Canadian, Mexican, and U. S. Fisheries: Recent Developments

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Introduction

The creation of extended zones (EEZ's) has shifted some aspects of fisheries management and policy from the arena of international negotiations to the economic and political decision making process within the coastal state. The transition from a world of international commons to one of coastal state jurisdiction raises a variety of issues. The one of concern here is a broad welfare question: Given the transfer of assets from the international commons to the coastal state, how well (efficiently) has the state used these new assets to increase the flow of income and Gross National Product (GNP)?

Under the usual assumptions, any increase in GNP with a given distribution of income suggests a welfare improvement. However, in the case of fisheries, the usual assumptions must be augmented by recognition of the central role of the common property problem in the analysis. While the GNP welfare framework provides theoretical guidelines for future macroeconomic evaluation of fisheries, here, perforce, we are limited to a statistical description of what has been recent history and some preliminary remarks suggestive of a research agenda.

Linking the national interest to the creation of EEZ's (i.e., to the acquisition of assets and the associated flow of income represented by fish stocks in the EEZ's) allows analysis of the economics of fisheries to include macroeconomic questions as well as the analysis of firm and industry problems. This paper emphasizes the national interest and in so doing it distinguishes itself from the current focus on local and regional interests which is embedded in the regional fisheries councils created by the 1976 Act. As with any macroeconomic approach, the underlying changes (the determination of economic and biological optima, etc.) in micro conditions are subsumed in the aggregation process. This neither asserts nor denies the validity of either body of analysis; it merely suggests a complementary approach (Pontecorvo et. al., 1980; Pontecorvo[1]).

In any empirical economic analysis of fisheries, it is banal to point out the importance of data problems, yet here it is useful to note that worldwide we have only the Food and Agriculture Organization's (FAO) data on catch. There are national statistics for a few countries on capital and labor. Further, data on costs of production, prices, etc., are available only in limited circumstances. Here we will use FAO catch data and statistics on capital and labor found in the U.S. annual publications "Fisheries of the United States."

The first section of this paper will review briefly the catch statistics for three countries of North America—Canada, Mexico, and the United States—from 1970 to date. In addition to changes in gross catch, changes by fishing area (as designated by FAO) will be noted as well as changes in the species caught. Three-year averages (e.g., 1970-72, etc.) are employed to reduce the impact of population variation and random events which influence landings.

The next section provides estimates of the gross value of the catch and a crude index of the value of the stocks. A final section will comment briefly on the relationship between long-run equilibrium in fisheries and short-run changes including the interaction between fisheries and the business cycle. It will also note problems in the measurement of technological change and productivity in fisheries.

Landings

Figure 1 shows the important geographic areas fished by the three countries. Table 1 notes the change in aggregate catch from 1970 to 1985.

[1]Pontecorvo, G. 1988. The enclosure of the marine commons: Adjustment and redistribution in world fisheries. Mar. Pol. 12(4).

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Table 1.—Catch by country (source, FAO data).

Nation	Average of 1970-72 (1,000 t)	Percent of world total	Average of 1976-78 (1,000 t)	Percent of world total	Average of 1983-85 (1,000 t)	Percent of world total	Gain/loss: Avg. (1983-85) less avg. (1970-72)	Gain/loss: Avg. (1983-85) less avg. (1976-78)
Canada	1,200.7	2.1	1,190.3	1.9	1,307.1	1.8	106.4	116.8
Mexico	382.5	0.7	588.6	1.0	1,021.2	1.4	638.7	432.6
United States	2,737.8	4.7	3,073.8	5.0	4,538.3	6.3	1,800.5	1,464.5
Total	3,120.30	5.4	3,662.4	6.0	5,559.5	7.7	2,439.2	1,897.1

