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Roundnose Grenadier Stocks in ICNAF Subareas 0+1 and 2+3

by

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INTRODUCTION

Although data collection by the Canadian Department of Fisheries and Oceans has not as yet been sufficient to reveal population parameters for roundnose grenadier in the Northwest Atlantic, sufficient catch and effort data are available for the construction of preliminary general production assessments (Shaefer, 1954) as was shown by Parsons et al (1978). This paper is an update of that work as well as an analysis of the stock condition based on Borrmann's (1978) data. Sampling recommendations are included.

MATERIALS AND METHODS

The standard used to calculate catch per hour fished for both Subareas 0+1 and 2+3 was tonnage class 7 (stern) trawlers as these consistently accounted for greater than 80% of the catch in both areas during the period examined (1967-1977). Catch and effort data were extracted from ICNAF Statistical Bulletins as described by Parsons et al (1978). Annual effort was determined by dividing the catch per unit effort into the reported grenadier catch for each year.

These effort data were then applied to the Shaefer general production model (Shaefer, 1954). Because of the small data base, running averages were not used. The 1971 catch and effort data for Subareas 2+3 were not used.

Borrmann's (1978) estimates of stock size and values of F as well as his estimates of $F_{0.1}$ at M = 0.10 and M = 0.20 were used to determine the stock condition during the period of his data. Because his catch curve is an average of the period examined, it was assumed to be equivalent to one year's data only. Therefore, F was considered to level off at the age of complete recruitment instead of continuing to increase as shown by Borrmann. The F at the age of complete recruitment was set at the F of $F_{0.1}$ for each M value. The F's of lower ages were then adjusted according to the established ratio (at greater ages F was set at $F_{0.1}$). A new, hypothetical catch at age was determined and this was converted to weight using Borrmann's growth parameters (t_0 K and W_∞). The yield is the sum of weights at age. If this value is greater than the estimated best TAC, then the stock may be considered to be in good shape. A yield lower than the TAC would indicate poor condition.

Borrmann's (1978) cohort averages (for 0+1 and 2+3) up to and including 1976 were projected up to the year 1984 in a number of ways. The values were considered to represent the stock in 1976 and the average catch during the period was used as the 1976 catch. The 1977 landings were used as was the 1978 catch for Subareas 2+3 as reported by "FLASH". For 1979 (and 1978 in 0+1) the existing TAC was used. From 1980 to 1984 the projections were carried out using (a) the present TAC levels and (b) the TAC levels suggested by Borrmann (1978) and the general production parabola (this paper). Recruitment was considered to be constant in all cases and equal to the number of three year-olds as determined by Borrmann (1978).

RESULTS AND DISCUSSION

Subareas 0+1

Figures 1 and 2 are based on calculations using the general production model. The maximum sustainable yield is indicated at 8,000 metric tons with an effort of 6,000 hours for the standard used while the optimum effort (2/3f at MSY) is approximately 4,000 hours with a yield of 6,700 metric tons. The average f (weighted by catch) was 5,000 hours (between f at 2/3f at MSY and f at MSY) and the average catch (weighted by f) was 7,000 metric tons (from 1968 to 1977). These values fall slightly below the general production parabola.

Tables 1 and 2 show the calculated catches at $F_{0.1}$ based on Borrmann's (1978) data. The value of $F_{0.1}$ was assigned to ages 14 and over. At M = 0.10 the estimate is 48% lower than the TAC. This is reduced to 40% if compared to the TAC suggested by Borrmann (1978) and the general production parabola (approximately 6,700-7,000 metric tons) but is still quite low. At M = 0.2, the estimated catch is 1.5% higher than the present TAC. Because the stock estimates are considered to be minimum, these catch estimates may be considered low but it does appear that the fishery noticeably affected the stock although it remained in fairly good condition during the period covered by Borrmann's analysis.

Figures 3 and 4 show projected changes in F up to 1984 based on Borrmann's cohort analysis. For M = 0.10 the values of F are above $F_{0.1}$ for TAC levels of both 8,000 mt and 7,000 mt. For M = 0.20, F is greater than $F_{0.1}$ after 1980 for a TAC of 8,000 mt only. In both cases the F has a much more rapid rate of increase with time at a TAC of 8,000 mt.

Subareas 2+3

The general production model calculations are illustrated in Figures 5 and 6. A maximum sustainable yield of approximately 31,000 metric tons at an effort of 30,000 hours fishing for the standard used is indicated. The optimum effort (2/3f at MSY) is approximately 20,000 hours with a yield of 27,500 metric tons. The average effort (weighted by catch) from 1967 to 1977 (1971 excluded) was 16,125 hours (less than suggested at 2/3f at MSY) while the weighted catch was 23,475 metric tons. These averages fall on the general production parabola.

Tables 3 and 4 show the calculations based on the data of Borrmann (1978). Full recruitment was assumed at age 15+ and $F_{0.1}$ was assigned to these ages. At M = 0.10 the estimated catch was below the TAC by 29% while at M = 0.20 it was greater by 19%. The TAC levels suggested by the general production model and Borrmann (1978) (approximately 27,500 metric tons) shift these percents so that catch at M = 0.10 is within 10% of the TAC (still below) but considering that stock estimates are minimum it can be concluded that on the average the stock was healthy with no detrimental effects caused by the fishery during the time period examined.

Figures 7 and 8 illustrate the change in F with time. As with Subareas 0+1, fishing at the present TAC results in a much more rapid rate of increase in F than at the lower TAC. The levels are presently closer to $F_{0.1}$ however indicating that this stock is in better shape than that in 0+1.

