Prediction and Assessment of the By-catch of Cod Taken During September-December 1977 from the Gulf of Maine and Georges Bank Cod Stocks

by

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Introduction

Closures of the United States 1977 directed commercial cod fisheries in the Gulf of Maine (ICNAF Div. 5Y) and on Georges Bank (ICNAF Div. 5Z and Stat. Area 6) were announced by the Regional Director, National Marine Fisheries Service on 8 July and 22 August, respectively, under authority of the 1977 Fishery Management Plan for Atlantic Groundfish. Termination of the fisheries was required since the 1977 catch quotas for licensed commercial vessels fishing cod in both stock areas had been achieved. The Groundfish FMP, however, does permit cod to be taken as a by-catch species so long as commercial vessels do not have on board (either at sea or at the time of offloading) amounts of cod in excess of 5,510 pounds (2.5 metric tons) or 10% by weight of all fish on board, whichever is greater.

The following report presents an assessment of the quantity of cod likely to be taken as reported by-catch during the remainder of 1977 (September through December) in both the Gulf of Maine and on Georges Bank. Cod by-catch landings were evaluated under current regulations as well as under several hypothetical schemes permitting greater amounts of fish to be taken. Implications of both present and alternate restrictions on cod by-catch are reviewed and discussed.

Methods and Materials

Cod landings in 1976 (entire year) and 1977 (January-June, latest data available) were summarized by stock area, vessel tonnage class, month and quarter, days fished, number of trips, catch per day, and catch per trip. Additionally, the total catch of vessels taking cod was examined in a similar format. Both the mean cod catch per vessel trip and the mean total catch per vessel trip were derived by time-area-vessel class categories. Frequency

distributions of both catch parameters were also analyzed on an areal-year-vessel class basis to assess the suitability of employing mean catch per trip values to predict the September-December cod by-catch landings.

September-December 1977 by-catch landings of cod were derived from vessel tonnage class data on cod trips, cod catch per trip, and total catch per trip during January-June 1976, September-December 1976, and January-June 1977. The January-June 1977 value of each of these parameters, by tonnage class, was multiplied by the ratio of the 1976 September-December/1976 January-June values to obtain estimates of the expected cod trips, cod catch/trip, and total catch/trip in September-December 1977. The expected cod trips multiplied by the expected cod catch/trip (for each vessel class) provided one measure of the anticipated catch of cod. Another estimate was obtained by multiplying the predicted total catch/trip for September-December 1977 by the percent of cod in the total catch (by vessel class) during the same period in 1976. This derived value of cod catch/trip was then applied to the predicted number of trips for each vessel category to derive a second estimate of cod catch. Summation of the predicted cod landings over the three tonnage class categories yielded total expected cod catch from each of the cod stocks.

The above procedures provide estimates of cod catch assuming an unregulated fishery. Analyses were also performed using the following by-catch restriction schemes: 1) by-catch limited to 10% of total catch (by weight) on board per vessel trip or 5510 pounds of cod whichever is greater (current regulation); 2) by-catch limited to 20% of total catch (by weight) on board per vessel trip or 5510 pounds of cod whichever is greater; 3) by-catch limited to 20% of total catch (by weight) on board per vessel trip or 11,020 pounds whichever is greater; and 4) by-catch limited to 30% of total catch (by weight) on board per vessel trip or 16,530 pounds whichever is greater. Vessel class

categories were individually examined for both the Gulf of Maine and Georges Bank fisheries to assess the impact in terms of yield of each of these options.

Implicit in determining the expected cod catches in September-December 1977 from the pattern of previous landings is the assumption that the behavior of the cod fisheries remains unchanged. Use of the 1976 and early 1977 cod fishery parameters was thought to provide the most representative data base from which to extrapolate the late 1977 cod landings. Major deviations in fishing practices for cod in response to the closure of the fisheries (apart from the by-catch restrictions) may result in deviations from these projections.

Results and Discussion

Gulf of Maine (ICNAF Division 5Y) Cod Stock:

Tables 1 and 2 summarize cod landings, by tonnage class and quarter-year, for the 1976 and 1977 Gulf of Maine cod fishery. Comparison of the 1976 and 1977 fisheries in terms of days fished, vessel trips, cod catch/day, cod catch/trip, and total cod catch is provided in Table 3. For the period January-June, all vessel class categories exhibited an increase in each of the fishery parameters (except for a slight decline in Tonnage Class 4 cod/trip) from 1976 to 1977. Total catch per trip (Tables 1 and 2) also increased between January-June 1976 and 1977 by 46% for Tonnage Class 2 vessels and 40% for Tonnage Class 3 vessels. Tonnage Class 4 vessels, however, exhibited a 19% decline in total catch/trip during the first half of 1977 compared with the same period in 1976.