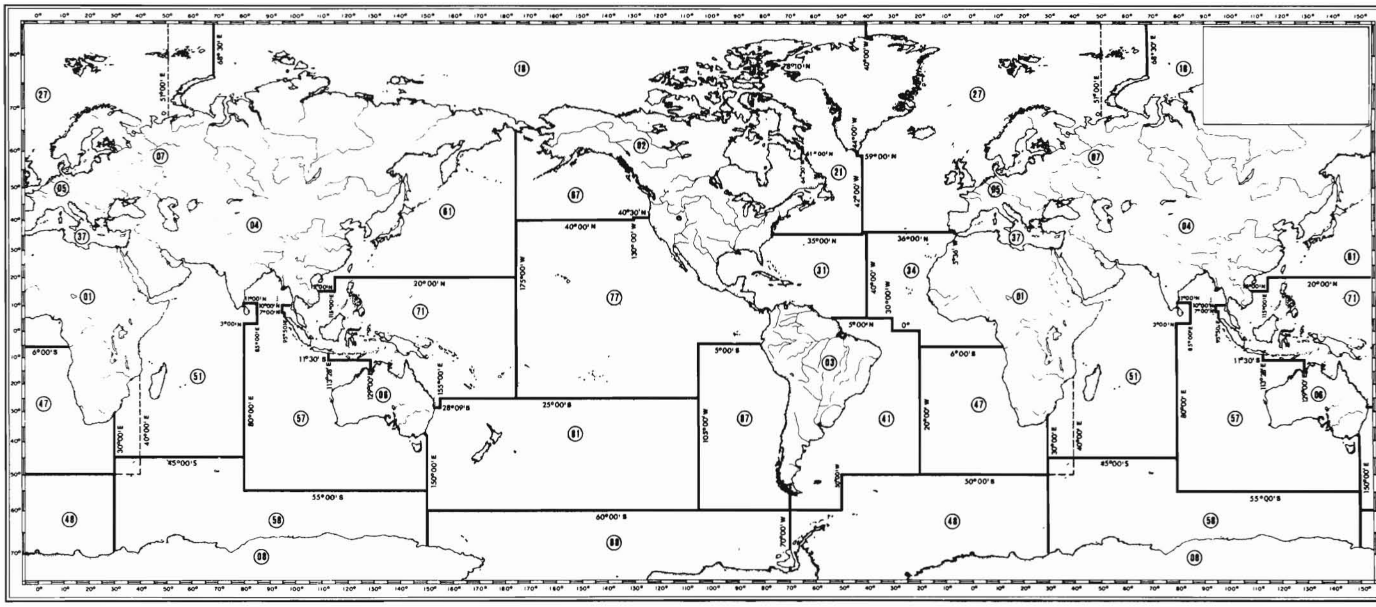

Figure 1.—Major fishing areas of the world for statistical purposes (source: FAO). Numbered major fishing areas of interest: 18, Arctic Sea; 21, Northwest Atlantic; 27, Northeast Atlantic; 31, Western Central Atlantic; 34, Eastern Central Atlantic; 37, Mediterranean and Black Seas; 41, Southwest Atlantic; 47, Southeast Atlantic; 48, Antarctic Atlantic; 51, Western Indian Ocean; 57, Eastern Indian Ocean; 58, Antarctic Indian Ocean; 61, Northwest Pacific; 67, Northeast Pacific; 71, Western Central Pacific; 77, Eastern Central Pacific; 81, Southwest Pacific; 87, Southeast Pacific; and 88, Antarctic Pacific.

Collectively the three countries both increased their catch by 2,500,000 metric tons (t) and also their share of world catch by more than two percent. The observed increase in landings involved enforced reduction of foreign fishing effort in the three EEZ's, the acquisition of a share of that catch by the fishermen of the coastal state, and recovery of certain stocks from reduced levels in the 1960's. The United States accounted for the bulk of the gains while Mexico had the largest percentage increase. By 1983-85, Mexican landings were more than 1,000,000 t, which placed Mexico among the first 18 countries in worldwide landings.