CONCLUSIONS

Subareas 0+1

This stock appears to have been in fairly good condition during the period examined although the fishery was having an effect and the stock's condition may be deteriorating. Because the estimates of catch at M = 0.10 for $F_{0.1}$ are so far below the present TAC, because the point representing the average catch and effort for the time period examined falls below the general production parabola and because the general production model and Borrmann (1978) both indicate a best TAC of about 7,000 metric tons, it is suggested that the 1980 TAC be set no higher than the present level of 8,000 metric tons.

Estimates of stock size for grenadier have been considered to be minimum in the past. Data represented in Figures 3 and 4 indicate that for this stock to be in good condition, the estimate must be low by a considerable amount. Since to date there is no indication of the actual stock size and thus no indication of how much of an underestimate exists, it is important to maintain the stock at a safe holding level until more data become available. Since a TAC of 8,000 metric tons results in a rapid increase in F while a TAC of 7,000 metric tons would tend to level off the increase in F, it is strongly suggested that the 1980 TAC be set at 7,000 metric tons as suggested by Borrmann (1978) and the general production model. Since the average annual catch in the past has been 6,900 metric tons, a lowering of the TAC will not decrease the fishery but will only prevent any increase and the possible accompanying detrimental effects.

Subareas 2+3

The general production model indicates an optimum sustainable yield of 27,500 metric tons a level between $F_{0.1}$ levels of 26,100 metric tons at $M = 0.10$ and 30,700 metric tons at $M = 0.20$ as determined by Borrmann (1978).

Hypothetical catches at $F_{0.1}$ with M - 0.10 are below the present level of 35,000 metric tons but very close to the level of 27,500 metric tons. The stock therefore appears to have been in excellent shape during the period examined. The point representing average catch and effort falls on the general production parabola. Once again, these determinations are based upon past data and should not be projected into the future. Because actual stock size is unknown as discussed with Subarea 0+1 it may be fortuitous that the TAC is not being achieved. It is suggested that the 1980 TAC be no higher than the present level and because of the rates of change of F with time it is suggested that the TAC be lowered to 27,500 metric tons. As in Subareas 0+1, this lowering would not result in a decrease in the actual fishery.

General

Because of the well known problems of breakage and regeneration in the tails of roundnose grenadier, it is again suggested (see Jensen, 1976; Parsons 1978) that partial lengths (anal fin lengths) be recorded (as has been initiated in Canada) in place of total lengths. Because of the limited data base, the formula of Jensen (1976) should be used with extreme caution. Also, preliminary studies in Canada indicate a possible difference between males and females. Studies should be initiated to illucidate these problems and to derive by measurements to the nearest millimeter and in the future, anal fin measurements be taken to the nearest 0.5 cm.

REFERENCES

Borrmann, H. 1978. Stock assessment of roundnose grenadier in the Northwest Atlantic. ICNAF Res. Doc. 78/VI/54.

Jensen, J.M. 1976. Length measurement of roundnose grenadier (Macrourus rupestris) ICNAF Res. Doc. 76/VI/93.

Parsons, D.G., Veitch, P.J. and W.E. Legge. 1978. Some characteristics of the roundnose grenadier fisheries in ICNAF Subareas 0+1 and 2+3. ICNAF Res. Doc. 78/VI/74.

Shaefer, M.B., 1954. Some aspects of the dynamics of populations important to the management of the commercial marine fisheries. Bull. Inter-Amer Trop. Tuna Comm. 1:26-56.

Table 1. Roundnose grenadier in Subareas 0+1: stock size and catch at $F_{0.1}$ with M = 0.10.

RESULTS FOR YEAR 76

AGE	POPULATION NUMBERS ($x10^{-3}$)	POPULATION WEIGHTS (mt)	FISHING MORTALITY	CATCH NUMBERS ($x10^{-3}$)	CATCH WEIGHTS (mt)	RESIDUAL NUMBERS ($x10^{-3}$)	RESIDUAL WEIGHTS (mt)
3	58558.0	936.9	0.0004	22.3	0.4	52964.3	847.4
4	52963.0	1430.0	0.0006	30.2	0.8	47894.2	1293.1
5	47880.0	2011.0	0.0014	63.7	2.7	43263.0	1817.0
6	43233.0	2594.0	0.0020	82.2	4.9	39040.7	2342.4
7	39003.0	3198.2	0.0118	435.4	35.7	34877.4	2859.9
8	34677.0	3779.8	0.0152	497.9	54.3	30903.7	3368.5
9	30679.0	4295.1	0.0230	663.9	93.0	27128.3	3798.0
10	26830.0	4695.2	0.0382	957.2	167.5	23366.9	4089.2
11	22938.0	4931.7	0.0412	881.4	189.5	19917.4	4282.2
12	19520.0	5055.7	0.0630	1134.8	293.9	16584.0	4295.3
13	16084.0	4937.8	0.1272	1830.1	561.8	12815.1	3934.2
14	12045.0	4324.2	0.2000	2081.2	747.2	8923.2	3203.4
15	8094.0	3367.1	0.2000	1398.5	581.8	5996.2	2494.4
16	5529.0	2631.8	0.2000	955.3	454.7	4096.0	1949.7
17	3583.0	1934.8	0.2000	619.1	334.3	2654.4	1433.3
18	2240.0	1361.9	0.2000	387.0	235.3	1659.4	1008.9
19	1367.0	929.6	0.2000	236.2	160.6	1012.7	688.6
20	784.0	591.9	0.2000	135.5	102.3	580.8	438.5
21	435.0	361.9	0.2000	75.2	62.5	322.3	268.1
22	276.0	252.0	0.2000	47.7	43.5	204.5	186.7
23	130.0	129.6	0.2000	22.5	22.4	96.3	96.0
24	68.0	73.6	0.2000	11.7	12.7	50.4	54.6
25	24.0	28.1	0.2000	4.1	4.9	17.8	20.8
26	11.0	13.9	0.2000	1.9	2.4	8.1	10.3
27	7.0	9.5	0.2000	1.2	1.6	5.2	7.0
TOTAL	426958.	53875.		12576.	4171.	374382.	44788.