The relative distribution of the total Gulf of Maine cod landings among the three vessel categories changed little between January-June 1976 and January-June 1977 (Table 3). Class 2 vessels landed the majority of the cod catch (>60%) while Class 3 vessels accounted for about a third of the total cod taken. Landings by Class 4 vessels were virtually insignificant during both time periods, comprising less than 3% of the total cod taken. A similar distribution of total cod catch is evident between vessel types for the entire 1976 fishery.

The frequency distributions of the mean cod catch/trip/vessel and the mean total catch/trip/vessel in 1976 and 1977 in the Gulf of Maine (Tables 4 and 5) show that prediction of 1977 cod catches from mean total catch date (and the ratio of cod weight/total weight of catch) is statistically reasonable since total catch/trip is approximately normally distributed in each tonnage class category. Use of mean cod catch/trip in deriving 1977 estimates may provide a positive bias to the projected catches (i.e., high predicted catches) since the distribution of mean cod catch/trip is skewed to the right in all tonnage categories. Further analysis is required to delineate the magnitude of this bias, if it is not a statistical artifact.

Table 6 lists the predicted 1977 (September-December) cod landings, by vessel tonnage class, for the Gulf of Maine fishery. An estimated total catch of 11.7 million pounds(5327metric tons) was derived using mean cod/trip data; an estimate of 10.0 million pounds (4547 metric tons) was obtained from the total catch/trip analyses. In both cases, Class 2 vessels have the highest predicted total cod catch (>50% of the total projection), while Class 4 vessels are expected to take only about 2% of the landings during this period.

Based on the predicted cod/trip values for each vessel class category (all less than 5,510 pounds), none of the cod fishery in the Gulf of Maine will be restricted by currently imposed by-catch regulations.

Georges Bank (ICNAF Division 5Z and Statistical Area 6) Cod Stock:

Georges Bank cod landings in 1976 and 1977 are summarized by vessel class and quarter-year in Tables 7 and 8, and are compared with each other in Table 9. For the January-June period, the 1977 fishery exhibited increases, for all tonnage categories, in cod catch, cod/day, cod/trip (Table 9) and total catch (Tables 7 and 8). Days fished increased slightly for Class 3 vessels between the first half of 1976 and 1977 and declined slightly in the two other tonnage classes. The number of trips were higher in vessel classes 3 and 4 during January-June 1977 than in the same period a year previous, but Class 2 vessels exhibited a small decline. Total catch/trip showed the same pattern between years for vessel class as the number of trips.

During January-June 1977, Class 3 vessels landed 70% of the total Georges Bank cod taken. Class 4 vessels accounted for 22% of the cod landed while Class 2 boats took 8% of the total Georges Bank cod catch (Table 9). The importance of the Class 2 vessels in terms of the fraction of total cod taken diminished by about half from 1976 to 1977 (15% in Jan.-June 1976), but Class 3 vessels increased slightly. Boats in tonnage category 4 remained nearly the same between years (24%, 1976; 22%, 1977) in the proportion of the total catch taken.

Tables 10 and 11 depict the frequency distribution of mean cod catch/trip/vessel and the mean total/trip/vessel, by tonnage category, in the 1976 and 1977 Georges Bank cod fisheries. Total catch/trip appears normally distributed in all vessel classes. Hence, use of the mean total catch/trip in estimating 1977 cod catches seems justifiable statistically. For cod catch/trip, however, almost all of the frequency distributions are bimodal. The effect of using mean cod catch/trip values in the 1977 predictions will presumably differ in each of the tonnage class forecasts. The direction of bias for each of the derivations has not been assessed.

Predicted 1977 (September-December) Georges Bank cod landings are listed in Table 12 by vessel tonnage category. In a fishery unregulated by by-catch limitations, an estimated total of 17.8 million pounds (8096 metric tons) would be taken predicted on the basis of cod catch/trip projections. Predicted total catch based on total catch/trip is somewhat smaller at 13.9 million pounds (6303 metric tons). In both analyses, Class 3 vessels had the highest predicted total catch (62-65% of the total estimates). Class 4 vessels were estimated to take greater than 30% of the predicted Georges Bank cod landings in each analysis, while the smallest-sized vessels (Class 2) accounted for no more than 5% of the total cod taken.

Tonnage Class 2 vessels will not be restricted by the current by-catch regulations, nor by any of the alternate by-catch schemes examined. The predicted cod catch/trip and the predicted total catch/trip (Table 12) are lower than any of the restrictive by-catch limits. However, Class 3 and 4 vessels will be affected by the currently imposed regulations. These vessels will take an estimated 9,829 and 34,201 pounds of cod/trip, respectively, during September-December 1977. Additionally, the predicted total catch/trip and

the percent of cod (by weight) comprising the trip catch for each of these vessel classes is sufficiently large as to exceed present limitations. Assuming that Class 3 vessels will land 5,510 pounds of cod/trip and that Class 4 will take 6,814 pounds of cod/trip (10% of predicted total catch/trip), a total of 8.5 million pounds (3836 metric tons) of cod will be removed from the Georges Bank stock during September-December 1977 by all vessel classes.

