.60	NA	NA	NA

NA - Not Available

Sources: Fisheries Statistics of the United States, 1964-80; Trends in North Carolina's Commercial Fisheries, 1965-81.

The number of fishermen, vessels, and gear (fish otter trawls) have all increased in the 1964-80 period in conjunction with increases in catch and exvessel price. However, unlike blue crabs, the number of inputs rose slower (three times during 1964-80) than the increase in catch (seven-fold).

Productivity in the North Carolina flounder fishery can be seen to be increasing steadily during the 1964-80 period (Table 11). As noted above, it is from a combination of increasing level of inputs and a catch and dollar value increasing even faster. While the peak physical productivity occurred in 1974 (catch per input unit), productivity in terms of nominal and real dollars per input continued to increase. When the flounder catch declined in 1980 from the peak 1979 catch, productivity measures dropped as expected, even with declines in all the fishing inputs.

The North Carolina flounder fishery is at a critical stage in its status as a major commercial fishery. It has enjoyed increasing catches and prices and increasing physical and monetary productivity over 1964-79. However, since 1979's record landings catches have declined to one-half as much in 1983, and productivity dropped significantly in 1980 (the last year available for calculating productivity data). The fishery could now be facing a cyclical decline in landings as stock availability may have peaked out; in fact, the downside of the cycle is occurring more rapidly than the build-up in catch previously. (It is not clear if the 1984 catch is a return to peak catch levels or an aberration.) Another critical problem is returns to fishing inputs (labor, vessels, and gear); while inputs did not increase as fast as increases in catch and monetary value, the same may hold true when catch and dollar value are declining. Thus productivity will decline greatly. A way to help restore the fishery to a higher level of catches may be a multi-state management plan pursued by the Division of Marine Fisheries in conjunction with other Atlantic coast states.

Croaker

The North Carolina croaker fishery rounds out the top five commercial species. For the 1964-80 period of the productivity analysis, croaker was in the top five only three of the seventeen years. It was selected over any other species for this last spot because of the consistency of its landings and dollar value and their growth during the period. (Grey trout was as consistent in catch and value during the period but did not experience the increase in catch that croaker did.)

The pattern of croaker landings in the 1964-84 period resembles that of flounder: a period of stability (or slight decline) in the 1960's followed by a rapid increase in catch throughout the 1970's culminating in a 1980 record catch, followed by declines thereafter (Table 12). The fishery is comprised of two segments -- a winter trawl fishery and a long-haul seine fishery in the Pamlico Sound during Spring-Fall. An ocean gill net fishery has also developed since 1980 (Division of Marine Fisheries, 1982).

As with the flounder fishery, the croaker fishery experienced continually rising prices in the face of increased landings during 1964-80, an indication of demand growing faster than supply. Nominal price and supply increases since 1971 have resulted in an increased share for the croaker fishery of North

Table 11. Productivity measures for the commercial flounder fishery in North Carolina, 1964-80.

Year	Catch per Fisherman	Catch per Vessel	Catch per Gear	Nominal Value per Fisherman	Nominal Value per Vessel	Nominal Value per Gear	Real Value per[a] Fisherman	Real Value per[a] Vessel	Real Value per[a] Gear
	(pounds)			(dollars)					
1964	9,305	24,487	19,385	1,844	4,851	3,841	1,947	5,123	4,056
1965	15,214	4,030	3,056	3,110	8,236	6,246	3,220	8,528	6,467
1966	11,944	33,512	25,759	2,220	6,228	4,788	2,225	6,244	4,799
1967	10,387	29,458	22,714	2,028	5,753	4,436	2,028	5,752	4,435
1968	5,621	15,984	9,379	1,352	3,845	2,256	1,319	3,751	2,201
1969	7,459	21,976	16,093	1,818	5,355	3,922	1,706	5,028	3,682
1970	9,113	27,731	20,468	2,215	6,739	4,974	2,007	6,106	4,507
1971	12,029	37,215	27,911	3,325	10,287	7,715	2,918	9,028	6,771
1972	11,609	35,821	26,119	3,325	10,260	7,481	2,792	8,616	6,283
1973	15,474	46,767	29,641	4,437	13,409	8,498	3,293	9,953	6,308
1974	24,340	74,283	45,376	5,757	17,526	10,706	3,596	10,949	6,688
1975	20,872	63,591	38,775	6,341	19,318	12,175	3,626	11,047	6,736
1976	21,537	66,392	40,449	7,595	23,414	14,265	4,150	12,795	7,795
1977	19,070	61,160	39,300	8,568	27,485	17,661	4,413	14,153	9,094
1978	16,959	56,352	36,186	8,568	28,468	18,280	4,093	13,601	8,734
1979	21,052	72,779	48,888	10,023	34,651	23,276	4,254	14,707	9,879
1980	18,074	63,174	42,776	8,086	28,264	19,138	3,009	10,519	7,122
Average	14,709	43,218	28,957	4,742	14,946	9,980	2,976	9,171	6,209
Standard Deviation	5,383	20,849	12,574	2,822	9,820	6,215	944	3,349	1,993

[a]Calculated by dividing nominal value per appropriate input by Producer Price Index (1967=100).

Note: The productivity estimates are calculated for the specific pounds, and associated dollar value, caught by the main gear (fish otter trawls), vessels using that gear, and fishermen on those vessels.

Source: Fisheries of the United States, 1964-80.

Table 12. Catch, exvessel value, average price, and level of fishing inputs in the commercial croaker fishery in North Carolina, 1964-83.

Year	Catch	Exvessel Value	Average Price	Number of		
				Fishermen	Vessels	Gear
	(Thou. lbs.)	(Thou. dllrs.)	(dllrs./ton)			
1964	1,867	139	164	240	76	96
1965	1,754	108	136	265	91	120
1966	1,267	63	110	295	103	134
1967	1,283	65	112	363	128	166
1968	1,201	60	110	377	115	196
1969	1,369	62	100	274	93	127
1970	807	38	104	283	93	126
1971	948	54	126	297	96	128
1972	4,109	227	122	324	105	144
1973	4,324	372	190	408	135	213
1974	6,082	600	218	411	135	221
1975	10,252	904	194	457	150	246
1976	15,038	1,577	231	447	145	238
1977	18,995	2,076	241	542	169	263
1978	10,898	2,735	555	638	192	299
1979	18,572	4,345	516	764	221	329
1980	21,145	5,214	544	755	216	319
1981	11,205	3,945	776	NA	NA	NA
1982	10,825	4,031	821	NA	NA	NA
1983	7,250	2,842	864	NA	NA	NA
1984	9,171	3,027	660	NA	NA	NA

NA - Not available

Sources: Fisheries Statistics of the United States, 1964-80; Trends in North Carolina's Commercial Fisheries, 1965-81.

Carolina's dollar value from less than 1 percent to 7.6 percent in 1980 (Table 14 on page 25).Since 1980 its share has dropped to 5.3 percent in 1984 because of sharply declining landings (Table 14). Nevertheless, its inflation-adjusted price has continued to increase since 1980, dampening some (but not all) of the negative effect on revenue from decreased landings.