Table 2. Roundnose grenadier in Subareas 0+1: stock size and catch at $F_{0.1}$ with M = 0.20.

RESULTS FOR YEAR 76

AGE	POPULATION NUMBERS ($x10^{-3}$)	POPULATION WEIGHTS (mt)	FISHING MORTALITY	CATCH NUMBERS ($x10^{-3}$)	CATCH WEIGHTS (mt)	RESIDUAL NUMBERS ($x10^{-3}$)	RESIDUAL WEIGHTS (mt)
3	207890.0	3326.2	0.0003	56.5	0.9	170154.9	2722.5
4	170187.0	4595.0	0.0003	46.3	1.2	139295.5	3761.0
5	139298.0	5850.5	0.0012	151.4	6.4	113910.8	4784.3
6	113963.0	6837.8	0.0015	154.8	9.3	93165.2	5589.9
7	93196.0	7642.1	0.0108	907.5	74.4	75482.8	6189.6
8	75719.0	8253.4	0.0150	1022.0	111.4	61070.5	6656.7
9	61330.0	8586.2	0.0252	1383.9	193.7	48963.2	6854.8
10	49329.0	8632.6	0.0453	1981.6	346.8	38598.5	6754.7
11	39115.0	8409.7	0.0528	1824.9	392.4	30377.6	6531.2
12	30850.0	7990.1	0.0867	2325.4	602.3	23160.2	5998.5
13	23757.0	7293.4	0.1854	3655.1	1122.1	16159.0	4960.8
14	17065.0	6126.3	0.3000	4028.7	1446.3	10350.4	3715.8
15	11304.0	4702.5	0.3000	2668.7	1110.2	6856.2	2852.2
16	7548.0	3592.8	0.3000	1781.9	848.2	4578.1	2179.2
17	4829.0	2607.7	0.3000	1140.0	615.6	2928.9	1581.6
18	3000.0	1824.0	0.3000	708.2	430.6	1819.6	1106.3
19	1829.0	1243.7	0.3000	431.8	293.6	1109.3	754.4
20	1066.0	804.8	0.3000	251.7	190.0	646.6	488.2
21	612.0	509.2	0.3000	144.5	120.2	371.2	308.8
22	389.0	355.2	0.3000	91.8	83.8	235.9	215.4
23	205.0	204.4	0.3000	48.4	48.3	124.3	124.0
24	121.0	131.0	0.3000	28.6	30.9	73.4	79.5
25	63.0	73.8	0.3000	14.9	17.4	38.2	44.7
26	41.0	51.7	0.3000	9.7	12.2	24.9	31.4
27	31.0	42.0	0.3000	7.3	9.9	18.8	25.5
TOTAL	1052737.	99686.		24866.	8118.	839514.	74311.

Table 3. Roundnose grenadier in Subareas 2+3: stock size and catch at $F_{0.1}$ with M = 0.10.

RESULTS FOR YEAR 76

AGE	POPULATION NUMBERS (x10⁻³)	POPULATION WEIGHTS (mt)	FISHING MORTALITY	CATCH NUMBERS (x10⁻³)	CATCH WEIGHTS (mt)	RESIDUAL NUMBERS (x10⁻³)	RESIDUAL WEIGHTS (mt)
3	175255.0	8061.7	0.0003	50.0	2.3	158529.7	7292.4
4	158545.0	10781.1	0.0006	90.5	6.2	143371.4	9749.3
5	143396.0	13335.8	0.0006	81.9	7.6	129672.2	12059.5
6	129671.0	15949.5	0.0009	111.0	13.7	117225.6	14418.8
7	117224.0	18404.2	0.0030	334.2	52.5	105750.9	16602.9
8	105806.0	20632.2	0.0036	361.8	70.6	95393.2	18601.7
9	95432.0	22426.5	0.0099	894.7	210.3	85499.8	20092.5
10	85607.0	23884.4	0.0279	2242.0	625.5	75329.1	21016.8
11	75594.0	24568.0	0.0402	2835.5	921.5	65705.1	21354.2
12	66049.0	24636.3	0.0582	3555.4	1326.2	56384.6	21031.5
13	56405.0	23859.3	0.1167	5918.1	2503.4	45415.7	19210.8
14	46095.0	21895.1	0.1923	7686.1	3650.9	34412.0	16345.7
15	35252.0	18577.8	0.3000	8716.4	4593.5	23630.1	12453.1
16	24549.0	14263.0	0.3000	6070.0	3526.7	16455.7	9560.8
17	16838.0	10692.1	0.3000	4163.4	2643.7	11286.8	7167.1
18	10863.0	7484.6	0.3000	2686.0	1850.6	7281.7	5017.1
19	6416.0	4767.1	0.3000	1586.4	1178.7	4300.8	3195.5
20	4011.0	3200.8	0.3000	991.8	791.4	2688.7	2145.5
21	2164.0	1843.7	0.3000	535.1	455.9	1450.6	1235.9
22	998.0	903.2	0.3000	246.8	223.3	669.0	605.4
23	242.0	231.8	0.3000	59.8	57.3	162.2	155.4
24	104.0	105.0	0.3000	25.7	26.0	69.7	70.4
25	14.0	14.9	0.3000	3.5	3.7	9.4	10.0
TOTAL	1356530.	290518.		49246.	24741.	1180694.	239392.

Table 4. Roundnose grenadier in Subareas 2+3: stock size and catch at $F_{0.1}$ with M = 0.20.