Under a scheme in which by-catch is increased to 20% of total catch (by weight) per trip or 5,510 pounds of cod, whichever is greater, both class 3 and 4 vessels would increase their cod catch by taking advantage of the 20% by-catch provision. For all vessel classes (each optimizing their cod catch), a total catch of 10.3 million pounds of cod (4688 metric tons) could be expected.

If by-catch were limited to 20% of total catch (by weight) per trip or 11,020 pounds (double the present limit) whichever is greater, the Class 3 vessels, in the Georges Bank cod fishery would benefit since the predicted cod catch/trip for these groups (9,829 pounds) could be taken without restriction. Class 4 vessels would be limited by the 20% regulation, and hence take the same amount of cod as in the previous scheme above. Total predicted Georges Bank cod landings could amount to 14.6 million pounds (6642 metric tons) under this by-catch scheme.

Liberalization of the by-catch restrictions to permit a cod by-catch of 30% of the total catch (by weight) per trip or 16,530 pounds (triple the currently imposed limit) whichever is greater would only increase the yield for Class 4 vessels. Since the unregulated predicted cod catch/trip is 34,201 pounds and total predicted catch/trip is 68,145 pounds for Class 4 vessels, greatest benefit is afforded using the 30% rule. A predicted total cod catch of 3.1 million pounds for all Class 4 vessels would arise from this by-catch scheme; a total cod catch (all vessel groups) of 15.7 million pounds (7123 metric tons) could subsequently be expected.

Table 1. 1976 Gulf of Maine (ICNAF Div. 5Y) cod Landings - quarterly summary.

1976	Days fished	Trips	Days fished / Trip	Pounds: Cod landed	Pounds: Total landed	Pounds: Cod catch / Day	Pounds: Cod catch / Trip	Pounds: Total catch / Day	Pounds: Total catch / Trip	% Cod (by weight) of total fish landed
Tonnage Class 2										
Jan.-Mar.	2,563.7	5,614.0	0.46	2,154,016	8,129,028	840.2	383.7	3,170.8	1,448.0	26
Apr.-June	3,486.8	6,922.6	0.50	3,945,906	15,036,869	1,131.7	570.0	4,312.5	2,172.1	26
Jul.-Sept.	2,981.2	5,648.9	0.53	3,836,834	18,249,815	1,287.0	679.2	6,121.6	3,230.7	21
Oct.-Dec.	2,259.7	3,785.6	0.60	2,237,882	11,622,408	990.3	591.2	5,143.3	3,070.2	19
Total	11,291.4	21,971.1	0.51	12,174,638	53,038,120	1,078.2	554.1	4,697.2	2,414.0	23
				65% of total Gulf of Maine 1976 cod catch						
Tonnage Class 3										
Jan.-Mar.	511.8	855.6	0.60	876,577	6,402,874	1,712.7	1,024.5	12,510.6	7,483.5	14
Apr.-Jun.	538.8	790.3	0.68	1,715,661	6,269,329	3,184.2	2,170.9	11,635.7	7,932.8	27
Jul.-Sept.	477.9	690.5	0.69	1,498,837	9,213,283	3,136.3	2,170.7	19,278.7	13,342.9	16
Oct.-Dec.	587.8	838.6	0.70	1,853,939	8,283,344	3,154.0	2,210.8	14,092.1	9,877.6	22
Total	2,116.3	3,175.0	0.67	5,945,014	30,168,830	2,809.2	1,872.4	14,255.5	9,502.0	20
				32% of total Gulf of Maine 1976 cod catch						
Tonnage Class 4										
Jan.-Mar.	95.5	42.9	2.23	138,002	2,255,371	1,445.0	3,216.8	23,616.5	52,572.8	6
Apr.-Jun.	176.7	46.8	3.78	93,813	4,578,229	530.9	2,004.6	25,909.6	97,825.4	2
Jul.-Sept.	144.4	35.9	4.02	73,865	3,502,110	511.5	2,057.5	24,252.8	97,551.8	2
Oct.-Dec.	110.0	50.1	2.20	187,472	2,682,190	1,704.3	3,742.0	24,383.5	53,536.7	7
Total	526.6	175.7	3.00	493,152	13,017,900	936.5	2,806.8	24,720.7	74,091.6	4
				3% of total Gulf of Maine 1976 cod catch						
GRAND TOTAL	13,934.3	25,321.8	0.55	18,612,804	96,224,850	1,335.8	735.1	6,905.6	3,800.1	19

Table 2. 1977 Gulf of Maine (ICNAF Div. 5Y) cod Landings - quarterly summary.