In recent years the Canadian fishing effort has been limited to two geographic areas—the Northwest Atlantic and the Northeast Pacific (Table 2). More than 85 percent of Canadian landings by physical volume are from the Atlantic. The growth of the Canadian catch since 1970-72 has been modest; more recently, however, Canada's east coast fisheries have recovered substantially from the depressed period of the mid 1970's.

Table 2.—Canadian, Mexican and U.S. catch in selected fishing areas (sources: FAO data).

Nation/area	Ave. of 1970-72 (1,000 t)	% of total catch	Ave. of 1976-78 (1,000 t)	% of total catch	Ave. of 1983-85 (1,000 t)	% of total catch	Gain/loss: Avg. (1983-85) less avg. (1970-72)	Gain/loss: Avg. (1983-85) less avg. (1976-78)
Canada								
Northwest Atlantic	1,066.2	88.8	990.2	83.2	1,116.0	85.4	49.8	125.8
Northeast Pacific	130.4	10.9	195.3	16.4	191.2	14.6	60.8	(4.1)
East Central Pacific	3.3	0.3	4.8	0.4	0.0	0.0	(3.3)	(4.8)
East Central Atlantic	0.7	0.1	0.0	0.0	0.0	0.0	(0.7)	0.0
Total (4 areas)	1,200.6	100.1	1,190.3	100.0	1,307.2	100.0	106.6	116.9
Mexico								
East Central Pacific	261.4	68.4	453.9	77.1	728.9	71.4	467.5	275.0
East Central Atlantic	121.1	31.7	133.4	22.7	282.9	27.7	161.8	149.5
Northwest Pacific	0.0	0.0	1.3	0.2	9.5	0.9	9.5	8.2
Total (3 areas)	382.5	100.1	588.6	100.0	1,021.3	100.0	638.8	432.7
United States								
West Central Atlantic	1,051.6	38.4	1,118.6	36.4	1,641.5	36.2	589.9	522.9
Northeast Pacific	368.4	13.5	478.9	15.6	1,300.8	28.7	932.4	821.9
Northwest Atlantic	979.4	35.8	1,057.7	34.4	1,234.7	27.2	255.3	177.0
East Central Pacific	319.1	11.7	407.1	13.3	217.4	4.8	(101.7)	(189.7)
West Central Pacific	0.0	0.0	0.0	0.0	140.9	3.1	140.9	140.9
Total (5 areas)	2,718.5	99.4	3,062.3	99.7	4,535.3	100.0	1,816.8	1,473.0

Table 3.—Catch by species for Canada, Mexico, and the United States (source: FAO data).