RESULTS FOR YEAR 76

AGE	POPULATION NUMBERS (x10⁻³)	POPULATION WEIGHTS (mt)	FISHING MORTALITY	CATCH NUMBERS (x10⁻³)	CATCH WEIGHTS (mt)	RESIDUAL NUMBERS (x10⁻³)	RESIDUAL WEIGHTS (mt)
3	698448.0	32128.6	0.0	0.0	0.0	571840.9	26304.7
4	571815.0	38883.4	0.0004	207.3	14.1	467975.3	31822.3
5	468109.0	43534.1	0.0004	169.7	15.8	383102.0	35628.5
6	383184.0	47131.6	0.0004	138.9	17.1	313599.1	38572.7
7	313626.0	49239.3	0.0020	568.0	89.2	256262.2	40233.2
8	256529.0	50023.2	0.0028	650.1	126.8	209440.9	40841.0
9	209741.0	49289.1	0.0084	1590.4	373.7	170285.0	40017.0
10	171016.0	47713.5	0.0264	4040.2	1127.2	136368.0	38046.7
11	138243.0	44929.0	0.0416	5108.9	1660.4	108571.9	35285.9
12	110949.0	41384.0	0.0744	7218.9	2692.7	84324.3	31453.0
13	87645.0	37073.8	0.1412	10485.2	4435.2	62308.3	26356.4
14	67057.0	31852.1	0.2480	13404.2	6367.0	42843.0	20350.4
15	48762.0	25697.6	0.4000	14667.2	7729.6	26761.2	14103.1
16	32933.0	19134.1	0.4000	9906.0	5755.4	18074.0	10501.0
17	21851.0	13875.4	0.4000	6572.6	4173.6	11992.1	7615.0
18	13731.0	9460.7	0.4000	4130.2	2845.7	7535.7	5192.1
19	7995.0	5940.3	0.4000	2404.8	1786.8	4387.7	3260.1
20	4839.0	3861.5	0.4000	1455.5	1161.5	2655.7	2119.2
21	2568.0	2187.9	0.4000	772.4	658.1	1409.3	1200.8
22	1189.0	1076.0	0.4000	357.6	323.7	652.5	590.5
23	345.0	330.5	0.4000	103.8	99.4	189.3	181.4
24	173.0	174.7	0.4000	52.0	52.6	94.9	95.9
25	66.0	70.0	0.4000	19.9	21.1	36.2	38.4
TOTAL	3610814.	594990.		84024.	41527.	2880710.	449809.