1977	Days fished	Trips	Days fished / Trip	Pounds: Cod landed	Total landed	Cod catch / Day	Cod catch / Trip	Total catch / Day	Total catch / Trip	% Cod (by weight) of total fish landed
Tonnage Class 2										
Jan.-Mar.	2,435.7	4,528.0	0.54	2,979,784	11,053,740	1,223.4	658.1	4,538.2	2,441.2	27
Apr.-Jun.	4,858.2	9,822.8	0.49	7,988,878	27,725,860	1,644.4	813.3	5,707.0	2,822.6	29
Jul.-Sept.										
Oct.-Dec.										
Total										
Tonnage Class 3										
Jan.-Mar.	676.2	998.9	0.68	1,519,683	8,504,816	2,247.4	1,521.4	12,577.4	8,514.2	18
Apr.-Jun.	788.3	1,120.8	0.70	4,579,790	14,346,096	5,809.7	4,086.2	18,198.8	12,799.9	32
Jul.-Sept.										
Oct.-Dec.										
Total										
Tonnage Class 4										
Jan.-Mar.	125.7	49.1	2.56	68,465	4,559,572	544.7	1,394.4	36,273.4	92,863.0	2
Apr.-Jun.	220.0	58.8	3.74	164,696	5,538,900	748.6	2,801.0	25,176.8	94,199.0	3
Jul.-Sept.										
Oct.-Dec.										
Total										
GRAND TOTAL										

Table 3. Comparison of 1976 and 1977 cod fishery in the Gulf of Maine (ICNAF Div. 5Y).

Quarter	1976 Days fished	1977 Days fished	1976 Trips	1977 Trips	1976 Cod catch / Day	1977 Cod catch / Day	1976 Cod catch / Trip	1977 Cod catch / Trip
Tonnage Class 2								
Jan.-Mar.	2,563,7	2,435.7	5,614.0	4,528.0	840.2	1,223.4	383.7	658.1
Apr.-Jun.	3,486.8	4,858.2	6,922.6	9,822.8	1,131.7	1,644.4	570.0	813.3
Jul.-Sept.	2,981.2		5,648.9		1,287.0		679.2	
Oct.-Dec.	2,259.7		3,785.6		990.3		591.2	
Tonnage Class 3								
Jan.-Mar.	511.8	676.2	855.6	998.9	1,712.7	2,247.4	1,024.5	1,521.4
Apr.-Jun.	538.8	788.3	790.3	1,120.8	3,184.2	5,809.7	2,170.9	4,086.2
Jul.-Sept.	477.9		690.5		3,136.3		2,170.7	
Oct.-Dec.	587.8		838.6		3,154.0		2,210.8	
Tonnage Class 4								
Jan.-Mar.	95.5	125.7	42.9	49.1	1,445.0	544.7	3,216.8	1,394.4
Apr.-Jun.	176.7	220.0	46.8	58.8	530.9	748.6	2,004.6	2,801.0
Jul.-Sept.	144.4		35.9		511.5		2,057.5	
Oct.-Dec.	110.0		50.1		1,704.3		3,742.0	

Jan.-Jun.	1976 Days fished	1977 Days fished	1977/1976 Days fished
T.C. 2	6,050.5	7,293.9	1.2055
3	1,050.6	1,464.5	1.3940
4	272.2	345.7	1.2700

Jan.-June	1976 Trips	1977 Trips	1977/1976 Trips
T.C. 2	12,536.6	14,350.8	1.1447
3	1,645.9	2,119.7	1.2879
4	89.7	107.9	1.2029

Jan.-Jun.	1976 Cod catch	1977 Cod catch	1977/1976 Cod catch
T.C. 2	6,099,922	10,968,662	1.7982
3	2,592,238	6,099,473	2.3530
4	231,815	233,161	1.0058
Σ	8,923,975	17,301,296	1.9387

Jan.-June	1976 Cod/Day	1977 Cod/Day	1977/1976 Cod/Day
T.C. 2	1,008.17	1,503.81	1.4916
3	2,467.39	4,164.88	1.6880
4	851.63	674.46	0.7920

Jan.-Jun.	% of Cod catch	% of Cod catch
T.C. 2	68	63
3	29	35
4	3	1

Jan.-June	1976 Cod/Trip	1977 Cod/Trip	1977/1976 Cod/Trip
T.C. 2	486.57	764.32	1.5708
3	1,574.97	2,877.52	1.8270
4	2,584.34	2,160.90	0.8362

Table 4. 1976 Gulf of Maine (ICNAF Div. 5Y) cod fishery-cod catch per trip per vessel and total catch per trip per vessel frequency distribution (1).