	Canadian catch					Mexican catch					U.S. catch				
Species	Avg. of 1970-72 (1,000 t)	% of total catch	Avg. of 1983-85 (1,000 t)	% of total catch	Gain or loss[1]	Avg. of 1970-72 (1,000 t)	% of total catch	Avg. of 1983-85 (1,000 t)	% of total catch	Gain or loss[1]	Avg. of 1970-72 (1,000 t)	% of total catch	Avg. of 1983-85 (1,000 t)	% of total catch	Gain or loss[1]
Salmons, trouts	74.5	6.2	79.7	6.1	5.2	0.0	0.0	0.0	0.0	0.0	148.5	5.4	312.0	6.9	163.5
Flounders, halibuts	160.5	13.4	113.7	8.7	(46.8)	0.3	0.1	0.8	0.1	0.5	88..6	3.2	214.9	4.7	126.3
Cods, hakes	304.6	25.4	583.7	44.7	279.1	0.0	0.0	0.0	0.0	0.0	64.1	2.3	719.0	15.8	654.9
Redfishes, basses	118.5	9.9	94.9	7.3	(23.6)	33.9	8.9	52.4	5.1	18.5	96.5	3.5	157.3	3.5	60.8
Jacks, mullets	3.5	0.3	37.2	2.8	33.7	10.0	2.6	18.4	1.8	8.4	46.1	1.7	38.3	0.9	(7.8)
Herrings, sardines	417.6	34.8	187.6	14.4	(230.0)	52.1	13.6	472.1	46.2	420.0	1,018.8	37.2	1,393.1	30.7	374.3
Tunas, bonitos	9.3	0.8	1.0	0.1	(8.3)	22.6	5.9	83.8	8.2	61.2	238.9	8.7	268.8	5.9	29.9
Mackerels, snoeks	15.7	1.3	20.8	1.6	5.1	0.4	0.1	5.2	0.5	4.8	3.2	0.1	41.6	0.9	38.4
Sharks, rays	0.7	0.1	3.2	0.2	2.5	8.8	2.3	33.0	3.2	24.2	1.4	0.1	11.2	0.3	9.8
Misc. marine fishes	4.5	0.4	29.3	2.2	24.8	121.1	31.7	199.6	19.5	78.5	67.0	2.5	48.1	1.1	(18.9)
Sea-spiders, crabs	7.8	0.7	44.8	3.4	37.0	1.0	0.3	7.4	0.7	6.4	133.1	4.9	146.3	3.2	13.2
Lobsters	16.7	1.4	29.6	2.3	12.9	1.9	0.5	2.1	0.2	0.2	19.9	0.7	22.9	0.5	3.0
Shrimps, prawns	2.2	0.2	14.0	1.1	11.8	71.8	18.8	75.9	7.4	4.1	173.2	6.3	139.2	3.1	(34.0)
Oysters	4.2	0.4	4.6	0.4	0.4	34.5	9.0	40.7	4.0	6.2	338.3	12.4	283.9	6.3	(54.4)
Scallops, pectins	45.3	3.8	44.7	3.4	(0.6)	0.0	0.0	0.0	0.0	0.0	42.1	1.5	283.9	6.3	241.8
Clams, cockles	5.8	0.5	11.8	0.9	6.0	6.5	1.7	8.4	0.8	1.9	223.0	8.1	394.0	8.7	171.0
Squids, octopuses	0.6	0.1	0.3	0.0	(0.3)	2.7	0.7	7.6	0.7	4.9	12.7	0.5	25.2	0.6	12.5
Total	1,192.0	99.7	1,300.9	99.6	108.9	367.6	96.2	1,007.4	98.4	639.8	2,715.4	99.1	4,499.7	99.4	1,784.3

[1]Average (1983-85) minus average (1970-72).

Table 4.—Catch by country by area and species in thousands of metric tons (source: FAO data).

	Northwest Atlantic						West Central Atlantic			
	Canada		U.S.		Mexico		U.S.		Mexico	
Species	M3[1]	M3-M1[2]	M3	M3-M1	M3	M3-M1	M3	M3-M1	M3	M3-M1
Salmons, trouts	2.1	(1.5)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flounders, halibuts	105.5	(34.6)	67 0	15.7	0.0	0.0	4.0	1.6	0.0	0.0
Cods, hakes	579.1	279.8	102.7	45.3	0.0	0.0	0.0	0.0	0.0	0.0
Redfishes, basses	71.5	(41.2)	31.3	(11.2)	0.0	0.0	20.5	(7.7)	35.1	10.2
Herrings, sardines	154.6	(245.4)	351.9	58.1	0.0	0.0	978.0	327.0	4.0	3.4
Tunas, bonitos	0.9	(1.8)	4.3	1.6	9.4	9.4	10.0	2.3	9.3	3.3
Misc. marine fishes	0.9	(2.1)	8.0	(12.1)	0.0	0.0	36.9	(8.7)	118.2	103.6
Sea-spiders, crabs	43.7	36.9	56.1	16.4	0.0	0.0	38.4	8.7	6.9	6.0
Scallops, pectins	44.7	(0.5)	72.1	45.2	0.0	0.0	207.5	196.5	0.0	0.0
Total	1,003.0	(10.4)	693.4	159.0	9.4	9.4	1,295.3	519.7	173.5	126.5