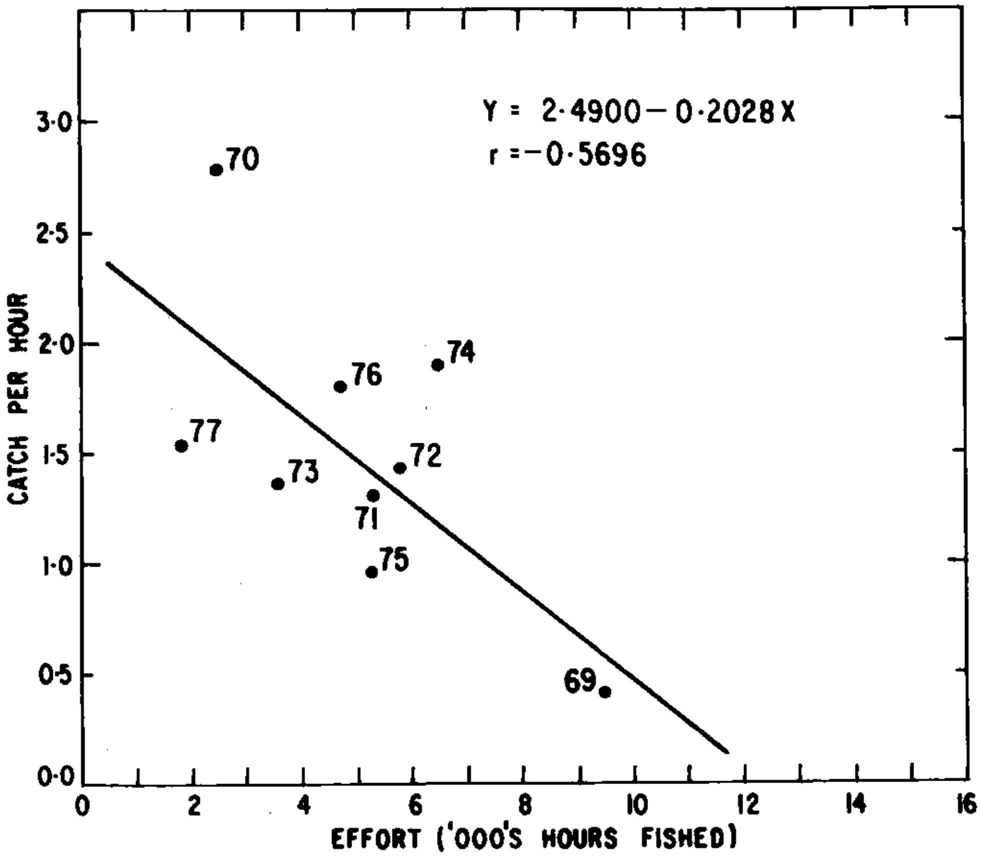

Fig. 1. Regression of CPUE against f - Subareas 0+1

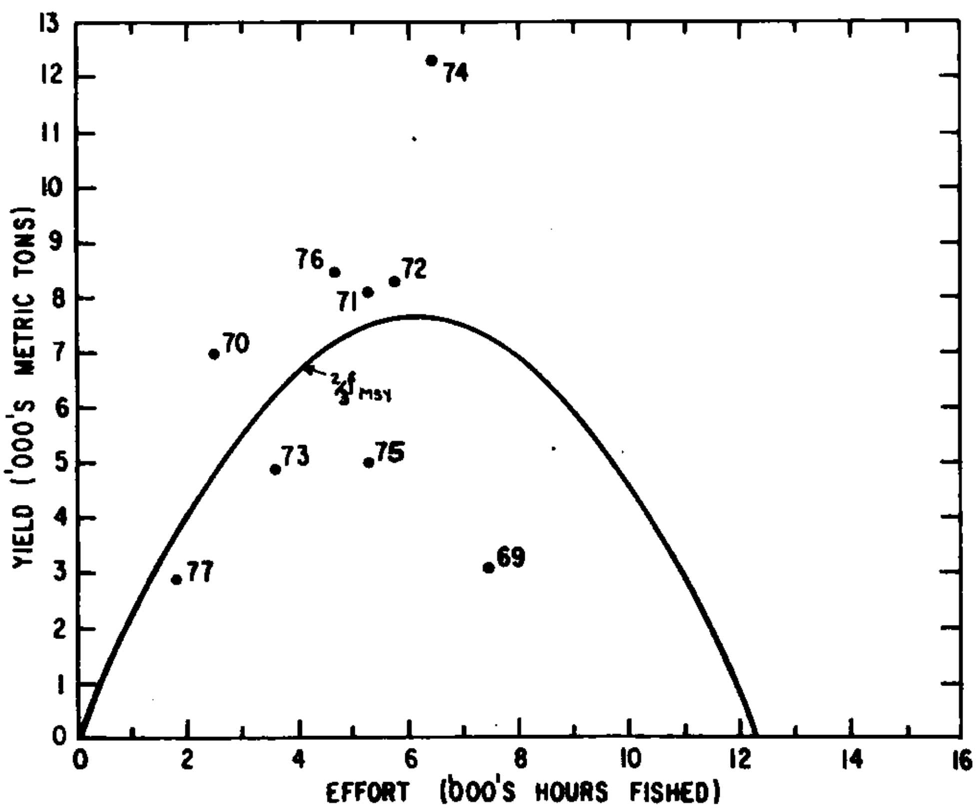

Fig. 2. General Production Parabola - Subareas 0+1

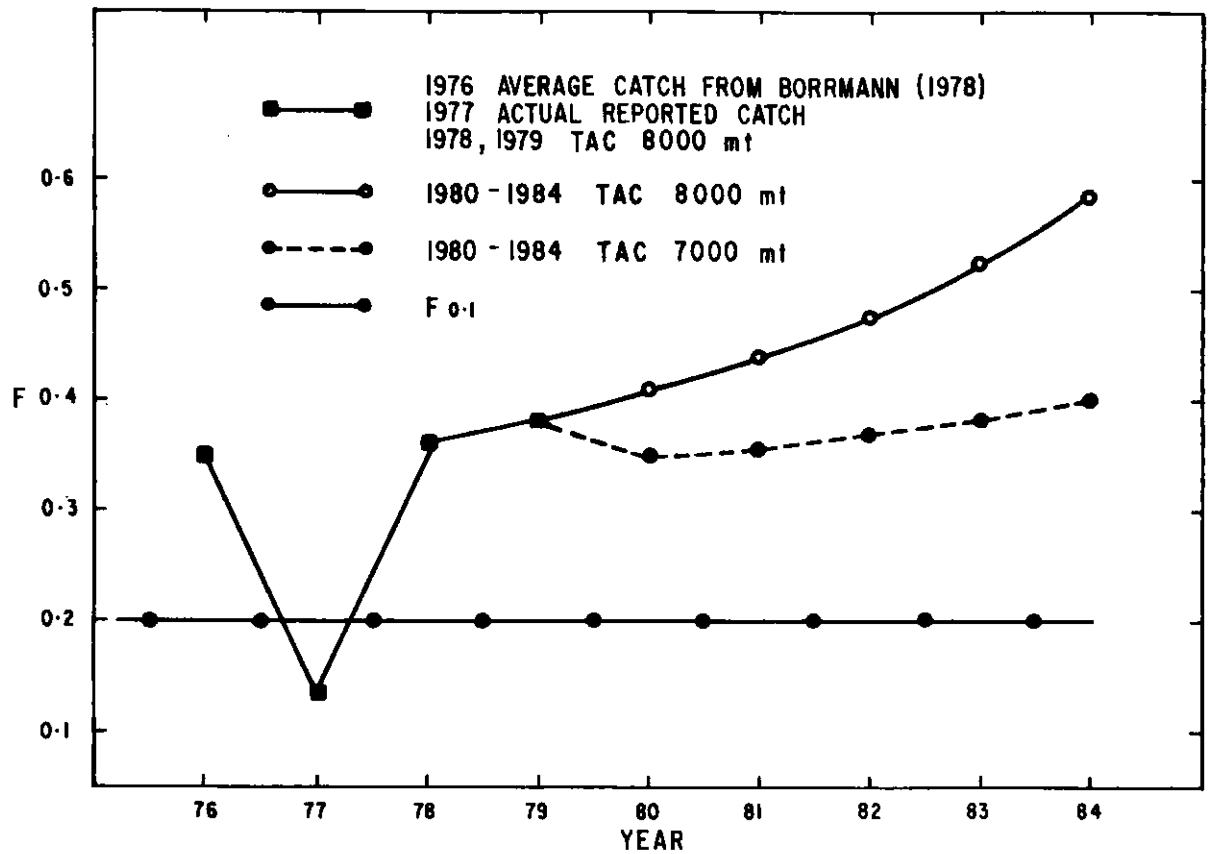

Fig. 3. Changes in F with changed TAC's - Subareas 0+1 M=0.10 assumed constant recruitment of 58,558 X 10^3