The number of inputs in this fishery indicates a similar growth as that in flounder and shrimp fisheries -- steady increases in number of fishermen, vessels, and gear. The vessels and gear (fish otter trawl) would be particularly applicable to the winter trawl fishery. The peak in inputs appears to be in 1979, with a slight decrease in 1980 which may be explained by the decreased landings in flounder or increased activity in the shrimp fishery.

The productivity estimates in the croaker fishery reflect the positive effects of increasing catch and price in combination with slower growth in the level of inputs (Table 13). Physical and monetary productivity estimates indicate increasing amounts, even through the last year of available data when catch declined, indicating an even greater decline in inputs that year. Overall, these estimates for croaker put the fishery at the same level as those estimates for the shrimp, blue crab and flounder fisheries.

Potential Major Commercial Fisheries

North Carolina's five major commercial species still exhibit a commanding portion of the state's total commercial fisheries. In 1984, they accounted for 59 percent of total commercial value and 79 percent of total commercial catch, both proportions of which are on par with the past 20-year average (Table 3). However, where the percentage of total commercial catch has undergone little or no trend, the percentage of total commercial value has been below average during 1978-84 as well as being more than one standard deviation below the average. (A standard deviation above and below the average contains two-thirds of the variation in a variable.) The implication here is that there must be one or more species becoming relatively more valuable relative to the top five, and identifying them would pinpoint potential major commercial species. Another approach would be to identify species more important than croaker in terms of catch and value during 1964-84.

Using both methods from above, it is possible to identify as many as six potential major commercial fisheries, some with more potential than others. Between 1964 and 1984 species which were at times more important than croaker in terms of catch and value included oysters, striped bass, alewives/river herring, bay scallops, sea scallops, spot, hard clams, and grey trout. However, of these eight species, only the last three have shown any upward trend, or at least stability, in catch and value (Tables 15-16). Oysters have remained fairly stable since the mid-1960's; however, all other fisheries have grown relative to it since then. The same is true for bay scallops, while the sea scallop fishery has been erratic. Alewives and striped bass exhibit a declining trend in catch and value.

In addition to spot, hard clams, and grey trout, other fisheries which can claim a growing portion of total catch and/or value include snapper/grouper, scup/porgy, and bluefish (Table 16). The North Carolina snapper/grouper fishery can be thought of as an extension of the intense fishery in Florida. Growth in the scup/porgy fishery is due principally to the close association of 1) scup to bottom fish (such as flounder and croaker) in the winter

Table 13. Productivity measures in the commercial croaker fishery in North Carolina, 1964-80.

Year	Catch per Fisherman	Catch per Vessel	Catch per Gear	Nominal Value per Fisherman	Nominal Value per Vessel	Nominal Value per Gear	Real Value per Fisherman[a]	Real Value per Vessel[a]	Real Value per Gear[a]
	(pounds)			(dollars)					
1964	6,423	16,903	13,381	464	1,222	967	490	1,290	1,021
1965	5,265	13,943	10,573	322	854	647	334	884	670
1966	3,562	9,995	7,683	173	486	373	173	487	374
1967	2,517	7,138	5,504	115	325	251	115	325	251
1968	2,819	8,017	4,704	119	338	198	116	330	193
1969	4,286	12,627	9,246	180	531	389	169	499	365
1970	2,105	6,405	4,728	96	184	215	87	264	192
1971	2,142	6,627	4,970	100	311	233	88	273	204
1972	9,650	29,776	21,712	454	1,399	1,020	381	1,175	857
1973	3,133	9,469	6,001	214	647	410	159	480	304
1974	4,567	13,904	8,494	356	1,085	663	223	678	414
1975	6,820	20,779	12,670	637	1,941	1,183	364	1,110	677
1976	18,406	56,741	34,569	1,672	5,153	3,140	914	2,816	1,716
1977	18,003	57,737	37,101	2,039	6,541	4,203	1,050	3,368	2,164
1978	17,082	56,760	36,448	2,532	8,412	5,402	1,210	4,019	2,581
1979	24,309	84,036	56,450	5,688	19,663	13,208	2,414	8,346	5,606
1980	28,007	97,894	66,285	7,170	25,062	16,970	2,668	9,327	6,316
Average	9,359	29,926	20,030	1,314	4,362	2,910	644	2,098	1,406
Standard Deviation	8,170	28,425	18,684	2,015	7,037	4,728	770	2,699	1,805

[a]Calculated by divided nominal value per appropriate input by Producer Price Index (1967=100).

Note: The productivity estimates are calculated for the specific pounds, and associated dollar value, caught by the main gear (fish otter trawls), vessels using that gear, and fishermen on those vessels.

Source: Fisheries Statistics of the United States, 1964-80.

Table 14. Percentage of commercial nominal value of North Carolina's commercial fisheries held by each of the top five commercial fisheries, 1964-83.

Year	Menhaden	Shrimp	Blue Crab	Flounder	Croaker	Total
			(Percent)			
1964	28.0	18.7	15.9	6.0	1.7	70.3
1965	22.4	18.6	13.7	10.3	1.2	66.2
1966	26.5	26.8	9.1	7.8	0.7	70.9
1967	20.3	21.7	8.5	10.4	0.8	61.7
1968	20.2	24.3	18.9	6.4	0.6	70.4
1969	17.8	35.7	17.0	5.6	0.5	76.6
1970	16.8	26.6	13.2	8.3	0.4	65.3
1971	9.9	42.4	10.0	9.9	0.5	72.7
1972	10.3	30.0	11.4	11.7	1.9	65.3
1973	15.8	29.5	9.6	13.5	2.3	70.7
1974	16.5	26.3	7.9	16.3	3.4	70.4
1975	16.3	25.3	7.3	17.7	4.5	71.1
1976	16.5	29.7	8.8	14.8	5.7	75.5
1977	15.3	25.3	7.5	17.4	7.2	72.7
1978	18.5	9.6	10.7	15.5	6.7	61.0
1979	13.8	16.6	7.9	15.1	7.4	60.8
1980	10.4	25.0	8.7	11.5	7.6	63.2
1981	17.5	9.2	14.2	10.8	6.9	58.6
1982	9.0	25.7	11.3	8.9	6.3	61.2
1983	10.7	23.6	14.7	9.9	4.9	63.8
1984	8.3	18.3	11.6	15.8	5.3	59.3
Average	16.3	24.2	11.3	11.6	3.6	67.0
Standard Deviation	5.4	7.7	3.3	3.8	2.7	5.5

Sources: Fisheries Statistics of the United States, 1964-80; Trends in North Carolina's Commercial Fisheries, 1965-81.

[a]This total percentage is different from `Percent of Total Value' column in Table 3 as the five top species in that table were the top five species in each year, not over the whole period as in this table; the main discrepancy is the fifth position--croaker.

Table 15. Catch and value of minor North Carolina commercial fisheries, 1965-1983, in thousands of pounds and dollars.