Pounds/Trip	Tonnage Class 2		Tonnage Class 3		Tonnage Class 4	
	Cod Catch/Trip	Total Catch/Trip	Cod Catch/Trip	Total Catch/Trip	Cod Catch/Trip	Total Catch/Tr
0-99	46	-	1	-	1	-
100-499	124	11	10	-	-	-
500-999	70	40	18	-	2	-
1000-1499	21	45	13	1	6	-
1500-1999	17	40	11	2	1	-
2000-2499	7	32	5	-	2	-
2500-2999	5	31	5	3	-	-
3000-3499	2	21	7	2	2	-
3500-3999	1	16	5	3	2	-
4000-4999	1	23	11	7	4	2
5000-5499	-	7	3	8	-	-
5500-5509	-	2	-	-	-	-
5510-5999	-	3	3	1	1	-
6000-6999	1	7	4	7	1	-
7000-7999	1	6	-	5	-	-
8000-8999	-	2	1	6	-	-
9000-9999	-	2	1	5	1	-
10000-14999	-	6	2	18	3	-
15000-19999	-	-	-	10	-	-
20000-24999	-	-	2	3	-	1
25000-29999	-	-	-	6	-	1
30000-34999	-	1	-	7	-	1
35000-39999	-	-	-	1	-	3
40000-44999	-	-	-	1	-	2
45000-49999	-	-	-	1	-	-
50000-59999	-	1	-	3	-	1
60000-69999	-	-	-	-	-	1
70000-79999	-	-	-	1	-	3
80000-89999	-	-	-	-	-	4
90000-99999	-	-	-	-	-	1
100000-109999	-	-	-	1	-	1
110000-119999	-	-	-	-	-	2
≥120000	-	-	-	-	-	3
Total	296	296	102	102	26	26
Mean	554.1	2,414.0	1,872.4	9,502.0	2,806.8	74,091.6
Median	100-499	2000-2499	1500-1999	9000-9999	3000-3499	70000-79999
Mode	100-499	1000-1499	500-999	1000-14999	1000-1499	80000-89999

(1) Each observation represents the mean catch/trip/vessel.

Table 5. 1977 (Jan.-June) Gulf of Maine (ICNAF Div. 5Y) cod fishery-cod catch per trip per vessel and total catch per trip per vessel frequency distribution (1).

Pounds / Trip	Tonnage Class 2		Tonnage Class 3		Tonnage Class 4	
	Cod Catch/Trip	Total Catch/Trip	Cod Catch/Trip	Total Catch/Trip	Cod Catch/Trip	Total Catch/Trip
0-99	12	1	1	-	1	-
100-499	94	7	8	-	2	-
500-999	71	18	9	-	2	1
1000-1499	33	34	9	-	4	1
1500-1999	19	25	10	-	6	-
2000-2499	5	32	7	2	-	1
2500-2999	3	20	8	1	2	-
3000-3499	1	28	6	2	1	-
3500-3999	-	26	3	1	1	-
4000-4999	1	26	9	5	-	-
5000-5499	1	5	3	4	-	-
5500-5509	-	-	-	-	-	-
5510-5999	-	1	2	4	-	-
6000-6999	-	6	2	8	-	-
7000-7999	-	3	2	2	-	-
8000-8999	-	3	3	6	-	-
9000-9999	1	2	1	3	-	-
10000-14999	-	2	2	14	-	-
15000-19999	-	2	1	8	1	-
20000-24999	-	-	2	7	-	-
25000-29999	-	-	-	7	-	-
30000-34999	-	-	-	3	-	1
35000-39999	-	-	-	2	-	-
40000-44999	-	-	-	2	-	-
45000-49999	-	-	-	1	-	1
50000-59999	-	-	-	3	-	-
60000-69999	-	-	-	2	-	1
70000-79999	-	-	-	1	-	2
80000-89999	-	-	-	-	-	3
90000-99999	-	-	-	-	-	2
100000-109999	-	-	-	-	-	2
110000-119999	-	-	-	-	-	1
≥120000	-	-	-	-	-	4
Total	241	241	88	88	20	20
Mean	764.3	2,702.3	2,877.5	10,780.3	2,160.9	76,182.8
Median	500-999	2500-2999	2500-2999	10000-14999	1500-1999	80000-89999
Mode	100-499	1000-1499	1500-1999	10000-14999	1500-1999	≥120000

(1) Each observation represents the mean catch/trip/vessel.

Table 6. Gulf of Maine (ICNAF Div. 5Y) Predicted 1977 cod landings (Sept.-Dec.).

Tonnage class	Predicted trips	Predicted cod/trip (lbs)	Predicted cod catch (lbs)	Predicted total catch/trip (lbs)	% Cod of Sept.-Dec. cod catch	Predicted cod/trip (lbs)	Predicted cod catch (lbs)
2	6,234.8	947.8	5,904,343	4,564.1	.1933	882.24	5,500,593
3	1,372.4	4,083.4	5,604,058	14,383.5	.2176	3,129.85	4,295,406
4	78.1	3,015.9	235,542	50,561.7	.0581	2,937.63	229,429
			Σ 11,743,943 5,327 MT	$\overline{X}$ = 10,884,946 4,937 MT			Σ 10,025,428 4,547 MT

Table 7. 1976 Georges Bank (ICNAF Div. 5Z+SA6) cod landings - quarterly summary.