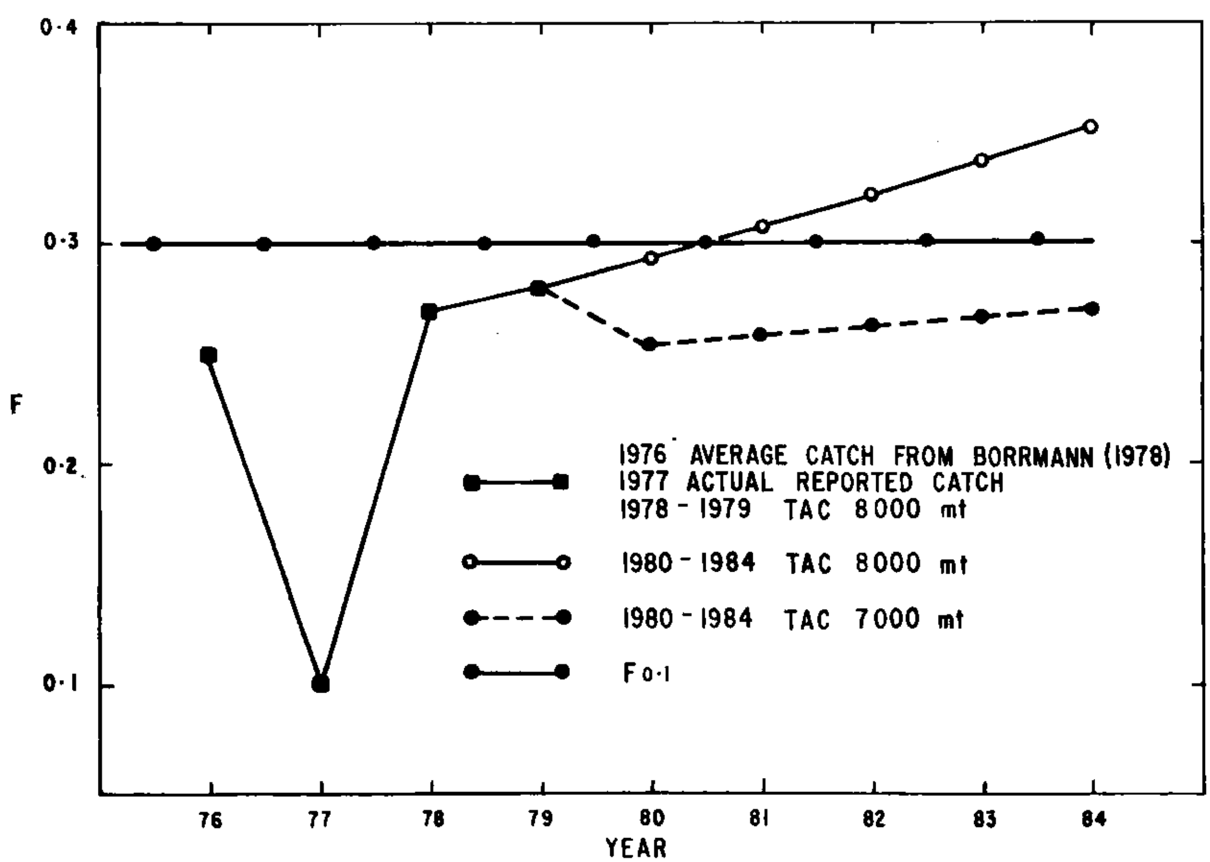

Fig. 4. Changes in F with changed TAC - Subareas 0+1 M=0.20 assumed constant recruitment of 207,890 X 10^3