Year	Oyster	Striped Bass	Alewives	Bay Scallops	Sea Scallops
1965	864 lbs.	484 lbs.	12,826 lbs.	379 lbs.	92 lbs.
	$473	$ 77	$ 133	$196	$56
1966	726	653	12,519	399	--
	398	100	134	184	--
1967	518	1,817	18,486	387	--
	316	253	318	211	--
1968	402	1,912	15,525	639	42
	269	385	235	422	42
1968	370	1,568	19,762	612	13
	260	325	304	383	13
1970	383	2,318	11,521	130	--
	269	479	194	91	--
1971	424	1,449	12,722	60	--
	289	314	203	42	--
1972	470	1,261	11,237	128	--
	344	358	196	110	--
1973	549	1,752	7,926	37	--
	446	592	213	33	--
1974	559	1,016	6,210	220	--
	436	393	247	199	--
1975	425	1,303	5,952	135	421
	330	630	215	105	421
1976	333	1,038	6,401	248	1,107
	292	523	337	194	1,432
1977	366	572	8,524	257	657
	354	405	422	509	954
1978	450	698	6,607	218	1,976
	548	623	287	389	4,457
1979	665	614	5,119	193	1,694
	926	577	314	514	4,898
1980	389	472	6,218	328	861
	562	435	444	1,107	2,979
1981	357	417	4,754	189	125
	476	452	317	656	478
1982	383	338	9,438	137	407
	600	531	705	352	1,324
1983	446	361	5,868	202	26,306
	678	491	464	498	150,656
1984	411	513	6,516	384	170
	734	452	596	876	816

Sources: Trends in North Carolina's Commercial Fisheries, 1965-1981; N.C. Landings, 1977-1983.

Table 16. Catch and value of minor North Carolina commercial fisheries, 1965-1983, in thousands of pounds and dollars.

Year	Spot	Hard Clams	Grey Trout	Snapper/ Grouper	Scup/ Porgy	Bluefish
1965	913 lbs	313 lbs	1,959 lbs.	--	982 lbs	704 lbs.
	$ 69	$ 137	$ 130	--	$ 126	$ 49
1966	1,091	233	1,896	18	1,926	821
	94	93	110	5	116	67
1967	3,048	201	1,769	13	462	888
	205	106	106	2	45	81
1968	1,575	204	2,286	67	176	872
	187	117	106	20	17	102
1969	1,488	252	1,539	< 1	252	871
	188	141	109	< 1	36	96
1970	1,529	282	2,441	< 1	212	495
	142	157	145	< 1	27	42
1971	1,190	253	3,645	21	207	578
	173	148	226	6	35	59
1972	3,902	274	7,373	< 1	39	1,167
	378	163	397	< 1	9	99
1973	5,398	379	6,222	23	27	2,008
	676	294	543	7	7	152
1974	5,607	288	6,056	91	66	2,183
	625	322	631	45	20	187
1975	8,300	285	6,725	78	149	1,975
	861	266	808	48	48	166
1976	2,674	306	8,714	17	216	1,356
	348	258	959	11	71	128
1977	3,805	739	8,671	56	136	2,331
	469	1,049	1,049	49	49	219
1978	4,878	892	10,849	695	1,212	1,948
	627	2,449	1,968	451	434	257
1979	7,303	1,455	14,759	1,008	1,695	3,406
	1,430	4,475	2,940	984	672	655
1980	7,100	1,542	20,344	1,086	1,752	5,444
	1,493	5,554	3,784	1,264	866	761
1981	3,516	1,458	16,893	1,395	2,178	6,610
	824	5,387	5,305	1,763	1,172	1,243
1982	4,919	1,702	12,052	1,512	2,297	4,291
	1,080	6,606	5,319	1,788	1,334	1,046
1983	2,952	1,342	10,234	1,435	1,473	6,747
	685	5,402	4,308	1,707	825	795
1984	3,482	1,388	12,991	1,345	1,562	3,560
	814	5,506	4,097	1,900	855	558

Sources: Trends in NC Commercial Fisheries, 1965-1981;
NC Landings, 1977-1983.

trawl-fishery and 2) porgy to the snapper/grouper complex. While bluefish is primarily a recreational fishery, its commercial growth since 1980 has come from offshore use of midwater nets.

Summarizing, eight species have been in the top five commercial fisheries at one time or another, replacing croaker during 1964-83. However, only three of these eight species, plus three other minor ones have exhibited growing catch and value figures over this time period. Therefore, six species can be identified as having the potential to be major North Carolina commercial fisheries: spot, hard clams, grey trout, snapper/grouper, scup/porgy, and bluefish. In any conscious or passive attempt to develop these into major fisheries, it would be useful to review the present situation in each fishery.

Most of the growth in hard clams appears fueled by increased demand from the Northeast U.S. and by a harvesting method known as "kicking" (using the propeller wash to dislodge clams from the bottom). Landings have been relatively stable at 1.5 million pounds of meat annually since 1980, suggesting the fishery may have attained its peak catch, most of it coming from Carteret County. Most of the clam catch continues to come from hand gears, so some increases in catch have come from these gear types, too. Even if more exploitable areas could be found, the questionable effects on bottom habitat by kicking and the large number of fishermen, especially part-timers, present unique management problems.

The snapper/grouper complex is the subject of a federal fishery management plan, covering a geographic area from North Carolina to Key West, Florida. There is some consensus that North Carolina stocks are limited (Division of Marine Fisheries, 1982) and they could not sustain more fishing pressure than at present. Any restrictions on the snapper/grouper complex would also affect porgies. A management plan prepared by the South Atlantic Fishery Management Council (Charleston, South Carolina) would probably emphasize recreational values and the recreational fishery. A recreational-commercial conflict may also develop in the bluefish fishery, even though the increase in the commercial catch has occurred offshore, away from recreational areas. Another problem in the bluefish fishery is the fluctuating price per pound between 1978 and 1984, varying between $0.12 and $0.24 per pound with no trend. (Price per pound calculated by dividing pounds by dollars in Table 16 for each appropriate year.) Such volatility is not conducive to planning long-term investments in vessels or gear.

The three remaining species, -- grey trout, spot, and scup--show more potential since 1) they are primarily commercial fisheries, 2) catches are mostly in North Carolina waters, and 3) their catches are still either stable (spot and scup) or substantial (grey trout). All three species are caught in otter trawls and occur together along with croaker. The historical (1964-84) catch record of grey trout in fact suggests a maturation pattern like that of croaker.

SUMMARY AND CONCLUSIONS

This study has documented the importance of a relatively small number (five) of species which account for over 50 percent of the value and 50 percent of the catch of all North Carolina commercial species during 1964-84. In addition, at least three, and as many as six, additional species may be considered as potential major commercial fisheries in North Carolina, or are on

the verge of becoming one.

By following the pattern of landings, value, and fishing inputs for major North Carolina commercial fisheries during the last twenty years, one can identify patterns and make tentative conclusions about trends and productivity for the major fisheries as a whole and individually. As a whole, the North Carolina commercial fishing industry appears to be in a peak period in terms of catch; the total catch may decline from a peak in 1981 towards levels experienced in the early 1970's because of environmental/climatic factors. Most of the underlying change behind increases or decreases in the total North Carolina catch is due to variations in the menhaden fishery. Other fisheries experienced substantial growth and also cyclical changes, but they are dwarfed by changes in the menhaden fishery.