	West Central Atlantic		East Central Pacific				Northeast Pacific			
	U.S.		U.S.		Mexico		Canada		U.S.	
Species	M3	M3-M1	M3	M3-M1	M3	M3-M1	M3	M3-M1	M3	M3-M1
Salmons, trouts	0.0	0.0	1.2	(1.0)	0.0	0.0	77.6	6.7	310.8	164.
Flounders, halibuts	0.0	0.0	6.8	1.6	0.8	0.4	8.1	(12.3)	137.0	107.
Cods, hakes	0.0	0.0	0.0	0.0	0.0	0.0	4.6	(0.7)	616.2	609.
Redfishes, basses	0.0	0.0	14.4	11.4	17.2	8.3	23.5	17.6	25.4	68.
Herrings, sardines	0.0	0.0	83.7	(52.7)	468.1	416.6	33.0	15.4	16.4	42.
Tunas, bonitos	0.0	(19.3)	108.5	(84.9)	65.1	48.4	104.7	(2.4)	2.0	(13.)
Misc. marine fishes	0.0	0.0	2.2	0.9	81.4	(25.2)	28.4	26.9	1.0	0.
Sea-spiders, crabs	0.0	0.0	1.1	((1.2)	0.5	0.3	1.1	0.1	117.2	(10.)
Scallops, pectins	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.
Total	0.0	(19.3)	217.9	(125.9)	633.1	448.8	281.0	51.3	1,230.3	968.

[1]M3: Average 1983-85
[2]M1: Average 1970-72

Mexican landings have also come primarily from two areas, the Eastern Central Pacific and the Western Central Atlantic, with more than 70 percent of Mexican production from the Eastern Central Pacific.

The United States fishes in five areas with more than one-third of the catch coming from the Eastern Central Atlantic and slightly less than 30 percent coming from the Northeast Pacific and the Northwest Atlantic. The most rapid growth in U.S. landings has been in the Northwest Pacific.

If we look at the species of fish caught, as classified by the FAO, (Table 3) 9 percent of Canada's landings in 1983-85 were flounders, halibuts, etc.; 45 percent cods, hakes, haddocks, etc; and 14 percent are herrings, sardines, anchovies, etc., so that more than two-thirds by volume of the Canadian catch is in these three categories. Similarly, the Mexican catch is heavily concentrated in two categories, as 46 percent of the Mexican catch consists of herrings, sardines and anchovies, etc., and another 20 percent by volume comes from miscellaneous marine fishes. The U.S. catch is somewhat more varied, with 31 percent in herrings, sardines, anchovies, etc., and another 16 percent classified as cods, hakes and haddocks, etc.

The breakdown by country, area and species can be combined to indicate the catch by country, by area and by species caught in each area (Table 4). More than 40 percent of the Canadian catch consists of cods, etc., caught in the maritimes. It is the recovery in these fisheries since the early 1970's that accounts for much of the overall increase in the volume of Canadian landings.

In Mexico, the increase in landings was primarily in the herrings category caught in the East Central Pacific with lesser gains in the miscellaneous category in the West Central Atlantic.

Changes in the volume of the U.S. catch are, as indicated, more varied. These include a shift in the tuna catch from the Eastern to the Western Central Pacific, a key increase in the Northeast Pacific (pollock), as well as increased in salmon in the Pacific and herrings in the Atlantic.

From the perspective of an economist, the existing state of the FAO classification of areas and species used in this paper and elsewhere is not satisfactory. Without a careful review of the problems in the collection, classification of, and cost of this data no one can say how an optimum classification scheme for purposes of economic analysis could be constructed and ordered. However, given the most important institutional change in ocean management in four centuries (the creation of EEZ's), the role of fishery products in trade and in providing protein, this would seem to be an approproiate time to examine the utility of the organization and the accuracy of the basic data that is available on worldwide landings.

Table 5.—Change in gross revenue of North American fisheries[1].