1976	Days fished	Trips	Days fished / Trip	Pounds: Cod landed	Total landed	Cod Catch / Day	Cod Catch / Trip	Total Catch / Day	Total Catch / Trip	% Cod (by weight) of total fish landed
Tonnage Class 2										
Jan.-Mar.	463.6	793.2	0.58	464,036	3,460,112	1,000.94	585.02	7,463.57	4,362.22	13
Apr.-Jun.	804.4	1,405.3	0.57	1,507,795	6,029,788	1,874.43	1,072.93	7,496.01	4,290.75	25
Jul.-Sept.	508.2	1,043.0	0.49	1,963,517	3,713,658	3,863.67	1,882.57	7,307.47	3,560.55	53
Oct.-Dec.	363.1	779.6	0.47	363,460	3,207,422	1,000.99	466.21	8,833.44	4,114.19	11
Total	2,139.3	4,021.1	0.53	4,298,808	16,410,980	2,009.45	1,069.06	7,671.19	4,081.22	26
				16% of Total Georges Bank 1976 cod catch						
Tonnage Class 3										
Jan.-Mar.	1,938.7	613.0	3.16	2,767,278	11,807,459	1,427.39	4,514.32	6,090.40	19,261.76	23
Apr.-Jun.	3,113.7	768.1	4.05	5,232,209	20,122,711	1,680.38	6,811.89	6,462.64	26,198.04	26
Jul.-Sept.	1,666.1	452.3	3.68	3,327,500	16,977,037	1,997.18	7,356.84	10,189.69	37,534.90	20
Oct.-Dec.	1,641.6	652.3	2.52	3,763,035	14,710,616	2,292.30	5,768.87	8,961.15	22,551.92	26
Total	8,360.1	2,485.7	3.36	15,090,022	63,617,823	1,805.00	6,070.73	7,609.70	25,593.52	24
				56% of total Georges Bank 1976 cod catch						
Tonnage Class 4										
Jan.-Mar.	397.5	99.0	4.02	1,330,593	3,631,960	3,347.40	13,440.33	9,137.01	36,686.46	37
Apr.-Jun.	378.0	88.6	4.27	1,840,088	4,191,143	4,867.96	20,768.49	11,087.68	47,304.10	44
Jul.-Sept.	368.6	89.0	4.14	2,350,651	4,638,215	6,377.24	26,411.81	12,583.33	52,114.78	51
Oct.-Dec.	370.5	107.6	3.44	1,960,195	4,788,036	5,290.67	18,217.43	12,923.17	44,498.48	41
Total	1,514.6	384.2	3.94	7,481,527	17,249,354	4,939.61	19,473.00	11,388.72	44,896.81	43
				28% of total Georges Bank 1976 cod catch						
GRAND TOTAL	12,014.0	6,891.0	1.74	26,870,357	97,278,157	2,236.59	3,899.34	8,097.07	14,116.70	28

Table 8. 1977 Georges Bank (ICNAF Div. 5Z+SA6) cod landings - quarterly summary.

1977	Days fished	Trips	Days Fished / Trip	Pounds: Cod landed	Total landed	Cod catch / Day	Cod catch / Trip	Total Catch / Day	Total Catch / Trip	% Cod (by weight) of total fish landed
Tonnage Class 2										
Jan.-Mar.	341.5	737.2	0.46	381,251	3,062,645	1,116.40	517.16	8,968.21	4,154.43	12
Apr.-Jun.	843.5	1,382.6	0.61	1,715,505	6,006,270	2,033.79	1,240.78	7,120.65	4,344.18	29
Jul.-Sept.										
Oct.-Dec.										
Total										
Tonnage Class 3										
Jan.-Mar.	2,007.7	748.6	2.68	3,842,547	15,766,027	1,913.90	5,132.98	7,852.78	21,068.68	24
Apr.-Jun.	3,935.1	1,263.4	3.11	14,780,504	39,188,402	3,756.07	11,698.99	9,958.68	31,018.21	38
Jul.-Sept.										
Oct.-Dec.										
Total										
Tonnage Class 4										
Jan.-Mar.	279.7	76.3	3.67	1,591,484	4,102,390	5,689.97	20,858.24	14,667.11	53,766.58	39
Apr.-Jun.	458.7	128.4	3.57	4,283,575	8,151,813	9,338.51	33,361.18	17,771.56	63,487.64	53
July-Sept.										
Oct.-Dec.										
Total										
GRAND TOTAL										

Table 9. Comparison of 1976 and 1977 Georges Bank (ICNAF Div. 5Z+SA6) cod fisheries.