In terms of the dollar value of landings, North Carolina's economy has benefited from ever-increasing dollar values between 1964 and 1984. The increased dollar value has come from two sources: growth in landings and increases in price. When the total dollar value of North Carolina commercial catches has declined (see Figure 1), as in 1970, 1981, 1983, and 1984 it has been due to either a decline in both landings and price or a larger decrease in one matched against a smaller increase in the other. Adjusting the total value of catches for inflation indicates "real" growth in economic fishing activity , again from the same two sources: increased landings and prices outpacing inflation. Closer examination of individual prices indicates shrimp, blue crab and croaker outpaced the general inflation, while menhaden and flounder prices kept pace with inflation.

With regard to the level of fishing inputs, almost every major commercial fishery experienced increased numbers of fishermen, vessels and/or boats, and fishing gear. Such increases help explain the increases in catch which in turn fueled higher levels of fishing inputs. The exception to this general observation is the menhaden industry, in which the level of every fishing input decreased. This trend may be explained by consolidation in this industry because of increased fish harvesting technologies and competition from imported fish meal and soybean meal. The level of fishing inputs when used with the catch and dollar value (nominal and real) result in productivity measures which are summarized below.

Static Productivity

Statically, or examining one point in time during 1964-80, one can identify on a year-by-year basis which are the most productive fisheries of the top five. For physical productivity, the menhaden fishery is by far the most productive in every year, measured in catch per fisherman (Figure 2). Excluding menhaden, which is a species made into industrial products other than for direct human consumption, physical productivity was highest in the blue crab fishery every year during 1964-80 (Figure 3). Flounder followed in productivity while the shrimp fishery had the lowest productivity in 8 of those 17 years and croaker had the lowest in 9 years (Figure 4).

In terms of monetary productivity, measured by nominal and real dollars per fisherman, the menhaden fishery's dominance is still evident, but only after 1971 which coincides with the low period of menhaden landings and continuing decline in fishing inputs (Figures 5 and 7). Up until 1972, the other fisheries, particularly shrimp, flounder, and blue crab, were as

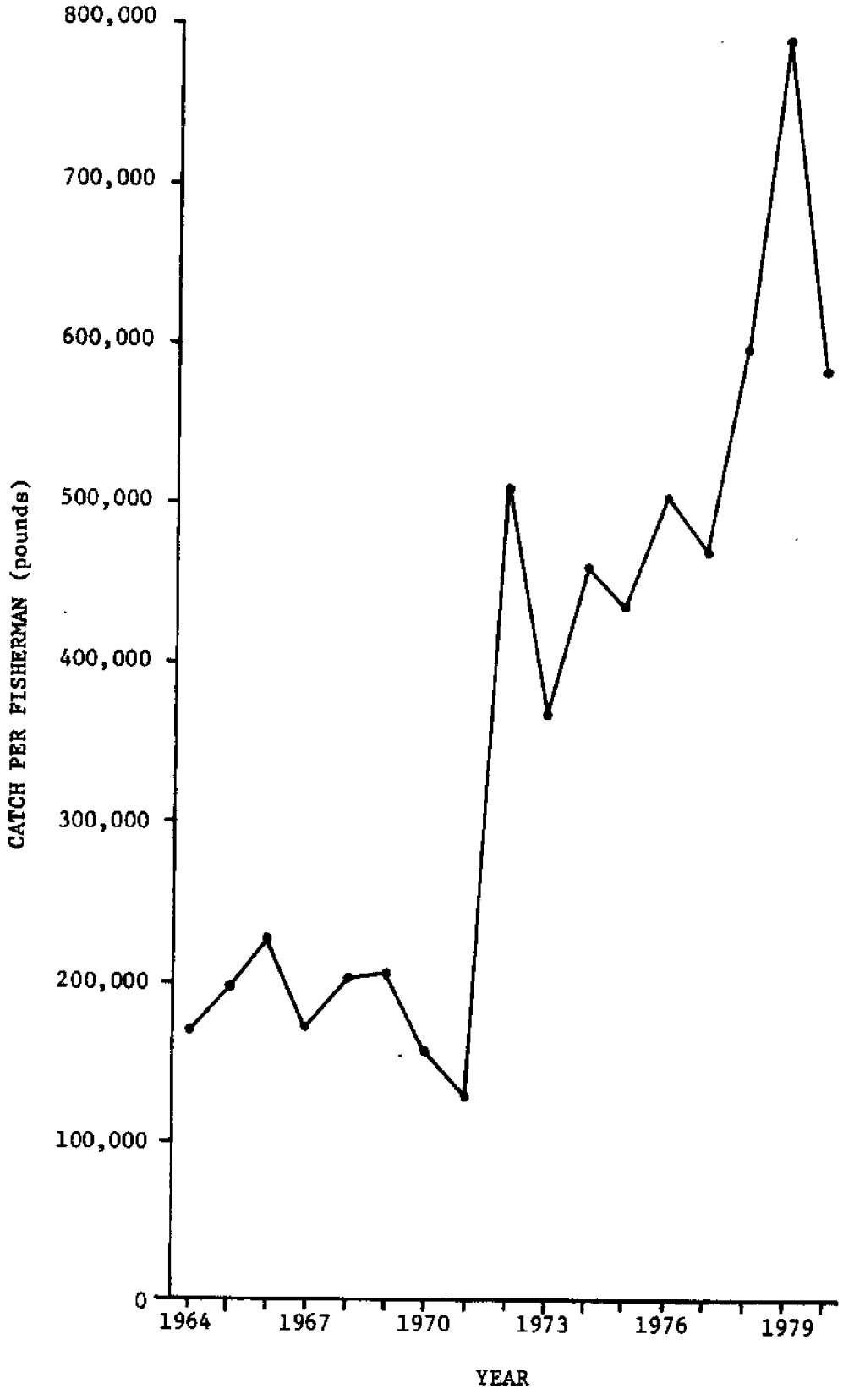

FIGURE 2.- Annual catch per fisherman of menhaden in North Carolina, 1964-80. (Fisheries Statistics of the United States, U.S. Dept. of Commerce)