Millions of metric tons			Millions of U.S. dollars
(1) Quan(70/72)	(2) Quan(83/85)	(3) Q2-Q1	(4) Change in total revenue
1.19	1.30	0.11	200.89
2.74	4.54	1.80	956.72
0.37	1.01	0.64	187.55
36.74	43.34	6.60	1,345.16

$\bar{X}1$ = Average catch for period 1970/72 by country.
$\bar{X}2$ = Average catch for period 1983/85 by country.
$\bar{X}2 - \bar{X}1$ = Change in average catch 1983/85 - 1970/72.

Change in total revenue 1983/85 − 1970/72. Equals change in quantity for each species times species price, summed over all species.

[1]Source: FAO Yearbook of Fishery Statistics. Prices are U.S. prices for 1985 and are obtained from Fisheries of the United States, U.S. Department of Commerce.

Table 6.—Index of present value of stocks (source: Table 5).

Nation	TR(1983-85) less TR(1970-72) (Millions of U.S. dollars)	Net Present Value[1] (Millions of U.S. dollars)
Canada	200.9	1,357.9
United States	956.7	6,466.4
Mexico	187.6	1,268.1

[1]Note: NPV calculations assume discount rate of 10% and a 10-year horizon. Revenue gain is assumed to take place immediately.

Revenue

The three countries gained substantial benefits from the extension of jurisdiction. Collectively, in U.S. dollars at 1985 prices, the gross value of their catch increased by over $1 billion (Table 5). The United States accounted for the major share of the increase in gross revenue, but both Canada and Mexico increased the economic yield from their fisheries by around $200 million.

If we make an heroic assumption that gross revenue is equal to net, that is, that there are zero production costs, we can extend the gross revenue data into a crude index of the value of the stocks (the assets) acquired by the creation of EEZ's (Table 6). This approach provides limited insight into both the flow of income from fisheries and the value of the assets that generate the flow. These initial calculations are both indicative of the data problems inherent in measuring income and the basis for a crude ordering of the economic results of creation of EEZ's.

The numbers suggest that the value of the stocks of fish acquired by Canada and Mexico are greater than $1 billion. For the United States the number is in excess of $6 billion.

If we reflect for a moment on this enclosure process on a worldwide basis, we see that the creation of EEZ's involved a substantial redistribution of income and assets probably in the direction of greater international inequality.

Short Run—Long Run: Fishery Dynamics

The common property hypothesis suggests that in long-run equilibrium, the industry would have redundant capital and labor. The redundance is linked to the stability in a sustainable level of output and the price of fish. The short-run interaction of dynamic changes and the standard assumptions about long-run equilibrium, in a special case, have been noted by Pontecorvo (1986).

The elements in this model involve:

1) A shock that disturbs the initial equilibrium. A shock may be an increase in demand (increase in real price and therefore profitability), an increase in supply (more fish at constant or lower costs), technological change, expectations of future profitability (such as those expectations engendered by the advent of EEZ's), or all of the above. These shocks serve to increase short-run profits, or expectations of those profits.

2) Given profitability and easy entry, investment increases, and capital and labor enter.

3) Given supply-side limitations and a limit in the short-run to market-size, capital and labor become redundant, and profitability declines. With the asymmetry between entry and exit over some time-horizon, the industry requires government intervention to protect both capital and labor.

4) These short-run changes take place in a system where, over any long time period, demand grows with both income and changes in taste and the supply of fish protein is limited. In the long run, these forces bring about an increase in the real price of fish and the fishery again becomes profitable. In due time the short-run forces repeat the cycle.

This paper can only suggest the importance of the linkages between the long-run/short-run forces in fisheries and the underlying forces of business cycles and national economic growth. Here we can only comment briefly on a subset of these larger issues: the question of productivity change in the industry. The National Marine Fisheries Service provides data on the

Table 7.—U.S. input-output relationship[1].