Quarter	1976 Days fished	1977 Days fished	1976 Trips	1977 Trips	1976 Cod catch / Day	1977 Cod catch / Day	1976 Cod catch / Trip	1977 Cod catch / Trip
Tonnage Class 2								
Jan.-Mar.	463.6	341.5	793.2	737.2	1,000.94	1,116.40	585.02	517.16
Apr.-Jun.	804.4	843.5	1,405.3	1,382.6	1,874.43	2,033.79	1,072.93	1,240.78
Jul.-Sept.	508.2		1,043.0		3,863.67		1,882.57	
Oct.-Dec.	363.1		779.6		1,000.99		466.21	
Tonnage Class 3								
Jan.-Mar.	1,938.7	2,007.7	613.0	748.6	1,427.39	1,913.90	4,514.32	5,132.98
Apr.-Jun.	3,113.7	3,935.1	768.1	1,263.4	1,680.38	3,756.07	6,811.89	11,698.99
Jul.-Sept.	1,666.1		452.3		1,997.18		7,356.84	
Oct.-Dec.	1,641.6		652.3		2,292.30		5,768.87	
Tonnage Class 4								
Jan.-Mar.	397.5	279.7	99.0	76.3	3,347.40	5,689.97	13,440.33	20,858.24
Apr.-Jun.	378.0	458.7	88.6	128.4	4,867.96	9,338.51	20,768.49	33,361.18
Jul.-Sept.	368.6		89.0		6,377.24		26,411.81	
Oct.-Dec.	370.5		107.6		5,290.67		18,217.43	

Jan.-June	1976 Days fished	1977 Days fished	1977/1976 Days fished	Jan.-June	1976 Trips	1977 Trips	1977/1976 Trips
T.C. 2	1,268.0	1,185.0	0.9345	T.C. 2	2,198.5	2,119.8	0.9642
3	5,052.4	5,942.8	1.1762	3	1,381.1	2,012.0	1.4568
4	775.5	738.4	0.9522	4	187.6	204.7	1.0912

Jan.-June	1976 Cod catch	1977 Cod catch	1977/1976 Cod catch	Jan.-June	1976 Cod/Day	1977 Cod/Day	1977/1976 Cod/Day
T.C. 2	1,971,831	2,096,756	1.0634	T.C. 2	1,555.07	1,769.41	1.1378
3	7,999,487	18,623,051	2.3280	3	1,583.30	3,133.72	1.9792
4	3,170,681	5,875,059	1.8529	4	4,088.56	7,956.47	1.9460
Σ	13,141,999	26,594,866	2.0237				

Jan.-June	% of Cod Catch		Jan.-June	1976 Cod/Trip	1977 Cod/Trip	1977/1976 Cod/Trip
T.C. 2	15	8	T.C. 2	896.90	989.13	1.1028
3	61	70	3	5,792.11	9,255.99	1.5980
4	24	22	4	16,901.28	28,700.83	1.6981

Table 10. 1976 5Z+6 cod fishery - cod catch per trip per vessel and total catch per trip per vessel frequency distribution (1).

Pounds / Trip	Tonnage Class 2		Tonnage Class 3		Tonnage Class 3	
	Cod Catch/Trip	Total Catch/Trip	Cod Catch/Trip	Total Catch/Trip	Cod Catch/Trip	Total Catch/Trip
0-99	29	-	16	-	1	-
100-499	38	3	25	-	4	-
500-999	19	4	17	1	1	-
1000-1499	8	4	17	1	-	-
1500-1999	5	12	12	2	1	-
2000-2499	-	4	12	2	1	-
2500-2999	1	5	11	2	2	1
3000-3499	5	6	6	-	1	-
3500-3999	3	3	6	-	-	-
4000-4999	6	23	18	5	3	-
5000-5499	2	2	8	2	-	-
5500-5509	-	-	-	-	-	-
5510-5999	-	7	6	-	-	-
6000-6999	-	8	7	2	1	1
7000-7999	1	9	5	8	1	-
8000-8999	1	3	7	12	1	-
9000-9999	-	3	7	5	-	-
10000-14999	-	13	16	27	6	2
15000-19999	1	3	7	30	2	3
20000-29999	-	5	6	57	6	6
30000-39999	-	2	1	33	2	5
40000-49999	-	-	-	15	-	4
50000-59999	-	-	-	4	1	2
60000-69999	-	-	-	1	-	5
70000-79999	-	-	-	1	-	-
80000-89999	-	-	-	-	-	3
90000-99999	-	-	-	-	-	1
100000-109999	-	-	-	-	-	-
110000-119999	-	-	-	-	-	-
120000-129999	-	-	-	-	-	-
130000-139999	-	-	-	-	-	1
140000-149999	-	-	-	-	-	-
Total	119	119	210	210	34	34
Mean	1,069.1	4,081.2	6,070.7	25,593.5	19,473.00	44,896.8
Median	100-499	4000-4999	2500-2999	20000-29999	8000-8999	30000-39999
Mode	100-499	4000-4999	100-499	20000-29999	(10000-14999) (20000-29999)	20000-29999

(1) Each observation represents the mean catch/trip/vessel.

Table 11. 1977 (Jan.-June) Georges Bank (ICNAF Div. 5Z+SA6) cod fishery-cod catch per trip per vessel and total catch per trip per vessel frequency distribution (1).