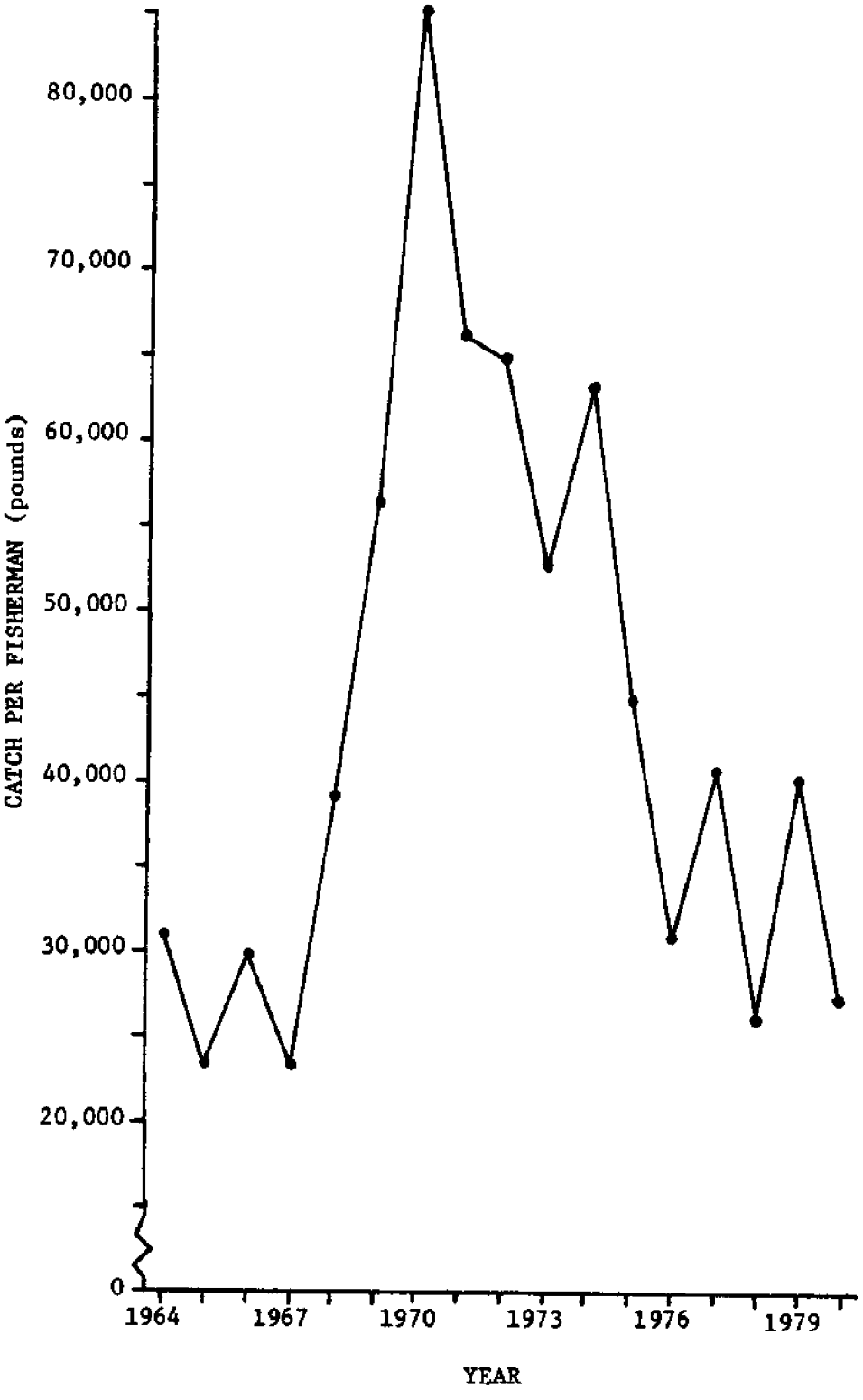

FIGURE 3.- Annual catch per commercial fisherman of blue crabs in North Carolina, 1964-80. (Fisheries Statistics of the United States, U.S. Dept. of Commerce)

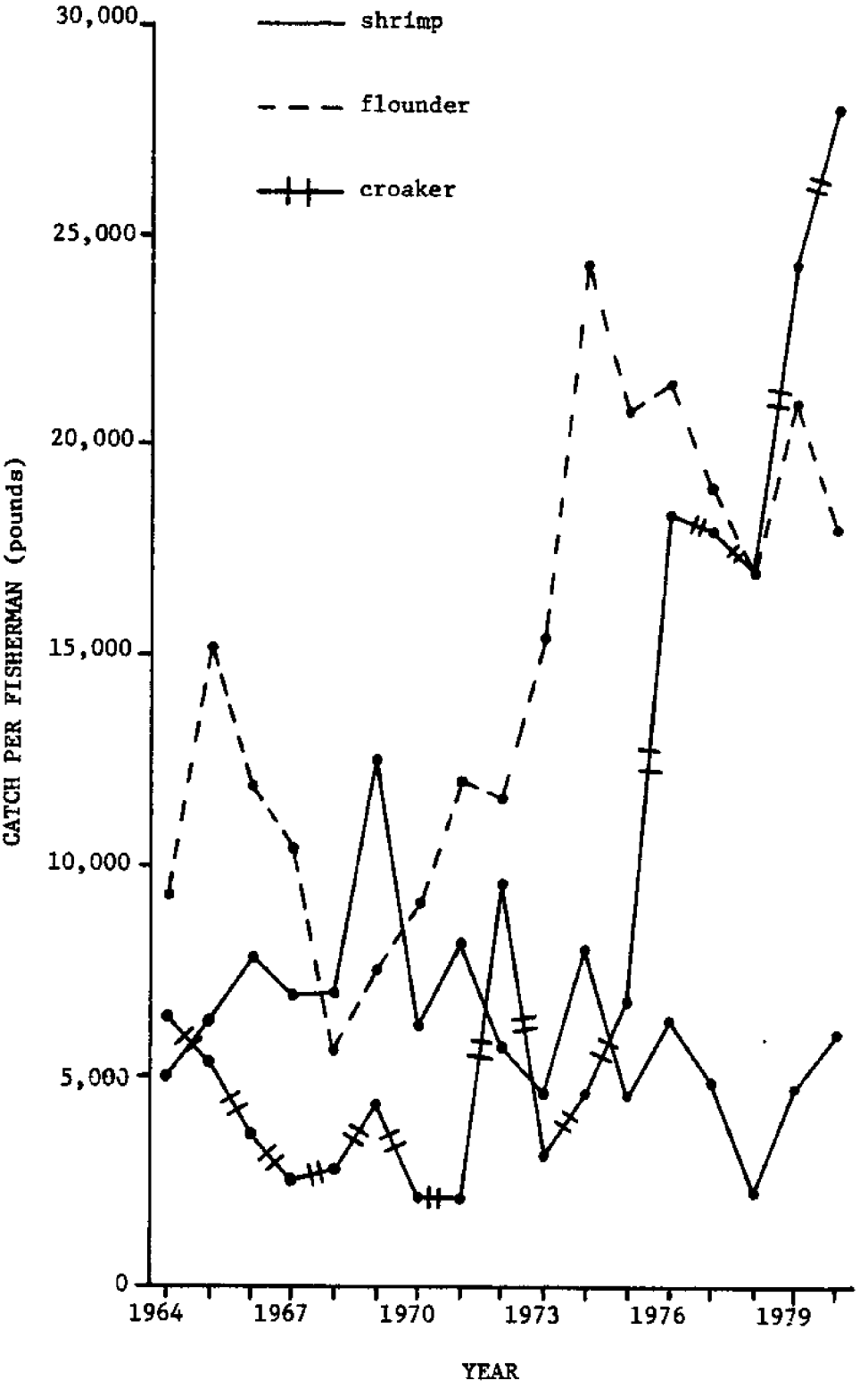

FIGURE 4.- Annual catch per commercial fisherman of shrimp, flounder, and croaker in North Carolina, 1964-80. (Fisheries Statistics of the United States, U.S. Dept. of Commerce)