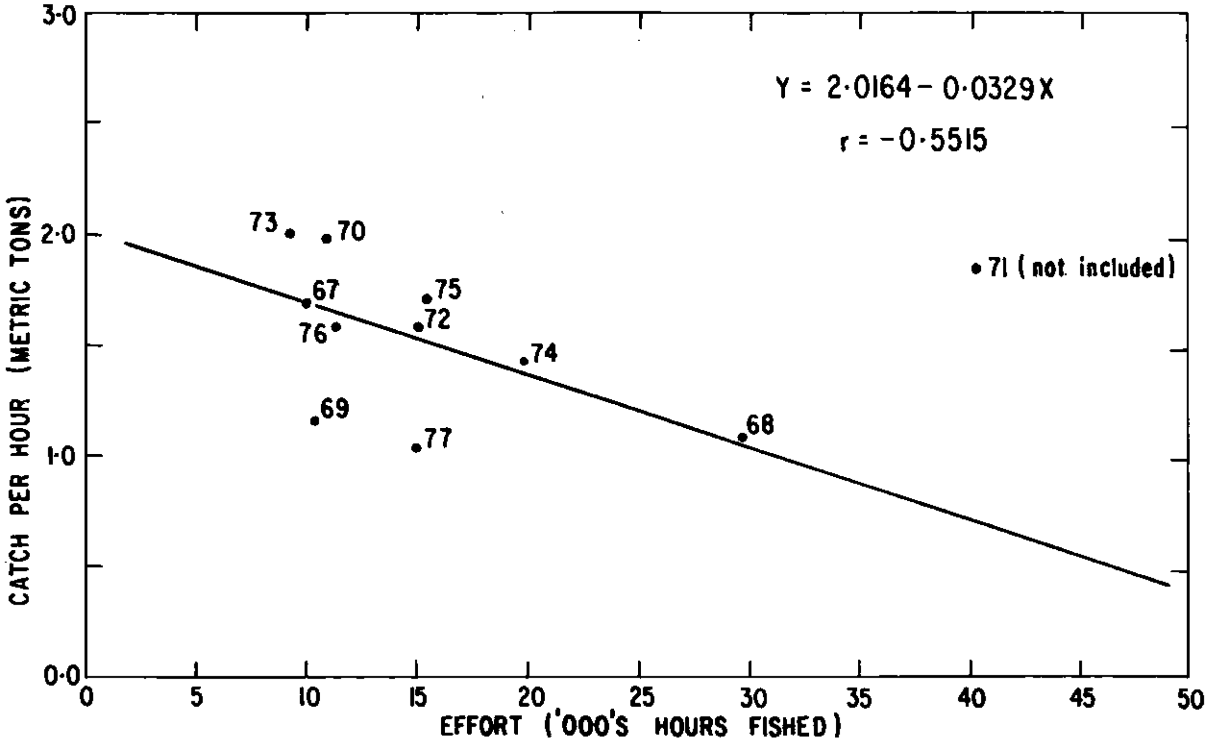

Fig. 5. Regression of CPUE against f - Subareas 2+3

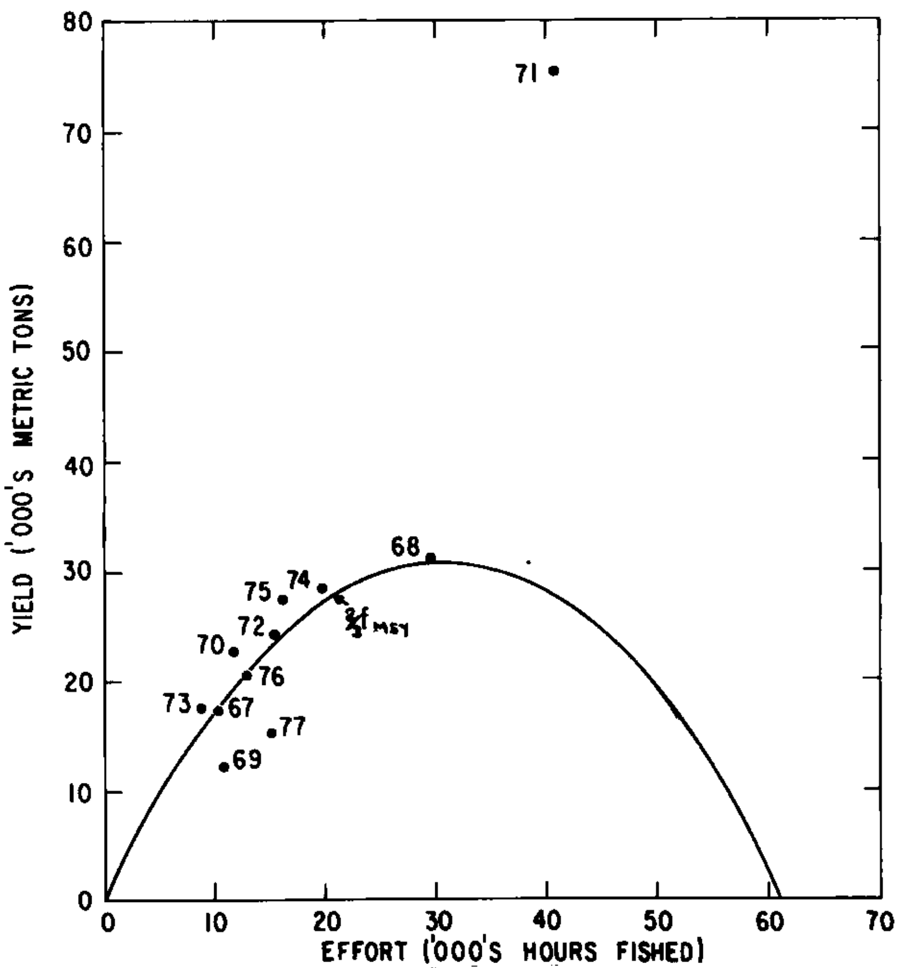

Fig. 6. General Production Parabola - Subareas 2+3

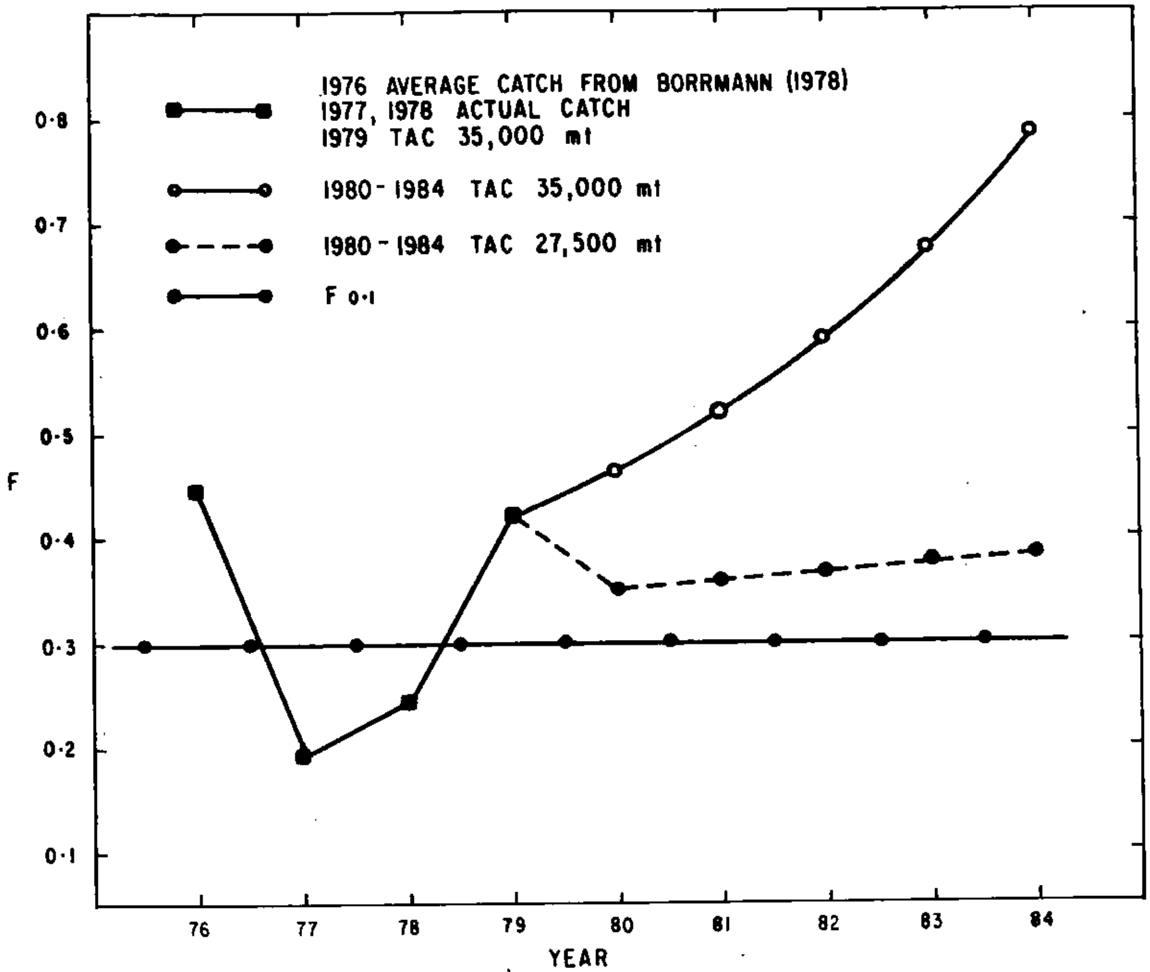