Pounds / Trip	Tonnage Class 2		Tonnage Class 3		Tonnage Class 4	
	Cod Catch/Trip	Total Catch/Trip	Cod Catch/Trip	Total Catch/Trip	Cod Catch/Trip	Total Catch/Trip
0-99	28	1	10	1	-	-
100-499	28	3	18	-	4	-
500-999	16	4	14	-	3	-
1000-1499	7	6	9	-	1	-
1500-1999	2	5	11	-	-	-
2000-2499	2	6	5	2	2	-
2500-2999	1	10	7	1	-	-
3000-3499	1	6	9	2	-	-
3500-3999	1	5	9	3	-	-
4000-4999	1	14	11	2	-	1
5000-5499	-	3	4	2	-	-
5500-5509	-	-	1	-	-	-
5510-5999	-	1	2	6	-	-
6000-6999	1	4	7	2	1	-
7000-7999	1	1	8	8	-	-
8000-8999	1	6	7	10	-	-
9000-9999	-	3	7	6	-	-
10000-14999	-	5	22	26	2	2
15000-19999	2	4	15	10	3	-
20000-29999	2	6	19	51	4	3
30000-39999	-	1	6	26	3	1
40000-49999	-	-	2	22	4	5
50000-59999	-	-	-	17	1	1
60000-69999	-	-	-	2	1	5
70000-79999	-	-	-	1	-	2
80000-89999	-	-	-	2	-	3
90000-99999	-	-	-	1	-	2
100000-109999	-	-	-	-	-	2
110000-119999	-	-	-	-	-	-
120000-129999	-	-	-	-	-	-
130000-139999	-	-	-	-	-	1
140000-149999	-	-	-	-	-	1
Total	94	94	203	203	29	29
Mean	989.1	4,278.2	9,256.0	27,313.2	28,700.8	59,864.2
Median	100-499	4000-4999	4000-4999	20000-29999	15000-19999	60000-69999
Mode	(0-99) (100-499)	4000-4999	10000-14999	20000-29999	(100-499) (20000-29999) (40000-49999)	(40000-49999) (60000-69999)

(1) Each observation represents the mean catch/trip/vessel.

Table 12. Predicted 1977 Georges Bank (ICNAF Div. 5Z-SA6) cod landings Sept.-Dec.

Tonnage class	Predicted trips	Predicted cod/trip (lbs)	Predicted cod catch (lbs)	Predicted total catch/ trip (lbs)	% cod of Sept.-Dec. 1976 catch	Predicted cod/trip (lbs)	Predicted cod catch (lbs)
2	966.71	886.77	857,249	4,062.78	.1962	797.12	770,584
3	1,186.43	9,829.01	11,661,432	30,993.77	.2344	7,264.94	8,619,343
4	155.82	34,201.02	5,329,203	68,144.87	.4243	28,913.87	4,505,359
			Σ17,847,884 8,096 MT		$\overline{X}$ = 15,871,585 7,200 MT		Σ13,895,286 6,303 MT

Projected greatest catch: 17,847,884 lbs (8096 MT)

10% or 5510 whichever is Greater per trip

2	966.71	886.77	857,249	4,062.78	.1962	797.12	770,584
3	1,186.43	5,510.00	6,537,229	30,993.77	.1000	3,099.38	3,667,197
4	155.82	5,510.00	858,568	68,144.87	.1000	6,814.49	1,061,834
			Σ 8,253,046 3,744 MT		$\overline{X}$ = 6,881,331 3,122 MT		Σ 5,509,615 2,499 MT

Projected greatest catch: 8,456,312 lbs (3836 MT)

20% or 5510 whichever is Greater per trip

2	966.71	886.77	857,249	4,062.78	.1962	797.12	770,584
3	1,186.43	5,510.00	6,537,229	30,993.77	.2000	6,198.75	7,354,383
4	155.82	5,510.00	858,568	68,144.87	.2000	13,628.97	2,123,666
			Σ 8,253,046 3,743 MT		$\overline{X}$ = 9,250,840 4,196 MT		Σ10,248,633 4,649 MT

Projected greatest catch: 10,335,298 lbs (4688 MT)

20% of 11,020 whichever is Greater per trip

2	966.71	886.77	857,249	4,062.78	.1962	797.12	770,584
3	1,186.43	9,829.01	11,661,432	30,993.77	.2344	7,264.94	8,619,343
4	155.82	11,020.00	1,717,136	68,144.87	.2000	13,628.97	2,123,666
			Σ14,235,817 6,457 MT		$\overline{X}$ =12,874,705 5,840 MT		Σ11,513,593 5,222 MT

Projected greatest catch: 14,642,347 lbs (6642 MT)

30% of 16,530 whichever is Greater per trip

2	966.71	886.77	857,249	4,062,78	.1962	797.12	770,584
3	1,186.43	9,829.01	11,661,432	30,993.77	.2344	7,264.94	8,691,343
4	155.82	16,530.00	2,575,705	68,144.87	.3000	20,443.46	3,185,500
			Σ15,094,386 6,847 MT		$\overline{X}$ =13,834,907 6,376 MT		Σ12,575,427 5,704 MT

Projected greatest catch: 15,704,181 (7123 MT)