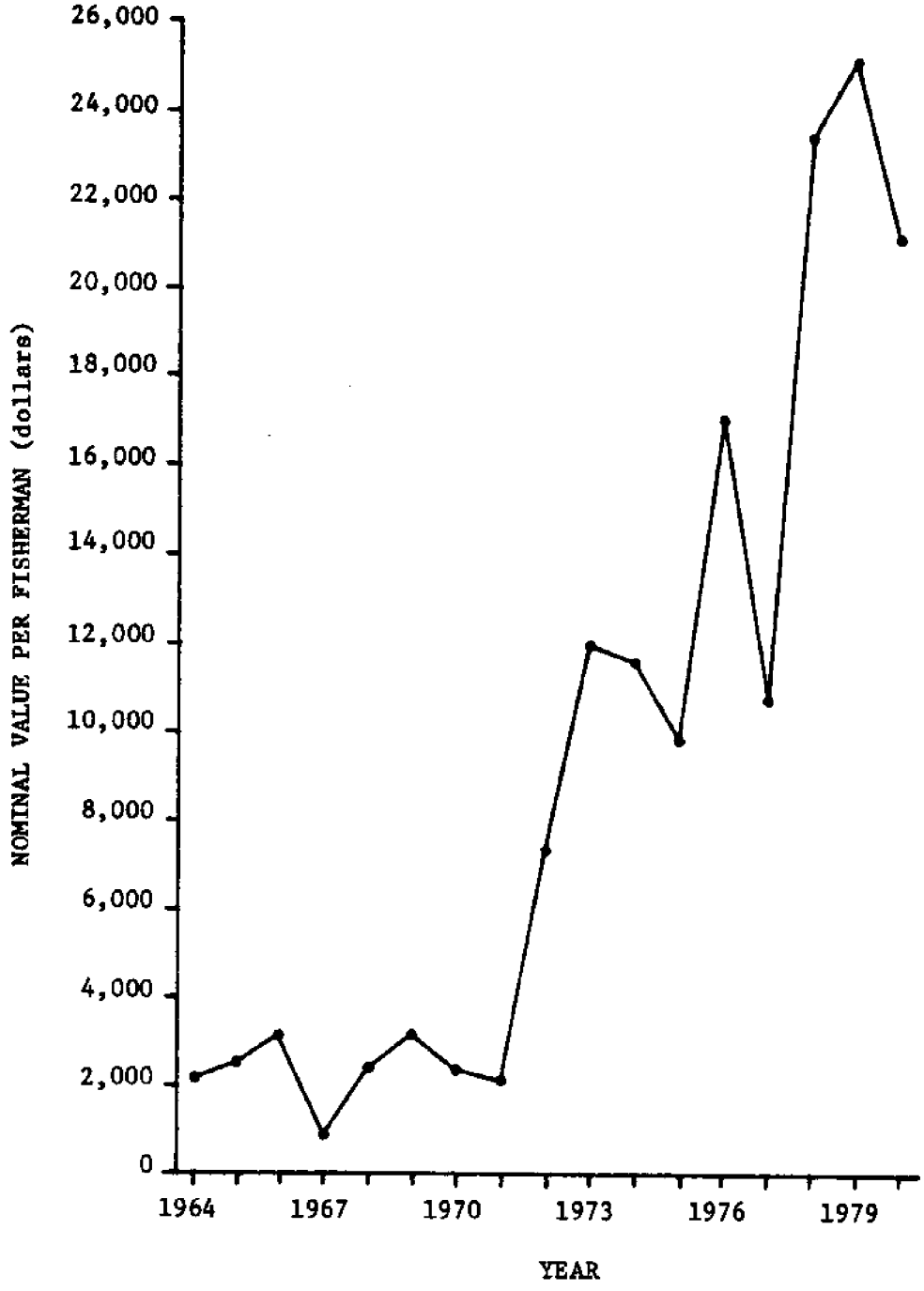

FIGURE 5.- Annual nominal dollars per commercial fisherman from the menhaden fishery in North Carolina, 1964-80. (Fisheries Statistics of the United States, U.S. Dept. of Commerce)