Fig. 7. Changes in F with changed TAC - Subareas 2+3 M=0.10
assumed constant recruitment of 175,255 X 10^3

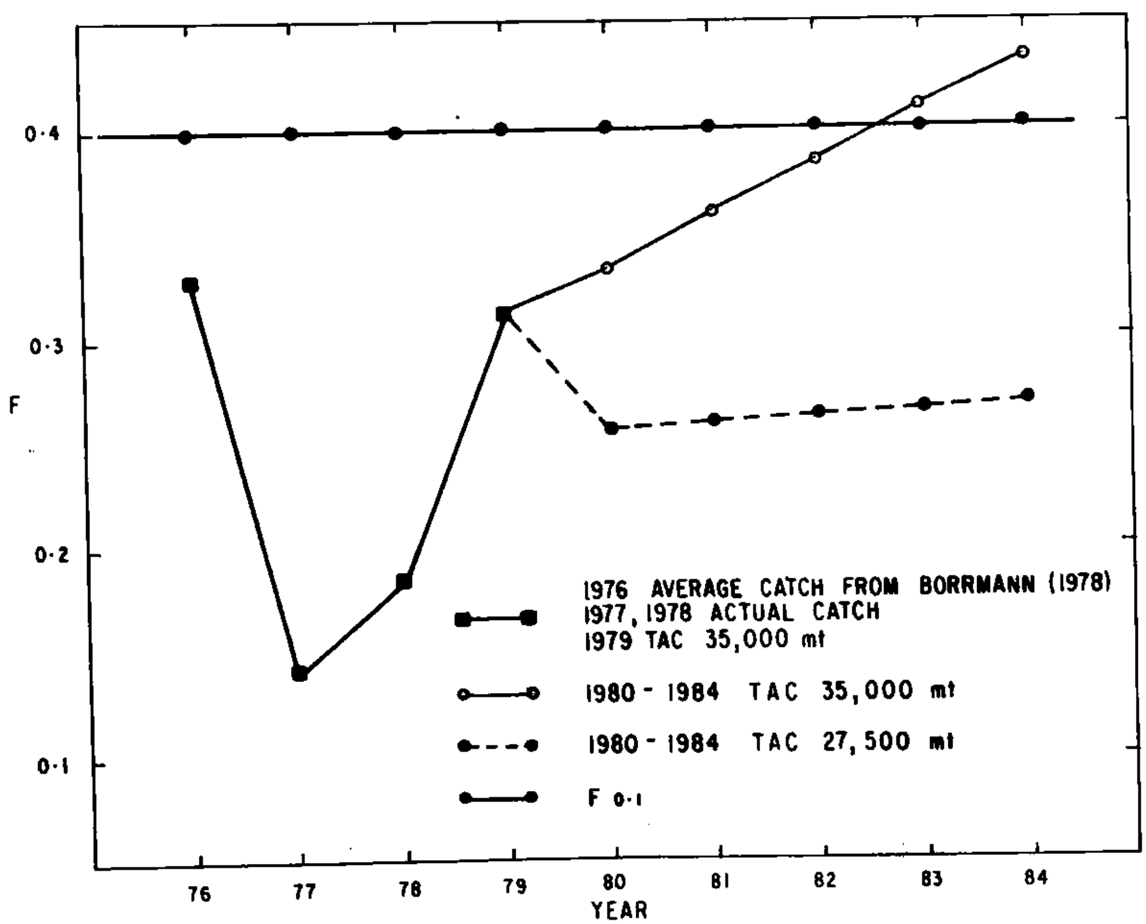

Fig. 8. Changes in F with changed TAC - Subareas 2+3 M=0.20
(assumed constant recruitment of 698,448 X 10^3)