Item	No. of fishermen	Percent change	No. of Vessels	Percent change	Total U.S. catch	Percent change
Average of 1970-72	140,016		14,023		2,737,833	
Average of 1983-85	230,833	+64.9%	23,133	+65.0%	4,538,291	+65.7%

[1]Data preliminary, 1978 on; 1977 data: Vessels = 17,517; tonnage = 76,350 ÷ 44 tons per vessel.

Table 8.—Relationship between fisheries capital stock and productivity.

Item	Capital stock in U.S. fisheries	Nonfarm productivity in U.S. (output per man-hour)	Effictive U.S. fisheries capital stock[1]	Effective[2] U.S. fisheries capital stock if 25% excess capacity in 1970-72
Average of 1970-72	[3] 100/14,023[4]	[3]100	[3]100/14,023	125/17,529
Average of 1983-85	165/23,133	112	177/24,821	221/31,026
Indicated excess capacity in light vessels			1,688	7,893

[1]Effect on U.S. fisheries capital stock of increased productivity during time period.
[2]Large base (125) because of excess capacity. Growth to (1983-85) takes increased productivity growth into account.
[3]Index numbers, 1970-72 = 100.
[4]Actual number of vessels in the United States.

number of fishermen and vessels.[2] These data suggest constant returns during this time period (Table 7). The number of fishermen increased by 65 percent, and output by 66 percent.

Assume that in the period 1970-72 the fisheries were efficient, i.e., 1970-72 output was achieved at minimum cost. Assume also that, subsequently, productivity in fisheries grew at the same rate as the U.S. nonfarm economy. Given these assumptions, the stock of capital available in the fisheries in 1983-85 was larger than indicated by the amount of the growth in the quantity of capital, i.e., the number of vessels.

In other words, by 1983-85 the observed constant relationship between output and capital concealed the presence of more than 1,600 redundant vessels (Table 7). If we further assume 25 percent excess capacity in 1970-72 then the condition of the U.S. fisheries is significantly worse when we reach 1983-85; i.e., there were almost 8,000 redundant vessels (Table 8).

In this context, "worse" has several meanings. It suggests less efficient use of resources; i.e., the presence of redundant capital and labor relative to the level of output. Worse is also a proxy for increased risk in the industry. All industries and firms are linked to business cycles and therefore are at risk of financial collapse with changes in demand, interest rates and other costs. These risks tend to be higher with small firms with few financial resources and options.

If an industry is inefficient, cyclical fluctuations in earnings have an increased impact on the viability of firms. Also, if the industry is subject to supply shocks, resulting from instability in the underlying fish populations and ecosystems, risk is increased further. Therefore, in the short run, fisheries tend to be subject to the usual economic risks plus the risk of supply side shocks and the risks inherent in redundant capacity.

Underlying the productivity issue, business cycles, economic growth, and stock instability problems are a set of empirically interesting questions involving capital, labor, and technological change.

In the United States:

1) What has happened to technological change and productivity as expressed in the average size and quality of vessels over this period? Has there been a change in vessel size and performance since the early 1970's? Has the introduction of sophisticated electronic devices increased productivity and safety? Is it reasonable to assume that both the quality and quantity of capital have increased over this time horizon and that these changes in technology have particularly increased productivity? If this is the case then an index of productivity change plus the additions to capital should reveal a declining catch per ton.

2) A similar set of questions involve the human capital in U.S. fisheries. Is there reason to believe that conditions of employment and experience have contributed to the creation of more efficient and skilled labor?

[2]Parts of the time series on vessels were provided to me by personal communications. Capital on vessels is broken down into vessels (5 net tons and over), data on motor boats, and other boats. Here I have used only vessels. In 1977, adjusted for sailboats, the 17,517 vessels had an average of 44 tons per vessel. The last year for which this data is available is 1977, and therefore one cannot tell if there has been any change in the distribution of vessel size. This is potentially important if one assumes links between size and productivity of capital. Suggestions about productivity changes over time are discussed below

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