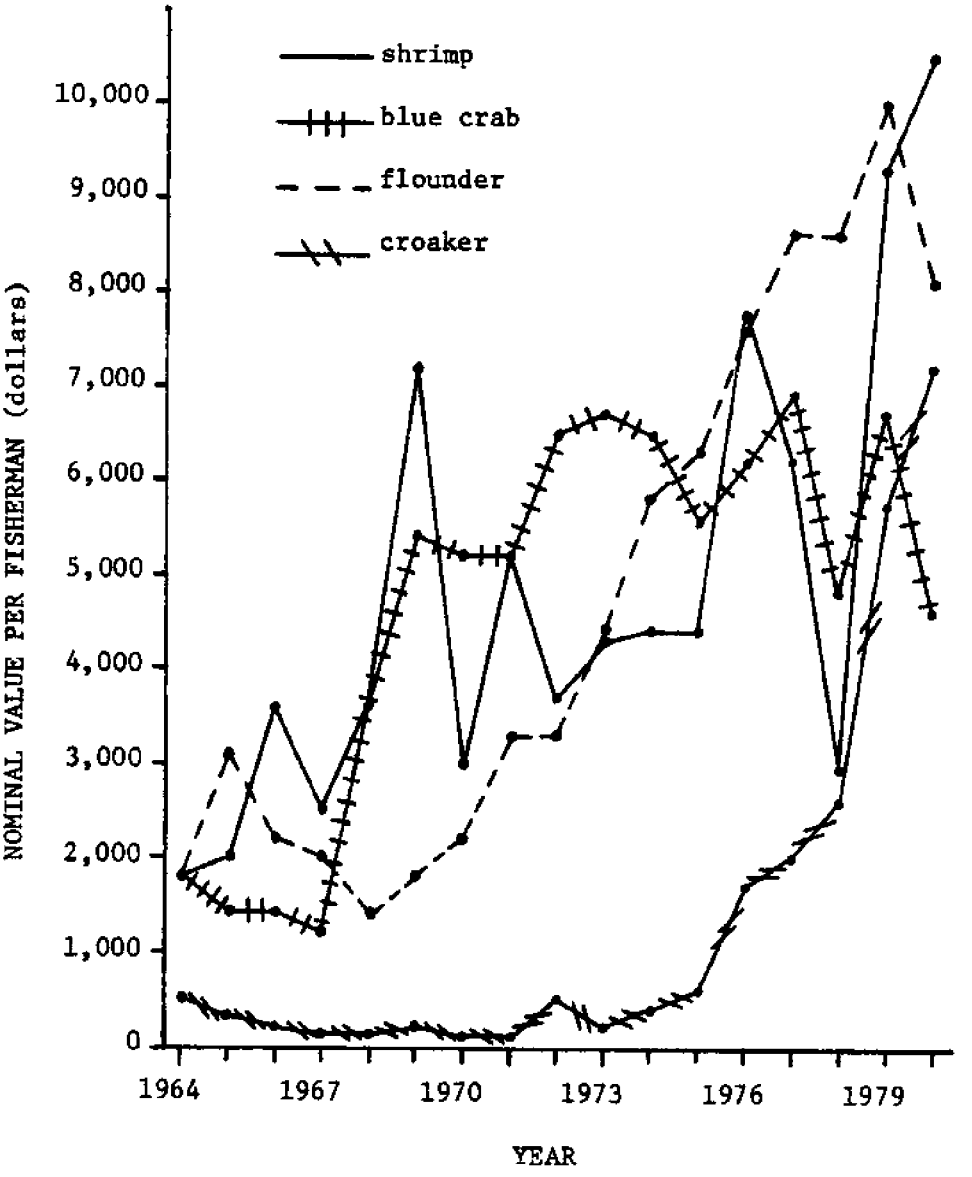

FIGURE 6.- Annual nominal dollars per commercial fisherman from the blue crab, shrimp, flounder, and croaker fisheries in North Carolina, 1964-80. (Fisheries Statistics of the United States, U.S. Dept. of Commerce)

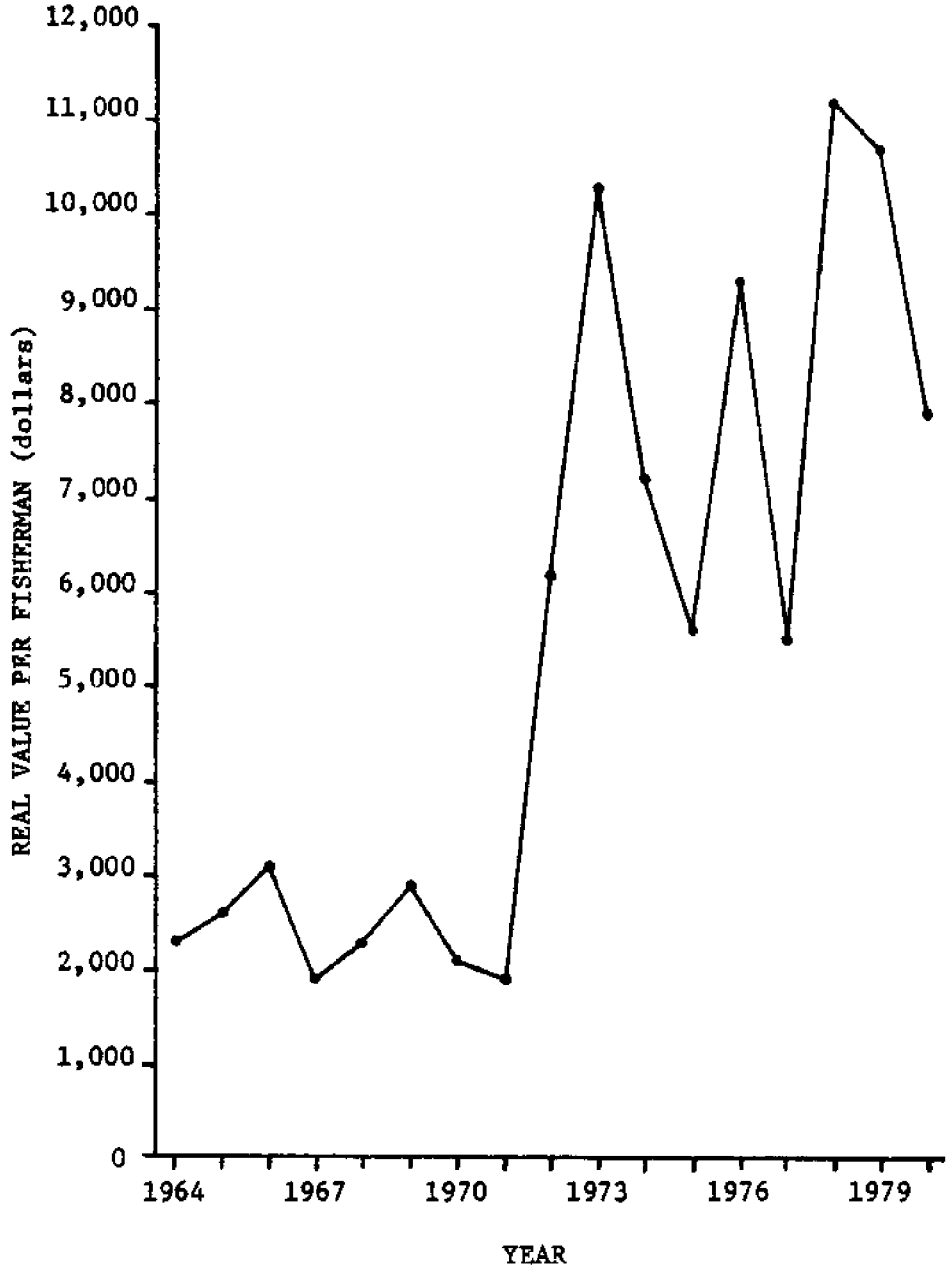

FIGURE 7.- Annual real dollars per commercial fisherman from the menhaden fishery in North Carolina, 1964-80. (Fisheries Statistics of the United States, U.S. Dept. of Commerce)

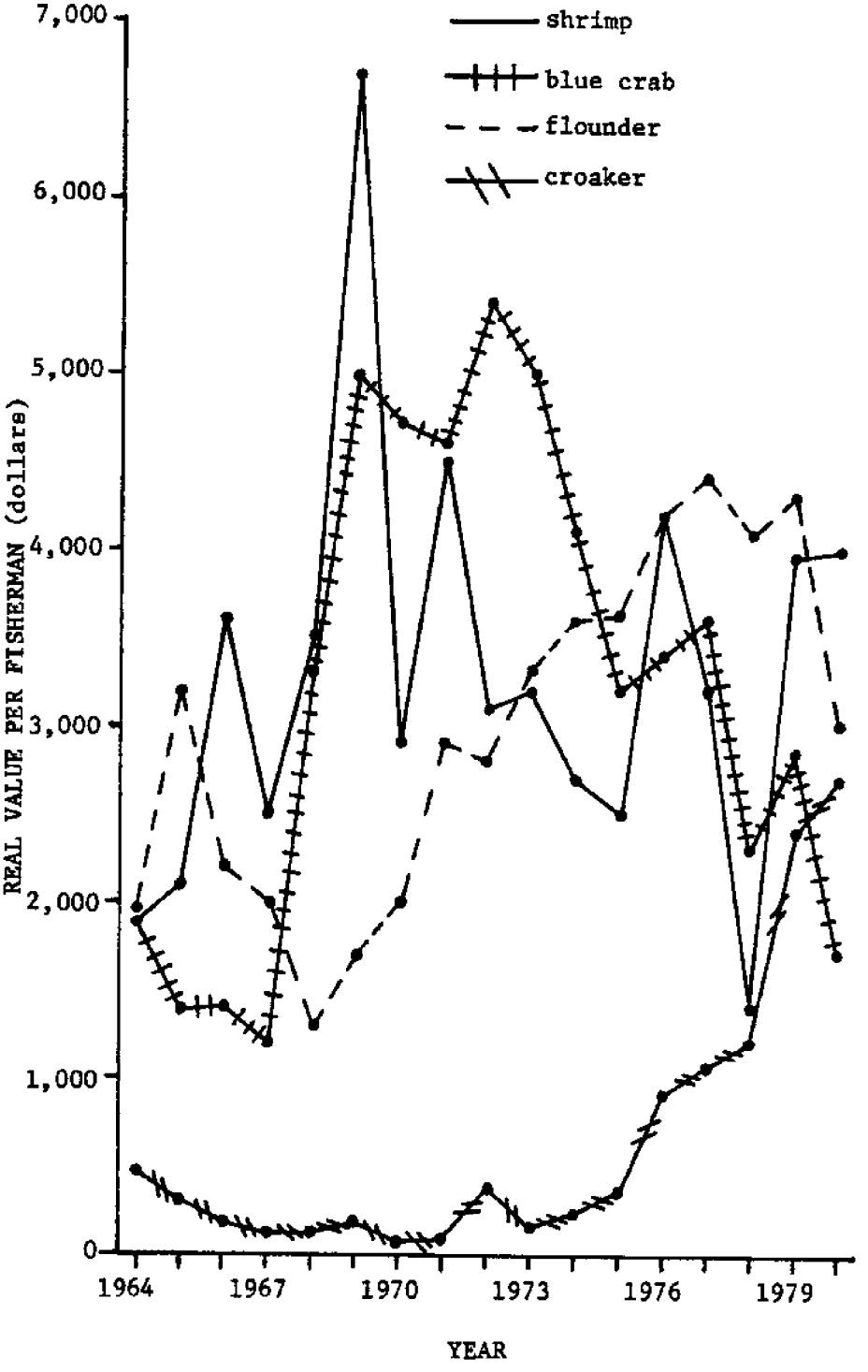

FIGURE 8.- Annual real dollars per commercial fisherman from the blue crab, shrimp, flounder, and croaker fisheries in North Carolina, 1964-80. (Fisheries Statistics of the United States, U.S. Dept. of Commerce)

productive for the average fisherman (Figures 6 and 8). Examining only the foodfish and shellfish, the flounder, shrimp and blue crab fisheries appeared to have traded the number 1, 2, and 3 spots among this group of four fisheries between 1964-80.

Several caveats are in order when conducting comparisons between species statically or dynamically. The first is that there is considerable duplication in the number of fishermen reported in each fishery as well as craft and gear. For example, fishermen operating a shrimp vessel may fish for shrimp in the summer with shrimp otter trawls, then switch gear to fish otter trawls and catch flounder and croaker during the winter. Thus, the second caveat is the existence of multi-species fisheries, such as croaker-flounder-scup, or snapper-grouper-porgy, which should be added together to get a composite productivity estimate. Third, the productivity for fishermen are for those associated with the craft (vessel or boat) and main gear type used in the fishery, not the total number in the fishery. Nevertheless, a fourth caveat is that some of these fishermen may be part-time, which would lower the average income for a group of full-time fishermen if there were also part-timers. This would create substantial differences between those fisheries with predominantly full-time participants (like menhaden, flounder and croaker) and those with many part-time fishermen (as in the blue crab and shrimp fisheries).

Dynamic Productivity

Examining productivity over the whole 17-year period of 1964-80, it is clear that the menhaden, flounder, and croaker fisheries have exhibited the most dramatic gains for both physical and monetary aspects. Measured in terms of catch per fisherman, menhaden physical productivity has tripled from a base of 200,000 pounds per fisherman, flounder has more than doubled from a base of about 10,000 pounds, and croaker has increased almost 6 times from a base of 5,000 pounds per fisherman. As stated previously in the case of menhaden, its productivity has been a result of increased landings starting in 1972 in combination with declining fishing inputs; in the cases of flounder and croaker, landings increased at a greater rate than the increase in fishing inputs. For the blue crab and shrimp fisheries, neither exhibited any discernible trend in physical productivity, although there was much more variation for the blue crab fishery (Figures 3-4).

Moving to monetary productivity, measured in dollars (nominal and real) per fisherman, these same three fisheries -- menhaden, flounder, and croaker -- exhibit the biggest gains during 1964-80. In nominal dollars, menhaden went from a base of about $3,000 per fisherman to over $22,000, flounder from $2,000 per fisherman to over $8,000, and croaker from $200 per fisherman to $7,000. The blue crab fishery exhibited an upward trend from $1,500 per fisherman to about $7,000, while shrimp exhibited no trend (Figure 6). Adjusting the nominal dollar productivity for inflation not only scales the absolute dollars down but also introduces more volatility in the patterns (Figures 7-8). Nevertheless, the menhaden, flounder, and croaker fisheries remain the biggest gainers over the 17-year period. The shrimp fishery still does not exhibit any trend, and now neither does the blue crab fishery.

Conclusions

All of North Carolina's major commercial fisheries have exhibited evidence of maturity; that is, there is ample evidence of a cyclical (wave-type) pattern

in their catches. This conclusion is applicable especially to those fisheries enjoying almost uninterrupted increased landings during the 1970's--flounder, croaker, blue crab, and grey trout. During the time period of analysis in this paper, 1964-84 altogether, and 1964-80 for productivity, North Carolina fishermen have received increased landings for three of the five major commercial fisheries. And for all species, fishermen have received higher prices. The result of these two developments is stable or rising productivity for North Carolina's major commercial fisheries.

Given the logical continuation in a cyclical catch pattern, namely downward since 1981, management of North Carolina marine resources faces a continuing challenge. On the one hand is the state's responsibility to conserve the resource and enable it to recover from a cyclical low. On the other hand is the desire of state officials to guarantee access by its citizens to the resources for commercial purposes, and in the process earn a normal rate of return for their inputs. Pursuing both of these aims may become very difficult since they may be in conflict with each other. The conflict arises from the predicted drop in future catches (assuming a cyclical pattern) which would decrease productivity, e.g., dollars per fisherman, with such high levels of fishing inputs in the fisheries now. Also, with current high levels of fishing inputs the ability of individual species to rebuild their populations may be jeopardized because so much effort may be expended in order to maintain the historically high catch or dollar per fishing input.

The challenge for fisheries management is to balance these sometimes conflicting aims of protecting the resource and its users. Helping make management decisions earlier during this most recent growth period was timely biological and economic information. Along with the information presented here, other data which may help resource management could include 1) the structure of fishing effort in North Carolina, i.e., part-time vs. full time fishermen, duplication in fishing inputs between fisheries, and multi-species fisheries, and 2) methods to explain the change in the level of fishing inputs in a particular fishery.

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We retain responsibility for any errors.

The views expressed herein are ours and do not necessarily reflect those of any State agency or institution.